The Prehistory of Jordan, II.
Perspectives from 1997

edited by

Hans Georg K. Gebel,
Zeidan Kafafi,
and
Gary O. Rollefson

Studies in Early Near Eastern
Production, Subsistence, and Environment 4

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* refers (mainly) to pre-Chalcolithic periods

Preface

by

H.R.H. Crown Prince El Hassan bin Talal

This comprehensive, scholarly and detailed study of the prehistory of Jordan comes at a most auspicious time. As more research centers are opened in Jordan, and more aspects of the country's rich heritage are discovered and analyzed, we find ourselves at the threshold of an exciting era of comparative, cross-disciplinary investigation of Jordan's past. For perhaps the first time in the country's history, the process of academic cross-fertilization is becoming a viable reality: students of archaeology, architecture, geology, history, agriculture, biotechnology, and art are partaking from one other, and combining their various specialties into a unified field, that of *Jordanian studies*.

This publication, *The Prehistory of Jordan*, II. *Perspectives from 1997*, continues this trend by showing that the prehistory of Jordan was subject to the very same constraints and incentives that characterized, and persists in characterizing, the country's development across time. Indeed, if geography is destiny, prehistoric artefacts, faunal remains and land use across the millennia are evidence of developments that far preceded the age of written history. For instance, whereas the interdependence between "the desert and the sown" has only recently been given scholarly credence, the meticulous investigations that went into this book show that even in prehistoric times, relations between nomads and settled peoples were a normal feature of the ordinary Jordanian's daily context. So too were the features of adaptation and innovation. Long seen as belonging purely to the modern industrial age, the flexibility and ingenuity characterizing prehistoric civilizations were essential elements in their expansion.

While there is a danger in pursuing historic parallels too far, this book even details the migration to the area now recognized as Jordan of thousands of "refugees" from Jericho several thousand years ago, who fled because of the over-exhaustion of their lands and other natural catastrophes. Examples such as these are but confirmation of the fact that no matter how we divide and subdivide eras of historical times, history itself is a continuum and repetition its key. The hope is that, as further excavations of our buried civilizations add to the historical record in much the same way that this book has, we will learn from our ancestors and no longer find it necessary to once again reinvent the wheel.

I wish to express my gratitude to the editors and contributors for their magnificent work and wish them every good fortune in their future endeavours.

H.G.K. GEBEL, Z. KAFAFI, and G.O. ROLLEFSON (eds.), *The Prehistory of Jordan,* II. *Perspectives from 1997.* Studies in Early Near Eastern Production, Subsistence, and Environment 4 (1997). Berlin, *ex oriente.*

Editors' Foreword

Hans Georg K. Gebel, Zeidan Kafafi, and Gary O. Rollefson

On the Need to Develop Jordanian Prehistoric Research

Jordan lies at the crossroads of Africa, Asia, and Europe. As exchange networks shifted throughout the ages along land bridges across the Red Sea to the caravan routes through inner Arabia and the Badiya, Jordanian regions served as corridors in prehistoric and historic times for migrations and the modification of technological innovation and changing subsistence modes. The extremely rich, diversified, but sensitive variety of environments from the Rift Valley to the eastern desert provided many possibilities for adaptations, but not necessarily unlimited growth. Paleolithic research has revealed Jordan's major involvement in the spread of early hominid expansion, and its later prehistory is rich with hypertrophic events emerging from developments in neighbouring regions that were environmentally more favourable and thus more stable. Long distance routes through the Rift and along the desert fringes allowed intrusive elements to pass through rapidly, and the areas in between had variable options: to reject these elements totally, to selectively modify them for local use, or to assimilate them relatively unchanged where they fit into the indigenous system.

Geographical regions that embrace a wide spectrum of biological zones, and particularly those areas that occur in fragile climatological circumstances, provide varied exploitation patterns that can change relatively rapidly and even dramatically. More than the "stable" regions, environmentally unstable areas offer insights into the complex nature of the progressive and reciprocal aspects of human development, including the unsuccessful paths of human evolution less traceable elsewhere. Thus, Jordan is an ideal study area, and it is more than understandable that an increasing number of scholars have become involved, underscoring the need to refine prehistoric research in country.

Another reason to amplify Jordan's prehistory lies in thoughts expressed below under the "Desert - Sown Tensions": given the specific nature of the Jordanian countryside, it is necessary to develop specific approaches to identify possible independent interaction spheres, techno-taxa, and chronologies. Once that has been accomplished, we can look for comparable elements west and east of Jordan.

Jordanian prehistory provides very early evidence of modern problems; it contributes to the patterns of repetition and continuity inherent to historic and modern mechanisms (*cf. e.g.* the preface of H.R.H. Crown Prince Hassan). To obtain insights into today's environmental problems and threats based on our prehistoric research, we must be able to convert our results into something meaningful for the public, which generates additional stimulus to improve our field of research.

On Research Development and the Current Situation

Occasional publications on prehistoric "Transjordan" began to appear in the late 1920s, resulting mostly from exotic forays into the hinterland by scholars working in Palestine. It was not until the 1960s and 1970s that we can speak of an emerging interest by prehistorians in Jordan itself. (For a comprehensive bibliography of early prehistoric investigations *cf.* HOMES-FREDERICQ and HENNESSY 1986). Colleagues such as de Contenson, Copeland and Hours, Kirkbride, Mellaart, and others laid the foundations for a rapidly growing Jordanian prehistory in its own right, leading through the 1970s into the increasingly intensive work of the 1980s and 1990s. Driving this development were the fascinating questions on human development formulated by the Azraq, Ras en-Naqb and 'Ain Ghazal projects, attracting many others to follow. To assess the status reached by prehistoric research in Jordan, a workshop was organized in 1986 by A.N. Garrard and H.G. Gebel in Tübingen (following the *3rd International Conference on the History and Archaeology of Jordan*; *cf.* GARRARD and GEBEL 1988) that aimed to advance, among other goals, comprehensive approaches to shared and identified problems in prehistory. Today the prehistory community of Jordan is larger than ever (*cf.* the "Blue List" recently published in *Neo-Lithics* 2/97). It is one of the most promising achievements in this development that the share of Jordanians among these scholars has constantly grown, a process that was promoted by the "relative stability" (GARRARD and GEBEL 1988: 1) in this threatened region. We are approaching the new millennium full of questions and perspectives for our field for which we have continued to lay good foundations during the 1990s, but beyond this we may sense that no one outside of our research field is interested in our insights into man's repeated mistakes since prehistoric times. Public awareness of the meaning of our work is an essential goal and responsibility of all of us archaeologists, despite the associated frustrations and the more comfortable escape routes of data massaging and production of speculation.

The prehistory of Jordan has become the most progressively developing field in prehistoric Near Eastern research, a growth unmatched in other areas of the Near and Middle East. Only a few years ago this heightened research remained at a stage that, at the utmost, presented collected and excavated materials in a synthesis framework, represented by *The Prehistory of Jordan I* . The constant thematic directions of the *International Conferences on the History and Archaeology of Jordan*, organized by the Department of Antiquities in cooperation with other institutions, together with many specialized workshops, have helped tremendously to begin a new era of prehistoric work in Jordan, one that involves an increasing number of interdisciplinary projects and that is gradually establishing an improved level of archaeological research already running smoothly in other countries. In addition, interpretative levels have now been reached in many fields, such as socioeconomic, demographic, or environmental approaches, that had only been weakly realized before. This is made abundantly clear by comparing the contents *The Prehistory of Jordan I* and *II*.

On Desert - Sown Tensions, or Rethinking Approaches

Although the rapid pace of prehistoric research in Jordan, Palestine, and Israel is impressive, it has created a somewhat unbalanced research situation for the prehistoric Near East as a whole. The results generally offer little beyond local insights, reflecting only their share of a complex polycentric and interdependent process of Near Eastern prehistoric developments. Prehistoric research must be attuned to the potentials of the *terrae incognitae* awaiting scholars outside the southern Levantine / Jordanian interaction spheres. It is not at all unfounded to ask emphatically if the arid fringes of the Fertile Crescent were not *the* major corridors of exchange and stability, and it is not justifiable to consider these desert zones as merely marginal to research that treats questions dealing with the semi-arid and Mediterranean zones. And while Jordan and the rest of the southern Levant were centers of prehistoric activity, it must be stressed that this does not make these countries the core of prehistoric developments. We should point out the clear danger that research outside the southern Levant is often measured by southern Levantine standards, and this hinders the efforts of many years of research to identify nearby regional traditions.

Jordan's Pleistocene and Early Holocene environments permitted only certain human adaptations, influenced by their specific environmental conditions. These habitats and habitat mosaics provoked developments specific to these conditions, and if such evolution reflected similar patterns outside Jordan, it is only if identical conditions existed elsewhere. The many narrow N-S running ecozones in Jordan represent a densely packed array of different physiographical and ecological units from west to east. In them we can anticipate very specific and regionally diversified human behaviours, highly flexible to self-made or outside impacts, and witnessing less uniform entities than in the larger ecologically homogenous regions to the west and north. The vast hinterlands of the Arabian Plateau to the east served as a conservative regulator for the more dynamic adaptations in the more varied zones elsewhere. Following the pioneer work of A.N. Garrard and A.V.G. Betts in the desert regions, the desert - sown dimension is essential for understanding Jordan's prehistory, and it leads us to emphasize that expanded arid zone prehistoric research is a must for the future.

A special aspect of the desert - sown aspect is the evidence of an adventurous experiment undertaken in the Jordanian highlands, the phenomenon of Neolithic megasites in the late 7th millennium bc. Some colleagues see startling similarities with the later urban developments in the Near East. Whether the Early Neolithic evolvement was a false start into the rise of cities or was a unique feature on its own, the growth of large permanent settlements at the edge of the steppe illustrates well the dramatic role the arid hinterlands could play, thus underlining our demand of rethinking the cooperative and confrontational potentials between the "desert and the sown". Two elementary different developments arose in Near Eastern prehistory, one that led to stratified social organization and another that remained more egailtarian. The demands and needs of settled farmers (and later city dwellers) in apposition to the freedom and contributions of pastoral nomads of the steppe and desert split socioeconomic patterns in the area right from the beginning of food production, a logical consequence that remains even characteristic today of those Near Eastern areas not strongly influenced by industrialization.

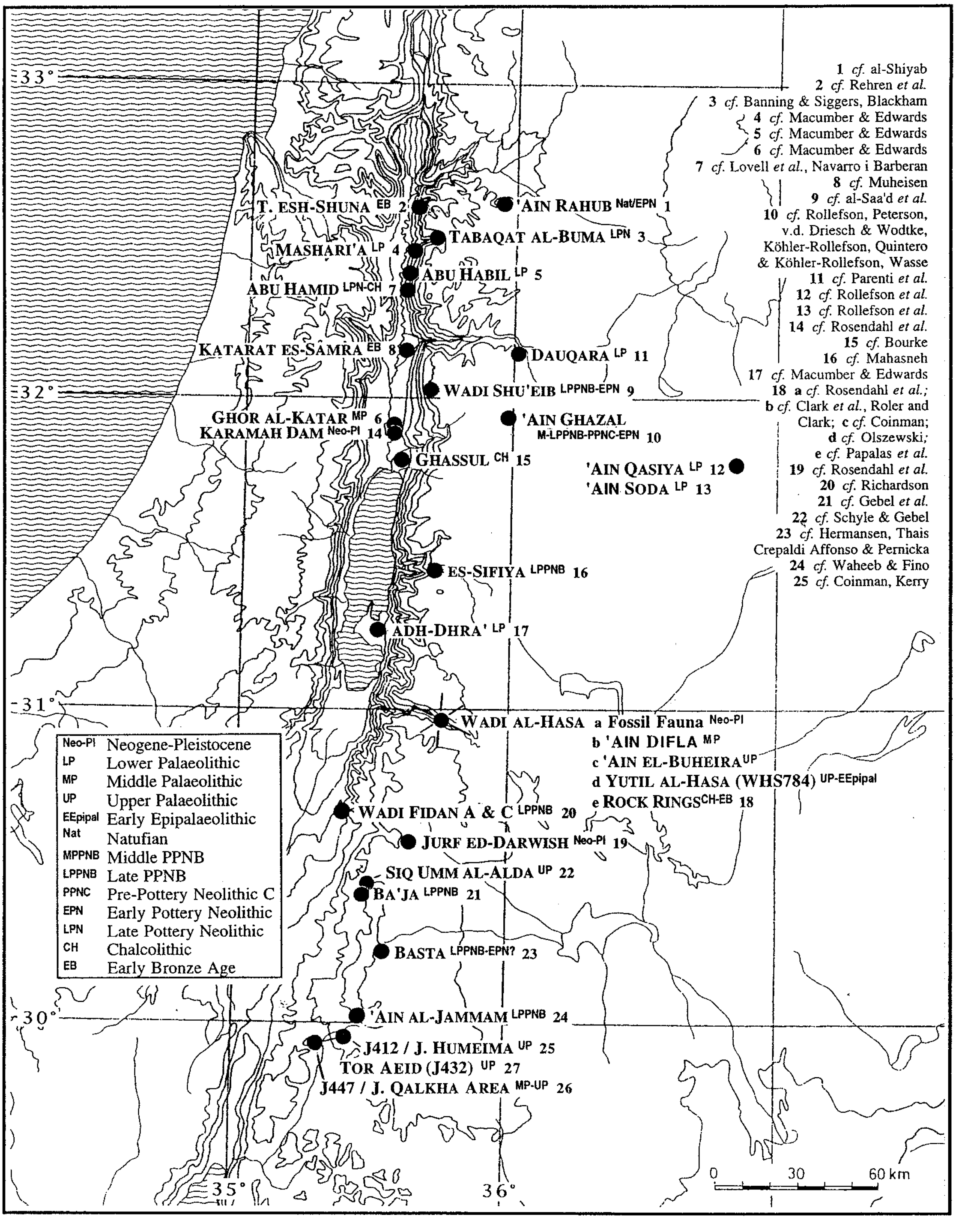

Fig. 1. Sites and survey areas presented in this publication (with reference to contributions).

On this Publication

We did not want this publication to present a new summary of research and approaches, as did *The Prehistory of Jordan I* provided in 1988 (GARRARD and GEBEL 1988), for this aim is being covered by two parallel publications currently in preparation (ADAMS, BIENKOWSKI and MACDONALD n.d.; HENRY 1998). We felt that at the brink of a new century of prehistoric research in Jordan, *insh'allah,* we should promote consideration of future advancement and goals. Thus it was deemed most appropriate to assemble a commendable mixture of essays and overviews, site reports and special studies that showed the whole range of currently applied methods and techniques under discussion on the one hand, but on the other also exhibited where new approaches and techniques had to be adopted in order to improve our understanding over the next generation of research.

The "perspectives" contributions (Copeland, Baird, Kerner, Neef, Köhler-Rollefson, al-Saa'd) have been placed at the end of each section of this book (on the Paleolithic, Neolithic, Chalcolithic, Archaeobiology, Archaeometry); they are not intended to summarize and introduce the contributions in the section, but rather to explain the recent research developments in their fields by referring to them and other recent publications in order to point out questions ignored or left open, crucial research progress, future needs of field and laboratory research, etc. The editors encouraged these colleagues to make their arguments as strong and provocative as necessary to make their points. In such a rapidly growing research environment, the premises, methods and aims must be constantly and critically re-evaluated to cope with this rising wealth of sites, information, and speculation.

The editors would like to emphasize that it was an arbitrary decision, of course, to "end" prehistory in this publication with the Chalcolithic. This is by no means justified in any archaeological respect, just as it was not appropriate for *The Prehistory of Jordan I* to have excluded the Chalcolithic. Nevertheless, considering the mass of material collected for the present volume, expanding the temporal/cultural scope to include the richness of the Early Bronze Age would have made editing too unwieldy a proposition.

We would like to thank all who contribute to prehistoric research in Jordan. The most immediate and persistent support in this respect has come from the Department of Antiquities in Amman, despite the fact that we prehistorians are in perpetual competition with the more impressive and tourist-attracting classical sites. Our deep thanks[1] also go to the contributors to this volume, not only for providing the results of their work, but also for their forbearance with the editors. This book is the result of patience and effort, the most rewarding attitudes in evaluating perspectives hidden in the soils of the Jordanian landscape.

Hans Georg K. Gebel
Zeidan Kafafi
Gary O. Rollefson

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1 We also thank Bernd Müller-Neuhof, Berlin for some of the formatting work of this volume.

H.G.K. GEBEL, Z. KAFAFI, and G.O. ROLLEFSON (eds.), *The Prehistory of Jordan, II. Perspectives from 1997*. Studies in Early Near Eastern Production, Subsistence, and Environment 4 (1997). Berlin, *ex oriente*.

Early Acheulean Stone Tools and Fossil Faunas From the Dauqara Formation, Upper Zarqa Valley, Jordanian Plateau

Fabio Parenti, Abdel Halim Al-Shiyab, Ernesto Santucci, Zeidan Kafafi, and Gaetano Palumbo
with an appendix by Claude Guérin

Abstract: *We present the results of a joint Italo-Jordanian mission in the upper Zarqa Valley in the Jordanian plateau. The chronostratigraphic sequence, formerly proposed, has been confirmed. It has three inset terraces comprised between at least the Middle Pleistocene and the Holocene. The uppermost one is a pediment composed of the Dauqara Complex, a mixed alluvial-colluvial formation. The middle terrace embraces both the Bire (upper Acheulean) and the Khirbet-Samra formation (Mousterian). The lowermost terrace is of Holocene age. This paper especially deals with 19 sections in the Dauqara Formation. One of these sections, near the village of Sukhne, yielded mammalian fossilized faunas and a rich flake industry. Identified teeth pertain to* Mammuthus meridionalis, Equus *cf.* tabeti *and* Bos primigenius. *The fauna is comparable with the one found at the Israeli site of 'Ubeidiya, dated at 1.4 my, but slightly more evolved. The 243 artifacts from the whole formation are quite peculiar in the context of Levantine Acheulean: there are no handaxes nor spheroids; there is just one chopper and a majority of globular cores. The debitage is composed of heavy flakes with cortical or plain butts, with rare centripetal flake-scars. All of the characteristics of the site allow a preliminary chronology at the beginning of biozone 20 between 0.9 and 1 my. A comparison is proposed with the most important sites of the Lower and Middle Acheulean in the Levant.*

Résumé: *On présente les résultats des nouvelles recherches de la mission conjointe italo-jordanienne dans la haute vallée du Zarqa, plateau Jordanien. La séquence proposée précédemment a été confirmée. Elle comprend trois terrasses emboitées allant au moins du Pléistocène moyen jusqu'à l'Holocène. La terrasse supérieure est un glacis constitué par la formation Dauqara, d'origine mixte colluvio-alluviale. La moyenne terrasse comprend les formations Biré (Achéuléen supérieur) et Khirbet-Samra (Moustérien). La terrasse inférieure est d'âge Holocène. L'article discute 19 coupes dans la formation Dauqara. Une en particulier, proche du village de Sukhne, a livré des restes de mammifères fossiles et une riche industrie sur éclats. Les dents identifées appartiennent à* Mammuthus meridionalis, Equus *cf.* tabeti *et* Bos primigenius. *La faune est proche de celle du gisement israelien de Oubeidiyéh, daté de 1,4 millions d'années, quoique plus évoluée. Les 248 pièces lithiques, provenant de l'ensemble de la formation, sont assez particulières dans le contexte de l'Acheuléen du Proche Orient: Il n'y a aucun biface ni sphéroide; un seul chopper est présent, avec une majorité de nucléi à debitage non prédéterminé. La plupart des pièces sont des éclats assez massifs, à talons naturels ou lisses, à rares enlèvements centripètes. L'ensemble des caractères suggère une attribution chronologique préliminaire se plaçant au début de la biozone 20, soit à un âge compris entre 0,9 et 1 million d'années. Une comparaison est faite avec les principaux gisements de l'Acheuléen inférieur et moyen du Levant.*

Introduction

The Palaeolithic archaeology of the Levantine Rift is one of the key areas for the study of the spread and adaptation of the genus *Homo* outside Africa. The presence of *Homo erectus* in the Levant is dated at 1.4 million years at the fluvio-lacustrine site of 'Ubeidiya in the Jordan valley, which can be referred - in biostratigraphic terms - to the biozone 19 or Upper Villafranchian age (TCHERNOV and

GUÉRIN 1986). Lithic industries in this site show an evolved Oldowan or lower Acheulean character (BAR-YOSEF and GOREN-INBAR 1993, GUÉRIN *et al.* 1993a). Other Levantine sites in different stratigraphic contexts have also been assigned to the Early Acheulean: Borj Kinnarit and Sitt Markho in Lebanon (HOURS and SANLAVILLE 1972, SANLAVILLE 1979), Kefar Menahem in Israel (BAR-YOSEF 1994), Khattab in Syria (COPELAND and HOURS 1993). In Jordan the assemblage of Abu Habil (HUCKRIEDE 1966) was formerly assigned to the Oldowan and the nearby site of Abu el-Khas has been correlated to it (VILLIERS 1980, 1983). Recent reappraisals of the East bank stratigraphy refute such an early date (WALMSEY *et al.* 1993). Middle Acheulean sites have been reported in Tabaqat Fahl formation, near Pella (MACUMBER 1992, WALMSLEY *et al.* 1993, WRIGHT 1993) and in the upper Zarqa Valley. The latter area is the subjet of this report. The Late Acheulean technocomplex is ubiquitous and well known all over the southern Levant. For the sake of brevity, the main problems of early prehistory in Jordan could be synthesized as: 1) the lack of absolute dates for the Lower and Middle Pleistocene; 2) the absence of fossilized mammalian faunas prior to the Upper Pleistocene; 3) the uncertainty about the first peopling of the eastern side of the Jordan Rift.

In this paper we report on the results of new research in the upper Zarqa Valley, focusing on the problem of the oldest peopling of the area in the context of the Early and Middle Acheulean of the Levant.

The Region and the Dauqara Formation

History of Research

The first systematic work inthe Zarqa-Dhulhayil Valleys was conducted by a French team of the University of Lyon (BESANÇON *et al.* 1984, BAUBRON *et al.* 1985, BESANÇON and HOURS 1985, BESANÇON *et al.* 1992, COPELAND and HOURS 1988). The important and useful results of the two fieldwork seasons (1980, 1981) allowed the recognition of at least three Pleistocenic artifact-bearing terraces, along with the absolute dating of the Pliocene basalt flows.

Since 1993 an Italo-Jordanian archaeological project has been carried out in the area[1]. The aim of the project is to reconstruct the cultural landscapes during different periods and episodes of human occupation, from early prehistory to modern times.

During the 1993 field campaign, prehistoric research in the area was limited to the identification of the sites discovered by Besançon and his colleagues and to a general diachronic outline of prehistoric settlement based on a number of sites located on the surface by our survey team. The sites ranged in date from the Late Acheulean to Neolithic, but other research priorities during this first campaign did not allow a more careful study of the industries found, nor a general geo-archaeological survey. One of the priorities of the 1996 campaign (the second field season) was to confirm the sequence proposed by Besançon and his team and to investigate the uppermost formations for the presence of artifacts and palaeontological remains. This optimistic objective was supported by observing the intensive agricultural activities and infrastructure development of this area, which included extensive bulldozing and terracing of wadi banks, especially in the vicinity of the village of Sukhne where the most consistent outcrops of the Dauqara Formation were to be found. The relative chronology proposed by Besançon and his colleagues, along with their reported field observations, had maximum value for our survey. Not only has their scheme been fully confirmed, but this previous comparative knowledge of the industries has oriented our analysis towards an extra-regional perspective.

The Region

The East bank of the Jordan River is cut by several wadis running westward from the central Jordan ridge. The Wadi Zarqa basin drains the western border of the Jordanian plateau, running northward from the city of Amman to the Zarqa-Dhulayil confluence and westward from the latter to the Jordan Valley (Fig. 1).

The present climate in the region is arid, with an average annual rainfall of 166mm (1950-1980). The original steppic vegetation has been destroyed by overgrazing and extensive use of tractors in the river banks. In the southwestern portion the landscape is dominated by rounded hills of Upper Cretaceous limestone (maximum elevation 880m) steeply dissected by the river. On the north-east, in the Dhulayil sector downstream of El-Hashimiya, several Pliocene basalt outcrops with a flat-topped morphology overly the base of limestone hills.

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[1] The project is co-sponsored by the Universities of Rome and Yarmouk (Irbid), and it is directed by Zeidan Kafafi, Gaetano Palumbo, and Paolo Matthiae.

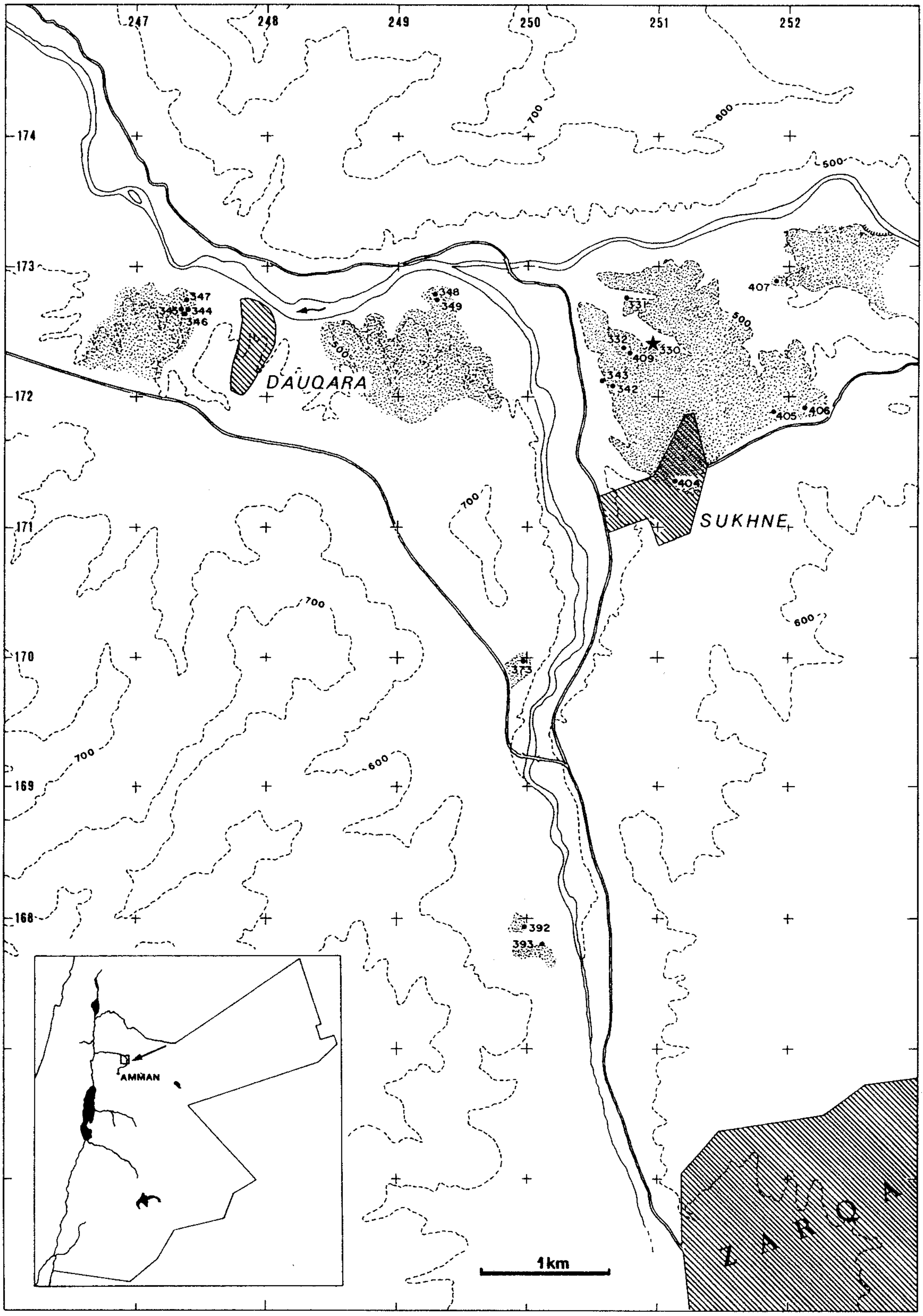

Fig. 1. The Zarqa-Dulhail Valley <*outcrops of Dauqara Formation dotted*>.

The basalts provided the only radiometric datings available in the region (BAUBRON *et al.* 1985). They span between 7 and 2.3my. The last basalt flow (B4) is clearly visible in the Dhulayil Valley at the bottom of upper Pliocene and Pleistocene alluvial sequence.

Three main Quaternary inset terraces have been defined in the valley. The uppermost (40-60m above river level) is a mixed pediment-alluvial unit, essentially composed by the Dauqara Formation with limestone slabs and alluvial pebbles. From Baubron *et al.* (1985), it is possible that the Dauqara Complex embraces several alluvial and colluvial units, spanning from Final Pliocene to Middle Pleistocene. As we can see below for the Sukhne sector, a consistent amount of the whole formation does contain cultural remains. The intermediate terrace (40-15m) is composed of the Biré and Khirbet Samra alluvial formations, both very rich in artifacts. The first is dated to upper Middle Pleistocene and contains a consistent Acheulean industry, and the second is dated to the Upper Pleistocene, containing a Middle Palaeolithic flake industry. The lower terrace, a few meters above the present river bed, is composed of the Sukhne Formation, of upper Holocene age[1].

The Sites

The core of Dauqara outcrops has been mapped by Besançon and coworkers as roughly comprising the flat landscape between the limestone hills south of Sukhne and the 500m contour line on the western and northern edges of the plateau. This includes an area of about 1.35km^2; about one third of this area is currently occupied by modern buildings and roads. The remnant is devoted to irrigation terrace agriculture. An extra 0.3km^2 are dispersed on some terraces on the west bank of the Zarqa, 3km north of the homonymous town. Some 0.5km^2 were mapped in the environs of Jebel Bakjie, but no visible section was exposed at the time of our survey, fall 1996 (BAUBRON *et al.* 1985, Fig. 1). Other outcrops, northward of the small village of Biré, will be checked during the next field seasons.

Table 1. Sections and lithic industries of Dauqara Formation <*PGN: Palestine Grid North; PGE: Palestine Grid East*>.

N	PGN	PGE	H. top	H. bottom	Choppers	Cores	Debitage	Retouched	Chunks	Undet.	Total
330	172.37	250.95	506.17	503.17	-	11	95	23 (+12 ?)	1	3	**145**
331	172.75	250.75	502.00	498	1	-	3	-	-	-	**4**
332	172.35	250.73	506.71	503.31	-	2	6	1 (+1 ?)	1	-	**11**
342	172.08	250.63	507.28	501.78	-	4	8	3 (+2 ?)	-	2	**19**
343	172.10	250.57	500.46	495	-	1	5	3 (+1 ?)	-	-	**10**
344	172.66	247.38	*c.* 485		-	1	2	-	-	-	**3**
345	172.67	247.33		*c.* 485	-	-	-	-	-	-	**-**
346	172.61	247.36	*c.* 485	481.5	-	2	1	2 (+2 ?)	-	-	**7**
347	172.73	247.37	*c.* 481		-	-	-	-	-	-	**-**
348	172.79	249.28	*c.* 507	*c.* 501,5	-	1	1	-	-	-	**2**
349	172.74	249.30	509.94	505.94	-	-	-	-	-	-	**-**
373	169.88	249.95	526.00	516.07	-	-	-	-	-	-	**1**
392	167.96	249.99	550.75	549.25	-	-	-	1	-	-	**1**
393	167.80	250.12	550.50	544.01	-	3	3	2	-	-	**8**
404	171.35	251.12	*c.* 518	*c.* 516	-	-	2	2	-	-	**4**
405	171.87	251.87	*c.* 515	*c.* 513	-	-	3	3 (+3 ?)	-	-	**9**
406	171.91	252.11	*c.* 513	*c.* 505	-	3	3	8 (+1 ?)	-	-	**15**
407	172.87	250.90	*c.* 498	495.15	-	-	3	-	-	-	**3**
409	172.31	250.79	*c.* 505.5	*c.* 503.5	-	1	1	-	-	-	**2**
				TOTALS	1	29	136	70	2	5	**243**
				%	**0.41**	**11.93**	**55.97**	**28.81**	**0.82**	**2.06**	***100***

A total of 85 sections were recorded and described during the 1996 survey. Nineteen of these are attributed to the Dauqara Formation, as previously defined by the French team, on the basis of: a) topography: elevation above the present river bed and grid references compared with the maps reported in Baubron *et al.* (1985) and Besançon and Hours (1985); b) morphology: concave surface of pediment instead of lower flat river terraces; c) sedimentology: granulometry, lithology and sedimentary structures. The sections and their archaeological content are listed in Table 1.

The sections have been cut by bulldozers in the last 15 years. Because of the scarcity of rainfall, the front is generally steep, clean and devoid of vegetation, a condition which provides for good visibility. In several circumstances another set of sections was bulldozer-cut just below and nearby an

1 For the sites recovered in these formation, see PALUMBO *et al.* 1997.

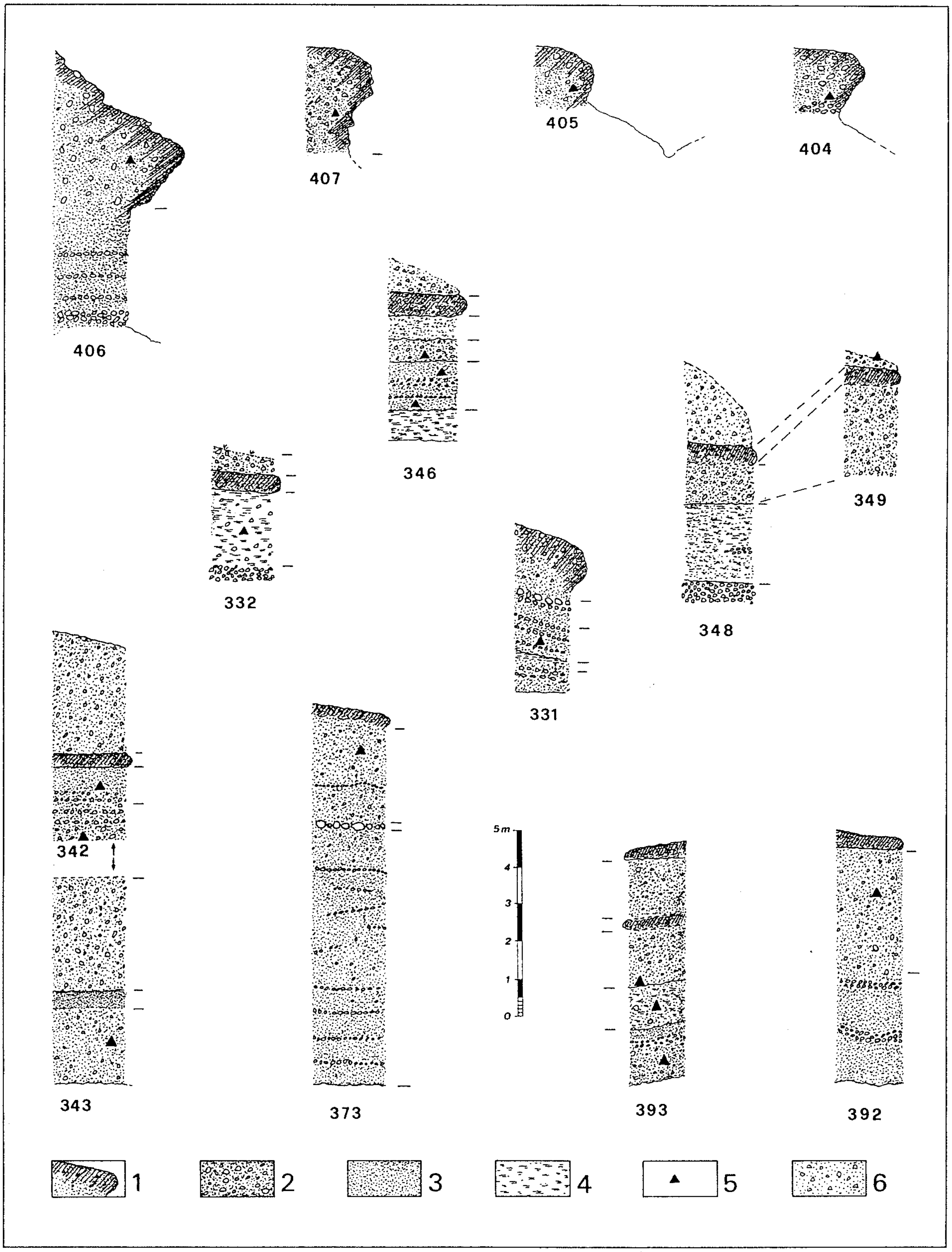

Fig. 2. Sections of Dauqara Formation
(1 limestone crust, 2 gravel, 3 sand, 4 silt, 5 presence of artifacts, 6 colluvium).

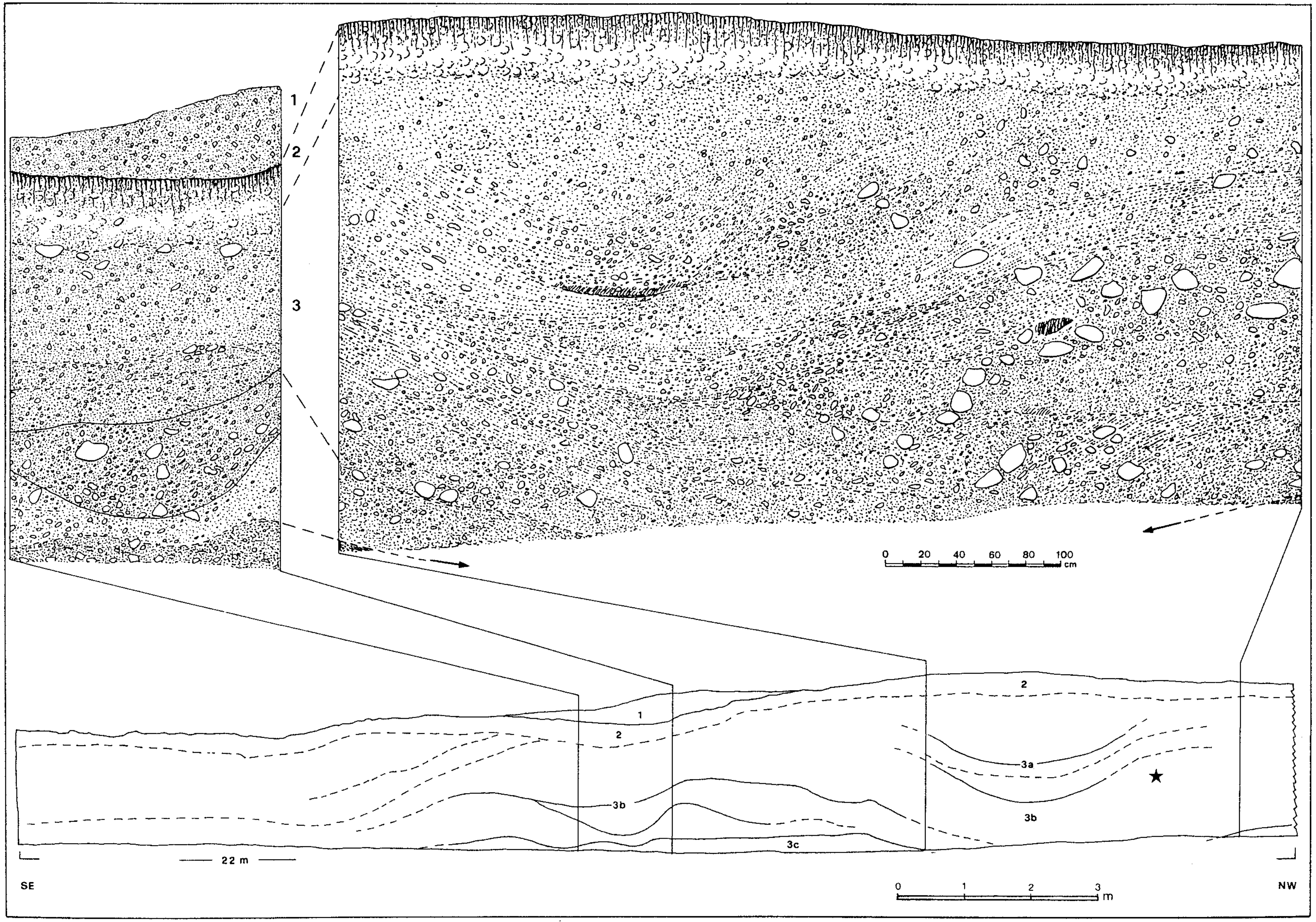

Fig. 3. Section 330. *bottom:* position of detailed areas and principal sedimentary structure (1 colluvium, 2 limestone crust, 3 sand and gravel lenses); *top:* A detail of channel filling, B detail of Mammuthus tooth (star area) <*Field drawing by M. Wilson*>.

upper one. In this (rare) case we have a sequence within the same formation. It is the interesting case of sections 342-343 (Fig. 2) which have a planimetric distance of about 50 metres and display a perfect continuity from a stratigraphic point of view. The majority of locations has been recorded on the top of the formation, with an uppermost limestone crust sealing the all of the strata. Within the same formation, the artifacts recovered at the bottom should be the oldest.

The crust is a typical *caliche* formation, between 0.3 and 0.7m thick, including sands and gravel lenses. At the bottom the carbonaceous accretion is gradual (tuffaceous crust); the top is a hard and consistent limestone slab. In many cases we found artifacts inside the crust as well as below (Sections 404-407, Fig.2). Sometimes the industries recovered just below the crust in fine-grained sediment appear in surprisingly fresh condition, as in the case of section 332 (Fig. 5:1,7,8). Above the crust we often observed a colluvial deposit: angular limestone clasts, cobbles, and poorly sorted sands. In some cases it seems to be the the remnant of ancient colluvia, because the sediment, although unstratified, is well compacted and the artifacts in it are homogeneous, generally pertaining to Late Acheulean. In other cases it is clearly the by-product of modern terrace-building earthworks: sedimentary matrix is absent and different industries as well sherds are visible.

Site 330 Sukhne North

Topography and Stratigraphy

The position of Section 330 is typical of the large majority of localities explored in Dauqara formation: just at the nickpoint between the pediment and the talweg. The section is oriented NW-SE, *i.e.*, almost parallel to the modern Wadi Dhulayil. It is about 30m long and between 1 and 2.5m high. Its top was surveyed at 506m above sea level. At the bottom there is a cultivated field. Agricultural work on the top stopped at about 4m from the front.

So far we have been able to examine only the upper part of the section and have not conducted any excavation at the bottom. This is the reason why we describe the stratigraphy from the top (Fig. 3):

1) Colluvium: sand and pebbles with no visible sedimentary structures; it is the current plough-zone, affected by agricultural activity. On the surface we recovered Late Acheulean bifaces.

2) Limestone crust: homogeneous, hard, tuffaceous at the bottom. Because of its height above the present surface and patina, we cannot confirm the presence of artifacts inside.

3) Channel-bed structures with sand and gravel lenses, sometimes reddened. We provisionally subdivided this unit into three sub-units, which could also represent nothing more than a lateral variation of facies. They are:

- 3a) colluvial lenses in a sandy-cemented matrix;
- 3b) graded gravel with cobbles and pebbles in a fine-gravel/ sandy matrix; a yellowish-brown (10/5.6) band is visible on the top (oxidized layer ?);
- 3c) mainly colluvial lenses in sandy cemented matrix. All the sub-units contain artifacts, but unit 3c, explored only at its top, is the richest artifact-bearing layer. The teeth were found in sub-unit 3b.

Palaeontology

Right at the beginning of the 1996 campaign, a fossilized tooth visible in the lowest portion drew our attention to Section 330. In the three days of work on the site, we recovered four more teeth and a fragment of long bone of small ruminant (probably gazelle). One of the teeth, a large fragment of elephantine molar, was submitted to Claude Guérin for further analysis (see below). One is a lower premolar of Equidae and three are upper molars of Bovidae.

Equidae

The exact position of an isolated equid tooth is difficult to identify, particularly P3-M2. The specimen belongs to *Equus* sp. and is probably the first molar (M1). This lower right first molar is badly preserved as it is broken in the lower third portion. In the Double Knot, the metaconid is larger and higher than the metastylid. The lingual groove (or linguaflexid, which is located between the metaconid and the metastylid) is almost V-shaped and slighty open at the lingual surface, and the lingual edges of the metaconid and the metastylid are convex. The vestibular groove between the protoconid and hypoconid is very deep. P. Turnbull and C. Reed (1974), S. Davis (1980), and V. Eisenmann (1980,1986) described in detail the morphology of teeth in different equid species, and they mentioned that if the lingual groove of the Double Knot is V-Shaped and the pli caballine is absent, the tooth will refer to the stenonian type. The morphology of the tooth of Sukhne North is typically stenonian because the lingual groove of the Double Knot is very narrow, deep and V-shaped. This tooth is definitely not hemion because hemion is characterized by the concavity and shortness of the lingual groove (EISENMANN 1986).

Eisenmann (1986) mentioned that there is one species of *Equidae* at 'Ubeidiya: *E.* cf. *tabeti.* With a further revision of the Pleistocene horse of Latamne, Eisenmann proposed for the 'Ubeidiya horse the definition of *Equus* cf. *altidens*, *Equus* cf. *tabeti* becoming junior synonym of it (GUÉRIN *et al.* 1993b). The fossil tooth of Sukhne North refers to the species *E. tabeti* - the first specimen recovered in Jordan - because the size and morphology are more or less similar to the one found at 'Ubeidiya. The dimensions are smaller, but the postflexidic index is almost the same as *E.* cf. *tabeti* of 'Ubeidiya (Table 2).

Table 2. Measurements of the first inferior molar of equids. LO = occlusal length; LF = length of postflexid; lo = maximal width; postfl. i = postflexidic index = (LF x 100) / LO.

Site	LO	LF	lo	postfl. i
Sukhne North	23	8.2	13	35.6
Ubeidiya	26.3	9.3	14.7	35.2

Bovidae

We describe here only the permanent tooth. It is a well preserved upper first molar tooth of Bovidae (M1). The parastyle, mesostyle and metastyle are very developed and mostly parallel to the axis of the tooth. The paracone and metacone are also present and are round-shaped. The posterior corner of the prefossette is higher than the anterior corner of the postfossette. The measurements of this tooth are almost within the range of the Aurochs (*Bos primigenius*).

The small fragment of long bone of small ruminant is undeterminable, although it is possible that this shaft femur could belong to *Gazella* sp.

Hypothesis on the Genesis of the Site

The sedimentary structures visible in Section 330 are related to a palaeomorphology in which the river bed of the Zarqa-Dhulayil Valleys - in existence since the lower Pliocene - were well above the present elevation. Its small tributaries would have eroded the upper pediment during the rainy season. Because Section 330 is roughly parallel to the Dhulayil course, the palaeochannels we observe are roughly cross-cut by the current front of the section. Some of the filling units would have experienced a sedimentation break with subsquent chemical alteration. This fact points to a broad time span in which several episodes of erosion, sedimentation and exposure would have contributed on the whole to the formation of Stratum 3. As already pointed out by Baubron *et al.* (1985: 278), the Dauqara Formation is probably polycyclic and polygenic, combining both alluvial and colluvial origins. This means that we are facing, at least in Section 330, a secondary "site": lithic and faunal remains, discarded on the top of the plateau, were transported and dismembered by the surface waterflow for an unknown distance and sometimes concentrated in the channel beds. Such taphonomic situations are well known in Pleistocene archaeology and palaeontology. Some of the sites at Olorgesailie (Middle Pleistocene, Kenya) or the palaeontological locality of Saint Vallier (Middle Villafranchian, France) are two of the clearest examples of this pattern (ISAAC 1977, DÉBARD *et al.* 1994).

Lithic Industries of Dauqara Formation

Composition

The assemblage presented here is a pooling of all the sections attributed to the Dauqara Formation, i.e, a total 243 artifacts. It is composed of 29 cores (12%), 135 products of debitage (56%), 71 tools (29%, of which 9% has dubious retouch), 7 chunks and undeterminables (about 3%). The 49 (proper) tools are: retouched flakes(41%), notches (24,5%), scrapers and denticulates (18,5%), rare awls (4%) and truncations (4%); just one specimen each for *raclette*, end-scraper, point, chopping-tool. Only two tools were made on a core. Both the cores and the chopping-tool have large cortical surfaces. The recurrent cores have been classified here as discoidal and globular. Some cores of other Levantine sites, morphologically very similar, have been considered as "pebble tools" and defined as discoids or polyhedrons. 'Ubeidiya is the best example (BAR-YOSEF and GOREN-INBAR 1993). The only real difference is the number of flake-scars and the regularity of shape, both poor in the Dauqara case. Till now, we do not have any handaxe or real, well-shaped polyhedrons.

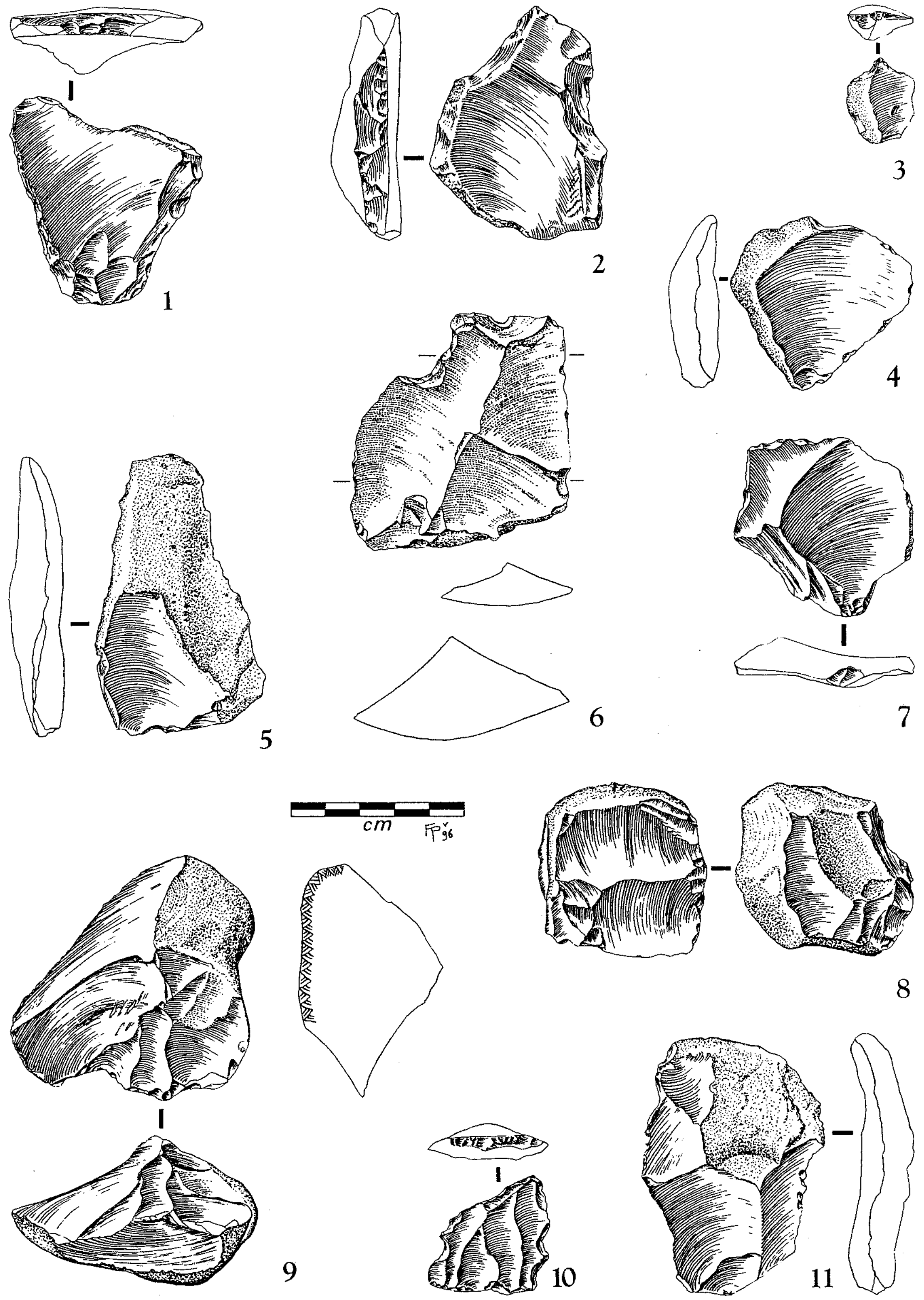

Fig. 4. Section 330: 1 utilized flake, double patina (330-2); 2 retouched flake, double patina (330-29); 3 awl (330-73); 4 flake (330-94); 5 flake (330-39); 6 notch (330-100); 7 retouched flake (330-41); 8 orthogonal core (330-120); 9 unidirectional core (330-22); 10 denticulate (330-67); 11 flake (330-57).

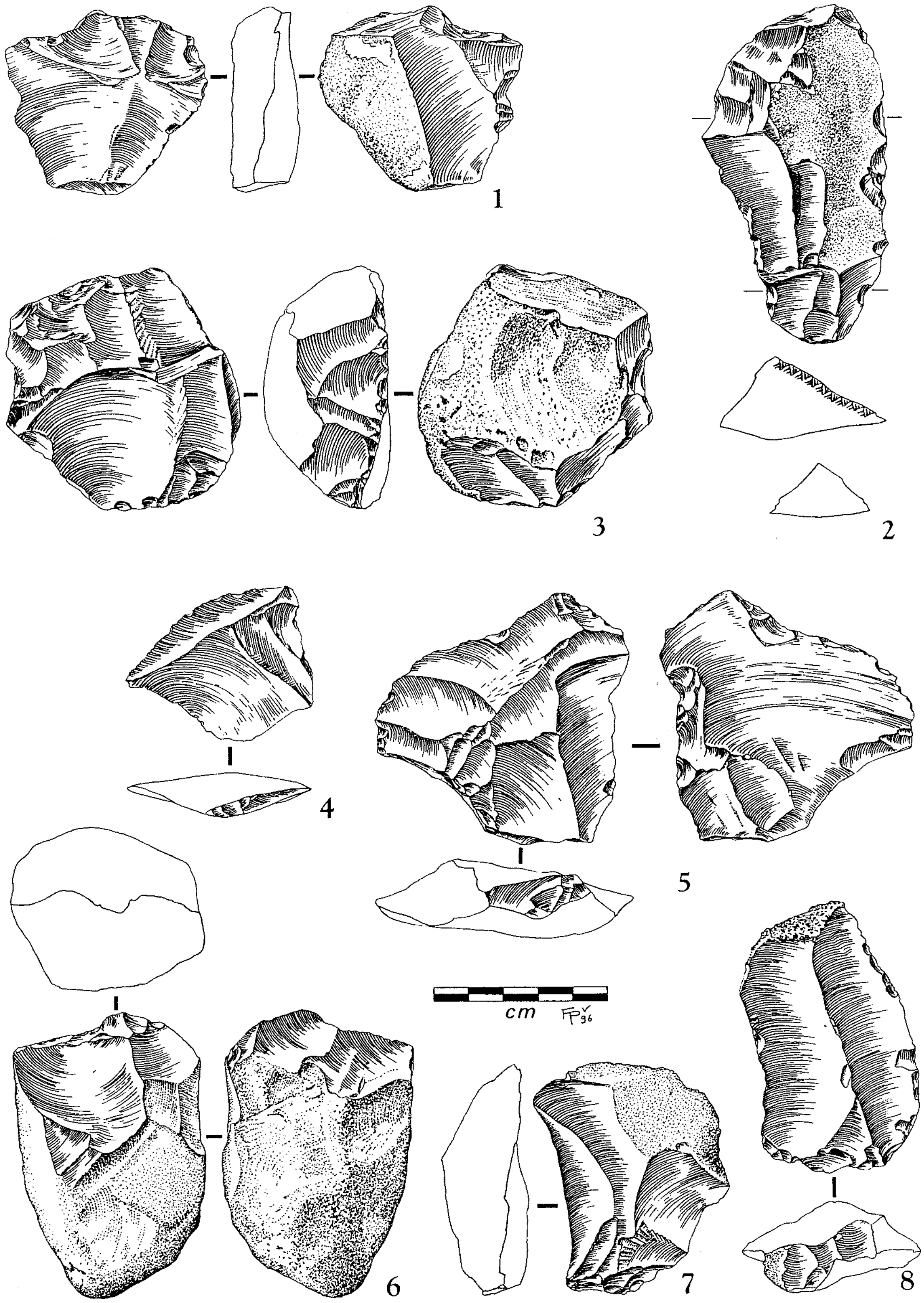

Fig. 5. Artifacts from several Dauqara sections. 1 denticulate (332-4); 2 elongated flake (344-1); 3 discoidal core (342-4); 4 flake from discoidal core (342-5); 5 retouched flake (342-2); 6 chopping-tool (331-1); 7 flake, with heavy whitish patina and fresh edges (332-2); 8 elongated flake (332-6).

Surface Conditions

All the Dauqara artifacts show some degree of rolling and smoothing of the edges. We measured the amount of rounding with the Shackley method. The index ranges between 1 and 6, the latter value being the maximum (SHACKLEY 1974). Of the whole industry, 4% of tools are fresh, 75% slight abraded or abraded and 21% heavily or very heavily abraded. The average value for Dauqara Formation is 3.8. Rolling in the lowermost Middle and Upper Pleistocene terraces is much lower: 3.3 for the 178 artifacts of Biré Formation and 3 for the 77 artifacts of Khirbet-Samra Formation. About 19% of the artifacts are fractured. As regards patina, because of the high subjectivity of this kind of evaluation, we prefer to wait for a more advanced study. Nevertheless, we noted that about 8% have a clear double patina and that, on the whole, the colour is brownish-gray. In many cases we noted marginal retouch, generally old, sometimes isolated, other times extensively distributed on the edges in an apparent disorder. In some cases we classified them as pseudo-retouch or macro-wear; in others they totally hampered the reading of possible real retouch, forcing us to a provisional classification.

Technology

So far, the Dauqara assemblage seems to be mainly a flake industry. If we consider the size of cores and debitage, we can argue that it was produced from large siliceous pebbles: average weight of cores is 206 g, average length 77mm (debitage 29.3 g, 53mm). Among the cores the unidirectional type is most common (31%). Globular cores make up 17%, sub-discoidal 14% and sporadic 7%. The number of flake-scars[1] ranges between 6 and 9, with the maximum in the globular type and the minimum in the unidirectional type. As regards the amount of cortex, the average value for the cores is 2.5 (in a range 1-5); it covers half the dorsal face in more than 50 of the 100 measured complete flakes. Whereas totally cortical flakes are 14.4%, the debitage without any cortex is less than 2%. Moreover, among the 164 preserved and recognizable butts, cortical platforms are at 44.5%, flat/plain 40.9%, linear and punctiform 6.2%, dihedral 6.2%, and facetted 1.8%. The average number of flake scars on the dorsal face is 2.5 and the average flaking index, defined as the number of flake scars / kg of raw material, is shown in Table 3.

Table 3. Average values of attributes defining the intensity of flaking.

Average	Flake scars	Weight	Flaking index
cores (24)	8	205,45	67,5
debitage (100)	2,51	29,3	215,95
retouched (40)	2,89	41,75	217,81

On the whole, this cursory inspection of the main technological features suggests that stone-working was essentially limited to hard-hammer percussion flaking on local fluvial pebbles, without any careful preparation of surfaces nor the complete exploitation of raw material. Reduction processes were quite simple, and the availability of flint in the limestone and at the surface of the pediment allowed an almost expedient technology. We do not observe a conscious morphological pattern in this lithic production.

General Remarks and Comparisons

The Dauqara assemblage has been recovered from different layers and localities within the same sedimentary body. It is highly probable that the result of this - necessary - confusion would not only be a palympsest from a diachronic point of view, but also the mixing of sites with different taphonomic history and behavioral significance. Nevertheless, this is often the kind of context the archaeologist deals with when facing very old cultural remains. The same situation, in which the chronology embraces a time span of unknown duration, occurs in other contemporaneous formations, as at El Khattab or Borj Kinnarit. More substantive reference localities, such as 'Ubeidiya or Latamne, have a better chronological control, the former because a relative sequence of the different units is possible, the latter because, at least its most important site (the living floor) is considered the result of a short term occupation (COPELAND and HOURS 1993). For a first comparative look at Dauqara industry, in Table 4 we match the broader artifact classes of the most relevant sites of Early and Middle Acheulean age in the Levant:

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1 Only considered scars >10mm.

Table 4. Comparison among Early and Middle Acheulean Levantine sites per tool classes: 1 choppers; 2 polyhedrons, discoids; 3 handaxes; 4 cores; 5 heavy duty; 6 flake tools; 7 debitage. Middle Acheulean sites at the top of the table.

	1	%	2	%	3	%	4	%	5	%	6	%	7	%	TOT
Latamne	63	5.23	34	2,82	55	4.56	230	19.09	11	0.91	56	4.65	756	62.74	**1205**
Joubb Jannine	147	15.03	255	26.07	372	19.21	152	7.85	-	-	204	10.54	806	41.63	**1936**
Dauqara1996	1	0.41	9	3.70		-	20	8.23	-	-	49	20.16	164	67.49	**243**
Dauqara 1980	1	2.38	3	7.14		-	3	7.14	-	-	-	-	35	83.33	**42**
Dauqara TOT	*2*	*0.70*	*12*	*4.21*	-	-	*23*	*8.07*	-	-	*49*	*17.19*	*199*	*69.82*	**285**
Kefar Menahem	47	2.3	5	0.24	?	-	118	5.78	?	-	133	6.51	1740	85.17	**2043**
Borj Kinnarit	2	12.5		-	-	-	2	12.5	-	-	-	-	12	75	**16**
Khattab	7	31.82	2	9.09	1	4,55	-	-	1	4.55	1	4.55	10	45.45	**22**
Ubeidiya TOT	985	10.82	418	4.59	219	2.41	140	1.54	78	0.86	2366	26	4894	53.78	**9100**

Some points should be stressed regarding the comparative criteria employed in Table 4:1) In order to adapt our classification to the generally utilized "pebble-centered" terminology, our globular and subdiscoidal cores have been "translated" into polyhedrons and spheroids, a category which has a very broad sense for the authors reviewed; 2) the "debitage" class includes not only the real debitage, but also the dubious tools, which can be considered -at least- as simple debitage.

Because the cultural subdivision of 'Ubeidiya does not perfectly fit with the chronology based on biostratigraphy, we prefer to consider the assemblage of this site as a whole, pertaining to Lower Pleistocene. In any case, the bulk of the industry is contained in the Fi member, and the whole sequence is estimated to represent a short lapse of time.

The artifacts recovered in the terrace of El-Khattab are of the QfIV Formation, older than the lowermost Latamne Formation. The small assemblage recovered, devoid of handaxes and essentially composed of choppers, polyhedrons and spheroids, seems to pertain to the Early Acheulean tradition of the Rift (COPELAND and HOURS 1993: 72).

Kefar Menahem is an open-air possible quarry between the Dead Sea and the Mediterranean coast of Israel. Among the 185 shaped tools there is a plurality of choppers (28%) and scrapers (27%). Judging from the illustrated pieces, one light-duty tool has impressive resemblances with our industry from Dauqara Formation. It is the case of the awl of Fig. 7 (GILEAD and ISRAEL 1975: 9), which is very similar to N. 73 of Site 330 Sukhne North (Fig. 4:3). The few handaxes of the lowermost unit are roughly shaped and morphologically undefined. On the whole site, the authors proposed a broad parallel with 'Ubeidiya Early Acheulean.

At the sandstone quarry of 'Evron (Israeli Mediterranean coast), in a rescue excavation an *in situ* assemblage was recovered. The huge handaxes look like the ones from Unit K6 of 'Ubeidiya, although the latter is considered slighltly older (GILEAD and RONEN 1977). The authors proposed a Mindel age on the basis of a closer likeness to the Latamne industry owing to the type of stone-working, the low number of choppers and a broad correspondence of the fauna.

Two sites in Lebanon need special attention: at Borj Kinnarit, a beach formation attributed to the Günz-Mindel interglacial gave a small assemblage without handaxes or flake-tools (HOURS and SANLAVILLE 1972). It is worth noting that among 17 recovered artifacts, there are 10 flakes and 2 cores. The two choppers are quite different from the known Oldowan industry. At the site of Sitt Markho, Lebanon, 90 artifacts have been recovered, 17 of which were classified as tools. The deposit pertains to the Qf IV Formation (HOURS 1981). These assemblages, though very poor, are important because of their chronostratigraphic attribution prior to the Middle Acheulean.

For this latter period, the reference site is Latamne. We have included all the industries of the homonymous formation and not only the assemblages from the living floor. Joubb Jannine, though a surface site, has also been considered because of the high number of artifacts and the almost certain chronological attribution proposed by Besançon *et al.* (1982).

The Jordanian sites of Abu Habil and Abu el Khas - on the contrary - have been excluded from this comparison because of the attribution to the Tabaqat Fahl Formation (Late Acheulean), based on new detailed stratigraphic work (MACUMBER 1992, WALMSEY *et al.* 1993, WRIGHT 1993).

Debitage is the most relevant class in all the assemblages reported in Table 4. Almost 70% of the Dauqara artifacts consist of simple flakes; this is almost the same percentage of the Kefar Menahem assemblage. (The high debitage percentage for Borj Kinnarit, with a total of only 16 artifacts, is suspicious) If we repeat the comparison excluding the debitage, we can perceive some interesting resemblances between Dauqara and other Early Acheulean assemblages: in fact Dauqara has the same percentage of flake tools as 'Ubeidiya, almost the same percentage of polyhedrons and discoids as at Khattab, and Dauqara is devoid of handaxes, exactly as at Borj Kinnarit and - it is to be stressed - as the lowermost layers of 'Ubeidiya. The extremely low frequency of choppers (just one specimen) is a particular feature of Dauqara. However, as already mentioned by Francis Hours (1981), the presence or absence of handaxes in the Levantine Acheulean could have more a geographical than a chronological meaning.

Conclusions

Age of the Formation

A first dating for the Dauqara Formation is presently available on the basis of three different criteria: biostratigraphy, morphostratigraphy, and archaeology. It is to be stressed that each of them needs further testing: the chronology proposed here will be possibly modified in the future.

Two of the three identified species of Sukhne North, *Mammuthus meridionalis* and *Equus* cf. *tabeti*, have been recognized in the 'Ubeidiya Formation (Lower Pleistocene). They became extinct at about 0.9 my, at the upper limits of biozone 19, to which the 'Ubeidiya formation is assigned. The third taxon is represented by *Bos primigenius*, well known in Europe after 1my (GUÉRIN and FAURE 1988). In the Levant its oldest remains have been identified in the Latamne Formation, now attributed to the upper biozone 22, some 0.6my old (GUÉRIN *et al.* 1993b).

The morphostratigraphic scheme proposed by Besançon and Hours (1985) for the Zarqa Valley assigned to Dauqara Formation a relative position corresponding to QfIII formation in the Orontes River valley, Syria. Nevertheless, a slightly older estimated age is reported in Baubron *et al.* (1985: Table 2). In that paper the authors included the beginning of the Dauqara complex within the Lower Pleistocene, correlating Dauqara to the Erk el Ahmar formation (Villafranchian), Hishmar Hayarden (Qf IV) and 'Ubeidiya Formation.

The lithic assemblage we recovered, quite limited till now, is clearly devoid of handaxes and shows, on the whole, a closer proximity to the Lower than to the Middle Acheulean cultural tradition. Nevertheless, the choppers are also very rare and a subdiscoidal debitage is present, pointing to a more advanced phase than the 'Ubeidiya Developed Oldowan.

In summary, it seems probable that the Dauqara Formation fills the lower part of the gap already mentioned in Guérin and Faure (1988), regarding the biozones 20-22, and that it could be assigned to the final biozone 19 or to the beginning of biozone 20, with an estimated age between 0,9 and 1 my.

Future Work

The results we have presented clearly point to a more fruitful situation than previously supposed for the Quaternary of the eastern side of the Levantine Rift. Not only promising archaeological evidence has been recovered from a formation that, on the present state of knowledge, we shall attribute at least to the beginning of Middle Pleistocene, but we are facing the possibility of decoding a missing chapter in Near Eastern palaeoenvironmental history. As the reader can understand, incipient research has many more questions than resolved problems. What we should like to know is virtually unknown: the time span of the formation studied, the taphonomy of the fossils, the location of primary archaeological sites.

We can define the most important short and middle term research steps: 1) collection of samples for an independent chronology of the formation by radiometric dating or palaeomagnetism; 2) excavation of a small portion of Site 330 for recovery of more faunal and archaeological remains; 3) mapping of different sedimentary facies within the formation by test pits and augering. It is worth noting that the conditions allowing the preservation of primary undisturbed sites are very local ones. It is possible that the "fresher" lithic remains recovered in fine-grained units from other sections of Dauqara Formation may be the remains of nearby archaeological localities that experienced a lesser amount of diagenetic alteration.The primary task of our future work in the area will be both a contextual analysis at the micro-regional scale and the identification of behaviourally meaningful sites.

The Elephant Tooth (Appendix by Claude Guérin)

The most relevant fragment pertains to a permanent molar; the scanty conditions of the tooth do not allow any recognition of its rank or symmetry. It is composed of three laminae, one of which is incomplete. The outline of laminae (the sinuosity of enamel, sketch of median sinus) accords very well with the genus *Mammuthus*. Four of the attributes proposed by M. Beden (1979) can be applied and allow the attribution at the specific level: it is *Mammuthus meridionalis* (Nesti, 1825). In fact: 1) the thickness (e) of the enamel strip is between 2.5 and 4mm; this value excludes a deciduous molar; 2) the width (I) is $\geq$ 88 mm; 3) the estimated height is 170mm; 4) the laminar frequency (F), obtained with the infra-laminar distance, is about 5.2.

The Jordanian specimen pertains to the same species of the 'Ubeidiya elephant, which is close to subspecies *tamanensis* (DOUBROVO 1964). Among the four attributes considered, three are consistent with the latter (BEDEN 1986): for the two last molars, the enamel thickness is between 2.2 and 3.5mm, width is between 83 and 99mm, laminar frequency is between 4.5 and 7. The height alone is smaller at 'Ubeidiya (a maximum of 144mm), showing that the Jordan elephant is a more advanced and thus recent one. The species *M. meridionalis* spans between 2 and 0.9 million years. Since the 'Ubeidiya specimen is dated at 1,4 million years, the Jordan one can be aged at about one million years.

Because of the bad preservation of the tooth fragment, it is impossible to assign it to one or another defined subspecies of *Mammuthus meridionalis*. This species is already known in the Levant, at Braghite in the Nahr el-Kebir in Lebanon (MALEZ and KANSOU 1974), Hama and Latamne in the Orontes River valley, Syria (HOOIJER 1961, 1962, 1965), and in Turkey (SENYÜREK 1960).

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Preliminary Results From the Acheulian Site of Mashari'a 1, and a New Stratigraphic Framework for the Lower Palaeolithic of the East Jordan Valley

Phillip G. Macumber and Phillip C. Edwards

Abstract: *Mashari'a 1, the major focus of this paper, is an open-air, in situ Late Acheulian site located in the Tabaqat Fahl Formation, east Jordan Valley. The site contains abundant flaked stone artefacts (including a conjoinable core), faunal remains and burnt materials providing evidence for the use of fire. As such, Mashari'a 1 stands as one of the best preserved Late Acheulian sites in the area. Here a chronostratigraphic context is provided for this site and also for further Acheulian sites belonging to the Mashari'a series. Subsequently we put forward a re-evaluation of Lower Palaeolithic chronostratigraphy for the east Jordan Valley, arguing that the Abu Habil Formation should be equated with the Middle Pleistocene Tabaqat Fahl Formation, rather than with the Early Pleistocene (Oldowan) period as previously assigned. The final part of the report summarises research at the rich, multi-period flint quarries on the Dana Formation at Dhra'.*

Introduction

The work described here grew out of geological reconnaissance carried out in the East Jordan Valley in 1989, which in turn formed the basis for a season of archaeological survey and excavation undertaken in 1993-1994. The latter project, called "The Early and Middle Pleistocene geology and archaeology of the East Jordan Valley", was developed with the aim of investigating the earliest sites in this region, part of the so-called "Levantine Corridor" (BAR-YOSEF 1987, 1994), which must have formed a key route for the dispersal of hominids and modern humans out of Africa. Over the last few decades parts of the Jordan Valley have yielded a rich series of Lower Palaeolithic sites, which also include southwestern Asia's earliest, such as Ubeidiya (BAR-YOSEF and GOREN-INBAR 1993), Gesher Benot Ya'akov (GOREN-INBAR 1992) and Berekhat Ram (GOLDBERG 1989, GOREN-INBAR 1985).

While the Israeli sequence is firmly based on detailed excavations and supported by geological, biostratigraphic and radiometric dating, none of this was available for the eastern valley in Jordan. On geological grounds the lack of a well-preserved Lower Palaeolithic sequence in the eastern Jordan Valley is somewhat surprising, given the large aquifer systems that have operated there throughout much of the Pleistocene and the consequent large-scale sediment deposition in the region. Having had some experience in the region in the course of carrying out a decade of Late Pleistocene research in the 1980s (EDWARDS and MACUMBER 1995), we felt that we were in a position to begin to erect the scaffolding of an initial stratigraphic framework for the Lower Palaeolithic of the eastern Jordan Valley.

The project involved excavation of new sites we had discovered, revision of already-known sites and formations, and prospection for new sites. Sometimes we hit it lucky, other times not, and as these things go, we occasionally found very interesting things we weren't looking for[1]. The project targeted

1 This project was funded by an Australian Federal Government Large Central Starter Grant, administered through La Trobe University, and co-directed by the authors. Personnel largely consisted of staff and students of the La Trobe University School of Archaeology, including Dr Richard Cosgrove (field director at Mashari'a 1), and students Allyson Halsey, Tania Hardy-Smith, Tracey Johnston, Joanne Jordan, and Jennifer Tulloch. Julia Cusack assisted with the laboratory analysis of archaeological materials. Other Australian staff included geologist Richard Lakey (Oman), and John Head (ANU Quaternary

Middle Pleistocene and Early Pleistocene open sites and geological formations at several localities along the eastern Jordan Valley. We investigated, *inter alia,* the Abu Habil Formation and the Ghor al-Katar Formation in the central Jordan Valley and the Dana Formation located farther south on the Lisan Peninsula east of the Dead Sea (Fig. 1). However, the centrepiece of the operation was the Acheulian site of Mashari'a 1 near Tabaqat Fahl (ancient Pella), stratified in the Tabaqat Fahl Formation (MACUMBER 1992).

Geology and Geomorphology of the Tabaqat Fahl Formation

Tabaqat Fahl is a large, buttress-like plateau rising abruptly 125 metres above the Jordan Valley floor, which in this region lies at about -180 metres. The town of Mashari'a lies at the foot of the Tabaqat along its western edge with the Jordan Valley (Fig. 2). In elevation the plateau surface lies between the -75m. contour at its western edge adjacent to the Rift Valley and the -25m contour where it adjoins the hills at Abu al-Khas to the east. The plateau is bounded to the north by Wadi al-Hammeh and to the south by the stream channel of Raud al-Bayad.

The Tabaqat Fahl gives its name (MACUMBER 1992) to the sediments comprising the Tabaqat Fahl Formation (Fig. 3, Pl. 1:A). These consist of dense conglomerates, hard white and sometimes nodular limestones, and thick tufas. At the valley edge the formation is about 120 metres thick. In its more easterly outcrops under the Tabaqat Fahl plateau, the Tabaqat Fahl Formation unconformably overlies dipping sequences of Cretaceous/Lower Tertiary sediments. Nearer the Rift Valley it overlies steeply dipping conglomerates, sandstones and pinkish limestones lithologically similar to the Ghor al-Katar Series. The Ghor al-Katar series is thought to be Early Pleistocene in age (BENDER 1968, 1974); however, as yet it lacks absolute dating, and its age is therefore largely conjectural. The Tabaqat Fahl sequences are tilted and gently folded in places, but elsewhere they are horizontally bedded. Considering the position of the Tabaqat Fahl perched high in the landscape (*c.* 120m above the Jordan Valley floor), and also that its limestones (which represent a paludal, lakeside palaeoenvironment) have no lateral equivalent surviving in the Jordan Valley itself, it follows that the formation has undergone a remarkable degree of tectonic uplift since its deposition. However, viewed from the perspective of Kohn and Eyal's (1981) results in the Sinai Peninsula, where they demonstrated uplift of its basement Precambrian rocks by at least 5 kilometres, with uplift rates calculated as 0.1 - 0.2mm per year, the degree of uplift at Mashari'a does not seem so extravagant.

The basal unit in the Tabaqat Fahl sequence is commonly a conglomerate largely composed of chert and limestone pebbles in a calcareous and siliceous matrix. This conglomerate caps the hills to the east of Tabaqat Fahl and passes beneath the Tabaqat, where it is overlain and partly replaced by an 80m thick tufaceous limestone member that comprises large numbers of fossil *Phragmites* reeds cemented in a calcareous matrix and significant numbers of the freshwater gastropod *Melanopsis praemorsa.* The Mashari'a 1 site is contained within this member. The Tabaqat Fahl Formation thickens on approaching the Rift Valley edge. The basal conglomerate is replaced by a uniformly dense, white limestone with occasional bands of hard nodular concretions that are varyingly flattened and distorted. The dense limestone outcrops as an apron at the base of the Tabaqat, visible in outcrops along the highway at Mashari'a between the Raud al-Bayad and Wadi al-Hammeh. Here the conglomerate is missing and the tufaceous limestone rests directly on dense nodular limestone. The latter is interpreted as representing a paludo-lacustrine Rift Valley unit.

The overall pattern of facies variation within the Tabaqat Fahl Formation, passing from conglomerate on the hills to predominantly tufaceous limestone on nearing the Rift Valley, is similar to that observed in the Late Pleistocene valley-fill sequence in Wadi al-Hammeh (MACUMBER and HEAD 1991); that is, there is a change from ephemeral fluvial sedimentation (represented by the conglomerates) to a zone of massive spring deposition (represented by the tufas) in a zone of groundwater outflow adjacent to a large lake (hard uniform limestone) within the Jordan Valley. The sequence represents a depositional cycle earlier than the existence of Lake Lisan. It also represents a

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Dating Research Centre). The surveyor was George Findlater (University of Edinburgh). We are indebted to Professor Basil Hennessy for his initial enthusiasm and support for the project and for generously providing us access to the Pella dighouse and its resources. We thank Dr. Safwan Tell, then Director-General of the Department of Antiquities of Jordan, for approving and supporting the work. Our warmest thanks go to our Jordanian project members Abu Isa, Abu Sami, Abu Fawzi and Allahadin. Special thanks are due to Department of Antiquities inspector Ali al-Khayyat for expediting every facet of our progress. We thank the people of Tabaqat Fahl and Mashari'a for their welcome during our stay in their communities, and the excavation staff from those two villages who included Mishrif Abdullah, Abu Afif, Hassan, Muhammad and Musa'ad Khashan. In Mazra'a, we were very grateful to Ahmed al-Idwan, director of the Jordan Valley Authority, for the generous offer of JVA premises as project accommodation, and also thank Konstantinis (Dino) Politis for his assistance in guiding us to them. We thank William Lancaster, the then director of the British Institute at Amman for Archaeology and History, and its staff for their general welcome, assistance, and loans of equipment. Thanks are due to Robin Torrence for discussion on the Dhra' chert quarries and to Lorraine Copeland for helpful correspondence on the Mashari'a 4 bifaces. Finally, many thanks are due to La Trobe Archaeology staff members Rudy Frank for photography and Wei Ming for drafting the maps.

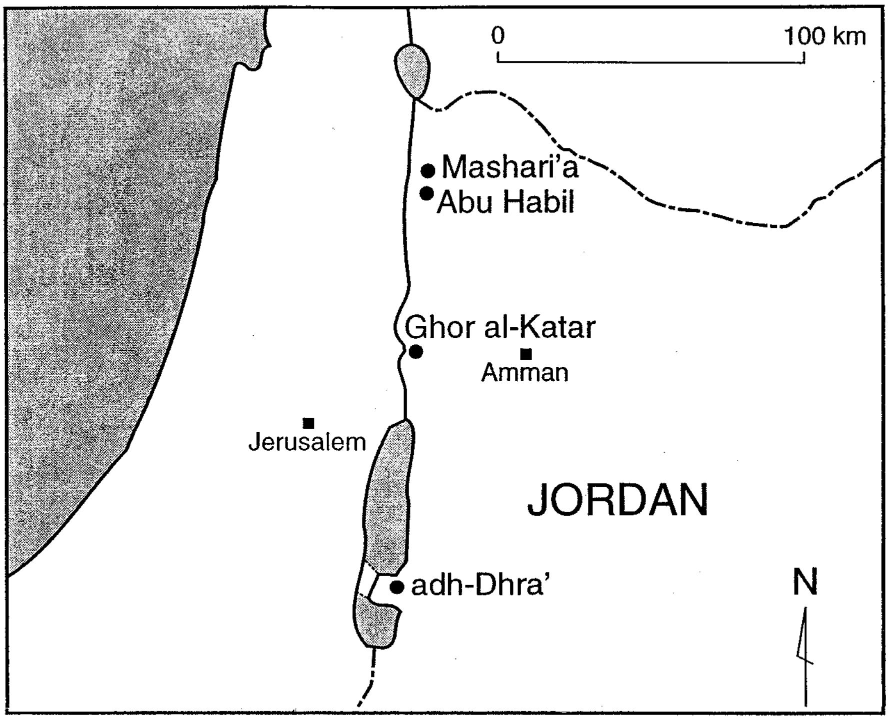

Fig. 1. Sites and localities investigated in the present study.

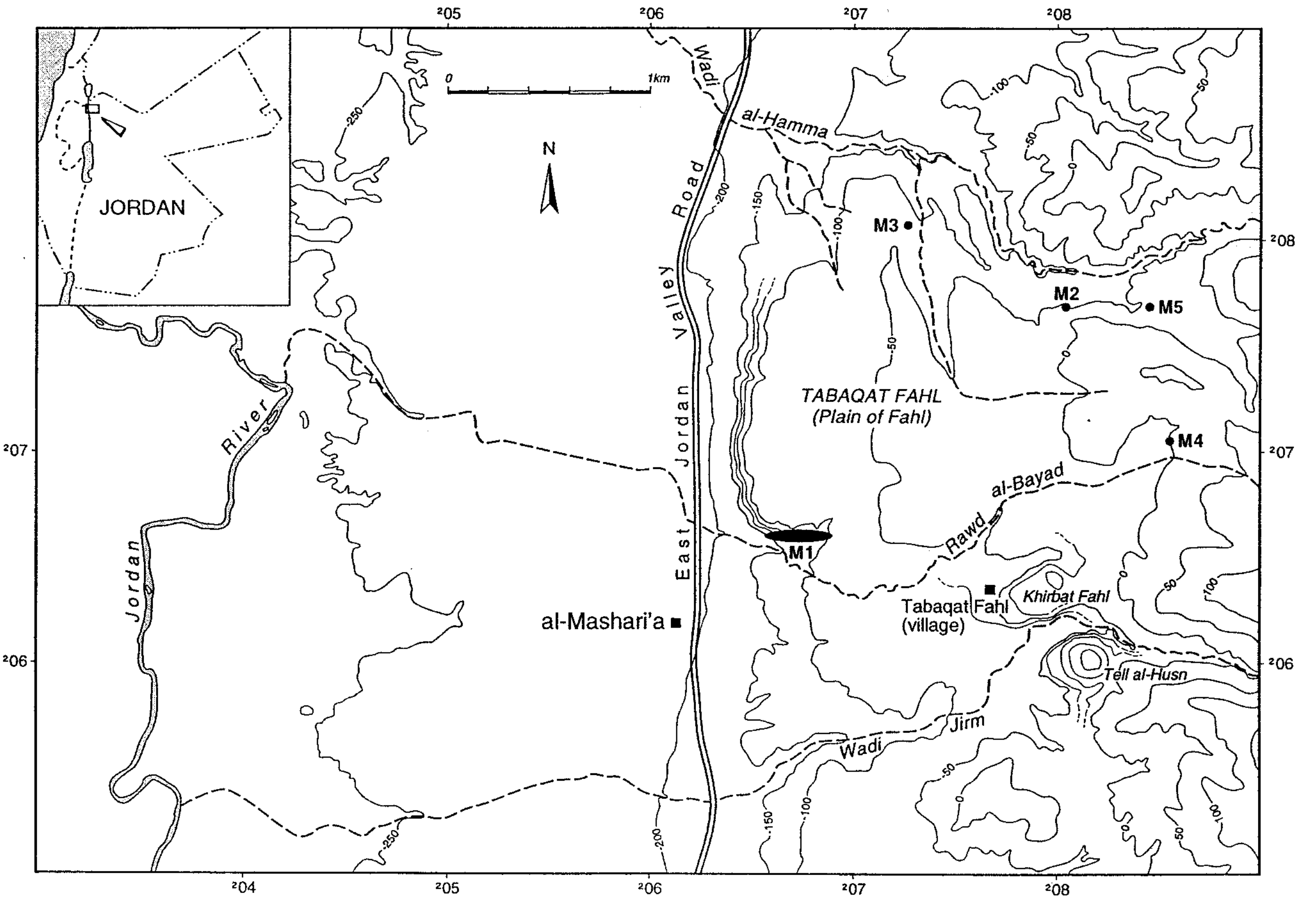

Fig. 2. The Tabaqat Fahl / Wadi al-Hammeh region, indicating the Mashari'a (M) series of Lower Palaeolithic sites.

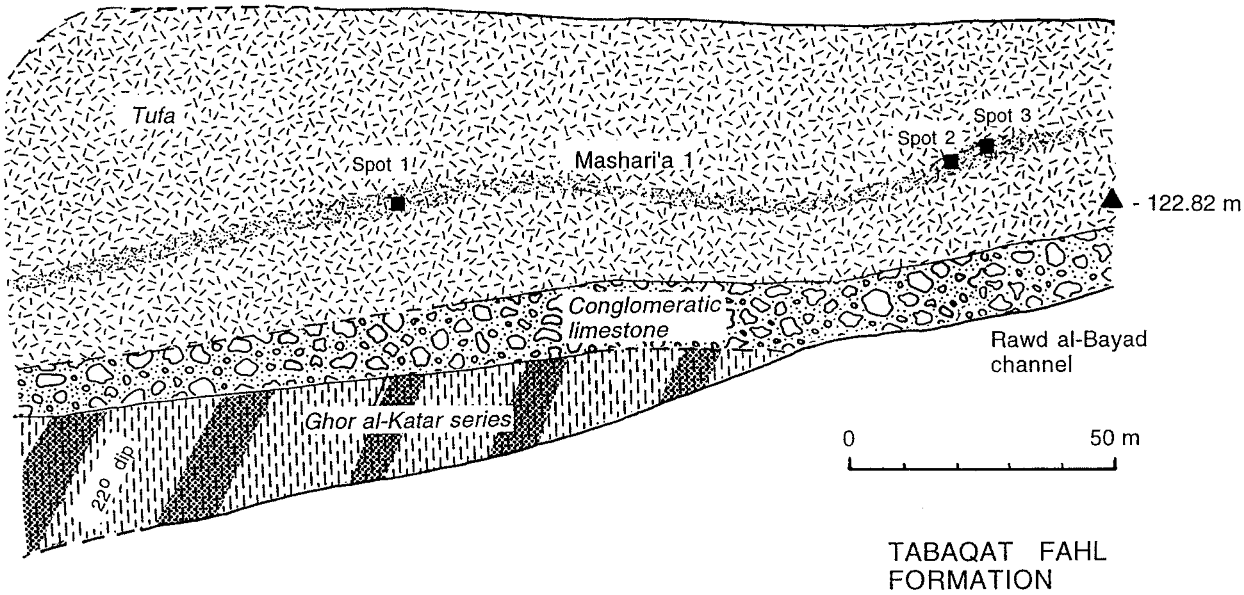

Fig. 3. Geological section of the Tabaqat Fahl Formation (south elevation), indicating Mashari'a 1 site.

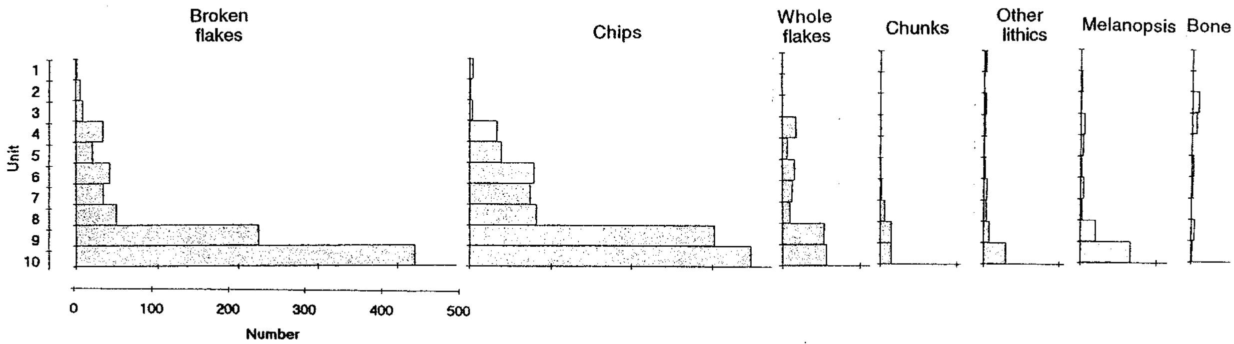

Fig. 4. Frequency of artefacts and other finds in Mashari'a 1, Spot 2, Locus 1.1-1.10.

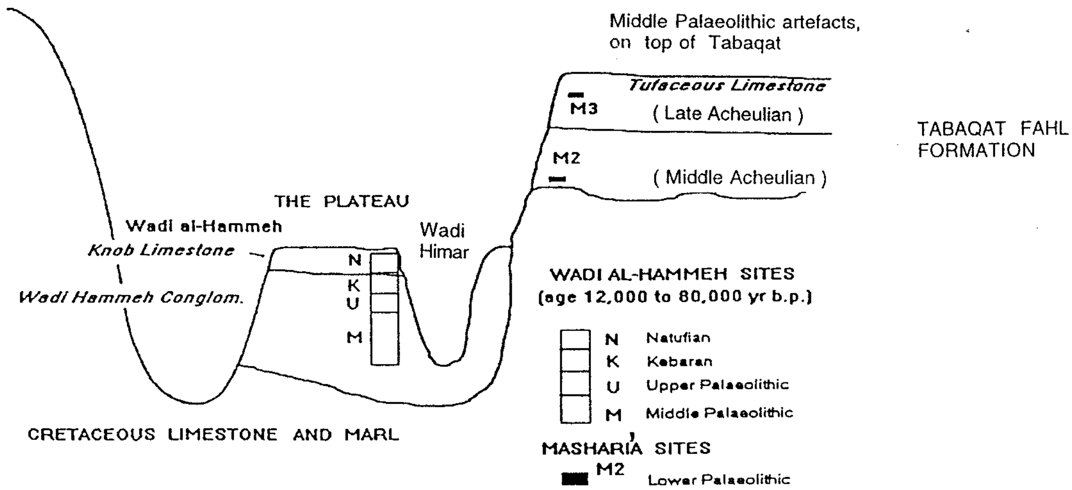

Fig. 5. Schematic diagram of the relationship between the Tabaqat Fahl and Wadi al-Hammeh terraces.

much larger and more persistent version of the occupational environment present during Middle, Upper and Epipalaeolithic times in Wadi al-Hammeh. The tufa member of the Tabaqat Fahl Formation represents a massive version of the modern adjacent Wadi Jirm spring system, now cultivated but only recently a riparian jungle including dense stands of *Phragmites* reeds. Groundwater carbonate presently accretes around the stems of the plants as they grow in place, illustrating the processes which lead to the deposition of the adjacent Tabaqat Fahl. Clusters of *Melanopsis praemorsa* gastropods are also frequently encountered in the spring waters of Wadi Jirm.

Excavations at the Acheulian Site of Mashari'a 1

Mashari'a 1 is an open-air *in situ* Acheulian site that extends in cliff section for several hundred metres along the southern edge of the Tabaqat Fahl plateau (Fig. 3, Pl. 1:A). Artefacts continue to outcrop from the sediments around the return to the western cliff section of the massif (Fig. 2). On the southerly face overlooking Raud al-Bayad, the archaeological horizon is stratified in the tufa member some two-thirds of the way up the 100m high limestone cliff. At this level, and over the face below, numerous bifaces and flakes erode from the deposit over a distance of several hundred metres. There are also artefacts, including discrete clusters of flakes, embedded in solid rock (Pl. 1:B), which prior to the commencement of operations suggested to us excellent conditions of preservation.

Our investigations encompassed a 115m stretch of the site. Two excavation pits (Spot 1 and Spot 3) spanned this distance (Fig. 3, Pl. 1), and another (Spot 2) was placed between them. The cultural stratum occurs in a cemented layer of calcareous silts. This sediment may partly derive from the weathering of tufa deposits during that period when artefacts were discarded at the site and before sedimentation resumed. This possibility is indicated by the occurrence in the excavations of tufa blocks with embedded artefacts found within the cemented silts (Pl. 1:C). We are presently attempting to date limestone and molluscan samples from the site as well as from the hard limestones at the base of the Tabaqat Fahl Formation.

Our optimism about the good conditions of site preservation prompted by surface exposures of *in situ* artefact clusters was borne out by the results of the excavations. The flaked chert assemblages yielded a highly consistent series of flaked stone products that included only a few bifaces but numerous biface-thinning flakes, notched flakes (many of which were formed through use), invasively retouched flakes, some invasively retouched scrapers, marginally retouched flakes and a few flake cores. The good conditions of preservation were confirmed by frequent finds of fine shatter chips and small flakes (Pl. 2:A:1), and particularly by refitting a flake core from a single 5cm deep spit (Spot 2, Locus 1.9) that yielded six conjoinable flakes struck from a chert core (Pl. 2:B).

The core was embedded in a rich layer of knapping debris that produced an equivalent density of 15,125 pieces per m^3. According to the fragments so far conjoined, the core is a small, semi-ovoid flake core (65mmx51mm), with the cortex at one end of its long axis having been facetted before five small flakes were detached from this same platform. A single flake had also been struck from a cortical platform at the opposite end. The raw material is a brown chert with lighter pigmented veins, and on unflaked surfaces the cobble has developed a thick white patina. The distinctive colouring of the piece has aided in the recognition of its constituent fragments among the thousands of fragments of additional chert debitage. Several other fragments of this cobble occur in the underlying 10cm unit, but they have not yet been refitted successfully. In addition to the large number of flakes bearing acute platform angles and multiple dorsal scars indicative of biface reduction, this small core and other opposed platform and multiple platform cores from the site demonstrate an alternative pathway to flake production besides biface reduction (Pl. 2:A:10-11).

Since processing of all material from the excavations finds remains incomplete, quantitative results are given for the first ten of seventeen excavation units in Spot 2 (Fig. 4). Units 1 to 9 are all 5 centimetres deep while Unit 10 is 10 centimetres thick. (Note that larger excavated volumes in the lower units would correspond to amplified equivalent densities per m^3 for these units). Artefacts (and also *Melanopsis* gastropods) consistently increase in amounts from Locus 1.1 to Locus 1.10. The gradual and coherent increase of this pattern suggests continuous sedimentation in an area repeatedly visited by tool-making hominids. Whether the vertical artefact distribution resolves itself as a sharp maximum centred on unit 10 and the adjacent ones or not must await further analysis. Our impression at this stage, in roughly judging the amounts of finds in the bags from units 11 to 16, is that densities peak at unit 11 and dwindle rapidly thereafter to Unit 16.

Several possibilities may account for the vertical artefact distribution. The first is that the overlying material represents post-depositional disturbance from an originally sharply defined occupational land surface. But several lines of evidence weigh against this conclusion: the sharp, unabraded condition of the artefacts; the presence of small chips and microflakes retained in each unit; the small conjoined fragments which all derive from a single 5cm deep unit; and finally the conditions of deposition in a zone of low-energy groundwater outflow. Alternatively, the higher numbers of objects of various types clustered around Locus 1.10 may correspond with a hiatus in sedimentation at that time, or its abatement, leaving longer periods for surface debris accumulation. This would explain the larger numbers of *Melanopsis* gastropods considered to occur naturally in Unit 1.10.

The flaked chert assemblage is numerically dominated by flakes, both broken and whole, and small pieces of chert shatter products. A few blades occur together with a small number of retouched tools (Pl. 2:A) that include notches, retouched flakes, scrapers, and a multiple tool (notch-scraper, Table 1). While no complete bifaces were found in this particular part of the site, their presence is well attested by several biface fragments. The shallow platform angles on many of these pieces, and also on many of the small flakes in the assemblage carrying multiple dorsal flake scars, indicates their origin as by-products of biface reduction.

Elsewhere in the site a single gracile and asymmetrically shaped biface was found (Spot 3, Locus 1.9, Pl. 3:4) very similar in form to a Mashari'a 1 surface find (Pl. 3:3), and another was found at a similar altitude in surface sediments on the western face of the Tabaqat Fahl Formation (Pl. 3:5). The excavations also yielded some diminutive bifaces (Pl. 3:6-8). A number of other bifaces was found on the slopes just below the Mashari'a 1 site (but none above it), these having eroded from the sediments. They include pointed bifaces of Micoquian type (Pl. 3:1), cordiform to ovate types (Pl. 3:2), and the aforementioned asymmetric "D-shaped" bifaces. They consistently bear numerous shallow, hinge-terminated flake scars and are themselves relatively small and gracile, indicating manufacture by the soft hammer technique.

Table 1. Mashari'a 1, spot 2, Locus 1.1-1.10. Numbers of "Other Lithics" presented in Fig. 4.

	Cores	Core trim	Broken blades	Whole blades	Biface frags	Scrapers	Multiple	Notches	Ret. flakes
Unit 1	0	0	0	0	0	0	0	0	0
Unit 2	0	0	0	0	0	0	0	0	0
Unit 3	0	0	0	3	0	0	0	0	0
Unit 4	0	0	0	1	0	1	0	0	0
Unit 5	0	0	0	1	0	0	0	0	0
Unit 6	0	0	0	0	2	0	0	0	0
Unit 7	0	0	0	2	2	0	0	1	0
Unit 8	0	0	0	0	1	0	0	2	0
Unit 9	1	2	1	0	1	0	0	1	2
Unit 10	2	1	1	0	0	5	3	11	7

The range of retouched tools includes a flake trimmed by deep, flat, invasive retouch (Pl. 2:A:9) and a sidescraper similarly formed (Pl. 2:A:12), marginally retouched flakes (Pl. 2:A:7-8), and several notches formed on thick flakes (Pl. 2:A:2-6). Many of the notches were formed by edge damage through use rather than by formal patterning and are characterised by multiple tiny, stacked step fractures.

The Relationship of Mashari'a 1 to Earlier and Later Palaeolithic Sites at T. Fahl

In advance as yet of any radiometric dates for Mashari'a 1, a consideration of the site's stratigraphic position with respect to earlier and later Palaeolithic sites in the Tabaqat Fahl/ Wadi al-Hammeh region goes some way towards clarifying its position within the Levantine Lower Palaeolithic. Flaked stone material is not apparently issuing from any of the *c.* 30m thick tufa deposits overlying Mashari'a 1. All of the bifaces and other surface artefacts so far collected are found immediately below its *in situ* sediments, and on the lower slopes below. As far as we know, Mashari'a 1 is the uppermost site in the sequence in this particular area. However considerable numbers of flaked stone artefacts are distributed across the top of the Tabaqat Fahl Formation, particularly over its north-west sector, which is one of the small areas of the plateau where ploughing is not traditionally carried out.

The flat top of the Tabaqat Fahl Formation has formed a lag deposit since sedimentation ceased in the Pleistocene, accumulating artefacts of all types from Palaeolithic flints to Hellenistic sculpture (MCNICOLL 1992: 117). One of the major components consists of white-patinated flakes of Middle Palaeolithic character that have facetted, sinusoidal platforms and thick bulbs of percussion; occasional Levallois points also occur. Middle Palaeolithic sites are also stratified in the Wadi Hammeh Conglomerates that constitute the lower two-thirds of the 'Plateau'. This later terrace infilled the valley formed by the higher Tabaqat Fahl terrace on its western side (Fig. 5). Seven Middle Palaeolithic sites are stratified in the Plateau, and all are overlain by a radiocarbon date of 35,300 B.P (WALMSLEY *et al.* 1993: 174-175, EDWARDS and MACUMBER 1995: 8-9). Above this lie stratified Upper Palaeolithic and Epipalaeolithic sites (EDWARDS *et al.* 1996, EDWARDS 1991, EDWARDS and MACUMBER 1995). The basal sediments of the Wadi Hammeh Conglomerate are thought to date to *c.* 100,000 - 80,000 B.P., coeval with the filling of the adjacent Lake Lisan (MACUMBER and HEAD

Plate 1:A. The southerly face of the Tabaqat Fahl Formation, indicating Mashari'a 1 (excavation Spots 1 - 3).

Plate 1:B. Mashari'a 1: cluster of small flakes embedded in limestone.

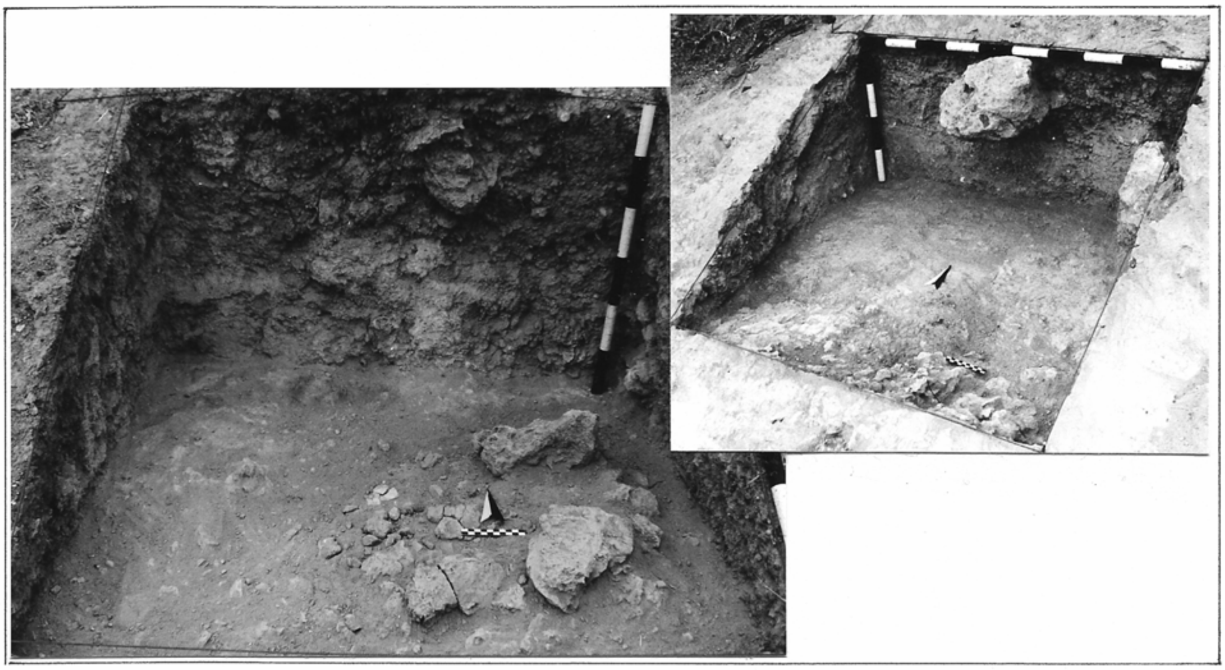

Plate 1:C. Mashari'a 1: Spot 3 (right) and Spot 1 (left) during excavation.

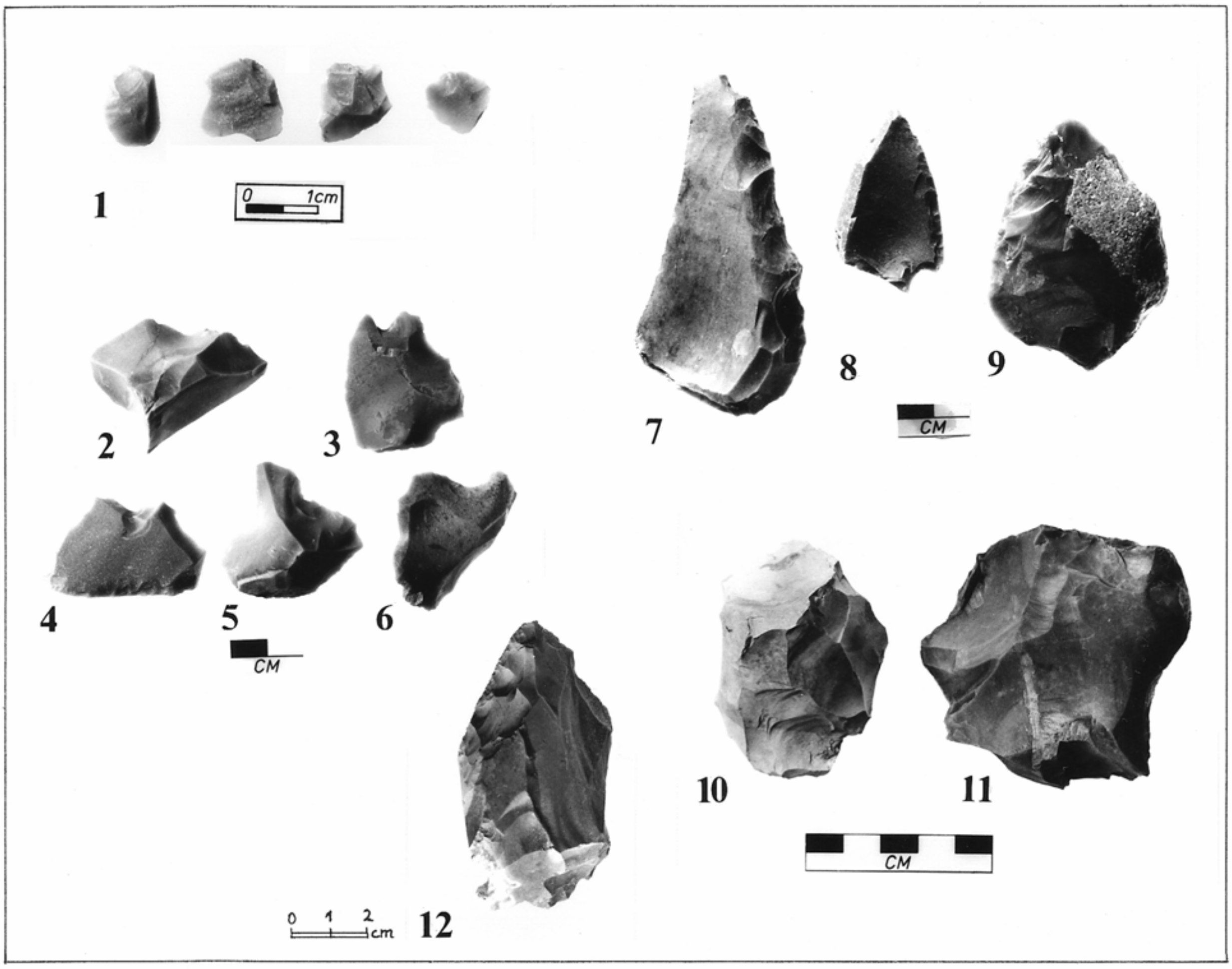

Plate 2:A. Mashari'a 1: 1 small flakes (Spot 2, Locus 1.9), 2-6 notched flakes. (2: Spot 2, Locus 1.8; 3-4: Spot 2, Locus 1.9; 5: Spot 2, Locus 1.10: 6: Spot 3, Locus 1.6), 7-8 retouched flakes (7: Spot 2, Locus 1.10; 8: Spot 3, Locus 1.4), 9 invasively-retouched flake (9: Spot 3, Locus 1.5), 10-11 multiple platform cores (10: surface; 11: Spot 2, Locus 1.3), 12 sidescraper (Spot 3, Locus 1.10) <*Note different scales*>.

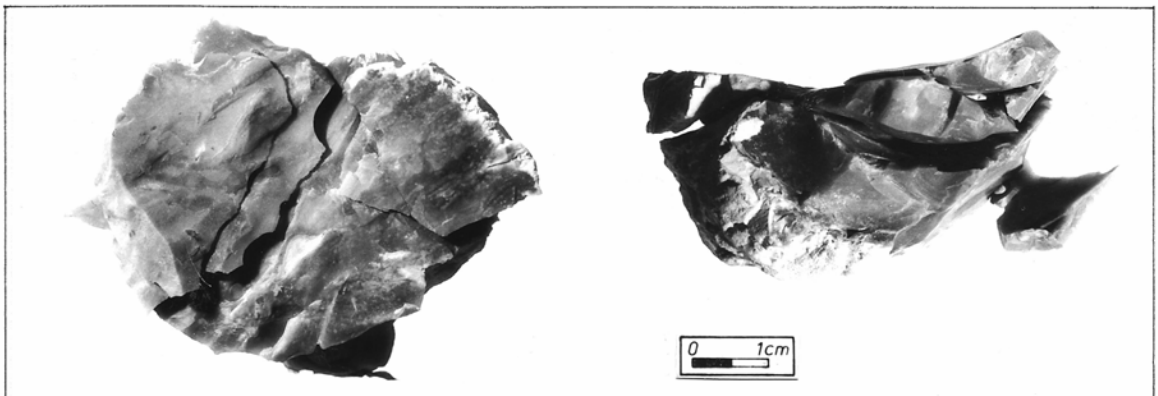

Plate 2:B. Mashari'a 1: flake core with conjoined flakes (top and side views) from Spot 2, Locus 1.9.

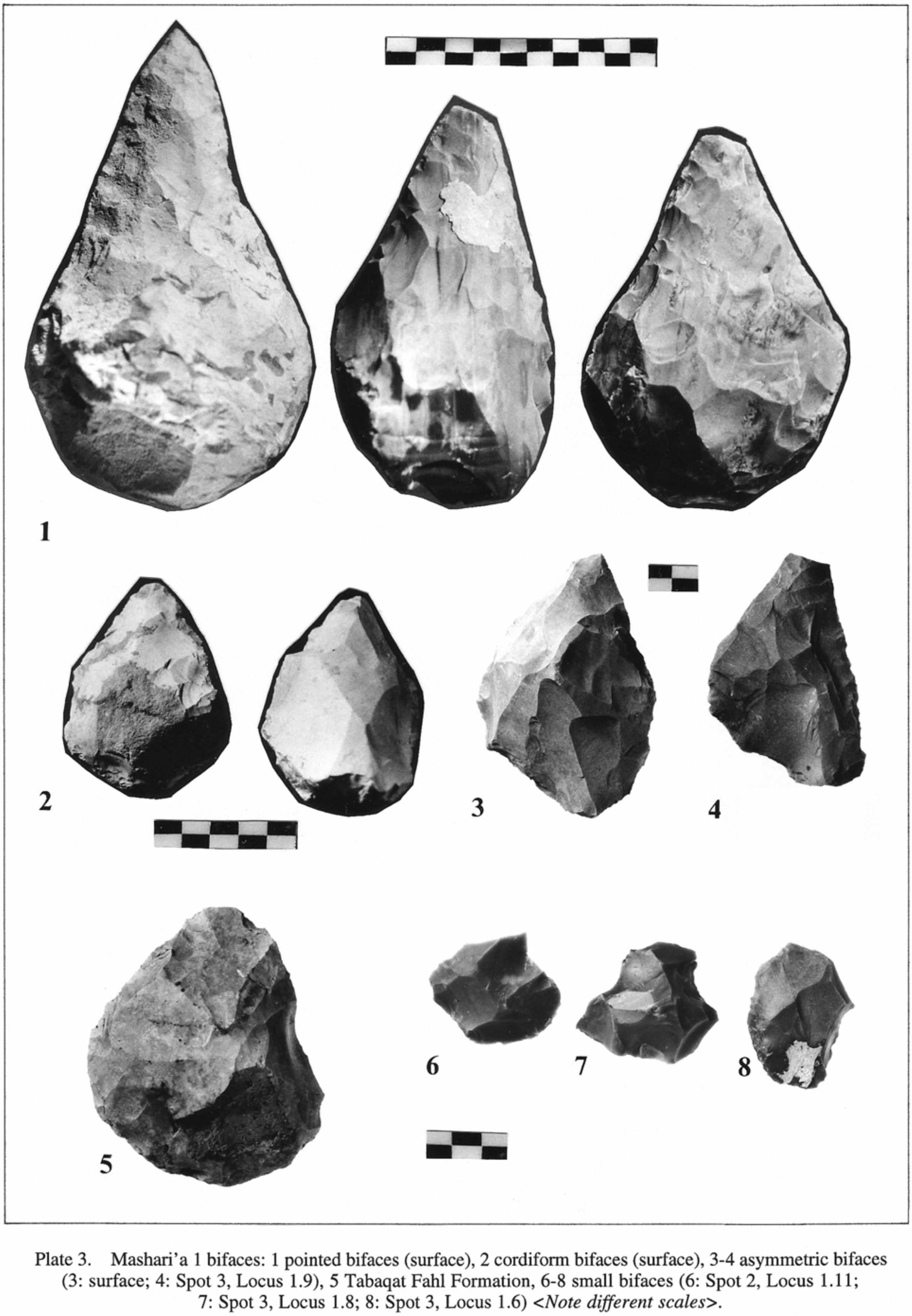

Plate 3. Mashari'a 1 bifaces: 1 pointed bifaces (surface), 2 cordiform bifaces (surface), 3-4 asymmetric bifaces (3: surface; 4: Spot 3, Locus 1.9), 5 Tabaqat Fahl Formation, 6-8 small bifaces (6: Spot 2, Locus 1.11; 7: Spot 3, Locus 1.8; 8: Spot 3, Locus 1.6) <*Note different scales*>.

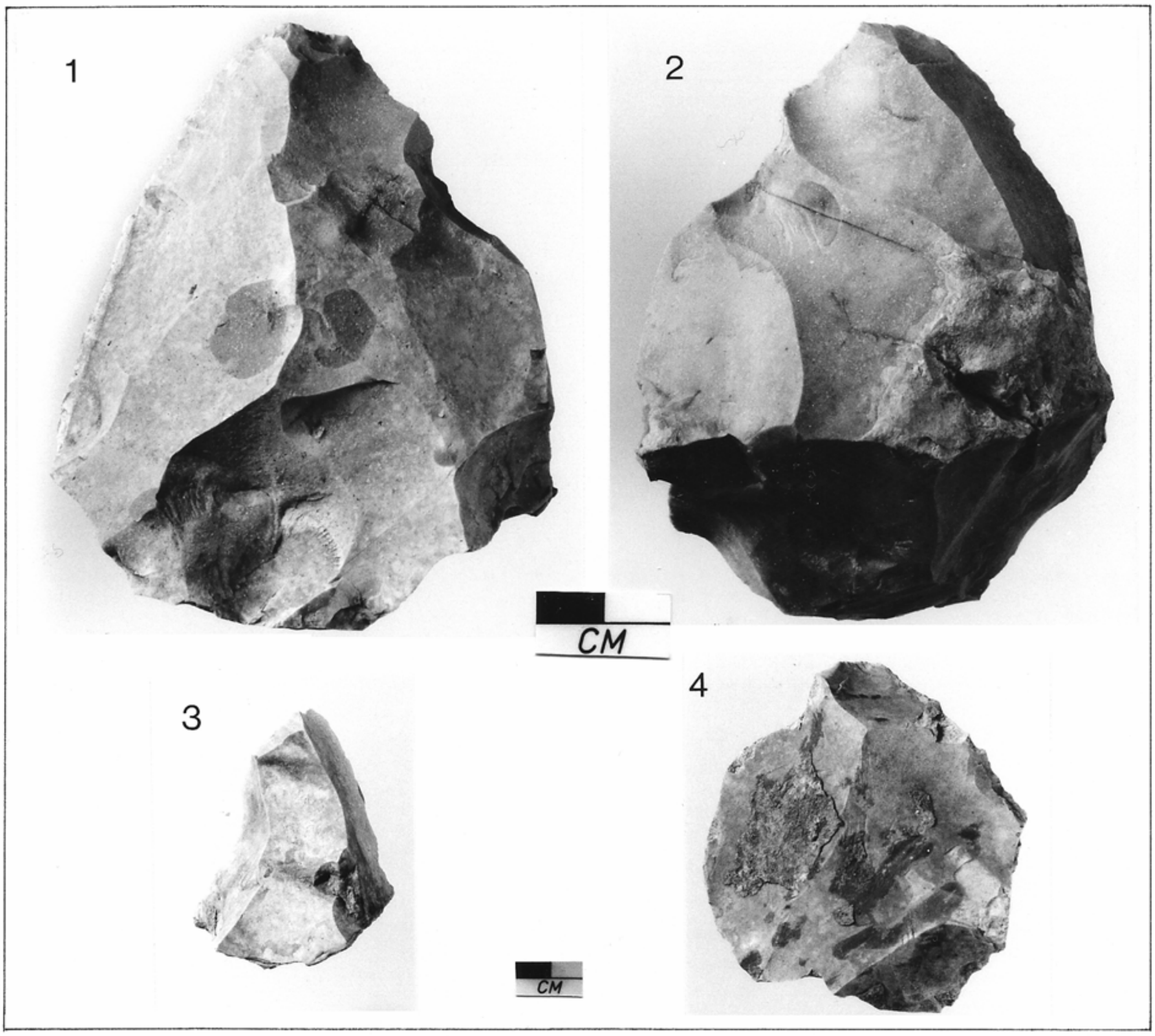

Plate 4:A. Abu Habil: 1 biface with Levallois point core on reverse (2), 3 Levallois-like point core, 4 discoidal core <*Note different scales*>.

Plate 4:B. Back-tilted sediments of the Dana Formation on Wadi adh-Dhra', capped by horizontally-bedded Late Pleistocene gravel (view to east).

1991). Because Middle Palaeolithic artefacts are located both within these sediments and across the top of the Tabaqat Fahl Formation that overlooks Wadi al-Hammeh, it seems likely that the erosive phase between the cessation of sedimentation of the former terrace and the beginning of sedimentation of the latter occurred during the early part of the Middle Palaeolithic period, or some time between *c.* 200,000 - 80,000 B.P.

Mashari'a 1 and another biface-bearing site - Mashari'a 3, on the northern slopes overlooking the Wadi al-Hammeh (*cf.* Fig. 2) - are embedded in tufas which directly overlie conglomeratic limestones. While the tufa lenses out away from the Rift Valley, the conglomeratic limestone underlying this tufa continues thickening under the foothills to the east, where it contains three more sites: Mashari'a 2, Mashari'a 4 and Mashari'a 5 (MACUMBER 1992, 1993)[1].

This region includes the area near Abu al-Khas and Abu ar-Rumayl ridge, on the watershed between Wadi al-Hammeh and Wadi Jirm, where Villiers (1982) noted Early Acheulian sites. In shallow excavations, artefacts were found to occur within only 30cm of the surface, with the lower part of this sequence contained within a heavily cemented conglomerate. Roman-Byzantine pottery sherds occurred together with lithic material in the shallower level. Villiers (1982) noted that the artefacts in the conglomerate showed evidence of crushing and rolling. From the recovered material, Villiers concluded that there were two distinct industries. The earlier industry was assessed as Lower Palaeolithic, probably Early Acheulian, and consisted of large, thick flakes and retouched flakes. The later industry contained Levallois cores, flakes and blades, which Villiers regarded as Middle to Late Acheulian.

A more recent inspection of the area during the geological survey of archaeological provinces suggests that the excavated site at Tell al-Baab is a thin lag deposit sitting on Cretaceous/Early Tertiary sediments. The lag deposit is partially derived from the reworking of high level hard siliceous and calcareous conglomerates from the Tabaqat Fahl Formation that cap the Rumayil ridge and adjacent areas immediately above the site. Although this is essentially a mixed and reworked sequence, the Villiers excavation did indicate the presence of Acheulian industries in this area.

Mashari'a 4, at the eastern edge of the Tabaqat in conglomeratic limestones, yielded two large bifaces with minimal patination. These artefacts are longer and heavier than those associated with the Mashari'a 1 site, and they bear the larger, deep flake scars associated with hard hammer flaking. Little can be made statistically of the Mashari'a biface assemblages given their low numbers, but the fact that Mashari'a 4 is stratified in a geological layer that underlies the one containing Mashari'a 1, and that its bifaces are heavier, longer and hard-hammer flaked in contradistinction to the gracile Mashari'a 1 bifaces, strongly suggest the presence of a local, differentiated sequence from Middle Acheulian to Late Acheulian in the Tabaqat Fahl region.

Writing before the excavation of Mashari'a 1, Wright (1993: 173) suggested that the entire Tabaqat Fahl series yielded only a "later Acheulian"[2]. The available stratigraphic evidence from Mashari'a 4, Mashari'a 1, the top of Tabaqat Fahl, and the Middle Palaeolithic sites in the basal Wadi Hammeh Conglomerate now prompts us to propose that Mashari'a sites 2, 4 and 5 should be placed in the Middle Acheulian, while Mashari'a 1, sandwiched between these sites and the overlying Middle Palaeolithic occurrences, should be assigned to the Late Acheulian.

The Place of Mashari'a 1 in the Lower Palaeolithic of the Southern Levant

While the scope of this paper and the limited analysis carried out so far do not permit an extensive digression on external techno-typological parallels to the Mashari'a 1 assemblage, several major regional trends are already reflected in this site and Mashari'a 4.

Mashari'a 1 is only the second rich *in situ* Acheulian knapping floor reported from Jordan. The other is the Late Acheulian site of C-Spring, embedded in the silty marsh clays of the Azraq oasis (COPELAND 1991), although, it should be added, the nearby site of Lion Spring (COPELAND 1989a, 1989b; KIRKBRIDE 1989) was equally well-stratified if less well-known. Due to good preservation C-Spring, like Mashari'a 1, had a strong component of small flakes and knapping debitage (COPELAND 1991), including biface reduction flakes with acute platform angles. Thus the type of debitage, rather than just the existence of bifaces *per se*, may indicate the existence of an Acheulian biface site in cases where bifaces may be highly curated or rare in comparison to the large quantities of reduction products necessary to make them. Copeland (1991) noted that C-Spring contained mainly ovate biface types and lacked the numerous pointed or elongated biface types of more westerly sites, though Lion Spring (COPELAND 1989b: 241), as well as the desert Wadi Acheulian

1 Unfortunately, large-scale excavations for agricultural terracing carried out during 1990-1991 along the steep slopes of Wadi al-Himar destroyed the Mashari'a 2 and Mashari'a 5 sites.

2 Wright also examined the issue of why the entire Tabaqat Fahl series lacked faunal remains. The subsequent excavation of Mashari'a 1 has revealed that faunal remains are present in the Tabaqat Fahl limestones, though in poor and fragmentary condition.

Azraq sites (COPELAND and HOURS 1989), included elongated bifaces of lanceolate and Micoquian type.

It is notable that there are as yet no well-preserved and stratified Lower Palaeolithic cave sites from Jordan as there are to the west of the Jordan Valley. The chronological sequence has so far largely been developed on the relative stratigraphic positions of artefact-bearing river terraces. Intermediate between the Tabaqat Fahl region and the wadi terraces feeding into the Azraq Basin, another multi-component system yielding Acheulian sites lies on the Zarqa River (BESANÇON *et al.* 1984) in the Upper Zarqa - Khirbet Samra area. Here, as at Tabaqat Fahl, Lower Palaeolithic sites have been assigned to two distinct geological horizons, namely the Dauqara Formation, tentatively correlated with the Latamne Formation in Syria (Middle Acheulian), and the later Bire Formation, which contains mainly rolled Late Acheulian artefacts. It is likely that the lower conglomeratic member of the Tabaqat Fahl Formation correlates with the Dauqara Formation and that the upper tufaceous member correlates with the Bire Formation.

On typological grounds also, the long trihedral sections of the Mashari'a 4 bifaces resemble the Middle Acheulian types from Latamne (COPELAND n.d.). For parallels to Mashari'a 1, one looks to one of the closest *in situ* comparisons to Tabaqat Fahl: the classic sequence from Mugharat at-Tabun (GARROD and BATE 1937). While the types of Mashari'a 1 bifaces have been influenced by the vagaries of chance finds, it is noticeable that the majority of the small number so far found are pointed or Micoquian types, unlike C Spring but like many in Tabun Phase E. Similar forms derive also from the more southerly cave site of Umm Qatafa, Phases D and E (NEUVILLE 1951).

The Mashari'a series of sites indicates the existence of a Late Acheulian (typified by Mashari'a 1), stratified in the tufaceous upper member of the Tabaqat Fahl Formation, overlying Middle Acheulian sites (*e.g.*, Mashari'a 4), stratified in the lower conglomeratic member. This sequence corroborates the seriation of southern Levantine Acheulian biface sites developed by Gilead (1970), in which bifaces are deemed to become shorter though time. One additional parallel remains to be discussed in relation to the Mashari'a Lower Palaeolithic sites: the nearby - and problematic - Abu Habil Formation.

Relationships Between the Tabaqat Fahl and Abu Habil Formations

The presence of Late Acheulian artefacts in the Tabaqat Fahl Formation raises questions as to its relationship to the nearby Lower Palaeolithic site at Abu Habil, located 15 kilometres to the south of Mashari'a (Fig. 1). In a brief, one-page report on the Pliocene to Holocene geology, palaeoenvironment and archaeology of the Jordan Valley, Huckriede (1966) comments that pebble tools of "Oldowan and Munzenburger" ages occur in steeply dipping pisolitic and conglomeratic limestones plastered on the eastern Rift Valley edge. No site locality is given, however similar sequences, albeit only gently dipping, are found along the Rift Valley at Tabaqat Fahl and at Abu Habil, in both localities overlying the steeply dipping Ghor al-Katar series. For instance at Abu Habil hard conglomerates, conglomeratic pebbly limestones and travertines - the Abu Habil fornation - outcrop as low hills bordering the main road (BENDER 1968, 1974). Citing Huckriede, Bender and subsequent authors (HOROWITZ 1979, VITA-FINZI 1982, ABED 1985) tentatively correlate the Abu Habil Formation with the Early Pleistocene Ubeidiya Formation, now thought to to date as early as 1.4 million years old (TCHERNOV 1987).

On lithological and stratigraphic grounds the Abu Habil Formation has been alternatively correlated with the Tabaqat Fahl Formation (MACUMBER 1992). As described above, similar sequences at Tabaqat Fahl contain a Late Acheulean site (Mashari'a 1), *c.* 0.5 million years old. Contrary to the later citations, Huckriede did not specifically mention Abu Habil in his original paper, and there is only his very brief note about the Oldowan occurrences which have not been reproduced. Instead, recent work by Muheisen (1988) and us has only produced Acheulean and Middle Palaeolithic artefacts at Abu Habil.

Bender (1974) noted that along the eastern side of the Rift Valley, the hard conglomeratic, partly pisolitic limestone of the Abu Habil Formation overlies steeply dipping conglomerates, sandstones, clays and limestones of the Ghor al-Katar Series. Similar sequences outcrop periodically between Abu Habil and Mashari'a, often as discrete outcrops lying westwards of the main Rift Valley fault. These locations include Wadi al-Hammeh, the Tabaqat Fahl Formation, and Wadi Jirm. At the Tabaqat Fahl Formation and in the mouth of Wadi Jirm, as at Abu Habil, the Ghor al-Katar series underlie the nearly horizontally bedded limestones of the Tabaqat Fahl series.

Muheisen (1988) revisited the Abu Habil area during the 1985 archaeological survey of the Jordan Valley. He noted a Lower Palaeolithic site (Site 44), extending over a 16-metre vertical interval. Two assemblages were obtained: a lower one came from the conglomerates, and the upper from a disturbed zone near the surface. The upper assemblage had a light grey to white patina, and included Levallois cores and a Levallois point. Muheisen tentatively dated the upper assemblage as Late Acheulian. In the lower zone an assemblage yellow-brown in colour included bifaces, picks and a spheroid. An age of between 0.6 and 1.8 million was given. The basis for this age is ultimately typological, however it is presumably based on correlations with Ubeidiya. Whatever the age, the assemblage described by Muheisen seems better described as Acheulian rather than Oldowan in character.

During the 1993-1994 season we revisited the Abu Habil Formation to inspect surface artefact exposures. Most of those encountered had the same white to light gray patina as reported by Muheisen and observed by ourselves on surface finds from the Tabaqat Fahl Formation (though this white patina rarely occurs on excavated artefacts). Our brief survey on the slopes and across the top of the Abu Habil Formation yielded numerous artefacts of Middle Palaeolithic character, in that flakes often exhibited thick protuberant bulbs of percussion and bore facetted platforms. Discoidal cores (Pl. 4:A:4) and Levallois point cores (Pl. 4:A:3) were also observed. An unusual artefact, with one face formed as a Levallois point core (Pl. 4:A:2) and the other invasively flaked as a biface (Pl.4:A:1), was embedded in the limestone conglomerate on the top of Abu Habil. The artefact singularly combines characteristics found in the Late Acheulian and Middle Palaeolithic in the Levant. Our brief observations at Abu Habil indicate the widespread distribution of Middle Palaeolithic artefacts. These finds and the presence of bifaces suggest, in our opinion, an age of *c.* 250,000 B.P. or later for its stone artefacts and do not suggest an Oldowan affiliation.

In order to obtain radiometric dates for Abu Habil, we took samples of hard pisolitic limestones from an outcrop protruding from the lower slopes of the Abu Habil Formation. Lithologically and sedimentologically, the hard conglomerates and pisolitic limestones at Abu Habil are similar to the dense calcareous conglomerates and nodular limestone which form the basal sequences to the Tabaqat Fahl Formation. Both the Abu Habil and Tabaqat Fahl Formations are underlain by Ghor al-Katar sequences and protrude into the main Rift Valley from the steeper rises farther east. Furthermore, neither formation compares readily with the steeply dipping conglomerates and lacustrine clays of the Ubeidiya Formation, with which the Abu Habil Formation has been commonly correlated. Artefactually also, its upper strata, at least, seem more closely correlated with the late Acheulian/Middle Palaeolithic than with the Oldowan or Lower Acheulian. Altogether, the Abu Habil Formation is better assigned to the latter part of the Middle Pleistocene than to the Early Pleistocene.

Ghor al-Katar

Ghor al-Katar, the type site for the steeply dipping sequences of conglomerates, sandstones and limestones that underlie the limestones of Tabaqat Fahl and Abu Habil, occurs as a long and narrow outcropping ridge near the Jordan River northwest of the town of Karameh (BENDER 1968: 92-93, 1974: 93-94). Some 350m of dipping rocks are exposed consisting of "alternating conglomerates, conglomeratic sandstones, and sandstones, marls and marly clays" (BENDER 1974: 93). The contrasting colouration of the alternating beds endows the sequence with its distinctive red, white and black striped appearance. At present the construction of the Karameh Dam has resulted in the excavation of a clear section of the dipping sediments, against which the onlap of the later, horizontally bedded Late Pleistocene Lisan marls is clearly visible. While we found occasional rolled chert artefacts of Middle Palaeolithic character in the Lisan deposits here, none has so far been observed in the Ghor al-Katar series, despite the ubiquitous natural chert constituents of the conglomerates. The Ghor al-Katar is intruded by a major basalt dyke. Given that the cooling of the basalts could provide a minimum age for the formation, we collected basalt samples, which are currently being processed[1].

Investigations of the Dana Conglomerate Formation on the adh-Dhra' Plain

The third part of the field season centred on the Dhra' Plain, between the villages of Ghor al-Mazra'a and adh-Dhra' on the east shore of the Dead Sea adjacent to the Lisan Peninsula (Figs. 1, 6). Our interest here was aroused by the Dana Conglomerate (DC) Formation, which is lithologically and structurally similar to the Ghor al-Katar Formation but which, unlike the Ghor al-Katar, is littered with abundant chert artefacts. While the DC Formation was named for a type sequence located further south between Dana and Shobak, it outcrops most extensively in this region (KHALIL 1992:40-41). Here the formation is manifest in two major exposures extending over approximately 20 km^2 north of the village of adh-Dhra' and east of the larger town of Ghor al-Mazra'a (Fig. 6). The outcrops extend to the east of the Kerak road at the rift edge, and smaller outcrops occur south of Potash City.

The DC Formation consists of alternating beds of cherty conglomerates, pink calcarenite and white limestone. The conglomerate beds range from 1-16m in thickness and many of them are substantially composed of black chert pebbles and cobbles. The co-occurrence of conglomerates and lacustrine limestones suggests that the sediments were deposited as a massive alluvial fan deposition within a subsiding lake basin (KHALIL 1992: 40). Nearer to the edge of the rift and the adh-Dhra' monocline, the Dana Formation is composed of steeply-dipping vertical and overturned fault blocks

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1 By Dr David Foster of the La Trobe University School of Earth Sciences.

(POWELL 1988: 93). Farther west the dip is shallower, and tectonic activity has resulted in back-tilted blocks still farther west in the adh-Dhra' plain (Pl. 4:B).

The age of the Dana Formation is still unclear. The formation is divided into an earlier lower member (DC^L) and a later upper member (DC^U). Doleritic basalts intrude the DC along the lower course of the Wadi al-Kerak (Fig. 6). These have not been radiometrically dated, but they are considered to be petrologically similar to samples obtained at other localities near the Dead Sea and near Kerak, dated respectively to 18.3 ± 0.9 and 18.9 ± 0.8 million yrs (BARBERI *et al.* 1980: 670-672, KHALIL 1992: 52). Fossils have not been discovered in the DC in this area, though the calcarenites contain burrows considered similar to *Thalassinoides*. Fossil collections from the adh-Dhra' area have also produced *Globigerina officinalis subbotina*, *G. senilis* and *G. tripartita,* all thought to be Oligocene in age. By analogy then, the DC^L should be Oligocene to Miocene in age. On the other hand, the latest age for DC^U is given by Bender (1974) as Middle Pleistocene because in the Dana area it is overlain by gravels containing flint implements diagnosed by him as Middle Pleistocene (BENDER 1974, POWELL 1988). In this connection it is worth noting that we have found several white-patinated Levallois points (*i.e.*, Middle Palaeolithic; Late Pleistocene) in the adh-Dhra' plain (Pl. 5:C:2) associated with the Pleistocene gravels which unconformably overlie the DC (Pl. 4:B). This correlates with the placement of these gravels as the terrestrial equivalent of the Lisan Formation (KHALIL 1992: 42). Occasional gracile flint bifaces have been found by us in the vicinity also, but not so clearly associated with the gravels.

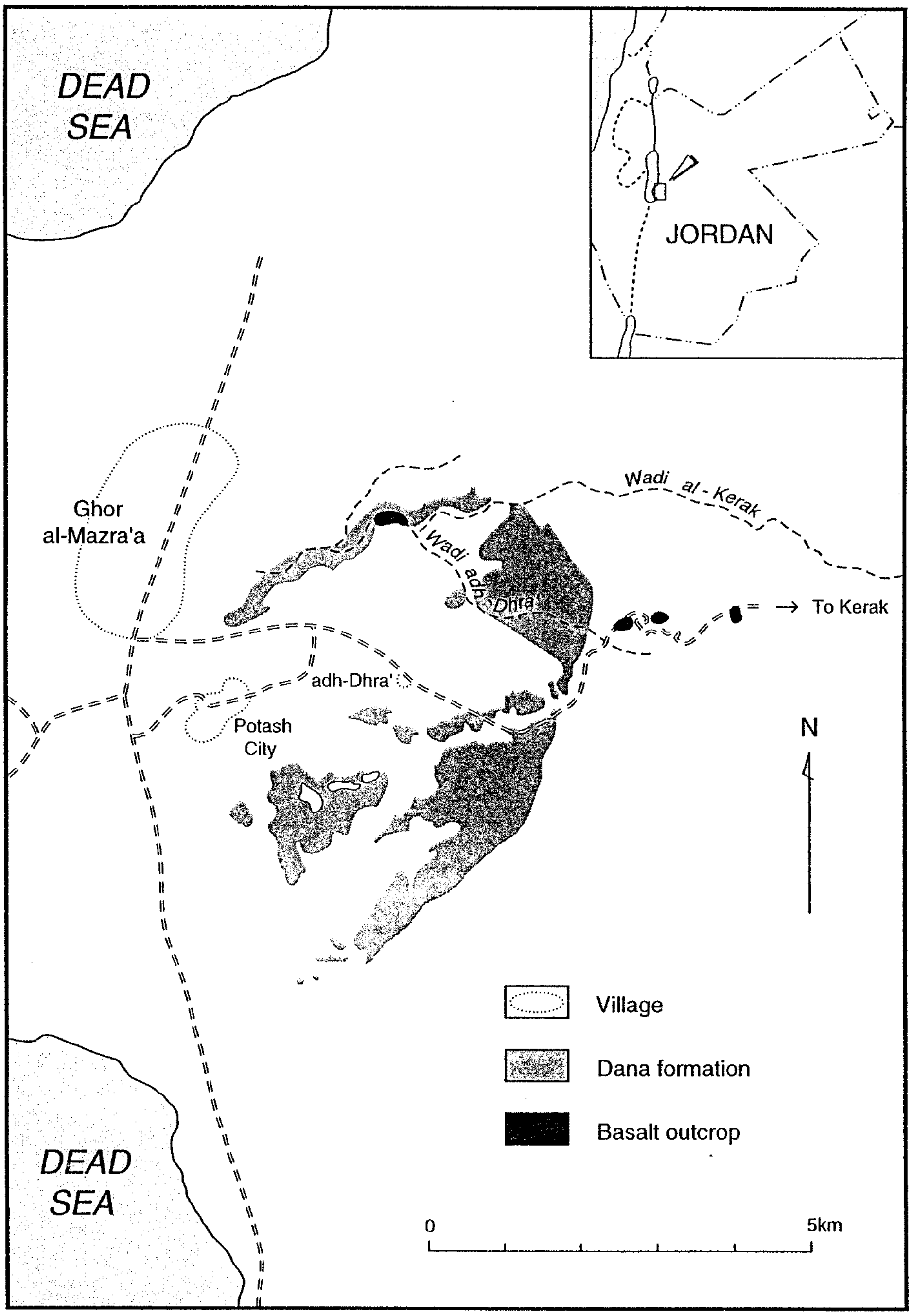

Fig. 6. The adh-Dhra' / Ghor al-Mazra'a region.

The barren plain of Dhra' has a surprisingly rich archaeology that has been the subject of numerous archaeological surveys. R. Raikes (1984) observed that, in the past as now, the apparent barrenness of the area is somewhat misleading. While rainfall is extremely low, the area is well watered by numerous springs, including 'Ain Sikkin, 'Ain Mughra, and 'Ain Hammam al-Hamra. Indeed, the name Mazra'a of the largest town in the plain translates as "the Farm". At present the groundwaters are

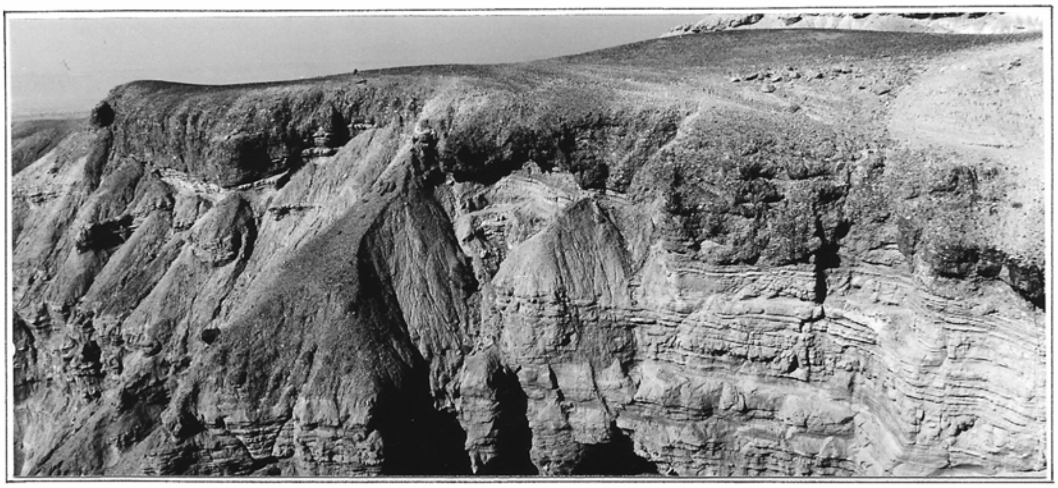

Plate 5:A. Dana Conglomerate Formation outcrop in Wadi adh-Dhra', showing thick chert conglomerate (dark capping layer) <*Note human scale*>.

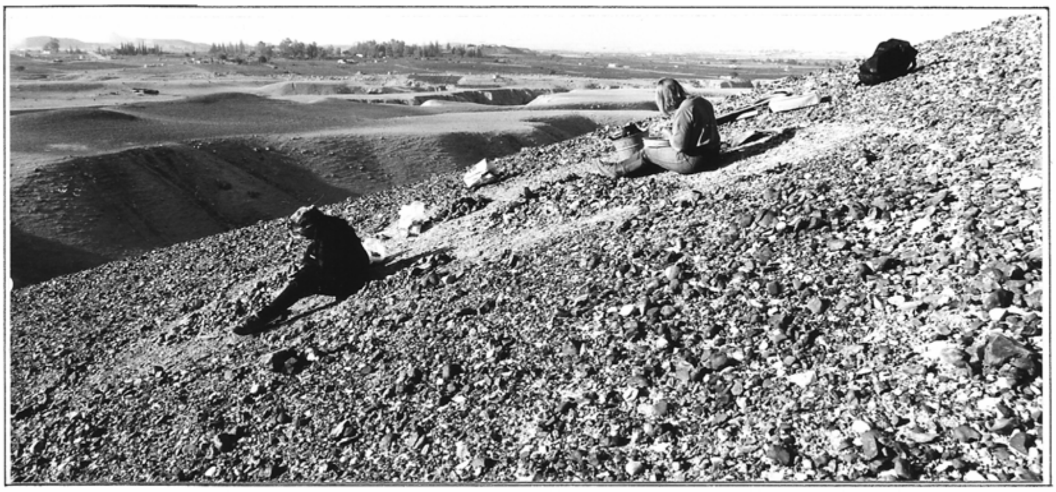

Plate 5:B. Artefact sampling at Dhra' chert quarry (Spot 6).

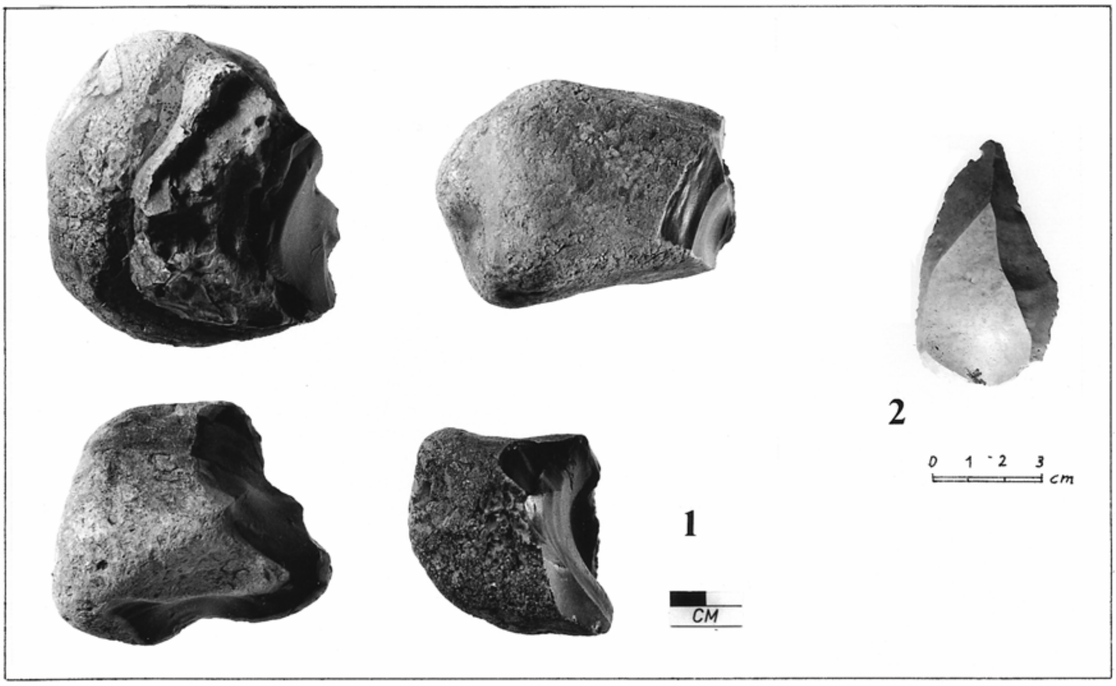

Plate 5:C. Pleistocene gravel cap, Dhra': 1 flaked cobbles (Dhra' quarry, Spot 7), 2 Levallois point.

locally utilised to irrigate extensive vegetable gardens in the area. While rife illegal excavations in the region have substantially damaged most encountered sites, fewer sites have undergone systematic excavations. Perhaps the best known of these is the Early Bronze Age town of Bab adh-Dhra' with its associated necropolis (RAST and SCHAUB 1981, SCHAUB and RAST 1989). Others also exist, for example the Dhra' Neolithic site excavated by Bennett (1980), and more recently by Kuijt and Mahasneh (n.d.). Nearby the "Monumental Pillar" site has been excavated by Körber (1992).

These projects are just east of the region investigated by us on the banks of the Wadi Dhra' on a ridge just north of the major market gardens of Dhra' (Figs. 6-7). Other surveys have been carried out in the region but situated outside of this specific area. To the north of Wadi al-Kerak Worschech (1985) discovered numerous sites of many periods. To the west McConaughy (1981) located prehistoric sites in the fan of the Wadi al-Kerak. Both researchers have reported Lower Palaeolithic sites. Worschech's surface Site 1 was dated as Late Acheulian by Rollefson (1985: 78). The assemblage included a chopper, a ficron handaxe and a Levallois flake core. While these artefact types could be found though a great time range, Rollefson assigned them to the Late Acheulian on the basis that all artefacts from the site exhibit a similar degree of patina and abrasion.

West of our study area, McConaughy (1981) reported several Palaeolithic sites that yielded diagnostic artefact types such as Levallois points and bifaces, including one "full-fledged Lower Palaeolithic site" (MCCONAUGHY 1981: 188) eroding from the south bank of Wadi al-Kerak. This he assessed as being rolled and in secondary context.

Like us, these researchers have found numerous artefacts datable to the Middle Palaeolithic and Acheulian. The numerous "choppers" present more of a problem. Not only could they be diagnostic of every period from the Oldowan onwards, but as we shall see, they are particularly common on flint quarry sites where they may represent the initial stages of core reduction or merely the testing of chert cobbles by itinerant knappers. Also, despite the likelihood that points and handaxes are correctly attributed to the Middle Palaeolithic and Acheulian, such artefacts, like the choppers, point to the pressing need for a stratigraphic framework for the Lower Palaeolithic of the Dhra' Plain. Nevertheless, many simply flaked cobbles were strongly associated with the outcropping chert conglomerates of the DC, and there still remained the possibility that these artefacts were issuing from the DC. If so, they could on geological grounds only be Early Pleistocene or Middle Pleistocene at the latest.

Given the possibility that the DC dated up to the Middle Pleistocene, interest centred on the large number of flaked chert artefacts, including numerous flaked cobbles, which are distributed over its thick chert beds (Pl. 5:C:1). On flat surfaces the naturally-rounded chert cobbles weather loose from the conglomerate and lie intermingled with prodigious numbers of flaked chert artefacts (Pl. 5:A). The crucial question that needed to be resolved here was whether the artefacts were eroding *from* the conglomerate, and so dated from the Middle Pleistocene or earlier, or whether they were merely surficial, resulting from surface quarrying for chert well after the deposition of the DC.

Excavations at Spot 9 (Fig. 7) on a broad, shallow slope of the chert-rich conglomerate proved conclusive. Artefacts were distributed on top of the deposit and filtered down some 30 centimetres into a 90cm deep excavation pit (Fig. 8), but they were not embedded within the conglomerate. The verdict must be that these are not among the earliest sites in southwestern Asia. Had artefacts been found in the Dana Formation's alluvial chert veins, they would have been rolled by water transport. Other sediments in the formation are marine and therefore unlikely to produce evidence of human occupation. In a few cases yellow sandstone deposits exist that provide possible findspots. Although we clambered up and down considerable areas of these rugged outcrops, both in this area and to the south of Potash City, we had no luck in finding *in situ* artefacts despite the presence of numerous bands of thermally shattered flint. We hope that the basalt samples from the Wadi al-Kerak will determine if the DC in this area antedates the Plio-Pleistocene and is thus earlier than the hominid lineage.

Nevertheless, the millions of artefacts distributed across the chert conglomerates include handaxes and Levallois point cores, which indicates the use of this barren place as a quarry over hundreds of thousands of years. While previous surveys in the Dhra' region have emphasized the many discrete sites present, it is also important to stress that these sites are overprinted (and often, in chronological terms, "underprinted") by the more or less continuous scatters of flaked stone artefacts that carpet much of the plain.

The chert veins produced countless rolled cortical cobbles, a form that could have served as an immediately useful flake core. While flakes, cores and retouched tools are most abundant on the quarry, these items were also widely distributed in the surrounding region. Rather than accent discrete findspots, our sampling strategy was designed to capture any pattern in the lateral distribution of stone artefacts in relation to the major chert bands and on a variety of geological substrates across the plain. In order to sample this distribution, we made total artefact collections at points successively farther away from the sources of the flat-topped Dana chert conglomerates concentrated near the Kerak road.

The scope of the survey was restricted by limited time and local topographic features. To the east the Kerak road immediately borders the vertical slopes of the Rift Valley edge. To the south, ex-

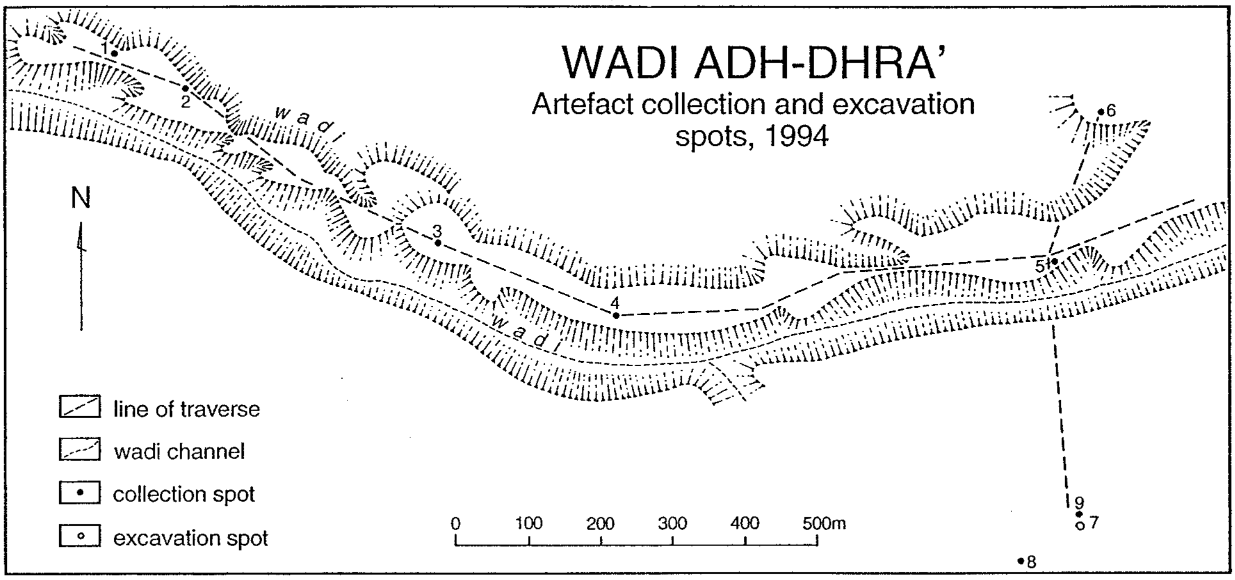

Fig. 7. Artefact collection and excavation areas on the Dhra' Plain.

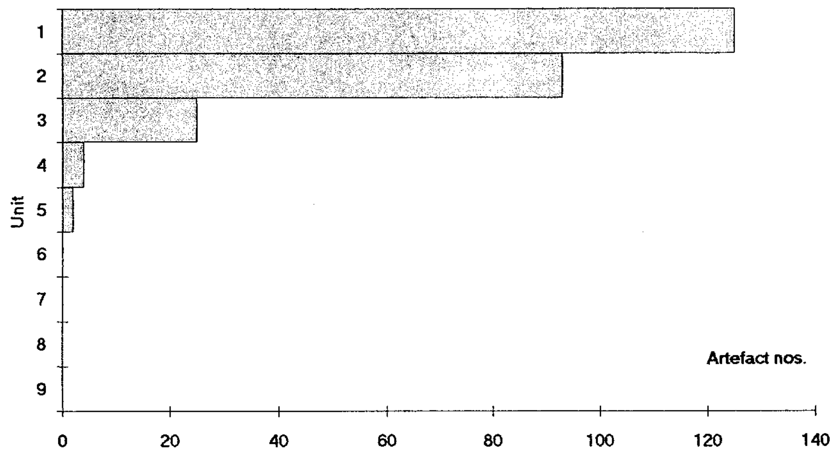

Fig. 8. Excavation of Dhra' Spot 9. Artefact distribution according to depth.

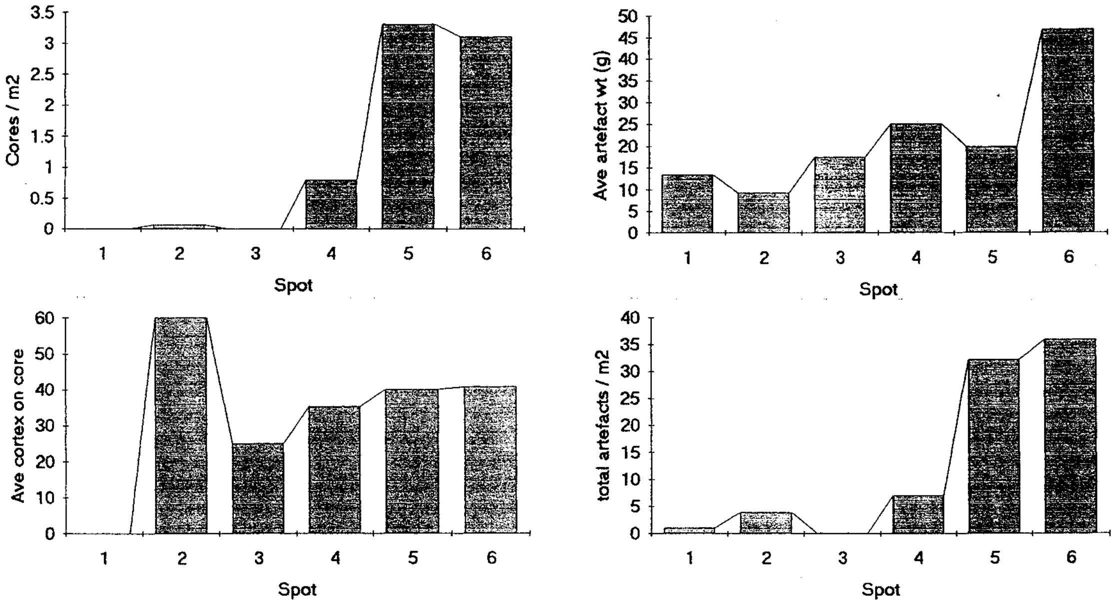

Fig. 9. Flaked stone artefact distribution across Dhra' collection points
<Note that Spot 2 in bottom graph consists only of two cores.>.

tensive vegetable gardens obscure and have silted over the ground surface. Immediately north of the gardens, the flat-topped ridges of Dana Conglomerate and their overlying sediments are dissected by the deeply incised, westward-trending gorges of Wadi adh-Dhra', Wadi al-Kerak and their tributaries. In the past, as at present, travel would only have been convenient along the ridge tops, and certainly their ancient surfaces preserve the whereabouts of discarded artefacts, whereas the down-cutting of the wadi channels have erased others.

Four collection circles (each 3m diameter) were effected at successive distances to the west of the conglomerates along a ridge overlooking the Wadi adh-Dhra'. Three collections of half this size were also made on the conglomerates, for which Spot 5 and Spot 6 (Pl. 5:B) are reported here (Fig. 7). The results reveal "fall-off" curves in terms of total artefact numbers, numbers of cores, degree of reduction of the cobbles as indicated by cortex coverage, and also decreases in the average size of artefacts (Fig. 9). The pattern of transported artefacts indicates that the great majority of them emanate from the chert quarries, an additive process exacerbated over hundreds of thousands of years.

These patterns of distribution are usually associated with the transport of stone materials over considerable distances (hundreds of kilometres) from the source (*e.g.*, TORRENCE 1986). Here we stress that we do not intend to explain the similar patterns encountered here, given the short distances involved, as resulting from exchange patterns, but as the casual, serial use of a raw material carried away over long periods from its source. Analogous to Renfrew's "law of monotonic decrement", many scenarios of raw material procurement can ensure that "effective distance from a localised source will be a monotonic decreasing one" (RENFREW 1977: 72).

In the Dhra' Plain the coherent fall-off patterns are not so much to be explained as a 'distance-decay' phenomenon, but rather that the massive amounts of flaked cobbles and chert cores on the conglomerate bands simply dwarf those adjacent to them. Furthermore, the major practice of initial core reduction in this vicinity results in much higher cortex frequencies than away from it. There is some indication that retouched artefacts are more common as distance from the quarry increases. While the dark brown chert cobbles of the Dana conglomerate are distinctive, the geology of the region further complicates the distribution pattern. For example, one of the sampled areas consisted of barren lacustrine silts (Spot 3). Another (Spot 4) was located on a Late Pleistocene gravel cap (Pl. 4:B) with its secondary source of alluvial chert and rolled chert artefacts, and still another collection point (Spot 1) coincided with a major Middle Bronze Age town site. While raw material origins cannot be vouchsafed for any single artefact in the Dhra' Plain, overall the coherent pattern of distribution indicates long-term use of the Dana Conglomerate as a quarry for tool making.

While the antiquity of the Dhra' chert quarries is open to question, the existence of these massive chert sources, their close proximity to freshwater springs, and the narrowness of the Dhra' Plain between the Jordanian Plateau and the Dead Sea raise the issue of the accessibility and importance of these resources of stone and water to early hominids travelling north through the Rift Valley.

Since the major rifting events associated with the formation of the Jordan Valley in this locale were completed by the Pliocene (KHALIL 1992), it is probable that the Dana Conglomerate cherts would have been available at all times since the advent of the earliest hominids. This factor bears on the question raised by Goren-Inbar (1992) as to whether the earliest hominids in the Levant recognised and utilised chert as a convenient raw material. At Gesher Benot Ya'aqov the earliest artefacts are made primarily on basalt, with chert use only widespread in a second phase (GOREN-INBAR 1992). On this basis Goren-Inbar has suggested that because of their prior experience in East Africa, where chert sources were scarce, the earliest hominids in the Levant did not widely utilise chert as a resource in tool-making.

This model comes under some pressure in the context of the Dhra' chert quarries in view of their accessibility, abundance, convenience and proximity to water. Given that early hominids in the Levant travelled up the Rift Valley following the lines of freshwater springs, they must have inevitably encountered the rich adjacent chert beds of Dhra', located in the narrow plain between the sheer escarpments of the rift edge and the Dead Sea. Here, where basalt and other stone resources are rare and isolated, the Dana Conglomerate is carpeted with Wheeler's "infinitude of split stone", much of it thermally shattered and clearly indicating its properties of conchoidal facture. It seems difficult to countenance that *Homo erectus* did not understand the implications of these shiny fractured stones.

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'Ain Soda and 'Ain Qasiya: New Late Pleistocene and Early Holocene Sites in the Azraq Shishan Area, Eastern Jordan

Gary O. Rollefson, Douglas Schnurrenberger, Leslie A. Quintero, Richard P. Watson, and Russanne Low

Abstract: *Recent construction activity in the Azraq Shishan pools area of Jordan's eastern desert has revealed what appear to be significant* in situ *deposits of Late Acheulian, Levantine Mousterian, early Epipaleolithic, and PPNB exploitation around two pools ('Ain Soda and 'Ain Qasiya), as well as potentials for tracing environmental and paleoclimatic change in well-dated contexts. This report considers a sample of lithics material collected from disturbed contexts in 1996 and comparisons with earlier excavations in the area. Among the conclusions, the oasis area was clearly a lucrative Pleistocene hunting area, and the extreme importance of cleavers in the collection substantiates earlier observations that the conditions in the Azraq Basin spawned a unique facies of the Late Acheulian industry.*

Introduction

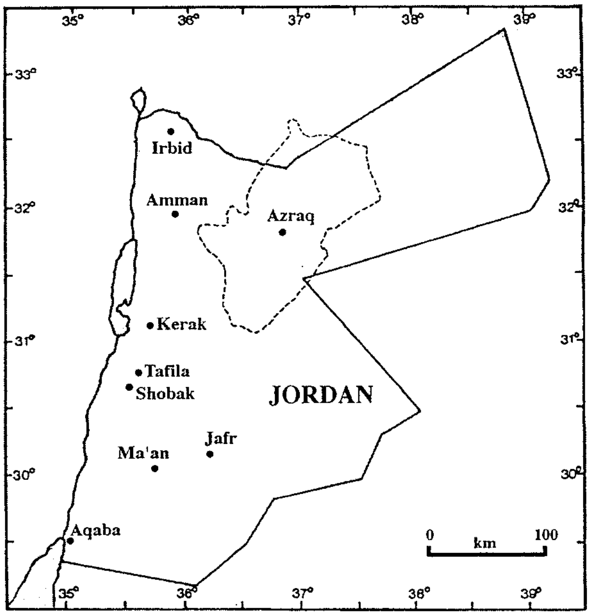
During the summer of 1996 several of the authors (Low, Schnurrenberger, and Watson) worked together as members of the paleoenvironmental team of the Madaba Plains Project. One of their major goals for the season was to locate suitable sites for extraction of pollen proxy evidence for Holocene paleoenvironmental and paleoclimatic change. Lacking typical pollen sample sites (lakes, bogs, etc.) in the vicinity of the Madaba Plains, the team investigated areas outside the Madaba Plains Project area.

Late in the field season, the team traveled with Dr. Daoud al-Eisawi, Professor of Biology at the University of Jordan, to the newly developed pools at the Azraq Oasis Conservation Project in Azraq Shishan (Figs. 1-2). Dr. al-Eisawi had previously recovered pollen from buried lacustrine deposits in the Azraq area, and it was hoped that sites could be located which would allow for a temporally controlled reconstruction of changes in environment and climate. The team recovered several shallow cores from the northern edge of the 'Ain Soda pool and made plans to return to the site to sample a section exposed by bulldozing activity.

The next day, while Low and Schnurrenberger were collecting sediment samples for pollen analysis on the north side of the pool, Watson made a reconnaissance of the western side of the pool and noted the presence of black chert flakes eroding out of a buried gravel stratum near water level. After finishing their sediment sampling operations, the entire team began a search for additional artifacts exposed by the enlargement of the pool. In an examination of a peninsula on southern edge of the pool, which had been exposed by dropping water levels, Watson noted the presence of numerous bifaces and a proboscidean (*Elephas* sp. or *Stegodon* sp.) tooth that were apparently *in situ* within a gravel stratum directly overlying a green clay stratum. A brief survey of the areas surrounding the pool revealed an astonishing number of lithic artifacts and faunal remains. These materials were, of course, seriously, displaced having been excavated from the area of the pool during bulldozer operations to enlarge it some 24 months earlier.

Following these discoveries, the MPP Paleoenvironment Team contacted Rollefson and Quintero, who were working at 'Ain Ghazal in Amman. The following morning, the entire group returned

Fig. 1. Location of the Azraq basin (dashed line) in eastern Jordan.



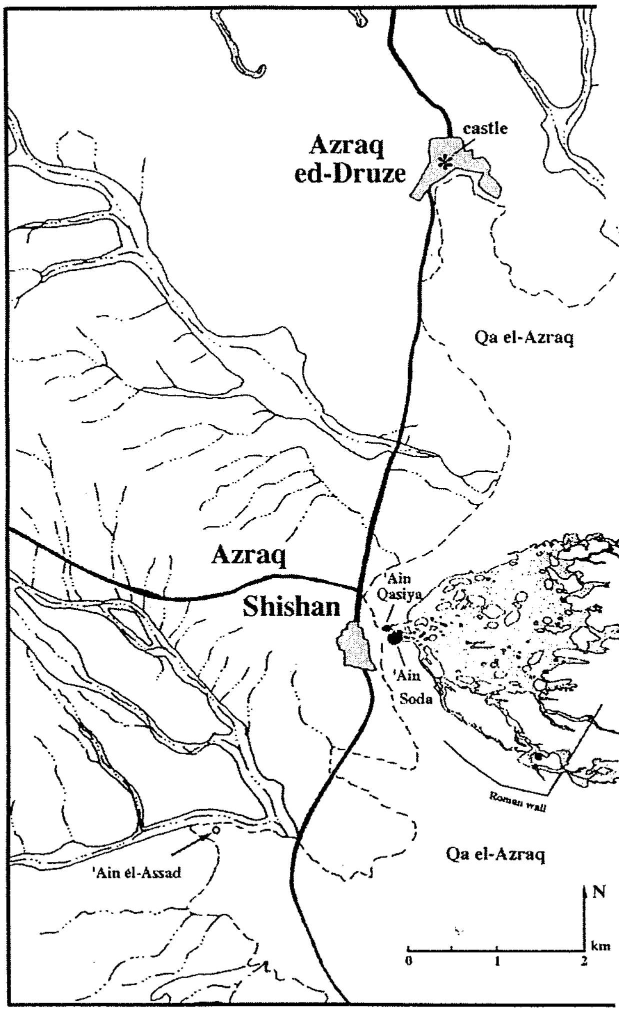


Fig. 2. Detail of the Azraq oasis area, including the locations of the Azraq Shishan marsh, 'Ain Qasiya and 'Ain Soda, and 'Ain el-Assad.

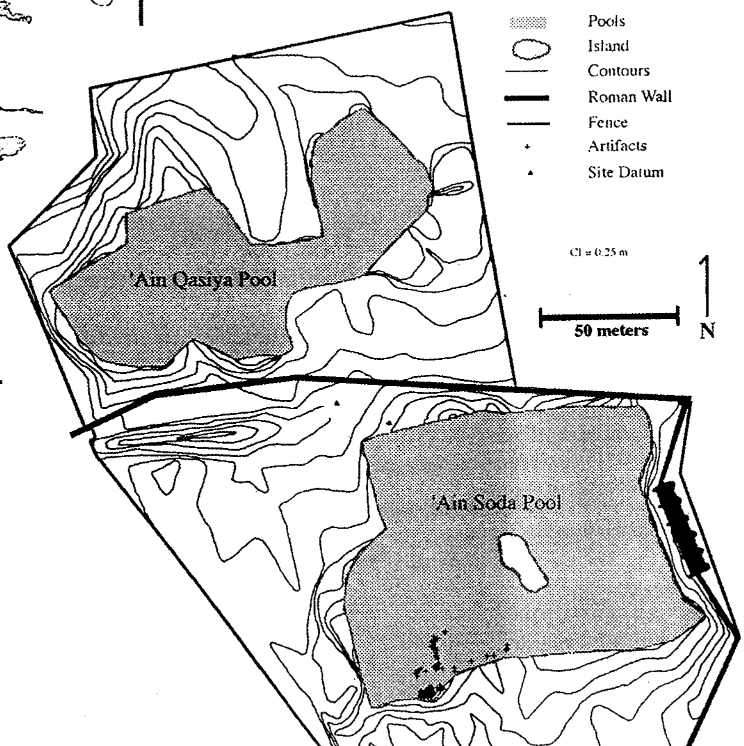


Fig. 3. Plans of the artificially created pools at 'Ain Qasiya and 'Ain Soda.

to Azraq Shishan and began a systematic documentation and recovery of stone tools and faunal remains. The documentation and recovery focused on the artifacts and faunal remains which appeared to be *in situ* along the margins of the ever shrinking pool, as well as on the areas of backfill to the west and south of the 'Ain Soda pool (Fig. 3).

Stratigraphy ('Ain Soda)

The excavation team made several brief visits to 'Ain Soda during the 1996 field season. Much of the team's effort was devoted to a systematic collection of artifacts from the pool where they were exposed by a recent drop in pool level and from the disturbed sediments in the area around the pool. During the visits the team undertook a brief examination of the sedimentary section exposed on the north side of the pool (Pl. 1:a-b). Exposure was limited in all other areas by recent disturbance and flowing of poorly-consolidated saturated sediment into the pool following the drop in water level.

A description of the sedimentary section is provided in Table 1. Further elaboration and an interpretation of the depositional environment of these sedimentary facies is provided below.

Table 1. Stratigraphy of the 'Ain Soda sediments.

Depth in cm	Description
0-10	Recent fill from bulldozer operations
10-45	White (7.5 YR 8/2D), partially indurated calcrete surface horizon. Contains flecks and chunks of charcoal up to 0.5cm diameter
45-65	Light brownish gray (10 YR 6/2 D) coarsely laminated silty clay with occasional pea gravel and containing thin but distinct very dark gray (10 YR 3/1 D) organic lenses
65-87	Light brownish gray (10 Yr 6/2 D) matrix-supported pea gravel in a matrix of silty clay
87-120	Grayish brown (10 YR 5/2 D) silty clay
120-153	Light brownish gray (10YR 6/2 D) matrix-supported pea gravel in a matrix of silty clay
153-225	Black (10 YR 2/1 M) organic rich silty clay with occasional chert gravels (5-10cm diameter) and chert flakes
225-230	Peat
230-240	Artifacts interspered with gravel and sand
> 240	Greenish-gray (5-6 Y 6/1) clay

Clarification of the stratigraphy, with special emphasis on the age of the various facies and distributional hiatuses, will be the focus of the team's research during the 1997 field season.

The exposed section at 'Ain Soda extends from the surface down to the water level in the pool, which fluctuates, but was 240cm below the surface at the time it was observed by our team. The basal stratum is a greenish gray clay that, based on only limited observation in the field, is mostly devoid of artifacts or other large objects such as megafaunal remains; on the other hand, two concentrations of bifaces were noted at the southern and western edges of the pool, exposed evidently *in situ* in the greenish gray marl (see ROLLEFSON 1997 for evidence of bifaces in an overlying dark brown-to-black marsh deposit at 'Ain el-Assad). While wading through the waters of the pool, one of the authors sunk through approximately 70cm of greenish gray clay. Further descent into the clay was prevented by a firm, buried surface that underlies the greenish clay everywhere within the pool area. Although it was impossible to examine this buried surface, it is possible that it is similar to the gravel stratum overlying the greenish clay, and it may in fact contain artifacts that predate those recovered from higher stratigraphic levels during the 1996 season.

Overlying the greenish clay with a sharp, probably unconformable contact lies a sandy gravel artifact-bearing stratum. This stratum is composed of numerous sub-angular to rounded, black chert pebbles and granules with sharp micro- and macroflakes. It is believed that the majority of the bifaces recovered in disturbed context could have originated from this stratum. This stratum was approximately 30cm above water-level on the northern exposed section of the pool (Fig. 2) on the last day of the field season. This same stratum was below or at the water line on the southern portion of the pool (depending upon daily fluctuations), indicating that this stratum dips towards the south at approximately 0.3cm per meter. If this assessment is correct, the artifacts have been totally removed from the northern portion of the pool but may still be *in situ* in the southern portion. The dip to the south may reflect a dip in the paleolake bottom or post-depositional, sub-aerial erosion. This stratum is interpreted to represent lacustrine sediments deposited in a permanent lake of unknown depth. Evidence of this paleolake Azraq is represented in deposits from 'Ain al-Assad and C-Spring (ROLLEFSON 1983, HUNT and GARRARD 1989) in other parts of the basin and may correlate to high strandlines noted elsewhere (VAN LIERE 1960-61: 55, GARRARD *et al.* 1985; but see BESANÇON *et al.* 1989: 31).

The sandy gravel stratum is unconformably overlain by a thin peat lens at the base of a thick, organic rich, silty clay. The only large clasts contained within the organic silty clay are rare black chert flakes of as yet undetermined age. These sediments are indicative of a drop or disappearance of the permanent lake from the basin and the development of at least a local, seasonally inundated marsh adjacent to the spring.

The organic-rich stratum is conformably overlain by a thick sequence of silty clay containing occasional carbonate nodules and intercalated with thin, but distinct, organic lenses. These sediments are interpreted to represent periodic drying of the marshy area and lowered water tables.

The uppermost stratum is a calcrete horizon. This soil horizon is interpreted to represent prolonged drying and a low water table resulting in precipitation of carbonates and sulfates from soil water.

The Artifact Collections

Surface collection of artifacts exposed in the pool area of Azraq Shishan ("South Azraq") was undertaken in two stages: the first in late July - early August and the second from 17 to 22 August 1996[1]. A preliminary typological and descriptive analysis of tools from the first stage has been finished, although a technological analysis of tools, cores, and debitage remains to be conducted on this collection. No typological or technological research has been carried out yet on the collection from the second stage.

The material from the first stage consists of 218 bifaces (handaxes and cleavers) and 152 flake tools, all of which probably date to the Late and Final Acheulian. (The dating confidence for the bifaces is very high, but much less so for the flake tools). In addition, there are 10 tools possibly dating to the Middle Paleolithic (Levantine Mousterian), eight tools from the Epipaleolithic (probably either Kebaran or Geometric Kebaran), three from the PPNB, and 27 flake tools of unknown age. Altogether, there are 196 flake tools in the first collection; the numbers of cores and pieces of debitage have not been counted.

Table 2. Absolute and relative frequencies of biface types in the 'Ain Soda sample compared to other Azraq area assemblages. (Note: AA(R) refers to 'Ain el-Assad, ROLLEFSON [1983], AA(K) to the Kirkbride and Harding collections from 'Ain el-Assad [COPELAND 1989 a, b]; C-Spring [COPELAND 1989c]).

	'Ain Soda			AA(R)	AA(K)	C-Spring
Type	n	%	%'	%'	%'	%'
Lanceolate	10	4.59	4.65	2.47	15.36	0.00
Ficron	8	3.67	3.72	3.70	0.00	0.00
Micoquian	4	1.83	1.86	0.00	0.00	0.00
Cordiform	6	2.75	2.79	2.47	3.91	0.00
Elongated cordiform	2	0.92	0.93	0.00	0.00	0.00
Amygdaloid	23	10.55	10.70	11.11	25.26	9.86
Subcordiform	7	3.21	3.26	4.94	0.00	0.00
Ovate	3	1.38	1.40	11.11	27.60	38.03
Limande	0	0.00	0.00	1.23	5.47	12.68
Cleaver	135	61.93	62.79	32.10	7.55	25.35
Cleaver on flake	3	1.38	1.40	1.23	0.26	0.00
Naviform	0	0.00	0.00	1.23	0.00	0.00
Diverse	3	1.38	1.40	19.75	3.65	5.63
Partial	3	1.38	1.40	7.41	7.81	4.23
Abbevillian	1	0.46	0.47	1.23	0.00	0.00
D-Shaped	7	3.21	3.26	-	3.13	4.23
Subtotal	**215**		**100.00**	**100.00**	**100.00**	**100.00**
Indeterminate	3	1.38				
Total	**218**	**100.00**	**215**	**81**	**384**	**71**

For the artifacts in the second (and so far unanalyzed) collection from 'Ain Soda, there are 193 bifaces, 127 flake tools, 127 cores, and 310 pieces of debitage. All of the bifaces are Late/Final Acheulian, but the rest of the collection has not been assigned any preliminary dates. Nevertheless,

1 Dr. Phillip Wilke (UC-Riverside) joined the second collection effort, and we are grateful for his help in the field and the discussions about paleolithic technology.

Plate 1:a. Artifact-bearing surface (disturbed) exposed in the southwest corner of 'Ain Soda following a drop in the water table.

Plate 1:b. More than two meters of sediment layers were revealed along the northern edge of 'Ain Soda.

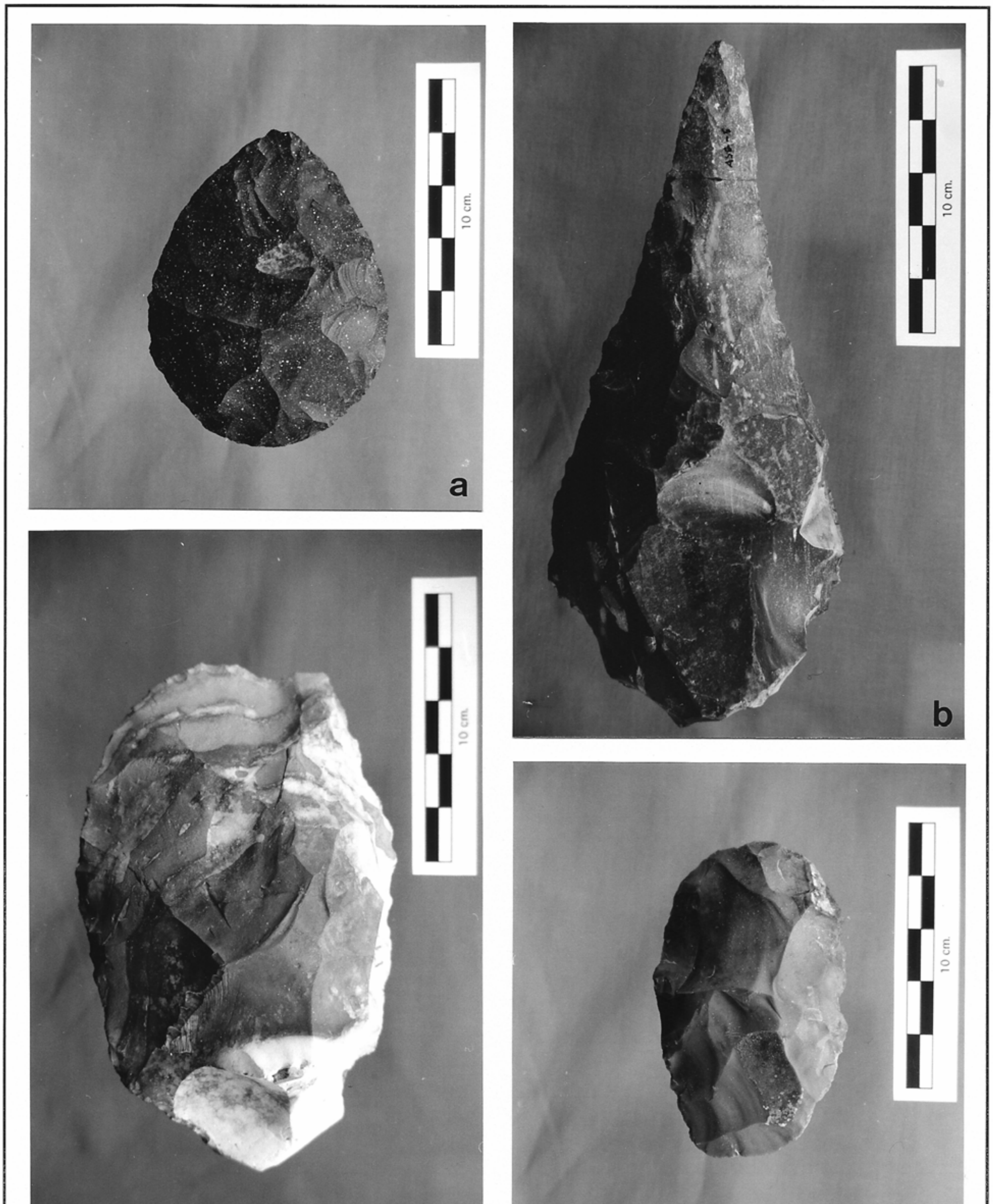


Plate 2. a cordiform biface, b Micoquian biface,
c-d cleavers (Note the tranchet scar along the upper transverse edges.).

field observations indicate good evidence for PPNB Neolithic (several excellent examples of projectile points) and Epipaleolithic (typical cores) occupations. There is less reliable testimony for the presence of Late Neolithic (two concave truncation burins), and there is no clear evidence for Upper Paleolithic or Natufian Epipaleolithic presence.

Collections were also made at 'Ain Qasiya, just to the north of 'Ain Soda (*cf.* Fig. 3). None of these artifacts have been studied, but they consist of 45 tools, 27 cores, and 138 pieces of debitage. It should be noted, however, that only one biface was found at 'Ain Qasiya, indicating that this pool was not available to Acheulian hunters. In view of the relatively high number of Levallois flakes, blades and points in the 'Ain Qasiya collection, there is strong evidence that the pool was in existence in Middle Paleolithic times. Epipaleolithic and Neolithic presence at 'Ain Qasiya is also reflected among the tools, cores, and debitage.

The Bifaces

The biface sample of 218 specimens was described and typed (Table 2) according to a system developed some years ago (Tables 1-2; *cf.* ROLLEFSON 1980, 1981, 1983). The most striking feature about the sample is the extraordinary dominance of bifacial cleavers (Type 213), which at 63% far exceeds cleaver relative frequencies from anywhere else in the Near East (Fig. 4). It has long been recognized that at most Late and Final Acheulian sites in the Levant, cleavers account for only 2-5% of the bifaces (GILEAD 1973), although other sites in the Azraq region have revealed how distinct this local biface industry is. Cleavers ranged in popularity from *c.* 6% in the Harding collection at 'Ain el-Assad (Lion's Spring) (COPELAND 1989a) to 19% in Kirkbride's excavations at the same site (COPELAND 1989b) to 25% at C-Spring (COPELAND 1989c); another biface collection from 'Ain el-Assad contained 33% cleavers (ROLLEFSON 1983).

It would appear 'Ain Soda represents a specific activity locus that focused on butchery to a much greater degree than at C-Spring and 'Ain el-Assad. To some degree the concentration on cleaver use at 'Ain Soda may be associated with the numbers and *kinds* of animals that had been killed there, although the scarcity of published faunal information from the Acheulian layers at the Azraq sites makes such speculation spurious (*cf.* TURNBULL 1989, CLUTTON-BROCK 1970). The condition of most of the cleavers reflects very heavy use, particularly at the bit; in some cases use damage was so severe that it was difficult to detect the tranchet blow(s) that define the biface type.

Although cleavers are relatively easy to recognize since they reflect a technological definition, the absence of a firm biface typology for the Levant makes detailed comparisons of collections classified by different authors problematic in terms of specific morphological types (*cf.* Copeland citations noted above). For this reason the morphological types have been collapsed into biface "classes" to facilitate comparative analysis, and the results are presented in Table 3 and Figs. 5-6.

The mean dimensions of analytically complete bifaces from 'Ain Soda are presented in Table 4. Not surprisingly, the Lanceolate class has a greater average length than the others (as well as the greatest variability), while the Other class (which includes the normally small D-shape and partial bifaces) is the smallest of the groups. The ratios of the dimensions are general indices that relate to elongation (W/L), cross-section (Th/W), and long-section (Th/L). Once again, the Lanceolate class is expectedly the most slender in relation to length, and the Ovate and Cordiform groups almost by definition the broadest in plan form. As for the cross- and long-sections, Lanceolate bifaces tend to be more robust than the other classes. The Cleaver group is inclined toward the averages in all dimensions and ratios, a reflection of its technological definition. This is shown by the shapes among the cleavers (Table 5), which are represented well among all the morphologically defined bifaces except for the Lanceolate class.

Post-depositional changes on the bifaces are shown in Tables 6 (surface condition) and 7 (patina). Surface condition followed Copeland's literal "rule of thumb" (COPELAND 1989c: 326), whereby the ridges and edges were rubbed with the finger to judge abrasion. As Table 6 demonstrates, well over half of the bifaces were abraded and another eighth of the sample was rolled. Superficially this should mean that many of the tools lay exposed (or were later exposed) on a surface for a considerable amount of time, subject to wind erosion and damage due to water transport of either the artifacts themselves or the movement of material over them. The patina data (Table 7) confuses the picture, since half of the pieces bear no visible patina. Although patinating processes can be very unpredictable, the absence of patina would suggest immediate burial; even for the other half that were patinated, the black-gray-white series may have been due to subsurface reactions to water table levels and local chemical concentrations (*cf.* COPELAND 1989b: 214). Three bifaces with double patina indicate they were left on a surface long enough for patina to develop before being re-used, and nine bifaces showed the development of desert varnish, also evidence of prolonged exposure on a surface. Notably there were only isolated spots, usually very small, of lustrous deposits on the 'Ain Soda artifacts, with none of the "spring gloss" (SHACKLEY 1989) that characterized a substantial number of artifacts from 'Ain el-Assad but was virtually absent at C-Spring (COPELAND 1989c: 326).

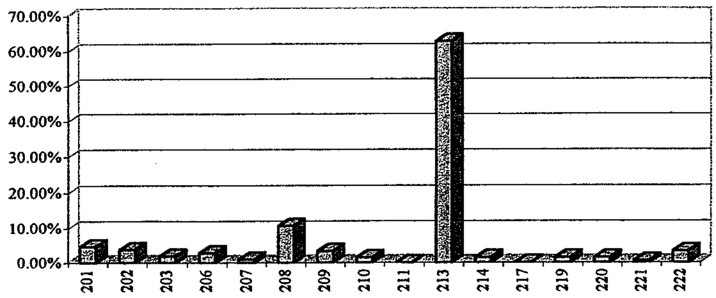
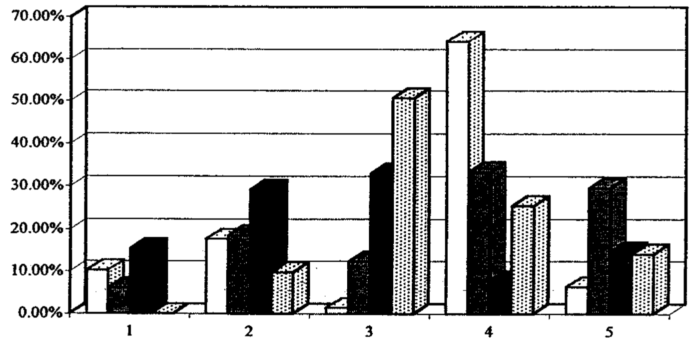


Fig. 4. Biface type frequencies from the surface collections of 'Ain Soda.

Fig. 5. Biface classes from several Azraq area collections. The classes are represented by groups 1-5: 1 Lanceolate class, 2 the Cordiform class, 3 the Ovate class, 4 the Cleaver class, 5 Non-classic/ "Other" class <*white bars: 'Ain Soda, gray bars: Rollefson's collection from 'Ain el-Assad, dark bars: combined Kirkbride and Harding collection from 'Ain el-Assad, stippled bars: C-Spring biface assemblage*>.



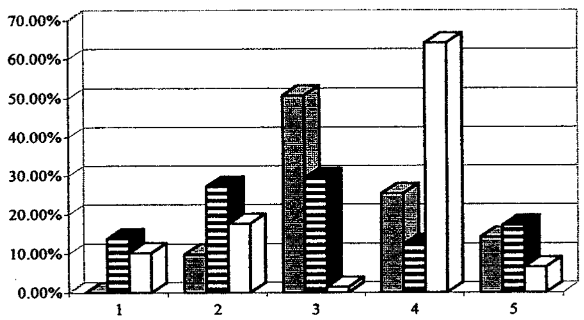


Fig. 6. Biface classes from the Azraq area; in this instance, the three assemblages from 'Ain el-Assad have been combined to form a single collection <*gray bars: C-Spring, striped bars: 'Ain el-Assad, white bars: 'Ain Soda*>.

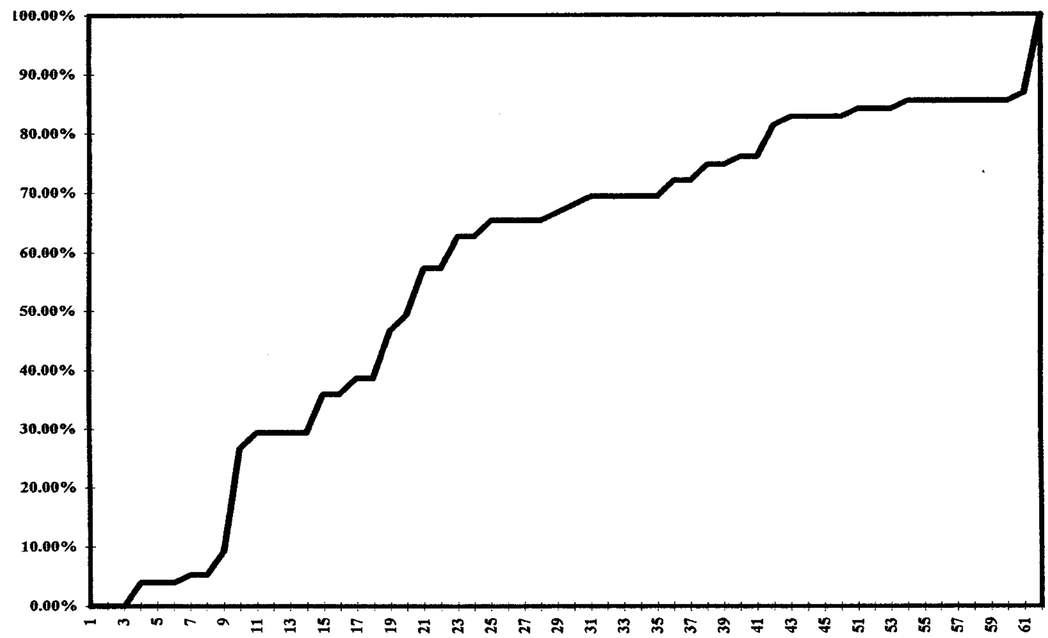


Fig. 7. Cumulative graph of *essentiel* relative frequencies of Late Acheulian flake tool types from the 'Ain Soda surface sample.

Flake Tools

Flake tools were assigned to various phases (Acheulian, Mousterian, Epipaleolithic) on the basis of particular technological (*e.g.* Levallois or naviform techniques) or techno-typological characteristics (broad endscrapers on blades, thinning of Levallois point/blade bulbs, etc.). There is a scale of confidence in these assignments that ranges from "high confidence" for the Epipaleolithic and Neolithic tools to "no confidence" for those assigned to the Phase "0" category; flake tools assigned to the Late/Final Acheulian fall into the broad middle range, with many of the assignments relatively secure, others less so.

Table 3. Relative frequencies of bifaces among biface classes at 'Ain Soda (AS), and other Azraq basin sites (AAR - 'Ain el-Assad, Rollefson; AAKH - 'Ain el-Assad, Kirkbride and Harding; AA* - total 'Ain el-Assad, and C - C-Spring. For references, see Table 2).

Biface Class	AAR %	AAKH %	AA* %	C %	AS %
Lanceolate	6.17	15.36	13.76	0.00	10.23
Cordiform	18.52	29.17	27.31	9.86	17.67
Ovate	12.35	33.07	29.46	50.70	1.40
Cleaver	33.33	7.81	12.26	25.35	64.19
Other	29.63	14.58	17.20	14.08	6.51
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 4. Average dimensions and dimensional ratios of bifaces from 'Ain Soda <*Numbers in parentheses under the dimensions refer to standard deviation as a percentage of the mean dimension*>.

Class	L	W	Th	W/L	Th/W	Th/L
(All bifaces)	108.7	73.2	28.43	.673	.388	.261
(n= 208)	(21.2)	(18.1)	(30.9)			
Lanceolate	128.1	74.1	34.8	.579	.470	.272
(n = 22)	(32.9)	(24.8)	(24.6)			
Cordiform	100.3	70.5	26.7	.703	.379	.266
(n = 38)	(16.5)	(14.0)	(23.2)			
Ovate	108.3	80.3	27.7	.741	.345	.256
(n = 3)	(4.2)	(3.8)	(12.7)			
Cleaver	108.9	74.5	28.3	.684	.380	.260
(n = 138)	(18.4)	(17.1)	(31.6)			
Other	96.9	64.6	23.9	.667	.370	.247
(n = 17)	(27.0)	(22.2)	(36.7)			

Late/Final Acheulian Flake Tools

Table 8 lists the absolute and relative frequencies of flake tools assigned to the Late/Final Acheulian phase. The small number of tools is probably indicative of a sampling problem in the surface collection process: the larger bifaces were more noticeable. It is notable that at least 44% of the tools (n=152) are Levallois elements, it has not yet been possible to identify Levallois pieces retouched to form other tool types. Although Copeland's tabulations are difficult to unravel in this regard, it appears that Levallois techniques at C Spring and 'Ain el-Assad were much less utilized (see also Rollefson 1983). The Racloir Index is 54.8 and the Upper Paleolithic Index 8.3, as is the case with any surface collection, these indices should be viewed with caution. On the other hand, the inventory presented in Table 4 is consistent with Late/Final Acheulian assemblages (*cf.* Fig. 7).

Later Prehistoric Phases

There is little need to comment on the few tools assigned to post-Acheulian times. Notably, the few "Middle Paleolithic" artifacts are mostly Levallois elements with finer, more elaborate platform preparation. Among the 10 Middle Paleolithic tools are an Emireh point and two Emireh blades, an atypical backed knife, two convergent convex racloirs, a Levallois point and two Levallois blades. Tools that are likely Epipaleolithic consist of five endscrapers, a sidescraper, and two retouched blades, Neolithic (PPNB) tools include a borer, a concave truncation burin and a retouched blade.

The absolutely small number of tools from the later prehistoric periods might indicate that there is an under-representation of specimens from later periods, and that some of the tools in Table 8 may have been mis-assigned. This possibility is supported by the surface condition and patina descriptions in Tables 6 and 7, for the "Acheulian" flake tools are much less abraded and rolled, and the patina variation is very unlike the presumably contemporaneous bifaces. But if there is a considerable non-Acheulian content represented in Table 8, it is most likely a Levantine Mousterian presence, and perhaps a later part of this period in view of the three Emireh pieces[1]. It should be pointed out that at least for the Epipaleolithic and Neolithic periods, the landscape appears to have been a marsh (based on the sediment color and texture), which would have made intensive occupation and utilization more problematic than for earlier hunters who hunted animals on the shores of pools or lakes[2]. Clearly, the absence of diagnostic Epipaleolithic microliths is directly related to their small size and the cement-like consistency of the dried-out backdirt.

Table 5. 'Ain Soda cleaver "type" based on morphological criteria.

"Type"	n	%
Cordiform	11	11.7
Elongated cordiform	3	3.2
Amygdaloid	26	27.7
Ovate	5	5.3
Discoid	3	3.2
Limande	26	27.7
D-shape	7	7.4
U-shape	6	6.4
Lageniform	2	2.1
Abbevillian	2	2.1
Partial	3	3.2
Total	**94**	**100.0**

Class	n	%
Cordiform	40	42.6
Ovate	34	36.2
D- / U-shape	13	13.8
Other	7	7.4
Total	**94**	**100.0**

Table 6. Surface condition of Late Acheulian artifacts in the 'Ain Soda collection.

	Bifaces		Flake tools	
Condition	n	%	n	%
Fresh	50	22.9	74	50.0
Abraded	139	63.8	65	43.9
Rolled	27	12.4	6	4.1
Chalky	2	0.9	3	2.0
Total	**218**	**100.0**	**148**	**100.0**

Table 7. Patination of Late Acheulian artifacts from 'Ain Soda. (BGW refers to Black-Gray-White).

	Bifaces		Flake tools	
Patina	n	%	n	%
None	109	50.2	45	30.4
Black	43	19.8	43	29.1
Gray	23	10.6	16	10.8
White	12	5.5	20	13.5
Mixed, banded BGW	9	4.9	10	6.8
Mixed, mottled BGW	8	3.7	1	0.7
Double patina	3	1.4	1	0.7
Desert varnish	9	4.1	8	5.4
Other	1	0.5	4	2.7
Missing	1			
Total	**218**	**100.0**	**148**	**100.0**

Comparisons with Other Azraq Basin Sites

The biface distribution at 'Ain Soda is compared with available data from other Azraq collections in Table 4, which displays how wildly variable the different collections are.[3] Differences in the

[1] As this book is going to press, Copeland has remarked that the "Emireh elements" are much more likely to be truncated faceted Levallois pieces. She is correct, and we thank her for her sharp attention to detail.

[2] There is a clear indication that some of the Acheulian bifaces come from gray-green "lake" marls, as Quintero and Wilke both discovered in their search of 'Ain Soda. It is also possible that the lowermost parts of darker "marsh" sediments also contain considerable Acheulian deposits. A visit to 'Ain el-Assad in 1996 showed that Acheulian cleavers and flake tools were eroding from the dark marsh sediments at about one meter below the modern surface.

[3] The variability is very pronounced even for the three collections from 'Ain el-Assad, although here there may have been a sampling error introduced by who was doing the collection while the pool was being excavated in the 1950s; what was collected by Rollefson was what had been ignored by the untrained workmen more than 30 years earlier.

Cleaver class aside, the proportions of Lanceolate, Cordiform and Ovate classes is remarkable, and if there is a form-function relationship, the representation of specific activities at all three localities was wide and perhaps only partially overlapping.

As Table 9 reveals, the 'Ain Soda bifaces are relatively longer, wider, and thinner than the bifaces from the other Azraq sites, particularly in relationship to the 'Ain el-Assad combined sample. Dimensional ratios also show some interesting contrasts. The W/L ratio, which provides a relative measure of elongation in plan form, is low for 'Ain Soda, as is the cross-sectional ratio Th/W. The Th/L relationship reflects "robusticity" in terms of the long section, and again the 'Ain Soda value is diminished in comparison to the 'Ain el-Assad samples. Altogether, the dimensional ratios show that while the 'Ain Soda bifaces are generally larger, they are less "massive" in terms of chunkiness. Nevertheless, it must be emphasized that the dimensions under consideration are not really very different to begin with; it is difficult to interpret what a 1cm difference in average length is supposed to mean, for example, particularly if resharpening episodes occurred on many of the bifaces.

Table 8. Absolute and relative frequencies of flake tools in the 'Ain Soda collection. (% refers to the "*réel*" count; %' to *réel* without the unclassifiable and variously retouched material; %‡ to the "*essentiel*" count, and %* to the cumulative *essentiel* count).

Type	n	%	%'	%‡	%*
Levallois flake/blade	23	15.13	16.55		
Atypical Levallois flake/blade	20	13.16	14.39		
Levallois point	21	13.82	15.11		
Retouched Levallois point	3	1.97	2.16	4.00	4.00
Mousterian point	1	0.66	0.72	1.33	5.33
Simple racloir, straight	3	1.97	2.16	4.00	9.33
Simple racloir, convex	13	8.55	9.35	17.33	26.67
Simple racloir, concave	2	1.32	1.44	2.67	29.33
Double racloir, biconvex	5	3.29	3.60	6.67	36.00
Double racloir, conv.- conc.	2	1.32	1.44	2.67	38.67
Convergent convex racloir	6	3.95	4.32	8.00	46.67
Convergent concave racloir	2	1.32	1.44	2.67	49.33
Transverse racloir, straight	6	3.95	4.32	8.00	57.33
Transverse racloir, convex	4	2.63	2.88	5.33	62.67
Racloir, inverse retouch	2	1.32	1.44	2.67	65.33
Racloir, alternating retouch	1	0.66	0.72	1.33	66.67
Endscraper	1	0.66	0.72	1.33	68.00
Endscraper, atypical	1	0.66	0.72	1.33	69.33
Backed knife	2	1.32	1.44	2.67	72.00
Naturally backed knife	2	1.32	1.44	2.67	74.67
Truncated piece	1	0.66	0.72	1.33	76.00
Notched piece	4	2.63	2.88	5.33	81.33
Denticulate	1	0.66	0.72	1.33	82.67
Pieces w. various retouch	9	5.92			82.67
Tayac point	1	0.66	0.72	1.33	84.00
End-notch piece	1	0.66	0.72	1.33	85.33
Chopping tool	1	0.66	0.72	1.33	86.67
Diverse	10	6.58	7.19	13.33	100.00
Unclassifiable fragment	4	2.63			
Totals	**152**	**100.00**	**100.00**	**100.00**	

Gilead (1977) noted a positive correlation between increased biface length and increased age, but in this case another element is at play that probably makes this temporal relationship deceptive. Most of the biface types are morphologically defined; that is, shape and relative dimensions control how bifaces are classified, and the prominence of some biface types (especially the lanceolates and Micoquian types) associated with specific butchering tasks could play a role that negates the long-term trend identified by Gilead. Even though the relatively large number of bifaces in the 'Ain Soda collection would appear to offset potential sampling error, the simple fact that almost two-thirds of the bifaces are cleavers introduces a different kind of sampling problem altogether.

The "Azraq Cleaver"

Until a collection of bifaces from the backdirt piles at 'Ain el-Assad was published in the early 1980s (ROLLEFSON 1980), the character of the Late Acheulian in the Azraq area remained unknown, and Harding's brief reference was filed away by most prehistorians as an interesting account of Pleistocene hunters who had gathered at a desert oasis. Convincing prehistorians that cleaver percentages in the eastern deserts of Jordan were 10 to 15 times higher than the average in the more westerly reaches of the Levant was both difficult and frustrating (ROLLEFSON 1997). It took the intervention of the veteran prehistorian L. Copeland to confirm that the elevated cleaver proportions at 'Ain el-Assad were not the results of typological error (*cf.* Table 2). But the strong presence of cleavers in the Azraq assemblages raises questions about why they were so popular here and not elsewhere, and just what were the cleavers like? Based on the analysis of the 'Ain Soda collection, a preliminary description of the "Azraq Acheulian Cleaver" can be offered, and suggestions can be made concerning the popularity in the Azraq Basin.

Table 9. Average dimensions (in millimeters) and dimensional ratios of bifaces from 'Ain Soda and other collections from Azraq. (* = combined collections from 'Ain el-Assad, K = Kirkbride collection [COPELAND 1989a: Table], H = Harding [COPELAND 1989b: Table], R = Rollefson [unpublished, but *cf.* ROLLEFSON 1982: 29]; numbers in parentheses refer to sample sizes).

Collection	L	W	Th	W/L	Th/W	Th/L
'Ain Soda	108.7	73.2	28.4	.673	.388	.261
	(174)	(208)	(208)			
C-Spring	103.7	–	–	–	–	–
	(72)					
'Ain el-Assad *	99.1	67.5	29.3	.681	.434	.296
	(330)	(288)	(288)			
'Ain el-Assad (K)	102.9	71.8	32.9	.698	.458	.320
	(38)	(38)	(38)			
'Ain el-Assad (H)	98.4	65.6	27.9	.667	.425	.284
	(215)	(173)	(173)			
'Ain el-Assad (R)	99.3	69.8	30.6	.703	.438	.308
	(77)	(77)	(77)			

Since cleavers were made mostly from nodules (or very large flakes), as other bifaces usually were, we can assume that the mass of the tool was an important feature in the function of the tool; this is a characteristic that is still seen in butcher shops today, where cleavers are more massive than the knives butchers use. But cleavers, like any other chipped stone tool, can be used for their intended task only until the working edge (in this case, the tranchet or double-tranchet bit) becomes too dull for further effort. Since we have no valid access to the paleopsychology of the Acheulian hunters in the Azraq Basin, it can't be demonstrated that a broad bit was necessarily the most desirable aspect the butchers had in mind, but modern butchers' tools would suggest this was a useful aspect even in the Late Acheulian.

Once a cleaver bit became dull or chipped or somehow else inefficient, the cutting edge could be renewed by preparing the lateral edges near the bit for new tranchet blows, a process that required less time than the production of a new cleaver, as Dr. Phil Wilke's replication experiments in 1996 showed. When cleavers were resharpened, length was reduced considerably in direct proportion to the number of resharpening episodes, and just as important was the observation that the original shape of cleavers (assuming they begin as limandes or U-shapes to maximize the bit) changed progressively towards the more pointed examples (amygdaloids and cordiforms).

The working edge of cleavers from 'Ain Soda demonstrated heavy use in most cases, often with "retouch" that may, in fact, be a reflection of intensive use-wear. An examination of Table 5 suggests the possibility that the resharpening process as reproduced by Wilke was in effect at 'Ain Soda[1]. The summary information on the right side of Table 5 reflects a high popularity for cleavers on relatively pointed pieces (Cordiform class morphology). (Notably, the percentage of the Ovate class shape among cleavers is dominated by the broader-bit limandes, as the left side of Table 5 shows). The argument could be made that the Cordiform class of cleavers represents the final stage of their use-life, since additional efforts to resharpen the cleaver bit would have resulted in a narrower, almost pointed tip.

The dimensional implications of Wilke's resharpening experiments on cleavers in the 'Ain Soda assemblage are inconclusive. If cordiform-shape cleavers represent resharpened cleavers that were originally broadly ovate in form, then that group should also be shorter in general, and the W/L ratio should be relatively high. This was not the case, however: mean length and dimensional ratios were not significantly different among the shape classes of cleavers.

[1] Note that the total number of cleavers in Table 5 is only 94, 68% of the total number of cleavers in the sample. This is a reflection of the belated suspicion of the possible "use-life" of a cleaver while the analysis was in progress.

Cleaver definition is based fundamentally on the presence of at least one tranchet scar across the distal end of the tool. But there are also other elements of the "Azraq cleaver" that occur with such persistence that the may be assumed to be part of the Azraq cleaver definition. A prominent feature concerns the lateral edges, which in most cases were either deliberately battered to utter dullness or took advantage of cortex or a naturally blunt (*méplat*) facet on one or both sides of the nodule from which the cleaver was fashioned. It seems unlikely that the blunting was intended to facilitate hafting, but it may have been a normal means of protecting the hands during the use of the tool. Lateral blunting appears to be relatively rare among most other non-cleaver biface types, and it could be the case that those cleavers with sharp lateral edges were bifaces that had performed their original tasks and then were converted to cleavers to continue the butchering process. It is also noteworthy that the base of many of the cleavers was bifacially worked to produce a sharp edge, often heavily damaged, so that cleavers frequently were two tools in one: a chopping/hacking implement at the base as well as a slicing one at the distal end.

Concluding Remarks

What has been provided above is based on a short period of research that developed as an appendage to other field concerns at the time of the discovery of the artifacts. The brief period of time spent in the 'Ain Soda and 'Ain Qasiya pools, as well as the short visit to 'Ain el-Assad, have made evident the exciting potential that the area holds for expanding our awareness of how our Pleistocene ancestors dealt with exploiting what may have been a vastly different landscape, certainly with a markedly different set of animal and plant resources. But the brevity, while it whets the thrill of anticipation, also offers us only limited confidence on how the area looked over the past quarter-million years and in what ways the energies of human hunting-gathering bands had to change to take advantage of what was available at any time.

At the moment the collections of artifacts, faunal remains, and preliminary stratigraphic/ sedimentary observations have led to the development of many research questions that we hope can be answered by a prolonged multidisciplinary research project, planned to begin in 1997. Among the major research problems are:

1. The changing geomorphological, paleobiological and paleoclimatological conditions in the area;
2. The absolute time frame with demonstrable milestones in relevant changes in the environment;
3. An essential determination if there are microstratigraphic episodes to explain the distribution of the artifacts and faunal remains;
4. A distributional framework of animal remains, stone tools, and other archaeological information that may explain typological and technological variability; and
5. A more detailed understanding of all of the chipped stone industries employed by hunters-gatherers in the eastern desert, especially among those who were responsible for what Copeland (1989c: 344-345)has called the "Late Acheulian of the Azraq Facies".

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An Initial Technotypological Analysis of J447, an Open-air Levantine Mousterian Site in Southern Jordan

Alan P. Olson

Abstract: *The recently completed work at the sites of Tor Faraj and Tor Sabiha in southern Jordan have allowed for the reconstruction of local settlement and procurement patterns in the study region for the Middle Paleolithic period. The preliminary lithic analysis presented here for J447, an open-air site in the region, has been utilized in terms of the transhumance model. The tentative results serve to continue inter-site analysis for the region.*

Introduction

Recent investigations of the Middle Paleolithic sites of Tor Faraj and Tor Sabiha in the south of Jordan (Fig. 1) have produced valuable information on the patterned differences between natural settings, site plans, and artifact inventories. Such differences are the basic elements in the study of local settlement and procurement patterns, including transhumance.

The site under discussion in this paper is known only as J447 (Fig. 2), an identification given to the site after its discovery in 1994 (HENRY 1995). The site is situated on an upland about 4.5km from the site of Tor Faraj. J447 is currently the only known open-air Levantine Mousterian site in this region of southern Jordan. The site has an estimated area of 200m^2 and unfortunately has been impacted by erosion. The post-depositional deflation and erosion has brought many artifacts to the surface. Their moderately patinated condition suggested that most were derived within the recent past. The elevation of the site is 1,000m a.s.l. (meters above sea level), which is also the altitude of Tor Faraj (HENRY 1995, HENRY *et al.* 1996). A controlled collection was conducted in an effort to gather all the surficial artifacts, and no observed material was left on site.

The study region in southern Jordan is confined to the Judayid Basin and the Jebel Qalkha areas. Henry (1995, HENRY *et al.* 1996) located only two sites with *in situ* materials dating to the Middle Paleolithic period (Tor Faraj and Tor Sabiha). It is with these two sites that direct comparisons will be drawn with the material from J447. Using paleoenvironrnental reconstruction and radiometric dating techniques, Henry discovered that the two sites from his investigation were archeologically synchronous, dating to approximately 70,000 bp (HENRY 1995: 49). He also found data that indicated that the sites had apparent differences in the nature of their settlement and procurement patterns. These differences were taken as indicators of an annual cycle of transhumance. The analysis of J447 is considered in terms of seasonality and Henry's model of Middle Paleolithic transhumance for the region (HENRY 1995, HENRY *et al.* 1996).

Setting and Resources

Site J447 is located in an embayment that is within one-third of a kilometer of the Wadi Qalkha, a major Pleistocene stream in the Judayid Basin (Fig. 2). At present the site rests along the edge of an erosional ravine of the Wadi Aheimir. The Wadi Qalkha is likely to have been the nearest source of surface water for the inhabitants of the site. Chert sources within the site's catchment are generally poor, with stream cobbles and small nodules from nearby (0.5km) comprising the bulk of the material. Headward erosion of the small adjacent gully appears to have contributed to the exposure of the site and has likely resulted in the dispersal of a number of the site's artifacts. The number of recovered

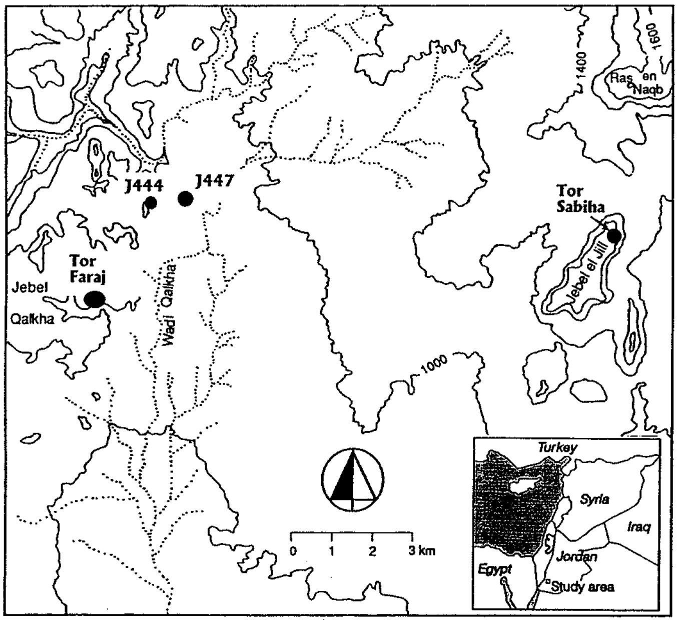

Fig. 1. Overview of the study area (after: HENRY 1996).

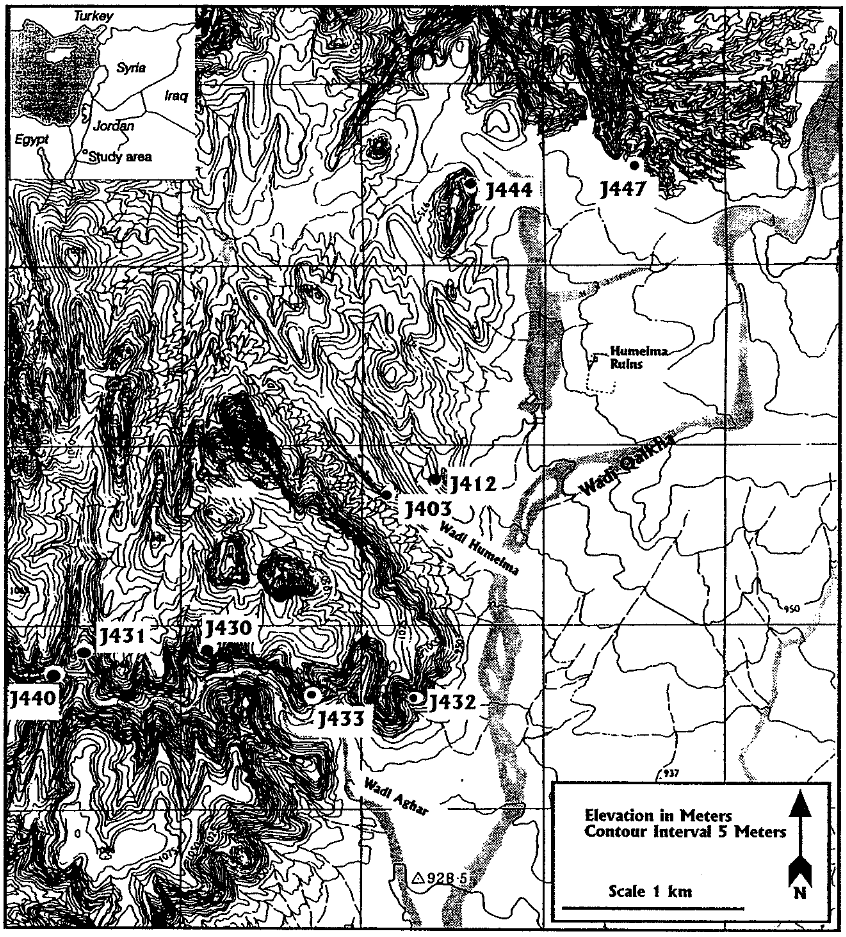

Fig. 2. Map of the Judayid Basin, showing Tor Faraj (J430) and J447 (after: HENRY 1996).

artifacts totals 496, of which 489 are Middle Paleolithic in age. The other seven pieces are Upper Paleolithic to Chalcolithic in age. The presence of this more recent material on the site can be explained from two perspectives. The first is that the material may be the remnants of cultural horizons that have been deflated and carried away by erosional forces. Secondly, the material could be isolated finds transported to the site locality by various undetermined cultural means. Either way, these artifacts are quite limited and they have been discounted in terms of the present study.

The Artifacts

The material recovered from the surface collection at J447 consists entirely of chipped stone artifacts. As the artifacts were in various stages of patination and condition, tool identification was undertaken cautiously, as some minor edge damage was present on a few of them. All the specimens date to the Middle Paleolithic period and have been treated as a single assemblage. The presence of Levallois points and point cores in the assemblage confirms an occupation by Levantine Mousterian hominids at the site.

In general, the relatively high frequency of primary elements (Table 2) denotes that a significant amount of initial processing activities took place on the site. These activities involved the initial shaping of cores followed by a full reduction stream encompassing blank production, tool manufacture, tool maintenance and rejuvenation. The apparent central focus was on the production of Levallois points from both unidirectionally and bidirectionally prepared cores. This emphasis finds typologic expression in the toolkits, which are dominated by Levallois points accompanied by moderate proportions of tools on blades (HENRY 1995: 59). Although the assemblage at J447 only contains six Levallois points, the emphasis on Levallois production can be inferred from the indices of the debitage (cores, flakes and blades: Table 2). The characteristic, apparently stylistic, shared by both Tor Faraj and Tor Sabiha of proportionately high amounts of inverse retouch (HENRY 1995, 1996) is nearly as prevalent at J447 (Table 1). It is notable that although the incidence of inverse retouch is less at J447, the proportion is still higher then previously noted for the rest of the arid zone of the Levant (HENRY 1995). The assemblage shares the general configuration of Tor Faraj and Tor Sabiha in that the Levallois points have heavily faceted butts and "*concorde*" profiles. Yet the J447 assemblage varies from the neighboring sites in that the proportion of blades and points is much lower, with a corresponding higher emphasis on flakes. It is possible that the incidence of flakes can be attributed to a functional difference of the site.

Raw Material

Within the site area, material suitable for knapping is restricted mainly to cherts occurring in outcrops and derived nodules found in the Wadi Qalkha stream bed. These cherts are generally of a poor quality and were not favored in Levallois point production (HENRY *et al.* 1996). The cherts from Late Cretaceous limestones that form the plateau and flank the Rift Valley were the preferred material for Levallois production (HENRY 1995). The nearest source of this material is some 12km distant (HENRY 1995: 61).

Reduction Stages, Cores, and Debitage Attributes

As noted by Henry (1995) for the analysis of the Tor Faraj material, the apparent emphasis upon initial processing activities at J447 is somewhat surprising due to the distance from raw material sources: the material collected from J447 shows a large percentage of cores and primary elements (Table 2). Curiously, other Levantine Mousterian sites, including those located near chert resources, tended not to exhibit such a high frequency of primary debitage (CREW 1976, MUNDAY 1976, MEIGEN and BAR-YOSEF 1989). Still, raw material appears to have been economized by extending the productive life of the cores, as evidenced by the number of small exhausted cores in the assemblage.

Tools and Debitage

In the assemblage scrapers, retouched pieces, and notches are the dominant tool classes followed by smaller numbers of burins, truncated faceted ("Nahr Ibrahim") pieces, and Levallois elements. Notably, no denticulates or perforators were found in the assemblage. Of interest is Table 2, which outlines a number of Bordes' (1961) indicies for J447, Tor Sabiha, and Tor Faraj.

Levallois Points. Only six Levallois points are in the collection, yet notably all were obversely retouched. Henry's work at Tor Faraj and Tor Sabiha noted a high frequency of inverse retouch on the Levallois points. Additionally, an unusually high number and percentage of Levallois points was recovered from both Tor Faraj and Tor Sabiha, nearly some 50 percent of the tools (HENRY 1995). It is possible to infer from the sample that most of the Levallois points produced at J447 were used or

Table 1. The incidences of retouch on tools for Tor Faraj, Tor Sabiha, and J447.

	Faraj Top C		Faraj Upper C		Faraj Mid C		Faraj Low C		Sabiha		J447 Surface	
Retouch	N	%	N	%	N	%						
Obverse	86	66.2	13	56.5	13	61.9	4	66.7	57	66.3	44	68.7
alternate	-	-	-	-	-	-	-	-	-	-	11	17.2
inverse	44	33.8	10	43.5	8	38.1	2	33.3	29	33.7	9	14.1
inver./alt.											20	31.3
Total	130	100	23	100	21	100	6	100	86	100	64	100

Table 2. Artifact counts, indices, and ratios for Tor Sabiha, Tor Faraj, and J447.

	Tor Sabiha C		Tor Faraj Lower C		Tor Faraj Mid C		Tor Faraj Upper C		Tor Faraj Top C		J447 Surface	
	N	%	N	%	N	%	N	%	N	%	N	%
Tools	*129*	*1.9*	*15*	*10*	*54*	*4*	*53*	*7*	*203*	*17*	*78*	*16.4*
Lev. Pts. Rtc.	19	14.7	1	6.7	8	14.8	7	13.2	40	19.0	6	7.7
Lev. Pts. Unr.	34	26.4	4	26.7	27	50.0	29	54.7	62	29.3	0	0
Sd. Scrpr.	4	3.1	1	6.7	3	5.6	1	1.9	8	3.8	9	11.6
End Scrpr.	0	0	0	0	0	0	0	0	6	2.9	5	6.4
Burins	1	0.8	1	6.7	0	0	1	1.9	14	6.7	6	7.7
Perforators	1	0.8	0	0	0	0	0	0	1	0.5	0	0
Truncations	3	2.3	0	0	1	1.9	0	0	3	1.4	4	5.1
Notches	10	7.8	1	6.7	6	11.1	2	3.8	8	3.8	12	15.4
Denticulates	13	10.1	0	0	0	0	2	3.8	5	2.4	0	0
Retouch Pcs.	40	31.0	7	46.7	9	16.7	11	20.8	56	26.7	29	37.2
Other	4	3.0	0	0	0	0	0	0	7	3.3	1	1.3
Debtiage	*1,748*	*26.2*	*90*	*57.3*	*515*	*35.9*	*321*	*40.0*	*828*	*70.9*	*408*	*83.4*
Cores	10	0.6	4	4.4	12	2.3	2	0.6	41	4.9	32	7.8
Blades	652	37.3	20	22.2	66	12.8	15	4.7	162	19.4	48	11.8
Flakes	843	48.2	48	53.3	277	53.8	246	76.6	435	52.2	219	53.7
Lev. Blades	11	0.6	0	0	7	1.4	9	2.8	22	2.6	3	0.7
Lev. Flakes	48	2.7	3	3.3	11	2.1	6	1.9	17	2.0	6	1.5
CTE	32	1.8	1	1.1	10	1.9	2	0.6	15	1.8	30	7.4
P. Elem.	152	8.7	14	15.6	132	25.6	41	12.8	136	16.3	70	17.2
Burin Spalls	0	0	0	0	0	0	0	0	5	0.6	0	0
Debris	*4,786*	*71.8*	*52*	*33.1*	*867*	*60.4*	*429*	*53.4*	*125*	*10.7*	*3*	*0.6*
Chips	4,041	84.4	38	73.1	833	96.1	387	90.2	89	71.2	2	66.6
Chunks	745	15.6	14	26.9	34	3.9	42	9.8	36	28.8	1	33.3
Total Art's.	*6,663*		*157*		*1,436*		*803*		*1,168*		*489*	
Indicies												
IL	4.4				9.3		12.0		13.8		20.8	
IF	37.5				---		---		46.5		41.3	
ILAME	37.1				20.2		5.4		26.4		5.3	
Ratios												
Tools:Debit.	1:13.6				1:9.5		1:6.1		1:4		1:5.2	
Cores:Tools	1:12.9				1:4.5		1:26.5		1:5		1:2.4	
Cores:Debit.	1:173.8				1:42.9		1:159.5		1:19		1:12.8	
Debit.:Chips	1:2.3				1:1.6		1:1.2		1:0.1		na	
P.Elem.:Debit.	1:115				1:3.9		1:7.8		1:6.1		1:5.8	

Taken in part from Henry (1995:60)

transported off site with only discarded or curated retouched points left behind. The retouch on the points at J447 varies from light and marginal to being heavily inset in the piece, though all of the retouch was discontinuous in nature.

Sidescrapers. Those with obverse retouch represent the most common type in this class. Although substantial, the retouch tends to be only moderate and normally covers about two-thirds the length of the edge. Elongated flakes and blades typically represent the blank form.

Déjeté scrapers. Only two scrapers of this type were present in the sample. They are on large flakes and exhibit medial and distal retouch. Under the Bordian method both of the *déjeté* scrapers are classified as being Type 21 and single in nature as only two of the edges meet asymmetrically (DEBENATH and DIBBLE 1994).

Endscrapers. In the sample endscrapers are nearly as well represented as sidescrapers (Table 2). They are well manufactured, a trait that is directly opposed to the findings for Tor Faraj (HENRY 1995). In addition to simple endscrapers on flakes, other specimens include those with thick and heavy retouch.

Burins. Most have been formed by multiple blows and are found on flakes. Of note is the fact that no burin spalls were represented in the assemblage.

Notches. There is a large number of notches, most formed by several small contiguous retouch scars on flakes. While it is possible that a few of these may have been created by post-depositional traumas, all exhibit contiguous retouch. Any pieces with Clactonian notches were eliminated from the tool class in an attempt to reduce possible errors.

Truncated faceted pieces. Flakes dominate the class and have been extensively described for other Levantine Mousterian assemblages (SOLECKI and SOLECKI 1970, CREW 1976, GOREN-INBAR 1988). Such modification has generally been attributed to the thinning of the specimens for hafting, although Crew (1976) found no such evidence during his use-wear study. Within the site the retouch forming the truncations is composed of fairly large uniform flake scars. As stated by Debenath and Dibble (1994:123), a truncated faceted piece is in effect a core on a flake, although there is no current consensus as to the purpose of the technology.

Cores. A large number (over 50%) of the cores from the site are unidirectionally and bidirectionally prepared for Levallois point production. Based on the fact that cores comprise 7.8% of the debitage at the site, and the debitage some 83.4% (Table 2), it can be inferred that the six Levallois points are not representative of the total number produced. It then follows that most of the points that were produced were removed from J447. Of interest is the presence of a single *lame à crête* core trimming element at the site.

Blades. Based on Table 2, the dearth of blades at J447 in comparison to Tor Faraj can not be readily explained at the present time. Tor Faraj exhibits the full reduction stream, as does J447 in nearly every way. The percentages of Levallois blades more closely match those of Tor Sabiha. Of the blades recovered from J447, only six are in the Levallois tradition.

Retouch by Debitage Type

An examination of the distribution of tools relative to the blanks upon which they were manufactured shows flakes to be the most common variety with Levallois elements second (Table 2). Within the collection blades appear to be underrepresented as retouched elements while Levallois points are over-represented; of the six points in the assemblage all exhibit retouch. This point over-representation is consistent with technological characteristics that are found when an emphasis is placed upon Levallois point production (HENRY 1995).

Inverse Retouch: a Regional Stylistic Indicator?

Although obverse retouch is dominant (68.75%) in the assemblage and alternate retouch is second (17.9%), retouch on the inverse surface of tools is at 14.06% in the sample. As noted by Henry (1995), with the single exception of Kebara, the relative frequency of inverse retouch in other Levantine Mousterian sites outside of southern Jordan is quite low, ranging from 0-4%. It would be more than mere coincidence that the only other assemblages to register such a high proportion of inverse retouch are nearby Tor Faraj and Tor Sabiha. Based on the number of similarities among the three sites, Tor Faraj and Tor Sabiha may also be temporally close to J447 within the late Levantine Mousterian. Of note (see Table 2) is that Henry (1995) originally placed alternate retouch in the category of inverse retouch, which accounts for the perceived incidence of higher portions of that retouch at Tor Faraj and Tor Sabiha. When the two categories are combined for J447, the percentage of inverse retouch is nearly equal to the other sites.

Technotypological Summary

Tor Faraj, Tor Sabiha, and J447 are all found within the same region. Paleoenvironmentally, J447 and Tor Faraj, based on elevation, distance to water, an emphasis on primary lithic reduction, and distance to raw materials, were likely to have occupied the same econiche. Tor Sabiha is similar to J447 in the fact that it is a small temporary habitation (estimated 200 m^2). Additionally, Tor Sabiha has a high incidence of notches in its assemblage. Tor Sabiha differs from J447 in that it is elevationally higher, has numerically and proportionately more Levallois material (as does Tor Faraj), a greater emphasis on tool rejuvenation, and a closer proximity to high quality chert resources. The assemblages from the two sites reflect an emphasis on the production of Levallois points from both unidirectionally and bidirectionally prepared cores. The majority of the points were generated using classic *chapeau-de-gendarme* basal preparation along with Y-arrete scar patterns, but a significant proportion of the points display compact diamond/triangular shaped butts and parallel convergent scars (HENRY 1995). Although the production of Levallois points was clearly a focus of the inhabitants of the sites, the generation of other Levallois products was generally ignored as reflected in the low Levallois indices of the assemblages (HENRY 1995: 66). The toolkit of each of the sites displays roughly similar configurations when tool classes are compared. The differences that exist relate to the higher frequencies of burins at Tor Faraj and higher frequencies of notches and denticulates at Tor Sabiha (HENRY 1995: 66, Table 2). The presence of high proportions of inverse retouch serves to distinguish the assemblages and may well represent a stylistic attribute (Table 1).

The major differences in the assemblages are found in the stages of reduction they represent, not in techniques or styles of blank production and tool fabrication. While all stages of reduction are represented at the sites, much more core shaping and blank production was undertaken at Tor Faraj than at Tor Sabiha. Tool fabrication, maintenance, and rejuvenation were carried out at both sites, but these appear to have been the focal activities at Tor Sabiha.

Based upon the sample for J447, it can be inferred that the major differences noted by Henry (1995) between Tor Faraj and Tor Sabiha apply here. The differences between the three sites are in the stages of reduction they represent, not in the technique or style of blank production and tool fabrication. While all stages of reduction are represented at all the sites, much more core shaping and blank production appear to have taken place at Tor Faraj and J447 than at Tor Sabiha. Tool fabrication, maintenance, and rejuvenation were carried out at all three sites, but these activities were most prevalent at Tor Sabiha. Both Tor Faraj and Tor Sabiha exhibit a high percentage of Levallois points in the their assemblages; at J447 where there are only six Levallois points, the question is whether these are really representative or a sampling error. Based on current information for the site, the question can't be answered. In examining a third possibility, as to there being an alternative explanation, the following is offered. If site J447 represents a logistical resource procurement camp or even an opportunistic station, it is possible that the points found there are from exhausted and/or discarded tools. This being the case (all the points in the sample exhibit retouch), points without retouch might have been transported away for use off-site. In view of the core and debitage indices, it seems likely that the site witnessed a much higher number of manufactured Levallois points.

Transhumance

It is within the framework of Henry's (1982a, 1982b, 1986, 1995; HENRY *et al.* 1983, 1996) discussions on the cultural ecology of the Middle Paleolithic and hominid cognition that J447 will be examined in this section in order to see how the site fits in the model presented for southern Jordan.

Over the last twenty years ongoing investigations in the central and northern Levant have been complemented by intensive and long term studies of historically ignored areas in the south. The area-oriented projects conducted in the Negev (MARKS 1976, 1977, 1983; GORING-MORRIS 1987; GILEAD and BAR-YOSEF 1987) and Sinai (BAR-YOSEF and PHILLIPS 1977) have furnished a body of evidence that has prompted a reevaluation of long-held cultural and environmental schemes. This relatively recent research in the southern Levant has revealed a richer and more complex cultural pattern than was previously believed. Additionally, the area-wide approaches of the investigations in the south have provided a better understanding of the variability within site types for discrete time frames (HENRY 1995:19). This in turn has brought a much greater understanding of settlement procurement patterns and prehistoric cultural ecology for the arid zone region as a whole.

The scale at which the research in the Wadi Hisma makes a significant contribution relates to local prehistoric ecology. The undulating terrain of the area acts to compress all of the Levant's major biotic zones into tightly spaced elevational belts separated by less than 20km (HENRY 1995:20). Extensive erosion of the Pleistocene deposits in the area resulted in the exposure of a large number of archeological sites stretching back into the Middle Paleolithic period.

Study areas, selected from different elevational belts and representing each of the modern biotic zones, were surveyed for sites. Results of the surveys, coupled with evidence obtained through excavation of selected sites, revealed patterns in the natural and cultural data that were linked to differences in elevation (HENRY 1995, HENRY *et al.* 1996). Henry (1995) states that such patterns reflect the presence of transhumance, an adaptive strategy that involved a hominid group scheduling adjustments in its size and mobility along with determining when (season) and where (elevational belt) it would reside (HENRY 1995:20).

Given the density of sites dating to the Middle Paleolithic, it was possible to reconstruct specific prehistoric patterns of transhumance and to trace changes in these patterns. Reconstructing the past environment is a fundamental step toward understanding changes in human adaptation, for even if environmental forces were not linked to behavioral changes, they have to be known to be eliminated as causal factors (HENRY 1995). Certain natural characteristics of the study area made this a reasonable task for Henry's survey. The area's elevationally governed biotic zones provided a sensitive record of past climatic changes. These zones retreated or expanded up- or down-slope with fluctuations in precipitation and temperature patterns (HENRY *et al.* 1983). Therefore, when paleoenviromental evidence pointing to a certain biotic community was recovered from a dated deposit at a specific elevation, an area-wide reconstruction of the prevailing climate and environmental settings could be made with considerable certainty.

The presence of numerous rockshelters is a natural feature of the area that aided in environmental reconstruction. Shelter deposits, with their thick stratigraphic sequences and tendencies for the preservation of organics, are rare in the southern Levant (HENRY 1995: 20). However, such features are common to the Wadi Hisma because of the sandstone geology and weathering forces of the area. Rockshelters formed the most common site type in the study. For the Middle Paleolithic, Tor Faraj and Tor Sabiha revealed stratigraphied, multicomponent cultural successions accompanied by well preserved pollens and phytoliths (HENRY *et al.* 1996).

Differences in site type, setting, and artifact inventories have been linked to transhumance in other areas of the Levant (GORING-MORRIS 1987, LIEBERMAN 1993). Such suggestions have been based upon evidence from single or small groups of sites thought to represent individual segments of an annual round (HENRY 1995). The site types, settings, and artifact inventories for these other segments have been based upon assumptions concerning the availability of resources. The data pointing to prehistoric transhumance in the Wadi Hisma is unique in that it is derived from sites representing multiple segments of an annual cycle within a compact geographic area (HENRY 1995). While an entire annual round within a transhumant cycle was probably not captured by the study due to the absence of evidence from above 1,400m and below 700m, representative warm and cold season segments clearly have been identified in the sites of Tor Faraj and Tor Sabiha. Beyond the comprehensive and detailed reconstruction of the settlement procurement strategies associated with prehistoric transhumance, the study examined specific changes in these strategies over the last 70,000 years.

The Middle Paleolithic is represented by five Levantine Mousterian sites found in the Judayid Basin and the Jebel Qalkha study areas (HENRY 1995: Fig. 2). Two of the sites, Tor Faraj and Tor Sabiha, became the focus of research for the period. Several lines of evidence indicate that the occupations of Tor Faraj and Tor Sabiha were archeologically synchronous, yet other data point to substantial differences in the nature of their prehistoric occupations, especially in relation to settlement and procurement behaviors (HENRY 1995: 7,49). Patterned differences in the configurations and contexts of the artifact assemblages parallel other differences in the natural settings of the sites. This asymmetry between sites in both cultural and natural evidence prompted a view that the occupations reflect different segments of an annual cycle of Middle Paleolithic transhumance (HENRY 1995, HENRY *et al.* 1996). Beyond having regional paleoecological significance, such a notion is also pertinent to questions of hominid cognitive development and the emergence of cultural behaviors as we known them.

The sheltered sites of Tor Faraj and Tor Sabiha appear to have been occupied *c.* 70,000 years ago based upon amino acid racemization and uranium series dates of ostrich eggshell fragments. Paleoenvironmental data collected from their deposits indicate a generally cooler and moister climate than today. Low shrubs and grasses would have dominated the landscape with isolated stands of trees occurring along water courses an in the uplands (HENRY 1995: 82-83).

Although the sites are only some 17km apart, they have different local settings and resource catchments. With its eastern exposure, Tor Sabiha (*c.* 400m higher than Tor Faraj) is most likely to have served as a warm-season camp. Depending on how early it was occupied in the season, standing water would have been available for its inhabitants within 0.5-3 km. The occupants would also have been able to exploit numerous, high quality chert sources that were exposed along the nearby escarpment of the plateau (HENRY 1995). In contrast, Tor Faraj would have provided an ideal cold-season camp spot with its southern exposure and lower elevation. Seasonal water would most likely have been available within the wadi beneath the shelter, but high quality raw material would not have been found within the site catchment (HENRY 1995).

Conclusions

Based on the technotypological information and comparisons drawn with other sites in southern Jordan, the following preliminary conclusions are offered for J447 when considered within the framework of the Henry's transhumance model for the arid zone

First, the present artifact sample from which the analysis is based is too small for any conclusive concrete arguments. It is known that the site is late Levantine Mousterian in date and similar in many ways to the sites of Tor Faraj and Tor Sabiha. It is also known that the technology and the unusually high incidence of inverse retouch is common to all three sites. Yet in a number of ways J447 is different than either of its regional counterparts. It has a substantially lower incidence of Levallois points and a proportionately large number of scrapers. As an open-air site at a lower elevation, it is difficult to take a seasonal approach, and yet there are a number of possible indicators as to the past function of this site.

In the model presented for the region of the Wadi Qalkha, J447 could have played several possible roles. Even though the site is open-air, J447 would have been relatively comfortable in the late fall and early spring as well as during the summer months. It is possible that the site might have functioned as a base camp similar to Tor Faraj, although with a total area of only *c.* 200 m^2, this seems unlikely. Admittedly, deflation and erosion of the site could have affected its original size, but it is more likely that such natural forces would have made the site appear larger by scattering the artifacts over a wider area. Given the current artifact counts, it seems likely that the site was occupied for only a short period of time, possibly briefly for a number of different visits.

The next possibility is that the site represents a camp as part of an opportunistically motivated hunter and gatherer seasonal catchment pattern, as Tor Sabiha is presumed to be. Within this framework the site fits a number of the same indices as Tor Sabiha. J447 is small and offers no real protection from the elements or predators, as one would want for a long-term habitation location. Accounting even for the erosional effects to the site, the artifact assemblage is numerically quite low. In the assemblage there are high numbers of notches, as was noted for Tor Sabiha. The scarcity of Levallois points and the presence of only retouched ones is an indicator that many of the points may have been carried off the site.

The third possibility is that the site represents a resource procurement camp or station for a site similar to Tor Faraj (or perhaps for Tor Faraj itself). The question, then, is what resources could have come from this location in order to make it attractive to hominids practicing a logistical catchment. The answer is not lithic resources, as the cherts around J447 are generally of a poor quality. The answer probably would lie in the form of a food resource, either plant material or animals. The site exhibits no evidence for plant collection or processing, though even if this were the function it is unlikely that substantial evidence would remain. The only logical choice, given the present evidence, is in the form of an animal resource. The fact that the site is out in the basin, in proximity to and overlooking a stable water source, forms the beginning of the argument. Next is the assemblage of the site itself. Trusting that the sample is representative of the site as a whole, a number of tentative conclusions can be drawn from it. The presence of mostly exhausted cores of a raw material from over 12km distant is not a problem, as hunters tend to carry cores as part of their toolkits. All the Levallois points on the site exhibited retouch, and this has been shown in use-wear studies to indicate the activity of slicing or cutting (SHEA 1995). The low incidence of points on the site can be explained by their transport from and use off-site. Another possible indicator is the high percentage of scrapers on the site. It has been shown in use-wear studies that this tool type is commonly used in the processing of animal resources (SHEA 1995). In the end, these factors point toward the possibility that J447 was a hunting camp in a logistical catchment system for a larger habitation. When viewed in Henry's transhumance model for southern Jordan, it seems plausible that J447 could have been a temporary camp, possibly revisited, as part of either an opportunistic or logistical pattern of hominid transhumance.

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Cultural and Geologic Successions of Middle and Upper Paleolithic Deposits in the Jebel Qalkha Area of Southern Jordan

Donald O. Henry

Abstract: *Investigations of Paleolithic sites and geologic localities located in the Jebel Qalkha area of the western Hisma of southern Jordan have identified correlations between the cultural and geologic successions of the Late Pleistocene. Stratified deposits define four episodes of wind-borne sedimentation alternating between sand and loess and separated by significant erosional intervals. While artifacts were not found within the earliest loess deposit (Q4 Yellow Silt), the overlying sand (Q3 Red Sand) contains numerous late Levantine Mousterian occupations (50-70 kya) and a probable transitional Middle-Upper Paleolithic site. The succeeding accumulation of loess (Q2 Yellow Silt) formed extensive deposits containing several Upper Paleolithic occurrences dominated by Early Ahmarian occupations (40-28 kya). The final episode of sand accumulation (Q1 Red Sand) occurried during the early Epipaleolithic with deposits containing Qalkhan and Early Hamran (Kebaran) occupations throught to date from c. 15-20 kya.*

Introduction

Investigations undertaken over six field seasons beginning in 1980 have defined a general correlation between the cultural and geologic successions within the deposits of seven Paleolithic sites and several geologic localities located in the Jebel Qalkha area of the western Hisma (HENRY 1994, 1995; HENRY *et al.* 1996). The definition of cultural-geologic correlations is fundamental to areal studies that seek to reconstruct prehistoric human ecologies. Such correlations are integral to establishing cross-references between cultural and paleoenvironmental data, especially when the environmental data are collected from non-cultural, off-site contexts. Attempts to reconstruct prehistoric settlement patterns also are dependent upon an understanding of the relationship between an area's cultural succession and its landscape evolution. The distinction of culturally induced from naturally derived site distributional patterns are basic to such studies, but all too often the geologic effects on the distributions of prehistoric sites are ignored.

Cultural-geologic correlations also furnish important basic insights relative to the development of cultural-historic frameworks. Specific to the Middle and Upper Paleolithic of Jordan, sites are extraordinarily rare and their chronologies are poorly understood. Placed in the wider context of the differing views of the chronology and cultural succession of the Levantine Middle and Upper Paleolithic (BAR-YOSEF 1995, MEIGNEN and BAR-YOSEF 1992, BAR-YOSEF and BELFER-COHEN 1988, MARKS and FERRING 1988, GILEAD 1991, GORING-MORRIS 1987), area specific cultural-geologic correlations are likely to offer insights that will assist in resolving some of these regional problems.

The Jebel Qalkha Area

Jebel Qalkha, the most prominent of several Cambrian sandstone outliers, joins the Ras en Naqb escarpment with a range of granite mountains to its south to form the western margin of the Wadi Hisma (OSBORN and DUFORD 1981). This range of western mountains separates the broad topographic basin of the Hisma from the Rift Valley, located about 15km to the west. The jebel is drained mainly to the southeast through the steep walled canyons of the Wadi Humeima and Wadi Aghar (Fig. 1). These feed into the Wadi Qalkha close to where it skirts the eastern edge of the jebel

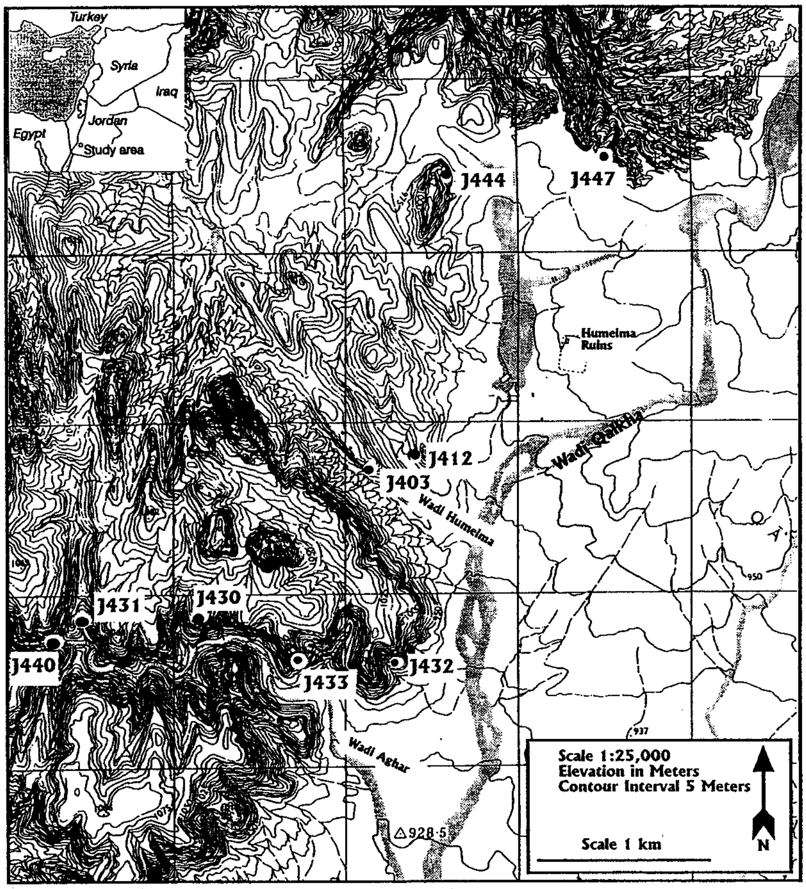

Fig. 1. Map showing the locations of Middle and Upper Paleolithic sites in the Jebel Qalkha area.

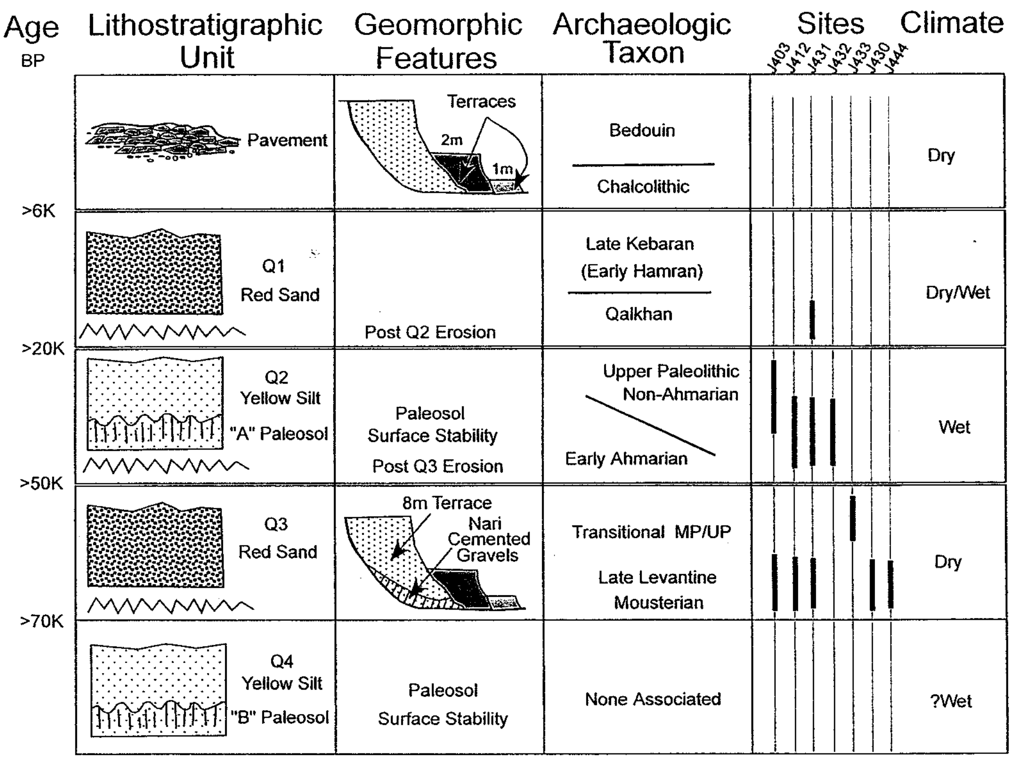

Fig. 2. Schematic illustration showing the correlations between the geologic and archaeologic successions identified within the Jebel Qalkha area.

before turning eastward into the central part of the Hisma. The western slopes of the Jebel Qalkha drain to the northwest to meet the Wadi Aheimir as it drops westward to the Rift.

Aeolian Sediments

The Late Pleistocene deposits that accumulated during the prehistoric occupation of the area are composed primarily of aeolian sediments. These consist of alternating light brown-yellow silt (loess) and red sand deposits that form valley fills which in the Wadi Humeima measure over 10m thick (Fig. 2). Two calcic paleosols appear within this succession, both associated with silt deposits. Although eroded, their calcic B-horizons reveal Stage III carbonate concretions and nodules, a degree of development that indicates each of the soils required 10-20,000 years to form (HALL n.d.).

Most of the surfaces surrounding the Jebel Qalkha are covered with a weathered talus scree (5-10m thick) of sandstone rubble that declines in size and density with distance from the jebel's escarpment. It is noteworthy that rubble lenses defining screes on paleosurfaces buried within the silt and sand deposits never show the thickness or density seen in the scree on the modern surface.

Q1 Red Sand. This uppermost of the red sands has been identified only within the Wadi Humeima where it extends from the surface to reach a thickness of *c.* 2m. Exposures in archaeological excavations and natural erosional cuts reveal a massive, coherent red sand (2.5YR 4/5) occasionally containing thin lenses of small, angular sandstone detritus. The lenses, representing weathered talus scree, define much gentler valley slopes than exist in the area today. Culturally, the Q1 Red Sand contains Epipaleolithic assemblages from five sites (Early Hamran and Qalkhan) that should date from *c.* 15-20 kya based upon cross-reference dates (HENRY 1995: 231-34).

Q2 Yellow Silt. This upper yellow silt (7.5YR 6/4-10YR 6/6) is not only exposed extensively within the Wadi Humeima, it fronts most of the eastern escarpment of the Jebel Qalkha extending well into the Hisma. The unit, over 2m thick, is associated with a calcic paleosol that developed during the early accumulation of the silt. Stratigraphically, the yellow silt is seen to underlie the Q1 Red Sand in an erosional exposure just east of the Qalkhan Site J407. A sharp, unconformable contact joins the two units. Culturally, the Q2 Yellow Silt contains Upper Paleolithic (Early Ahmarian, Non-Ahmarian) and/or Middle Paleolithic (Late Levantine Mousterian) assemblages at five sites. Stratified Upper-Middle Paleolithic sequences have been defined at four of them.

Q3 Red Sand. This lower red sand (2.5YR5/6) is occasionally exposed within the Wadi Aghar and Wadi Humeima valley fills, but it shows extensive exposure within the area north of Jebel Qalkha where it measures some 3-4m thick. Exposures in the upper reaches of the Wadi Humeima reveal unconformable contacts between it and the overlying Q2 Yellow Silt as well as the underlying Q4 Yellow Silt. Similarly, the archaeological deposits of the rockshelter sites J403 and J412 show the Q3 Red Sand, resting on bedrock, to underlie Q2 silt deposits. Culturally, the Q3 Red Sand contains Late Levantine Mousterian assemblages at five sites and a likely transitional Middle-Upper Paleolithic assemblage at another.

Q4 Yellow Silt. This lower silt is found underlying the Q3 sand in exposures within the upper reaches of the Wadi Humeima. The unit is *c.* 1m thick and contains a calcic paleosol. Artifacts have not been found in this lowermost unit.

Alluvial Sediments and Nari

Our understanding of the alluvial geology of the Jebel Qalkha area is derived primarily from a study of the Wadi Aghar drainage basin undertaken by Hall (HENRY *et al.* 1996). The drainage displays a single high terrace and two lower inset terraces. The high terrace is predominantly composed of gravels and contains numerous Levantine Mousterian artifacts, while the lowest two terraces appear to date to Chalcolithic and recent times, respectively. An alluvial fan and nari carbonate deposits also contain numerous Levantine Mousterian artifacts.

Eight-meter Terrace. An alluvial terrace, situated 6.5-8m above the present channel, forms the principal feature of Wadi Aghar. The terrace consists of poorly sorted red (2.5YR 5/6) to reddish-yellow (7.5YR 6/6) sandy gravels derived from local sandstone. The imbricated gravels, with individual clasts up to 40cm, occur in weakly-defined beds alternating with a few sand-dominated zones measuring less than 20cm thick. Paleosols were not observed within the terrace deposit.

The terrace gravels contain Levantine Mousterian artifacts presenting no apparent stratigraphic pattern. Given that artifacts recovered from the terrace are restricted to those of Levantine Mousterian age and that artifacts of Upper Paleolithic, Epipaleolithic, and Chalcolithic sites located within the wadi are not found within the terrace, it seems most likely that the terrace dates to the Middle Paleolithic.

Three-meter Terrace. This lower terrace, inset against the eight-meter terrace, is preserved in only a few sections of the wadi where about a meter of the deposit is exposed. The lower 40cm is composed of imbricated, sandstone gravels overlain by *c.* 60cm of light-red gravelly sand. Only three artifacts were recovered from the three-meter terrace. Two were nondiagnostic and the third was tentatively classified as Chalcolithic in age.

One-meter Terrace. Remnants of a one-meter terrace were observed in only two localities within the Wadi Aghar. These show about one meter of reddish-yellow (7.5 YR 6/6), silty, fine sand with scattered granule gravels and occasional lenses of small gravels. The deposit contains the *in situ* remains of more than 20 small hearths similar in structure and content to numerous Bedouin hearths found on the sandy surface of the terrace. Diagnostic artifacts were not found in the terrace deposit.

Alluvial Fan. Deposits of a remnant fan of the prehistoric Wadi Aghar are exposed near the present-day mouth of the wadi. The fan sediment is a reddish-yellow, gravelly sand, massive with some cross-beds, with zones of imbricated small sandstone gravels, carbonate coats on gravels, and carbonate nodules in the lowermost massive sand horizon. Paleosols do not occur sedimented within the deposit. A Levallois point, diagnostic of the Levantine Mousterian, was recovered within the fan 1.7m above its base. Hall (HENRY *et al.* 1996) noted that although the alluvial fan and the eight-meter terrace appear to have accumulated synchronously, the fan is composed primarily of sand while the terrace consists mainly of gravels. Given these sediment differences, Hall suggests that the discharge of Wadi Aghar was insufficient to transport gravels out of the canyon as far as the fan. The wadi today carries only sand as far as the fan remnant.

Nari. Nari, a variety of travertine-like carbonate cement, has developed in the Wadi Aghar through the dissolution and secondary precipitation of carbonate from the calcareous sandstone that forms the canyon walls of the drainage basin. It occurs as carbonate crusts on sandstone outcrops, cements colluvial gravels that cover the canyon slopes, and cements basal gravels of the 8-meter terraces where they contact bedrock. The occurrence of nari carbonates is related primarily to proximity to bedrock. Hall (HENRY *et al.* 1996) observed that the nari is most likely to have originated during a period of wetter climate, not just one of greater effective moisture, but of actual increased precipitation sufficient to cause the dissolution of carbonate cement from the Cambrian sandstone. Moreover, the nari in Wadi Aghar appears to result from a single period of formation. Four nari localities yielded diagnostic artifacts, all attributed to the Levantine Mousterian.

The Archaeological Sites

Nine sites containing Upper or Middle Paleolithic horizons have been discovered in the Jebel Qalkha study area (Fig. 1). All but Site J447 occur as protected sites, but these range from deep rock-shelters (J430, J431) to shallow shelters (J403, J412, J432) to little more than narrow overhangs (J433, J440, J444). All of the sites are situated along major drainages and command southern exposures.

Middle Paleolithic Occurrences

Although Middle Paleolithic horizons were exposed in all but Site J440 and the "transitional" Site J433, only three sites contain deposits limited to the Middle Paleolithic. These include the intensively investigated Tor Faraj (J430) and the newly discovered sites of J444 and J447.

Tor Faraj (J430). Following an initial sounding of this large shelter, excavations were undertaken during summer seasons in 1993 and 1994 (HENRY 1995 n.d., HENRY *et al.* 1996). Late Levantine Mousterian artifacts occur within a deposit over 4m thick. The deposit was formed by a classic shelter evolution that involved episodes of brow collapse and retreat. The roof-fall events created natural walls across the talus behind which were entrapped sediments of fine grained silty sand (Q3 Red Sand). The upper 2m of the nearly level-bedded deposit yielded stratified living floors accompanied by numerous hearths and artifact concentrations. The artifact assemblage is characterized by the pro-duction of broad-based triangular, Levallois points with heavily facetted butts. These account for about 50% of the tool-kit throughout the deposit. Blades also make up a high proportion of the assemblage. In general, the assemblage resembles the Tabun Type-B Industry as recently defined at Kebara Cave (MEIGNEN and BAR-YOSEF 1992). Chronometric dates on ostrich eggshell fragments derived from uranium series and amino acid racemization assays indicate an age of 65-70 kya for the deposit (HENRY 1995: 54, HENRY and MILLER 1993). Phytoliths, along with the ostrich eggshells, point to a steppic environment, a setting moister than the desert today.

Site J444. With a southern exposure the site is protected by only some one to two meters of a slight cliff overhang. Soundings revealed a deposit of more than 1.3m showing the highest density of artifacts within the upper 0.5m, but with no clear artifact horizon. Establishing the site area is problematic in that much of the surface is covered in reworked drift sand which obscures the artifact distribution. Also, the site consists of a Levantine Mousterian occupation, closest to the cliff face, and an Upper Paleolithic or Epipaleolithic occupation near the foot of the talus slope. The Mousterian occupation consists of a main artifact concentration extending along the cliff for some 20-30m and forming a swath some 15-20m wide. Another smaller concentration also appears across a minor drainage some 40m north of the main occupation. The massive deposit consists of Q3 Red Sands with little to no detritus. In the area of the main concentration, an endscraper on a blade and other artifacts were discovered fixed to the cliff face in a carbonate cement some 3.5m above the present-day surface. Presumably of Upper Paleolithic age, this remnant of an overlying occupation points to substantial erosional episode following the deposition of the Q2 Yellow Silt.

Artifacts from J444, show a assemblage configuration very similar to Tor Faraj. The assemblage is denoted mainly by broad based Levallois points bearing classic *chapeau de gendarme* butts and "*concorde*" silhouettes. Although these show a close affinity to the points from other Type-B horizons (*e.g.*, Kebara, Amud Cave), like other south Jordan assemblages (Tor Faraj, Tor Sabiha), the points occur in much higher proportions than in the assemblages from northern Israel. Similarly, the southern Jordan assemblages display much higher blade proportions than the Type-B assemblages of the Mediterranean zone. Both the higher point proportions and blade indices may be attributed to the greater emphasis upon hunting in the arid zone, a phenomenon also observed for later time-frames.

Although without chronometric determinations, the technotypologic similarities to nearby Tor Faraj and Tor Sabiha, as well as a common lithostratigraphic position in the Q3 Red Sand, would imply an age of 60-70 kya. Such an age is also consistent with the Kebara TL determinations of *c.* 60 kya.

Site J447. This represents the only open-air Levantine Mousterian site found in the Jebel Qalkha area. Although numerous find-spots of Levantine Mousterian artifacts have been located in the upper reaches of the Wadi Humeima, there have been no other discoveries of artifact concentrations. The site is situated at the edge of one of the many head-cuts that form the extensive gullies of the Wadi Aheimir. Artifacts appear recently eroded, but with relatively fresh edges and light to moderate patination.

The small assemblage shares the general technotypologic configuration of other nearby assemblages (J430, J444, J8) in yielding broad based Levallois points with heavy facetted butts and "*concorde*" profiles (*cf.* OLSON, this volume). The J447 assemblage stands apart from the others, however, in yielding much lower point and blade proportions and a higher percentage of flakes. The flakes, for the most part, are non-Levallois in character. The technotypologic contrasts between the assemblage from Site J447 and those from the nearby sites may be attributed to functional differences between the occupations.

Wadi Aghar (J433): a Transitional Occurrence. The assemblage of Wadi Aghar (J433) is thought to represent a very early Upper Paleolithic or "transitional" occurrence because of its technotypologic configuration and geologic position in a Q3 Red Sand deposit. The deposit, found beneath a shallow overhang, is only some 30-50cm thick. The lowermost part of the deposit is formed by a zone of carbonate cemented sand that extends some 10-15cm from the bedrock floor of the shelter.

After a sounding of the site in 1983-84, a small excavation was undertaken in 1993. Although analysis of artifacts recovered from the renewed work at the site is still in progress, our initial findings are consistent with those reached after study of the material recovered from the earlier sounding (COINMAN and HENRY 1995). Cores and blanks reflect a technology focused on the production of relatively large, pointed blades with unidirectional convergent facet patterns. These appear to have been delivered from cores with little attention given to platform preparation or edge regularization; both are hallmarks of early Ahmarian assemblages. The modal blade length (50-70mm) for Wadi Aghar assemblage is significantly longer than that of nearby Upper Paleolithic assemblages (20-50mm) and similar to the lengths of blades and points from local Levantine Mousterian assemblages.

Multi-component Sites

Four sites contain stratified horizons attributed to Upper and Middle Paleolithic occupations. Three of these (J403, J412, J431) contain a relatively thick Upper Paleolithic horizon, associated with a Q2 Yellow Silt unit, underlain by a late Levantine Mousterian horizon in a Q3 Red Sand unit overlying bedrock. The site of Tor Aeid (J432), differs somewhat from this pattern in producing Mousterian artifacts without a Q3 Red Sand association. At each of the sites containing a Q3 Red Sand unit, there exists a sharp contact between the silt and sand units.

Tor Fawaz (J403). Following soundings in 1983-84, a small block excavation was begun in 1993. The excavation was placed behind the drip-line in the eastern part of the shelter where the overhang extends some 5-6m from the backwall. This exposed a deposit of roof-fall and Q2 Yellow Silt (*c.* 90cm thick) underlain by a thin (10-20cm thick) layer of Q3 Red Sand that is truncated by bedrock toward the back of the shelter.

The assemblage recovered from the silt is characterized by a blade technology that produced large, thick debitage and tools (dominated by thick endscrapers and burins), thus resembling what would traditionally be classified as Levantine Aurignacian. Given that many researchers now recognize considerable variability within this general assemblage pattern, it might be best to merely refer to it as "non-Ahmarian" until we have a better sense of the time-space systematics of these "heavy debitage" Upper Paleolithic assemblages (COINMAN and HENRY 1995).

A small sample of artifacts was recovered from the Q3 Red Sand, but these clearly showed several late Levantine Mousterian characteristics: a broad-based Levallois point with heavily facetted butt and heavy facetting on other debitage.

Jebel Humeima (J412). Renewed work in the shelter in 1993 involved a single 2x3m excavation block positioned behind the drip-line just east of the earlier soundings (*cf.* KERRY, this volume). This exposed a massive layer of Q2 Yellow Silt (*c.* 120cm thick) underlain by a Q3 Red Sand unit (*c.* 20-30cm thick) that rested on bedrock. Near its contact with bedrock, a 5-10cm thick zone of the sand was cemented. Two hearths with gray ash were found in the Q2 Yellow Silt layer.

The artifact assemblage recovered from the silt fits nicely within the technotypologic parameters of the Early Ahmarian Industry. High proportions of bladelets, well prepared, subpyramidal cores, and El Wad points indicate an Early Ahmarian placement. In contrast, the underlying Red Sand unit yielded a small sample of tools and debitage associated with a Levallois technology.

Tor Hamar (J431). In 1988, excavations of the deep deposit of this shelter revealed Early Ahmarian horizons in Layers F and G, both composed of Q2 Yellow Silt. These were found to overlay a red sand containing only a few artifacts, some of which were Levallois products.

Layers F and G, distinguished primarily from anthropogenic features (*e.g.*, ash content, burned sediment), are some 60-80cm thick. Artifact density shows significant stratigraphic variability in density throughout the layers, reflecting at least two floors of intensive occupation. Layer H rests on bedrock and resembles the Q3 Red Sand deposits of other shelters in containing a zone of carbonate cemented sediment and rubble near its bedrock contact.

Tor Aeid (J432). Work resumed at this shelter in 1994 with excavation of a 2x3m block beyond the drip-line (*cf.* WILLIAMS, this volume). The excavation exposed a massive Q2 Yellow Silt layer to a depth of 1.3m without encountering bedrock. The lower portion of the layer revealed a carbonate rich zone, perhaps correlating to the Paleosol A recorded in the Q2 silt in many off-site localities.

An Early Ahmarian horizon occurs within the upper part of the deposit accompanied by the highest density of artifacts. This is underlain by a Levantine Mousterian horizon. Although this lower horizon displays contains a much lower artifact density, it displays high proportions of Levallois products.

Summary and Discussion

Investigations of seven Paleolithic sites in the Jebel Qalkha area of southern Jordan have revealed consistent correlations between local lithostratigraphic units and certain archaeological taxa (Fig. 2). Specifically, Upper Paleolithic assemblages have been recovered from deposits formed of an aeolian silt (Q2 Yellow Silt) that rests upon a red sand unit (Q3 Red Sand) containing Middle Paleolithic artifacts. At one site, an assemblage thought to be very early Upper Paleolithic or transitional between the Middle and Upper Paleolithic is found within the Q3 Red Sand. These correlations have intertwined cultural-historic and paleoenvironmental implications.

In resting within the Q3 Red Sand unit, the Middle Paleolithic assemblages appear to have accumulated under predominantly dry conditions. An absence of paleosols within the sands indicates that paleo-surfaces were insufficiently stable to support the plant cover necessary to retard the extensive mobilization of sand grains derived from the local Ordovician sandstone. Similar areas of drift-sand occur under today's desertic conditions and are especially prominent along the bases of the sheer-walled jebels that flank the Hisma Basin. Unlike the modern accumulations of drift sand, however, the deposits of sand that formed during the Pleistocene (*i.e.*, Q3 and Q1 Red Sands) must have been mobilized by predominantly eastern winds. This is especially clear along the western margins of the basin, and the Wadi Humeima in particular, where deposits of Q3 Red Sand more than 2m thick rest against the eastern base of the jebel. In contrast, drift-sand is not accumulating in the Jebel Qalkha area today but instead is building along the western faces of jebels, most noticeably for those jebels located along the eastern and southeastern flanks of the basin. And this is consistent with contemporary meteorological data that show western and northwestern winds to be prevalent for the area. Therefore, it would appear that within the area, the formation of drift sand is linked to dry conditions, but the sand deposits of the Pleistocene (Q3 and Q1 Red Sands) were formed under prevailing eastern winds where western winds are dominant today.

The presence of broad-based Levallois points with classic *chapeau de gendarme* butts in several of the assemblages denotes affiliation with a Tabun Type-B Industry. Dated from near the end of Isotope Stage 5 to early Stage 3 (*c.* 70-50 kya), this Late Levantine Mousterian interval is widely associated with an arid episode that followed the much moister conditions of Early Levantine Mousterian (Tabun Type-D) times (BAR-YOSEF 1995). In several localities in the Negev, extensive erosion and downcutting have also been attributed to the onset of arid conditions during the Late Levantine Mousterian (GOLDBERG 1986). Within the Jebel Qalkha succession, the unconformable contacts between the Q3 Red Sand and Q2 Yellow Silt point to a similar erosional hiatus, as does the downcutting following the formation of the 8-meter Mousterian terrace in Wadi Aghar.

In fact, the 8-meter terrace deposit may reflect the progressive drying of the climate during Isotope Stage 4. The presence of nari cemented gravels at the base of the deposit perhaps points to the moister conditions of late Stage 5, whereas the absence of nari in the overlying deposit suggests the emergence of drier conditions that ultimately triggered an erosional cycle.

In addition to Type-B Levantine Mousterian assemblages, the Q3 Red Sand contains what appears to be a Middle-Upper Paleolithic transitional occurrence as represented by the assemblage from the site of Wadi Aghar (J433). Dominated by large pointed blades with unidirectional, convergent preparation, the assemblage retains some of the basic technical characteristics of the Late Levantine Mousterian. But the points lack the broad, heavily facetted butts and Y-arrete dorsal pattern of the Type-B Levallois points. And typologically, the presence of numerous well fashioned endscrapers on blades is in sharp contrast to Levantine Mousterian toolkits.

Also, when compared to other transitional or very early Upper Paleolithic assemblages, Wadi Aghar shows some major differences. Dominated by large, unfacetted platforms, the pointed blades of Wadi Aghar differ from the heavily facetted ones from Boker Tachtit, level 4 (MARKS and KAUFMAN 1983) and from the "transitional" levels of Ksar Akil (OHNUMA and BERGMAN 1990). The absence of Emireh points from the Wadi Aghar assemblage also represents a striking typological difference with the transitional assemblages from Boker Tachtit and Ksar Akil. Interestingly, the assemblage from Wadi Aghar seems most similar to the *intermédiaire* assemblage from Umm el Tlel in the el Kowm Basin of Syria (BOËDA and MUHESEN 1993).

Dating the period of transition from the Middle to the Upper Paleolithic in the Levant is difficult to establish with precision, but would appear to fall from *c.* 45-50 kya as judged from the Boker Tachtit radiocarbon assays. Environmentally, this coincides with what is thought to be a return to moister conditions (GOLDBERG 1986). In resting within the Q3 Red Sand, thought to be associated with arid conditions, Wadi Aghar may fall very early within this interval or even before 50 kya.

Following an erosional hiatus, the thick accumulation of aeolian silt (forming the Q2 Yellow Silt unit) signaled the onset of moister conditions in the Jebel Qalkha area. Sufficient moisture must have been available to support a vegetation cover that entrapped loess derived from fluvial outwash from the nearby uplands and from the mudflats located in the central basin of the Hisma. In a sedimentation cycle, the landscape must have been sufficiently stable to support plant cover and the formation of soils as evidenced by Paleosol A. Pollen spectra recovered from the Q2 Silt in the shelter deposits of sites J403, J412, and J431 suggest a grassland interspersed with oak and alder in protected, better-watered settings (EMERY-BARBIER 1995).

Based upon radiocarbon dates for Early Ahmarian assemblages in the Negev and Sinai (PHILLIPS 1994), the Q2 Yellow Silt, associated with the Early Ahmarian in Jebel Qalkha, should have accumulated sometime within a period stretching from *c.* 40-28 kya. Various paleoenvironmental data suggest that this interval was initiated by moister conditions, but it became progressively drier until *c.* 20 kya when it was succeeded by a dry episode (GOLDBERG 1981, 1986). These drier conditions were accompanied by an erosional episode.

Within the Jebel Qalkha area, this is likely represented by the erosional interval reflected in the unconformable contact between the Q2 Yellow Silt and overlying Q1 Red Sand. Similarly, the discovery of Upper Paleolithic artifacts "suspended" on the cliff-face some 3.5m above the Q3 Red Sand deposit at Site J444 indicates a substantial amount of landscape scouring and removal of Q2 Yellow Silt subsequent to the accumulation of the artifacts. Such a widespread erosional episode may be partially responsible for the poorly preserved record of very late Upper Paleolithic and early Epipaleolithic occurrences in the southern Levant.

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Chronostratigraphic Contexts of Middle Paleolithic Horizons at the 'Ain Difla Rockshelter (WHS 634), West-Central Jordan

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Abstract: *Excavation and paleoenvironmental research at the 'Ain Difla rockshelter (WHS 634) in 1984, 1986, 1992 and 1993 has yielded much information on the stratigraphy, chronology, archaeology and geomorphic setting of a series of Tabun-D type Mousterian occupations dated by thermoluminescence (TL), uranium (U) series and electron spin resonance (ESR) to the 90-180 kyr bp interval (oxygen isotope Stages 5, 6). This essay constitutes a progress report of work accomplished to date, focusing on (1) local and regional depositional cycles recorded at the rockshelter, and in the drainage systems of the wadis Hasa, Ali and Wanid; (2) the techno-typological composition of the archaeological assemblages recovered, as defined by conventional systematics; (3) the palynology, with implications for Levantine coastal models of paleoclimatic change; and (4) the dates obtained since 1995, which have not been reported previously, together with commentary on radiometric dating in the Levant and some of its implications.*

Introduction

The 'Ain Difla rockshelter (WHS 634) was located by Burton MacDonald's Wadi Hasa Survey (WHS) in 1982, was tested by Clark in 1984 and 1992, and by Clark and Rollefson in 1986 (MACDONALD 1988; LINDLY and CLARK 1987; CLARK *et al.* 1987, 1992). The archaeological site consists of a small wedge of sediment preserved because of its location under the overhang of a large rockshelter, the contents of which have mostly been removed by fluctuations in the course of the Wadi Ali. This is the only segment of an upper stream terrace (High Terrace - HT) that has been sealed in by extensive hillslope colluviation. A talus slope extends to the base of the Wadi Ali. Most of the Pleistocene HT that once extended across the wadi, abutting the bedrock valley wall, has been denuded in the immediate vicinity of the site. The site surface is about 12m above the present bed of the Wadi Ali.

Major excavations were conducted at the site in 1984, 1986 and 1992, and they are identified as Tests A, B and C in Pl. 1. The earlier tests produced some 12558 artifacts (4159 in 1984, 8399 in 1986) pertaining to Phase 1 (COPELAND 1986) or Tabun D (JELINEK 1981, MARKS 1983) elongated Levallois Mousterian industries, with lots of points but almost no retouched artifacts. These excavations did not penetrate below *c.* 1m from the surface of the deposits, which was variable from one unit to the next because of irregularities in the rockshelter floor. There was no evidence of human occupation subsequent to the Mousterian, nor of significant change in the composition of the archeological assemblages. The 1992 campaign yielded an additional 6607 lithic artifacts, bringing the total for all three field seasons to 19165, although only the 1984 sample has been described to date (LINDLY and CLARK 1987).

The 1992 excavations sought to deepen the exposure in Test A. Combining the three field seasons, we excavated a maximum of 20 levels in 10cm arbitrary units, for a total depth of 2.10m, reached only in Units E49/N52 and E50/N52 in Test A. A geological trench (Test C), 7x1x4m deep, was excavated along the upper talus slope below the main excavations, revealing a fragment of either the HT or a lower Middle Terrace (MT) of the Wadi Ali. Exposures disclosed a series of colluvial, rubble, spall, and slopewash deposits that interdigitate with each other and cap the stream laid sediments of the terraces (Figs. 1, 3 and 4). All deposits, including remnants of the High and Middle Terraces (12-30, 5-6m respectively above the present wadi bed), produced artifacts generally similar to those recovered from Test A. The locations of Tests A-C in relation to each other and to the shelter overhang, and a synopsis of the levels tested in each unit is given in Fig. 2. No later (*e.g.*, Upper Paleolithic) archaeological remains were recovered in any of the three field seasons and, based on a TL date of 105 kyr bp from Level 5, it appears likely that this part of the rockshelter had become filled with sediments by around 100 kyr bp, precluding its use by humans after that date.

Geomorphology and Stratigraphy

Geoarchaeological observations along the Wadi Ali and within the 'Ain Difla rockshelter were undertaken over the course of a single field season in 1992. Primary objectives were to preview general stratigraphic and landform relations linking the rockshelter to the overall terrace sequence. Topographic relations suggested that the rock shelter fronted the alluvial trench of the Pleistocene drainage at a time when the regional base level was more than 10m higher than at present. The following discussion presents the general landscape context of the rockshelter and focuses on larger scale field relations based on an initial examination of the stratigraphy exposed by Test C, extending from the floor of the rockshelter along a north-south transverse of the upper talus slope.

An earlier summary of the geomorphology of the Hasa basin described the division of the Hasa basin into two discrete hydrographic segments (SCHULDENREIN and CLARK 1994). The Upper Hasa, the segment containing the majority of *in situ* prehistoric sites tested to date, forms a lake plain infilled by late Quaternary sediments. It is separated from the Lower Hasa by the el-Hasa Fault, which created a steeper incised terrain characterized by a series of strath and fluvial terraces, paralleling the length of the drainage to its juncture with the Jordan Rift. The Wadi Ali is a steep-sided tributary to the Hasa in the lower drainage.

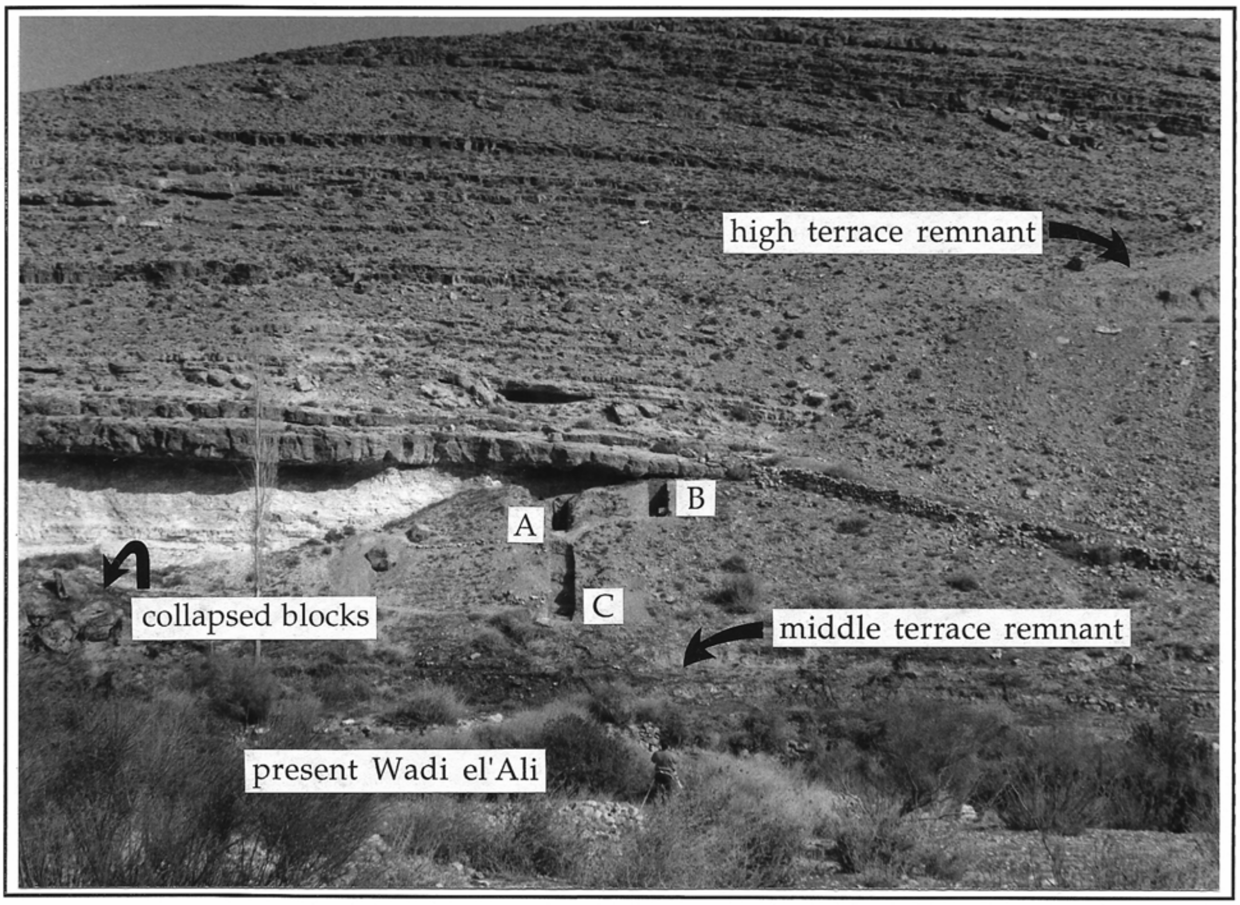

Plate 1. 'Ain Difla rockshelter (WHS 634): Photograph of the site taken from the south bank of the Wadi Ali (April, 1992), showing the locations of Tests A-C, the High (12-30 m) and Middle (3-7 m) Terraces, and the present wadi flood plain (foreground). A large pile of boulders from a major episode of collapse of the shelter overhang can be seen at the left. The position of these rocks indicates that this particular collapse occurred during the Mousterian occupation, and that the shelter overhang extended at least 10m beyond its present location.

Terraces of the Lower Hasa Basin at Wadi Ali and 'Ain Difla

The rockshelter of 'Ain Difla is at an elevation of 780m. Field observation traced the approximate surface of the rockshelter to a semi-continuous 12-30m terrace several kilometers up and downstream of the site (Fig. 3, Pl. 1). It forms the uppermost surface (High Terrace - HT) in a three-tiered cut and fill sequence and is associated with coarse, high energy fluvial sands and gravels for most of its length. The gravels also include subangular boulders eroded from the overlying limestone bedrock. HT surfaces are intermittently eroded and preserve indurated conglomerates on eroded strath benches the length of the drainage. Intermediate fluvial terraces form a second stream-cut terrace (Middle Terrace - MT); these are laterally discontinuous, and range from 3-7m above the channel floor (Fig. 3). They consist of imbricated gravel separated by upward fining sands and silts, pockets of subangular colluvial debris, and channel lags. Portions of the Middle Terrace have been contoured and relandscaped for agriculture, thus altering the natural appearance of this landform. The lowermost fluvial surfaces (Lower Terrace - LT) are 0.5 to 1.5m high wadi gravel and sand benches. Sediments are poorly sorted and only isolated pockets are preserved due to lateral erosion by the contemporary channel. Both the MT and LT are dominated by intricate fluvial sequences with alternating bedload gravel and fining upward sands and silts, punctuated by shorter term colluvial and erosional episodes.

Northwest of the rockshelter, at the approximate elevation of the HT, at least three massive blocks of tufa cover the colluvial slopes to the base of a tributary, the Wadi Wanid (Fig. 3). The uppermost tufa forms a 15m high, nearly vertical wall accumulated on a midslope bench. Block falls have resulted in episodic collapses of the tufa along the lower middle and toeslope surfaces grading down to the wadi floor. Significantly, the uppermost tufa as well as portions of the basal outcrop are intact. The higher tufa is at approximately the same elevation as the HT, and by extension, altimetrically equivalent with the uppermost occupation levels of the rockshelter. The deposit itself represents a remnant spring that could have fed the active wadi systems during the Upper Pleistocene prior to the cyclic cutting and filling represented by the lower fluvial sequences (MT and LT).

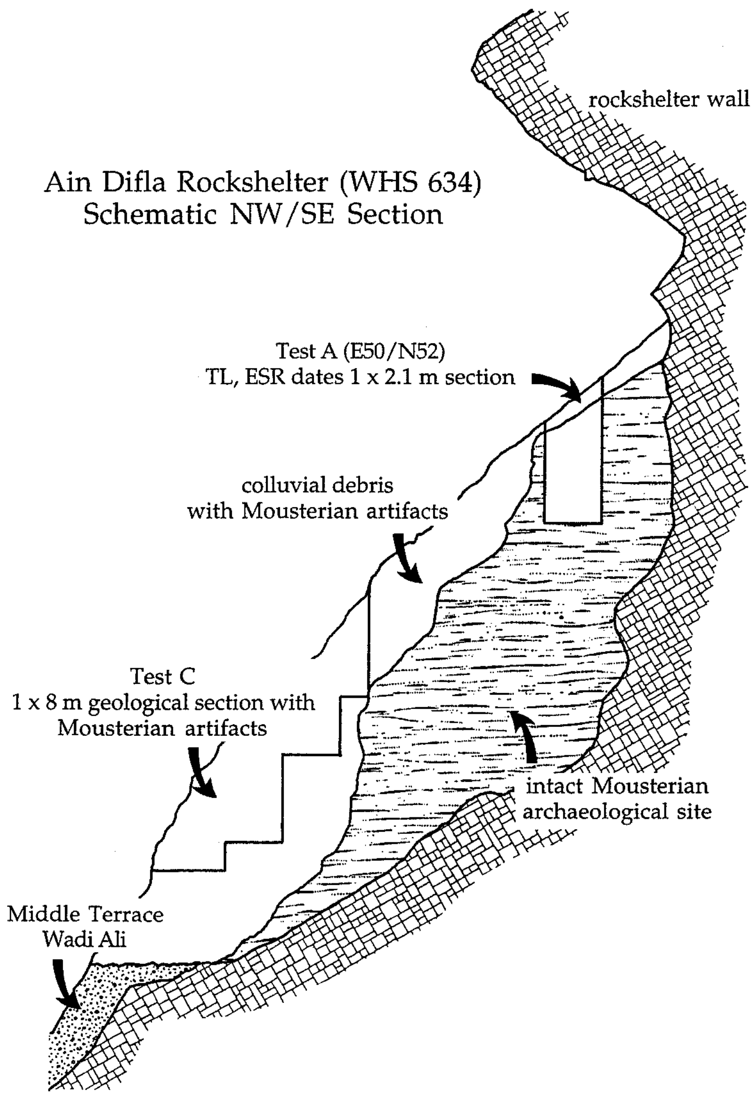

Fig. 1. 'Ain Difla rockshelter (WHS 634): a schematic NW/SE section through the rockshelter, showing gross stratigraphy in relation to bedrock and to what is probably the Middle Terrace of the Wadi Ali <*not to scale*>.

Chronostratigraphy of the Tufa and the High Terrace

Two specimens of the tufa were collected for U-series determinations and provided ages of 8000 ± 3000 bp (Tufa 1, "upper") and 141000 ± 20000 bp (Tufa 2, "lower"). The relative position of Tufa 2 is shown in Fig. 3. The modern surface of the rockshelter caps the highest, most recent

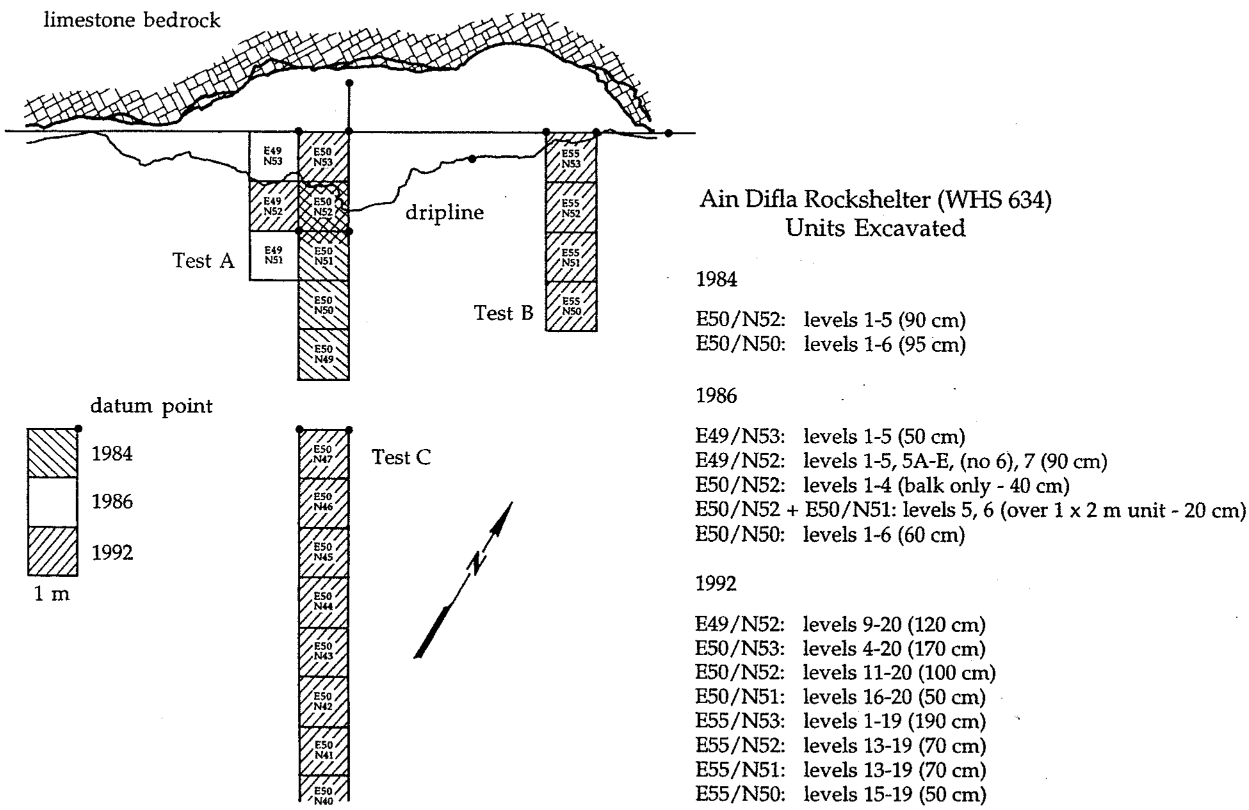

Fig. 2. 'Ain Difla rockshelter (WHS 634): units excavated during the 1984, 1986 and 1992 field seasons in Tests A, B and C.

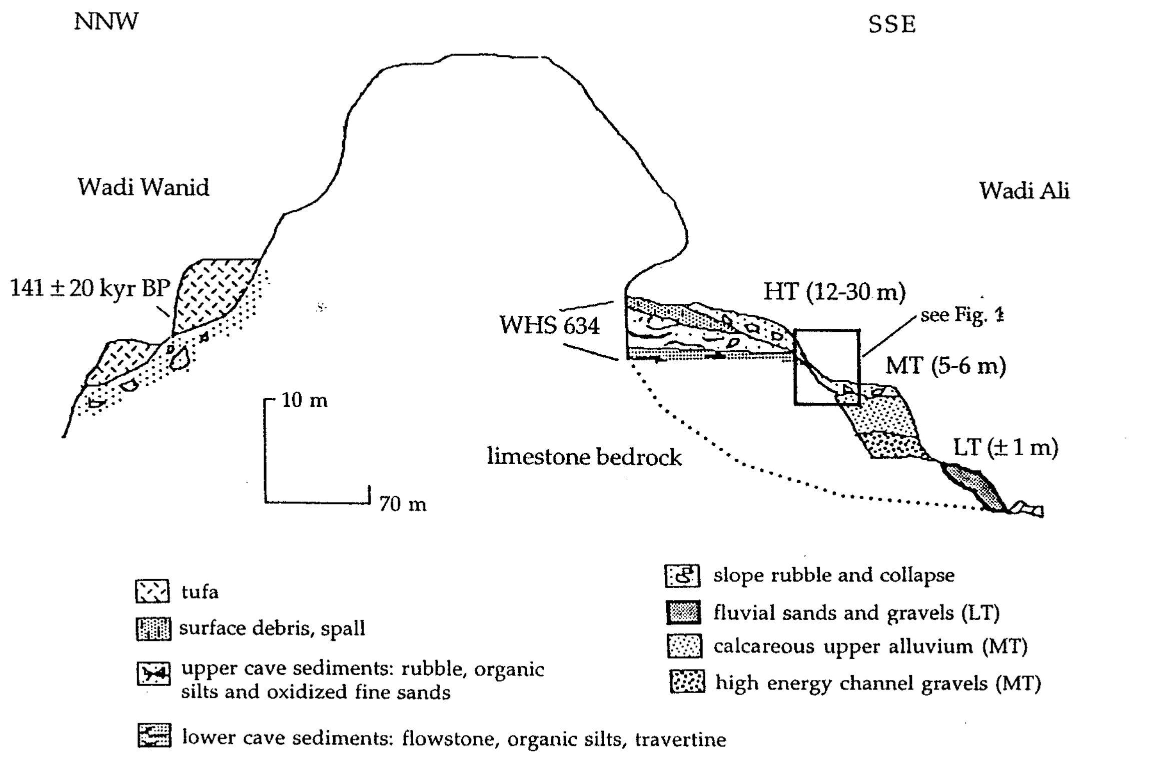

Fig. 3. 'Ain Difla rockshelter (WHS 634): schematic NNW-SSE transect through the *cuesta* ridge separating the drainages of the *Widyan* Ali Wanid <*vertical scale exaggerated*>.

occupation, and the infilling grades laterally into the HT. As noted, the archaeological excavations have exposed a deep (2.1m) early Middle Paleolithic succession which has collectively produced an array of radiometric dates in the 90-180 kya time range; variability is a function of dating techniques (TL, ESR) and the materials on which the dates were processed. However, the plausibility of the overall time range is lent a measure of credibility by the Tufa 2 determination for three reasons. First, it is the only radiometric determination in the project area processed by U-series, thus providing an independent check on the battery of TL and ESR dates. More significantly, it is the only specimen procured from a context outside the rockshelter proper but in a setting topographically and environmentally consistent with the habitat utilized by the rockshelter's Middle Paleolithic occupants. Third, the tufa may register a terminal age for the HT, perhaps documenting a phase of surface stability when springs were recharging the drainage and creating moister habitats in the vicinity of the shelter. The presence of more than 20 small, laterally and vertically discrete hearths and the more than 2m depth of deposit suggests sustained, albeit sporadic, human activity for many millennia as the HT was aggrading.

Stratigraphy and Sedimentation within 'Ain Difla

Only the most generic observations have been made of rockshelter sediment stratigraphy to date. This is because the depositional vectors within and external to the shelter have not yet been isolated (although see discussion of Test C below). It is clear, however, that the unique preservation within the rockshelter is a function of its location, nestled within a recessed cavity and protected from slope retreat. Field profiles record as many as 30 thin, moderately sloping (7-15°) to sub-horizontal layers of sediment.

There are three primary sediment "packages" (Fig. 3). These include:

1) Surface debris including overhang spall, rubble, deflated silts and organic residues (0.0-0.6m); deposition is a function of recent mechanical weathering, human activity and degradation;
2) "Upper" rubble, organic silts and oxidized sands associated with weathering and water-laid sedimentation (0.6 - 1.4m), the latter perhaps related to seasonal water flow; and
3) "Lower", more consolidated flowstones and breccias capped by organic lenses and cave travertines (more than 1.4m); these accumulated episodically and were subsequently calcified.

The lowest deposits interdigitate with moderately sorted alluvial silts and fine sands. It remains unclear whether this unit is a localized facies of the HT surface. While the HT is typically registered by coarser gravels and sands over most of its course, a finer grained facies at WHS 634 may reflect localized, more subdued stream activity under the rockshelter. Alternatively, finer sediments may register an overbank facies in the early aggradation of the HT.

Stratigraphy of Test C

The talus slope fronting the 'Ain Difla rockshelter has effectively sealed in deposits of the terraces along the Wadi Ali. In an attempt to unravel the sequence of sedimentary events bearing on the stratigraphy of the site, it was decided to place Test C along the upper talus slope, thus affording the possibility of identifying the interfaces between interior sediments, the presumed alluvial facies, and bedrock and regolith materials immediately underlying the occupation units. Since no indications of bedrock were previewed by the soundings inside the shelter, it was presumed that the softer alluvial sediments might be encountered. Figs. 2 and 3 and Pl. 1 show the location of Test C with respect to the rockshelter and the three terraces (HT, MT and LT) identified in the local landscape reconnaissance (SCHULDENREIN and CLARK 1994). This placement of Test C offered the additional (albeit limited) possibility that the section would expose discrete fills of both the MT and HT.

Fig. 4 presents the detailed stratigraphy of the section. Six primary depositional units were recognized and three were sub-divided into discrete facies (Alluvial Unit 4 was discontinuous and is not depicted in this section). Generally, the two uppermost units (1, 2 and 2A) contain coarser clastic debris laid down over the course of recent and historic slope wearing and roof collapse; Unit 1 incorporates the eroded matrix of excavation backfill and rubble mobilized over the course of several seasons of trampling and site activity by excavators. Unit 2 is a localized scree probably representing episodic overland flow. Most critical, however, is facies 2A, which consists of more massive colluvium that is thick (more than 0.5m) and consolidated, thus accounting for the preservation of the underlying sedimentary units. The latter, in turn, record the older Pleistocene history of the rockshelter and the terrace. Units 3, 3A, and 3B feature larger clasts of roof spall, mass wasted boulders and brecciated matrix that appear to represent collapse of the rock shelter interior; isolated artifacts were retrieved from the matrix. These units cap the horizontally bedded, finer grained alluvium exposed at the base of the test (Units 4-6). The antiquity of Unit 3 may be indicated by 3A which is highly calcareous and features a continuous band of nodules that may be autochthonous and reprecipitated.

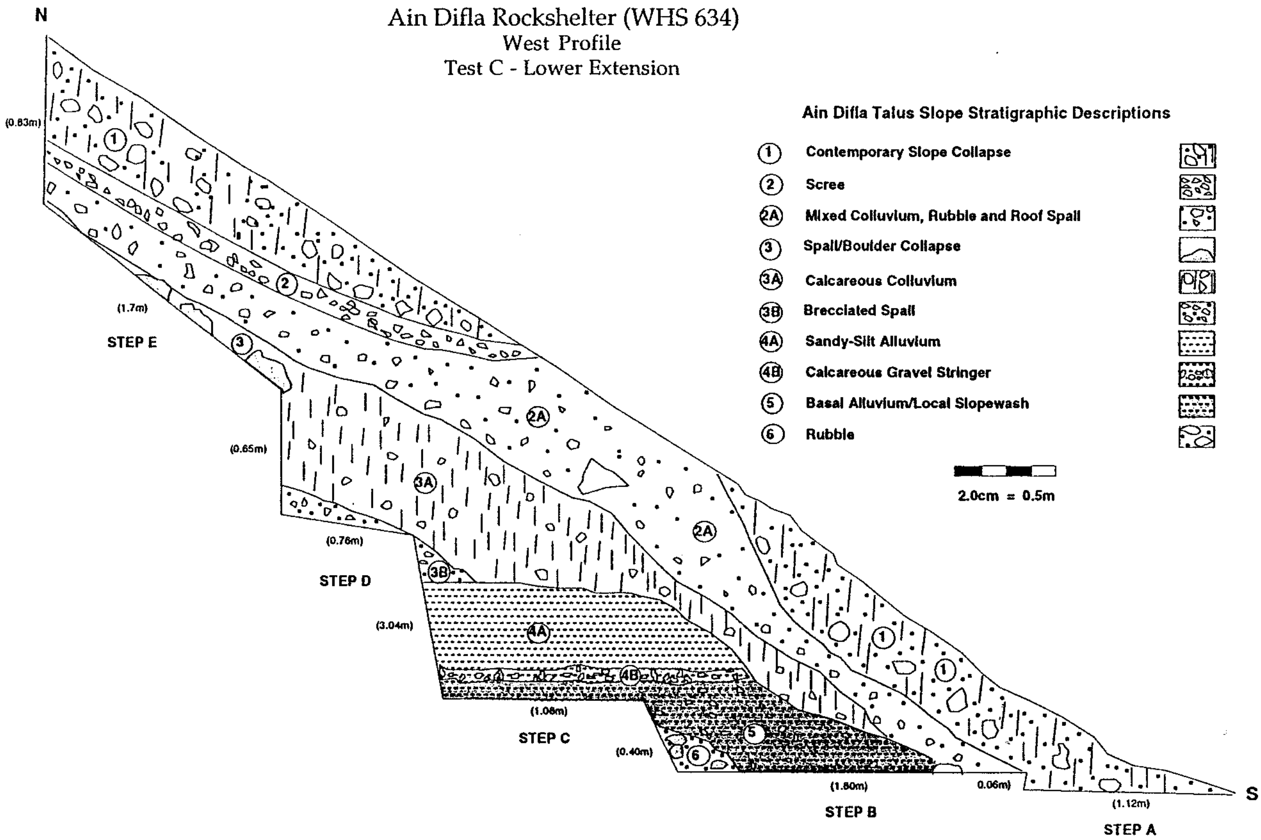

Fig. 4. 'Ain Difla rockshelter (WHS 634): Test C, west profile, lower extension.

The alluvial units feature bedding structures and a sub-horizontal stringer (4B). The disposition and bedding in these units is apparent in Fig. 4; vertical fissures of the overlying colluvium (3B) are absent in the stacked and finer underlying alluvial fill. The depth of the exposure in Test C limited more detailed resolution of the stratigraphy, as only the uppermost alluvial surfaces were exposed.

It is stressed that stratigraphic classifications and interpretations are provisional to this point. It is not clear whether the alluvial facies belong to the HT or MT, since regional terrace outcrops have not yet been examined and no radiometric materials have been processed to index any component of the terrace stratigraphy. However, the isolation of discrete facies previews finer grained resolution. Future work will attempt to structure the terrace chronology and link the fluvial history of the drainage with the occupational sequence.

The Lithic Assemblage

Table 1 summarizes the artifact frequencies recovered from the three field seasons. Recovery was excellent because of the use of 2mm mesh screens and the relatively dry, loose consistency of the sediments. As indicated in Fig. 2, the 1984 and 1986 excavations were confined to Test A, and sampled Levels 1-6. The 1992 excavations deepened Test A to Levels 19 or 20 (depending upon the unit involved), and also saw the opening of Tests B and C. Overall, the collection contains a large number of small flakes (less than 3cm) (25.8%) and debris or shatter fragments (35.5%), and a modest number of primary elements (11% - defined as flakes and blades with 10-80% cortex on the dorsal surface). Primary decortication flakes (80-100% cortex) are very rare. The complete cores recovered are few (0.9%), small and mostly "exhausted" (Table 2). Core types include Levallois point and flake cores, and both single and multiple (opposed) platform flake, blade and mixed (flake/blade) cores. There are also 297 "chunks" and unidentifiable core fragments, mostly recovered in 1986 and concentrated in Levels 1-5 in Units E49/N52-3 and E50/N52. The small size of the complete cores (in relation to the sizes of complete flakes and blades), the large number of core fragments and small "trimming" flakes suggests that most of the reduction sequence occurred at the site. Only evidence for primary decortication is missing, although it should be kept in mind that "the site" is only a small part of a much larger rockshelter, now devoid of fill (Pl. 1).

Technology

There is a low frequency of Levallois pieces in the assemblage (2.1%), possibly due to our exclusion of blades from this category. As in previous publications (*e.g.*, LINDLY and CLARK 1987; CLARK *et al.* 1987, 1988), it was thought that, because of the lack of consensus about the definition, identification and classification of Levallois blades (COPELAND 1984: 19; JELINEK 1975: 314, 1982: 75), it would be prudent to create a separate prismatic blade category. These blades are characterized by exterior flake scars parallel to the lateral edges of the piece and have triangular or trapezoidal cross sections. If prismatic blades were included in the Levallois category, the Levallois index would increase from 2.1% to 11.2% of the lithics recovered.

The frequency distribution of cores shows the low incidence of Levallois types (10%) expected from the overall scarcity of Levallois blanks in the assemblage (Table 2). Most of the 180 identifiable cores are single (40.5%) and multiple (opposed) platform (49.4%) types with flake cores dominant, although there are also substantial numbers of mixed flake/blade cores, especially in the 1986 collection. Despite the fairly common and visually impressive Levallois points, and a subjective impression of "bladeyness" to the entire assemblage, blade cores make up only 14.9% of the core total. The cores themselves are almost uniformly small (much smaller than the blanks obtained from them), there are substantial numbers of core fragments (297), and it is difficult to escape the impression that the cores were discarded at or near the end of their use lives. In Kuhn's terms, they are the kinds of cores that would have been carried about and eventually discarded by mobile foragers, rather than the larger ones expected from the "provisioning of places" (KUHN 1995). This in turn implies a degree of uncertainty in the extent to which a forager could predict the locations of suitable raw material sources as he or she moved about the landscape. The lack of evidence for primary decortication would also tend to support the provisioning of highly mobile individuals. These observations about primary decortication notwithstanding, there is also much evidence for all of the sub-

Table 1. 'Ain Difla. Artifact frequencies by type group.

Type Group	1984		1986		1992		Total	
	No.	%	No.	%	No.	%	No.	%
Cores	37	0.9	42	0.5	101	1.5	180	0.9
Primary Element[1]	377	9.1	1209	14.4	533	8.1	2119	11.0
Flakes (> 3cm)	727	17.5	663	7.9	1361	20.6	2751	14.3
Prismatic Blades[2]	247	5.9	691	8.2	799	12.1	1737	9.1
Levallois Elements[3]	94	2.3	102	1.2	214	3.2	410	2.1
Tools (essential)	80	1.9	77	0.9	54	0.8	211	1.1
Flakes (< 3cm)	1177	28.3	2557	30.4	1215	18.4	4949	25.8
Debris	1420	34.2	3058	36.4	2330	35.3	6808	35.5
Total	**4159**	**100.1**	**8399**	**99.9**	**6607**	**100.0**	**19165**	**99.8**

[1] flake or blade with cortex
[2] includes 'Levallois blades' (see Jelinek [1982: 75], Copeland [1984] for a discussion of problems related to the definition of Levallois blades
[3] flakes + points

Table 2. 'Ain Difla. Core frequencies.

Core Type	1984			1986			1992			Total		
	N	%	%TG	N	%	%TG	N	%	%TG	N	%	%TG
Levallois												
flake	2	5.4		1	2.4		2	2.0		5	2.8	
point	4	10.8	16.2	-	-	2.4	9	8.9	10.9	13	7.2	10.0
Single Platform												
flake	7	18.9		5	11.9		25	24.7		37	20.5	
blade	1	2.7		13	30.9		9	8.9		23	12.8	
mixed	5	13.5	35.1	2	4.8	47.6	6	5.9	39.5	13	7.2	40.5
Opposed Platform												
flake[1]	6	16.2		5	11.9		36	35.6		47	26.1	
blade	3	8.1		2	4.8		-	-		5	2.8	
mixed	9	24.3	48.7	14	33.3	50.0	14	13.9	49.5	37	20.5	49.4
Total Ident. Cores	**37**	**99.9**	**99.9**	**42**	**99.9**	**99.9**	**101**	**99.9**	**99.9**	**180**	**99.9**	**99.9**
Unident. Frags.	56			212			29			297		

[1] includes full and partial disk cores

sequent phases of lithic reduction in the site, implying that 'Ain Difla was the locus of the full spectrum of tool manufacture and maintenance activities. The exceptionally high contextual integrity in the site has allowed for the partial reconstruction of a number of cores, the identification of more than 20 small oval hearths (*c.* 25cm in diameter) and at least two pits, and the recovery of a number of Levallois point bases and tips, taken as evidence for refitting and the maintenance of hafted tools and weapons.

Typology

The 211 formal tools comprise a very low 1.1% of the assemblage, classified here for comparative purposes using the Bordes typology (1961). Because of the scarcity of retouched pieces, they are combined in Table 3 without regard to excavation season. The "real" tool count (which includes Levallois elements) is dominated by Levallois points (48.1%), many of which are extremely elongated (see LINDLY and CLARK [1987: 287, 288] for a comparison of the 'Ain Difla blank metrics [1984 sample] with those of other Tabun D assemblages). These are followed by moderate frequencies of typical and atypical Levallois flakes (12.4%). The "essential" type list has high frequencies of notches (18.5%), burins (19.9%) and, interestingly, pseudo-Levallois points (13.3%). Naturally backed knives (9.9%) and denticulates (8.1%) are the only other types represented in significant numbers. It is worth remarking that these categories were the same ones that were prominently represented in the 1984 sample, implying a general consistency in the make-up of the retouched tool component throughout that part of the stratigraphic sequence tested so far. The naturally backed knives and pseudo-Levallois points are probably better considered indicators of raw material "package size" and reduction mode than formal tool types (JELINEK 1975: 304), and as such are expected components in laminar industries like that of 'Ain Difla. The substantial miscellaneous category (20.4%) is dominated by Types 45-49, which comprise various categories of marginally retouched flakes and blades.

Table 3. 'Ain Difla. Retouched tools.

No.	Type	Real List No.	Real List %	Essential List No.	Essential List %
1.	Levallois flake, typical	25	4.7	-	-
2.	Levallois flake, atypical	41	7.7	-	-
3.	Levallois point (all)	257	48.1	-	-
4.	Levallois point, retouched	2	0.4	2	0.9
5.	pseudo-Levallois point	28	5.2	28	13.3
6.	Mousterian point	1	0.2	1	0.5
19.	sidescraper, double convergent	1	0.2	1	0.5
22.	sidescraper, transverse straight	2	0.4	2	0.9
30.	endscraper, typical	1	0.2	1	0.5
31.	endscraper, atypical	3	0.6	3	1.4
32.	burin, typical (all)	36	6.7	36	17.1
33.	burin, atypical	6	1.1	6	2.8
34.	perforator, typical	1	0.2	1	0.5
35.	perforator, atypical	3	0.6	3	1.4
38.	naturally backed knife	21	3.9	21	9.9
40.	truncated blank	4	0.7	4	1.9
42.	notch	39	7.3	39	18.5
43.	denticulate	17	3.2	17	8.1
44.	alternating burinating bec	3	0.6	3	1.4
62.	miscellaneous	43	8.0	43	20.4
	Total	**534**	**99.9**	**211**	**99.9**

Comparisons with Other Sites

The 'Ain Difla typological Levallois index (ILty), restricted scraper index (IRe), Mousterian (IIe), Upper Paleolithic (IIIe) and denticulate (IVe) indices are given in Table 4, along with the corresponding indices for three "early" (Tabun IX, Rosh Ein Mor, Nahal Aqev 3) and two "late" (Tor Sabiha C, Boker Tachtit 1) Tabun D type assemblages (JELINEK 1982: 72, HENRY 1982: 424, MARKS and KAUFMAN 1983: 80). Because of the high incidence of points, 'Ain Difla has a rather high Levallois index (60.9), comparable to those of Tabun IX (62.2) and Rosh Ein Mor (60.6). Both these sites are "early" (MARKS 1990, 1992). Recently published ESR and TL chronologies date Tabun IX to oxygen isotope Stage 6 (*c.* 145-188 kyr bp) and to Stages 7-8 (*c.* 235-275 kyr bp) respectively (MERCIER *et al.* 1995). Rosh Ein Mor, in the Negev, has produced only *terminus ante quem* ^{14}C dates on ostrich eggshell ranging from >37 to >50 kyr bp. It is believed to be about 160-

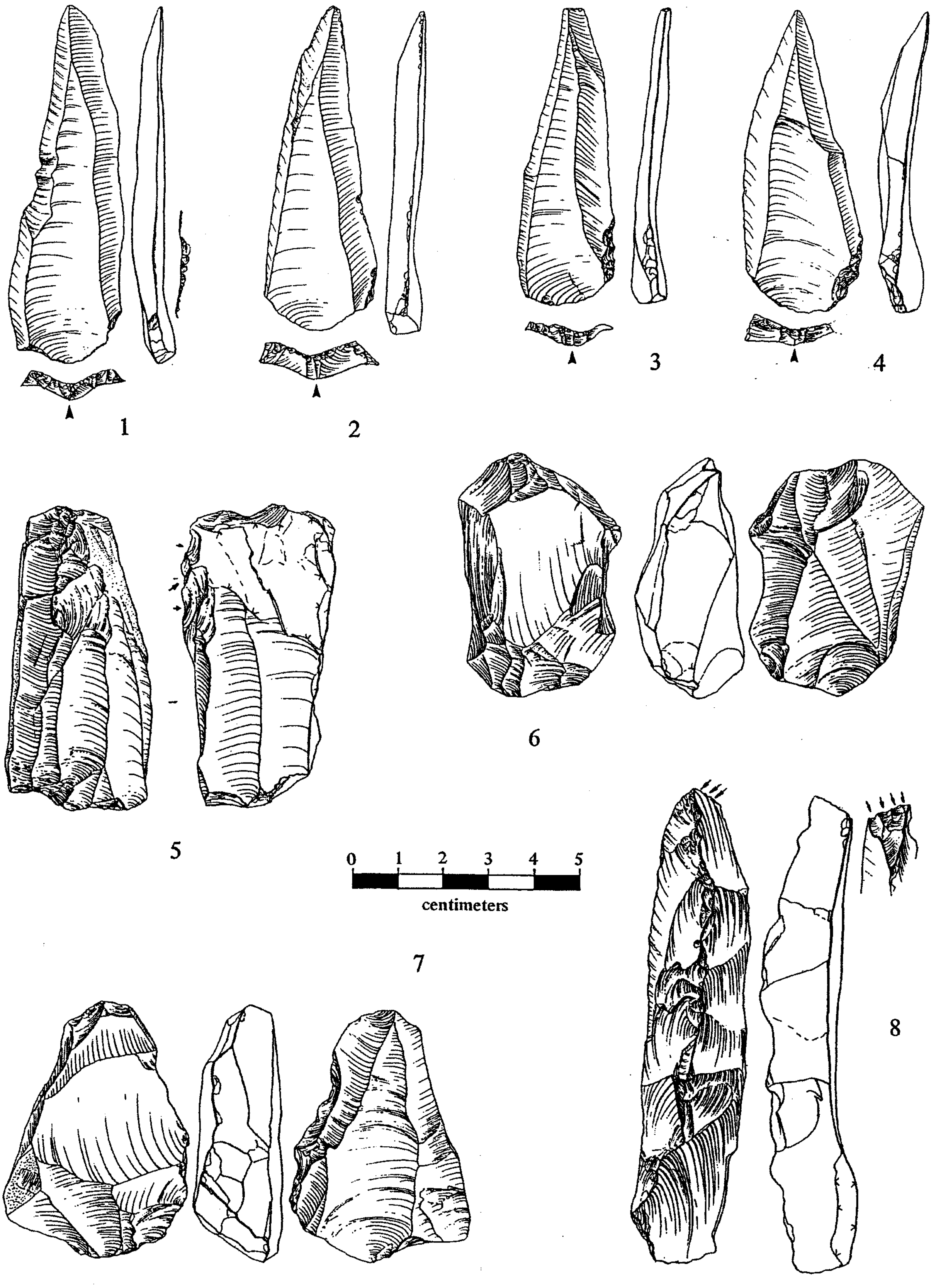

Fig. 5. 'Ain Difla rockshelter (WHS 634): 1-4 Levallois points (1: E50/N52, Lev. 6; 2: E49/N52, Lev. 5E; 3: E50/N52, Lev. 5; 4: E50/N52, Lev. 4); 5 blade core: E50/N52, Lev. 6; 6 disk core: E50/N52, Lev. 7; 7 Levallois point core: E50/N50, Lev. 6; 8 lame à crête: surface, 1984.

170,000 years old (WEINSTEIN 1984). Thus, 'Ain Difla is "early" on the basis of its typological Levallois index. Early Tabun D-type assemblages are found both in the northern and southern Levant (MARKS 1990, 1992).

Table 4. 'Ain Difla. Typological indices, compared with 'Early' and 'Late' Tabun D industries.

Site	ILty	IRe	IIe	IIIe	IVe
'Ain Difla (WHS 634)	60.9	1.4	13.8	23.7	8.1
Tabun IX	62.2	36.1	43.4	19.3	3.2
Rosh Ein Mor	60.6	8.6	10.8	30.4	14.3
Nahal Aqev 3	47.1	12.8	13.1	20.3	9.2
Tor Sabiha Layer C	39.3	6.2	6.2	9.2	12.3
Boker Tachtit Level 1	47.0	2.1	2.1	42.5	6.4

There is a near-absence of sidescrapers (Types 9-29) at 'Ain Difla, and the restricted scraper index (IRe) is 1.4, which resembles those from Boker Tachtit Lev. 1 (2.1), Tor Sabiha Layer C (6.2) and, to some extent, Rosh Ein Mor (8.6). These are all southern Levantine sites located in what are today xeric, Irano-Turanian steppe environments. Their IRes differ markedly from that of scraper-rich Layer IX (36.1) at the northern, coastal Levantine site of Tabun, located on Mount Carmel in a mesic, Mediterranean scrub oak forest-parkland setting. Boker Tachtit and Tor Sabiha are both regarded as "late", with the former dated by four ^{14}C determinations (with large standard deviations) to *c.* 47 kyr bp (best considered *terminus ante quem* dates), and the latter thought to be about 50-60,000 years old (BAR-YOSEF 1994). In sum, 'Ain Difla's affinities in respect of its restricted scraper index are with "late" southern sites. But, as will become evident below, 'Ain Difla is an "early" Tabun D assemblage.

If, for typological purposes, the pseudo-Levallois points are disregarded as a byproduct of a laminar reduction sequence, rather than considered to be intentionally manufactured, the restricted Mousterian index (IIe) drops from 13.8 to 0.5, underscoring a near-total absence of "Mousterian" tool types at the site. In this respect it is nearly unique in the Levantine context, although Tor Sabiha and Boker Tachtit also have low restricted Mousterian indices (6.2, 2.1 respectively). If the IIe indices are taken at face value, 'Ain Difla most closely resembles Nahal Aqev 3, an open site in the Negev Desert which has not been dated directly (although pre-Mousterian spring deposits in close proximity to the archaeological site have produced dates ranging from 211 ± 19 kyr bp [Layer B] to 85-74 kyr BP [Layer D]) (BAR-YOSEF 1994). Hence, 'Ain Difla's affinities in respect of its restricted Mousterian index are with a southern Levantine site generally regarded as "early", but clearly not demonstrably so.

At 23.7, the restricted Upper Paleolithic index (IIIe) is comparable to those from Tabun IX (19.3) and Nahal Aqev 3 (20.3) which, given the equivocal age of the latter, defies any temporal or geographical correlation. The restricted denticulate index (8.1) most closely aligns 'Ain Difla with the Negev (6.4, 9.2, 14.3) and south Jordan (12.3) sites, suggesting that these casually-produced and readily discarded "expedient" tools might have played more prominent roles in xeric steppic environments than they did along the Mediterranean coast.

Tabun D-Type Assemblages

There is a widely-accepted consensus definition of what constitutes the Tabun D type Mousterian. It is a laminar industry in which blanks, blades and elongated points were (mostly) detached from Levallois unipolar convergent cores, typically with minimal preparation of the striking platforms. Elongated retouched points, numerous blades, sidescrapers, and burins are among the common tool types. The rare bifaces noted at Tabun could have been derived from mixture with Layer E. In addition to the sites mentioned above, Tabun D type assemblages have also been reported from Tor Abu Sif, Sahba, Jerf 'Ajla and Douara Cave, Layer 4 (BAR-YOSEF 1994: 34). The 'Ain Difla assemblage departs from the consensus definition in regard to (1) a very low incidence of retouched pieces of any kind, (2) a near-absence of sidescrapers and "Mousterian" tools, (3) a wider range of core types, and (4) a very high incidence of platform preparation (IF = 64.7 on the 1984 sample).

Observations on Technotypological Systematics

Derived from French paradigms in terms of their fundamental biases and preconceptions, Levantine Middle Paleolithic systematics are based on the Tabun sequence, the longest and best-dated in the region. However, as more sites are discovered and excavated outside the Mediterranean coastal plain, the extent to which we can generalize from Tabun about vectored temporal change in the Levantine Mousterian is becoming more limited. It is worth asking whether *any* site, no matter how

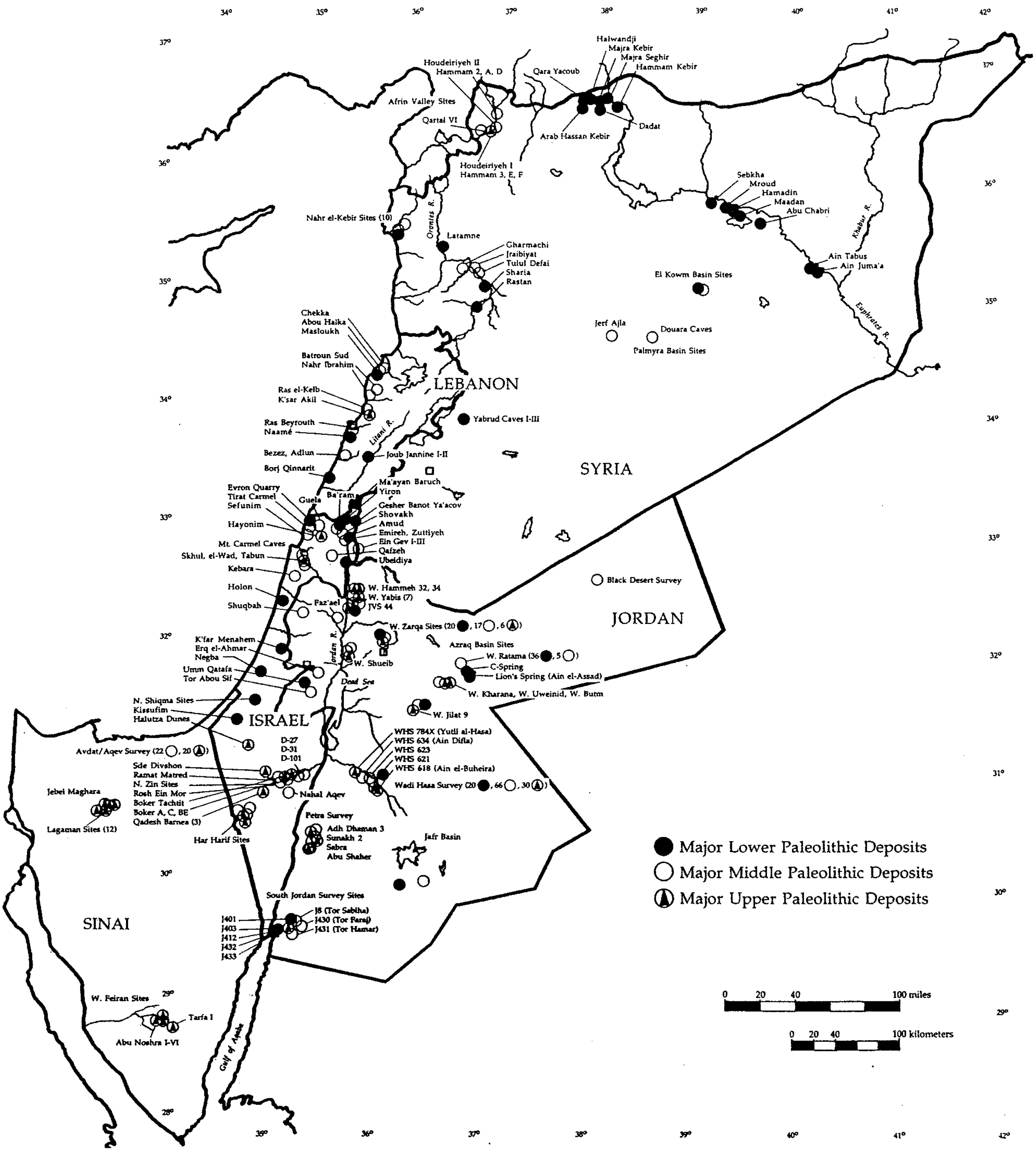

Fig. 6. Major Levantine Lower, Middle and Upper Paleolithic sites restudied, excavated, tested or re-excavated since the mid-1970s. Many sites contain both Middle and Upper Paleolithic components.

long, well-studied and dated its sequence of industries, should have any generalizable properties whatsoever beyond the immediate area in which it is located. In the southern Levant, Tabun D assemblages are both "early" and "late" and evidently persisted for hundreds of millennia. Moreover, Tabun B and C type industries appear to be relatively rare in the desert-steppe areas of the Levant (although not completely absent - there is a convincing Tabun B-C (Phase 2-3) assemblage from the eastern Wadi Hasa at WHS 621 [CLARK *et al.* 1988: 214-226]). Although beyond the scope of this paper, it would be interesting and probably informative to do a multivariate statistical analysis (*e.g.*, a discriminant analysis) of the typological and technological indices of the major Levantine Mousterian assemblage types (Tabun D, C, B) in order to try to isolate patterns that appear, on superficial inspection, to cross-cut them (*cf.* LINDLY and CLARK 1987: 283-287, CLARK *et al.* 1988: 220-225).

The Tabun Chronology

It is important to note that the chronology of the different kinds of Lower and Middle Paleolithic industries at Tabun has undergone five major revisions since the early 1980s. Based initially on geoscience data (and supported to some extent by vectored change in blank metrics), the new chronologies have come to rely more and more heavily upon absolute dating methods (esp. ESR, TL) which, although themselves problematic, have had the effect of increasing the temporal span of the entire Tabun sequence nearly five-fold (MERCIER *et al.* 1995). What this might mean in terms of paleolithic systematics is debatable, of course, but -at the very least- it has resulted in a change in our perceptions of the duration of the early paleolithic stages, and all but obliterated the conventional boundary between the Lower and the Middle Paleolithic. Work over the last decade shows very clearly that (1) Levantine Mousterian assemblages encompass a much wider range of variability than had previously been supposed, (2) modal assemblage types are more numerous than those recognized at Tabun, (3) it is no longer possible to assort all Levantine Mousterian assemblages into two or three modal categories defined at Tabun, (4) that, in the southern Levant, there is as yet no clear temporal sequence evident in the different kinds of Mousterian, and (5) that Tabun D assemblages, at least, are time-transgressive there.

'Ain Difla Pollen

Pollen samples were taken in 1986 and 1992, but only the 1986 samples have been analyzed to date. Pollen was recovered in adequate quantities for tabulation of 200 grain counts only in Test A (one sample from Level 1, three samples from Level 3). An additional sample from lowermost Level 3 and four samples from Levels 4 and 5 failed to yield sufficient pollen for 200 grain counts. Values for samples in Table 5 are calculated as a percentage of all tabulated pollen by level.

Table 5. 'Ain Difla. Pollen data, Test A.

Types	Lev. 1[1]	Lev. 3	Lev. 3	Lev. 3	Levs. 4, 5
Tubuliflorae	15.0	10.0	7.5	8.0	insufficient pollen
Ambrosia-type		0.5			
Liguliflorae	1.0	1.0		0.5	
Artemisia	5.0	10.5	3.5	9.0	
Gramineae	4.0	9.5	8.0	5.5	
Chenopodiaceae	50.0	51.0	52.5	55.5	
Amaranthaceae	1.0		1.0	2.0	
Celosia-type		0.5			
Cruciferae	1.0	2.5	5.5	4.0	
Boraginaceae		2.0		1.0	
Euphorbia-type	1.0		0.5	4.5	
Liliaceae		0.5		2.0	
Umbelliferae	1.0	1.0			
Solanaceae			0.5		
Caryophyllaceae	1.0	1.0			
Boerhaavia-type			0.5		
Justicia				0.5	
Papillionoideae	1.0	0.5	2.0	1.0	
Zizyphus		0.5			
Rhamnaceae	1.0	0.5	0.5		
Ephedra		1.0	0.5		
Pinus	2.0	1.0	2.5	1.0	
Quercus	6.0	0.5	3.0	1.5	
Cupressaceae		0.5	1.0	0.5	
Ostrya-Carpinus				0.5	
indeterminate	10.0	5.5	11.0	3.0	
Total	**100.0**	**100.0**	**100.0**	**100.0**	

[1] Level 1 percentages are based on a 100-grain count; Level 3 on a 200-grain count. Levels 4, 5 had insufficient pollen in the samples to make a count.

The four 'Ain Difla spectra show similar distributions; vegetation stability is apparent during the sampled interval. In each case, the assemblage is dominated by non-arboreal taxa, with arboreal types consistently less than 10% of level totals. A steppe vegetation is clearly indicated, with trees as minor and localized elements. Typical steppe shrubs are identified by moderate percentages of *Artemisia* and the occurrence of *Ephedra*. Frequencies of Gramineae (grass) and Tubuliflorae (a broad division of the Compositae family) are both relatively low in the 'Ain Difla spectra. Leroi-Gourhan (1980; HENRY *et al.* 1981) and Emery-Barbier (1988, 1995) associate a predominance of these two pollen types with climatic conditions cooler and moister than those of the present. Drier conditions are signaled by the dominance of Chenopodiaceae and Liguliflorae (another division of the Compositae typified by dandelion). While the pollen type that encompasses most chenopod species (cheno-am) constitutes the majority in 'Ain Difla assemblages, it is not accompanied by appreciable quantities of Liguliflorae.

The morphologically similar pollen of most chenopod and some amaranth species is designated cheno-am in this analysis. Two divisions within this broad category have been associated with different temperature regimes: (1) *Atriplex*-type, with a round shape and many pores, predominates during cool, dry intervals, and (2) *Noaea*-type, with a hexagonal shape and fewer, larger pores, predominates during warm, dry intervals (EMERY-BARBIER 1988, 1995). The 'Ain Difla cheno-am pollen is overwhelmingly *Atriplex*-type. In modern samples from Syria and Lebanon, such a configuration is paralleled only in steppe and desert-steppe environments (BOTTEMA and BARKOUDAH 1979). Both shrub and herbaceous species can contribute to cheno-am totals.

Small percentages of abundant windblown *Pinus* (pine) pollen probably reflect transport over substantial distances from upland sources; a single occurrence of *Ostrya/Carpinus* (hornbeam) pollen may have found its way into the site in a similar manner. Other trees or large shrubs identified by pollen are compatible with Mediterranean *maquis* taxa (ZOHARY 1973). Low frequencies of *Quercus* (oak), Cupressaceae (juniper or cedar), Rhamnaceae, and *Zizyphus* suggest a distributional pattern of widely scattered individuals or small pockets of trees in particularly favorable habitats such as drainages.

The 'Ain Difla pollen from Test A, Levels 1-3, does not resemble that recovered from Mousterian Layer C at Tor Sabiha in southern Jordan, in which *Noaea*-type cheno-ams and grasses are dominant. Minor types in this layer also are xerophytes, however (EMERY-BARBIER 1995: 379). Although these two pollen records may be disjunct in time within the Mousterian era, each registers open, steppe-like vegetation and a relatively dry climatic regime.

'Ain Difla Paleoenvironments in Regional Context

'Ain Difla was originally considered a "late" site, based on a preliminary report of the pollen, which indicated a relatively dry, steppe-grassland environment thought to correspond to the 60-50 kyr bp interval, when xeric conditions prevailed over much of the southern Levant (*e.g.*, BAR-YOSEF 1994, HENRY 1995). However, on the basis of a series of absolute dates, it now appears that the site was occupied intermittently over a 90,000 year period between *c.* 90 and 180 kyr bp (oxygen isotope Stages 5,6). Although pollen is not well preserved at the site, the more complete pollen analysis given above is now available (Table 5). It indicates that human use of the rockshelter coincided with a cool interval, characterized by a relatively xeric flora dominated by Chenopodiaceae (always greater than 50%), Tubuliflorae (7.5-15.0%), *Artemisia* (3.5-10.5%), Gramineae (4.0-9.5%) and Cruciferae (1.0-5.5%). No arboreal species were reported in the preliminary analysis (CLARK *et al.* 1988: 235), and it was thought that at least some trees would have been present, given the protected microenvironment of the Wadi Ali and the proximity of strong springs, if the site pertained to the 100-60 kyr bp interval, regarded by Marks as optimal for human habitation of the nearby central Negev highlands (MARKS 1981, 1983). As Table 5 shows, we now have low frequencies of oak (*Quercus*), juniper or cedar (Cupressaceae), buckthorn (Rhamnaceae), jujube (*Zizyphus*) and Umbelliferae (aquatic taxa), making the environment in the immediate site vicinity more mesic than it had appeared to be in 1988.

Because of a much longer tradition of paleoenvironmental research along the Mediterranean littoral, discussions of environmental change in the Levant are usually couched in terms of temperature and moisture gradients along a N/S transect (*e.g.*, GOLDBERG 1981, HOROWITZ 1979). With the post-1970 accumulation of data from the Sinai and the Negev and, since 1980, from sites east of the Jordan Rift, it is becoming apparent that there is also marked paleoclimatic variability along a W/E transect that cannot be accommodated by models developed along the coast. The Wadi Hasa is usually compared to one of these better investigated areas: the central Negev highlands (MARKS 1975, 1977, 1983). The Wadi Hasa is, however, much more topographically and elevationally variable than the central Negev, making comparisons between the two areas at best "coarse-grained" and, at worst, misleading. A brief discussion of the Wadi Hasa drainage system helps to clarify some of the differences between it and the central Negev, and underscores the need to take a more sophisticated view than previously of pattern in environmental data along a W/E transect. As will be seen, the Wadi Hasa is a big place, with as much or more internal variation over its course than between it and other regions.

The Wadi Hasa is the only perennial watercourse draining the central Jordan Plateau between the Dead Sea and the Gulf of Aqaba. Its catchment encompasses portions of the Eastern (or Syrian) Desert and the western highlands of the Jordan *horst*. Approximately 70km long, its bed ranges in elevation from *c.* 900m to 0m a.s.l., where it joins the Wadi Araba near as-Safi, south of the Dead Sea. The steep gradient dissects the predominantly Cenomanian limestones of the Jordan Plateau, with maximum elevations of 1200+m. Precipitation increases with elevation, of course, reaching *c.* 350mm annually in the western mountains, while the eastern Hasa lowlands receive as little as 50mm. As a result of the W/E moisture gradient and in combination with orographic factors, the western third of the wadi receives more precipitation than areas to the east and southwest at comparable elevations.

Environmental zones within the Hasa system vary with altitude and topography. The eastern third is dominated by desert shrubs (*e.g., Anabasius*, Chenopodiaceae), while most of the wadi presently lies in the Irano-Turanian phytogeographic zone. With an increase in elevation a sparse, degenerated Mediterranean *maquis* is encountered, most densely developed on west-facing highland slopes. Broad sections of the valley bottom are farmed today, and springs occur at intervals along the steep wadi walls throughout the western and central portions.

A summary of paleoenvironmental research locations (mostly lake cores) indicates that the central Negev highlands (GOLDBERG 1976, HOROWITZ 1976) are indeed most comparable overall to the Hasa (Table 6), but important differences exist. The Wadi Hasa is characterized by much greater elevational variability than the Negev highlands, and the average elevation is also considerably greater. Precipitation data suggest that most sections of the wadi receive more rainfall on average than the Negev does, as well as including a far greater range of microenvironments. Although at similar latitudes, Wadi Hasa's higher elevations resulted in more favorable conditions over the long term, capable of supporting human populations almost continuously from the Middle Paleolithic to the present. In contrast, there is no evidence of human settlement in the Negev during the latter part of the Middle Paleolithic (*c.* 90-45 kyr bp) (MARKS and FREIDEL 1977).

Table 6. Locational and other data concerning Levantine paleoenvironmental study areas.

Pollen Site	Elevation (m)	Annual Precipitation (mm)	Distance from Hasa (km)	Direction	Core Depth (m)	Number of Samples
Ghab	+190	c.4450	c. 520	NNW	11	76
Berekhet Ram	+850	1000	c. 240	NNW	200	27
Hula (Horowitz)	+70	400-500	c. 220	NNW	120	15
Hula (Tsukuda)	+70	400-500	c. 200	NNW	55	?
Kinneret	-200	c. 450	c. 170	NNW	16	11
Melek-Sedom 1	-350	50-100	c. 60	WNW	2000	20
Central Negev	+400-600	50-100	c. 30-90	WSW	-	20
Wadi Hasa	+100-1100	50-350	-	-	-	40

Considering the very limited available paleoclimatic data, it is difficult to assess the probable impact that increased effective moisture would have had on inland environments in the southern Levant. Horowitz (1979) suggested that climatic and vegetation belts along the coast were displaced southward as much as 200-250 kms during the maximally moist interval corresponding to the early Mousterian (then reckoned to date *c.* 150-90 kyr bp). This estimate was based primarily on lake cores from the central and northern Levant (northern Israel, Syria), while absolute changes in the south might have been much reduced due to disruption of cyclonic patterns by the Sinai Peninsula to the west and a possible compression of circulation patterns toward the equator. A re-evaluation of pollen data from early Mousterian site D35 in the Negev (HOROWITZ 1976, 1979) does not fully support his interpretation of conditions now present in northern Palestine, but rather a Mediterranean *batha* transitional zone with only limited tree cover. (It would be injudicious to put too much emphasis on the results of a single pollen sample, given the considerable range of within-sample variability from identical locations).

An alternative or corollary approach toward a better understanding of past environmental conditions might be to examine changes in animal body size over the course of the Pleistocene (TCHERNOV 1981). Birds, micro- and macromammals respond in a more or less regular fashion to changes in (especially) the moisture regimen and, on the basis of these, Tchernov (1982) suggested that a decrease of *c.* 200mm in annual precipitation and a drop of *c.* 5° C had occurred over the past 130,000 years, implying that changes in effective moisture did not take place solely along a N/S gradient, but also were strongly correlated with altitudinal isohyets.

An increase of approximately 200mm in precipitation, combined with a decrease in evapotranspiration due to lowered temperatures, would bring the Negev highlands into the lower range of the Mediterranean phytogeographic zone proper rather than resulting in the appearance of a *maquis*. A similar increase in precipitation in the Wadi Hasa (from *c.* 50-350mm to *c.* 250-550mm) would bring much of the drainage (including the Wadi Ali) into the lower ranges of the Mediterranean vegetation zone, while the Hasa uplands would probably have supported a *maquis* forest. The areal extent, density and diversity of Irano-Turanian steppe vegetation would also have increased. As noted for the Negev, increased moisture would tend to recharge aquifers, increase the flow volumes of active springs and possibly create new ones (MARKS and FREIDEL 1977). Thus an increase in effective moisture would bring about the depression of vegetation zones along altitudinal clines, and an overall amelioration of climatic conditions manifest in a patchy distribution of Mediterranean vegetation along a W/E (as well as a N/S) transect.

If the enriched, expanded environments of the early Mousterian can be taken to represent the maximum effective moisture levels reached in the late Middle and early Upper Pleistocene, as many believe, what were the effects for subsequent periods? The big increases in aridity detected for the late Mousterian of the Negev are not strongly reflected in other paleoenvironmental indicators but, if they occurred, it seems reasonable to suppose that they might also have affected climate in more marginal locations like the Hasa, resulting in shrinking vegetation zones and retreat to higher elevations of more mesic associations, accompanied by decreased spring activity and increased erosion. But the presence of typologically "late" Mousterian sites in the Wadi Hasa (*e.g.*, WHS 621) does not reflect the occupation hiatus seen in the Negev, and it suggests that conditions did not reach the levels of aridity found in the area today (COINMAN *et al.* 1986). In sum, data from the Wadi Hasa surveys suggest that, while the pattern of human occupation was clearly tied to long-term environmental fluctuations, the relationship between climate and settlement was far more complex than suggested by models developed along the Levantine coast or in the geographically-proximate but topographically distinctive central Negev highlands.

Age of the Site

'Ain Difla Th/U, TL and ESR dates are summarized in Table 7. All are from Test A, with the exception of a U-series determination on a travertine sample from the uppermost tufa in the adjacent Wadi Wanid, some 300m northwest of the rockshelter, and at approximately the same elevation (SCHULDENREIN and CLARK 1994: 43). Taking the error ranges typical of these methods into account, and acknowledging the systematically younger determinations associated with early uptake ESR dates, it would appear that the interval of human use/occupation of the site falls roughly between 90,000 and 180,000 years ago (oxygen isotope Stages 5,6). Unsurprisingly, these dates correspond best to the ESR series from Tabun IX, which spans the 102-186 kyr bp interval (GRÜN *et al.* 1991). A recently published TL series from that unit is considerably older (215-303 kyr bp) (MERCIER *et al.* 1995: 503). If these dates are taken at face value, it is clear that the Tabun D type assemblage at 'Ain Difla pertains to the "early" rather than the "late" site group.

Table 7. 'Ain Difla Th/U, TL, and ESR dates.

Provenience	Lab. No.	Type	Material	Age (kyr BP)	Range (kyr BP)
Test A, Level 5	Oxford	TL	burnt flint	105 ± 15	90 - 120
Upper Tufa	McMaster	Th/U	travertine	141 ± 20	121 - 161
Test A, Level 12	McMaster 94812	ESR (EU)	equid teeth	114.9 ± 14.2	100 - 129
Test A, Level 12	McMaster 94812	ESR (LU)	equid teeth	165.7 ± 20.5	145 - 185
Test A, Level 19	McMaster 94814 C	ESR (EU)	equid teeth	95.8 ± 12.0	84 - 108
Test A, Level 19	McMaster 94814 C	ESR (LU)	equid teeth	154.7 ± 21.3	134 - 176
Test A, Level 20	McMaster 94816 A	ESR (EU)	caprid teeth	88.3 ± 11.5	77 - 100
Test A, Level 20	McMaster 94816 A	ESR (LU)	caprid teeth	142.8 ± 20.7	122 - 163
Test A, Level 20	McMaster 94816 B	ESR (EU)	caprid teeth	112.5 ± 14.6	98 - 127
Test A, Level 20	McMaster 94816 B	ESR (LU)	caprid teeth	185.6± 26.6	159 - 212
			mean ESR date (EU) =	102.9 ± 12.9	90 - 116

Levantine Dating Methodologies and Some of Their Implications

As part of a long essay discussing the contributions of southwest Asian data to modern human origins research, Bar-Yosef (1994: 36-38) summarizes most of the radiometric determinations from Acheulo-Yabrudian, Mousterian and early Upper Paleolithic archaeological sites available through 1992. This table is reproduced here in its entirety with the kind permission of the author (Table 8). It is a very enlightening document. Inspection of it allows one to make the following observations pertinent to southwest Asian archaeological chronologies, some of which are more or less well-understood by Levantine researchers (see, *e.g.*, JELINEK 1992). Others are not so evident, however, and have profound implications for the conduct of paleolithic (and, more broadly, paleoanthropological) research in the region.

Problems with Inter-Method Comparability

It seems pretty clear that the dates cannot be taken at face value, are not in any sense comparable, and sometimes vary systematically according to technique and substance dated (see also JELINEK 1992). This is most apparent in respect of radiocarbon determinations, many of which are *terminus ante quem* dates that fall at or near the limits of consensus application of the method. Based on the ^{14}C dates, a global average age for the west Asian Mousterian (Shanidar, Kunji caves plus the Levantine sites) is 48.7 kyr bp, including two amino acid racemization and one fission-track barite determination from Douara Cave, which are substantially older than the rest. If these exceptionally controversial dates are excluded, the mean age of the southwest Asian Mousterian drops to 44.2 kyr bp. The mean for the "greater than" (>) dates is 45.3 kyr bp.

Table 8. Pre-Mousterian, Mousterian and early Upper Paleolithic chronometric dates from Middle Eastern sites (from BAR-YOSEF 1994: 36-38).

TH^{230}/U^{234}		
Site	Dates	Source
El-Kowm		
Oumm 5 - pre-Yabrudian, travertine	245+16 ka	1
Hummal 2 - Yabrudian, travertine (layer Ib)	156+16 ka	1
Oumm 3 - Yabrudian, travertine	139+16 ka	1
Tell 6 - Yabrudian	99+16 ka	1
Oumm 4 - inter-Yabrudian-Mousterian	76+16 ka	1
Zuttiyeh Cave		
76ZU 1 pre-Acheulo-Yabrudian, travertine	164+21 ka	2
76ZU 4 Acheulo-Yabrudian, travertine	148+ 6 ka	2
76ZU 1 pre-Mousterian, travertine	95+10 ka	2
76ZU 6 pre-Mousterian, travertine	97+13 ka	2
Naamé (Mousterian)		
Strombus level - Enfean II	90+20 ka	3
Strombus level - Enfean II	93+ 5 ka	4
vermet level - Naamean	90+10 ka	3
Nahal Aqev (fossil spring)		
Layer B (average of 3 samples) pre-Mousterian	211+19 ka	4
76NZ6d-4 layer D below Mousterian	85.2+10 ka	4
76NZ1 layer D below Mousterian	74+ 5 ka	4
Ksar Akil Rockshelter		
Layer XXVI B, bone G-88174s	47,000±9,000	11
Layer XXVIB, bone G-88173b	19,000±5,000	11
Layer XXXII, bone G-88177s	51,000±4,000	
Layer XXXII, bone G-88178b	49,000±5,000	
TL		
El-Kowm		
Hummal Well: Three readings for Layer Ib-Yabrudian, pre-Hummalian, Flint	180±25; 145±20; 160±23	12
Average for the Yabrudian	160±22 (Ox85-TLfg 235 Ib)	12
Three readings for Layer 6b (abraded Mousterian flints)	97±8; 105±9; 112±10	12
Average: Abraded Mousterian artifacts	104±9 (Ox85-TLfg235)	12
Kebara Cave (Mousterian)		
Unit VI	48,300±3,500	5
Unit VII	51,900±3,500	5
Unit VIII	57,300±4,000	5
Unit IX	58,400±4,000	5
Unit X	61,600±3,600	5
Unit XI	60,000±3,500	5
Unit XII	59,900±3,500	5
Qafzeh Cave (Mousterian)		
XVII-XXII range of dates	85.400±6.9-109.900±9.9	5
The mean date	92±5 kyr	5
ESR		
Quneitra (Mousterian), Average	EU 39.2± LU 53.9±1.7 kyr	6
Kebara Cave (Mousterian), Unit X	EU 60±6 kyr LU 64±4 kyr	6
Qafzeh Cave (Mousterian)		
Average XV-XXI	EU 96±13 kyr LU 115±15 kyr	6
Skhul Cave (Mousterian)		
Range of dates	EU 54.6±10.3 to 101.0±19 kyr	6
	LU 77.2±15.7 to 118.0±25.1 kyr	6
Average	EU 81±15 kyr LU 101±12 kyr	6
Tabun (Average dates)		
B Mousterian	EU 86±11 LU 103±18 kyr	6
C Mousterian	EU 102±17 LU 119±11 kyr	6
D Mousterian	EU 122±20 LU 166±20 kyr	6
Ea - Acheulo-Yabrudian	EU 154±34 LU 188±31 kyr	6
Eb - Acheulo-Yabrudian	EU 151±21 LU 168±15 kyr	6
Ec - Acheulo-Yabrudian	EU 176±10 LU 199± 7 kyr	6
Ed - Acheulo-Yabrudian	EU 182±31 LU 213±46 kyr	6

Table 8. cont.

^{14}C			
Kebara Cave (Mousterian			
chB	GrN-2561	41,000+1000	6
Same sample, "rest fraction"	GrN-2551	35,300+500	6
Tabun Cave			
Tabun B Ch	GrN-2534	39,700±800	7
Tabun C Ch	GrN-2729	40,900±1000	7
Tabun Unit I Ch	GrN-7408	>47,000	7
Tabun Unit I Ch	GrN-7409	51,000±4,800/3,800	7
Tabun Unit I Ch	GrN-7410	45,800±2100/1600	7
Tabun Bed 42 very black soil	LJ-2084	38,800±2,400	7
Geula Cave (Mousterian)			
B1 chB	GrN-4121	42,000±1,700	7
Ras el Kelb Cave (Mousterian) chB	GrN-2556	>52,000	7
Ksar Akil Rockshelter (Mousterian)			
Layer XXVI dark clay band	GrN-2579	43,750±1,500	7
Jerf 'Ajla Cave (Mousterian) Ch	NZ-76	42,000±2,000	7
Douara Cave (Mousterian)			
layer E Ch	TK-111	>43,900	8
IIIB Ostrich eggshell	GrN-8638	46,700±2,200 8/1,700	8
IIIB Ostrich eggshell	GrN-8058	>53,800	8
IVB Ch	TK-165	38,900+1,700	8
IVB Ch	TK-166	>43,200	8
IVB Ch	TK-167	>43,200	8
IVB Ch	TK-168	>43,200	8
IVB Ch	GrN-7599	>52,000	8
Fission-track IVB Barite	Kyoto	75,000	8
Racemization IIIB		ca. 85,000	8
IIIB		ca.110,000	8
Rosh Ein Mor (Mousterian)			
Ostrich eggshell	Tx-1119	>37,000	7
Ostrich eggshell	Pta-543	>44,000	7
Ostrich eggshell	Pta-546	>50,000	7
Shanidar Cave (Mousterian)			
D Ch	GrN-2527	46,800+1,500	10
D Ch	GrN-1495	50,600+3,000	10
Kunji Cave (Mousterian)			
135 cm Ch	SI-247	>40,000	10
145 cm Ch	SI-248	>40,000	10
Earliest Upper Paleolithic			
Boker Tachtit (Transitional Industry)			
Level 1 Ch	GX-3642	>35,000	9
Level 1 Ch	SMU-580	47,280+9,050	9
Level 1 Ch	SMU-259	46,930+2,420	9
Level 1 Ch	SMU-184	>45,490	9
Level 4 Ch Early Ahmarian	SMU-579	35,055+4,100	9
Shanidar Cave (Baradostian)			
C near base, Ch	I-3351	32,300±3,000	10
C-Lower, Ch	GrN-2015	34,540±500	10
C-Lower, Bone fraction	GrN-2016	35,440±600	10
C-Lower, Ch	W-650	32,300±1,000	10
C-Lower, Ch	W-180	>34,000	10
The Ahmarian Tradition			
Negev			
Boker A Ch	SMU-181	>33,600	9
Boker A Ch	SMU-260	>33,420	9
Boker A Ch	SMU-578	37,920±2810	9
Northern Sinai			
Lagama VII Ch	SMU-172	34,170±3670	13
Lagama VII Ch	SMU-185	31,210±278	13
Lagama VII Ch	RT-413A	>19,000	13
Lagama VIII Ostrich eggshell	SMU-119	32,980±2140	13
Lagama IIID Ostrich eggshell	SMU-118	30,050±1240	13
Qadesh Barnea B501 Ostrich eggshell	Pta-2819	33,800±940	14
Qadesh Barnea B601 Ostrich eggshell	Pta-2964	32,470±78	14
Southern Sinai			
Abu Noshra I Ch	B-12125>30,440		15
Abu Noshra I	B-13198	29,580+1610/-1340	15
Abu Noshra I	SMU-2007	35,805±1520	15
Abu Noshra II	SMU-1762	31,536±2275	15
Abu Noshra II	ETH-3076	33,940±790	15

Sources: 1. HENNIG and HOURS 1982; 2. SCHWARCZ, GOLDBERG and BLACKWELL 1980; 3. LEROI-GOURHAN 1980; 4. SCHWARCZ *et al.* 1979; 5. VALLADAS *et al.* 1987, 1988; 6. SCHWARCZ *et al.* 1988; STRINGER *et al.* 1989; GRUN and STRINGER 1991; 7. WEINSTEIN 1984; 8. AKAZAWA 1987; 9. MARKS 1983; 10. HENRY and SERVELLO 1974; 11. VAN DER PLICHT, VAN DER WIJK and BARTSTRA 1989; 12. Ancient TL Supplement, date list, 1989; 13. BAR-YOSEF and PHILLIPS 1974; 14. GILEAD 1983; IS. PHILLIPS 1988.
Legend: EU = Early uptake; LU = Linear uptake; Ch = charcoal; chB = charred bone.
Comments: 1. 14C dates of Mousterian samples later than 38ka were not included. 2. The dates for Level 6 in Hummal Well are of Mousterian flints derived from the top of the Mousterian sequence in this site. An estimate of 150-llOk is for the Hummalian and other Levalloiso-Mousterian. The chronological assignment of the Yabrudian as earlier than 150ka will corroborate the Th/U dates for Hummal, Oumm, and Zuttiyeh. The date should, therefore, be rejected or its context reexamined in the field.

When this exercise is carried out for the U-series determinations (Th^{230}/U^{234}), the Mousterian grand mean age jumps to 62.7 kyr bp, but there is a systematic difference according to the substance dated, with travertines yielding systematically older determinations than bone. Four bone dates from Mousterian Layers XXVIB and XXXII at the K'sar Akil rockshelter (Lebanon) average only 42.1 kyr bp. The corresponding TL mean (all on flint samples) is 66.1 kyr bp (El Kowm 6b, Kebara IV-XII, Qafzeh XVII-XXII). The Mercier *et al.* (1995) chronology for Tabun is not included in these calculations (see below). In respect of ESR-dated Mousterian sites, and excluding the 'Ain Difla dates reported here, the grand mean is 124.5 kyr BP which, depending upon how the dose rate is calculated, drops to 113.6 kyr bp (early uptake), and increases to 135.4 kyr bp (linear uptake).

All that really can be concluded from this number crunching is that the southwest Asian Mousterian occupies a chunk of time - depending upon dating method - between *c.* 49,000 and *c.* 135,000 years ago. When the mean standard errors are taken into account, that range increases substantially to *c.* 180,000 years as an upper limit but, interestingly, does not decline very much (to *c.* 44,000 years) at the lower limit, probably because it "collides" with the upper limit of radiocarbon. A more restricted comparison of dated Tabun D type assemblages produces the following average ages: (1) ^{14}C = 46.8 kyr bp, (2) Th/U (no dated Tabun D levels), (3) TL = 263 kyr BP (Tabun IX - MERCIER *et al.* 1995: 501), (4) ESR = 144 kyr bp (EU = 122 kyr bp LU = 166 kyr bp).

Implications for Modern Human Origins

The dates have important implications for modern human origins research since, in the opinion of biological replacement advocates like Stringer (1992) and Vandermeersch (1993), the fossils are "site specific" (*i.e.*, "moderns" at Qafzeh, Skhul; "Neanderthals" at Tabun, Amud, Kebara). If these taxa are accepted as credible (see CLARK [1992], CLARK and WILLERMET [1995] for reasons why they should *not* be so accepted), no temporal precedence whatsoever of either alleged morphotype can be established. The resulting picture of "climatically-induced time sharing", as John Lindly felicitously put it (LINDLY and CLARK 1990), is contradicted by the principle of competitive exclusion (MAYR 1950) and, in fact, by everything we know about the evolutionary eco-logy of large, K-selected, social mammals.

Because it is so strongly supported empirically (and thus generally accepted) in evolutionary ecology, the competitive exclusion principle would seem to require no further discussion. However, since replacement advocates claim that archaic and modern humans coexisted for more than 50,000 years as discrete populations in the Upper Pleistocene Levant, neither interbreeding nor showing any archaeological or biological indications of different adaptations (*e.g.*, STRINGER 1992, BAR-YOSEF 1992), it must be assumed that these workers consider them to be sympatric species. The problem with this contention is that sympatric species - in order to be sympatric - must have different adaptations. By definition, sympatric species occupy distinct niches, or limited portions of a shared environment, and, since niches overlap, there is competition in direct proportion to the extent of overlap. Aspects of the niche (*e.g.*, food supply, predation, physical space) limit population growth and force competition, resulting in emigration, extinction or adaptive shifts in order to avoid or eliminate the competition. Over the long term, the most probable outcome for K-selected species is the survival of a single lineage. The extant hominoids in general, and humans in particular, are K-selected species. So, if neandertals and moderns did not occupy distinct niches, they could not have persisted over the course of the Upper Pleistocene as distinct biological populations. There is no evidence that they occupied distinct niches, so it appears most reasonable to conclude that the biological taxonomic units themselves are suspect. In all probability, what we are accustomed to call "neandertals" and "moderns" simply represent parts of a morphological continuum - a single, evolving, polytypic lineage sampled at different points in time and artificially dichotomized into two groups on the basis of an outmoded typological species concept discarded by evolutionary biology for nearly a century.

Obliteration of the Lower/Middle Paleolithic Boundary

Chronometrically, the pre-Mousterian of the Levant (JELINEK's [1982] Mugharan Tradition - Acheulo-Yabrudian, Yabrudian, Amudian) overlaps extensively with, and usually cannot be distinguished from, the Mousterian. A grand mean for the U-series, TL and ESR determinations from the El Kowm sites, Zuttiyeh Cave, Nahal Aqev and Tabun Units X-XIII is 198.3 kyr bp. Five Th/U determinations from pre-Yabrudian sites at El Kowm average 143 kyr BP; the mean of four pre-Mousterian travertine samples from Zuttiyeh is only 126 kyr bp (U-series grand mean = 132.4 kyr bp). The El Kowm Yabrudian mean (3 TL readings from Layer 1b) is 161.7 kyr bp, but the TL grand mean nearly doubles (to 283.7 kyr bp) when the Mercier *et al.* (1995) dates for Tabun Units X-XIII are included. However, it should be kept in mind that this latest Tabun chronology is considerably "longer" than anything proposed previously. The ESR grand mean is a more modest 178.8 kyr bp; the constituent EU average is 165.7 kyr bp, and the corresponding LU mean is 192 kyr bp.

One conclusion that could be drawn from this is that there is no longer a credible chronological boundary between the west Asian Lower and Middle Paleolithic, just as there are no clear-cut techno-typological distinctions between them (*e.g.*, CLARK 1982; *cf.* MERCIER *et al.* 1995: 508). Despite much evidence to the contrary, cited but subsequently ignored (*e.g.*, TRINKAUS 1983, 1984; VANDERMEERSCH 1981), Mercier *et al.* (1995) accept without question the integrity of neandertals and moderns as discrete biological populations, just as they adopt the normative characterizations of the Tabun Lower and Middle Paleolithic assemblage types. Consequently, their interpretation of the significance of the Tabun TL dates rests entirely upon the assumption that both the fossils and the industries are in some sense rigidly bounded phenomena. They conclude from their analysis that a pre-Würm neandertal population might have established itself in the Levant during oxygen isotope Stage 6, and that the Mugharan/Mousterian transition occurred around the end of Stage 8, more than 200,000 years ago. However, the pattern suggested by the dates is one of extensive temporal overlap. Moreover, and despite the persistence of variety-minimizing normative characterizations favored by many workers, the industries themselves appear to blend seamlessly one into another, and can only be disentangled statistically.

The Middle-Upper Paleolithic Transition

Ideas about the nature of the transition from the Middle to the Upper Paleolithic in the Levant are well-known to most prehistorians and have, in any event, recently been summarized by Bar-Yosef (1994: 40-43), from which this account is drawn. There are two scenarios, one based on the K'sar Akil rockshelter (Lebanon), the other on the open site of Boker Tachtit (Israel). The two views are mutually incompatible, underscoring the utter futility of attempting to generalize on a regional scale from a few well-studied and dated "key" sequences (CLARK and LINDLY 1989).

An analysis of the K'sar Akil collection stored in the Institute of Archaeology (London) originally led Copeland (1975) to suggest that an *in situ*, technological transition between the Middle and Upper Paleolithic was evident there, based on continued use of Levallois reduction strategies. However, subsequent work by Ohnuma and Bergman (1990) showed that the earliest EUP levels at the site (XXV-XXI) were characterized by increasing numbers of prismatic, unipolar cores, although evidence for Levallois reduction also continued. These levels underlie the blade-dominated, Upper Paleolithic Ahmarian. Meanwhile, a re-analysis of another, larger part of the K'sar Akil collections stored at Harvard's Peabody Museum indicated that the latest Mousterian assemblages (XXXII-XXVI) exhibited a trend toward increasing use of radial preparation and that it was, therefore, unlikely that these assemblages could have led to the EUP transitional industries at the site, much less the full-blown Ahmarian (MARKS and VOLKMAN 1986). There is, however, a depositional hiatus at K'sar Akil between the latest Mousterian level (XXVI) and the earliest EUP industries (XXV-XXI) and, as Bar-Yosef points out, Levels XXV and XXIV are impoverished.

On the basis of more than 200 refitted cores, Marks (1983) has made a strong case for an *in situ* technological transition at Boker Tachtit involving a gradual frequency shift from a Tabun D-like Levallois Mousterian (Level 1, dated by radiocarbon to 47-46 kyr bp) to an assemblage containing typological Levallois points made on unipolar blade cores (Level 4). Because of a short, coarse-grained stratigraphy (vis à vis cave and rockshelter sites), the duration of this transition is not well established but, on the basis of a single ^{14}C determination (35.1 ± 4.1 kyr bp) from Level 4, it evidently took place over *c.* 10,000 years. It is worth noting that the Boker Tachtit core reconstructions have profound implications for paleolithic systematics in general because they decouple typology from technology, and show beyond the shadow of a doubt that they can vary independently from one another. Most workers have accepted the evidence for an *in situ* technological change at Boker Tachtit, whereas the situation at K'sar Akil is more equivocal.

Chronometrically, the Middle/Upper Paleolithic transition coincides with a shift in dating methods to radiocarbon which, while understandable for practical reasons, nevertheless makes that divide much more sharply defined than it would have been otherwise. In fact, inspection of Table 8 shows that there is little to distinguish the earliest Upper Paleolithic from the radiocarbon-dated Mousterian series. This is an especially interesting observation in light of the fact that radiocarbon dates of Mousterian samples later than 38 kyr bp apparently exist but, for unexplained reasons, were not reported (BAR-YOSEF 1994: 38). For the most part these are charcoal dates. Three of the Lagama sites (IIID, VIII) and two Qadesh Barnea determinations are on ostrich eggshell; there is one Shanidar date on bone. No systematic differences are correlated with the dated substance.

There are 25 radiocarbon dated EUP levels, including the transitional sequence at Boker Tachtit in the Negev. The EUP is represented in highland western Asia by the poorly-understood Baradostian, dated at Shanidar Cave (Iraq) to 33.7 kyr bp (lower Lev. C, mean of 5 dates). In the Levant, the earliest Upper Paleolithic pertains to the Ahmarian Tradition (after Erq al-Ahmar, in the Judean Desert). A grand mean for Ahmarian levels at Boker A (Negev); Lagama IIID, VII and VIII and Qadesh Barnea B (northern Sinai), and Abu Noshra I and II (southern Sinai) is 32 kyr bp. A mean for Level 1 at Boker Tachtit is 43.7 kyr BP and, as noted, there is a single determination for early Ahmarian Level 4 (35.1 kyr BP). The grand mean for the earliest Upper Paleolithic series is 34.3 kyr bp, but the figure is extremely misleading for at least two reasons.

First, there are enormous standard deviations associated with 14 (56%) of the dates (vs 13 [43%] for the Mousterian series), which underscores the fact that these determinations are either old solid carbon assays (*e.g.*, Shanidar) or, more commonly, that the assays are operating close to the upper limits of the method. Second, of the remaining 11 determinations, six are *terminus ante quem* dates, which effectively have no standard errors. In short, the EUP radiocarbon determinations "behave" very much like their Mousterian counterparts, and it is difficult to escape the impression that the limitations of the method are constraining pattern in the results of the assays, rather than any archaeological reality. The apparent existence of Mousterian ^{14}C dates younger than 38,000 years naturally leads to speculation about why they were not reported, and causes one to ponder whether, if they were, they might not make the Middle/Upper Paleolithic transition appear to be more gradual than it seems if the dates are taken at face value. A summary of the preceding chronometric pattern searches is given in Table 9.

Table 9. Chronometric pattern search summarized.

Major Paleolithic Unit	^{14}C	Th/U	ESR	TL[1]	Grand Mean[1]	Grand Range[2]	
Early Upper Paleolithic	34.3	-	-	-	34.3	>19-56	
Mousterian	48.7	62.7	124.5	66.1-222.5	75.5-114.6	19-186	154-290
Pre-Mousterian	-	132.0	178.7	198.3-283.7	169.7-198.1	79-261	248-383

1 MERCIER *et al.* (1995): Tabun dates included, and expressed as range
2 MERCIER *et al.* (1995): Tabun dates expressed as range in the second column

Conclusions

Over the past 15 years, archaeological reconnaissance and excavation east of the Jordan Rift has profoundly changed our picture of Middle Paleolithic adaptations in the Levant. However, the most sweeping changes have been conceptual ones, rather than ones arising from surveys or the excavation of single sites. The changes - how to divide up the paleolithic but, more significant, what things are important to look at in attempting to understand early forager adaptations - are partly a consequence of Levantine research, but are mostly due to paradigmatic shifts in Europe and America that have effected the archaeology of early hominids. Major, post-1980 conceptual developments include (1) a de-emphasis on traditional typological systematics (those concerned with the study of retouched stone tools), (2) an emphasis on technology (analysis of the characteristics of the débitage component of lithic assemblages), (3) the rise of archaeotaphonomy (the study of death assemblages) and (4) raw material procurement and processing (especially in relation to tracking mobility patterns, and in monitoring the spatial extent and temporal duration of site occupations). The advent of thermoluminescence (TL) and electron spin resonance (ESR) dating methods in the middle 1980s has also completely changed our perceptions of the duration of the early paleolithic stages, and - as pointed out above - has all but obliterated the conventional boundary between the Lower and the Middle Paleolithic at *c.* 100 kyr bp. Levantine research is in the forefront of these developments, since the Early Paleolithic is exceptionally well-represented there.

Typological Systematics

Typological systematics were an early casualty of the conceptual changes that took place since 1980. This approach to the study of the paleolithic arose in France between 1880 and 1920 with the work of pioneers like Gabriel de Mortillet, Denis Peyrony and Henri Breuil, and was brought to its fullest development in the 1950s and 1960s by their intellectual progeny, workers like François Bordes and, in the Levant, Dorothy Garrod, Jean Perrot, Réné Neuville, Jacques Tixier, Lorraine Copeland and Francis Hours. It emphasized the study of retouched stone and bone/antler tools to the near exclusion of anything else. The reasoning behind doing this, practically always implicit, was that retouched tool forms were thought to reflect ethnic, linguistic and/or social boundaries of the kinds evident in recent European history. This culture-historical paradigm, which dominated Old World paleolithic research for more than a century, has, since the early 1980s, come to be viewed as extremely limited in what it can tell us about past human behavior. Moreover, the logic of treating the formation processes of paleolithic archaeology as if they were analogous to those of history has been seriously questioned (*e.g.*, CLARK 1993, 1994).

Technological Systematics

Technological studies have tended to gain equal status with, and in some cases to supplant, the traditional emphasis on typology. This is due in part to the loss of faith in the credibility of typological systematics just mentioned, but also to the realization that the débitage component (usually more than 95% of most lithic assemblages) contains information about raw material accessibility, differential transport, patterns of site use, reduction strategies and tool function (*e.g.*, KUHN 1995). These in turn can sometimes be related to, and explained by, changes in generalized mobility strategies. Technology was usually de-emphasized or ignored altogether by European-trained prehistorians, so stringent was their adherence to the typological paradigm. Most paleolithic archaeologists active in Levantine research between 1920 and 1975 were trained in Europe, which tended to look to France, with its strong natural science research tradition, for leadership. Since the mid-1970s, however, French dominance of the field is weakening in the face of increasing numbers of Anglo-American trained workers, and the rise of indigenous archaeologies characterized by an amalgam of different approaches.

Archaeotaphonomy

The third major trend in recent paleolithic research is the appearance and rapid development of archaeotaphonomy. With roots in Germany and Russia, archaeotaphonomy is the study of the cultural and natural processes that contribute to the formation of an archaeological record and, more specifically, those processes involved in the accumulation of faunal remains, an area long neglected in traditional research designs. Most archaeotaphonomic research is very recent (in the Anglo-American research traditions, it dates to the early 1980s), and it has become really visible in the literature only in the past decade. While still in the pattern searching stages, it has already called into question the human contribution to the formation of faunal assemblages at many "classic" Lower and Middle Paleolithic sites (*e.g.*, Olduvai Gorge in Tanzania, Torralba and Ambrona in Spain, Swanscombe and Hoxne in England, Zhoukoudian in China, Grotta Guattari in Italy, Klasies River Mouth in South Africa, and practically all of the French Middle Paleolithic Neandertal "burial" sites such as Le Moustier, La Ferrassie, Le Regourdou, etc.). The general effect on Paleolithic research has been to sharpen our perception of the complex series of natural processes that contribute to the formation of early archaeological sites, with the result that the human component in many of them can be shown to have been minimal. This in turn has "dehumanized" the early hominids involved, who increasingly appear to have exhibited a range of scavenging and foraging behaviours analogous in various ways to those of our closest primate relatives, the great apes, certain Old World monkeys (especially baboons and mandrils) and social carnivores like hyenas and wolves. That faunal remains associated with stone artifacts in some of these early sites can be attributed mainly to scavenging activities, rather than to human hunting, is a striking conclusion. It marks the demise of the ethnography-based "man the hunter" model dominant in the Anglo-American research traditions since the late 1960s.

Raw Material Procurement and Processing

As an outgrowth of the new emphasis on technology, paleolithic archaeologists have been paying increased attention to the factors that govern raw material procurement and processing. This research, which originated with Harold Dibble's work in the mid-1980s, showed that the conventional Middle Paleolithic artifact types (mainly sidescrapers) were the results of generalized reduction and resharpening sequences conditioned by the shape of the original blade or flake, rather than idealized tool forms held in the minds of their makers, as was widely believed in Europe up until that time (see, *e.g.*, DIBBLE 1995, for a recent assessment). Since about 1987, these avenues of research have expanded to include studies of the size and shape characteristics of flakes, exterior scar morphology (which tells us something about the sequence of detachment), platform preparation attributes (an indication of the size of the original blank and the reduction strategy used to detach it), cortex percentages and patterning (which indicate when in a reduction sequence a particular flake was de-tached), breakage, and the factors that govern variation in the reduction of cores. Together with archaeotaphonomy, these new studies have shed considerable light on the duration and periodicity of human site use, stability (or lack thereof) of mobility strategies and, on the intrasite level, activity variation (what particular groups of people were doing within sites). Issues relating to the maintenance, renewal and curation of stone tools have been shown to underlie some of the most pronounced differences in the intensity of reduction among Lower and Middle Paleolithic archaeological assemblages.

Chronology

As is evident from this essay, another major area of radical change has been chronology. Until the mid-1980s, the chronological boundary between the Lower Paleolithic (equated in the Levant with the Acheulian and the Acheulo-Yabrudian - the handaxe industries) and the Middle Paleolithic (the flake and blade-dominated Mousterian) was set by a kind of tacit consensus at *c.* 90-100 kyr bp. Since then, however, the widespread application of TL and ESR dating has more than doubled the time span allotted the Mousterian, and rendered utterly meaningless the conventional chronostratigraphic division between the Lower and the Middle Paleolithic (Table 8). Handaxe-dominated assemblages can now be shown to have persisted long after 100 kyr bp, and the Mousterian extends well back into the Middle Pleistocene (to *c.* 250 kyr bp). What is probably the oldest site in the region, Ubeidiya in northern Israel near Lake Galilee, has recently been dated by its micromammal assemblages to 1.4 mya. Fig. 6 shows Lower, Middle and Upper Paleolithic sites that have been restudied, excavated or tested, or re-excavated since the mid-1970s. The map is noteworthy for the increased tempo of work in Jordan. Prior to the mid-1980s, Paleolithic research in the Levant was concentrated in Israel.

Modern Human Origins

Finally, beginning in 1987 and continuing until the present, the Levant has become the major geographical focus of what has come to be known as "the modern human origins controversy". Sparked by the implications of the TL and ESR dates from the "neandertal" sites of Kebara and Tabun, and the "modern human" sites of Qafzeh and Skhul, the debate centers on two hypotheses offered to describe (and supposedly explain) the transition between archaic and modern humans. The first states that moderns appeared early in the Levant (prior to 100 kyr bp), and coexisted with Neandertals, who arrived at a later date (*c.* 65 kyr bp). The second states that moderns evolved in the Levant, as elsewhere, from the local archaic *Homo sapiens* stock (see, *e.g.*, CLARK and LINDLY 1989). These two perspectives, which cannot be reconciled, are sometimes referred to as the "replacement" and "continuity" positions (CLARK 1992). While "replacement" advocates have claimed that Levantine Neandertals are later immigrants from Europe, and are thus unrelated to modern human origins in the Levant, the weight of the fossil and archaeological evidence, coupled with a much more sophisticated explanatory framework, clearly supports the view that modern humans evolved *in situ* in the Levant from their archaic *Homo sapiens* ancestors.

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Use-Wear Analysis of Levallois Points from the 'Ain Difla Rockshelter, West-Central Jordan

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Abstract: *A low-power use-wear analysis of Levallois points from 'Ain Difla rockshelter shows a wide range of functional applications for this morphological tool type. While no evidence of projectile damage is found, edge damage suggestive of longitudinal, transverse, and graving motions is indicated. Along with other research, this study supports the contention that morphologically based lithic classification schemes, while useful in the construction of coarse-grained time-space grids, tend to mask functional variability within tool types.*

Introduction

Typological classification schemes are commonly used by archaeologists to allow the comparison of assemblages from different sites within a region. Almost invariably, such classificatory systems are based on the morphological variability evident in a class of (retouched) artifacts. Perhaps the best known example of such a classificatory system for lithics is that proposed by François Bordes (1954) for the Middle Paleolithic stone tools of western Eurasia. While artifacts of a given type within a classificatory system will share a common morphology, the classification typically is not based on the *function* of the artifact. Not infrequently, however, *post hoc* functional assumptions have been applied to the various types within a system.

Use-wear analysis is one method for getting beyond mere assumptions about the functions of artifacts. While only about 30 years old, these approaches have witnessed significant advances in the systemization and application of their methodologies. Use-wear studies enable us to determine the function of various classes of stone artifacts that have been grouped together on the basis of morphology. The present analysis focuses on one relatively clear-cut Middle Paleolithic morphological tool type, Levallois points from the site of 'Ain Difla, Jordan. The results of this study suggest that the 'Ain Difla points were used for a wide variety of tasks. While the morphology of these artifacts is quite similar across vast stretches of the Old World, the research reported here should not be taken as an indication that all Levallois points were necessarily used for similar functions.

Lithic Typologies

The typological system currently used for lithic assemblages in Europe and the Near East was first developed by Bordes (1954). The development of this typology was a major contribution to the study of lithic assemblages, since it allowed for the systematic comparison of whole artifact assemblages from sites widely separated in space and time. The definition of the various Middle Paleolithic tool types is made "on the basis of technology (including techniques of blank production, such as Levallois, and techniques of retouch) and overall morphology (location of retouch on the piece and shape of the retouched edges)" (DIBBLE 1984: 431). Bordes' classification system recognizes 63 tool types for the Middle Paleolithic (BORDES 1961). The compilation of the frequencies of each tool type is used to determine which kind of "industry" is present at a site.

In Europe, at least, various kinds or "facies" of Middle Paleolithic industries have long been recognized (*e.g.*, Typical Mousterian, Quina-Ferrassie or "Charentian" Mousterian, Denticulate Mousterian, Mousterian of Acheulian Tradition). Leaving aside the question of how valid these taxa are (FREEMAN 1994), whether and how they assort in time (MELLARS 1996), and what they might mean in a global or universal sense (DIBBLE 1995), these industries differ from one another in the percentage of the various tool types present in the assemblage. The definition of the facies was developed from the study of European collections, but the basic Bordes' typology is also used to describe lithics from southwest Asia. The frequency-based industries (*e.g.*, Denticulate Mousterian) do not apply to this region, however, and the term "Levantine Mousterian" is used instead, with subdivisions based upon the sequence of industries defined in Garrod's excavations at Mugharet et-Tabun, on Mount Carmel in northern Israel (*e.g.*, JELINEK 1982: 1369-1375; BAR-YOSEF 1994: 34-40, 1995: 253-256, 1996: 176-179).

There are 23 different "scraper" types identified in Bordes' typology, but many other morphological tool types are represented as well (*e.g.*, points, knives, burins, awls, notches, choppers). An important defining characteristic of Middle Paleolithic assemblages is the variable use of Levallois technique. As Bordes defined it, this technique involves "pre-determining the form of the flake by a careful preparation of the upper surface of the core" (BORDES 1968: 27). Flakes, blades, and points are made using Levallois methods. The Levallois point may have partial or no retouch, and the point itself "has to be located on the flaking axis, opposite the bulb" (BORDES 1970: 7). An advantage of the use of the Levallois technique is that it "allows a great degree of control over the shape of the resulting debitage by determining the trajectory of flake propagation through preparatory shaping of the striking platform" (SHEA n.d.: 6).

The traditional use of Bordes' typology involved the description and categorization of a site's assemblages into one of the several facies. Often, this was used as a method for dating the site, as establishing accurate dates for sites beyond the limits of radiocarbon dating is still problematic (see CLARK *et al.*, this volume). It was thought by some workers that the various industries represented not adaptations to environmental factors, but different stages in a chronological sequence. More recently, there has been an attempt to use the patterning of lithic assemblages over time to determine the nature of the Middle/Upper Paleolithic transition. An example of this can be seen in Mellars' analysis of the Upper Paleolithic industries of Europe (MELLARS 1989, 1996). He suggests that early Upper Paleolithic Châtelperronian assemblages were made and used exclusively by archaic *Homo sapiens* (AHS), while Aurignacian industries were supposedly manufactured by morphologically-modern humans (MMH). Since these industries date to the same period, and even "occur *interstratified* in at least three sites in western France and northern Spain" (MELLARS 1989: 352, emphasis in original), Mellars asserts that this is evidence to support the hypothesis that AHS was replaced by, but did not evolve into MMH.

Form *versus* Function

Since the Ford and Spaulding exchanges of the 1950s (FORD 1954, SPAULDING 1954), archaeologists have debated the nature and use of archaeological typologies. As Brew (1946) pointed out 50 years ago, classifications serve a purpose for archaeologists. Bordes' lithic typologies work well for comparing assemblages; however, they very clearly mix stylistic and functional variation (SACKETT 1982). "Functions" for Bordesian types are sometimes assumed (implicitly) to be indicated by the type's name. For example, Levallois points are sometimes (often?) taken to have been thrusting spear points, convex sidescrapers are assumed to have been used for scraping, etc. Although preliminary, the research presented here casts doubt upon the credibility of such assumptions.

Some of the problems arising from the conflation of artifact form and function can be demonstrated empirically. Ethnographic studies indicate that modern users of stone tools do not categorize their assemblages in the same manner as do the scientists who study them. Gould *et al.* (1971), in a study of the tools used by the aboriginal inhabitants of Australia's Western Desert, found that only two tool classes were recognized by the indigenes. Aboriginal classification was shown to be based exclusively on the "cross-section shape of the working edge . . . of the stone flake" (GOULD *et al.* 1971: 149). Gould and his colleagues found that this distinction could be demonstrated empirically, through measurements of edge angles. They conclude their study by noting that

> " . . . it would be a mistake to overclassify the ethnographic adzes and adze-slugs of the Western Desert. Ethnographic observations over an extended period of time and in a variety of situations lead, instead, to an appreciation of the casualness and opportunism of present-day Aborigine stone chipping. To these people, the primary aim is to perform a task" (GOULD *et al.* 1971: 154).

They illustrate this point with several different "types" of adzes now recognized by researchers, "types" that "have no place in their present-day behavior" (GOULD *et al.* 1971: 154).

All stone tool usage was not as casual as that of the Australian aborigines, however. Dibble (1984) points out that the availability of raw materials, and therefore the intensity with which they are used, can have a great effect on the appearance of lithic assemblages. He found that a number of different "types" of Middle Paleolithic scrapers, recovered from a site in northwest Iran, actually "represent the same basic tool that was discarded at certain points along a continuum of remodification and reduction" (DIBBLE 1984: 432). His results, like those of Gould, suggest that the typologies employed to examine lithic assemblages probably are not measuring factors that were actually important or meaningful to the creators and users of those tools. Dibble suggests that almost one-fourth of Bordes' morphological types can be attributed to the point (in a generalized reduction and use model) at which they entered the archaeological context, rather than intentional end products (DIBBLE 1984: 435).

Why do lithic typologies created by modern researchers fit the emic categorization of these objects so poorly? Barton has suggested that this is partly due to implicit acceptance by archaeologists of what he calls the modern "Industrial Paradigm," particularly as seen in metal working technology (BARTON 1991). Metal objects in modern society have very different use-lives than do lithic tools. "In modern western, industrial societies, most metal implements undergo little if any morphology-altering maintenance during their use life . . . When these pieces eventually are worn or broken they are often discarded and replaced by new ones" (BARTON 1991:145-146).

This is a very different pattern of manufacture, use, modification and discard from the one suggested by Dibble for Middle Paleolithic scrapers. According to Barton, this discordance is due to an archaeological confounding of modern and ancient technologies. Modern tools are formally diverse and functionally specific; ancient tools are not.

The importance of the "Industrial Paradigm" becomes clear in light of some of the problems with typological systematics mentioned above. The modern mindset matches a tool to a job, thus modern researchers are inclined to assign significance to minor differences in the form of a stone tool. This is in sharp contrast to the attitude towards "types" seen among the Australian aborigines, which likely corresponds pretty closely to that of prehistoric foragers. While we tend to divide tool functions into specific formal categories such as wrench, screwdriver, pliers, scissors, and razor blade, our Stone Age ancestors probably saw nothing more functionally specific than a multipurpose pocket knife.

High and Low-Power Use-Wear Analysis

One method that is useful for determining the actual function of a tool, without reference to its morphology, is to examine the artifact for traces of use, wear and damage on its edges. Semenov (1964) was the first to provide a systematic approach to the microscopic analysis of use-wear damage. His approach was based on experimentation, giving the field a firm empirical foundation. Two different approaches to use-wear analysis are currently employed; these are low-power and high-power magnification. They differ in terms of methodology, but not in their overall goal, which is to determine how a tool was used and to what broad classes of material a tool edge was applied.

The high-power technique focuses on polishes and striations left on lithics by various worked materials (NEWCOMER and KEELEY 1979). While this provides a fairly high degree of specificity, it requires a much higher magnification (up to 1000X) than that required by low-power use wear (10-100X). The drawback of this approach is that the use of higher levels of magnification takes much more analysis time per tool than is required with the low-power approach. While Newcomer and Keeley (1979: 195) report that "considerable time [was] necessary to record and study the use wear on the tools" in their study, Odell and Odell-Vereecken (1980: 117) report that each tool required "an average of just under 13 minutes" to record this information. The amount of information that may be obtained by each method, and its accuracy, is of paramount importance. The loss of exact specificity regarding worked material, however, must be weighed against the cost, in time, of the analysis. There has also been some concern over the accuracy of the high-power approach, and its claims for specificity in material worked (HOLLEY and DEL BENE 1981).

The low-power technique requires a much smaller investment of time per unit analyzed, but provides slightly different information. While specific material worked (*e.g.*, plant, skin, antler) cannot be identified, the relative hardness of the material (*e.g.*, soft, medium, hard) can usually be determined. In many cases, this distinction is sufficient for making assessments about different use patterns. In addition, certain environments present only a limited number of possible materials within a given hardness category. For instance, there is a lack of wood in many environments, so that the "hard" category can only indicate bone or antler.

The analysis of edge damage, rather than polish, is the main objective of the low-power technique. This damage can be seen in the removal of flakes, crushing, edge rounding, and striations. In examining the patterns of this damage, it is possible to determine the location of use and prehension, the relative hardness of the worked material, and the motion or activity for which the material was used. Odell and Odell-Vereecken (1980) tested the accuracy with which the above factors can be determined. They found that the location of use could be determined accurately approximately 80% of the time. They obtained a 70% success rate for determining the activity for which the tool was used and approximately 68% accuracy in determining the relative hardness of the worked material (ODELL and ODELL-VEREECKEN 1980: 119). This compares favorably with the 63% success rate obtained by Newcomer and Keeley in identifying, albeit more specifically, the material worked (NEWCOMER and KEELEY 1979: 204).

A common feature of both approaches is the difficulty in learning to apply these techniques. Different criteria or "standards" have been suggested by various workers in the field. These range from approaches that are rather free-form and intuitive (KNUDSON 1979) to suggestions for the systemization of the very recording forms used (ODELL 1979). As with all typologies, if comparisons are to be made across assemblages and workers, it is very important that a consensus is reached, particularly with respect to defining criteria. The Conference of Lithic Use-Wear (1977) represents an important step in this direction (HAYDEN 1979). As can be seen in the above examples (KNUDSON 1979, ODELL 1979), however, we are still far from consensus. Further experimentation, where the accuracy and credibility of the various criteria employed can be tested, should help to resolve this dilemma.

Broader Issues

Use-wear studies have also proven valuable for investigating larger issues related to tool use. Lewenstein (1987), in a use-wear study of tools from the Maya site of Cerros, was able to address issues of craft specialization. She found that tools with similar morphologies and use lives were scattered throughout the site, and did not cluster in spatially discrete areas (LEWENSTEIN 1987:196). She concluded from this that full-time craft specialization could not be documented at Cerros during the main phase of occupation. With this study, Lewenstein provided a test of one common component of theories invoked to describe or explain the rise of social complexity in Mesoamerica - full-time craft specialization. While many theories have been proposed to explain the rise of social complexity, they are often difficult to evaluate empirically. Lewenstein's use-wear analysis provides exactly this type of evaluation.

Most lithic use-wear studies have focused on much earlier time periods than Lewenstein's analysis. One interesting study that has taken a new approach to an old issue is Shea's examination of tool use and human evolution in the late Pleistocene of Israel (SHEA n.d., 1989). His analysis involved a use-wear study of the lithic assemblages from the Kebara and Qafzeh rockshelters, in northern Israel. While the industry present in both sites was Levallois-Mousterian (SHEA 1989: 613), the hominid skeletal remains found in them have been classified as MMH (Qafzeh) and AHS (Kebara). Shea demonstrated that "raw material collection, manufacturing and tool use appear undifferentiated in the archaeological collections associated with hominids at Kebara and Qafzeh" (SHEA n.d.: 11). His conclusions regarding the significance of this finding are especially pertinent for understanding the place of use-wear studies in archaeological research. While he clearly finds no differences in use patterns between the two sites, he still accepts - without question - the assertion that the associated hominids at these sites really represent two discrete biological populations that probably differ at the species level (*i.e.*, modern humans at Qafzeh, Neandertals at Kebara). Many researchers have questioned the discreteness of the biological taxonomic units involved (see esp. CLARK and LINDLY 1989, CLARK 1992), yet Shea, in a puzzling display of cognitive dissonance, dismisses any and all behavioral indicators of similarity between them. It seems clear that, although use-wear studies can provide us with valuable information regarding past behavior, it cannot tell us unambiguously what that information might mean.

Non-Experimental Studies

Another application of the low-power technique to a Middle Paleolithic assemblage is Panagopoulou's (1985) analysis of scrapers from the site of Nahr Ibrahim, Lebanon. This study is significant in that the author used "published experimental data" (PANAGOPOULOU 1985: 182), rather than direct experimentation, as the source of her attribute definitions. Her results also lend support to Dibble's (1984) conclusions concerning the credibility of Bordes' morphological scraper types. Panagopoulou found that "the scrapers were used in a multifunctional context, in multiple use motions and multiple classes of worked material" (1985: 183). In addition to scraping motions, these "scrapers" had been used to cut, grave, bore, and to serve as projectile points. Further, there was no use pattern within scraper types. Instead, each type was "used to work several different varieties of contact materials in several use motions" (PANAGOPOULOU 1985: 83). Her descriptions of these Middle Paleolithic scrapers resemble the multipurpose implements anticipated by Barton (1991).

Panagopoulou provides an excellent compilation of the criteria used to determine use motion, drawn from definitions currently employed by workers in the field (PANAGOPOULOU 1985). These definitions are similar to those of Odell and Odell-Vereecken (1980), and specify a combination of several aspects of edge damage that together indicate a type of use motion. The definitions and the accompanying photographs allow for the application of the low-power technique by those who have not come to this knowledge "first-hand" through experimentation. While experimentation is valuable for learning the fabrication techniques and fracture properties of new materials, these summaries allow for the accumulation of experience - without requiring a "reinvention of the wheel" with each new investigator. In addition, initial experimental results of Odell and Odell-Vereecken (1980: 119) have shown that "certain principles of low-power microwear analysis are able to be generalized from at least European chalk flint to certain fine-grained igneous rocks." This is a promising trend, which if found to hold for other workers and materials, will allow for more applications of the technique in the future. The present study was undertaken using published illustrations and definitions of use-wear damage, but without the benefit of prior experimentation. This was due in part to time constraints and in part to the difficulty in obtaining raw materials that would provide an experimental collection relevant to the site of 'Ain Difla.

Methodology

The definitions and criteria used in this analysis to evaluate the nature of edge damage are an amalgam of those provided by Odell and Odell-Vereecken (1980), Ahler (1979), and Panagopoulou (1985). The possible categories of edge damage were taken from Panagopoulou (1985: 37-40) and Odell and Odell-Vereecken (1980: 98-100) and include (1) transverse, (2) longitudinal, (3) graving, (4) boring, (5) chopping, (6) abrading, (7) pounding, (8) projectile head or tip, and (9) prehension. As an example of the actual kinds of damage these behaviors can cause, a condensed version of Odell and Odell-Vereecken's (1980: 98-100) descriptions of edge damage classes is provided:

1. *Motions longitudinal to the working edge: Cutting* usually produces scarring on both surfaces of an edge, alternating from side to side and developing with use into denticulation of the lateral margin . . . if striations are visible, they occur near the edge and parallel to it.
2. *Motions transverse to the working edge:* In *scraping* or pulling motions, the scarring is exclusively unifacial, or almost so, and occurs on a relatively wide area ... striations, if present, are perpendicular to the edge, on the surface opposite the scarring.
3. *Graving* has elements of either, or both, longitudinal and transverse motions ... the principal difference is that it occurs on a point, or tip, rather than on an entire side of a piece.
4. *Boring:* A complex motion involving downward pressure and lateral twisting. The downward pressure can usually be ascertained from 'roughening' of the tip and scarring that emanates from the tip. Twisting often results in removals from the lateral edges that lead to the point. This damage can be unifacial or bifacial.
5. *Chopping:* Damage is usually bifacial if the edge is symmetrical when viewed head-on ... if it is asymmetrical, damage of all kinds favors one side over the other. Heavy impact typically results in scars possessing well-defined terminations (hinged and stepped).
6. *Projectile:* Removals of all sizes usually have sharply defined terminations. These sometimes look like burin spall negatives. If striae can be observed, they are typically parallel to the long axis of the piece... and as often away from the edge as close to it.
7. *Abrading:* Typically the surfaces of the tool, not the edges, receive the brunt of the pressure, and wear is primarily abrasive.
8. *Pounding:* Use as a hammer, an activity employing a surface rather than an edge and usually resulting in pitting and cracking of that surface.

These definitions (and those given in PANAGOPOULOU 1985) were chosen because they rely on a combination of edge damage attributes such as location(s) of scars, size and shape of flake terminations, and position and direction of striations. It was thought that this approach was appropriate for a small, initial study, and would prove to be less complicated and time consuming than other approaches which require the recording of many separate attributes for each "employed unit" of a piece.

The Sample

The Levallois points used in this analysis come from the 1984 and 1986 excavations at the site of 'Ain Difla in west-central Jordan. The deposits lie beneath, and at one end of, a large rock shelter discovered during the Wadi Hasa Survey (MACDONALD *et al.* 1983: 315). The lithic industries from the site have been classified as a Tabun D-type or Phase 1 Mousterian (LINDLY and CLARK 1987, CLARK *et al., this vol*ume). The assemblage was characterized by a low frequency of formal tools (1.9%), a low frequency of Levallois pieces (2.3%), and "a notable absence of sidescrapers" (LINDLY and CLARK 1987: 285). Recent ESR dates indicate that the site was occupied sporadically over a long interval between 90 and 180 kyr BP (CLARK *et al.*, this volume).

This use-wear study of the "Levallois point" category from the excavations at 'Ain Difla was performed to determine whether this morphological type was used as a function-specific tool or whether it resembled the multipurpose implement described by Barton (1991). The points used in this study were all composed of the same raw material type (a fine-grained, dark grey flint) and were in good condition. The Levallois point "type" was chosen for this preliminary analysis because these points, by definition, have partial or no lateral retouch. Without the complication of intentional retouch, these tools are ideal for a use-wear study. For heavily retouched tools, it is much more difficult to distinguish edge damage caused by use from patterns of modification caused by the retouch itself.

The procedure for analyzing the 'Ain Difla points involved the microscopic examination of their edges for signs of use-wear. The points were initially scanned at 10X, and then reexamined at 40X. During the initial scanning, the overall placement of the scars along the edges was determined. At 40X, the shape of the scars' terminations could be determined, and the relative sizes of the scars were assessed. All edges of each piece were examined, so that expectations about the predicted location of use damage did not bias the analysis. Drawings were made of each piece, so that the location of use and prehension damage could be noted. This was important since the location of use damage is one of the major components of the definitions of each type of use motion. Through 1986, a total of 79 Levallois points was recovered from the site, and a 20% random sample (n = 16) was analyzed. The lithics were washed prior to the analysis, but received no other treatment.

Results

The use-wear analysis data are summarized in Table 1. Evidence for only three of the original nine categories of use motion was found. Two of the points showed only ephemeral signs of use damage. The frequencies for the remainder of the tools do not add up to the actual sample number because several tools displayed evidence of more than one function. Approximately two-thirds of the tools exhibited evidence of longitudinal motion (*e.g.*, cutting, sawing). Graving was the next most frequent type of use indicated. This often occurred with other categories, as it is defined largely by its location, on the tip of the tool. Finally, four of the tools exhibited signs of transverse motion, which can include scraping or whittling.

Table 1. Use-wear damage on Levallois points from 'Ain Difla.

Types of Use Motions	**n**
Longitudinal	10
Transverse	4
Graving	5
Other Damage	
Prehension	5
Hafting	3
Retouch	1
Polish	2
No Damage	2

Five of the points in this sample displayed patterns indicating they were used only for longitudinal motions (Table 2). Most of the scars on these tools were small with feather terminations, indicating that they were utilized on relatively soft materials. Three of these points had scarring on only one side, while both sides showed damage on the other two points. Slight prehension damage was found on one of these pieces, and one of the points appears to have been hafted. Burin spall scars were present on both the proximal and distal ends of the latter piece. Finally, polishing appeared on both edges of one of the points.

Evidence of exclusively transverse motions was present on two of the points in this sample. The use-wear occurred on only one edge of each of these tools. The edge damage on these tools included feather and hinge fractures, with some crushing of the edge. This indicates that they were used on a material of soft-medium hardness. One of these points had the only evidence of retouch present in this sample.

The sample included two points that were used exclusively for graving. Both of these pieces showed evidence of prehension (or possibly hafting). One of these tools was more heavily used, with scarring patterns indicative of use on a medium-hard material.

The remaining five tools showed evidence of more than one type of use motion. Two of these showed signs of both longitudinal and transverse motion, and may have been used for whittling. One of these has extensive edge damage, including large step flakes and crushing of the edge. This indicates that the piece was used with medium-hard or hard material. The final three points showed evidence of both longitudinal use and of graving. On two of these pieces, the tips were more heavily damaged than were the edges. In these cases it appears that the different sections of the tool were used on different materials: soft material with the longitudinal motions versus medium material for the graving at the tips. Evidence of polish was found on the edge of one of these tools. Prehension damage was found on all three pieces.

Table 2. Functional categories of Levallois points from 'Ain Difla: use damage by motion category.

Motion	n
Longitudinal	
Longitudinal use only	3
Longitudinal plus polishing	1
Longitudinal plus hafting and burin damage	1
Transverse	
Transverse only	1
Transverse plus retouch	1
Graving	
Graving only	0
Graving plus hafting or prehension damage	2
Longitudinal and Transverse	
Longitudinal and transverse only	0
Longitudinal and transverse plus prehension	2
Longitudinal and Graving	
Longitudinal and graving only	0
Longitudinal and graving plus prehension	2
Longitudinal and graving plus prehension and polish	1

The above data indicate that five different functions were performed with the Levallois points in this sample (Table 2). These functions include (1) longitudinal motions (slicing or sawing), (2) transverse motions (scraping), (3) graving, (4) whittling (longitudinal and transverse), and (5) multipurpose (longitudinal and graving). In addition, these categories included use on soft, medium, and hard materials. The presence of polish indicates that at least some of the soft materials worked were plants. Finally, there is evidence of both hafting and prehension damage in this sample.

Discussion

The results of this analysis suggest that, at least at 'Ain Difla, the Levallois point type does not represent a discrete functional category. These results are similar to those obtained by Panagopoulou (1985) for a sample of Levantine Middle Paleolithic scrapers. One interesting difference between the two studies is that while Panagopoulou reported that a small percentage of the Nahr Ibrahim scrapers showed signs of projectile damage, no evidence of projectile damage was found in the present analysis. Other analyses of Levallois points also do not support their use as projectiles (ANDERSON-GERFAUD 1990, BEYRIES 1987, HOLDOWAY 1989). One exception is Shea's analysis of the Qafzeh and Kebara Levallois points, where he found that projectile damage accounted for 25% of the edge damage (SHEA 1989: 617). Further use-wear studies of Middle Paleolithic assemblages should help to indicate which morphological types - if any - were being used as projectile tips.

In sum, the research reported here supports the contention of a number of archaeologists that our lithic classification schemes, based on morphologically defined types, do not correlate with tool functions. While morphology-based typological systematics has its uses, as noted above, it should be kept firmly in mind that no correlations between types created by 20th century prehistorians and types held in the minds of people long dead can be assumed to exist (BINFORD and SABLOFF 1982). Additional methods of analysis must be used in order to investigate the function of lithic artifacts within extinct human social contexts. These methods can include experiments, metrical data, and use-wear analyses. Panagopoulou found that use-wear patterns from Middle Paleolithic scraper types indicated that these morphological types were used for multiple purposes, including scraping. The present study of a sample of Levallois points from the 'Ain Difla rockshelter has demonstrated that there was considerable functional variability within this type as well, variability masked by the current classification system. Methods such as use-wear analysis have the potential to help us better understand the range and kinds of variability that existed within prehistoric material culture technological systems.

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Upper Paleolithic Technologies: Core Reduction Strategies

Nancy R. Coinman

Abtract: *Recent research suggests that the Upper Paleolithic in Jordan is dominated by a technology that is most closely associated with the Ahmarian, exhibiting although some differences in blade and bladelet production between assemblages in the Wadi al-Hasa and those from southern Jordan. Analytical methods for exploring on-site core reduction strategies are presented as a means of defining technological similarities and differences that are considered part of a single technological complex in the inland regions of the Levant during the Late Pleistocene.*

Introduction

One of the primary concerns of hunter-gatherer research has been the focus on the relationship between settlement-subsistence organization and technology. This research issue stems largely from discussions of foragers and collectors and the archaeological correlates for their associated technologies (*e.g.*, BINFORD 1979, 1980, 1982). Recent studies have attempted to link mobility and settlement patterns directly with technological organization (*e.g.*, HENRY 1989, 1994; KELLY 1983; KELLY and TODD 1988; MARKS and FREIDEL 1977; PARRY and KELLY 1987; SHOTT 1986, 1989, 1990; TORRENCE 1983, 1989a,b). Variability in technological organization is thus expected to result in distinct reduction strategies and tool-using behavior.

For researchers working in the early time ranges of the Paleolithic, technology consists primarily of what can be reconstructed from lithic artifact assemblages, which in many Paleolithic sites are dense, complex and often surprisingly sophisticated. Critical to the reconstruction of technological subsystems is the perception of technology as a dynamic set of organized responses: an extensive sequence of behavioral responses to the constraints posed by residential structure and subsistence strategies in specific environments. Geneste (1985) refers to the sequence of responses as the *chaîne opèratoire*. Thus, technological organization includes both on- and off-site behaviors, such as the procurement of raw materials, tool production, use, maintenance, reuse and discard.

In the Levant limited research has been directed explicitly at unraveling the complex relationships among technology, settlement organization and the environment. Exceptions have been the works of Marks and his colleagues on the Paleolithic of the central Negev (MARKS 1976, 1977, 1983a, 1988) and the on-going research of Henry (1982, 1987a,b, 1989, 1992, 1994, 1995) in southern Jordan. They have integrated detailed survey and excavation data to model technological responses to environmental factors. Both of these studies are notable in Levantine research for taking long-term systemic views of settlement patterns and identifying the archaeological correlates for settlement-subsistence and technological organization.

Upper Paleolithic Technologies

Research on the Paleolithic of the Levant during the last 20 years has resulted in a number of major revisions to the interpretations and explanations of the Upper Paleolithic in this region. The unilinear evolutionary explanations of Neuville (1934, 1951) and Garrod (1954) have since been replaced with a multilinear model that focuses on two cultural traditions. These assemblage types are now formally recognized as the Levantine Aurignacian and the Ahmarian (RONEN 1976, 1984; GILEAD 1981, 1991; MARKS 1981). Research in the Negev, Sinai and most recently in Jordan (Fig. 1) has been critical in establishing the multilinear nature of cultural evolution in the Levant during the Late Pleistocene. Currently, however, there is a lack of agreement on the nature of these assemblage

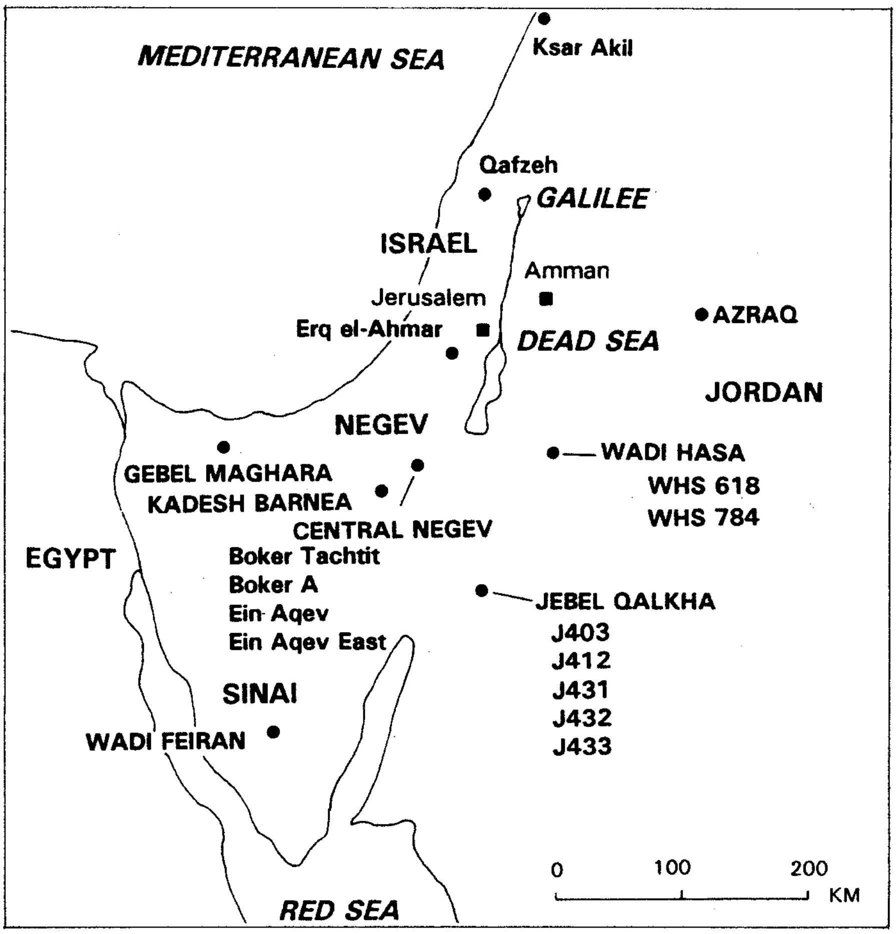


Fig. 1. Map of the Levant showing archaeological sites with important Upper Paleolithic assemblages.

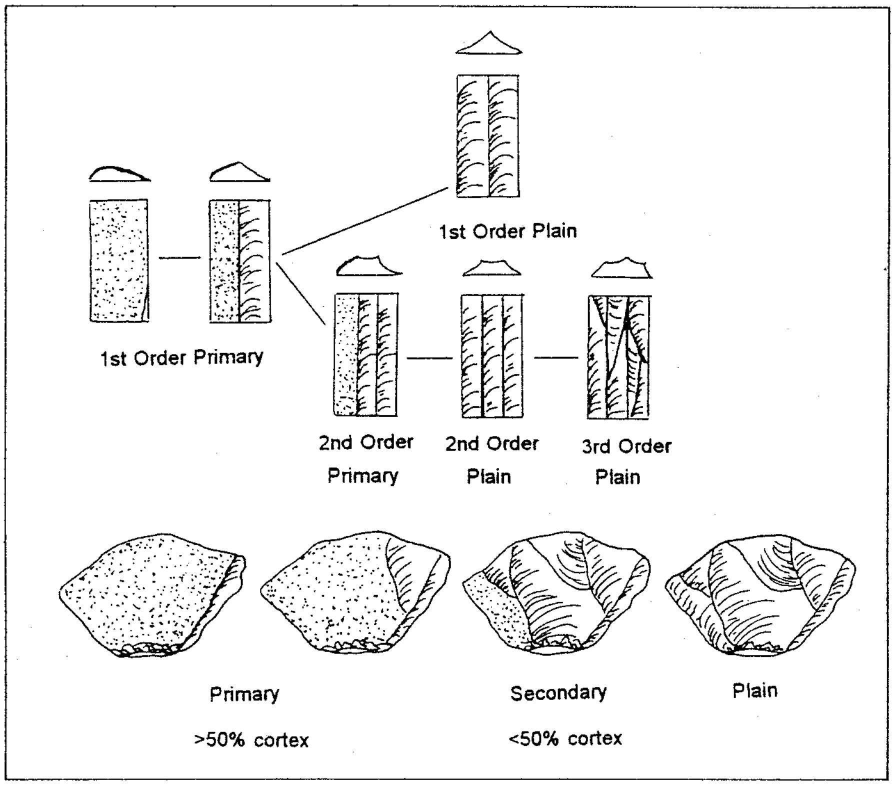


Fig. 2. Illustration of the classification scheme for blades and flakes.

types and the technologies they represent as they occur across the greater Levant, especially in the southern and eastern regions that include Jordan. In recent years, the Levantine Aurignacian / Ahmarian dichotomy has been subjected to increasing scrutiny with some criticism focused on the applicability of a two-traditions model to the entire Levant and more specifically, the relevance of the Levantine Aurignacian, as traditionally defined, to Upper Paleolithic occupations outside the core Mediterranean zone (*e.g.,* BERGMAN and GORING-MORRIS 1987; BERGMAN 1988a,b; COINMAN 1990, 1993, n.d.; COINMAN and HENRY 1995).

Surveys in the Jebel Qalkha area of southern Jordan (HENRY 1979, HENRY *et al.* 1983), the Wadi Hasa (MACDONALD *et al.* 1980, 1982, 1983), and the Azraq Basin (GARRARD and PRICE 1977) encountered predominantly blade technologies that can be identified for the most part as Ahmarian. These occur in a variety of ecological settings and site types, including both rockshelters and open-air sites in lacustrine, marsh, desert, steppe and piedmont environmental settings. Assemblages that vary from the well-defined Ahmarian blade-bladelet technology are rare and inconsistently identified. Evidence that the Levantine Aurignacian is relevant and present in eastern regions of the Levant is limited and equivocal (COINMAN 1990, 1993, n.d.).

The evidence from Jordan suggests there is an important overlap in technology between the Ahmarian and those assemblages occurring outside the Mediterranean area that have been identified as Levantine Aurignacian. The most important overlap is represented by various kinds of blade technologies ranging from large, bulky, sometimes poorly-developed blades to fine blade and bladelet dominated assemblages. Comparative analyses of Upper Paleolithic assemblages from southern Jordan suggest that some of the variability identified in blade-oriented technologies, which previously had been attributed to the Levantine Aurignacian (HENRY 1982, COINMAN 1990, COINMAN and HENRY 1995), does not represent a significantly different underlying technology from a more generalized Ahmarian blade technology since so many of the technological parameters appear to be similar; they vary in quality and quantity rather than kind. In order to define technological similarities and differences that potentially distinguish major Upper Paleolithic adaptations in the Levant during the Late Pleistocene, we have to be able to delineate the parameters that define the underlying technology and distinguish between them and differences in technological organization. Differences in Upper Paleolithic assemblages may be due to organizational differences that are tied to larger settlement-subsistence organization associated with the duration of occupation (*i.e.*, short term, long term, seasonal) and site function. More significant technological differences may be associated with systemic changes through time or with adaptations to different environmental zones. This paper presents some initial approaches to demarcating technological organization through the reconstruction of core reduction strategies and on-site reduction sequences. This in turn should begin to identify specific technological strategies and activities that may be similar at contemporaneous Upper Paleolithic sites. Ultimately, we should be able to model Upper Paleolithic adaptations in inland ecological settings that so far appear to differ significantly from Mediterranean coastal sites during the Late Pleistocene.

Reconstructing Core Reduction Sequences

Monitoring on-site tool production, use, maintenance and discard can be accomplished through the integration of technological evidence and specialized analytical approaches. These include: 1) identifying assemblage composition and diversity, 2) dimensional data on cores, debitage and tools, 3) use-wear analyses to identify tool function and use and 4) spatial analyses of on-site production, tool use and discard behaviors. This paper focuses on the first two types of evidence and analytical techniques since no formal use-wear analyses have been done on any of the Upper Paleolithic assemblages to date. Also, because the Upper Paleolithic assemblages in the Hasa and from southern Jordan represent limited test excavations, no spatial analyses, which require broad exposures of excavated areas, have been completed. Upper Paleolithic assemblages included in these analyses come from sites in the Jebel Qalkha area of southern Jordan and the eastern end of the Wadi al-Hasa. General discussions of these sites are found in Clark *et al.* (1988), Coinman (1990, 1993, n.d.), Coinman and Henry (1995), Henry (1982, 1986, 1994, 1995), and Olszewski *et al.* (1990, 1994).

Assemblage Composition and Diversity

The overall composition of an assemblage is the most important monitor of site function related to on-site technological activities. Simple proportional differences in primary reduction elements, other debitage categories and tools provide an initial indication of reduction activities and tool production and use carried out at the site. Comparative data on debitage and tool assemblages may be used for comparing sites in terms of functional or technological differences, as well as potential changes through time. Primary elements in these analyses are defined as cortical blades or bladelets and flakes with 50% or more cortex (Fig. 2).

Proportional data can be displayed in a variety of scatterplots for comparative purposes. These allow a visual display of intrasite proportional breakdowns and similarities in assemblages using proportions of reduction categories. For example, the relative amounts of initial core reduction that occurred at a site may be established and intersite comparisons made using simple plots. In Fig. 3 the comparison of percentages of cores and primary elements at Upper Paleolithic sites from southern Jordan and the Wadi al-Hasa suggests that greater degrees of primary reduction of cores occurred at 'Ain el-Buhira (WHS 618) and Jebel Humeima (J412).

The plot in Fig. 4, on the other hand, provides ratios of cores, primary elements, and core trimming elements. The ratios identify more precise relationships between specific reduction elements. Primary reduction, including decortication and core platform rejuvenation, occurred at all of the sites but in varying degrees. Primary reduction activities, characterized by high ratios of primary elements to cores and cores to core trimming elements, are found at Jebel Humeima (J412) and 'Ain el-Buhira (Area HI, WHS 618). Ratios are lower at the other sites, indicating that primary reduction occurred but less frequently at Tor Fawaz (J403) and Tor Hamar (J431, F-G) and significantly less intensively at Yutil al-Hasa (WHS 784), 'Ain el-Buhira (Area C, WHS 618), and Tor Aeid (J432). It is notable that ratios between cores and core trimming elements are approximately 1:1 at most of the sites except Tor Fawaz (J403) and Tor Hamar (J431, F-G). Various techniques of core rejuvenation, primarily the use of core tablets, were standard and clearly define on-site core reduction strategies at most of these sites. Core trimming elements are discussed in greater detail below. The comparative ratio data indicate primary reduction activities at all of the sites at varying levels of intensity, reflecting some functional variability among them that may be attributed to site size and/or duration of occupation. These factors would be expected to affect the level of intensity of core reduction.

Dimensional Features of the Reduction Sequence

Decortication

The reconstruction of the reduction sequence can be approached through the integration of dimensional and morphological data on classes of debitage and tools. Classification of debitage and tools (defined as retouched pieces) based on morphology, relative percentages of cortical material, dorsal scar patterning, and presence/absence of formal retouching is combined with distributional data on metric dimensions to reflect the process of decortication, core rejuvenation, blank selection and modification. Following the traditional model of decortication (*e.g.*, BRADLEY 1975, COLLINS 1975, FERRING 1988, HENRY 1989), two general principles apply to the process. First, during the process of decortication, the production of early stage cortical pieces decreases as the cortex is removed from the core, and progressively more plain or non-cortical pieces are produced. Second, as decortication progresses, the dimensional range of cortical pieces, especially cortical blades, will decrease (Fig. 5). That is, a trend in diminution characterizes both cores and blanks (HENRY 1989:140, COINMAN 1990:278). Nevertheless, deviations from this model may result when the size and shape of the raw material package dictates a variation on initial decortication. While there is a general trend toward diminution in blank dimensions, decortication or the removal of blanks with cortical material may occur at various points along the reduction stream.

Classification of blades and bladelets is based on the number of dorsal ridges that reflects their position or order in a sequence of removals (*i.e.*, first- and second-order blades) (Fig. 2). These classes have been supplemented by a third order in which complex dorsal scar patterning indicates an advanced position in the reduction stream of blade production. The presence or absence of cortex provides finer distinctions within the sequence (*e.g.*, first-order primary blade, second-order primary blade, or third-order plain blade). Flakes have been classified as primary (>50%), secondary (<50%) or plain flakes. Primary elements, therefore, include both flakes and blade/bladelets.

Data on dimensions of all reduction elements in the Wadi al-Hasa assemblages are indicative of variations to the traditional approach in decortication in which primary elements are expected to occur early and be large, while plain elements represent smaller interior production goals. A series of scatterplots of length against width for all reduction groups, excluding trimming flakes less than 20mm in width, illustrates the variability (Fig. 6). The data illustrate differences in the size of specific morphological types of blanks. Since size, especially length, would have represented the greatest constraint and offered the least options in core reduction, the greatest variability may occur in the order of detaching specific morphological blank types. None of the assemblages exhibits a consistent pattern of the expected order of removals or direction from primary through plain elements. According to the model, we expect to see two positive slopes from the lower left to upper right corners of the plots. The outer slope would represent the wider primary through plain flakes. The inner slope would represent the primary through plain blades and bladelets. In each plot, however, we see variations from the expected pattern.

The WHS 618C assemblage at 'Ain el-Buhira (Fig. 6a) most closely approximates the decortication model in that primary removals are the largest for both flake and blade elements. All plots illustrate an overall trend in diminution for blade blanks from primary through plain blades, but in all three, second- and third-order plain blades were produced prior to the removal of first-order plain

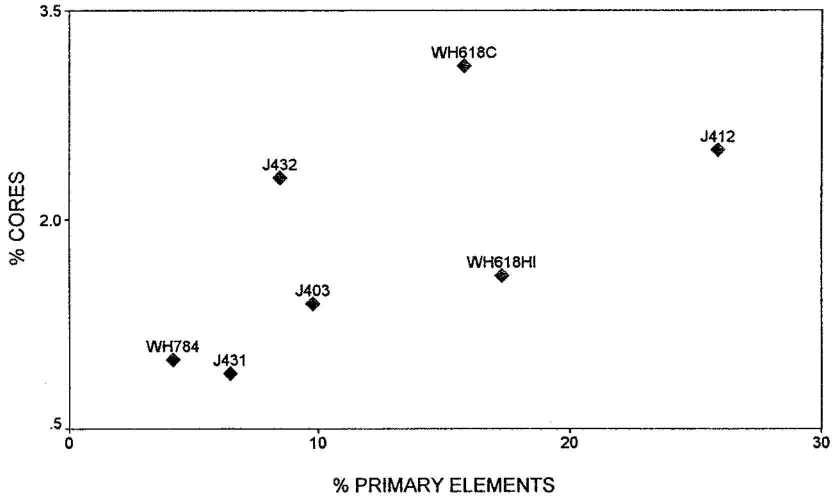


Fig. 3. Plot of the percentages of primary elements.

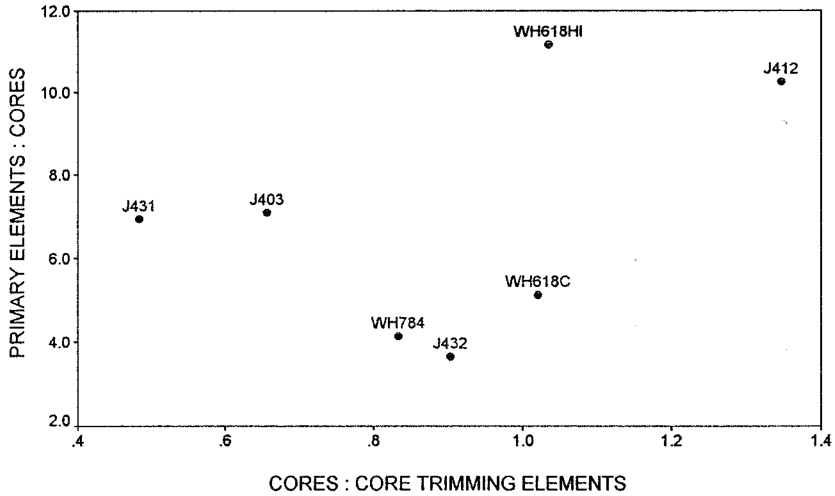


Fig. 4. Plot of the ratios of cores, primary elements and core trimming elements.

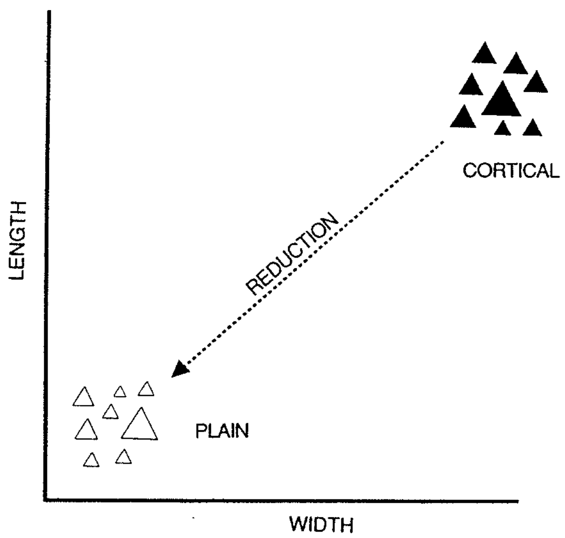


Fig. 5. Traditional reduction model featuring decortication and diminution in size.

blades. First-order plain blades are the shortest, while second- and third-order blades are longer and wider at WHS 618C. As cores get smaller, the number of dorsal ridges used to determine blade removals decreases. Third-order blades representing complex dorsal scar patterning will be variable in both length and width. Rather than representing an advanced stage in reduction, third-order blades appear to represent an earlier stage when the core offered a greater number of options in alternating platforms, as well as blank dimensions.

The most variable aspect of core reduction in these assemblages involves the removal of primary flakes. Only in the WHS 618C assemblage (Fig. 6a) are primary flakes larger and do they appear to occur, as indicated by their size, before the removal of other flakes, while those in WHS 618HI assemblage (Fig. 6b) are longer but narrower than subsequent secondary flake removals. In the assemblage at WHS 784, a more conservative approach to initial removals appears in the detachment of relatively small primary pieces, while secondary flake removals are the largest.

The overlap of primary and plain blades beyond the first order in two of the assemblages suggests that core size and shape may have dictated a different sequence of removals. Cores are often thin, flat nodules on which removals alternated from side to side, including in each removal cortical material along the margins (see Figs. 8 and 9, discussed below). In many cases the core was reduced less in length from platform to distal end and more from the front of the core to the back. A great number of first- and second-order primary tool blanks attests not only to the importance of these blank products, but to the fact that decortication did not involve an initial preparatory strategy in which all cortex was removed before blade production began.

The dimensions of specific reduction elements in these assemblages help shed light on the original size and shape of the cores that were reduced. In summary, the dimensional aspects of the reduction stream in these assemblages dominated by blade and bladelet production does not follow the expectations of the traditional model of decortication in which there was a straightforward diminution in core and blank size and in the removal of cortex. Decortication need not have been a discrete stage at the beginning of reduction and may have been restricted to a limited number of primary flake removals. This may be followed by reduction of cores where cortex remained on parts of the core throughout most of the reduction sequence, and production goals may exhibit substantial amounts of cortical material, suggesting that smaller, non-cortical or plain blanks were not necessarily the preferred reduction goals. Furthermore, the sequence of removing first-, second-, and third-order blanks may be less patterned than expected. Reconstruction of the dimensional range of cortical elements and comparisons of debitage and blanks selected for tools help to define alternative reduction strategies for blade technologies to those described for most classic Upper Paleolithic technologies in Europe and the Near East.

Core Rejuvenation

By far the most characteristic form of core rejuvenation in the Jordanian Upper Paleolithic assemblages is the core tablet technique in which the core's platform is removed. Other platform preparation techniques included the removal of blades that were initiated from the back of the platform and included a portion of the core's platform (COINMAN 1990: 265; COINMAN and HENRY 1995: 145,155). The resulting blank is a transverse blade with a "dorsal" ridge representing remnants of the core's platform. These were used to reorient and initiate a new platform on the back of the core, resulting in a change in the orientation of the platform at 90 degrees to the original platform.

In these assemblages the ratios of core tablets to cores is close to or greater than 1:1 in all but one of the assemblages, which mirrors on-site core reduction and the regular use of the core tablet technique. In order to reconstruct the core rejuvenation process, the lengths of core platforms were compared to the lengths of core tablets (Fig. 7). Core tablets are elongated flakes formed by removing the core's platform, accomplished by initiating the removal of the tablet on the face of the core from front to back. Thus, the core tablet is a record of the size, shape and platform angle of the core's platform at the point of rejuvenation. Their dimensions can be compared to those of the platforms of cores, providing some indication of maximum core size (depth) and identification of "platform maintenance points" during the core's use life. The line graph in Fig. 7 illustrates the comparisons of four assemblages with good samples of cores and core tablets, which give estimated initial core platform lengths and some insight into the process of platform rejuvenation. The dimensions of the WHS 618C core platforms and core tablets provide estimates of the maximum length of core platforms not inferable from the discarded cores themselves. The process of platform rejuvenation in this assemblage appears to have been an invariable and dependable strategy throughout core reduction. Similarly, a comparison of the lengths of core platforms and core tablets in the Tor Aeid (J432) assemblage establishes that core platforms were considerably longer than indicated by the abandoned cores. In the other two assemblages (WHS 618HI and WHS 784), the removal of core tablets mirrors a more restricted segment of the dimensional range represented in the reduction sequence of the cores, which hints at less reliance on this form of core rejuvenation.

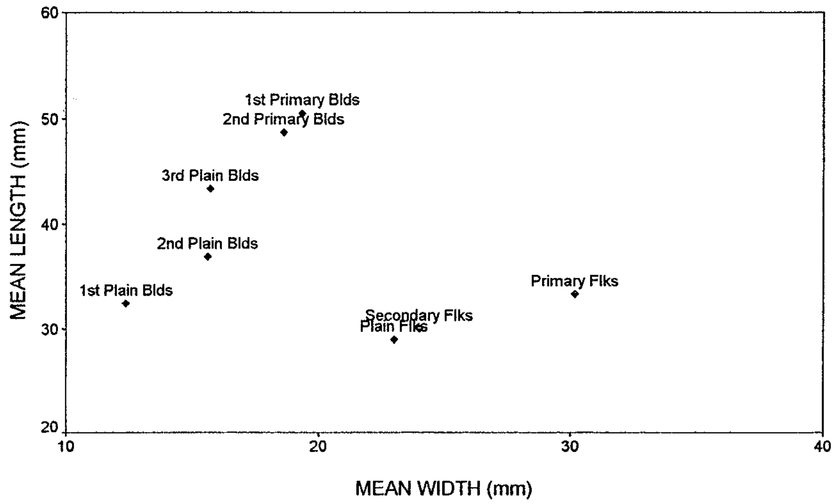


Fig. 6:a. Dimensions of reduction groups for WHS 618C (n = 473).

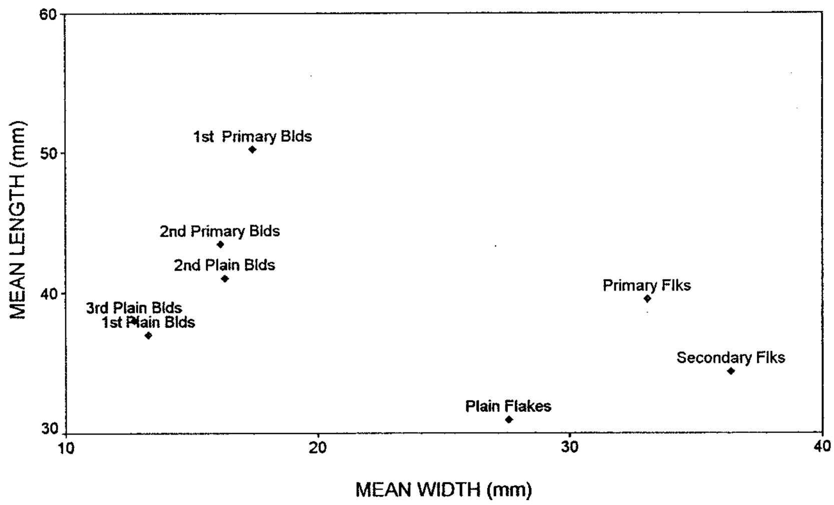


Fig. 6:b. Dimensions of reduction groups for WHS 618HI (n = 249).

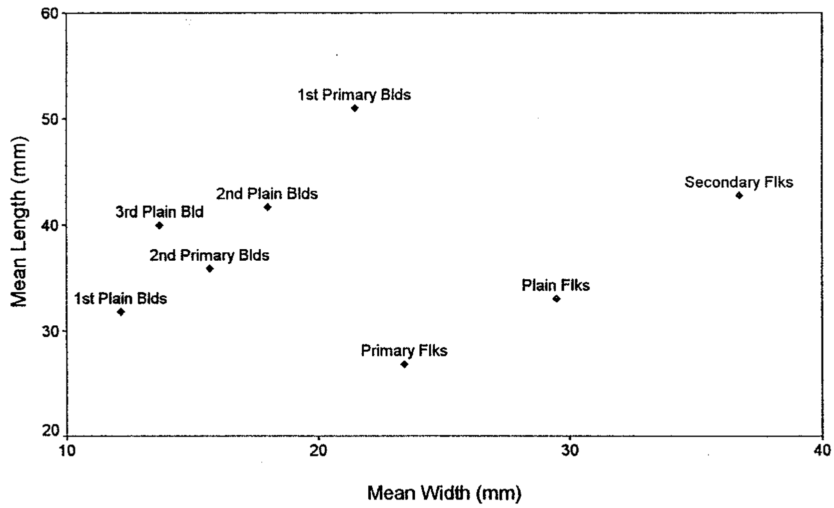


Fig. 6:c. Dimensions of reduction groups for WHS 784 (n = 157).

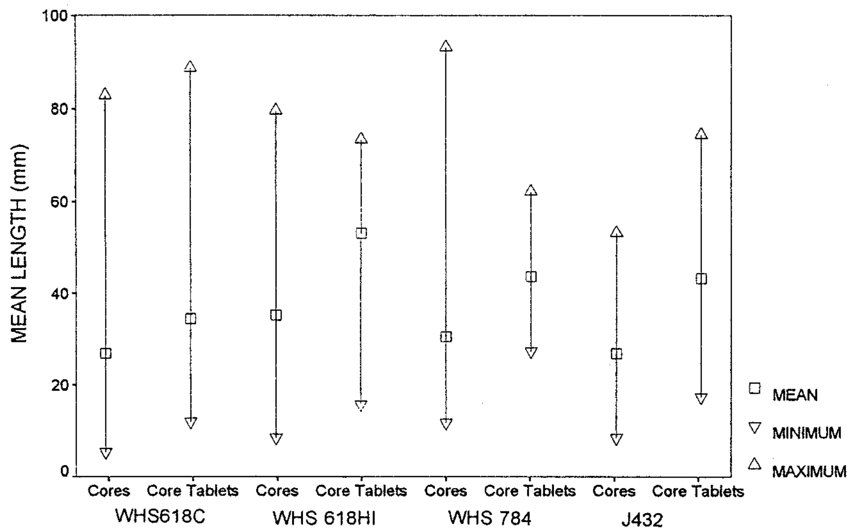


Fig. 7. Line graph comparing the dimensions of core platforms and core tablets: WHS618C (n = 202, n = 83); WHS618HI (n = 30, n = 11); WHS784 (n = 22, n = 6); J432 (n = 65, n = 15).

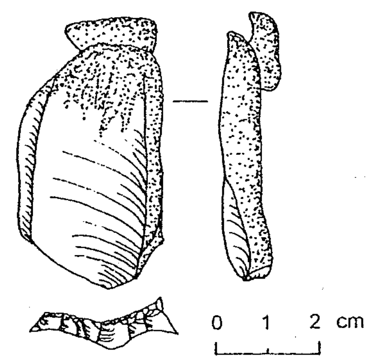


Fig. 8. Illustration of refitted core tablets from Ain el-Buhira (WHS 618).

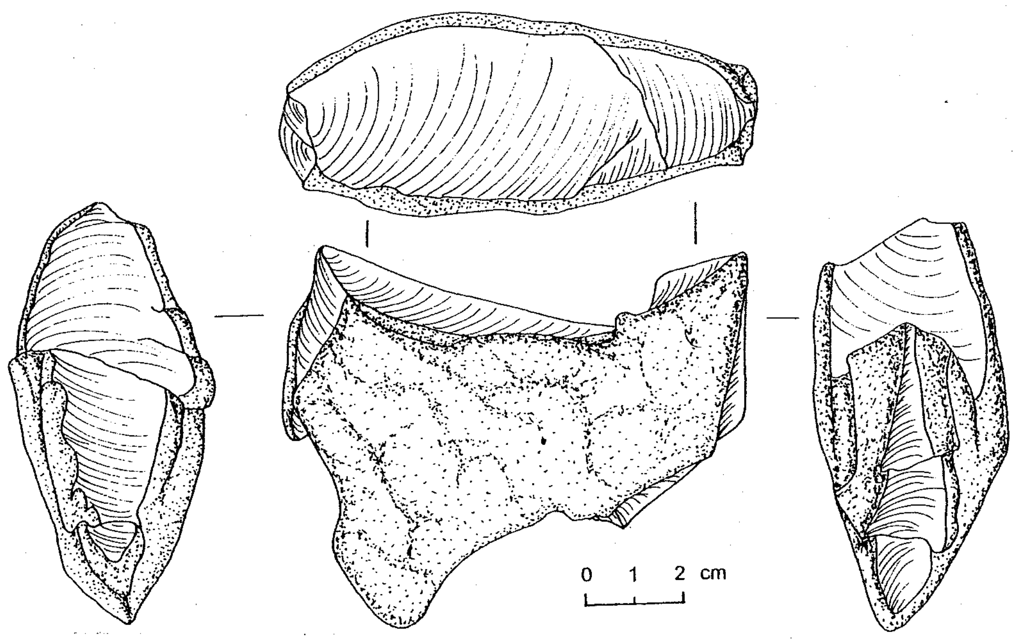


Fig. 9. Core from Ain el-Buhira (WHS 618).

Core reduction is illustrated through refitted core tablets from 'Ain el-Buhira (WHS 618HI) (Fig. 8). In this case, the cortex is present on one side of both core tablets and probably was near the other edge also. From this configuration we can infer the shape of the core to be a relatively thin, flat nodule with limestone cortex. After an initial core tablet was removed, the core was extensively reduced from the front face of the core to the back with virtually no alteration of the core's platform until the core was probably quite small, if the very small size of the second core tablet is an accurate estimate. Again, the core tablets provide information on the size and cortex of the raw material package and the reduction techniques. Removals were restricted to the front portions of the core, but it is not known whether all removals were initiated from a single platform or if an opposed, opposite platform also was being used.

The information that can be inferred from core rejuvenation techniques and the dimensions of reduction groups discussed above indicates that a simplified strategy of core preparation, decortication, and platform rejuvenation was at least one of the operating strategies at these sites. Simple platforms were prepared by the removal of a single, initial large primary flake. This was followed by removals from front to back along the long axis, maintaining cortical material along one or both sides for most of the reduction sequence, as evidenced by the core tablets removed periodically throughout the reduction stream. With these types of cores, primary and plain blades tend to vary little in length since the core maintains its length throughout most of the reduction process. Smaller cortical flakes may have been removed during the sequence to maintain the core's shape.

Currently there is little evidence that accessibility to chert sources was a problem for occupants of the sites in the eastern Hasa basin. Fig. 9 is an illustration of a core recovered from Area C at 'Ain el-Buhira. The core was tested and then abandoned, but it provides an excellent model of the size, shape, and cortical configuration of flint nodules available within a few kilometers of the site. It is this type of core that produced a great many of the core tablets, primary blades in the debitage, and large tools occurring on primary blades that are illustrated in Fig 10. Note that artifacts *a*, *b* and *f* in Fig. 10 are endscrapers and burins made on core tablets with cortex on at least one lateral edge. These are good examples of the types of blanks generated from cores with cortical distributions similar to those shown in Fig. 9. In the Hasa area most site catchments would have included access to a variety of chert sources. Regional bedrock includes marine limestones that contain abundant quantities of chert, especially along the steeper slopes of the eastern basin (SCHULDENREIN and CLARK 1994:36). Primary sources of chert have been located within a 5km catchment of sites in the eastern basin that supplied high-grade brown to tan cherts in limestone nodules. Additional sources of chert were available in the drainage channels, represented by rolled nodules, or from extensive nearby *hamadas* or desert pavements. On-site recycling of cores as an additional source of raw material at 'Ain el-Buhira and the neighboring Epipaleolithic site of Tor al-Tareeq (WHS 1065) is demonstrated by a high frequency of cores with differential patination.

The Complete Reduction Sequence

An overall reduction sequence can be reconstructed using dimensional data on cores, debitage and tools. The assemblage from the Jebel Humeima site (J412) provides a good illustration of such a reconstruction to compare visually the dimensional parameters of specific reduction elements in a systematic reduction sequence (Figs. 11 and 12). Comparisons of the dimensions of tools with the debitage allows evaluation of dimensional factors that may have been important in the selection of blanks for retouching.

Fig. 11 illustrates a comparison of length and width distributions for cores, blade debitage, and primary elements. Primary elements and blade debitage exhibit similar length distributions but vary considerably in width. The predominantly flake-like character of the primary elements is well illustrated and contrasts with the blade debitage.

In Fig. 12, the complete reduction scenario is displayed through the means and ranges of all reduction components. The metrics illustrate the potential range in the lengths of the raw material packages and the lengths of specific goals in debitage production and the manufacture of tools. It also provides an indicator of the status of discarded cores relative to production needs. The graph is arranged to show both a model of decortication and diminution of the raw material in debitage (through decreasing mean lengths) and the selection of tool blanks during the reduction sequence.

For the Jebel Humeima assemblage, metric comparisons of primary elements and other debitage indicate that decortication of cores was achieved through the removal of flake-like primary pieces that ranged in size from 9.9 to 76.5mm, with a mean length of 31.7mm and a length:width ratio of 1.5. Alternatively, cortical "primary" pieces were removed at varying positions along the sequence, as suggested by the cores and core tablets from the Wadi Hasa. The process then shifted to larger production goals. Long blade blanks ranging in length from 18.2 to 96.0mm encompass the lengths of all the retouched tools. Many of these include large first- and second-order primary blanks. The dimensions of specialized tools, such as endscrapers and burins, do not exhibit unique dimensional pa

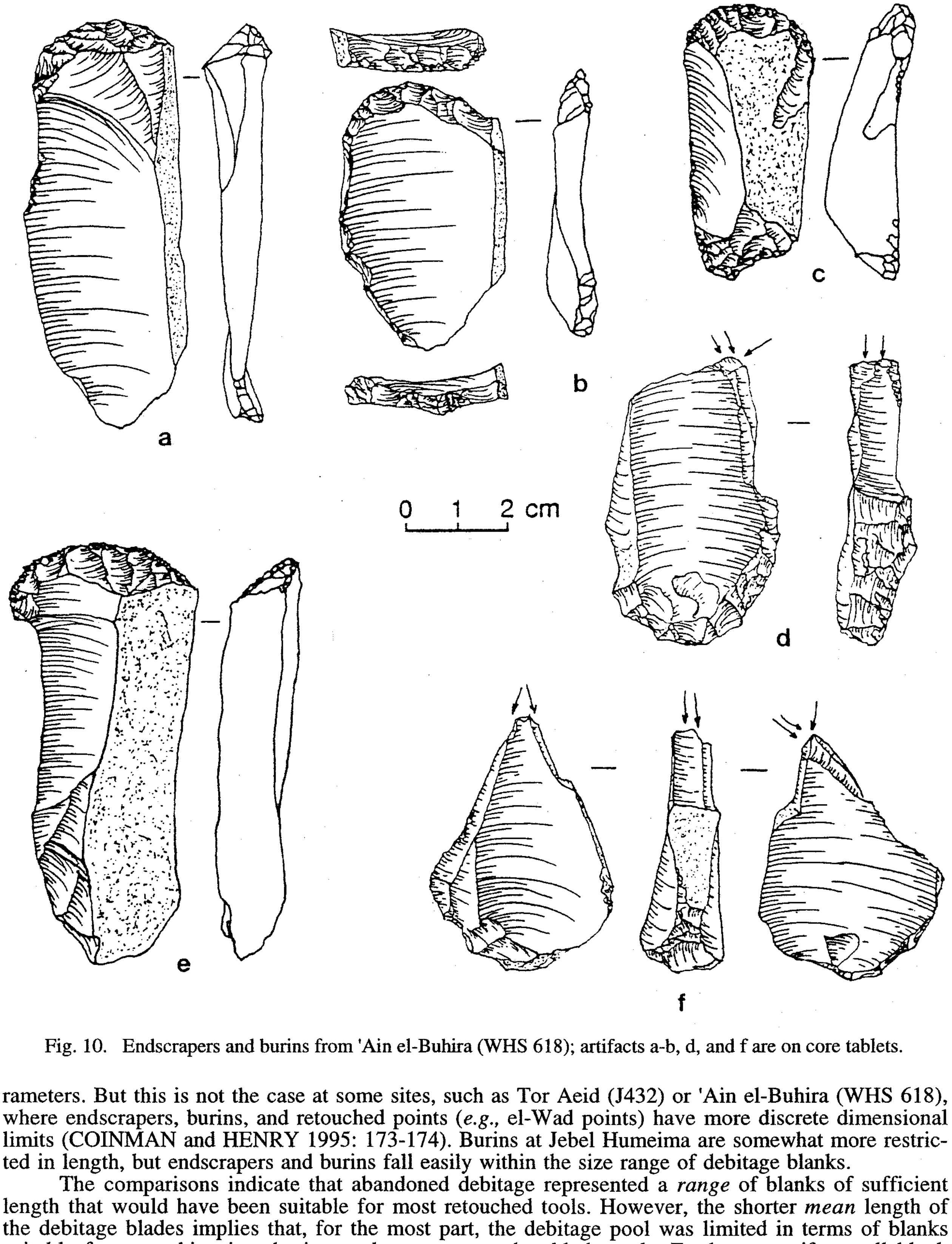


Fig. 10. Endscrapers and burins from 'Ain el-Buhira (WHS 618); artifacts a-b, d, and f are on core tablets.

rameters. But this is not the case at some sites, such as Tor Aeid (J432) or 'Ain el-Buhira (WHS 618), where endscrapers, burins, and retouched points (*e.g.*, el-Wad points) have more discrete dimensional limits (COINMAN and HENRY 1995: 173-174). Burins at Jebel Humeima are somewhat more restricted in length, but endscrapers and burins fall easily within the size range of debitage blanks.

The comparisons indicate that abandoned debitage represented a *range* of blanks of sufficient length that would have been suitable for most retouched tools. However, the shorter *mean* length of the debitage blades implies that, for the most part, the debitage pool was limited in terms of blanks suitable for retouching into burins, endscrapers, or other blade tools. Furthermore, if overall blank size is considered, the remaining debitage is inadequate for most tool needs. A look at the index of size (size = length x width x thickness/100) for debitage blanks (69.1) in Fig. 13 reveals that it is significantly smaller than the blank sizes of any of the tools. The debitage pool of complete pieces at

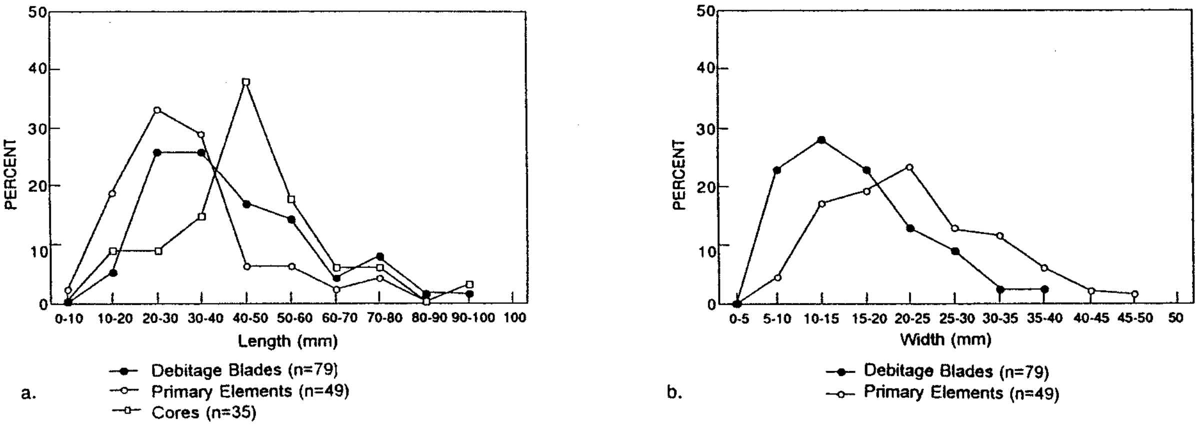
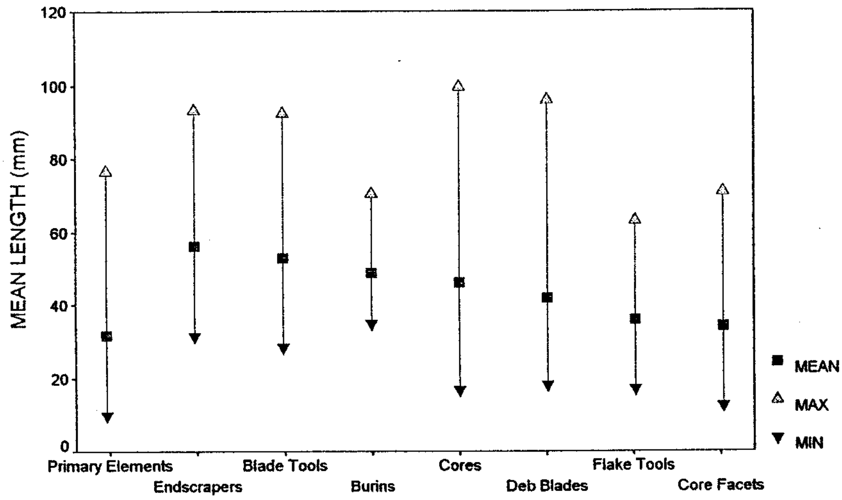


Fig. 11. Length (a) and width (b) distributions for cores and debitage from Jebel Humeima (J412) in southern Jordan.

Fig. 12. Dimensions of major reduction groups in a reduction sequence from Jebel Humeima (J412) in southern Jordan.



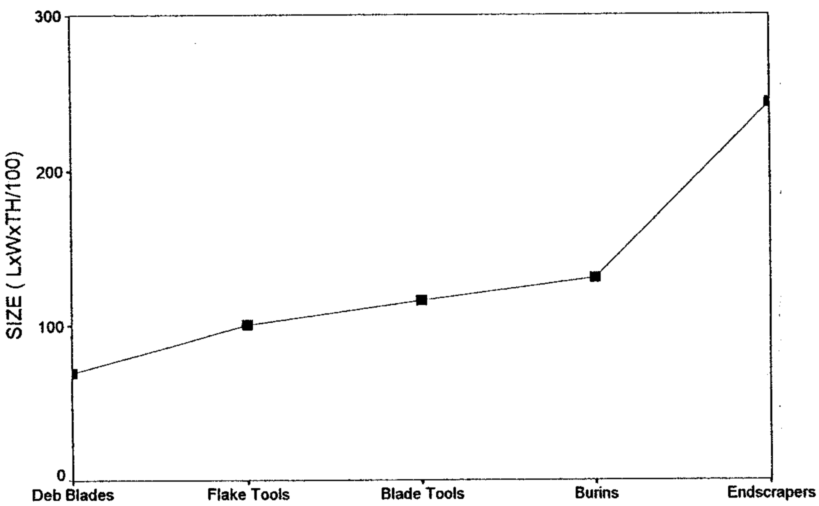


Fig. 13. Blank size comparisons for tools from Jebel Humeima (J412) in southern Jordan.

abandonment would have provided blanks most suitable for smaller bladelet tools, but bladelet tools were not an important class of tools in this particular sample from Jebel Humeima. More recent excavations in other areas of the site have provided technological evidence for Early Ahmarian blade production (HENRY, pers. comm.; see also COINMAN and HENRY 1995: 152-160,191-195 and COINMAN n.d. for a detailed discussion of this assemblage).

Conclusions

Reconstructing core reduction strategies provides a more in-depth analysis of technological organization at both the intra- and intersite levels than simple comparisons of assemblage composition, which is typical of most preliminary lithic analyses and site reports. The methods presented in this paper represent attempts to characterize more precisely the nature of the technologies at Upper Paleolithic sites in Jordan. All of the known Upper Paleolithic assemblages need to be included in broad comparative analyses. The bulk of the analyses to date, including those presented here, have indicated few technological differences in the assemblages from southern Jordan and the Wadi Hasa, although previously it had been suggested that some of the sites could be attributed to the Levantine Aurignacian. In conjunction with other lithic data, this research suggests that during the Upper Paleolithic, core reduction was focused on blades, and in some cases, bladelet production. There is little evidence in the debitage or in the tools for core reduction directed at the production of flakes. While flake debitage and tools made on flakes are certainly part of each assemblage, they were obviously of little importance when we look at the overwhelming evidence in the form of assemblage composition and dimensional data in each of the assemblages.

Reconstruction of the dimensional range of cortical elements and comparisons of debitage and blanks selected for tools has defined alternative reduction strategies for blade technologies to those described for most classic Upper Paleolithic technologies in Europe and the Near East. Without exception, the entire sequence of reduction activities from initial primary reduction of cores through core rejuvenation, blank selection and modification into tools, and tool resharpening and maintenance has been identified at these sites. Differences appear to be minor variations in decortication, some of which must be due to the size and shape of raw material.

Through recent excavations, important intrasite variability in reduction activities has been identified in Ahmarian assemblages at Jebel Humeima in southern Jordan, reversing preliminary identifications of this assemblage as Levantine Aurignacian and supporting subsequent indications that little was different in the underlying core technology of this assemblage from other Ahmarian blade technologies. Ultimately, we should be able to use core reduction analyses as important analytical techniques to identify technological strategies that vary considerably among Upper Paleolithic assemblages and that may be attributable to broader systemic factors beyond site functional differences. The results so far indicate Upper Paleolithic adaptations in inland ecological settings that differ significantly from Mediterranean sites during the Late Pleistocene. Continued research will define more precisely the technological parameters of the Ahmarian as an adaptation to a variety of mostly desertic inland environmental settings.

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Jebel Humeima: a Preliminary Lithic Analysis of an Ahmarian and Levantine Mousterian Site in Southwest Jordan

Kristopher W. Kerry

Abstract: *Excavations at Jebel Humeima in southwest Jordan have produced deposits associated with both Upper and Middle Paleolithic technology. Initial research placed the Upper Paleolithic occupations in the Levantine Aurignacian complex, while newly recovered assemblages (1994) contradict this technological placement and are more Ahmarian in character. The following presents a preliminary technotypological description of these assemblages and attempts to correlate these data with the current understanding of the Ahmarian complex and its association to the underlying deposits reminiscent of the Levantine Mousterian.*

Introduction

Excavations led by Donald Henry in southern Jordan during the early 1980s uncovered several Middle, Upper and Epipaleolithic sites (HENRY 1995). Many of the Middle and Epipaleolithic assemblages fit well within existing taxonomic framework. Conversely, the ambiguity of the Upper Paleolithic, combined with sampling error, contributed to a misinterpretation of the taxonomic placement of the Upper Paleolithic assemblage from Jebel Humeima (J412). It was initially identified as Levantine Aurignacian, but renewed excavation of the site in 1994 yielded artifacts equated with the Ahmarian technological complex. The larger excavation area and deeper sounding added substantially to previous information from 1983-84. Preliminary results of these soundings not only led to a reinterpretation of the taxonomic placement of J412's Upper Paleolithic assemblages, but they also revealed a Levantine Mousterian occupation under the Ahmarian horizon.

Sites in the arid ecological zone of the southern Levant that contain stratified Middle and Upper Paleolithic deposits are rare. In addition to J412 only four other sites have been located that contain such a sequence: Tor Fawaz (J403), Tor Hamar (J431) and Tor Aeid (J432) in the Jebel Qalkha area of southern Jordan and the Negev site of Boker Tachtit.

This paper will focus on a preliminary description of the technotypological parameters from the lithic assemblages recovered in 1994 at J412. It will also attempt to correlate these data with the current understanding of the Ahmarian complex and the transition from Middle to Upper Paleolithic technology.

Site Settings, Resources and Paleoenvironments

Jebel Humeima, a southwest facing rockshelter, overlooks Wadi Qalkha from an elevation of approximately 960m asl (Fig. 1). With a shallow overhang, it extends between 15-20m along a steep cliff. Excavation was carried out in this naturally protected area.

Humidity levels during the late Pleistocene were significantly higher and water would have been readily available in both Wadi Qalkha and nearby Wadi Humeima. Local palynological studies indicate a drier environment during Mousterian occupations, followed by a more humid setting in Ahmarian deposits (EMERY-BARBIER 1995). Today surface water is easily obtainable during the winter season when it collects in bedrock pools (COINMAN and HENRY 1995). An extinct spring was discovered within walking distance of J412: it cannot be determined how long ago it flowed, but similar evidence concerning Middle/Upper Paleolithic sites in direct association with extinct springs was found in the Avadt/Aqev area of the central Negev (GOLDBERG 1981).

Plentiful chert resources are directly adjacent to J412. A limestone hill containing large chert outcroppings provide abundant raw material, but these nodules are hard to extract and relatively small (COINMAN and HENRY 1995). In addition, a substantial amount of rolled cobbles can be found in and along the beds of both adjacent wadis. A third raw material source 20-22km away up on the Ma'an plateau contains abundant high quality flint.

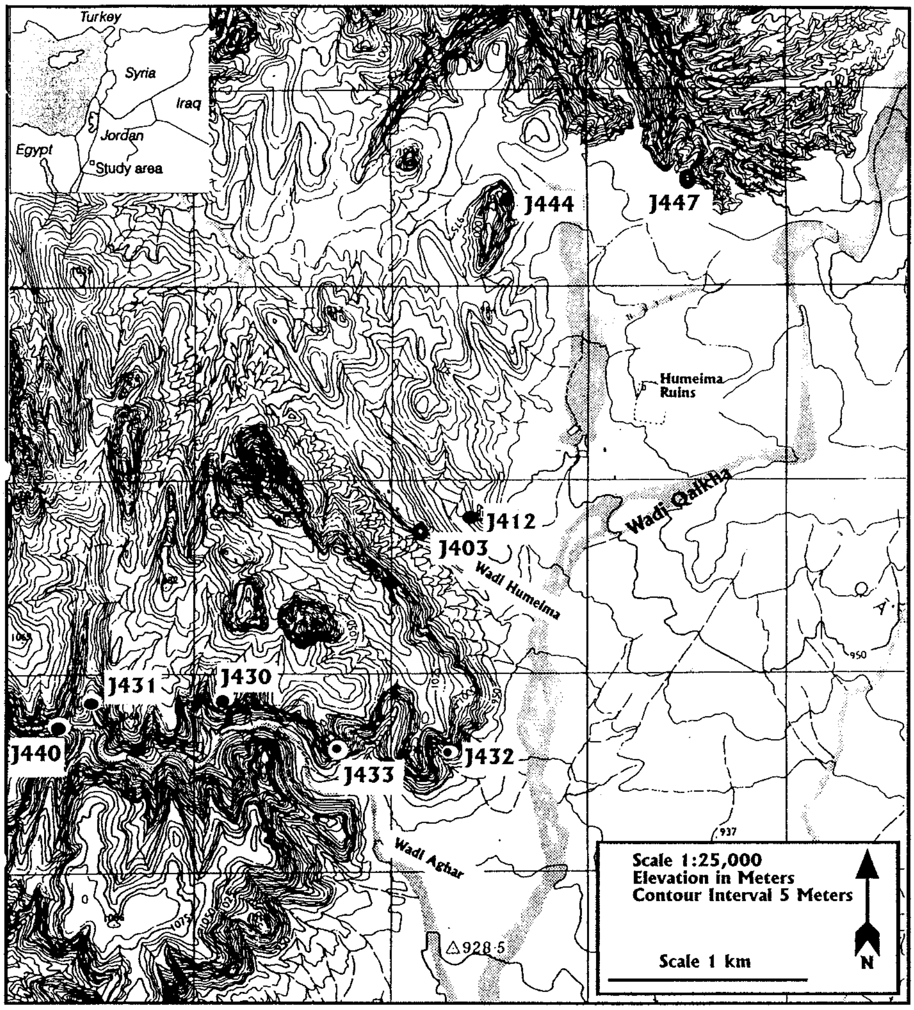

Fig. 1. Wadi Qalkha area with J412 site settings (adapted from HENRY *et al.* 1996).

Site Plans and Stratigraphy

During initial soundings a 90cm thick cultural deposit, terminating at bedrock, was revealed at J412. The subsequent excavation in 1994 uncovered deeper cultural deposits that reached 150cm. The earlier excavations were composed of two 1x1m squares; in 1994 a larger 2x3m block was excavated.

The stratigraphy from top to bottom consists of a partially disturbed area about 30cm deep (Layer A), a light-brown aeolian silt (Layer B) and a red sandy silt (Layer C), which are common to nearly all sites of the Wadi Qalkha area. This light-brown silt was found from 40-50cm to approximately 130cm below the surface, and the red sands lay below 130cm.

Excavation was conducted using 10cm arbitrary levels. In order to make stratigraphic comparisons, material was lumped into larger vertical intervals to generate reliable samples. Paying attention to both natural and cultural stratigraphy, J412 was divided into five cultural strata (Horizons I-V) (Fig. 2). The most shallow of these deposits, Horizon I, is correlated with a disturbed area (Layer A). Layer B is partitioned into three separate horizons (upper, middle, and lower) based on perceived technotypological variation. Layer C corresponds to the red sand, which throughout the Wadi Qalkha region commonly contains Middle Paleolithic deposits.

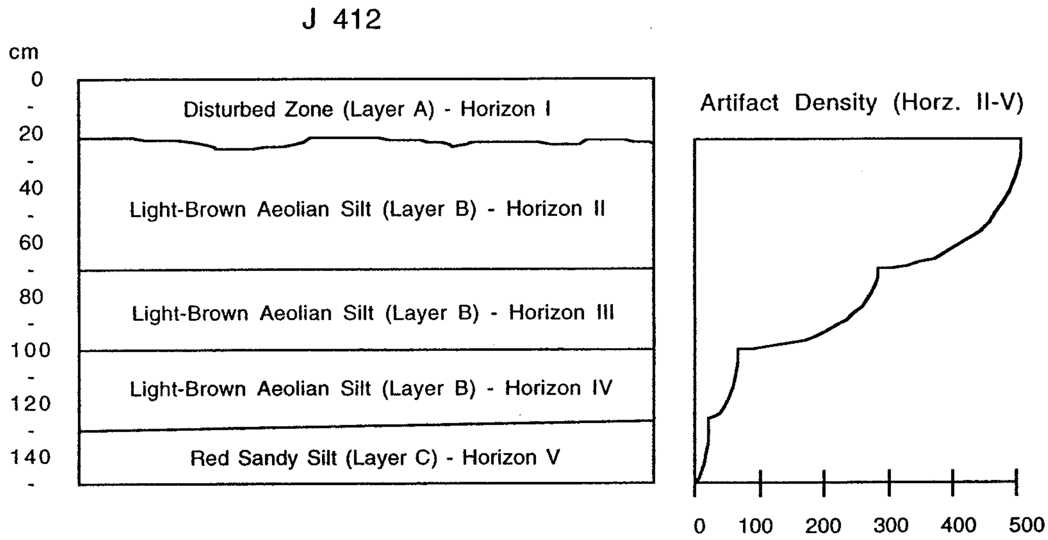

Fig. 2. Natural and cultural stratigraphic representation of J412 compared with artifact density.

Horizon I

Approximately 30cm of deposits account for this horizon. Due to the disturbed nature of Layer A, Horizon I was not included in this analysis.

Horizon II

Located within the upper 30cm of Layer B, Horizon II proved to be the most abundant in lithic material, with over 500 artifacts per $0.1m^3$ (Fig. 2, Table 4). The technotypological profile of collection fits neatly in the current Upper Paleolithic technological taxonomy of the Levant. Artifacts from this horizon exclusively reflect an Early Ahmarian occupation as demonstrated by a large amount of retouched pieces, endscrapers, burins and a high percentage of both retouched bladelets and el-Wad points (Table 1). Debitage consisted mainly of bladelets and flakes (Table 3).

Table 1. Typological counts and frequencies from J412.

	Horizon II		Horizon III		Horizon IV		Horizon V		Totals	
Type	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sidescraper	3	0.90	3	1.79	1	3.23	-	-	7	1.27
Endscraper	69	20.60	24	14.28	6	6.45	-	-	95	17.27
Burin	34	10.15	23	13.69	1	3.23	1	5.88	59	10.73
Perforator	1	0.30	-	-	-	-	-	-	1	0.18
Truncation	1	0.30	-	-	-	-	-	-	1	0.18
Notch	17	5.07	10	5.95	2	6.45	4	23.53	34	6.18
Denticulate	7	2.09	2	1.19	-	-	-	-	9	1.64
Retouched piece	88	26.27	63	37.50	17	54.83	11	64.71	179	32.55
Retouched bladelet	55	16.42	17	10.12	4	12.90	-	-	76	13.82
Trunc./faceted piece	7	2.09	17	10.12	1	3.23	1	5.88	24	4.36
Mulitple use	11	3.27	3	1.79	-	-	-	-	14	2.55
Varia	1	0.30	2	1.19	2	6.45	-	-	5	0.91
Ret. Levallois point	-	-	1	0.59	-	-	-	-	1	0.18
el-Wad point	41	12.24	3	1.79	1	3.23	-	-	45	8.17
Totals	**335**	**100.00**	**168**	**100.00**	**31**	**100.00**	**17**	**100.00**	**550**	**100.00**

Horizon III

The middle 20cm of Layer B provided an abundant amount of lithic material that is also representative of the Ahmarian technological complex. Artifact density is quite high and is dominated by Ahmarian tool types. The small number of Middle Paleolithic artifacts found in the lower section of Horizon III, including a single Levallois point, have been determined to be outside this horizon's technological repertoire, and they may or may not reflect post-depositional infiltration. Nevertheless, the vast majority of the material in Horizon III strongly suggests an Ahmarian occupation.

Horizon IV

Artifacts associated with both the Middle and Upper Paleolithic are found within the lowest 30cm of the light-brown silt deposit of Layer B. The artifact density of this horizon dropped significantly, and the resulting sample size is too small for typological comparisons. Again, the apparent "mixture" may reflect either a transition or post-depositional activity.

Horizon V

While very few artifacts were recovered from this horizon, they seem to display Middle Paleolithic attributes. Although the sample size from this horizon may not be adequate to concretely assign it a technological placement, it seems likely this horizon represents a Middle Paleolithic occupation.

Lithic Assemblages

The bulk of the recovered material from J412 was comprised of chert artifacts; relatively few organics were preserved. Nodules with limestone cortex from nearby outcrops and rolled cobbles were utilized. In addition to the chipped stone artifacts, a small number of probable hammer stones survived.

Typology

Ahmarian assemblages typically contain toolkits dominated by a high percentage of endscrapers, burins and el-Wad points (BERGMAN 1988, FERRING 1988, GILEAD 1991, MARKS and FERRING 1988). Endscrapers and burins were numerous at J412, particularly in Horizons II and III (Table 1); el-Wad points were abundant but were found almost exclusively in Horizon II.

Levantine Mousterian toolkits in the Wadi Hisma area were dominated by retouched pieces and Levallois points, with smaller numbers of notches, burins, side scrapers and endscrapers (HENRY 1995). While there were no Levallois points found in Horizons IV and V, a proportionally large frequency of retouched pieces and a low frequency of endscrapers and burins were recovered (Table 1). Although the small size of these collections is susceptible to sampling error, these typological indices suggest a Levantine Mousterian influence.

Table 1 is a synthesis of both Middle and Upper Paleolithic artifact inventory lists used to describe assemblages in the Wadi Qalkha area (HENRY 1995, COINMAN and HENRY 1995). Retouched flakes were the most prominent tools overall, closely followed by endscrapers and retouched bladelets. Tools accounted for about 3% of the J412 assemblage (Table 3).

Scrapers

Endscrapers dominated this tool class, made on flakes, primary elements, cores and the occasional core trimming element, but blades were the most abundant tool blank. Thumbnail and circular types were represented, but steeply retouched carinated and symmetrical endscrapers with lightly retouched working bits were most frequent (Fig. 3). Often endscrapers exhibited lateral retouch or were integrated into multiple tools, with notches and burins being the most common additional component.

Most endscrapers were intact although a small number were broken, usually at the base. Little evidence of resharpening was found. Only a few broken working-bits were identified, suggesting that rejuvenation of endscrapers may have been done by flaking instead of by a single lateral blow.

Endscrapers were found primarily in Horizons II and III, with the highest percentage represented in the latter collection. A dramatically smaller percentage characterizes Horizon IV.

Burins

Burins occurred on a variety of debitage types but predominantly on blade blanks. Transverse and angle burins were the most common varieties, although the occasional dihedrial burin was also present. Burins were often made on snaps or on old surfaces of other tool types, particularly endscrapers; several burins were fashioned on the old working-bit of symmetrical endscrapers. Often burins opposed endscrapers as components of multiple tools. Accounting for nearly 11% of the entire tool assemblage, burins exhibit the highest frequency within horizon II, dropping off considerably within the deeper horizons.

Retouched Pieces

Though retouched pieces were the most prolific tool class in all lithic assemblages, it is worth noting the apparent gradational change in frequency through the technological horizons. With about

26% of the tool assemblage in Horizon II, retouched pieces increased in frequency by jumps of 10% to almost 20% with depth. Both obverse and inverse retouch are common throughout the assemblage, although obverse retouch seems to have been preferred in the lower two horizons.

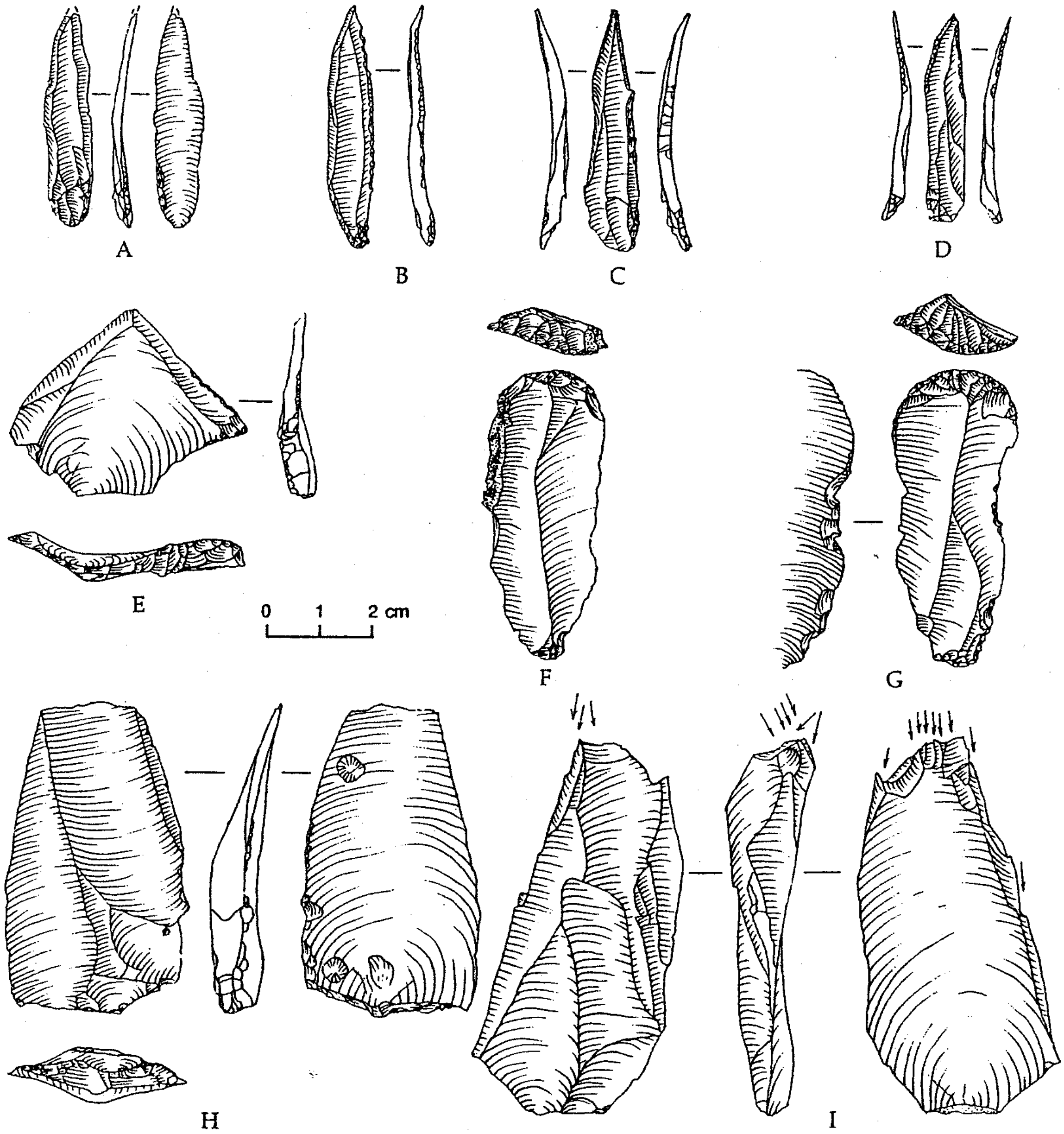

Fig. 3. Tools from J412: a-d el-Wad points, e Levallois point, f-g end scrapers, h retouched Levallois flake, i multiple burin.

Retouched Bladelets

While not as dramatic a gradational pattern as retouched tools, retouched bladelets also seem to reflect a technological shift from earlier to later deposits. The bulk of recovered retouched bladelets were found in Horizon II, generally decreasing in frequency within each subsequent level, with none being recovered from Horizon V. No preference for obverse or inverse retouch seems apparent; retouch on both sides and at either end of blanks can be found. Some bladelets, particularly in Horizons II and III, exhibited Ouchtata retouch. Ouchtata retouch also was frequently present on el-Wad points, not to create the point, but on the lateral edges.

el-Wad Points

A significant proportion of the assemblages from J412 is represented by el-Wad points with just over 8% of the total tool count (Fig. 3). Nearly all of the el-Wad points come from Horizon II

(41 of 45), accounting for over 12% of this horizon's tools. The occurrence of el-Wad points dropped substantially in the lower horizons, with none at all in Horizon V.

The el-Wad point typifies Ahmarian deposits. It is created on a bladelet blank by minimal semi-abrupt or abrupt retouch on one or both sides of the tip; the retouch may occur on both inverse and obverse surfaces. Occasionally, retouch may be found on both surfaces of the proximal end as well. Ouchtata retouch is also commonly found on el-Wad points. The el-Wad points from J412 are typical examples, with retouch occurring equally on both sides and both ends. Ouchtata retouch is somewhat uncommon in this assemblage, occurring substantially less often than semi-abrupt retouch and exclusively within Horizon II.

Other tool classes

A single Levallois point exhibiting a small amount of retouch was recovered at Jebel Humeima at the base of Horizon III. Notched pieces frequently exhibited more than one notch, and often they were components of multiple tools, usually occurring with endscrapers. Interestingly, the percentage of notched tools seems to increase with depth.

Truncated faceted pieces, or blanks exhibiting Nahr Ibrahim retouch, were most abundant in Horizon III. This method of blank manipulation, associated with use of cores on flakes, is often correlated with Middle Paleolithic technology.

Perforators, truncations, and denticulates represent a small amount of Jebel Humeima's tool kits. Only one perforator and truncation were found, the first on a blade and the latter on a bladelet. Denticulates were found on both blades and flakes.

Technology

Ahmarian lithic technology focused on producing bladelets from either single or opposed platform cores, probably through soft-hammer detachment (FERRING 1988). Early Ahmarian reduction techniques relied heavily on single platform cores, while later Ahmarian reduction processes became varied, utilizing opposed platforms with higher frequencies (FERRING 1988). Core rejuvenation was frequently effected with the core tablet technique, which produces a clean, single faceted platform (MARKS and FERRING 1988). As a result, blanks detached from these cores usually exhibit single faceted platforms.

Levallois reduction strategies depended on hard-hammer converging detachment and profuse basal preparation. As a result, Levallois points, flakes and blades typically display multiple faceting on the butt. A substantial portion of the blanks from Horizons IV and V exhibit multi-faceted butts. The broad base of the single Levallois point, as well as most of the Levallois debitage elements, is consistent with a Levantine Mousterian B-type industrial assignment.

The full range of reduction processes appears to have been carried out at J412. The presence of probable hammer stones along with a large percentage of debitage and debris depict a broad lithic processing sequence (Table 3).

Raw Material

Chert resources are within a short walking distance of J412. Wadi Humeima *in situ* chert sources approximately 2km away, and numerous river-borne cobbles from adjacent wadis were heavily utilized. A third chert source on the the Ma'an Plateau seems to be only slightly represented, if at all. The *in situ* nodules are identifiable by limestone cortex, whereas wadi cobbles display characteristic gravel cortex. Rolled cobbles were the dominant material in each horizon (Table 2).

Cores

Aspects of reduction technology can be enhanced by the recovery of large numbers of cores. Horizons II and III mainly included single platform cores that reflected the removal of long slender blanks (Fig. 4). Many cores exhibit multiple platforms; most of them involve a change in orientation, but some have opposed platforms or possess a twisted shape. Cores exhibiting change in orientation are most numerous in Horizon II. Both discoidal and Levallois cores increase in frequency with depth, and nearly all the Levallois cores from Horizon III were found in the lowest 20cm (Table 2).

While cores fashioned from cobbles appear to be favored over the more distant *in situ* cherts in the upper two horizons, indeterminate cores (or cores lacking cortex) were very common in Horizon III. Additionally, the size of many of the cores from Horizon III is noticeably smaller than those from Horizon II. These clues may point to a more intensive utilization and conservation of raw material.

Table 2. Classification of cores by raw material and core class from J412.

	Horizon II		Horizon III		Horizons IV-V	
Raw Material	n	%	n	%	n	%
Wadi cobble	42	56.00	34	38.20	2	40.00
Limestone nodule	18	24.00	22	24.72	3	60.00
Indeterminate	14	18.67	32	35.96	-	-
Other	1	1.33	1	1.12	-	-
Totals	**75**	**100.00**	**89**	**100.00**	**5**	**100.00**
Core Class						
Single platform	29	38.67	37	41.57	2	40.00
Opposed platform						
Opposite	7	9.33	6	6.74	-	-
Same	2	2.67	1	1.12	-	-
Twisted	5	6.67	4	4.49	-	-
Change of orientation	19	25.33	10	11.24	-	-
Levallois	1	1.33	12	13.48	3	60.00
Discoidal	1	1.33	6	6.74	-	-
Globular	11	14.67	13	14.62	-	-
Totals	**75**	**100.00**	**89**	**100.00**	**5**	**100.00**

Table 3. Absolute and relative frequencies of debitage classes from J412.

	Horizon II		Horizon III		Horizon IV		Horizon V		Totals	
Category	n	%	n	%	n	%	n	%	n	%
Core	75	5.39	90	9.16	4	2.84	1	2.17	169	6.60
Bladelet	467	33.55	222	22.61	35	24.82	1	2.17	725	28.31
Blade	105	7.54	86	8.76	9	6.38	5	10.87	205	8.00
Flake	454	32.61	382	38.90	59	41.84	26	56.53	921	35.96
Levallois flake	-	-	6	0.61	4	2.84	5	10.87	15	0.59
Levallois blade	-	-	1	0.10	-	-	-	-	1	0.04
Core trimming element	53	3.81	20	2.04	5	3.55	1	2.17	79	3.08
Primary element	227	16.31	169	17.21	22	15.60	7	15.22	425	16.60
Burin spall	11	0.79	6	0.61	3	2.13	-	-	21	0.82
Subtotals	**1392**	**100.00**	**982**	**100.00**	**141**	**100.00**	**46**	**100.00**	**2561**	**100.00**
Chips	9,492	91.99	3,422	91.99	543	91.57	211	90.56	13,668	91.65
Chunks	827	8.01	298	8.01	50	8.43	22	9.44	1,197	8.05
Subtotals	**10,319**	**100.00**	**3,720**	**100.00**	**593**	**100.00**	**233**	**100.00**	**14,865**	**100.00**
Tools	335	2.78	168	3.45	31	4.05	17	5.74	551	3.07
Debitage	1,292	11.56	982	20.16	141	18.43	46	15.54	2,561	14.25
Debris	10,319	85.66	3,720	76.39	593	77.52	233	78.72	14,865	82.68
Totals	**12,046**	**100.00**	**4,870**	**100.00**	**765**	**100.00**	**296**	**100.00**	**17,977**	**100.00**

Bladelets

The majority of bladelets came from Horizons II and III (Table 3). They parallel the frequencies of retouched bladelets that also decline with depth. Bladelet attributes are similar in Horizons II and III: blanks were detached from cores with a plain unfacetted platform. Many of the bladelets were also pointed and could have been used as projectiles without further retouch.

Other debitage classes

While flakes were the most prolific debitage class in each horizon, they show a steady increase with depth from just over 32% in Horizon II to over 56% in Horizon V (Table 3). Levallois flakes and blades were found in small numbers in Horizons III-V, increasing in frequency with depth. Despite minor fluctuations, other classes remained relatively stable through the sequence. Both blades and burin spalls stayed relatively constant, and primary elements and core trimming elements also displayed little stratigraphic variability, thus suggesting similar reduction activities within each horizon.

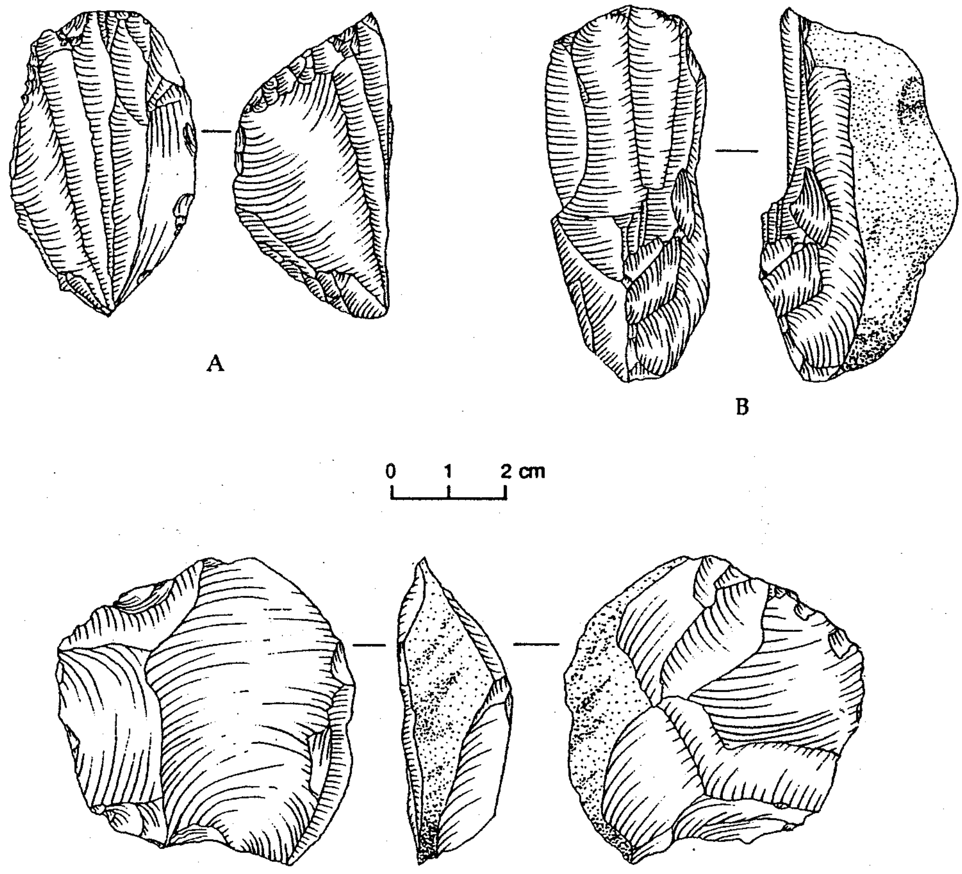

Fig. 4. Cores from J412: a single platform bladelet core, b change of orientation bladelet core, c Levallois core.

Technological Trends

Single unfacetted platforms associated with cores common to the Ahmarian reduction strategy dominated both tools and blanks in Horizon II (Tables 5 and 6). Unfacetted platforms decline in frequency with depth. Dihedral platforms peaked in Horizons III and IV but occurred with much less frequency in Horizons II and V. Multiple facets, representative of a high amount of platform preparation, increased markedly with depth and is indicative of a significant change in technological reduction.

Just as basal faceting is affected by different technological techniques in platform preparation, so is platform shape. Certain platform shapes are indicative of different technological reduction and detachment procedures. Lenticular shape is generally associated with Upper Paleolithic blanks, while *chapeau de gendarme* platforms are associated with Middle Paleolithic reduction technology. Lenticular platforms decrease in frequency for both tools and debitage with depth, indicating a less pervasive use of Upper Paleolithic reduction techniques. Conversely, V-shape platforms increase in each subsequent horizon, with the highest frequencies being in Horizons IV and V. If these trends reflect a technological transition or merely represent post-depositional infusion cannot be ascertained from the present sample.

Table 4. Artifact densities in Horizons II-V at J412.

Horizon	Volume (m^3)	Number of Artifacts	Density (n/m^3)
II	2.4	12,046	502
III	1.8	4,870	271
IV	1.8	765	43
V	1.8	296	16

Table 5. Comparisons of counts and relative frequencies for artifact platforms at J412<*Horizons IV and V collapsed, due to small sample size*>.

	Horizon II		Horizon III		Horizon IV		Horizon V	
Debitage Category	n	%	n	%	n	%	n	%
Single	64	64.00	36	36.00	29	41.43	6	20.00
Dihedral	16	16.00	38	38.00	21	30.00	4	13.33
Multiple	11	11.00	21	21.00	16	22.86	18	60.00
Crushed	8	8.00	4	4.00	3	4.28	2	6.67
Cortical	1	1.00	1	1.00	1	1.43	-	-
Totals	**100**	**100.00**	**100**	**100.00**	**70**	**100.00**	**30**	**100.00**
Tools	**Horizon II**		**Horizon III**		**Horizon IV+V**			
Single	61	61.00	21	35.00	7	31.81		
Dihedral	15	15.00	20	33.33	4	18.18		
Multiple	15	15.00	17	28.33	8	36.37		
Crushed	6	6.00	2	3.34	3	13.64		
Cortical	3	3.00	-	-	-	-		
Totals	**100**	**100.00**	**60**	**100.00**	**22**	**100.00**		

Table 6. Comparison of counts and relative frequencies of platform shape of artifacts from J412 <*Horizons IV and V collapsed, due to small sample size*>.

	Horizon II		Horizon III		Horizon IV		Horizon V	
Debitage Shape	n	%	n	%	n	%	n	%
Lenticular	47	47.00	32	32.00	16	22.86	9	30.00
Triangular	17	17.00	12	12.00	9	12.86	3	10.00
Diamond	3	3.00	6	6.00	7	10.00	1	3.33
V-shaped	3	3.00	9	9.00	8	11.43	6	20.00
U-shaped	4	4.00	2	2.00	3	4.28	2	6.67
Other	20	20.00	35	35.00	24	34.28	7	23.33
Indeterminate	6	6.00	4	4.00	3	4.29	2	6.67
Totals	**100**	**100.00**	**100**	**100.00**	**70**	**100.00**	**30**	**100.00**
Tools	**Horizon II**		**Horizon III**		**Horizon IV+V**			
Lenticular	40	40.00	22	36.67	6	27.27		
Triangular	12	12.00	6	10.00	4	18.18		
Diamond	11	11.00	6	10.00	2	9.09		
V-shaped	5	5.00	5	8.33	2	9.09		
U-shaped	3	3.00	-	-	1	4.55		
Other	25	25.00	19	31.67	4	18.18		
Indeterminate	4	4.00	2	3.33	3	13.64		
Totals	**100**	**100.00**	**60**	**100.00**	**22**	**100.00**		

Discussion

Absolute dates for the Middle-Upper Paleolithic succession in the Wadi Qalkha area are available only from Tor Faraj, dated by amino acid racemization to circa 70,000 BP; thus no chronological point of reference has been established for the Upper Paleolithic (HENRY 1995:49-84). Undated ostrich shell, recovered at 130cm below the surface where Layers B and C intermingle, may soon provide a chronological reference point for occupations within both layers.

Site Activity Patterns

Jebel Humeima covers a relatively small area (approximately 400 m^2), and probably represents several different episodes of small encampments. Occupation and activity appear to be much more intensive during the Upper Paleolithic: the depth of these deposits indicates a local affinity for this site, which evidently was revisited often.

It is particularly the Upper Paleolithic horizons that show a wide range of reduction activity on site. The relatively large number of cores and primary elements indicate that initial processing was an important function. The prominence of points, reworked scrapers and burins demonstrate a variety of tool production and use, and a number of core trimming elements points to a substantial amount of core rejuvenation. Toolkits were dominated by retouched pieces, endscrapers, retouched bladelets, burins, and notches, especially in Horizons II and III.

Despite the small number of artifacts recovered from Horizons IV and V, a full range of production seems to have occurred within these deeper occupations. Although few cores were recovered from these horizons, the number of primary elements suggest an appreciable amount of initial core preparation; several core trimming elements also suggest some degree of core maintenance and rejuvenation.

Settlement and Procurement Patterns

Middle Paleolithic adaptive strategies are often described as being focused on intensive exploitation of the immediate resource environment. Palynological and geological evidence depict a warm semi-humid climate during this period, which proved favorable to such adaptive strategies (HOROWITZ 1976, EMERY-BARBIER 1995, BOTTEMA and VAN ZEIST 1981, SCHULDENREIN and CLARK 1994). Towards the end of the Middle Paleolithic the environment became considerably drier, culminating in the contraction of the Mediterranean woodland zone (HIETALA and MARKS 1981). This development in climate initiated the two-fold nature of Levantine environmental settings: the Mediterranean woodland in the north and along the coastline, and the arid zone to the south and east. The Jebel Qalkha area would have been on the threshold of these two zones, with a Mediterranean-like environment in the highlands and a warmer arid setting at lower altitudes. It has been suggested by data recovered at Tor Faraj and Tor Sabiha that a system of transhumance may have developed during this climatic reformation (HENRY 1995). As the environment became less homogeneous, prehistoric groups became more diverse in re-adapting to new and fluctuating climatic episodes (HIETALA and MARKS 1981). This trend is likely to have continued into the early Upper Paleolithic. As the Levantine environment solidified into the Mediterranean woodland and the arid-steppe, Upper Paleolithic technology may have developed several different strategies to exploit this environmental variation.

In the absence of necessary environmental information, seasonal occupation of J412 must be inferred indirectly. The connection between elevation and seasonality at nearby Tor Faraj and Tor Sabiha may prove useful in determining site seasonality. Tor Sabiha, located at a high elevation, represents a summer encampment, while the more sheltered Tor Faraj, at a much lower altitude and facing south, is considered a cold-season camp (HENRY 1995). J412's lower elevation (960 masl) and southwest positioning would have been very warm during summer months but comfortable in winter. Like Tor Faraj, plentiful water resources would be available during the colder season at nearby Wadi Qalkha and Humeima, as they were probably infused with run-off from winter precipitation. While Upper Paleolithic settlement patterns and seasonal transhumance has yet to be explained, it is likely that Middle Paleolithic settlement patterns continued throughout the region and the succeeding technological period.

Temporal and Regional Relationships

Despite potential problems in using "type fossils" as technological markers, the Emireh point appears to signify the Middle to Upper Paleolithic transition in several Levantine assemblages. Its distribution ranges from such northern sites as Abu Halka and Ksar Akil to the central Levantine sites of Shubbabiq, el-Wad, Kebara, Qafza, and Emireh, and into the southern Levant at Boker Tachtit. The Emireh point is produced from an opposed platform core using the Levallois technique, but unlike earlier Levallois points the Emireh point exhibits inverse basal thinning (MARKS 1983). Assemblages that include the Emireh point, especially Boker Tachtit, show an increase in the use of blades and such Upper Paleolithic tools as endscrapers and burins. This transition has been associated with both a typological and, more importantly, a technological change from the Middle to Upper Paleolithic (MARKS 1983).

The lack of Emireh points or any other examples of inverse basal thinning casts doubt on whether J412 represents a transitional site. Horizon V stratigraphically parallels other Middle Paleolithic sites in the Wadi Qalkha area and lies beneath Upper Paleolithic material, but instead of reflecting a technological transition, the small collection may be the result of post-depositional mixing. Although Horizon V may merely be an earlier and unrelated occupation, its artifacts appear to be at one end of a gradational trend in basal facet preparation and platform shape (Tables 5 and 6). As previously stated, the Levallois reduction process hinged on basal preparation, producing multiple facets on points and other blanks, while Ahmarian lithic technology relied upon single platform cores with unfacetted platforms. Despite this contrast, a sufficient technotypological connection cannot be constructed between the Upper and Middle Paleolithic deposits at J412.

The Upper Paleolithic and its current taxonomy still lack the degree of certainty other periods of Levantine prehistory enjoy. The Ahmarian is seen as a native complex, with its earliest industrial development exhibited in the Negev where it evolved from the Emireh phase of the incipient Upper Paleolithic (GILEAD 1983, 1989, 1991; MARKS 1981; MARKS and FERRING 1988). A similar Middle/Upper Paleolithic transitional site has yet to be found in southwest Jordan.

By definition the Ahmarian deposits at J412 resemble other assemblages found in the region and those from the Negev, but some prehistorians consider the Ahmarian to be defined ambiguously, grouping several different archaeological entities together (PHILLIPS 1988). A significant amount of variability and spatial patterning in the Ahmarian complex makes it difficult to isolate regional differentiation. Many sites exhibit tight artifact groupings where the majority of a given tool type will be found in clusters of a few square meters (MARKS and FERRING 1988). This variability combined with artifact clustering can drastically affect small excavation samples.

The possibility of post-depositional "mixing" makes the interpretation of a transition in the sequence at J412 a tenuous undertaking. Despite this, technotypological trends appear to be present that change incrementally with depth. Further excavation needs to be done to increase sample size and perhaps provide a higher resolution of site stratigraphy.

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Tor Aeid: An Upper Paleolithic Occupation in Southern Jordan

John K. Williams

Abstract: *Over one meter of cultural deposits has been excavated at Tor Aeid, an Upper Paleolithic site located in the Jebel Qalkha region of southern Jordan. A technotypological analysis was performed on the lithic assemblage, which contained predominantly Upper Paleolithic artifacts of an Ahmarian nature stratigraphically situated above a small Middle Paleolithic component. The Upper Paleolithic artifacts are most akin to other sites in the southern Levant attributed to the early manifestation of the Ahmarian.*

Introduction

Recent research in Southern Jordan has revealed several *in situ* sites ranging from the Lower Paleolithic through the Epipaleolithic (HENRY 1994, 1995). Tor Aeid (J432) is one of six Upper Paleolithic occupations that were discovered as a result of this research. This report provides the results of a preliminary analysis of the stone tool assemblages recovered from the 1994 excavations at Tor Aeid[1]. Upper Paleolithic artifacts, which comprised the majority of the lithic assemblage, were found stratigraphically overlying Middle Paleolithic artifacts. The pronounced Ahmarian nature of the Upper Paleolithic tools and debitage was examined in the context of the defining characteristics of the Ahmarian/ Levantine Aurignacian dichotomy. Finally, regional comparisons and settlement patterns were taken into consideration in an attempt to gain a better understanding of the placement of Tor Aeid in the Levantine Upper Paleolithic.

Site Settings and Resources

Modern Settings

Tor Aeid lies in the Jebel Qalkha study area of southern Jordan, a 6 km^2 region located some 55km northeast of the Gulf of Aqaba (Fig. 1). Situated on a shallow south-facing rockshelter at 920 masl, the site falls within the Irano-Turanian phytogeographic zone (HENRY 1995:9). It rests on a gently sloping terrace overlooking a minor wadi to the south that drains into the Jebel Humeima. This minor wadi contains a number of seasonal pools and provides access to the top of a cliff with an extensive view in all directions. Upper Paleolithic artifacts were discovered on the surface in an area covering 540 m^2, forming a cluster near a shallow overhang and extending to an area further downslope where Levallois points were found eroding from the terrace (HENRY, pers. comm.). The artifact concentration is thought to define accurately the cultural limits of the site because it lies on a moderate slope that prevents the artifacts from being removed or greatly dispersed.

The Paleo-Setting

The terminal Middle Paleolithic and Upper Paleolithic periods in southern Jordan (*c.* 45,000-20,000 bp) are characterized by significant paleoclimatic and environmental fluctuations. Around 45,000 bp the climatic situation shifted from relatively moist conditions to drier conditions. This was followed by a trend toward a more humid climate from 38,000 to 30,000 bp, after which warmer and drier conditions emerged and persisted through the late Upper Paleolithic times (EMERY-BARBIER 1995: 378).

[1] The excavation was funded through grants from the Office of Research, University of Tulsa, and the National Science Foundation (DBS92238S5) awarded to D.O. Henry.

Site Plans and Stratigraphy

In 1983 and 1984 a 1x2m sondage was excavated at Tor Aeid[1]. The test units were placed five meters from the dripline of the rockshelter at the northeast corner of the site. Arbitrary levels were excavated in 10cm increments below the modern surface. Upper Paleolithic artifacts were found througout the sondage, but excavations were halted at a depth of 60cm because the 1x2m test unit would not accommodate greater depths. Excavations resumed in 1994, when six $1m^2$ units were opened adjacent to one another, forming a 2x6m excavation block in the south-central portion of the site.

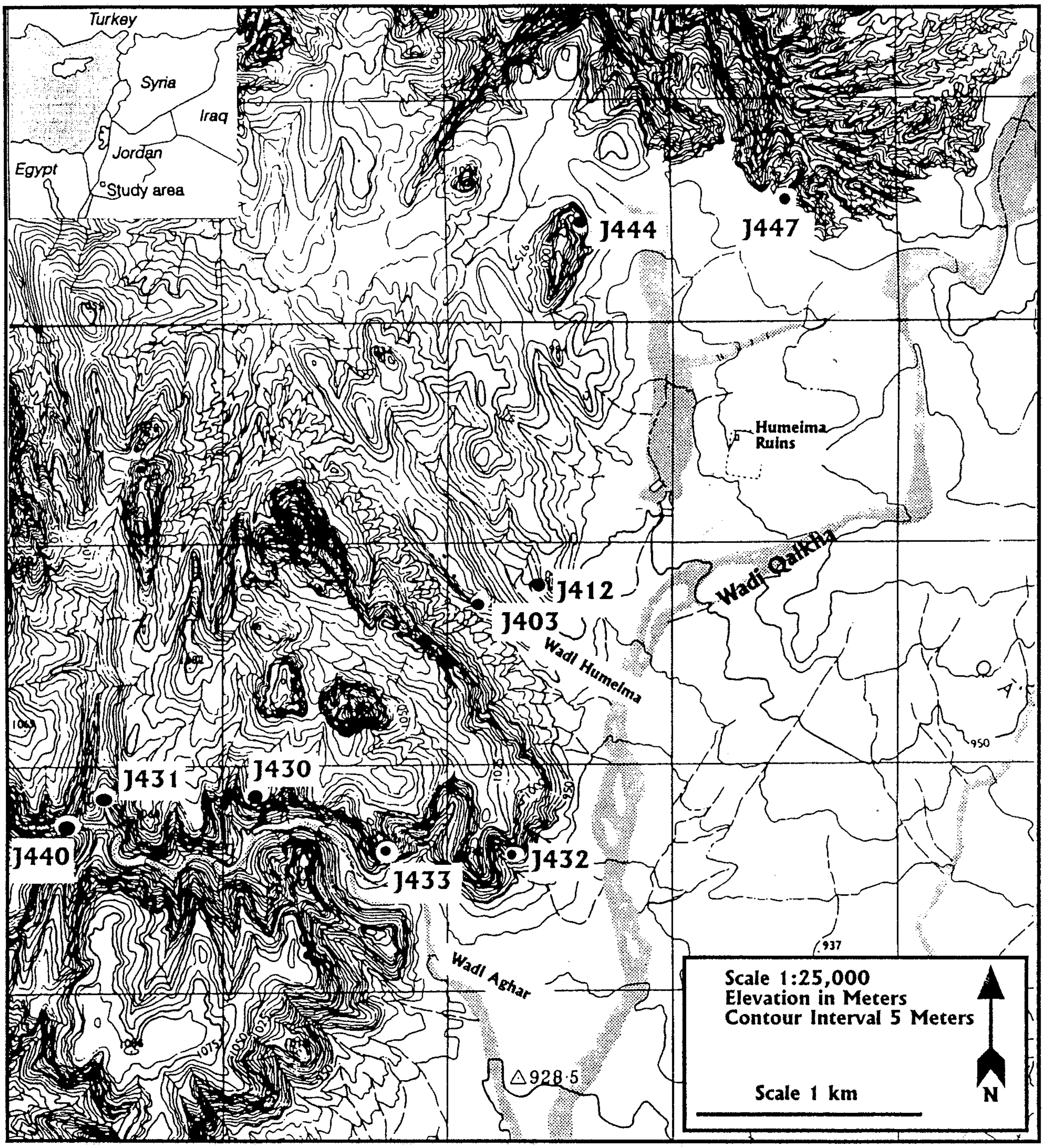

Fig.1. Location of Tor Aeid (J432) in the western Hisma.

[1] The 1983-84 excavations are reported by COINMAN and HENRY 1995.

Arbitrary levels were again excavated in 10cm increments from the modern surface. Both Middle and Upper Paleolithic stone tools were recovered during the 1994 excavations, but due to time constraints, excavations were halted at a depth of 130cm before a culturally-sterile layer was reached.

The sedimentary deposit was dominated by carbonate-cemented sandy silt with sandstone gravel inclusions. With the exception of a possible carbonate concentration at a depth of 40-65cm, the sediments are not visibly layered. The sandy silt gradually changes from yellowish-brown at 0-30cm to yellow reddish-brown at 35-100cm, and finally to reddish-yellow brown below 100cm (HENRY and HALL, pers. comm.).

The Lithic Assemblage

With the exception of five small marine shells from the upper 20cm, only lithic artifacts were recovered. Artifacts from both the 1983-84 and 1994 excavations were combined and analyzed for the purposes of this report. The lack of definite stratigraphic layering throughout the 130cm of cultural deposits made it necessary to examine general artifact trends according to depth rather than assigning cultural layers. One of the most readily apparent vertical trends involves artifact density, which peaks just beneath the surface and gradually declines with greater depth (Table 1 and Fig. 2).

Technology

The debitage and debris counts and relative frequencies are presented in Table 2. The lithic technology above a depth of 70cm focused on the production of blades and bladelets from single platform cores. In contrast, the basic technology below 90cm depth was oriented toward the production of flakes from discoidal cores. The debitage counts for primary elements and core trimming elements significantly decrease below a depth of 70cm. This decline in primary elements can also be seen in the ratio of cores to primary elements (1: 3.5 at 0-20cm compared to 3.3: 1 at 110-130cm) (Appendix 2). This trend appears to represent less onsite primary processing at greater depths, a technological change that could indicate differential raw material procurement strategies through time.

Cores

The collection of cores represents 4% of the debitage. The majority of these were reduced to the point where no cortex remained that would allow identification of their raw material forms. From those cores with cortex, 30% were identified as rolled cobbles with gravel cortex, while the remainder (16%) were nodules with limestone rind or cortex (Table 3). Cores lacking cortex increase sharply beneath 70cm depth. There also seems to be a preference for rolled cobbles in the upper layers (rolled cobbles 34%, limestone cobbles 15%), while limestone cobbles are more frequent in lower layers (rolled cobbles 12%, limestone nodules 21%). The most significant changes occur in the core class. The frequency of single platform cores is highest just beneath the surface and steadily decreases with greater depth, while discoidal cores are nearly absent just beneath the surface and increase with greater depth.

Blades, Bladelets, and Flakes

Trends can also be seen in the percentages of blade, bladelet, and flake debitage. Bladelet frequencies steadily decrease from 0-130cm, while flake frequencies steadily increase (Fig. 3). Blades and bladelets dominate the technology at 0-60cm. Flakes at this depth appear to be by-products of core shaping and platform preparation. Debitage from depths below 70cm, especially 90-130cm, show a technology markedly oriented towards the production of flakes rather than blades or bladelets.

Typology

The tool frequencies are presented in Table 4. A total of 466 tools was recovered, comprising 4% of the total assemblage (Appendix 1). The toolkit is dominated by endscrapers, retouched pieces, burins and el-Wad points (Fig. 5). Of the tools from 0-60cm depth, those on blades and bladelets are predominant, while tools from 70-130cm depth are mostly on flakes (Fig. 6).

Retouched Pieces

Retouched pieces (bladelets, blades, and flakes) together are the most dominant category of tools in the lithic assemblage, constituting 42% of the toolkit. Of these, retouched bladelets are the most common (17%), followed by retouched flakes (14%) and finally by retouched blades (11%). While the percentage of retouched blades remains relatively steady throughout the assemblage, retouched bladelets and flakes tend to have inverse proportions. In other words, the percentage of bladelets decreases with greater depth while the percentage of flakes steadily increases. Most pieces exhibit

Table 1. Tool and total artifact density from Tor Aeid (J432).

	Cubic m	Density Tools (*n* tools/0.1m³)	Density Total Pieces (*n* total pieces/0.1m³)
0,10,20cm	0.8	15	484
30&40cm	1.5	12	264
50&60cm	1.3	7	191
70&80cm	1	3	110
90&100cm	0.9	1	62
110,120,130cm	1.1	2	52

Table 2. Technological counts and frequencies from Tor Aeid (J432).

	0,10,20cm		30&40cm		50&60cm		70&80cm		90&100cm		110,120,130cm		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Debitage														
Cores	43	2.5%	47	3.2%	29	4.6%	16	5.6%	7	5.6%	16	7.8%	**158**	**3.6%**
Bladelets	742	43.9%	563	38.6%	151	24.0%	48	16.8%	6	4.8%	7	3.4%	**1517**	**34.5%**
Blades	119	7.0%	193	13.2%	121	19.2%	70	24.5%	22	17.7%	39	19.0%	**564**	**12.8%**
Flakes	570	33.7%	499	34.2%	260	41.3%	142	49.7%	83	66.9%	137	66.8%	**1691**	**38.5%**
CTE	50	3.0%	31	2.1%	17	2.7%	3	1.0%	1	0.8%		0.0%	**102**	**2.3%**
Primary Elements	150	8.9%	99	6.8%	47	7.5%	6	2.1%	5	4.0%	5	2.4%	**312**	**7.1%**
Burin Spalls	18	1.1%	28	1.9%	4	0.6%	1	0.3%		0.0%	1	0.5%	**52**	**1.2%**
Total	1692	100.0%	1460	100.0%	629	100.0%	286	100.0%	124	100.0%	205	100.0%	**4396**	**100.0%**
Debris														
Chip	1871	90.8%	2064	89.0%	1878	83.6%	544	69.7%	267	63.6%	195	56.9%	**6819**	**83.5%**
Chunk	189	9.2%	256	11.0%	368	16.4%	236	30.3%	153	36.4%	148	43.1%	**1350**	**16.5%**
Total	2060	100.0%	2320	100.0%	2246	100.0%	780	100.0%	420	100.0%	343	100.0%	**8169**	**100.0%**

Table 3. Classification of cores by raw material and core class from Tor Aeid (J432).

	0,10,20cm		30&40cm		50&60cm		70&80cm		90&100cm		110,120,130cm		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Raw Material														
Rolled Cobble	17	35%	15	35%	11	33%	3	27%		0%	1	6%	**47**	**30%**
Limestone Cobble	8	16%	5	12%	6	18%		0%	2	33%	5	31%	**26**	**16%**
Indeterminate	24	49%	23	53%	16	48%	8	73%	4	67%	10	63%	**85**	**54%**
Total	49	100%	43	100%	33	100%	11	100%	6	100%	16	100%	**158**	**100%**

	0,10,20cm		30&40cm		50&60cm		70&80cm		90-130cm*		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Core Class												
Single Platform	27	57%	20	45%	8	25%	3	25%		0%	**58**	**37%**
Opposed Platforms												
Opposite	3	6%	4	9%	2	6%	3	25%	2	9%	**14**	**9%**
Same		0%		0%		0%		0%		0%	**0**	**0%**
Twisted	2	4%		0%		0%		0%		0%	**2**	**1%**
Change of Orientation	5	11%	2	5%	5	16%		0%		0%	**12**	**8%**
Others												
Discoidal	1	2%	2	5%	2	6%	3	25%	8	35%	**16**	**10%**
Other	9	19%	16	36%	15	47%	3	25%	13	57%	**56**	**35%**
Total	47	100%	44	100%	32	100%	12	100%	23	100%	**158**	**100%**

*Combined due to small sample size

Table 4. Typology from Tor Aeid (J432).

	0,10,20cm		30&40cm		50&60cm		70&80cm		90&100cm		110,120,130cm		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Tools														
Side Scrapers	5	4.2%	12	6.6%	6	6.4%	1	3.2%	1	6.3%	1	4.0%	**26**	**5.6%**
End Scrapers	23	19.3%	20	11.0%	13	13.8%	3	9.7%	1	6.3%	3	12.0%	**63**	**13.5%**
Burins	19	16.0%	14	7.7%	6	6.4%	1	3.2%	1	6.3%	2	8.0%	**43**	**9.2%**
Perforators	5	4.2%		0.0%	1	1.1%		0.0%		0.0%		0.0%	**6**	**1.3%**
Backed Piece		0.0%	3	1.7%	1	1.1%	3	9.7%		0.0%		0.0%	**7**	**1.5%**
Truncations	2	1.7%	8	4.4%	1	1.1%		0.0%		0.0%		0.0%	**11**	**2.4%**
Denticulates	4	3.4%		0.0%		0.0%	2	6.5%		0.0%		0.0%	**6**	**1.3%**
Notches	10	8.4%	19	10.5%	10	10.6%	2	6.5%	3	18.8%		0.0%	**44**	**9.4%**
Retouched Bladelets	14	11.8%	46	25.4%	10	10.6%	7	22.6%	1	6.3%	2	8.0%	**80**	**17.2%**
Retouched Blades	7	5.9%	23	12.7%	12	12.8%	3	9.7%	4	25.0%	2	8.0%	**51**	**10.9%**
Retouched Flakes	10	8.4%	16	8.8%	17	18.1%	7	22.6%	5	31.3%	12	48.0%	**67**	**14.4%**
Multiple Use Tools	6	5.0%	7	3.9%	4	4.3%	1	3.2%		0.0%	1	4.0%	**19**	**4.1%**
Points	11	9.2%	12	6.6%	13	13.8%	1	3.2%		0.0%		0.0%	**37**	**7.9%**
Varia	3	2.5%	1	0.6%		0.0%		0.0%		0.0%	2	8.0%	**6**	**1.3%**
Total	119	100.0%	181	100.0%	94	100.0%	31	100.0%	16	100.0%	25	100.0%	**466**	**100.0%**

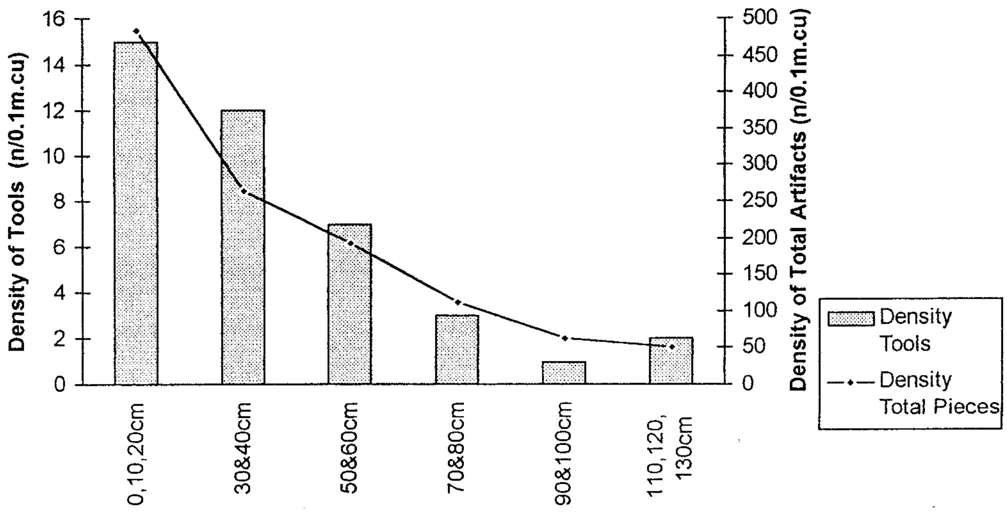

Fig. 2. Tool and total artifact density from Tor Aeid (J432).

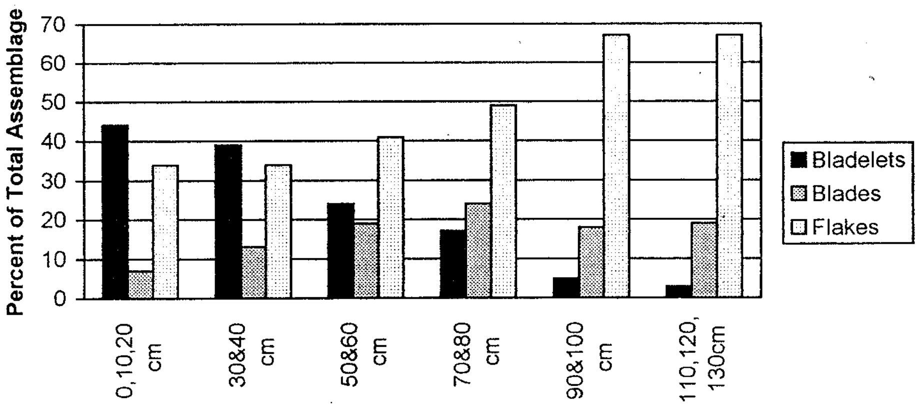

Fig. 3. Bladelet, blade, and flake percentages from Tor Aeid (J432).

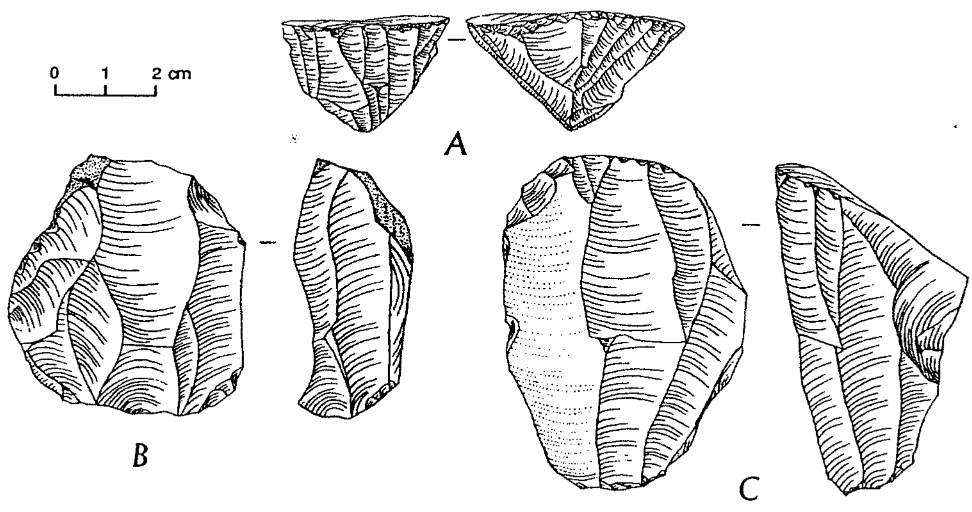

Fig. 4. Cores from Tor Aeid (J432): A single platform core, B discoidal core, C opposed platform core.

unilateral retouch on the obverse sides. Some of the more unusual retouched pieces include seven backed bladelets and one *lamelle Dufour.*

Scrapers

Scrapers are the second most prolific category (20%), with endscrapers being the dominant form throughout the entire assemblage. Endscrapers occur most frequently on blades from 0-60cm and on flakes from 70-130cm, and are predominantly retouched to a semi-steep working edge on thin nosed blanks. Only three endscrapers from the entire assemblage were classified as carinated. The percentage of sidescrapers remains fairly stable throughout the distribution (*c.* 6% of the toolkit). Most sidescrapers are on flakes with semi-abrupt working edges.

Burins

Burins comprise 9% of the toolkit, occurring most frequently at 0-20cm. The majority of burins are found on uncommonly large core-like blanks or old surfaces, making them relatively large with thick bits and multiple spall scars. The remainder of the burins occurs mostly on flakes, while those on blades are poorly represented. Also occurring as members of the multiple tool category, burins are commonly found opposite scrapers and retouched pieces.

Points

The most diagnostic tools in this assemblage are the projectile points. Thirty-seven points were discovered during both excavations, 36 of which are el-Wad points. Most of the points are either proximal or distal fragments, occurring on both flat and incurvate blanks, but rarely are the profiles twisted. The el-Wad points consistently feature semi-abrupt to fine obverse retouch. El-Wad points occur most frequently at 50-60cm, and do not occur at any depth greater than 60-70cm.

A single Levallois point represents the only pointed tool below a depth of 70cm. The unretouched Levallois point is missing a tip, but it exhibits converging dorsal flake scars and a pronounced V-shaped, or *chapeau de gendarme*, platform with multiple facets. Such broad based, triangular points are characteristic of the Late Levantine Mousterian (B-type) reduction technology (BAR-YOSEF and MEIGNEN 1992).

Other Tool Classes

Single and multiple notches on a variety of blanks are fairly common, forming 9% of the toolkit. Conversely, perforators, truncations, and denticulates are poorly represented, comprising as a whole only 3% of the toolkit.

Discussion

No radiometric assays are available for Tor Aeid, or any of the other Upper Paleolithic assemblages in the Jebel Qalkha study area, that could provide an absolute date for the occupation of the site. However, most of Tor Aeid's lithic assemblage clearly display features of Upper Paleolithic assemblages in the Levant included under the heading of "Ahmarian".

Stratigraphic Patterning

At least two technotypological complexes are apparent at Tor Aeid. The lowest levels are dominated by a flake industry with some characteristic Levallois pieces. Artifacts from the upper levels, on the other hand, exemplify an Upper Paleolithic blade/bladelet industry. Middle and Upper Paleolithic components are not discrete in the vertical distribution but instead they overlap. Middle Paleolithic elements at the lowest levels gradually decline and are eventually replaced by Upper Paleolithic elements in overlying levels. The depth at which a dominant Middle Paleolithic assemblage seems to give way to a dominant Upper Paleolithic assemblage appears to be around 70cm below the modern surface. The percentages of tools and debitage occurring on flakes versus blade/bladelets are a good example of this dividing point (Figs. 3 and 6). Another example can be seen in Table 3 and Fig. 7, which show that a Middle Paleolithic core type (*i.e.*, discoidal) dominates the assemblage below 70cm depth, while an Upper Paleolithic core type (*i.e.*, single-platform) is predominant throughout 0-60cm depth.

Due to the paucity of tools below a depth of 60cm, technological data such as core reduction strategies are likely to reflect Middle and Upper Paleolithic occurrences better than typological data. A good indicator of core reduction strategies is the type of faceting that occurs on the platforms of debitage blanks. Middle Paleolithic core reduction strategies involve repetitive preparation to produce the desired result, whereas Upper Paleolithic core reduction involves little or no re-preparation of the

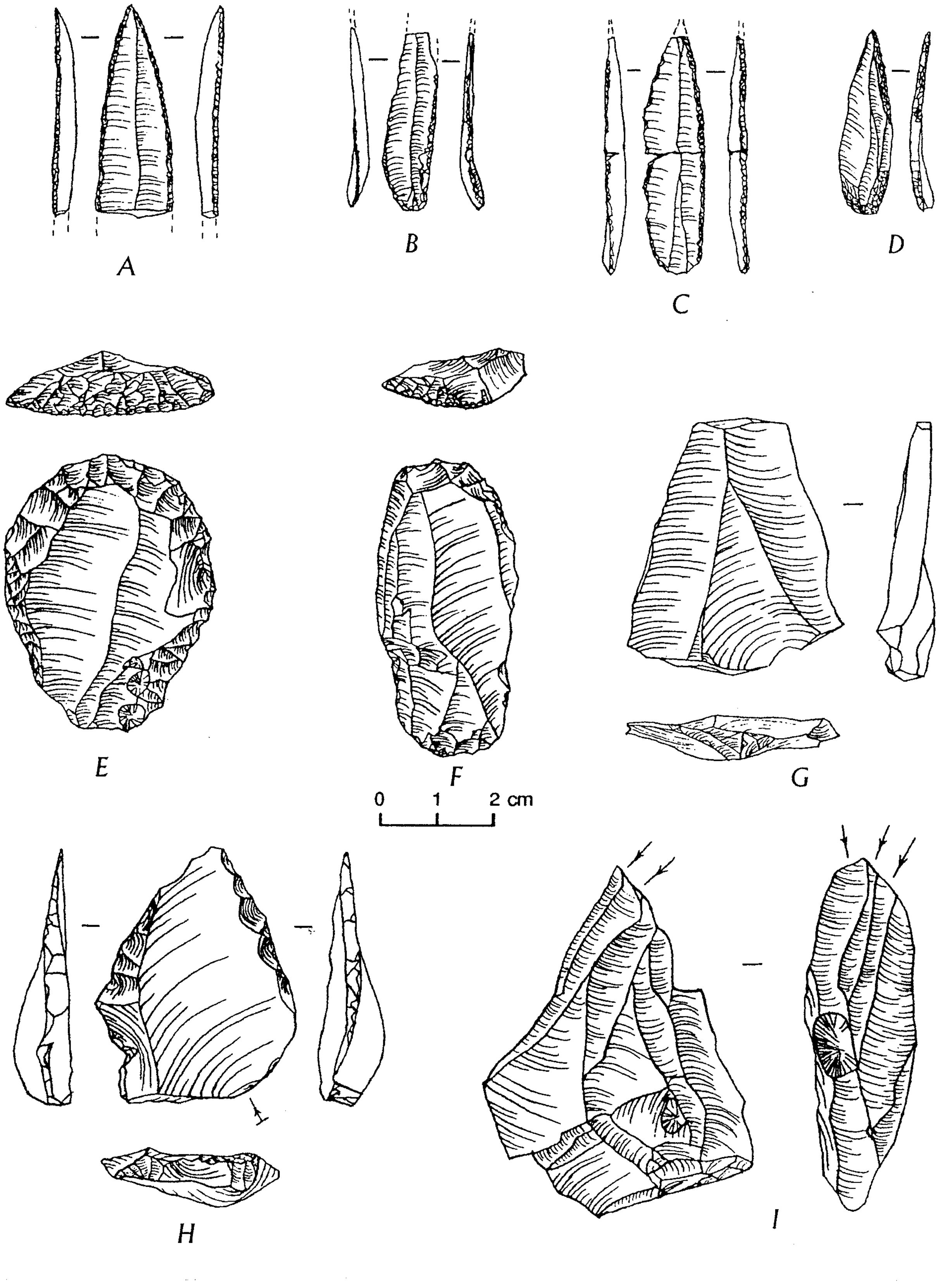

Fig. 5. Tools from Tor Aeid (J432): A-D el-Wad points, E-F endscrapers, G Levallois point, H sidescraper of Levallois flake, I multiple burin.

platform before the removal of separate blanks (BAR-YOSEF and MEIGNEN 1992). Thus, multiple facets occur more commonly on the platforms of Middle Paleolithic blanks while Upper Paleolithic blanks are typically unfaceted.

Data from a random sample of 313 debitage blanks were analyzed to determine the type of platform faceting occurring on blades, flakes, and primary elements throughout the vertical distribution. Displayed in Table 5, the results of this analysis show that the percentage of unfaceted (single) platforms for each category of debitage decreases with greater depth, while the percentage of platforms with multiple facets increases with greater depth. This can be interpreted as indicating a gradational shift from a Middle to Upper Paleolithic core reduction strategy.

Comparisons between shallow and deep levels should be approached with caution, however, due to a significant decrease in sample size below a depth of 70cm and the nature of the stratigraphy or lack there of. Although definite trends are apparent that suggest behavioral horizons, there is a possibility that vertical comparisons are somewhat distorted due to an insufficient sample size below a depth of 90cm, a possibility that can only be confidently tested with further excavation and more intensive stratigraphic analysis.

The Upper Paleolithic Occupation at Tor Aeid

The number of artifacts above 70cm depth is sufficiently large to draw valid conclusions about the nature of the assemblage. The artifacts from 0-60cm epitomize an Upper Paleolithic assemblage and resemble groups currently described as Ahmarian.

Table 6 displays a comparison of the lithic assemblage from Tor Aeid with Gilead's (1981) definition of the Ahmarian and its counterpart, the Levantine Aurignacian. The assemblage from a depth of 0-60cm appears to fit more closely with Gilead's broad definition of Ahmarian.

Recently however, this "two traditions" model to define the Ahmarian and Levantine Aurignacian (GILEAD 1981, MARKS 1981) has come under close scrutiny (BERGMAN and GORING-MORRIS 1987, BERGMAN 1988). Some researchers have questioned the applicability of Marks and Gilead's model to the entire Levant because the data used to create this model was taken primarily from the southern Levant. Most of the criticism is aimed at some of the southern Levantine sites classified under the rubric of "Levantine Aurignacian" that lack the basic elements of the original definition found in the northern assemblages (BELFER-COHEN 1995, BAR-YOSEF and BELFER-COHEN 1988, BELFER-COHEN and BAR-YOSEF 1981). Southern "Levantine Aurignacian" sites are classified as such only on the basis of a flake-based technology and a toolkit dominated by endscrapers and/or burins (GILEAD 1981). In this, the southern "Levantine Aurignacian" sites in no way match the complexity of those from northern cave sites, which often exhibit nosed and shouldered endscrapers with Aurignacian retouch, endscrapers on Aurignacian blades, and an elaborate worked bone industry (BELFER-COHEN 1995).

Some of the southern sites that were initially included under the heading of "Levantine Aurignacian" have since been found to have been incorrectly assigned after more intensive examination. For example, before major excavations took place at Tor Aeid and the nearby site of Jebel Humeima (J412), both appeared to represent Levantine Aurignacian occupations (HENRY 1982), but they have since been recognized as Ahmarian. This mistake is likely to occur commonly for a number of smaller assemblages with relatively nondescript tools (*i.e.*, simple scrapers and burins) that do not represent the full complexity of the assemblage. These problematic situations are a result of the current definition of Levantine Aurignacian that includes under its generalized criteria any non-Ahmarian Upper Paleolithic assemblage.

In contrast, the Ahmarian appears to be a valid entity throughout the Levant. Gilead's (1981) definition of the Ahmarian is somewhat more specific than for the Levantine Aurignacian and has since been further refined into early and late stages to account for the variability of sites falling under its heading (FERRING 1988).

Artifacts recovered from a depth of 0-60cm at Tor Aeid are characterized by a single reduction strategy, focused on the production of slender, elongated interior blades and bladelets from predominantly single platform cores that were used for el-Wad points and retouched blade/bladelet blanks. These are the defining criteria of the Early Ahmarian (FERRING 1988: 342) that are shared by a number of sites in the southern Levant dated to *c.* 38,000-30,000 BP (MARKS 1983: 37, MARKS and FERRING 1988: Table 3, HAAS 1977: 261-264, BAR-YOSEF 1984: Table 6, PHILLIPS 1987: 111). Tor Aeid is most analogous in technology and typology to Tor Hamar (J431) and Jebel Humeima (J412) in southern Jordan, Abu Noshra I and II from southern Sinai (PHILLIPS 1988) and Boker A and BE in the Central Negev Highlands (JONES *et al.* 1983).

Further evidence for an Early Ahmarian presence at Tor Aeid is found in the metric dimensions of retouched bladelets. The results of Coinman's (1990) analysis of lithic assemblages throughout the southern Levant reveals that dimensional data from retouched bladelets are better able to distinguish Early and Late Ahmarian groups than any other tool or debitage category (COINMAN 1990: 172).

Retouched bladelets from Early Ahmarian groups exhibit wider and thicker dimensions than those from Late Ahmarian groups, which mostly consist of finely retouched Ouchtata bladelets, the diagnostic tool of the Late Ahmarian (FERRING 1988).

Complete retouched bladelets are rare in most lithic assemblages, requiring a heavy emphasis on width and thickness dimensions. Dimensional data for retouched bladelets are presented in Table 7

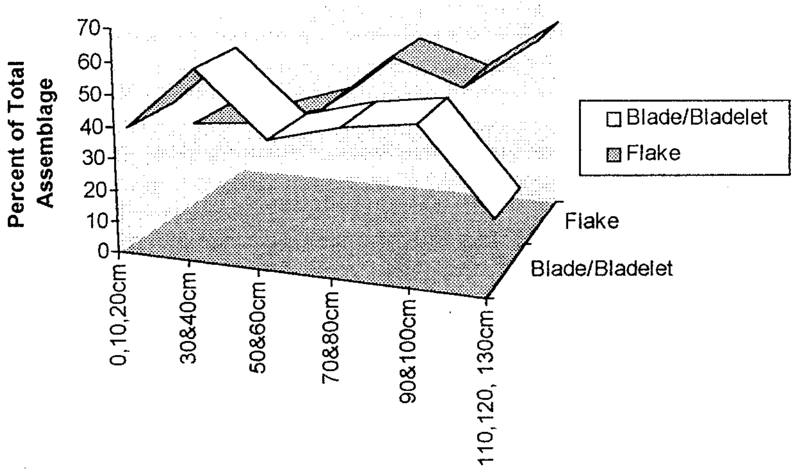

Fig. 6. Proportional occurrences of blank forms for retouched tools from Tor Aeid (J432).

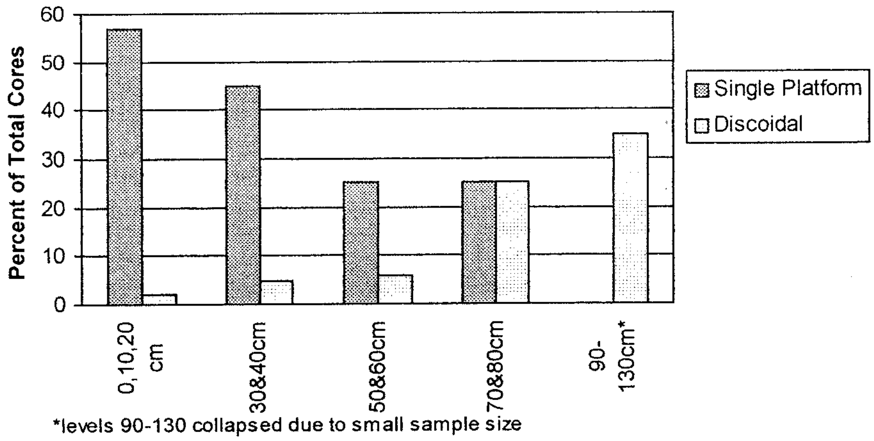

Fig. 7. Percentages of single platform and discoidal cores from Tor Aeid (J432).

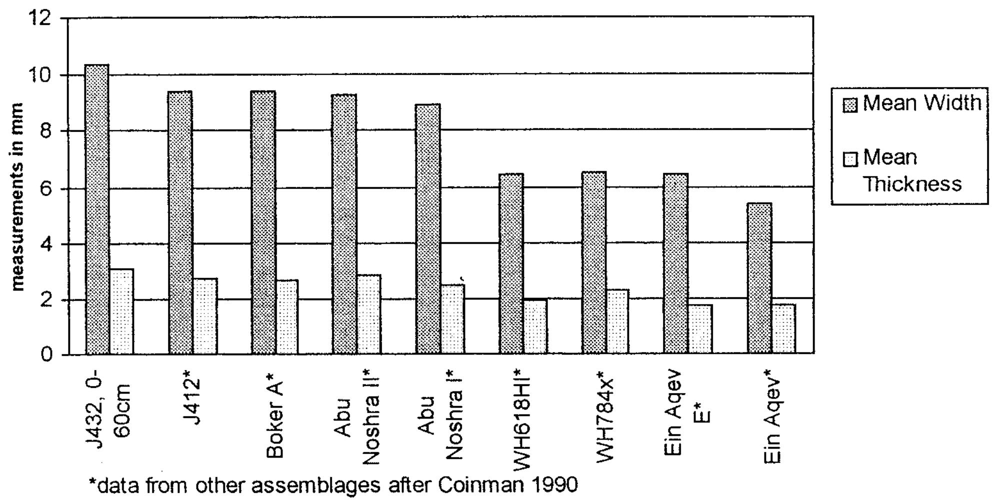

Fig. 8. Assemblage means for retouched bladelets from Tor Aeid (J432).

Table 5. Platform faceting on debitage blanks from Tor Aeid (J432).

	0,10,20cm		30&40cm		50&60cm		70&80cm		90&100cm		110,120,130cm		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Blades	20		20		20		20		20		20		**120**	
Single		70%		80%		75%		55%		30%		35%		**58%**
Multiple		15%		5%		20%		35%		40%		40%		**26%**
Crushed		10%		10%		5%		0%		25%		15%		**11%**
Cortex		5%		5%		0%		10%		5%		10%		**5%**
Flakes	20		20		20		20		20		20		**120**	
Single		75%		65%		55%		35%		30%		30%		**48%**
Multiple		5%		15%		25%		40%		55%		55%		**33%**
Crushed		20%		15%		15%		20%		10%		15%		**16%**
Cortex		0%		5%		5%		5%		5%		0%		**3%**

	0,10,20cm		30&40cm		50&60cm		70-130cm*		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Primary Elements	20		20		20		13		**73**	
Single		75%		65%		50%		23%		**56%**
Multiple		5%		10%		10%		15%		**10%**
Crushed		10%		15%		15%		23%		**15%**
Cortex		10%		10%		25%		39%		**19%**

*Levels from 70-130 cm collapsed due to small sample size

Table 6. Technological and typological percentages of defined upper Palaeolithic complexes in comparison with Tor Aeid (J432).

	Levantine Aurignacian*	Ahmarian*	J432 0-60cm	J432 70-130cm	**J432 Site Total**
Technology					
Blade/Bladelets	<*ca* .50%	>*ca* .30-40%	49%	29%	**48%**
Flakes	>*ca*. 50%		36%	61%	**38%**
Typology					
Endscrapers &Burins	>ca.50%	<*ca* .40%	24%	14%	**23%**
Bladelet Tools	<*ca* .20%		29%	18%	**27%**
Retouched & Backed Blade/Bladelets & Points		>*ca* .30-40%	45%	38%	**46%**

*based on definitions by Gilead, 1981

Table 7. Metric attributes of retouched bladelets from Tor Aeid (J432).

Early Ahmarian	*n*	x̄ Width	x̄ Thickness
J432, 0-60cm	70	10.39	3.09
Abu Noshra I*	19	8.93	2.45
Abu Noshra II*	68	9.27	2.82
Boker A*	92	9.38	2.68
J412*	23	9.8	3.92
Late Ahmarian			
WH784x*	46	6.51	2.31
WH618HI*	98	6.43	1.91
Ein Aqev East*	255	6.45	1.73
Ein Aqev*	60	5.35	1.72

*data from other assemblages after Coinman 1990

and Fig. 8 for Early and Late Ahmarian sites from the southern Levant. Retouched bladelets from Tor Aeid and other Early Ahmarian groups (Boker A, Abu Noshra I and II, and J412) have wider and thicker dimensions than Late Ahmarian groups (Ein Aqev East in the Negev and the Wadi Hasa assemblages at WH618HI and WH784x) (MARKS 1976, COINMAN 1993).

Taking into consideration what appears to be an unbroken lithic sequence from Middle Paleolithic to Upper Paleolithic, in conjunction with the dimensional data of retouched bladelets, lends support to Tor Aeid's classification as Early Ahmarian.

Jebel Qalkha Settlement Patterns

Given its relatively low elevation (*c.* 920m a.s.l.) and its location on a south-facing rockshelter, which provides exposure to sunlight and protection from the prevailing winter winds from the northwest, Tor Aeid would have been an ideal winter camp. This specific setting also provides for convenient movement along the three major phytogeographic zones: Mediterranean, Irano-Turanian, and Saharo-Arabian, maximizing the potential for exploitation of these zones in all directions (HENRY 1988). Tor Aeid was most probably a site frequented during the winter by small groups seasonally exploiting the western end of the Wadi Hisma in southern Jordan.

Summary

Technotypologically, the artifacts from Tor Aeid are divided into Middle and Upper Paleolithic assemblages. Due to the small sample size for the Middle Paleolithic artifacts, however, the validity of broad comparisons within the vertical distribution is hindered. The Upper Paleolithic assemblage is characterized by a single reduction strategy, focused on the production of slender, elongated interior blade/bladelets from predominantly single platform cores that were used for el-Wad points and retouched blade/bladelet blanks. It is comparable to other assemblages throughout the southern Levant presently grouped under the heading "Early Ahmarian". The site appears to represent a Middle Paleolithic and early Upper Paleolithic temporary winter camp frequented by a small group of inhabitants exploiting the diverse environments of southern Jordan.

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Appendix 1. Inventory of Lithic Assemblage from Tor Aeid (J432)

	0,10,20cm		30&40cm		50&60cm		70&80cm		90&100cm		110,120,130cm		Site Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Tools														
Side Scrapers	5	4%	12	7%	6	6%	1	3%	1	6%	1	4%	**26**	**6%**
End Scrapers	23	19%	20	11%	13	14%	3	10%	1	6%	3	12%	**63**	**14%**
Burins	19	16%	14	8%	6	6%	1	3%	1	6%	2	8%	**43**	**9%**
Perforators	5	4%		0%	1	1%		0%		0%		0%	**6**	**1%**
Backed Piece		0%	3	2%	1	1%	3	10%		0%		0%	**7**	**2%**
Truncations	2	2%	8	4%	1	1%		0%		0%		0%	**11**	**2%**
Denticulates	4	3%		0%		0%	2	6%		0%		0%	**6**	**1%**
Notches	10	8%	19	10%	10	11%	2	6%	3	19%		0%	**44**	**9%**
Retouched Bladelets	14	12%	46	25%	10	11%	7	23%	1	6%	2	8%	**80**	**17%**
Retouched Blades	7	6%	23	13%	12	13%	3	10%	4	25%	2	8%	**51**	**11%**
Retouched Flakes	10	8%	16	9%	17	18%	7	23%	5	31%	12	48%	**67**	**14%**
Multiple Use Tools	6	5%	7	4%	4	4%	1	3%		0%	1	4%	**19**	**4%**
Points	11	9%	12	7%	13	14%	1	3%		0%		0%	**37**	**8%**
Varia	3	3%	1	1%		0%		0%		0%	2	8%	**6**	**1%**
Subtotal	119	100%	181	100%	94	100%	31	100%	16	100%	25	100%	**466**	**100%**
Debitage														
Cores	43	3%	47	3%	29	5%	16	6%	7	6%	16	8%	**158**	**4%**
Bladelets	742	44%	563	39%	151	24%	48	17%	6	5%	7	3%	**1517**	**35%**
Blades	119	7%	193	13%	121	19%	70	24%	22	18%	39	19%	**564**	**13%**
Flakes	570	34%	499	34%	260	41%	142	50%	83	67%	137	67%	**1691**	**38%**
CTE	50	3%	31	2%	17	3%	3	1%	1	1%		0%	**102**	**2%**
Primary Elements	150	9%	99	7%	47	7%	6	2%	5	4%	5	2%	**312**	**7%**
Burin Spalls	18	1%	28	2%	4	1%	1	0%		0%	1	0%	**52**	**1%**
Subtotal	1692	100%	1460	100%	629	100%	286	100%	124	100%	205	100%	**4396**	**100%**
Debris														
Chip	1871	91%	2064	89%	1878	84%	544	70%	267	64%	195	57%	**6819**	**83%**
Chunk	189	9%	256	11%	368	16%	236	30%	153	36%	148	43%	**1350**	**17%**
Subtotal	2060	100%	2320	100%	2246	100%	780	100%	420	100%	343	100%	**8169**	**100%**
Tools	119	3%	181	5%	94	3%	31	3%	16	3%	25	4%	**466**	**4%**
Debitage	1692	44%	1460	37%	629	21%	287	26%	124	22%	205	36%	**4397**	**34%**
Debris	2060	53%	2320	59%	2246	76%	779	71%	420	75%	343	60%	**8168**	**63%**
Total	3871	100%	3961	100%	2969	100%	1097	100%	560	100%	573	100%	**13031**	**100%**

Appendix 2. Lithic ratios from Tor Aeid (J432).

	0,10,20cm	30&40cm	50&60cm	70&80cm	90&100cm	110,120,130cm	**Site Total**
Flakes:Blades/Bladelets	1:1.5	1: 1.5	1: 1	1: 0.8	1: 0.3	1: 0.3	**1: 1.2**
Tools:Debitage	1:14.2	1: 8	1: 6.7	1: 9.3	1: 8.3	1: 8.5	**1: 9.5**
Cores:Tools	1: 2.8	1: 3.9	1: 3.2	1: 1.8	1: 2.1	1: 1.5	**1: 2.9**
Cores:Debitage	1:39.3	1:31.1	1:21.7	1:16.9	1:17.7	1:12.8	**1:27.7**
Debitage:Chips	1:1.1	1: 1.4	1: 2.9	1: 1.9	1: 2.2	1: 1	**1: 1.6**
Primary Elements:Debitage	1:11.3	1:14.7	1:13.4	1:47.8	1:24.8	1:41	**1:14.1**
Cores:Primary Elements	1:3.5	1: 2.1	1: 1.6	1: 0.4	1: 0.7	1: 0.3	**1: 2**
CTE:Cores	1:0.9	1: 1.5	1: 1.7	1: 5.7	1: 7	1: 0	**1: 1.6**

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Upper Palaeolithic Siq Umm al-Alda 1, near Wadi Musa, Southern Jordan

Daniel Schyle and Hans Georg K. Gebel [1]

Abstract: *This paper presents the geomorphological context and the description of Upper Palaeolithic material eroding from playa-like sediments near the entrance of Siq Umm al-Alda north of Wadi Musa/ Petra. The results of the technological and typological analysis of the lithic artefacts reveal characteristics close to the assemblages of Wadi Jilat 9, Qadesh Barnea 602, Boker BE Levels III-IV, and Ksar Akil Level X. Thus, an approximate date between 30,000 and 26,000 bp is suggested for the assemblage.*

Introduction

Although never systematically surveyed for its Upper Palaeolithic occupation (except for the Sabra vicinities in 1983, *cf.* SCHYLE and UERPMANN 1988), the Greater Petra Area is expected to have been frequented during this period like any other of the survey areas in the eastern tributaries of the Rift Valley (Wadi Hisma, Wadi al-Hasa; see contributions in the Palaeolithic section of this volume). This is supported by the fact that UP sites can be found by accident, as was true for Siq Umm al-Alda 1[2] and two other chance finds of possible Upper Palaeolithic date (Thugra 2 and Wadi Batha 1, unpublished[3]). This is despite the erosional activity that affected a typical sedimentary environment of UP sites, the upper layers of the playa remants in the area.

The surface collection carried out was non-systematic since the distribution of the material evidently was the result of erosion and did not reflect any reliable spatial pattern. Only 279 artifacts were collected during two visits that invested altogether 4.5 hours of search in an area of approx. 2000 m^2. No sieve was used, but attention was directed to possible microliths. The second visit in 1989 also was aimed to enlarge the amout of retouched material. However, we expect that the surface collection encountered most of the artifacts that were exposed at that time.

The artifacts mostly derive from the surfaces of the sediment flow below the steep parts of the lowermost playa remnant of the site (Pl. 1.B: "1"); less was found in other areas, such as the flatter area between the lower and upper playa remnants, on the sediment flow from the upper playa remnant (Pl. 1.B: "2"), and especially on the slope below the lower playa remnant, which belongs to the right (northern) bank of upper Wadi Siq Umm al-Alda.

The low density of artifacts, their isolated and non-embedded appearance on the top of the playa flow, and their good preservation uninfluenced by erosional transport damage characterize the find circumstances.

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1 The analysis of the industry was carried out and is presented by D. Schyle, the remaining parts were contributed by H.G.K. Gebel, and the conclusions were written jointly. We thank Gary Rollefson for editing the English of this contribution.

2 The site was in encountered in autumn 1989 by one of the authors (H.G. Gebel); subsequent surface collection was carried out twice in 1989 with the help of Bo Dahl Hermansen in the framework of the project "Palaeoenvironmental Investigations in the Greater Petra Area, Holocene Research". Our sincere thanks for the generous approval and support of this work go to H.E. Dr. Ghazi Bishi, then director of the Department of Antiquities, and to Suleiman Farajat, representative of the Departments' Petra-Section (H.G.G.). In September 1990 the site was revisited for photographic documentation during an excursion with Bo Dahl Hermansen, Burton MacDonald, Charlott Hoffmann Pedersen, and Gary O. Rollefson.

3 found by H.G. Gebel in 1984 and 1989 respectively.

Present-day Environmental Setting

The Upper Palaeolithic site of Siq Umm al-Alda 1 (30°25'40"N / 35°26'56"E; 995-1000m a.s.l.) is situated some 11km north of Petra, just east of the spot were Wadi Siq Umm al-Alda starts its course to the west from the northernmost parts of the Jabu plain (Fig. 1, Pl. 1:A). In 1989, the new road from Wadi Musa entered here at Wadi Siq Umm al-Alda to continue via Shaqqarat Musai'id into the Wadi Araba. The Jabu plain is a vast intermontane basin surrounded by *siq*-dissected sandstone formations in its northern parts; here the landscape is characterized by an isolated cone-shaped mountain ("*Kegelberg*") at the plain's ea-stern edge.

The sandstone area in this part of the Petra region is of modest relief (950-1100/1200m) and receives today some 200-300mm of rainfall (dry-wet years). Current land-use is mostly devoted to grazing and small to large agricultural fields. The Jabu Plain especially allows for large-scale rain-fed agriculture in the event of sufficient winter rainfall. Due to the favourable hydrology (moisture storage capacity of the sandstone and rain capture by the eastern steep limestone slopes in the east, from which numerous springs emerge), the area provides a wide range of ecological niches (swampy habitats in gorges with hydrophytic vegetation; dry desert conditions on the playas with xerophytic vegetation; shady *siqs* with more temperate climate, intermittent wadis, water-storing clefts with fine sediments; etc.). Remains of Mediterranean open forests are to be found here, especially in the *siqs* (wooded by *Pistacia atlantica, Quercus calliprinus*, and *Juniperus phoenicea* coming down from the eastern limestone slopes). Steppic elements of the Irano-Turanian floral zone (*Artemisia sieberi*) penetrate into the area from the Arabian Plaetau, and at some spots near playa surfaces one finds elements of the typical hot desert vegetation of the Saharo-Arabian floral zone (GEBEL 1988).

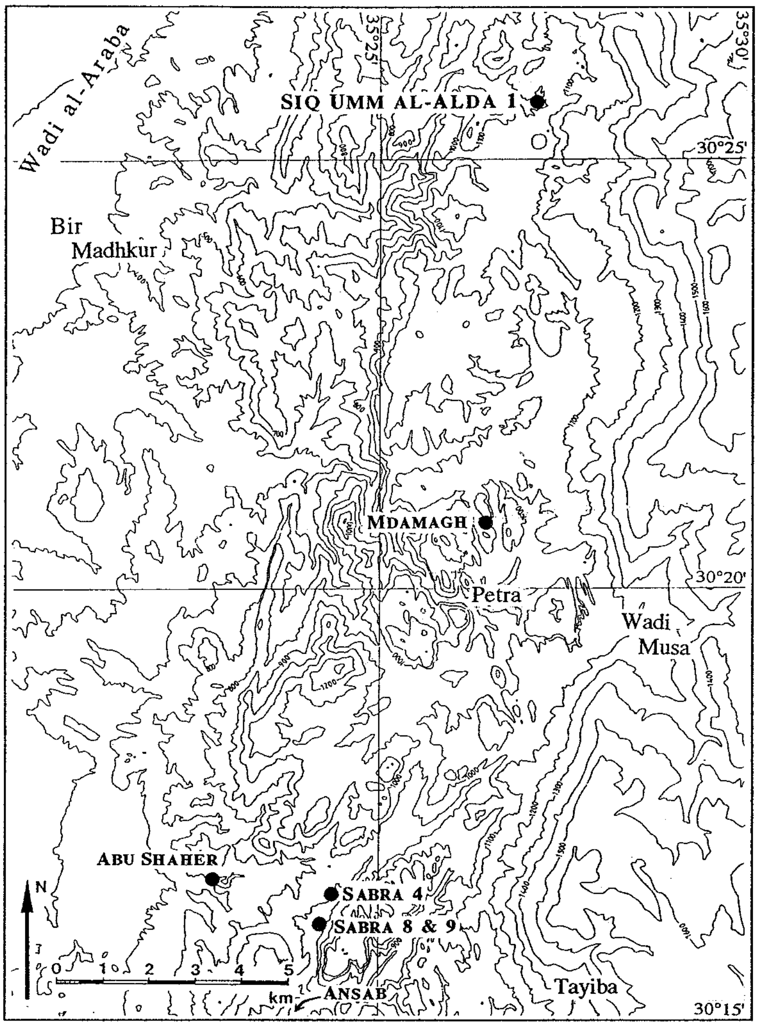

Fig.1 Petra- Area: Upper Palaeolithic sites.

Geology, Geomorphological Setting and Site Preservation

Geologically the site is situated within the Cambrian "Massive, Brownish Weathered Sandstone" (cb of BENDER 1974), followed to the east by overlying "Massive, Whitish Weathered Sandstones" (o1, Early Ordovician Arenigian ?), the "Varicoloured Sandstones" (c1, Early Cretaceous), and the "Nodular Limestone Member" (c2, Early Cenomanian). Flint is brought to the area by the drainage systems emerging from the limestone formations above c2 (Upper Cretaceous and Lower Tertiary), although it cannot be certain that the raw materials used in Siq Umm al-Alda 1 stem from these wadi sources. Other possible source areas might be the ill-investigated tt+c5-2 and c5-2 formations some 5-9km to the west, which lie between the igneous rocks starting 1.5km west of Siq Umm al-Alda 1 and the alluvial fans at the Wadi Araba.

The drainage system passing the northern Jabu Plain emerges from the steep-sided limestone formations of the Arabian Plateau in the east, traverses the sandstone formations around the site, and enters the above mentioned igneous rocks area in the west. During the Upper Palaeolithic, the "Mas

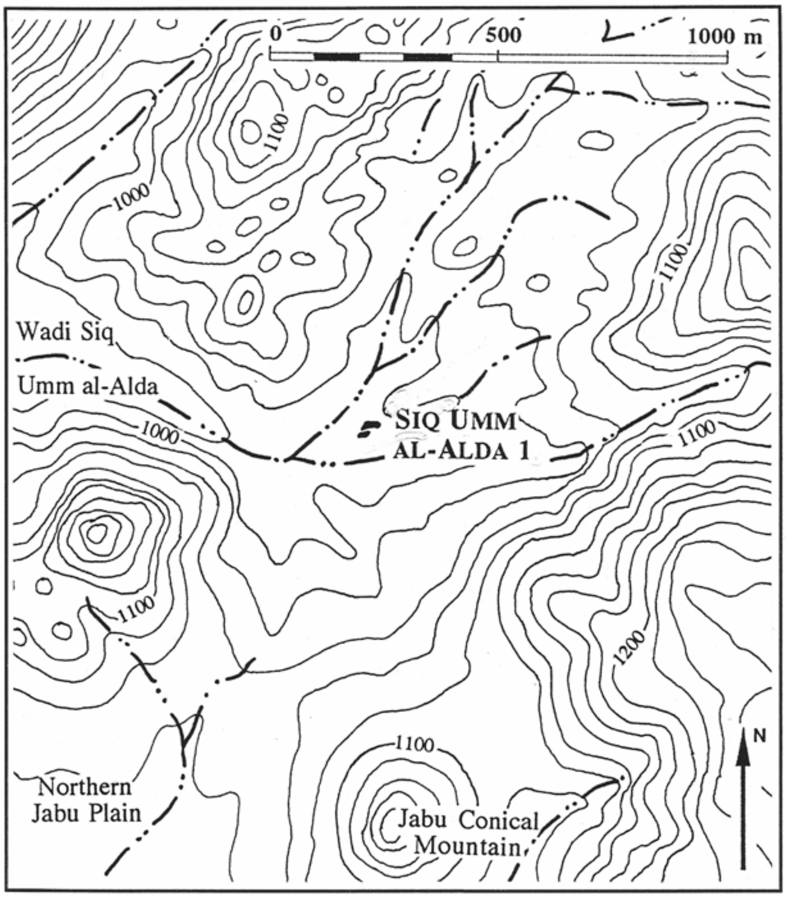

Plate 1:A. Siq Umm al-Alda 1. Topographical setting of the site in the upper drainage system of Wadi Siq Umm al-Alda.

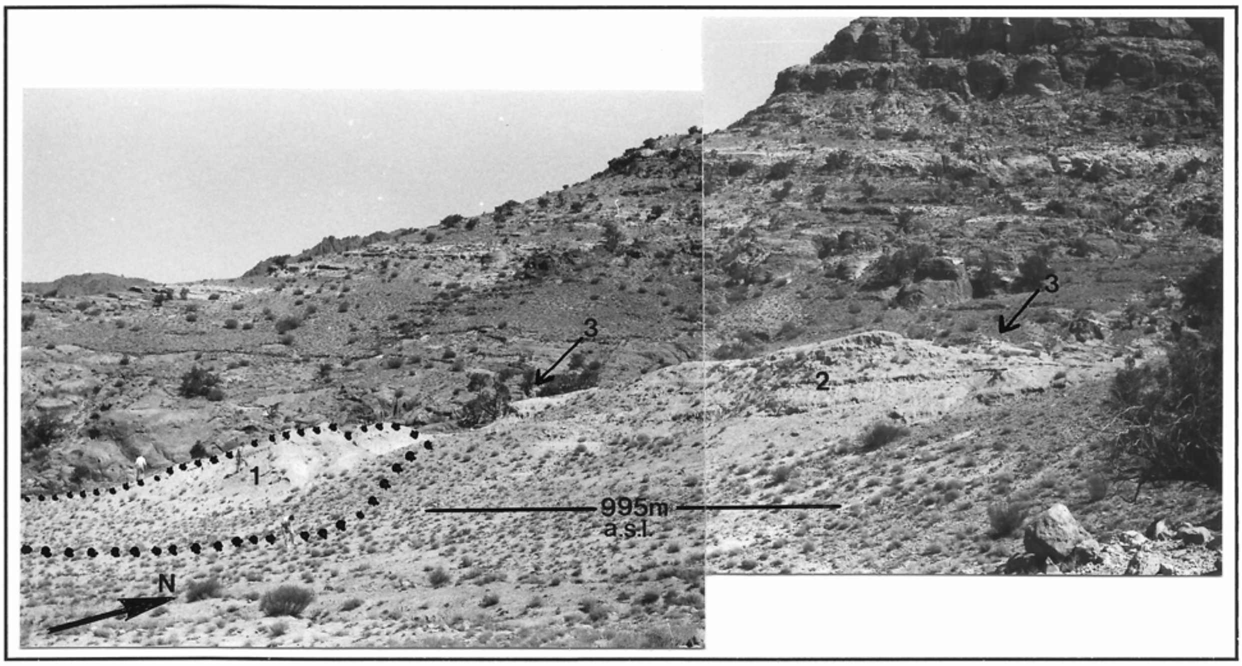

Plate 1:B. Siq Umm al-Alda 1: view from ESE. 1 surface distribution of Upper Palaeolithic finds eroding from the layers of the lower *playa* remnant, 2 upper *playa* remnant, 3 course of the minor tributary to Wadi Siq Umm al-Alda W of the site.

Table 1. Siq Umm al-Alda 1: distribution of artifact classes.

	n	%
blades (sensu stricto)	92	33.0
bladelets	38	13.6
flakes	45	16.1
PE	28	10.0
CTE	15	5.4
cores	11	3.9
chunks	17	6.1
chips (< 2cm)	33	11.8
	279	100.0
tools (included above)	24	

One burin spall exhibits the parameters of blades, and four of those bladelets are included above.

PE: primary elements, for definition see MARKS (ed.) 1976

CTE: core trimming elements, for definition see MARKS (ed.) 1976

Table 2. Siq Umm al-Alda 1: preservation of blanks.

	blades (s.l.)		flakes	
	n	%	n	%
Completely preserved	48	36.9	31	68.9
Prox. end pres.	20	15.4	4	8.9
Medial part pres.	21	16.2	1	2.2
Dist. end pres.	19	14.6	8	17.8
P.e. + m.p. pres.	10	7.7	0	.0
D.e. + m.p. pres.	12	9.2	1	2.2
Total	130	100.0	45	100.0

Table 3. Siq Umm al-Alda 1: amount of cortex on blades (top) and flakes (bottom).

Type of blank	without cortex	up to 1/3	up to 2/3	more than 2/3	com-plete	total
Blades (s.s.)	73 49.32%	19 12.84%	2 1.35%	3 2.03%		97 65.54%
Bladelets	34 22.97%		1 .67%	2 1.35%		37 25.00%
Burin spalls	4 2.70%		1 .67%			5 1.00%
Core tr. blades	8 5.40%		1 .67%			9 6.08%
Total blades	119 80.41%	19 12.83%	5 3.38%	5 3.38%		148 100.00%

PE's: 10 (6.76%)

Type of blank	without cortex	up to 1/3	up to 2/3	more than 2/3	com-plete	total
Flakes	32 46.38%	13 18.84%	5 7.25%	8 11.59%	5 7.25%	63 91.30%
Core tablets	2 2.90%					2 2.90%
Core tr. flakes	3 4.34%	1 1.45%				4 5.80%
Total flakes	37 53.62%	14 20.29%	5 7.25%	8 11.59%	5 7.25%	69 100.00%

PE's: 18 (26.09%)

sive, Brownish Weathered Sandstone" relief of the Jabu basin was already a playa. This filling process possibly was in its latest stages when the artifacts entered the strata. We expect that the major part of of the intermontane Jabu basin stratigraphy (today's surface *c.* 2.5-3 km^2) consists of playa sediments, which were relieved in the northern Jabu Plain by the opening of Siq Umm al-Alda in possibly the Late Pleistocene/ Early Holocene. Whether this was caused by tectonics, flooding or a combination of both factors is not very relevant for the preservation of the site. The effects on the artifact-bearing upper playa strata were the same: an unkown portion of the site's strata must have been washed out through the Siq Umm al-Alda, since their location was just at the spot where the Wadi Siq Umm al-Alda starts to drain this part of the northernmost Jabu Plain and basin respectively. What today is preserved of the fills in this immediate vicinity are the two small remnants of the playa from which artifacts continue to erode, mainly from the upper meter of the lowermost playa remnant (Pl. 1.B: 1); in these layers the artifacts can with difficulty be detected "*in situ*". These playa strata possibly are not the original context of the artifacts; they are expected to have been moved by erosion and deflation before being embedded, but they would not have been transported from far. No traces of *in situ* installations, ash, or artifacts other than flint were found. If the site ever existed as an open-air camp with primary contexts, organic materials would have disappeared anyhow. Since the artifacts show almost no traces of transport battering, they probably did not travel far, although the fine sedimentary milieu of the playas helped preservation.

Sample Size and Bias of the Chipped Industry

Although the assemblage was non-systematically collected and the number of artifacts is rather small, there is no obvious indication of a bias toward most artifact classes. Chips (or smaller pieces in general) certainly are underrepresented compared to excavated assemblages and cores probably are somewhat overrepresented. The percentages of the other artifact classes (Table 1) seem to fall within the usual range of other Levantine Upper Palaeolithic sites. Nevertheless, the collection may not be representative of the site's assemblage as a whole.

From the decline in artifact frequencies at the 30mm maximum size class in the histogram of Fig. 2, it is evident that the pieces smaller than *c.* 25-30mm were either not recovered adequately or they were swept away by natural agencies prior to the collection. In excavated assemblages, this decline in artifact frequencies (otherwise continously increasing with decreasing size) usually occurs at the size of the smallest sieve-mesh used or at the metrical limit of flakes/blades and chips (KIND 1987: 110-111).

Most pieces (about 85%) have slightly damaged edges. It is impossible to tell whether this results from use, on-site natural agencies or transport. In some cases it was even difficult to decide whether the edge was damaged or modified by intentional retouch. Thus, only very regular edge-retouch was accepted as intentional modification (see below).

Raw Materials

Most of the artifacts are made of chert; chalcedony was used for less than 10% of the artifacts. There are two varieties of chert, one brown to tan in color, opaque, grading from fine grained to extremely coarse texture and displaying fresh cortex. (The coarse grained pieces are probably the result of patination). The other variety is of grayish to tan color, being fine grained, slightly translucent to opaque and displaying rolled cortex or pebble surfaces. Due to varying degrees of patination and overlapping colors, it was not possible to make a distinction with every piece, but, subjectively, both chert varieties seem to be represented in approximately equal amounts. The restricted range of raw materials is almost identical to that found at other Upper-, Epipalaeolithic and Neolithic sites in the vicinity of Petra (SCHYLE and UERPMANN 1988, GEBEL 1988) and, although not verified, the raw material is most probably of local origin.

Technology

Debitage Classes

According to the widely used artifact classification system as defined by Marks (MARKS 1976), blades *sensu lato* outnumber flakes by far more than 2:1. It is difficult to interpret this predominance of blades, because it seems to be dependent at least partially on the number of fragments, which as usually are included in the counts. As demonstrated by Table 2, the blades *sensu lato* of Siq Umm al-Alda 1 tend to be almost twice as frequently broken as flakes, thus the number of blades is somewhat inflated. Among the completely and almost completely preserved blanks, blades amount to only 68%. This partial dependance of the flake/blade ratio on the state of preservation of a site is important for a comparison to other sites and will be adressed later.

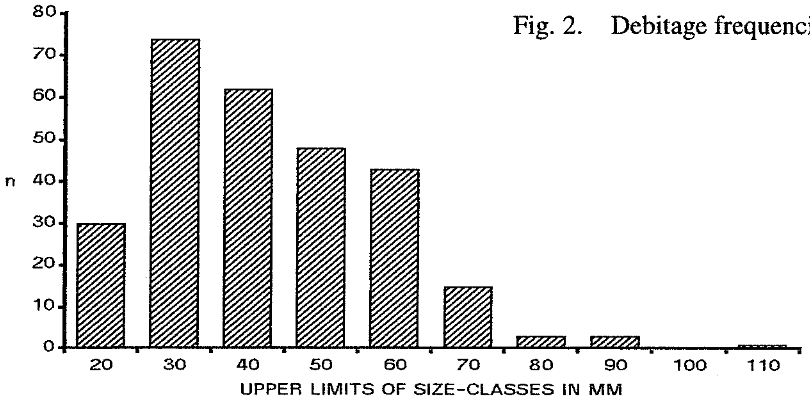

Fig. 2. Debitage frequencies (n) by size-classes in mm.

Fig. 3. Relative blank frequencies by platform size classes in mm.

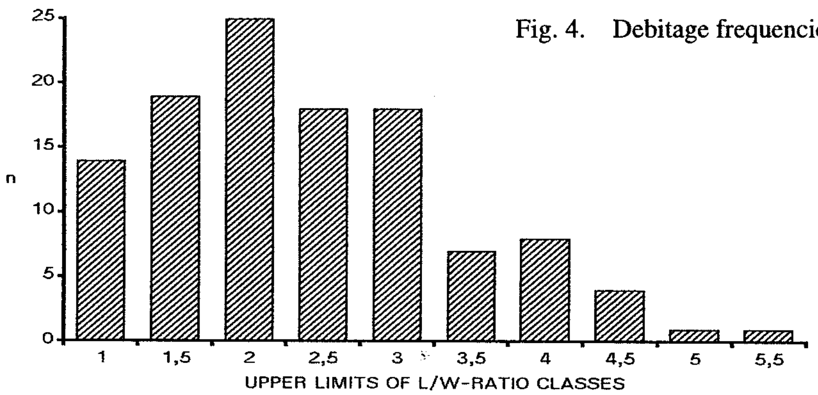

Fig. 4. Debitage frequencies (n) by length/width ratio classes.

Fig. 5. Length/width scattergram of complete blanks.

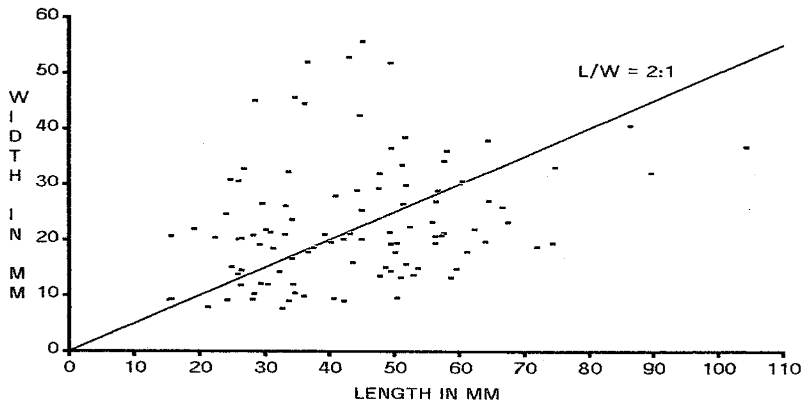

Table 4: Siq Umm al-Alda 1: platform preparation and platform shape of blades *sensu lato* and flakes.

4a: Platform preparation

	Blades n	Blades %	Flakes n	Flakes %
Plain	59	79.7	25	78.1
Facetted	14	18.9	5	15.6
Cortex	1	1.4	2	6.3
Total	74	100.0	32	100.0

4b: Platform shape

	Blades n	Blades %	Flakes n	Flakes %
Lentiform	40	51.3	18	51.4
Punctiform	6	7.7	2	5.7
Linear	15	19.2	2	5.7
Triangular	5	6.4	5	14.3
Rectangular	1	1.3	1	2.9
Irregular	7	9.0	4	11.4
Crushed	4	5.1	3	8.6
Total	78	100.0	35	100.0

Table 5. Siq Umm al-Alda 1: platform edge regularization.

	Blades n	Blades %	Flakes n	Flakes %
No regularization	18	23.4	23	65.7
Pointed negatives	10	13.0	0	.0
Hinged negatives	8	10.4	1	2.9
Abrasion	5	6.5	3	8.6
P.n. + a.	20	26.0	3	8.6
H.n. + a.	7	9.1	3	8.6
P.n. + h.n.	4	5.2	1	2.9
P.n. + h.n. + a.	5	6.5	1	2.9
Total	77	100.0	35	100.0

Table 6. Siq Umm al-Alda 1: distal blank shape and blank profiles of blades *sensu lato* and flakes.

6a: Distal blank shape

	Blades n	Blades %	Flakes n	Flakes %
Pointed	37	46.8	9	22.5
Obtuse	22	27.8	21	52.5
Hinged	5	6.3	5	12.5
Stepped	2	2.5	3	7.5
Overpassed	13	16.5	2	5.0
Total	79	100.0	40	100.0

6b: Blank profile

	Blades n	Blades %	Flakes n	Flakes %
Straight	45	36.3	22	59.5
Incurvate, medial	36	29.0	13	35.1
Incurvate, distal	2	1.6	0	.0
Twisted	41	33.0	2	5.4
Total	124	100.0	37	100.0

Table 7. Siq Umm al-Alda 1: mean length, width (in mm) and L/W-ratio of complete blades, bladelets and flakes.

	Length (n=79)	Width (n=168)	L/W-ratio (n=79)
Mean	44.02	19.02	2.36
Std Dev	17.25	8.46	1.00
Range	88.70	45.85	4.04
Minimum	15.75	5.85	.76
Maximum	104.45	51.70	4.80

Table 8. Siq Umm al-Alda 1: mean length, width (in mm) and L/W-ratio of blades (*sensu lato*).

	Length (n=48)	Width n=126)	L/W-ratio (n=48)
Mean	49.27	16.20	2.99
Std Dev	17.76	6.34	.75
Range	83.15	34.55	2.75
Minimum	21.30	5.85	2.05
Maximum	104.45	40.40	4.80

Table 9. Siq Umm al-Alda 1: mean length (in mm) of complete blades, bladelets and flakes.

	Blades (n=35)	Bladelets (n=13)	Flakes (n=31)
Mean	55.96	31.27	35.88
Std Dev	15.92	6.02	12.93
Range	72.10	20.95	48.65
Minimum	32.35	21.30	15.75
Maximum	104.45	42.25	64.40

Table 10. Siq Umm al-Alda 1: mean width (in mm) of blades, bladelets and flakes.

	Blades (n=88)	Bladelets (n=38)	Flakes (n=42)
Mean	18.87	10.02	27.47
Std Dev	5.72	1.59	8.45
Range	28.25	6.10	38.00
Minimum	12.15	5.85	13.70
Maximum	40.40	11.95	51.70

Table 11. Siq Umm al-Alda 1: mean L/W-ratio of complete blades, bladelets and flakes.

	Blades (n=35)	Bladelets (n=13)	Flakes (n=31)
Mean	2.89	3.26	1.39
Std Dev	.71	.83	.35
Range	2.44	2.53	1.22
Minimum	2.05	2.27	.76
Maximum	4.48	4.80	1.99

Table 12. Siq Umm al-Alda 1: tool typology.

	Blade	Flake	Total	
Simple endscrapers	5		5	Figs. 9.5-9
Retouched steep endscraper	1		1	Fig. 9.10
Simple steep endscraper	1		1	Fig. 9.1
Carinated endscraper		1	1	Fig. 9.2
Steep endscraper on CTE		1	1	Fig. 9.3
Nosed endscraper		1	1	Fig. 9.4
Total endscrapers	**6**	**4**	**10**	**(41.67%)**
Dihedral burins		4	4	Figs. 10.7-8 11.4-5
Truncation burin on CTE		1	1	Fig. 10.9
Total burins		**5**	**5**	**(20.83%)**
Backed blade (point?) with impact fracture/burin blow	1		1	Fig. 10.5
Broken bilaterally retouched blades	3		3	Figs. 10.1-3
Bladelet with retouched tip	1		1	Fig. 10.4
Total retouched blades	**5**		**5**	**(20.83%)**
Carinated endscraper transformed to truncation burin	1		1	Fig. 10.6
Core scraper/burin		1	1	Fig. 11.3
Sidescraper		1	1	Fig. 11.2
Splintered piece		1	1	Fig. 11.1
Total various tools	**1**	**3**	**4**	**(16.67%)**
Total tools	**12**	**12**	**24**	

Blades and flakes differ not only in the state of preservation, but also in other respects. The amount of cortex preserved is higher among flakes than among blades (see Table 3). This is to be expected, because more flakes than blades are produced during the initial stages of core preparation. The inflated number of blades caused by the different state of preservation may have influence as well.

Platform preparation and shape do not vary according to blank type (Table 4); most blanks have plain and more or less lentiform platforms. Blades tend to have smaller platform sizes[1] than flakes (Fig. 3). This is in good accordance with the difference in platform regularization (Table 5): most of the blades have regularized platform edges, most of the flakes have not. Thus, blades seem to have been produced predominantly by direct soft hammer percussion, flakes by direct hard hammer percussion (at least according to the interpretation of technological attributes suggested by WEINER 1988). This does not mean that two different reduction strategies were employed; a look at experimental flintknappers at work shows that the initial stages of core reduction and rejuvenation (during which most of the flakes are produced) are primarily done by hard hammer percussion, whereas the final detachment of blades may be done by direct soft hammer percussion or other methods.

The distal ends of blades (Table 6) are predominantly pointed, whereas flakes are more often obtuse ended. Blades also have rather frequently overpassed ends. The blank profiles of blades are almost equally distributed: about one third of the blades each display straight, curved or twisted profiles. Flakes tend to have predominantly straight or curved profiles; twisted flakes are rare.

A summary of blank dimensions may be found in the Tables 7-11, the histogram of L/W ratios in Fig. 4 and the L/W scattergram of complete blanks in Fig. 5. The latter clearly indicates a homogenous distribution; thus the separation of flakes, blades and bladelets on the basis of their dimensions or L/W ratios is purely arbitrary.

Cores

There are 11 cores, of which two may equally be classified as tools: Fig. 8:1 as a nucleiform burin and Fig. 7:1 as nucleiform or core- scraper. Among the remaining 9 specimens, there are two irregular flake cores (not illustrated); two single platform bladelet cores (Fig. 6:1-2); two opposed platform cores with one flaking surface, one for blades (Fig. 7:2) and one for bladelets (Fig. 6:3); one opposed platform bladelet core with two flaking surfaces (Fig. 6:4) and two 90° bladelet cores (Figs. 7:3,8:2).

The small size of the cores is apparently in contradiction to the generally non-microlithic size of the complete blanks, but this may reflect either the loss of smaller blanks in a surface collection or simply a high degree of core reduction (*i.e.*, an economic use of the available raw material, or, most probably, both.

Typology

The 24 tools (Table 12) were made equally on flakes and blades. The simple endscrapers are rather insignificant, but the steep, carinated and nosed types (Figs. 9:1-4,9:10) are worth noting. The endscrapers are generally well made, whereas the burins are of inferior quality and in most cases (Figs. 10:8-9,11:4-5) rather dubious. Difficult to evaluate are the few fragments of retouched and backed blades; the only backed fragment (Fig. 10:5) represents almost certainly the lower part of a backed point which was broken during use as evidenced by the impact fracture at the distal end (for comparison see BERGMAN and NEWCOMER 1983). Two other pieces (Figs. 10:1-2) may be basal point fragments as well, although they display normal transversal breaks. The retouch at the tip of the twisted bladelet (Fig. 10:4) and on the remaining retouched blade fragment (Fig. 10:3) is at least regular enough to assume intentional modification. Most interesting among the various tools in the collection is a double steep or carinated endscraper on a blade, where the scraper-retouch at both ends was subsequently used as platform for a burin blow (Fig. 10:6). The remaining pieces are composed of a combined core/sidescraper/burin (Fig. 11:3), a pointed sidescraper (Fig. 11:2) and a splintered piece (Fig. 11:1).

Siq Umm al-Alda-1 and the Levantine Upper Palaeolithic

Although the tool sample is too small to be representative of the assemblage as a whole, a comparison with other UP assemblages in Jordan and the Levant may be useful to get at least an approximate date for the assemblage. In a survey of Near Eastern Upper Palaeolithic sites (SCHYLE 1990, 1992) I recorded 26 sites in Jordan, to which should be added two other recently published sites (COINMAN and HENRY 1995) that are considered to be of Upper Palaeolithic date. However, half of

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1 Platform size was computed as the square root of platform length x platform width.

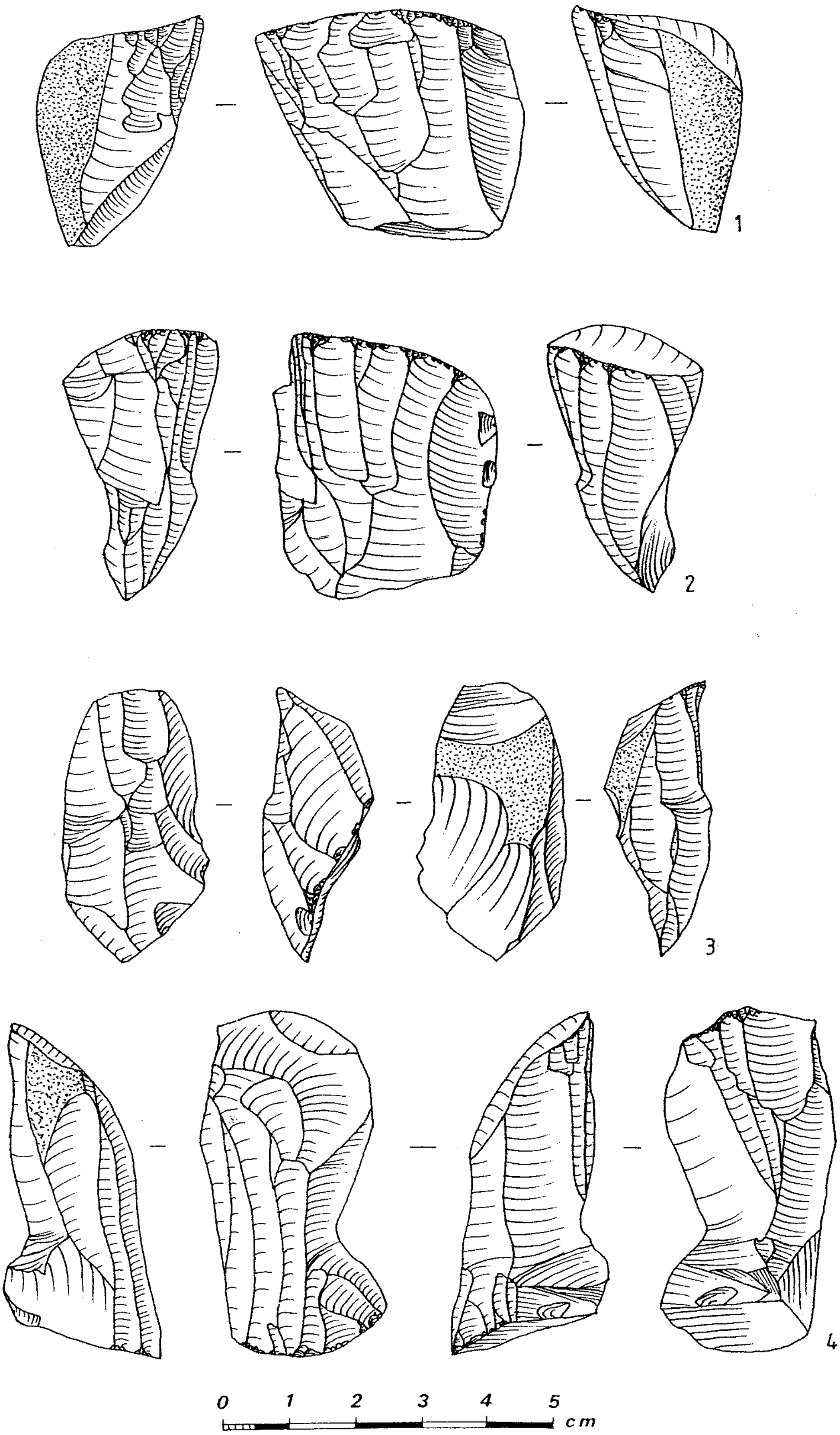

Fig. 6. Bladelet cores.

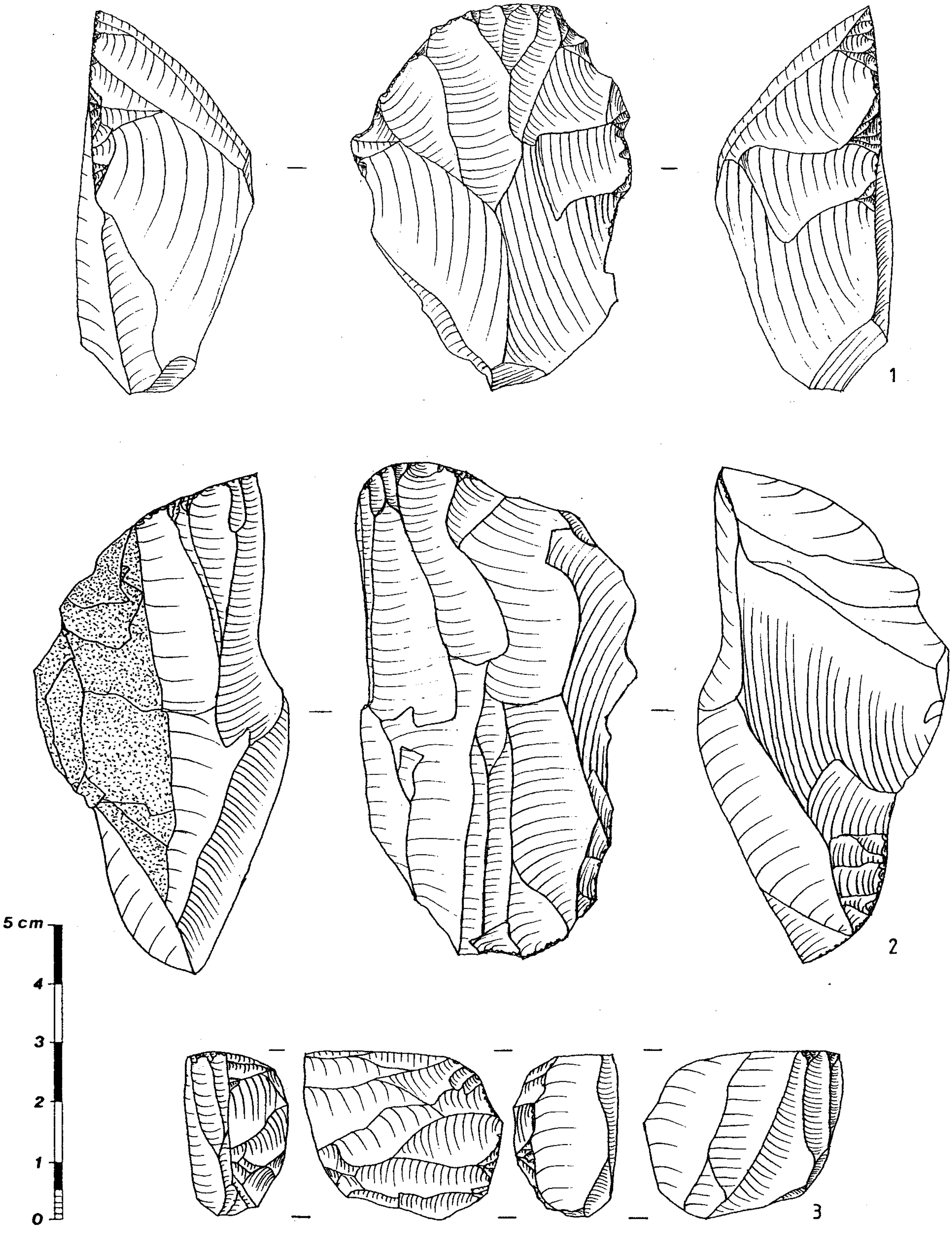

Fig. 7. 1 "core scraper", 2 blade core, 3 bladelet core.

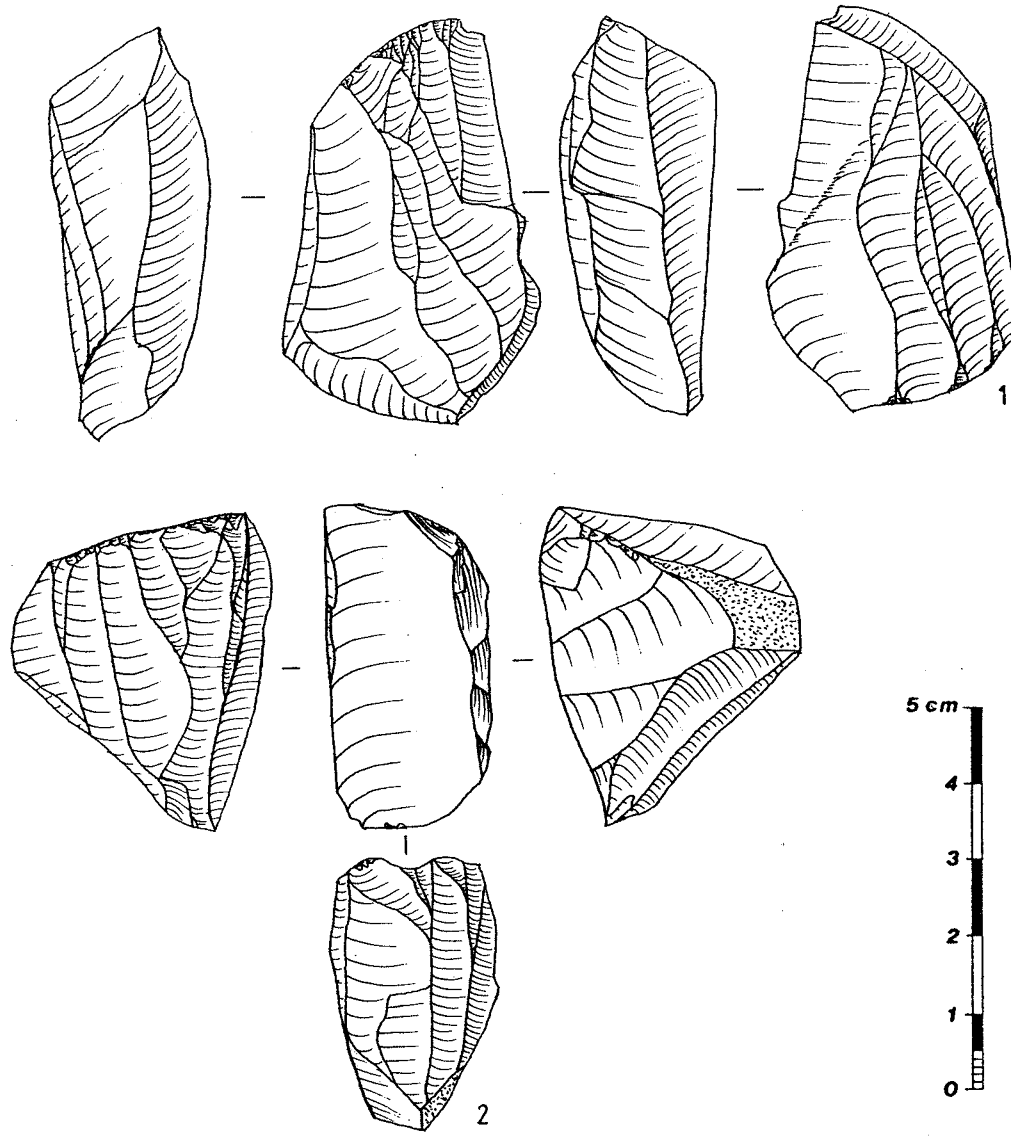

Fig. 8. 1 "nucleiform" burin, 2 bladelet core.

them are merely survey observations[1] with only few and often not securely identifiable or mixed artifacts. More substantial research (systematic surface collections or excavations) has been done at 14 sites so far[2]. Information on the lithic technology and typology at 13 of these sites is currently available (see Table 13).

All these assemblages have been excavated recently. In most of them blades outnumber flakes; one extreme value (Mdamagh) results most probably from the use of a different artifact classification system[3], the other one (Kharaneh 4, Phase A) may be similarly explained, but it is at present not understood. Even the smaller differences between the remaining assemblages are likely to be artificial, because fragments seem to have been included in the debitage counts from the Wadi el-Hasa

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1 Abu Shaher, Ansab, Sabra 4, 8 and 9 (SCHYLE and UERPMANN 1988); sites 221 and 222 at landing ground D, site 218 at landing ground H (Garrod 1960), Ail, El Jafr School, Qa Abu Qureishi, Qa Umm Salab, Umm er Rassal (ZEUNER, KIRKBRIDE, and PARK 1957) and Ras en Naqb (HENRY 1979).

2 Azraq 17, tr. 2, Uweinid 18 lower, Wadi Jilat 9 (GARRARD, BYRD, and BETTS 1986; GARRARD *et al.* 1987), Kharaneh 4 (MUHEISEN 1983, 1988), Mdamagh (SCHYLE and UERPMANN 1988), WH 618, WH 623X, WH 784X (CLARK *et al.* 1988; OLSZEWSKI, CLARK, and FISH 1989; COINMAN 1993), J 403, J 412, J 431, J 432, J 433 and J 440 (HENRY 1986, 1988; COINMAN and HENRY 1995).

3 For the preliminary report (SCHYLE and UERPMANN 1988) I defined chips as being smaller than 1 cm; thus the number of flakes presumably includes a high number of chips.

(OLSZEWSKI, CLARK and FISH 1990; CLARK *et al.* 1988), but not from the Azraq basin (GARRARD, BYRD and BETTS 1986; BYRD 1988; BYRD and GARRARD 1990). Whether fragments are included (2.9) or not (2.0), Siq Umm al-Alda 1 is at the upper end of the blade/flake ratio range. Unfortunately, it is not possible to compare the numbers of bladelets in all cases, because blades and bladelets have not been separated (Byrd) or defined using changing criteria (Olszewski and Clark). There are sharp differences at the tool class level among the assemblages: Azraq 17, Kharaneh 4A, Wadi al-Hasa 784X, Wadi al-Hasa 618H-I and Mdamagh all display high frequencies of microliths (mainly marginally retouched bladelets), whereas Wadi al-Jilat 9 and the sites from southern Jordan including Siq Umm al-Alda 1 contain almost no microliths at all. Wadi al-Hasa 618C is singular in having only a few microliths. In Jordan, these microlithic assemblages all seem to date from a final stage of the Upper Palaeolithic beginning not much earlier than approximately 20,000 bp.[1]

Only one non-microlithic assemblage has been dated radiometrically by material directly associated with human occupation. At Wadi al-Jilat 9 a burnt bone sample gave a ^{14}C date of 21,150 ± 400 bp (OxA-519: BYRD and GARRARD 1990). A second date of 25,950 ± 440 bp (Beta-559288) is said to relate to marshy organic sediments below the thick artifact-bearing deposits at Wadi al-Hasa 618C (COINMAN 1993). However, it is not clear to what extent this assemblage combined from numerous artificial levels may be regarded as a representative sample of an occupation, since at least some levels seem to have been definitely redeposited (COINMAN 1993: 19). As far as can be said on the basis of the scarce information relating to Wadi al-Jilat 9 (GARRARD, BYRD and BETTS 1986) and the small number of finds from Siq Umm al-Alda 1, both assemblages seem to be similar in most aspects, the main difference being the amount of burins. However, this may be not very significant, because most of the burins at Siq Umm al-Alda 1 are not very typical and the tool sample as a whole is certainly too small to be entirely representative. At Wadi al-Hasa 618C, retouched pieces, truncations and microliths seem to be more numerous than at the other two sites, whereas endscrapers and burins occur in lower percentages. Given the fact, that at least parts of the assemblage have been redeposited, this may reflect a certain amount of damage caused by erosional movement prior to excavation as it is the case with numerous collected pieces at Siq Umm al-Alda 1, which have not been included among the tools even though their edges are irregularly retouched. The distinctive number of microliths at Wadi al-Hasa 618C, too low regarding Late Upper Paleolithic and too high for earlier Upper Paleolithic assemblages, may result as well from the redeposition of the sediments that caused either a loss of smaller pieces or a mixing of earlier (non-microlithic) and later materials.

Of the remaining recently excavated assemblages from southern Jordan, two (J403 and J412) are characterized technologically by the production of rather squat blades with predominantly large and plain platforms that reflect hard hammer production. The mean values of the blade/flake and L/W ratios of the blades are significantly lower than at Siq Umm al-Alda 1. Typologically, both assemblages are quite different from Siq Umm al-Alda 1 in comprising very large numbers of informal retouched blades and flakes and rather few typical Upper Paleolithic types as endscrapers and burins. El-Wad points are completely lacking in both assemblages.[2]

The two other assemblages J431 and J432 have blade/flake ratios higher than at J403 and J412 and lower than at Siq Umm al-Alda 1, and they also have the highest L/W ratios for blades. The predominantly lipped and crushed platforms of the blades reveal a preponderance of the soft hammer technique. El-Wad points occur at both sites and endscrapers, burins and retouched pieces are present in similar moderate frequencies.

A fifth, surface-collected assemblage (J440) has blade/flake and blade L/W ratios similar to Ahmarian values, but it lacks el-Wad points and is typologically dominated by burins and informal retouched pieces. The last southern Jordanian UP assemblage (J433) is different from all other assemblages in having much larger blades struck by the hard hammer technique from large subpyramidal cores with converging negatives, as shown by the large plain platforms.

Within Jordan, Siq Umm al-Alda 1 shows the strongest similarities to Wadi al-Jilat 9, J431 and 432, although there remain differences in some aspects.

Farther west beyond the Jordan Valley, a fairly large number of UP-sites is known (SCHYLE 1990, 1992). Those most recently excavated and published are located mainly in the Negev and Sinai (MARKS 1976, 1977, 1983; GILEAD 1981; GORING-MORRIS 1987). The most complete UP stra-

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1 The radiocarbon dates obtained so far are exclusively single dates, most of them considered to be aberrant (too late). The only reasonable dates are 19,000 ± 1300 bp (UA- 4396) at WS 784X (OLSZEWSKI, CLARK and FISH 1989) and 20,300±600 bp at WH618H-I (UA-4395: COINMAN 1993); presumably aberrant are 13,260 ± 200 (OxA-369) at Azraq 17/2 (BYRD and GARRARD 1990), 14,770 ± 150 (Q-?) at Kharaneh 4, phase A (MUHEISEN 1983) and 15,300 ± 600 (KN-3594) at Mdamagh D1 (SCHYLE and UERPMANN 1988). A probably similar but not yet described assemblage has been found at Uweinid 18 in a stratigraphic position below what seems to be a Kebaran assemblage; the former is dated to 23,200 ± 400 (OxA-867), the latter to 19,800 ± 350 (OxA-864) and 19,500 ± 250 (OxA-868) (BYRD and GARRARD 1990).

2 After more recent excavations the assemblage of J412 has turned out to have characteristics rather similar to the assemblages of J431 and J432 (*cf.* KERRY, this volume)

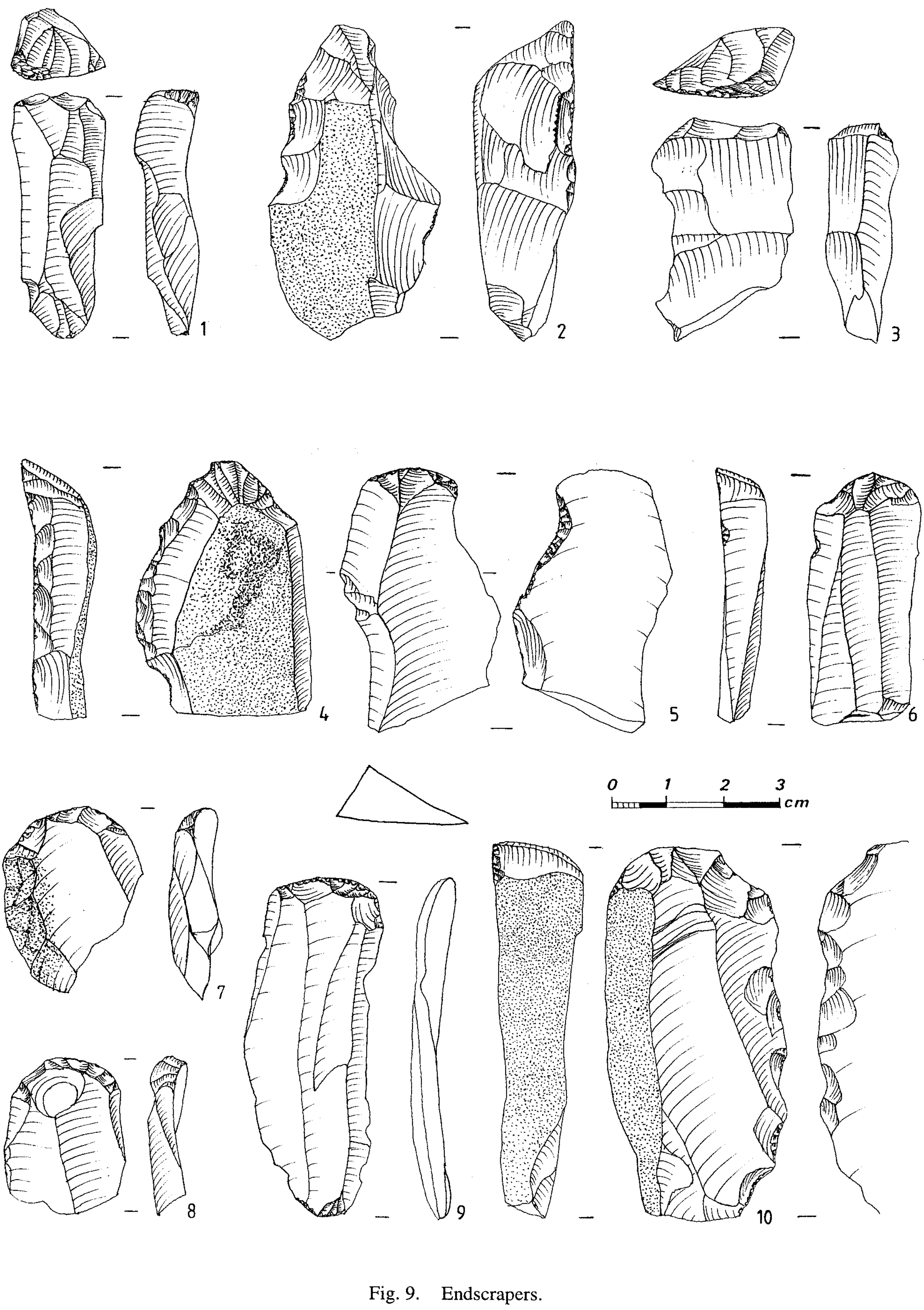

Fig. 9. Endscrapers.

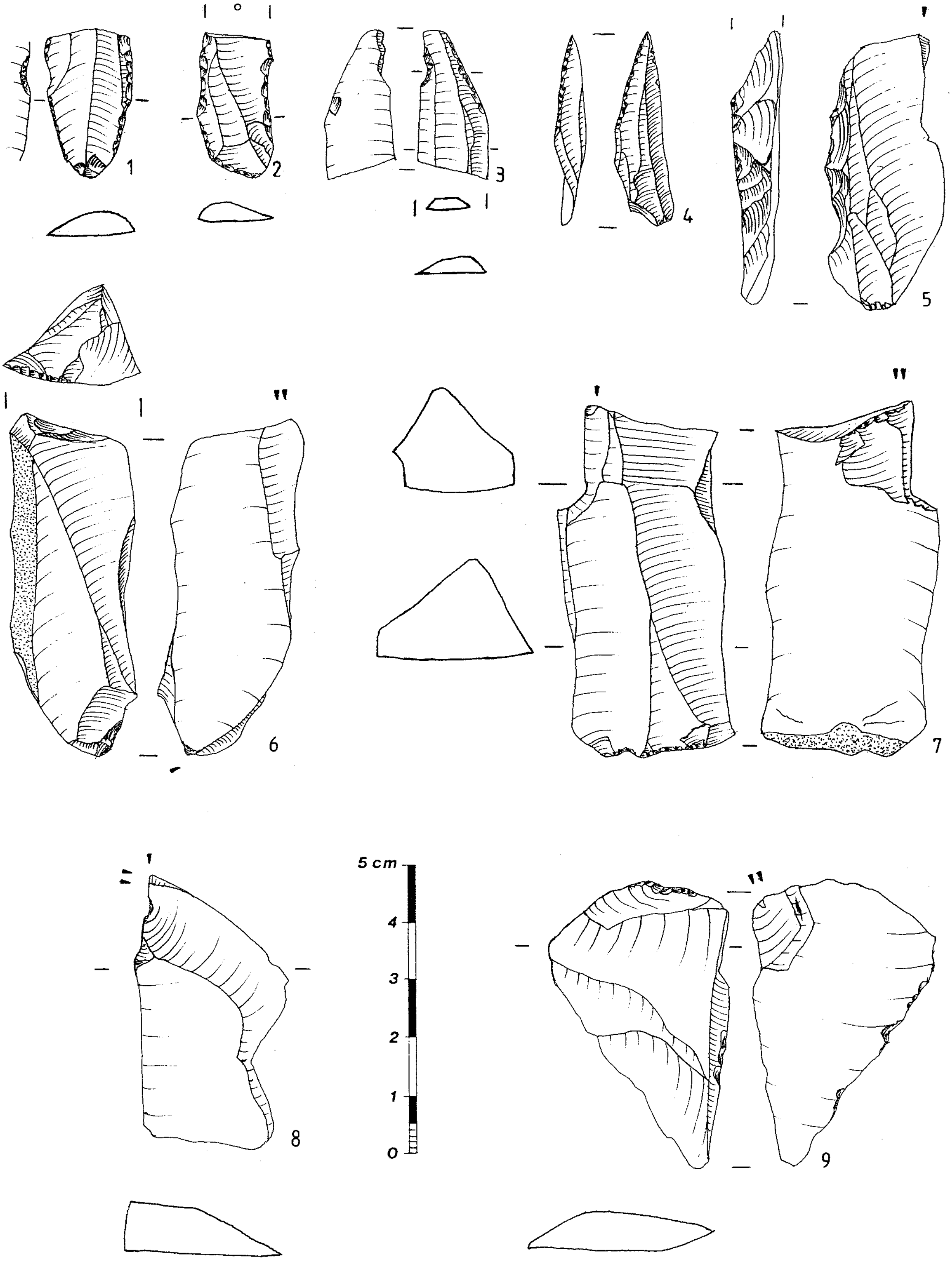

Fig. 10. 1-5 retouched and backed blades and bladelets, 6-9 burins.

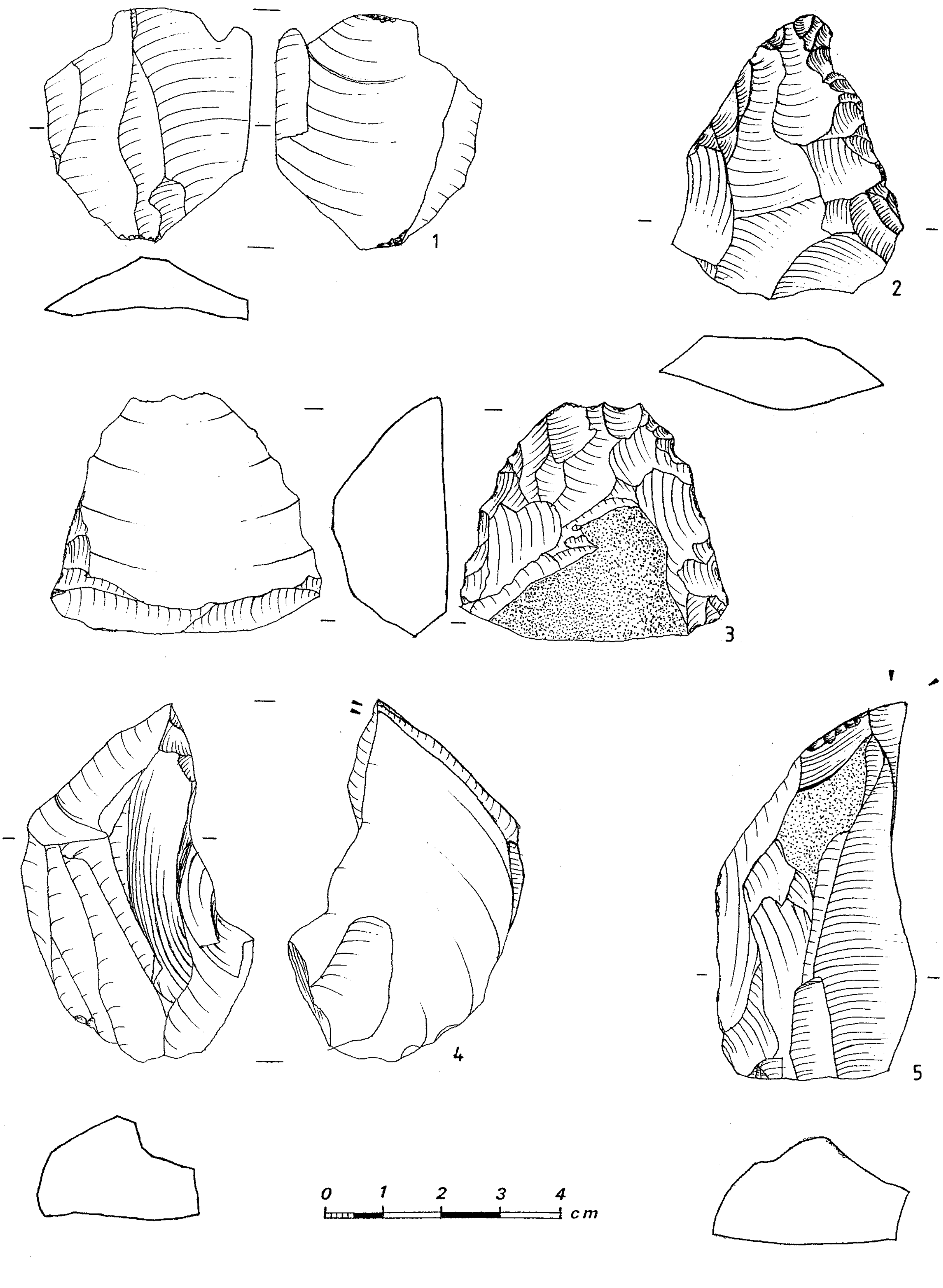

Fig. 11. 1 splintered piece, 2 side scraper, 3 combined tool, 4-5 burins.

Table 13. Tool classes of Jordanian UP-assemblages.

	A17/2	Kh4A	Md	WH784X	WH618C	WH618H-I	WJ9	SUA-1	J403	J412	J431	J432	J433	J440
ES[1]	19.8	30.3	4.8	7.3	13.0	7.6	35.7	41.7	6.0	9.2	13.6	22.1	40.7	9.4
BU[2]	7.1	7.3	3.2	8.0	9.5	3.4	3.2	20.8	5.4	5.7	22.5	22.1	11.1	26.4
N&D[3]	.6	6.2	.0	16.4	5.5	.8	8.7	.0	17.7	17.8	7.7	9.7	29.6	9.5
RET[4]	11.0	5.2	16.1	32.5	37.2	24.5	24.6	16.7	51.3	54.8	38.1	24.7	7.4	33.9
TR[5]	2.2	2.1	.0	2.2	15.2	8.0	3.9	.0	8.4	4.1	4.5	4.1	.0	7.6
M[6]	55.5	44.0	75.8	31.0	14.1	54.1	7.3	4.2	7.2	4.1	10.3	6.2	.0	9.4
V[7]	3.9	4.9	.0	2.6	5.5	1.7	11.1	16.7	3.9	4.2	3.0	11.0	11.1	5.7
total tools	(182)	(386)	(62)	(147)	(935)	(237)	(126)	(24)	(333)	(314)	(155)	(145)	(27)	(53)

A17/2 = Azraq 17, trench 2; Kh4A = Kharaneh 4, Phase A; Md = Mdamagh, 1981 sounding; WH 784X = Wadi al-Hasa 784X/Yutil al-Hasa; WH618 = Wadi al-Hasa 618/Ain el-Buhira; WJ = Wadi al-Jilat; SUA-1 = Siq Umm al Alda 1; J403 = Tor Fawaz; J412 = Jebel Humeima; J431 = Tor Hamar; J432 = Tor Aeid; J433 = Wadi Aghar.

percentages of [1] endscrapers (related to the total number of tools), [2] burins, [3] notches and denticulates, [4] retouched pieces, [5] truncations; [6] microliths, [7] and of various tools (i.e. borers, splintered pieces, combined tools etc.).

Table 14: Debitage classes, blade profiles, blade dimensions and tool classes in selected Southern Levantine Upper Palaeolithic assemblages and Siq Umm al-Alda 1 (Boker A and Qadesh Barnea (QB) 601b: Ahmarian; Boker BE (BBE), level III and Qadesh Barnea 602: Ahmarian or Aurignacian; Boker BE, level I and Har Horesha (HH) I: Levantine Aurignacian); Blade/Flake-ratio = plain blades + bladelets : plain flakes (i.e. excluding PE's and CTE's).

Table 14a: Debitage classes

	Boker A n=4032	QB601b n=7563	BBE/III n=7308	QB602 n=3214	BBE/I n=860	HHI n=5283	SUA-1 n=229	J432 n=2398	J431 n=1606	J412 n=1387	J433 n=191	J440 n=137	WH618C n=6526	WH618H-I n=1926
Blades (s.l.)	62.4	66.4	46.6	41.9	30.3	15.0	55.5	54.2	60.6	21.5	51.3	51.7	48.1	49.4
Flakes	21.8	19.7	39.4	34.2	54.7	56.2	19.7	32.4	30.0	48.2	27.7	30.0	29.4	29.8
PE	10.1	9.4	8.8	19.4	12.6	14.2	12.2	8.5	6.5	25.9	8.9	10.0	16.2	17.4
CTE	3.4	3.5	3.1	3.1	3.8	12.6	6.6	2.6	1.9	1.9	3.7	8.3	3.0	1.5
Cores	2.4	1.0	2.2	1.5	3.7	2.0	4.8	2.3	.9	2.5	8.4	11.4	3.1	1.6
B/F-ratio	2.8	3.4	1.2	1.2	.5	.3	2.9	1.6	2.0	.5	1.8	1.7	1.8	1.9

Table 14b: Blade profiles

	Bok. A n=281	QB601b n=220	QB602 n=107	BE/III n=584	BE/I n=66	SUA-1 n=124	J432 n=110	J431 n=287	J412 n=100	J433 n=65
Straight	13.5	19.0	17.0	44.9	27.3	36.3	31.5	15.0	47.0	20.0
Curved	44.9	60.0	68.0	23.8	27.2	30.6	27.1	36.2	16.0	50.8
Twisted	41.6	21.0	15.0	31.2	45.5	33.0	38.7	43.5	36.0	24.6
Other							1.8	5.2	1.0	4.6

Table 14c: Mean dimensions of blades (s.l.) in mm

	Boker A n=281	QB601b n=220	BE/IV n=210	QB602 n=107	SUA-1 n=48*	J431 n=188	J432 n=104	J412 n=79	J433 n=32	J403 n=56
Length	51.8	50.6	44.0	46.3	49.3	39.0	42.8	41.8	55.2	42.6
Std dev	18.8	20.0	8.0	16.3	17.8	13.4	13.8	17.2	9.5	19.3
Width	15.0	14.3	16.0	16.8	16.2	12.0	14.3	16.1	18.7	16.6
Std dev	5.6	5.9	3.6	7.7	6.3	4.7	6.1	7.5	4.7	8.3
L/W-ratio	3.5	3.5	2.7	2.7	3.0	3.4	3.2	2.7	3.1	2.6

* Length and L/W-ratio only, for width: n= 126.

Table 14d: Tool classes

	Boker A	QB601b	QB602	BE/III	BE/I	HHI	SUA-1
ES[a]	2.2	3.1	15.5	19.1	35.8	60.6	41.7
BU[b]	15.9	10.6	6.7	2.1	.0	12.3	20.8
N&D[c]	12.2	20.3	26.5	19.4	26.4	4.1	.0
RET[d]	61.9	59.4	33.0	51.0	34.0	3.8	26.7
TR[e]	1.5	6.1	6.9	.9	.0	1.5	.0
M[f]	3.7	.0	5.0	2.1	.0	4.9	4.2
V[g]	2.5	.5	6.5	5.4	3.8	12.7	6.6
Total tools	402	611	464	535	53	220	24

percentages of [a] endscrapers (related to the total number of tools), [b] burins, [c] notches and denticulates, [d] retouched pieces, [e] truncations, [f] microliths, [g] and of various tools (i.e. borers, splintered pieces, combined tools etc.)

Table 15. Debitage classes, blade profiles, blade dimensions and tool classes in selected assemblages from Ksar Akil and Siq Umm al-Alda 1 (KA XII = Ksar Akil, level XII [Stage 3]; KA X = Ksar Akil, level X [Stage 4]; KA VIII = Ksar Akil, level VIII [Stage 5, similar to, if not identical with Southern Levantine Aurignacian]; KA VI = Ksar Akil, level VI [Stage 6]).

Table 15a: Debitage classes (in %)

	KA XII (n=602)	KA X (n=1726)	KA VIII (n=343)	KA VI (n=147)	SUA-1 (n=229)
Blades (s.l.)	61.0	64.2	17.5	4.8	55.5
Flakes	20.9	21.5	60.1	60.1	19.7
PE					12.2
CTE	5.3	5.7	2.3	3.4	6.6
Cores	12.8	8.6	20.1	19.7	4.8
B/f-ratio	2.3	2.7	.4	.9	2.8

Table 15b: Blade profiles

	KA XII n=328	KA X n=268	KA VI n=104	SUA-1 n=124
Straight	5.5	8.9	.9	36.3
Curved	29.9	51.9	34.6	30.6
Twisted	64.6	39.2	64.4	33.0

Table 15c: Blade (s.l.) length in mm

	KA XII (n=353)	KA X (n=272)	KA VIII (n=44)	KA VI (n=107)	SUA-1 (n=48)
Mean	48.0	34.0	27.0	30.0	49.3
Std dev	13.0	13.0	13.0	10.0	17.8

Table 15d: Blade (s.l.) width in mm

	KA XII (n=353)	KA X (n=272)	KA VIII (n=44)	KA VI (n=107)	SUA-1 (n=126)
Mean	15.0	11.0	10.0	7.0	16.2
Std dev	5.0	4.0	6.0	4.0	6.3
Mean L/W-ratio	3.2	3.0	2.7	4.3	3.0

Table 15e: Tool classes

	KA XII	KA X	KA VIII	KA VI	SUA-1
ES[1]	12.6	26.1	61.5	32.7	41.7
BU[2]	45.1	15.5	1.3	28.6	20.8
N&D[3]	2.9	.0	10.3	1.4	.0
RET[4]	28.9	54.2	24.4	34.1	30.9
TR[5]	7.1	.6	1.2	.0	.0
V[7]	3.4	3.7	1.3	3.2	6.6
total tools	381	349	78	220	24

percentages of [1] endscrapers (related to the total number of tools), [2] burins, [3] notches and denticulates, [4] retouched pieces, [5] truncations, [6] microliths, [7] and of various tools (i.e. borers, splintered pieces, combined tools, etc.)

tigraphy was excavated rather early at Ksar Akil in Lebanon, but it has only recently been published (AZOURY 1986, BERGMAN 1987). There is no agreement on the chronology nor the definition of the industries of the later UP among these scholars.

According to the earlier opinion expressed by Marks (MARKS (1981) and Gilead (GILEAD 1981), which replaced the first framework established by Garrod and Neuville in the 1920s (NEUVILLE 1934), two almost synchronous cultural traditions occupied the same territory for the whole Upper Palaeolithic time span. One of them, the Ahmarian, is characterized technologically by the production of blades and typologically dominated by retouched or backed blades and bladelets. It is believed to have developed locally from the MP/UP-transitional industries and to have lasted over the whole UP, finally merging into the Epipalaeolithic Kebaran industries. The other tradition, the Levantine Aurignacian, is technologically characterized by the production of flakes and typologically dominated by scrapers and burins on flakes; it is interpreted as a probable foreign intrusion (from the north?), first detectable at about 30,000 bp and vanishing without a trace around 17,000 - 15,000 bp.

The alternative view, first expressed by Goring-Morris (1987), argues for a unilinear development, in which assemblages characterized by blades *sensu stricto* (*i.e.*, Ahmarian) predate flake-dominated assemblages (the Levantine Aurignacian), which subsequently are followed by bladelet-dominated assemblages merging into the Kebaran. The reasons for my preference of the latter have been presented elsewhere (SCHYLE 1990, 1992) and will not be repeated here.[1] The main advantage of the latter approach consists in enabling us to date assemblages approximately by means of techno-typological comparison if there is no other dating alternative like radiometric samples or stratigraphy.[2]

When various technological and typological data from selected assemblages representative of the Ahmarian and Levantine Aurignacian in the southwestern Levant (Table 14) are compared to Siq Umm al-Alda 1, it is obvious that Siq Umm al-Alda 1 is different from the assemblages of the Levantine Aurignacian. The blade/flake ratio is most similar to the typical Ahmarian values of Boker A and QB 601, whereas the distribution of blade profiles approaches the value of the assemblage from Boker BE, level III, which is neither typical Ahmarian (as defined by GILEAD 1981) nor Levantine Aurignacian. As indicated by the differences in blade profile distribution between the assemblages from Qadesh Barnea (analyzed by GILEAD 1981) and Boker (analyzed by JONES, MARKS and KAUFMAN 1983), this probably depends largely on individually different classificatory criteria and may not be significant, but further similarities to Boker BE, level III/IV and QB 602 are to be found in the mean L/W ratio of blades and the distribution of tool classes, at least as far as can be said on the basis of the small tool sample from Siq Umm al-Alda 1.

The comparison of Siq Umm al-Alda 1 to the assemblages of the different stages at Ksar Akil is more difficult, mainly because the earlier levels cannot be compared.[3] Stage 3 is technologically peculiar in having an extremely high percentage of twisted debitage presenting frequently offset platforms. Typologically it is characterized by many carinated pieces (probably representing the cores for a good deal of the twisted blanks) and a predominance of burins over endscrapers, as well as a moderate percentage of retouched and pointed blades, these also frequently being of the twisted, offset type. These characteristics have not been described so far from any other Levantine Upper Palaeolithic assemblage. Consequently, this stage is believed to be exclusively represented at Ksar Akil (BERGMAN 1987, 1988). At Siq Umm al-Alda 1, twisted blades are only half as frequently represented and offset platforms are very rare.

The assemblages of Stage 4 at Ksar Akil[4] are more closely related to Siq Umm al-Alda 1 in having a similar blade/flake ratio, a preponderance of curved and straight blade profiles (the low percentage of straight profiles at Ksar Akil may be due to individual differences in classification criteria; see above), a similar mean L/W ratio of blades (although the blades at Ksar Akil are considerably smaller) and a comparable typology with a predominance of endscrapers over burins and a moderate to high amount of retouched and pointed blades. Stages 5 and 6[5] have much lower blade/flake ratios, higher

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1 This alternative chronology does not solve every problem either; see Marks's (1988) reply on Goring-Morris's proposal, Gilead's (1988) renewed argumentation in favor of the synchronous framework and BERGMAN (1988) for a general discussion.

2 This is not possible following the view held by Marks (1988) and Gilead (1981); see *e.g.* the rather frustrated statement on the date of the different assemblages recovered in the Wadi Sudr (BARUCH and BAR-YOSEF 1986: 83).

3 Azoury's (1986) technological classification system does not allow a detailed comparison, but according to Bergman (1987, 1988) the levels belonging to the later stage 2 are almost identical to the Southern Ahmarian.

4 Samples from layers of the latest (Tixier's) excavations at Ksar Akil, stratigraphically equivalent of stage 4 have been radiocarbon-dated (MELLARS and TIXIER 1989) to 32000 ± 1500 (MC-1192), 32400 ± 1100 (OxA-1805) and 31200 ± 1300 (OxA-1804). For a synchronization of the old and new excavation levels at Ksar Akil see BERGMAN 1987, BERGMAN and GORING-MORRIS 1987 and BERGMAN 1988a.

5 Dated samples from the Tixier's excavation equivalent to stage 5 (MELLARS and TIXIER 1989): OxA-1803: 30250 ± 850 and OxA-1798: 29300 ± 800; equivalent to stage 6: MC-1191: 26500 ± 900, OxA-1797: 26900 ± 600 and OxA-1796: 21100 ± 50 (contaminated and aberrant sample).

percentages of twisted blades and squatter (Stage 5) or definitely more elongated (Stage 6) and much smaller blades (*i.e.*, more bladelets) than Siq Umm al-Alda 1. Typologically, Stage 5 is different from Siq Umm al-Alda 1 in having an extremely high percentage of endscrapers, whereas Stage 6 seems to be rather similar. This is probably misleading, because in Stage 6 at Ksar Akil the retouched pieces are represented mainly by marginally retouched ("Dufour"- bladelets (BERGMAN 1987). Furthermore, the most characteristic tool type of Stage 6 is a "burin on Clactonian notch" not present at Siq Umm al-Alda 1.[1]

Conclusions

The small number of recovered artifacts probably is the result of the fact that the major part of the host playa sediments already were eroded after the opening of the northernmost playa of the formerly closed Jabu basin. This took place probably after the end of the Pleistocene or in Early Holocene. The two isolated playa remnants with their preserved upper stratigraphy, from which the artifacts erode, rest on the northern bank of the spot where minor drainages meet to form the Wadi Siq Umm al-Alda; from here the sediments from the area are transported westward. The nature of the site is not clear; the deposits from which the Upper Palaeolithic artifacts erode may not represent their primary context or contain the original Upper Palaeolithic surface. Before deposition they may have been transported by erosion and deflation, but not from far as the good preservation of the artefacts suggest.

The lithic assemblage of Siq Umm al-Alda 1 has been found to have technological and typological characteristics similar to a few other Levantine Upper Palaeolithic assemblages including Wadi Jilat 9 in Jordan and Qadesh Barnea 602, Boker BE Levels III-IV in the Negev and Sinai and those of Ksar Aqil Stage 4 in the Central Levant. These characteristics include balanced flake/ blade ratios, moderate L/W ratios of blades, and moderate frequencies of endscrapers, burins, and retouched pieces. Thus they are neither typical of the Ahmarian nor of the Levantine Aurignacian. With exception of Wadi Jilat 9, these assemblages are dated to 30.000 and 26.000 bp and seem to fit chronologically in between those two techno-typological complexes.

The assemblage from Siq Umm al-Alda 1 is certainly different from the Levantine Aurignacian as found at Har Horesha I, Boker BE Level I and Stage 5 of Ksar Akil, and it differs as well from the presumably Late Upper Palaeolithic assemblages typologically characterized by numerous marginally retouched bladelets.

The blade/flake ratio approaches those of typical Ahmarian assemblages, but the closest parallels are to be found in assemblages displaying neither typical Ahmarian nor Levantine Aurignacian characteristics.[2] These have been radiometrically dated not later than *c.* 26,000 bp.[3] Stratigraphically, they occur above typical Ahmarian layers (at Ksar Akil and Qadesh Barnea), the latter comparatively well dated radiometrically to between approximately 38,000 and 30,000 bp.

If these similarities are indeed chronologically significant, Siq Umm al-Alda 1 should date to between approximately 30,000 and 26,000 bp, thus being considerably earlier than indicated by the single date of *c.* 21,000 bp from the only dated similar Jordanian assemblage, Wadi al-Jilat 9. At present, it is not possible to decide whether this contradiction results from the single date of Wadi al-Jilat 9 being aberrant, the comparison of Siq Umm al-Alda 1 and Wadi al-Jilat 9 being too superficial or the similarities to the Ksar Akil, Stage 4 assemblages being chronologically not significant.

At present I tend to prefer the first of the three alternatives, especially regarding the fact, that the artifacts of Siq Umm al-Alda 1 were eroding from the upper parts of a playa stratigraphy similar to those described from various locations in Negev and Sinai, enclosing Ahmarian (and thus presumably earlier), but so far never Aurignacian (presumably later) assemblages (MARKS 1976, 1977, 1983; GILEAD 1981; PHILLIPS 1988).

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1 Bergman (1987) does not separate retouched bladelets from retouched blades; thus the amount of microliths in the different levels at Ksar Akil cannot be estimated. Consequently, the retouched bladelet of SUA-1 was counted with the retouched pieces for comparison.

2 For practical reasons, I included these "hybrid" assemblages within the Ahmarian on the TAVO-map for the Upper Palaeolithic (SCHYLE 1990, 1992), although I am aware that this is certainly an oversimplification.

3 At Boker BE, level III: 27,550 ± 1,300 (SMU-188); 26,760 ± 500 (SMU-229); 26,130 ± 600 (SMU-228); level II: 27,050 ± 520 (SMU-227) and 24,730 ± 390 (SMU-565), the latter date being in clear contradiction to the stratigraphy and consequently considered to be aberrant (MARKS 1983: 37).

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From the Late Ahmarian to the Early Natufian: A Summary of Hunter-Gatherer Activities at Yutil al-Hasa, West-Central Jordan

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Abstract: *Yutil al-Hasa (WHS 784) is one of several well preserved sites located within 10km of Pleistocene Lake Hasa, in west-central Jordan. This small rockshelter was extensively utilized as an activity locale (task site) during the interval from approximately 19,000 to 11,000 bp. At least three chrono-stratigraphic traditions were documented through test excavations: late Upper Paleolithic (Ahmarian), early Epipaleolithic (Madamaghan) and late Epipaleolithic (early Natufian). These occupations are briefly described and compared to other tested sites in the Wadi al-Hasa. Subtle changes in the brief visits to this site over time are suggested. Comparisons also are made to the Azraq region where a similar archaeo-ecological situation pertained during the late Pleistocene. Finally, terminological issues that influence interpretations of chipped stone traditions are discussed and future research is outlined.*

Introduction

Investigations in the Wadi al-Hasa region of west-central Jordan have documented an extensive record of past human use of this region from Paleolithic times to the Ottoman period. Of particular interest is evidence of a Pleistocene lake that characterized the eastern portion of the Wadi al-Hasa drainage system. The Pleistocene sites in this region represent aspects of settlement systems that were keyed to the lake and the springs that fed into it, or to a series of marshes, ponds and springs that were present throughout much of the Wadi al-Hasa and its tributary drainages during periods when the lake was greatly reduced in size.

Presently, the best preserved record of human occupation during the Pleistocene appears to date primarily to the late Upper Paleolithic and to much of the Epipaleolithic period. At least 16 sites with buried deposits are known in addition to numerous deflated surface sites (Fig. 1). Five of the better preserved sites (Tor Sadaf, Tor Sageer, Tor al-Tareeq, Yutil Abu Kharaf, and Yutil al-Hasa) are associated with collapsed rockshelters, two (Ain al-Buhira, Tabaqa) are open-air locales and nine are eroding out of lake marl sediments (WHNBS 92-96, 367, 515, and 518-519). To date, only the sites of 'Ain al-Buhira, Tabaqa, Tor al-Tareeq and Yutil al-Hasa have been tested. The two occupations at 'Ain al-Buhira are late Upper Paleolithic (COINMAN 1990, 1993), Tabaqa has a single Epipaleolithic occupation (BYRD and COLLEDGE 1991), those at Tor al-Tareeq appear to represent at least two periods within the Epipaleolithic (CLARK *et al.* 1987, 1988, 1992), and Yutil al-Hasa was used during the late Upper Paleolithic and during at least two Epipaleolithic periods (CLARK *et al.* 1994; OLSZEWSKI *et al.* 1990, 1994).

The discussion presented in this paper uses data retrieved from the late Upper Paleolithic and Epipaleolithic occupations at the site of Yutil al-Hasa (WHS 784). This site was recorded initially during surveys of the south bank of the Wadi al-Hasa (MACDONALD *et al.* 1983), and test excavated first in 1984 (CLARK *et al.* 1987, 1988; OLSZEWSKI *et al.* 1990), and subsequently in 1993 (CLARK *et al.* 1994, OLSZEWSKI *et al.* 1994). The 1984 excavations yielded evidence of a late Ahmarian use of the rockshelter, while the 1993 excavations revealed Madamaghan and Early Natufian occupations.

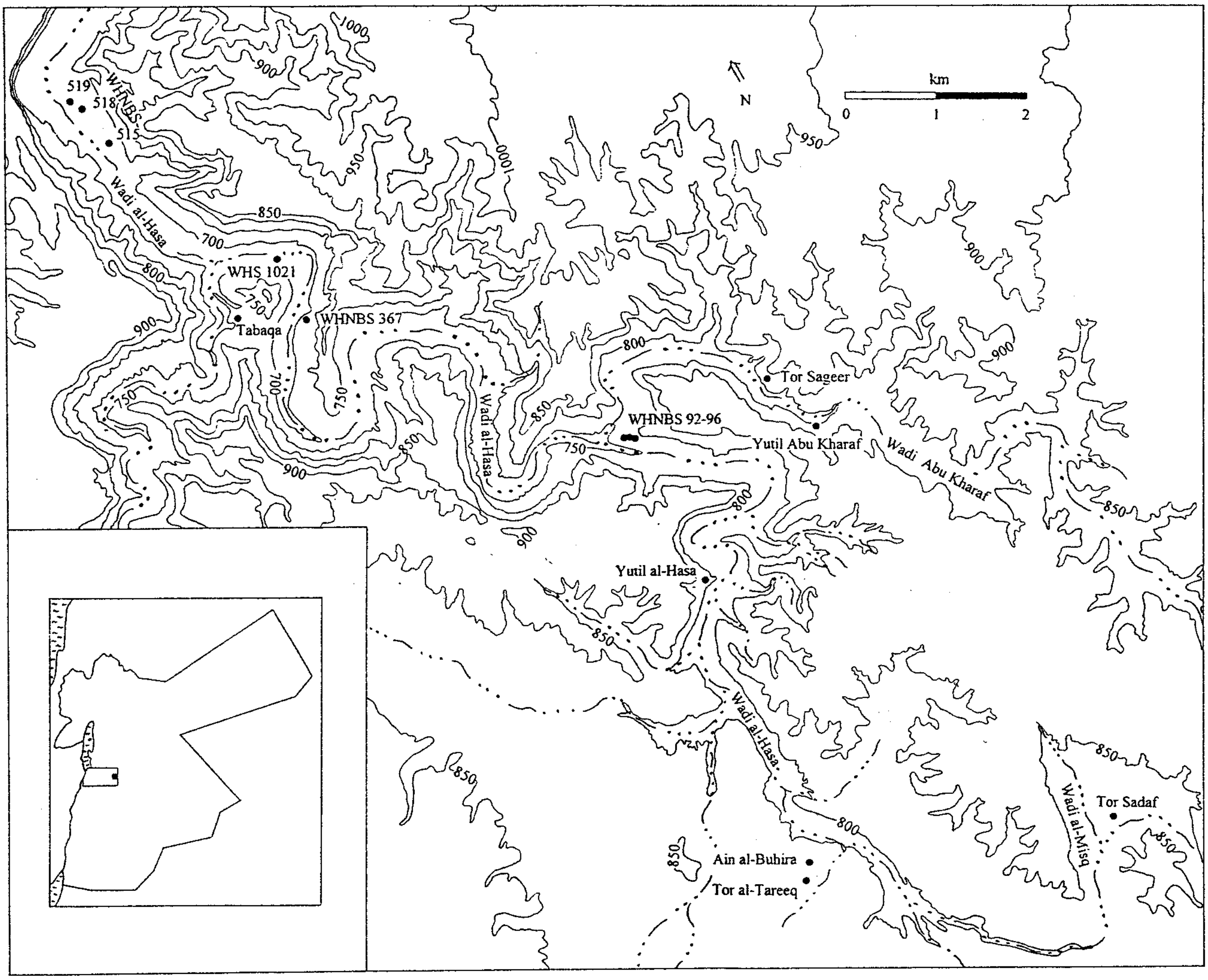

Fig. 1. Upper Paleolithic and Epipaleolithic sites in the eastern Wadi al-Hasa, Jordan. *<top>*

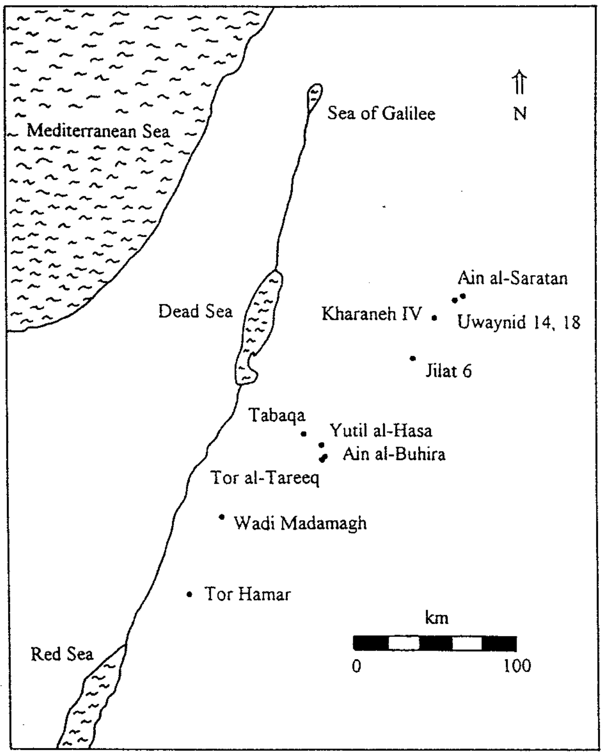

Fig. 2. Jordanian Late Upper Paleolithic and Epipaleolithic sites mentioned in text. *<left>*

Yutil al-Hasa and Its Topographic Setting

The site of Yutil al-Hasa is situated about 10m above the channel of the Wadi al-Hasa and is located in the area where the wadi narrows in its transition from the broad, open lake plain of the eastern portion of the drainage system to the very narrow lower Hasa sectors. Yutil al-Hasa is a collapsed rockshelter on a ridge slope characterized by numerous immense boulders that represent past collapses of the ledges that formed the roofs of rockshelters at this locale. Downslope erosion of some areas of open sediments has resulted in a talus deposit that includes some artifacts. This talus deposit is at the base of the ridge and immediately above the drainage channel. It is likely that the preservation of the majority of the sediments that constitute the occupations at Yutil al-Hasa is due directly to the large boulders that overlie many areas of the site.

Late Pleistocene sites in the eastern portion of the Wadi al-Hasa are associated with the 10 to 20m terrace (SCHULDENREIN and CLARK 1994: 37). In the period from about 25,000 to 20,000 bp, the Pleistocene lake that occupied the eastern portion of the Hasa Basin began to retreat (SCHULDENREIN and CLARK 1994: 49). But there were numerous springs that remained active during the retreat and for millennia afterwards. These fed the retreating lake and various marshes and ponds throughout the drainage system. Remnants of these ancient springs are present in preserved tufas, as at 'Ain al-Buhira (SCHULDENREIN and CLARK 1994: 39) and directly across the wadi from Yutil al-Hasa (CLARK *et al.* 1994: 52). Iron and sulphur streaks in sediments were encountered in the deposits of the late Ahmarian and of the Madamaghan occupations at Yutil al-Hasa, and these are indicative of seeps at the site (SCHULDENREIN and CLARK 1994: 53).

Table 1. Summary of tool assemblages from Yutil al-Hasa.

CLASS	LATE AHMARIAN		MADAMAGHAN		EARLY NATUFIAN	
	COUNT	%	COUNT	%	COUNT	%
Scraper	20	7.4	7	1.8	-	-
Burin	21	8.1	7	1.8	2	2.9
Borer	5	1.8	-	-	2	2.9
Backed Piece	3	1.1	1	0.3	-	-
Truncation	6	2.2	4	1.0	2	2.9
Notch/Denticulate	45	16.6	24	6.1	16	23.9
Retouched Piece	69	25.5	24	6.1	5	7.5
Special Tool	3	1.1	-	-	1	1.5
Nongeometric	98	36.2	315	80.1	21	31.3
Geometric	-	-	11	2.8	17	25.4
Varia	-	-	-	-	1	1.5
TOTAL	270		393		67	

Late Pleistocene Occupations at Yutil al-Hasa

In 1984 two 1x1m test units (Units A and B) were excavated into the deposits immediately above the lower bedrock ledge on the ridge slope (OLSZEWSKI *et al.* 1990). Both yielded lithic assemblages of the late Ahmarian Upper Paleolithic. A radiocarbon sample from a hearth in the uppermost layers in Unit A produced a date of 19,000 ± 1300 bp (UA-4396) (CLARK *et al.* 1987, 1988; OLSZEWSKI *et al.* 1990). Yutil al-Hasa was revisited in 1993, when three 1x1m test units (Units C, D and E) were dug into areas of the site higher upslope than Units A and B. The lithic assemblages of Units C and E, and probably the lowest levels of D, are characteristic of the Madamaghan Epipaleolithic, while that from upper levels of Unit D is attributable to the Early Natufian Epipaleolithic (CLARK *et al.* 1994: 50-52, OLSZEWSKI *et al.* 1994).

The Late Ahmarian Occupation

At the time that Yutil al-Hasa was occupied by late Ahmarian groups, Pleistocene Lake Hasa was shrinking towards the south and east (SCHULDENREIN and CLARK 1994). Active freshwater springs, however, aided in the formation of paludal conditions that included marshes and ponds throughout many areas of the Wadi al-Hasa drainage. Pollen in samples taken from Unit B at Yutil al-Hasa include *Typha* (cattail), *Salix* (riparian willow), and *Quercus* (oak), all of which are indicative of locally moist conditions (OLSZEWSKI *et al.* 1990: 46). Faunal remains also include species linked to moister regimes, such as *Bos primigenius* (auroch), although the faunal assemblage from Yutil al-Hasa is dominated by steppic representatives such as *Gazella* (gazelle) and *Equus* (probably the onager) (OLSZEWSKI *et al.* 1990: 45).

Previous research identified the lithic assemblages from Units A and B as most similar typologically and technologically to the Ahmarian Upper Paleolithic tradition (OLSZEWSKI *et al.* 1990). The assemblage consists of 5224 artifacts, of which 270 (5.2%) are tools. No differences were observed in the composition of the assemblage either between the two test units or within either of the test units. Table 1 presents a summary of the tool types present, and Table 2 shows the distribution of blades, bladelets and flakes used as blanks for tools and in the debitage. Core data are displayed in Table 3.

There are several points of interest in the Ahmarian lithic assemblage from Yutil al-Hasa. The first of these is the relatively limited diversity of the tool assemblage. While most tool classes are represented, the most numerous are nongeometric microliths followed by retouched pieces and then by notch/denticulates. This type of assemblage might indicate that relatively specialized activities occurred at Yutil al-Hasa as opposed to a variety of maintenance tasks typical of extended basecamp occupations. The second aspect relates to technology, which for Ahmarian assemblages should be highly oriented toward blades and bladelets (GILEAD 1981: 339-340). At Yutil al-Hasa about 64% of the tool assemblage is manufactured on blade or bladelet blanks, while the debitage is overwhelmingly dominated by flakes. However, the flake category includes a very high quantity of flakes smaller than 2cm in size. If these are removed from consideration as potential blanks for tools, then the debitage blade(let) percentage is about 56%, somewhat more in line with the "typical" Ahmarian assemblage. Finally, cores are not very common (0.9%), and their frequency is very small (0.4%) if core fragments are removed from the count. This suggests either that extant cores were used intensively or that most debitage and tools were brought into Yutil al-Hasa as blanks or finished products.

The Ahmarian lithic assemblage from Yutil al-Hasa compares favorably in most respects with that from Area C (rather than the Area H-I assemblage) at 'Ain al-Buhira, located about 4km upstream at the edge of the Pleistocene lake (COINMAN 1993). Both assemblages are similar with respect to the frequency of blade(let) blanks used for tools (64% at Yutil al-Hasa and 63% in Area C at 'Ain al-Buhira), cores are rare, and 34% to 43% of each assemblage is composed of small flakes (less than 2cm in size). Metric attributes such as width and thickness for bladelets also are similar. However, microliths are far less common in Area C at 'Ain al-Buhira than at Yutil al-Hasa, while 'Ain al-Buhira has more retouched pieces, truncations and endscrapers. These differences in the composition of the tool assemblages from the two sites may relate to differing site functions or to chronological change, particularly because Coinman (1993: 34) has described the Area C 'Ain al-Buhira assemblage as possibly encompassing a developmental change toward the highly specialized bladelet technology of the late Ahmarian.

Table 2. Summary of tool blanks and debitage from Yutil al-Hasa.

	LATE AHMARIAN				MADAMAGHAN				EARLY NATUFIAN			
	TOOL BLANK		DEBITAGE		TOOL BLANK		DEBITAGE		TOOL BLANK		DEBITAGE	
	N	%	N	%	N	%	N	%	N	%	N	%
Blade	71	26.3	264	5.4	26	6.6	279	4.9	14	20.9	15	1.9
Bladelet	101	37.4	689	14.0	334	85.0	1137	20.0	40	59.7	85	11.1
Flake	95	35.2	796	16.2	31	7.9	704	12.4	13	19.4	130	16.9
Small Flake	-	-	2298	46.8	-	-	2587	45.5	-	-	367	47.6
Microburin	-	-	8	0.2	-	-	167	3.0	-	-	39	5.0
Burin Spall	-	-	72	1.5	-	-	18	0.3	-	-	3	0.4
Shatter	3	1.1	782	15.9	2	0.5	792	13.9	-	-	131	17.0
TOTAL	**270**		**4909**		**393**		**5684**		**67**		**770**	

Table 3. Summary of cores from Yutil al-Hasa.

CLASS	LATE AHMARIAN		MADAMAGHAN		EARLY NATUFIAN	
	COUNT	%	COUNT	%	COUNT	%
single platform	8	17.8	12	40.0	3	42.8
double platform	7	15.5	5	16.7	2	28.5
multiple platform	7	15.5	5	16.7	-	-
fragment	23	51.1	8	26.6	2	28.5
TOTAL	45		30		7	

Data available from the two small test excavations that yielded evidence of Ahmarian occupation at Yutil al-Hasa suggest that this rockshelter site was a limited activity locale. Its relatively small size and restricted range of chipped stone tools further suggest that prehistoric occupations at this site were of limited duration. Although each use of the site probably was brief, the Yutil al-Hasa rockshelter was a favorable locale as indicated by the depth of deposits with Ahmarian assemblages, at least 70cm in Unit A and 85cm in Unit B (OLSZEWSKI *et al.* 1990: 36-37). Because Unit B is situated downslope from Unit A, the total depth of Ahmarian deposits likely exceeds 1.5m.

There are at least three reasons why Yutil al-Hasa was an optimal spot in the landscape for Ahmarian groups. First, Yutil al-Hasa is in an area where the drainage narrows considerably, forcing game animals travelling along the drainage into a relatively small area where they would be readily visible from the rockshelter and quickly accessible. Second, freshwater was available both at the site, as evidenced by seeps, and across the wadi from the site, as reflected by the presence of a spring tufa. The spring additionally would have attracted game. Finally, the contemporaneous open-air late Ahmarian site of 'Ain al-Buhira is only 4km upstream, and Yutil al-Hasa may have functioned as a satellite task camp associated with the longer term basecamp at 'Ain al-Buhira.

The Madamaghan Occupation

In the eastern Levant the Madamaghan is apparantly both contemporary with the end of the late Ahmarian Upper Paleolithic as well as chronologically later (see Terminological Issues section below), ranging in date from perhaps as early as ca 19,800 ± 350 bp (OxA-864) to as late as *c.* 12,680 ± 320 bp (SMU-1399) (BYRD 1994: 219-220). Characteristics of the Madamaghan lithic assemblage (narrow nongeometric microliths with microburin technique) from Yutil al-Hasa in the absence of radiocarbon dates suggest that this occupation is relatively early in the Madamaghan sequence, perhaps comparable in time to dated assemblages from the nearby site of Tor al-Tareeq, in the range from 16,900 ± 500 bp (UA-4391) to 15,580 ± 250 bp (UA-4392) (CLARK *et al.* 1988: 265; NEELEY *et al.* n.d.).

During the period of Madamaghan use of Yutil al-Hasa, the retreat of Pleistocene Lake Hasa continued (SCHULDENREIN and CLARK 1994: 46). It is likely that areas immediately adjacent to Yutil al-Hasa were characterized increasingly by spring-fed pond and marsh biomes, as were many areas surrounding a much reduced lake some 4 or more km to the south and east in the vicinity of the Epipaleolithic site of Tor al-Tareeq. Pollen samples from the Madamaghan deposits at Yutil al-Hasa have yet to be analyzed, but those from Tor al-Tareeq include species typical of a wetter regime. Arboreal species are rare but they include *Pinus*, *Pistachia*, *Ceratonia* (carob tree), *Quercus*, *Salix*, and *Oleaceae* (olive family). Trees likely were restricted to areas around springs and to wadi bottoms. Additional indicators of a moist setting (at Tor al-Tareeq) include *Sparganium* (bur-reed) and *Typha*. The majority of the pollen present, however, is dominated by open steppic representatives of Chenopodiaceae (chenopods) and Amaranthaceae (amaranths) (NEELEY *et al.* n.d.; SCHULDENREIN and CLARK 1994: 39). The Madamaghan faunal assemblage from Yutil al-Hasa consists primarily of steppic species, such as *Gazella* and *Equus*, but it also includes *Bos primigenius* and tortoise (OLSZEWSKI *et al.* 1994: 134).

The lithic assemblages from Units C, lower D, and E are most similar typologically and technologically to those characterized as Madamaghan (HENRY and GARRARD 1988), although this resemblance is particularly striking if the comparison is made to the assemblages from the Wadi Madamagh (KIRKBRIDE 1958: 56), to various sites in the Azraq Basin (BYRD 1988: 259-260; GARRARD and BYRD 1992: 56) or to Tor al-Tareeq (NEELEY *et al.* n.d., STEVENS 1996), rather than to Tor Hamar (HENRY and GARRARD 1988). The assemblage from Yutil al-Hasa comprises 6107 artifacts, of which 393 (6.4%) are tools. Preliminary analysis has not yielded differences in the composition of the Madamaghan assemblage either between the test units or within test units. Table 1 presents a summary of the tool types present; Table 2 indicates the distribution of blades, bladelets and flakes used as blanks for tools and among the debitage; Table 3 displays core data.

Compared to the limited diversity of tools present in the late Ahmarian assemblage at Yutil al-Hasa, the lithic assemblage of the Madamaghan contains so little variety that it is difficult to resist labelling it "specialized". Microlithic elements that characteristically are extremely narrow, nongeometric in form, and produced using the microburin technique constitute almost 83% of the tools. Much of the remainder of the assemblage is comprised of notch/denticulates and retouched pieces, with rare scrapers, burins, truncations and backed pieces. As might be predicted, tools are overwhelmingly manufactured on blade(let) blanks. Interestingly, this is not the case for the debitage class, where small flakes predominate. As small flakes often are assumed to be the by-products of resharpening activities, it is intriguing that few of the tools that potentially could be resharpened, such as scrapers, are present at Yutil al-Hasa. This suggests that such tools were curated to other locales. The fact that cores are less common (0.5%) than in the late Ahmarian, - and if core fragments are removed from the counts, even less so (0.4%) - also signals the limited diversity present in the Madamaghan assemblage from Yutil al-Hasa. As during the late Ahmarian, the low frequency of cores likely indicates limited core reduction activity on-site.

Although the lithic assemblage from the lower levels at Tor al-Tareeq (Unit B all levels, Unit C levels III, IV, Step B levels 1 to 5, and Step C level 7) has been referred to as "Kebaran" (CLARK *et al.* 1987: 54-56, 1988: 258; NEELEY *et al.* n.d.; SCHULDENREIN and CLARK 1994: 36), its typological and technological composition place it more comfortably within the Madamaghan industry. For this reason, several points of comparison between the Yutil al-Hasa Madamaghan and Tor al-Tareeq lower level assemblages are undertaken. Both sites contain extremely high percentages of nongeometric microliths, which at Yutil al-Hasa account for 80% of the tools, and at Tor al-Tareeq, from 50% to 84% of all tools[1]. Illustrations of the lower level Tor al-Tareeq microliths (NEELEY *et al.* n.d.) show nongeometric forms comparable to those from Yutil al-Hasa (especially Dufour inversely retouched, backed and truncated, lunate-type, curved/microburin curved, and microburin trapeze bladelets). At both sites, retouched pieces are the next most frequent type, followed in some cases by notch/denticulates. One notable difference is the somewhat larger representation of scrapers, burins and truncations at Tor al-Tareeq (NEELEY *et al.* n.d., STEVENS 1996: 104). Both sites have numerous microburins, few cores and a tool component dominated by blade(let) blanks. In contrast to the Yutil al-Hasa debitage, the debitage at Tor al-Tareeq reported by NEELEY *et al.* (n.d.) is dominated by blade(let)s, although Stevens' (1996: 81) analysis of the Step C lithics indicates a much higher frequency of flake debitage.

As during the late Ahmarian, the Madamaghan occupation at Yutil al-Hasa appears to have been focused on a limited range of activities. The small size of the rockshelter and the extremely narrow range of chipped stone tool types add supporting evidence that groups utilizing the site during the period represented by the Madamaghan deposits most likely did so in the context of temporary visits. The Yutil al-Hasa rockshelter remained a favorable setting as attested to by the depth of deposits with Madamaghan assemblages, at least 120cm in Unit C (OLSZEWSKI *et al.* 1994: 129-130)[2]. Because bedrock was not reached in Unit C, the depth of Madamaghan deposits probably exceeds 1.2m.

The reasons for chosing Yutil al-Hasa as an activity locale during the Madamaghan are those previously cited for the late Ahmarian period. These include optimal access to animals following the drainage and availability of freshwater through springs across from the site and seeps at the site. The lithic assemblages from Yutil al-Hasa and Tor al-Tareeq are more similar during the Madamaghan than to the late Ahmarian at 'Ain al-Buhira. This might suggest that Yutil al-Hasa was not a satellite task camp associated with a basecamp at Tor al-Tareeq, but that both sites were relatively small temporary occupations, the typical archaeological signature of a relatively mobile population.

The Early Natufian Occupation

The chronologically latest of the Epipaleolithic traditions in the Levant is the Natufian, *c.* 12,500 to 10,000 bp (BYRD 1994: 209-212). In the Wadi al-Hasa three sites (Yutil al-Hasa, Tabaqa and WHS 1021) have yielded lithic assemblages characteristic of the early portion (12,500 to 11,000 bp) of the Natufian sequence. Geoarchaeological investigations in the Wadi al-Hasa, in the Rift Valley and in the Wadi al-Hammeh, as well as general environmental studies (*e.g.*, MOORE and HILLMAN 1992), have indicated that the interval corresponding to the early Natufian was moist and typified by high spring levels (MACUMBER and HEAD 1991: 172, SCHULDENREIN and CLARK 1994: 48). Locally, the Wadi al-Hasa and some of its tributary drainages would have been characterized by areas of spring-fed marshes, perhaps seasonal in nature (SCHULDENREIN and CLARK 1994: 48). Pollen samples from the early Natufian deposits at Yutil al-Hasa have yet to be analyzed; macrobotanical remains from the site of Tabaqa yielded charred Gramineae, indicating the presence of grasses (BYRD and COLLEDGE 1991: 272-273). Faunal remains from Yutil al-Hasa include both mesic species such as *Bos primigenius* and open steppic representatives such as *Gazella* (OLSZEWSKI *et al.* 1994: 135).

The lithic assemblage from the early Natufian occupation at Yutil al-Hasa (upper levels of Unit D) is relatively small. A total of 844 artifacts were recovered, including 67 tools (7.9% of the assemblage). Helwan retouch is present on the majority of the lunates as well as on several backed bladelets. One curious aspect of this assemblage is the slight dominance of nongeometric microliths, a feature of Mediterranean forest early Natufian assemblages (BYRD 1987: 295-296, 1989: 181; OLSZEWSKI 1986: 103, 1988: 136), although this may be an artifact of small sample size at Yutil al-Hasa. Summary information on the tool types is presented in Table 1. The quantities of blades, bladelets and flakes used as blanks for tools, and among the debitage are detailed in Table 2. Data on cores are found in Table 3.

Early Natufian tools from Yutil al-Hasa are dominated by microliths but they also include a moderate amount of notch/denticulates. All other tool classes are rare. Two interesting comparisons can be made between this tool assemblage and the Madamaghan and late Ahmarian assemblages from

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1 The 1992 Unit B and C frequencies are the highest, while the 1984 Step B and C frequencies are somewhat lower in NEELEY *et al.* (n.d.). This appears to reflect the difference between a preliminary field sort in 1984, without further detailed study, and the more detailed classification of the 1992 Units B and C materials. It should be noted that a recent reanalysis of the 1984 Step C assemblages by STEVENS (1996: 104) shows that microlith frequencies usually range between 60% to 70% for the lower levels.

2 Unit E contained only a thin occupation layer immediately above bedrock, and Unit D had 26cm of deposit with probable Madamaghan lithics (field notes in possession of author).

earlier occupations at the site[1]. First, the percentage of microliths in the early Natufian is greater than that of the late Ahmarian, but far less than during the Madamaghan. Second, the frequencies of other tool classes in the early Natufian are closer to those of the Madamaghan than to the late Ahmarian. Thus, the early Natufian assemblage from Yutil al-Hasa appears to reflect an emphasis on a somewhat specialized toolkit. Debitage patterns in the early Natufian are almost identical to those of the late Ahmarian and Madamaghan, with the predominance of small flakes indicative of core reduction, tool manufacture and resharpening.

A comparison of the Yutil al-Hasa assemblage to that from the site of Tabaqa, some 6.5km northwest (downstream), reveals a similar tool kit composition. Tabaqa also has slightly over 50% microliths, followed by notch/denticulates and retouched pieces. Interestingly, nongeometric elements are important at Tabaqa, occurring almost as frequently as geometric forms. Unlike Yutil al-Hasa, however, the site of Tabaqa contains higher frequencies of scrapers and burins. There is also a diverse array of ground stone implements from Tabaqa (BYRD and COLLEDGE 1991: 272). Another difference between the two sites can be seen in the debitage. At Tabaqa, flakes and blade(let)s are almost equally numerous, while the assemblage from Yutil al-Hasa is clearly dominated by flakes (especially small flakes).

The early Natufian occupation at Yutil al-Hasa seems to reflect a continuation of a limited range of activities at the rockshelter. It is probable, as with earlier occupations, that the early Natufian represents a series of short-term visits. The rockshelter must have served as a favorable location, at least intermittantly during the early Natufian period, when seasonal marshes were active. The Yutil al-Hasa early Natufian deposits occur near the top of the slope deposits, and were located throughout approximately 50cm of deposits in Unit D (OLSZEWSKI *et al.* 1994: 129-130).

It is likely that access to animals following the drainage and availability of freshwater at springs across from the site were continued attractions of the site area during the early Natufian. The chipped stone assemblages from Yutil al-Hasa and Tabaqa are similar in many respects, although the greater diversity of tools and the presence of numerous examples of ground stone implements at Tabaqa argue for a basecamp function. Yutil al-Hasa might represent a task camp associated with Tabaqa, located about 6.5km downstream. These site functional assignments are reminiscent of the late Ahmarian period in the Wadi al-Hasa, rather than those of the Madamaghan period.

Comparisons to the Azraq Region

The nearest parallel to the archaeo-ecological situation in the Wadi al-Hasa can be found in the extensive research accomplished in the Azraq region, where an analogous lake, marsh, pond, and springs biome was present during the Pleistocene (GARRARD *et al.* 1985, 1986, 1987, 1988). Three non-contiguous areas were intensively surveyed; these include an area of the Wadi Jilat[2], a portion of the Wadi Uwaynid and a section of central Azraq Basin. Late Upper Paleolithic assemblages from this region have not been attributed to the late Ahmarian tradition, so this period is not considered below. A discussion of the wide geometric industries from Kharaneh IV (MUHEISEN 1985, 1988) in the Azraq area and from Tor al-Tareeq (NEELEY *et al.* n.d., STEVENS 1996), and of the "Non-Microlithic" industries of the Azraq (BYRD 1994: 211-212) also are not applicable to this discussion because these types of assemblages were not retrieved from Yutil al-Hasa.

The Madamaghan Period

In the period from about 20,000 to sometime after 14,000 bp, there are a number of chipped stone assemblages from sites or levels of sites in the Azraq region that have been classified generally as "Non-Natufian Microlithic" (BYRD 1994: 210-211). Most of these assemblages can be attributed to the Madamaghan tradition (see Terminological Issues section below). These assemblages are characterized by the extensive use of the microburin technique, the production of numerous nongeometric microliths (curved, arch backed bladelets predominate early; wider La Mouillah points are typical of later assemblages) and rare tools of classes other than microliths. Sites with these assemblages include Wadi Jilat 6 (lower and middle phases), Wadi Uwaynid 14 (middle and upper phases) and Wadi Uwaynid 18 (Trench 1 upper phase, and Trench 2 upper phase) (BYRD 1988: 259-260) (Fig. 2).

The sites in the Wadi Uwaynid are within 10km of the Azraq marshes (BYRD and GARRARD 1990: 91). As a result, fauna from the Uwaynid sites includes *Bos primigenius*, indicative of relatively moist local conditions. In both the Uwaynid and Jilat areas, however, the most numerous faunal remains are those of open steppic game such as *Gazella* and *Equus*. A minor amount of *Lepus capensis* (hare), *Canis lupus* (wolf) and *Testudo graeca* (tortoise) also occur (BYRD and GARRARD 1990: 88-89).

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1 The small size of the early Natufian assemblage might bias these comparisons.

2 This area was previously surveyed as the Wadi Dhobai by WAECHTER and SETON-WILLIAMS 1938.

Local ecological conditions in the Wadi Jilat also appear to have been more moist during this period, based on sediment and root cast analyses from the deposits at Wadi Jilat 6 (GARRARD and BYRD 1992: 52). Additionally, analysis of profiles of sedimentological sequences in the Wadis Jilat and Uwaynid has indicated that water tables were higher and vegetation cover was more continuous across the landscape during the period from about 23,000 to 15,000 b.p. (GARRARD *et al.* 1988: 333).

Settlement patterning during the Madamaghan period in the Azraq area has been interpreted as one of repeated, short-term visits to favored locales (BYRD 1988: 260). Additionally, the seemingly "specialized" tool kit of the Madamaghan (almost exclusively focused on microliths) might be attributable to an emphasis on hunting, with microliths serving as projectiles (BYRD 1988: 260). The situation in the Azraq region apparently mimics the patterning seen in the Wadi al-Hasa at the sites of Yutil al-Hasa and Tor al-Tareeq (lower levels). As yet unanswered is the question of why this period is characterized by a highly mobile settlement pattern in regions where lakes, marshes, or ponds, and the presence of springs, were local attractions that in earlier (*e.g.*, late Ahmarian/late Upper Paleolithic) and in later (*e.g.*, early Natufian) periods appear to have been influences leading to logistically organized settlement patterning.

The Early Natufian Period

Chipped stone assemblages of the early Natufian period are widespread throughout the southern Levantine region. In recent years, the notion that this lithic complex was restricted to areas of the Mediterranean forest has been challenged by the discovery of early Natufian assemblages in areas of the eastern Levant that were not characteristic of Mediterranean forest or wet steppe (*i.e.*, the Wadi al-Hasa and the Azraq Basin) (BYRD 1994: 214, BYRD and COLLEDGE 1991, GARRARD 1991, OLSZEWSKI *et al.* 1994: 135). The only Azraq region site characterized as early Natufian is the site of 'Ain al-Saratan in the central Azraq basin survey area (Fig. 2). The lithic assemblage is typically early Natufian, with Helwan retouched lunates and bladelets, followed by retouched pieces and rarer endscrapers, perforators and notches (GARRARD 1991: 237, GARRARD *et al.* 1987: 20-21). Ground stone implements also were recovered, as were human burials.

Ain al-Saratan is located adjacent to a small spring, within a kilometer of major springs at the oasis at Azraq and within a half kilometer of a large playa area that often forms a marsh of several square kilometers (GARRARD 1991: 236). The central Azraq Basin during this period was characterized by a large lake, perhaps on the order of 700 km^2; this lake is thought to have fully retreated by the end of the late Natufian period (GARRARD *et al.* 1985: 8). The locally mesic conditions are reflected by the presence of *Bos primigenius* in the faunal assemblage from 'Ain al-Saratan. Other major constituents of the faunal assemblage are *Equus hemionus*, *E. asinus*, and a few *E. hydruntinus*, as well as *Gazella*. A minor number of *Lepus capensis*, *Canis lupus*, *Vulpes* (fox), and two birds, *Anas acuta* (pintail) and *Anas querquedula* (garganey) were present (GARRARD 1991: 239-240).

Settlement patterning in the Azraq region during the early Natufian period is difficult to characterize. The cultural materials and burials from 'Ain al-Saratan suggest that it may have been a base camp locale (GARRARD 1991: 242), possibly as part of a logistically organized system. But intensive survey of the area chosen in the central Azraq basin, as well as the surveys in the Wadis Jilat and Uwaynid, did not locate any other sites attributable to the early Natufian period. On the basis of presently available data it is not possible to determine whether the lack of early Natufian sites other than 'Ain al-Saratan reflects a genuine absence of most occupation during this period in the central Azraq basin, or if these sites are undiscovered due to burial (GARRARD 1991: 242). Their absence in the Wadis Jilat and Uwaynid, where most sites have been exposed through deflation, may argue for minimal use of the Azraq region during the early Natufian period.

Several comparisons and contrasts between Azraq and the Wadi al-Hasa during the early Natufian period can be made. Both areas contain sites with chipped stone assemblages that are primarily microlithic, suggesting some continuation of emphases on hunting activities, although ground stone implements in both regions probably also point to use of plant foods such as various grasses (most likely the cereals). Settlement patterning in both regions appears to reflect a logistically organized system, with the presence of basecamps (Ain al-Saratan and Tabaqa). In the Wadi al-Hasa there also are documented task locales (Yutil al-Hasa and WHS 1021[1]). At present, early Natufian occupations seem to be more visible in the Wadi al-Hasa region. It is possible that this variation has its roots in differences in local ecological conditions, in smaller chronological divisions within the early Natufian, in conditions of preservation, or in some combination of these factors.

1 The latter is cited as a task camp associated with Tabaqa (BYRD and COLLEDGE 1991: 273).

Terminological Issues

Research over the past twenty years in the eastern Levant has added considerable knowledge about the range of variation present in lithic assemblages of the late Upper Paleolithic and Epipaleolithic periods (BYRD 1988, 1990; CLARK *et al.* 1987, 1988, 1992, 1994; COINMAN 1990, 1993; GARRARD and BYRD 1992; GARRARD and PRICE 1975; GARRARD *et al.* 1985, 1986, 1987, 1988; HENRY 1989, 1995; MUHEISEN 1985, 1988; NEELEY *et al.* n.d.; OLSZEWSKI *et al.* 1990, 1994). One important realization has been that these lithic assemblages often constitute industries that are quite distinct from those previously known from the western Levant. At the same time, however, the industries of the eastern Levant can be recognized as belonging to broader lithic complexes characteristic of both the western and eastern Levant (following HENRY 1995).

At the present time the systematics of typology and industry nomenclature with respect to these eastern Levantine assemblages is undergoing rapid growth, with the creation of newly designated types and industries[1] or the rebirth of industries named earlier during this century[2]. Additionally, some researchers (BYRD 1994: 210-211) have opted to use labels that are more generic, such as "Non-Natufian Microlithic" and "Non-Microlithic". To some extent, the use of either the plethora of specific named industries or of generic labels reflects the difference between "splitters" and "lumpers". The choice of one set of labels or another has implications for our understanding of the archaeological record, for potentially important variability often is masked by adopting a "lumper" approach, while the "splitter" tactic concentrates so heavily on the minutia of lithic assemblages that it is difficult to determine whether or not such lithic differences are indeed important or meaningful. The rush to name new industries has meant that the implications of linkages between industries, and between industries and complexes, are not always allotted sufficient research and time to resolve.

A good case in point is the Madamaghan industry, which was recognized by HENRY and GARRARD (1988) based on their work at Tor Hamar in southern Jordan (Fig. 2). Rather than keying this assemblage to Tor Hamar, however, they chose to use Wadi Madamagh in the Petra region (KIRKBRIDE 1958) as the type site. Further complications include the attribution of the Madamaghan industry to the Mushabian Complex by HENRY (1989: 134-138, 1995: 295-297), the recognition of assemblages similar to that from Wadi Madamagh in both the Wadi al-Hasa (OLSZEWSKI *et al.* 1994) and the Azraq Basin (BYRD 1988, GARRARD and BYRD 1992), as well as with the Nebekian of Syria (RUST 1950), and the chronological precedence of the microburin technique at sites in the Azraq Basin (BYRD 1988: 260, GARRARD and BYRD 1992: 50) compared to Tor Hamar and to Mushabian Complex sites of the Negev and Sinai (HENRY and GARRARD 1988: 5, PHILLIPS and MINTZ 1977).

It is clear, at the very least, that the assemblages from Wadi Madamagh in the Petra area, from Yutil al-Hasa and perhaps the early phases at Tor al-Tareeq in the Wadi al-Hasa, from Uwaynid 14, 18 and Jilat 6 in the Azraq region, and from Jabrud III/6-7, are not linked to the Mushabian Complex sites of the Negev and Sinai (BYRD 1988: 263, GARRARD and BYRD 1993: 59, OLSZEWSKI *et al.* 1994: 139). Whether or not the assemblage from Tor Hamar is more closely aligned with these eastern Levantine arid adaptations, or with the arid adaptations of the Mushabian Complex of the southern Levant is not readily apparent.

In this paper, Madamaghan is the term selected for one of the sets of Epipaleolithic occupations at Yutil al-Hasa. This is because the characteristics of the Yutil al-Hasa assemblage are extremely similar to the assemblage from Wadi Madamagh and to early Epipaleolithic eastern Levantine assemblages from the Azraq. I have chosen to disassociate the term Madamaghan from the Mushabian Complex linkage (claimed most recently in HENRY 1995), believing that the weight of the archaeological evidence does not support this contention. On the other hand, to use BYRD'S (1994: 210-211) Non-Natufian Microlithic as a descriptive label seems to me to hold too much potential for masking the very variability we are attempting to coax from the archaeolgical record of ancient hunter-gatherers.

Our assemblage labels are, of course, ultimately only classificatory devices that allow us to address various aspects of past human behaviors. They can be and have been interpreted as representing everything from distinct groups of peoples (*e.g.*, GORING-MORRIS 1995, HENRY 1989), to specialized activity sets (*e.g.*, the Jilat knives and related assemblage from Phase C at Wadi Jilat 22 in GARRARD and BYRD 1992: 59), and to processes of lithic reduction and utilization of raw materials (*e.g.*, NEELEY and BARTON 1994). The debates that these differing perspectives have generated often have been productive, although at times also disconcerting in their intensity. As I (OLSZEWSKI 1994: 88-89) and others (BELFER-COHEN 1995: 252, BYRD 1988: 263, PERLES and PHILLIPS

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1 For example, the Qalkan, Hamran and Madamaghan industries proposed by HENRY (1989), and the "Hasa lunate" coined by NEELEY *et al.* (n.d.).

2 For example, the Nebekian proposed by RUST 1950, and mentioned in BYRD 1988: 263 and in GORING-MORRIS 1995: 151-152 as having temporal precedence as a named industry.

1991) have urged elsewhere, our use and creation of terminology, particularly when it is linked to the hypothesis of distinct human groups, should reflect more than a single differing criterion. We should strive to generate sets of criteria that incorporate distinctions in lithic assemblages but that do not rely exclusively on lithic assemblages as their *raison d'être*.

Conclusion

Intensive archaeological research in the Wadi al-Hasa region began with the surveys of the south bank of the drainage (WHS) (MACDONALD *et al.* 1980, 1982, 1983) and have continued up to the present with the surveys of the north bank of the drainage (WHNBS) and test excavations at selected sites (CLARK *et al.* 1987, 1988, 1992, 1994; NEELEY *et al.* n.d.; OLSZEWSKI *et al.* 1990, 1994). The site of Yutil al-Hasa (WHS 784), a small collapsed rockshelter in the Wadi al-Hasa, was one of several tested sites. Excavation seasons in 1984 and 1993 documented the use of this locale during at least three chronological periods of the late Pleistocene, the late Upper Paleolithic (late Ahmarian), the early Epipaleolithic (Madamaghan), and the late Epipaleolithic (early Natufian) (OLSZEWSKI *et al.* 1990, 1994). The archaeological record from this site indicates that it was used intermittently as a small task camp throughout almost 8,000 years. Repeated visits to the site probably were temporary in nature and keyed to locally mesic conditions occasioned by the presence of numerous springs and a lake and marsh/pond biome.

Cultural materials recovered from Yutil al-Hasa, as well as other late Pleistocene sites in the Wadi al-Hasa (Ain al-Buhira, Tabaqa, Tor al-Tareeq), have afforded a small glimpse into prehistoric adaptations linked to a paludal setting. The most comparable archaeo-ecological research to that of the Wadi al-Hasa is the survey and excavations in the Azraq region (BYRD 1988, 1990; GARRARD 1991; GARRARD *et al.* 1985, 1986, 1987, 1988). The archaeological record of the two regions during the late Pleistocene is quite similar, although there are notable differences that remain to be explained (*e.g.*, the relative intensity of early Natufian occupation in both regions).

There are at least two critical areas of future research needs and strategies with respect to gaining a more complete understanding of past adaptations that were centered on lake/marsh settings. The first of these is expanded testing at sites previously examined to retrieve larger sample sizes and improve knowledge of the time resolution in these deposits through more extensive dating. This should be undertaken in conjunction with preliminary testing at previously unexcavated sites targeting not only those with deeply stratified deposits, but also those that document "single occurrence" visits (or at least a small number of repeated visits). The recovery of these data sets is necessary to the further development and refining of settlement systems in regions such as the Wadi al-Hasa and the Azraq. This program of research for the late Upper Paleolithic and Epipaleolithic periods is in the planning stages for the Wadi al-Hasa[1].

Second, a synthethic overview of all available data from Levantine areas characterized by Pleistocene lakes (Wadi al-Hasa, Azraq Basin, Damascus Basin, Jafr Basin, Wadi al-Hammeh, and others) needs to be undertaken. This type of overview will result in a better understanding of the range of variation in locally mesic conditions and their potential influences on the settlement systems of past hunter-gatherer populations. For example, the intensive survey of the entire Wadi al-Hasa drainage system and all areas within a kilometer of it has produced a comprehensive picture of site distributions in the immediate vicinity of the lake/marsh compared to the Azraq region, where several non-contiguous areas were intensively surveyed. In the latter case, a comprehensive picture of an extremely large region has resulted.

There is much research and field work remaining to be done. The ultimate results of these pursuits will be the addition of interesting, and perhaps exciting, information about ancient human groups' adaptations to changing environmental conditions throughout the late Pleistocene.

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[1] Nancy Coinman (Iowa State University) and the author currently are developing a preliminary settlement system model based on the available Wadi al-Hasa data. They also are planning a return to the Wadi al-Hasa to continue research necessary to refine the preliminary model.

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Status, Perspectives and Future Goals in Jordanian Paleolithic Research

Lorraine Copeland

Introduction

Each of the twelve contributions to the present volume reviewed here have something refreshingly thought-provoking to say about one or another aspect of Jordan's Paleolithic. Not all areas of the country or archaeological subjects are covered (for example, all the papers on the Middle Paleolithic concern just the southern sites), so that this volume is not to be seen as giving a complete overview of the Paleolithic period. I will try to redress the balance by discussing the other research projects recently carried out in Jordan, as well as the more illuminating work done in neighbouring countries.

A number of the contributions herein report on important new discoveries of lithic, faunal or other material, and discuss the implications of these for Near East prehistory, while others offer re-evaluations (there are several of these!) of the interpretations first applied, sometimes only a few years ago, to certain sites or materials. The need for such re-evaluations is illustrative of the problems resulting from the acceleration so marked in the last two decades in the acquisition of new data on the Paleolithic. Research has taken place in areas of Jordan from which, previously, almost no information had been obtained. The same period saw the emergence of new analytic methods and research tools which allowed users to study the finds in more depth (or, as some might say, according to more fashionable ways of viewing it). Nevertheless, a glance at the map will show that the data come from small "patches", with large areas of *terra incognita* in between. I will return to this point later.

I am assuming that the contributions will have been read, and that no lengthy synopsis of each will be necessary (I don't want my comments to sound like a series of book reviews). I am aware that many comments will sound as though I am preaching to the converted; yet the editors have asked me to focus on directions for future research, as well as to discuss the questions which have arisen as a result of recent work.

The articles herein may conveniently be divided chronologically according to whether they deal with the Lower, the Middle or the Upper/Epipaleolithic periods in Jordan.

The Lower Paleolithic

The three contributions are so varied in scope that I can best deal with them individually.

Up to now, evidence for the Jordanian Lower Paleolithic (henceforth LP) has been based (with certain exceptions) on unstratified material and on the Late Acheulean/ late Middle Pleistocene phase. Now, a new dimension of major importance has been added to our knowledge of the earlier Paleolithic by the finds of Early Pleistocene fauna (PARENTI *et al.*, this volume) in the Early (or Early Middle) Pleistocene of the oldest fluviatile terrace in the upper Zarqa valley - the Dauqara Formation. This was first identified by Besançon *et al.* (1984) in 1982-3. Whether the poor flake industry found then by my team and now augmented by the artifacts (in sub-unit 3c) found by Parenti *et al.* are directly or only relatively contemporary with the fauna (in sub-unit 3b) remains to be established; the species present include *Mammuthus meridionalis*, *Equus* cf. *tabeti* and *Bos primigenius* and are considered by Guerin (a co-author) to refer to Biozone 19/20, *i.e.*, a stage slightly more evolved than that at Ubeidiya and earlier than the fauna associated with the Latamne Middle Acheulean. The suggested date is *c.* 0.9 - 1 mya. The artifacts in the same formation, collected at various points, consist of cores and rough flakes but no bifaces. These finds considerably alter our perceptions of the pre-Late Acheulean phase in Jordan.

Up to now, claims (regarded as dubious by most workers: *cf.* Macumber, this volume) for these early periods had been made by Huckriede (1964) and by Bender (1974), for example that the Abu Habil Formation near Pella referred to the Middle Pleistocene or referred to the Early Pleistocene Ubeidiya Formation in Israel. These views were supported by reports of archaic-seeming surface finds (thus undatable) of "Oldowan", "Pebble Tool Culture" etc., both in northern and southern Jordan. In the first draft of a paper on the Lower Paleolithic (COPELAND n.d.), I was able to write "... there is no unequivocal evidence for Early Acheulean occupation east of the Rift and little which might refer to a Middle Acheulean phase either." This is no longer the case (I will discuss use of the terms Early and Middle Acheulean later). Given that the fauna and the flints are (if only broadly) contemporary in the substantial and complex Dauqara Formation, which was considered, after continued research, to have included traces of more than one climatic cycle (BAUBRON *et al.* 1985), it appears that the East Bank Highlands were occupied by hominids fashioning a coarse flake and core industry at a time not much later than that of 'Ubeidiya (the latter dating to *c.* 1.4 - 1 mya; BAR-YOSEF 1994a). At the very least we can say that they lived before the well-known and ubiquitous Late Acheulean industries were in use; the latter are associated on the Zarqa with the next oldest Zarqa terrace: the Bire Formation (Q2) of Baubron *et al.* (1985).

Parenti *et al.* review the various other Near East assemblages thought to preceed the 'classic' Late Acheulean in the Levant, but except for the well known Latamne Middle Acheulean and related sites, the earlier occurrances are shadowy entities, perhaps vestiges of unstandardised industries without bifaces; they were found in ancient shorelines (Borj Qinarit) or fluviatlle terraces (Khattab) as noted by Hours (1981); none seem to resemble the Dauqara material closely, and the artifact types present are somewhat different from most of those coming from the 'Ubeidiya Formation, where, although bifacials are absent in one assemblage, the main tools consist of picks, trihedrals, choppers, polyhedrons (or cores) and flakes (BAR-YOSEF and GOREN-INBAR 1993). Bar-Yosef (1994b) has asked what this apparent diversity could represent: different groups? arrivals from Arabia or the Red Sea coast instead of by way of the "Levantine corridor"? Are they to be called "Early Acheulean"? Hopefully, Parenti *et al.* will augment their finds in the near future, and I suggest that efforts be made to study other early terrace sequences in Jordan, especially to the south where past high rainfall regimes have produced vast quantities of fluviatile debris (see MACUMBER, this volume). Meanwhile, it is gratifying to me and my Lyons team to realise that our approach (to establish the geochronological stratigraphy of terraces in major river valleys (BESANÇON *et al.* 1988), *e.g.* on the Orontes (SANLAVILLE *et al.* 1993), was not *sans lendemain* and has borne fruit in Jordan!

Now to tackle the confused state of Acheulean phase nomenclature. The following comments are based on a detailed discussion on this subject by Bar-Yosef (1994a), who sees a kind of consensus in the Near East that all the early industries, even those without bifaces, could refer to Acheulean variants and that terms such as "Oldovan" should be avoided. Time will tell whether this view will remain valid; already some authors are not following this custom (*cf.* the "Oldowan" of Whalen *et al.* [1989] at Shuwaihitiyah near Wadi Sirhan, just over Jordan's frontier with Saudi Arabia).

As to the "Middle Acheulean", both in early publications and in the Levant today this means different things in different regions depending on authors (BAR-YOSEF 1994a). D. Gilead (1970) proposed a typological scheme based on the elaboration of biface forms. The term is used, largely subjectively, by Le Tensorer *et al.* (1993) at Nadaouiyeh I/Ain Askar, El-Kowm. At Dawadmi/Saffaqa in Saudi Arabia, Whalen *et al.* (1983) base their use of the term on the perceived resemblance of the artifacts to those of the typesite, Latamne. The problem is exacerbated by the fact that already in the Middle Acheulean there are variants which do not resemble the one at Latamne, *e.g.* Ras Beirut lb and Berzine (HOURS 1981).

As a solution, perhaps interim, to the problem, I have recently proposed (COPELAND n.d.) to refer artifact occurrences to their geological context and thus to their relative position in the regional geochronological sequence; this is an implicitly linear scheme whereby flint occurrances found in Early Pleistocene contexts are referred to the Early Acheulean (Q4; *e.g.* 'Ubeidiya), any that are from early Middle Pleistocene contexts (Q3) to the Middle Acheulean (*e.g.* Latamne, Evron), and those relating to the late Middle Pleistocene (Q2) to the Late Acheulean (*e.g.* Mashari'a 1). Of course, this is difficult when the context is not as yet known, but we should still try to avoid categorising an assemblage only on the basis of the perceived coarseness of the technology. An assemblage could represent the remains of a factory area, from which the 'good' pieces had been removed. Sometimes, the presence of a marker (I hesitate to use the usually-despised term 'type-fossil') is helpful. However, ideally, stylistic and other attributes (as well as typotechnological features such as those of Gilead's scheme for Late Acheulean bifaces) should be looked for, *e.g.* the percentage of straight edges, worked bases, symmetric silhouettes (*cf.* the C-Spring analyses, COPELAND 1989a).

Turning to the work of Edwards and Macumber, this has taken place in the Pella region near the edge of the Rift Valley and in fluviatile terraces in the upstream areas further east. So far the results seem to have produced the only evidence for an industrial development (from Middle to Late Acheulean?) occurring within one alluvial terrace complex, but this remains to be confirmed. Of the five LP sites identified in the substantial Tabaquat Fahl Formation (henceforth TF), Mashari'a 2, 4 and 5 are referred to the lower, conglomeratic member, and sites 1 and 3 to the upper, tufaceous member overlying the conglomerate at the lip of the drop to the Rift. While a fine Late Acheulean assemblage was found *in situ* at Mashari'a 1, embedded in the tufas, the lower member contained material which may refer to the (so far missing in Jordan) Latamne-type Middle Acheulean phase, with narrow, heavy trihedric bifaces (see these illustrated in MACUMBER 1992: Plate 2). The expected datings could throw light on this curious situation; meanwhile we assume that the lower member was laid down considerably earlier than the upper one (or that the Middle Acheulean traditions, if they are what is represented here, continued later in Jordan than in Syria).

The evidence for the presence of two depositional episodes in the TF Formation may explain a similar situation reported by, *e.g.*, Villiers (1983) and by Muheisen (1988) in the adjacent Abu Habil Formation, that is, if Macumber (1992) is correct in regarding the latter as equivalent to the TF Formation. Abu Habil, then, may be alive and well after all, even if it contains Late and Middle Acheulean rather than anything earlier.

When the authors question the meaning of the Mashari'a assemblages (discrete entities? the results of repeated visits from tool-using hominids? due only to a hiatus in sedimentation?) I am reminded of discussions on this subject held on the Orontes terraces with Besançon and Sanlaville, who stressed the role of chance in situations of water flowing over a river bed, which affects not only spatial distributions (artifacts scattered or concentrated?) and physical condition of the artifacts (sharp or rolled?), but also their variability (sorting into heavy versus light pieces). However, if archaeologically *in situ* they may not be, they are geologically at least referred to the time of the river when it flowed at that elevation, and thus can't be *younger*.

I think the authors are right to draw attention to the flake component in Late Acheulean industries, in which not all the flakes result from biface production. (This has a bearing on the question, discussed earlier, of Acheulean variability in all three phases and on the old question: how many bifaces are needed for an industry to be classed as Acheulean?).

In considering the two above-mentioned contributions, I am wondering if data will be found linking up the TF and the Bire Formations. They should be of relatively the same (Q2) age; conversely, will traces of a QIII-IV (Dauqara) Formation turn up in the Pella area? If not, why not?

The third paper on the LP is that of Rollefson *et al.* The recent finding in the Shishan spring area of the Azraq Basin of hundreds of bifaces and later material, discovered fortuitously, forms a good example of how good (new data) may follow evil (bulldozer trenching). The finds come from ancient lakebed sediments in areas previously inaccessible to prospections such as those of Besançon *et al.* (1989) - the spring pools at Shishan. Since the team includes the finders, who are paleoclimatologists, we may expect some interesting new kinds of environmental information to emerge, including that resulting from coring into the lake bed sediments.

I need hardly urge the team to focus on a search for stratified sediment sequences which might contain traces of more than one Acheulean phase. It will be recalled that either two phases or a distinct shift in environmental conditions were evidenced in Kirkbride's 1956 excavation at Lion Spring, not far to the south; in her lower, sandy levels (5f - 5b) 42% of the artifacts were brown-patinated, and black patinas were absent. Above, in levels 5a2 and 5a, black patinas formed 42% of the artifacts and only 10% were brown. In the grey clay of level 4, there were no brown patinas and black patinas amounted to 43% (COPELAND 1989b). This means that the Kirkbride materials should not be lumped in comparative analyses.

The new sites of Rollefson *et al.* promise to expand our knowledge of the amazingly rich Acheulean occurrances at Azraq. What will their relationships turn out to be with the adjacent site excavated at C-Spring, which contained well-defined stratigraphy and was provisionally interpreted as a knapping area (COPELAND 1991)? At the time of writing nothing similar has been located in the Near East (except possibly Ma'ayan Barukh in Galilee), even at El-Kowm, where the Acheulean sites seem to cluster more closely around the mound spring pools. It is worth recalling the large body of evidence indicating that the explosion of Late Acheulean industries in the Near East coincided with a climatic amelioration. Examples are the well-dated "Acheulean wet phase" of Wendorf *et al.* (1994), with lakes and spring episodes, in the Eastern Sahara, the earliest spring outbursts at Kharga Oasis with Late LP industries of Caton-Thompson and Gardner (1932), the abundance of Late Acheulean in the spring deposits at El-Kowm and Azraq, the numerous reports of Acheulean in the most arid areas of Arabia. A comprehensive list of the latter can be found in Abdul Nayeem (1990). So, the Shishan sites may represent the first and perhaps earliest penetration of hominids into Arabia.

Or do they? There are hints that the Late Acheuleans were not the earliest arrivals. They could have been preceeded by Early/Middle Pleistocene groups fashioning Latamne-type Middle Acheulean tools (trihedrals, polyhedrons), for example, as seen in the El-Kowm basin at El-Meirah in paludal deposits (*i.e.* in an earlier wet phase?) some distance from the springs (BOËDA and MUHESEN 1993: 51, 91). Furthermore, as mentioned already, at Dawadmi/Saffaqa Latamne-like assemblages were discovered, significantly, in a region containing fossil waterfalls (WHALEN *et al.* 1983). Even more ancient typo-technologically may be the "Oldowan" (?) assemblages reported at Shuwaihitiyah, near the Wadi Sirhan (WHALEN *et al.* 1989, WHALEN and PEASE 1990). So far, although these are excavated sites, there are no reliable dates or independent evaluations of the material.

In light of the above, it is regrettable that there is so little contact between workers in Jordan and her eastern neighbour. No Arabian sites are mentioned by the contributors. Could this be due to regional politics? I feel that the last word has not yet been written on the subject of Acheulean distributions both in time and in space, and that paleolithicists should keep a weather eye on research developments in the Peninsula. These could have major implication for our understanding of the chronology and the routes of human migrations during the LP era.

Concerning the end of the LP, so far the presence of Yabrudian has not been clearly attested in Jordan - but watch this space! To sum up, a wealth of new information on all three Acheulean phases has been discussed in the three papers on the LP, but none concern southern Jordan. This suggests the direction which future research should take. We know from the work of Macumber (this volume), Rollefson (1981) at Wadi Bustan and Henry (1995) at Jebel Qalkha, for example, that Acheuleans inhabited this area. It would be all the more valuable if research could begin in the Aqaba area, which, given the reports of Acheulean finds along the Red Sea coast (WHALEN *et al.* 1988) should produce some interesting links.

The Middle Paleolithic

Almost nothing was known of Jordan's Middle Paleolithic (MP) phase only 2 decades ago. Although isolated surface finds were ubiquitous, even now the most valuable data sets come from "patches", isolated from each other in four areas: Wadi Hammeh in the north (EDWARDS and MACUMBER, this volume, Fig. 5), the Azraq Basin (Wadi Enoqiyyah; HOURS 1989), the Hasa drainage (CLARK *et al.*, this volume) and the Ras el-Naqb (HENRY, this volume) in the south. This illustrates the old saying: that site distribution represents the distribution of archaeologists.

In the present volume, in contrast to the northern-oriented papers on the LP, here we are in the south, and only two patches are dealt with: Hasa and Naqb. Both areas have been the focus of major projects since the 1980s and much has been learned. Curiously, the results have brought up unexpected problems. The MP of Jordan does not seem to "fit in" with what is known or believed of the MP period in the western Levant, *e.g.* at Tabun (hey, the east is not like the west!). This may be partly (but not wholly) due to the "sweeping changes" noted by Clark *et al.* in the way we deal today with archaeological data, such as the focus on technology, of which more later. The long, wide-ranging synthesis of these authors is, I'm sure, going to raise cries of dissent from some quarters. Their article is based on the new information from 'Ain Difla rockshelter with its Tabun D-like early Mousterian industry which now has TL, U/Th and ESR dates which place it in the *c.* 180 - 90 kyr bp time range. (This refers it to Tabun IX which, by the "old" (pre-MERCIER *et al.* 1995) datings, is in Stage 6 (or to *c.* 235-278 kyr, Stage 7-8, by the latter authors' latest dating). I note that Clark *et al.* use a pre-Mercier date list of Bar-Yosef (1994b). They use the data to tackle some of the major issues concerning Mousterian research today such as human evolution, transitions, the latest datings from Tabun.

It is an important article because it gives an airing to the "Alternative" or regional continuity view of modern man's origins - alternative, that is, to the much more often exposed "Replacement" or "Out of Africa" theory of, *e.g.*, Bar-Yosef (1989) and Stringer (1989). Clark *et al.* view these issues from an anthropological rather than from an archaeological background (*cf.* "climatically-induced time-sharing", "sympatric species", "competitive exclusion principle", etc.). Concerning the racial overlap, I think that the constraints of the "Levantine corridor" would have had a very different effect on events compared to those in the Western European situation with its range of widely-spaced niches. Would this constriction not have promoted population contact and (on the principle of "if they can, they will") therefore interbreeding? Could this explain the confidence-destroying tendency of paleoanthropologists to change their taxonomic classifications of human types, as well as the rather upsetting fact that the Paleolithic population, mixed or not, used the same range of flint reduction processes subsumed as the "Levantine Mousterian"?

Concerning the detailed discussion of MP dates, the publication of the latest, much older Tabun datings, which form a kind of watershed in our thinking (some of us think pre-MERCIER *et al.* 1995, others now think post-MERCIER *et al.* 1995), strangely cause Clark *et al.* to accept *all* the dates and use them to see "temporal overlap" and an "obliteration" of the division between the LP and MP in Western Asia. And I wonder what will techno-typologists make of the comment about the Mugharan/Mousterian transition that "...the industries themselves appear to blend seamlessly one into another and can only be disentangled statistically?"

It would be very useful to know which dates or sets of dates are mutually exclusive, *i.e.*, whether they have come from the same contiguous samples; if they do, both sets can't be right. If we believe - and most of us do - that like industries are relatively contemporaneous, then we can't have the Yabrudian at Tabun ending before it began at Yabrud I (as Farrand [1994] and Jelinek [1992] have noted in other articles; Mercier *et al.* say that the not-yet-updated determinations are too young and should be re-evaluated to bring them into line with their latest dates from Tabun). Would it be better perhaps to follow Sanlaville (n.d.) in presenting, as an interim measure, two possible scenarios, one accepting the previous dates (*e.g.* BAR-YOSEF 1994b: Table 8) whereby the Mousterian of Tabun IX occurred in Stage 6-5, the other according to the latest datings, which puts it into Stage 7-8?

I must protest that French prehistorians *do* pay attention to the technical aspect of flint analysis. After all, the present 'star' interpreter of MP technology (Éric Boëda) is French! In fact, I think that today the obeisance paid to technology, often at the expense of the typology, smacks of the politically-correct (I note that Bar-Yosef and Belfer-Cohen [1996] tend to agree). Of course it is necessary to pinpoint (as a hostage to fortune perhaps) exactly what reduction-method was in use in the successive levels at a site, but this knowledge has become somewhat of a dead end in the context of our ignorance of what the variability means: different groups occupying the site? or did a grandchild develop knacks /techniques different from those of his grandfather (especially if he never knew the latter)? So have technological studies reachedt heir limits? Not yet, I feel, since even Boëda is still learning (see his important article on the long Mousterian sequence being excavated at Umm el-Tlel [BOËDA and MUHESEN 1993], where many inter-level technical changes occur). Speaking of grandparents, let us remember that there are more than one ways to skin a cat, as Marks and Volkman (1983) found at Boker Tachtit, where Levallois points could be fashioned by different methods, not all involving the "Levallois conception" of Boëda.

As Roller and Clark (this volume) comment, neither technology nor typology can fully explain the function of tools nor can they tell us, for example, why Mousterians needed racloirs while Aurignacians needed end-scrapers and burins. However, it is intriguing to learn from their use-wear studies at 'Ain Difla that Levallois points were used for cutting and scraping but not as arrowheads.

Further to the south in the Jebel Qalkha area a previously unknown series of MP rockshelters were discovered and studied by Henry (this volume) and his team since the 1980s. In contrast to the Hasa drainage sites, which are referred to the Early Mousterian Tabun D-like time range, we have here an occupation by a Late Levalloiso-Mousterian population. There is a very welcome attention to the geostratigraphic and sedimentological aspects and convincing correlations of these with the cultural successions. Have readers noticed the sudden disappearance of the the earlier "southern continuity" idea according to which the Late Mousterian of southern Jordan was referred typologically to the Tabun D-like facies? Henry now likens the Jebel Qalkha MP material to that of the Late Mousterian (Tabun B-like) at Kebara.

The paper of Olson (this volume) discussed the only open air site in the area, referred also to the late LM and interpreted in terms of the altitude-dependent model of Henry (1995), whereby elevational belts are connected to the biotic zones and exploited seasonally by the Mousterians. These studies indicate that the occupations took place in arid steppic conditions, while in the following Early Ahmarian phase the climate became more moist. The contrast between these arid conditions and those said to have existed earlier in the upstream Hasa (lakes; marshes) is marked. One has to ask, what was the reason for this curious division of Mousterian occupations: mainly (*i.e.*, except at site WHS 621) early in Hasa and late in Jebel Qalkha? If not entirely due to environmental shifts, why did the late occupations take place in an arid area and why did the population chose an apparently transhumant way of life? Further surveys, stressing equally detailed sedimentological aspects in both areas as well as the areas in between, will surely go some way to providing answers.

The MP in northern Jordan is today far less well-known and is mainly found, redistributed, in fluviatile contexts. Nevertheless the post-TF formations in the Wadi Hammeh (presumed to refer to the Stages 5-4) contain Mousterian (EDWARDS *et al.* 1988). The oasis of Azraq contains abundant sites, so far found disturbed by erosion or peasant excavation, but curiously the stratified site of C-Spring did not produce any clearly definitive form of Mousterian in the post-Acheulean layers, levels P and Q (COPELAND 1989a; GARRARD *et al.* 1987). I am relying on Rollefson and his team to remedy this lack. If the Tabun D-like Mousterian is no longer regarded by all as "time-transgressive" in Jordan (although it may be in the Negev), it is also clear that even now no "broad oval" facies resembling that in Tabun C (and Qafzeh, Ras el-Kelb, basal Nahr Ibrahim, etc.) has been reported. Tabun B-like assemblages may be present in the bed of the Wadi Ennoquiya (HOURS 1989), but this cannot now be determined.

The Upper Paleolithic (UP) and Epipaleolithic (EP)

These phases in Jordananian sites seem to merge into each other and in this section I will treat the contributions on all the phases in turn. The five contributions bring up entirely new problems and cover a range of subjects; as with the MP, only sites in southern Jordan are discussed.

The "history of research" is short. Although there were many surface surveys by the pioneers, for a long time the only Late Pleistocene excavated industries known from east of the Rift were Wadi Madamagh, Al-Safat and Wadi Dhobai. An explosion of new information came during the 1980s, but no sooner had the first interpretations (based on the perceived cultural succession in the western Levant) been published, than there came the "Ahmarian Revolution," whereby the old linear scheme for the UP (Emiran-Aurignacian-Kebaran) was rejected. Instead, I. Gilead (1981) proposed, based mainly on data from the Negev and Sinai, that an Early UP phase which he named Ahmarian was succeeded by one where, after *c.* 30 kya, contemporary Late Ahmarian and Aurignacian groups inhabited the Levant for the rest of the UP. The Ahmarian was characterised by blade technology, the tools including (at first) straight retouched El-Wad points and few other types, while the Aurignacian tools included classical burins and end-scrapers on flakes and smaller, often twisted, El-Wad points on bladelets. In the Late Ahmarian phase the industries consisted more and more of microlithic forms, in great variety according to region. This scheme was not universally adopted, but workers in the south soon began renaming their "Aurignacian" levels as Early or Late Ahmarian. Later, however, it was found that the new scheme did not in fact fit all the evidence (MARKS 1981), and recently a further change of heart has taken place whereby the old scheme has been partly rehabilitated (*cf.* BAR-YOSEF and BELFER-COHEN 1996), as we shall see from the contributions to be discussed below.

The MP/UP Transition

The question of a MP/UP Transition (sometimes called Emiran and presumed to preceed the Early Ahmarian) is dealt with by Kerry and touched on by Henry (this volume). No Emireh Points were found at Jebel Humeima, and indeed none (except for some possible specimens found on the Wadi Hasa surveys; see Rollefson in MACDONALD *et al.* 1983: 315) have been reported so far from Jordan. Kerry concludes that the small and equivocal samples underlying an (ex-Aurignacian) Early Ahmarian layer cannot be said to represent an Emiran phase. Another site, J433 (Wadi Aghar), was re-excavated in 1993 and, although only briefly mentioned herein by Henry, is interpreted (HENRY 1995) as a Transitional/EarlyAhmarian facies along the lines of the "*Intermédiaire*" levels at Umm el-Tlel at El Kowm.

Clearly, the whole "Transition" question has been revitalised by excavations at Umm el-Tlel by Boëda and Muhesen (1993). Three levels (II'base, III2a and III2b) underlie the Aurignacian (Yes!) of levels 1 and 2 and overlie a series of 20 Mousterian levels (IVla - VI2b). In the three *intermédiaire* levels, the reduction processes differ, but all are aimed at the production of blades and bladey points, including the newly-named "Umm el-Tlel Points", which resemble elongated Levallois Points. Retouched tools consist of burins (truncation and dihedral), robust endscrapers and, instead of bladelets, the small debitage component consists of miniature elongated Levallois-like points. Just as at Umm el-Tlel, the Wadi Aghar retouched tools consist of endscrapers and burins, thus indicating that the assemblage is already UP. In my view, this material bears certain resemblances not only to that at Boket Tachtit 1-4 but also to that in the early UP (Emiran or "Ksar Akil Phase A") levels XXV - XVIII at Ksar Akil (OHNUMA 1988) and has no resemblance to the "Early Ahmarian" in southern Jordan except here at Wadi Aghar (see also the similar views of BAR-YOSEF and BELFER-COHEN 1996: 140). If these interpretations are valid, they do tend to confirm the overall "lateness" (Tabun B) of the MP in the Neqeb, and, as mentioned above, the idea of continuity from Tabun D into a transitional phase does not seem to hold up.

Umm el-Tlel, with its long multi-cultural sequence, is going to become a key site, joining Ksar Akil in this respect; it is especially valuable in being excavated by modern standards. Meanwhile, since the Intermediate levels are as yet undated, Boker Tachtit remains the earliest dated UP site in the Levant; the lowest level has Emireh Points and the typology (burins and endscrapers, not racloirs) is already UP, so that it could be argued that the transitional stage had already been passed. Thus, the origins of the UP here remain in doubt.

The Ahmarian and the Aurignacian

At Umm el-Tlel the overlying UP levels were C-14 dated to *c.* 30,300 - 30,700 bp (considered to be too young; CAUVIN and STORDEUR 1994) and the industry was first referred by Molist and Cauvin (1990) to the Levantine Aurignacian B as known at Ksar Akil; it is a mainly blade facies with plenty of bladelets struck from the sides of chunky cores (hence twisted), with burins, nosed and carinated endscrapers among the larger tools; analyses are not yet complete and so the assemblages are not assigned to a particular UP phase by Boëda and Muhesen (1993).

As for the "Early Ahmarian" in the upper level at Jebel Humeima (KERRY, this vol.), I note that it is said to contain 20% endscrapers, 10% burins, 12% El-Wad points and plenty of bladelet debitage! A later Ahmarian stage is reported at Tor Aeid (WILLIAMS, this volume) where new excavations added Ahmarian material to the earlier finds. Some curiously-broad El-Wad Points occurred here and the core reduction changed upward from discoidal to unipolar; Williams interprets this and other evidence as indicating that the Aurignacian does not exist in southern Jordan, even though scrapers and burins are present, and that there is enough evidence to propose an Early and a Late Ahmarian phase.

Schyle and Gebel provisionally refer the industry at Siq Umm al-Alda 1 to the Ahmarian but note that it has several Aurignacian attributes. They do not buy the dichotomy theory but prefer the scheme of Goring-Morris (1989), who saw a unilinear succession of Early Ahmarian with points, followed by more Aurignacian-like assemblages dating to about 30 kyr leading into the pre-Kebaran bladelet and Kebaran microlithic industries of the Epipaleolithic.

Some confirmation of such a model has come from the analyses of the Levantine Aurignacian levels at Kebara in Units I-II (BAR-YOSEF and BELFER-COHEN 1996), in which it is considered that the material closely resembles that in levels 13 - 11 at Ksar Akil; this was originally defined by myself as "Levantine Aurignacian A" (COPELAND 1975). They conclude that the Aurignacian A phase was not just a northern Levant phenomenon and suggest that we should return to a more comprehensive model which would take into account not just the technology but the lithic typology as well (BAR-YOSEF and BELFER-COHEN 1996: 143).

In his detailed analyses Bergman (1987) showed that levels 13-11 at Ksar Akil had bladelet technology with Aurignacian tool-types, the latter including carinated scrapers. Since his analyses were modeled on the dichotomy principle, this phase was regarded as Ahmarian. Even levels 10 and 9 were assigned, on the basis of a technical change to blanks on straight bladelets and different El-Wad types, to the Ahmarian in spite of the presence of flakes and flake scrapers in level 9. (This was explained as due to a subsidence, unnoticed by the excavators, of part of level 8 (Aurignacian) into level 9.) This view was slightly modified later (BERGMAN and GORING-MORRIS 1987). The upshot of all this seems to be that Ksar Akil does not fit neatly into the dichotomy theory either.

In this connection it is interesting that Schyle and Gebel find some resemblances between the facies at their site and that at Ksar Akil Phase 4 of Bergman, as well as Boker BE3 and also Jilat 9 (Azraq), all of which are not typical of either the Ahmarian or the Aurignacian but yet all date to around 30,000 BC (*i.e.* mid-UP).

This brings up the new body of evidence (sadly, not dealt with in this volume although the results are referred to by many contributors), which has come from the productive work of Garrard and his team in the Azraq Basin (GARRARD *et al.* 1994 and references). Many of the UP and later assemblages are dated, but here too some unexpected problems have arisen with industry attributions as well as with tool forms entirely new to Levant prehistory (*e.g.* "Jilat Knives").

What to do? Perhaps if an assemblage does not fit one or another model, workers should not force it to do so; they should "tell it like it is" and continue to search for reasons for the variability - as some of the contributors to this volume have already started to do (*e.g.* Coinman). These attempts are, of course, hampered by our ignorance as to the functions of the various tools, large and small; use-wear studies will hopefully reduce this lack of understanding.

Concerning lithic analysis in general, I wonder if it is fully appreciated that advances in lithic technology, as against developments in typology, do not always occur synchronously through time. In a hypothetical sequence, one aspect (*e.g.* the typology) seen in level 1 will change in level 2 above, while the technology remains the same as that in level 1. By level 3 the laggard aspect will catch up. Interpretation of this will thus be affected by the orientation of the analyst. Many examples can be cited (Boker Tachtit; Ksar Akil, El-Kowm) and I have observed it also in the Kebaran and Neolithic as well.

The Late Upper Paleolithic (LUP) and Epipaleolithic (EP)

At Yutil al-Hasa Olszewski accepts without discussion a Late Ahmarian in the lowest level dating to *c.* 19,000 by C-14. She terms the next level "Madamaghan", which is followed by a Natufian occupation seen as illustrating the carrying-out of similar activities. This valuable sequence points up how, here at the end of the Paleolithic, we arrive at an acute stage of confusion over the nomenclature of the industries. This seems to be based almost entirely on the microlith morphology; the actual number of variants is enormous when all the regional types are taken into account. Byrd, at Azraq, has in fact retired from the fray and uses non-commital terms such as "non-Natufian microlithic", etc.; he has even dropped the term Epipaleolithic entirely (BYRD 1988). It must be remembered that similar variability in the microliths is seen in the northern Levant. One of the most puzzling cases is that of the adjacent (*i.e.* in the same ecological niche) and contemporaneous Kebaran levels at Jiita and Ksar Akil, in which entirely different microliths occur: micropoints and backed bladelets at Ksar Akil, minute triangles, Jiita points and Dhour Choueir bladelets in Jiita (HOURS 1973: 199; MELKHI n.d.). I remember being horrified by Henry's introduction of yet more industry names (Hamran; Qalkhan) - until I was shown the artifacts; their attributes did not indeed combine in familiar ways (can one have a Kebaran without Kebaran Points?). As Olszewski points out, Henry took the "splitters" road while Byrd is more of a "lumper". I think she is wise to recommend non-lithic (*e.g.* environmental/ comparative) approaches in the search for explanations.

Fortunately, there is quite good control on the chronology, given the many series of dates for this final Pleistocene period (see the useful table of GARRARD, BAIRD and BYRD 1994: Fig. 2; the datings (more would be better!) allow a certain amount of sorting out of developments in microlith types through time). At Yutil Coinman observes a certain sameness in the approaches to flint-knapping throughout the Ahmarian and concludes that the range seems to represent adaptations to a variety of mostly desertic inland environmental settings.

The Natufian at Yutil al-Hasa seems to refer to the earlier phase dating to *c.* 12 - 11, 000 BC, having Helwan lunates and many non-geometric forms. But wait a minute, is something missing here? Where is the familiar Geometric Kebaran characterised by trapeze-rectangles, which comes just before the Natufian in the western Levant? It would seem that (east-west differences again!) this variant is replaced at Azraq by something similar, which appears to be present at some sites, *e.g.* at Azraq in Jilat 8 and Jilat 22 dated to between 13 - 11,900 years BC (GARRARD *et al.* 1994).

Natufian perspectives have expanded radically over the years. An earlier proposition, that it referred to the coastal forest zone, has had to be rejected; the Natufian, *sensu lato,* occurs everywhere in the Levant (in desert oases, Euphrates valley, Mediterranean coast, the Petra area, the East Bank Highlands, at the base of a ceramic Neolithic tell, etc.). One must ask why, following the extraordinary lithic variability seen during the preceeding period, did the techno-typology suddenly become standardised (or nearly so) in the Natufian?

In overview, in considering the LUP/EP of southern Jordan one gets the impression that more time wiil be needed before all the new data can be digested fully. Should we hold a conference devoted to rationalisation of industry nomenclature? Should we not examine more closely the environnmental/climatic angle? In this regard, an important review written by P. Sanlaville has just appeared, which draws together every conceivable kind of published climatic evidence for the Late Pleistocene (*c.* 25 - 10 kya), such as marine cores, pollen, Dead Sea and Lake Lissan sediments, fluviatile and aeolian deposits, flora and fauna, etc. When correlated with well-dated archaeological evidence, the chronology of the several climatic oscillations known to have occurred during this period revealed that, taking into account the (not yet well identified) N-S cultural shifts, in the mainly favourable periods (such as that between 15 - 11,000 BP), the sites became more numerous and widespread; however, the main socio-economic changes seem to have taken place at the end of the dry and cold phases, for example in the Late Dryas between 11 - 10,000 BP (SANLAVILLE 1996).

Conclusions

One thing clearly shown by these contributions is that prehistoric models are not written on stone, which is as it should be. I regret that many issues brought up by the contributors could not be dealt with. My main recommendations are that workers should "work with the geochronology", especially in areas between the "patches", which would hopefully produce a more balanced picture of industrial distributions in Jordan; to initiate more cross-border contacts and exchanges of information, and to hold a conference on Epipaleolithic nomenclature. Surely this is enough to be going on with for the time being!

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Trying to Fit Round Houses into Square Holes: Reexamining the Timing of the South-Central Levantine Pre-Pottery Neolithic A and Pre-Pottery Neolithic B Cultural Transition

Ian Kuijt

Abstract: *Drawing upon excavation results from Tell Aswad, field research in the northern Levant, and changes in stone tool technology, it has been argued that a transitional cultural phase existed between the Pre-Pottery Neolithic A and Middle Pre-Pottery Neolithic B phase in the south-central Levant. Based on a critical re-evaluation of the substantive and theoretical nature of these arguments, as well as changes in architecture practices and radiocarbon data from the sites of Jericho and 'Ain Ghazal, I argue that there are insufficient data to support arguments for a transitional stage in the south-central Levant. Arguments for and against the existence of such a transitional stage are, at least partially, linked to the kinds of data that are employed in creating cultural-historical sequences, and focus new attention upon the need for further field research to examine the nature at timing of the PPNA and PPNB transition.*

Introduction

Despite the importance of understanding the nature and timing of the south-central Levantine Pre-Pottery Neolithic A (PPNA) and Pre-Pottery Neolithic B (PPNB) period transition, considerable debate exists as to when this transition occurred, which archaeological data sets best illustrate this transition, and if this transition should be viewed as one of local cultural continuity or abrupt replacement of specific populations by others. In recognizing the importance of resolving these issues before addressing broad anthropological questions, such as the origins of food production and the emergence of social inequality in the Levant, researchers since the mid-1970s have generally employed a cultural-historical framework that envisions the transition from the PPNA cultures, such as found at the settlements of Netiv Hagdud and Jericho, to the Middle Pre-Pottery Neolithic B period occupations at 'Ain Ghazal, Jericho, and Yiftahel, as having occurred after a transitional period lasting from approximately 9,600 to 9,200 bp, termed the Early Pre-Pottery Neolithic B (EPPNB). This interpretation is based, at least partially, on reference to well established cultural-historical sequences from the northern Levant and excavated cultural materials from Tell Aswad, and is supported by Aceramic Neolithic settlements documented in field surface surveys documenting the association of curvilinear residential architecture and Helwan projectile points.

Based on the development of new research and reevaluation of previously published works, I suggest that our currently available data from southern Syria, Jordan, and Israel illustrate that there is a strong case for temporal continuity between the PPNA and MPPNB period in the south-central Levant at select settlements, many of which appear to be centered around the Jordan Valley, and that this transition occurred at around 9,300/9,200 radiocarbon years ago. A number of studies (BAR-YOSEF 1981; CAUVIN 1987; GOPHER 1989, 1994; ROLLEFSON 1989) have illustrated that variation between cultural-historical sequences of the northern, central, and southern Levant are at least partially related to variation in the timing and dissemination of cultural practices. Recognizing the soundness of this argument, as well as the geographical proximity between Aceramic Neolithic settlements within the Jordan Valley and those around Damascus, in this essay I treat settlements from these areas as being part of a single expanded region with shared practices of stone tool technology, architecture and mortuary practices. Readers are referred to the following for more detailed considerations of chronological-historical sequences for the Levant (BAR-YOSEF 1981, 1991; CAUVIN 1987; GEBEL 1987; KUIJT and BAR-YOSEF 1994; ROLLEFSON 1989; ROLLEFSON *et al.* 1992) (Fig. 1).

Previous Research on the Pre-Pottery Neolithic A and B Transition

When considering any cultural-historical sequences it must be kept in mind that they are created within a specific social, economic, and intellectual context by researchers. Cultural-historical sequences are based on data available at any specific time and are, therefore, tentative and subject to revision and refinement over time. In discussing any chronological sequence we have to recognize that, although based on empirical observable data, cultural-historical sequences are generalizations drawing on archaeological data recovered from many different sites, at times excavated with different methods, located in different environmental locations, and representing a wide range of time. Cultural-historical sequences are, therefore, well-intentioned abstractions of data designed primarily for the compartmentalization and exploration of data sets on the basis of temporal and geographical location. This point is elegantly made by Rollefson (1989:168) when discussing cultural-historical tables: "The rigid vertical and horizontal divisions are perhaps misleading, for the temporal and geographical boundaries are to some extent tenuous and occasionally arbitrary." By their very nature, then, cultural-historical schemes necessarily obscure important variability so as to create an organizational framework in which newly discovered data sets can be placed within a chronological sequence and comparisons can be undertaken.

At times the archaeological creation of cultural-historical sequences involves far more than the placement of prehistoric data, for if the past is anything like the present, then it was dynamic and usually based on a degree of cultural continuity. On the basis of material indicators, such as stone tools or transitions in architecture, archaeologists segment the past as best we can; but in the process, we unintentionally impart aspects of our broader views on the past that reflect our conceptualizations of relative cultural complexity, or even measures of relative cultural continuity through time. For example, the cultural-historical sequence for the Levantine Neolithic presented by Moore (1985: 14) stresses continuity through time by treating all PPNB sites from modern day Syria, Jordan, Lebanon and Israel as part of the same phenomenon within an explicitly evolutionary developmental scheme illustrated in the selection of terms such as the Archaic Neolithic and Developed Neolithic. This emphasis on cultural continuity starkly contrasts with other schemes that emphasize the division of cultures based on changing material variation, such as Gebel (1987: 345), who divides up the period of 11,000-7,500 bp into seven individual phases (compared to the four phases of Moore). Without imparting any comment as to the relative value of these sequences, for none is intended, we should recognize that both of these examples outline links between the questions addressed by researchers and the organizational frameworks employed by individual researchers. To facilitate comparison and synthesis, however, there is a need for consensus among researchers.

In discussing the cultural-historical transition between *c.* 9,500 and 9,100 bp, I follow Kenyon's general cultural-historical division for the Neolithic in the south-central Levant and will refer to the general period of 10,300 to *c.* 8,000/7,750 bp as being the Pre-Pottery Neolithic period. This term is employed as an organizational tool, not as a statement of the relative use of pottery in the south-central Levant (as geographically defined by ROLLEFSON 1989). Kenyon (1957), in her excavations at Jericho, provided the first solid evidence to indicate that the Aceramic Neolithic should be divided into at least two different cultural phases. On the basis of variation in architectural systems, mortuary practices, and material culture between the upper and lower levels at Jericho, Kenyon (1957) proposed a two part division of the Pre-Pottery Neolithic into the Pre-Pottery Neolithic A and the Pre-Pottery Neolithic B. From its inception in the 1950s until the late 1970s this classification scheme remained largely unmodified and continues to be widely accepted as the major cultural and chronological divisions for the Pre-Pottery Neolithic in the south-central Levant.

Excavations conducted during the 1970s and 1980s furnished new data on site level chronology, architecture, and stone tool technology and permitted several researchers to identify important variability within the PPNB sequence of the Levant. Based on architectural and stone tool evidence at the key site of Mureybet in the northern Levant, J. Cauvin (1977) noted that material and cultural variability in the PPNB was chronologically based. Similarly, in his Neolithic synthesis, Mellaart (1975: 55) mentioned that select layers at Beidha, Munhata, and some of the Syrian PPNB sites may represent a late PPNB phase. Mellaart and Cauvin's early published attempts to divide the Aceramic Neolithic was further developed by Bar-Yosef (1981: 564-565), who explicitly argued that in the southern Levant the PPNB sequence should be provisionally subdivided into three (Early, Middle, and Late) phases. As an important expansion on the previously noted transition from circular/oval residential structures to rectangular ones (AURENCHE 1981, FLANNERY 1972, KENYON 1957), Bar-Yosef (1981: 562) provided an initial outline of the diagnostic aspects of the differences between the PPNB and PPNA, including: 1) the use of bipolar cores (naviform) for blade production; 2) heat treatment

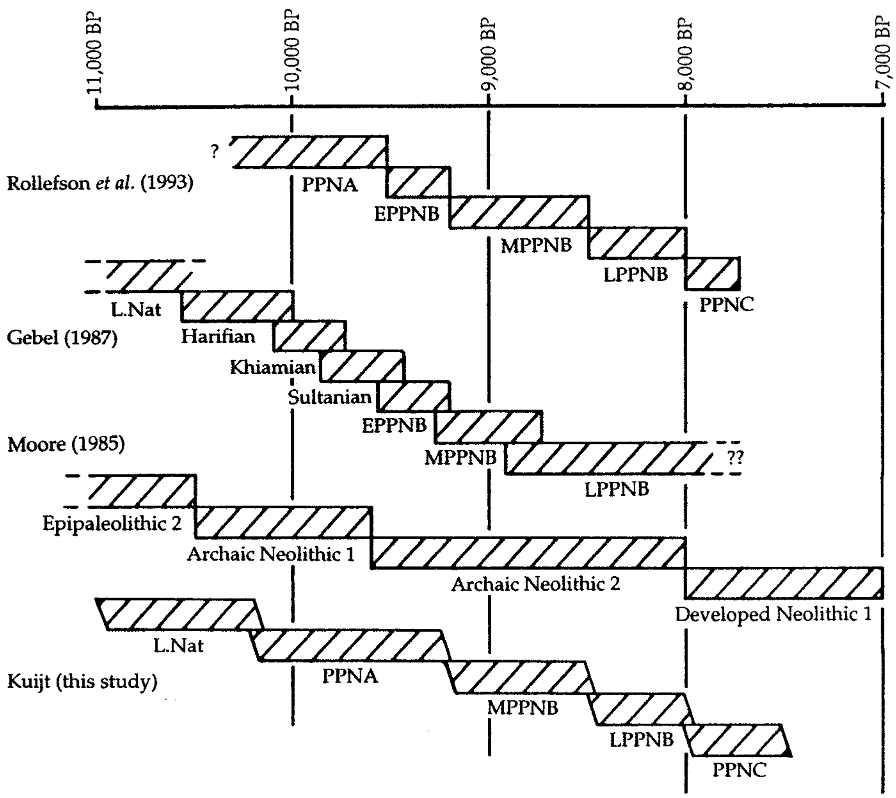

Fig. 1. Different cultural-historical organizational schemes for the south, central, and northern Levantine Neolithic.

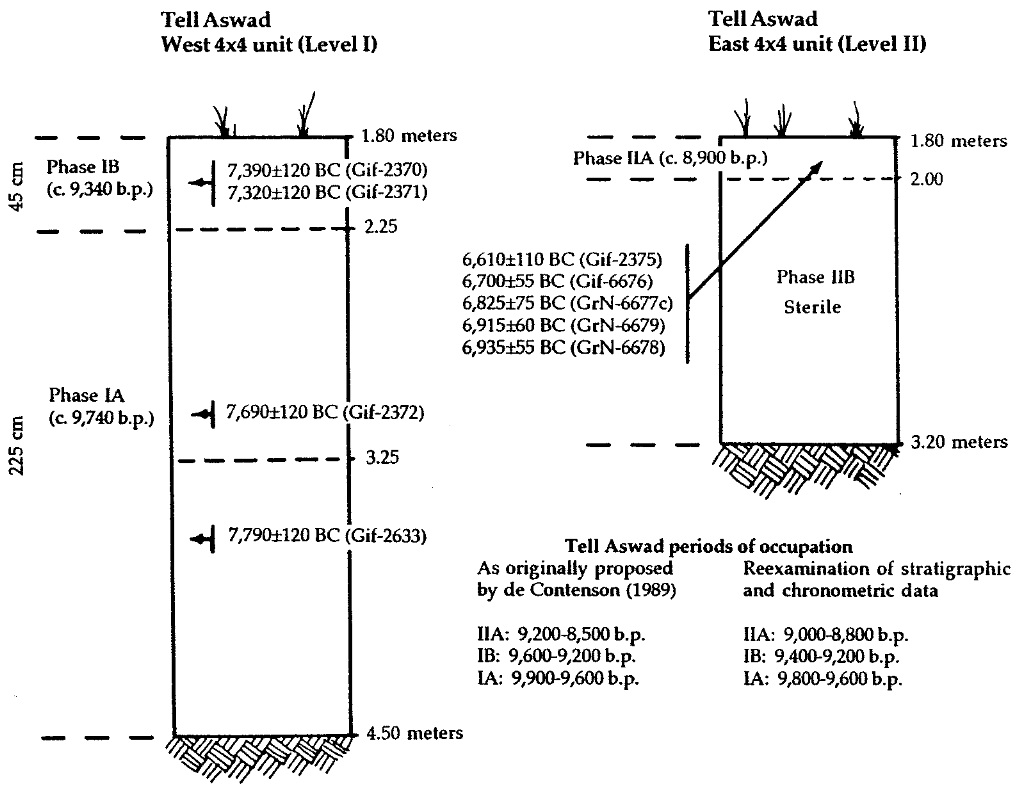

Fig. 2. Schematic representation of Tell Aswad excavation Units for Areas I and II.

of flints; 3) the high frequencies of arrowhead types shifting from Helwan points to Jericho points, Byblos points and Amuq points; 4) changes in the morphological features of axes, sickle blades, and retouched blades. Based on archaeological levels from sites then known in the southern Levant, Bar-Yosef's synthesis and division of the PPNB represented a significant conceptual revision of the Neolithic cultural-historical sequence with the recognition that there was material and cultural variability within the PPNB sequence (Table 1).

Continued field research and publication of previous research in the 1980s has continued to sharpen our understanding of the material and chronological change within south-central Levant PPNA and B sequences. As a major step in this direction, Bar-Yosef's (1991) synthesis of the PPNA of the south-central Levant provided a much more detailed understanding of the period preceding the PPNB. In an overdue and inportant integration of new Levantine data from the PPNB, Rollefson (1989) explored how individual Levantine Aceramic Neolithic sites fit into either an Early, Middle, or Late Pre-Pottery Neolithic B phase, or the PPNC phase which appears to date from *c.* 8,000- *c.* 7,500 bp. Although widely recognized as an critical reaffirmation of the PPNC phase, an often unrecognized important dimension of this paper is Rollefson's (1989: 168-9) recognition of the paucity of data for an EPPNB phase (*c.* 9,600-9,200 bp) in the south and central Levant. For example, when discussing the EPPNB phase Rollefson (1989: 169) remarks "Objectively, it can be stated that the situation outside of the northern Levant remains unclear, and that only continued work can resolve the present dilemma", which reemphasized the earlier caution of Bar-Yosef (1981) and Cauvin (1987). In many ways the continued relevancy of these sentiments in 1996, and the recognition that some existing archaeological data sets do not fit within a regional cultural-historical framework based on an EPPNB phase, are cause for concern and illustrate that this lack of consensus may be linked to the specific cultural-historical framework employed by archaeologists rather than individual data sets. There is, in brief, a need to critically reevaluate the theoretical and substantive data and the models upon which the EPPNB phase was originally defined for the south-central Levant.

A Critical Examination of Arguments for the EPPNB

Although not articulated in any single publication, general arguments for the Early Pre-Pottery Neolithic B period, lasting between *c.* 9,600-9,200 bp in the south-central Levant are generally founded upon the following criteria: 1) arguments for a similar distinct cultural phase for this period in the northern Levant; 2) the presence of supportive radiocarbon dates and excavation results from a few select sites, most importantly that of Tell Aswad; 3) a perceived absence of clear PPNA occupations dated to the period *c.* 9,600-9,200 bp; 4) the existence of settlements, almost all of which are undated by radiometric means, that combine circular architecture and Helwan projectile points; and 5) continuity in select projectile points styles and naviform cores over this period of time. Of these, it is the first three that have emerged as the intellectual cornerstone of arguments for the EPPNB phase in the south-central Levant. It is not at all clear, however, that these actually support the argument. For example, re-examination of available stratigraphic data from Tell Aswad does not support arguments for a distinct EPPNB phase, while stratigraphic and architectural remains at Jericho indicates that architectural practices of the PPNA continue up to 9,300 years ago. Similarly, the existence of an independent EPPNB phase in the northern Levant does not logically require the existence of a similar cultural-historical phase in the south-central Levant, some 500km away.

Tell Aswad and the Northern Levant

In developing arguments for the EPPNB period, researchers have focused considerable attention upon the settlement of Tell Aswad, specifically the occupation termed IB, as being crucial in understanding the transition from the PPNA to the PPNB periods in areas south of Damascus. Based on his excavations, de Contenson (1979, 1989) argues that phase IB includes many characteristic PPNB chipped stone tools in association with radiocarbon dates of 7,390 ± 120 bc (GiF-2370) and 7,320 ± 120 bc (GiF-2371), and is representative of an independent phase dating from 9,600 to 9,300 bp (Fig. 2).

It is not at all clear, however, to what extent the stratigraphic and radiocarbon data from Tell Aswad support arguments for an independent EPPNB phase. First, it must be recognized that the cultural material upon which the phase IB designation is based were recovered from the upper 35-45cm of cultural deposits from a single four by four meter area and, therefore, may well represent charcoal and chipped stone materials from multiple Neolithic occupations. The lack of any well preserved *in situ* architecture with the Phase IB deposits, the proximity of later occupation(s?) near this area dating to phase IIa (dating to approximately 8,900 bp) some 100m away, and the shallowness of these deposits are all of concern.

Even if we assume that the cultural materials from phase IB are not from a mixed context, examination of the radiocarbon dates from this level do not logically support arguments for an occupa-

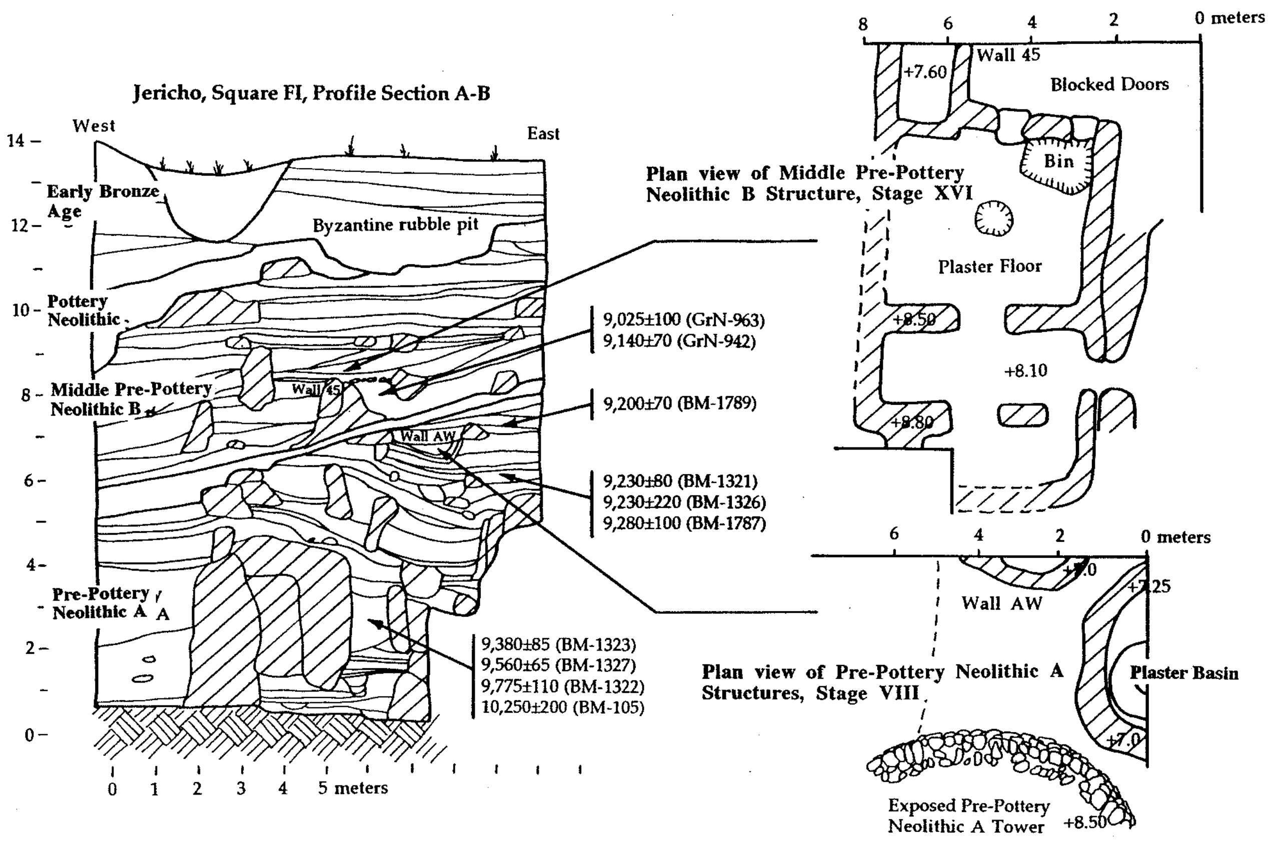

Fig. 3. Cross-section of Trench I, Jericho, stratigraphic placement of radiocarbon dates, and associated plan views of PPNA and MPPNB structures.

Bar-Yosef (1981)	PPNA (period not defined.) Nahal Oren III, Jericho, El Khiam 4, Abu Madi, Salibiya IX, Netiv Hagdud, Gilal I	EPPNB (period not defined) Nahal Oren I-II, Michmoret, Jericho, Nahal Boqer, Nahal Lavan 109, Tel Aswad IA?	MPPNB (period not defined) Munhata 6-3(?), Abu Gosh (early), Jericho, Nahal Oren, Tel Eli III-IV
Rollefson (1989)	Not Discussed, but pre-dates 9,600 b.p.	EPPNB (9,600-9,200 b.p.) Tel Aswad	MPPNB (9,200-8,500 b.p.) Beidha, Jericho, Munhata, 'Ain Ghazal
Kuijt (1995)	PPNA (c.10,300-9,300 b.p) Nahal Oren III, Jericho, El Khiam 4, Abu Madi Salibiya IX, Netiv Hagdud, Gilal I, Hatoula, 'Iraq ed-Dubb, Dhra', Gesher, Tel Aswad IA, Sabra I, Tell Batashi, 'Ain Darat		MPPNB (9,300-8,500 b.p.) Beidha, Jericho, Munhata, 'Ain Ghazal, Kfar Hahoresh, Er-Reheb, Kfar Galadi, Nahal Hemar, Tel Aswad IB (?), Wadi Shu'eib, Ghwair I

Table 1. Cultural-historical divisions and archaeology sites upon which they are based.

tion from 9,600-9,200 bp (Fig. 2). For example, sample GiF-2371, if in a primary context associated with the chipped stone materials in phase IB, indicates that there is a 66% chance that this Neolithic occupation occurred approximately 9,390 to 9,150 bp. Assuming that both of these samples are within the 66% range, these radiometric data only support arguments for an occupation at some point between approximately 9,400 and 9,150 bp. It is not possible to determine unequivocally if these dates and materials represent an independent phase dating from 9,600 to 9,300 bp or if the phase IB occupation is the upper surface of the PPNA occupation with some derived PPNB materials.

It is also important to note that in many ways arguments for an EPPNB phase in the south-central Levant have been founded, be it explicitly or implicitly, upon the untested assumption that there should be a similar chronological phase as documented in the northern Levant, perhaps most clearly defined at the important site of Mureybet. In fact, the view of the southern Levant through the lenses of the north is often expressed in the unintended, but problematic, prioritizing of certain material similarities over others. When discussing the flint assemblage of Tell Aswad IA (later termed Aswadian), for example, de Contenson (1989: 58) argued: "The assemblage resembles that of contemporaneous Mureybet III but shows few connections with Jericho PPNA." Similarly, when discussing the tools of phase IB radiocarbon dating to approximately 9,350 bp, he states: "... can be compared to that from Mureybet IVA, which is also dated in the same period." While these perceived material similarities with Mureybet are entirely understandable, strong arguments can be made for these materials to be more similar to assemblages from Jericho, Netiv Hagdud and other south-central Levantine settlements than to settlements located much further to the north. In light of these similarities one has to ask why the Tell Aswad cultural-historical sequence needs to be based on regional cultural-historical sequence from other cultural areas (see also CAUVIN 1987; ROLLEFSON 1989 for similar arguments).

Radiocarbon Dates, Architecture and Stone Tools

Another argument used to support an independent phase between 9,600-9,200 bp is the lack of archaeological evidence, such as radiocarbon dates from a clear stratigraphic context, to indicate that the PPNA continued later than 9,600 bp in the south-central Levant. Although there is no question that little information exists from the period of 9,600 to 9,000 bp compared to earlier or later periods, this argument does not account for clear architectural and radiometric data which demonstrate that the PPNA architectural system of round/oval residential structures continued up to approximately 9,300 bp and were, at least within large settlements around the Jordan Valley, replaced by the highly formalized rectangular structures and MPPNB of the south-central Levant.

Although there is on-going disagreement as to when the PPNA first appeared, and if the earlier PPNA should be divided into two phases (see BAR-YOSEF 1991; CROWFOOT PAYNE 1976, 1983; GARFINKEL and NADEL 1989; NADEL 1990), radiocarbon dates from Jericho and indirect evidence from Netiv Hagdud (BAR-YOSEF *et al.* 1991) in the south-central Levant indicate that the PPNA ended at approximately 9,300 bp. Charcoal samples from several round/circular semi-subterranean structures at Jericho, specifically: Trench I, stage VI, structure BA phase DI x-xi; structure CA; and; stage VIIIa, structure AR, provided a total of six radiocarbon dates that outlined a clear occupation between 9,380 and 9,230 years before present (KENYON 1981, KENYON and HOLLAND 1983) (Fig. 3). Similarly, excavation at Netiv Hagdud Locus 1001, some 2.4m below the surface of the settlement, produced a charcoal sample dated to 9,400 ± 180 (RT-762D). Given that all of the radiocarbon dates from Netiv Hagdud were recovered from contexts at least 1.5m below the surface in the deep sounding, and do not date to the final occupation at the settlement, it is entirely reasonable to assume that Netiv Hagdud was also occupied at this late point.

Radiocarbon dates from the earliest MPPNB contexts from Jericho and 'Ain Ghazal outline that the transition from round/oval to rectangular residential structures occurred at around 9,300 to 9,200 bp. For example, an examination of the stratigraphic relationship between Aceramic Neolithic house forms and their associated radiocarbon dates at Jericho Square FI reveals that while Kenyon clearly documented an erosion zone between the PPNA and MPPNB occupational horizons, with associated architecture, radiocarbon dates show that there is a general continuity of occupations at Jericho and that this transition probably occurred at around 9,300 bp (Fig. 3). It should also be noted that this pattern of overall cultural continuity and the timing of the architectural transition is also seen in Kenyon's excavations in area M at Jericho. Dove-tailing with the Jericho final PPNA dates, the 'Ain Ghazal radiocarbon dates of 9,100 ± 140 (AA-1164), 9,030 ± 80 (GrN-12960), 9,200 ± 110 (GrN-12966), and 9,050 ± 80 (GrN-12965) indicate that the earliest occupation during the MPPNB occurred at around 9,200 bp (ROLLEFSON *et al.* 1992). Needless to say, it should be kept in mind that all of these radiocarbon samples provide a range of possible dates based on statistical probability within which this transition occurred. Nevertheless, when viewed collectively, these illustrate a recurring pattern, based on associations between different architectural forms and radiocarbon samples, that outlines that in select areas of the south-central Levant region the architectural transition occurred at around 9,300 years ago.

To date, the strongest arguments for an EPPNB phase in the south-central Levant come from the field recording of several Aceramic Neolithic settlements with circular architecture and Helwan projectile points by Gopher (1989, 1994). Based upon the statistical analysis of the distribution of Helwan projectile points from occupational horizons from individual settlements, Gopher outlines a pattern of gradual appearance of Helwan projectile points from the northern to the southern Levant. This patterning for the temporal distribution of projectile points helps us to understand technological changes in different areas of the Levant, and possibly the diffusion of technology and people moving from the north. As with broader arguments for an EPPNB phase in the south-central Levant, the weakest link in our understanding of the chronological and geographical distribution of Helwan projectile points from the northern to the southern Levant clearly is that of Tell Aswad Level 1B. Briefly, we cannot assert that all of the radiocarbon dates and archaeological materials are contemporaneous, and even allowing their contemporaneity, available radiocarbon dates do not support arguments that Level 1B dates to 9,600 bp.

A second line of argument for an EPPNB phase in the south-central Levant is based on the perceived concurrence of curvilinear architecture and Helwan projectile points; unfortunately, this is based on surface finds or soundings/excavations of very shallow cultural deposits, and they are rarely dated by radiometric means. For example, surface examinations of Abu Hudhud recovered Helwan projectile points associated with curvilinear architecture, as well as pottery (ROLLEFSON 1996). But funding limitations have not permitted detailed excavation to document the stratigraphic and chronological association between the projectile points, pottery, and architectural remains. Another possible example is provided by excavations by Garrard *et al.* (1994) at Jilat 7, located in eastern Jordan. Results included the recovery of stone tools from basal levels of adjoining areas A and C that typologically fit in the second half of the 10th millennium bp. Associated stone tools include Khiam and Helwan projectile points, Hagdud truncations, high proportions of bladelets, single platform and change of orientation blade/bladelet cores, and opposed blade/bladelet cores including some naviform types. While there is no question that most, if not all, of this lithic assemblage predates the MPPNB occupation at the settlement, the associated radiocarbon samples are from a later occupation. Garrard *et al.* (1994: 193) argue that this occupation dates to the PPNA, as exemplified by the recovery of Khiam projectile points and Hagdud truncations. While it is possible that some of these deposits are linked to a transitional EPPNB phase, available evidence clearly supports the argument that this occupational horizon dates to the second half of the 10th millennium bp. In both of these cases, as well as other possible EPPNB settlements, researchers have yet to adequately document stratigraphically the temporal and spatial association of curvilinear architecture, specific lithic technologies and radiocarbon samples in different regions of the south-central Levant.

Discussion

In what is the most current review of the cultural-historical sequence of the PPNB of the Levant, Rollefson (1989) noted that relatively little archaeological research has focused on the two periods of 9,600- 9,000 and 8,500-8,000 bp into the PPNC. Although on-going field excavations have started to clarify aspects of material culture, chronology, and economic practices in the later periods of the PPNB sequence at Es-Sifiya, 'Ain Ghazal, Basta, and 'Ain Jammam, few field excavations have examined the period immediately preceeding the MPPNB phase. Following arguments by Cauvin and others, I believe that there is insufficient evidence to support arguments for a comprehensive regional transitional EPPNB phase across the entire south-central Levant. Previous studies at Tell Aswad IB provide questionable support for an EPPNB phase between 9,600 and 9,200 bp, and as noted earlier, broader models often fail to account for radiocarbon evidence that indicates that PPNA occupations continued up to approximately 9,300 bp. Radiocarbon estimates are statistical approximations and individually must be treated with caution. When grouped together, however, collections of radiocarbon samples, such as the six radiocarbon dates of between 9,380 and 9,230 years bp at Jericho (KENYON 1981, KENYON and HOLLAND 1983), increase the statistical probability that these data accurately reflect a real archaeological pattern. Moreover, in light of the extensive nature of archaeological field research in the south-central Levant, it is difficult to believe that the absence of an archaeological entity similar to those identified in the northern Levant for the period of 9,600-9,200 bp is due to a lack of research.

Having noted this, arguments against a pan-Levantine EPPNB transition do not necessarily exclude the possible temporal co-existence and physical association of curvilinear architecture, Helwan projectile point and naviform cores at, before, and after *c.* 9,300 bp in select areas of the south-central Levant. For example, it is possible that the timing and nature of the PPNA/PPNB transition, as illustrated through architecture and/or lithic technological changes, varied within different geographical areas such as along the desert margins or south of the Dead Sea. There is no question that the reconstruction of the temporal and spatial distribution of projectile points and core forms provides an important means of understanding cultural changes (*cf.* BAR-YOSEF 1981, GOPHER 1989), and there is some preliminary evidence to suggest that naviform cores and Helwan projectile points may cross-cut the PPNA/PPNB boundary in some geographical areas. Similarly, it appears that in some environmentally marginal areas, such as south of the Dead Sea in the Rift Valley and at the site of Beidha, curvilinear architecture was replaced by rectangular residential housing later than in more northern areas. Unfortunately, very little is known about the preceding PPNA occupation in this area, and there are currently no excavated Aceramic Neolithic settlements radiocarbon-dated between 9,600 to 9,200 bp in this area (KUIJT 1995). Therefore, current evidence indicates that the overall architectural transition appears to have occurred later than that in the other areas, but this does not necessarily support arguments for an EPPNB phase in the south-central Levant.

In sum, arguments for a pan-Levantine EPPNB cultural-historical temporal unit are undermined by several issues: a) radiocarbon evidence outlining a PPNA occupation up to approximately 9,300 years ago at Jericho; b) the lack of definitive radiocarbon and stratigraphic data from Tell Aswad level IB; c) the logical fallacy that the existence of a EPPNB phase in the northern Levant supports arguments for a similar entity in the areas south of Damascus; and d) the lack of radiocarbon-dated single component settlements with clear stratigraphic association of architectural forms and stone tool technology. On the basis of these circumstances, I believe that the most plausible interpretation of the available data is that the architectural transition from the PPNA to the MPPNB probably occurred at around 9,300 bp/9,200 bp within large early agricultural settlements situated along the Jordan Valley between Damascus and the Dead Sea.

In many ways the real question being debated is what criteria should be used to identify and name a cultural phase on the basis of the archaeological record, and what materials are to be prioritized over others. The key question is how different do things have to be before defining a separate cultural-historical entity? Just as important, how much archaeological evidence is sufficient to confidently employ such a label? Recent field surveys in the south-central Levant have recorded, usually through surface collections and observations of exposed architecture, a number of settlements that have curvilinear architecture, naviform cores and Helwan projectile points. Based on the questionable dating of Tell Aswad, in several of these cases it is implicitly assumed that these materials are reflective of a transitional cultural phase in which select cultural materials co-exist. Unfortunately in many of the cases, funding limitations have precluded researchers from undertaking detailed field excavations to resolve the chronological placement of different occupational horizons at individual settlements. Without these data, it is not possible to place observed archaeological patterns in time and space confidently, let alone construct arguments for an entire cultural-historical phase in the south-central Levant. Thus, part of the debate as to the real or perceived existence of EPPNB phase among researchers may be linked to the specific lines of evidence employed by individual researchers, as well as the methodological framework which indicates how much data are necessary before developing different time-space labels.

At the same time, it is clear that there are differences as to the timing and nature of architectural and stone tool technology transition within different areas of the south-central Levant. To understand why and when this transition occurred, as well as if the changes in the archaeological record are sufficient for a totally different cultural designation, it will be necessary for researchers to focus upon the description, analysis, and radiocarbon dating of occupational horizons of individual settlements in the south-central Levant. Such data, if accompanied by clear stratigraphic analysis, chronometric control and associated architecture, will hopefully avoid the logical problems currently plaguing arguments for existence of an EPPNB phase and allow researchers to debate the more important question of when is there sufficient cultural and material differences to employ different cultural-historical labels. As it currently stands, however, extant archaeological data sets do not provide sufficient data to support arguments for an EPPNB phase in the modern states of Jordan, Israel, and southern Syria and Lebanon.

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The 1995 Season at the Neolithic Site of Es-Sifiya, Wadi Mujib, Jordan

Hamzeh M. Mahasneh

Introduction

Until the beginning of the last decade, very little research had been undertaken on the prehistoric periods of Jordan. Since then we have acquired a much better understanding of Jordan's prehistory due to a series of archaeological surveys and excavations conducted by the foreign and local archaeological institutions.

During preparations for dam construction in Wadi el-Mujib near Jisr Wadi el-Mujib, Neolithic remains were discovered at Es-Sifiya by the Cultural Resource Management staff of the Department of Antiquities (Fig. 1). The first reconnaissance at the site showed that this settlement is one of the largest PPNB sites in the Levant and is comparable to 'Ain Ghazal, Wadi Shu'eib, Basta, and Tell Abu Hureyra.

A bulldozer cut of a track running 20m in an east-west direction exposed substantial architecture and cultural layers up to 2m thick. Disturbed dirt from the bulldozer cut revealed a few ground stone tools, dense amounts of chipped stone artifacts, bone remains and ashy deposits.

The site has experienced severe damage at least since the beginning of the 1980s. Rock debris from agricultural activities on the upper slope of the site partly covered or destroyed most of the uppermost cultural layer. In addition, a small water pool was created in the upper part of the site for the purpose of storing water from nearby springs for irrigating tomato plants which cover almost the whole site. On the western side of the site, adjacent to the north bank of Wadi el-Mujib, a modern cemetery covers around 300m^2 of the settlement area. Further damage includes several small pits probably dug by local residents in the search for antiquities.

The site is jeopardized by the construction of a dam in the vicinity. If the site of Es-Sifiya is left unexcavated, water behind the dam will engulf the site in the next few years and its evidence for the Neolithic culture of Jordan will be lost.

Site Setting

Es-Sifiya is an extensive site 100m to the east of the King's Highway Bridge of Wadi el-Mujib (Palestine Grid 228.4 East, 094.3 North). The site clings to the relatively steep hillside some 100m above the broad flood plain of Wadi el-Mujib and its tributary Wadi Salayta (Fig. 2) at an elevation of about 210m above sea level in a broad valley, surrounded by high ranges of limestone in three directions: north, south and east. These limestone cliffs were once lined by forests of oak, pistachio and juniper. The drainage systems are oriented east- west (ABED 1982: 82-84, ABED and SCHNEIDER 1980: 332, BENDER 1974: 33 and Fig. 73).

The Wadi el-Mujib is the second longest drainage in Jordan after Wadi Zarqa in northern Jordan. It contains a permanent stream fed by numerous springs, and two of them flow near Es-Sifiya. The greater region around the site receives approximately 250-300mm of rainfall annually, which is sufficient for dry farming on the tops and slopes of the neighboring hills (and despite the steepness, also the the banks of Wadi el- Mujib). The recent agricultural activities show that the soil is very rich and productive, and this indicates the same potential capability which the area possessed in the past. Modern agricultural disturbances at the site itself have shown that rainfall is presently sufficient for

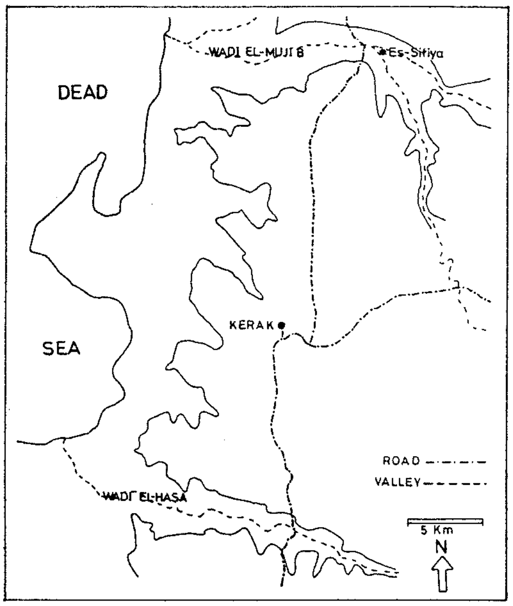
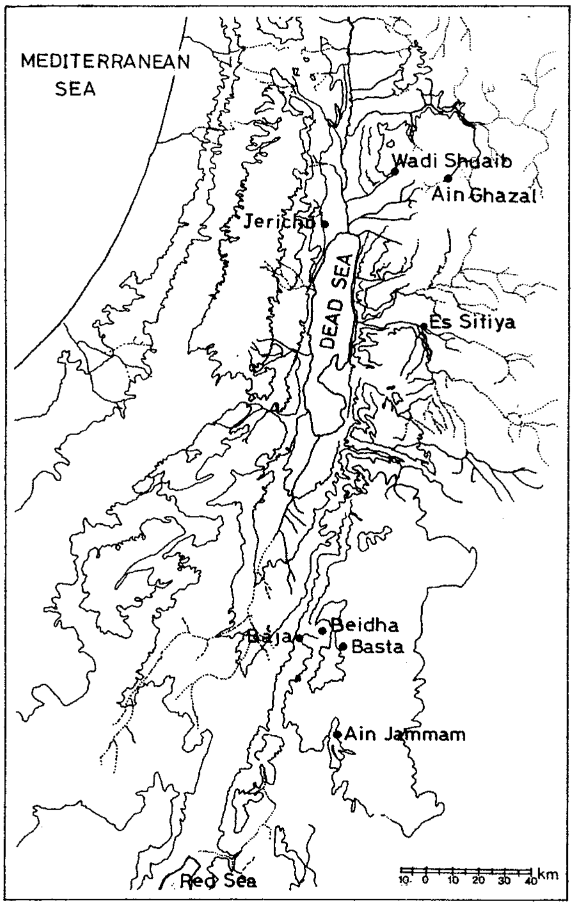


Fig. 1. Location of es-Sifiya and other PPNB sites in southern Jordan (bottom), location of the site east of the Dead Sea (right).



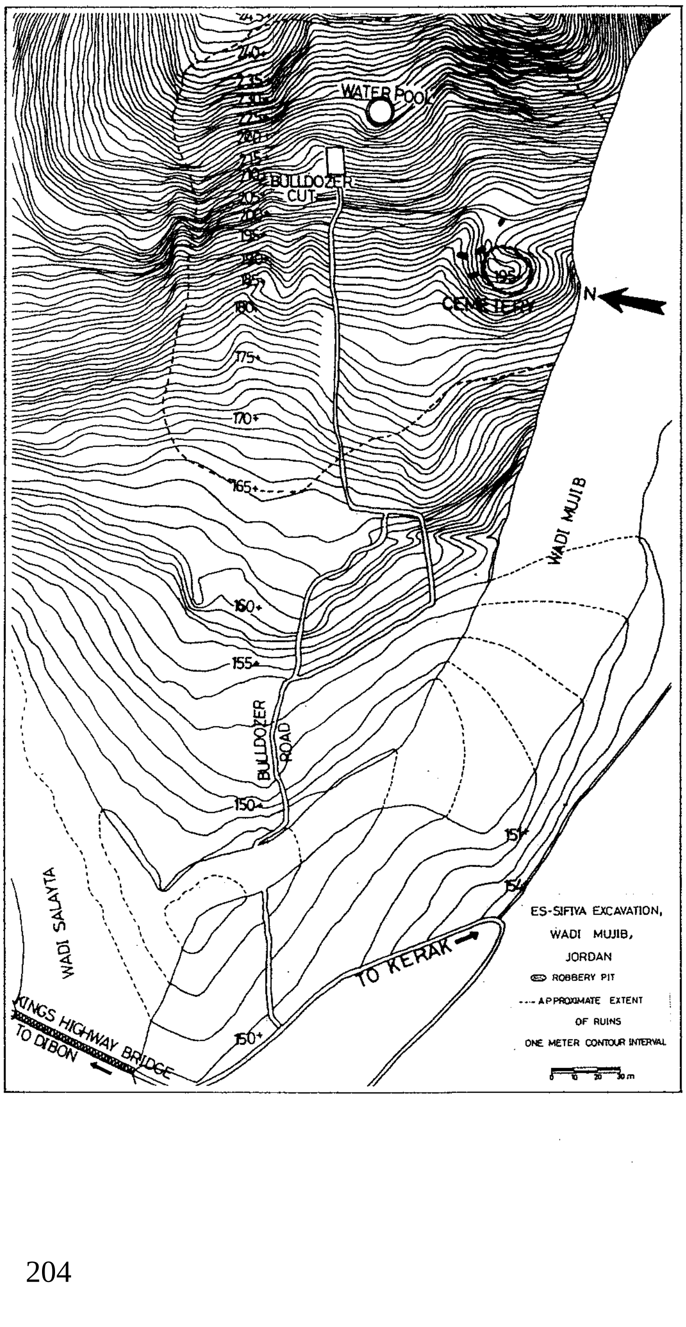


Fig. 2. Topography of es-Sifiya (right).

dry farming in some years, although irrigation of the flood plain is responsible for most of the agricultral production in the area today.

The present vegetation on the eastern and western slopes of Wadi el-Mujib consists of thistles, low woody shrubs and tall grass, and acacia trees occur throughout the lower flood plain. Terraces at medium elevations of about 100-200m are not far away from Es-Sifiya. Probably this variety of habitats produced various kinds of wild game, birds, pasturage and plant resources.

The whole site surface is covered with flint tools and debitage, numerous fragments of stone objects such as querns, grinders, bowls and the typical stone debris of an early settlement. However, the recent agricultural terracing, plowing, burials, irrigation activities, severe erosion and disturbances make it difficult to assess the real size of the Neolithic village with appreciable accuracy. An estimate of 118 dunams of the area covered by the PPNB deposits is reasonable., but visible architectural remains seem to be confined to upper slopes of the site across some 20 dunams. This ranks Es-Sifiya in size with Tell Abu-Hureyra (MOORE 1975: 56) and Mureybet (VAN LOON 1966: 215-216, SINGH 1974: 57) in the Euphrates Valley, 'Ain Ghazal (KAFAFI 1990: 134, ROLLEFSON, SIMMONS and KAFAFI 1992: 444), Wadi Shu'eib (SIMMONS *et al.* 1989: 29) in northern Jordan, Basta (GEBEL *et al.* 1988: 107), 'Ain Jammam (BISHEH *et al.* 1993: 121, GEBEL n.d.: 3) in southern Jordan and three times of the size of Jericho (KENYON 1979: 27) and Beidha (KIRKBRIDE 1960: 141).

Architecture and Chronology

The first season of excavation at the site was conducted in March of 1994 in the bulldozer cut area, which is named Area A (*cf.* Fig. 2). This small scale of excavation mainly focused on trimming and clearing the bulldozer cut; this effort revealed that the cultural layers of Es-Sifiya are dated to the seventh millennium bc. Fragments of plastered floors, stone walls and the remains of sub-floor structures were cleared and recorded. In this bulldozer cut a trial trench was dug and bedrock was reached at three meters depth. Nothing was found prior to the seventh millennium bc.

The second season of excavation, which contributed the bulk of this paper, was conducted in January and Febraury of 1995. The goal of this season was to expose architectural structures beyond the bulldozer cut. For this purpose two squares 4.5x7m were opened adjacent to the bulldozer cut from the east side. Due to shortages in budget and time, our intention was to dig these two squares down to an *in situ* surface of sealed loci, which we achieved.

The structures of Area A prove to have been built at about same time, All the walls and floors uncovered in both squares seem to constitute two building units, each building unit formed of a large room connected with small ones. The walls of building unit 1 are much better preserved than those of unit 2; for instance, the north wall of Room 5 is preserved to a considerable height of 2.10m. above floor level.

The first unit consists of seven small but variably sized rectangular rooms numbered from 1-7 (Fig. 3). The main room of this unit was perhaps destroyed by the bulldozer work.

The second building includes a large room (Room 11) that measures 2.50m x 3.50m. This room, the largest that we found, is surrounded on two sides by rows of small-sized rooms, three on the west side (Rooms 8-10) and two on the east side (12 and 13). All of the rooms are rectangular, although Room 12 has a curved wall (Fig. 3). The small rooms are connected to the large one by way of low, narrow passages or doorways that are incompletely preserved. The doorways occur at different heights above the level of the floor in the large room. (Fig. 4), indicating that traces for doors could be lost even if the lowest courses of the walls were preserved. This is the case for Room 13, whose walls are preserved to a height that has left no traces of a doorway.

Only two passages were found completely preserved, including the entire door frame plus some additional structures above the lintels. Both were found in the first building unit. One of these passages connects Rooms 1 and 2, while the other one connects Rooms 5 and 6; each passage way measures 50cm high and 35cm wide.

The building technique was nearly identical in both buildings. The builders of Es-Sifiya took advantage of the fact that the local limestone flaked off in layers of equal thickness, providing ideal building material. The slabs were dressed in most cases to form rectangular blocks. The walls were generally made of two rows of medium sized stones laid horizontally and arranged to present a regular vertical face. Clay mortar bonded these stones together to create walls up to 2.10m, such as the north wall of Room 5 (Fig. 5). Small, thin stones were used to wedge the joints. The dressing of the stone faces and the use of wedge stones were characteristic. The design of the two Es- Sifiya buildings, the material and the method of construction are identical with those of Basta (GEBEL *et al.* 1988: Fig. 6, NISSEN *et al.* 1987: 88, NISSEN *et al.* 1991: 15 and Fig. 1) and 'Ain Jammam (GEBEL n.d.: 3) and Ghwair I site (NAJJAR 1994: 79) at Wadi Feinan in southern Jordan.

Terrace walls occur at Es-Sifiya supporting small and large rooms. The north wall of the large room (no. 11) in Square 2 and the wall that separates Rooms 5, 6 and 7 from Rooms 8, 9 and 10 in

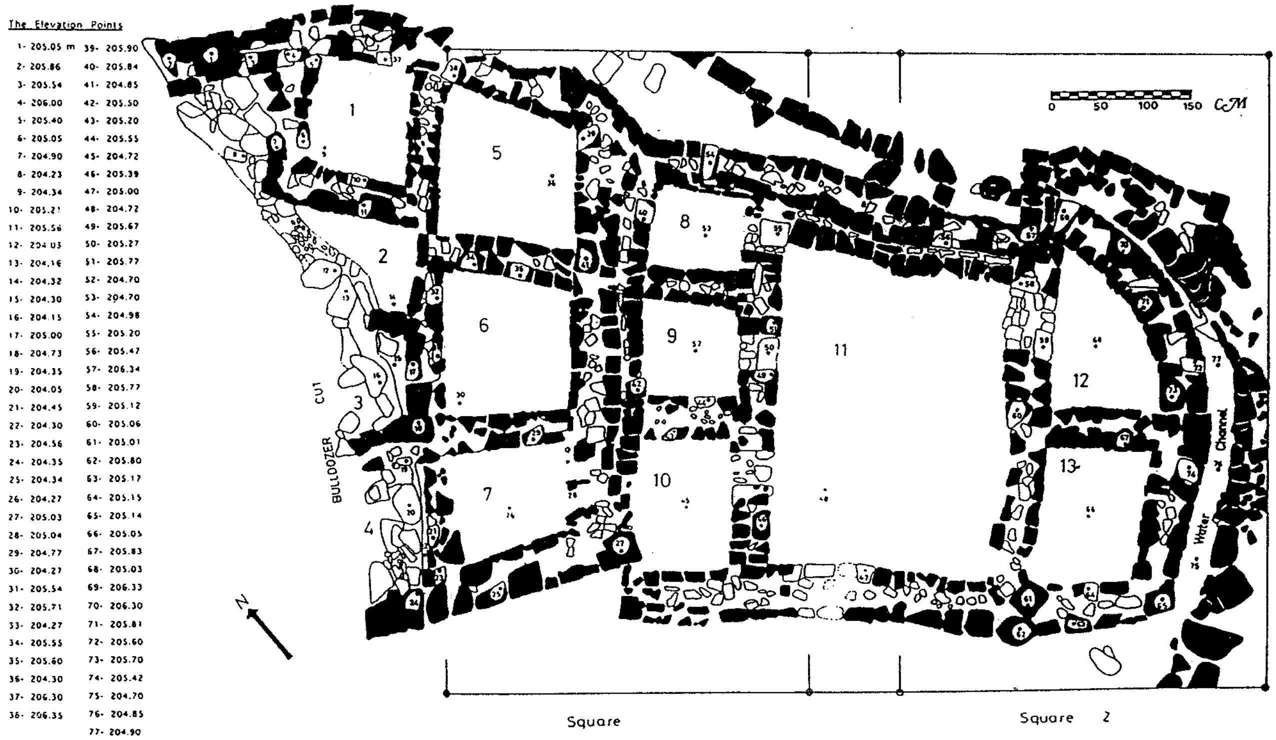


Fig. 3. General plan of Area A.

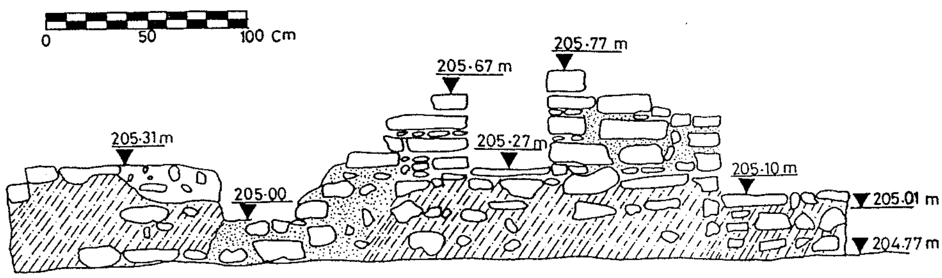


Fig. 4. Doorway passages of Rooms 8-9 with levels.

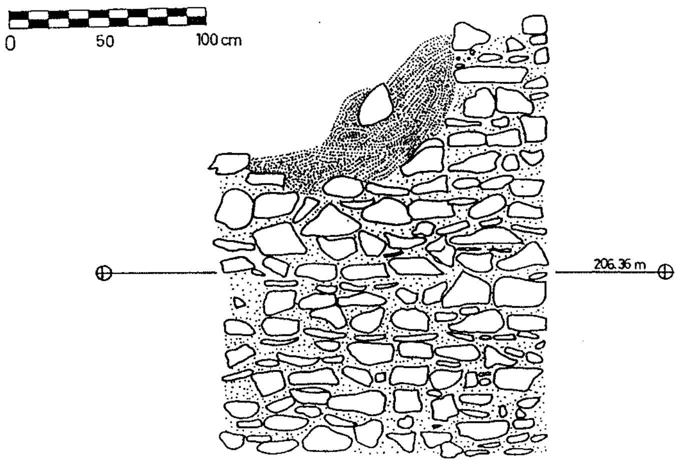


Fig. 5. Northern wall of Room 5.

Square 1 are terracing walls. The latter serves at the same time as the west wall of Rooms 8, 9 and 10 and the east wall of the Rooms 5, 6 and 7. The floors of Rooms 5-7 are lower by a half meter than those of Rooms 8-10. We should mention here that the settlement in Es-Sifiya was built on and following a line of slope. This is clearly evidenced by the floors at different levels of six adjacent small rooms using the same walls. The slope setting of the site most likely is responsible for the excellent conditions of architectural preservation, a situation similar to Basta (NISSEN *et al.* 1987: 88) and 'Ain Jammam (GEBEL n.d.: 3) in southern Jordan. The steep slope setting allows for a high rate of hillwash accumulation. The long use of carefully build and maintained walls, terraces and retaining walls represent major factors in height preservation.

In both squares well-plastered floors were buried beneath deep layers of loose fill that consisted of earth and stones. There is an accumulation of several re-plastering episodes, and this is also attested very well in the walls of Rooms 2-4, 6-7 and 11. The walls received an interior coating of mud plaster and were finished by a thinner layer of white plaster. The collapsed sections of these walls reveal the white plaster still adhering to wall fragments that fell forward.

The borders of the floors curve upwards towards the plastered walls, giving the corners of the rooms a bathtub-shaped appearance. The floors of Es-Sifiya resemble in form and building technology those found at Basta (GEBEL *et al.* 1988), 'Ain Jammam (GEBEL n.d.: 3) in southern Jordan and 'Ain Ghazal near Amman (BANNING and BYRD 1984: 15, ROLLEFSON 1983: 12, ROLLEFSON and SULEIMAN 1983: 471-478). They were built of a hard matrix base with burned limestone mixed with gravel and small pebbles coated with a thin layer of plaster. The floors were then burnished and have red paint. Floor thickness ranges from 3-6cm, and the consistency is as hard as modern cement. The application of red paint on some floors and walls in Rooms 1 -6 and 11 is very clear, but there is no indication of painted designs on the floors and walls. The red pigment probably comes from the grinding of red ochre, as the presence of rubbing stones and the fragments of mortars with red stains on their surfaces show.

The most interesting architectural features are represented by the sub-floor structures. Four channel-like sub-floor structures were found beneath the floors of Room 1-4. They were exposed by the bulldozer work and run in an east-west direction. All are completely filled with very fine soil. A fifth channel-like structure was exposed adjacent to the east wall of Rooms 12 and 13 (Fig. 3). We were unable to dig the first three sub-floor structures, but the fourth channel-like structure was excavated.

After removing a layer of small stones and rubble near the east bulk of Square 2, rows of large slabs appeared in parallel rows in a north -south direction, connected to each other by a central row running east-west. The spaces between these slabs were filled with smaller rubble. Both the slabs and the associated small rubble were removed revealing a channel behind. The channel is 23cm wide and 50cm deep. The floor of the channel was made of a beaten mud, while the walls were built of flat stones; no evidence for mortar or plaster was found to bind the flat stones together. The channel-like structures of Es-Sifiya are identical with those of Basta (*e.g.*, NISSEN, MUHEISEN, and GEBEL 1987: 89) and 'Ain Jammam (GEBEL n.d.: 3). It is possible that the channel system was for drainge since it was filled with a seepage of soft soil. No burials have been found in the channels, as was the case at Basta (NISSEN, MUHEISEN, and GEBEL 1991: 17-18), but perhaps some still may remain undiscovered in the unexcavated area.

Flint Industry

The Neolithic occupants at Es-Sifiya enjoyed a plentiful supply of raw material of fine quality. Two sources of flint are near at hand: wadi pebbles and the tabular flint from the limestone strata of wadi el-Mujib cliffs, although the pebbles formed the chief supply. There is an enormous amount of waste which indicates that the chipped stone industry was carried out at the site.

All the main types of the PPNB tool kit were recorded at Es-Sifiya during this season of excavation. They fully reflect the distinctive elements of the chipped stone industry of the period. The double-ended, bi-directional naviform cores represent 7% of the total collection, and this indicates that part of the flint tool manufacturing was conducted in the site. The debitage at the site is dominated by flakes. Extensive use was made of pink-purple flint, probably heat-treated. The products of this process were not only pink-purple lustrous blades, but also brown and grey artifacts. The numerous waste products and cores suggest that whole nodules were heated rather than blades in the final stage of preparation. The phenomenon of heat treatment in PPNB assemblages has been claimed for many sites of the period (MAHASNEH 1989: 203). It seems that in assemblages of this period there is a tendency to exploit heat-treated flint specifically for the production of points and for pressure flaking.

The arrowheads (Jericho, Byblos and Amuq types) of Es-Sifiya are well fashioned and represent 12% of the inventory, which indicates that the occupants of the site relied to a certain degree on hunting wild game, which has been proven through the faunal remains recovered at the site. The last two types were common in the Late PPNB while the first type is predominant in the Middle PPNB and rare to absent during Late PPNB (BAR-YOSEF 1981: 599, Fig. 2; GOPHER 1985: 56-59; MORTENSEN 1971: 17-26).

Burins represent 29% of the total collection, mostly made on flakes and broken arrowheads. Scrapers make up 22% of the tool kit. They are mainly of the rounded-scraper type (GEBEL *et al.* 1988: Fig. 10-6) and made by direct retouch on flakes. Borers represent 2%; they are made on blades, with little retouch near the point only, or made on small fine flakes with a blunt point. Sickle blades represent 8%, they belong to the common type of the PPNB, made on long blades with fine denticulation achieved by semi-abrupt retouch, usually on the ventral face. Axes, adzes and chisels account for 18% of the tools; this high percentage indicates that the occupants of Es-Sifiya practiced a prime woodworking industry, probably tree-chopping and wood processing. These tools are sharpened by bifacial flaking. The working edge was sharpened by transverse blows. In the entire chipped stone industry collection of Es-Sifiya, no obsidian pieces were found, probably due to the small scale of the excavated area.

Ground Stone Industry

Thirty-one ground stone vessels and tools were found during this season of excavation, including stone bowls, mortars, pestles, hammer stones, rubbing and polishing stones, The material used for the stone vessels and tools include limestone, basalt, quartzite, flint and chert. Pecking, chiseling, grinding or polishing and flaking were used in forming these artifacts. The presence of these stone objects reflects the strong reliance on plant resources. This confirms that the occupants of Es-Sifiya were familiar with the processing of wild or domesticated crops.

Eleven stone vessels were found including three complete bowls and a mortar, while the rest of the group are fragmentary and incomplete. All of these vessels are made of limestone. They range in diameter from 7cm to 28cm and comprise various forms (Fig. 6). The bowls are finely worked and carefully finished. Some of them have thick (5cm) walls coming up from rounded interior and exterior bases to rounded rims (Fig. 6:1-3,8,10-11) or a flattened rim (Fig. 6:6), while bowls 4, 5 and 7 in the same figure have flat bases. The most common method of manufacturing these vessels was by blocking out the rough shape of the vessel by pecking or punching and then the surface was finished by grinding and polishing. Often the exterior of the vessel was left with the punch marks only partly ground away, while the interior was ground and polished completely or to an acceptable degree. These vessels no doubt would have been supplemented by others of materials which have perished, probably of skin and wood. Fig. 6:9 is a complete mortar hollowed out with a cup-like depression.

The stone vessels of Es-Sifiya have parallels at Jericho, Beidha and Basta. Fig. 7:2-3,7-9 resemble those of PPNB at Jericho (DORRELL 1983: Pl. 13-c, Figs. 224:16, 228:11,22, 225:11). Fig. 7:5,7,10 resemble those of Basta (NISSEN *et al.* 1991: Pl. III, NISSEN *et al.* 1987: Fig. 15:4-5, GEBEL *et al.* 1988: Fig. 13:10-11), while Fig. 7:7 is identical with a bowl discovered at Beidha (KIRKBRIDE 1966: Fig. 7:8).

Eight stone pestles were recorded, they are made of volcanic basalt and had been carefully worked by initial pecking followed by grinding and smoothing. Two types of pestles were recognized. The first is the long and cylindrical type; the mortars must have been sufficiently hollowed to permit effective use of such pestles. The second type is the small and angular pestle that has a single, smooth, flat or sometimes convex pounding surface and was possibly used for pounding pigments or other minerals or for beating plaster. Both types of pestles have parallels at Jericho (DORRELL 1983: Fig. 226:8-10). Cylindrical wadi pebbles pitted by use at one or both ends were another frequent type of find.

Five grinders were recorded, all made of basalt. Some of these implements still maintain traces of red ochre. In shape they are either elongated ovals (*cf.* Fig. 7) or sub-rectangular bun-shapes with flat or rounded tops. The grinders of Es-Sifiya have parallels at Basta (NISSEN *et al.* 1987: Fig. 13: 7). We recovered five rubbing stones made of porous volcanic basalt graded from coarse to fine. The lower rubbing surfaces are flat or convex, while the upper side is shaped to fit the hand. These rubbing stones are roughly circular in plan with an average diameter 10cm and average thickness 4cm (Fig. 7). Six pecked and polished basalt axes were recorded their size ranges from 11-14cm long and 5-6cm wide.

Two stone weights were found, one complete and one broken. Both are made of basalt, and they are perforated through the central and narrowest area. The perforation is biconical in section. The shape tends to be that of a pyramidal stump with rounded edges. They have parallels at Basta (*e.g.*, NISSEN *et al.* 1991: Pl. III). Two perforated stone discs were also discovered. One is complete while the other is fractured (*cf.* Fig. 7). Their diameters range between 6.5 to 8.5cm and both are made of limestone. These discs could have been used for smoothing wood.

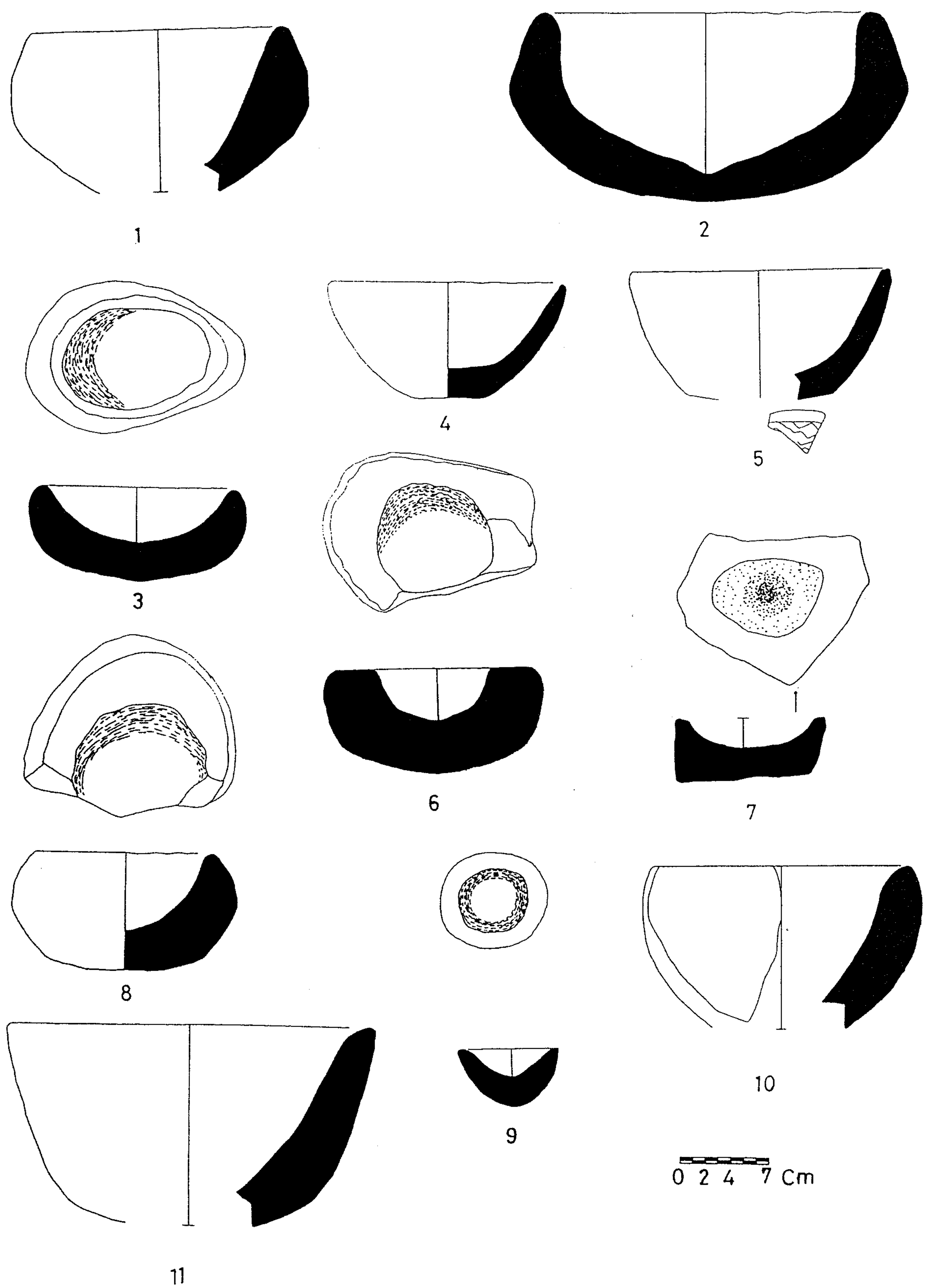


Fig. 6. Stone vessels.

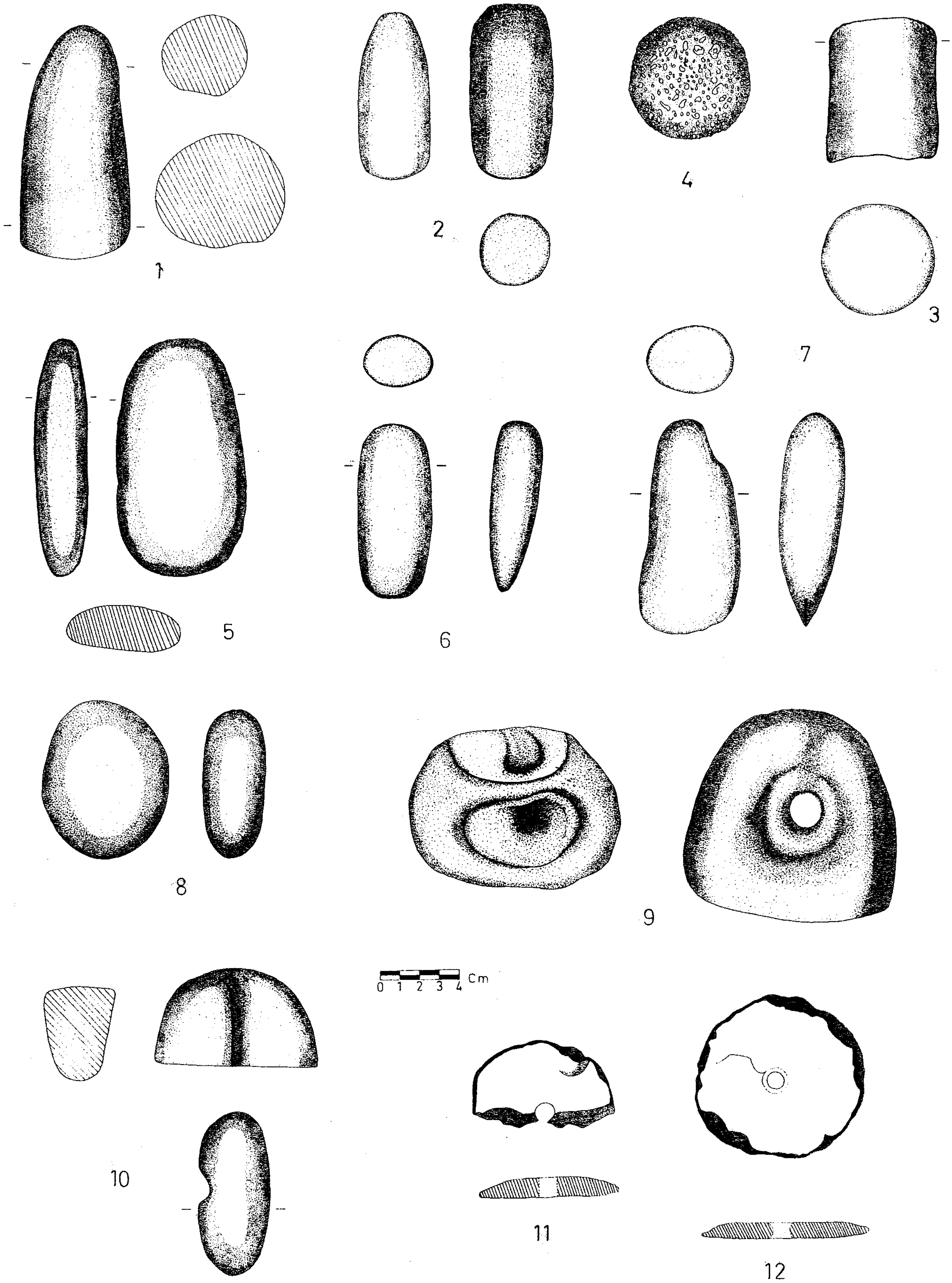


Fig. 7. Ground stone implements: 1-3 basalt pestles, 4 hammerstone, 5 mano, 6-7 basalt celts, 8 mano, 9 stone weight, 10 grooved stone, 10-11 perforated stone discs.

A fragment of a grooved stone appears to have been made on a basalt polishing stone. It has a loaf-shaped profile and a concave groove. It has been carefully and finely made with a surface as smooth as the material permitted. It is 10cm long, 8cm wide and 3cm high. The groove is straight in plan and the shape of the cross section remains constant along the length. The straightness and consistency of groove make it likely that the tool was used to straighten and smooth arrow shafts, for sharpening bone points, or possibly for finishing beads. The specimen resembles those found at Basta (*e.g.*, GEBEL 1988: Fig. 11:14).

Small Finds

Small finds, made of crystal, bone, greenstone, sandstone, or marine shell, were not numerous. Fig. 8:1 is a human figurine made of milky white quartz. It has a red ochre in the incisions representing the eyes and neck and in the center of the head. Two fragments of polished bone were found (Fig. 8:2-3). The first has a hole it was probably used as a pendant. It has a counterpart at Baja near Petra (GEBEL *et al.* 1988: Fig. 16:2 and 6); a bone awl or perforator was also recovered.

The excavations also produced several beads. Fig. 8:5 is a fragment of an incised cylindrical bone, and 6 and 7 are small bone rings similar to some from Basta (NISSEN *et al.* 1991: Fig. 5:6-7, GEBEL *et al.* 1988: Fig. 14:13-14) and Beidha (KIRKBRIDE 1966: Pl. XVII-9). Numbers 8 and 9 are greenstone beads; number 8 is unfinished and number 9 is broken. The latter has a counterpart at Jericho (TALBOT 1983: Fig. 360:15).

A fragment of a polished sandstone bracelet (Fig. 8:10) has close parallels at Basta (*e.g.*, GEBEL *et al.* 1988: Fig. 15) and 'Ain Ghazal (KAFAFI 1990: Fig. 22). Polished and worked cowrie shells (Fig. 8:11-12) resemble those recorded at Basta (NISSEN *et al.* 1987: Fig. 18:1-2), Beidha (KIRKBRIDE 1966: Pl. XVI-b) and Jericho (TALBOT 1983: Fig. 360:24). Fig. 8:13 is a polished sea shell pendant, oval in shape, with two holes.

All of the small finds mentioned above were found in Room 13 with the exception of the two cowrie shells, which were found in Room 11. This suggests that Room 13 of building unit 2 may have been a workshop for manufacturing small things.

Subsistence

The palaeoeconomic data obtained from the Es-Sifiya cultural layers show a typical Neolithic economy, consisting of self-sufficient farmers who herded sheep and goats but still obtained part of their meat supply by hunting. The faunal material of Es-Sifiya is mostly disarticulated, heavily fractured and obviously represents consumption residue.

Domesticated animals clearly dominated. Goats supplied 45% of the meat while sheep contributed 25%. The remaining food supply was obtained by hunting a variety of wild animals such as gazelle, fallow deer, wild boar, ibex, hare, fox and birds[1]. This variety of species indicates two things. First, it would appear that the hunters of Es-Sifiya did not specialize in their hunting activities and they sought out a wide variety of game over a broad territory. Second, the settlers of Es-Sifiya exploited different ecological areas including the flat steppes above the Wadi el- Mujib and the terrain of the wadi itself.

The floral remains recovered from Es-Sifiya are similar to other Near East Neolithic settlements and show that two-row hulled barley (*Hordeum distichum*) and emmer wheat (*Triticum dicoccum*) were cultivated. Beside this cereal production, the occupants of Es-Sifiya gathered wild nuts such as almonds and pistachio[2].

The presence of numerous sickle blades and milling equipment from the site supports the idea of cereal cultivation and food production.

Discussion and Summary

Despite heavy damage sustained in recent agricultural activities, dirt road traffic and bulldozer activity, the excavations at Es-Sifiya have revealed the potentials of the site. It is classified among the most important PPNB sites encountered so far in the southern Levant, particularly in view of its large size and the well-preserved and well-executed architecture, which has striking similarities to the structures at Basta and 'Ain Jammam, including the curious subfloor channel system. Floral and faunal preservation are excellent, which will be of enormous value in detailing the subsistence economy practiced in central Jordan. Digging tools, pounding milling and grinding objects, sickle blades and numerous picks and axes that were recovered, reinforce that the settlers or inhabitants of Es-Sifiya

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[1] I wish to thank K. Gruspier for analyzing the faunal remains.

[2] I would like to express my gratitude to the members of the Faculty of Agriculture at Mu'tah University for analyzing the soil samples.

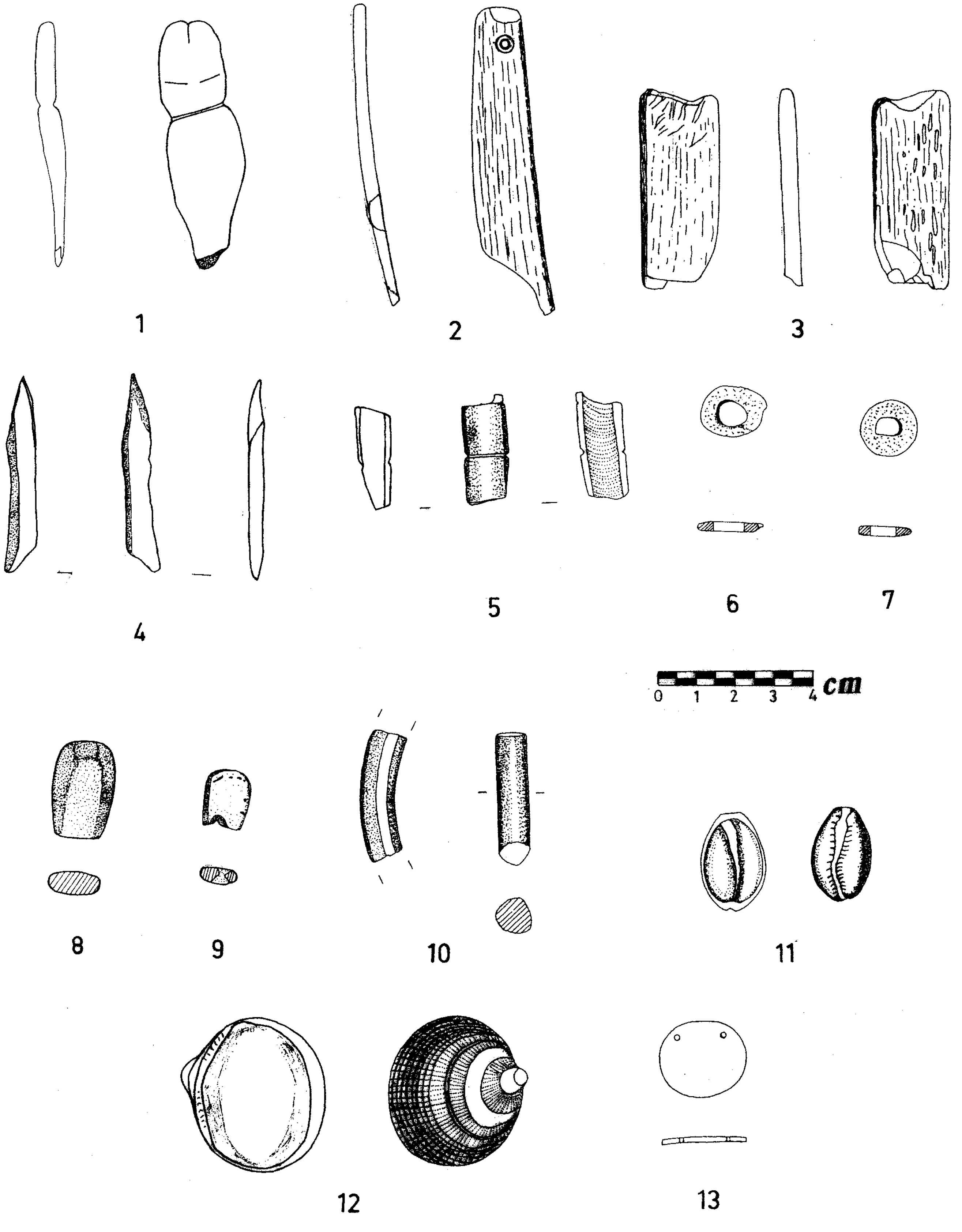

Fig. 8. Selection of small finds: 1 human figurine, 2-3 bone spatulae, 4 bone awl, 5 incised bone, 6-7 bone beads, 8-9 greenstone beads, 10 sandstone bracelet, 11-13 sea shell ornaments.

were engaged in agriculture and food production, although they had continued collecting and picking wild fruits and nuts.

It is clear that the area excavated in 1994 and 1995 dates to the Late PPNB: a radiocarbon sample was obtained from the floor of Room 11 and processed in the U.S. It gives the date 7.930 ± 70 (ISGS-3279), Delta 13C: 25.2.

Concerning the PPNC or related layers which has been attested at the counterparts of Es-Sifiya, such as Basta and 'Ain Jammam in Southern Jordan, and Wadi Shu'eib and 'Ain Ghazal in northern Jordan: we have to wait for further investigations at Es-Sifiya, and possibly we have to expect here a similar Post-PPNB occupation.

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'Ayn el-Jammam: a Neolithic Site Near Ras en-Naqb, Southern Jordan

Mohammed Waheeb and Nazeh Fino

Abstract: *The second season of rescue excavations was concluded recently at 'Ayn el-Jammam, a medium-size permanent settlement between Ras en-Naqb and Ma'an. The following report provides a brief description of the three periods of occupation at the site: LPPNB, PPNC and Pottery Neolithic.*

Introduction

The Neolithic settlement at 'Ayn el-Jammam ('Ain Jammam) has been known for some time. Glueck visited the spring ('Ayn) more than half a century ago (GLUECK 1935: 65), although he failed to recognize the presence of Neolithic artifacts there, as was also the case for Hart and Falkner (1985: 255) in their survey of the region. But the site was recognized later by Jobling, who collected some flints but did not ascribe an age to them (JOBLING 1983: 199, 207). It was not until Gebel visited the site in 1986 that the significance of 'Ayn el-Jammam was appreciated (GEBEL 1992); artifacts clearly showed LPPNB to Pottery Neolithic occupation.

'Ayn el-Jammam's location on a steep slope below the Desert Highway on the way to Aqaba led to a major problem when the Ministry of Public Works decided to widen the road. In preparation for mitigation, the Cultural Resource Management office of the Department of Antiquities undertook an emergency survey through an agreement with the Ministry of Public Works (BISHEH *et al.* 1993) and conducted two seasons of excavations in 1995 and 1996. It is the aim of this report to describe the occupational sequence revealed by field work.

The Site of 'Ayn el-Jammam

'Ayn el-Jammam is a medium-size Neolithic farming village located at the edge of the escarpment near Ras en-Naqb at UTM coordinates 7376 33240 and Palestine Grid coordinates 194.4 937.1 (Fig. 1). It is situated on a steep slope near a spring that produces a copious flow of water, and the settlement has a majestic view of the Wadi Hisma far below. There are Roman and Nabatean ruins nearby, but the Neolithic site itself extends for 6 - 8 hectares. There are modern terraced orchards on the slope today, irrigated by water from the spring, but in antiquity fields probably also were located on the plateau just above the escarpment.

During the cleaning of a bulldozer section in 1992, radiocarbon samples were collected. Two assays produced ^{14}C dates of 8520 ± 190 bp for the lowest sample and 8030 ± 120 bp for a sample from near the center of the sequence. Excavations have now shown that 'Ayn el-Jammam was occupied over parts of three major periods:

Pottery Neolithic	(*c.* 7,500 - 5,700 bp)	Three sub-phases (5, 6 and 7)
PPNC	(*c.* 8,000 - 7,500 bp)	Two sub-phases (3, 4)
LPPNB	(*c.* 8,500 - 8,000 bp)	Two sub-phases (1, 2)

The Architecture

Architecture at 'Ayn Jammam was well preserved, including some walls that remained standing to a height of 3m. The builders took advantage of the fact that the local limestone flaked or spalled off in layers of uniform thickness, providing a ready resource for construction in the hills immedia-

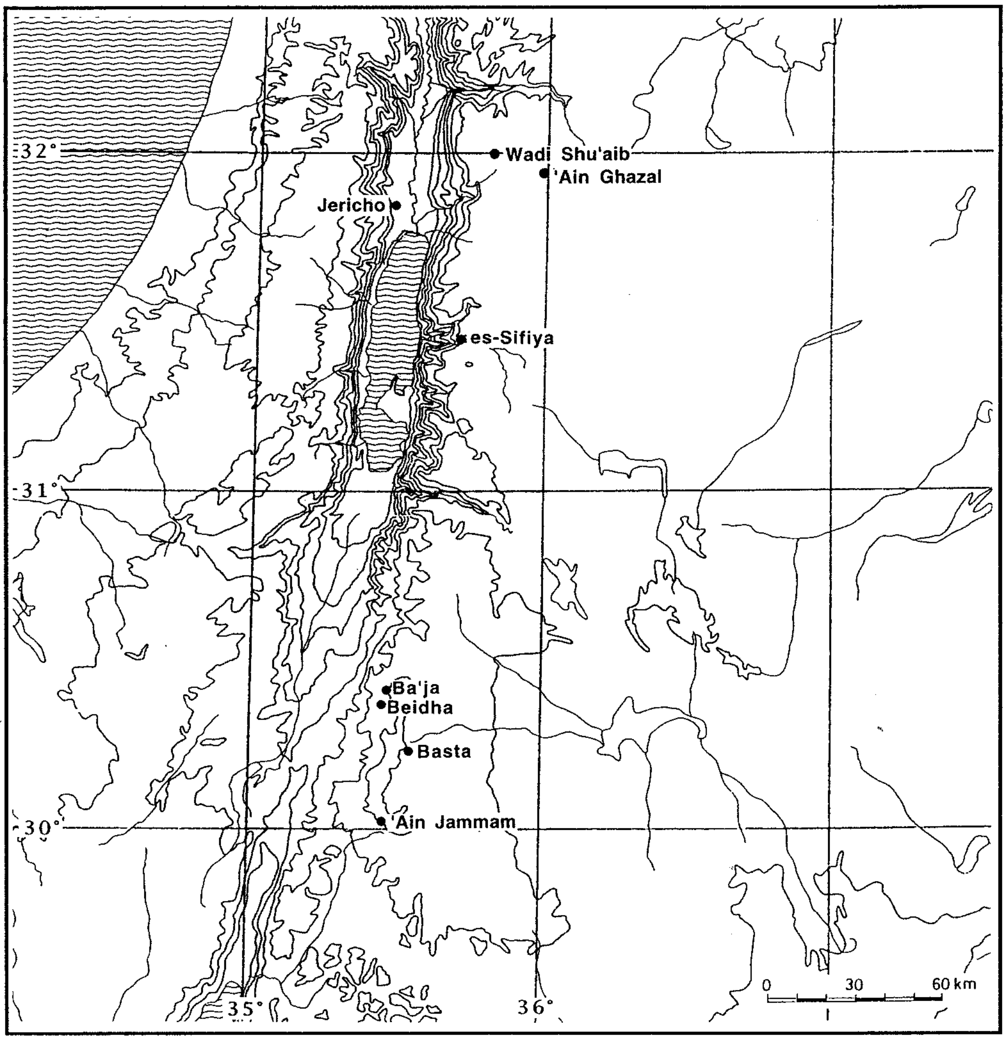

Fig. 1. 'Ain Jammam and the other large late PPNB settlements.

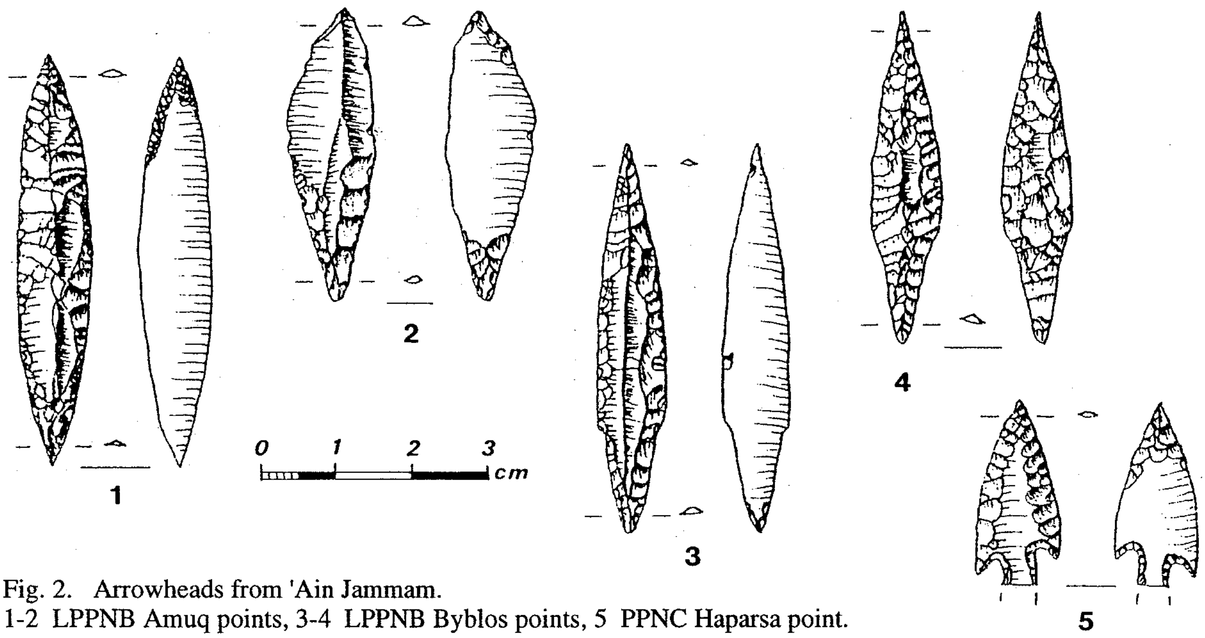

Fig. 2. Arrowheads from 'Ain Jammam.
1-2 LPPNB Amuq points, 3-4 LPPNB Byblos points, 5 PPNC Haparsa point.

Plate 1:a. View of the 'Ain Jammam excavations from uphill NE.

Plate 1:b. View of Ain Jammam LPPNB structures from NW.

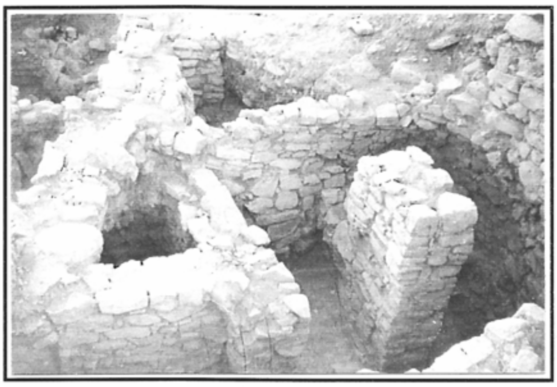

Plate 1:c. 'Ain Jammam: LPPNB structure with a free-standing column build of stones.

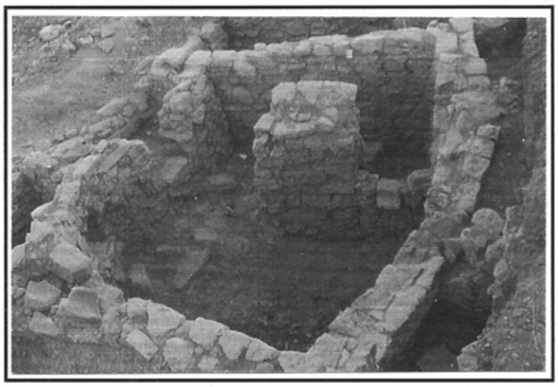

Plate 1:d. 'Ain Jammam: LPPNB room with the free-standing column.

tely to the north above the settlement. The rectangular, dressed stones were set in mud mortar, and the joins in most cases quoined with small, thin flat stones.

The LPPNB buildings (Pl. 1:a-b) reflect many similarities with Basta (NISSEN *et al.* 1987: 85-95), es-Sifiya (MAHASNEH, this volume), and especially with Ba'ja (GEBEL *et al.*, this volume) because the latter site has similar topographical demands on groundplans. To some degree architectural features of Beidha (KIRKBRIDE 1967: 8) and Jericho (KENYON 1957) are attested. Floors were made of lime plaster, and walls were also plastered, usually covered with a thick smear of red pigment. A distinctive feature of the 'Ayn el-Jammam architecture was the use of free-standing pillars, built up of the same stones as used in the walls, placed near the center of rooms (Pl. 1:c-d), but sometimes also as pilasters against walls.

PPNC architecture remained very similar to the LPPNB styles, although one new feature was the use of limestone cobbles for flooring, a practice also noted Abu Ghosh and Wadi Falaha (KAFAFI 1982: 29-30). In sub-phase 4 no architectural remains were found, despite the presence of artifacts, indicating that at this time the people of 'Ayn el-Jammam settled in camps nearby but not on the site itself.

With the appearance of ceramics and the beginning of the Pottery Neolithic occupations at 'Ayn el-Jammam, some architectural developments distinguished the newer structures. Of particular importance was the adoption of a curvilinear floor plan with well-constructed curved walls; room size also grew, so more pillars were necessary to support the roof. Floors were made of mud, cobbles and white mortar. Similar, or at least contemporaneous sites, include Abu Thawwab (KAFAFI 1993: 103), Wadi Shu'eib (SIMMONS *et al.* 1989), Tell Wadi Feinan (NAJJAR *et al.* 1990: 41) and 'Ain Ghazal (*e.g.*, KAFAFI and ROLLEFSON 1995: 14-16).

Artifacts

More than 3,500 chipped stone artifacts (with a broad variety of tool types) have been recovered so far, as well as numerous groundstone (limestone and basalt) examples, bone tools, and jewelry. The chipped stone is predominantly chert/flint, although the use of locally available orthoquartzite is also attested.

Arrowheads have been useful in assigning ages to the occupational sub-phases, with classic examples of Byblos and Amuq points (LPPNB) and Haparsa and Nizzanim types in the PPNC and Pottery Neolithic levels (Fig. 2).

Hundreds of grinding stones reflect the strong reliance on plant resources; characteristic are plano-convex handstones, saddle-shaped querns and spherical flint hammer stones. Identified plant remains (HANSEN n.d.) from the site include two kinds of wheat (*Triticum vestirum* and *T. dicoccum*), two kinds of barley (*Hordeum distichum* and *H. vulgare*) as well as chickpea, lentils, and figs. Of particular interest was the presence of grape, the first time this fruit has been identified in the Neolithic of Jordan. Finally, two wood species (*Juniperus* sp. and *Pistacia* sp.) represent construction material and fuel used by the residents at 'Ayn el-Jammam (FINO n.d.).

Concluding Remarks

Because of the importance of 'Ayn el-Jammam, an agreement has been reached between the Ministry of Public Works and the Department of Antiquities (CRM) in which the MPW will build a retaining wall to protect the site from threats during the road-widening operations.

Acknowledgements: We would like to thank Dr. Julie Hansen for her analysis of the plant remains, and we are also grateful to Hans Georg K. Gebel for his support.

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Ba'ja Hidden in the Petra Mountains. Preliminary Report on the 1997 Excavations

Hans Georg K. Gebel and Hans-Dieter Bienert
with contributions by Tobias Krämer, Bernd Müller-Neuhof, Reinder Neef, Jan Timm, and Katherine I. Wright

Abstract: *This contribution offers a preliminary report on the findings of the 1997 excavations at the Late Pre-Pottery Neolithic B (LPPNB) site of Ba'ja (late 7th mill. BC), north of Petra, southern Jordan, discussed with regard to current understandings of the mega-site phenomenon of that period east of the Rift Valley. Basic information is provided for the present-day setting, the site preservation, its architecture and building techniques, and the various industries, ended by a summary with reference to basic implications Ba'ja provides for a promoted understanding of LPPNB phenomena. Information on the technologies of LPPNB baked clay containers and sandstone rings are presented here the first time.*

Key Words: *Ba'ja, Southern Jordan, LPPNB architecture and material culture, mega-site phenomenon.*

Introduction (H.G.K.G. and H.-D.B.)

Between June 16 and July 20, 1997, the first season of large-scale excavations was conducted at the LPPNB settlement of Ba'ja in southern Jordan (*cf.* GEBEL and BIENERT 1997 a,b; earlier publications: GEBEL 1986, 1988; GEBEL and STARCK 1988). The 1997 season was carried out under the joint directorship of the main authors of this contribution, and under the institutional umbrella of the German Protestant Institute for Archaeology, Amman Dept. in cooperation with ex oriente e.V. at Free University of Berlin. The German Archaeological Institute, Orient-Department in Berlin was represented in the project by a special research commission to be carried out on pre-planning aspects of LPPNB architecture.[1]

Project History

The LPPNB village of Ba'ja rests on an intramontane terrace in the steep sandstone formations some 10km north of Petra and 5km north of Beidha, respectively (Fig. 2). With available information[2], it was difficult for H.G.K. Gebel to relocate the site in autumn 1984, who then recorded its location more precisely and carried out three soundings in the framework of his project *Palaeoenvironmental Investigations in the Greater Petra Area- Holocene Research* (P.I.G.P.A.; GEBEL 1986, 1988, 1990, 1992; GEBEL and STARCK 1985)[3]. These investigations identified Ba'ja as one of the

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[1] The excavations in Ba'ja were followed by an international symposium on the *Central Settlements in Neolithic Jordan* (Petra Mövenpick, 21- 25 July, 1997), organized by this projects' co-directors. This contribution benefited much from the discussions of this symposium.

[2] The site was originally found by M. Lindner and his team, who presented the collected chipped lithic finds to H.G.K. Gebel (for the history of finding Ba'ja *cf.* GEBEL and BIENERT 1997a, LINDNER 1996); it appears unlikely that Ba'ja would have been found by "normal" survey means. Here we would like to thank M. Lindner for his constant advice and support over the years, which also accompanies the renewed research on Ba'ja.

[3] In this report material and information of the earlier project is used (financed by the *Deutsche Forschungsgemeinschaft* through the *Sonderforschungsbereich* 19: Tübinger *Atlas des Vorderen Orients*). Sincere and deep thanks go to Wolfgang Röllig, that time chairman of the SFB 19 for all his support for this project. It allowed the first investigations of Basta and Ba'ja in 1984, establishing the initial interest in these sites for the later large-scale excavation projects (H.G.K.G.).

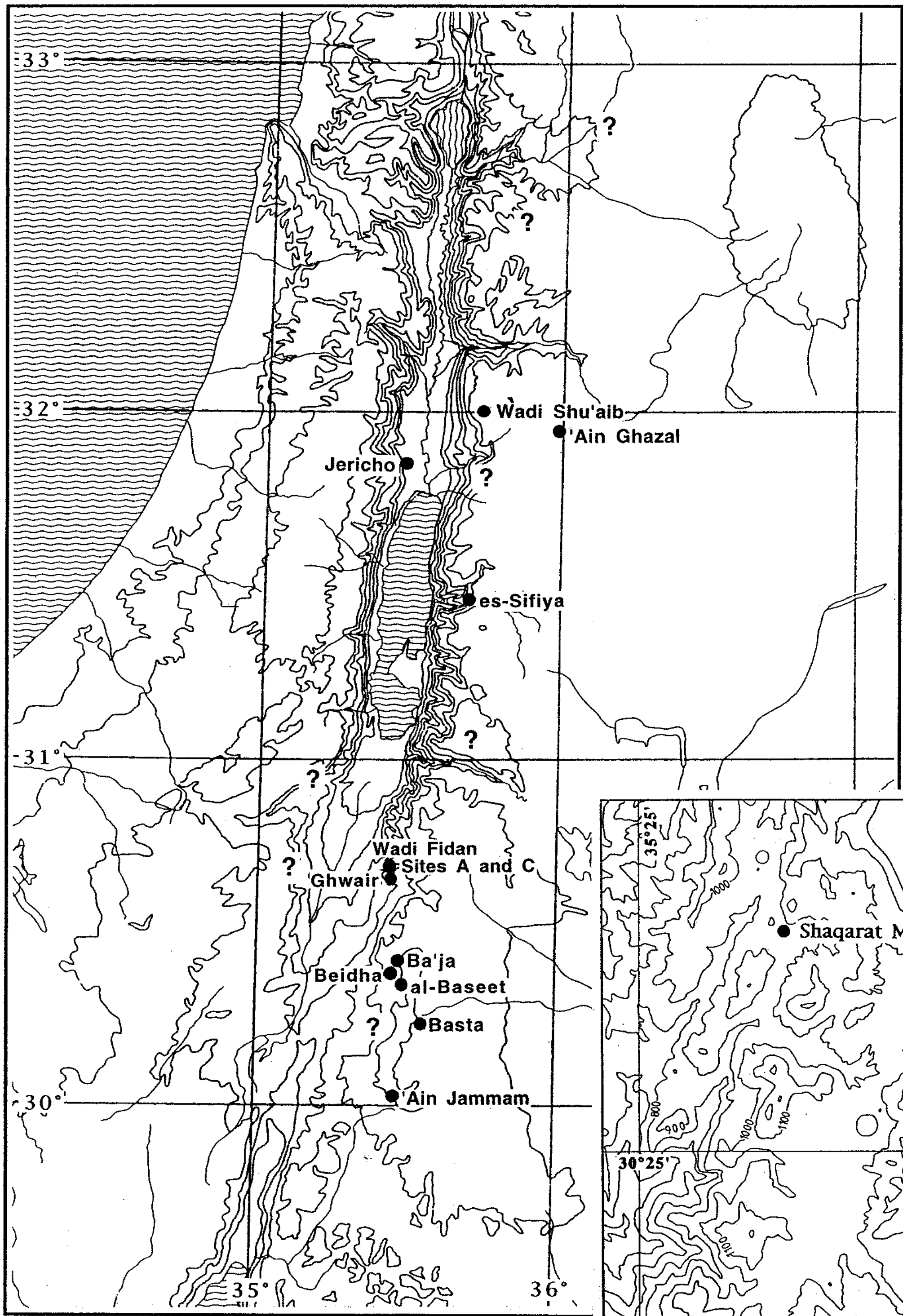

Fig. 1. MPPNB transitional / LPPNB villages along the Rift Valley, expected to relate to the mega-site phenomenon of the 7th mill. B.C. (*cf.* GEBEL n.d.). "?" refers to such expected sites in other regions.

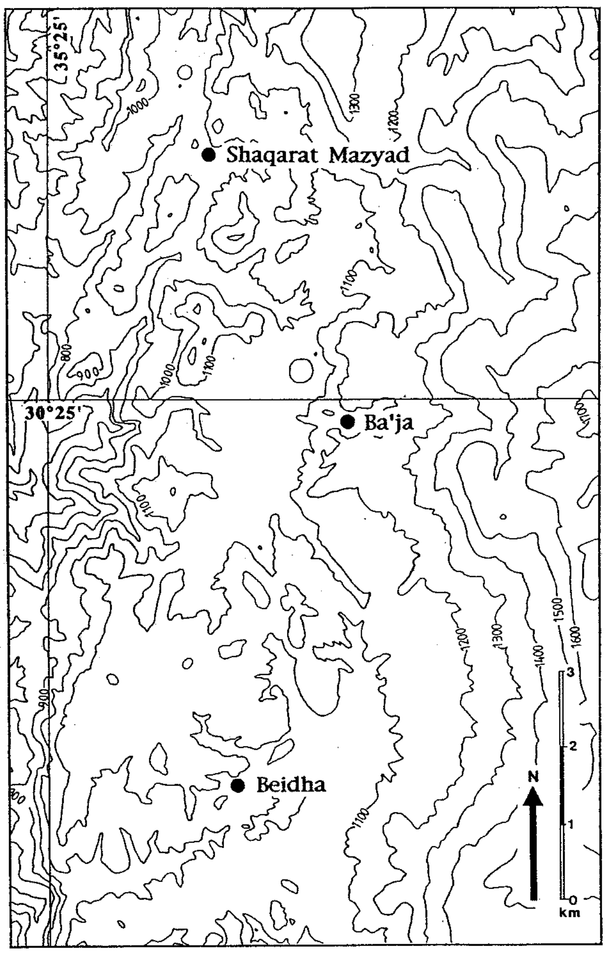

Fig. 2. Region north of Petra with the location of Ba'ja in relation to Beidha (M-L?PPNB) and Shaqarat Mazyad (M-L?PPNB).

Plate. 1:A. Intramontane setting of the site with excavation in Area C from SE (photo: Schatz-Haerle).

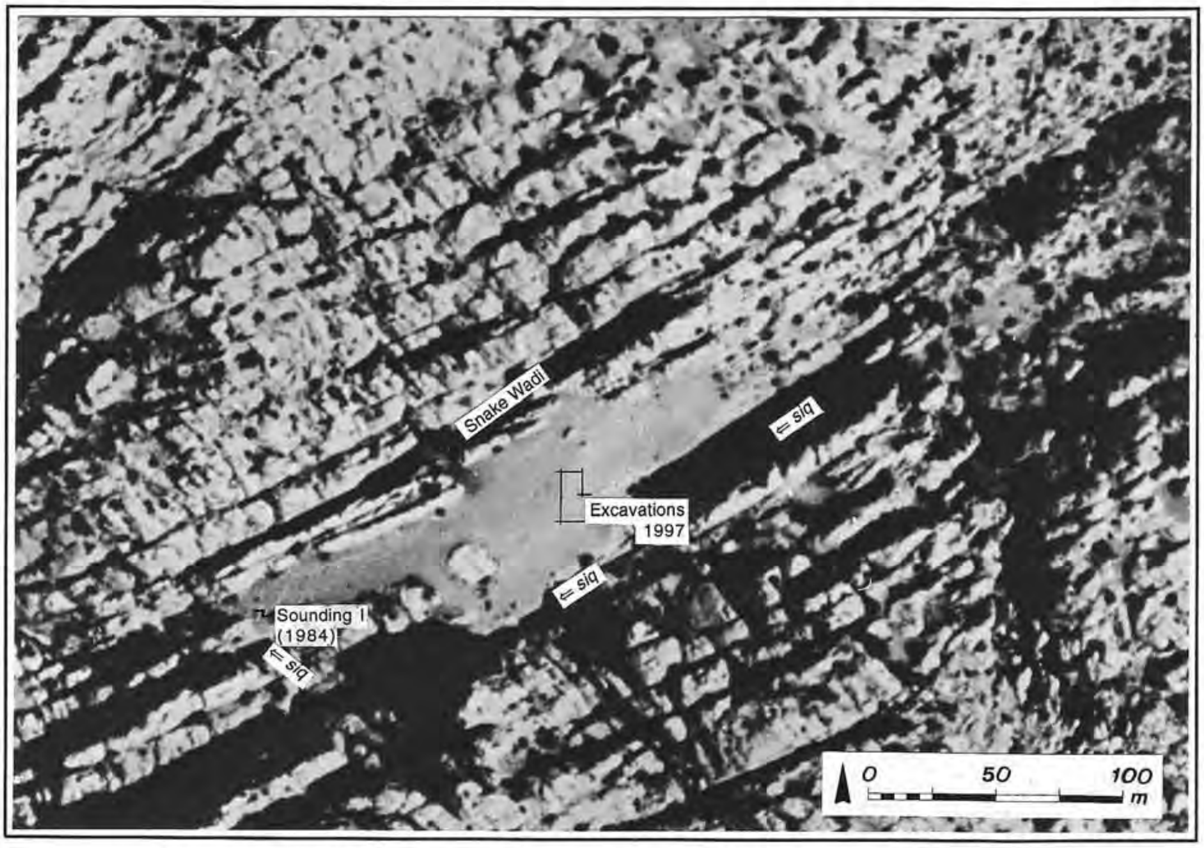

Plate 1:B. Aerial view of intramontane Ba'ja, surrounded by sandstone formations.

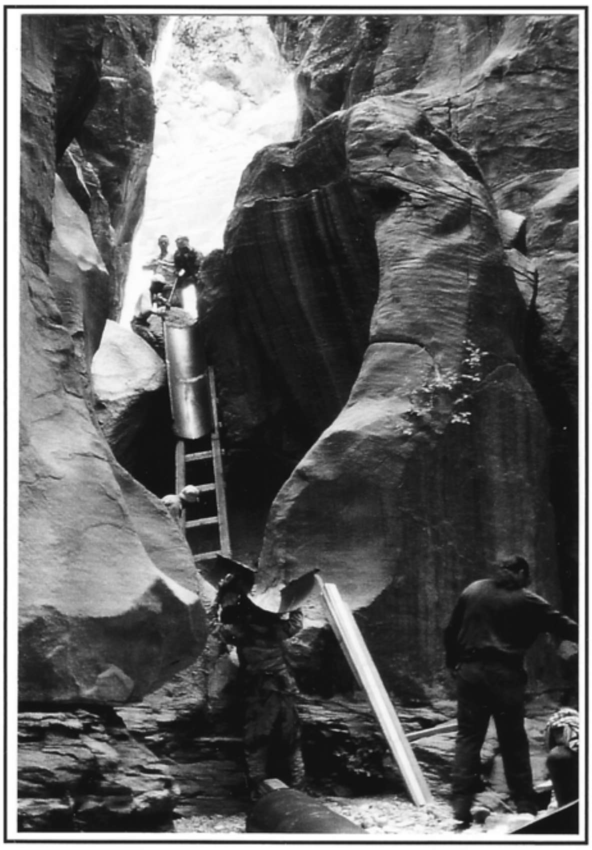

Plate 2:A. Working conditions: Bringing the sediment chutes up to the site through the *siq* (photo: Gebel).

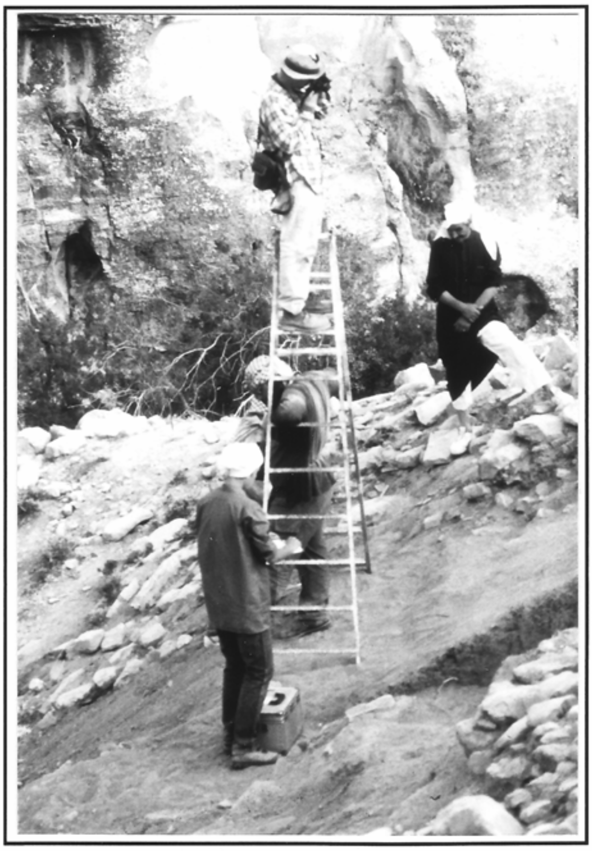

Plate 2:B. Working conditions: Photographers on a ladder at the edge of the *siq* slope (photo: Gebel).

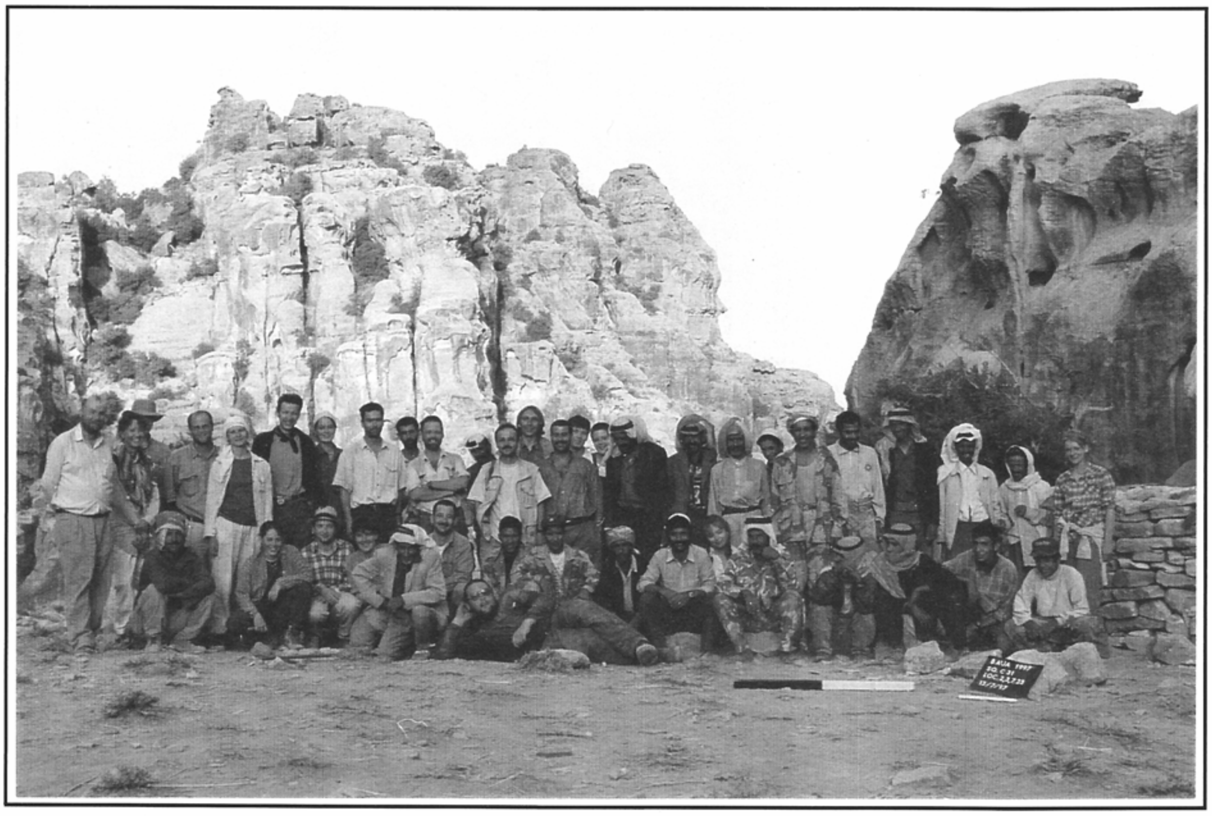

Plate 2:C. Excavation team 1997 (photo: Jeffs)

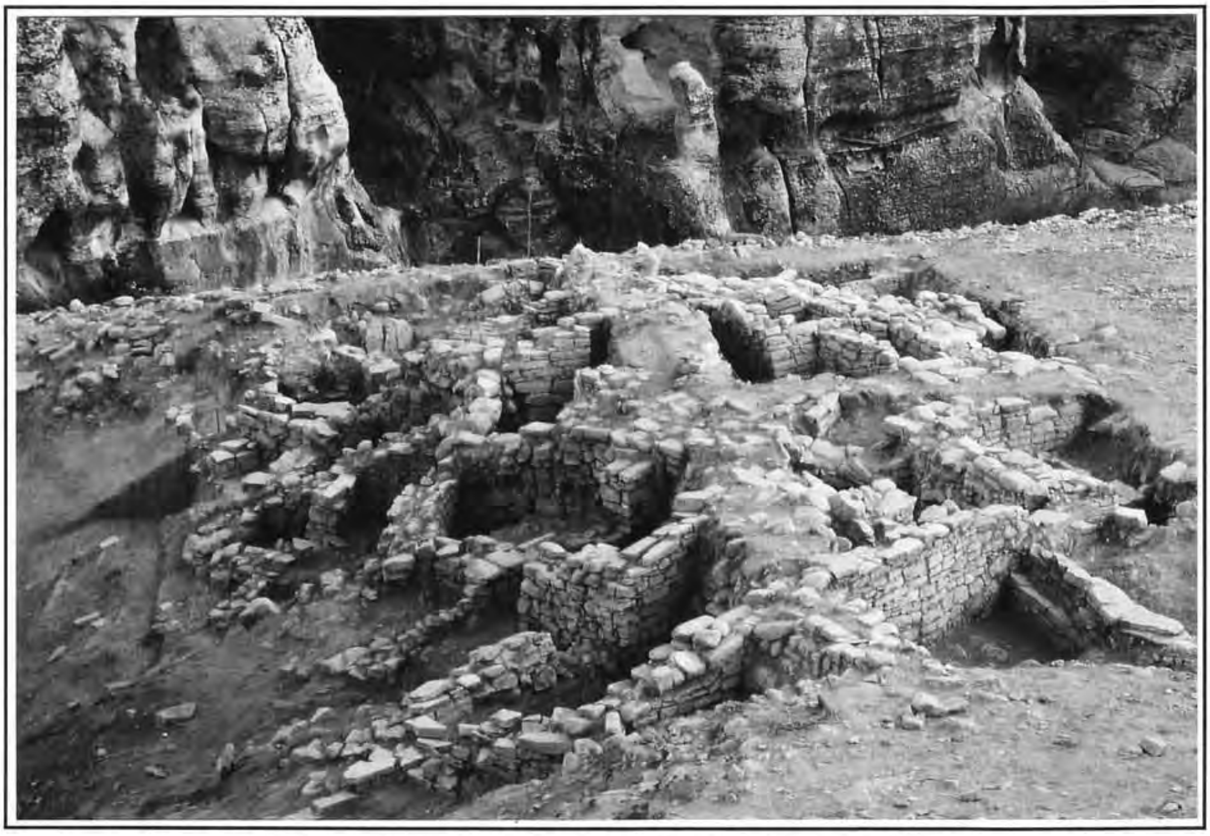

Plate 3:A. Excavation in Area C seen from north (photo: Gebel).

Plate 3:B. Excavation in Area C seen from southeast. Note the sharp line (foreground) between preserved walls and the exposed sterile deposits underneath (photo: Fengler/Höffgen).

large Late PPNB settlements in the Greater Petra Area, probably succeeding Beidha in the function as a regional center. A chain of settlements already existed in the MPPNB of the area (Beidha, Shaqarat Mazyad, adh-Dhaman; GEBEL 1990), which testified to the first permanent settlements and high population density in the region. It is from these that the LPPNB occupations must have emerged, although it cannot be considered certain that the sandstone areas developed demographically similar to what occurs in corridor settings on the fringes of the Arabian Plateau: mega-sites like Basta and 'Ain Jammam, or at the edges of Wadi Araba, sites like Wadi Fidan A and C, and Ghwair (GEBEL n.d.; RICHARDSON, this volume; Fig. 1).

In the years after the first investigations, Ba'ja's protected setting, the difficult access and the surrounding magnificent setting made it an attractive goal for only a few insiders. In 1996 H.-D. Bienert approached H.G.K. Gebel for an in-field cooperation. Since it had become imperative to contribute to the mega-site discussion by investigating also a smaller regional LPPNB center away from the corridors of that LPPNB large settlement expansion, Gebel proposed Ba'ja for this cooperation, provided that three field seasons would take place in order to the achieve the expected basic insights (*cf.* the goals discussed in GEBEL and BIENERT 1997).

Field Logistics and Conditions

Working at the site is a tough enterprise (Pl. 1-2), as was already experienced by the small team directed by Gebel in 1984. This year, a sounder infrastructure was established for 22 permanent team members (plus 3-4 part-time members; *cf.* Acknowledgments) from Germany, Jordan, the United States, England, and Sweden. During the most intensive work periods up to 24 local workman from the al-Amarin, al-Bdul, and al-Sey'idin tribes worked at the excavations. The co-directors shared their work in a way that the general organizational aspects were covered by Bienert, including supervision of the registration, while Gebel directed the excavations on the site.

To approach the site of Ba'ja demands climbing through a gorge (*siq*) for *c.* half an hour, crossing several barriers of fallen rocks reaching heights of up to 5m (Pl. 2:A). The entrance of the *siq* can be reached from the Jabu Plain west of the site by a four wheel drive, going through Siq Umm al-Hiran north of the Beidha/ al-Hishi/ Wadi Araba junction near al-Beidha Housing[1]. The site has no water nearby and almost no shady areas. All the water (in our case 130 l per day), food, and equipment, had to be brought up by carrying and climbing. On the site, there were no possibilities for personal hygiene; work was characterized by limited comfort, permanent stress on one's ankles (up to 40° steep slopes, *cf.* Fig. 4), few flat areas to rest, danger of snake and climbing accidents, etc. Two camps were maintained: a base camp with four houses at al-Beidha Housing, and the dig camp on the site. Most team members preferred to stay at the dig camp, since daily moves between the site and the base camp were very exhausting. However, the dramatic scenery (*cf.* Pl. 1:A) and the experience of its untouched natural setting were suitable compensation for much of the deprivation. Although the site can be approached with considerable difficulty from the east and the south, no more efficient track was found for transporting materials than that afforded by climbing through the *siq*.

Field Operations (Fig 4:A)

C. 250 m² (10 5x5m squares; 5 digging teams) were opened in the terraced housing area where the steep slope of Area C climbs up to the flat Areas B and D, forming at this spot a spur-like crest. Two of the squares were found free of any architecture, which resulted in a lively discussion of the state of preservation (see below). Two Test Units were opened, one above bedrock at the lowermost fringes in Area C (TU1, a step trench) in order to understand the Quaternary stratigraphy on which LPPNB layers rest, and one in the "Snake Valley" (TU2). The latter was in a small wadi immediately north of the site and yielded LPPNB ashy trash layers still preserved in a "sediment trap"[2]. It was investigated for its huge quantities of animal bones, chipped lithics, and occasional bone tools and ornaments in order to obtain a "control sample" for these find classes and to increase our sample sizes.

The archaeological surface reconnaissance mapped all the Neolithic (and other) wall remains visible on surface, the dense distribution of ground stone materials, and other surface features. In the last days of field work, the immediate vicinity of the site was surveyed in order to look for possible outliers of the occupation. (There seem to be none.). The site survey was the dangerous job of the surveyors who recorded the site's topography, including the bordering *siq*, wadi, and rock formations, by means of 5m-contour lines across the *c.* 1.2-1.5ha area of the site. (Fig. 4:A)

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1 The site of Siq Umm al- Alda 1 (*cf.* SCHYLE and GEBEL, this volume) is to be found immediately to the right of this same track (after passing the track leading off to the Ba'ja *siq* entrance) at a spot where the track leaves the playa fills of the Jabu Plain and again enters a rocky sandstone gorge (Siq Umm al-Alda). From here it continues to M-L?PPNB Shaqarat Mazyad and the Wadi Araba.

2 Many other spots, including the area of Sounding I from 1984, proved that the Neolithic settlers used the surrounding drainages and lower lying rock surfaces as disposal areas.

The practical goal of the excavation itself was to uncover the architectural remains down to the earliest floor of the upper occupation. Sieving was applied whenever *in situ* layers occurred in room fills.

Present-day Environment[1] (H.G.K.G. and R.N.)

Bioclimatologically, Ba'ja presently lies in a cold-temperate, semi-arid zone. The average annual precipitation is around 200-250mm[2], but there are large fluctuations in this area. The deeply dissected nature of the sandstone around much of the site has resulted in small landscape units with favorable edaphic conditions, such as small valleys and rock crevices where runoff water can collect. Here can be found small, well-developed stands of the evergreen oak (*Quercus calliprinos* s.l.). On more exposed places in rock crevices, for example, one can find pistachio trees and shrubs (*Pistacia atlantica* or *P. khinjuk*) and the Phoenician juniper (*Juniperus phoenicea*). (Fig. 3)

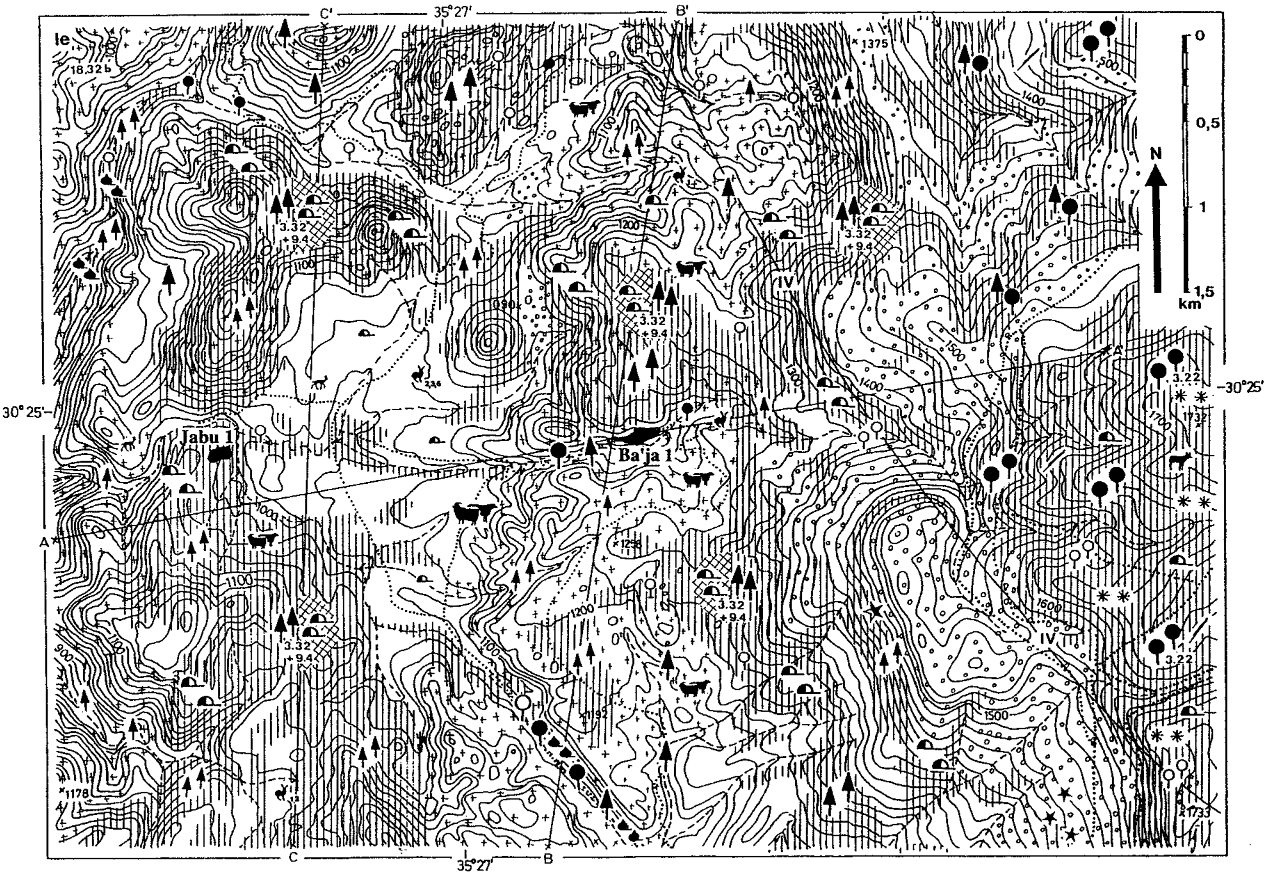

Fig. 3. Present-day environment of Ba'ja. (from GEBEL 1992; for legend, see GEBEL 1990).

Phytogeographically, the setting of Ba'ja is at the westernmost edge of the Irano-Turanian open forest steppe vegetation, which penetrates the sandstone area from the eastern limestone slopes of the Arabian Plateau with its characteristic element, the wormwood *Artemisia sieberi* (addressed before as *Artemisia herba-alba*). Somewhat farther south, this steppic artemisia cover even reaches as far as *c.* 2km west of Beidha (down to the 1040m- contour line; *cf.* GEBEL 1988: Fig. 2). These converging floral regions, the Irano-Turanian and the Xero-Mediterranean represented by oak, juniper, pistachio, create the habitat diversity of this area. Artemisia here became an undergrowth of the open juniper forests on the slopes just east of Ba'ja. Pure Xero-Mediterranean forests are preserved at higher altitudes some 3-4km east of Ba'ja: the famous woods of al-Hishi. The "vegetation of the rocky sandstone

[1] For the reconstruction of the environment in the late 7th millennium BC, see the description of the Palaeophysiographic Units V-VI in GEBEL 1990 (attached sheet) and 1992: 95.

[2] Ba'ja lies just west of the isohyet of 200/300mm in dry/wet years (marked with "IV" in Fig. 3). Rainfall within the areas can vary considerably: *e.g.* in 1966/67 200mm were recorded, but for 1959/60 only 50mm.

areas" north of the Jabu Plain (described by GEBEL and STARCK 1985: 96) is another type of floral community of the area. The Jabu Plain itself is characterized by its own plant cover, that of *playa* surfaces suitable for rain-fed agriculture (GEBEL and STARCK 1985).

Even today the diversity of the vegetation provides many different habitats attractive for a long list of mammals potentially living here: hedgehog, Arabian wolf (extinct?), fox, a small fox, wild cat (extinct), lynx (extinct), badger (extinct?), striped hyena, mountain leopard (extinct), various rats, mice, gerbils, jerboa (?), crested porcupine, ibex (extinct), wild boar, hare, hyrax, bats, and others.

The present-day environment (Fig. 3) is used for sheep and goat grazing and, to a small extent, for rain-fed agriculture (wheat and barley) on the Jabu Plain and some hydrologically favoured intramontane spots with loose sediments.

The mean daily day temparature in the area is in January 8°C, in August 28°C. The mean daily range of temperature is 10°C in January, and 14°C in August. Mean monthly relative humidities are for January around 60%, in August around 40%. (NAJ I and II 1984 and 1986).

Site Setting and Topography (H.G.K.G. and H.-D.B)

The location of Ba'ja, known locally also as "al-Mehmad", is at 35° 27' 45" E / 30° 24' 55"N; the altitudes for the identified cultural layers on the site range from 1060 to 1095m according to the surveyors' work (HARTL-REITER 1997) and are based on double-checked barometric readings and the consultation with the Topographical Map of Petra, al-Bayda Sheet (Royal Jordanian Geographic Centre 1997). Earlier determinations followed available maps (such as the topographical map Jordan 1:50.000, Petra sheet: 3050 I, Ministry of Economy / USAID to Jordan, n.d.) and had ascribed the site to *c.* 1120 to 1160m a.s.l. The region today belongs to the territories of the al-Amarin.

The Neolithic layers rest on a terrace (Pl. 1:B) that can be described as the remnant of an intramontane *playa*-like fill within the basin-like structure of al-Mehmad. The present-day topographical units (Areas A-I: Table 1, Fig. 4) of the site must have basically developed their shape after the resolution of this catchment (Upper Pleistocene, if compared with other spots in the Petra region) after this fill was partly transported out of the basin while forming the deeply incised *siq* by the coarse-grained material transported down from the limestone plateaus to the east.

Table 1. Ba'ja : Topographical Units.

Area	**Setting, topographical features, and drainage directions (directions taken from the report by T. Krämer; *cf.* also Fig. 4)**	**Commonly referred to as**
Area A	narrow, agriculturally terraced western slope (NE-SW)	"The Towel"
Area B	flat surface southwest of the site's highest part (no major drainage direction)	"The Saddle"
Area C	steep slope with the majority of the LPPNB terraced housing on the site's eastern extension (various drainages, N-SE/S/SW)	"The Amphitheater"
Area D	uppermost northern parts of the site with dense surface evidence of LPPNB walls (Area G belongs topographically to this area; NE-SW)	"The Acropolis"
Area E	small narrow slope with many wall remains starting north of Area B, ending in the wadi ("Snake Valley") bordering the site in the north (SE-NW)	"Snake Valley Slope"
Area F	southern central steep slope (W-S and NW-SE)	
Area G	small uppermost part of the site east of Area D (NW-SE)	
Area H	easternmost part of the site with little archaeological surface evidence (N-S/SE)	"The Restroom Area"
Area I	low terrace above the *siq* with no archaeological surface evidence (N-SW/S/SE)	

The site is bordered by the Siq al-Ba'ja to the south and vertical rock formations to the north. Its longitudinal axis is oriented SW-NE and is about 290m in length, with a width that varies from *c.* 20m at the western and eastern accesses to about 90 m in the central area. The area potentially occupied in the later 7th millennium B.C. is about 1.2-1.5ha, which is *c.* 5000m^2 larger than preserved Beidha. But contrary to nearby Beidha, the inhabitants had very limited possibilities to expand into the surrounding area; there seems to be no evidence for any outliers. (See below; in this respect, we may have to revise hypotheses concerning space pressure at Ba'ja; *cf.* GEBEL and BIENERT 1997a).

Functional units so far identified at the site are domestic areas on terraces (with evidence for indoor sandstone ring workshops) and dump areas in the westernmost parts of Area A, in "Snake Valley", and most likely in the *siq*. No evidence for burial grounds, animal pens, or open spaces were found in the limited area of excavation (*c.* 2%), which was placed in the centre of the Neolithic village. Finds of human bones in the dumps of Test Unit 2 (Fig. 4:A) led us expect intramural burials.

Vicinity Survey (B.M.-N.)

The aim of the 6 day-survey in the vicinity of Ba'ja was to locate possible smaller Neolithic outliers and sites from other periods. It was especially the smaller valleys that might have sustained more

Neolithic and later settlements or camps (*cf.* GEBEL and BIENERT 1997) due to the good water storage capacity of thick aquifers that might have existed at those times, which could have supported agricultural activities.

The survey was based on aerial photos (1: 30,000) covering the whole area of Ba'ja. As a preparation for the survey, these pictures were examined with a reflector stereoscope to mark areas with accumulations of soft sediments. However, the survey did not show any clues of Neolithic activities in the area other than Ba'ja itself. Surfaces and profiles of the gullies in the small valleys were sterile except for modern trash on the surface of some areas.

Neolithic artifacts were found only in a sediment trap of "Snake Valley" immediately north of and below the Neolithic village, investigated as Test Unit 2 during excavations. Here was a thick mass of just less than 2 cubic meters of ash, silt, burnt stones, LPPNB flint artefacts, and abundant animal but very few human bones.

Some of the surrounding plateaus showed post-Neolithic activities similar to the probable Nabataean terrace walls on Plateau "K" north of Ba'ja, where we also discovered sherds and non-diagnostic flint artifacts. The Iron Age sites of Jabal Shdeifeh northeast of Ba'ja and of Umm Baben southwest of Ba'ja had already been located by M. Lindner (Lindner, pers. comm.). In a gully near Jabal Shdeifeh we found only a fan scraper and the medial part of a tanged arrowhead, hints of pre-EB activities in this area. Just across the main gorge to the southeast of Ba'ja exists a small plateau (Area A) with a short linear setting of stones. The only artifacts found here were some non-diagnostic flints in a small ravine.

As a first result we may state that no other Neolithic settlements appear to have existed near Ba'ja. Two reasons support this:

1) The water situation was precarious, and springs might have been rare. Fossil springs exist in the slopes of the limestone plateau to the E, which once must have supplied the inhabitants of Ba'ja with water (in addition to the spring-time pools and aquifers of the surrounding wadis). Although we can imagine perennial springs in the area, given a less destroyed Early Holocene vegetation cover (GEBEL, pers. comm.), the capacities of these sources were not sufficient to permit even more people to stay all the year round than already those inhabiting Ba'ja itself.

2) The habitats around Ba'ja, even under conditions of an intact arboreal cover, were limited (farmland, grazing grounds, collecting areas for firewood, nuts, plants, etc.). Like the settlement of Ba'ja, which could not expand because of vertical rock formations and gorges, the areas that supplied the inhabitants with food were also restricted and not expandable. Only the big Jabu Plain west of the Ba'ja *siq* entrance offered extensive good farmland. But this area was, for topographic reasons, outside the direct control for the inhabitants of Ba'ja, and was different from the directly neighbouring intramontane small valleys and plateaus. We expect that the latter belonged to the catchment area of Neolithic Ba'ja rather than supporting other permanent settlements[1].

Site Survey (B.M.-N.)

The fact that LPPNB architectural remains are still visible on many parts of the site surface prompted a special site survey, undertaken parallel to the excavations in 1997. This survey[2] aimed to document and map surface evidence for the following goals:

1. reconstruction of the approximate extent of the LPPNB settlement;
2. identification of probable LPPNB settlement centres;
3. mapping of preserved architectural surface remains;
4. classification and description of structural features;
5. identification of possible activity areas by mapping ground stone surface distributions; and
6. recording of post-Neolithic activities and structures on the site.

As described below, the wall preservation on the surface resulted from the fact that a stone pavement rapidly developed from the decaying LPPNB village ruins, which sealed the surface after all cavities/ rooms were filled with fallen upper wall sections and colluvial sediments. This cover protected the area against further erosion.

In addition to the *in situ* walls, *manos* (handstones) and grinding slabs were found all over[3] the site's surfaces (Fig. 4). When almost completely preserved, they were included in the mapping in order

[1] These intramontane areas of difficult access are still exploited for herding by the local Bedouins, who also use some of the larger plateaus as camp areas.

[2] The 1:500 mapping was undertaken with EDM-Station. We am grateful to both our surveyors Ute Kopricz and Christian Hartl-Reiter for their help in mapping the surface evidence.

[3] The distribution of the ground stone items in Area A (*cf.* Fig. 4:A) is affected by the random sampling of K.I. Wright (see below) in 1987.

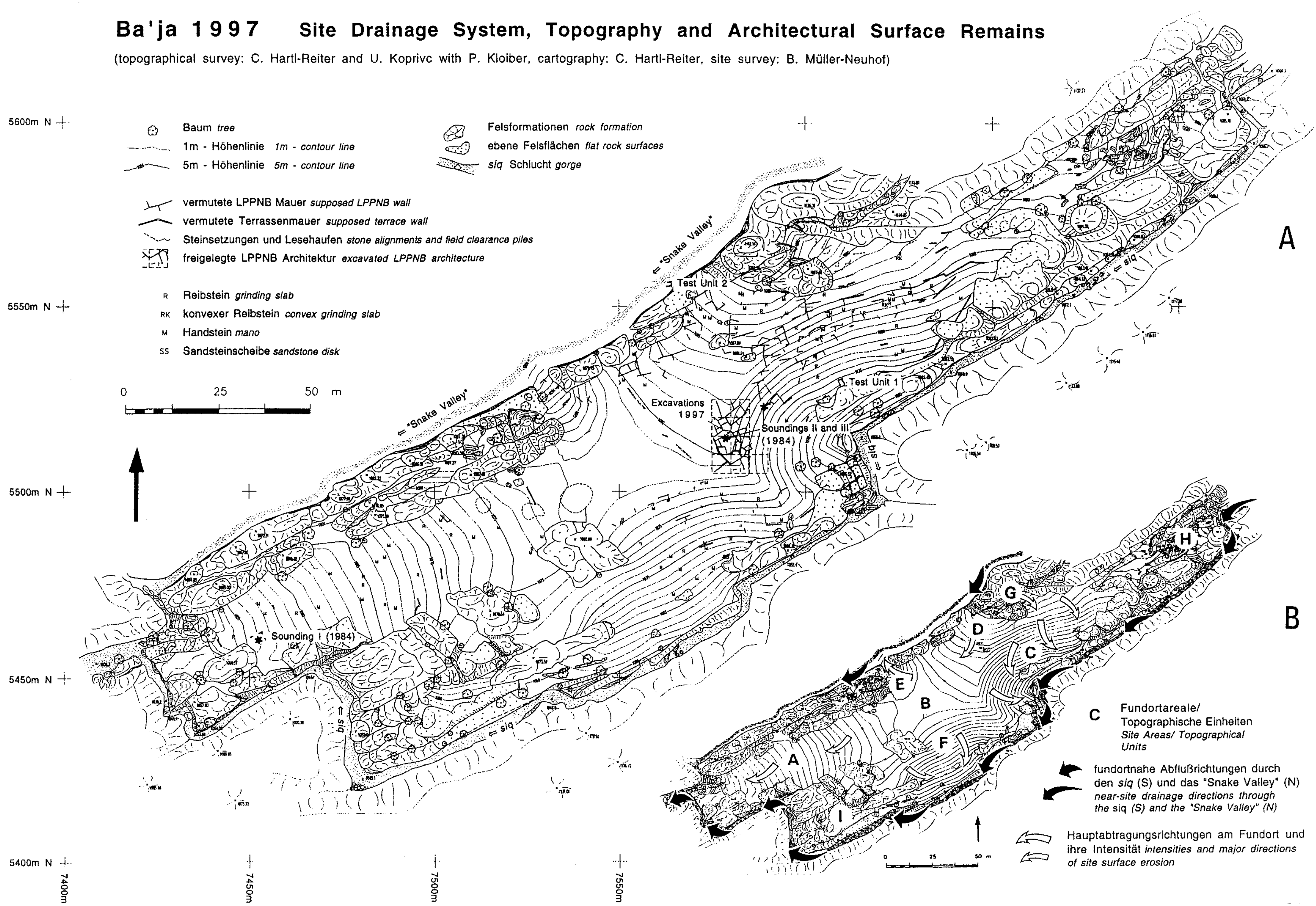

Fig. 4. A. Topography of Ba'ja, LPPNB architectural surface remains, other surface evidence, areas of investigation in 1984 (P.I.G.P.A.) and 1997; B. site drainage system.

to identify probable areas of food processing[1], although such activity areas could not be detected (see last paragraph of this section).

Surface architectural remains were divided into the following three categories:

1. Double-faced walls, consisting of courses with flat, sometimes large stones, mostly dressed on exterior faces. Connecting walls, often but not necessarily meeting at right angles (*cf.* Fig. 4), were interpreted as house/room walls. The walls of this first category can be dated to the LPPNB, as this is strongly supported by the characteristics they share with the LPPNB walls in the excavated area.
2. Undressed walls, built of larger undressed stones. The use of these structures as terrace walls is assumed due to their setting parallel to the contour lines of the slopes, as well as the absence of connecting walls. Comparison with similar masonry, mostly of Nabataean origin in the vicinity of Ba'ja, supports this interpretation and lets us presume a general post-Neolithic date for construction.
3. Stone clusters, not interpreted as walls, included low piles of stones (field clearance piles) of irregular shape and simple stone alignments. The latter also are set parallel to the contour lines of the slopes, but they do not have the massiveness of terrace walls. They might indicate other sorts of slope consolidation. All these structures are difficult to date, and no finds were associated with them. The fact that some structures of this category overly Category 1 walls points to a later date of construction.

Thus, at least two different phases of occupation respectively activities could be identified in Ba'ja.

Phase 1 is mainly documented by LPPNB house walls (double-faced walls). It seems that either the LPPNB occupation did not extend over all the site areas or it is not preserved in all of them. At least the lower and the middle parts of the very steep slopes (Area C, F, and partly E) did not reveal building remains; if this is not the result of erosion, then one reason might insufficient foundation engineering in LPPNB Ba'ja (see below).

The centre of LPPNB building activity may have been located in the upper parts of Areas C and F and in all of Area D. Intensive use of Area B as a housing area can be assumed because of the flat surface it provides, if this can be taken to represent the LPPNB topography. Due to later leveling and agricultural activities, no traces of LPPNB buildings could be identified here.

The reason for the absence of structures on the slope of Area A, which is not as steep Areas C and F, is unclear. It might be assumed that the climate here was less favorable for housing due to its comparatively long exposure to sun during day and a lack of access to winds. *Manos*, grinding slabs, and some terrace walls typical for Nabataean agricultural masonry represent the only surface evidence in Area A. The sounding by Gebel in 1984 in the lower end of this slope yielded no architectural remains, but the thick ash/silt layers contained animal bones, flint artefacts, ornaments, charcoal, etc. This indicates that this area was used as a dump area in the LPPNB (GEBEL and STARCK 1985).

Phase 2 illustrates the post-Neolithic activities in Ba'ja, which are mainly characterized by terrace walls and some stone clusters (Categories 2 and 3). They overlay LPPNB architectural remains and indicate, together with leveled Area B, activities associated with terraced agriculture and herding, but no permanent settlements appear to have been on the site after the LPPNB. This is also proved by the pottery found on the surface which is, even taking into account the collections of M. Lindner and his team, far too diffuse to indicate a later permanent occupation. Since most of the sherds found are Nabataean, we have at least one date for the post-Neolithic activities.

As already mentioned above, the distribution of *manos* and grinding slabs in some areas of the site could not finally be interpreted as representing Neolithic or post-Neolithic food processing zones. We think that they derived mostly from eroded LPPNB walls in which they were used as building material, which was a common feature for the LPPNB (GEBEL, pers. comm.[2]). Another factor that might have influenced their current surface distribution is a possible post-Neolithic re-use, supported by the fact that they were rarely embedded elements of the surface pavement.

Geomorphological Site Setting and Site Preservation (T.K. and H.G.K.G.)[3]

Present-day Surface

The formation of the present-day surface is the result of aeolian, fluvial, and anthropogenic action.

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1 Sandstone disks were also mapped.

2 They did not use only broken grinders in the house walls of Ba'ja and Basta: very often complete and perfect-looking pieces were used as building material. This unexplained feature must have reasons beyond the practical evidence (H.G.K.G.).

3 Parts of this section were translated from the report provided by T. Krämer.

Aeolian activity is limited due to the wind-protected setting of the intramontane terrace of Ba'ja. However, some deflation affected the thin fine-grained top soil, which helped to concentrate the Neolithic building debris to form a stone pavement.

Rain occurs as strong events from late autumn to early spring. The catchment areas of surface water from outside the settled area is not extensive at all; it mainly enters Areas D and G from small gorges north of G, but it does not penetrate into the top soil. Erosional forms are represented by rill and gully erosion. The erodibility is very high, especially in Areas C and F with their high relief intensity (slope of 22° and more). Erodibility in Areas A and D with 13° is weaker. In flat areas and the LPPNB ruins (*e.g.* Square C31 and other intramural parts on the spur on which the excavation took place), erosion "changed" into colluvial deposition. This is especially evident in Area B.

The LPPNB settlement considerably influenced erosion and sedimentation on the slopes of Ba'ja. On the one hand the massive presence of building debris helped to protect from deflation, which otherwise would have reduced the underlying fine-grained sediments. On the other hand, terrace and room walls hindered erosion and accumulated colluvial material upslope behind the structures (clearly visible in the section drawings).

Conditions of Site Preservation[1]

The settlement extends over the eroded steep slopes of Areas A, C, D, E, F and across flat areas with colluvial deposits, such as Area B. During use and after the settlement was deserted, the small rooms were quickly filled by building debris (wall plaster, ceilings, roofs, and walls; *cf.* section: Stratigraphy and Table 2); these kinds of fill reach thicknesses of up to 1.8m. In the colluvial deposits, rubble layers alternate with sandy deposits, whose inclinations are parallel with the slope, while settlement layers and the architecture are bedded horizontally. This interbedding triggers different erosional energy, and structures that function as barriers receive more erosional impact. This in time results in a leveled surface with walls outcropping from the settlement underneath. Since we are dealing with a rill and gully erosion, a rippled relief developed downslope, which can be nicely observed in Area C. In order to explore the extension of the site and the layers on which its architecture was founded, Test Unit 1 was taken down to the bedrock at the bottom of Area C (Figs. 4-5); in addition, we also excavated the step trench in northwestern C3 for this purpose (Fig. 6, Pls. 4:C and 5:C).

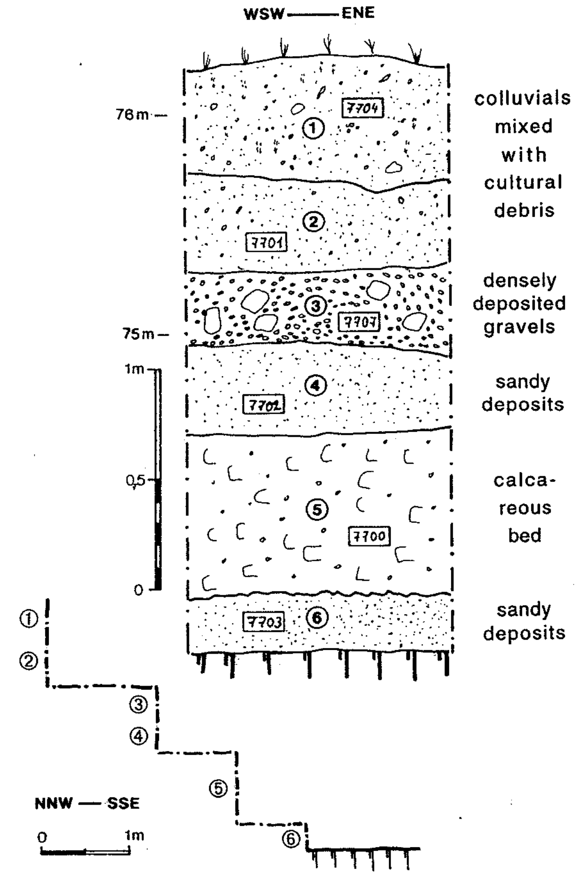

Fig. 5. Pre-occupational slope stratigraphy: supposed intra-montane basin sediments in Test Unit 1 (field record: T. Krämer).

Results from Test Unit 1 and the Step Trench in C3

The stratigraphy of TU1 (Fig. 5) is sterile of cultural remains except for Layer 1 (colluvial material with LPPNB finds). The lower layers (2-5) appear to represent fluvial episodes. The interbedding of sands and gravel/calcareous bands give evidence of different erosional energy. Sandy deposits might hint towards the existence of intramontane lakes. Such lakes would have existed before the *siq*

[1] Other influences on site preservation, not discussed in detail here, include: field clearance activities of historic farming through which stone piles accumulated (Area B), destroyed stone pavements thrown down the slopes for the same reason, and the effects on erosional energy these measures had together with the erected (predominantly Nabatean?) field terrace walls.

cut into the sandstone formations along existing clefts, or during periods when this way was blocked and erosional charges accumulated in the basin of al-Mehmad.[1]

Given the course of the *siq* and considering the morphology of Area C, it seems likely that the western slope of Area C is a cutbank created by high waters flushing down the siq, which also created the amphitheater shape of Area C. The position of this cutbank would make sense in this respect: it is situated just above a spot where, because of a strong rock barrier, the *siq*'s course twice (Fig. 4). This is also where the steepest and narrowest parts of the *siq* begin. If blockage of the *siq* is assumed to have occurred here (or further down?) in the post-Neolithic, it certainly would have resulted in a heavy impact on the preservation of structures potentially located on the lower two-thirds of the slope. This might explain the situation in the step trench in C3 and its immediate surrounding, where a sharp line cuts through the architectural remains at a certain elevation: no architectural remains were preserved below 1077.00m, 1077.60m, and 107800m, although floors and walls extended above these levels.[2]

Discussion: Preservation of the LPPNB Remains

The morphology of a pre-occupational cutbank in Area C would suggest that we are dealing with similar phenomena and affects persisting for site preservation in post-occupational times, and that this was a danger (aquatic activity undercutting the settlement in Area C), of which the settlers must have had been aware, too[3]. This premise can be attacked with the argument that there was not enough water to have caused impacts at heights around 1077m.a.s.l. That would require that, compared with current conditions, the bottom of the *siq* would have to have been 22m higher than at present!

But more than one cause may have operated in this situation. The reinforced terrace wall in C1/11 and the "half" wall fragments in the southern parts of C1 and C2 give evidence for an important problem facing the Ba'ja residents: walls sliding down slopes. This introduces a "slipping " option for the explanation of the lack of site preservation in its lower two thirds, which are the steepest parts in all of the settlement. A "slipping" of complete rooms or even parts of buildings probably did not need a specific layer agent, since the pressure of hundreds of tons of structures on the soft sediments underneath created enough instability in the terraced housing. It is likely that the settlers were aware of this problem: between the western and eastern terrace walls (see below) in C1 - C11 and C2 - C12, at a relatively firm setting on the aforementioned spur, stratified and even two-storied architecture with wall heights of up to 2.2m exist. Towards the steep eastern steep slope they restricted building to only single-phase rooms.

All this evidence suggests that two reasons might be responsible for the present limits of structural remains at the eastern fringes of the excavated area: 1) post-occupational slipping supported by 2) the erosion on a cutbank operating with a temporarily higher *siq* bottom.[4]

Stratigraphy (H.G.K.G.)

The general sequence of events resulting in the stratigraphy registered in the excavated area appears more or less clear and is presented -to avoid a long description- in Table 2. The actual sequence at an individual spot often is more complex, and it is not at all easy to reconstruct the microstratigraphical events and their interbedded deposits. More work must be invested to understand the microstratigraphy, since it is especially important for the interpretation of activities at higher levels (on roofs and upper floors and on terraces further uphill).

In the excavated area we are so far dealing with one main building phase, which shows alterations of an original groundplan through added walls and reinforcements, blockages and insertions of wall openings, and the possible addition of another story in C21 (Fig. 7). These subphases seem to represent locally restricted functional changes, most likely associated with social factors. So far, the western rooms in C21 are a special case: an opening in a lower wall was blocked before the height was increased by a superimposed wall, leaving a step between both faces. This step seems to have been a

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1 The sterile sediments reached in C3 much resemble the common *playa*-like fills in formerly closed intramontane basins of the greater Petra-Area. The nearest such sedimentary environments to Ba'ja are currently exposed at the eastern edge of the Jabu Plain, which itself seems to be a vast *playa*-fill in an unknown palaeotopography. The *playa*-fills of the Petra-Area are a hitherto neglected but excellent source of information for the Pleistocene geography and prehistory, for which these sediments contain rich materials.

2 The next step must be to evaluate the correlation of the stratigraphies of both trenches: TU1 needs to be extended upslope, and the trench in C3 needs to be extended downslope. Dating the deposits is a further need. The hypothesis of the *siq* blocking needs further investigation, too (*e.g.* investigation of preserved sediment traps along and inside the siq.

3 If a damming by fallen rocks happened in post-PPNB times, could it have accumulated gravels that raised the bottom of the *siq* to elevations that were dangerous for the house ruins above?

4 However, there is another possibility. A less sophisticated and dramatic explanation for the sharp cut through the rooms in C3/13/23/33 is that it is the result of minor slipping processes of what was the lowermost architecture in this setting, and that no structures ever existed further downslope.

support for the joists of an upper floor; its height also coincides with the top of a western partition wall. The room below had red-stained wall plaster and contained at least one fallen lintel.

As of yet, no detailed information can be given on the deeper stratigraphy in the excavated area. Since we have no detailed evidence on the palaeotopography of the intramontane terrace at the time when the LPPNB settlers entered al-Mehmad -area, we are unable to make any conclusions concerning a possible occupational phase beneath the remains of Squares C1/11/21/31. The elevational evidence from northwestern C3 may indicate that there is no substantial building phase below; nevertheless, LPPNB sites have demonstrated that they always are good for a few surprises!

Observations at nearby Basta revealed a long use of LPPNB structures, using stable groundplans and maintained with care. The duration of occupation at Ba'ja points in the same direction, although building in Ba'ja suffered from the special topographical constraints and impacts, which might have also influenced the duration of occupation. One major source of information is lost in this special topography: the amount of accumulated cultural debris in refuse areas. While elsewhere thick deposits of trash deposits provides an idea about the intensity/duration of occupation, in the case of Ba'ja this information has gone down the adjoining drainages. What has remained on the site itself are the remains of only the last occupants. In this respect, a careful survey for the small sediment traps in surrounding drainages and terraces are also important for future investigations.

Table 2. Generalized room stratigraphy attested in Ba'ja (Note: Not all deposits/ events need to be represented in a room stratigraphy.).

	Deposit	Event	Position
1a	surface pavement: dense but unstable due to the slope; cover of wall stones protect layers underneath	erosion (little deflation impact)	above (embedded) preserved wall tops, sometimes preserved wall tops are part of surface pavement
1b	topsoil: up to 15 cm thick, fine grained material with finds	very limited soil formation	only exists in certain protected spots
2	colluvial deposit: may reach thicknesses of 70cm, carrying stone rubble of all sizes, including wall stones and finds	erosion of building debris and from upper housing terraces, site's surface with outcropping room walls gets evenly "closed" (post-Neolithic)	intramural or laid against preserved walls or covering walls; may accumulate even as nearly soil-free stone piles
3a	upper main room fill: material of latest collapses and decay of walls /floor/ ceiling / roof, sometimes intermixed with colluvial material arriving from further upslope	collapse and decay of last exposed walls/ ceiling/ roof inside and outside the room, possible share of colluvials transported from higher upslope (immediately after the end of the LPPNB occupation)	depending on the topographical position of the room : central to upper room stratigraphy
3b	main room fill: composed of material from tumbling walls, decaying wall plaster, and upper floor/ceiling/ roofs with their inventory; may contain deposits influenced or created by ruin dwellers	rapid filling of the room interior by the structure's own debris; lower fill may contain temporary floors, fireplaces or other evidence of LPPNB ruin users (immediately after the end of the LPPNB occupation)	major part of room stratigraphy
4	lowermost room fill: shallow layers with temporary floors and high density of cultural debris and artifacts/ animal bones, representing last permanent occupation and ruin use (mostly food processing and preparing, *tabuns*)	first products of collapse and decay mixed with the evidence of last permanent room occupations and/or the remains of LPPNB ruin dwellers	lowermost room stratigraphy above first floors
5	*in situ* deposits related to room function: food processing and preparation, stone ring manufacture, disturbed by events in 4)	related to room function in the LPPNB community	near-floor stratigraphy
6	building and altering of structures (accumulation of immense quantities of stone materials on an unstable slope, partly dug into sterile deposits underneath)	terracing the slope topography by building and changing structures, related impacts (LPPNB)	main building phase encountered above sterile deposits of possibly an intramontane terrace (former basin)

Architecture[1] (H.G.K.G., H.-D.B., J.T.)

The architecture of Ba'ja represents the cellular LPPNB architecture now known from many LPPNB sites in Jordan (Fig. 1). Characteristic for this architecture are 1) small quadrangular/ rectangular/ polygonal rooms connected by wall openings, 2) rooms were built, apparently without open spaces, on terraces in a *pueblo*-type manner, and 3) "aesthetic" double-faced walls with nicely set courses with interwedged smaller stones[2]. We are at the beginning of the study of a vernacular LPPNB

1 The research on the Ba'ja architecture included an investigation on the role of architectural pre-planning, which was commissioned and funded by the Deutsches Archäologisches Institut, Orient-Abteilung. We thank Ricardo Eichmann for his trust in our approach to these difficult questions.

2 This LPPNB "wall aesthetics" could be misunderstood as a dating feature. We do have this wall technique in the LPPNB where ever tabular stone materials existed (even today); the erection of these walls and their dressed wall faces was executed

architecture, a new and most rewarding chapter in the history of Near Eastern architecture. It is the richest source we have so far for the understanding of PPNB social patterns, as this is well demonstrated by the contribution of G. Rollefson in this volume. A future need will be more attention for functional aspects attested archaeologically, to be reconstructed from more work on room furnishings and inventories. A major concern in that respect must be the proper investigation of room fills that might contain materials from a second floor or the roof underneath slope wash layers.

Building Layout and Functional Aspects (Fig. 6; Pls. 2-5)

As explained before, only Squares C1 - C2, C11 - C12, C21 - C22 and C 31-32 of the excavation area contained well preserved architecture, which represented a *pueblo*-type terraced housing, with some evidence for true two-storied structures (at least in the westernmost rooms of C21; *cf.* Fig. 7 and Pl. 5:A). The top of the wall ruins occurred just below a thin layer of colluvials or were exposed on surface.

The principal rooms in the excavated area are more or less rectangular and thus probably planned on even terraces. They are expected to have a deeper stratigraphy and be partly two-storied. Terrace walls clearly exist (the one running NNW-ESE in C11/C1, and one N-S and somewhat bent in C12/C2); both these walls protected the large rooms between them, most likely fortifying here against the spur-like topography. Their structural engineering did not differ much from ordinary walls, although they were somewhat thicker. This might have caused stability problems; for example, the terrace wall in C11/C1 was reinforced by a second wall to the west. Since that action did not seem to provide reasonable stability for the terrace, two additional buttresses were added, partly built over the first reinforcement wall (Pls. 4:A and 5:B).

While we have no evidence so far for architecture west of this reinforced terrace wall (either due to erosion or to the possibility that we are still too high in excavation), the evidence on the eastern side is clear: here a chain of small rooms (C2/12/southern C13) existed without evidence for an upper story, a feature that would not be unexpected in this extreme slope setting. Their ground plans tend to be polygonal, which is interpreted as an adaptation to the contour lines of the slope in order to establish a degree of structural stability. At least the easternmost rooms in C2/12 seem to have been dug into the sterile layers underneath, on which floors may have been created using a cobble bed with superimposed whitish (lime) plaster (*e.g.* Pls. 4:C and 5:C). It became clear at this spot, at least, that walls were also founded directly on such floors (Pl.5:C: here a small partition wall) without any further foundation!

The depths reached in Squares C11, C12 and especially in C31 and 32 are not sufficient to conclude on the rooms' functions. Here we still are in the room fills from three sources: activities of ruin users intermixed with material from fallen walls (and in some cases possibly from second stories or the roof) and colluvial debris carrying LPPNB artifacts.

We cannot identify yet functional units. But, with reference to ground plans in Basta, 'Ain Jammam (WAHEEB and FINO, this volume) and es-Sifiya (MAHASNEH, this volume), there are reasons for the assumption that we have two building units in the excavation area that roughly follow the scheme of a central courtyard with adjacent small rooms. These courtyards are probably represented by the large spaces mostly covered by C11 and C21/C32. In the large room mainly in C11 we found a sequence of fire pits, a stone-lined structure with an inserted grinding slab and many *manos* (food-processing area), as well as a large amount of sandstone disks ready to be transformed into stone rings (production of this prestige goods on a household level).

The construction formula consists of a courtyard or large room with surrounding rows of small cells, which seems to be common for the LPPNB of southern Jordan. This element of LPPNB planning was altered where topographical conditions dictated, as on the slopes of Ba'ja. We stress that regional climate should receive more attention in the interpretation of LPPNB courtyard houses; representing "closed" units centering inwards (NISSEN, MUHEISEN, and GEBEL 1991: Fig. 1), they are shady and cool in summer and retain warmth in winter (Ba'ja at 1060 to 1095m a.s.l., Basta at 1460-1420m, 'Ain Jammam at 1290-1240m; see discussion in GEBEL n.d.). The rooms within such a unit are connected only by wall openings for ventilation and light and possibly through the ceilings; wherever two-storied structures existed, the lowermost rooms might have had a cellar-like character preserving the produce of the inhabitants from climatic impacts. If there is a social meaning behind these ground plans, this must remain speculation: The use of common walls for the units results, in principal, in complexes without passages and open spaces. This makes them in a way a communal

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with great care, resulting also in good stability for these walls. But when no such building materials were available, *e.g.* near cobble-carrying wadis (as attested with the settings of Wadi Fidan A and C or Ghwair), this architecture *appears* "non-LPPNB". As attested now at Ba'ja, even in areas with tabular raw materials a large variety of wall qualities (*cf.* Pl. 5:D) may appear, but this was the consequence of less skilled repairs or changes of ground plan and not from later period construction episodes. "Wall-face chronologies" are dangerous. (H.G.K.G.)

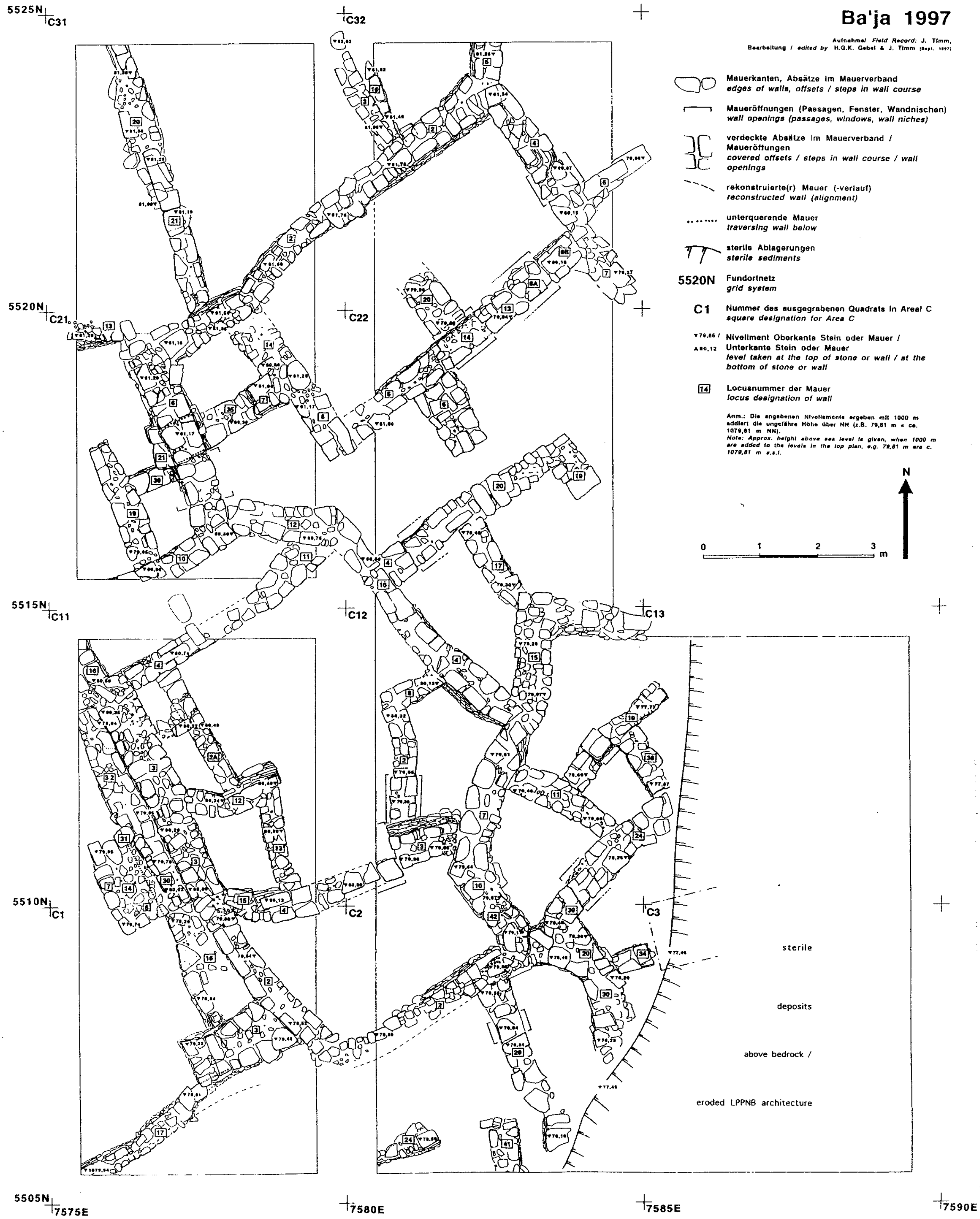

Fig. 6. Architecture of Main Building Phase excavated in Squares C1-3, C11-13, C21-22 and C31-32.

Plate 4:A. Terrace Wall in C1/11 (Loci 2-3), with attached reinforcement wall (Loci 16/32) and buttresses (Loci 3 and 6/7/14), from S (photo: Fengler/Höffgen).

Plate 4:B. View from N with the large, partly excavated room in C31 (foreground), followed by C21, C11, and C1 (photo: Fengler/Höffgen).

Plate 4:C. Northeastern corner of C2 with floor cut by erosion, and trench into sterile sediments, from NE (photo: Fengler/Höffgen).

Plate 4:D. Part of the curved terrace wall Loci 42/10/7 in C3/13, and the adjoining polygonal/ irregular rooms, from NE (photo: Fengler/Höffgen).

Plate 5:A. View into a two-storied room in C21 (foreground) with a room partitioning wall, a fallen lintil, and the support for the second floor, from W (photo: Fengler/Höffgen).

Plate 5:B. Another view (*cf.* Pl. 4:A) of the reinforced terrace wall in C 1/11, from W (photo: Fengler/Höffgen).

Plate 5:C. Stone layer on the sterile deposits used as the foundation for a lime plaster floor, on which a small partition wall was directly built (C3, Loci 3-6) (photo: Fengler/ Höffgen).

Fig. 5:D. Examples of the various qualities of stone masonary attested in Ba'ja (photos: Gebel).

Plate 6:A. Surface of a clay sherd from the LPPNB layers in Ba'ja (photo: Bienert/Fengler/Höffgen).

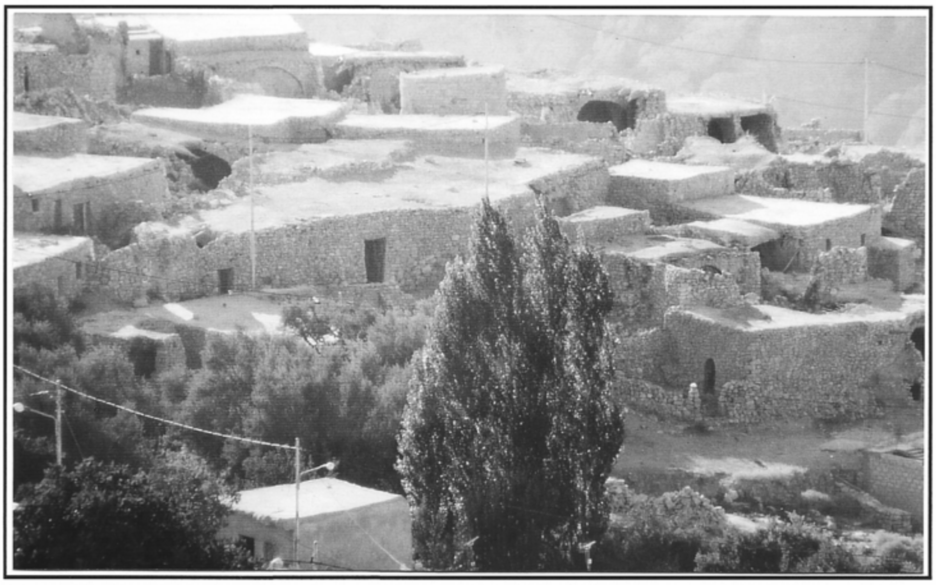

Plate 6:B. Traditional terraced housing in the region: Dana village.

Plate 6:c. Traditional terraced housing in the region: Tayiba village.

fortified complex not easy to enter and better to control. Most likely we are dealing with an architecture with an internal orientation in most respects (GEBEL n.d.). If we may speak at all of "public" and "private" sectors for the community of Ba'ja, communication between the units may have occurred via the roofs of the terraced housing, the roofs serving as "public" spaces for the settlement.

Three types of activities have so far been identified by *in situ* evidence: 1) The previously sandstone ring manufacture, 2) food processing, and 3) food preparation. The last is represented by the chain of small rooms in the east of C2/ C13/ C23: here the clay sherds of many installations were found, together with many animal bones and ash. Most likely the ash was disposed downslope, a feature quite common for the *tabun* areas in the fringes of present-day traditional villages in the region. So far we interpret these clay sherds as the remains of ovens used for baking and roasting. Their use and function might be similar to those still in use today (*cf.* GEBEL *et al.* 1994).

We have not found burials in the architecture yet, but most probably we can expect them eventually. Human remains were encountered among the trash deposits in Test Unit 2 in the "Snake Valley" just north of the site (just 30-40m north of the excavated area). Given the LPPNB habit to bury intramurally, and to remove post-cranial bones of disturbed burials (during rebuilding episodes, for example) into dumps, this evidence from TU2 is a strong hint for burials inside the Ba'ja architecture.

Functional changes in the architecture were reflected by inserted walls, changed wall courses, blocked wall openings, etc. To interpret these changes remains a task of a comprehensive functional analysis that must take into account the different wall qualities (Pl. 5:D). We have no evidence for any later occupation influencing the main building phase encountered so far in Ba'ja (except for activities of ruin dwellers, which we expect to belong to the LPPNB, too). Thus we consider the different wall techniques as applied within a single phase, representing functional changes and carried out by persons with different masonry skills. As far as can be interpreted, the walls of the stable and long-lived ground plan were planned and built by masonry specialists, while later alterations could have been carried out on the "household level" by persons without specialist skills.

However, in general one could say that the quality of buildings and building techniques in Ba'ja is somewhat "less skilled" compared to Basta, 'Ain Jammam, and es-Sifiya, and that (lime?, not analyzed yet) plaster floors are rare compared with these large sites[1]. Ba'ja, in this respect, triggers the implication of a more rural settlement.

A pre-planned, intentional ground plan seems to be inherent in the architecture. Preconceived layout ideas were executed by adaptation to the slope topography and by building on surfaces created by terraces. The evident digging of rooms into the sterile layers is another sort of "terracing" measure. As suggested by the site survey, walls did not necessarily follow contour lines. Most likely long-used major walls served as stable compound and terrace/retaining walls for the terraced architecture, and this explains that both social *and* physical topography were elements of planning and spatial stability.

Building Techniques (J.T.)

The dramatic topographical setting of the LPPNB architecture in Ba'ja required building techniques that were not necessarily matched by the builders' skills. The techniques can be characterized as follows:

As for the floor and sub-floor construction, we have limited evidence so far. We can distinguish between casual temporary earth floors within the lower room fills and intentionally constructed lime and stone slab floors. While the first are common and the result of use (including activities that raised intra-mural levels), identified by horizontally bedded finds, the latter two types are not well attested: lime floors, if set in a room at all, seem to be preserved only for earliest excavated occupations, and one floor paved with large sandstone slabs (Locus 22 in a room-like structure in Sq. 11 between walls Loci 2A and 3). The best example of a lime (?) floor with preserved patches stained in red (Pls. 4:C and 5:C) was found in the NE corner of C2 (Loci 33/36) and partly in C3 (Loci 4-5): It was constructed on a surface, which was dug into the sterile fine-grained sediments underneath. Hereon, the builders placed a layer of over-fist-sized gravels, which was filled and leveled by finer stones and a thick lime "bed". Near the floor's surface this bed had an increasingly higher lime component; in the uppermost centimeter it was a solid but crumbly preserved plaster spread. Stray fragments and *in situ* evidence prove the existence of red and cream stained plaster coats. (For terminology and similar floor construction from Basta, see REHHOFF KALISZAN with GEBEL n.d.). All these layers had a thickness of 5-6 cm, and extended up onto the interior wall in bathtub fashion. It represents the standard construction of LPPNB floors in the area.

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1 Red-stained plaster was found *in situ* only attached to the walls of the lowermost room in C21, where we have evidence of two storeys, and at one other wall. Particles of red-stained plaster in the room fills were rare, too, and this was also true for the Soundings SI-III in 1984.

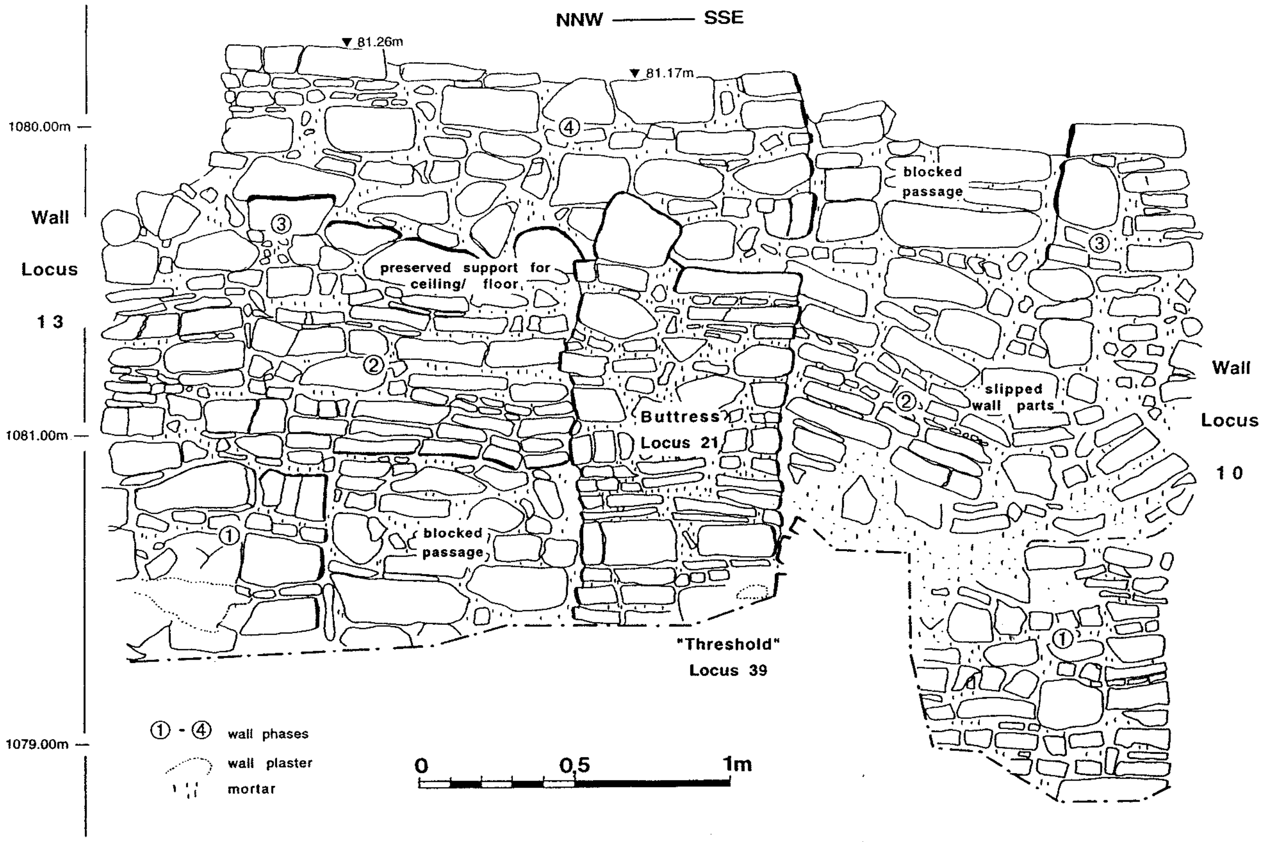

Fig. 7. Western face of wall Locus 6 in the two storied room in western C21 (drwg.: Dahl Hermansen).

Channel-like subfloor construction for leveling the building grounds and probably for a dry room climate (as attested in Basta, es-Sifiya, and 'Ain Ghazal) is not yet attested for certain.[1] So far we have not reached evidence for wall foundations; however the example Pl. 2:C shows that walls could be just founded on a floor.

The wall techniques in Ba'ja can be well compared with other LPPNB sites. All wall qualities are attested, ranging from cobble walls to properly set double-faced walls made of selected regular thick local sandstone slabs that were roughly dressed and stabilized by "interwedged" smaller stones in parallel courses (*cf.* GEBEL and BIENERT 1997). Plate 5:D illustrates the different wall types present. The faces of double-faced walls were not linked with headers, which caused a considerable structural instability in this slope setting (*e.g.*, the long wall that fell apart in C1/2, Loci 17/2 or the fragment of Wall 24 that washed downslope in C2). The double-faced walls reached thicknesses of more than 60cm; the spaces between the two faces were filled with mortar and smaller stones of various sizes. Mortar was used for all the walls; dry stone masonry is not yet evidenced. The mortar does not seem to contain lime, but instead it appears to consist of silty-sandy material of possibly on-site origin. (A possible source might be the *playa* sediments underneath; GEBEL, pers. comm.). Wall plaster is rarely attested *in situ*; a "larger" piece of red-stained wall plaster was found just above the floor on the walls Loci 6 and 13 in Square C21.

Another element of structural instability is often visible at wall joins: meeting walls were frequently just abutted against each other without bonding, although often wall corners were constructed properly with bonding courses. However, the Neolithic architects knew measures to respond to the structural instability of room and terrace walls. For example, in C1/11 they added another wall (Loci 16/32) in front of an endangered terrace wall and applied additional necessary buttresses (Locus 3 and Loci 6/7/14) (Plate 3:A).

[1] However, the sediments of the floor layers excavated in the room west of Wall 6 in Square C21 were found trickling into cavities below, a common feature that in Basta announced such channel-like subfloor construction.

Connections between the rooms only are reflected by window-like wall openings, the size of which often would not allow a small person to pass through. They have nicely built jambs and lintels of large tabular sandstone. A true passage with fallen lintels was found between Walls 6 and 19 in Square C21 (Plate 3:B).

The stone building material comes from two sources: the majority was selected from the nearby consolidated bedded layers in the Ordovician sandstone formations, while the cobbles for the "less aesthetically" built walls probably derived from the gravels of the *siq*, which also brought down types of sandy limestone.

There is indirect evidence for roof construction. The good preservation of the small rooms indicate their rapid filling. This material could only have come from upper floors or roofs and the possible walls of second stories (*cf.* GEBEL and BIENERT 1997). We reconstruct the roofs and upper floors as being supported by wooden beams (which need not have spanned large rooms, anyhow), over which a secondary layer of branches and twigs was laid. Periodical renewals of mud plaster may have resulted in a considerable thickness of ceilings, as can be seen in present-day traditional architecture in the region.

Although the wall techniques at Ba'ja evidence a high skill in setting "aesthetic" courses and precisely built corners and wall openings, the constructive skills and the structural know-how of the builders was somewhat undeveloped for the needs of terraced slope architecture: the lack of wall foundations, non-bonded walls, the absence of headers in double-faced walls. The last two features reflect a "naive" static understanding. The builders were not able to cope with the dangers of an earthquake-afflicted region and the extreme slopes on which they settled. The structural engineering at Ba'ja was not yet developed enough for a stable terraced housing, and it might not have been accomplished here during the LPPNB.

Flint Industry (Figs. 10-11) (H.G.K.G.)

The primary production of the flint industry contains very few "true" naviform cores and their typical preparation waste. There are instead bi-directional cores that recall the intention of the naviform technology, this material- and effort- efficient detachment of blades flourishing in specialized workshops of the LPPNB (for cores found at Ba'ja, see BIENERT and GEBEL n.d.). The bi-directional Ba'ja cores often have circular striking platforms with detachments all around the core's edges. Cores were reduced completely, and blades in Ba'ja are shorter on average than those from the workshop areas in Basta, for example. A contributing factor might be the fact that the tabular flint exploited by the Basta workshops is rare at Ba'ja: instead, most of cores are of a grayish flint raw material group, also well-known from Basta (MUHEISEN n.d.: Flint Raw Material Group 3). They are mainly nodules with minimum sizes of 8cm, but sizes may range up to 20cm or more. The raw material comes from the limestone formations east of Ba'ja, transported in part from here through the *siq* to Ba'ja, where they occur as lenticular and/or semi-tabular forms. Their matrix is fine-grained to slightly fine-grained and homogeneous with almost no inclusions; the flaking ability shows a tendency for a tenacious character, sometimes resistant against an uncontrolled spread of the removal energy (good flaking quality). Colours vary from "gray - pinkish gray - light gray - white- pinkish white" to "white - very pale brown - light gray, gray, light brownish gray - pale brown - light yellowish brown".

Aside from the non-naviform bidirectional cores at Ba'ja, there are also unidirectional blade cores in addition to many flake cores. Workshops have not been found at Ba'ja yet, and cores are generally quite rare. We expect that this may be the result of constant clearance of this potentially harmful waste, as evidenced by the masses found in TU1 and Sounding I. Nevertheless, this is no argument to assume a significant number of workshops on the site.

According to first insights and observations from 1984, the tool kit appears somewhat restricted as compared with Beidha and Basta. It comprises the following tool classes :

1. heavy duty tools: hammerstones (frequent), celts (frequent), adzes, and chisels;
2. non-formal tools (all sorts of retouched blades and flakes);
3. formal tools (types): leaf-shaped arrowheads (frequent), tanged arrowheads, scrapers (frequent), borers with tips <2mm, heavy duty borers, and denticulated blades (rare).

Since we lack drawings of the 1997 materials at the present time, we selected similar material from earlier surface collections for illustration (Figs. 10-11). Many of these types were also present in Sounding I in 1984 (GEBEL 1986: Fig. 11, except piece No. 20). Leaf-shaped arrowheads with two S-shaped edges seem to occur often; one Khiamian point was found on the surface.

As a preliminary observation, we would interpret the tool kit as representing daily need activities on household levels rather than representing manufacturing goods on an "industrial" surplus scale. However, the expected tools used for chiseling/ graving the sandstone rings (see below) have not been identified yet among the chipped lithic implements.

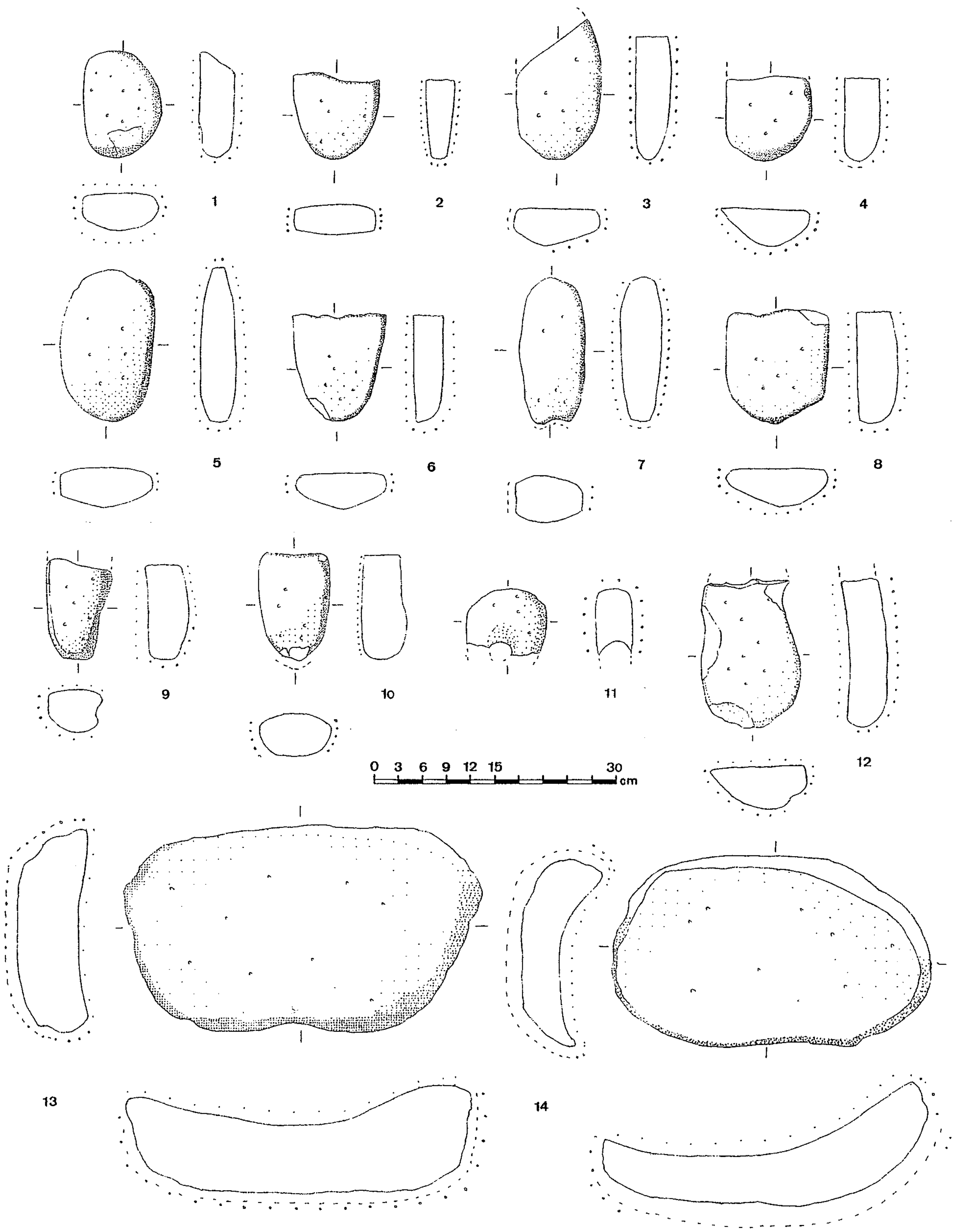

Fig. 8. Ground stone industry (surface investigation K. Wright, 1987): 1-9 handstones (1-2 bifacial ovate/ lenticular, 3-6 bifacial ovate/ triangular, 7 bifacial loaf/ ovate, 8 bifacial rectilinear/ triangular, 9 bifacial rectilinear/irregular), 10 handstone/ pestle, 11 "weight", 12-14 grinding slabs (12,14 saddle; 13 trough) <illustrations by K.I. Wright>.

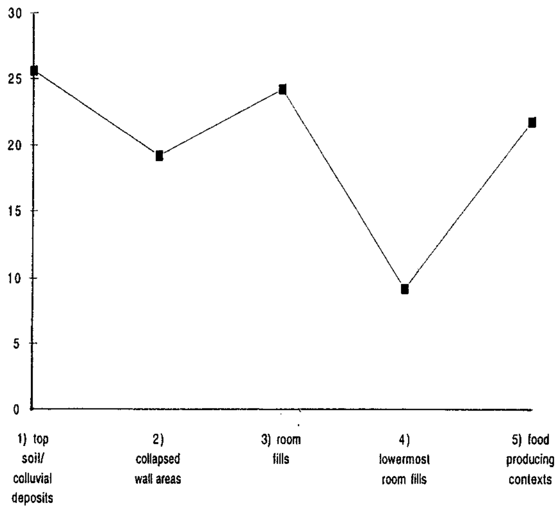

Fig. 9:a. Frequencies of ground stone tools in the various stratigraphical units (%).

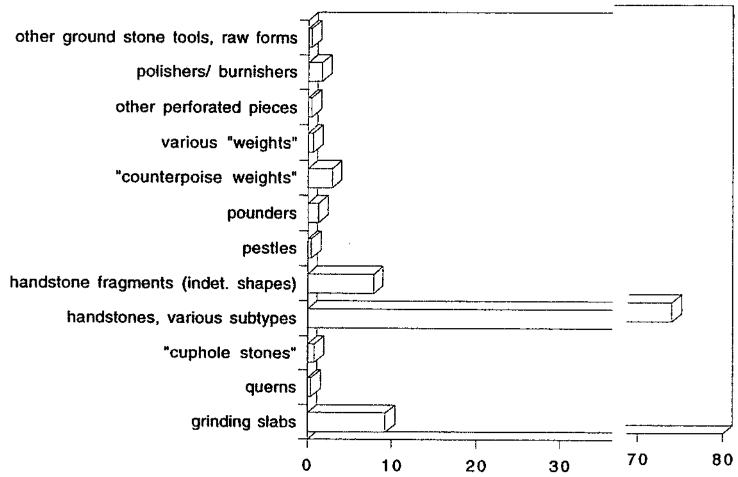

Fig. 9:c. Frequencies of ground stone tool classes as distributed in all excavated loci (%), *cf.* Table 3.

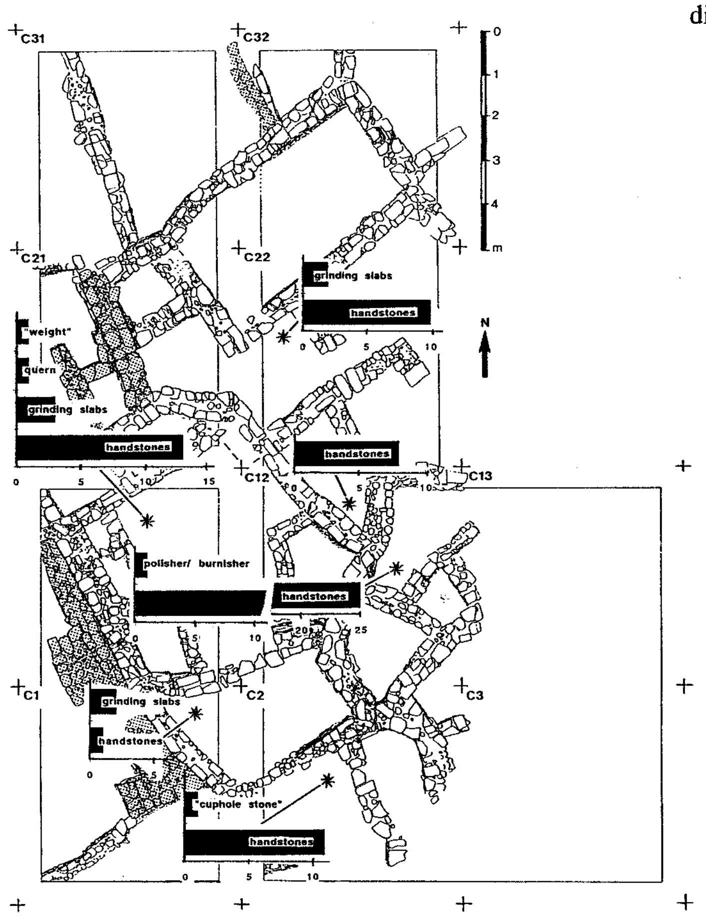

Fig. 9:b. Major *in situ* evidence of grinding activities in the excavated LPPNB layers by numbers of attested ground stone tools

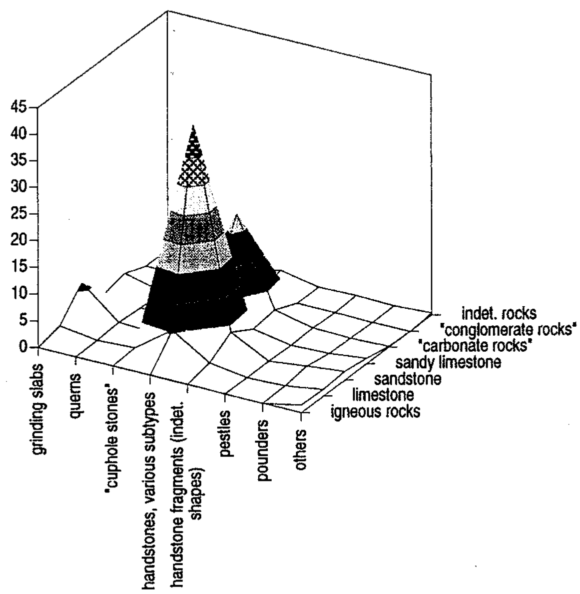

Fig. 9:d. Frequencies of ground stone tool classes as represented in the raw material classes (%).

Fig. 9. Frequencies of ground stone stools and their raw materials from the LPPNB layers in Area C.

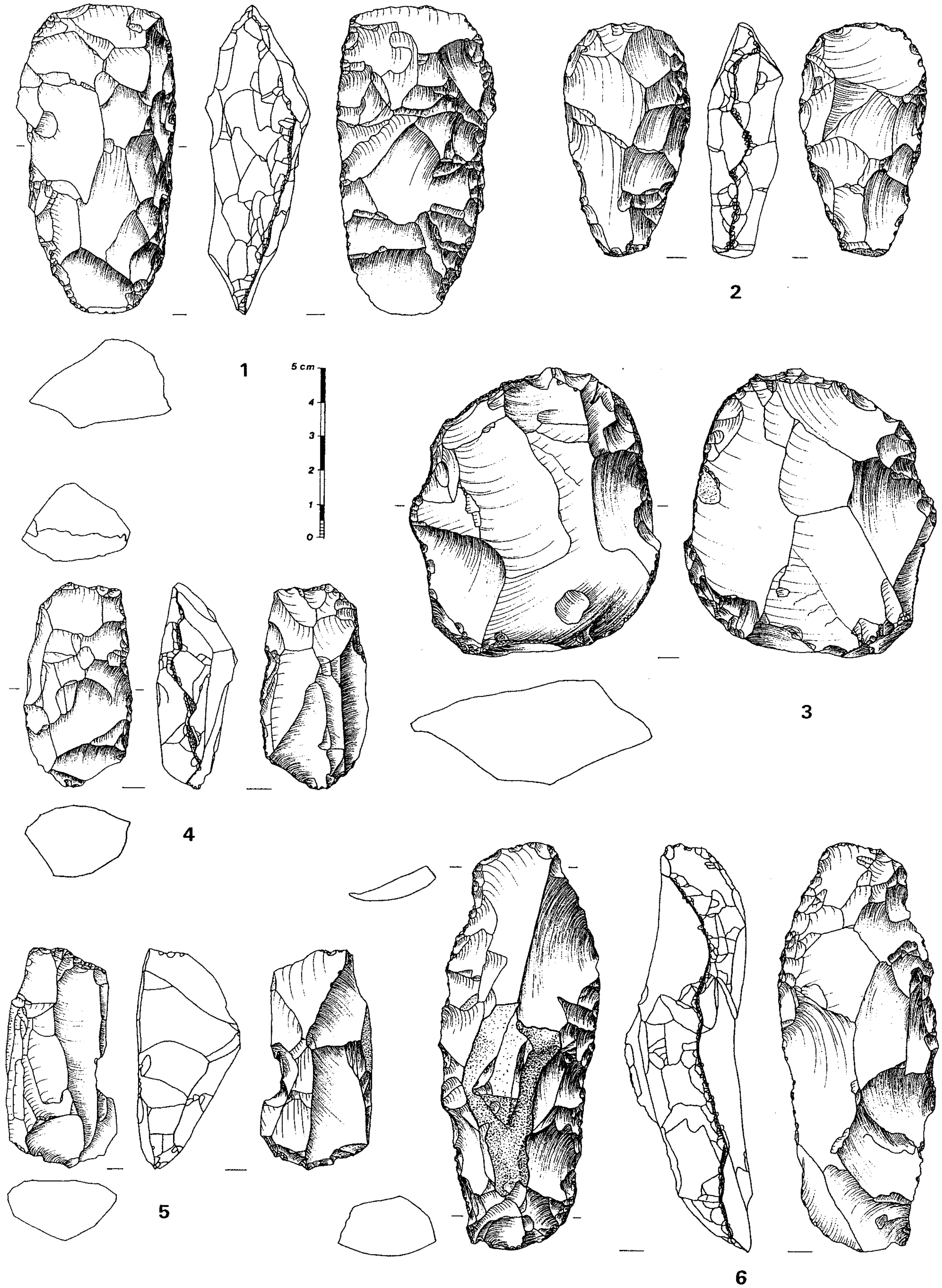

Fig. 10. Selection of heavy duty tools : 1-2 celts; 3 cleaver-like instrument; 4-5 adzes; 6 adze/ celt (all from surface). <illustrations by I. Raidt; material of the P.I.G.P.A. collections>.

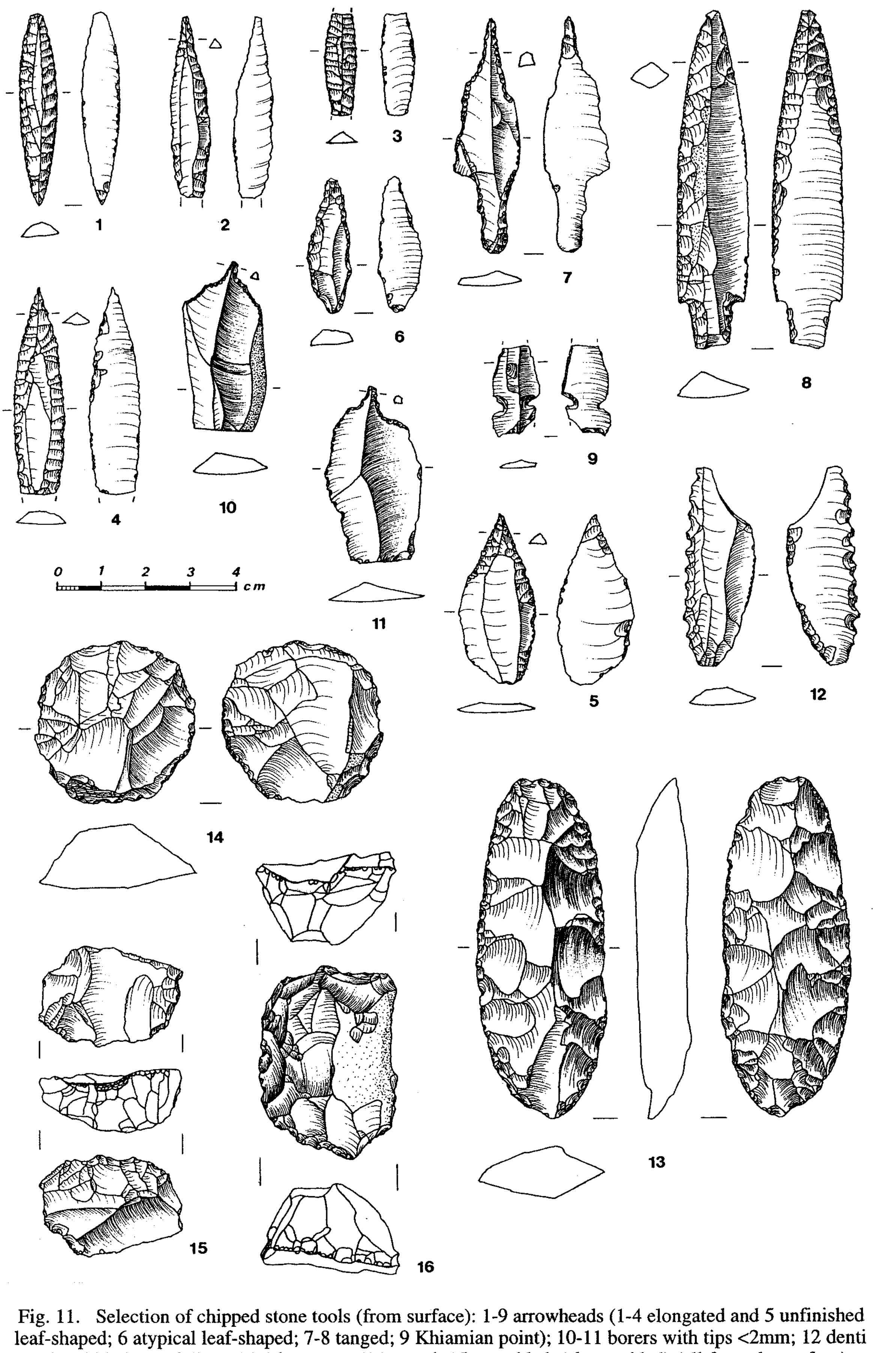

Fig. 11. Selection of chipped stone tools (from surface): 1-9 arrowheads (1-4 elongated and 5 unfinished leaf-shaped; 6 atypical leaf-shaped; 7-8 tanged; 9 Khiamian point); 10-11 borers with tips <2mm; 12 denti culated blade; 13 foliate; 14-16 scrapers (14 round, 15 one-sided, 16 two-sided) (all from the surface). <illustrations by I. Raidt; material of the P.I.G.P.A. collections>.

We excavated the dump area of TU2 in "Snake Valley" in order to enlarge our chipped lithic assemblage. In this sample (F.no. 2123), only a small number of cores was found together with some crested blades, but a large number of bi-directional blades is attested, together with a dominating element of flakes.

Ground Stone Industry

The ground stone industry attested is typical for the LPPNB large settlements and also well represented in Ba'ja. However, stone vessels are rarely attested, which remains a puzzling feature.

Results from the 1987 Surface Investigation of Ground Stone Artifacts (K.W.)[1]

The aim of the systematic surface collection at Ba'ja[2] was to compare it with stratified assemblages from 'Ain Ghazal, Basta and Late PPNB sites in the Azraq Basin. Documentation of ground stone assemblage variations from sites in different environments is a prerequisite to an understanding of changes in the technology and organization of plant-food processing and consumption with the growth of agricultural villages (WRIGHT n.d.). The surface sampling procedure at Ba'ja itself was intended 1) to permit estimation of the full variation of ground stone and 2) to obtain a statistically useful sample.[3]

Technology, Typology, and Raw Materials

Ground stone artifacts have received little attention in prehistoric studies, a circumstance that is puzzling since they are highly relevant to the origins of food production. Most studies of these artifacts have dealt with them as "finished products" and classified them according to a wide range of typologies based on various morphological criteria. In place of these "normative" typologies, a recent analysis of ground stone assemblages in the Levant has shown that these tools may be better understood as products of a particular set of lithic reduction strategies (WRIGHT n.d.). Different tool forms may be the result of differentials in blank selection, manufacture, use, refashioning and discard of these items, as has been shown for certain chipped-stone assemblages (*cf.* DIBBLE 1987). In fact, many of the analytic techniques that have been applied to chipped stone are valid for ground stone, even debitage analysis, since many ground stone tools are made via flaking as well as pecking and abrasion. In this summary, only the descriptions of the sampled Ba'ja tools are presented. (For the definitions of the classes see WRIGHT n.d. and the final report of this study)[4].

As at Beidha and Basta, the great majority of the Ba'ja artifacts are large and made on local sandstone types (see following section). Sandstone is not necessarily the best material for grinding/ pounding tools, as sand grains are easily detached and the use-life of the tool is shortened by many "resharpenings." Basalts are superior materials for grinding tools (the nearest large source of basalt to Ba'ja would have been Shobak, 35km away). However, the use of local materials for large utilitarian ground stone tools is characteristic of village sites in the PPNB.

Grinding Slabs/ Querns

Saddle-shaped Grinding Slab (N = 4) (Fig. 18:11-14)

Two complete and two fragmentary saddle slabs were recovered. Of the complete examples, only one is very large (No. 9609). These artifacts were heavily used and were made by flaking and

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1 This contribution is a summary of a final report provided by K. Wright for the final publication of the project *Paleoenvironmental Investigations in the Greater Petra- Area - Holocene Research* in 1990. The typology therefore is slightly different in some aspects from the classification published in WRIGHT 1992b.

2 This surface investigation was carried out in Ba'ja while visiting the Basta Joint Archaeological Project in 1987. My thanks go to the Department of Antiquities, and its local representative at Petra, Suleiman Farajat, for providing me this opportunity, and to the Basta J.A.P. for its hospitality. Hans Georg K. Gebel invited me to study the surface ground stone industries of Ba'ja; Cornelia Becker, Reinder Neef and H.G.K. Gebel helped me carry out this strenuous work. I appreciated and acknowledge my discussions in Basta with Nabil Qadi, Yarmouk University, about LPPNB ground stone industries.

3 For the systematic sampling, Area A (*cf.* Fig. 4) was divided into 24 squares of 5 meters on a side. Using a table of random numbers, a 50% sample was chosen from this universe. Twelve squares were randomly selected for collection and all ground stone artifacts found in each of these squares were removed for study. When this procedure was completed, a small judgement sample of large grinding slabs from Area F was collected. The total number of artifacts removed from the site was 53.

4 It should be noted that the descriptive typology as used herein is regional in scope, hierarchical, and flexible enough to permit addition of new types when new material is excavated. In format this typology is structured in ways similar to those for chipped stone tools. That is, the typology is based on variations in blanks, primary and secondary reduction techniques, and the morphology and wear patterns of use surfaces. These variations permit general functions to be identified, although determination of specific functions must await residue or chemical analyses.

pecking. Large, squamous flake scars cover the dorsal sides, indicating that removal of extra weight from the blank was desired.

Trough Grinding Slab (N = 1) (Fig. 8:13)

A single complete trough grinding slab was recovered. This is the largest and heaviest ground stone artifact in the sample; trough grinding slabs or querns are well known from PPNA until the Middle PPNB sites such as Nahal Oren, Jericho, and Beidha.

Slab/Quern Fragments (N = 4)

The grinding slab fragments require little comment. All are made of sandstone.

Miscellaneous Grinding Slabs/ Querns (N = 3)

The three small slabs included under this category are small (hand- held?) saddle-shaped grinding slabs that could have been easily moved from one place to another. We have simply called these "small grinding slabs." They are made on elongated cobble blanks similar to those used for loaf- shaped handstones. However, the concave use surfaces indicate that these are actually lower stones in a pair of tools. Similar tools are common at Basta (QADI in GEBEL *et. al.* 1988: Fig. 12:1).

Mortars

Mortar Fragments (N = 1)

This fragment is classified as a mortar since there is evidence for a concave surface indicating pounding but no finishing to suggest that it was a vessel. It may be noted that rough mortars are not particularly common among PPNB sites, although carefully made stone vessels are very common.

Handstones (N = 4)

Three of the handstones of this class are made of sandstone and one is of quartzite. These tools appear to have been made on loose surface cobbles as blanks, most of which do not appear to have been water-worn. These tools tend to be about 100 to 150 mm. in length and 80 to 90 mm. in thickness. They could thus be used with one hand. Similar tools are documented at Beidha (WRIGHT n.d.) and Basta (QADI in GEBEL *et. al.* 1988: Fig. 12:6).

Bifacial Ovate/Planoconvex Handstones (N = 2)

Only fragments of this type were recovered, though enough of the tools remain to make them identifiable. One of them is of limestone. These types are common at Beidha, too.

Bifacial Ovate/ Triangular Handstones (N = 7) (Fig. 8:3-6)

This is the most common handstone type in the collection and reflects the use of handstones in a rocking motion. Strictly speaking, such tools are actually "trifacial," having a flat surface opposite to two adjacent surfaces which form an angle. Similar tools are seen at Beidha and Basta (*e.g.* QADI in GEBEL *et. al.* 1988: Fig. 12:7). These tools would be expected to represent an advanced stage of use.

Bifacial Loaf/ Oval Handstones (N = 3) (Fig. 8:7)

Three complete examples were found. The lengths of these are similar to the widths of the complete saddle slabs . Occurrence of use-striations along the transverse or short axis of the tools supports the hypothesis that these were used with two hands with the long axis perpendicular to the long axis of the grinding slabs. The oval cross-section may be an indication that these tools had not yet been heavily used (WRIGHT n.d.).

Bifacial Loaf/ Lens Handstone (N = 2)

Two fragments of this type were found. It is possible that the tools with lens-shaped cross-sections were originally oval in section but have been worn to the flatter shape through long use.

Bifacial Loaf/Triangular Handstone (N = 1)

Bifacial Loaf/ Plano-irregular Handstone (N = 1)

One fragment of this type was found. Some tools at Beidha having plano-irregular sections appear to have been made on large flakes detached from large cores (WRIGHT n.d.). It is not clear whether this was the case here.

Bifacial Rectilinear/ Lens Handstone (N = 1)

Bifacial Rectilinear/ Triangular Handstone (N = 2) (Fig. 8:8)

Bifacial Rectilinear/Plano-irregular Handstone (N = 1)

Bifacial Irregular Handstone a posteriori *(N = 1)*

One fragment of this type was found. Unifacial handstones may be an "early stage" in the lithic reduction (through use) of these tools (WRIGHT n.d.). If this is so, these tools would appear to have been discarded early in their use-lives.

Unifacial Ovate Handstone (N = 1)

Handstone Fragment (N = 6)

Six tools could not be identified as to type and thus were classed simply as fragments.

Perforated Stones

Counterpoise Weight (N = 2)

Two counterpoise weights were retrieved from Ba'ja. They are fragmentary but robust in size and appear to be similar to objects seen at Beidha and at Basta (QADI, pers. comm.). Their functions are unknown but the off-central perforation suggests use as weights, perhaps to hold ropes.

Multiple Tools

Miscellaneous Pestle/ Handstone (N = 6) (Fig. 8:10)

Three complete and three fragmentary handstone/pestles were recovered. A handstone was classed as also being a pestle if flake scars were seen on the ends, oriented in such a way as to suggest pounding use (*i.e.*, with the negative bulb of percussion near the end of the artifact). Similar tools are seen at Basta (QADI in GEBEL *et al.* 1988: Fig. 12:10).

Summary and Conclusion

The lithic technology of the Ba'ja ground stone is quite similar in most respects to that of the nearby PPNB sites of Beidha and Basta. The collection contains morphological types that are attested in Beidha (mainly Middle PPNB) and an more commonly in Basta (Late PPNB) assemblages.

The Ba'ja surface collection is dominated by grinding tools, of which handstones are the most common. As handstones are smaller and more portable objects, they might be expected to have entered the archaeological record more quickly than larger tools such as querns. Ethnoarchaeological studies elsewhere in the world show that this tends to be the case (HAYDEN and CANNON 1984). The same studies also indicate that the number of querns or grinding slabs may be a useful indicator of village population, especially of the number of adult females (HAYDEN and CANNON 1984: 81). This possibility is of interest for questions about potential changes in domestic subsistence tasks with the origins of agriculture (WRIGHT n.d.). The stone vessels to be expected at Ba'ja were not represented in the collection.

Ground Stone Artifacts from the LPPNB Strata (H.G.K.G.)[1]

Ground stone tools were encountered in the following contexts (in stratigraphic order, *cf.* Table 2):

1) surface pavement/ top soil and colluvial deposits;
2) collapsed wall areas (sometimes with portions of the material deriving from further upslope);
3) room fills (in the upper parts with colluvial deposits);
4) lowermost room fills, sometimes intermixed with disturbed LPPNB food processing loci[2];

[1] The project is indebted to Bo Dahl Hermansen, assisted by Ghattas Sayej, for recording the 1997 ground stone findings. The raw material classification made use of the raw material groups identified at Basta (QADI n.d.).

[2] These food processing loci partly seem to originate from LPPNB use of the house ruins.

5) *in situ* LPPNB food processing contexts; and

6) built into walls (used as building material; no recordable frequencies).

The ground stone material is distributed by frequency according to these general contexts, as shown in Fig. 9:a.[1] Keeping the complex formation processes of the loci in mind (*cf.* Table 2), the majority of the ground stone tools came from contexts evidencing 1) their secondary function as building materials and 2) their use on roofs or in upper stories: some 20% were found in the debris of collapsed walls and *c.* 25% were deposited as colluvial material primarily from such contexts higher up the slope. Another *c.* 25% were found in room fills that not only resulted from the collapsing walls of the immediate structure, but also might contain material from eroded nearby (including roofs or upper stories), food processing layers, or layers with other grinding/ pounding activities. About 20% of the pieces were found in contexts indicating their *in situ* use, and approximately 10% came from disturbed, previously primary contexts (*e.g.* C21,25+34).

The *in situ* evidence includes a high concentration of ground stone tools, mostly in connection with (other) evidence of food preparation (ash layers, hearths, fire places, destroyed "tabuns", burnt animal bone concentrations, etc.) in C1,13; C2,11; C11,23+33; C12,18; C12,29; C22,3+11; C21,32. Fig. 9:b shows the numbers of grinding tools associated with food processing loci (mainly handstones and slabs). Food processing loci without ground stone tools occur in the tabun areas in the chain of partly preserved rooms at the eastern edge of excavation.

As of yet, no detailed information is available on the typology and frequencies of ground stone tools excavated from Ba'ja; the complete determination of raw materials also remains to be undertaken. But a preliminary assessment of these features is provided in Table 3.

Table 3. Raw materials represented in the ground stone tool classes (percentages by pieces, without consideration of questionable pieces; fragments and complete pieces distinguished only for the handstones.

Ground stone tool classes	**igneous (incl. volcanic) stone**		**limestone (incl. 2x quartzitic limestone)**		**sand-stone**		**sandy limestone**		**"carbonate stone"**		**"conglo-merate stone"**		**indet.**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
grinding slabs			5	1,03	29	5,98	3	0,62	8	1,65					**45**	**9,28**
querns					2+1?	0,41									**2**	**0,41**
"cuphole stones"			2	0,41			2	0,41							**4**	**0,82**
handstones, various subtypes (4)	1?		26	5,36	198	40,82	40	8,25	87+3?	17,94	1	0,21	7	1,44	**359**	**74,02**
handstone fragments (indet. shapes)			5	1,03	18	3,71	6	1,24	9	1,86					**38**	**7,84**
pestles (3)									1	0,21			1	0,21	**2**	**0,41**
pounders			1	0,21	4+1?	0,82	1	0,21							**6**	**1,24**
"counterpoise weights"	3	0,62	1	0,21	6	1,24	3	0,62	1	0,21					**14**	**2,89**
various "weights"			1	0,21	1	0,21	1	0,21							**3**	**0,62**
other perforated pieces (2)	1	0,21											1	0,21	**2**	**0,41**
polishers/ burnishers	3	0,62	4	0,82			1	0,21							**8**	**1,65**
other ground st. tools, raw forms (1)					1	0,21							1	0,21	**2**	**0,41**
Total	**7**	**1,44**	**45**	**9,28**	**259**	**53,40**	**57**	**11,75**	**106**	**21,86**	**1**	**0,21**	**10**	**2,06**	**485**	**100,0**

(1) includes 1 sandstone disk, 1 "celt" (unknown material)

(2) includes 1 igneous rock "macehead" (QADI n.d.: "bead"), 1 sandstone "hemisphere"

(3) including a phallus-shaped piece (unknown material)

(4) includes 1 round handstone (sandy limestone)

Handstones comprise the most numerous class of ground stone tools by far (Fig. 9:c; 74% or 359 complete pieces, or *c.* 80 with the fragments). The frequency relationship between handstones with planoconvex/ triangular and semi-rectangular small sections is about 1:4.5; the relationship between incompletely and completely preserved handstones is *c.* 1:15 (!). Handstones show a clear preference for sandstone as raw material, followed by a raw material tentatively identified as "carbonate stone" (Fig. 9:d). This raw material group is somewhat problematic, since neither the source nor the petrographic description is presently on a sound basis.

Grinding slabs are less frequent in the sediments than observed on the surface. Their range mostly covers the types illustrated as Fig. 4:5-6 in WRIGHT 1992. The two querns belong to the types illustrated as Fig. 4:10 and 1(WRIGHT 1992); the latter extremely large specimen (31x66x42cm) was found resting on its obverse side. The "cuphole stones" (on pebbles or cobbles with ground obverse

[1] This evaluation is based on *c.* 80% of the ground stone tools found, comprising all loci with more than 5-6 ground stone tools; fragments and complete tools were not distinguished.

rims) normally are taken to be mortar-like tools, but it is worth to mentioning that they do not have regular depressions, a feature which would be expected for the anticipated uniform motion. The single pestle found was formed by pecking the central longitudinal part of a semi-rectangular hand-stone.

The raw materials attested in the ground stone industry (Fig. 9:d) appear predominantly local, although the source of the important "carbonate rocks" needs to be identified.

Baked Clay Industry (H.G.K.G.)

One of the most outstanding finds of the 1997 season is the presence of burnt sherds of clay that represent vessels or container-like installations; almost no rims or base fragments have been identified. Most of the evidence comes from the 4)- and 5) contexts (*cf.* Table 2) in the easternmost chain of rooms in the excavated area, associated with the latest LPPNB site use.

Since the ceramic discoveries at Basta (NISSEN, MUHEISEN, GEBEL *et al.* 1987: Pl. 5:2-3; NEUBERGER n.d.) it is not surprising to find clay installations or vessels in the Late Pre-Pottery Neolithic B. The only question was if we were dealing with fired pottery or simply sun-dried materials.

A quick survey of the baked clay samples from Ba'ja sorted them into the following classes: sherds from an unidentified kind of container or vessel that clearly exhibit finished inner and exterior surfaces and often reduction cores, and pieces that belong to the class of burnt building materials (mud? plaster). The sherds are very coarse (Pl. 6:A), soft to fragile, and have thicknesses of around 20mm. Chaff and mineral tempering is present, although "naturally" tempered material with various mineral inclusions appear, including weathered sandstone particles.

Below we describe four representative samples:

Sample 1615.1 (large fragment of burnt building material with imprints of reed/ twigs, is part of a smoothed edge of plaster; no organic temper; was burned in an reducing atmosphere; dissolves in water: no consolidation of clay minerals, meaning that the firing temperature was below 550°C.

Sample 1608 (fragment of burnt building material): mineral but no organic temper <1mm; smoothed on one side; dissolves in water: exposed to fire well below 550°C, consolidation reversible.

Sample 1615.2 (sherd of a container)*:* organic tempering (chaff) with natural mineral inclusions or even intentional mineral temper > 2mm; slight central reduction core, but also slight signs of an oxidizing atmosphere in the outer parts; smoothed on both surfaces; does not dissolve completely in water: clay minerals are partly consolidated (burnt slightly below 550°C).

Sample 1614 (sherd of a container): carbonate encrusted fragment; smoothed on both sides; chaff tempered; rim slightly bends inwards; clear reduction core; "outer" part with a thick oxidation zone; does not dissolve in water (but too porous for keeping liquids): fired probably around 600°C, consolidation of clay minerals not reversible.

Samples 1615.2 and 1614 present a problem: is this really "pottery" in the technological sense? Technologically, pottery can be understood as intentionally fired containers that have irreversibly consolidated clay minerals. This happens at *c.* 550°C. In that sense we would indeed have evidence for pottery at Ba'ja, but only if this material was heated intentionally; *i.e.,* that it represents an intended technological undertaking. This is not at all certain. If the sherds really belong to *tabuns*, they were fired as pottery due to their function: *tabuns* easily can be carried in a sun-dried stage to the operating place (GEBEL *et al.* 1994).

As can be seen from Table 3, there is no evidence for the use of stone vessels in Ba'ja, which are so common in other LPPNB sites. It might be argued that this reflects that these functions already were taken over by clay containers. But the virtual absence of rims and base fragments, and the curvature of the sherds attested in Ba'ja, indicate that more likely the sherds are from very large installations, beyond the dimensions of typical (stone) vessels. As a preliminary interpretation, also based on the fact that these sherds occur in and with large ashy accumulations containing burnt animal bones and charcoal, we suggest the sherds are from a sort of *tabun* functioning as described in GEBEL *et al.* 1994. In southern Jordan, food preparation by roasting and baking in clay ovens might be one beginning for the use of clay for vessel-like products. The introduction of a large variety of portable and standardized vessels that were heat-tolerant and leak-proof for cooking directly over fires, that were able to store water and other liquids, that created appropriate storage facilities for many different sorts of food, etc., is a development later than the LPPNB of southern Jordan, and it even might not have reached all the areas in southern Jordan during the Pottery Neolithic that in many regions in this region remained aceramic. But we should not be worried with pottery in the LPPNB; instead, we should admit our unsupported preconceptions that might subconsciously emerge from the term "Pre-Pottery" into our considerations.

Prestige Goods Manufacture (H.G.K.G. and H.-D.B.)

Prestige Goods in General

Except for the recovered evidence of sandstone ring production, ornaments were quite rare in 1997. This is explained by the fact that we were mainly digging in room fill accumulated from fallen roofs and walls, with only limited investigation of *in situ* layers and their inventories; furthermore, and no burials were encountered. Therefore, there is no reason to exclude a wealth of this artifact class, although they might not be as well represented in Ba'ja as on the main routes along the plateau ('Ain Jammam, Basta). So far, we have some sewn-on mother-of-pearl objects, tiny rings made of the same material, beads made from Red Sea mollusks, a very few "greenstone" objects, and beads of various stone varieties (*cf.* Fig. 12).

Sandstone Ring Industry 1997[1]

One of the most outstanding LPPNB prestige goods found at Ba'ja is the sandstone ring. Revealed in all its manufacturing stages, it is clear that Ba'ja was a production center and a source of distribution of this product. Production seems to have taken place in specialized households at Ba'ja. Several loci contained concentrations of sandstone disks and sandstone waste classes (Pl. 7, Figs. 14 and 15:a); in one instance, there was even a supply of the disks ready for concentric graving of the interior portion (Stages 2-3; Pl. 7). It is not clear yet if production occurred only on the household level or if an "industrial scale" was involved, too. So far, all waste classes appear in the same contexts, which indicates that all steps of the *chaîne opératoire* were executed in one social environment. However, the level of skill[2] for this technology does not necessarily require talent work hierarchies". The principal stages and waste classes distinguished on a preliminary level are presented in Table 4 and Pl. 7; a replicative system analysis is a must to achieve a thorough reconstruction of the *chaîne opératoire*.

The precise function of this artefact type, always interpreted as being an ornament, is actually not clear at all (*cf.* STARCK 1988: "pendants or clasp-like ornaments"), and this is the reason for the continued use of the neutral term "sandstone rings". The interpretation as arm bangles was questioned by the argument that the inner diameters are a bit too small for even dainty adult hands; they may vary from 30/40mm to 90mm, with an average between 60-80mm. However, we must admit that we do not know which segment of the community used them. The standard diameter would fit well for sub-adults currently living in the area.

Aside from the great amount of sandstone ring material found, only a single fragment of a ring (F.no. 1234.10) was made from a bitumen-rich, highly fossiliferous chalky-marl (called oil schist) or a bituminous limestone (AFFONSO and PERNICKA, this volume and n.d.). Most of the sandstone rings and manufacturing debris were heavily encrusted with carbonate.

In the following we describe the hitherto identified characteristics of the six major stages (Pl. 7, Fig. 14) of the sandstone ring *chaîne opératoire*:

Stage 0: Acquisition and selection of the locally abundant raw material in the schistic - tabular veins of local Cambrian sandstone formations and in unidentified limestone formations. A limestone and two, possibly three qualities of sandstone were exploited: ferruginous sandstone (high mechanical resistance), clayey-silty sandstone (medium mechanical resistance), and possibly feldspathic sandstone (arcosic sandstone; low mechanical resistance). Preference was given to the reddish-violet ferruginous sandstone, occasionally to whitish tabular sandstone. Bichrome layered varieties were collected intentionally, too; certainly the choice of raw material had a prestige aspect.

Stage 1: Fracturing the tabular piece in a roughly round shape, and initial bifacial flaking. Pl. 7: Stage 1 shows pieces that still have the linear edges from fracturing the resource. Some disks apparently were given up at this stage because the selected raw material was too "schisty", which resulted in removals of layers rather than of flakes.

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1 Basic information on the Ba'ja rings morphology is given in STARCK 1988 and not repeated here. Ba'ja provides for the first time insights into the manufacturing technologies of this unique ornament class, clearing away problems of earlier misunderstandings. At Basta and 'Ain Jammam sandstone (and also limestone) disks also rarely occur, and they were misinterpreted ("throwing disks") here. At Basta some sandstone raw ring tori and pieces such as those in NISSEN, MUHEISEN and GEBEL *et al.* 1991: Fig. 5:2 are attested, but no large-scale workshops are assumed for Basta. However, the sandstone ring waste and the aforementioned piece in Fig. 5:2 give strong evidence that occasional production of sandstone rings took place in Basta, including a variety made from bituminous limestone.

2 A more efficient technology would have been the use of "Kreisschneider", a flint tool with two tips of which one served for cutting the interior circle, while the distance of the two tips would have provided a standard radius. The graving out of an interior disk is much more costly in effort. This technology was first suggested by Bo Dahl Hermansen while studying this ornament class in Basta contexts.

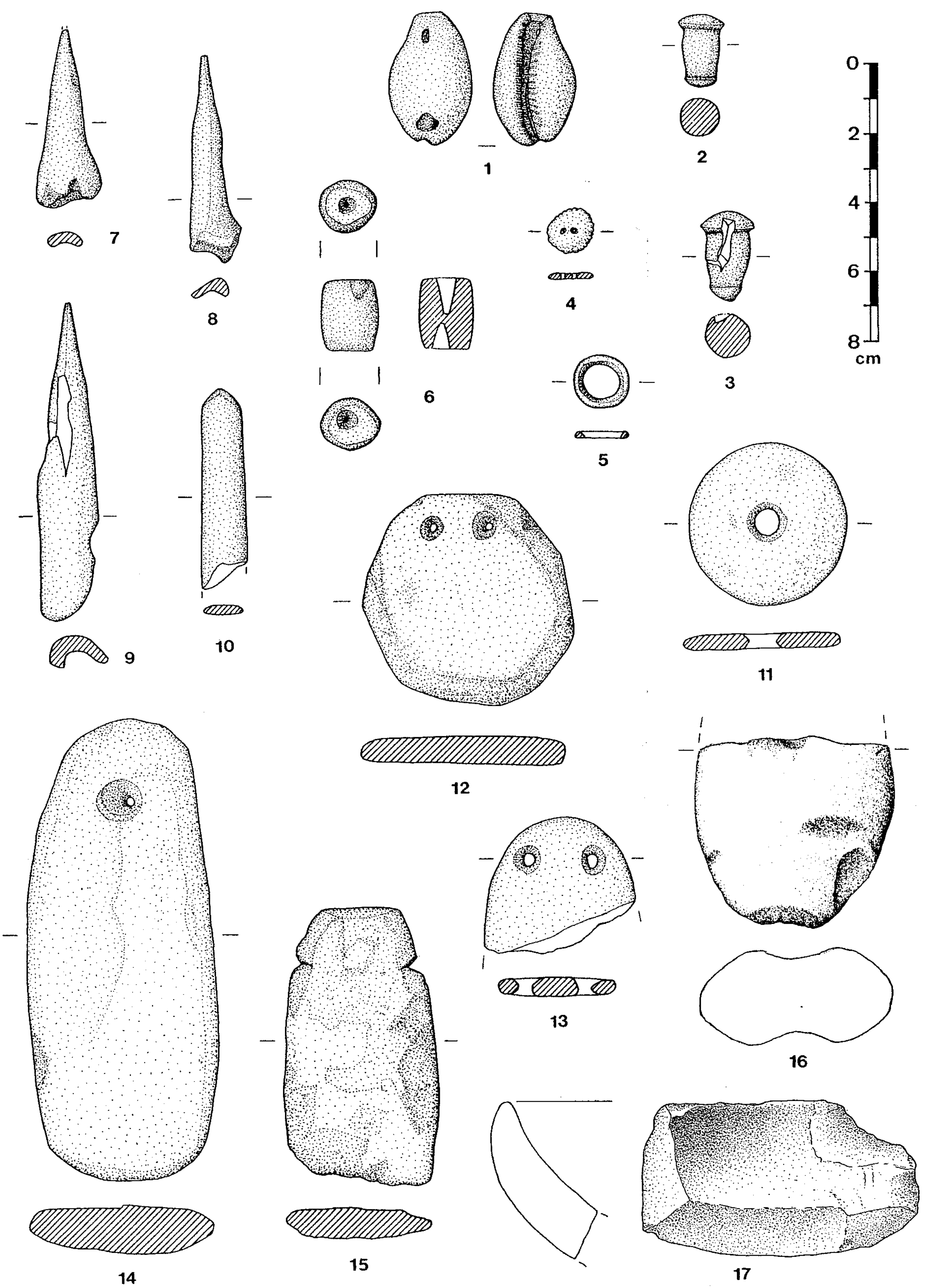

Fig. 12. Stone objects, bone implements, and ornaments. 1-6 ornaments; 7-10 bone industry; 11-16 stone objects, 17 small vessel. (1 perforated cowrie shell; 2-3 ear ornaments ? <bituminous limestone?>; 4 button / sewn-on object <mother-of-pearl>; 5 ring <mother-of-pearl>; 6 unfinished bead <"greenstone">; 7-9 bone awls; 10 bone spatula; 11-13 perforated sandstone disks/ pendants, sandstone whetstone ?; 14 sandstone palette, 15 soft limestone ? (common item in the LPPNB of the area), 16 "Näpfchenstein" <grey limestone>; 17 rim of small limestone? vessel) <illustrations by S. Shraideh (1-15) and I. Raidt (16-17; material of the P.I.G.P.A. collections)>.

Table 4: Preliminary classification and frequencies of sandstone ring waste and fragments according to production stages.

Fragment Classes	Stage	n	%
Fragments of finished products			
fragments of finished sandstone rings	Stage 6	249	99.6
fragments of finished rings made from carved oil shale (bituminous limestone; *cf.* AFFONSO and PERNICKA, this volume)		1	0.4
Total		**250**	**100.0**
Waste/ fragments of unfinished sandstone ring products			
circum-bifacially flaked sandstone disks (including some Stage 1- specimens)	Stage (1-) 2	77	40.3
incompletely graved interior disks with the outer raw ring still attached, broken during this stage of manufacture	Stage 3	4	2.1
fragments of raw rings (raw tori) with traces of graving/ chiseling on both sides, broken during this stage of manufacture	Stage 4a	45	23.5
fragments of semi-finished rings with final grinding on at least one side, broken during this stage of manufacture	Stage 5a	22	11.5
fragments of almost finished sandstone rings	Stage 5a-6a	11	5.8
graved-out interior disk (sections show pointed edges from graving / chiseling; always preserved completely)	Stage 4b	17	8.9
interior disks with central or off-center "biconical" perforations resulting from chiseling/ graving a hole alternately from the two sides; this graving motion is oriented to the center, whose thickness is reduced in that way, and where the hole finally appears to be opened by a sort of punch blow (signs of bursting off on the other sides found); holes often are polygonal or squared (influenced by inwardly oriented grooves, see above)	Stage 5b	15	7.9
Does such a stage exist? No products were found, but piece Fig. 12:11 possibly gives evidence for such by-products.	(Stage 6b ?)	(1?)	
Total		**191**	**100.0**

Stage 2: Subsequent circum-bifacial flaking transferred Stage 1 products into perfectly round disks (Fig. 15:c). The exterior diameter was controllable at this stage of work, and working accidents could still be corrected by creating rings with smaller diameters.[1] The maximum exterior diameters concentrated between 85 - 100mm (Fig. 15:c), as opposed to exterior diameters of 70-90mm for finished rings; the maximum exterior diameters of the sandstone disks and the raw rings nicely fit with each other (Fig. 15:e), showing that further reduction and adjusting occurred during Stages 2 and 4a. The random sample in Figs. 15:b and d reveals that the sandstone disks of Stage 2 may vary considerably in weight and thickness, and that, at least for these parameters, no standards were set for this stage of work.

Stage 3: Concentric graving/ low-pressure chiseling of an interior disk. This was the most effort- consuming part of the work, possibly carried out on a semi-resistant support. Working traces indicate a chisel-like instrument with a sharp edge of *c.* 1.5mm, which left stepped grooves with quadrangular sections that became deeper and wider after their starting point (lengths 9- 12mm). Possibly a flint tool was used for this, but none has been identified in the tool kit yet. This graving/ chiseling process was carried out from both sides (for the section developments *cf.* Fig. 14) until a raw torus (raw ring) for the intended sandstone ring could be removed.

Stage 4a: Removal of the raw torus from the interior disk. Start of final grinding and graving of interior and exterior sides, which involved a great deal of danger of fractures at weakest, thinnest parts.

Stage 5a: The raw torus for the sandstone ring underwent several stages of grinding for the obverse sides and graving/ grinding for the exterior/ interior edges. This process, especially its sub-stages, is still imperfectly understood: while the obverse sides might have been ground on the flat surfaces such as a tabular piece of the hard ferruginous sandstone, it remains subject to further investigation just how the interior and exterior facets of the ring were smoothed. Graving scars from a tangential motion occur on the exterior sides of the rings, and a similar process is in evidence for the interior sides (nicely shown in the drawings of STARCK 1988; Fig 1; however, here Piece 4294 indicates also the graving of grooves from the obverse sides or the cutting by facets). Both measures (obverse grinding and inverse/exterior graving and grinding) may have been applied in no strict order.

[1] As some pieces show: if an intended diameter failed, bifacial flaking was continued until a smaller perfect diameter was gained.

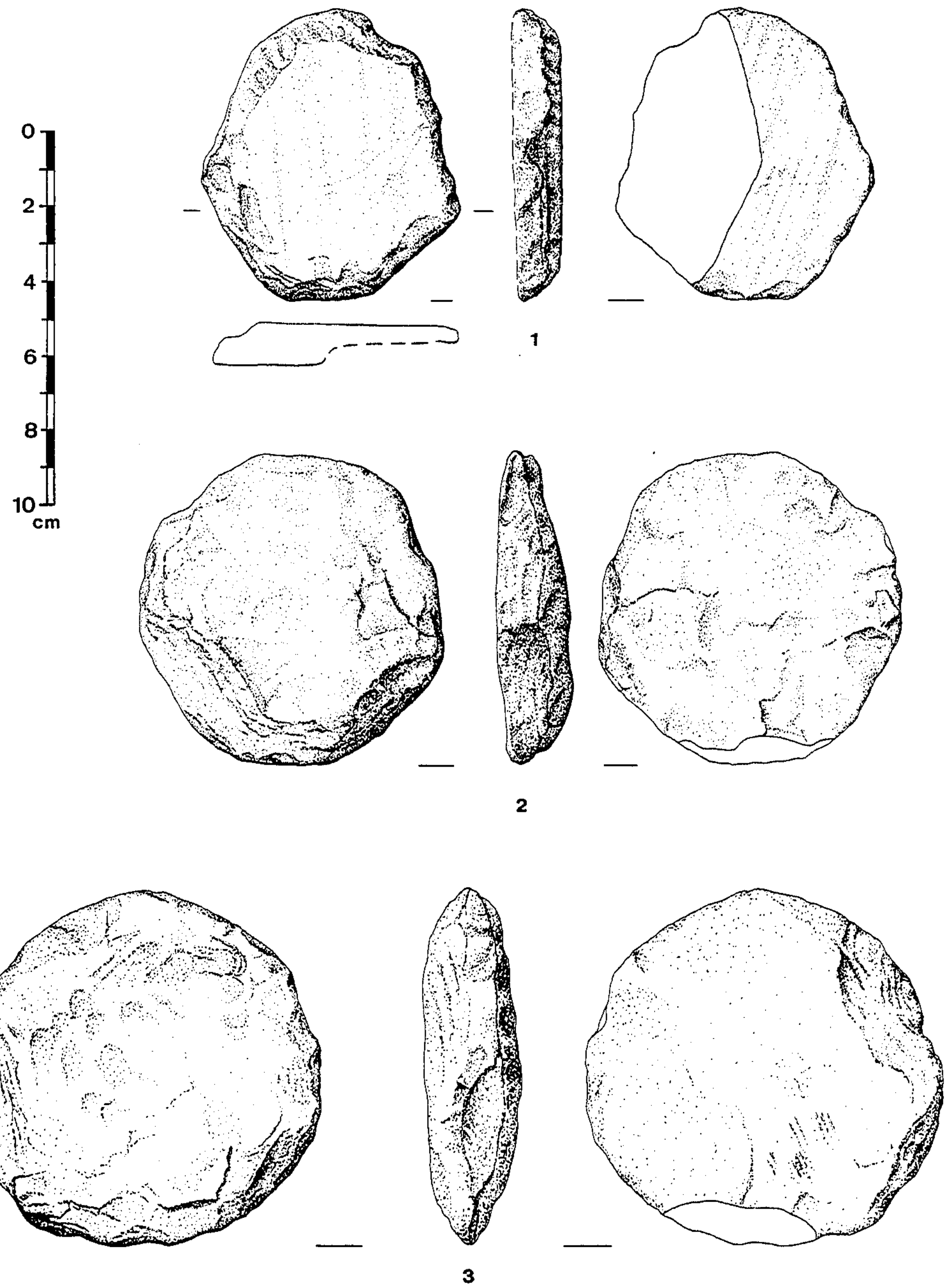

Fig. 13. 1-3 examples of flaked sandstone disks, used as blanks for graving and chiseling out the sandstone rings (bangles?). <illustrations by I. Raidt; material of the P.I.G.P.A. collections>.

Stage 6a: Final grinding sub-stages, occasionally or often combined with "reserved painting". This sequence of sub-stages is not understood perfect-ly either. A bichrome decoration is common for this stage and is the result of the coloured raw material itself and the removal of an applied black (or rarely red) stain by grinding it off from the interior or obverse surfaces ("reser-ved painting", *e.g.* F.nos. 1237.7 and 1291.2).[1]

[1] In some cases (*e.g.* 1207, 1221, 1268.2, 1248.2,4) the whitish variety of sandstone was used and then stained blackish, probably in order to reach a colour closer to the more durable and work-intensive (and thus more precious?) reddish-violet qualities. The very rare pieces with a burnished red paint (*e.g.* 1286.1) have an extremely smooth feel on the skin.

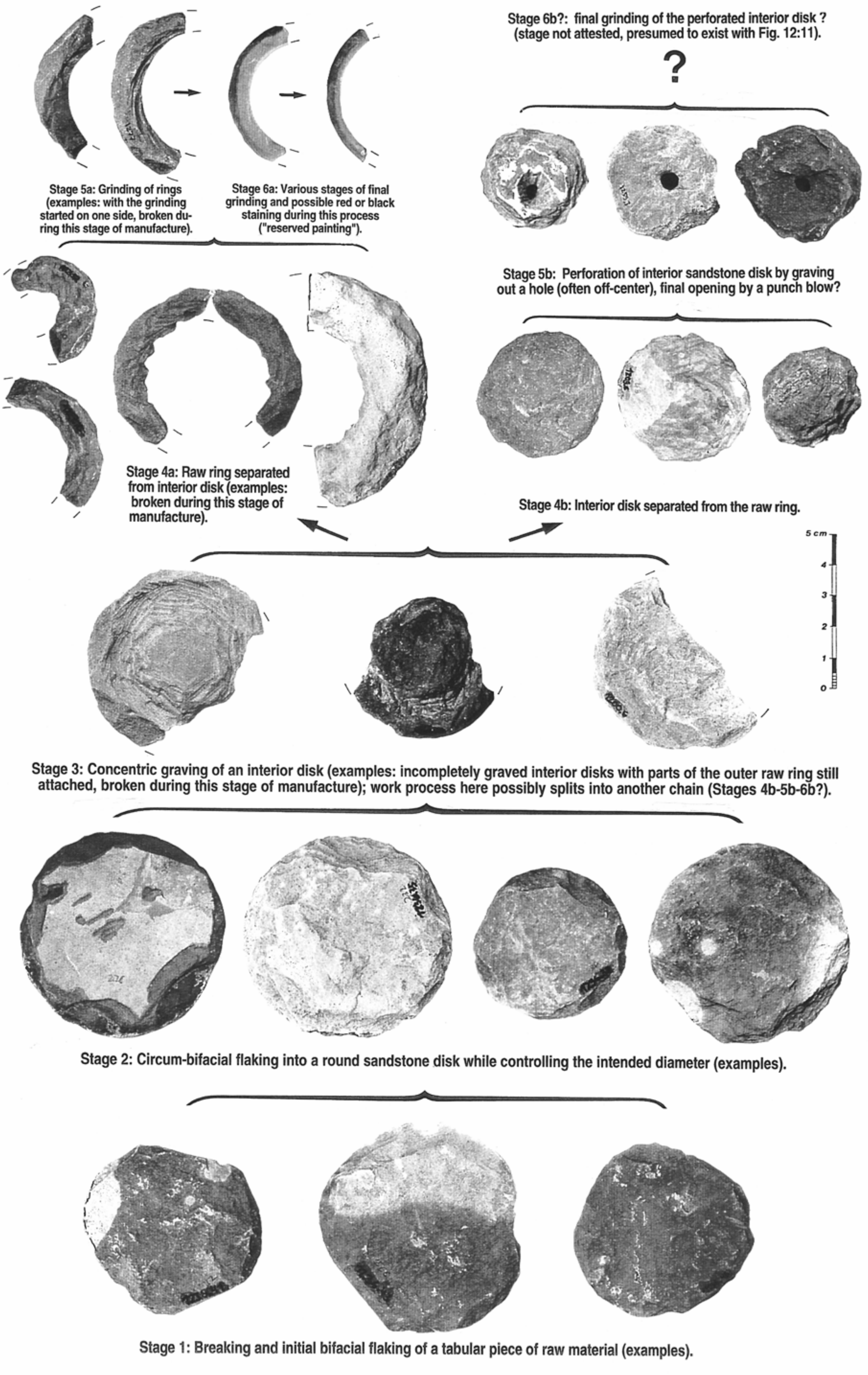

Plate 7: *Chaîne opératoire* of the sandstone ring production.

The most numerous products found were those of Stage 2 (including some of Stage 1), representing 40% in the 1997 sample. The frequencies of waste/fragments in Fig. 15:a clearly show that accidents were related to the removal of raw rings (Stage 4a) that lost the "support" of an attached interior disk (Stage 3), and were thus in danger of breaking at their thinnest or smallest sections during the following grinding attempts on their surfaces. Fractures during graving out the interior disc only rarely occurred (Stage 3, *cf.* the examples in Pl. 7). The loses in Stages 5a-6a reached figures similar to that for 4a.

Interior disks (Stage 4b) may have been transferred into perforated interior disks (Stage 5b), but their further treatment and function remains unclear. Together, they represent 17% in the 1997 sample. No finished artefacts of this possible side-chain of sandstone ring production (Chain b, Pl. 7) were found, with the exception of one artefact (Fig. 12:11) that might represent an intended item. The weights of interior disks are relatively uniform compared with the disks of Stage 2 from which they were taken (Fig. 15:b).

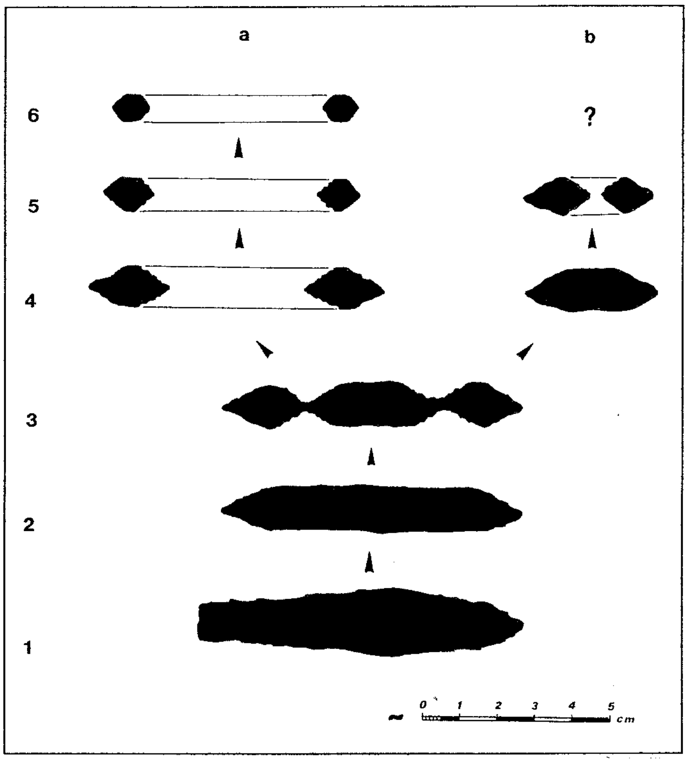

Fig. 14. Development of sections in the *chaîne opératoire* of sandstone ring production.

Subsistence Evidence

Faunal Remains

Exploited animals included wild and domestic goat, domestic sheep, aurochs (*Bos primigenius*), an equid (*Equus africanus*?), wild boar, a small and a large type of gazelle, hedgehog, hyrax, hare, and a small carnivore (fox?) (SÖFFNER 1996, based on the material found in Sounding 1; C. BECKER, pers. comm., based on an on-site check of the material from TU2).

Archaeobotanical Remains (R.N.)

Only carbonized botanical remains were preserved at Ba'ja, mainly wood charcoal. Most of the charcoal belonged to a juniper species, most probable the Phoenician juniper, which still is one of the main components of the woody vegetation in the vicinity. All the wood identifiable as construction wood belonged to juniper. The rest of the charcoal was pistachio, most probable *Pistacia atlantica* or *P. khinjuk*. The absence of oak wood in the samples is remarkable.

Remains of fruits that could have been collected belonged to wild pistachio, hawthorn (*Crataegus azarolus/aronia*) and fig (*Ficus sp.*). Remains of cultivated plants were scarce, suggesting that crop plant cultivation was less important in PPNB Ba'ja. Only a few remains (the so-called glume bases and spikelet forks) from the processing of emmer wheat (*Triticum dicoccum*), , were retrieved. It should be considered that the direct vicinity of the site hardly offers the possibility for the laying out of fields.

Summary and Discussion (H.G.K.G.)

Main results of 1997 excavations

1) The occupation is Late Pre-Pottery Neolithic B (2nd half of the 7th mill. bc) on the basis of its architecture and associated material culture; occupational layers within the room fills of fallen roof/ wall materials most likely are related to the end of the same period, representing the use of the ruins after sedentary habitation came to an end or shifted elsewhere outside the (excavated) area.

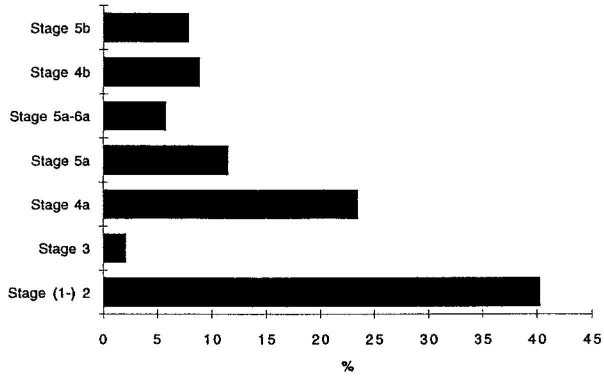

Fig. 15:a. Waste/ fragments of sandstone ring production stages (%), *cf.* Table 4.

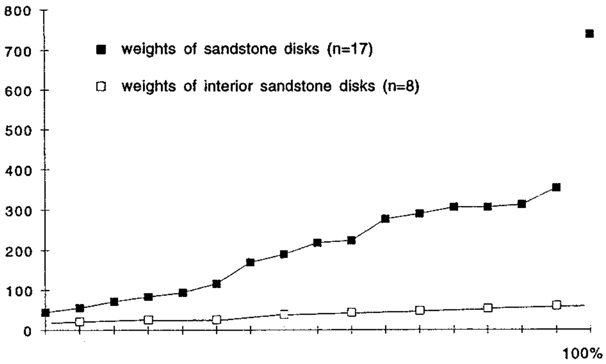

Fig. 15:b. Comparison of weights (g) of sandstone disks (Stages (1-) 2) and interior sandstone disks (Stage 4b), based on the data of a random sample.

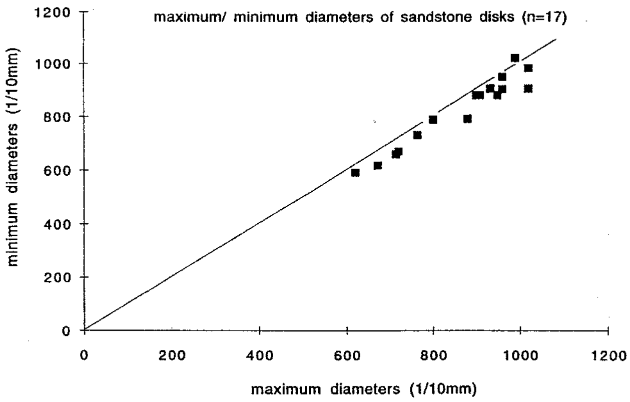

Fig. 15:c. Scattergram of maximum/minimum diameters (1/10mm) of sandstone disks, based on the data of a random sample.

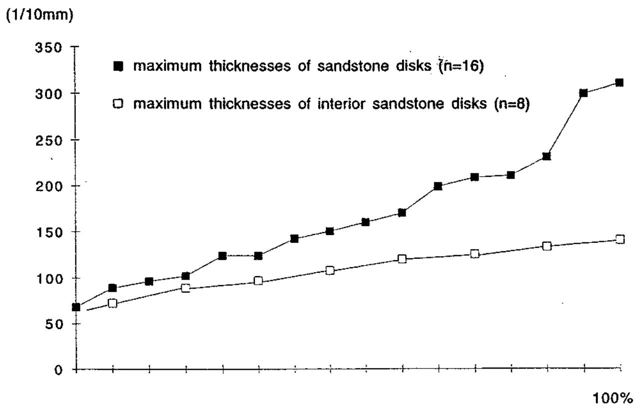

Fig. 15:d. Comparison of maximum thicknesses (1/10mm) of sandstone disks (Stages (1-) 2) and interior sandstone disks (Stage 4b), based on the data of a random sample.

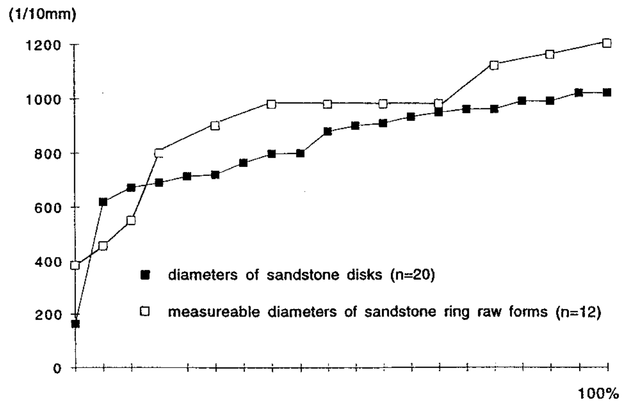

Fig. 15:e. Comparison of maximum diameters (1/10mm) of sandstone disks (Stages (1-2) and of measureable fragments of sandstone ring raw forms (Stage 4a), based on the data of a random sample.

2) The type of architecture resembles in all respects what has been found at Basta, 'Ain Jammam, Ghwair 1, and es-Sifiya, but only partly at 'Ain Ghazal; it is a multi-roomed association of rectangular and polygonal rooms around courtyard-like open spaces. There seem to be no open spaces between building units, which occur in a *pueblo*-type manner on terraces (*cf.* present-day examples from the region in Pl. 6:B-C). Connections between rooms was effected through wall-openings, the large central rooms or courtyards, and most likely, the public spaces of roof tops. Two stories are attested in one spot (western C21).
3) Architectural subphases exist that altered a ground plan within the framework of the major terrace walls. Whenever topography required it, the ground plan of the smaller rooms became curvilinear or polygonal. Room sizes varied from 1.5-15m^2. Subphases can be distinguished by additions onto existing wall tops, blockage or insertion of wall openings, as well as additions to the ground plan, e.g. reinforcement buttresses and walls to stabilize a terrace and the rooms behind.
4) The lower two-thirds and steepest part of the site – at least in Area C – was eroded away in post-occupational periods. Currently the best explanation evokes aquatic force during a temporarily raised *siq* base, in connection with slippage of architecture and deposits down the unstable slope.
5) Contact zones of the cultural layers with the underlying sterile deposits so far show that the palaeotopography on which the settlement rests accumulated in its upper parts as water-laid sandy sediments (*playa*-like deposits) that may represent a once closed intramontane basin-like structure. At certain spots it was obvious that rooms were dug into these sterile layers.
6) The ground stone industry is attested mainly by grinding tools in considerable amounts. Their contexts indicate food processing areas, including on the roofs, and a secondary function as building material.
7) The chipped lithic industry is striking in that it does not seem reflect specialized naviform workshops. Instead, there was a non-naviform bidirectional blade technology represented by cores with detachments from all around a circular platform. The tool kit mirrors no show specialization and reflects activities on household levels, including hunting and possibly wood acquisition and working.
8) The baked clay samples represent burnt building material (plaster) and sherds of containers/ vessels, possibly the remains from *tabuns*. The latter were either intentionally burnt or exposed to fire while in use, but they can nevertheless be considered technologically as pottery (partly fired beyond 550°C).
9) The ornament industry is not very rich so far. However, the site certainly was a fabrication center for sandstone rings on at least a household level. All stages of the manufacture of this prestige item are attested, and we can expect that it played a major role for the settlement's exchange pattern (trade).
10) Plant foods included at the very least emmer wheat, wild pistachio and perhaps fig. Juniper and pistachio were exploited as fuel, with juniper the principal timber material. Animal protein in the diet came from the following species: wild and domestic goat, domestic sheep, aurochs (*Bos primigenius*), an equid (*Equus africanus*?), wild boar, a small and a large type of gazelle, hedgehog, hyrax, hare, and a small carnivore (fox?). Hunting played a major role in Ba'ja in addition to herding.

Selected Interpretations on Building in Ba'ja

The terrace walls were the stable element of spatial organization. While the layout of the individual building units seem to have been inwardly oriented (courtyard houses), the general structure of the settlement appears to represent a corporate organization (as opposed to "public"). This must have been a major concern for the maintenance of those buildings that stabilized the secure setting of houses on the slope. The closed agglomeration aspect of the building units themselves were protective for their inhabitants, and it may actually have functioned as a fortification. Ba'ja's protected setting itself may be a conscious selection that reflected the need felt by the inhabitants for protection and defense.

Planning of buildings basically relied on adapting frameworks according to local topographical conditions, whereby preconceived courtyard buildings were erected. "Free" or re-planning elements in these plans were restricted to alterations influenced by social or functional changes, and are confined to such within an unit itself.

The southern Jordan LPPNB large courtyard building seems to be a new building type not known in the MPPNB. The assumed corporate character of the settlement not only has present-day parallels in the traditional architecture of the region, but also with the *pueblos* in the southwest of North America (e.g. the Anasazi) or mountain settlements in the Old World arid zones from Libya (Tripolitanian-Tunisian mountainous regions) to Central Iran (*e.g.* Abyaneh/ Kashan). Cellular buildings using storage cellars and using other heat/cold-protecting elements are common for such climatic settings, and there are even strong similarities in masonry techniques in these regions compared to the LPPNB of Jordan.

Ba'ja provides additional insights into specialized and non-specialized construction. Building layouts were executed by skilled specialists, but repairs and minor alterations might have been done by less skilled members of the community. There are clear deficits in Ba'ja's structural competence (walls placed without foundation on floors, double-faced walls made of stretchers only, unbonded walls.), which represents a sort of "naive" building technology.

Settlement System Questions

Unlike the research situation for other LPPNB large settlements, more information is available on the possible M-LPPNB settlement pattern in the Greater Petra-Area (through the surveys by Diana Kirkbride and H.G.K. Gebel). According to earlier (GEBEL 1986, 1988, 1990) and more recent results (surveys around Basta), we do not expect a hierarchical settlement pattern in the sense called for by central place theory, at least not in the southern extension of the mega-site episode in the second half of the 7th millennium bc (GEBEL n.d.). The hypothesis is that we are dealing with "anodal" systems, with fast-growing, isolated, and self-sufficient settlements being "central" in the sense of being the regional foci of local land-use and for the distribution of exchanged goods. These "centers" may have developed a size and social complexity that deserve an interpretation beyond a village understanding (see contributions and discussions at the Symposium: *Central Settlements in Neolithic in Neolithic Jordan*, published in *Neo-Lithics* 2/97, especially the arguments of Rollefson and Gebel).

Ba'ja possibly came to exist after nearby Beidha was abandoned, and Shaqarat Mazyad (*cf.* Fig. 2), another MPPNB site in the immediate area was possibly deserted around this time. Occupation then might have concentrated in Ba'ja and possibly at al- Baseet, a newly discovered LPPNB site in Wadi Musa (FINO, pers. comm.). Ba'ja was a rural center beside the main corridors along the plateau and the Wadi Araba; however, it sits at *the* major N-S connection through the sandstone areas of Greater Petra. It belongs to the adventurous spread of large village communities, the mega-site phenomenon, into southern Jordan.

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With deep appreciation we thank our excavation team for the splendid work and good spirits under the very hard conditions: Christian Hartl-Reiter and "Umm Ba'ja" Ute Koprivc (topographical surveyors); Bernd Müller-Neuhof (archaeological surveyor); Tobias Krämer (sedimentologist), Jan Timm (architect); Stephan Fengler and Nina Höffgen (photographers); Philip Rassmann (registrar); Abd al-Nasser Hussein al-Hindawi, Benjamin Jeffs, Muhammad Fadel Khatatbeh, Christiane Meckseper, Sandra Schatz-Härle (square supervisors); Salaheddin al-Abbasi, Annalisa Alvrus, Ulrika Andersson, Jessica Anderson, Brian Conn, and Lena Gebel (assistant square supervisors). In the latter third of the season, the project was joined by Reinder Neef, German Archaeological Institute - Eurasien-Abt. (palaeobotanical samplings). Considerable support came also from part-time participants: Patrick Kloiber (topographical surveyor), Johannes Meier, Julia Littmann (dig assistants), and Sonja Striegl (reporter). During the final work we received the well appreaciated help of Bo Dahl Hermansen and Ghattas Sayej. The project owes sincere gratitude to Bernd Müller-Neuhof, who considerably helped in the pre-excavation organization.

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Pragmatic Studies of Near Eastern Neolithic Sickle Blades

Leslie A. Quintero, Philip J. Wilke, and J. Giles Waines

Abstract: *Study of the sickle blades from the Neolithic town of 'Ain Ghazal, Jordan, prompted experiments on reaping of cereal grasses. Major areas of concern were the recognition of unglossed Neolithic sickle blades, and reasons for morphological variation in archaeological sickle blades. Reaping experiments were conducted to understand the performance of sickle blades and the macroscopic patterns of gloss formation and use wear. These studies led to the development of criteria for identification of unglossed sickle blades in archaeological assemblages and practical understanding of the variability in edge and surface modification of Neolithic sickle blades.*

Résumé: *L'étude de lames de faucilles dans la ville néolithique d'Ain Ghazal en Jordanie a incité à effectuer des expériences sur la moisson de plantes céréales. L'essentiel de la recherche s'est porté sur l'identification de lames de faucilles néolithiques non lustrées, et les causes de la variation morphologique des lames de faucilles archéologiques. Des expériences de moissons ont été réalisées afin de comprendre la performance des lames de faucilles et les tendances macroscopiques de formation de lustre et d'usure. Ces études ont mené au développement de critères pour l'identification de lames de faucilles dans les assemblages archéologiques et pour la compréhension pratique de la variabilité dans la modification du tranchant et de la surface des lames de faucilles néolithiques.*

Introduction

During the last two decades we have aquired a broadened perception of the prehistory of Jordan and the processes of "sedentarization" that led to the florescence of towns on its Neolithic landscape. In part, this awareness is due to the exploration of a number of major townsites, such as Basta (NISSEN *et al.* 1987, GEBEL *et al.* 1988, NISSEN 1990) and 'Ain Ghazal (ROLLEFSON *et al.* 1992). In part, also, it is due to significant advances in analytical methods, such as technical studies of lithic artifacts, that allow a clearer understanding of past behaviors than was possible heretofore. A central focus of recent studies, and the concern of this paper, is how to refine our analyses of stone tools to understand better the subsistence economies of these early agrarian communities.

Microwear analyses currently addressing such problems in Near Eastern lithic studies are building on the long-standing tradition of Semenov (1964) and Keeley (1980) in that their research framework relies primarily on experimentation and replication-based analogies. The goals of microwear studies range broadly from the determination of individual use-actions of a single tool to assessments of economic strategies. In essence, however, Near Eastern analyses are concerned with the specifics of tool use. For example, evidence of patterned residues, wear, and gloss (or "sickle sheen") allows the reconstruction of tools, such as composite sickles and their related hafting strategies (*e.g.*, CAUVIN 1983); gloss and striation patterns on sickles also may reveal reaping and cutting motions (HELMER 1983). Keeley and many others have identified functional classes of tools, such as adzes and axes (KEELEY 1983a, COQUEUGNIOT 1983); microlithic projectile points for hunting (ANDERSON-GERFAUD 1983); blade tools for cutting plant material (ANDERSON-GERFAUD 1983, CAUVIN 1983); and burin spalls as bead drills (FINLAYSON and BETTS 1990). In general, these behavioral interpretations are used to verify the functional significance of morphological tool typologies.

A primary focus in Near Eastern Neolithic work concerns the use of sickles and other glossed tools. Research centers on the causes of gloss formation (UNGER-HAMILTON 1983, 1988; LEVI SALA 1988; FULLAGAR 1991), gloss as an indicator of cereal reaping (UNGER-HAMILTON 1989, 1991), and gloss and microwear as evidence of the domestication of cereal grasses (UNGER-HAMILTON 1985, 1992; ANDERSON 1992). The substantial effort invested in this area is due in part to the complexity of microwear analyses, as well as to the magnitude of the concerns. Successes have been difficult to obtain, and there remains much controversy regarding fundamental issues. Many of these problems stem from the ambiguous nature of wear and gloss and their multiple causes. It is now evident that many contact materials other than cereal grasses (such as wood) cause gloss to form on stone tools, and that many variables affect glossing patterns and their rates of development (UNGER-HAMILTON 1983, FULLAGAR 1991, GIJN 1992).

In spite of the behavioral correlations that microwear analyses do offer, it seems apparent that some clarity is needed, perhaps from a slightly different research orientation. We also use experimentation and replication-based analogies to consider use wear, but ours is a more practical approach; we study the macrowear evidence of reaping, rather than microwear traces. We take inspiration in this endeavor from Keeley,[1] for we too think that different questions need to be asked of the data. It is also our belief that there is great need for pragmatic studies and longitudinal field experiments that explore sickles as utilitarian tools. The reaping experiments detailed below were structured toward that end. The large collection of sickle blades from the Neolithic site of 'Ain Ghazal, numbering well over 500 glossed specimens alone, was used as a reference standard for this research.

Structure of Near Eastern Sickles

Archaeological sickles[2] have been recovered from Near Eastern sites dating from the Natufian through the Late Neolithic (CATON-THOMPSON and GARDNER 1934, MELLAART 1970, BAR-YOSEF and ALON 1988, EDWARDS 1991). They consist of sickle blades set in one edge of hafts that range from straight (*e.g.*, late Neolithic of the Fayum, Egypt) to strongly curved (*e.g.*, late Neolithic of Hacılar). Sickle blades are in most cases set with their cutting edges parallel to the haft, whatever its straightness or curvature, and one example from the Natufian site of Wadi Hammeh 27 (EDWARDS 1991) has two rows of blades set parallel in the same edge.

On curved hafts, the blades are usually set in the inside curve, but some Natufian examples have blades set in a gradual outside curve (EDWARDS 1991). Sickle blades may be entire stone blades, sections of blades, or, as sometimes occurs in Yarmoukian times, completely pressure-flaked pieces. Sickle blades usually were set in a groove in the edge of a haft and fixed with a matrix of bitumen, lime plaster, or other material. Archaeological sickle blades are not always butted together. In some cases there is substantial space between blades that is filled in with hafting matrix. Apparently there also is much variation in the placement of the insets. On the basis of glossing patterns, Cauvin (1983) reconstructed a sickle with a curved haft in which blades were set on the inside curve, step-wise and partly overlapping rather than parallel to the haft. Nishiaki (1990) suggested a similar strategy for obsidian blades.

Focus of the Current Research

The focus of our current study is on developing a better understanding of Near Eastern Neolithic sickle blades in order to derive generalizations useful for the study of the sickle blade assemblages from 'Ain Ghazal and related sites. We are especially concerned with two broad issues: the recognition of unglossed sickle blades in Neolithic assemblages; and the reasons for morphological variability in Neolithic sickle blades. These issues encompass a number of variables, including the ways in which properties of stone and different aspects of the reaping process may affect the development of diagnostic attributes on sickle blades. Fortunately, many of these variables lend themselves to observations that are derivable from pragmatic field experiments. Our intent, therefore, is to study the performance and macroscopic use modification of sickle blades as parts of the functioning composite implements that were so common and important in prehistory.

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1 "My limited contact with Neolithic tools has convinced me that Neolithic technologies were quantitatively, perhaps qualitatively, different from those of the preceding periods and that we must adjust our methods of study to match those differences. It is clear to me that if the study of tool function is limited to just the reconstruction of tool action and worked material, not only will we miss seeing potentially important data about the behavior of prehistoric people but such a restriction of inference leads directly to the trivialization of microwear analysis" (KEELEY 1983b: 256).

2 As used here, the term "sickle" refers to a composite tool consisting of a haft set with a series of stone blades that form the cutting edge, sometimes called by others a "reaping knife". Other authors sometimes use the term "sickle" to refer to a single stone sickle blade (*e.g.*, OLSZEWSKI 1994); for these objects, we use the term "sickle blade". "Sickle element" is occasionally used by others to refer to any sickle inset, or sometimes to extensively pressure-flaked Yarmoukian "sickle blades" whose origin as blades, flakes, or bifaces cannot be determined.

Recognizing Unglossed Sickle Blades

The convention among current researchers is to define sickle blades by the presence of gloss (*e.g.*, HOLE 1977: 166) that develops on surfaces of stone tools used for reaping cereal grasses. This exclusive definition overlooks evidence to the contrary, such as ample experimental data that gloss development is a dynamic process that requires time. A complete sickle fitted with unglossed blades from Hacılar (MELLAART 1970: 161, Fig. 178-1) reminds us of this fact. Existing convention thus often precludes the recognition and, consequently, the classification of potentially large numbers of sickle blades that lack gloss, or, because of the natural qualities of the stone, do not display gloss easily. While this may seem a trivial problem, its ramifications are significant. How does one reconcile, for instance, the relatively small number of glossed sickle blades found in many Pre-Pottery Neolithic (PPN) and Pottery Neolithic (PN) sites with the undeniable importance of harvesting cereal grains in the Neolithic subsistence economy?

This problem is compounded by some recent microwear studies (*e.g.*, CAUVIN J. 1968, CAUVIN M.C. 1983, UNGER-HAMILTON 1988, FULLAGAR 1991) suggesting that a large class of glossed sickle blades, particularly those of the Pottery Neolithic, were not used for harvesting cereal grasses at all. If that is the case, where are the grain-reaping tools used by the Neolithic farmers? It would seem that classification standards for sickle blades need to be revised so that data other than gloss are also considered, and so that such standards incorporate practical information from modern reaping studies. Effective criteria need to be developed to enable the recognition of unglossed sickle blades readily in the field laboratory where the crucial initial sorting of artifacts takes place.

Reasons for Morphological Variability in Sickle Blades

Currently, there is not a clear understanding of the causes of morphological variation that occurs in the structure of Neolithic sickle blades. Why, for instance, are PPNB[1] blades generally made from large blades or blade segments with slight edge modification, but in the Pottery Neolithic many sickle blades are made from extensively modified, pressure flaked, very short blade segments or flakes? The latter, deeply serrated Yarmoukian sickle blades, are a puzzle to many who question why they were made as they were, how they were used, and why they were restricted to the Pottery Neolithic.

Recent technological studies (WILKE and QUINTERO 1994, QUINTERO and WILKE 1995) suggest that differences in the underlying lithic economies of these two periods were responsible for the contrasting sickle blade morphologies. Yet, some researchers have proposed that these morphological variations relate to differences in tool function, and that Yarmoukian sickles may have been used to cut reeds, for instance, rather than cereal grasses (CAUVIN 1968). Others attribute variation of this kind simply to stylistic changes that may be independent of any fundamental changes in technology. Several studies have been conducted since Cauvin's research that attempted to differentiate microwear that results from reaping wheat from that which results from cutting reeds and other materials (UNGER-HAMILTON 1988, FULLAGAR 1991). These tests have been inconclusive and the work continues.

Variables Considered

In order to address the above issues, it is necessary to focus on the performance and durability of sickle blades and on factors that affect gloss formation and morphological variability in sickle blades. We do not know whether Neolithic people reaped monocrops or mixed crops, dense stands or thin ones, reaped high or low, or what actions they used in reaping. Clearly, today's experiments cannot be expected to duplicate prehistoric conditions. Nonetheless, we can attempt to approximate the prehistoric situation by drawing on the archaeological data (for example, sickle form, sickle-blade properties, botanical information, etc.) to restrict the variability to meaningful categories. Therefore, our studies focused on the following factors:

- the properties of stone from which sickle blades were made
- the structure of sickles, including the ways stone blades were modified and prepared for hafting, how they were hafted, and the position of the blades within the cutting arcade of a sickle
- the reaping process, including the actions employed and the time spent reaping
- the effect of harvesting at different stages of plant maturity and ripening
- the appearance of use damage on sickle blades.

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1 PPNB designates the Pre-Pottery Neolithic B phase. At 'Ain Ghazal, occupation began in the Middle PPNB (MPPNB, *ca.* 9,250-8,500 bp), and continued through the Late PPNB (LPPNB, *c.* 8,500 - 8,000 bp), PPNC (8,000 - 7,500 bp), and the Yarmoukian phase (*ca.* 7,500-7,000 bp) of the Pottery Neolithic.

Stone Type

Some researchers have suggested that stone composition affects the formation of gloss and other traces that result from harvesting cereal grasses. Unger-Hamilton (1983, 1988) and others (*e.g.*, BALCER and SCHILD 1980, VAUGHAN 1981a, HOLMES 1987) noted that different flint types acquire micropolish and gloss at different rates. But longitudinal studies that explore this variation have not been conducted. Obsidian dominates in some regions, and sickle blades of that material are often suspected to be present in archaeological assemblages but they rarely are reported. Mortensen (1970a: 33) and Hole (1983: 243) discussed the problem of identifying sickle blades of obsidian that did not show gloss, or sheen, readily.

This dilemma has important consequenses for recognizing obsidian sickle blades, particularly if gloss is a requisite criterion for their identification (*cf.* HOLE 1977: 166). While some researchers have reported identifying obsidian sickle blades on the basis of criteria other than gloss (BIALOR 1962, CAUVIN and BALKAN 1985, NISHIAKI 1990, BADER 1993), we find it unsettling that obsidian sickle blades have not been reported in assemblages from some major Neolithic sites where obsidian is a dominant raw material (*e.g.*, at Aşıklı Höyük: ESIN 1991, BALKAN-ATLI 1994). It seems reasonable to wonder if the reported absence of obsidian sickle blades in such contexts is due to their not being recognized.

Recent studies suggest that gloss on obsidian may be discernible microscopically (VAUGHAN 1981b, HURCOMBE 1985), although the task remains difficult. With these considerations in mind, we structured our experiments to identify diagnostic attributes of reaping that may be apparent macroscopically on obsidian blades. Tests were also designed to compare the effects of reaping on juxtaposed sickle blades of flint and obsidian within the most active portion of the cutting arcade.

Heat Treatment

Heat treatment alters the texture and fracture properties of flint, rendering it less grainy and more waxy (RICK and CHAPPELL 1983). Our own experience in blade-making has shown that it is often necessary to heat-treat flints of lesser quality in order to produce good blades. Because we are not certain that heat treatment was never employed anywhere in the prehistoric Near East, we cannot assume that reaping experiments conducted only on raw[1] flint will always duplicate conditions represented archaeologically. Sickle blades of heat-treated flint may gloss differently from those of raw flint.

Therefore, we conducted reaping experiments with both heat-treated and raw flint and compared the results.

Hafting of Sickle Blades

Among the variables that help us recognize sickle blades in archaeological assemblages, hafting is important because preparation of individual blades for hafting may create diagnostic attributes that are independent of glossing. A clearer understanding of the morphological features created by preparing sickle blades for hafting can be obtained by analyzing archaeological collections as well as by replication studies. An analysis of the 'Ain Ghazal collection, which provides a data base comparable to those of other Neolithic assemblages from the Levant, suggests that many blades were prepared for hafting in several ways, including retouching and trimming, but some were used with little alteration.

Our experiments were structured to explore the kinds of modification that were necessary to prepare blades for hafting, and to use that evidence to understand the patterns of hafting observed in the 'Ain Ghazal collection.

Position and Attitude of Blades in the Haft

Near Eastern sickles discussed above have cutting arcades that average 20cm or more long. This length suggests that the position of a blade within the arcade of a sickle may affect the degree to which that blade is actively involved in the reaping process and therefore subject to greater or lesser degrees of use modification. Likewise, on any given blade, some surfaces may be more actively involved in the reaping process and will therefore show greater degrees of glossing or other use modification.

Our experiments, therefore, considered the hafting position of sickle blades within a given cutting arcade and the surface configuration of individual blades as it might affect glossing.

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[1] Our use of the term "raw" to indicate flint not subjected to heat treatment follows standard usage in the literature.

Blade Edge Treatments

From the Natufian through the Late Neolithic there is much variation in the edge morphology of individual sickle blades (CAUVIN 1983). Some investigators (*e.g.*, UNGER-HAMILTON 1989) have noted an evolutionary trend toward greater modification of the cutting edges of sickle blades through time. However, the reasons for variation in edge morphology are not clear and require further study. Examination of 'Ain Ghazal PPNB glossed blades revealed that most blades have nicking or very fine denticulations on the working edge, a property widely noted in PPNB assemblages throughout the Near East by various people (*e.g.*, MORTENSEN 1970b, CAUVIN 1983, CROWFOOT PAYNE 1983). Questions continue to be raised whether this trait is due to intentional edge modification or is a result of use (OLSZEWSKI 1994).

The other major issue regarding edge modification of sickle blades involves the very coarse denticulation typical of the Yarmoukian phase of the Pottery Neolithic. While there is no question that such edge modification is intentional, there is little agreement on the reason(s) for its occurrence (J. CAUVIN 1968, M.C. CAUVIN 1983). In the present context, our concern is whether such sickle blades are efficient for reaping cereals.

Our harvesting experiments studied the performance of sickle blades with various degrees of edge modification. Coarseness and fineness of denticulation, or of edge serration, as employed here, are described as follows: *Fine serration*, typical of the PPNB, consists of minor, usually unifacial, nicking of the exposed edge of the sickle blade.[1] *Moderate serration* consists of deliberate unifacial pressure flaking of the exposed edges of sickle blades, with about 3.5-4 serrations per centimeter. *Coarse serration* closely resembles that seen on Yarmoukian sickle blades from 'Ain Ghazal, and consists of deliberate, usually bifacial, pressure flaking of the exposed edge of the sickle blade, with about 2 serrations per centimeter.

Reaping Actions

Some investigations have suggested that the action of reaping will affect the location and extent of polish and gloss formation on a given sickle blade (*e.g.*, KEELEY and NEWCOMER 1977). And, while some studies indicate that a specific reaping action may leave a discernible signature on individual blades (see BALCER and SCHILD 1980, CAUVIN 1983, HELMER 1983), interpreting the meaning of these effects is confounded by a lack of information on the functions of the tools that held the blades (see GIJN 1992). We have no reliable information on the specific actions involved in Neolithic reaping. Therefore, our experiments were conducted to try to identify reaping actions that were the most efficient and least tiring, with the assumption that they might best mimic the prehistoric situation.

Moisture Content of Material Being Cut

Recent research has stressed that the onset and intensity of gloss formation are affected by the moisture content of the plants being cut (UNGER-HAMILTON 1983, 1992; ANDERSON 1992). Gloss appears earlier and becomes better developed when plants are harvested while still at least partially green, or while the stems still contain some natural moisture. Our experiments were designed to extend from the time the grain being harvested was still in the "dough-stage" (that is, the grains were still slightly soft, and stems were still half-green, with a high moisture content)[2] until it was fully ripe and dry. The intent was to understand how the timing of the harvest affects the performance of sickles of various constructions, and the development of macroscopic use traces on experimental sickles.

Macroscopic Damage

Glossing is recognized as an indicator of the reaping process and has been studied extensively. Less attention has been given to gross, macroscopically observable use damage as an indicator of harvesting. Whether glossed or not, sickle blades of whatever material might be identified by other attributes of use, such as edge wear, edge failure, surface abrasion, breakage, etc.

Examination of the 'Ain Ghazal sickle blade collection led to the recognition of a number of possible cases of macroscopic use damage. Since experimental observation of such variables is more likely in prolonged reaping tests, our experiments were designed accordingly.

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1 Based on observations made on the glossed PPNB sickle blades in the 'Ain Ghazal assemblage, and through experimentation, we determined that this edge treatment is best duplicated by simply pressing the edge of a flint blade against the cutting edges of sickle blades.

2 "Dough-stage" and "half-green", as used in this paper, are approximately equivalent to "green" as used by Zohary (1992: 85).

Duration of Reaping

Several studies demonstrate that the intensity of gloss and wear increase with the duration of reaping (LEVI SALA 1988, UNGER-HAMILTON 1988, FULLAGAR 1991). These studies suggest that glossing is a developmental process that occurs in varying stages. If this is the case, duration of reaping could account for differences in glossing on archaeological sickles.

By conducting experiments in which sickles were used for comparatively "long" periods of time, it was thought the overall performance of sickles and the actual reaping process could be better understood.

Experimental Studies

Reaping experiments were conducted on the grounds of the Agricultural Experiment Station, University of California, Riverside, in May and June, 1993, with a further minor test in June 1996 (Pl. 1). In all, 6,541m^2 of cereal grasses (1.62 acres) were reaped, using 11 replicated sickles for a total of 112.5 hours, as follows:

1. Durum wheat (*Triticum turgidum* L. ssp. *durum* Desf. cv. Mexicali) was cut at the dough stage, 1,026 m^2, average of 405 stalks per m^2. Reaping time, 25 hours.
2. Durum wheat was cut from the same plot at the dry stage after it had fully ripened, 2,820 m^2. Reaping time, 45.75 hours.
3. Six-row barley (*Hordeum vulgare* L.), 1,660 m^2, average of 600 stalks per m^2 (a dense stand planted for erosion control), and oats (*Avena sativa* L.), 1,035 m^2, average of 460 stalks per m^2, were cut at the dough stage. Reaping time, 41.75 hours.

The sickles used in these experiments are described below. For all of the sickles, blades were made from stone percussion blades detached from naviform cores (WILKE and QUINTERO 1994). All of the flint used came from sources on the Edwards Plateau of Texas and is of Lower Cretaceous age. Considering the range of archaeological sickle forms, we elected to use somewhat curved hafts and to set the blades with pitch in a U-shaped groove in the inside of the curve.[1] It was not our intention to model any prehistoric sickle form, but rather to produce sickles that were of a general Neolithic configuration and that would withstand prolonged and intensive reaping.[2]

Reaping Dough-Stage Wheat with Various Kinds of Stone Blades

These experiments compared different sickle blades, emhasizing the performance and durability of various flints (coarser-grained vs. finer-grained), various obsidians, and flints vs. obsidians. They also considered the effectiveness of edge treatments, the performance of raw vs. cooked flints, the position of sickle blades in the haft and the effect of hafting position on the development of gloss. All of these experiments were conducted on dough-stage durum wheat.

Sickle No. 1

This sickle was used to test the reaping performance and glossing rate of heat-treated, fine-quality flint, the cutting efficiency of unaltered blade edges, and the durability of a haft set with overlapping, untrimmed blades. Five fairly short sickle blades made from fine-grained flint from Williamson County, Texas, heat-treated, nonserrated, were set with pitch, slightly lapped, in a distally curved hardwood haft of white alder (*Alnus rhombifolia* Nutt.) (Pl. 2:a).

The sickle was used for eight hours. Gloss was first apparent after about one hour of reaping. After three hours, gloss was well developed with many striations. At five hours the sickle blades were extremely glossy and scratched parallel to the edge, with prominent gloss in the first millimeter or so from the cutting edge, but continuing down to about 5mm from the edge. The unaltered blade edges dulled quickly, making reaping less efficient. These edges did not suffer edge damage or use modification that mimicked PPNB serration. The haft fitted with lapped blades proved problematic, as grass stems were caught between the blades, inhibiting the reaping process and dislodging the hafting matrix.

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1 Pitch for these studies consisted of five parts conifer resin to one part gilsonite (natural, hard bitumen), melted and poured onto powdered charcoal, then rolled into sticks that were remelted for use. The U-shaped hafting groove employed here differs from the V-shaped groove seen on many Near Eastern sickles. For the hafting matrix used, this groove configuration was more effective.

2 Initially, we were assisted by a cadre of volunteer harvesters during the reaping of dough-stage wheat. All later cutting was done by the authors working at an aggressive pace.

Sickle No. 2

This sickle was used to test the efficiency and glossing capability of two qualities of raw flint, the cutting performance of PPNB-type fine serration on the edges of sickle blades, and the durability of a sickle arcade set with end-trimmed, butted blades. Four sickle blades of alternately set fine-grained raw flint from Williamson County, Texas, and somewhat coarser-grained raw flint from Gillespie County, Texas, with fine (PPNB-type) serration, were set with pitch, butted together, in a slightly curved hardwood haft of white alder (Pl. 2:b).

The sickle was used for eight hours. The first gloss was observed after about two hours of use. After three hours, gloss was clearly visible on the cutting edges and adjacent dorsal surfaces, but less evident on the ventral surfaces. After five hours, blades in the center of the cutting arcade were well glossed, those toward the ends much less so. The somewhat coarser flint from Gillespie County developed less gloss than the finer-grained material from Williamson County. The PPNB-type serration provided an excellent cutting edge far superior to that of an unmodified blade. End-trimmed and butted sickle blades set in a gradually curving arcade provided an efficient and durable cutting implement.

Sickle No. 3

Sickle No. 3 was used to test the reaping efficiency and glossing rate of three grades of obsidian and of raw, fine-grained flint; also tested was the cutting efficiency of the unmodified blade edges of these materials and the use damage that occurred to them. Three short sickle blades of obsidian were alternately set with three of flint; none were serrated. The obsidian included both somewhat coarse-grained and fine-grained material from Mono County, California, and very glassy material from Modoc County, California; the raw flint was fine-grained stone from Williamson County, Texas. All were set with pitch, butted together, in a distally curved hardwood haft of Chinese elm (*Ulmus parvifolia* Jacq.) (Pl. 2:c).

The sickle was used for eight hours. Minute areas of initial glossing were observed on the margins of the flint blades after about two hours of use. After three hours of reaping, flint sickle blades showed modest glossing on the edges and slightly up the dorsal and ventral surfaces. Also after three hours, obsidian blades had developed rounded edges and striations, mostly parallel to the cutting edges. After five hours of reaping, the flint blades in the middle of the cutting arcade were quite glossed on their margins, while the gloss on the end blades was less developed. After five hours of use, obsidian blades were very smooth and "glossy", but it was not possible to tell whether their appearance was due to gloss deposition or to abrasive polish, or both. Edges were smooth and dull, and there were many scratches parallel to them; a few scratches were diagonal to the edges, at nearly right angles to them, or oriented in other directions. At the end of the reaping, glassy obsidian showed the most wear and appeared glossiest (Pl. 3:a,b). Less glassy material was less smooth and somewhat less glossy. Coarse-grained obsidian showed the least modification.

Reaping Dry Wheat with Various Kinds of Sickle Blades

These experiments parallel those discussed in the preceeding section in that they explored variations in the performance of heat-treated and raw flints and of obsidians, and different blade-edge treatments. Also considered was the development of use modification as a function of the position of blades in the haft. These experiments were conducted on dry durum wheat.

Sickle No. 4

This sickle was used to test the reaping performance and gloss development of fine-grained raw flint and good-quality obsidian, all with moderately serrated edges, and also to test the effect of hafting position on use modification of the blades. Four long sickle blades of flint from Williamson County, Texas, and obsidian from Mono County, California, were set with pitch, butted together, in a slightly curved hardwood haft of white alder (Pl. 2:c).

The sickle was used for 14 hours. After five hours of use, the edges of the obsidian sickle blades showed slight rounding, but there was no gloss and no obvious wear on the flint blades. After eight hours of use, the edges of the obsidian blades were very worn, while the edges of adjacent flint blades showed little macroscopic wear. After 10.75 hours, slight gloss was visible on the flint blades, and through the duration of the experiment they developed only a modest amount of gloss. After the reaping was completed, the denticulations on an obsidian blade (Blade 3) near the center of the reaping arcade were almost completely obliterated (Pl. 3:c-d), whereas those on the adjacent flint blade (Blade 2) were still pronounced and showed little attrition. While the edge of the obsidian blade may originally have been sharper than that of the flint blade, it did not hold up during use, and soon lost

Plate 1. Reaping experiments.

a: Harvest of dough-stage durum wheat in progress. The figure in the far corner of the harvested area provides a scale.

b: Harvesting dough-stage oats.

c: Sickle No. 8, shown here with other varieties of wheat following the main harvesting experiments. The blades are heavily glossed. Most of the sickles used in the reaping experiments reported here had this basic structure.

d: Reaping "back-hand". This reaping motion was found to be the most efficient and least tiring.

Plate 1:a-d.

Plate 2. Some of the sickles used in the reaping experiments, shown here after fieldwork was completed. See text for more detailed descriptions of construction and use.

a: Comparison of heat-treated and raw flint, with different edge treatments. *Upper*: Sickle No. 5, with moderately serrated blades of raw flint. The serrations are toward the ventral surfaces of the blades, as shown here. *Lower*: Sickle No. 1, with nonserrated blades of heat-treated flint, heavily glossed.

b: Comparison of different edge treatments. *Upper*: Sickle No. 2, with finely serrated (PPNB-type) blades of raw flint of different qualities, the dorsal surfaces of which are shown here; the serrations were pressed toward the ventral surface. *Lower*: Sickle No. 5, described above, showing the dorsal surfaces of different qualities of flint sickle blades.

c: Comparison of flint and obsidian, and different edge treatments. *Upper*: Sickle No. 3, with nonserrated blades of obsidian (Blades 1, 3, and 5, counting from the handle end) alternating with nonserrated blades of raw flint (Blades 2, 4, and 6). *Lower*: Sickle No. 4, with moderately serrated blades of obsidian (Blades 1 and 3) alternating with raw flint (Blades 2 and 4). The dorsal surfaces of the sickle blades are shown here, and the serrations were pressed toward the opposite surface.

d: Comparison of edge treatments. *Upper*: Sickle No. 7, with finely serrated (PPNB-type) blades of heat-treated flint, the dorsal surfaces of which are shown here, the serrations having been pressed toward the opposite surface. The zone of most intensive cutting, and hence gloss formation, is in the center of the cutting arcade. *Lower*: Sickle No. 10, with coarsely denticulated (Yarmoukian-type) blades of raw flint.

Plate 2:a-d.

Plate 3. Condition of sickle blades following the reaping experiments.

a: Sickle No. 3, Blade 3, near the center of the cutting arcade, glassy obsidian, dorsal surface, showing striations and scratches in the surface and use-damage flake scars at the heavily worn, nonserrated cutting edge. See Pl. 2:c. The adjacent end of Blade 4, of flint, is burinated, and the burin scar is heavily glossed. Used on dough-stage wheat for 8 hours.

b: Same blade, ventral surface. A small flake scar, reflecting use damage, is visible on the right end near the cutting edge.

c: Sickle No. 4, Blade 3, in the active part of the cutting arcade, average-quality obsidian, dorsal surface (see Pl. 2:c). There are obvious use-wear striations in the surface diagonal to the cutting edge and heavy abrasion of arrises, with almost complete obliteration of denticulations on the cutting edge. Used on dry wheat for 14.25 hours.

d: Same blade, ventral surface. The arrises at intersections of flake scars are heavily abraded.

e: Sickle No. 7, Blade 2 (see Pl. 2:d), heat-treated flint, ventral surface. Heavy gloss and moderate rounding of denticulations on the cutting edge. The gloss extends down to the hafting mastic, although with diminishing intensity. Used on dough-stage barley and oats for 14.75 hours.

f: Sickle No. 8, Blade 2, near the center of the cutting arcade, heat-treated flint, ventral surface. There is a heavy deposition of gloss and a pronounced rounding of the denti-culations on the cutting edge. Used on dough-stage barley and oats for 14.75 hours.

g: Sickle No. 8, Blade 3, near the center of the cutting arcade, heat-treated flint, dorsal surface. There is heavy gloss on the undulations and on the blade-scar facet adjacent to the cutting edge, but almost no gloss below the arris on the blade scar extending into the hafting mastic.

h: Sickle No. 8, Blade 1, near the handle and not in the center of the cutting arcade, heat-treated flint, dorsal surface. See Pl. 1:c. A crescent-shaped failure of the cutting edge, 7mm wide, shown in the center of the photo, occurred during use.

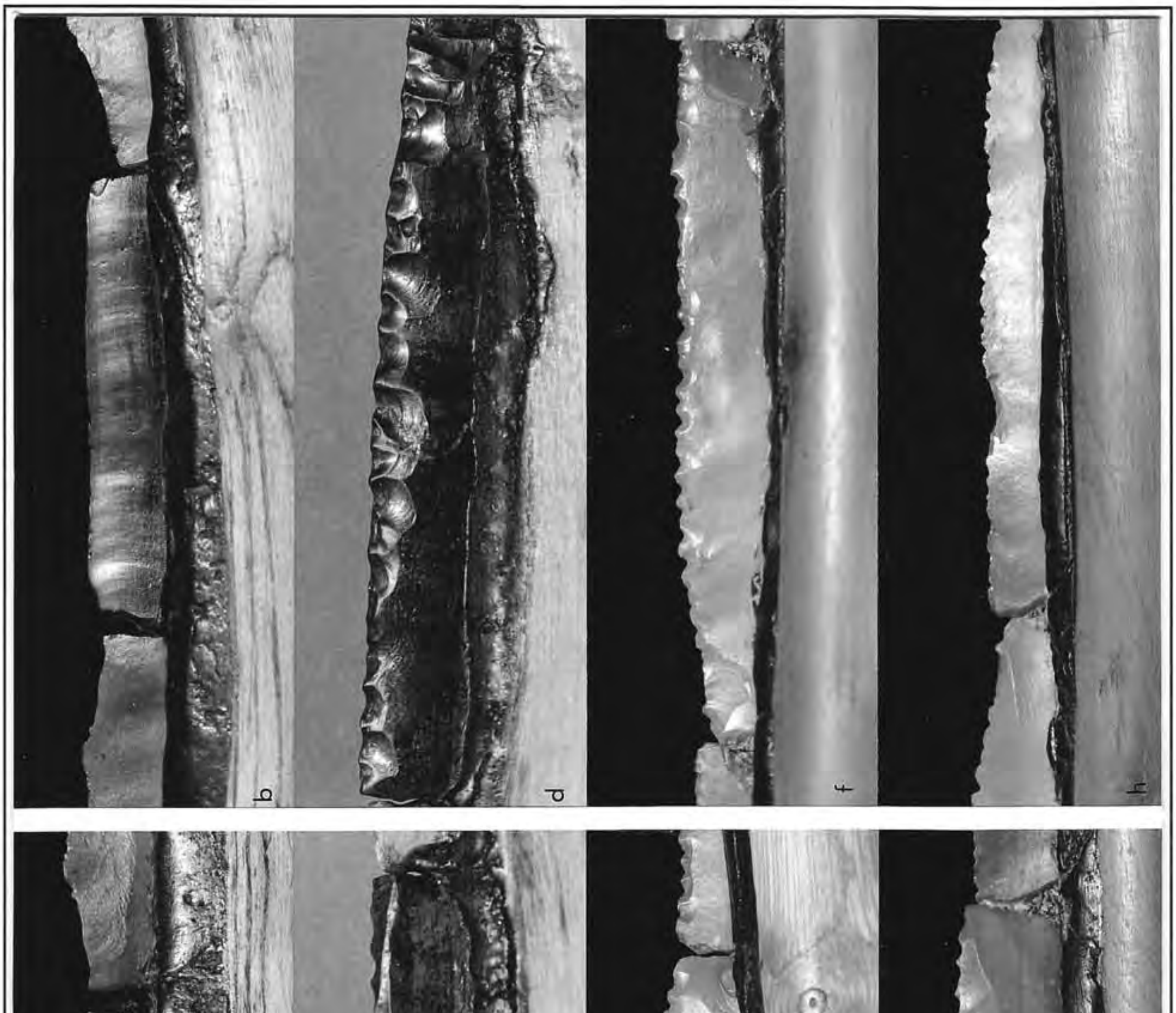

Plate 3:a-h.

its cutting efficiency. Denticulations on Blade 1 (obsidian) were far less worn, reflecting the zone of less intensive reaping, although the distal end of the blade in part broke away during use. As in the case of Sickle No. 3, the surfaces of the obsidian blades showed varying degrees of "gloss" and abrasion. Areas on the ventral surfaces displayed what may be silica gloss deposition, while the dorsal surfaces suffered the effects of contact with the plant material and were heavily abraded, scratched, and had a dull appearance.

Sickle No. 5

Sickle No. 5 was used to test the effect of hafting position and moderate serration on the performance of sickle blades made of raw flints. Four fairly long sickle blades of fine-grained flint from Williamson and Gillespie counties, Texas (two blades from each) were set with pitch, butted together, in a distally curved hardwood haft of Chinese elm (Pl. 2:a-b).

The sickle was used for 14.25 hours. There was little erosion of the denticulations on the blade edges. Glossing began to develop late in the reaping, at about 11 hours, and never became very obvious. Wear and glossing were more evident in the central part of the cutting arcade.

Sickle No. 6

This sickle was used to test the effects of heat-treatment and fine (PPNB-type) serration on the performance of flint sickle blades and to understand how heat treatment affects the glossing rates of like-quality flints when reaping dry grasses. Five short sickle blades of fine-grained flint from Williamson and Kimble counties, Texas (three from the former and two from the latter), were set with pitch, butted together, in a gradually curving hardwood haft of white alder.

The sickle was used for 15 hours. The finely denticulated blades were no less efficient than the moderately serrated blades in Sickle No. 5, used on similar material. At 9.75 hours, glossing was apparent on the edges of the sickle blades; at the end of the experiment the blades were only moderately glossed. Denticulations were only slightly worn. No significant differences were seen in edge wear or glossing between the two flints.

Reaping Dough-Stage Barley and Oats with Finely Serrated, Heat-Treated Flint Blades

These experiments considered gloss formation and edge damage on finely serrated and heat-treated flint blades used to reap dough-stage barley and oats. The tests explored the overall glossing rate, variability in heat treatment, gross use damage, and the effect of blade edge angles and haft positions on gloss formation. The experiments did not consider the glossing rates of different grasses. Sickle construction materials and design were held generally constant.

Sickle No. 7

Four long sickle blades of fine-grained, optimally heat-treated flint from Kimble County, Texas, were set with pitch, butted together, in a gradually curving hardwood haft of European buckthorn (*Rhamnus cathartica* L.) (Pl. 2:d).

The sickle was used for 14.75 hours. Glossing was first observed in less than an hour. After four hours of use, the sickle blades showed well-developed gloss. At the end of the experiment, blade surfaces at more obtuse angles to the cutting direction (particularly dorsal facets near the cutting edge, and flake scars within the serrations) were heavily glossed, surfaces at more acute angles far less so. Glossing was brightest within the center of the cutting arcade (Pl. 3:e), with little glossing near the ends. There was a noticeable dulling of the denticulations on the cutting edge.

Sickle No. 8

Four long sickle blades of fine-grained, optimally heat-treated flint from Kimble County, Texas, were set with pitch, butted together, in a distally curving hardwood haft of mountain mahogany (*Cercocarpus ledifolius* Nutt.) (Pl. 1:c-d).

The sickle was used for 14.75 hours. Initial glossing appeared in less than an hour. After 3.75 hours of use, the sickle blades showed well-developed gloss. Gloss patterns at the end of the experiment paralleled those in Sickle No. 7, in that glossing was heaviest in the serrations (Pl. 3:f) and on the dorsal surfaces near the blade edge (Pl. 3:g). Denticulations were moderately worn. Gross edge damage on one blade consisted of a 7mm-wide collapse of a margin (Pl. 3:h), and two small flake scars had appeared in the edge of the distal blade.

Sickle No. 9

Three long sickle blades of medium-to-fine-grained flint from Kimble County, Texas, heat-treated but not very effectively, were set with pitch, butted together, in a gradually curving hardwood haft of mountain mahogany.

The sickle was used for 11.75 hours. Gloss was first observed after only 0.75 hours of reaping, but by the end of its use the blades had become only moderately glossed. The results indicate that just as flakeability of siliceous stone varies with the degree of heat treatment, so also does the rate and extent of glossing. Obvious wear to the denticulations was slight.

Reaping Both Dough-Stage Wheat and Barley, and Dry Wheat with Coarsely Serrated Blades of the Yarmoukian Type

This experiment was a test of the efficiency of very coarse (Yarmoukian-type) serration on dough-stage and on dry durum wheat, and on dough-stage six-row barley. Only brief tests were conducted because the purpose was to determine the efficiency of a coarsely serrated cutting edge, and gloss formation and other forms of use wear were not considerations.

Sickle Nos. 10 and 11

For Sickle No. 10, four sickle blades of varying lengths of fine-grained flint from Williamson and Kimble counties, Texas, all raw, with very coarse serration, were set with pitch, butted together, in a nearly straight softwood haft of Pacific yew (*Taxus brevifolia* Nutt.) (Pl. 2:d). For Sickle No. 11, six short sickle blades of fine-grained raw flint from Williamson County, Texas, with coarse serration, were set with pitch, butted together, in a strongly curved antler haft of mule deer (*Odocoileus hemionus* Raf.).

Sickle No. 10 was used for 0.5 hour each on dough-stage wheat and barley, and for 2.5 hours on dry wheat. Sickle No. 11 was used for 0.5 hour on dough-stage wheat. Coarsely serrated sickle blades were found to be effective for reaping dry wheat, but they were ineffective for cutting ripening cereal grasses. The coarse serrations caught on the plant stems of the dough-stage cereals and did not cut them well, regardless of the reaping motion employed. However, both fore-handed and back-handed cutting motions were effective for reaping dry wheat, as the stalks partly broke and partly were cut by the blades. When bunches of stems were held in the hand and cut, the back-handed cutting motion was more effective and faster. Cutting in a fore-hand, swinging, motion without holding the wheat at all was by far the most efficient; dry stalks essentially were mowed down as they were partly cut and partly broken by the sickle. However, in both fore-hand and back-hand strokes it was observed that the coarse serration, while not a major hinderance, was not necessary for reaping dry cereals.

General Observations

These experiments led to a series of general observations that can best be discussed with reference to the variables outlined above.

Stone Type

As noted by other researchers, the quality of flint is an important consideration in the development of gloss. Finer-grained flint tends to gloss more readily and more extensively than coarser-grained flint (Pl. 2:b). When cutting dough-stage wheat, juxtaposed sickle blades of finer-grained flint glossed more rapidly and to a greater extent than those of coarser-grained flint in the same sickle. Therefore, in lithic assemblages composed of coarser flint, it would be unlikely that sickle blades would show heavy glossing. No differences were observed in the gross edge wear to sickle blades of varying grades of raw flint in the same sickle.

With regard to obsidian, various authors (*e.g.*, MORTENSEN 1970a) have commented on the difficulty of observing gloss on obsidian sickle blades. Our observations confirm that gloss is difficult to see on obsidian; nonetheless, the effect of reaping is recognizable, whether or not that effect actually is due to depositional gloss or to abrasive wear. On better-quality obsidians, the surfaces of sickle blades become noticeably waxy to the touch. Under low-power magnification (20X), a comparison of surfaces that were protected by the hafting matrix with those exposed to the reaping action revealed that irregularities such as hackles and gull wings[1] in obsidian were partially or completely obliterated on the active surfaces.[2] In addition, because obsidian is less resistant to wear than is flint (Pl. 2:c), edges and arrises of obsidian sickle blades undergo pronounced erosion during use, as can be seen in Pl. 3:a-d. Moreover, striations form easily on obsidian and are readily observable, even with the unaided eye. Obsidians are as variable in quality as are flints and range from glassy to fairly grainy. At this point, our observations suggest that gloss and wear are more visible on glassy obsidians than on other types, but further study is needed.

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1 "Hackles" and "gull wings" are minute fissures and ridges that occur on the surface topography of a blade as the stone is stressed and bent by the force that detaches the blade from the core.

2 These traits also were noted under higher magnification (250X) by Hurcombe (1985).

These findings suggest that obsidian is a poor choice for use as sickle blades, but that in places where it may have been used for that purpose, these insets would have been resharpened often to maintain reaping efficiency. Resharpening would destroy other evidences of reaping, and discarded obsidian sickle blades probably would be heavily edge modified. Blades would also have been replaced often. Recognizing them as sickle blades would require consideration of variables observed in these studies (*e.g.*, gross, intentional edge modification and heavy abrasion of raised surface topography).

Heat Treatment

Based on this experiment, we believe heat-treated flint wears and glosses much faster and to a greater degree than raw flint, all other variables held constant. Also, optimally heat-treated flint wears and glosses faster and more intensively than imperfectly heat-treated flint. However, heat treatment is rarely considered an important factor in microwear studies of sickle blades. This study suggests that analysts should determine if heat treatment is indicated in sickle blade assemblages before proceeding in standard fashion with interpretations of gloss formation and wear.

Whether or not heat treatment was used in prehistory must be decided on a case-by-case basis because the extent to which it was used in prehistory is not known. However, at this point it should be noted that heat treatment does not make a sickle blade more effective. In fact, studies (OLAUSSON 1983, RICK and CHAPPELL 1983) have shown that the edges of heat-treated microcrystalline quartzes such as flint are less durable than are those of similar material that has not been heat-treated, a finding supported by our own research. We think it very unlikely that flint intended for production of sickle blades was intentionally heat-treated during the Neolithic unless the quality of stone available was such that heat treatment was necessary for effective blade production.

Hafting of Sickle Blades

Laboratory observations and replicative experiments confirm that there are many ways of preparing blades for hafting in sickles, but some of these are more successful than others. All leave diagnostic characteristics on the blades. Effective ways of trimming blades to desired lengths are: pressure flaking the ends; percussion flaking or nibbling the ends of blades while resting them on an anvil; percussion sectioning on an anvil (as in bipolar reduction)[1]; and simply snapping off the ends, a process that can be aided by notching at the desired breaking point. Blades can be adjusted to fit the curved ends of hafting grooves by flaking or burination. Archaeologically, one would expect to see all of these treatments, and they should all be considered when assessing the presence or absence of unglossed sickle blades in assemblages.

Our work with construction of sickles and field performance tests shows that tightly fitted blades enhance the performance of sickles. Gaps between blades impede cutting unless, as in some archaeological examples, they are filled in with hafting matrix. Gaps lead to excessive use wear, including burination of cutting edges and the development of diagonal striations and strong gloss on exposed corners of blades as the stems of cereals are drawn forcefully between the blades. These observations suggest that untrimmed sickle blades in archaeological assemblages probably were lapped or they were hafted with hafting matrix covering and protecting the joints between blades.

A small number of long, untrimmed, glossed blades in the 'Ain Ghazal collection suggests a distinctive hafting strategy. Typical of the percussion blades of the PPNB, these long, straight blades have slightly curved proximal ends (QUINTERO and WILKE 1995: Fig. 9). The hafting technique may have involved the use of only two blades that were set in the haft with the bulbar ends slightly lapped, ventral surfaces together, in the middle of the cutting edge. Our observations suggest that when hafted in this manner, the dorsal-ventral curve of each blade overlaps and accommodates the curve of the other, making a straight cutting edge. Single large blades of this type have sometimes been identified as individual reaping knives. Smaller complete blades were noted in the 'Ain Ghazal collections, and may have been hafted in a like manner along with other blades.

Snapped and sectioned blades in the 'Ain Ghazal collection suggest intentional blade-trimming strategies. Both are quick and effective for preparing blades for hafting, and permit blades to be butted together tightly. Snapping also is useful for removing curved ends and bulbs of blades. The 'Ain Ghazal debitage contains large numbers of snapped bulb ends of blades and conspicuously low numbers of straight blade midsections.

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1 Such trimming may result in diagnostic waste, especially when adjusting the lengths of obsidian blades. Our experiments have shown that this technique is useful for making minor adjustments in the lengths of blades, especially when it is necessary to replace a single blade in a haft. The process results in production of the minute and distinctive "side-blow blade flakes" (BRAIDWOOD 1961, HOLE 1983, NISHIAKI 1995).

Adjusting the widths of blades by extensive backing or retouch is rarely necessary when the hafting groove is deeply cut. The hafting groove, filled with soft hafting mastic, leaves ample room for positioning blades of various widths and irregularities. Thus, the absence of backing or lateral retouch should not exclude an unglossed blade from the sickle blade category.

One should note that some scratching of the surfaces of sickle blades occurred during initial hafting and when they were reset, as a result of scraping away excess hafting matrix while using a stone blade as a finishing tool. Ordinary hafting or rehafting of sickle blades by PPNB peoples may have caused similar traces on sickle blades, particularly if the blades were of obsidian, or if the mastic contained grit.

Position and Attitude of Blades in the Haft

Within the length of the cutting edge of any given sickle, there is a zone of more intensive contact with the material being cut. This zone occurs midway in the cutting edge, and sickle blades in that zone develop the most gloss and wear (Pl. 2:d). End blades that have little contact with the grass being cut develop little gloss or wear despite lengthy periods of use. Therefore, minor development of gloss and wear on any particular blade is not an absolute indication of a short period of use, and the lack of gloss and wear does not necessarily indicate that a blade was never used for reaping.

Our studies also show that the more directly the surface of any given sickle blade comes into contact with the material being cut, the more that surface is glossed and worn. Therefore, blade edge angles and arrises are important considerations for understanding the extent of surficial glossing on every sickle blade. Because of their more abrupt angles, dorsal surfaces of sickle blades tend to gloss more extensively than ventral surfaces. Likewise, sickle blades with very acute edge angles tend to develop less surficial gloss. These findings support those of Moss and Newcomer (1982) and Unger-Hamilton (1988). Regardless of sickle blade morphology, gloss tends to form readily within edge serration scars. One would expect then that Yarmoukian blades with their coarse serrations and broad edge angles would tend to develop extensive gloss, and many of them have it. Resharpening of sickle blades would tend to create a broader edge angle that would gloss more readily, even though it would destroy some evidence of previous glossing.

Blade Edge Treatments

With regard to edge treatments (Pl. 2:a-d), unretouched blades do not acquire fine serration or nicking of the PPNB type through use. Such serration is a deliberate modification of the blade edge in order to enhance its cutting efficiency (*contra* OLSZEWSKI 1994). A sickle fitted with finely serrated (PPNB-type) blades is much more effective than one fitted with unretouched blades. Moderate serration, as used here, does not provide a better cutting edge than fine serration. When used in the Neolithic in the context of reaping cereal grasses, its purpose may have been to refurbish a dull edge rather than to create one originally, since it unnecessarily consumes the edge of the blade. Our studies suggest that refurbishing of denticulations may have been necessary from time to time for reaping dough-stage cereal grasses. Also, the coarse serration seen on Yarmoukian sickle blades is not effective for cutting dough-stage cereal grasses, but it performs quite satisfactorily on dry cereals.

Reaping Actions

Both fore-handed and back-handed cutting strokes were tested, and, in general, back-handed cutting is far easier and more efficient (Pl. 1:d). When cutting partially ripened wheat, all of the harvesters used both simple cutting strokes and sawing actions. When soil was loose or wet, causing the grasses to uproot easily, reaping was most efficient when larger bunches of stems were gathered and held with one hand while being cut with a sawing action. Generally speaking, reaping dough-stage cereal grasses with sickles edged with stone cutting blades is better described as a sawing action than a cutting action.

Moisture Content of Material Being Cut

Reaping dough-stage cereals leads to more gloss formation and wear of blade edges than does reaping dry cereals because it is necessary to saw and cut through the stems. This reaping action increases the contact time between the sickle blades and the material being harvested. Consequently, blades used for reaping dough-stage cereals should be easily recognizable; generally, flint will exhibit very strong glossing and obsidian will be heavily worn. As discussed previously, these basic patterns will be affected by other factors such as the quality of stone, heat treatment, and duration of use. Nevertheless, harvesting in the dough stage should be indicated in assemblages by high percentages of heavily glossed blades.

Reaping dry cereals results in less contact time because the stems are partly cut and are partly broken. As a result, sickle blades are subjected to less wear and glossing. Recognition of dry reaping is complicated, however, by the fact that wear and glossing are also affected by duration of reaping and other factors. Nevertheless, dry harvesting should be indicated in assemblages by low percentages of very heavily glossed blades.

Thus, the overall patterns of glossing and wear in assemblages of sickle blades should reflect the timing of the cereal harvest.

Macroscopic Damage

Several forms of edge and surface damage are evident on the sickles used in these experiments (Pl. 3:a-e). Attrition of the cutting edge, primarily rounding and general wearing down of denticulations, is a common occurrence. Small flakes also are occasionally detached from blade edges during use (Pl. 3:a-b).

Burination occurred to the edge of one flint sickle blade (Pl. 3:a), and constitutes a form of edge damage not previously anticipated, although edge burination is apparent in the 'Ain Ghazal material that we studied. Edge-damage burination seems to have been induced by pressure on the cutting edge at a joint between two blades, where stems being cut were able to catch on the end of the blade. Any gap between blades, combined with squared ends on blades, creates a potential weak point in sickle construction. For this reason, gaps between blades may have been filled with hafting matrix, and the ends of sickle elements, especially if truncated, rounded off to minimize the danger of burination. Besides burination, several examples of margin collapse were noted, both on flint (Pl. 3:h) and on obsidian.

The occurrence of obvious surface damage is strongly influenced by stone type, as noted above. Scratches and striations are more commonly seen on obsidian than on flint, the former being a less resistant material. In addition, reaping of cereal grasses that have grit adhering to their stems is a likely cause of scratches and striations on sickle blades. We observed that grit was splashed onto stems by a hard rain prior to harvest time. Lodging, or the tendency of plants to fall down at maturity, would seem to increase the likelihood of scratches and striations occurring on sickle blades when these plants are reaped, as would reaping close to the ground.

Duration of Reaping

Duration of reaping and area harvested are imprecise measures when considering gloss and wear on sickle blades. Also important are the density of the stand and the leafiness and moisture content of the plants being cut. Our measures of square meters cut and duration of reaping are therefore not readily comparable to those of other researchers, and *vice-versa*. Qualitative observations of glossing and edge damage may be more objective than quantitative ones, and the overall patterns we observed in these studies are sound. Yet, despite the time spent in our fieldwork, the fact remains that our experiments did not duplicate real-life farming situations in which harvesting implements may have been used seasonally over the course of many years. They therefore could only touch on a few of the complex variables that must have affected Neolithic sickle blades during the course of their use as harvesting tools. Nonetheless, the results of this work are encouraging, and they clearly demonstrate that longitudinal studies are essential for understanding the effects of reaping on ancient sickle blades.

Conclusions

The research documented here is a pragmatic study of Neolithic reaping that is intended to provide practical information for assessing the archaeological record. While many observations were generated by these experiments, our work is concerned primarily with understanding the use life of sickle blades and their morphological variability.

Recognizing Unglossed Sickle Blades

Our data strongly suggest that glossing alone is not a valid or sufficient criterion for the identification of sickle blades in archaeological assemblages. Recall that a complete sickle from Hacılar contained unglossed flint blades (MELLAART 1970: 161, Fig. 178-1). Many variables affect the deposition of gloss on sickle blades, so that under normal conditions of harvesting mature, dry, domesticated cereals, many hours of reaping are needed for gloss to appear and it may never become strongly developed. In the case of coarse flint sickle blades, and those that had a short use life, gloss may never have developed. However, these blades can be recognized and identified by their patterned attributes of preparation, hafting, and edge modification, by wear and use damage on their working edges, and, where it occurs, by the presence of gloss. Sickle blades should be identified in the same manner as axes and arrowheads, by all of their formal attributes rather than by patterns of wear discernible on them.

This research suggests that we should return to broad criteria for the identification of sickle blades, such as those attributes employed by Otte (1976) and Cauvin (1983), that were used before glossing became the requisite criterion for identification. These criteria should include intentional edge modification indicative of sickle blade preparation. They should include adjustment of blade lengths by percussion, pressure trimming, and snapping, all clear patterns that are present in the archaeological record and that tests have shown are effective and efficient.

Edge damage and other forms of use wear observed on our experimental sickle blades probably were common in prehistory. In our experiments, damage from use included occasional small nicks, irregular flake scarring, burination, and other breaks on the corners and margins of blades. Use alterations occurred on the margins and surfaces of blades, and were particularly evident on obsidian. Denticulations and dorsal arrises were worn down and dulled by abrasion, and striations formed, most often longitudinally, on blades.

Using these broader criteria to evaluate the 'Ain Ghazal blade collections, we have more than doubled the number of identified sickle blades for each phase of the occupation from the LPPNB onwards,[1] thereby providing a more realistic picture of the Neolithic tool kit. A similar approach should be useful for identifying sickle blades in areas where obsidian was a dominant raw material, but where sickle blades have not consistently been identified.

The inability to recognize obsidian sickle blades in archaeological assemblages can have profound effects on the interpretation of subsistence economies of Neolithic sites. The Pre-Pottery Neolithic site of Aşıklı Höyük in central Anatolia (8,700-8,500 bp) is a case to consider. The conclusion that the economy of the town was based almost entirely on intensive hunting has led to "a new model for the beginning of sedentary life" (ESIN 1991: 132) derived in part from a dearth of recovered botanical remains. Additionally, no sickle blades were identified in the flaked-stone assemblage that is entirely obsidian, and that comprises 72,000 artifacts, including more than 10,000 classified tools of which 2,300 are retouched blades (BALKAN-ATLI 1994). Given the larger Neolithic pattern of Anatolia and other parts of the Near East, with its emerging agrarian economies, Aşıklı Höyük clearly is an exceptional case. Perhaps a reassessment of the obsidian blade industry might reveal why this site appears to be such an anomaly.

Reasons for Morphological Variability in Sickle Blades

As noted in the discussion above, sickle blades with slight serration typical of the PPNB function well reaping both partially green and dry grass stems. But, unmodified blades do not make efficient reaping tools, and they do not develop the fine serration characteristic of PPNB sickle blades as a result of use. Therefore, the fine serration, or nicking of the working edge, that is so prevalent throughout Near Eastern collections must be seen as an intentionally created, identifiable attribute of PPNB sickle blades. The more regular, moderate serration used in these experiments also creates an effective edge, but it is more consistent with retouch to straighten or resharpen sickle blade edges than as an initial edge treatment on a well-formed PPNB blade.

Experiments indicate that heavily serrated Yarmoukian-style sickle blades that occur commonly during the early Pottery Neolithic are ineffective when cutting partially green grasses, but they function satisfactorily when reaping dry cereals. What is not clear is why these blades have such heavy serration since this feature is not necessary. A further concern is that many of these sickle blades are heavily glossed, yet our work indicates that reaping dry cereals is not likely to result in heavily glossed sickle blades.

The early Pottery Neolithic assemblage of sickle blades from 'Ain Ghazal contains several forms, with many examples having very little, if any, gloss. It seems reasonable to suggest that one or more of these forms were used for harvesting dry cereals, and that the heavily glossed strongly serrated blades also may have been used for some yet unidentified function.

Many species of plants were exploited at 'Ain Ghazal as early as the MPPNB, including field peas (*Pisum sativum* L.) and lentils (*Lens culinaris* Medic.) that appear to have constituted "primary staples in the diet" (ROLLEFSON and SIMMONS 1986: 152).[2] By focusing attention only on sickles and cereal grasses, the importance of tools that may have been used to manipulate other wild or domesticated crops has remained obscure. In fact, these tools remain largely unidentified.[3]

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1 Reanalysis of the MPPNB data is currently in progress.

2 Kislev's (1992) conclusion that pulses were of major importance in the early Neolithic economy supports this observation.

3 Initial studies of this type have been conducted by Unger-Hamilton (1991). Lentils are pulled by hand in the Near East today, and exploitation of some of the other plants recovered at 'Ain Ghazal may have required no special tools.

Implications

At this point, the quite mundane and practical decisions concerning modification of the edges of sickle blades may be seen as important aspects of the technology that supported domestication, and relate to underlying assumptions concerning the harvesting of cereal grasses in Neolithic times. For instance, it is generally agreed that wild grasses were reaped while still partially green and moist so that the grain spikes would stay intact; however, dry reaping was likely for domesticated cereals with nonshattering spikes (ZOHARY 1992). It should be possible to document these patterns with the lithic data.

The macrowear observations detailed above, combined with preliminary analyses of the sickle blades from 'Ain Ghazal, suggest a broad developmental sequence in subsistence technology involving the domestication of cereal grasses. Examination of the glossed sickle blades from the Pre-Pottery Neolithic and Pottery Neolithic periods of 'Ain Ghazal reveals the following pattern. The glossed sickle blade assemblage from MPPNB contexts (*c.* 9,250-8,500 bp) is overwhelmingly dominated by heavily glossed pieces. In fact, the MPPNB assemblage contains most of the heavily glossed blades from all phases of the occupation. There are far fewer moderately glossed blades, and there is only a minor occurrence of blades that are lightly glossed. This pattern suggests that in the MPPNB, cereal grasses were reaped while still partially green.

The pattern is drastically altered in the LPPNB (*c.* 8,500-8,000 bp), which contains few heavily glossed blades, a small proportion of moderately glossed blades, and an abundance of those that are lightly glossed. These findings suggest that by the LPPNB the reaping of cereal grains occurred when the plants were dry and the crops were fully ripened.[1] In essence, the transition to harvesting of mature, dry cereal grasses, which marks the domestication of wheat and barley, had occurred. This pattern extends into the PPNC (*ca.* 8,000-7,500 bp), in which heavily glossed blades are very few, and blades displaying light gloss and only slight edge wear are numerous, suggesting that sickle blades of this period continued to be used to reap dry cereals.

These findings imply that during the earlier stages of the Pre-Pottery Neolithic at 'Ain Ghazal cereal grasses were not fully domesticated; the spikes still shattered and the cereals had to be reaped while partially green. By the LPPNB, about 8,500 years ago, cereal grasses were fully domesticated. This developmental sequence supports recent conclusions by Kislev (1992) that the first clear botanical evidence for domestication of cereal grasses in the Near East occurs in the late PPNB, possibly as late as 8,600 bp.

We are left with a certain dilemma. The frequencies of reported sickles blades from the PPNB to the Pottery Neolithic do not follow logically in the developmental sequence outlined above. An increasing reliance on cereal grains is an accepted aspect of the Neolithic from the MPPNB through the Yarmoukian. Yet the reported frequency of sickle blades shows a drastic decline, which is very perplexing (ROLLEFSON and KÖHLER-ROLLEFSON 1993, ROLLEFSON *et al.* 1992). We think the problem lies not in declining frequencies of sickle blades through time, as reported for 'Ain Ghazal, but rather it is due to a failure to recognize the larger population of sickle blades that includes nonglossed examples.[2] Such may be the case also with regard to the small numbers of sickle blades recovered from LPPNB Basta (NISSEN *et al.* 1987) and 'Ain el-Jammam (personal observation of the authors). Domesticated cereals of the later Neolithic would have been harvested when the plants were dry, and it is to be expected that most sickle blades would not be heavily glossed, and that many blades would show no glossing at all.

There is a logical overall pattern in the development of agrarian economies in the Near Eastern Neolithic that is becoming increasingly clear. Gaps in our understanding of how artifacts relate to this development result from our inability to see similar logical patterning in the forms and evolution of the tools that supported these economies. Without such understanding, our conception of the subsistence economies of the Neolithic is bound to suffer.

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[1] One can expect some heavily glossed blades to result from prolonged dry harvesting, particularly on the blades hafted in the middle of the cutting arcade. Since few things are "cut and dried", one should always leave room for variation in behavioral patterns. An example is the harvesting of green (dough-stage) durum wheat in Jordan and elsewhere in the Near East today in order to make *frike*, a dried, soft, wheat-grain product. If intensive, this practice could lead to the occurrence of some heavily glossed blades even after wheat was fully domesticated. Of course, the consumption of *frike* may have been more or less common, or even nonexistent, in Neolithic times.

[2] For an alternate view see Rollefson (1993: 97).

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Changes in Architecture and Social Organization at 'Ain Ghazal

Gary O. Rollefson

Abstract: How people organize their space - with barriers, walls and houses - reflects to a great extent how society organizes itself along kinship and economic units. After ten seasons of excavations at Neolithic 'Ain Ghazal, sufficient areal exposure for each of the four major archaeological periods (MPPNB, LPPNB, PPNC and Yarmoukian Pottery Neolithic) is now available to trace the social adaptations that helped to resolve the pressures and problems of a growing population in a delicate ecological setting. Architecture reflects how small, independent socioeconomic units (nuclear families) of the MPPNB gave way to consolidated households of two or more families in the late 9th millennium bp to cope with growing competition for farmland in a constantly degraded environment. By the beginning of the 8th millennium, social organization was completely rearranged, so that corporate kin groups consisted of both permanently resident nuclear families and temporarily absent kin who left the town for long periods of the annual round with sheep and goat herds. Coincident with the emergence of the Pottery Neolithic period, another major socioeconomic transformation transpired with the development of fully settled farmers, on the one hand, and a mostly segregated pastoral community on the other.

Introduction

Decades of archaeological research into Neolithic developments of the southern Levant have produced small mountains of information that have enabled prehistorians to reconstruct a considerable amount of detail concerning the material culture and subsistence economy at particular periods of time. Whereas earlier research tended to concentrate in mostly Mediterranean phytogeographic zones in the Jordan Rift and territory west towards the Mediterranean littoral, in the past generation a strong shift in geographical emphasis has included survey and excavation projects in the semi-arid and arid zones of the Negev and Sinai, as well as concentrated investigations in all of the ecozones of Jordan.

In addition to an expanded scope of regional and environmental backdrops of Neolithic developments, changes in theoretical and methodological approaches to Neolithic research design and interpretive frameworks have improved the breadth and quality of cultural reconstructions, so that beyond stones, bones, and housing, prehistorians now can consider more abstract elements of daily life, including how the people of large and small settlements organized themselves into a cohesive and perpetuating social fabric that provided stability and security for the members of the hamlets, villages, towns, and perhaps even larger territorial groupings. Much of the improvement in our ability to realize the ideational aspects of Neolithic societies is attributable to the use of ethnoarchaeology and its capabilities (and constraints) to place archaeological evidence into a range of perspectives according to controlled social correlates.

'Ain Ghazal (Fig. 1) has provided the longest unbroken sequence of Neolithic occupation in the Near East, with a chronological period spanning more than 2,500 years and passing through the entire length of the MPPNB, LPPNB, PPNC and Yarmoukian periods (*cf.* ROLLEFSON *et al.* 1992). Stretching across this entire chronological panorama is an architectural record that has recorded how people divided the space around them (and between them), and how the rules governing these barriers changed to cope with the evolving conditions of both the natural environment as well as the social surroundings.

What follows is a brief description of the architectural situations in the four archaeological periods at 'Ain Ghazal. The changes are then interpreted in terms of the problems the 'Ain Ghazal

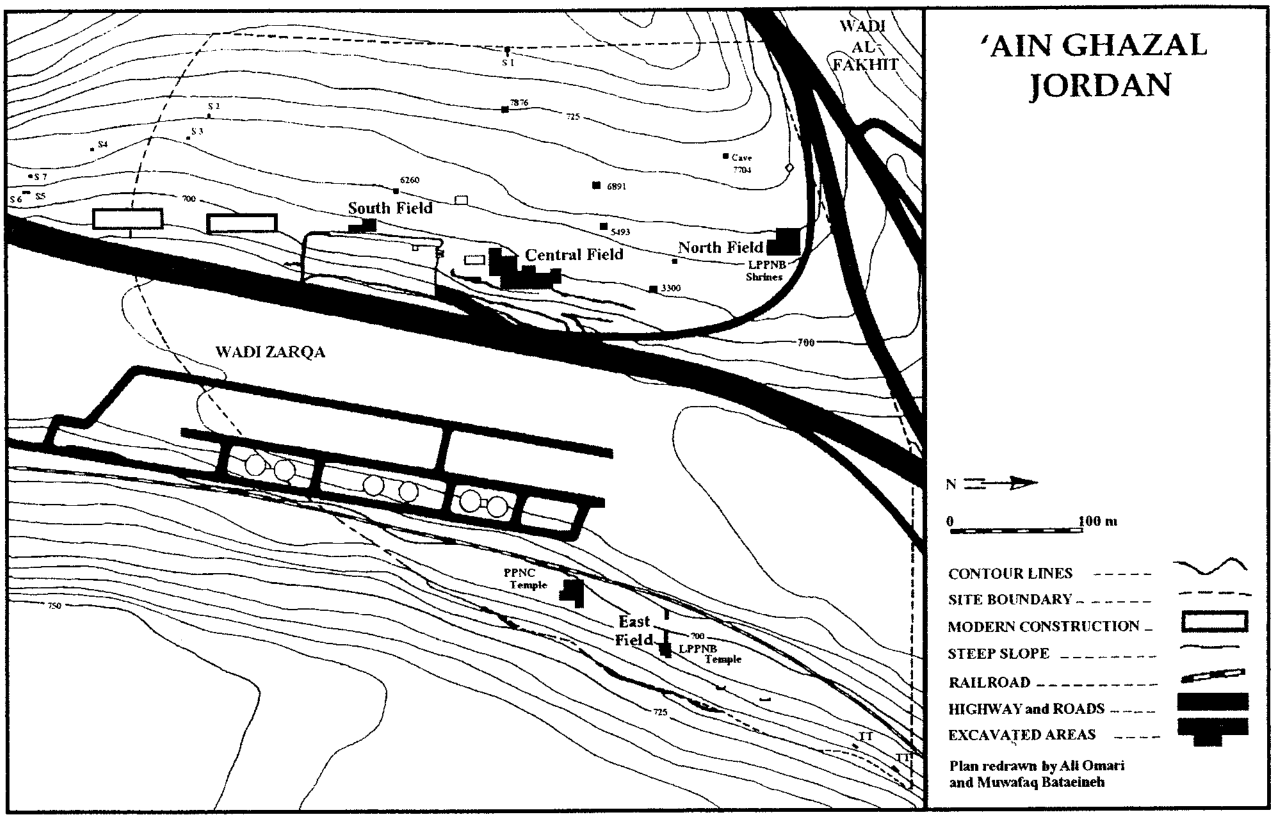

Fig. 1. 'Ain Ghazal site map, showing the locations of the various excavation fields.

community faced as it grew in size and unwittingly affected the environment in the immediate vicinity of the town, and how the farmers adjusted to the growing pressures by reorganizing the social network to maintain community harmony.

Middle PPNB (MPPNB) Architecture

The architecture of the period has been the subject of several earlier articles (BANNING and BYRD 1984, 1987; BYRD and BANNING 1988). Briefly, houses appear to have been relatively small (35-50m^2) and single-storied. There was evidently an evolution in architecture that reflected, among other things, changes in the locally available wood resources for roof supports (*cf.* ROLLEFSON and KÖHLER-ROLLEFSON 1989: 81-82): beginning as large single-room structures that ranged up to 6x8m with four or more large (*c.* 40-60cm diameter) posts, interior space became subdivided into two and three rooms separated by stone walls that assumed the burden of propping up the house superstructure (Fig. 2). Overall, space in the houses was only slightly decreased by the replacement of posts by load-bearing walls.

It is notable that in the houses only a single floor hearth is found, regardless of the number of rooms. Storage features were limited; extensive excavations in the areas outside of houses did not reveal any exterior storage pits. Only one "formal" storage bin has been found, a small three-quarter-round silo

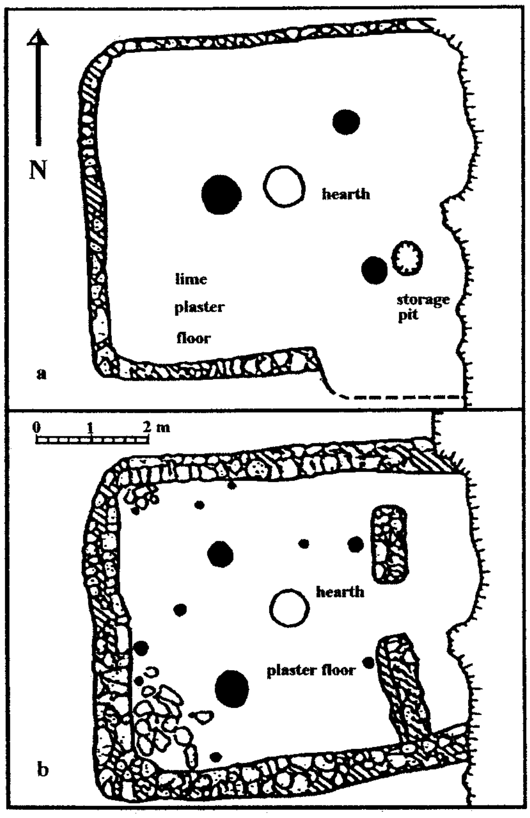

Fig. 2. MPPNB house during two of the four renovations it underwent during its 400 year lifetime. a earliest phase at *c.* 9100 bp, b a later phase at *c.* 8900 bp. *<black circles represent postholes, after BANNING and BYRD 1989>.*

in the corner of a house area that had apparently lost its "living room" character (*cf.* ROLLEFSON and SIMMONS 1986: Fig. 11). Another house[1] may reflect typical storage practices during the MPPNB: a corner of one room had been set off from the rest of the area by a single line of stones, and in the restricted area were stored large quantities of peas, lentils and minor amounts of barley, presumably in baskets or bags, that had caught fire (ROLLEFSON and SIMMONS 1986: 152, Fig. 9).

Housing appears to have been constructed closely together, reaching almost "row house" density at times. Two contemporaneous houses, for example, were separated from each other by less than 40cm, although between others there were occasionally up to 5m or more of empty space. The external areas at MPPNB 'Ain Ghazal appear to have been simple and unelaborate. Since the settlement was constructed on a hillslope, the hillside had been converted to a series of level terraces, which were protected with low terrace walls. On the other hand, not a single courtyard wall that separated one family's domestic area from another on these terraces has been located.

Late PPNB (LPPNB) Architecture

As of 1996, the amount of exposed LPPNB deposits at 'Ain Ghazal is almost three times that of the MPPNB, but this ratio is misleading in terms of architectural information. Much of the LPPNB architecture in the Central and South Fields at 'Ain Ghazal suffered serious damage due to later digging by PPNC and Yarmoukian residents, although sufficient LPPNB architectural details remained to identify the former presence of late 9th millennium bp houses. The situation in the North Field was only slightly less dire for LPPNB preservation, although here there are at least some more substantial remnants of housing[2].

Domestic Buildings

While LPPNB residents still relied on terracing for level house floors, one innovation included "split-level" construction that eliminated the need for work to provide deep and broad horizontal spaces. In the "Terraced House" in the North Field, each of four rows of rooms (of up to three rooms each) was built on "mini-terraces", so that although each adjacent uphill/downhill room was not more than 50cm higher, overall the westernmost row of rooms stood 88cm above the lowest rank (ROLLEFSON and KAFAFI 1996: 4, Fig. 2).

The Terraced House provides important information concerning architectural change beyond the clever adoption of micro-terracing. Although perhaps 50% or more of the building was destroyed by bulldozers, some characteristics allow for at least a partial reconstruction of the original structure. Fig. 3 shows the preserved portion of the house, and one can see along the westernmost wall that at least three rooms existed at one time (Rooms 1, 5 and 8). Along the southern wall is a series of four rooms stepping down the hillside, although Room 4 was virtually obliterated by erosion in post-LPPNB times. The southern column of rooms (Nos. 1-4) are small in size, as are Rooms 5 and presumably 6. The important elements for the following discussion deal with Room 5, whose floor plan is intact, and the presence of the 35cm floor hearth in Room 6.

Compared to the MPPNB, Room 5 is unique in the sense that it has three doorways: one each that provided access to the north to Room 8, to the east to Room 6, and to Room 1 to the south (where an entrance from outside the house led down two steps from a doorway in the western wall). The doorway between Rooms 5 and 6 is "obstructed" by a low plastered sill of not more than 10cm height, a situation that recalls the sinusoidal ridge at the doorway between two of the rooms of a late three-room MPPNB house in the Central Field[3], which may indicate that Room 6 was sensitive to any flow of water or other means of cleaning the floor of Room 5[4]. Part of that sensitivity is undoubtedly associated with the presence within a half meter of the Rooms 5-6 doorway of a deep floor hearth (also near the Rooms 2-6 doorway). Of critical importance, perhaps, is the presence of a tabun in the SW corner of Room 6.

The circumstances of Rooms 5 and 6 suggest that the doorway between them and the location of the floor hearth might provide two points along an axis of symmetry between the southern and

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1 see footnote 1, following page.

2 In fact, the worst damage to the LPPNB buildings, as far as we have detected, has been the road building activity of the mid-late 1970s).

3 This house, although constructed in later MPPNB times, may have continued into use into the earlier part of the LPPNB, based on ^{14}C dates. It is the same house mentioned in Footnote 1, previous page.

4 See the brief discussion of the function of the sinusoidal ridge (ROLLEFSON and SIMMONS 1985: 48), which may also apply to the LPPNB Terraced House. Interestingly, this MPPNB house had one room slightly lower than another, and thus it is a simpler, albeit less elegant, forerunner of the LPPNB "Terraced House".

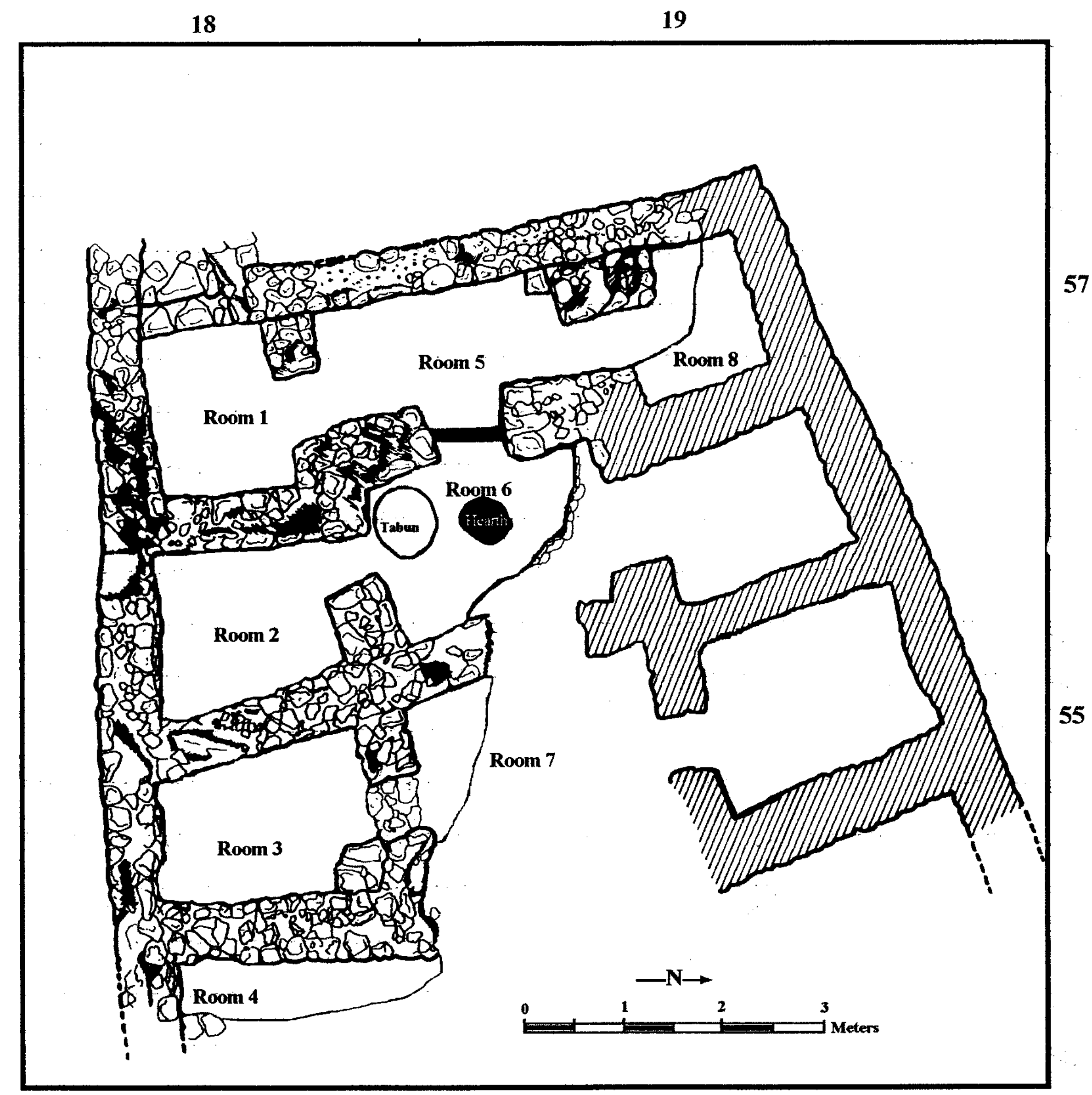

Fig. 3. Reconstruction of the ground plan of the two-story LPPNB house from the North Field. (from a drawing by M. Bataineh).

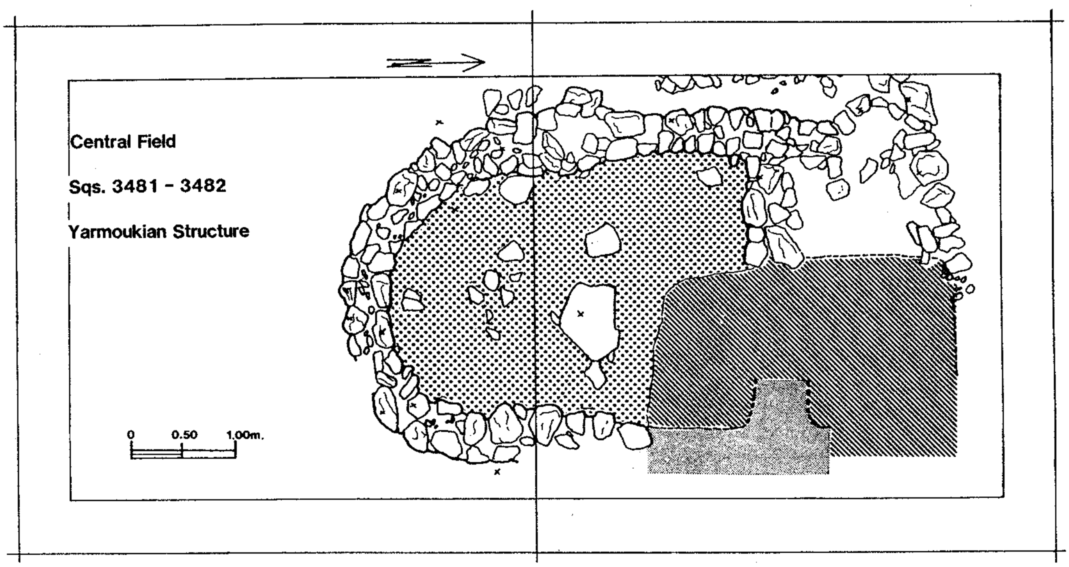

Fig. 4. LPPNB apsidal building in the Central Field, re-used as a Yarmoukian public building.

northern parts of the structure[1]. Under this assumption, the Terraced House would have consisted of a ground floor of at least 11 rooms, with two parallel rows of four rooms each at the northern and southern edges of the structure (including Rooms 1-4 and 8 plus the presumed 9-11), Room 6, and Room 7 (which is barely preserved). Altogether, the ground plan would have covered at least 65-70m^2, or roughly twice the size of the MPPNB house area. One trouble here is the extent of Room 7: if it maintained the general room size of Rooms 1-6 and 8, it would have been a small room as well, and one could expect that there was an adjacent Room 12 to the east, midway between Rooms 4 and the postulated Room 11. Since Rooms 1-3 all indicate a floor area of less than 4 m^2, it might be assumed that all of the rooms along the southern, western and northern periphery were of similar size: *i.e.*, "small". It might be, then, that Room 7 was twice as long EW as it was wide NS, giving it a size of more than 12 m^2, providing space for social activities beyond storage, sleeping, and work functions[2].

Besides its size, the Terraced House also has implications that differ dramatically from its MPPNB ancestors. The first of these concerns the contents of the fill in Rooms 1-2 and 5-6. Amid the dirt and rubble were numerous pieces of burned clay, with preserved impressions of ceiling beams, that attested to the fire that destroyed the house. Also included were many hand-sized stones that seemed to have served as fillers between the branches and logs that formed the room ceiling and upper floor, as well as literally hundreds of thousands of lentils and peas that were stored above[3]. But the most intriguing aspect of the room fill is the presence of thick, red-painted lime plaster flooring that could only have fallen in from an upper story; in other words, the Terraced House was a two-storied structure over at least a part of the building's area.

The burned clay, charred lentils and peas, and floor plaster evidence was restricted mostly to the fill in the southwest and central parts of the building, suggesting that this part of the structure was the most severely damaged by the fire. But the evidence also raises questions about the rest of the house in terms of its two-story character. Two aspects must be addressed. The first is the absence of charred peas and lentils, burned clay with beam impressions, and upper floor plaster in the fill of Rooms 3-4 and 7. The preserved evidence from Rooms 4 and 7 is so restricted that we should concentrate only on Room 3. Here, despite the absence of the dramatic conflagration to the west and north, there were still many stones of similar size as the fill in Rooms 1-2 and 5-6. Also, above the floor in Room 3 there were numerous thick fragments of a tabun installation that may have collapsed from an upper story. Altogether, the absence of material similar to the fill in Rooms 1-2 and 5-6 might indicate that the second story of the house was restricted to the two westernmost rows of rooms, although this is only tentative.

The second element of interest is the obvious addition of the two eastern rows of rooms to the building at some time after the original construction of the Terraced House. There is a clear distinction in the size of stones used in the southern wall over the stretch of Rooms 3 and 4 compared to the original Rooms 1 and 2, and this addition (including Room 7 and the postulated Rooms 10-11 and perhaps 12) are clearly later. One is left with contemplating a complex two-storied house, with two floors at least in the western half and with either a single or double story in the eastern section.

The changes in room size, at least, are known from other LPPNB structures at 'Ain Ghazal. The smaller room dimensions have been found in the South Field (ROLLEFSON 1993: Pl. I-2), as well as in newly exposed buildings in the East Field (ROLLEFSON and KAFAFI n.d.). Inspection of the bulldozer section in the South Field has also shown the presence of considerable amounts of thick, red-painted plaster in the room fills of LPPNB buildings that argue for more two-story buildings in this part of the site. In the East Field, there are well-preserved LPPNB buildings that are "terraced", but the exposures are too small to indicate if these are multi-storied buildings or simply split-level houses.

Apsidal Buildings

Remains of at least three buildings with an apse contour at one end have been found in association with LPPNB deposits: one in the Central Field[4], with the apse at the southern end (Fig. 4); one in the East Field, with the apse to the north (ROLLEFSON and KAFAFI 1996); and at least one in the North Field (with the apse at the western end) that underwent three phases of use (ROLLEFSON and

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1 The center of the doorway is one point, and the center of the hearth the second. The latter landmark is based on the observation that MPPNB floor hearths were inevitably placed at the geometric center of rooms.

2 Of course, The ground floor may have had many more than the postulated 11 or 12 rooms based on a simple folding over of the floor plan; the circumstances at Basta show how complex an LPPNB house plan can be (*cf.* NISSEN *et al.* 1987: Figs. 4,7).

3 Radiocarbon dates place the fire at about 8100 bp (*cf.* ROLLEFSON *et al.* 1992: Table 1).

4 Originally the apsidal house in the Central Field was thought to have been the work of Yarmoukian builders using an LPPNB plaster floor (ROLLEFSON *et al.* 1990: 110-111, Fig. 12), but it is now clear that the building's design was an LPPNB tradition.

KAFAFI 1994: 20-24). (A second possible apse building in the North Field is too badly damaged by later activity to be certain of its original shape). All three cases show similar details of size and proportion; they are approximately 4.5x3.5m in exterior dimension, and the Central Field example consisted of a 'larger main room (3.4x2.25m) and a smaller antechamber (*c.* 1.5x2.25m). The relatively well-preserved floor of the building from the East Field had a broad checkerboard pattern of red and white rectangles on the floor.

The function of these buildings is conjectural, but the small floor area (maximum of $16m^2$) indicates that they were not "houses" in the normal sense, for they are about one-half to one-third smaller than the common dwelling of the MPPNB phase. The association of the North Field apsidal structure with a "lime-plaster courtyard"[1] is reasonable evidence that these edifices may have served non-domestic functions, perhaps in relationship to ritual activity; this interpretation is supported by a final structural renovation to the North Field building (Phase 4) that appears to have served as a shrine (see below).

Shrines

Two buildings in the North Field are so different from any other PPNB construction at 'Ain Ghazal that there is little doubt that they were used in some aspect of ritual observance (Pl. 1:a). Both structures are circular and of virtually identical dimensions (*c.* 2.5m diameter, interior). The better preserved of the two is the Phase 4 reconstruction of the three-phase LPPNB apsidal building mentioned above and will be briefly described here.

The circular room had a doorway that led eastwards to an evidently rectangular antechamber of unknown dimensions, since this room was destroyed by erosion in antiquity. The floor, made of lime plaster, consisted of eight reflooring episodes, each directly atop the preceding one and each painted with a red pigment; the surface of the last floor was covered with a thin calcrete coating, so it is not possible to determine if there were any designs on the floor.

In the center of the room was a large circular hole of *c.* 60cm diameter, and the characteristic upward coving of the plaster at the edge of the hole reveals that a feature, probably a hearth or altar, once rose from it. In the sides of the hole were two pairs of radiating channels, one to the north and south and another pair oriented northeast and southwest. The channels were formed by vertical slabs of limestone on each side of the channel, "capped" at the top by slabs to form a tunnel roughly 15-20cm square that ran from the hole towards the room wall (Pl. 1:c). The absence of stone slabs at the base of the channels is an indication that these were not drains, but they may have served to draw air into the hole from outside the room in order to enrich a fire in the raised hearth or altar above the floor.

The poorly preserved second circular structure is located only about 4m to the south of the first, and the careless construction of the walls (using fist-sized cobbles) and the thinness and badly laid foundation of the floor (two flooring episodes) argue that the structure was hastily built and probably not intended for prolonged use. The stratigraphy between the two buildings was hopelessly disturbed by later activity, but the absolute elevations of both buildings suggests a general contemporaneous relationship, and it could be argued that the less carefully constructed shrine was a temporary successor to the sturdier Phase 4 shrine, which may have suffered some structural damage that made abandonment necessary[2].

The LPPNB Temple

The East Field at 'Ain Ghazal appears to be a section of the site that grew rapidly near the beginning of the LPPNB period (ROLLEFSON 1989: 137). Near the top of the steep slope in the central part of the East Field (Fig. 1) a medium sized building of not less than 4x5m was exposed that undoubtedly played a major ritual role in the lives of the population at 'Ain Ghazal, at least those who lived in the East Field (*cf.* ROLLEFSON and KAFAFI n.d.). The western end of the structure has eroded down the 35% slope, but the remaining area is impressive in terms of its "furniture" (Fig. 5). Three "standing stones" about a half-meter high set off the eastern third of the structure. (The central orthostat had tumbled towards the west [downhill] sometime after abandonment). A floor-level altar was situated along the southern wall, consisting of clay burned so intensely that it had taken on the color and texture of pottery; the fired clay was surrounded by two long slabs of stone to the north and south and a cluster of smaller slabs to the east. Midway between the orthostats and the eastern wall

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1 The courtyard and surrounding walls were actually the remnants of an abandoned MPPNB house that was converted to an exterior space closed off from public access (ROLLEFSON and KAFAFI n.d.).

2 There are two large cracks in the floor of the Phase 4 structure that might reflect some subsidence or other form of earth movement that resulted in the destruction of the walls and ceiling. Since we have no other evidence of major earth movement in LPPNB floors on either side of the Zarqa River, an earthquake is not likely.

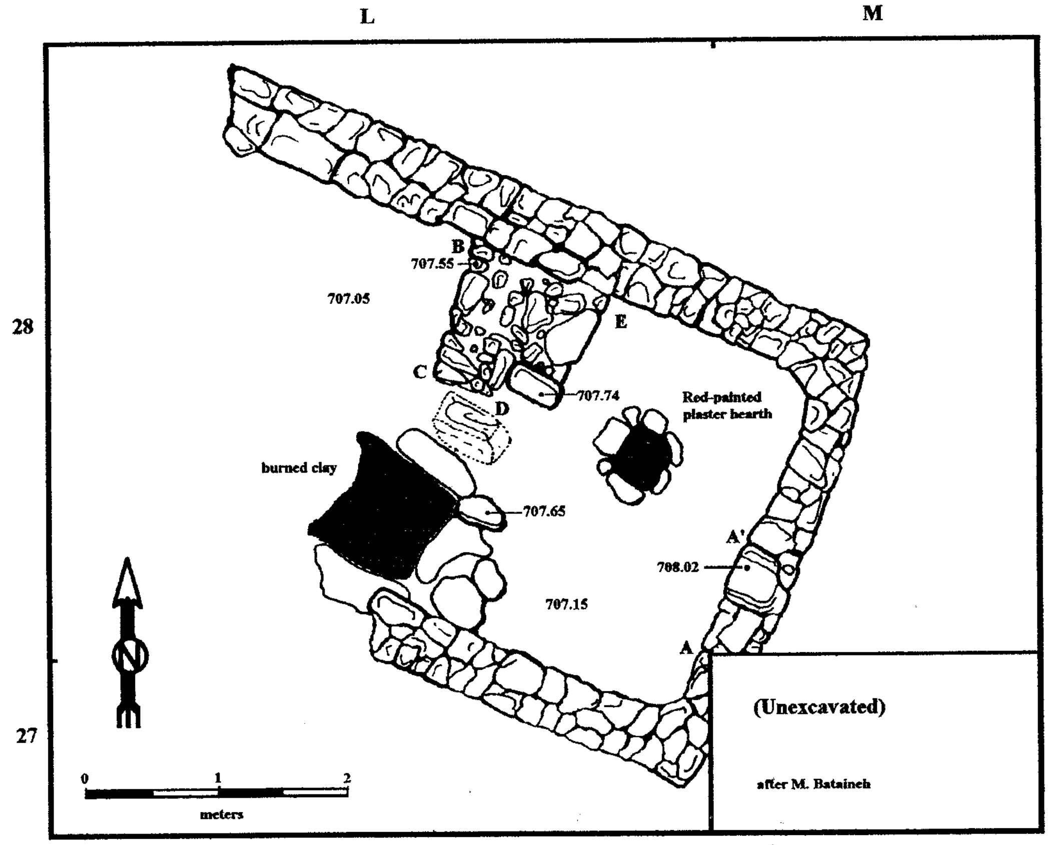

Fig. 5. LPPNB temple from the East Field. The low platform along the northern wall (BCDE) and the blocked doorway (A-A') are later modifications of the original structure.

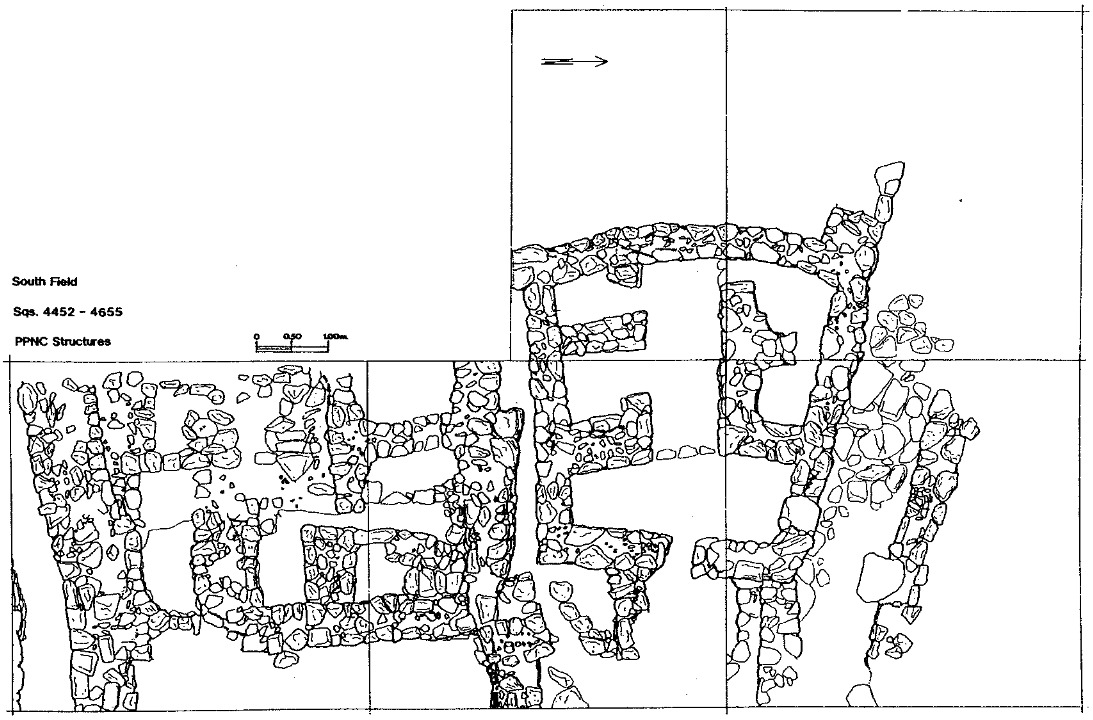

Fig. 6. A PPNC corridor building in the South Field. A flagstone ramp is between the north wall and a courtyard wall at the right; portions of other corridor buildings are at the left of the figure.

(but situated closer to the northern wall than the southern one) was a rectangular floor hearth of red-painted lime plaster, surrounded by seven stones of various shapes. A remarkable feature is that, among all the known PPNB buildings at 'Ain Ghazal, this is the only one that has a dirt floor, not one of lime plaster.

The temple underwent at least two changes. At one time there was a doorway just under a meter wide near the southeastern corner of the eastern wall (A-A' in Fig. 5). The doorway was later closed with stones, including a massive, rounded orthostat that stood some 85cm above the floor; the upper contours of this columnar orthostat suggest an anthropomorphic shape (Pl. 1:b). Another change, perhaps coincident with the closing of the doorway, was the construction of a low platform between the northernmost standing stone and the north wall of the building, which effectively made two rooms out of the original space; access to the eastern section would have been through the narrow spaces between the three standing stones.

Other LPPNB Architecture

As was the case for the MPPNB, no definite courtyard or compound walls have been identified around domestic buildings in LPPNB strata at 'Ain Ghazal, although this may be an illusion left by the destructive activities of later PPNC residents at the settlement. (Recall, on the other hand, the courtyard behind the apsidal building in the North Field that was set off from all its neighbors). In the East Field there are numerous massive walls, most of which are evidently PPNC retaining walls, although some are also clearly LPPNB in date. There was at least one thin wall in an LPPNB courtyard, but it seems to have served as a screen to protect several hearths from wind rather than to set off one family's area from another (*cf.* ROLLEFSON and KAFAFI 1996). In the long Step Trench in this part of the site (ROLLEFSON and KAFAFI n.d.) are several large walls that could have served as courtyard/ compound walls, but their age is uncertain.

PPNC Architecture

Architectural variety, noted in the LPPNB period at 'Ain Ghazal, is also present in the PPNC deposits, but here the variability is more complex than the LPPNB domestic: ritual opposition. Although there is one ritual building in the PPNC, there are different kinds of domestic (or at least "profane") architecture.

PPNC Houses

The large two-story houses of the LPPNB period at 'Ain Ghazal evidently disappeared in the PPNC phase, although there are some structural remnants in which LPPNB rooms in unknown types of structures (single story? two-story?) were modified for PPNC use and even further altered during Yarmoukian times (ROLLEFSON 1993: 94, Pl. 1:b, Fig. 2).

The common dwelling during the PPNC appears to have been a single-room structure about 4x4.5m, possibly with some interior subdivisions using thin screen walls that could not have borne much weight. Floors were made of a substitute plaster called *huwwar*, a mixture of crushed chalk and mud. A doorway led from the house outside into a small "courtyard" or walled exterior work area two to three meters on a side; the small yard included fireplaces and milling areas. The size of the houses and the work areas indicates that they were single-family units (*cf.* Pl. 2:a-b), and the distance between houses suggests a major decrease in population density (and therefore absolute population) at the settlement.

PPNC "Corridor Buildings"

The second major building type in the PPNC period is the semisubterranean storage bunker, called "corridor buildings" by Kirkbride at Beidha (*e.g.*, KIRKBRIDE 1966: 13-17). So far these characteristic buildings (Pl. 2:c, described in detail in ROLLEFSON and KÖHLER-ROLLEFSON 1993 and ROLLEFSON *et al.* 1993) have been found only in the South Field at 'Ain Ghazal, suggesting that this was an area of the site reserved for these kinds of structures. There is no evidence for a superstructure above the 'Ain Ghazal examples, and it would appear that the platform built above the partially buried storage rooms might have been used for erecting temporary shelters such as tents (Fig. 6).

The PPNC Temple

Although the East Field does not appear to have been intensively settled during the PPNC period, some LPPNB buildings have what seem to be PPNC modifications. But one structure is most likely entirely PPNC in construction and design, and it is clearly a ritual edifice that maintained some

Plate 1:a. Circular shrine from the North Field.

Plate 1:b. The eastern wall of the LPPNB temple in the East Field. The anthropomorphic orthostat stands against the northern edge of a former doorway (southern edge of the doorway is visible at tip of the north arrow).

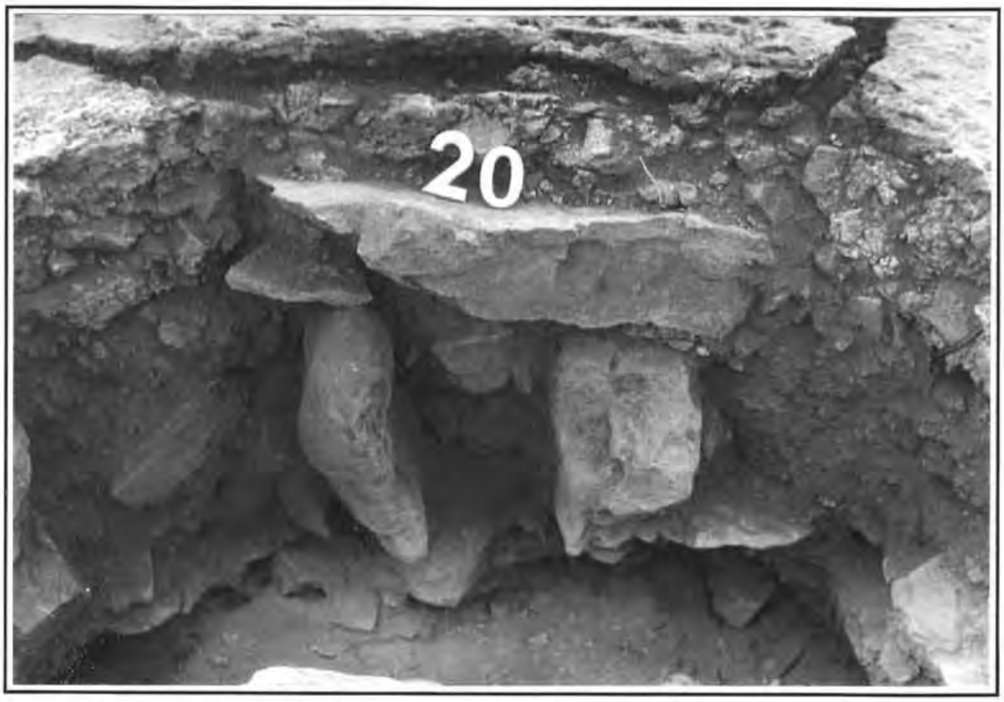

Plate 1:c. One of the four sub-floor channels that may have served as air ducts into the central hole in the shrine.

Plate 2:a. The PPNC "Great Wall" runs east-west at the right-center of the photo. To the upper left is a small single-room PPNC house. Just to the left of the "Great Wall" is a slightly narrower Yarmoukian courtyard or compound wall.

Plate 2:b. A walled PPNC "courtyard" or workspace outside a house; note the rectangular "milling bin" towards the upper left.

Plate 2:c. View towards the east of a PPNC storage bunker, with the entrance near the top of the photo. A paved ramp leads down-hill towards the east at the left side of the photo.

LPPNB traditions while simultaneously introducing others that appear in later temple structures in the Levant.

The temple was destroyed on its downhill (west) end by some bulldozer activity and by erosion, but it is still possible to say that it was a two-roomed structure at least 5.5m EW by 6.5m NS. The eastern room is well preserved and contains a raised altar at the center of the eastern wall, an unpainted lime plaster hearth on the floor in front of it (surrounded by seven stone slabs, as in the LPPNB temple), and a small rectangular feature built against the center of the northern wall. A previous doorway in the southern wall was blocked, and a new doorway opened in the western wall of the room; just 60cm to the west of the doorway, a wall forced one to turn to the east to enter the western room, and this right-angled wall also prevented any observation of activities that may have been underway in the eastern room. The secrecy preserved for the eastern room may foreshadow a "holy of holies" in later regional temple designs (Fig. 7; ROLLEFSON and KAFAFI n.d.).

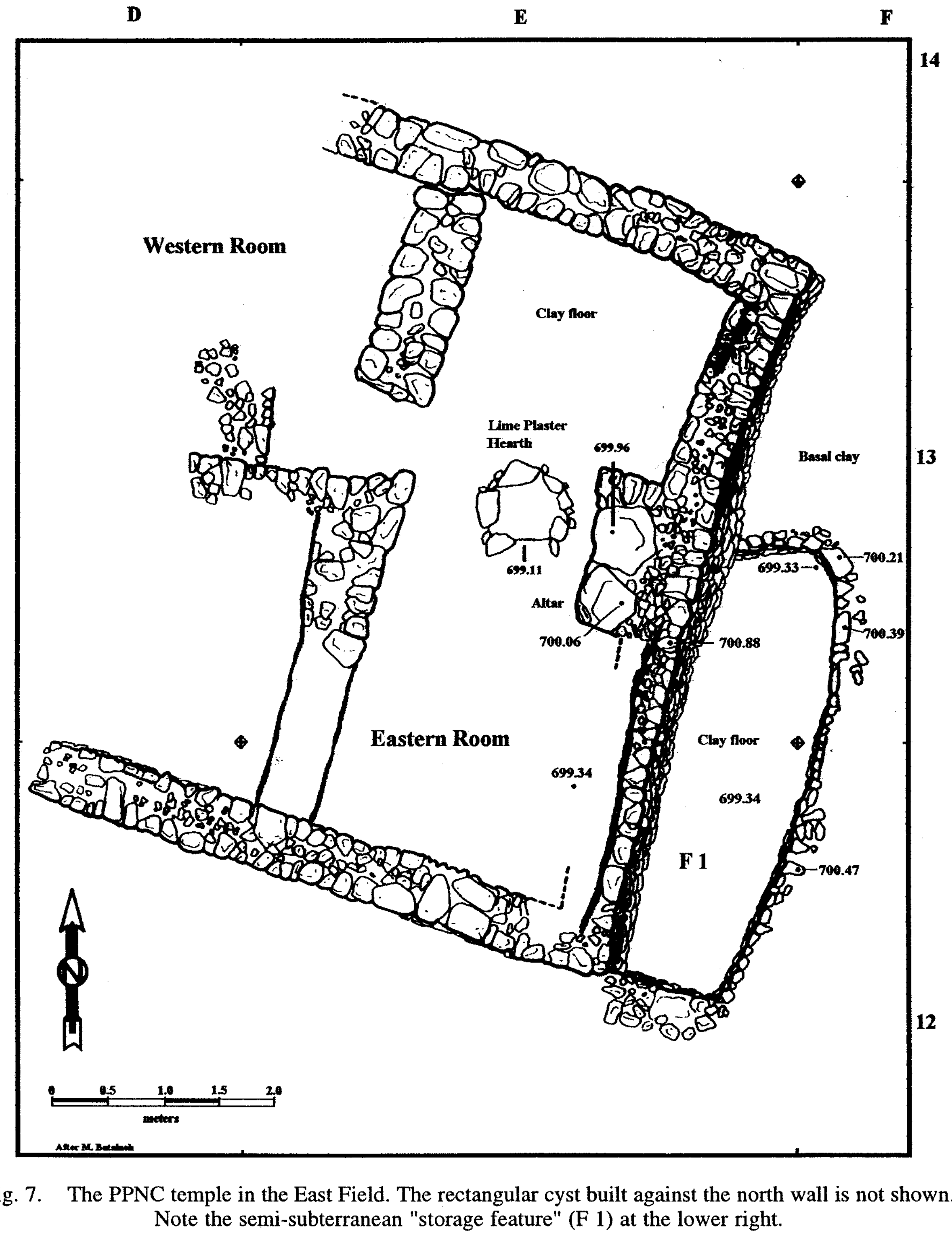

Fig. 7. The PPNC temple in the East Field. The rectangular cyst built against the north wall is not shown. Note the semi-subterranean "storage feature" (F 1) at the lower right.

Outside the temple proper, at its southeastern corner, there is a semisubterranean feature 2x1.5m dug into sterile basal clay; the fill from this feature may have been used to cover a river cobble pavement to floor the eastern room of the temple There might have been an entrance at the southeast corner of the temple, but if so, it would have been very narrow; just as likely, entry into the *c.* 1m deep feature may have been via a ladder or similar apparatus.

Other PPNC Architecture

The "Great Wall"

One of the more curious architectural elements is the "Great Wall" in the Central Field (Pl. 2:a). Originally constructed in the PPNC period, it was also used and remodeled in the Yarmoukian phase of occupation. *Huwwar*-covered surfaces flank both sides of the 1.4m wide wall, and no evidence of any return walls have been noted along the more than 11m exposed so far (ROLLEFSON *et al.* 1993).

The Walled Street

A passageway about 2.5m wide, including the walls that set it off from courtyards on both sides of it, climbed westwards up the Central Field slope in a series of steps built of limestone slabs and dirt fill. Like the Great Wall, the walled street was first built in the PPNC but also used extensively in the Yarmoukian, when it was periodically paved and repaved with *huwwar*. The street was truncated at the eastern end by bulldozer work in the 1970s, and the other end, about 9m to the west, was destroyed by later Yarmoukian construction (ROLLEFSON and KAFAFI 1994: 13-14; Figs. 4, 7).

"Industrial Installations"

In several parts of the site there are relatively large areas that appear to have functioned in some industrial manner. In the Central Field, for example, deep and extensive patches of *huwwar* were spread over much of the area of the 5x5m excavation trench Sq. 3883, confined to some degree by thin walls of small cobbles; this appears to have been an activity area associated with *huwwar* manufacture.

In the North Field there were numerous large fire pits, constructed of massive stone blocks, inside a walled courtyard that was characterized by dense distributions of fire-cracked rock, as well as large flakes and shatter of limestone and poor quality chert (KAFAFI and ROLLEFSON 1995: Fig. 6); what was being burned or treated with fire in this area remains unknown, but the compound was situated near a "normal" domestic structure (Fig. 8).

The East Field Step Trench, which was only 2m wide, encountered several locations of dense ash, fire-cracked rock, and immense walls and features that remain obscure in terms of use and age, although the material is probably either final LPPNB or PPNC. Some of the walls are probably retaining walls in view of the steepness of the slope in the East Field, but some were clearly designed for other purposes. Until the trench can be broadened considerably, the nature of these architectural manifestations will remain speculative.

Yarmoukian Architecture

The variability seen in PPNC architectural types was reduced in the Yarmoukian period, although different kinds of buildings were introduced for the first time in the last half of the 8th and first half of the 7th millennia bp.

Yarmoukian Houses

In contrast to the simple houses of the PPNC period, Yarmoukian dwellings became more substantial again, paralleling in some ways the situation in the MPPNB period. Most of the more than 1000m^2 of excavated Yarmoukian deposits have been severely damaged by agricultural activities at least as old as the Byzantine period, but some parts of the Central Field and the South Field have some largely intact houses that provide a glimpse of the architectural traditions of the period.

The most impressive aspect about the Yarmoukian period is the low density of architecture across the settlement, which appears to have decreased in physical size considerably[1]. The Yarmou-

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[1] Evidence of Yarmoukian presence in the East Field is limited to a few pits, sometimes deep, with Yarmoukian potsherds. Only a single potsherd has been found in the area sampled by the North Field excavations (*c.* 375 m^2), suggesting that this section of the earlier settlement was no longer a major focus of Yarmoukian activity. Overall, it would appear that the

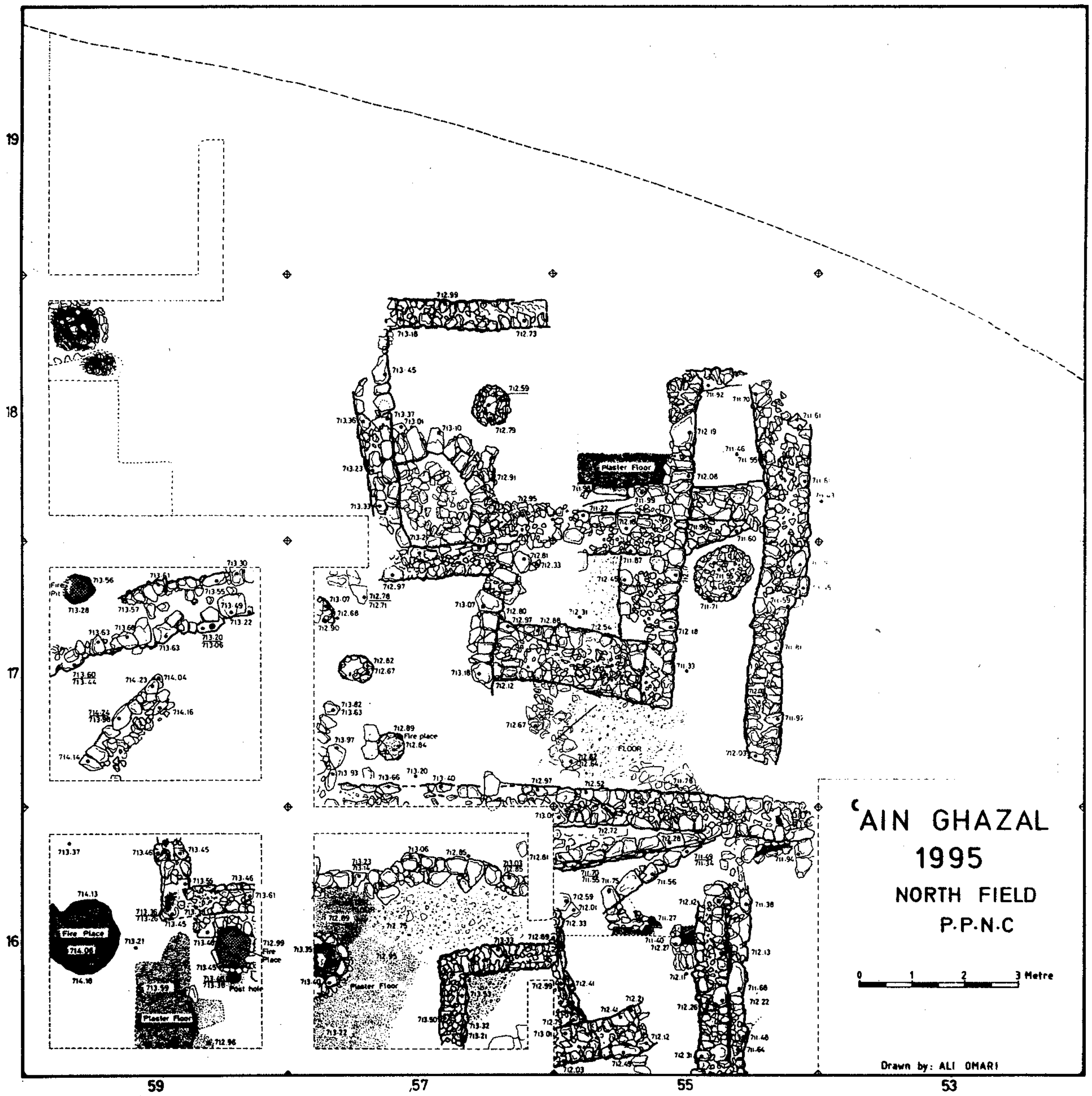

Fig. 8. A PPNC "industrial complex" in the North Field, with huge fire pits, walls and domestic structures (center bottom) represented. The sediments in the upper (northern) three-fourths of the figure were characterized by heavy amounts of fire-cracked rock, ash and burned bone. (Note: the walls in the bottom right corner of the figure are LPPNB and transitional LPPNB-PPNC).

kians maintained the terrace system originally begun in MPPNB times, and on each terrace there are great distances between houses in contrast to the almost row-house, proto-urban density of MPPNB times. In the Central Field, for example, the terrace on which one Yarmoukian "long house" (Sq. 4073) was constructed is devoid of any other structures for at least 15m to the north (*cf.* Fig. 9). The situation to the south is unknown since this part of the terrace not been sampled. On the adjacent terraces uphill (west) and downhill there are other "nearby" Yarmoukian houses, although it is not clear if they are temporally coeval with Sq. 4073.

The house in Sq. 4073 in the Central Field is the best conserved, not only at 'Ain Ghazal, but throughout the Yarmoukian area of the Levant (KAFAFI and ROLLEFSON 1995: 14-16). The preserved length of the house is almost 9m, and it is 4.3m wide (Fig. 9). There are at least three rooms,

Yarmoukian settlement had shrunk to about half of the LPPNB extent, and the diffuse distribution of houses would indicate a population at 'Ain Ghazal that was probably at its lowest since the founding of the settlement 2,000 years earlier.

and in the central one there is a large patch of *huwwar* plaster in the center of the room; otherwise, the floors of the house are made of dirt or "beaten earth". All three rooms are similar in size, *c.* 2.5x1.8m. Possibly there is a fourth "room" at the northeast end of the house, although this area was badly damaged by later terracing and agricultural activity; the room may actually have been a two- or three-sided "porch" extension at the front of the house, similar to the walled working areas of PPNC houses. Other Yarmoukian porch remnants have been found in the Central Field. One of the outstanding aspects of the house is the thickness of the interior walls, which ranged up to 90cm (or roughly twice the thickness of M- and LPPNB walls but approaching the massive dimensions of the PPNC storage bunkers). It is probable that the roofs of Yarmoukian houses were used for storage and other functions.

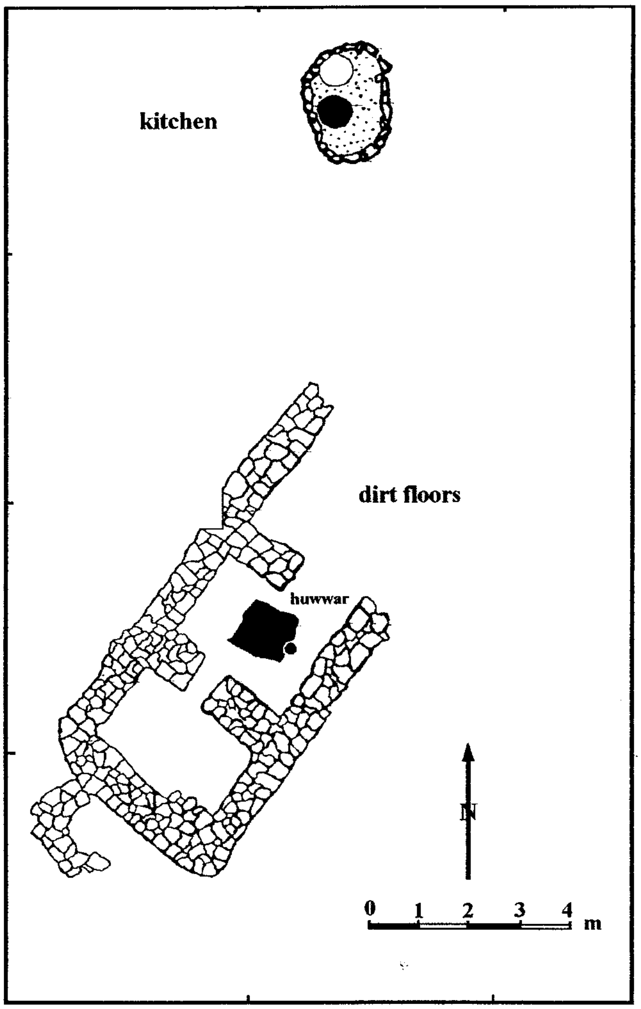

Fig. 9. The Yarmoukian "Long House" in the Central Field. The black circle in the"kitchen" outbuilding near the top of the figure is a hearth, the open circle a large storage jar. The kitchen is not necessarily contemporaneous with the house.

In the South Field, portions of another rectangular Yarmoukian house (built over one of the PPNC storage bunkers, and using some of its walls as a foundation) were exposed, whose eastern (downslope) end was destroyed by erosion, plowing, and bulldozer work. This house had a different configuration in comparison to the Central Field "long house". Only two rooms could be detected, although both were at least 6m long, and one of them was also at least 3.5m wide. Due to the excavation area, it could not be determined if there were more than two rooms to the house. In the westernmost part of the house was a rectangular platform, *c.* 35cm high and 80cm wide, that continued into the unexcavated section; the use of this platform is open to conjecture. The floor of the house was dirt.

Other Yarmoukian Architecture

The Yarmoukian use and maintenance of earlier PPNC structures, including the Great Wall and the Walled Street, has already been mentioned. Courtyard or compound walls were also evidently common during the Yarmoukian period (*cf.* Pl. 2:a), and within the courtyards and compounds the presence of regularly spaced postholes indicates the use of *arisha* or ramada-type shade structures (ROLLEFSON and KAFAFI 1994, KAFAFI and ROLLEFSON 1995). Notable is the absence of "industrial installations" common in the PPNC and perhaps the later part of the LPPNB.

Kitchen Outbuildings

Hearths or fireplaces have not been found inside Yarmoukian dwellings at 'Ain Ghazal. On the other hand, firepits of varying dimensions have been found in the courtyard areas outside Yarmoukian houses, some of which are large enough to have served some ill-defined "industrial" purpose, possibly even as primitive pottery kilns. In 1993 and 1994 four subrectangular features were found in the Central Field, averaging *c.* 2x1.5m, that were probably used for food preparation, including both the grinding of grain and cooking. At least, this is the clear implication of one feature (Fig. 9), where the interior of the structure included a large storage pot (*c.* 50cm diameter), two grinding slabs, and an area set aside as a hearth (KAFAFI and ROLLEFSON 1995: 16).

The "Public Building"

Like their PPNC ancestors (ROLLEFSON 1993), Yarmoukian residents at 'Ain Ghazal spent a lot of time digging into earlier cultural deposits. In one of these projects, a buried LPPNB building was encountered that was put to Yarmoukian use. The exclusive occurrence of Yarmoukian fineware cups and bowls inside and immediately outside the renewed structure is strong testimony that the "contemporary" (*i.e.*, Yarmoukian) building served a public function, since no domestic coarse ware was found. The small size of the building (see above) is unimposing and suggests that it may have been no more than a council chamber; certainly there is no "furniture" to suggest a ritual use as seen in the East Field LPPNB and PPNC temples.

Yarmoukian Tents

Certainly the earlier part of the Yarmoukian occupation at 'Ain Ghazal concerned farmers who lived at the settlement all year long; following the changes in environment and faunal opportunities witnessed in the LPPNB and PPNC, it is likely that agriculture and pastoralism had already become essentially separate sectors of the subsistence economy early in the Yarmoukian period, and that the bifurcated residence pattern of the PPNC (ROLLEFSON and KÖHLER-ROLLEFSON 1993) had been supplanted by full-time residence of farming families in the Yarmoukian period; the pastoral component of the Yarmoukian Neolithic was now a separate aspect, and sheep/goat pastoralists visited the *vicinity* of 'Ain Ghazal for pasture and exchange, but 'Ain Ghazal itself was still an agricultural community in the earlier part of the Yarmoukian period.

But there are also clear indications of later occupation of 'Ain Ghazal by people living in temporary structures who also used Yarmoukian pottery. The clearest evidence comes from the Central Field, although there were also peripheral visits in the East Field (ROLLEFSON and KAFAFI n.d.) and northwest across the Wadi Fakhit tributary to the Wadi Zarqa (ROLLEFSON and SIMMONS 198 6: Fig. 1). Circular structures of *c.* 3.5m diameter were first revealed in the 1985 season (ROLLEFSON and SIMMONS 1987), but a well-preserved circular tent foundation was exposed in 1993. In the latter case, the 4.5m diameter tent was oriented with the opening towards the rising sun, with stone platforms just inside and on both sides of the entrance; a hearth was located just off-center in the northwestern part of the interior (ROLLEFSON and KAFAFI 1994: Fig. 7). The surface near the opening consisted of *huwwar*, which is a strong argument against the use of the structure as an animal enclosure.

Architectural Comparisons and Interpretation

The architectural situations described above for the different occupational phases find many parallels in other settlements in the southern Levant, although there are some interesting regional divergences as well. There are major problems in developing comparisons for the PPNC period in particular, for this period has been encountered only rarely in other excavation projects (*e.g.* GARFINKEL 1994, GALILI *et al.* 1993) or the architectural elements have been either unpublished or not well preserved (*e.g.* Wadi Shu'eib). The situation is nearly as bad for the Pottery Neolithic, primarily since architectural preservation during this period suffered from the persistent coeval practice of pit-digging or the proximity of PN cultural deposits to modern surfaces, which led to recent agricultural damage or to the robbing of stones for recent construction projects.

MPPNB Architecture and Subsistence Economy

Beidha is the only site where part of the MPPNB sequence differs significantly in architectural terms from the rest of the southern Levant. The semisubterranean circular post houses "arranged in clusters like cells in a honeycomb" (KIRKBRIDE 1967: 6) are most similar to PPNA structures (*e.g.* KENYON 1981: Plates 277-280, KUIJT and MAHASNEH n.d.); that at least portions of Levels V and VI might belong to a pre-MPPNB phase is suggested by the presence of substantial numbers of Khiam points (2-3%) and Helwan points (1-1.5%) in these layers (ROLLEFSON n.d. a; *cf.* MORTENSEN 1970-71: 21-22, Fig. 19); certainly there is a possibility that a transitional EPPNB layer might exist in this stratigraphic complex at Beidha.

Aside from Beidha, the situation for the MPPNB for the rest of both the southern Levant and the northern part of the region is one where relatively small and simple architecture is characteristic. The buildings all appear to be free-standing and essentially independent of other architectural features, including any boundary markers such as courtyard or compound walls.

The subsistence economy of the MPPNB period at 'Ain Ghazal has been detailed in earlier publications (KÖHLER-ROLLEFSON *et al.* 1988, 1993; ROLLEFSON *et al.* 1992, with references) and will be briefly summarized here; presumably it reflects the situation for other MPPNB settlements in the rest of Jordan in its essentials[1]. Farming was the major source of plant resources, although wild

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1 An exception to this generalization would appear to be the Galilee area of northwestern Israel, where goats barely reach 15% of the faunal record (*cf.* HORWITZ 1987: 181),

or "cultivated" resources were also important contributors to the diet. Hunting provided *c.* 50% of the meat in the diet, while the control of goat herds contributed the rest of the meat in the daily menu (at least seasonally) (ROLLEFSON and KÖHLER-ROLLEFSON n.d.). The faunal remains reflect a richly varied ecotonal situation around 'Ain Ghazal, including open woodland, maquis, riverine gallery, steppe and desert ecozones within a small radius around the settlement (KÖHLER-ROLLEFSON *et al.* 1988).

Taking into account the kind of subsistence economy and the architectural arrangements at MPPNB settlements, the situation appears to be one where nuclear families constituted both the normal independent residential and economic production/consumption unit. Certainly sporadic misfortune may have required assistance for one or more families due to flood, fire, or death, but these tragedies were probably handled informally through family and friendship ties.

It is tempting to view the close physical relationship of some of the houses at 'Ain Ghazal as a reflection of the clustering of families with close kin relationships, but the problems entailed in the labor-intensive terracing of the slopes and the very long occupational history (up to 400 years in one case) of some of the buildings introduce difficulties in making such determinations. The absence of obvious boundary markers, such as courtyard/compound walls, is of no use concerning questions of land tenure or other concepts of "private property". The persistent renovation of some MPPNB structures at 'Ain Ghazal (and presumably at other settlements) clearly shows some form of inheritance with rights to alter the conditions of the legacy, but how these rights were transmitted anthropologically is unknown.

The exposed architecture at 'Ain Ghazal and most other Levantine MPPNB sites does not provide convincing evidence of any corporate kinship structure, although Byrd has noted that Beidha's Phase B (presumably correlated to Kirkbride's Level IV) has some larger-than-normal buildings with non-domestic attributes that indicate some public use (BYRD 1994: 650-652 and Table 3). All of the buildings, in fact, are relatively small (the maximum is less than $39m^2$), and the argument for public architecture (BYRD 1994: 652) is not strongly supported.

But architecture is not the only archaeological source for defining a corporate kinship structure. While dwellings and other buildings may not directly reflect this kind of anthropological complexity, the burial evidence and statuary from 'Ain Ghazal, Jericho, Beisamoun and Tell Ramad constitute strong support for characterizing the MPPNB social structure as something other than a "simple" egalitarian arrangement. In fact, the ritual evidence (and the null set of "non-evidence", where the mortuary population is simply too small to reflect post-mortem treatment of the dead (ROLLEFSON n.d. a) is the strongest foundation for viewing MPPNB social structure as other than egalitarian (*cf.* ROLLEFSON n.d. b).

In the earlier centuries of the MPPNB, when population at 'Ain Ghazal and neighboring settlements was relatively small, access to land for building a house and for farming was probably not problematic, but as populations in the settlements began to grow (rapidly, it seems; *cf.* KÖHLER-ROLLEFSON and ROLLEFSON 1990), concerns for rights of access to land inside the settlement and farther afield may have intensified, and conflicts over such access may have increased in number and tempo as the distance of housing from water sources and farm land from the settlement grew. The face-to-face or egalitarian-based kin resolutions to such problems, inherited from a simpler social organization dating back perhaps to the PPNA and even the Natufian, may no longer have been effective. This may especially have been true when one considers that the pressure of the quickly expanding population in each settlement across the region was adding additional strains to the overall social fabric of the southern Levant, particularly in view of the environmental degradation that was imposed on the immediate vicinity of the population centers (ROLLEFSON and KÖHLER-ROLLEFSON 1989).

LPPNB Architecture and Interpretation

Dramatic changes in settlement patterns took place during the LPPNB period, including the amazing growth of settlements to "megasite" (or "town") proportions, a phenomenon that probably resulted in part from a considerable movement of populations from abandoned villages in the Jordan Valley (ROLLEFSON 1989). At the same time architecture during the LPPNB period witnessed major evolution at numerous sites in Jordan, including Basta (*e.g.* NISSEN *et al.* 1991), es-Sifiya (MAHASNEH, this volume), 'Ain Jammam (WAHEEB and FINO, this volume), Wadi Shu'eib (personal observation), Ghwair I (personal observation; *cf.* NAJJAR 1994, SIMMONS and NAJJAR 1996), and 'Ain Ghazal (ROLLEFSON and KAFAFI 1996). Perhaps the most impressive aspect of this development is the large size that some buildings reached, up to $160m^2$ in the case of one structure in Area B at Basta, for instance (NISSEN *et al.* 1991: Fig. 1).

Room sizes also tend to be smaller than MPPNB examples, although there is great variability from room to room and site to site. Most of the smaller rooms ($1\text{-}3m^2$) were probably used for storage, although some of them could also have been special work areas as well; the larger chambers were presumably the "living" rooms where most social activities were carried out.

The evidence for two-storied buildings is widespread in the Neolithic (SMITH 1990: 325; EICHMANN 1991: 45, MOLIST and CAUVIN 1991: 106-109), although most of these multiple-story buildings appear to consist of a ground/semisubterranean "basement" or storage area and an upper floor where normal living activities took place (SCHIRMER 1990: 371). The case for two story buildings in Jordan appears to be different. At 'Ain Ghazal, the lower story included food preparation and probably living rooms, although it is not clear if the upper story was used for anything but storage; on the other hand, tabun fragments found in the fill above the floor in Room 3 of the Terraced House suggest that the tabun fell in from an upstairs location, which would indicate an "apartment" existed up there, parallel to the conditions of the ground floor. A wall preserved to 4m high in Area B at Basta still has the sockets in place that held the beams supporting the ceiling/floor, although it is possible that this may have been a split-level building rather than a true two-storied structure (GEBEL, pers. comm.).

When one considers structure size, internal variability in room size and presumed functional differences (NISSEN *et al.* 1991: 15), and the two-storied "apartment" situation at 'Ain Ghazal, it is obvious that one is no longer dealing with the simple single-family dwelling of the MPPNB; instead, the large LPPNB buildings are probably the residence of a multiple family unit, perhaps based on the extended family principle of parents and one or more married children, which acted as a single unit of production and consumption to cope with the pressures of a large population in an area that had undergone long-term environmental degradation. Not all members of a community necessarily lived in extended family units (*cf.* KRAMER 1979: 148, 155; WATSON 1979: 223), but it was a new option that had not been used before, and one that may have been adopted due to the relatively rapid rate of population growth in some settlements.

The faunal remains from the 1993-1995 seasons (VON DEN DRIESCH and WODTKE, this volume) reflect the general pattern of reduced species variability after the close of the MPPNB (KÖHLER-ROLLEFSON *et al.* 1989, KÖHLER-ROLLEFSON *et al.* 1993), and the change was already dramatic by the onset of the LPPNB period, which reflects the cumulative effect of cultural degradation on the environment (KÖHLER-ROLLEFSON and ROLLEFSON 1990). Although farming seems unchanged in comparison to the MPPNB, there appears to have been a major transformation between the beginning and end of the LPPNB in terms of domesticated animals that were herded (see WASSE, KÖHLER-ROLLEFSON, VON DEN DRIESCH and WODTKE, this volume), and there is some reason to suspect that the beginnings of long-distance pastoralism may have begun by the middle of the LPPNB (*cf.* BAIRD *et al.* 1992: 25-27). For the first time at 'Ain Ghazal, there is more than one structural style in the LPPNB, and alterations in architectural concepts may reflect accommodations to stresses in the subsistence economy.

The shrines at 'Ain Ghazal (perhaps lineage- or clan-oriented) and at Jericho (KENYON 1981: 307) and the LPPNB temple at 'Ain Ghazal (community-oriented, possibly with a full-time priest, *cf.* ROLLEFSON n.d. b) may also be associated with the treatment of social stress, for there appears to be a major change in burial rites and other religious observances[1]. There is also a room in one of the LPPNB (?) buildings at Ghwair I that may have had an altar (SIMMONS and NAJJAR 1996: 6). (The age of the Beidha "sanctuary complex", with its three temples [KIRKBRIDE 1968: 93-96], is uncertain). The "channel burials" at Basta, for example, are a departure from MPPNB norms elsewhere in Jordan, and the virtual absence of any burials in Area B at Basta (NISSEN *et al.* 1991: 17-18) reflects a very different concept of mortuary ritual. The proportion of "trash burials" (*e.g.*, ROLLEFSON 1986: 50) at 'Ain Ghazal is high in comparison to the MPPNB period, although the sample may not be representative since LPPNB subfloor excavations have not been numerous. The absence of plastered skulls from any LPPNB context, as well as the possible disappearance of the plaster statuary, are also indications that the ancestor cult, which appears to have disappeared altogether by the PPNC period, may have undergone a gradual disappearance in the LPPNB, replaced by a ritual and religious system based on another foundation.

PPNC Architecture and Interpretation

Discussion of the two principal architectural forms (full-time houses and storage bunkers) has appeared elsewhere (ROLLEFSON and KÖHLER-ROLLEFSON 1993). Essentially, the differences in

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[1] The appearance of the remarkable two-headed busts from the 1985 statuary cache (ROLLEFSON n.d. b), which probably dates to the earlier part of the LPPNB period, can be interpreted in many ways, including the spontaneous birth of three sets of Siamese twins. On the other hand, a less emotional interpretation might reflect a symbolic union of either 1) one or more formerly separate communities that migrated, at least partially, to 'Ain Ghazal from abandoned settlements in the Jordan Valley or, 2) an increased intimacy with hunter-gatherer groups living in the steppes and desert, where LPPNB families from farming towns like 'Ain Ghazal began bringing their flocks.

the design and character of these contemporaneous building types at 'Ain Ghazal are taken to reflect what has been termed "incipient migratory pastoralism" as part of a "fluctuating population" village model (KÖHLER-ROLLEFSON 1992). The houses were used by the permanent resident farmers of 'Ain Ghazal, while the storage bunkers were the repositories of stored equipment and harvest shares of families who left the settlement with flocks of sheep and goats for a major part of the year[1]. This adaptation to continued population pressure on the local ecology would have been one "logical" outgrowth of LPPNB visits to the steppe and desert in the rainy season (*cf.* BAIRD *et al.* 1992), a transitional form between village based herding and full-time nomadic pastoralism. The removal of a significant part of the population would have reduced the need for multiple-family dwellings; in fact, the population density (indicated by housing density) fell remarkably during the PPNC, and overall population at 'Ain Ghazal appears to have decreased perceptibly.

Certainly the presence of large populations through the LPPNB period (as at Basta and es-Sifiya), sometimes even through the entire MPPNB period as well (Wadi Shu'eib and 'Ain Ghazal), would have had severe consequences on local habitats, as is indicated by the lowest species variability during this period (VON DEN DRIESCH, pers. comm.). The absence of the sheep and goat herds from the village over extended periods my also be the reason that PPNC hunting of wild goat was pursued by the villagers (VON DEN DRIESCH and WODTKE, this volume).

It is possible that the extended family experiments in the LPPNB led from a rearranged social situation, where micro-lineage units operated at a broader level than in the MPPNB, to another on a higher hierarchical kinship level in the PPNC, at the macro-lineage or even clan level. It is in the PPNC that for the first time large "boundary walls" appear, suggesting that there were socially designated signals of restricted access to "private" areas within the settlement and, by extension, to lands outside the town as well. As some families in each lineage operated as part-time herders over numerous generations, tenure rights to local land access may have dissolved through time, setting the stage for a fully segregated set of land/farming social units (lineages or clans) versus mobile animal herders who maintained nostalgic, perhaps even formal kinship and economic ties with the "home" settlement population. This appears to be the case after the beginning of the Yarmoukian period, anyway. The increasingly centrifugal strains on the settlement, spread over some 500 years, may have been tempered by an alteration in religion.

The changes in the ritual arena of the PPNC population at 'Ain Ghazal, where the end of special skull treatment probably signaled an end to the ancestor cult of earlier times, suggest that a generation-by-generation selection of some family members for special recognition may have ended, perhaps as early as the later LPPNB period. A non-egalitarian family or lineage structure is still indicated by the relative rarity of interments at 'Ain Ghazal, and of the few burials for the PPNC period, it is remarkable that almost half are secondary burials of people who died somewhere else and were returned to 'Ain Ghazal. The existence of the PPNC temple is a clue that the as yet unknown functions of the altar and hearth at the temple acted as centripetal ties to hold the otherwise fractious community together.

The "Great Wall" at PPNC 'Ain Ghazal is an argument that the settlement was subdivided at least in two parts, although what the factions represent is unclear. Too little of the PPNC deposits have been investigated with enough thoroughness on either side of it to investigate this strange demarcation. The Walled Street, being unique in the PPN in the southern Levant, also poses major questions, including who controlled the effort to erect this seemingly public project, and why would such a thoroughfare be necessary, either practically or symbolically?

Yarmoukian Architecture and Interpretation

As is the case for PPNC architecture, Yarmoukian buildings have also not been well documented in the southern Levant. The evidence from Munhatta indicates small circular dwellings (*e.g.* PERROT 1964: Pl. 22) of possibly a temporary nature that would correspond with the Yarmoukian tent structures of the early 7th millennium bp (?) at 'Ain Ghazal. The situation at Sha'ar Hagolan remains obscure in terms of architectural remains, although Garfinkel claims that one system of walls a meter thick may represent a "massive public building" (GARFINKEL 1993: 128); on the other hand, this situation, including a "rectangular pier" on one face, is similar to the broad Yarmoukian compound wall at 'Ain Ghazal (*cf.* Pl. 2:a, to the left of the PPNC "Great Wall"). Tell Abu Thawwab, a Yarmoukian village between Amman and Jerash, reportedly had apsidal buildings (KAFAFI 1993: 103), as other reports have suggested (*e.g.*, GARFINKEL 1993: 128-129); on the other hand, many of these structures are only partially preserved, and it is possible that they may be parts of oval or "opposed apsidal" structures instead.

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1 This would imply that the corridor buildings at Beidha were also temporarily occupied during the annual round, although the clear presence of an upper story there could indicate a somewhat different model for a "fluctuating population" village (*cf.* BYRD 1994: 653-656). For a discussion on the PPNC age of these buildings, *cf.* ROLLEFSON n.d. a.

The circular structures at 'Ain Ghazal are clearly temporary structures, and it might be assumed that the same is true for those at Munhatta and some of the buildings from Tell Abu Thawwab. Circular architecture is often associated archaeologically and ethnographically with temporary (but perhaps repeated) habitation (FLANNERY 1972), an interpretation that is supported by the last phase of "visitation" at 'Ain Ghazal.

The use of the Great Wall and the maintenance of the Walled Street reflect the transitional nature of the change from the aceramic PPNC to the pottery-dependent Yarmoukian residents at 'Ain Ghazal. Presumably social and economic pressures were constant and not sudden in their effect. The Yarmoukian "long house", and its early parallel in the South Field at 'Ain Ghazal, are also not documented elsewhere, so it is unclear how 'Ain Ghazal may differ in domestic architecture from other permanently occupied farming villages. (Wadi Shu'eib was, without doubt, a major permanent Yarmoukian farming village, but little architectural remains have been sampled and reported).

In a negative sense, Yarmoukian architecture argues (almost silently) for a changed ritual nature. Despite the use of a recycled LPPNB apsidal building for some kind of public function (ROLLEFSON, KAFAFI, and SIMMONS 1990), it is possible that this structure was simply used for public meetings of a local council rather than some religious purpose. Otherwise, we have very little evidence for Yarmoukian ritual. To date, only three burials from the southern Levant have been attributed to the Yarmoukian period (GARFINKEL 1993: 127), and one wonders if these are reliable in view of the absence of any burials from the large Yarmoukian exposures at 'Ain Ghazal and Wadi Shu'eib[1]. Human and animal figurines exist, but in small numbers. The human versions appear to be associated with fertility (*e.g.* GARFINKEL 1993: Figs. 8-10), but there is little to indicate any broader application. Nothing resembling shrines or public temples has been found so far.

Concluding Remarks

Although the revolutionary method of Neolithic food production had been underway for more than a thousand years by the beginning of the MPPNB, the subsistence economy was still a novelty in terms of human evolution and one that was capable of upsetting local ecological conditions. Sustained population growth over a long period inevitably strained the fragile environmental balance in the southern Levant, and it should not be surprising that there was a widespread abandonment of permanent settlements in the 9th millennium bp (ROLLEFSON and KÖHLER-ROLLEFSON 1989). The rapid growth of established population centers, and of newly founded ones, in the Jordanian highlands during the LPPNB created new stresses on the social fabric of the communities. Older methods based on a simple kinship system within and between populations of several hundred people to maintain harmony and social identity were probably already threatening to break down during the MPPNB, and the huge clusters of people in LPPNB villages and towns had to readjust the social organization to meet new demands and satisfy increasing conflicts of interest.

The extensions of these changes in the social and economic aspects during the PPNC managed to reduce population pressure by 1) moving parts of the population into the steppe and desert, where 2) increased resources could be created by converting otherwise useless plants into sheep and goat products (KÖHLER-ROLLEFSON 1988). The reduced numbers of permanent farmers in the settlements may have reduced tensions, and the community-oriented rituals carried out in the temples reinforced social cohesion and identity. By the Yarmoukian period, perpetual farming in many of the long-established farming areas began to witness drastic reductions in crop yields on land within a reasonable distance from permanent fresh water sources; populations had to move again to other areas where springs occurred in settings that had not been devastated by earlier exploitation, and such springs and settings were probably difficult to locate. It is likely that little was available except small springs, which would have supported only small groups, so that social organization could once again function well on the simpler forms from the earliest part of the Neolithic period.

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Ecological Changes During the Late Neolithic in Jordan: a Case Study

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Abstract: *While much Neolithic research has focused on its origins, some contemporary research is examining the consequences of Neolithic subsistence strategies. In particular, the transition from Pre-Pottery to Pottery Neolithic cultures entailed dramatic economic shifts. Research at large Neolithic communities in Jordan suggests that it was during this time that the classic economic dichotomy between the "desert," or pastoral nomads, and the "sown," or village farmers, may have had its origins. This contribution examines potential causes for this change, which includes humanly induced ecological degration as well as climatic deterioration. One possible physical manifestation of both elements may be the massive layers of cobbles at many Jordanian Neolithic sites. I argue that in order to understand this turbulent time, it is necessary to examine the interaction between environmental impacts, climatic changes, and cultural responses to it.*

Introduction

The investigation of Neolithic food producing societies has been a major theme in Near Eastern prehistory for decades. Most of this research has focused on the origins of agriculture, developing models for explaining why hunting and gathering economies that had been so successful for thousands of years were supplanted by economic strategies based on the domestication of plants and animals (*e.g.*, COWAN and WATSON 1992, GEBAUER and PRICE 1992). While this is a critical and as yet unsatisfactorily resolved issue, some contemporary research has focused on the opposite end of the Neolithic spectrum. Once farming villages were firmly established, what were some of the *consequences* of food production? In particular, recent research in Jordan had addressed this issue in some detail, notably at huge settlements like 'Ain Ghazal (*e.g.*, KÖHLER-ROLLEFSON 1992; ROLLEFSON 1993; ROLLEFSON and KÖHLER-ROLLEFSON 1989, 1992; SIMMONS *et al.* 1988).

It is abundantly clear that by the late Pre-Pottery Neolithic and into the Pottery Neolithic periods, turbulent changes were occurring throughout the Levant. Dramatic economic shifts from intensive farming and herding towards more modest agricultural pursuits and pastoral nomadism appear to have characterized at least the eastern Levant (*cf.* KÖHLER-ROLLEFSON 1988, 1992; KÖHLER-ROLLEFSON and ROLLEFSON 1990). The reasons why these shifts occurred are not yet fully understood. I believe that the only way that this may be comprehended is through a regional approach, examining individual sites within a consistent and systematic framework. In this paper I elaborate on our previous arguments suggesting that climatic changes, including increased summer monsoonal rains, were a contributing factor towards these economic changes. Specifically, we believe that debris flow, represented by layers of cobbles at major Jordanian sites, were triggered by torrential rainfall, contemporary with an episode of increased Northern Hemisphere summer precipitation (DAVIS *et al.* 1990, SIMMONS 1995b).

Background

Neolithic sites are abundant and relatively well-dated in the Levantine Near East (KUIJT and BAR-YOSEF 1994). The local expression of the earliest Neolithic usually is referred to as the Pre-Pottery Neolithic, subdivided into two major phases, Pre-Pottery Neolithic A (PPNA, *c.* 8350-7350 B.C.) and Pre-Pottery Neolithic B (PPNB, *c.* 7350-6000 B.C.) (GOPHER 1994). This division was initially based on Kenyon's Jericho excavations in the Jordan Valley during the 1950s

(KENYON 1957). Following the Pre-Pottery Neolithic is a series of sequences containing ceramics (*e.g.*, Pottery Neolithic A and B, Yarmoukian) (STEKELIS 1972, KAFAFI 1982).

The PPNB is the best known Neolithic entity, with well over 200 sites documented throughout the Near East (BAR-YOSEF 1981b; MOORE 1973, 1978). The PPNB in many ways represents the height of Neolithic achievements. In the Levant during the PPNB, Jericho was clearly an important center, covering an estimated 10 acres (KENYON 1957). Although Jericho remains to many the "typical" PPNB site, recent studies have documented a large range of site types. These include small settlements such as Beidha in Jordan (KIRKBRIDE 1966, 1968), Nahal Oren (NOY, LEGGE, and HIGGS 1973) in Israel, or Tell Ramad in Syria (DE CONTENSON 1971, DE CONTENSON and VAN LIERE 1966), to larger villages such as Tell Abu Hureyra in Syria (MOORE 1979; MOORE, HILLMAN, and LEGGE 1975) or Beisamoun (LE BRUN 1969) in Israel (Fig. 1).

In addition to villages, numerous specialized small PPNB sites are known throughout the Levant (*e.g.*, BAR-YOSEF 1981b; BAR-YOSEF and PHILLIPS 1977; BETTS 1990; BURIAN and FRIEDMAN 1973; GARRARD *et al.* 1994; NOY 1970, 1971; ROLLEFSON and FROHLICH 1982; SIMMONS 1980, 1981). Most of these are open-air sites, although a cave (Nahal Hemar) containing well-preserved ceremonial PPNB materials has recently been investigated in Israel (BAR-YOSEF and ALON 1988). Another cave, El-Khiam (ECHEGARAY 1964, 1966), presumably contains PPNB materials as well. In the southern Levant, many of the smaller sites have been postulated as reflecting a seasonally mobile hunting and gathering strategy (*e.g.*, BAR-YOSEF 1981a). It seems clear that during the PPNB, a wide and diverse array of economic pursuits was followed. This appears to have changed during the subsequent Pottery Neolithic.

Many researchers (*e.g.*, DE VAUX 1966, KENYON 1960, PERROT 1968) felt that the Pottery Neolithic was temporally separated from the Pre-Pottery Neolithic by a gap of up to a millennium, a proposition supported at major sites in the western Levant. They also believed the Pottery Neolithic reflected intrusive populations, filling a gap created by the cessation of the "PPNB Interaction Sphere" (BAR-YOSEF and BELFER-COHEN 1989). Increased aridity often was cited as a major reason for this change. Recently, however, this position has been challenged, due to better dating techniques resulting in a shrinkage of the presumed gap, more sophisticated understanding of paleoclimates, and research at newly discovered sites. Many researchers now believe that shifts in site location were frequent, although regional abandonment and replacement by new populations were not (GOPHER and GOPHNA 1993: 304-307).

This new position has been strongly supported with the documentation of a transitional phase (the Pre-Pottery Neolithic C, or PPNC) at major Jordanian sites, such as 'Ain Ghazal, Wadi Shu'eib, and possibly Basta (MUHEISEN 1995; ROLLEFSON and KÖHLER-ROLLEFSON 1993; SIMMONS *et. al.* 1988, 1989). At these large sites, an unbroken sequence from mid-PPNB through Pottery Neolithic is documented, with subsequent abandonment. While the PPNC appears largely restricted to major Jordanian settlements, it may also occur at smaller sites further to the west in Israel (*e.g.*, GALILI *et al.* 1993, GARFINKEL 1994). The implications of the PPNC are substantial, as it suggests local *in situ* development rather than abandonments and resettlement by "new" peoples whose material inventory now included pottery. Clearly, the adaptations occurring during the end of the Pre-Pottery Neolithic and extending into the Pottery Neolithic are much more complex than previously believed.

Regardless of precisely what happened at the end of the Pre-Pottery Neolithic, the larger PPNB sites contain all the "classic" elements that have interested researchers working with this period. These include architecture, abundant lithic materials, burials, ceremonial objects, such as the spectacular 'Ain Ghazal human statues (TUBB and GRISSOM 1995), and, perhaps most importantly, economic data in the form of plant and animal remains. This last information is, of course, crucial to understanding the economic transformations that highlighted the Neolithic. At 'Ain Ghazal, where interdisciplinary investigations concentrated on obtaining paleoeconomic data, a wide range of domesticated and non-domesticated resources characterized the PPNB phases - over 50 vertebrate species were exploited. In the subsequent phases, however, diversity was greatly reduced, down to only 15 species for the PPNC and even less for the Pottery Neolithic (KÖHLER-ROLLEFSON and ROLLEFSON 1990; ROLLEFSON and KÖHLER-ROLLEFSON 1989, 1993; ROLLEFSON, SIMMONS and KAFAFI 1992; SIMMONS *et al.* 1988). Unfortunately, botanical preservation, while rich in PPNB levels, was poor in PPNC and Pottery Neolithic deposits and precludes precise comparisons of plant resources, but the patterns seem clear.

In fact, during the Pottery Neolithic a general "deterioration" in many aspects of material culture has been demonstrated. Architecture is less substantial, chipped stone technology less sophisticated, and the artistic achievements of the PPNB are not matched. One has an overall impression of Pottery Neolithic life reflecting a generalized decline in the standard of living over earlier phases (KENYON 1960: 60, MELLAART 1975: 237-238, PERROT 1968: 404-416). While current research (*e.g.*, BANNING, RAHIMI, and SIGGERS 1994; GARFINKEL 1993) suggests that this is an over-simplification and has perhaps been exaggerated, there is no denying that the overall complexity and florescence seen during the PPNB disappeared by the Pottery Neolithic.

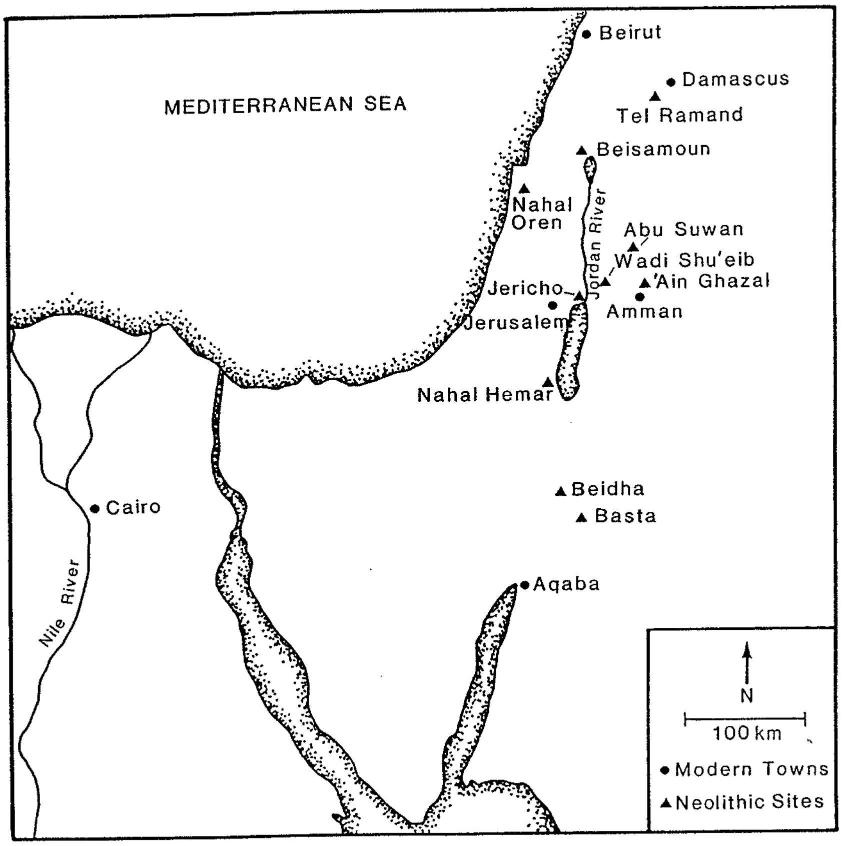

Fig. 1. Map of the Levantine Near East, showing some of the Neolithic sites mentioned in the text.

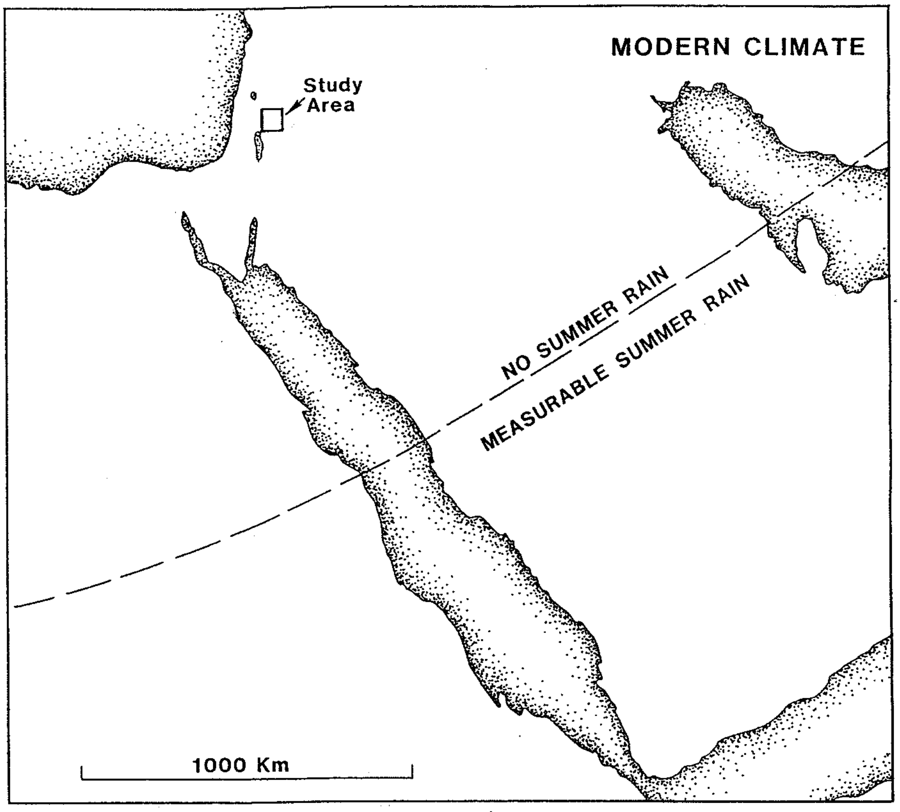

Fig. 2. Modern boundary for monsoonal summer precipitation.

To add to the complexity, recent research at large Jordanian settlements has modified our view of Neolithic developments in the Levant. We now know that there are numerous large Neolithic settlements located, essentially, along the eastern edge of the Levant. These include 'Ain Ghazal, Wadi Shu'eib, Basta, and Abu Suwwan (although the later has not been investigated). These enormous Neolithic centers were substantially different than those closer to the Mediterranean coast, in what Bar-Yosef and Meadows (1996: 73-74) have termed the "Levantine Corridor." There, different processes were occurring, often with the result of abandonment, but frequently subsequent resettlement, of favored locales (*e.g.,* Jericho) (see GOPHER 1994 and BAR-YOSEF and MEADOWS 1996 for summaries). Huge Jordanian settlements such as 'Ain Ghazal and Wadi Shu'eib, in contrast, represented unique desert-edge adaptations (SIMMONS 1995a). These settlements were initially founded during the mid-Neolithic, with earlier developments (such as PPNA) apparently occurring primarily to the west. It is possible that natural population increase in the west associated with sedentary Neolithic economies ultimately depleted local environments and that an adaptive strategy was to abandon established settlements and expand eastward towards the desert margins. Large sites such as 'Ain Ghazal perhaps served as population "magnets," with the consequence of dramatic population increase centered into a few nearly urban centers (SIMMONS 1995a).

The focus of this discussion is on these large sites. It is important to note, however, that while this pattern appears to be accurate for west-central Jordan, there is considerable diversity in Neolithic settlement types in the southern portion of the country. There, a complete range of Pre-Pottery Neolithic sites exist, including large settlements such as Basta (MUHEISEN 1995, NISSEN 1990) and Es-Sifyia (MAHASNEH 1995) that may contain PPNC components. More modest villages, such as Beidha (KIRKBRIDE 1966, 1968), Khirbet Hammam (ROLLEFSON and KAFAFI 1985), and Ghwair I (NAJJAR 1994) also are documented, as are specialized sites with no or limited architectural features. These include Dhra', near Safi, (BENNETT 1980, RAIKES 1980), the Hisma Basin in Wadi Rumm (KIRKBRIDE 1978, JOBLING and TANGRI 1991, VIANELLO 1985), the adjacent Wadi Hafir (BORZATTI VON LÖWENSTERN 1984), and between Aqaba and Ma'an, where nearly 20 stone circle sites datable to the PPN have been recorded (JOBLING and TANGRI 1991: 147). We note though that Pottery Neolithic sites appear rare in southern Jordan. Those that are known appear to be related to either the Jericho IX PN or the Qatifian variant of the Wadi Raba PN (*cf.* GOPHER and GOPHNA 1993: 318, 337; GOREN 1990).

This diversity in the south has prompted some authors (*e.g.,* JOBLING and TANGRI 1991: 147) to suggest that the Neolithic adaptation here was one characterized by seasonally mobile hunters and gatherers. Such a strategy has been suggested for Neolithic sites in the Sinai (*e.g.,* BAR-YOSEF 1981a, TCHERNOV and BAR-YOSEF 1982). While this may be the case for some areas, the village sites such as Basta and Es-Sifyia clearly do not support such a model. Another observation about this region that demands explanation is the scarcity of Pottery Neolithic sites. Obviously there are some very interesting and highly variable Neolithic events occurring in this arid region. Overall, unfortunately, few sites have been systematically investigated and very little is known of Neolithic adaptations in the challenging ecological setting posed by southern Jordan, as Rollefson and Kafafi (1985: 69) have noted. Certainly, none of the above projects have taken the explicit ecological approach used at 'Ain Ghazal, so it is difficult to make direct comparisons. What is interesting, however, is that this diversity does not seem to occur in central Jordan. Although huge villages are common there, the small sites so typical of the southern and eastern desert areas of Jordan do not appear to be as abundant. This could, of course, be a reflection of research bias.

Paleoecological Perspective: Human-Induced Ecological Degradation and Climate Change

It is unlikely that pre-agricultural Near East populations had a serious impact on the landscape. This changed dramatically with the Neolithic, when intense human exploitation of natural resources and modification to the landscape had an irreversible environmental impact (*cf.* HERSHKOVITZ 1989, KÖHLER-ROLLEFSON and ROLLEFSON 1990, SIMMONS *et al.* 1988). The constellation of agriculture and animal husbandry had substantial ecological consequences, ultimately straining the landscape. This would have been particularly acute at sites such as the large Jordanian settlements, which were located in ecologically fragile zones to begin with. While the pattern of population aggradation and pooling of scarce resources was initially adaptive, eventually it also depleted the environment. This resulted in critical resource shortages that first required an economic split between farmers and herders, and ultimately resulted in the abandonment of the large Jordanian villages and an increase in pastoral activity at the end of the Neolithic (*cf.* KÖHLER-ROLLEFSON 1992). All of these cultural developments were occurring, we believe, against a backdrop of steadily deteriorating climatic conditions (*cf.* DAVIS *et al.* 1990).

Largely as a result of interdisciplinary investigations at large Jordanian settlements such as 'Ain Ghazal and Wadi Shu'eib, the traditional view of Neolithic adaptation has been challenged over the past 15 years. As just noted, these huge settlements differ substantially from both more western and northern Neolithic communities. For example, they dwarfed contemporary Jericho further to the west. They were occupied continuously from the PPNB through the Pottery Neolithic phases, and they lack the presumed hiatus between aceramic and ceramic phases. Rather, an unbroken development occurred during the previously mentioned transitional PPNC phase. What is equally intriguing about these sites is that they remained abandoned after the Neolithic, in stark contrast to Neolithic sites closer to the Mediterranean, where favored locales frequently were re-occupied after a hiatus from terminal Neolithic occupations (SIMMONS 1995a).

The reasons for this abandonment are undoubtedly complex, but compelling arguments have been made that these Neolithic villagers totally depleted their environment. The most thorough argument proposes that over two thousand years of successful agricultural and herding strategies, initially mutually compatible, finally had a combined effect of severe environmental degradation. The cultural response to this was the beginnings of the famed Near Eastern dichotomy between the "desert and the sown," or between village farmers and pastoral nomads (KÖHLER-ROLLEFSON 1988, 1992; KÖHLER-ROLLEFSON and ROLLEFSON 1990; ROLLEFSON and KÖHLER-ROLLEFSON 1989; SIMMONS *et al.* 1988).

At issue is the question of to what degree these changes were driven by climatic variables as well as culturally induced ones. While we know that Neolithic peoples had a severe effect on the natural landscape, it is altogether another problem to document this systematically at individual sites. How do we convincingly demonstrate human vs. natural impacts on the environment? Köhler-Rollefson and Rollefson (1989, 1992) clearly prefer a model where environmental degradation was culturally induced. However, the role of climatic change also must be considered. Certainly, climatic variations have long been invoked as an explanatory scenario in the Near Eastern Neolithic. Most models, however, have dealt with this as a device for stimulating agricultural *origins* (*e.g.,* MCCORRISTON and HOLE 1991, MOORE and HILLMAN 1992) and have not addressed subsequent events.

Using a variety of paleoenvironmental techniques, such as pollen analysis from sites and lake and sea cores, lake levels, geomorphology, and floral/faunal distributions, we may be able to demonstrate overall regional climatic deterioration, but can this be specifically documented at individual sites? Recently, supporting evidence has in fact been observed at some major settlements. Based on regional archaeological, climatic, and geological data, we believe that the combination of renewed summer drought in the Levant during the Pottery Neolithic, the cumulative impacts of expanded human population, intensive agriculture and herding, and deforestation for fuel together caused an environmental crisis resulting in a degraded landscape that has dominated human adaptation in the region ever since (DAVIS *et al.* 1990, SIMMONS 1995b). The evidence for the *climatic* component of this complex equation is in the form of massive cobble layers in the upper strata of sites such as 'Ain Ghazal, Wadi Shu'eib, and Abu Thawwab (KAFAFI 1988). Their interpretation has been problematic, but our research (DAVIS *et al.* 1990) suggests that the cobbles represent direct evidence for increased rainfall associated with summer monsoons during the Pre-Pottery Neolithic. It is worthwhile to consider this is more detail.

Paleoenvironmental research employing General Circulation Models (GCMs) of the atmosphere consistently shows that a major aspect of climate from between 11,000 to 7,000 years ago was the enhancement of summer monsoons (DAVIS *et al.* 1990, KUTZBACH and GUETTER 1986, KUTZBACH *et al.* 1993). This increase in summer precipitation is based primarily on the study of changing lake levels (STREET and GROVE 1979). The monsoons are driven by summer heating over the continents. Specifically, stronger heating about 9,000 years ago drew significantly more moisture from the subtropical oceans into continental interiors and generated summer thunderstorm rains. This both increased summer precipitation amounts in areas that now still receive summer precipitation and expanded the area of summer precipitation. While it has been suggested that subtropical monsoons did not extend into the mid-latitudes of the Middle East (STREET-PERROTT and ROBERTS 1983), this position has been questioned (EL-MOSLIMANY 1994: 128). Davis *et al.* (1990) believe that the Levant, in fact, was on the edge of the expanded areas of summer precipitation. Such a position also is supported by palynological data (*e.g.,* EL-MOSLIMANY 1994). Roberts and Wright (1993: 218) note that paleoclimatic data in the form of higher lake levels, stabilized sand dunes, and a shift from desert or semidesert scrub to savanna grassland vegetation are in excellent agreement with the GCM scenario, at least for the southern-eastern part of the Near East.

Modern climate in the Levant rarely if ever includes summer precipitation (Fig. 2). Recent weather records show that the northernmost effect of the summer precipitation of the monsoon is at about the Egypt-Sudan border and through Jeddah and Riyadh in Saudi Arabia. A movement of the summer monsoon about 1,000km to the northwest from its present position, however, would produce measurable summer precipitation in the Levant. GCM results suggest that this was so about 9,000 years ago, to at least a limited extent (DAVIS *et al.* 1990).

We (DAVIS *et al.* 1990) hypothesized that increased summer precipitation indeed affected the Levant from about 11,000 to 9,000 years ago, with a monsoon maximum at *c.* 9,000 years ago. The beginning of this is precisely the time that the Neolithic began in earnest, while the initial decline in precipitation roughly corresponded with the collapse of the PPNB.

This is of course an immensely complex issue that we cannot do justice to here. For example, McCorriston and Hole (1991) and Moore and Hillman (1992) offer alternate climatic scenarios that suggest increased dryness for stimulating agricultural origins. It is clear, however, that there were substantial climatic differences at least between 6000 B.P. and today and between 9000 B.P. and today (ROBERTS and WRIGHT 1993: 215). What is at issue here is that a variety of paleoenvironmental data often present conflicting interpretations. For example, palynological data indicate that parts of the eastern Mediterranean were drier than at present during the early Holocene, while the GCM position suggests the opposite (ROBERTS and WRIGHT 1993: 218). It is important to realize, however, that *increased* precipitation, as proposed here, does not necessary translate into increased *effective* moisture. It is thus possible to have short-term and intense seasonal precipitation in conjunction with overall increasing aridity.

In any event, initially this postulated increased precipitation may have helped propel the Neolithic. By *c.* 9000 B.P., a Mediterranean climatic regime apparently was well established in the Levant (ROBERTS and WRIGHT 1993: 201). However, at roughly the same time, summer precipitation may have declined and ceased altogether by about 7,000 years ago. This corresponds with increased human-induced environmental degradation, brought about by intense farming and herding, and eventual abandonment of major Jordanian centers at the end of the Neolithic.

Precise evidence for the incursion of subtropical moisture into the Levant at individual Neolithic sites is scant but tantalizing. We have suggested that loss of agricultural productivity may have begun with erosion by torrential summer rains (DAVIS *et al.* 1990). Land previously forested but now cleared for fields, pastures, fuel, and settlements would have been especially prone to erosion. Rollefson (1990), in fact, has indicated that the insatiable PPNB use of lime plaster would have been one variable accelerating the decline in trees needed as fuel to produce the plaster. Reduction in precipitation may ultimately have limited upland cereal grain production, without actually making agriculture impossible. Drop in productivity, but continued high population, may have contributed substantially to the end of the PPNB fluorescence. The adaptive response to this was the divergence of farming and herding activities.

Evidence for this comes from a regional perspective and is in the form of slope instability at several Jordanian Neolithic sites. This appears as fine-grained colluvium and slopewash interlayered with cultural debris, and as layers of the aforementioned comparatively well-sorted cobbles at sites such as 'Ain Ghazal, Wadi Shu'eib, Abu Thawwab, and possibly Basta. Although these layers have not been studied in the detail they deserve, they appear to occur in late PPN and Pottery Neolithic contexts. The cobble layers may be attributed to debris flow that was caused by torrential summer thunderstorms - the physical manifestation of the increased monsoonal pattern. Erosion could have been accelerated via debris flows that mobilized the cobbly sediment, especially if surrounding vegetation had been substantially reduced by the cumulative effects of both human activity and increasing aridity. Thus we suggest that the cobbly layers observed at these sites indicate an increased incidence of torrential precipitation. Because torrential precipitation is much more common during the summer than the winter, this constitutes plausible evidence of an early Holocene incursion of subtropical moisture into the Levant.

Based on the GCM data presented earlier, the timing of this maximal precipitation would have been at *c.* 9,000 years ago, during the PPNB. Following the PPNB, summer precipitation gradually declined, ultimately resulting in summer drought by the end of the Neolithic. Thus, during the late Neolithic inhabitants of many of the large Neolithic settlements may have been subjected to literal "floods" of cobbles on an annual basis. This was largely brought on by their having denuded much of the vegetation that could have minimized cobble erosion. Following the Pre-Pottery Neolithic, drought conditions would have caused more difficulty in productive agriculture, thus leading first to the divergence of farming and herding and ultimately to the abandonment of the large settlements.

Conclusions

There may be alternate explanations for the presence of the massive layers of cobbles at sites such as 'Ain Ghazal, Abu Thawwab, and Wadi Shu'eib. The only way to resolve the issue is through a regional approach to see if any consistent patterns emerge. A much larger site sample, including both large villages and smaller settlements, geological study of non-site areas, and refined chronology to pinpoint when the cobble layers were deposited are clearly needed. In formulating this type of research, several questions can be posed. For example, do the numerous Neolithic sites in southern Jordan exhibit similar patterns, where, as noted earlier, a wide diversity of site types occur? Basta, in the south, appears to contain the cobble layers, but we do not know if they exist at other sites. Another question is: do the cobble layers only occur at large settlements, which is where they have thus far been documented (although Abu Thawwab is smaller than the other major settlements considered here). Finally, and critically, if cobble layers can be documented at other Neolithic sites, where do they fall in the chronological sequence? Are they only present in late Pre-Pottery and early Pottery Neolithic contexts? This is important because in the scenario developed here, it was necessary for substantial cultural impacts, in the form of removing vegetation from hill slopes, to have occurred first, easing the erosion of the cobbles into the settlements.

In order to address these questions, it is necessary to conduct systematic geoarchaeological investigation of a large sample of site types and phases occurring over a variety of environmental settings. While such a task may appear daunting, in fact much of this research could be accomplished relatively inexpensively. Many of the Neolithic sites recorded in the Levant have substantial erosional (or modern cultural) cuts, thus exposing sections. If the cobbles are present, they should be clearly visible to the educated eye of a geoarchaeologist knowing what to look for. In addition, on-going excavations at Neolithic sites should make an effort to record and clearly describe any cobble layers that might be encountered.

While many issues remain unresolved, we are convinced that these cobble layers do in fact represent concrete *in situ* archaeological examples of a constellation of both humanly induced environmental degradation in conjunction with heavy summer precipitation. In their zeal to increase arable land and obtain fuel, Neolithic peoples cut down the very vegetation that previously had served as a retardant to erosion. Without the vegetation, which may have already been stressed by increasing aridity, there was no resistance to more active slope wash, accelerated by torrential summer rains. The result was that settlements were subjected to annual "floods" of cobbles. These events were occurring after the PPNB florescence, against a backdrop of steadily deteriorating (*i.e.*, increasing aridity) climatic conditions. All these activities influenced Neolithic settlement landscape activity, ultimately contributing to the forced abandonment of major villages.

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Technological Strategies at a Late Neolithic Farmstead in Wadi Ziqlab, Jordan

Edward B. Banning and Julian Siggers

Abstract: *Excavations at Tabaqat al-Bûma, a small Late Neolithic site in northern Jordan, provide the basis for research into the reasons for technological changes that followed the collapse of the Pre-Pottery Neolithic B (PPNB) complex at the end of the ninth or beginning of the eighth millennium bp. The site appears to have been a largely self-sufficient farmstead, probably occupied by only one or two conjugal families from 6700, or earlier, to 6200 bp (5600 - 5100 cal BC) (BLACKHAM n.d.). The initial impression of the site's lithic, ceramic and bone technologies is their pragmatism. Here we take the theoretical perspective that levels of design investment and technological standardization are proportional to the level of risk that technological applications involve in an attempt to explore technological change in the Neolithic.*

Introduction

Tabaqat al-Bûma (Fig. 1) was discovered by a small sounding in 1987 and was subject to excavations in 1990 and 1992 (BANNING *et al.* 1989, 1992, 1994; BANNING 1995). The earliest Neolithic use of the site appears to have been as a cemetery in the eighth millennium bp. Subsequently, a series of construction episodes (see BLACKHAM, this volume), each involving one to three structures, resulted in the development of a small settlement only about 1000m^2 in extent that we interpret as a farmstead. Most of the structures consist of a single "broad" room ranging from about 8m^2 to about 15m^2 in size and constructed of double-leaf stone walls without foundation trenches (Pl. 1). Some of the structures had crude cobblestone floors; others had only earth floors. Features in some of the structures included plastered hearths, a mud-lined silo, a large limestone mortar, and small platforms.

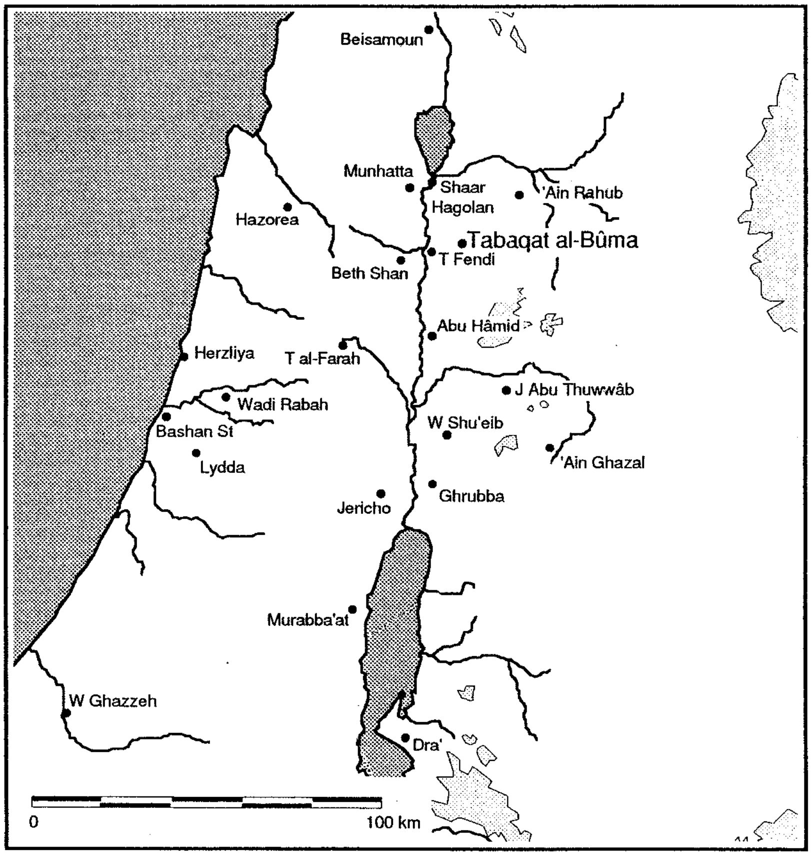

Fig. 1. Location of Tabaqat al-Bûma in northwestern Jordan, and other Neolithic sites in the southern Levant (drawing by E. Banning).

Technological Repertoire at Tabaqat al-Bûma

The bulk of the artifacts from Tabaqat al-Bûma consists of ceramics and lithics. The excavations recovered only very small numbers of bone artifacts and only indirect evidence for textiles. One of our first impressions of this assemblage was that it resembled a farmers' tool kit: most of the tools were crudely executed but functionally efficient. We believe that the *ad hoc* nature of Late Neolithic lithic and ceramic technology was a technological response to economic and settlement change during this period. The lithic and pottery repertoire was produced by the local inhabitants for strictly local consumption. Technological change during this period reflects the new risks and pressures involved with Late Neolithic settlement and economic behaviour (BANNING *et al.* 1994; SIGGERS n.d.a, n.d.b).

Plate 1. View of structure E33 <*right*> at Tabaqat al-Bûma, with large limestone mortar in centre of floor (photo by T. Dabney).

The Lithics

In the broadest sense, the assemblage is made up of two major categories of tools: flake tools with no or minimal retouch and formed tools made on flakes and blades. Flake tools make up the majority of the sample (see Tables 1 and 2), and the formed tools are limited to few classes, of which sickle blades predominate. The sickle blades have a range of morphologies. Most have a denticulated working edge with either abrupt or semi-abrupt backing, and about 90% of them exhibit sickle polish. Other formed tools include adzes, awls, borers, burins, scrapers and retouched and unretouched used blades (Figs. 2-3). Retouched blades include endscrapers, burins and backed pieces. No complete projectile points have been found. Of the formed tools, the metric dimensions illustrate that there is considerably less consistency than in the corresponding tool forms recorded in the aceramic Neolithic. Cherts in this area of Jordan are from Eocene limestone formations and are highly variable in quality. The majority of the formed tools were made of chert of high to medium quality, available 500m west of the site, while the expedient flakes were made of material of medium to poor quality available in the immediate vicinity.

Recovered ground stone is fairly limited (Fig. 4), but it includes large querns, handstones, a stone bowl, small mortars, one very large limestone mortar, some basalt pestle fragments and a complete

Table 1. Tool types from secure Late Neolithic living surface contexts.

	N	Percentage
Flake Tools		
Unretouched Used Flakes	125	38.1
Retouched Flakes	79	24.1
Flake Formed Tools	27	8.2
Blade & Bladelets		
Retouched Blades	18	5.5
Unretouched, Used Blades	12	3.7
Blade Fragments	23	7.0
Retouched Bladelets	4	1.2
Unretouched Used Bladelets	14	4.3
Bladelet Fragments	3	0.9
Sickle blades	21	6.4
Core Tools	2	0.6
Total	328	

Table 2. Lithic distribution from 1992 excavations from all Late Neolithic contexts except surface and mixed horizons.

	N	Percentage of Tools
Used Unretouched Flakes	283	28.6
Retouched Flakes	169	17.1
Burins	10	1.0
Awls	15	1.5
Adzes	4	0.4
Sickle Blades	62	6.3
Used Unretouched Blades	91	9.2
Backed Blades	9	0.9
Retouched Blades	40	4.0
Blade Fragments	126	12.8
Used Unretouched Bladelets	40	4.0
Backed Bladelets	30	3.0
Retouched Bladelets	21	2.1
Bladelet Fragments	88	8.9
Single-Platform Cores	29	n/a
Multi-Platform Cores	8	n/a
Bladelet Cores	13	n/a
Debitage (Fine Grain Chert)	560	n/a
Debitage (Medium Grain Chert	2322	n/a
Debitage (Coarse Grain Chert)	741	n/a
Debitage Total	3623	n/a
Total	4661	

Table 3. Ceramic types from all Late Neolithic contexts. Numbers in parentheses indicate totals including sherds of less certain form.

Ceramic Form	N	Percentage
Cups (diameter < 11 cm)	21 (55)	10 (15)
Hemispherical	9 (21)	4.5 (5.8)
Concave or carinated	3 (4)	1.5 (1.1)
Vertical or slightly inverted	4	2.0 (1.1)
Vertical or slightly everted	1	0.5 (0.3)
Outward inflexion	4	2.0 (1.1)
Bowls (diameter > 10.9 cm)	64 (187)	39 (52)
S-profile	4 (7)	2.0 (1.9)
"Lamps" or small, shallow bowls	6	3.0 (1.7)
Concave, carinated	12 (52)	6.0 (14)
Hemispherical	15 (28)	7.5 (7.8)
V-shaped (straight, open)	3 (36)	1.5 (10)
Inverted, outward inflexion	15	7.5 (4.2)
Vertical/everted, outward inflexion	5	2.5 (1.4)
Open, carinated	4	2.0 (1.1)
Total Bowls and cups	85 (242)	42 (68)
Jars		
Holemouth, simple rim[2]	62	31 (17)
Holemouth, thickened rim[3]	13	6.5 (3.6)
Holemouth, T-shaped rim	3	1.5 (0.8)
Everted neck	4	2.0 (1.1)
"Bow rim"[4]	1 (3)	0.5 (0.8)
Total Jars	83 (85)	41 (24)
Indeterminate large forms[5]		
Slightly inverted	14	7.0 (3.9)
Vertical	7	3.5 (1.9)
Everted	12	6.0 (3.3)
Total Rim Sherds	201 (360)	

[1] In particular, note that many of the uncertain "cups" and even some of the "bowls" could actually belong to the upper portions of jar necks (e.g., "concave cups" could be "bow-rim" necks).
[2] The rim profiles are symmetrical and round, bevelled or slightly pointed. The bevels usually slope down on the interior, perhaps to facilitate covering with a lid.
[3] The thickening is assymetrical, usually on the interior, and bevelled down on the interior.
[4] Here defined by sharp angle at the shoulder join, as only one complete bow-rim (and that an atypical one from the A.72 cist grave) was found.
[5] Most of the following probably belong to jar necks but, because they show no evidence of the shoulder and there is nothing particularly jar-like about their size or fabric, many could as easily belong to deep bowls or craters.

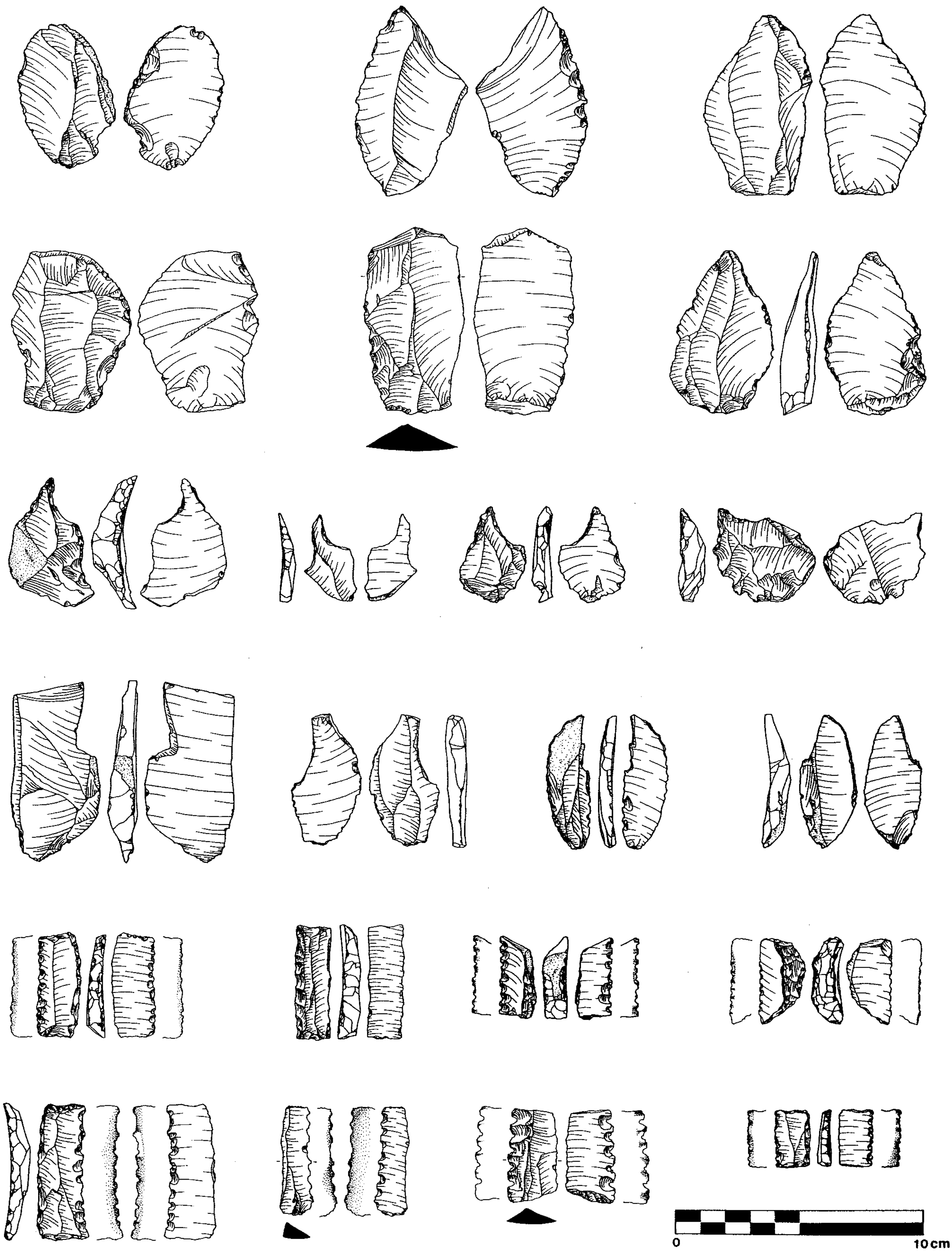

Fig. 2. A selection of "expedient" and "formed" tools from Tabaqat al-Bûma (drawings by J. Pfaff): Rows 1 and 2 utilized flakes, Row 3 awls/ borers, Row 4 burins, Rows 5 and 6 sickle blades.

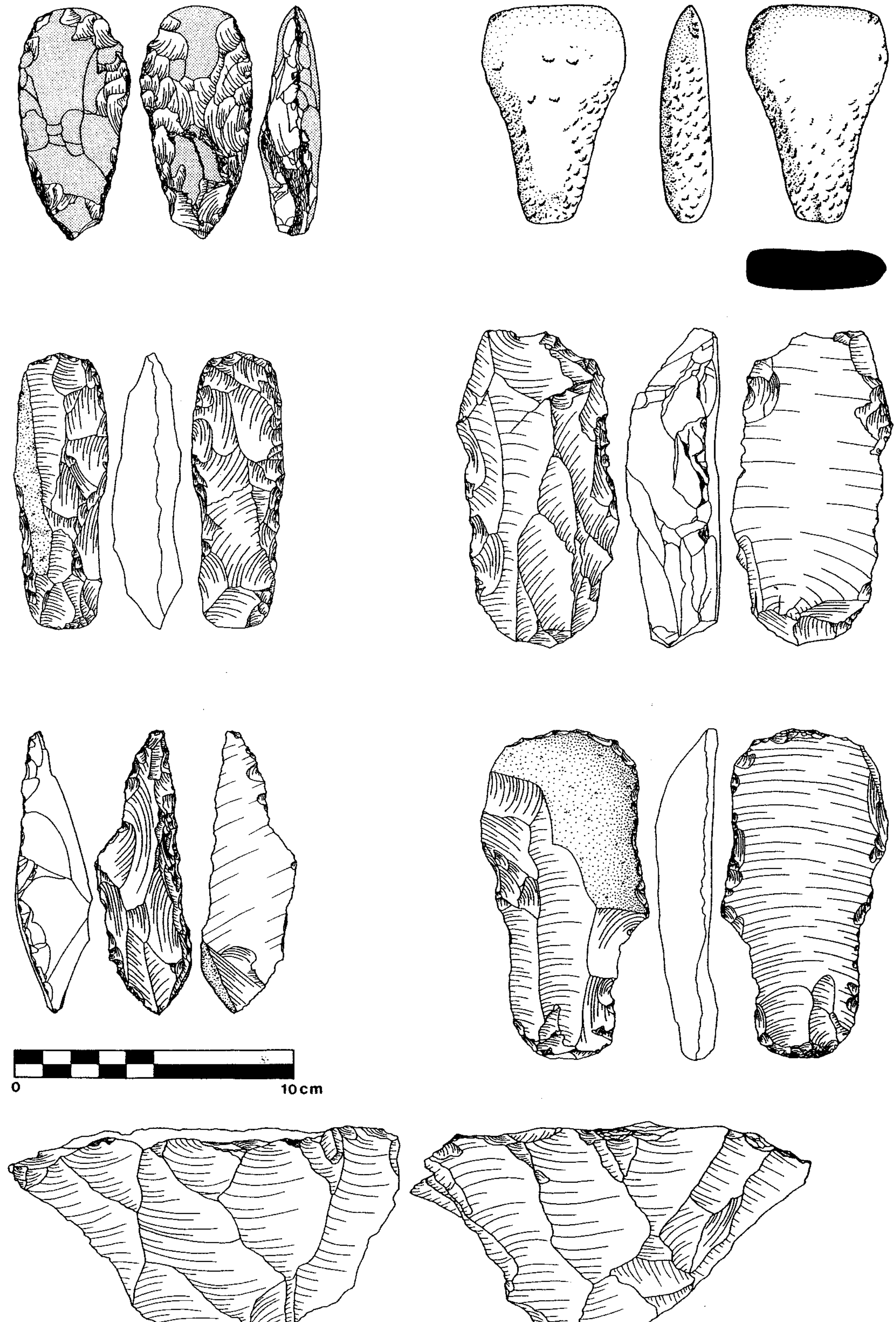

Fig. 3. A selection of heavy duty tools and a single-platform core from Tabaqat al-Bûma (drawings by J. Pfaff).

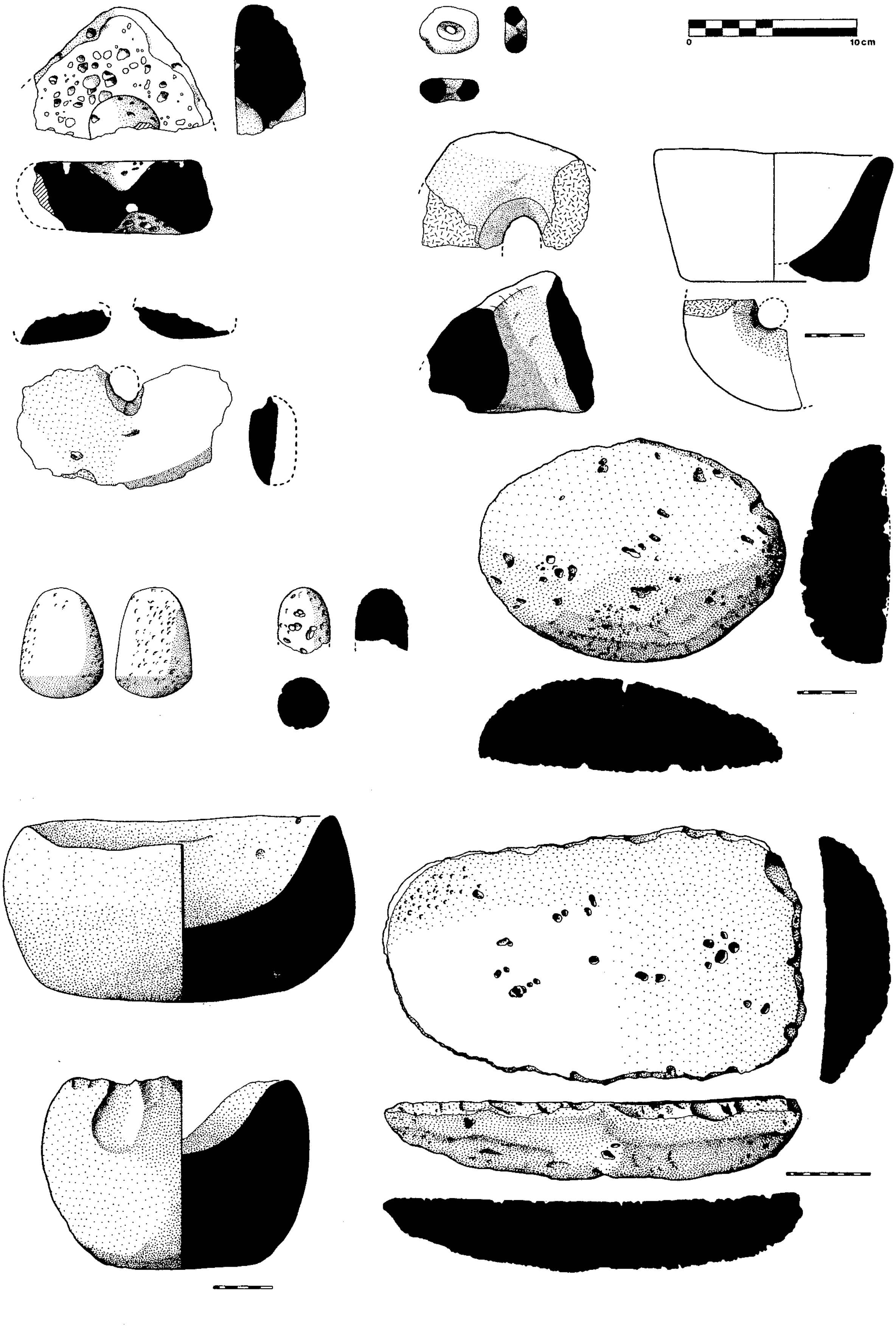

Fig. 4. A selection of ground-stone tools from Tabaqat-al-Bûma (drawings by J. Pfaff).

small pestle, and a single pecked basalt adze-like tool. There are also small, mortar-like stones that are likely cap-stones for bow-drills.

Tables 1 and 2 present tool types and lithic data from two levels of contextual integrity: the first table includes only tools recovered from secure Late Neolithic living surfaces; and the second includes tools and debitage from all excavated horizons except surface contexts, contexts of Roman or later age and those which were mixed with earlier Kebaran occupation.

When one considers the risks involved with the prehistoric tasks that the inhabitants of Tabaqat al-Bûma encountered, the dichotomous nature of the tool assemblage is understandable. With the advent of more sedentary settlements in the Neolithic, the nature of subsistence risk changed. With subsistence now focused on pastoralism or agriculture or both, the risks involved were no longer the short-term risks associated with hunting and gathering, but ones associated with crop and storage failure (TORRENCE 1989). The assemblages at Neolithic sites such as Tabaqat al-Bûma probably reflect the risks involved with this fundamentally different mode of subsistence (BANNING *et al.,* 1994). Tool forms whose manufacture represents a high level of expertise and large amounts of time and energy input, such as the sickle blades and adzes, could reflect a technology that needs to be more efficient and reliable, as its role in the subsistence economy was critical. The inferred use of sickle blades is cereal reaping. The window of opportunity for harvesting can be narrow (UNGER-HAMILTON 1989). Moreover, harvesting is well attested as "the most important activity of the agricultural year" for cereal-based agricultural communities in ancient Syro-Palestine (BOROWSKI 1987: 57). This was probably also the case in Neolithic agricultural communities such as Tabaqat al-Bûma.

Unlike the subsistence base of the Pre-Pottery Neolithic, which spread risk out by exploiting many strategies, Late Neolithic communities appear to have focused on far fewer resources. Although the limited exploitation of wild cattle, deer and pigs in the Late Neolithic would help to buffer against subsistence failure, the degree of risk that a predominantly agricultural subsistence entailed would be high, especially when compared with the Pre-Pottery Neolithic. Consequently the efficiency of the sickles used would be of great importance. On the other hand, the *ad hoc* nature of most of the flake tools may be a reflection of the lack of critical risk in the tasks for which they were used. In turn, this would imply that the set of behaviours with which the basic tools were involved represented a low level of risk. They were used to undertake non-critical jobs in and around the household that, unlike high-risk tasks, were not severely temporally restricted. However, this does not imply that basic tools are necessarily less efficient than formed tools at satisfying the requirements of a particular task. When the design requirements are fairly broad, both highly designed and "basic" tools may work equally well, although the basic one may fail (break or dull) more frequently, while being less costly to replace. The tool forms that we see reflect the manufacturer's compromise between these factors. In this assemblage, it is the formed tools, not the basic tools, that are anomalous.

Variability in the selection of chert for the manufacture of tools sheds further light on this issue. Unretouched and minimally retouched flake tools were often made of coarse and medium-grained chert, whereas formed tools were made using medium or, more often, fine-grained cherts that are not readily available in the immediate vicinity of the site. We believe that this reflects the levels of risk associated with these tool categories. Formed tools are often expected to perform with greater efficiency and reliability (PYE 1964), so are made from more finely grained raw materials that are easier to work and therefore can produce tools to stricter design perimeters. Conversely, the expedient nature of tasks associated with flake tools does not necessitate raw material of highest quality, so the abundantly available coarser cherts were deemed adequate. The ground-stone grinding equipment, which plays a central role in the subsistence of the site's inhabitants (the processing of flour) was made of basalt. The nearest sources in a linear direction are in the Wadi al-Arab, 15km to the north, and the northern Jordan Valley to the west. Because the basalt grinding equipment was vital to the agricultural system of the site, the travel costs of basalt were justified.

Ceramics

Pottery, one of the innovations of the Late Neolithic, possibly absorbed much of the design effort that lithic technology gave up or redirected. Although Tabaqat al-Bûma may not have the earliest pottery in the southern Levant, it nonetheless shows signs of being a relatively new technology. On the one hand most of it is relatively poorly fired and has not held up very well to the ravages of time. On the other, it shows a wide variety of forms (Fig. 5) and some variety in fabric that betray some technological sophistication.

Except for a small number of whole and restorable vessels from a cist grave in the deepest Neolithic deposits at the site, our evidence for the form of most vessels is limited and does not provide a reliable basis for typological analysis. Where forms can be distinguished with some confidence, however, we show their distribution in Table 3 to allow comparison with other published assemblages and to provide some hints as to the functional emphases of vessel technology at the site. Prominent among them are forms probably used for serving and consuming food and beverages, but jars are

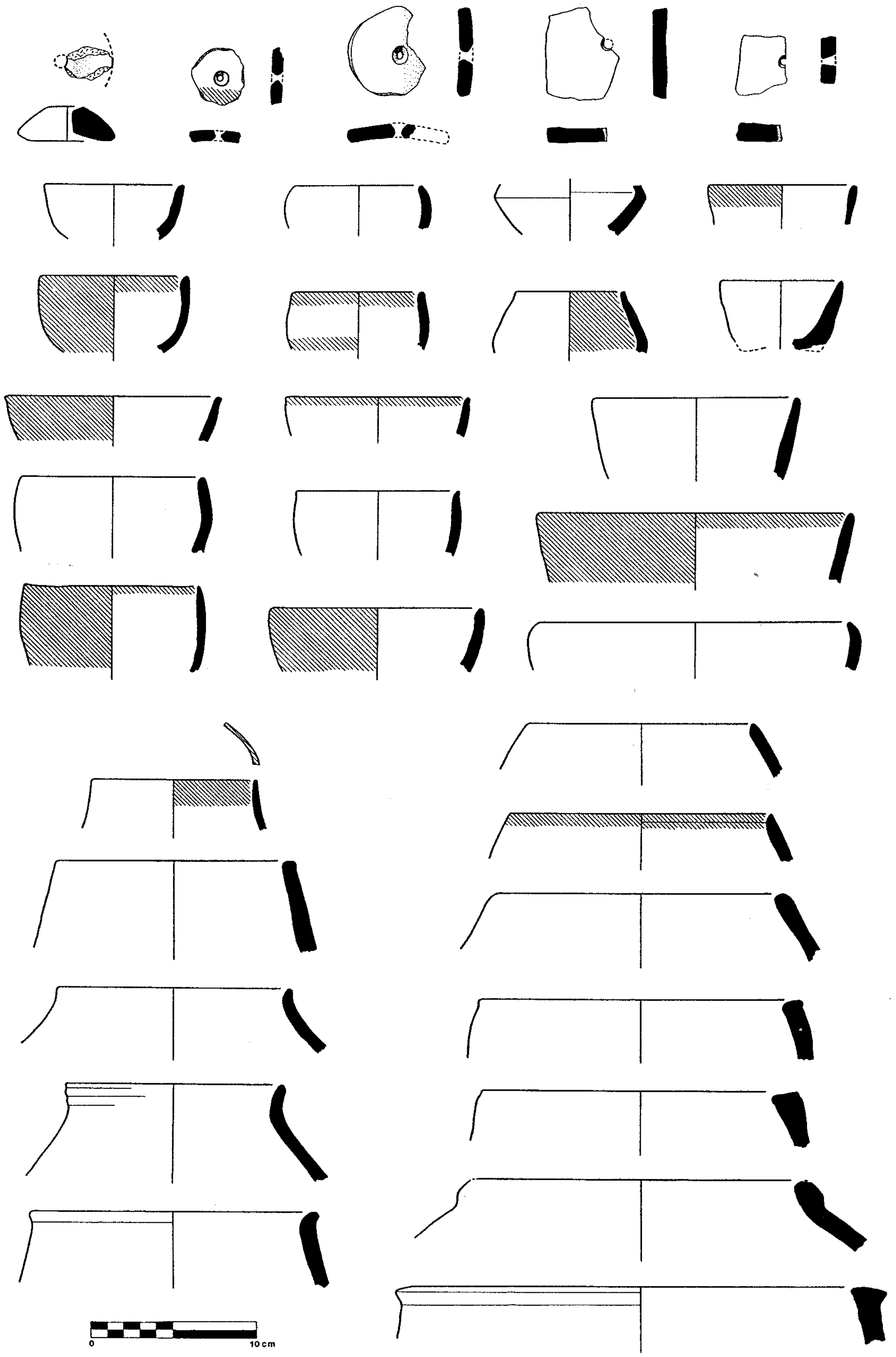

Fig. 5. A selection of pottery from Tabaqat al-Bûma (drawings by J. Pfaff).

possibly underestimated because the statistics are based on rim sherds. Recognizable bases are predominantly simple and flat, but concave bases occur in all of the complete and restorable vessels from the earliest Late Neolithic phase, and disk bases, many probably belonging to S-shaped bowls, also occur. Round bases have been identified but are probably greatly underrepresented in the identified sample.

Most of the pottery has one of two fabrics. One group is characterized by subrounded inclusions of limestone, chert and crystalline quartz ranging from grit to coarse sand. The other, of similar grade, has inclusions consisting principally of nodules of silty, calcareous clay. More rarely, sherds exhibit a fabric of coarse grains of limestone with abundant foraminifera and fine silt quartz. Rarer still are sherds from vessels, thought to be exotic, that exhibit coarse sand-grade inclusions of rounded basalt (R. Mason, pers. comm.). The latter seems to be similar to fabric groups VL1 and VL6 at Munhata (GOREN 1992: 334).

Apart from vessels, the only significant use of ceramic technology appears to have been to produce small, pierced ceramic disks, possibly used as spindle whorls, although most of them are rather light. Most of these are fashioned from relatively flat body sherds. The biconical section of the hole indicates piercing by a stone drill. The edges were shaped by chipping and grinding. There is one example of a pierced ceramic plaque (with at least one rectilinear corner) of unknown function.

The rapid development of ceramic vessel technology in the Late Neolithic throughout the Levant and its thorough replacement of "white ware" plaster vessels found in the PPNB suggest that containers for secure storage and boiling food, and vessels for serving food, had suddenly become critically important. This should be seen in the context of rapidly increasing dependence on cereals, pulses and, perhaps, dairy products for the economic and social maintenance of Neolithic communities.

Bone

Bone tools were rare and consisted mainly of awls, awl fragments, and flat polished pieces of spatula-like tools, possibly used in weaving. There is a single example of an elongated, flat, bone artifact of unknown function in which several small holes have been drilled. Bone preservation at the site was relatively poor, and our sample probably underrepresents bone tools.

Hypothesized Agricultural, Pastoral, and Domestic Tasks

Our approach to technology at this site is to attempt to relate variation in the design investment in artifacts to the potential risk of tool failure associated with the artifacts' use. The evidence of faunal and other remains suggests that Tabaqat al-Bûma was a small farmstead, and this allows us to make some hypotheses about the economic activities for which the tools were intended. In some cases ethnographic analogy can help us flesh out these hypotheses in more detail. Currently we are exploring the assemblage in terms of agricultural and pastoral activities, food preparation and storage, and house construction.

Most agricultural activities probably took place off-site and involved perishable tools, but tools were probably made and maintained on-site during the off-season. Axes, possibly in conjunction with fire (*cf.* STEENSBERG 1980), would have been used in land clearance, while digging sticks would have been used to prepare the ground for planting. A single ground-stone hoe-like tool (Fig. 3) found during the 1992 field season may also be evidence for ground preparation. Broadcast sowing would have involved use of a bag, basket or other vessel to transport the seed from storage facilities on the site, but it would difficult to identify these containers archaeologically. Tending and weeding the fields need not have required any tools, but reaping was a particularly important activity that had to be carried out efficiently and rapidly. Denticulated sickle blades, one of the most abundant categories of formed tools, would have been part of composite tools that could be resharpened or, as long as replacement elements were kept on hand, repaired quickly in the field. Threshing, winnowing and sieving of grain and other seed crops were critical activities and would have depended on carefully made tools, but these would have been made of wood, gut, sinew and other perishable materials. These are only a sample of agricultural activities, and it is possible that some did not involve seed crops, although seeds and oil from them appear to have been predominant in early agriculture (*cf.* RINDOS 1984: 144-149).

Our working hypothesis is that pastoralism at the site was not nomadic, and that a herd, consisting mainly of goats, was small enough to be pastured year-round on the neighbouring hillsides and on the stubble of harvested fields. Modern agro-pastoralists in Wadi Ziqlab take their sheep and goats on a daily round up one slope and down another, altering the route each day so as to spread the grazing pressure. The hypothesis implies that fodder was stored for the months when pasture was in short supply. We might also expect some evidence of fences and animal dung. Additional hypotheses of interest are that the livestock were exploited for dairy products and hair or wool, and not only meat and hides. Henry (1995: 372) suggests that cortical "scrapers" may actually be designed for use in shearing sheep. Other tools that may be related to the processing of hair or wool include pierced ceramic disks (possibly spindle whorls).

Food preparation activities at the site may have included a number of processes to make grain, meat and milk either more storable or more usable in addition to roasting, boiling or frying food for consumption (STAHL 1989: 181),

Wheat and barley could have been used in a number of forms, including cracked wheat, flour, bread, and beer. Processing grain into flour may have increased its nutritional efficiency (STAHL 1989, WRIGHT 1993). Brewing, meanwhile, may have increased its attractiveness in other ways (KATZ and VOIGT 1986). The large limestone mortar from structure E33 at Tabaqat al-Bûma (Pl. 1) was probably used in combination with a wooden pestle or pounder to dehusk grain. It could also have been used to pound malted barley (CARSCALLEN n.d.). Several large loaf-shaped grinding slabs (Fig. 4), each made of imported basalt and representing considerable manufacture effort, were probably used for grinding grain into flour. Large jars with restricted orifices (bow-rims and everted necks), could have served for the fermentation and storage of beer. We have begun but not yet completed residue analyses to confirm these tentative functional identifications.

If, as we suggest, Tabaqat al-Bûma was an agro-pastoral site, its inhabitants able to store meat "on the hoof", smoking or drying meat may not have been important activities. This may be a point of contrast with steppe and desert PPNB sites, some of which may have depended on large gazelle kills (BETTS 1988) that would require processing to preserve the meat. In the neighborhood of "desert kites", wind-drying on portable racks would seem the most cost-effective method for preserving thin strips of meat. In some cases, however, it is possible that smoke from burning thyme or sage, both widely available in Mediterranean and steppic regions of the southern Levant, was used to produce cured meat. Here we may see another shift in subsistence-related risk: the Late Neolithic's much reduced reliance on hunting would have obviated the need for the rapid processing of large quantities of meat.

If dairying was already an important aspect of the agro-pastoral economy of the Late Neolithic, we might expect vessels suitable for the containment and transport of liquids and possibly for churning butter or heating it to make ghee. Excavations at the site have uncovered one example of what seems to be an early form of churn handle. Many of the jars have constricted and easily closed apertures that would make them suitable as containers for dairy products (as well as water or beer), but only residue analysis will allow us to determine whether or not they were used these ways. Any of the vessels that could have been used to make ghee would have been equally suitable for cooking.

At present it appears that all cooking at the site took place over open hearths, as we have not discovered any clay ovens. A number of the ceramic vessels have forms suitable for use as cooking pots. In particular, round-bottomed "jars" and "deep bowls" that would have had efficient heat transfer and could have rested on hearth stones are good candidates, but the sherd evidence underrepresents round bottoms because they are difficult to distinguish from body sherds, and we have yet to complete intensive searches for scorching and other signs of cooking use (*cf.* SKIBO 1992). The flat, plastered surfaces of hearths, however, would also have facilitated use of some of the flat-bottomed, neckless "jars" and deep bowls as cooking pots. Stahl (1989) showed how important cooking technology can be in improving the nutritional reliability and efficiency of foods.

Storage of food and fodder should have been critical if the site was indeed occupied year-round. Features at the site that may have been storage facilities include stone cists and a clay-lined bell-shaped feature built into the wall of structure D35. All of these were ultimately used for the interment of child burials, but they were probably originally designed as silos for the storage of grain or pulses. In addition, some of the structures on the site may have been designed for storage rather than habitation. In particular, the small room in Area E36 is less than 4m^2 in area, had a cobbled floor and a bench, and could have been used for storage of fodder. Stone or clay linings on storage pits and cobble floors represent investments in design, construction effort and materials concomitant with the importance of stored agricultural products in a self-sufficient farmstead.

In general, the structures at Tabaqat al-Bûma do not involve quite as much design investment as those of the PPNB complex, but perhaps more than some researchers have implied in their claims that Late Neolithic architecture constituted a "degeneration" (AHARONI 1978: 32, KENYON 1979: 43, YASSINE 1978). In particular, they lack the plaster floors that are typical in PPNB sites in the region; the use of plaster was restricted, it seems, to special features such as hearths. Tabaqat al-Bûma displays two plastered hearths: a circular one in G34 and an oblong or horseshoe-shaped one in the earliest phase of E33 (predating construction of the structure shown on the plans). The latter seems similar to the hearth in the only well preserved structure from Beisamoun (LECHEVALLIER 1978) as well as to the plastered features at 'Ein el-Jarba that Kaplan (1969: 5) called "plaster floors". Lime-burning and plaster production were time-consuming and costly enterprises (*cf.* SIMMONS *et al.* 1988; ROLLEFSON and KÖHLER-ROLLEFSON 1989, 1990) that unlike the PPNB, apparently, were only called for in these contexts. Possibly the plastered surface improved heat reflection and facilitated removal of ash; it may also have facilitated placement of flat-bottomed cooking pots.

Year-round occupation of the structures would require them to provide adequate protection from winter rain and cold, and the fact that they would be in use for at least a couple of decades would justify fairly substantial initial investment in order to minimize maintenance costs (MCGUIRE and SCHIFFER 1983, AUSTIN 1990). Consequently the walls are solidly built of stone and sometimes still survived to heights of 1m when excavated. Yet the lack of non-kin neighbors perhaps obviated the use of architecture for social display, and so the structures are simple, one-room structures with no evidence for dedicated social space. Furthermore, the relative lack of compartmentalization may imply that there was little risk that simultaneous tasks or varying social roles would interfere with one another (HUNTER-ANDERSON 1977). Meanwhile, some of the technology involved in the construction of structures would include axes, adzes and other woodworking tools, but the bulk of each structure was built of fieldstones and mud that were easily available and required little or no preparation before use.

Conclusion

Rather than view the lithic technology of the Late Neolithic as somehow degenerate, or pottery technology as something inevitably copied or introduced from more innovative northerners, we prefer to view the sometimes substantial differences between the material culture of the PPNB complex and that of the Late Neolithic complexes as stemming from shifts in decision-making priorities. These shifts, in turn, were responses to changes in the distribution of economic and social risks and priorities.

For example, much greater reliance on agro-pastoralism in the Late Neolithic appears to have reduced hunting to a relatively minor, subsidiary activity. If Late Neolithic people did not rely on hunting for their survival or status, there was relatively little risk associated with failed hunting forays and, consequently, little need to invest a great deal of effort in hunting kit. Although some Late Neolithic sites still show specialized projectile points (GOPHER and GOPHNA 1993), their design and production appear to have required much less effort than, for example, the finely made Abu Gosh points of the PPNB.

Sickles, by contrast, appear to exhibit greater standardization and design effort in Late Neolithic assemblages than in PPNB ones. Late Neolithic sickles were composite tools with sufficient standardization in their component parts to allow rapid repair in the field. This was important to prevent loss of time during the critical and temporally restricted harvest. Sickle elements consumed the best raw material and were more likely to be curated and recycled - this would explain the elements with denticulations on both edges - than most other lithics.

The relatively sudden emphasis on pottery in the Late Neolithic, meanwhile, can perhaps be explained by a much greater need for secure containers once agriculture became the pre-eminent source of carbohydrates and, especially, once dairying and beer-making created demand for more waterproof vessels. One of the great risks that early agriculturists must have faced was the risk of losing much or all of their crop to mould, rodents, or other pests. Improved storage technology, including the use of large jars, was one response to this problem. Production of beer, yogurt, cheese and ghee would certainly require secure, clean containers. We should not be surprised, then, if the first makers of these products very quickly developed a broad repertoire of containers with features designed to enhance the vessels' usefulness for roasting barley sprouts, storing and pouring liquids, and cooking stews and porridges.

In general, we would suggest that the small scale of the Neolithic settlement at Tabaqat al-Bûma and its self-sufficient agro-pastoral economy were interrelated with the distribution of design effort in the site's technology. The distribution of this effort depended on tool makers' evaluation of the risks of tool failure. Sometimes even a simple tool was sufficient for carrying out a task without undue risk, but unusually large investments of design effort, including redundancy, seem to be associated with tasks in which the risks of tool failure were unacceptable. When hunting was no longer a critical element in Neolithic economies, then, investment of design effort in equipment critical to agro-pastoral production, such as sickles, grain silos and liquid containers, increased at the expense of effort expended on hunting kit. Most of the basic cutting and scraping activities on the site, including butchering and hide preparation, were not temporally critical and, consequently, very simple tools, such as flakes produced by hard-hammer percussion and with little or no retouch, were sufficient for these tasks.

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Art and Ritual Behaviour in Neolithic Basta

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Abstract: *This paper presents and discusses a small collection of art works found at the Neolithic site of Basta. Some of the pieces are comparable to objects from other sites and it appears that these were part of an iconographic tradition which was beginning to be established in the PPNB-PNA. Two of the objects seem to represent a dual symbolism which includes a phallic element. These, along with other pieces, were apparently deliberately deposited at the bottom of masonry-robbing pits. They are, consequently, viewed as evidence of a form of ritual behaviour in Neolithic Basta.*

Introduction

Like other Neolithic sites in Syria-Palestine, Basta has yielded some objects of apparently symbolic character (*e.g.*, GARFINKEL 1995; ROLLEFSON 1983, 1986; BAR-YOSEF 1985). In some cases these have been found in contexts that seem to be relevant for our understanding of ritual behaviour among Basta's prehistoric inhabitants. In the following pages the most important finds from Basta will be presented and discussed. Additionally, a hypothesis about ritual behaviour in prehistoric Basta will be proposed. The ideas presented here are based on Renfrew's assertion that the aim of cognitive-processual archaeology is "to gain insights into how the minds of the ancient communities in question worked and into the manner in which that working shaped their actions" rather than "to enter the mind of the early individuals involved" (RENFREW 1994b: 6). It will attempt to follow the procedures suggested by the philosopher of science, James A. Bell (1994).

The Archaeological Finds

The first object to be discussed is a fragment of a mask-like object of limestone that was recovered from Area A in 1987 from an unclear context datable to the Late PPNB (Pl. 1; NISSEN *et al.* 1987: Fig. 16:1). Its state of preservation is poor and there seem to be no traces of painting. Additionally, the object may have been subjected to harsh treatment since the edges of the recovered fragment are broken and there are large scars on the recto that may have been caused by more or less systematic destruction. Alternatively, random post-depositional processes could have produced a similar result. At any rate, it is still possible to see the edges of eye holes and a series of small perforations that could have been used for tying the object onto something or attaching something to it, such as feathers, leaves, straw or the like. Consequently, it might be suggested that this object was actually meant to be a mask. Unfortunately, it is in such a bad condition that visual comparison with similar objects is difficult. An approximately contemporaneous conceptual parallel was found at Nahal Hemar (BAR-YOSEF 1985: 14; BIENERT 1991: 15, Figs. 12-13). The latter had perforations along the edges all the way round and clearly resembles a human face. The Nahal Hemar specimen was found in a context that also contained skulls and ornaments, which may illuminate its original use. Additionally, two alleged PPNB masks from the Hebron area should be mentioned in this context (PERROT 1979: Pls. 20, 26).

Another interesting find was recovered in Area B in 1992. At the bottom of a "stone robbing pit" of a post-LPPNB date, dug into the Late PPNB architecture from layers representing the use of the site contemporary to the PPNC or to the Early Pottery Neolithic, four small sculptures were found so closely together that it could only be understood as a hoard deposit. This find includes two objects that were perforated to allow them to be put on a string. One is the likeness of a bucranium made in fired clay (Pl. 2:A, Fig. 1:2) and the other is apparently made from limestone and seems to represent the head of a ram (Pl. 2:B, Fig. 2:2). The latter object has "coffee bean" eyes and the horns, rendered in relief, are curved down across the face to encircle the eyes. An incision circumscribes the lower part of the object, apparently to emphasize the area around the mouth. But if the object is turned 180 degrees it seems to represent a phallus (as shown in Pl. 2:B). The two other objects are small figurines in the shape of a gazelle (Pl. 3:A, Fig. 1:1) and perhaps a bear (Pl. 3:B, Fig. 2:1). The former is apparently of limestone and the latter sandstone. It is worth noticing that the bear figurine was made without legs and that the head of the gazelle was broken off, apparently in Neolithic times since the fractiure is old. The objects are stylistically different but two of them have known parallels. The gazelle resembles the famous "Natufian" gazelle from Umm ez-Zuweitina (VALLA 1975: Pl. II.1) and a PPNB specimen recovered at Azraq (BETTS 1987: Pl. 10).

The ram-head/phallus figurine has "coffee bean" eyes that situate it well within the early Pottery Neolithic tradition. More interestingly, however, it has parallels distributed all over the Near East. This piece is apparently an early specimen in what may turn out to be a typological tree with branches that might be followed at least until the Late Bronze Age. Among typological parallels (some closer than others) are the so-called "fertility goddesses" (BAUMGARTEL 1960: 73-74, Pl. VI.2), "bull's" or "ram's head figurines" from Predynastic Egypt (PETRIE 1914: 44, Pl. XXXVIII.212a-m; 1920: 11, Pl. IX.1-5) and Palestine (GOPHNA 1976: 15, Fig. 5, Pl. III.4), a supposedly contemporary small stone vessel from Egypt (BAUMGARTEL 1960: Pl. VI.3; PAYNE 1993: Fig. 57.1201), and a "ram's head figurine" of LB date from Alalakh (WOOLLEY 1955: Pl. XLV). The association between representations of rams and phalluses represents a dual symbolism well known in the Near East. It finds one of its most subtle expressions in the iconography of the Egyptian god Amun. Since the Middle Kingdom of Egypt this god was sometimes represented as an ithyphallic figure (LANGE and HIRMER 1955: Pl. 92). In some other representations he was shown as a man with a ram's head (LEPSIUS: Abb. 191.a,d). Here we are dealing with a different mode of visualising the ram-phallus association, which nevertheless may be rooted in a tradition that dates back to prehistoric times.

At this point it should be stressed again that the four objects discussed in this section were found together on the bottom of a post-LPPNB "robbing pit". They are of high aesthetic quality and represent shapes of natural entities which are generally recognizable to modern observers.

Two further finds from LPPNB layers in Area B must be mentioned here. One is a fragment of a limestone object (Pl. 4:A) with features of a human head, but more interesting in the present context is the "green head" (Pl. 4:B, HERMANSEN 1991: Fig. 6:2). This object was found in connection with the destroyed floor of the central house of the PPNB occupation that had been robbed of stones. The context is later than the occupation of the PPNB house and apparently structurally similar to the context of the hoard discussed above. The "green head" is made of green marble and it is of high aesthetic quality. It is perforated in one end only, and if it is hung on a string through that perforation gravity will force the object into a position where it seems to represent a phallus. Thus, we have another example[1] from Basta where one object may represent two motifs simultaneously. This phenomenon is also known from other Neolithic sites in the Near East, such as a limestone object from PPNB Mureybit III (CAUVIN 1978: Fig. 26).

Finally an object from Area C should be mentioned (Pl. 4:C, HERMANSEN 1991: Fig. 6:1). It represents a human physiognomy rendered on a tabular piece of white sandstone, but this piece was apparently discarded in unfinished condition (HERMANSEN 1991: 26). Notice that the lower part of the object is ornamented with two incised lines. This is reminiscent of the lower part of the object from Mureybit III mentioned above, although its significance may be entirely different.

Discussion

All of the objects mentioned above represent more or less recognizable shapes. Whether or not the Neolithic people saw them the same way as we do, the quoted parallels allow the proposition that the objects were part of an iconographic tradition that may have been common to most of the Levantine cultural horizon during PPNB and PNA times. The archaeological contexts seem to date the Basta contributions in this tradition to the latest PPNB and the transition to the early Pottery Neolithic. Here the question is whether we can say something meaningful about their use.

It is of relevance to this topic that we have found several burials in Basta (GEBEL *et al.* 1988: 116-117, Pl. 2.1; NISSEN *et al.* 1987: 96, 1991: 17-18; SCHULTZ 1987: 96-97; SCHULTZ and SCHERER 1991: 18-19, Pl. I.2). There is evidence of unequal treatment of the dead, and skull deposits have been found. Additionally, one of the burials is unique: it is an individual who was buried in a flexed position with face and chest downwards and the soles of the feet turned up. The face rested

[1] H.G.K. Gebel stresses that both objects, the ram's head and the "green head", can be worn also in their phallus meaning, since both objects are prepared for two orientations: For the ram's head this is allowed by using the groove around the glans, for the "green head" by using the perforation resembling the mouth. For the understanding of the orientations not only the perforations are important, but also the grooves (in the case of the "green head" the groove is between the nipple and the top of the head).

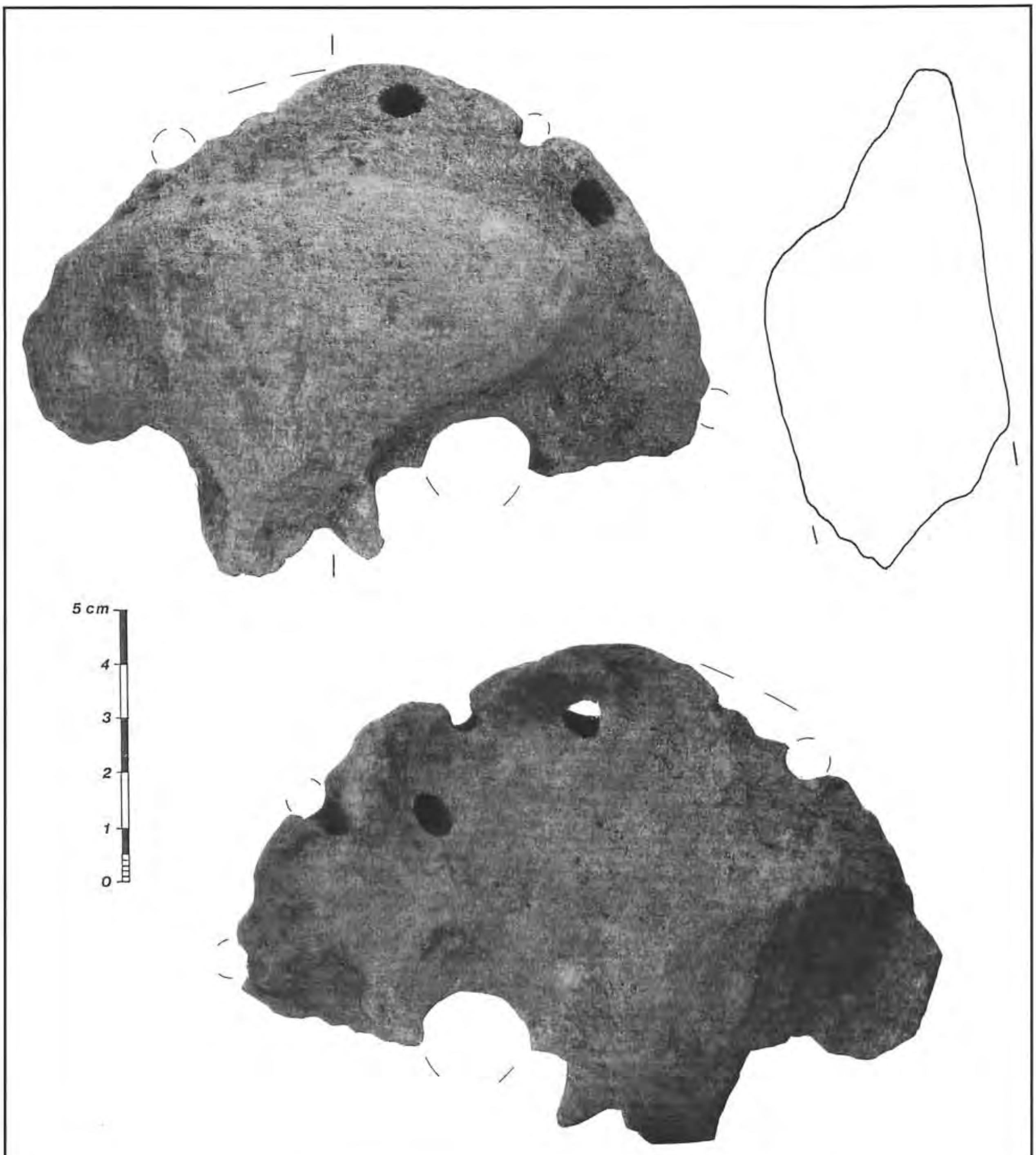

Plate 1. Fragment of a stone mask from Basta Area A, front /face *<top>* and back *<bottom>* views (limestone).

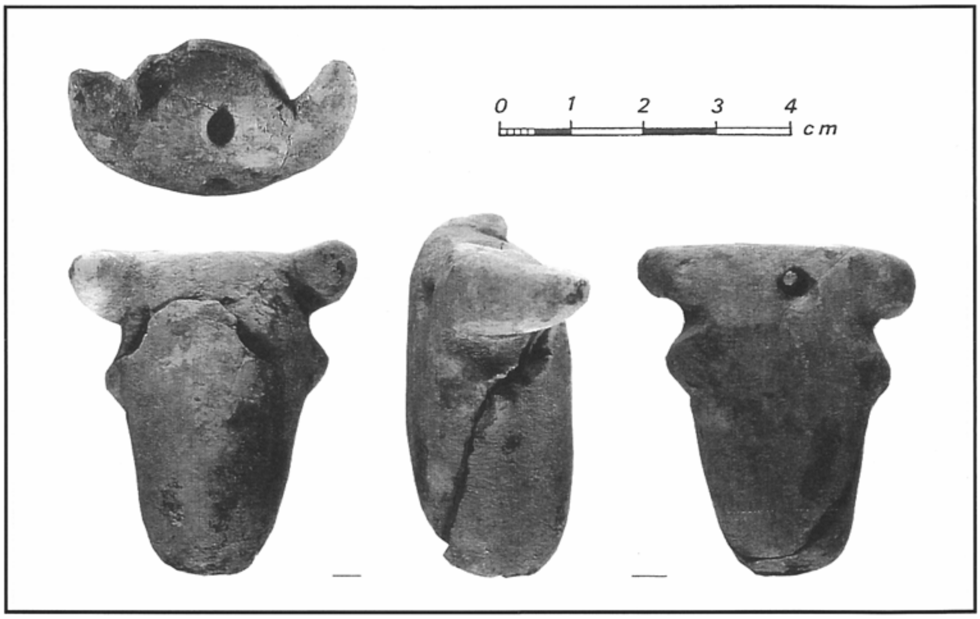

Plate 2:A. Bucranium pendant from the hoard found in Basta B 102/3, Locus 53 (baked clay).

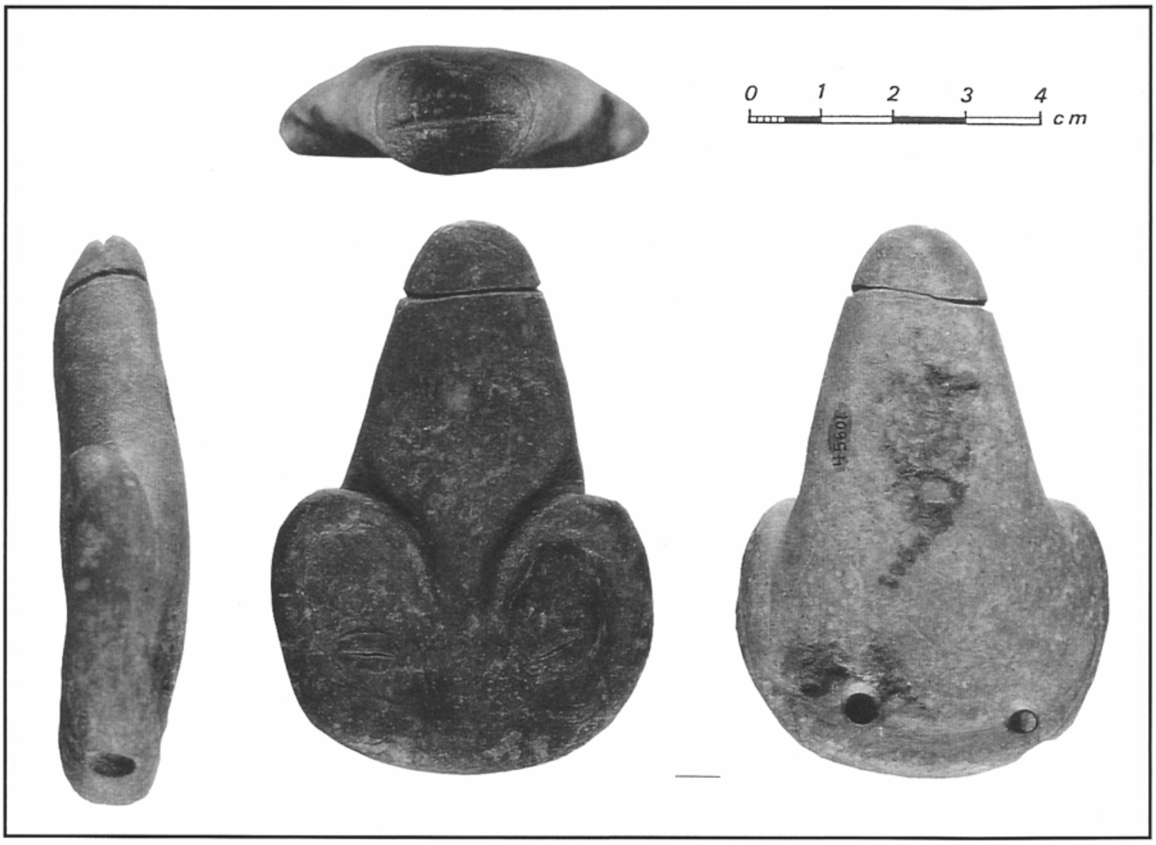

Plate 2:B. Ram's head/phallus pendant from hoardfound in Basta B 102/3, Locus 53 (limestone).

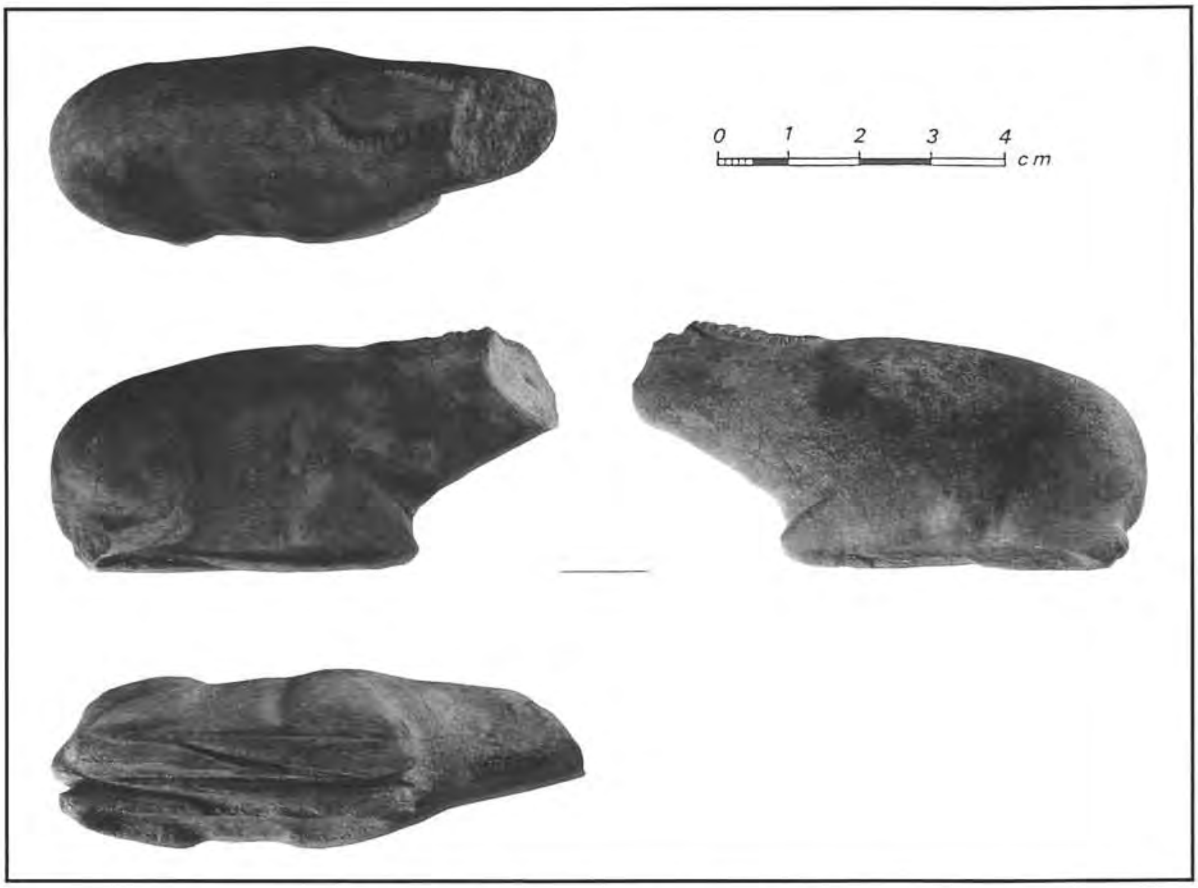

Plate 3:A. Gazelle figurine from the hoard found in Basta B 102/3, Locus 53 (limestone).

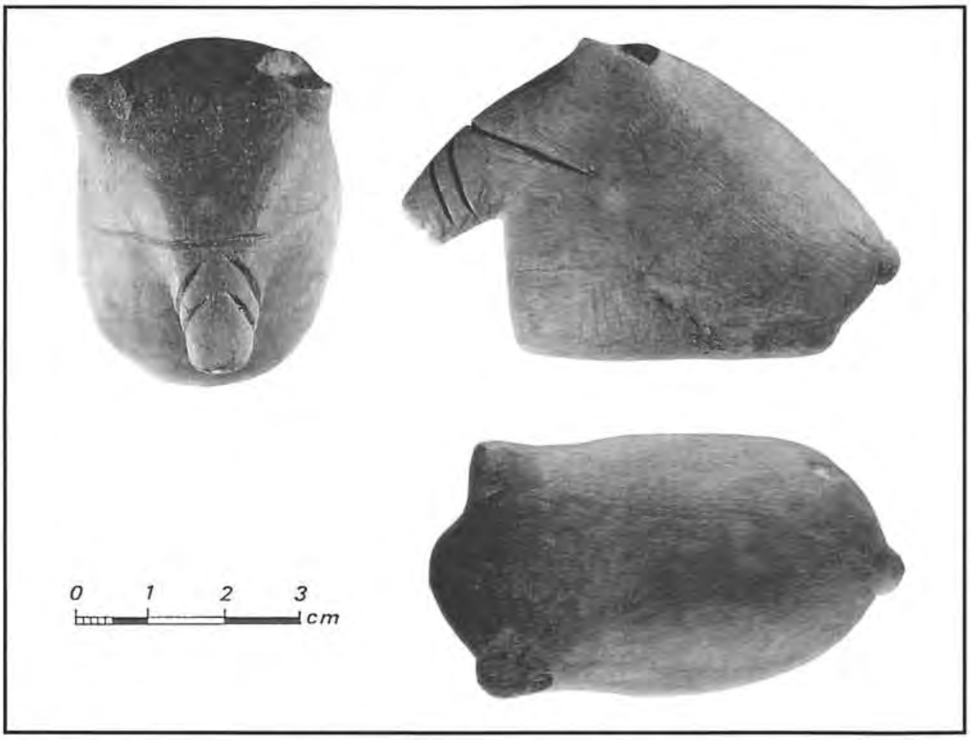

Plate 3:B. Possible bear from the hoard found in Basta B 102/3, Locus 53 (sandstone).

Plate 4:A. Fragment of object which represents the features of a human face from Basta Area B (limestone).

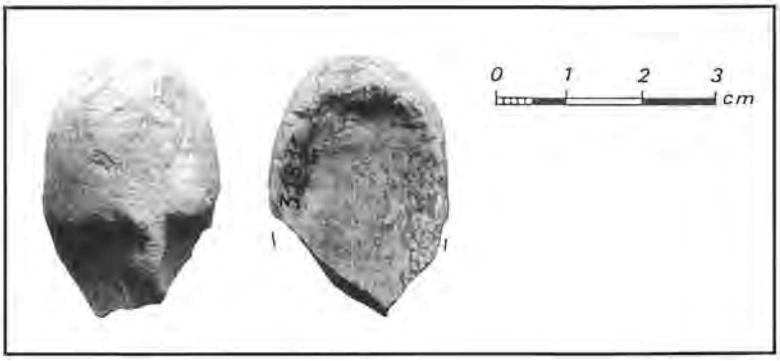

Plate 4:B. "Green head" from Basta Area B (green marble).

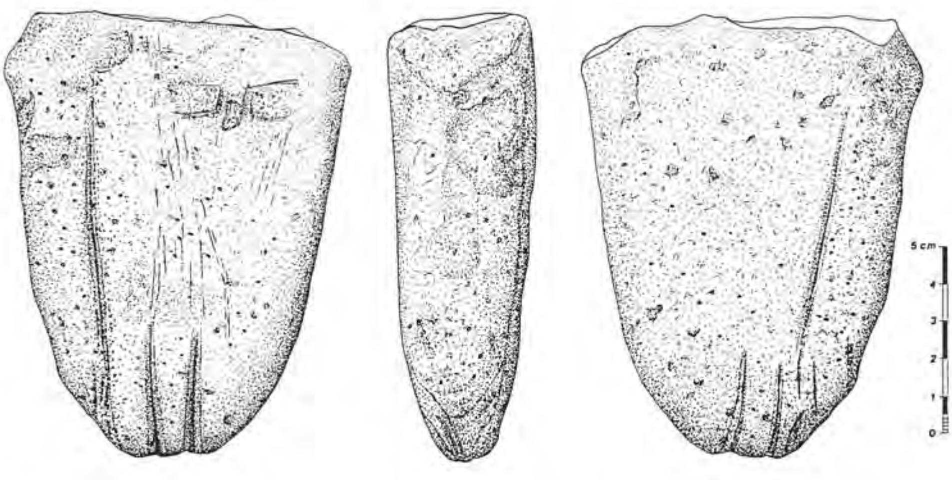

Plate 4:C. Unfinished human face representation from Basta Area C (white sandstone).

15cm deeper than did the feet. The significance of these finds is not to be discussed here, but in the following it will be attempted to expand our knowledge of the spectrum of ritual behaviour practiced by the prehistoric inhabitants of Basta.

At this point some theoretical considerations about "primitive" societies are appropriate. In response to Karl Polanyi's work (1944), and often in opposition to it, a theoretical discussion about "primitive" economies has evolved in recent decades. Rather than entering this discussion we shall simply consider one of the concepts that have been subject to discussion; *i.e.*, the concept of "reciprocity". Implicitly, this principle was brought into a theoretical context by Mauss (1954). Based on ethnographic observations, Mauss suggested that primitive people live in a universe where powers and forces of the surrounding world are potentially hostile. In order to enter a friendly relationship with something or someone, a person might donate a gift. To avoid conflict the recipient is obliged to accept the gift and to reply in kind. A kind of social contract is established between the parties that obligates all to give, accept and reciprocate. Reciprocal relations may exist within the family, the village or between parties from different communities or societies. Reciprocal exchange may operate between equal or unequal partners; and in our context it is particularly interesting that reciprocal relations are even projected into "the other world" in order to establish social contracts between people and otherworldly beings: *Do ut des.*[1] According to this model cultic life becomes the focus of reciprocal relations between beings in this and the other world. In actual fact, the concept of reciprocity covers a wide variety of behaviour patterns. Between people and gods the relationship usually conforms to the concept of "generalized reciprocity", but in some cases the opposite extreme or "negative reciprocity" might be practiced (SAHLINS 1972: 193,195). In view of these considerations, it might be proposed that the Neolithic inhabitants of Basta engaged in ritual gift exchange with beings in "the other world".

If the ingredients of exchange consisted of lasting materials at both ends of the system, and human beings reciprocated the gifts of the gods on the spot without subsequent redistribution (*i.e.* a form of conspicuous consumption), then the material correlates would be "negative imprints" of the exchanged goods that were brought into precisely the same context: humans removed lasting materials from their original context and left a negative imprint, for which they placed a return gift on the spot that in turn allowed the gods/spirits to enjoy the "essence" of the return gift but left its material remnants on the spot in the material world. Consequently, the proposition would be archaeologically corroborated if the negative imprints of the "godgiven" gift and the return gift could be identified stratigraphically in the same archaeological context. It is my belief that these conditions are fulfilled in the finds from Basta since:

1. It is clear that abandoned houses were used as sources of building stones.
2. The hoard was recovered from the bottom of a "stone robbing pit" of post-PPNB date dug into an abandoned and largely buried PPNB house ruin. The stratigraphic sequence is: a) "robbing pit", then b) hoard then c) fill.
3. The "green head" was recovered from a disturbed floor in a PPNB house that was robbed of stones. Here the stratigraphy also seems to be: a) "robbing pit", then b) object then c) fill. The pattern thus appears to be fundamentally identical except that this find only comprises one object.

We are apparently dealing with two occurrences of the a) through c) stratigraphic pattern. Additionally, the apparent phallic aspect establishes an iconographic relation between the ram head/phallus representation in the hoard and the "green head".

The stratigraphic pattern corresponds with the predictions of the proposition made above. Consequently, if my identification of the representations and assessment of the recovery contexts is correct, the following propositions may be offered:

1) The Neolithic inhabitants of Basta were involved in ritual, reciprocal gift exchange with beings in "the other world", from which it follows that

2) the Neolithic inhabitants of Basta believed in "another world", inhabited by beings with whom they could engage in reciprocal gift exchange.

The identity of these otherworldly beings is not clear. But by comparing the shapes which seem to be represented in the objects we may approach an understanding of some elements of the exchange. Here it must be repeated that if the suggested identifications are acceptable, the two deposits have objects in common that represent a phallus in combination with human head and ram's head, respectively.

According to historians of religion, offerings in a general sense are to be understood as part of a generalized reciprocal relationship between people and otherworldly beings (SÖRENSEN 1988: 24). In such an exchange the offerings themselves will typically refer to a) the recipient (representing himself or an attribute), to b) something the parties have in common, or to c) the donor (representing himself or an attribute) (SÖRENSEN 1988: 23).

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[1] "I give in order that you shall give me something ..." (the editors).

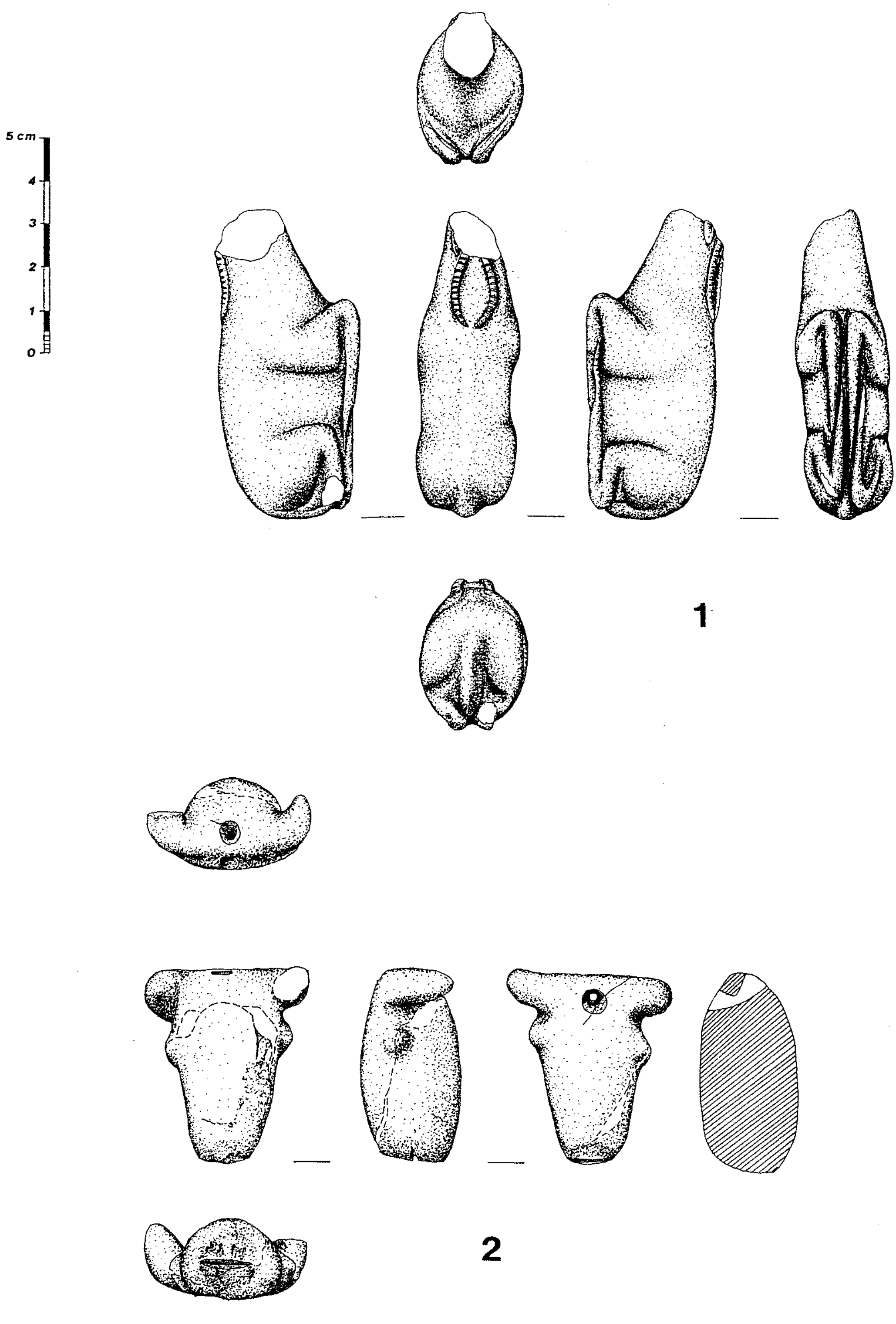

Fig. 1. 1 Gazelle figurine (limestone), 2 bucranium pendant (baked clay), from the hoard found in Basta B 102/3, Locus 53.

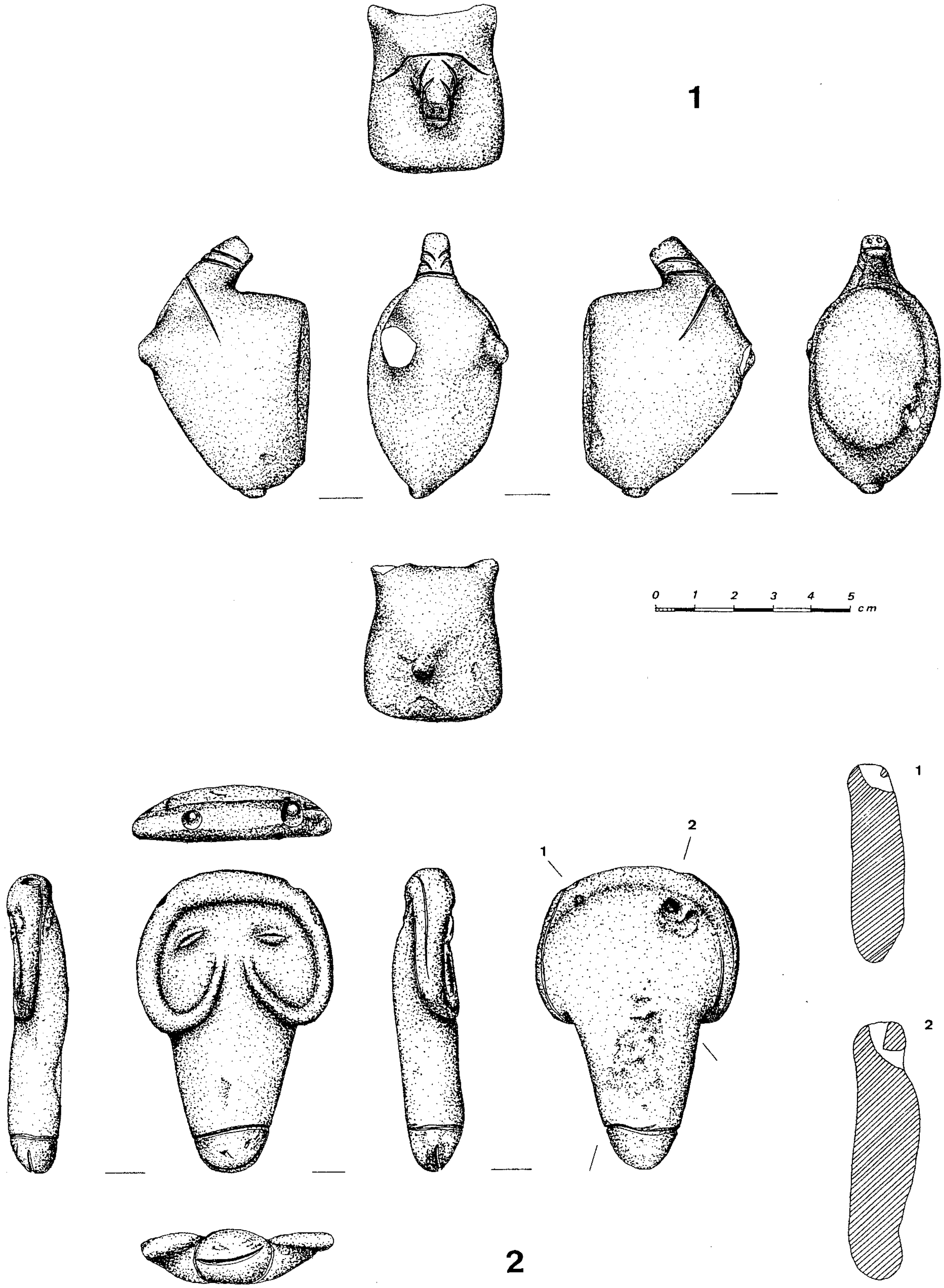

Fig. 2. 1 Possible bear (sandstone), 2 ram's head/phallus pendant (limestone), from the hoard found in Basta B 102/3, Locus 53.

Unfortunately it is difficult to distinguish the material correlates of these three possibilities, and it can only be stated that whatever the phallus symbol represented for the Neolithic Bastans, this would have been an ingredient in the exchange between the donors in "this world" and the recipients in "the other world". However, it has been pointed out (RENFREW 1994a: 51-54) that the occurrence of iconographic representations in ritual contexts often do represent the supernatural beings towards whom the rituals in question are directed. Since the two finds or deposits from Basta Area B seem to have the phallic element in common, it may be proposed informally that the phallus symbol could represent an attribute of the otherworldly recipient or recipients to whom the ritual offerings were addressed.

Closing Remarks

Ritual exchange between people and gods not only expresses aspects of the world view of the humans involved, it also articulates social structures and economic relations. Additionally, it is part of an entire system of activity chains that involve technological activities, consumption, recirculation and (sooner or later) ejection of the objects from the living system. Thus, as regards the representations and symbolic objects discussed above, this paper has only dealt with one aspect of their use in prehistoric Basta. Other aspects are to be discussed in future works.

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Changing Settlement at Tabaqat al-Bûma in Wadi Ziqlab, Jordan: a Stratigraphic Analysis

Mark Blackham

Abstract: *This paper analyses and defines the nature and duration of occupation phases at the Late Neolithic site of Tabaqat al-Bûma in northwestern Jordan. Understanding settlement changes within individual sites requires an empirical method for the chronological division of site deposits into meaningful occupational units. This can be accomplished by means of a detailed stratigraphic analysis which includes the differentiation of cultural and non-cultural deposits, the construction of a stratigraphic sequence for all individual deposits, and the correlation of these deposits within the site as a whole. On the basis of this data and using stratigraphic models of occupation, repair, and abandonment, it is possible to reconstruct the changing nature of site use. Finally, using radiometric dates, the reconstructed occupation phases at Tabaqat al-Bûma are integrated into a regional chronological framework.*

Introduction

The site of Tabaqat al-Bûma is situated in the Wadi Ziqlab drainage basin of northwestern Jordan (BANNING and FAWCETT 1983; BANNING *et al.* 1989, 1992; BANNING and SIGGERS, this volume). It sits on a low colluvial terrace at the confluence of Wadi Sofar and Wadi Ghudran adh-Dhi'b, tributaries of Wadi Ziqlab. The site was first identified in 1987 during a subsurface survey of stream terraces and, at that time, was identified as site WZ 200. Archaeological evidence suggests it was occupied during the Epipaleolithic (Kebaran), Late Neolithic, and Roman Periods, but the greatest portion of the archaeological deposits can be attributed to the Late Neolithic period. The general character of the remains from this period suggests the site was occupied as a sequence of farmsteads (BANNING 1995: 10).

This paper examines the changing settlement at Tabaqat al-Bûma during the Late Neolithic period. In this interval, four distinct phases of occupation can be identified. The commencement and termination of each phase is defined by shifts in construction activities, the particular nature and degree of these activities, and site degradation.

The stratigraphic sequence for the site was constructed in the usual manner through an analysis of site formation processes and an application of stratigraphic principles. The results of the analysis have been represented graphically by means of a Harris matrix (HARRIS 1975, 1989) and mathematically as superimposed sets of associated deposits. The final sequence of superimposed strata is used as an analytical device to identify the nature and degree of construction activities. In the final analysis, radiocarbon dates are integrated with the phase sequence so that events at Tabaqat al-Bûma can be tied to those at other sites within the greater region.

Using conservative estimates, radiocarbon dates from the Late Neolithic sequence at Tabaqat al-Bûma suggest that occupation for this period spanned from approximately 6400 to 5000 BC. During this time, several structures at the site underwent various stages of building, rebuilding, renovation and abandonment (BANNING *et al.* n.d.). The methods of analysis employed here seek to correlate these multiple depositional events in order to reconstruct site use.

Site Formation

As a site forms over time, it may experience periods of occupation, abandonment, and re-occupation. Throughout all periods, sediments are constantly deposited, reworked, and eroded as the direct result of both non-cultural and cultural activities, processes that Schiffer calls n-transforms and c-transforms respectively (SCHIFFER 1987: 22). The erosion or degradation of site strata is a continuous process but, when a site is occupied, deposits formed by erosion processes are not as prevalent as when it is abandoned. The constant repair, cleaning, and deposition of refuse during the course of daily human activities obscures the actions of natural erosion. Identifying and distinguishing deposits resulting from n-transforms and those resulting from c-transforms can tell us much about how the site was used, when it was used and when it was abandoned.

Deposits are seldom as neatly defined as we would like. Within an archaeological site, there is often an inseparable and systemic relationship among the physiogenic, biogenic and anthropogenic components of sediment formation (BUTZER 1987: 77). In some instances the processes of sediment formation can be clearly distinguished, such as in the burrows caused by rodent activity, the formation of carbonaceous layers and the deposition of some artifacts. But often interpretation is confounded by the considerable amount of sediment mixing, or reworking, that occurs over the course of time. The problem of mixing as it affects interpretation can be overcome to some degree if the extent of the disturbance is not too great relative to the total volume of soil excavated. If sediment mixing is confined to a specific locale, then it is possible to isolate the affected strata within the stratigraphic sequence. Rarely does mixing affect the site as a whole. This is an important point to the analysis at hand because it implies that disturbed sediments can still be placed in a stratigraphic sequence constructed from more reliable contexts. At Tabaqat al-Bûma, most sediment mixing results from human activity. Formations resulting from natural processes appear confined to the collapse of features, erosional surfaces, and the sporadic deposition of colluvium.

The specific geographic nature of the local landscape as well as regional weather patterns dictate much of the natural site formation processes occurring at the site. For most of the year the weather is dry, but when it rains in the fall and winter months, the rainfall is intense. Rainwater mixes with sediments on the steep slopes above the terrace and, because of the lack of deep-rooted vegetation, this mixture moves downward as colluvial mass-flows. During these periods of intense rainfall, the ephemeral streams come to life and their rushing waters erode the foot of the terrace. Thus, the primary natural causes of past and present soil erosion and soil deposition at the site are rainfall patterns, rainfall intensity, and the actions of ephemeral wadi streams (BANNING *et al.* 1992: 48, FIELD 1993: 259).

As a consequence of these climatic and geomorphological processes, the Late Neolithic deposits at Tabaqat al-Bûma consist primarily of anthropomorphic deposits mixed with intervening deposits of colluvium. The manner in which these water-laid sediments were deposited had much to do with the existence and position of walls and other features that affected the direction of water courses and the spatial limits of colluvial deposition. For instance, colluvium could wash down the hillside and settle either in front of a wall or flow around it to settle in other areas.

Human activities affecting site formation included the erection of buildings, terrace walls, and other structures. Site disturbance resulted from the digging of burials, pits and hearths, leveling of the ground for wall construction, the re-use of stones from previous structures and modern road construction.

Phases of site occupation were reconstructed by identifying and characterizing these various types of deposits and the processes that created them.

The Excavations

Tabaqat al-Bûma underwent minor excavations in 1987 and more extensive excavations in 1990 and 1992 (BANNING *et al.* 1989, 1992, n.d.). Two areas were excavated in the 1987 season (Areas A and B). In 1990 and 1992, the excavations were laid out in a grid of 4m x 4m squares (BANNING and SIGGERS, this volume). Coordinates were labeled by letters along one axis and by numbers along the other. Each excavation unit (called an "Area") was then labeled by the coordinates of its southwestern corner (*i.e.*, G34). In all, there are 24 excavated areas from the 1990-92 seasons and two smaller ones from 1987. Between areas, there was normally a one meter baulk east to west and a 50cm balk north to south, so that the effective excavation area for most squares was 3x3.5m (BANNING *et al.* 1992). During the course of excavations many baulks were eventually removed, but this was not always the case. The vertical extent of excavations per area was arbitrarily set, depending on whether or not artifacts, features and specific deposits were present. As a result, not all areas were excavated to the same depth or to the same lateral extent.

During excavations, the total sediment volume of each excavated area was divided into numerous loci. In this discussion, a locus is synonymous with a deposit and is defined as any three-dimensional volume of material that is spatially discrete and appears to have resulted from a single depositional episode, or it is an interface between two such volumes. A locus represents an archaeological event, or related natural event, which can occur both vertically and horizontally, and would include such things as sediments, facies, interfaces, pits, rock features, walls or burials.

For the purpose of analysis, areas and loci are employed as analytical units. The initial objective is to place each locus within a stratigraphic sequence, first in its own area and then within the site as a whole.

The Stratigraphic Sequence

The primary device employed here for an analysis of changing site activities is the stratigraphic sequence of cultural and non-cultural deposits. The sequence for Tabaqat al-Bûma was created using the *Bonn Archaeological Statistics Package, Version 4.5* (SCOLLAR *et al.* 1993). The mathematical structure underlying the sequence is that of a partially ordered set (ORTON 1980: 67, HERZOG 1993: 203). It is partially ordered because, in most cases, the exact vertical and horizontal placement of individual deposits to all other deposits is not always possible. Ideally, fully ordered horizontal sets would consist of contemporaneous deposits. While every effort was made in the present analysis to correlate deposits among all excavated areas on the basis of stratigraphic, lithological, and some artifactual evidence, it was virtually impossible to correlate all deposits with confidence, particularly those that were small and localized or those which were separated by intervening deposits. Such deposits could, however, be placed between contexts that have been correlated so that, overall, their placement is known relative to the upper and lower limits of these more firmly positioned contexts.

Horizontal arrays of contemporary deposits are determined by their correlation and are referred to as 'sequence levels'. A sequence level consists, for the most part, of a set of synchronically associated deposits, although some multilinearity of deposits still exists (a topic discussed below). As a group, these sets of associated deposits form a superimposed stratigraphic sequence and are used to represent a chronological order for the site.

In all, a total of 25 areas was analyzed, encompassing an overall site area of approximately 360m^2 and, from these, a total of 402 loci were defined for correlation and phasing (BLACKHAM n.d.). Because of its size, the sequence diagram cannot be shown. Altogether, there are 21 levels in the sequence containing 385 final loci (loci considered to be equal were merged). The levels are numbered in sequence from 1 at the top to 21 at the bottom. The primary levels of interest in this analysis, the Late Neolithic occupation, range from 16 to 3 inclusive.

Sequence levels represent relative time and do not delineate a fixed duration of occupation. Periods of increased human activity at any location tend to produce longer vertical sequences in the matrix because of the creation of many differentiated deposits. Any area in which there is a constant disposal of refuse, as well as construction and reconstruction, will produce more deposits than areas that are used less or which are cleaned more often, such as living floors. Because each individual deposit must be placed into a sequence, Area A with its activities may have, for example, five sequential deposits, whereas Area B may accumulate only one deposit in the same period of time (Fig. 1). In this example, a sequence consisting of seven levels ranging from deposit 99 to deposit 01 is produced. The five deposits from area A would be placed on one side of the sequence and the single deposit from area B on the other side. The single deposit is positioned at the top, level with deposit A1. We may not know the exact correlation of deposit B1 with any deposit from Area A and, in fact, there may not be one. All that can be said with confidence is that deposit B1 accumulated at some time between levels one and seven.

A similar situation arises when a wall or other "upstanding" stratum divides deposits (HARRIS 1989: 48). If we substitute a wall for deposit 99 in the example above, we can imagine that the five deposits accumulated on the outside of the wall during the same period of time as a single living floor was used on the inside of the wall. As a group, the deposits are defined on their lower limit by the wall and on their upper limit by a common deposit that overlies both the floor and one of the deposits on the outside of the wall (A1 and B1 in the example). We know, therefore, that the wall and the associated floor were in use from the time of their construction to the time the floor was covered with debris. All deposits intervening between these two events are associated with this interval and, therefore, the occupation phase.

These kinds of enclosed deposits are often referred to as multilinear sequences (HARRIS 1984, TRIGGS 1993) and, as mentioned above, can be difficult to correlate. If, in our previous example, there were two deposits in Area B, we could not be sure which deposits were chronologically associated without incorporating some other means of analysis, such as seriation techniques (in particular, see TRIGGS 1993) or mean ceramic dates (SOUTH 1972). In a sense, deposits within a multilinear sequence are "floating deposits" (ORTON 1980: 74, DALLAND 1984: 122). The problem of correlating multilinear deposits deserves further attention but cannot be addressed here. The immediate objective of this analysis is to define phases based on an interpretation of building strata as set out earlier. In this method, deposits associated with multilinear sequences are grouped within an occupation phase as defined by the use-span of a building wall and, as such, are treated as a single unit of time.

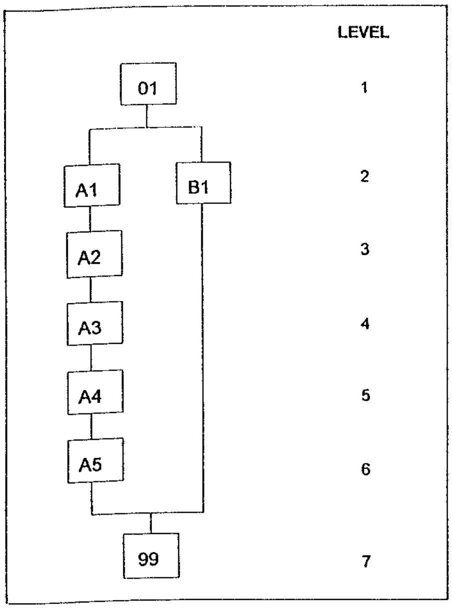

Fig. 1. An idealized multilinear sequence.

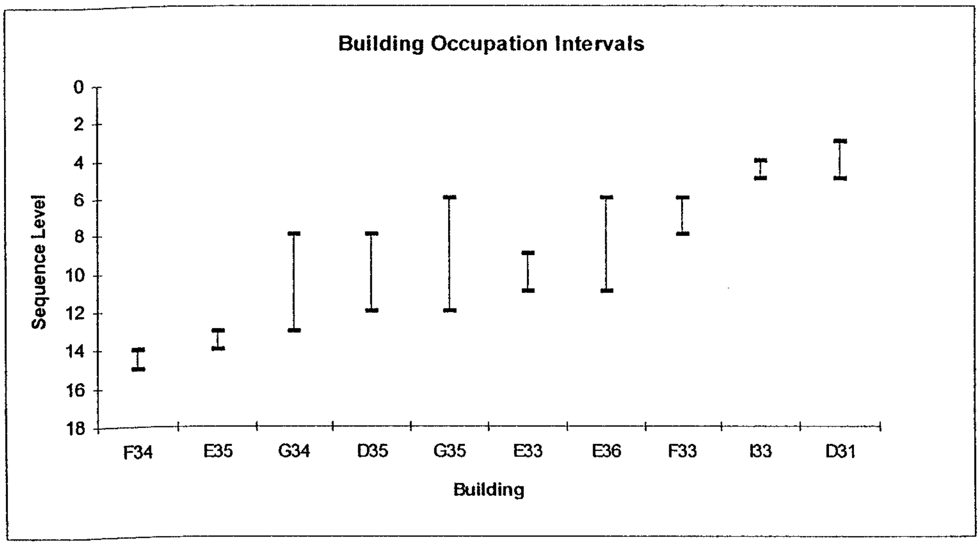

Fig. 2. Building occupation intervals as determined from construction starts and erosional events.

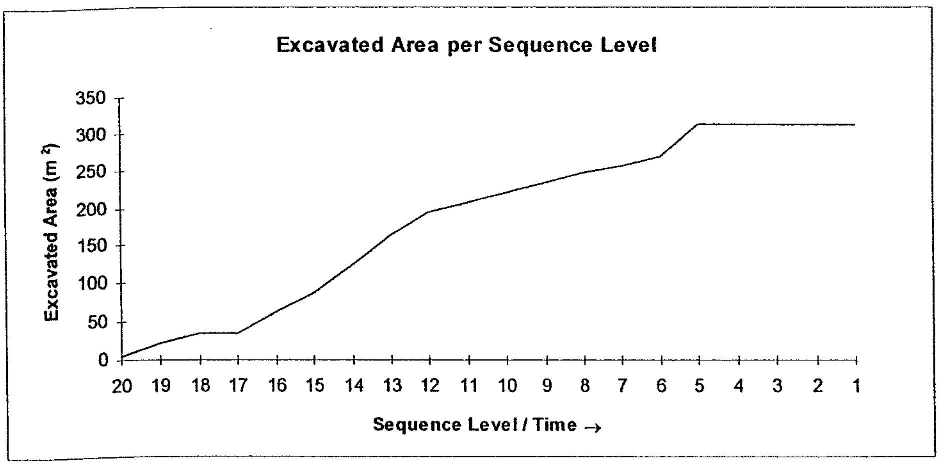

Fig. 3. The total site area excavated per sequence level.

Occupation Models

The patterning of erosional events in conjunction with building and feature construction enables us to distinguish unique settlement periods. Was the site continuously occupied or was there an alternating pattern of settlement and abandonment? The definition of occupation phases as presented above assumes that any site activities that occurred during an occupation interval belong to that interval. This is a simple model but, from this rudimentary basis, we can expect to observe several patterns in the chronological distribution of buildings and features. First of all, if settlement activity is continuous throughout the Late Neolithic occupation, we would expect to see a continuous chronological distribution of building and feature construction. Even if buildings and features are used for a long period of time, we would at least expect to see repairs and reconstruction occurring throughout the sequence. Secondly, if the occupation of the site comprises a new settlement, we would expect new buildings to be constructed, either on fresh soil or over old buildings. It is most likely in these situations that the construction of other features would immediately follow the construction of buildings. This means that at the point where new buildings are erected, few features would be found. In a third situation, if the site is abandoned, we would expect to see no construction events.

We cannot assume that all walls at the site were used for buildings. Building walls are here defined as those walls forming at least partially enclosed rectilinear shapes and containing inner floors or surfaces. Buildings may or may not be roofed structures; there is no archaeological evidence of roofs for any of the buildings defined. All other walls are designated as secondary walls. The alignment and character of secondary walls suggest they were used as terrace walls or animal enclosures.

Throughout the Late Neolithic occupation at Tabaqat al-Bûma, ten buildings could be identified by their remaining foundations or other features. These occur in Areas D31, D35, E33, E35, E36, F33, F34, G34, G35, and I33 (see BANNING and SIGGERS, this volume). The remains of buildings often cross one or two excavation areas. To avoid confusion when referring to different structures, each structure was identified by the southwest area number except in those instances where ambiguity might arise. There is only one situation where such ambiguity exists, and that is in the naming of buildings E33 and F33. In this case, one structure appears to have been built from the remains of the other.

The different characteristics of building foundations imply differences in building function and permanence. These differences, in turn, lead to inferences about site use and the nature of settlement. Some walls, as at G34 and G35, are relatively substantial while others, such as at D31 and I33, are of much lighter construction. The sizes of structures vary. The E36 building, for example, appears too small for comfortable habitation (approx. 1.5m x 1.5m) and may simply be an adjoining room to the D35 house.

Not all buildings were excavated or preserved to the same degree, and some caution must be exercised when interpreting the results. Building G35, for example, was partially destroyed by both road construction and stream erosion and could not be fully excavated. The existence of building E33 is inferred from the remains of a plaster floor and a hearth found within the walls of the F33 house. Both of these features end abruptly on their southeast side, suggesting that a segment of wall on this side had been removed and the structure rebuilt. The plaster floor and hearth both date to sequence Level 10. As the inferred wall must have preceded the floor, this wall would be dated to Level 11.

The Definition of Occupation Intervals

The use-interval of each building was established on the premises outlined previously. In all cases, the beginning of the interval is the point of wall construction and the termination point is the first locus of sediment fill or collapse that covers the living floor. If we assume that the living floor of the building is intrinsic with the use-span of the building, then the point where the floor was covered by sediment or rubble is the time when the building was no longer in use. In nearly all cases, deposits covering the floors can be clearly identified as rubble fill or stone collapse from the walls. On this definitional basis, building use-intervals were recorded in terms of sequence levels and these intervals are shown in Fig. 2.

The first building (F34) was constructed at Level 15. The true horizontal extent of this building is unknown because, at Level 13, some of it was removed during the construction of building G34. The stratigraphic evidence suggests that building F34 was abandoned by Level 14 and that some period of time intervened before the G34 house was constructed.

The E35 structure was altered by the later construction of both D35 and E36 buildings. A hearth, which directly underlay a later secondary wall, was associated with the E35 building wall. The E35 building was constructed at about the same time or a little later than the F34 building, so its construction was associated with Level 14. The D35 house was built directly over the remains of E35 at Level 12, which led us to conclude that structure E35 fell into disuse by Level 13 at the latest.

Level 13 inaugurated a period of heightened construction activity and considerable alteration to the site. Some time after the construction of house G34, the buildings G35, D35, E33 and E36 were erected. All of these buildings co-existed to Level 8, where buildings G34, D35 and E33 fell into disuse or were dismantled. The G34 house was built in two stages, with major reconstruction occurring at Level 10. After Level 8, two other buildings (E36 and G35) continued to be used in modified form. Both buildings show evidence of reconstruction or at least re-use. Paved surfaces and other features were added after an initial occupation period and, at both locations, these additions occurred at Level 8. At the same time as these changes were taking place, building F33 was constructed. Finally, all three of these buildings fell into disuse by Level 6.

Level 5 was a period of new building activity. Two smaller and less substantial buildings were constructed at this time, D31 in the southwest and I33 in the north. Once again, the stratigraphic evidence suggests there was a considerable gap in occupation between Level 6 and Level 5. For instance, approximately 1/2m of deposits separate building F33 and building D31, which was constructed almost directly above it. The character of these later structures suggests they were temporary or seasonal dwellings; perhaps they functioned as tent foundations similar to those still used in Turkey by contemporary nomads (CRIBB 1991). This notion is supported by the discovery, in Level 4, of a "bed platform" located in the southwest corner of Area D35. This kind of platform is still used today by tent-dwelling Bedouin in Jordan.

The Relative Extent of Walls

From the stratigraphic sequence it is possible to determine not only the point at which any wall or feature was constructed, but also the relative degree of construction activity as interpreted from the relative extent of walls and features.

Not all features can be considered equal in terms of energy expenditure. In the sequence, a 5m long wall and a single pit would both count as a single event but, clearly, the construction of a wall and the digging of a pit carry different implications in terms of settlement activity. Furthermore, not all levels can be considered equal because the extent excavated in each area for each level differs considerably.

Ideally, the degree of energy expenditure for each wall should be appraised in terms of its horizontal and vertical extent. Unfortunately, because of the collapsed state of most walls, their true vertical extent will never be known, but we can judge the limits of horizontal extent with some confidence. The best measure of wall construction with the evidence at hand would be a simple linear measure adjusted to the size of the sample. Even with this method, there remains the possibility that certain walls or other rock features were robbed of their stones for other purposes. This could affect the results for earlier levels.

The extent of exposed wall length is not independent of the excavated area per stratigraphic level. The amount of soil excavated at any level forms a sample of the total site, and the size of that sample varies at each level. Generally speaking, more soil is removed from the upper levels of an excavation than from lower levels, as was the case at Tabaqat al-Bûma. The quantity of archaeological evidence recovered from different levels in a site can only be compared to that of other levels when some adjustment is made for the size of the sample.

The variation in the horizontal extent of excavations for each area at any particular sequence level was taken directly from the excavation records. The total excavated area (m^2) for the 25 areas at each sequence level is represented graphically in Fig. 3. To account for the difference in sample size, wall construction is measured in terms of its total linear extent relative to the amount of area excavated (m/m^2). This measure applies only to those walls that were *constructed* at that level and does not consider any walls continuing into the next level.

When all building wall lengths have been measured, and these measures standardized, the relative extent of wall length can be calculated for each sequence level (Fig. 4). Surges of construction activity occur at Levels 15, 13, 8, and 5. These levels coincide with buildings F34 and E35, the building group G34, G35, D35, E33, E36, building F33, and group D31, I33.

The presence of various features, including secondary walls, also conveys some idea as to the nature and degree of site activities. The incidence of such walls, standardized to the size of the sample, is shown in Fig. 5. Notice that at Levels 15, 13 and 5 there was an absence of secondary wall construction at a time when building wall construction begins. This pattern of alternating house and feature construction is what we would expect if the building walls represent a new settlement of the site. The highest relative frequency of wall construction occurred at Level 10. According to our model, the walls at this particular level would be associated with the occupied buildings G34, G35, D35, and E36. The existence of secondary walls that could function as terrace walls or animal enclosures implies a degree of settlement permanence for this period and reinforces the notion that the site was once used as a farmstead. Note that walls categorized as 'secondary walls' were not reconstructed or repaired

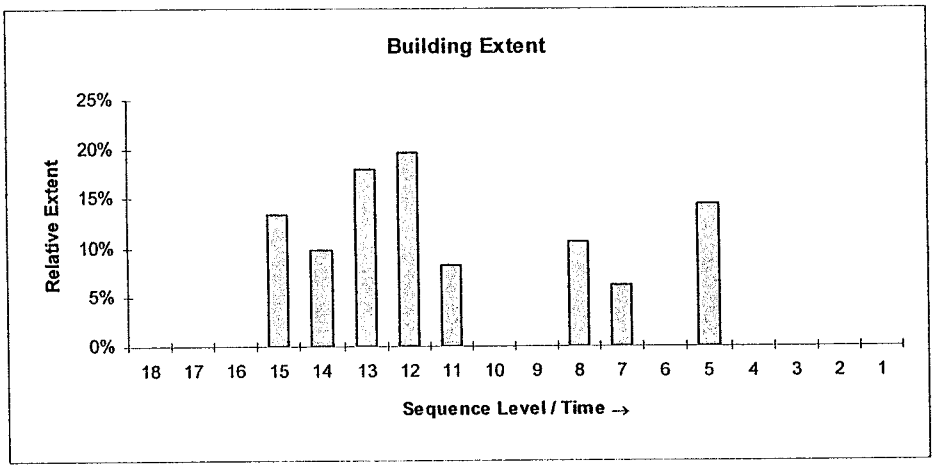

Fig. 4. The relative extent of building wall construction per sequence level.

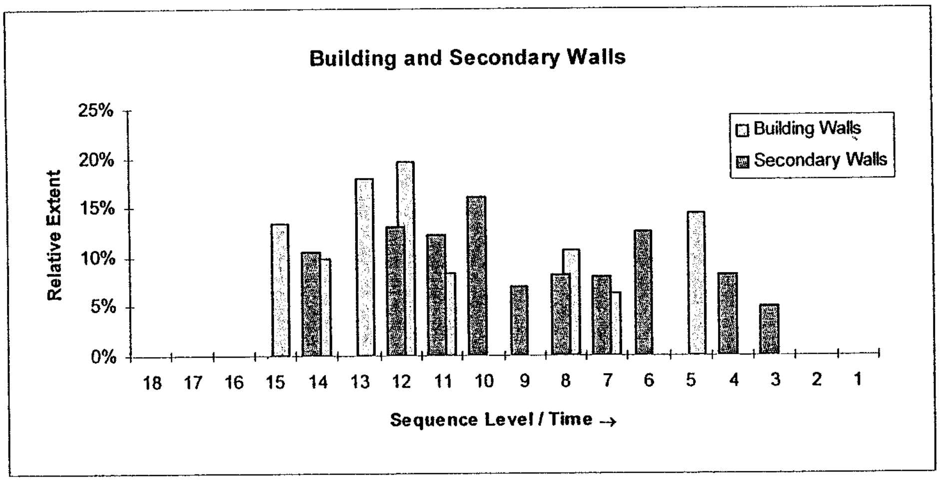

Fig. 5. The extent of secondary wall construction as compared to building wall construction per sequence level.

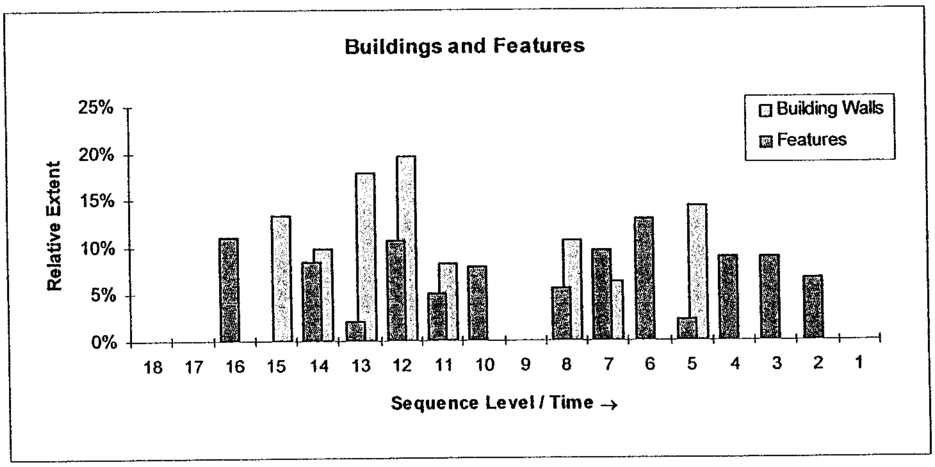

Fig. 6. The relative extent of features compared to that of building walls.

walls, but instead they were new walls constructed at the level indicated. In addition to these walls, the presence and timing of other features help to delineate occupation phases and site activities.

The Relative Frequencies of Other Features

Apart from miscellaneous rock walls, six other types of features were defined for use in analysis. Features were counted per sequence level and then adjusted for sample size. This was done by calculating the frequency of features as a function of excavated area; that is, as the number of individual features per 100m^2 of excavated area per level. Features include additions, hearths, pits, paved surfaces, living floors and burials. "Additions" include construction events in which buildings or secondary walls were repaired or reconstructed by the addition of smaller rock agglomerations at specific points. For example, at one spot a corner may have been added between two walls to create an enclosure.

It is difficult to assign individual values of human activity to different categories of features. It may take more energy to construct a burial than it does a hearth but, on the other hand, a burial usually represents a single event whereas a hearth can be used for a long period of time. The same is true when comparing additions to the accumulation of a floor. For the sake of consistency, all features are considered equal in importance.

There is a total of 65 features for consideration. Table 1 lists the counts for each feature type per sequence level and the total number of each feature type for the site as a whole. This figure was adjusted by standardizing the count to the size of the area excavated. The relative frequencies of the standardized counts are given in the far right column. These relative frequencies were compared to the relative extent of building wall construction (Fig. 6). When secondary walls were compared to building walls, as they were above, both were measured in the same units. That is not the case in Fig. 6, where the relative extent of walls is compared to the relative frequencies of features. Here, it should be kept in mind that the purpose of this comparison is to judge relative site activity in terms of features and how this activity relates to building wall construction. The comparison shows that low relative frequencies or the absence of features occurred at Levels 15, 13, 9 and 5. With the exception of Level 9, the patterning is similar to that observed for secondary walls. Once again, this pattern of new buildings coupled with the low frequencies of features is one expected in new settlements. Some features do occur at Levels 13 and 5. The single feature coinciding with the construction of house G34 at Level 13 was a hearth just south of this building while, at Level 5, two features occurred, corresponding to the founding of structure D31 and I33. These two features were additions, suggesting that some rebuilding was going on at that time.

Table 1. The counts, standardized counts (no./m^2), and relative frequencies of standardized counts (RF) for all features per sequence level. Area (m^2) refers to excavated area per level.

LEVEL	Addition	Burial	Floor	Hearth	Pit	Surface	Total	Area m^2	n/100 m^2	RF
1	0	0	0	0	0	0	0	313	0.00	**0%**
2	0	0	0	1	4	1	6	313	1.92	**7%**
3	1	3	0	2	1	1	8	313	2.56	**9%**
4	2	1	2	1	1	1	8	313	2.56	**9%**
5	2	0	0	0	0	0	2	313	0.64	**2%**
6	4	2	1	1	0	2	10	268	3.73	**13%**
7	2	0	1	1	1	2	7	255	2.75	**10%**
8	1	0	1	2	0	0	4	248	1.61	**6%**
9	0	0	0	0	0	0	0	234	0.00	**0%**
10	1	0	2	1	0	1	5	220	2.27	**8%**
11	0	0	1	3	0	0	4	208	1.92	**7%**
12	2	0	1	0	2	1	6	195	3.08	**11%**
13	0	0	0	1	0	0	1	165	0.61	**2%**
14	0	0	0	1	0	1	2	125	1.60	**6%**
15	0	0	0	0	0	0	0	87	0.00	**0%**
16	0	2	0	0	0	0	2	63	3.17	**11%**
TOTAL	**15**	**8**	**9**	**14**	**9**	**10**	**65**	**3733**	**28.46**	**100%**

The nature of events occurring during the interval spanning Levels 13 to 6 is not clearly evident and deserves closer attention. At Level 9 the relative frequency of secondary walls drops, but they are not absent. At the same level, however, features do not occur. Is this a point of site reoccupation or a continuation of the previous settlement? To make sense of this combination, it is best to refer to the use-span of each building and the location of activities. Previously the site was quite active but at Level 9 activities drop rapidly; activity appears to have resumed at Level 8. During the interval from Level 8 to Level 6, which is associated with building F33, buildings G34 and D35 fell into disuse at approximately the time when house F33 was constructed. The F33 house itself represents a reconstruction and expansion of the previous E33 structure. Meanwhile, it appears as though buildings G35 and E36 continued to be used well into Level 6. This is because the rise in the number of features at Levels 6 and 7 took place mainly in or near buildings G34, G35 and E36. For example, immediately to the east of G35 and E34 a cobble surface was laid down, while in the small building of E36 a stone bench was constructed. At the next level, just outside this building, two burials were dug into the cobble floor, an outer surface was refinished, and a section of wall was built.

The preceding observations lead us to infer that a demise in site occupation occurred at or near Level 9. The construction of house F33 suggests the site was reoccupied at Level 8 and, soon thereafter, some use and modifications were made to the general areas corresponding to buildings G35 and E36. The character of the buildings and the nature of modifications suggest these two locations were not used for occupation but had other uses. For example, the small size of building E36 makes it unsuitable for habitation, and the paved surface added to the east of G35 appears to wrap around the north end of the wall and can be traced to the west. This implies that the wall had collapsed by this time and did not fully enclose the surface. Finally, this phase is marked by a number of wall additions, reinforcing the notion that it was a period of site reclamation and reuse.

By Level 5 structures D31 and I33 had been constructed while the eastern section of the site lay in ruins. Three burials took place in the rubble of house G34 and another in the old storage silo built into the northern wall of house D35. Like the preceding phase, several wall additions to existing structures suggest that some areas were rebuilt, probably with stones taken from older walls and features.

The Occupation Phases

The preceding discussion has helped to understand the sequence of alternating cultural and non-cultural site formation processes that took place at Tabaqat al-Bûma during the Late Neolithic occupation. The processes relevant to the objectives of this paper are primarily those of construction activity and building erosion. From the nature and timing of these events, it is postulated that different periods of occupation, and perhaps site use, can be identified. An ideal situation for site-use reconstruction would be to analyze all archaeological materials and place them in their respective chronological levels. That task, however, is beyond the scope of this paper. For the moment, building or occupation phases are identified solely on the basis of the types of structures and their synchronic associations with other structures or features.

From this analysis, four occupation phases were defined for the Late Neolithic period while one phase each is assigned to both the Kebaran and Byzantine periods. The schematic diagrams shown in Figs. 7 to 10 are reconstructions of site architecture for building phases 1 to 4.

• *Phase 0, Levels 21 to 17.* This phase is assigned to the Kebaran occupation. The soils containing Kebaran material were heavily eroded and excavations for this period are minimal.

• *Phase 1, Levels 16 to 14* (Fig. 7). Phase 1 is the initial Late Neolithic occupation of the site, and is associated with buildings F34 and E35. The first activity on the site is the construction of two cist-graves, one to the north and another to the south. These were built with stone linings and topped with rock slabs. Because they precede the buildings stratigraphically, it is possible that these burials occurred well before the appearance of structures.

A small building was constructed immediately north of the southern burial while another was constructed just to the east of this burial. A short section of secondary wall appeared further north. The F34 building was partially destroyed when truncated by the later construction of house G34 and it is likely that structure E35 was dismantled when house D35 was built. The northern wall may have been a terrace wall but this is unlikely; this wall extends north-south and, because the land slopes downward to the northeast, we would expect a terrace wall to be aligned southeast to northwest. It could be the remains of another structure robbed of its stones. It is likely that many features of this period were obscured or destroyed by the increased activity of the succeeding period, and that the true extent of building construction at this time is under-represented by the length of remaining walls.

• *Phase 2, Levels 13 to 9* (Fig. 8). This was a time of considerable building activity. The size, character and frequency of buildings, secondary walls, and other features suggests that Phase 2 comprised a relatively permanent and continuous settlement. Two relatively large rectilinear buildings were constructed to the north (G34) and south (D35) of the original structure. House D35 was built on top of the E35 structure. At the time of its construction, a clay-lined storage silo was integrated into its northern wall. The walls of this phase are substantial, being made with two or three leaves of stones.

In addition to these two main structures, buildings G35 and E36 were built at about the same time and a number of secondary walls were erected, probably as terrace walls and perhaps as animal enclosures. Structure E33, inferred from the floor and hearth remains, also belongs to this period. During this time, it is likely that the population at the site was at its peak. By the end of Phase 2, buil-

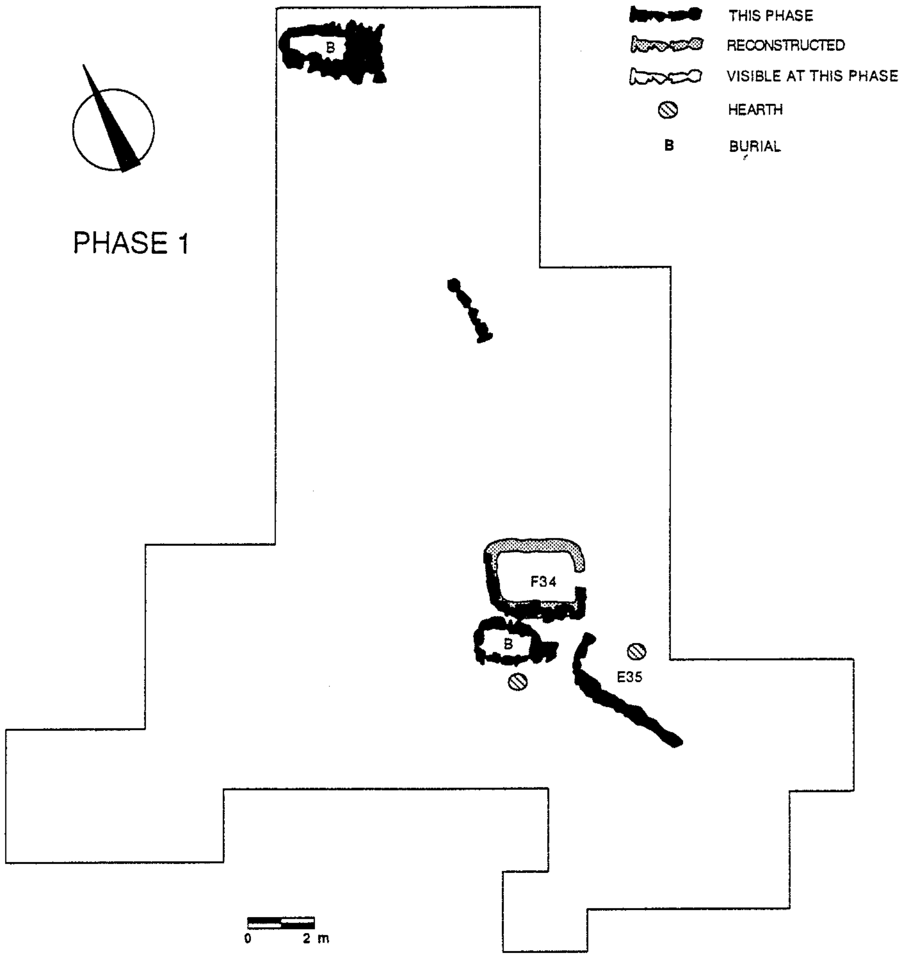

Fig. 7. A reconstruction of Phase 1.

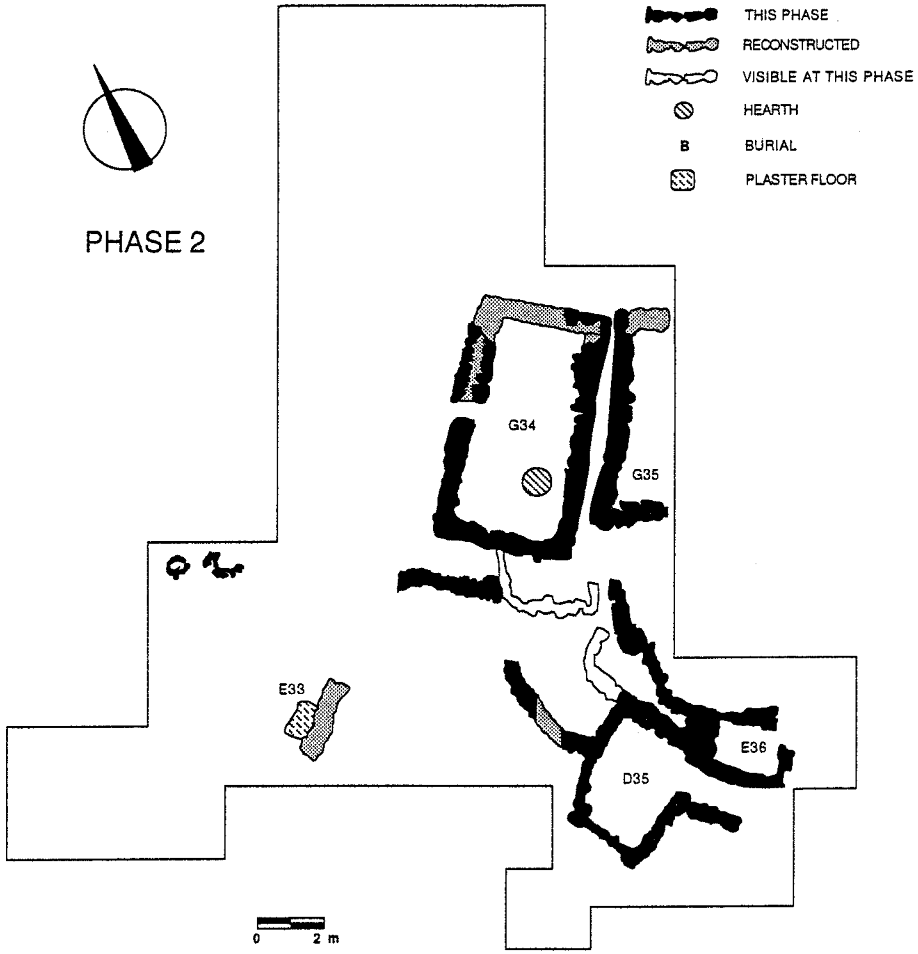

Fig. 8. A reconstruction of Phase 2.

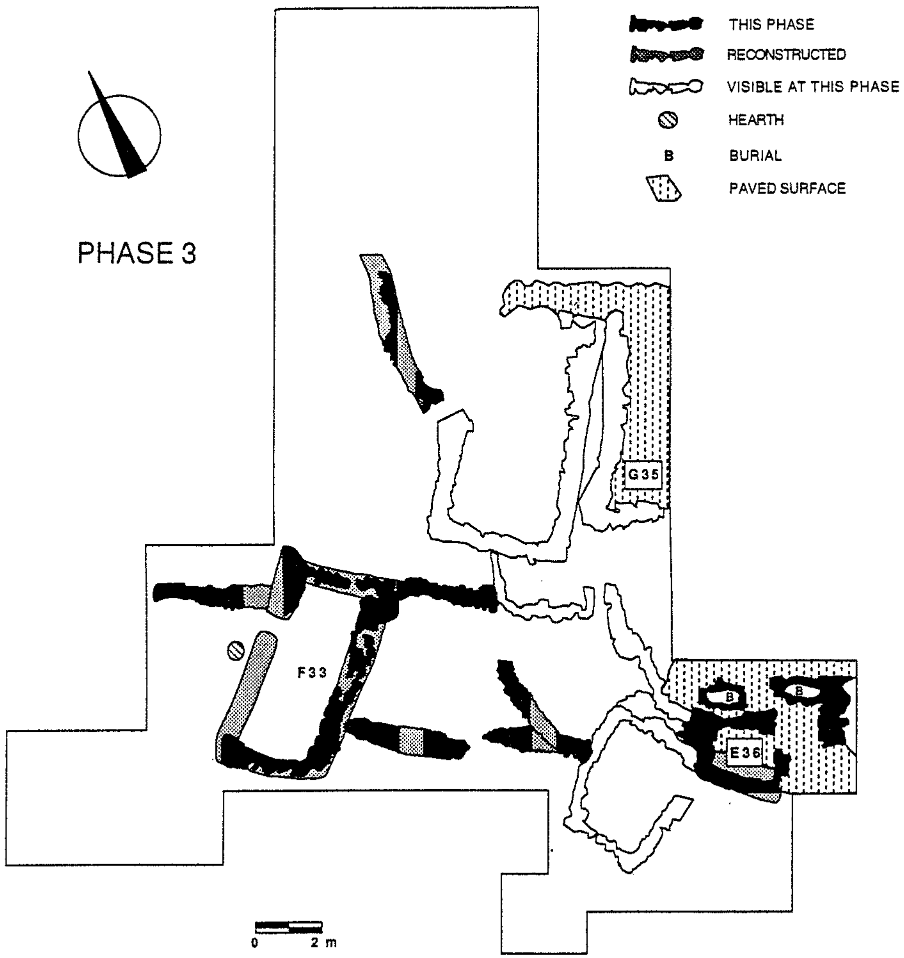

Fig. 9. A reconstruction of Phase 3.

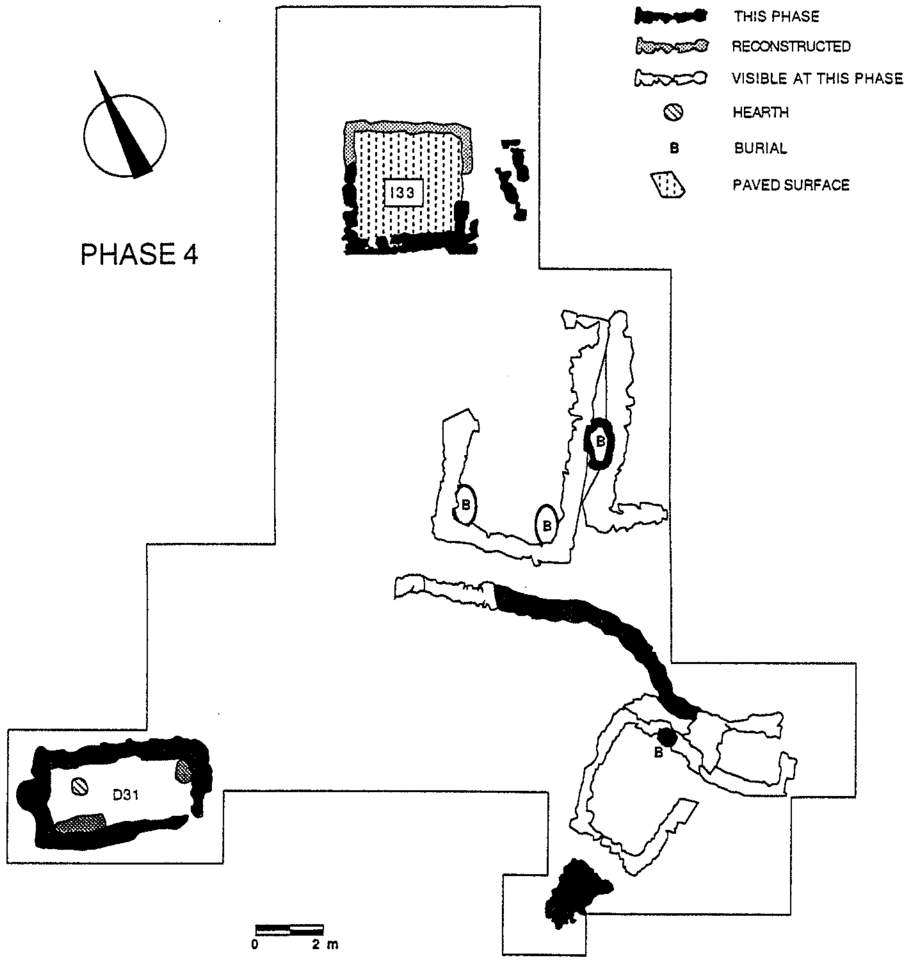

Fig. 10. A reconstruction of Phase 4.

dings G34 and D35 were no longer used as residences, although the remaining walls may have been put to other uses, perhaps as animal pens. Apart from one secondary wall, the end of this period is marked by an absence of feature construction, which suggests that the site may have been abandoned or only marginally used.

• *Phase 3, Levels 8 to 6* (Fig. 9). Phase 3 may overlap with Phase 2 to some degree, since the transition from Level 9 to 8 is poorly defined. This phase marks a shift in site occupation, with the main residence now situated to the west at F33, while at the same time some use of buildings G35 and E36 continued, albeit in modified form. House F33 was constructed at Level 8 from the remains of the earlier E33 house and, from the amount of reconstruction occurring at this time, it is likely that many previous structures were robbed of their stones. The reconstruction of F33 could mark either continued or new settlement. Either way, this was a time of considerable settlement shift within the site.

The site was relatively active in this period, despite the fact that only one house appears to have been occupied. During this phase a considerable amount of site reclamation occurred in the form of additions and secondary walls. This is evident from the number of new walls which were built directly over old foundations, as in Areas F34, G35 and D35. Apart from the many renovations and additions constructed at this time, two secondary walls were erected between the F33 house and the remains of the D35 house. One of these was built over previous building walls and covered a northern section of the F34 burial cist. The stratigraphic evidence indicates that the original wall ended at the northeast corner of the F33 building. Both wall alignments and relative levels on either side of the walls suggest they were used as terrace walls.

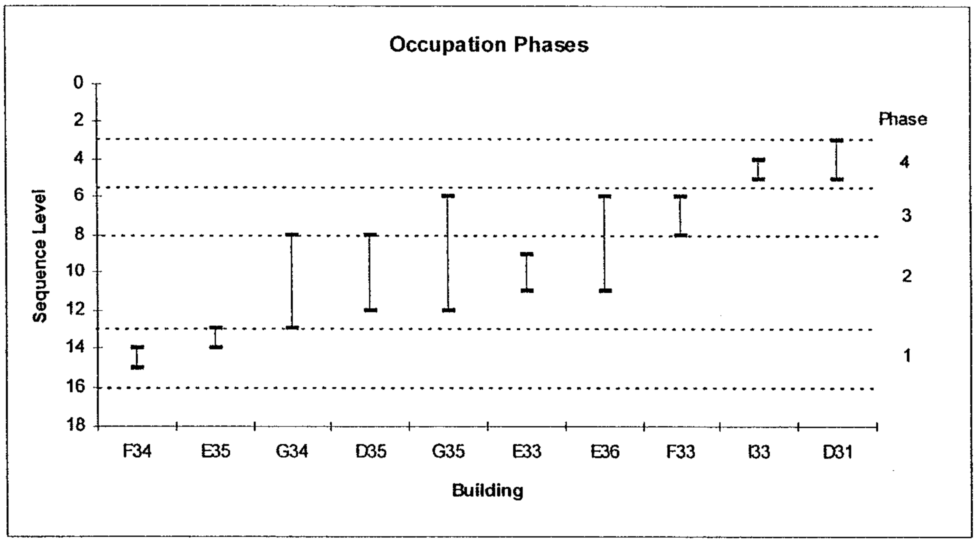

Fig. 11. The occupation phases at Tabaqat al-Bûma.

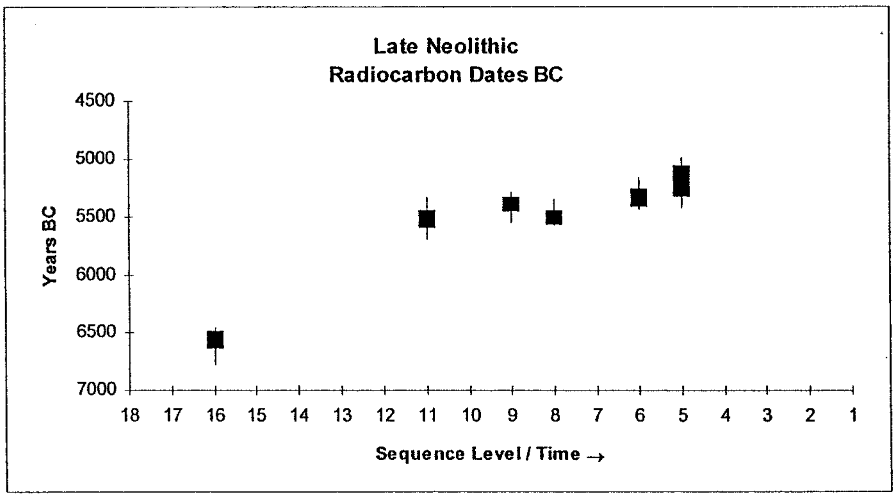

Fig. 12. Calibrated radiocarbon dates BC for the Late Neolithic period
*<thick bars show the range of dates for a 68% confidence level
while the lines represent a 95% confidence level>.*

Other features include a stone-ringed hearth in area F32, several pits, and a paved surface to the east of house F33. The combination of collapse and additions that occurred at this time implies that reclamation processes were at work and unused walls and rock features were robbed of their stones for new construction work. The site appears to have been abandoned for some time after Phase 3 but the length of this interval is uncertain.

• *Phase 4, Levels 5 to 3* (Fig. 10). This was the final phase of major construction activities and an active period in terms of renovation and burials. In this phase, a rectilinear building was constructed in the southwest (D31) and the remains of another was found farther north (I33). These structures lay well above those of the earlier phase, suggesting that a great chronological gap separates them from the previous construction phase. By this time much of the original site formed during Phase 1 was covered by approximately 1.5m of deposits. The earlier structures to the east remained abandoned and continued to collapse. During this phase, three burials took place in the rubble of the G34 and G35 buildings sometime between Levels 4 and 6. Another burial occurred in the D35 house, but its chronological placement is less certain. It is known to have occurred between Levels 7 and 4.

Some new walls were constructed in Areas E33, F35, and G34. Most of these walls, however, appear as no more than a single leaf of stones and lack the systematic construction methods of former walls. The character of the dwellings suggests a more transient lifestyle. While it is possible that these upper level walls were robbed of their stones for use elsewhere, it is more likely that they formed nomadic tent ballasts seen in similar stone structures today. We should keep in mind that such fixtures as bed platforms, hearths, animal pens, and storage facilities occur among contemporary nomadic pastoral campsites (BANNING and KÖHLER-ROLLEFSON 1992: 195, CRIBB 1991: 79, HOLE 1978: 151).

• *Phase 5, Levels 2 and 1.* These levels contain either Byzantine material or a mixture of modern artifacts. Some Byzantine features were preserved, such as an oven (*tabun*) between areas F33 and G33 from which good radiocarbon dates have been obtained.

The final sequence of phases is graphically summarized in Fig. 11, showing the buildings occupied during each phase.

Radiocarbon Dates and Occupation Phase Chronology

There are 17 radiocarbon dates for the Tabaqat al-Bûma site (Table 2), and of these, ten belong to the Late Neolithic sequence, beginning at 7800 bp and ranging to 5740 bp (6570 BC to 4340 BC). The two dates that define the upper and lower limits are problematic because they both come from the same context (the cist in Area A). The disparate results could be due to either intrusive material or poor bone collagen recovery. Neither of the radiocarbon dates obtained from the burial seem to fit the pattern established by the other dates. Apart from these two dates, two other dates obtained from different carbon samples in Locus E33.026 show some discrepancy, being about 400 years apart. This difference is possibly due to the burning of old carbon or the redeposition of charcoal by soil mixing. But other dates from Late Neolithic contexts are tightly clustered, ranging between 6900 bp and 6190 bp (approx. 5720 BC to 5140 BC).

Two levels have more than one date which may or may not be compatible. In order to check the compatibility of radiocarbon dates from the same context, a Z-test was used (two-tailed, $\alpha = 0.05$). This procedure can test the hypothesis that both dates are from the same population of dates. When the absolute value of the Z-test exceeded the Z-critical value, the dates are considered significantly different and the hypothesis that the two dates are from the same population was rejected (Table 3).

The results of the Z-tests led us to conclude that dates from Levels 5 and 11 are not significantly different and, therefore, belong to the same population of dates; these dates were averaged. The radiocarbon dates from samples in Levels 9 and 16 are significantly different and deserve further attention. For each level, the most appropriate of the two dates was chosen on the basis of context and its relationship to the sequence of other radiometric dates. At Level 9, the younger date of 6490 ± 70 bp is used because the other date is older than the oldest date at Level 11. At Level 16, the two widely conflicting dates are derived from a single burial. The younger date of 5470 ± 110 bp would place the burial within the range of Phase 4 while the older date of 7800 ± 70 bp would place the burial into the earliest Late Neolithic strata, occurring immediately over the Kebaran layer in Phase 1. The older date has been selected as the most likely date not only because the burial was dug directly into soils containing Kebaran artifacts but also because the burial contained what is thought to be some of the earliest pottery in the region (BANNING, pers. comm.). Nonetheless, the date of 7800 ± 70 bp should be viewed with some caution, and until more radiocarbon dates become available the dates for the initial Neolithic occupation of Tabaqat al-Bûma must remain tentative (Table 4).

The total length of site occupation and the duration of each phase can be estimated from the radiocarbon dates where interpolation is possible. It is important to note that sequence levels are measured on an ordinal scale while the radiocarbon dates are measured on an interval scale. In Fig. 12, for example, we know that the Level 16 date precedes the Level 11 date but we cannot be certain of the appropriate spacing between sequence levels. Moreover, we cannot safely extrapolate or predict dates beyond those that are known. Based on known radiometric dates, an estimation of phase intervals is given below (Table 5).

Table 2. Radiocarbon Dates. Uncalibrated (bp) and calibrated (BC) radiocarbon dates for the site of Tabaqat al-Bûma, sorted by sequence level and phase.

Phase[1]	Level	Locus	Lab No.	Material	Date bp ± 1σ		Calibrated BC Dates Minimum (Modal Ages) Maximum[2]
5	2	G34.002	TO-2117	Charcoal	1680	±60	260 (400) 430
5	2	G33.005	TO-4575	Charcoal	1580	±80	420 (460, 480, 510, 530) 590
4	5	E33.019	TO-3408	Charcoal	6190	±70	5220 (5200, 5180, 5140, 5120, 5080) 5050
4	5	E33.014	TO-3410	Charcoal	6350	±70	5410 (5270) 5220
3	6	G34.018	TO-3412	Charcoal	6380	±70	5420 (5290) 5260
3	8	D35.016	TO-2114	Charcoal	6590	±70	5570 (5480, 5450, 5450) 5440
3	9	E33.026	TO-4277	Charcoal	6490	±70	5450 (5430) 5330
3	9	E33.026	TO-3409	Charcoal	6900	±70	5810 (5720) 5670
2	11	E34.031	TO-2115	Charcoal	6630	±80	5580 (5570, 5550, 5520) 5450
2	11	F34.017	TO-3411	Charcoal	6670	±60	5600 (5580, 5540, 5530) 5490
1	16	A.005	TO-1086	Bone	5740	±110	4450 (4340) 4160
1	16	A.005	TO-1407	Bone	7800	±70	6640 (6600, 6570) 6470
0	19	B.007	TO-987	Bone	11170	±100	11240 (11130) 11020
0	19	E34.015	TO-2116	Bone	12660	±430	13640 (12940) 12320
0	19	B.007	TO-989	Bone	13110	±130	13880 (13660) 13420
0	19	B.007	TO-991	Bone	14850	±160	16000 (15810) 15610
0	20	F34.030	TO-4592	Charcoal	12810	±480	13930 (13180) 12450

[1] Some dates occur at the midpoint between phases.
[2] Dates are rounded to the nearest decade. Ranges are defined by a 68% confidence interval. Raw radiocarbon dates have been calibrated using CALIB rev3.0.3, Method B (Stuiver and Reimer, 1993). Calibration data sets are from Stuiver and Pearson 1993, Pearson *et al.* 1993, Linick *et al.* 1986, and Bard *et al.* 1993.

Table 3. Z-Tests for radiocarbon dates derived from samples in the same sequence level. All dates are uncalibrated.

Case	Level	Date 1	σ_1	Date 2	σ_2	Z-critical	Z-test	Sign. Diff.
1	5	6190	70	6350	70	1.96	-1.62	no
2	9	6490	70	6900	70	1.96	-4.14	yes
3	11	6630	80	6670	60	1.96	-0.40	no
4	16	5740	110	7800	70	1.96	-15.80	yes

Table 4. The final sequence of Late Neolithic radiocarbon dates ([1] See Table 2, Note 2).

Level	Date bp	±1σ	Calibrated BC Dates Minimum (Modal Ages) Maximum[1]
5	6270	±99	5420 (5258, 5227, 5223) 5060
6	6380	±70	5420 (5290) 5260
8	6590	±70	5570 (5480, 5450) 5440
9	6490	±70	5450 (5430) 5330
11	6650	±100	5600 (5572, 5549, 5522) 5440
16	7800	±70	6640 (6600, 6570) 6470

Table 5. Estimated dates for phase intervals.

Phase	From: BC Date	To: BC Date
4	5240 ± 180	?
3	5430 ± 60	5240 ± 180
2	?	5430 ± 60
1	6600 ± 90	?

Conclusion

In summary, there are four occupation phases. Phase 1 is the initial Late Neolithic occupation of the site (*c.* 6600 BC) during which settlement and site construction began. The inaugural date for this phase is tentative and may be too old. Until further artifact and material analyses are completed, it is not possible to determine whether the burials associated with this period are closely connected with the construction of the buildings.

The extent of construction at this time was probably greater than the evidence indicates due to the "robbing" of stones for subsequent construction and the small area excavated in the lower levels. Strong evidence for this type of activity exists not only for the transition from Phase 1 to 2, but also from Phase 2 to 3.

During Phase 2, initial construction began with two relatively large buildings, probably houses. Some time thereafter several other buildings or adjoining rooms were added. During this phase, the extent of building construction and other site activities reaches a peak, with up to five structures occupied at the same time. For this period there is evidence of horticulture, grain storage, domestic sheep and goat, and the hunting of gazelle, *Bos taurus* and wild pig.

By Phase 3 (*c.* 5400 BC), a new structure was added to the east, built from the remains of a previous dwelling. Two other buildings show signs of modifications and additions during this time. The buildings constructed in Phase 2 have deteriorated, suggesting they were abandoned, and two burials are placed among the collapse. Despite the collapse of some buildings, evidence suggests the site was still extensively used during this phase.

In Phase 4 (*c.* 5200 BC) the site was rejuvenated when new structures were built. Several new walls were constructed over the remains of others, but previously built houses were not reoccupied. In fact, one abandoned building was used as a depository for three burials. Apart from two rectilinear structures, several secondary walls were built, probably to serve as terrace walls for horticultural purposes. This is the last phase of Late Neolithic occupation at the site. The fact that these deposits are immediately followed by Roman/ Byzantine deposits suggests that a major erosional event occurred sometime after the Late Neolithic occupation. It is quite likely that subsequent Late Neolithic or other period deposits were washed away during the 5000 year interval between these two periods.

While this paper has not addressed many possible anthropological issues, it has provided an important chronological framework for Tabaqat al-Bûma, a framework within which archaeological materials can now be analyzed and interpreted. On architectural evidence alone, we can see that the character of site settlement changed from one of relative permanence to that of a more transient nature. Whatever implications this may have for the Late Neolithic prehistory of the southern Levant will be better understood when the cultural transitions at this site are compared to events at contemporaneous sites throughout the region.

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A Preliminary Note on the Ceramics from the Basal Levels of Abu Hamid

Jaimie Lovell, Zeidan Kafafi, and Geneviève Dollfus

Abstract: *Recent excavations at Chalcolithic Abu Hamid in the Jordan Valley have revealed even earlier deposits dating to the ceramic Neolithic. Pottery was found associated with semisubterranean dwellings, pits, and a newborn infant burial. Although detailed analyses are still in progress or remain to be initiated, we are able to present a brief description of the stratigraphy and architecture of the basal levels at Abu Hamid, along with preliminary findings concerning the fabrics and forms of associated pottery.*

In 1984 a Jordanian-French project concerning the Jordan Valley in the fifth and early fourth millennia was initiated by the Institute of Archaeology and Anthropology of Yarmouk University, Irbid, on the Jordanian side and on the French side by the Centre National de la Recherche Scientifique (C.N.R.S.-ERA 17) and the Direction Générale des Affaires Culturelles, Scientifiques et Techniques of the Ministère des Affaires Etrangères, with the help of the Department of Antiquities of Jordan[1].

One of the first goals was to establish firm stratigraphic and chronological sequences in order to rely on solid ground to observe the evolution of the human groups in a transitional period: neolithisation had been achieved and the process leading to the founding of cities was about to start.
The first step of this research was the excavation as much as possible of an early 4th millennium site in the Middle Jordan Valley. In 1984, Abu Hamid[2] was selected on the advice of Dr. M. Ibrahim, who with J. Sauer and K. Yassine and a group from University of Jordan and from the Department of Antiquities, surveyed the Jordan Valley in 1975. Abu Hamid required salvage excavations due to the extension of irrigation and of new cultivated fields. Since then, five seasons of excavations (1986, 1987, 1989, 1991 and 1992) have been conducted, and seasons of analyses of the material (which is in its totality stored at Yarmouk University) are still in progress. In the meantime, a great effort has been placed on the study of the paleoenvironment (HOURANI and COURTY n.d.) and more recently on ethnoarchaeological and experimental projects concerning the pottery[3].

Table 1: Radiocarbon dates from Abu Hamid.

Date uncal. bp	Square	Catalogue N°	Locus	Lab. No.
6200 ± 80	A1/A2	5625	612	Ly 6174
6190 ± 55	AG2	5327	736	Ly 6254
6160 ± 70	A1/A2	5348	742	Ly 6255
5205 ± 95	A1/A2	5617	612	Ly 6258[4]
6135 ± 80	A3	5623	-	Ly 6259

1 The project benefited from National Geographic Society grants in 1986, 1987 and 1989.

2 *cf.* NAVARRO i BARBERAN, this volume, Fig. 1

3 The paleoenvironment is being studied by Fuad Hourani; ethnoarchaeological and experimental projects on pottery by Nabil Ali. See also ROUX and COURTY 1997.

4 This date is clearly anomalous.

In contradiction to what we wrote in the articles published at the end of the survey and of the first two seasons of excavations (DOLLFUS and KAFAFI 1986, DOLLFUS and KAFAFI *et al.* 1988, DOLLFUS and KAFAFI 1988), the Abu Hamid site was not occupied only at the beginning of the 4th millennium bc - we thought at that time that the site had been inhabited no more than 150-200 years during the first half of the 4th millennium bc, - but in fact that it offers a long sequence of successive occupations without any significant gap. According to the ^{14}C dates the site was settled for the first time *c.* 6150 bp (Table 1) and seems to have been abandoned just after *c.* 5700 bp[1]. Although it is impossible to evaluate the size of the first settlement, we know from the survey, from some soundings, and from trenches or excavations made for agricultural or cemetery purposes as well, that at the beginning of the 6th millennium bp, it was *c.* 6ha in area[2]. Since its abandonment, the site has been severely gulleyed by erosion and during the past few decades agriculture has destroyed a large part of it.

The Basal Levels: Stratigraphy and Architecture

The basal levels were reached in two trenches - 2m wide - in the main operation (operation A). One trench runs east-west for 30m, the other north-south for 60m. In this article we give a brief report on the stratigraphy of these levels and of the pottery associated with the structures.

The North-South Trench

In the southern part of the trench (1.50 x 20m; squares AJ-AF2), above the sterile soil in a 60-80cm thick layer of a rather compact red clay sediment, a series of floors often covered by a thin layer of ashes - the skeleton of a new born child had been deposited on one of them under a large sherd of a jar[3], - as well as hearths and small basins filled with very powdery and ashy sediment and deep cylindrical or conical pits (1.20-1.60m in diameter; depth: 1.20- 2.50m, with powdery gray fill) are present. In these pits no water-borne deposits could be observed, and their walls were not at all burned (as would have been the case if they had been used to fire some pottery) nor were they plastered. A large (3.20m wide) and shallow (0.80m) depression that cuts the Lisan marl deposits is also present at the base of this layer; meanwhile from the observations made while we were excavating this large shallow pit, we cannot consider it as a dwelling, but most probably it was an earth quarry.

In the central and northern part of the N-S trench (AD-AA3: 1.50 x 20m) this level of compact red-orange silty sediment was reached but neither floors nor any domestic structures were observed and no artifact material was recovered. Moreover, the pottery sherds recovered in the layers just above it are different from the ones found in the basal levels of the squares AJ-AE2 just described. In the northern part of AA3, in A3 and A2, a large pit had been dug from and through this compact red sediment layer into the Lisan marls that are below it. In this pit some ashy floors could be distinguished and a lot of pottery sherds were collected (*cf. infra*).

The East-West Trench

It was in the E-W trench (2 x 30m; Squares A1-A6) that we were able to make some observations on Abu Hamid's first settlement:

1. In squares A1-A2-A3 three large and deep pits are present; their diameters vary between 1.80m to 3m and depths between 1.50m and 1.80m (*cf.* Section, Fig. 1). They had been dug through the compact loamy sediment into the surface of the Lisan marl deposits. Their bottoms are flat, their sides very regular (for one of them almost vertical). Inside the pits, the fill shows a succession of floors that were very trampled; some of them had been covered by mats[4] and ashy gray sediment, and layers of red clay most probably were deposited during periods of abandonment of the dwellings[5]. No domestic features such as hearths or basins were noted inside the pits, but there were some found on the surfaces (beyond the floors) from which they were dug. In the area we excavated, these shelters were very close one another. Sedimentological studies have shown that at least one of them had been re-used and its sides re-dug (HOURANI, pers. comm.; *cf.* HOURANI

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[1] GrN 16358 : 5745 ± 35 bp; GrN 17496 : 5651 ± 40 bp; GrN 14623 : 5670 ± 40 bp.

[2] Recently two big jars were found: one in the local modern cemetery on the eastern part of the site and the other one on an agricultural tract. They confirm the extension of the site as we evaluated it during our 1986 survey. They are identical to the one published in DOLLFUS and KAFAFI *et al.* 1988.

[3] This skeleton as well as the other human remains have been studied by A.M. Tillier (U. Bordeaux I); this kind of burial is similar to the ones found in the upper levels (DOLLFUS et KAFAFI 1988).

[4] These observations were made by F. Hourani on sediment thin sections during his micromorphological analyses.

[5] The rhythm of occupation and abandonment is being studied by F. Hourani.

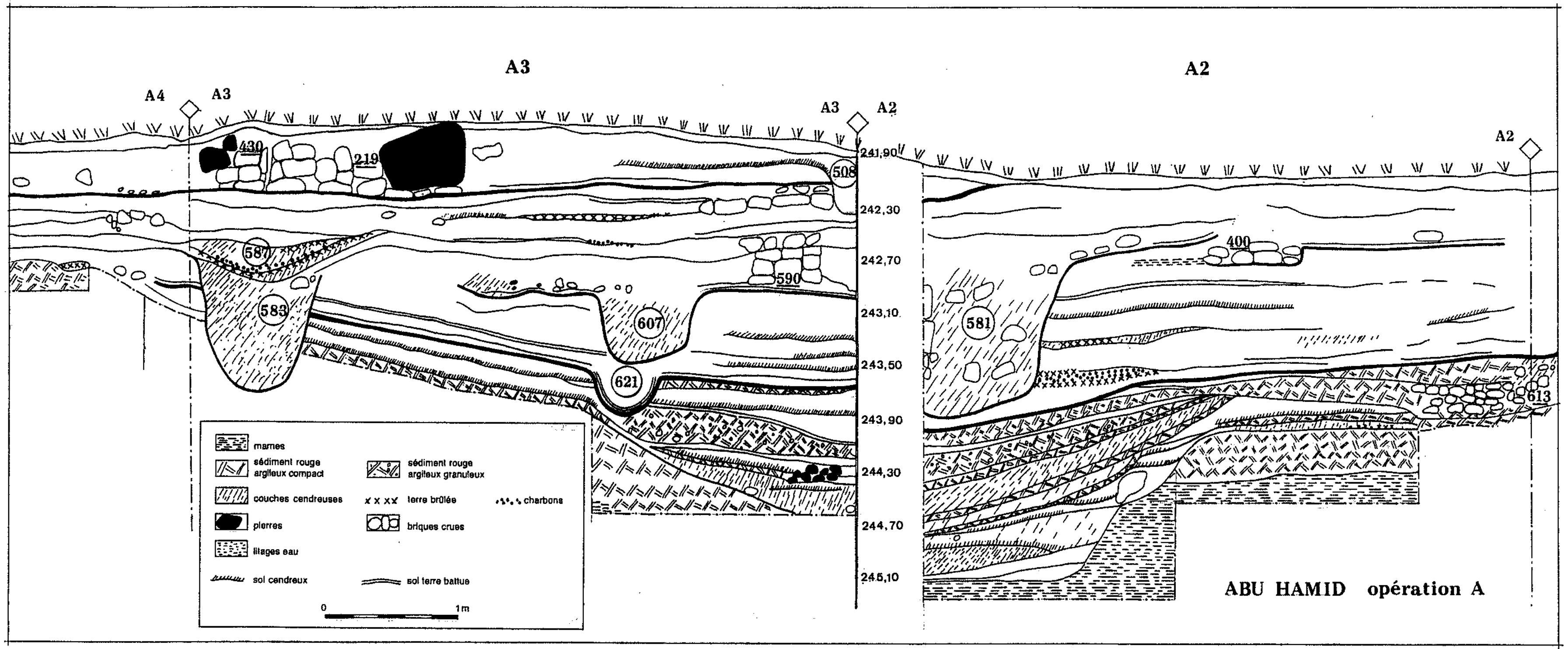

Figure 1. Part of the section of the southern side of the East-West Trench <*The bold lines show where the most evident changes in the material culture appear.*>.

1997). When these pits were abandoned, they were sealed by a 20-30cm layer of red compact clay (Fig. 1).

2. In this layer of compact red clay, a semisubterranean oval dwelling (Locus 612: 2.80m E-W / 1.80m N-S) was partially excavated. Its floor is 0.50cm below the outside surface; the inner side is lined with a wall made of very irregular small red bricks (Loc. 613). This wall seems to have been built higher than the surrounding outer surface on which, at the west of the dwelling, a large number of bricks had fallen. Most of these bricks were very decayed, and they seem to have suffered from heavy rains as well as the upper layers of the fill: all the artifacts and animal bones collected in loc. 612 were badly damaged by water (gypsification and oxidation, and some of them were rolled). Inside this dwelling two basins (20 x 30cm, 15cm deep) filled with ashes were dug from a floor made of yellowish clay. The relationship between the curvilinear wall (Loc. 613) of this shelter (Loc. 612) and a large firing(?) structure (Loc. 807) is still not clear. The firing structure was made of *c.* 1m high pile of stones; some of them on the northern side had been fired. Two large remains of wooden posts were found among the stones; this stone structure was surrounded by a thin (2cm thick) layer of charcoal.
3. In the E-W trench above the level of this structure, no architectural remains have been found, but the site was not totally abandoned: on 60- 80 cm of alternating pinkish and greenish sediment, ashy floors, pot holes, plastered basins (*cf.* Fig. 1: Loc. 621), deep circular and conical pits similar to the ones found in the southern sector are present (*cf.* DOLLFUS, KAFAFI *et al.* 1993: 262, Fig. 1-2). We consider them as testimony of the passage of more mobile groups. (G.D. and Z.K.)

Pottery

Introduction

The two sites of Tell Abu Hamid and Teleilat Ghassul form the backbone of the 7th-6th millennium bp ceramic sequence in Jordan, and it is hoped that ceramics from the same period will be treated and presented in a consistent manner. Two workshops on the proto-historic periods have been held in the last 18 months (at the Department of Archaeology at Durham University and at the Institute of Archaeology and Anthropology at Yarmouk University, Irbid). The Durham workshop, in particular, urged consistent recording and publishing terminology (PHILIP 1996: 1-3). Since various projects differ in excavation methodologies and aims this can never be guaranteed. However, the Tell Abu Hamid project has deliberately employed methods consistent with Teleilat Ghassul. What follows is a preliminary statement and will, no doubt, undergo revision in the course of further analysis[1]. This discussion focuses on the basal levels, for which the radiocarbon dates are given in Table 1.

Nature of the Assemblage

It is axiomatic that the analysis of archaeological material is determined by the nature of the excavations themselves and available storage. For the basal levels the excavated area consisted of *c.* 180 m^2, from which a total of 2,537 sherds have been analyzed[2]. Of these, *c.* 200 were diagnostic sherds (*i.e.*, rims, bases, etc.). The material presented in this discussion derives only from the most secure contexts.

Methods of Analysis

The methods used adapted a system already in use by the registrar at Teleilat Ghassul (see above). The ceramicist has not discarded any material in case another scholar might wish to reevaluate the material or the system employed. Under this system the material is processed in the following way: a sherd is classified in the first instance on the basis of its form, and then on its fabric. A new form receives an analysis number, other sherds with comparable forms receive the same number. For instance, Analysis Number 2[3] is a Bowl, simple (deriving from square A1/A2, Catalogue Number 5632) in Fabric 1a (painted). A number of other examples of this type will be noted on the same sheet

[1] I (J.L.) thank Prof. Zeidan Kafafi and Dr. Geneviève Dollfus for allowing me to analyse and discuss this material. The ceramics were drawn by Jean Humbert, Nawal Hawari and Lamia Khoury. The kind help of M. Gabriel Humbert, the project's finds registrar, is acknowledged with thanks.

[2] 32% of body sherds recovered in the excavations were discarded in the field before the analysis took place. These largely derived from contaminated or unreliable levels and were under 2 cm^2. Levels of particular interest were kept in their entirety. The analysis is therefore based on the remaining 68%.

[3] An Analysis Number is a number given by the ceramicist to a type, while the Catalogue Number is the number of a stratigraphic unit. All deposits excavated receive a catalogue number, some, in addition, receive a locus number if they form part of a recognisable feature (i.e., a pit, hearth or wall etc.).

regardless of fabric. Their provenance, fabric and other relevant details are, of course, noted. In this way statistical details of the occurrence of particular types can be built up.

The fabric[1] of a catalogued shape is recorded according to the following characteristics: sorting of inclusions (levigation), inclusion density (frequency of grits), type of inclusions including roundness (grits), firing colour and conditions, slip and/or decoration, other notes on manufacture, rim or base diameter (and % diameter). The remaining body sherds are counted according to fabric.

Preliminary Remarks

The fabrics of the bottom levels of Abu Hamid fall into various groups, but the levels sealed by a layer of *terra rossa* (*i.e.*, the "dwelling pits") are dominated by an orange-buff fabric that has very few inclusions and appears in a very well-levigated form (Fabric Group 1), and a more granular, less well-levigated form with slightly different proportions of inclusions (Fabric Group 3). These

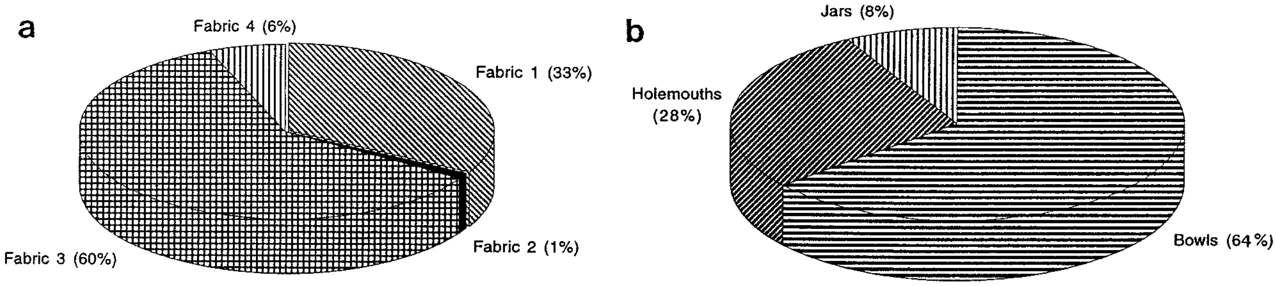

Figure 2. a percentages of fabrics in the basal levels, b percentages of vessel types in the basal levels.

Table 2: Preliminary fabric descriptions.

Fabric	Additions	Description
1a	Coarse (C) or Fine (F)	Dense buff, generally quite finely levigated with a few small, medium and large sub-rounded - sub-angular white lime, grog and/or stone grits.
1b	Coarse (C) or Fine (F)	Dense orange buff, generally quite finely levigated with a few small, medium and large sub-rounded - sub-angular white lime, grog and/or stone grits.
1c	Coarse (C) or Fine (F)	Dense grey buff, generally quite finely levigated with a few small, medium and large sub-rounded - sub-angular white lime, grog and/or stone grits.
2a	Coarse (C) or Fine (F)	Dense silty buff, generally quite finely levigated with occasional small, medium and large sub-rounded - sub-angular grog and/or stone grits.
2b	Coarse (C) or Fine (F)	Dense silty orange buff, generally quite finely levigated with occasional small, medium and large sub-rounded - sub-angular grog and/or stone grits.
3a	Coarse (C) or Fine (F)	Buff, moderately levigated with some small, medium and large sub-rounded - sub-angular grog and/or stone grits.
3b	Coarse (C) or Fine (F)	Orange buff, moderately levigated with some small, medium and large sub-rounded - sub-angular grog and/or stone grits.
3c	Coarse (C) or Fine (F)	Gray buff, moderately levigated with some small, medium and large sub-rounded - sub-angular grog and/or stone grits.
4a	Coarse (C) or Fine (F)	Hard Red, moderately levigated with some small, a few medium and large sub-angular white lime, red grog and/or ironstone grits.
4b	Coarse (C) or Fine (F)	Hard Gray, moderately levigated with some small, a few medium and large sub-angular white lime, red grog and/or ironstone grits.
4c	Coarse (C) or Fine (F)	Hard Red, moderately levigated with many small, medium and some large sub-angular white lime and some small, a few medium and large sub-angular red grog and/or ironstone grits. red grog and/or ironstone grits.
4d	Coarse (C) or Fine (F)	Hard Gray, moderately levigated with many small, medium and some large sub-angular white lime and some small, a few medium and large sub-angular red grog and/or ironstone grits. red grog and/or ironstone grits.

together make up about 93% of the assemblage (see Fig. 2:a). A hard buiscuity red/brown fabric appears in very small amounts, as does a silty buff fabric. Table 2 outlines the fabrics to be found in these levels with a brief description. The number codes given are preliminary and will not necessarily

[1] The word "fabric" is used here following recommendations of the Durham Early Bronze Age Ceramic Workshop. Fabric includes both the clay and its grits (both original and deliberately added).

correspond to codes given in the final publication. Petrographic and other micro-analysis is planned, but they have not yet begun.

Forms and Decoration

A brief statement on the general characteristics of the ceramics of the bottom levels has already been published (DOLLFUS and KAFAFI *et al.* 1993). For the most part forms are simple in this phase, and bowls dominate the assemblage (see Fig. 2:b). Orientations are often difficult due to the irregular nature of the pottery, but several examples are given here. Notable are the small bowls (Fig. 3:1-3), quite crudely made, but often painted in red-orange linear designs reminiscent of material from Kataret es-Samra (LEONARD 1989: see especially Figs. 5 and 6), Abu Thawwab (OBEIDAT 1995), Beth Shan (FITZGERALD 1935), Munhata (GARFINKEL 1992), Abu Habil (LEONARD 1992) and Tel Tsaf (GOPHNA and SADEH 1988/1989, see especially Fig. 7.8 and 8.6-9). There is a wide variety of decoration styles, however, which include spots and simple geometric patterns paralleling the material published by Mellaart from Ghrubba (MELLAART 1956: Fig. 5.62,76, 86 and 89). This type of painted decoration is not restricted to small vessels but appears also on holemouth jars (see Fig. 4:2,4,5) and handles (see for example DOLLFUS and KAFAFI *et al.* 1993: Fig. 1. 21).

Table 3. Bowls and necked jar from the basal levels.

N°	AN	Cat.	Loc.	Form	Description
1	3	5632	-	Bowl, small	Fabric 1aF painted, over which red painted linear decoration ext. and traces int.
2	79	5401	-	Bowl, small	Fabric 1bF, over which self-slip ext./int., over which red painted linear decoration ext.
3	235	4575	-	Bowl, simple	Fabric 1bF, over which white slip ext. and red slip/paint int. over which red painted linear decoration ext.
4	1	5632	-	Bowl, simple	Fabric 3a, fired buff throughout, over which red painted decoration int.
5	2	5632	-	Bowl, simple	Fabric 3b, over which red painted decoration ext./int.
6	16	5617	612	Bowl, simple	Fabric 1aC painted, over which self-slip ext./int., over which red painted linear decoration ext./int.
7	57	5423	612	Bowl, simple	Fabric 1b, grass wiped ext.
8	128	4289	553	Jar, short neck	Fabric 1b, over which traces of white slip ext.

Table 4. Rims, bases and handles of bowls and jars of the basal levels.

N°	AN	Cat.	Loc.	Form	Description
1	113	5300	738	Holemouth, simple	Fabric 2b over which self-slip ext./int.
2	112	5300	738	Holemouth, simple	Fabric 3aF, painted.
3	232	4575	-	Handle, lug	Fabric 3bC
4	81	5703	737	Holemouth, fine	Fabric 3b, painted.
5	225	4575	-	Holemouth, simple	Fabric 1b, painted.
6	82	5303	-	Handle, strap	Fabric 4cC
7	127	5310	553	Handle, lug	Fabric 3aC
8	231	4575	-	Base, flat	Fabric 1b
9	45	5423	612	Base, button	Fabric 1b (semi-oxidized).
10	44	5423	612	Base, button	Fabric 3b
11	223	4575	-	Base, button	Fabric 1a, red slip ext.
12	228	4575	-	Base	Fabric 3a
13	28	5545	612	Base, flat	Fabric 3bC

Holemouth jars appear with simple rounded rims, but also as a roughly beveled rim (Fig. 4:5). What other jars there are fall into two main types, one a simple tall neck jar (Fig. 3:8) and the same form with applied incised decoration around the base of the neck. (This type of decoration appears only on these jars in the basal levels). Handles are crudely made triangular lugs (Fig. 4:7), ledges or flat strap handles (the most common type, *e.g.*, Fig. 4:6, see No. 11 for a variation). A particularly interesting feature is the button base (Fig. 4:9,11), otherwise flat and disk bases dominate (Fig. 4:8,10,12-13; see also examples given by DOLLFUS and KAFAFI 1993: Fig. 1:10,13).

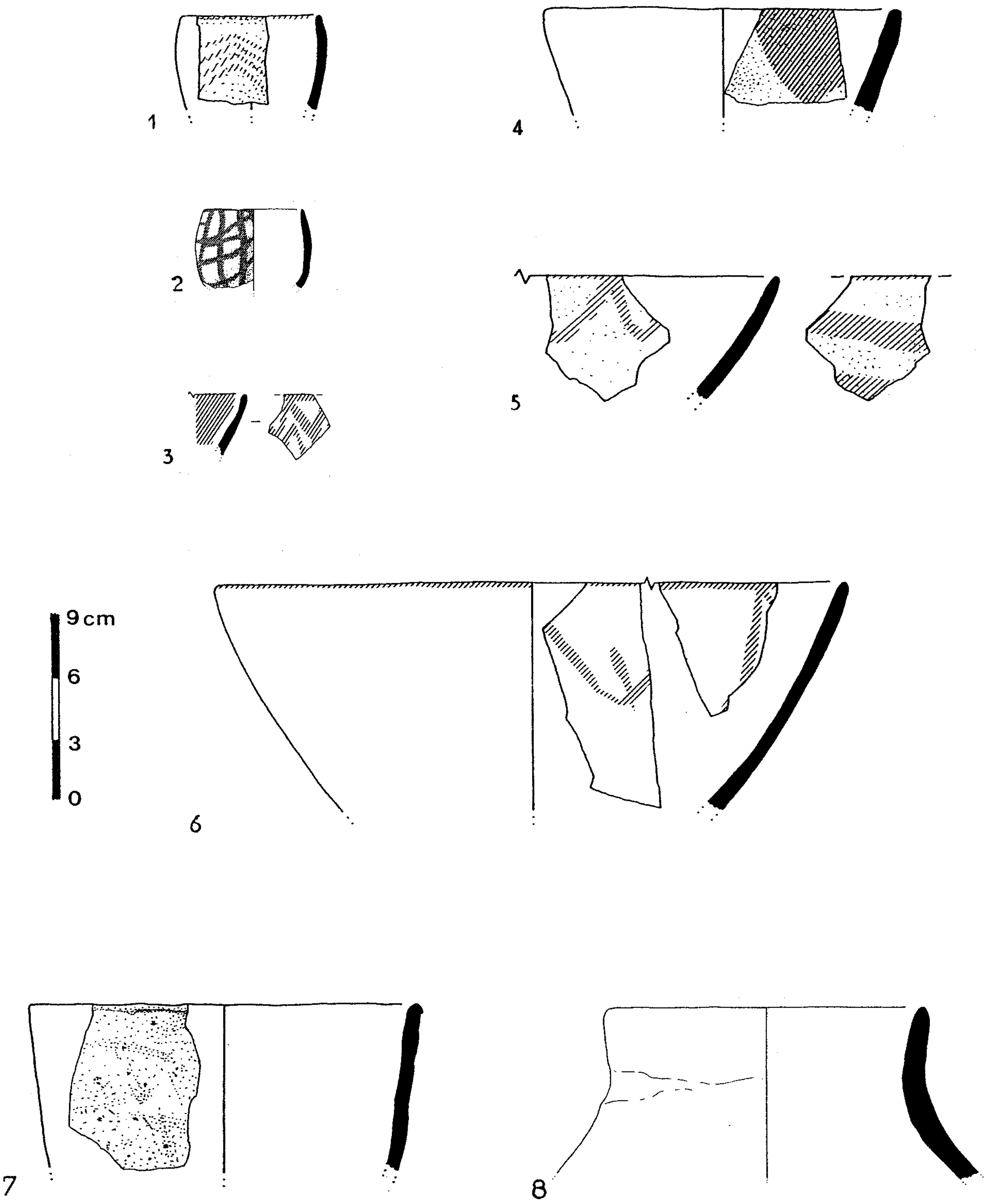

Figure 3. Bowls and necked jar from the basal levels.

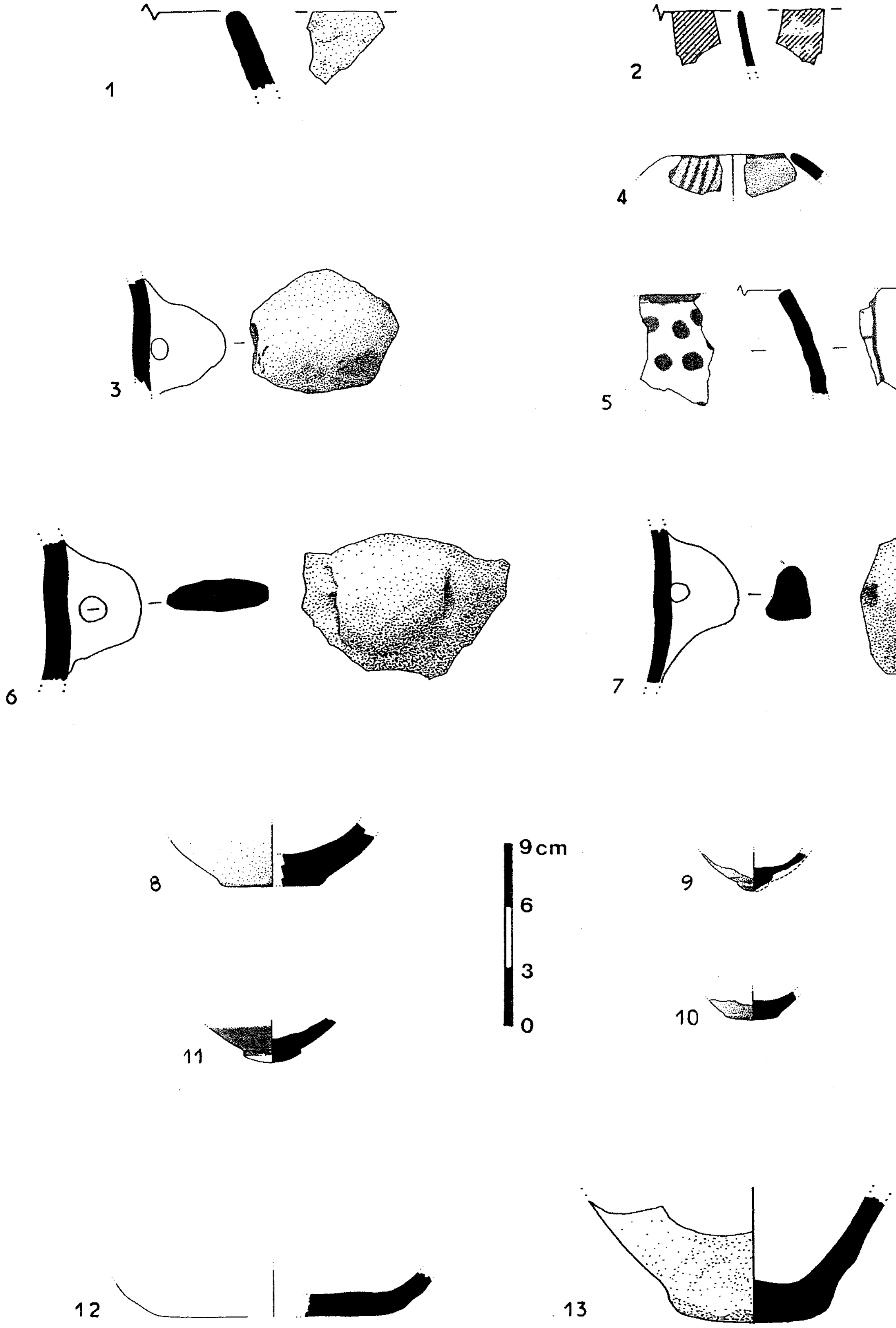

Figure 4. Rims, bases and handles of bowls and jars of the basal levels.

Additional Comments

It seems that all of the pits contain relatively homogenous material, with a striking number of comparable types despite the individual nature of each pot. The material in the levels directly above the bottom levels has not yet been analyzed in detail. However, a few preliminary comments can be offered on the nature of the transition from the early to middle levels. The transitional phase, which is devoid of architecture despite the presence of small basins, hearths, pits and other structures associated with human use, is characterized by redeposited terra rossa and other fill levels. These levels contain a wide variety of fabric types and a mixture of earlier and a few later forms. It is not until the first phases of the middle levels that the fabric groups begin to stabilize into easily definable groups.

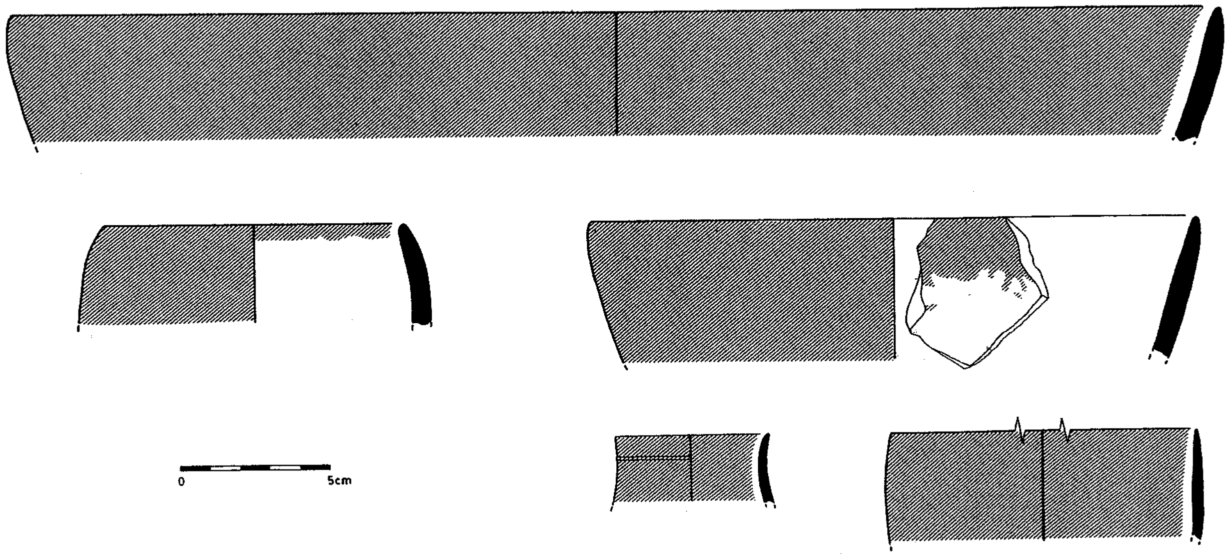

Figure 5. Burnished vessels from the middle levels.

It is the middle levels - especially the most recent ones - that have been associated with the Wadi Rabah chronological horizon courtesy of their red and black burnished ceramics and the presence of surface manipulation (DOLLFUS and KAFAFI *et al.* 1993: Fig; 2). This type of decoration includes the combed and incised decoration, which sometimes appears also on slipped vessels. A few examples of bowls and jars with burnished decoration are given in Fig. 5. It should be noted that the burnished surface decoration can be found on a variety of fabrics, although the truly fine versions (of which there are not many) seem to appear exclusively in conjunction with a very fine silty buff. The burnished sherds are estimated to make up less than 2% of the assemblage from the middle levels, while red and orange slipped sherds would make up considerably more. A number of new forms appear in the general assemblage, but further comments on these levels must await fuller analysis. (J.L.)

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Goals in Jordanian Neolithic Research

Douglas Baird

The purpose of this contribution is to present a critical resumé of major concerns of the papers in this section and a wider review of potential research strategies and issues for Neolithic Jordan and thus by default to some extent of immediately surrounding areas.

Review: Major Transformations in the Material Record[1]

A number of papers concern major transformations in the material culture of the Neolithic and interpretations of such in terms of significant transformations of past human behaviour.

An Early PPNB?

The manner in which we frame, calibrate, and date such transformations of the material record is clearly key to the way in which we comprehend them, and this is the point that Kuijt (this volume) makes when he challenges a section of opinion that sees a distinct Early PPNB period in the southern Levant between the PPNA and the "Middle" PPNB, as represented at sites such as 'Ain Ghazal and Jericho. Whether one agrees with Kuijt's specific solutions to this issue, he performs a considerable service in fully elucidating alternative frameworks for such a transition, whether as an Early PPNB transitional period or a perhaps more abrupt transition from PPNA to "Middle" PPNB. This is important because it may well indicate a more or less dramatic transformation of the record. Further, it is important to evaluate the claim for the existence of a chronologically distinct, albeit short, Early PPNB in the formulation of research strategies in that this, if it exists, would clearly represent an important transitional period about which little is known.

The significance of this transitional period could be very great in terms of dealing with the question as to when a package of crop cultivation became well established and spread through the southern Levant. At the moment it appears unclear whether an extensive range of cultivars had been adopted in the PPNA throughout the southern Levant. This makes the apparently clear evidence from the very arid setting of Wadi Jilat 7 for Early PPNB cultivated crops (wherever grown) very intriguing (GARRARD *et al.* 1994: 105). In addition, developments from PPNA to "Middle" PPNB witness the appearance of distinctive new forms of architecture, including possibly new degrees of architectural differentiation indicative of regional groups (see below) and possible distinctions within communities or the appearance of "public" buildings. The range and average size of communities seem to increase (BAR-YOSEF 1989: 61-2). A new range of symbolic paraphernalia appears. Greater differentiation may be present in mortuary practices. Cumulative changes appear profound, yet there has been no extensive excavation of a site which might have such a period of transition well represented. The only possible excavated site Kuijt can suggest is Jericho, and the evidence is far from conclusive. Soundings at Mujahiya were limited (GOPHER 1990), and Wadi Jilat 7 seems to represent an arid zone adapted settlement type. Therefore the excavation of such a site might be regarded as a priority in research strategies.

I myself do see one particular problem with Kuijt's arguments: he makes no suggestion as to how we should consider the Helwan point dominated, naviform-production strategy using assemblages that exist in several places in the southern Levant, *e.g.*, Nahal Lavan 109 (GOPHER 1994: 232-3), Wadi Jilat 7, and Mujahiya. The existence of such coherent assemblages seems to be the strongest reason for advocating the existence of a distinct Early PPNB phase rather than the reasons Kuijt states that others have advocated. I myself, for example, have never felt people claimed that they understood

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1 The contributions LOVELL *et al.* and GEBEL*et al.*, this volume, could not be considered in this contribution (the editors).

the architecture of this period. Indeed, Wadi Jilat 7 does have architecture associated with this phase. This has been published and is sub-square (GARRARD *et al.* 1994: 75), not circular; but as we have made clear on the Azraq project, the important thing to appreciate about that structure is that it is at the beginning of a long tradition of very specific architecture reflecting an arid zone adaptation. Whatever its nature, this crucial transformation must be a priority for research which might consist of more extensive excavation of key moister zone sites with Helwan point-dominated and naviform-strategy-using assemblages, or sites where late PPNA and earlier PPNB levels are present, preserved, and easily accessible. A number of the former may suggest themselves to researchers the latter may be more difficult to locate. Alternatively, and perhaps more fruitfully (see below), research might better concentrate on a limited geographical area where a sequence of sites exists through this transition.

PPNB-Late Neolithic Developments

Whilst the questions relating to the transition from the PPNA to PPNB still hinge very much on the nature of the record, because of the lack of definitive evidence of various sorts, questions relating to the transition from the PPNB to Late Neolithic (PPNC and Yarmoukian/PNA) seem more clearly framed by an increasing abundance of evidence from sites of the 7th to 6th and 5th millennia bc, *e.g.*, 'Ain Ghazal, Basta, 'Ain el-Jammam, and Tabaqat al-Buma, as reported in this volume. In this volume, different authors enunciate a number of factors to explain the transformations in the material record. What they seek to explain is the reduction in the elaboration of material culture by the end of this transformation (which I will address later), including the disappearance of especially large sites, the development of less elaborate architecture in Yarmoukian/PNA, decline in the degree of differentiation between buildings in the Yarmoukian/PNA, change in mortuary practices, disappearance of certain symbolic paraphernalia (*e.g.* statues, plastered skulls), and the disappearance of apparently more sophisticated knapping strategies (like the naviform strategy) associated with the use of high quality raw materials, but of course not necessarily the disappearance of sophisticated knapping techniques *per se* (see below).

It is suggested that this transformation is a consequence of the adoption of new food production techniques and strategies, environmental impact, and environmental change. Thus Rollefson (this volume) argues that food production resulted in long term population growth, and this had an impact on local ecologies resulting in the disintegration of population agglomerations seen in the 7th and earlier 6th millennium bc, the shift of population away from exhausted localities, and the separation of large scale pastoralism from a mixed farming subsistence base. The result is smaller and less complex communities. Simmons (this volume) suggests changing environmental conditions aggravated human environmental impact to reduce productivity of agricultural land around settlements and that this was compounded by aridification in the PN. Banning and Siggers (this volume) infer that much of the change seen in material culture relates to shifts of emphasis in risk management in crucial subsistence activities, namely a change from emphasis on risk management in hunting-related activities to those involved in agro-pastoralism. The argument is that those tools important in crucial, temporally constrained economic activities will show more investment in design and production. With the purported decline in the economic importance of hunting, they suggest that this is particularly apparent in less elaborate lithic tool kits.

Environmental Change and Impact

These explanations in themselves demand further research. Environmental change and human impact during the specific periods concerned remain poorly documented and are largely assumed. Cobble layers, reduction in plaster use, smaller post-holes brought forward as evidence of environmental degradation by Rollefson and Köhler-Rollefson (1989) and Simmons (this volume) could have a variety of explanations which may not directly relate to environmental change or human impact on the environment. Clearly the sediments on archaeological sites need detailed analysis from a variety of viewpoints, including those that seek to establish local environments. But site-specific depositional episodes may tell us only about environmental factors immediately adjacent to the site and nothing about wider environmental productivity. The past environment needs to be approached with a full range of analytical techniques, including sediment studies, palynological, macro- and micro-botanical, macro- and micro-faunal, and other techniques appropriate to local area settings. We will need relatively precise chronological resolution for that environmental record. We have to be careful, for example, comparing dating systems. Global climate models that refer to 9,000 years before present (SIMMONS, this volume) may not concur well with our assemblage-based periods deriving from a ^{14}C calibration-requiring chronology. Tree ring studies based on wood charcoals may offer a significant opportunity. Such samples are potentially relatively precisely datable, and the growth rings of many longer lived trees can be climatically highly sensitive in the sort of relatively arid settings typical of the southern Levant. Calibration of the response of local examples of specific species to climatic variation would be required as the first step in such an exercise. Site charcoals could thus provide a climatic record, but they may also tell us about surrounding environments in that they can indicate exactly what sort of wood was available, *e.g.*, whether well established mature trees, rather than degraded woodland, were available for exploitation, regardless of whether such were used in post holes or as fuel for plaster or other purposes. In other words charcoals have the advantage of providing a climatic record and some indication of human impact on "local" environments.

Another way we might wish to consider the issue of environmental impact is to investigate the sustaining areas around these Neolithic settlements: catchment analysis. How big would these communities have to have been to have exploited the whole area of suitable agricultural land and pasture situated in close proximity to these settlements and thus potentially to have had a detrimental impact on their resource base? Rollefson and Köhler-Rollefson (1989: 75-77) have embarked upon such a research in a preliminary manner. Some basic assumptions and the tenor of their conclusions contrast with the perspectives of Flannery. Analysis has suggested that communities have to reach very substantial sizes to really impact upon the resource base of their proximate territory (FLANNERY 1976: 93). Whether this is true or not, we can approach these issues in an empirical, detailed, and sophisticated fashion, such as carried out by Flannery (1976: 92-5 and 103-117) in central America; that has barely been attempted in the Neolithic of Jordan. Detailed inspection of catchments following Rollefson's initiative would seem to be in order.

Changes in Subsistence

That changes in technology and apparent reduction in complexity from PPNB to Late Neolithic relate to changes in subsistence, specifically the adoption of a full mixed farming regime including animal herding or the appearance of pastoralism, has some appeal. There are, however, a number of problems and issues requiring resolution if we are to accept such explanations. The nature of the subsistence changes are far from clear. Were many PPNB communities significantly reliant on hunting for subsistence (as opposed to crop cultivation), did hunting have other significance? How much variation existed in the subsistence base from one area of the southern Levant to another? Two important questions are involved here in relation to the issue of the changes from PPN through Late Neolithic. When was herding adopted, and was hunting and indeed herding of economic importance relative to other subsistence pursuits such as cultivation (see below)? Information on simple frequencies of occurrence of wild and domestic animals on sites does not provide us with useful information in this last regard.

Technological Change

Further, the changes in "technology" such as those in lithic industries (BANNING and SIGGERS, this volume) do not follow the trajectories one might expect if there is a simple and direct relationship between changes in subsistence and changes in risk management as mediated by technology. Sheep/goat pastoralism is clearly widely represented alongside crop cultivation by the 6th millennium bc (GARRARD *et al.* 1996), the earlier part of the Late Neolithic (PPNC and Yarmoukian). However, we do not see reduced investment in hunting technology if we look at the nature of projectile points, which may, plausibly, be for warfare as much as hunting in either period. Whilst points are smaller in the PPNC and PN, many are elaborately pressure-flaked in a way not noted in the PPNB and in a manner that might well require more investment than in the PPNB. At the same time, in the PPNC and PN we see the increase in frequency of pressure-flaked bifacials compared to the earlier PPNB. This would seem to represent increased investment in some components of the "tool kit", whatever their purpose. Sickles too are often elaborately retouched in the Yarmoukian/PN.

So there is an increase in investment in certain tool types across a range which covers, almost certainly, a number of activities, some of which might be more or less central to subsistence activities *per se*. The design of these tools may not reflect much in the way of risk management at all. It is also false to make a distinction between PPNB sickles and points in terms of design and time invested in making them. Since both are frequently produced from blades from opposed platform, frequently naviform, cores, the significant areas of investment of time and effort in design and production relate to the reduction strategy for the blanks, not the relatively limited time spent on retouching the tools to limited design specifications. Many PPNB points are not particularly elaborate. The specifications of a number of PPNB blades may well have had suitable design parameters for sickle elements without further retouch.

Changes in design and investment in individual tools - and indeed production strategies - do not neatly accord with changes in subsistence, indeed do not neatly accord with reducing complexity. If changes in the relative importance of different subsistence activities cannot account for changing investment in chipped stone reduction strategies and tool design and execution, what can? I would suggest that the changing role of those involved in chipped stone tool production is the key to understand changes in lithic types. This is an area of research ripe for investigation. How we might investigate the social position and role of knappers is something I will discuss in the section on specialization.

This aptly touches on issues elegantly raised by Wilke and Quintero in this volume. They further our understanding of changes in the frequency and nature of sickles through time in the Neolithic through their use of experimentation. They argue that a decline in the frequency of highly glossed sickles relates to the increased presence of tough rachis individuals in cereal crops, because gloss develops more slowly when cereals are reaped dry. They suggest that many PPNC and Yarmoukian sickle blades might not be glossed. Therefore, we need a new approach to the identification of sickle blades. Intriguingly, they are unable to advocate, on current evidence, a functional advantage to the specific features of Yarmoukian sickles, despite their desire to approach this problem. One area in which their research might be developed, apart from investigations of possible functional advantages of Yarmoukian sickle design, relates to post-6th millennium bc sickles. This might help establish whether reduction strategy and design changes relate to risk management and subsistence technology. If their argument that decline in sickle frequencies in late PPNB, PPNC and Yarmoukian assemblages relates to the increasing presence of tough rachis individuals in reaped cereals, and therefore the reaping of dry cereals, why are there relatively high percentages of at least moderately glossed blades in the PNB and Chalcolithic? Their researches might usefully be extended to this question. We must also not forget that methods for harvesting cereals alternative to the use of flint-toothed sickles exist.

Neolithic Beliefs

Bo Dahl Hermansen (this volume) approaches a difficult issue that undoubtedly needs to be more apparent in our discussion of the material culture of the Neolithic, the symbolic significance of artifacts and their contexts; this could also easily be said of buildings and their contexts. Whilst a number of buildings have been distinguished as potential settings for specific ritual activity at 'Ain Ghazal (ROLLEFSON, this volume), Jericho, or Beidha, the question of the wider symbolic significance of certain aspects of material culture has not really been addressed. This is part and parcel of the question of the role of these structures. One key question about society in these periods, (particularly the PPNB, rich in the presence of distinctive symbolic objects from figurines to statues, masks, and decorated skulls) is the extent to which ritual/symbolic/religious activity had a distinct defined public role, as the existence of specialized buildings might suggest, as opposed to a pervasive presence in a range of activities including those as "functional" as the robbing of buildings, or the digging of pits, or the occupying of otherwise domestic structures. Are some of the buildings at Beidha, 'Ain Ghazal, Wadi Jilat (GARRARD *et al.* 1994: 85), and Jericho with uprights (or the last case, possible uprights), or indeed other distinctive architectural features, dedicated shrines or buildings serving other purposes in which symbolic behaviour may also be manifest? Only a close study and presentation of the contexts such as that carried out by Hermansen can elucidate such issues. The question of the significance of particular symbols themselves, be they masks, statues or figurines, will require a study of the information encoded within the objects in conjunction with context, always wary of the arbitrariness of such symbols, by reference to different categories of material culture. This can only be achieved by a study of the range of such material from figurines to statues to mortuary practices (MCADAM 1997: 139) and the identification of themes of representation and contexts of practices. It is in such a manner that we may be able to establish emphases within representations or patterning in the occurrence of such material. Some discussion of how we might examine the role of buildings is presented later.

Research Strategies

The previous section has touched on a diversity of approaches possible in investigating the Neolithic. I seek not to offer a definitive, exhaustive and totalitarian research strategy, but rather to point out areas ripe for exploitation, but which until now appear to have been neglected or entered only hesitantly.

Landscapes of Settlement

Landscapes must not be understood merely as landforms. I would suggest that research into Neolithic landscapes requires not merely environmental reconstructions but the understanding of how communities spread themselves across landscapes and interact with each other in those landscapes.

Currently, research in Jordan and indeed many surrounding areas is focused on single sites. Geomorphological evidence and on-site environment-related evidence is used to reconstruct local landforms, climates, plant and animal communities in the best traditions of economic and environmental archaeology. Whilst broadly based surveys have located numerous sites, no one appears to be attempting an understanding of a network of broadly contemporary sites in a localized area. Those involved in the Netiv Hagdud project have intimated the potential of such an approach (BAR-YOSEF *et al.* 1991: 422-3). This would require intensive survey coverage of specific areas, probably exploiting a range of techniques to deal with the effects of alluviation and colluviation (BAR-YOSEF *et al.* 1991: 422-3, GOPHER 1994: 234) and ensure the recovery of as full a range of sites as possible. In addition, catchment analyses of areas around sites may well indicate the productive potential of the resource base and would allow some indication of resource areas for communities of particular sizes and interaction areas where several communities may have had to exploit the same resources. Only a study of the resource catchments of sites will tell us whether communities of certain sizes are likely to have had a detrimental impact upon their environments (see above). The need for a careful choice of the settings in which to conduct such survey are clear. The area around 'Ain Ghazal can now only offer limited possibilities because of the presence of Amman. Sites such as Basta and Es-Sifiya may be more informative in this regard.

In particular, the large size of a number of Middle-Late PPNB sites in Jordan is notable, two such sites are discussed in this volume Es-Sifiya and 'Ain Ghazal. This large size may require a certain degree of "explanation". It also still requires a degree of definition. How dense was housing on such sites? What proportion of such sites was occupied simultaneously? A key issue that remains to be resolved is whether these sites served as central places and whether their immediate catchment areas could have supported communities of their size (FLANNERY 1976: 93), or whether they were dependent upon the import of key resources or exploitation of abnormally large resource zones whether by task groups or exchange. They may have offered products, services, activities not available at other sites for their inhabitants, and/or for inhabitants of other sites. In order to address this second question, we need to establish whether these larger sites have smaller satellites and what the relationship, if any between surrounding smaller sites and larger sites might have been. Is there differentiation in architecture, access to exotic items, degree of continuity of occupation, and evidence for production between larger and smaller relatively proximate broadly contemporary sites?

The issue of the relationship between small arid zone sites, encampments for mobile groups, and the larger moister zone sites has been broached (ROLLEFSON, this volume). However, the issues are somewhat different and relate to whether components of the communities of these large sites dispersed to exploit the arid zone at certain seasons. Specific relationships proposed between sites as far away as 'Ain Ghazal and the Black Desert, Azraq, or Jilat would be tenuous and find little support in the material record (BAIRD 1994: 539). One might rather first examine the arid areas closer to settings such as 'Ain Ghazal or Basta for encampments of mobile task groups from larger or smaller sedentary communities. The documentation of such activity would not serve to answer the question of whether there are satellite sedentary communities around the larger sites, or indeed the relationship between surrounding sedentary communities and the larger sites.

Issues of Complexity

In the first section, much space was given over to discussions of transformations in the Neolithic because this was something of concern to authors in this volume. As I indicated there, many suggest that the PPNB was a period of greater social complexity than that of the succeeding Late Neolithic. I would suggest that a research priority would be to investigate that complexity further, whether the supposed differences are apparent or real (see below). The immediately preceding issue of the role and degree of distinctiveness of large settlements has already touched on this question, but there are other issues to resolve.

Specialization

One agent of increasing social complexity is the growth of specialization in production and the division of labour outside the family. It remains a challenge to identify the existence or absence of specialists, but also, if such exist, to define the level and role of specialization. A variety of possibilities for specialization exist, for example: 1) particular activities are only carried out by a limited number of specific individuals within the wider community or 2) certain people only carry out specific activities and don't engage in other production activities. If we can identify the second option, are these activities carried out "full-time" or only sporadically? To restrict a definition of specialization is not helpful. Specialization may be a matter of status as much as an economic role. The ethnographic record points to individuals who are approached for goods and services quite independently of the amount of time they spend supplying those goods and services, or indeed whether those "specialized" activities supply the basic material requirements of the "specialists" involved by reciprocity or exchange. A logical outcome of this is that we must be interested in the context of the production of particular components of culture or provision of services rather that in the identification of specialization *per se*. How can we approach specialization in the Neolithic record?

Traditionally, skill levels have been used to define products that it is likely few were capable of producing. Skill levels are difficult for us to assess, for we are talking about activities carried out in societies accustomed from birth to such tasks. The range of individuals involved in production of such "high skill" may be much greater than we suspect. Only extensive replication work on a much greater scale than thus far contemplated, involving a wide range of people, will even approach the possibility of really defining skill levels involved in production. Even then we must guard against the complacent view that we replicate the past. Alternatively, it has been suggested that the use of uncommon materials might indicate specialized production. However, this depends upon assumptions about the nature of the distribution of such materials, which are hard to substantiate. Conversely, many items and services may not demand high levels of skill and were made from raw materials readily available, yet they may have been specialist products; we must be able to approach the identification of these. This category would include the production and provision of many chipped stone and composite tools, much pottery, metal, stone items, plant and animal products and many services.

How can we approach the context of production in general rather than the highest levels/greatest degrees of specialization? We must understand the setting of activities in a community and thus on a site. If we wish to address of how specialized lithic, ceramic, ground stone production or other production processes were, we must understand the factors behind the distribution of evidence of production of those goods and use of tools on a site. Is production waste, or certain sorts of production waste, restricted to certain areas? What scale of activity is represented? We must thus comprehend the technological stages involved in different sorts of lithic (WILKE and QUINTERO 1994), ground stone (WRIGHT 1992), and other manufacture and the depositional processes operating in particular parts of sites. This will involve contextual analysis in a way rarely witnessed in the past, usually only applied when absolutely clear cut production evidence such as bead production areas have been identified (FINLAYSON and BETTS 1990, GARRARD *et al.* 1994: 107, GARFINKEL 1987). This, of course, has implications for the very controlled recovery of artifacts in appropriate contexts and micro-stratigraphic analysis of deposits, perhaps involving soil thin sections (MATTHEWS *et al.* 1996).

Earlier, when discussing transformations in technology, I suggested that an important aspect of changing technology might be the changing roles in society of those involved in production. If we are to address this question, then the sort of approach I have just outlined will be required.

Social Stratification

The potentially complex natures of Neolithic societies have been examined in the light of possible evidence of stratification in society and the existence of specialized religious roles relating to purportedly complex cults (BAR-YOSEF 1989: 63). This has involved the identification of differentiated or distinctive, in some cases putatively special purpose, buildings (*e.g.* 'Ain Ghazal, ROLLEFSON, this volume) that might represent the presence of public institutions or the dwellings of an elite (*e.g.* Beidha). Similarly, it has been posited that distinctions in mortuary treatment may relate to status, either particularly elaborate treatment as in plastering of skulls as indicative of particular status, and particularly unelaborated treatment, no burial or apparently in domestic contexts such as "trash" burials (ROLLEFSON, this volume).

How can we better research the question of the role of some buildings as possible public buildings and/or elite dwellings? Much will depend upon detailed contextual information. At the moment much interpretation hinges on what makes buildings distinct architecturally, but we need to approach, as far as possible, how they were used, otherwise we are in danger of applying our arbitrary views of the significance of particular features. Such arbitrariness can only be avoided by wider comparative information on other buildings, but also by a reconstruction of potentially dynamic life histories of such structures and activities represented within them at different times. For example, it may be one thing to identify a building as distinct on the basis of size or the presence of stone uprights (see 'Ain Ghazal Late PPNB temple, ROLLEFSON, this volume). Those uprights may have a symbolic purpose, but that symbolic or special purpose may operate in a domestic or public or purely ritual context. Without understanding activities, and possible changes in those activities, in and around buildings, it is difficult to distinguish the significance of such distinctive features and architecture. The possibility to reconstruct activities will depend upon the careful observation of the distribution of portable artifacts, of ecofacts, and the nature of the depositional environment. Thin section work on soils, soil micromorphology, may offer better opportunities to understand the depositional context more fully than at present (MATTHEWS *et al.* 1996).

Regionalism

There is increasing evidence of considerable degrees of regional variation in the material culture of the southern Levant, at least during the 7th millennium bc and the Pottery Neolithic. Regional variation appears to be a well attested feature of the earlier Epipalaeolithic, where it is ascribed ethnic or functional explanations (HENRY 1995: 434-7). It seems likely both factors of adaptation and of identity - community or sub-community, conscious and unconscious - play a part in the regional variation we encounter in the PPNB and Late Neolithic record. At the moment, better definitions of the degree of geographical variation in different aspects of material culture, and the extent to which such variation coincides or overlaps, is needed before the level of identity and the involvement of adaptations to local environments can be distinguished. We can at least point to a few instances that invite further work.

It has been appreciated for some time that there are local vernacular architectural traditions in different regions of the Levant at certain periods (further reflected in this volume by the papers on Es-Sifiya, 'Ain el-Jammam, and 'Ain Ghazal). The Middle PPNB pier houses of the central part of the southern Levant (BYRD and BANNING 1988) and the Late PPNB structures with sub-floor channels in the southern part of the south Levant are good examples. Whilst it may be stated that the sub-floor channels of the southern buildings reflect adaptations to local environments and terrain, the fact remains that these are very specific forms of adaptation not witnessed in other times in the same settings nor in other places in similar settings. The particular floor plans of the buildings with which they are associated must also be considered and are distinctive. Questions abound. How much are these forms related to particular environments and building materials? How sharp are the boundaries which separate settlements with one constructional feature as opposed to another and one ground plan as opposed to another? Do they coincide with environmental zones? To answer these questions sites will have to be chosen for excavation, not because they are there, or big, or even threatened, but because they are in particular environmental settings, date to particular quite specific periods of the Neolithic, and perhaps are set close to perceived boundary areas for particular traditions. It is such a phase of research that we may enter next.

The regions defined by other aspects of material culture are just as clear and indicate the evolution of identities which we are challenged to comprehend more clearly. Goring-Morris (1993: 72) suggests two regions with distinct material cultures in the southern arid areas of the Negev and Sinai. We can take one example, the burin sites of the northeast of Jordan. These are defined by the presence of numerous angle burins, many on truncations, many of which are concave. These burins are the cores for spalls used as drill bits for piercing tools, in turn used for making stone beads and probably piercing other materials as well. Further work has demonstrated that such burins were on occasion not just cores. The proportions of burins on a site seems to relate to the frequency of spall and bead manufacture relative to other activities and, therefore indirectly, lengths of occupation of what are mostly stations in a mobile settlement system (GARRARD *et al.* 1994: 90-1). We have evidence that this tradition of piercer manufacture appears in the steppe and desert areas of northeast Jordan or possibly south Syria in the Middle PPNB *c.* 7000-6500 bc and lasts at least through the 6th millennium bc, *i.e.*, through the dramatic transformations of the PPNB-Late Neolithic.

This phenomenon marks the development of a particular manufacturing technology, but it is more than that. Piercing technologies can be documented throughout the Levant in the Neolithic. Common features of settlements are piercing tools and beads, often with evidence for on site manufacture (GARFINKEL 1987, GORING-MORRIS 1993: 85). But only in the steppe and desert areas of northeast Jordan and immediately neighbouring moister areas do we witness the particular piercer package reflected by the burin sites. Since sites in other parts of the south Levantine arid zones do not possess this particular piercing technology, it does not reflect a specific adaptation to arid zone environments. It is a culturally contained technology specific to a number of communicating groups united by a common tradition worked out through practices not shared with certain neighbors.

Most investigated sites that typify this tradition have been excavated in the heart of the burin site distribution, the Black Desert and Azraq basin. To understand the nature of the identity expressed by this tradition, we must understand technologies from sites on the boundaries of this zone and whether other features also distinguish these communities and accord with such boundaries. Equally important in understanding the nature of such identities will be the abrupt or gradual character of the transition between one set of practices and another. 'Ain Ghazal may help us here, but sites also in the steppes of south-central Jordan may be informative.

Change

PPNB-LN Processes

As discussed above, a series of transformations characterize the archaeological record of the Neolithic. These may coincide imprecisely with the archaeological periodisation. The evolution of the features of the PPNA, bigger sites, changing mortuary activity, walled sites, possible economic changes, transition to Middle/Late PPNB with massive settlements, more elaborate and diverse rectangular architecture in most moister zone sites, the so-called PPNB collapse all require greater definition. Our view of the transformations from the 7th to the 6th millennia bc has been radically altered over the last decade by the accumulation of evidence. We need more evidence but of a somewhat different nature. In particular, we must start to study the transformation of communities and developments in whole clearly defined areas to really understand the nature of change. Until recently the developments in which societies were engaged were divined from the fragmented settlement record of individual sites like Jericho or less fragmented record from sites like 'Ain Ghazal. The individual and potentially idiosyncratic vagaries of a specific settlement in one location may not represent the general nature of developments. However, by piecing together a picture of developments from a number of different areas we lose sight of the interactions of communities with evolving local environments. We need to chart the dynamic settlement history of whole areas and compare a number of such settlement histories to fully understand the transformations in which we are interested. When large sites like 'Ain Ghazal are no longer inhabited, are they replaced by a number of smaller sites of the same aggregate size, for example, in the same or different environments, with similar or different economies? We need to chart the trajectory of communities through time, understanding at the same time the role of the local environmental dynamic.

When this is understood in conjunction with the need for catchment analysis and area studies of broadly contemporary settlements advocated earlier, a strong case can be made for future research strategies that embrace a study of whole but not necessarily vast areas, rather than focused on individual sites. This work, of course, is already beginning as Banning's Wadi Ziqlab project indicates.

A further point is worth making. Our knowledge of the Late Neolithic is still very restricted. Recent discoveries at 'Ain Ghazal have indicated the surprises that may await us on other Late Neolithic sites, *e.g.*, the PPNC-Yarmoukian "Great Wall" and walled street, and the Yarmoukian "public" building at 'Ain Ghazal (ROLLEFSON, this volume). Some of the contrasts between PPNB and Late Neolithic may relate to the very fragmentary nature of the Late Neolithic record, including, for example, the absence of evidence of the nature of mortuary activity. Further extensive exposure of significant Late Neolithic settlements and investigation of cemetery areas, if such exist, is a research priority.

Subsistence and Economic Changes

Much of the worldwide interest in the Neolithic of our region is fueled by the issue of the "origins of agriculture". Key economic changes that are seen as an essential attribute of human behaviour, that is whether communities subsist by purely hunting and gathering or with the significant addition of agriculture and herding, are understood to occur in the time range in the area with which we deal. Yet there is little convincing consensus on when such key changes can first be observed generally rather than in specific cases. Indeed, specific cases are often contested or contestable (HORWITZ 1989). The herding of goat, sheep, cattle, and pig and the cultivation of various cereals and legumes is posited as first occurring at quite different periods at different sites or in different settings.

Thus goat "management" is suggested at 'Ain Ghazal from the Middle PPNB (KÖHLER-ROLLEFSON *et al.* 1988: 425) and suggested ambiguously at Jericho (CLUTTON BROCK 1983: 802, 1987: 60) for the same period. Further south in the Middle PPNB (and possibly later) occupations at Beidha, Hecker (1975) has concluded caprines were not domesticated. On the other hand Legge (1996: 254) suggests that the small size of Beidha caprines indicates domestication. In sites in the north of Israel caprine herding is not claimed before the Late PPNB (GARRARD *et al.* 1996: 208-9) or later (HORWITZ 1989: 169). In the steppe and deserts of the Negev, Sinai and Jordan, caprine herding cannot be conclusively demonstrated before the Late Neolithic, with some ambiguity over the situation in the Late PPNB (*c.* 6500-6000 bc) (GARRARD *et al.* 1994: 106). Cereal domestication is intimated or suggested for a number of early to mid 8th millennium bc sites, such as Aswad, Jericho, and Iraq ed Dubb (GARRARD n.d.), but it is questioned at Netiv Hagdud, where cultivation of wild barley is suggested (KISLEV 1989). Cultivation is, of course, more difficult to demonstrate in the absence of clear evidence for domestication. The divergence of opinion is discussed by Bar-Yosef (1995: 195-6) in a recent synthesis.

These contrasts may be real differences in the economies of different communities and reflect time lapses in the spread of cultivars and herded animals, surely highly significant facts, or they may be the product of the different criteria and methods used by different analysts to identify cultivation, herding and domestication. There is a necessarily varied approach to the identification of cultivation, herding and domestication, particularly to different species (KISLEV 1989, LEGGE 1996). However, in order for the wider research community to at least assess the possibility of time lapses in the spread of cultivars and herded animals and the existence of economic contrasts, it seems vital for our future research strategies that the criteria on which cultivation and herding is identified in any given setting are made explicit. Indeed there will be a need for specialists to publicly assess their own criteria in relation to those of others. Mere statements of the presence of domestic animals and plants do not alleviate this situation, for example, at 'Ain el-Jammam and Es-Sifiya (this volume).

A rigorous reevaluation of general methodology is clearly required (HORWITZ 1989). If this is achieved we will have the possibility to document what is already apparent to some degree, that is the spread of individual species of cultivar and herded animals from specific settings (ZOHARY 1996) across the wider region and the assembling of particular agricultural, pastoral or agro-pastoral packages. This detailed documentation will in itself demand new explanations of the origins of cultivation and herding in specific settings and the spread and rate of spread of specific cultivars and herded species. This will also affect the assessment of the impact of new subsistence practices (see above). In addition, it is clear that in order to really establish the nature of change in the subsistence economy and gauge its significance, we have to develop more effective ways of measuring the relative economic importance of plant as against animal exploitation in particular communities. Isotope and trace element analyses of human bone and dental micro-wear studies may well help in this regard in the future (MOLLESON and ANDREWS 1996).

It is certainly inappropriate to think of plant and animal exploitation in purely economic terms. The importance of certain plants and animals will reflect the place of such species in contemporary beliefs and the status of the activities involved in their exploitation and consumption. One can easily cite, from the ethnographic and historical record, numerous examples of the use of specific foods or species for specific purposes in sacrifice and feast, for example. In terms of activities, the hunting of certain species can have an importance that far outweighs its economic benefits (KENSINGER 1989: 25). Ingold (1996) points out that among non-western cultivators, there is far more to growing plants and raising animals than the mere production of food. There are various ways to approach these issues, and the obvious include the iconographic record; an example is provided by Hermansen in this volume in which depictions of rams seem important. McAdam (1997: 140) has pointed out the dominance of the representations of aurochs at 'Ain Ghazal in the sample she studied, despite the importance of goat in the faunal samples of the periods concerned. In addition, contextual analysis may allow us to see the association of certain foodstuffs with certain settings on sites that might indicate a particular role for particular foods as reflected in settings for consumption and patterns of discard or placement.

Conclusions

There are a number of issues worthy of particular attention in our researches on Neolithic Jordan. These include

1) the degree of social complexity and variations in that complexity through time evidenced by Neolithic communities,
2) as part of this issue, the role of large sites such as 'Ain Ghazal and Basta,
3) the question of the nature and degree of specialization and stratification within societies,
4) questions relating to the timing of the appearance and spread of particular cultivated plants and herded animals,
5) the importance of Neolithic beliefs in shaping the material evidence with which we deal, including the non-economic roles of plant and animal "exploitation," and
6) the identification of regionally defined material culture traditions and their explanation.

In terms of significant changes within our record, I suggest we need to investigate

1) the 8th millennium bc "transition" from PPNA-Middle PPNB (Early PPNB?),
2) environmental impact and change as an explanation for changes from PPN to Late Neolithic, and
3) the importance of developments in the subsistence economy in explaining changes from PPN to Late Neolithic.

It is suggested that research strategies to investigate these issues could find reflection in fieldwork and related studies in the following ways:

1) by the development of area-based projects which include intensive survey and catchment analysis in order to better document contemporary settlement systems and the changes in the nature of settlement in relation to specific local environmental dynamics;
2) the conduct of some projects in specific boundary settings in reference to regionally defined material culture phenomena;
3) the retrieval of on-site evidence in a way that would ensure more detailed contextual analysis of activities and discard patterns on site. This should probably include some use of micro-stratigraphic analysis and more controlled plotting of artifact distributions;
4) attention by palaeobotanists and faunal analysts to the need for explicit published evaluations of their ability to identify domestication/cultivation/herding of specific plants and animals at each site and perhaps some attempt to assure standardization of approaches/ criteria;

5) more systematic gathering of environmentally related evidence, including geomorphological, sediment, palynological, molluscan and charcoal analysis;
6) more use of tree ring based studies for climate and environment reconstruction purposes;
7) human bone isotope, trace element and dental micro-wear analyses for dietary reconstruction purposes and thus an assessment of the relative economic importance of plant as against animal foods; and
8) identification of a site or sequence of sites in a restricted area that would allow us to approach developments in the transition from PPNA to "Middle" PPNB (Early PPNB?) and from PPNB through the Late Neolithic.

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Trois Ateliers de Taille de Silex à Abu Hamid (Jordanie)

Carles Navarro i Barberan

Abstract: *Preliminary analysis of some technological aspects of the flint industry from Abu Hamid, a site located on the east bank of the Jordan River where three flint workshops have been excavated in the upper levels dated to the early 6th millennium BP.*

Résumé: *Analyse préliminaire des aspects techniques de l'industrie lithique d'Abu Hamid, un site de la rive orientale du Jourdain, faite à partir de l'examen des produits recueillis dans trois ateliers de débitage dégagés dans les niveaux supérieurs datant du début du 6e millénaire BP.*

Mots-clé: *Abu Hamid, Jordanie, technologie lithique, débitage, 6e millénaire BP.*
Key words: *Abu Hamid, Jordan, lithic technology, knapping products, 6th millennium BP.*

Abu Hamid est situé dans la Vallée du Jourdain à égale distance du lac de Tibériade et de la Mer Morte à une altitude de - 240m sous le niveau de la mer (*cf.* DOLLFUS, KAFAFI *et al.* 1988; REWERSKI n.d.) (Fig. 1). Localisé sur une terrasse, il domine de nos jours le cours majeur du Jourdain de 40m. En 1976 M. Ibrahim, J. Sauer et K. Yassine attiraient l'attention sur ce site qui leur paraissait particulièrement intéressant pour la période Néolithique récent - Chalcolithique (IBRAHIM, SAUER, YASSINE 1976)[1]; en 1980 Z. Kafafi le revisitait (KAFAFI 1982) et, de 1986 à 1992, une mission jordano-française co-dirigée par Z. Kafafi et G. Dollfus y conduisirent avec l'aide du Département des Antiquités de Jordanie cinq campagnes de fouilles (DOLLFUS et KAFAFI 1986; DOLLFUS et KAFAFI 1988; DOLLFUS, KAFAFI *et al.* 1988; DOLLFUS, KAFAFI *et al.* 1993)[2].

Ces fouilles permirent de mettre en évidence trois principales phases culturelles (DOLLFUS, KAFAFI *et al.* 1993). Cet article ne portera que sur la plus récente (III) datée de la première moitié du 6e millénaire BP. Les vestiges attribués à cette phase ont été dégagés sur plus de 2000 m^2, la fouille ayant été conduite principalement dans deux zones A (1 700 m^2) et B (300 m^2) séparées par un ravin d'érosion postérieur à l'abandon du site.

Au cours de cette phase III ont pu être clairement distingués dans les chantiers A et B plusieurs niveaux d'occupation (A: de bas en haut: 3, 2c, 2b, 2a et 1; B: 2c, 2 b 2a et 1) que ne séparent aucune couche d'abandon durable ou de destruction notable; en revanche certaines maisons montrent d'une part des réfections et des ajouts, d'autre part de brefs abandons. En ce début du 6e millénaire BP, le village qui recouvrait environ 1400m d'est en ouest et 400m du nord au sud est formé de complexes d' habitation comportant:

- une grande pièce rectangulaire (aux murs dressés soit totalement en briques crues plan convexes, soit présentant un soubassement de pierres) à laquelle peut parfois être adjointe *a posteriori* une chambre de plus petites dimensions,
- une cour où se pratiquait les activités domestiques comme en témoignent des aires pavées de galets, des bassins recouverts d'une fine couche de plâtre, des fosses aux parois parfois enduites, des foyers

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[1] *cf.* aussi rapport de 1975 remis au Département des Antiquités de Jordanie.

[2] Yarmouk University du côté jordanien; Ministère des Affaires Etrangères, IFAPO et CNRS - ERA 17 du CRA/UPR 7537 du côté français qui financèrent les travaux. En 1986 et 1987 la mission bénéficia aussi d'une aide de la National Geographic Society, Washington.

- et, dans deux des complexes, d'un bâtiment de stockage formé de deux petites pièces oblongues ceinturées par un mur épais.

Les ateliers de silex

Au cours de la fouille de ce village ont été mis au jour dans le chantier A deux ateliers de taille du silex, les loci 574 (carré B2/C2; A: niv. 1) et 105 (carré AH01-AJ01; A: niv. 2a), dans le chantier B le locus 157 (carré AN9; B: niv. 2b).

Le matériel lithique, abondant, qui y fut recueilli comporte des nucléus, des outils, des éclats, des lames, des pièces techniques et de nombreux déchets de taille. On peut donc selon toute vraisemblance y retracer les étapes de la chaîne opératoire qui permet de mettre en forme des outils à partir du bloc de matière première. Dès l'abord ce qui semble être le caractère principal de ces ateliers est leur "spécialisation" dans la production préférentielle d'éclats. Ceci a déjà été noté sur d'autres sites de même époque, que ce soit Shiqmim I (ROSEN 1987) ou Jebel Jill (HENRY 1982) et, pour une période un peu plus tardive (Bronze ancien), Tell Iktanu (McCARTNEY 1996). Un autre aspect des ateliers d'Abu Hamid concerne leur installation en plein air, à proximité des lieux d'habitation.

L'atelier 574 (Pl. 1:A-B).

L'atelier 574 est le plus récent. Stratigraphiquement il se trouvait au sommet des couches de sédiment gris fin - dans lesquelles sont prises les maisons des niveaux 1, 2 et 3 - et au contact de la couche de terre remaniée de la surface. Les vestiges architecturaux du niveau 1 auxquels appartient l'atelier 574 sont très érodés; de ce fait, l'atelier n'a pu être relié avec précision à aucune habitation; toutefois il apparaît être localisé dans une aire non construite (G. DOLLFUS, comm. pers. 1995).

Les débris de taille couvraient environ 2,5m^2 (2 x1,30m) et formaient une épaisseur variant par endroits entre 0,15 et 0, 25m. Cette zone avait été légèrement perturbée par une inhumation postérieure (726) (Pl. 1:B).

8 215 produits de débitage ont été recueillis qui se décomposent en

- 1 333 supports entiers (1113 éclats, 149 lames et 71 lamelles).
- 600 fragments proximaux (415 éclats, 121 lames et 64 lamelles).
- 485 fragments médians et 894 distaux.
- Les esquilles (petits éclats de moins de 3cm^2) sont très nombreuses avec 2966 pièces.
- Les fragments informes dont on ne peut identifier le mode de fractionnement et que l'on ne peut rapporter à aucune catégorie d'objets (débris et cassons) sont eux aussi abondants avec 1 709 pièces.
- Les débris thermiques, au nombre de 228, témoignent d'une destruction par le feu (choc thermique violent) et non pas d'une chauffe volontaire destinée à améliorer l'aptitude du silex à la taille.

Ces 8215 produits de débitage représentent 97,85% des pièces recueillies dans l'atelier de taille. Les 2,15% restant se

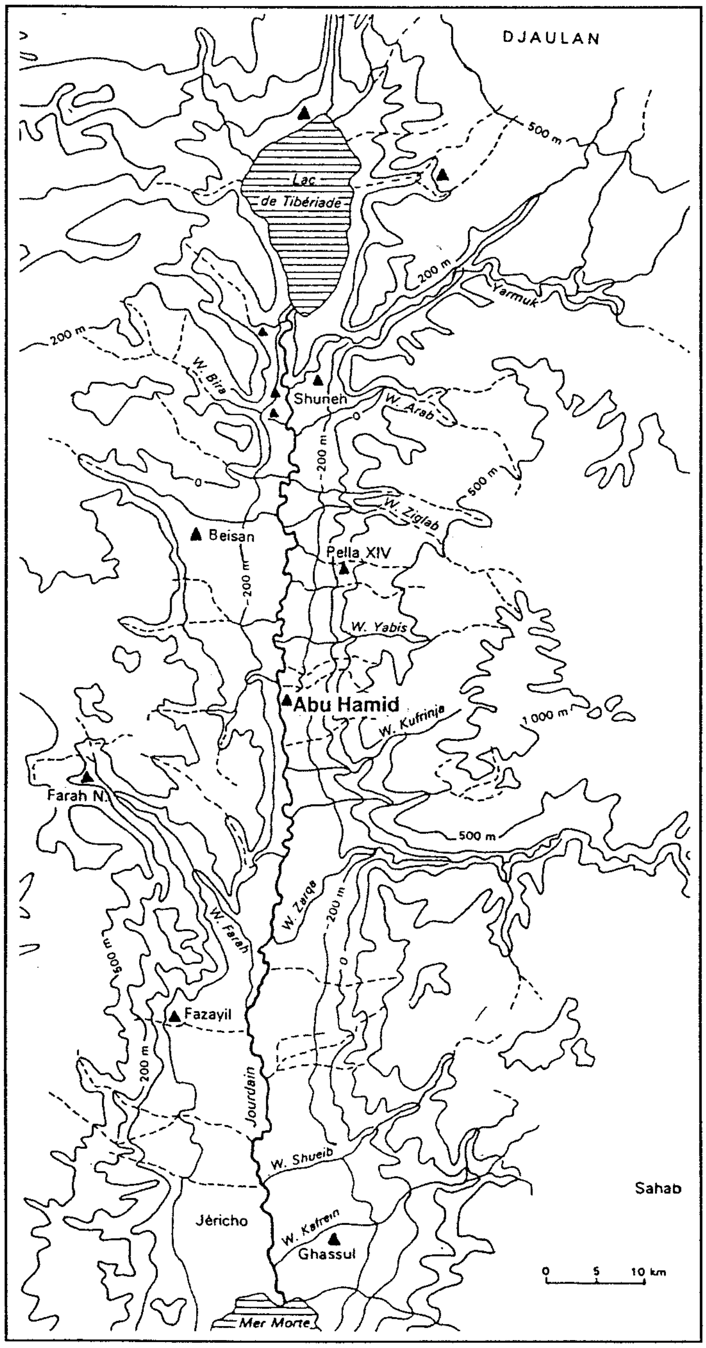

Fig. 1. Situation d'Abu Hamid.

partagent entre 22 nucléus, 42 éléments de mise en forme et 116 outils.

L'atelier 105

L'atelier 105 se trouvait à l'extérieur de la maison 136 (A/ 2b) directement sur le sol rouge qui affleurait en cette partie du site[1]. Il avait malheureusement souffert de l'érosion, se trouvant en bordure d'un ravin d'érosion. Ceci explique le faible nombre de pièces recueillies: 96 produits de débitage associés à 4 nucléus. On y décompte 69 éclats dont 61 supports entiers et 8 supports proximaux, 5 fragments médians et 7 distaux, 8 esquilles et 7 débris ou cassons. Aucun autre produit, que ce soit des lames ou des lamelles, des éléments de mise en forme ou des outils ne sont présents dans cet atelier.

L'atelier 157

L'atelier 157 (B/2b) se trouvait à l'extérieur du complexe de pièces où fut retrouvée l'une des grandes jarres de stockage (DOLLFUS et KAFAFI 1986, DOLLFUS et KAFAFI 1988). Les produits lithiques couvraient environ 2m^2 sur une épaisseur moyenne de 0,25 à 0,30cm.

Associés à 43 nucléus, ont été dénombrés 423 produits de débitage parmi lesquels 227 éclats (167 supports entiers et 60 fragments proximaux), 6 lames (3 supports entiers et 3 fragments proximaux) et une lamelle. A ceux ci s'additionnent 85 fragments médians et 13 distaux. Les esquilles sont au nombre de 33, les débris et cassons 32, et les débris thermiques 26. Aussi il apparaît que le débitage représente 86% du matériel recueilli dans l'atelier tandis que les 14% restants se partagent entre 43 nucléus, 2 éléments de mise en forme et 24 outils.

Matière première

Plusieurs variétés de silex ont été utilisés dans la première moitié du 6e millénaire BP par les tailleurs d'Abu Hamid. En effet l'on peut noter des silex à grain fin ou très fin mais aussi une qualité plus grossière; les couleurs aussi varient: gris, beige, brun. Les pièces en calcaire silicifié sont, quant à elles, rares. Ce silex correspond aux variétés que l'on trouve sur les autres sites de même époque de la vallée du Jourdain (Tell Abu Habil, par exemple). Il provient selon toute vraisemblance originellement de la chaîne des monts d'Ajlun et a souvent pu être recueilli dans les lits des wadis à proximité immédiate du village préhistorique (COQUEUGNIOT 1988). Toutefois l'étude d'E. Coqueugniot a bien mis en évidence qu'en dépit de l'abondance des galets de silex disponibles dans l'épaisseur de la terrasse et dans le lit des wadis, ceux aptes à la taille sont rares; cette observation pourrait expliquer le débitage intense des nucléus, souvent exploités jusqu'à épuisement et la rareté des nucléus de grande taille dans le matériel recueilli que ce soit dans ces ateliers et également sur le reste du site. Ce facteur expliquerait aussi l'emploi de matière première extraite directement des bancs *in situ*, dans la montagne, particulièrement pour l'obtention de supports de grande taille destinés à l'élaboration des outils lourds (haches, herminettes, pics et ciseaux).

L'étude pétrographique détaillée n'ayant pas encore pu être conduite nous avons utilisé la classification proposée par E. Coqueugniot et les informations que nous a données le professeur H. Mustapha, professeur de géologie à l'Université du Yarmouk. Pour eux il s'agit d'un silex local, celui que l'on trouve dans les flancs des monts d'Ajlun; une prospection systématique de cette région est prévue afin de repérer avec plus de précisions les sources de matière première et de pouvoir ainsi établir la distance qui les séparent du village et si au long de l'occupation du site les sources restent les mêmes ou varient. Il conviendra aussi de voir si certaines sources ne se situent pas dans d'autres régions comme en témoigneraient certaines catégories d'outils (par exemple certains micro-grattoirs).

La technologie

Les trois ateliers livrent des témoins de toutes les étapes de la chaîne opératoire. La classification a été effectuée en nous inspirant de Tixier *et al.* (1980) et de Pelegrin *et al.* (1988).

Les 69 *nucléus* (Fig. 2) des trois ateliers ont été analysés en fonction des stigmates des traitements qu'ils ont subis (plan de frappe, surface débitée, etc.). Ces nucléus sont variés: unipolaires, prismatiques, plats sur éclats, à deux plans de frappe croisés ou orthogonaux, ou à plans de frappe multiples. Ils sont toujours orientés vers la production d'éclats de dimensions variables et destinés à être utilisés soit tels quels, soit comme support d'outils peu élaborés. Il s'agit, en général de pièces de petit module, avec une dimension moyenne standardisée de 30 x 35x 30mm. Un phénomène similaire est observé à Jebel Jill (HENRY 1982) et à Tell Iktanu (McCARTNEY 1996). 90% des nucléus présentent des plages de cortex.

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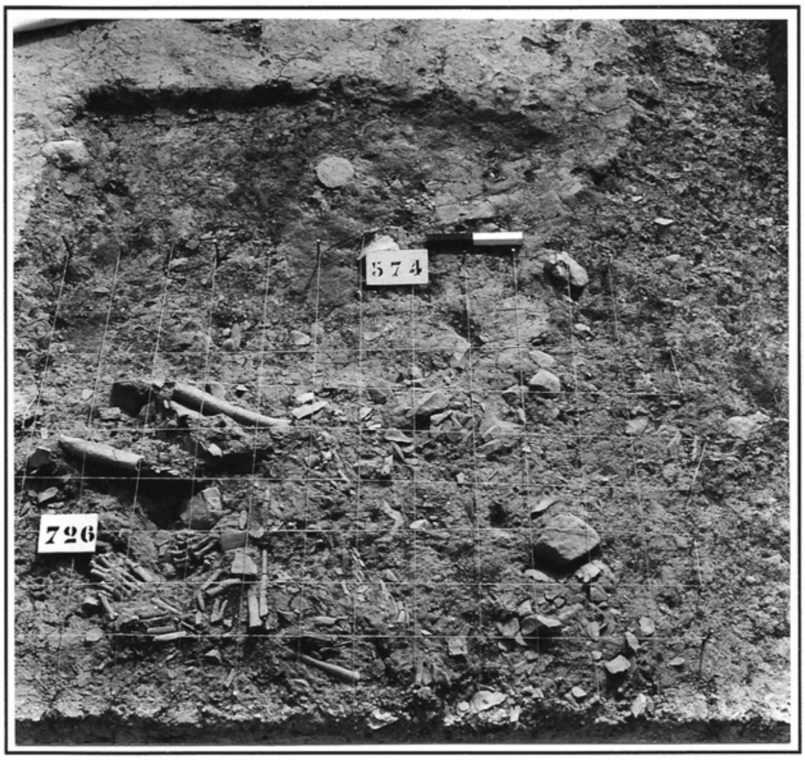
[1] Cette couche de terre rouge scelle les habitations de la phase I. Toutefois en plusieurs endroits du site qui ont souffert d'une forte érosion elle est directement sous jacente aux structures des niveaux des phases II et III. Ici l'atelier se trouvait sur un sol extérieur d'occupation légèrement cendreux associé au mur (102) est de l'habitation 136. A proximité se trouvaient quelques fosses à feu remplies de galets. DOLLFUS n.d. in DOLLFUS et KAFAFI n.d..

Pl. 1:A. L'atelier 574 en cours de dégagement.



Pl. 1:B. L'atelier 574 en cours de dégagement
(Noter l'intrusion de la sépulture.).

Les nucléus ont été abandonnés après une exploitation très exhaustive ainsi que l'attestent leurs très petites dimensions. Il est cependant clair qu'au début de la chaîne opératoire les rognons et les nucléus pouvaient être de plus grande taille ainsi que l'indiquent la présence d'éléments de mise en forme de grand module et celle de quelques gros éclats avec de larges plages corticales.

Les trois ateliers ont fourni 44 *éléments de mise en forme* (Fig. 3). Dans cette catégorie on décompte des lames à crête (Fig. 4:22), des tablettes de ravivage, des entames de nucléus, des flancs de nucléus. La présence et la bonne facture des lames à crête (Fig. 4:1-2) et des produits d'entretien (tablettes de ravivage) des nucléus indiquent une connaissance technique, un savoir faire qui *a contra-*

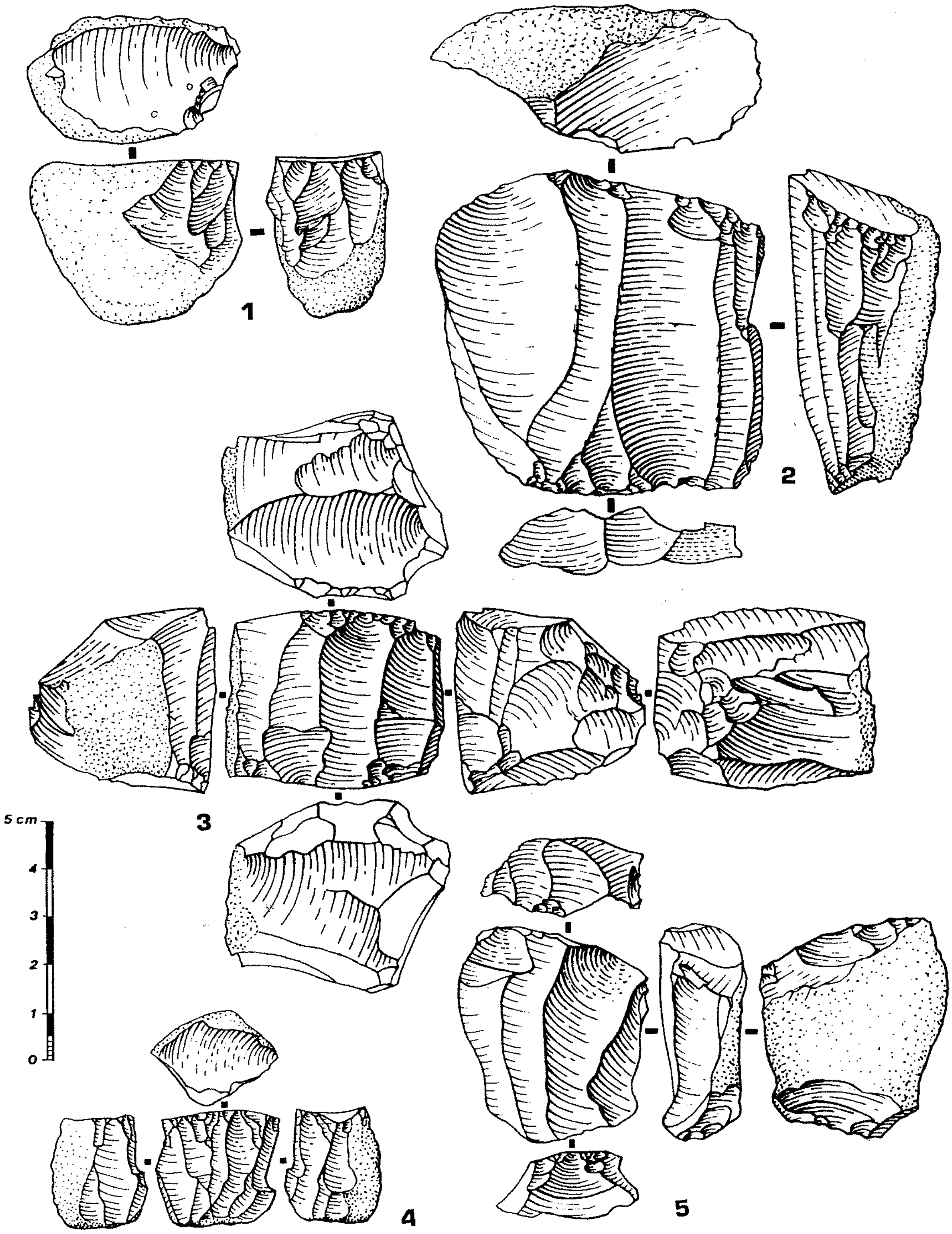


Figure 2. Nucléus. 1 nucléus avorté, 2 nucléus bipolaire, 3 nucléus à plans de frappe multiples, 4-5 nucleus prismatiques.

rio montrent que l'emploi concomittant de techniques "simples" résultent d'un choix, d'une économie du geste qui va de pair avec une économie de la matière première (non gaspillage) dont le résultat est la surexploitation des nucléus. Si les nucléus sont très variés et défigurés du fait de leur épuisement, il apparaît cependant des familles techniques qui suggèrent des habitudes, des gestes de tailleur que nous essayerons de retrouver.

La présence de *cortex* dans l'ensemble du débitage est constante. Les proportions obtenues illustrent que près de la moitié des supports (48,82%) présentent du cortex (21,42% en ont sur la face supérieure, 7,46% en extrémité distale, 4,56% sur le talon, 7,28% sur le côté gauche et 8,07% sur le côté droit). En revanche, 51,8% des supports n'ont aucune plage corticale. La présence du cortex en

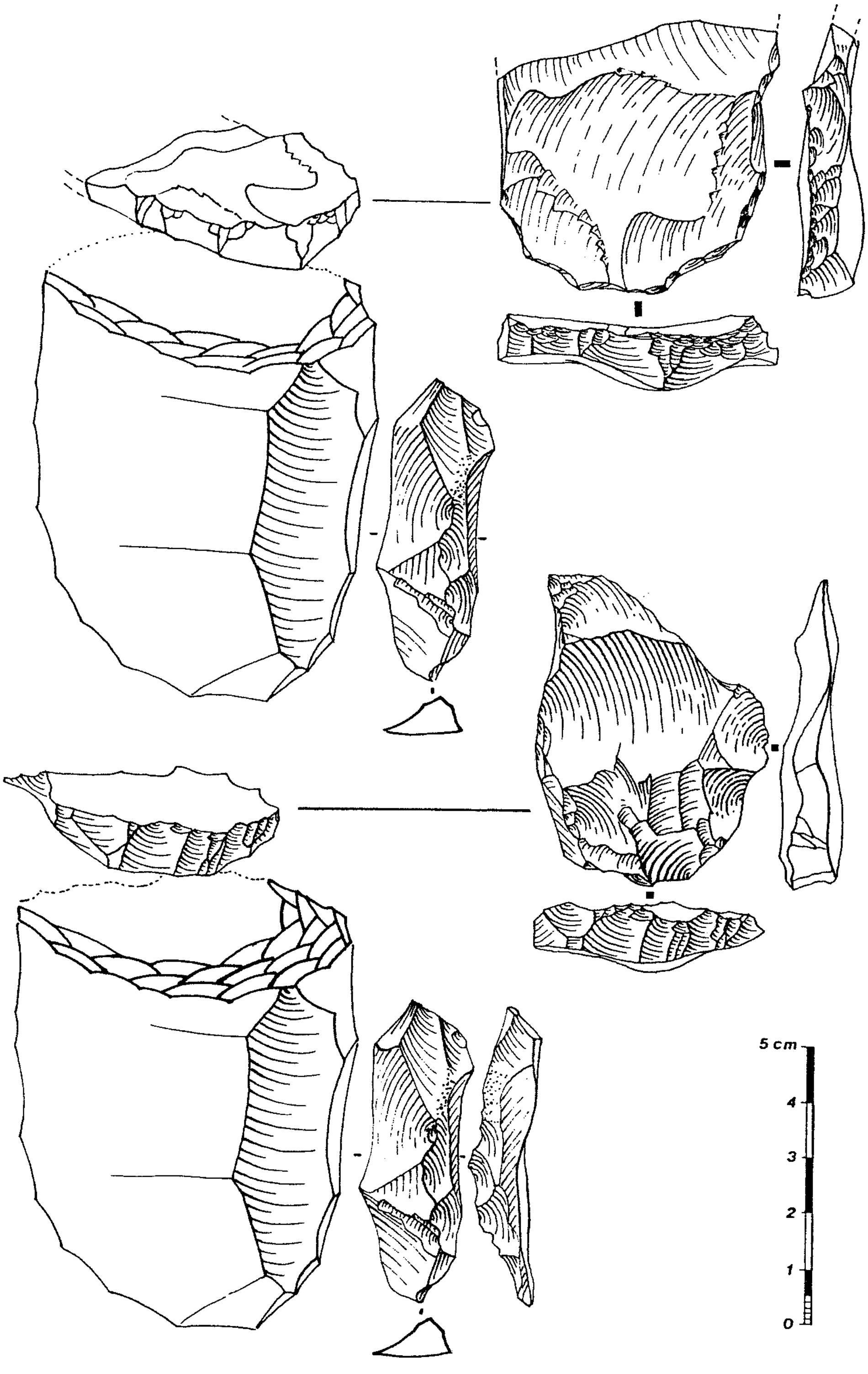


Figure 3. Figure montrant l'obtention des éléments de mise en forme: tablette de ravivage, lame à crêt et flanc de nucléus.

position latérale et distale doit être mise en relation directe avec le système de taille et la stratégie des réductions successives (McCARTNEY 1996).

Les *produits de débitage* (Fig. 4) sont extraits en vue de leur utilisation directe ou après retouche. L'analyse des caractères de ce débitage et de l'aspect des nucléus permet une reconstitution des diverses techniques de taille utilisées; pour notre analyse nous avons fait porter notre attention sur les supports entiers et proximaux.

Les éclats sont largement majoritaires et constituent un peu plus de 80% des produits de débitage. Parmi les produits de débitage, les éclats primaires (pour lesquels le cortex couvre plus de 50% de la face supérieure) représentent 6%. Parmi les supports 5,67% sont des lames et 6,38% des lamelles. Quant aux supports ayant conservé leur talon, 92,90% sont des pièces entières dont 7,92% des fragments proximaux. Le support "type" de cet ensemble mesure 39 x 33x 8mm; il s'agit donc de petits produits mais il y a évidemment aussi des pièces de plus grand module.

Sur les nucléus, les surfaces de débitage présentent des négatifs d'enlèvement à contre-bulbes bien marqués et l'absence fréquente d'un plan de frappe préférentiel indique que l'artisan a choisi le point de frappe au coup par coup, dans le but de détacher un éclat utilisable tel quel ou destiné à être transformé en outil. Par suite, les éclats obtenus sont de formes et d'épaisseurs variées, avec des talons sans forme stéréotypée. Il s'agit d'un mode de débitage systématique mais sans prédétermination ni choix préliminaire de la forme de la matière première brute dès lors qu'elle était d'épaisseur suffisante. L'abondance des produits sur éclat peu standardisés semble indiquer que ces ateliers correspondaient à un débitage domestique d'éclats.

Sur l'ensemble des pièces ayant conservé leur partie proximale (éclats entiers et fragments proximaux), les *talons* lisses sont dominants dans 71,64% des cas tandis que les talons corticaux représentent 8,60%, les linéaires 5%, les dièdres 1,22%, les écrasés 3,59%, les punctiformes 1,05% et les facettés 0, 96%. En revanche près de 8% des pièces ont le talon trop endommagé (talons écrasés ou éclatés, etc.) pour en permettre une lecture.

La présence des *points d'impact* (Fig. 4:4) est généralement associée à l'utilisation de la percussion directe avec un percuteur dur (pierre) (CALLEY 1986). Ce type de stigmate est visible sur 42,58% des supports et il s'agit d'un pourcentage similaire à celui obtenu à Tell Iktanu (McCARTNEY 1996) où 44% des supports comportent un point d'impact visible. *L'angle d'éclatement* moyen des supports est de 80° alors qu'il est de 90° à Iktanu. Un rapprochement entre les points d'impact et les types de talon des ateliers d'Abu Hamid nous montre que dans près de 90% des cas, ils sont associés à des talons lisses. Les 10% de talons restants (corticaux, dièdres, écrasés, facettés, linéaires, punctiformes) ont le point d'impact visible mais avec des fréquences d'association très partagées. La forte association entre talon lisse et point d'impact visible confirme l'utilisation dominante de la percusssion directe au percuteur dur.

Le *bulbe* constitue un des éléments importants pour préciser la technique de taille. Parmi les pièces concernées (entière ou fragments proximaux), 53,73% présentent un bulbe marqué - caractère souvent associé à un percuteur dur - 41,08% ont un bulbe diffus (percuteur tendre) et 5,17% ont le bulbe enlevé qui est la marque d'un enlèvement parasite inverse. Les indications fournies par l'aspect du bulbe montrent que nous pouvons avoir la combinaison des deux techniques de taille: la percussion directe dure et la percussion directe tendre. En suivant la méthode et les résultats de S. Calley (CALLEY 1984, 1986), nous remarquons que plus de la moitié des supports présentent un bulbe marqué et correspondent à une taille en percussion directe dure. La relative abondance des supports avec un bulbe diffus révèle l'emploi de la percussion tendre que ce soit pour des éclats ou pour des lames. Mais nous ne pouvons pas rejeter l'emploi d'une percussion indirecte tendre.

Outre le talon et le bulbe, la *lèvre* est un caractère morphologique qui peut apporter des indications sur la technique de taille car sa présence, associée à un angle de débitage aigu (CALLEY 1986) est souvent liée à l'utilisation d'un percuteur tendre. Dans les ateliers d'Abu Hamid, 42,31% des supports présentent une lèvre claire.

Dans l'atelier 574, un certain nombre d'éclats comportent des *plages résiduelles de polissage* (Fig. 5). Nous pensons qu'il s'agit d'indices soit de réaffûtage (dans le même atelier) du taillant de haches/herminettes endommagées soit du réemploi comme nucléus de gros débris de haches/ herminette cassées.

L'outilage lithique

Dans la catégorie des *outils stricto sensu,* à savoir les pièces retouchées, deux des ateliers livrèrent 140 outils: 116 dans l'atelier 574 et 24 dans le locus 157. L'étude des outils, sera jointe à celle de l'ensemble de l'outillage du site effectuée par E. Coqueugniot. Dès à présent nous pouvons signaler qu'il s'agit de pièces entières façonnées sur éclats. Certaines classes typologiques (grattoirs, racloirs, burins et perçoirs) sont peu représentées mais toujours taillées sur éclats. Les lames présentant du lustre ("faucilles") sont des lames à dos dont l'utilisation pour la coupe des céréales ou des végétaux tendres devra être vérifiée par une étude tracéologique; typologiquement il s'agit de tronçons de

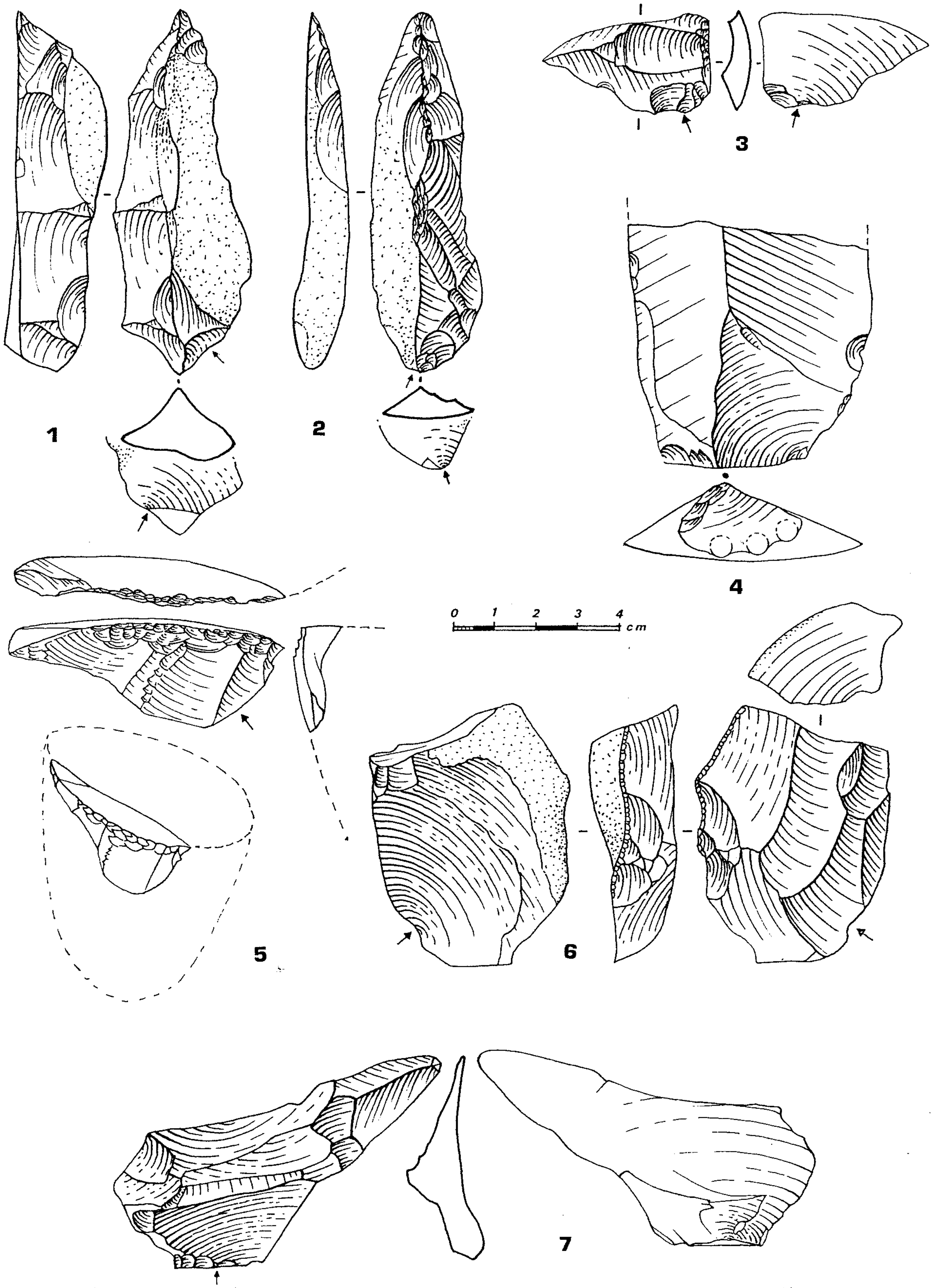


Figure 4. 1-2 lames à crête; éclats , sont indiqués les points d'impact.

lames. Les pièces denticulées sont façonnées sur éclat. Les pièces à encoches peuvent l'être sur éclat, sur lame et sur esquille et, en général, l'encoche est retouchée. Les éclats, lames et lamelles retouchés ne constituent pas un groupe typologique clair et seule une analyse tracéologique nous permettra de connaître leur fonction. Les outils lourds (haches, herminettes, ciseaux, pics) sont bifaces et caractérisés, en premier lieu, par l'opposition d'un talon et d'un tranchant, les ateliers n'ont livré aucune pièce entière de ce type et il s'agit toujours de fragments.

Conclusion

Les ateliers d'Abu Hamid sont en *position primaire*, c'est à dire qu'il s'agit des vestiges en place d'ateliers, de points de travail du silex et non pas d'amas de déchets en position secondaire (poubelle) résultant du nettoyage d'une zone de travail située ailleurs. En effet la plupart des artefacts recueillis étaient "à plat" (pendage horizontal, très peu de pièces sur chant ou piquées) et, d'autre part, le matériel y est homogène (presque uniquement des silex) et dans un excellent état de fraîcheur (peu de concassage, piétinement, etc.).

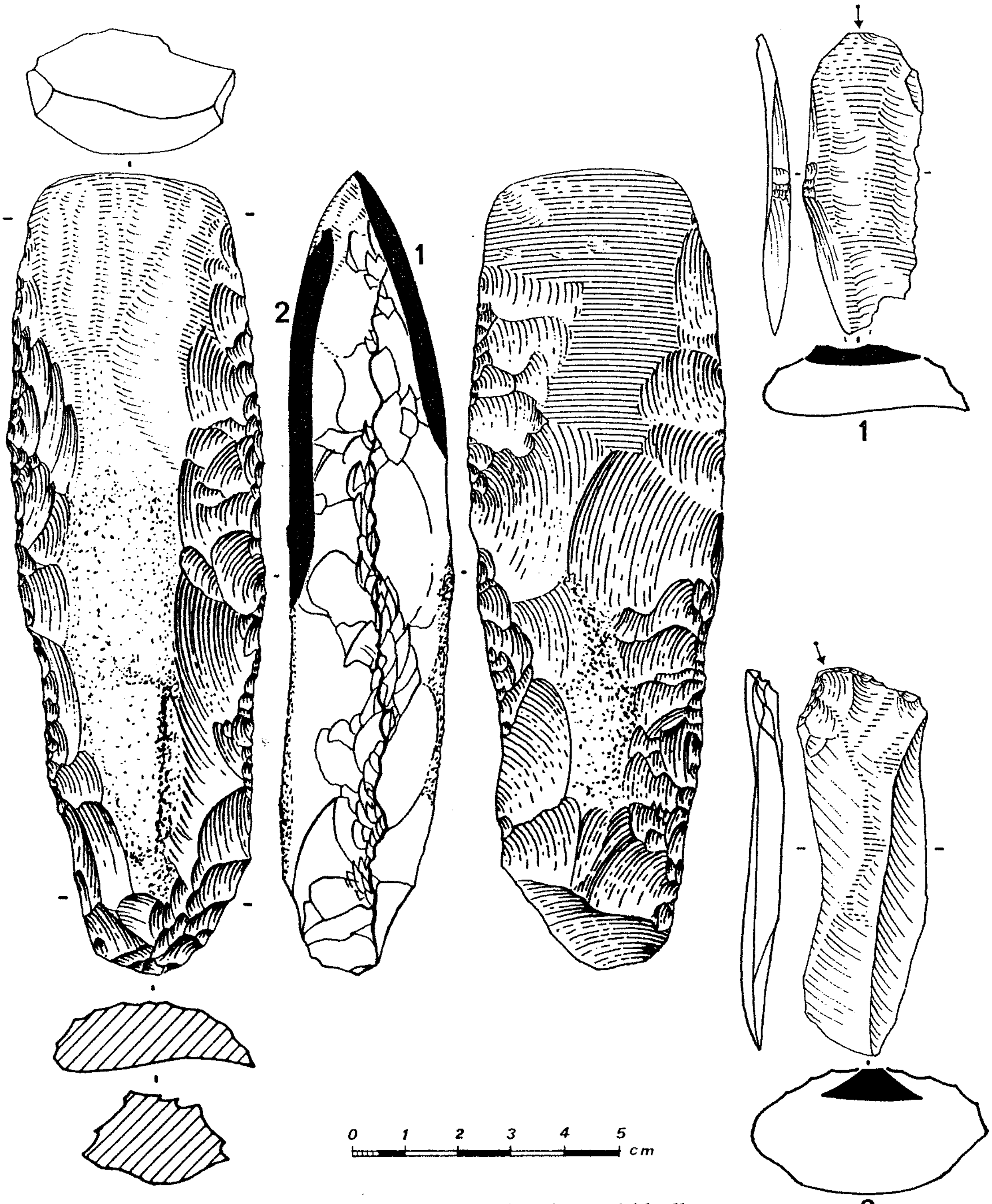


Figure 5. Eclats provenant de l'atelier 574 présentant des plages résiduelles de polissage et schéma théorique de leur emplacement sur une hache/herminette.

Sachant qu'il s'agit d'ateliers *in situ* leur *éventuel degré de spécialisation* serait un des points importants à préciser. En d'autres termes s'agit-il de simples "lieux de taille" ponctuels et liés aux activités domestiques ou au contraire d'ateliers où opéraient des "spécialistes"; nous entendons par ce terme des individus possédant un savoir-faire technologique qui ne serait pas à la portée de n'importe quel habitant du site. Les techniques de débitage employées sont relativement sommaires: pour l'essentiel de la percussion directe au percuteur dur, éventuellement au percuteur tendre; l'objectif n'était pas de produire des supports standardisés mais plutôt des éclats de morphologie et de dimensions très variées. De même il n'y a pas de choix préférentiel d'une qualité de matière première particulière et si le silex à grain fin ou moyen domine, il en est de même sur l'ensemble du site et ne traduit, semble-t-il, que la disponibilité de la matière première aux abords immédiats du site (galets roulés transportés par les wadis).

Les *nucléus* ont été abandonnés après une exploitation très exhaustive et ils sont tous de très petites dimensions. Il est cependant clair que, au début de la chaîne opératoire de débitage, les rognons et les nucléus pouvaient être de grandes dimensions que ainsi l'attestent la présence de tablettes de ravivage de grand module et celle de gros éclats avec de larges plages corticales.

L'absence de mise en oeuvre d'une technique de taille très élaborée n'est cependant pas synonyme d'un débitage aléatoire et sommaire qui pourrait, à la limite, attester une incapacité à faire autre chose. En effet la présence et la bonne facture des éléments de mise en forme (lames à crête) et d'entretien(tablettes de ravivage) des nucléus indiquent une connaissance technique, un savoir faire qui, *a contrario*, montrent que l'emploi concomittant de techniques "simples" résultent d'un choix, d'une économie du geste qui va de pair avec une économie de la matière première (non gaspillage) dont le résultat est la surexploitation des nucléus qui, par suite, nous sont parvenus dans un état d'exhaustion totale. Si les nucléus sont très variés et défigurés du fait de leur épuisement, il apparaît cependant des familles techniques qui suggèrent des habitudes, des gestes de tailleur.

L'atelier 574 a livré un certain nombre d'éclats comportant des plages résiduelles de polissage qui montrent qu'ils proviennent de la retaille de haches/herminettes. A ce stade se posait la question de savoir s'il s'agissait d'indices du réaffûtage, dans l'atelier, de taillant de haches/herminettes endommagées. Il semble que ces pièces sont, en fait, le produit du réemploi en nucléus de haches/herminettes cassées car, d'une part, certaines ont pour talon une large surface de cassure orthogonale à l'axe de la pièce originelle et, d'autre part, plusieurs grands enlèvements d'origine latérale (transverse) n'ont pas de justification dans l'optique d'un réaffûtage. Ainsi donc, lors du remplacement de la lame cassée d'une hache/herminette le (ou les) fragment(s) étaient éventuellement redébités au même titre que les galets de silex.

A côté des produits de débitage, cet atelier a fourni des outils *stricto sensu* et un certain nombre de pièces non retouchées mais présentant des traces d'utilisation (outils *a posteriori*) qui indiquent que l'activité ne se limitait pas au seul débitage du silex (seule une observation à la loupe binoculaire a, pour l'instant, été pratiquée, une étude au microscope métallographique sera entreprise). Au stade actuel de l'étude il semble donc que *la finalité de cet atelier ne se limitait pas à la seule activité de taille du silex ni à la réparation d'outils endommagés.*

Les trois ateliers d'Abu Hamid étaient des ateliers de débitage à caractère domestique marqué par une économie de gestes et de matière première, économie qui résulte d'un choix plus que d'une incapacité technologique.

Remerciements: Je tiens à exprimer ma très grande reconnaissance à G. Dollfus et Z. Kafafi qui m'ont permis de participer aux fouilles d'Abu Hamid et m'ont confié l'étude des techniques de débitage du silex; cette étude n'aurait pu être menée à bien si je n'avais pas été étroitement et amicalement guidé par E. Coqueugniot qu'il trouve ici mes profonds remerciements, et par G. Dollfus qui m'a offert la possibilité de participer à des stages consacrés à la technologie du silex. A. Der Aprahamian a exécuté les figures, je l'en remercie. L'accueil reçu et les facilités qui me furent offertes à l'Université du Yarmouk tant à l'Institut d'Archéologie et d'Anthropologie qu'au département de géologie ont été inappréciables. Les photos ont été faites par Y. Zu'bi.

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The "Pre-Ghassulian" Sequence at Teleilat Ghassul: Sydney University Excavations 1975-1995

Stephen J. Bourke

Abstract: *The University of Sydney has been excavating at Teleilat Ghassul for the past twenty years. Hennessy's early excavations (1975-77) concentrated on establishing a chronological sequence for the site, whilst discovering the sanctuary complex and a uniquely important cultic wall painting. The more recent excavations (1994-95) have been concerned to explore intra-site variability, whilst extracting controlled botanical, faunal and ceramic/lithic samples for intensive physico-chemical analysis. A consideration of the crucial "pre-Classic" Ghassulian levels confirms Hennessy's observations on the in situ development of the Ghassulian. The more recent work allows for a first formulation on the growth and internal organisation of the site through time, suggesting a growing specialisation through time. Faunal/botanical analyses are consistent with this view of specialised production and centralised storage of goods in the later phases on the site. The appropriate affiliate of the Early phase Ghassul assemblage remains unclear, but the Middle phase assemblage is clearly ancestral to the Classic Late Chalcolithic assemblage familiar to all. Analysis of foreign goods in the assemblages reveals little inter-regional contact in the Early phases, growing contact in the Middle phases, and greatest inter-regional interaction at the very end of the Late Chalcolithic sequence.*

Introduction: Previous Work on Ghassulian Origins

Concerted study of the Chalcolithic period in southern Levant began with the first excavations at Teleilat Ghassul, and the site has remained crucial to all advances in understanding since. The eight seasons of excavation by the Pontifical Biblical Institute (1929-1938) uncovered spectacular remains of the hitherto little-known pre-Bronze Age civilisation. Mallon and Koepell distinguished four main phases of occupation (Ghassul I-IV), with the latest (Ghassul IV) spread over some 20 hectares; the earlier three phases at the site were never investigated in detail. The assemblage from the latest phase of occupation on the site became synonymous with Ghassulian culture, *sensu stricto*.[1]

Contemporaneous with the excavations at Ghassul, twin American investigations in northern Palestine at Beth Shan (1921-32) and Megiddo (1923-38), and British excavations at the southern Palestinian site of Jericho (1932-36), began to uncover material considered to be both earlier and later than the Ghassulian assemblage. First assessments of the Beth Shan and Megiddo corpora reveal what was to become an abiding confusion. Neolithic and Chalcolithic period exposures at both large sites were not extensive and excavated in difficult circumstances with the result that the samples produced were inadequate for detailed exposition. Even so, the failure to recover a convincing assemblage identifiable as "Ghassulian" threw chronological analyses into confusion. When excavations at Jericho, a bare 8km west of Ghassul, also failed to reveal clearly defined "Ghassulian" material, but did reveal extensive Neolithic and Early Bronze Age deposits, the tendency to see the Ghassulian as a short-lived post-Neolithic phase gained strength.[2]

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1 Mallon *et al.* (1934) and Koepell *et al.* (1940) for primary data; Lee (1973): 19-26 for a considered summary of the first PBI excavations.

2 Engberg and Shipton (1934) and Shipton (1939) for the first evaluations of the Megiddo copora; Fitzgerald (1935) for Beth Shan; Garstang (1936), Ben-Dor (1936) and Garstang and Garstang (1940) for Jericho. Albright (1932, 1935) for a first assessment of the cultural relationships and relative chronology of the Ghassulian in Chalcolithic Palestine.

The degree of confusion surrounding the chronological length and sequential positioning of the Ghassulian was manifest in the first synthetic studies of Palestinian Neolithic and Chalcolithic assemblages. In his magisterial assessment of the late Prehistoric archaeology of Palestine, Wright placed the Ghassulian assemblage after the Jericho Neolithic, but before Beth Shan and Megiddo, whilst Shipton, in his detailed consideration of the northern assemblages, saw Ghassul as the last manifestation of Chalcolithic culture, later in date than Beth Shan/Megiddo, which became the exemplars of an Early Chalcolithic phase. However they differed on the sequential positioning, both Wright and Shipton agreed on the relatively short span for the Ghassulian phase of the Chalcolithic.[1]

In the post-war period, research in the Beersheba region of the Negev (1952-58), although concentrating on sites with short individual occupation histories, nonetheless developed a substantial documentation of the rich material components of the Chalcolithic "Beersheban" assemblage, soon loosely associated with Ghassul under the rubric of "Ghassul/Beersheba" culture. Having constructed an elaborate sequential relative chronology for the Beersheban site phases, Perrot concluded that the earliest manifestations of the Beersheban culture held a clear priority over the Ghassul IV assemblage, although he acknowledged that nothing of substance was known of the earliest three phases at Ghassul. Perrot's conclusions reinforced opinions that saw the Ghassulian as the latest manifestation of Chalcolithic material culture, consistent with the high standard of architectural, ceramic and artistic produce at Ghassul, and his newly revealed riches in the northern Negev.[2]

Further weight was added to this view with expanded work on the Palestinian Neolithic. Stekelis' description of an incised northern/inland culture, Kaplan's discovery of a slipped and burnished central/coastal culture, combined with Kenyon's intensive research at Jericho, seemed to populate the Neolithic with a surfeit of clearly delineated assemblages all showing little similarity with the Ghassulian.[3] Coupled with this, excavations at Tell Far'ah North and intensive survey work in the north/central Jordan Valley isolated an assemblage of apparently post-Neolithic material which displayed no obvious association with the Ghassulian.[4] This apparently "non-Ghassulian" material came to be seen as "pre-Ghassulian" in date. Finally, Dothan's work at Meser, which purported to find Ghassulian material in close association with earliest Bronze Age architecture and ceramics, seemed to clinch the argument in favour of placing the Ghassulian at the very end of the Chalcolithic sequence of cultures.[5] The apparent contrast between the materially impoverished "northern" Chalcolithic and the sophisticated Ghassulian culture seemed to reinforce this judgement. Indeed, a number of commentators flirted with the notion of a chronological overlap between the latest Ghassulian and the earliest EBA cultures, bringing the argument full circle to the original dispute between Mallon and Albright.[6]

A full resolution of the lingering doubts as to the chronological positioning of the Ghassul IV culture hinged on the exposition of the Ghassul I-III assemblages, left essentially unexplored when PBI excavations were brought to a halt. Responding to this need, North's single season of renewed PBI excavations at Ghassul in 1960 focussed on further exploration of the early horizons, particularly in Field III. His conclusions appeared unequivocal. He reaffirmed the fourfold division of occupation at the site, claimed that there was no significant difference in culture between the first three phases of occupation and the last, and discounted significant development from one stage to the next.[7] The clear inference of North's work was that there was no significant time depth at Ghassul, a

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1 Wright (1937), Shipton (1939), Garstang and Garstang (1940) and Albright (1949, 1954) for the widely differing views of the relative chronology of Beth Shan, Megiddo, Jericho and Ghassul.

2 Perrot (1955) for the first detailed treatment of the apparently long-lived multi-phase occupation at Beersheba. However, from the first de Contenson (1956) was unable to differentiate chronologically distinct ceramic assemblages at Beersheba. Dothan's (1959) excavations at Horvat Beter suggested a short-lived (if stratigraphically complex) occupation, which lent support to de Contenson's views. Commenge-Pellerin's (1987, 1990) definitive publication of the Beersheba ceramic assemblages confirmed de Contenson's views on the homogeneity of the assemblage.

3 Stekelis (1951) for the Yarmukian; Kenyon (1957) for Jericho Pottery Neolithic phasing and assemblages, and Kaplan (1958) for Wadi Rabah; Gopher (1995) for a thorough review of the development of Ceramic Neolithic research.

4 Mellaart (1956) for Ghrubba in particular, and (1962) for the Point IV Survey sites in general; de Contenson (1960b, 1961) for the relative chronology of Shuna North in particular and northern Palestine in general, and (1964) for an overview of his earlier work; Leonard (1992) for a detailed publication of much of the Point IV Survey material; de Vaux (1955, 1961) for the Chalcolithique Moyen at Tell Far'ah North.

5 Dothan (1957) and (1959b) for the Meser excavations in which Ghassulian and EBI material were apparently associated; de Vaux (1957) for the discovery of Ghassulian material at Tell Far'ah North, which he claimed to be later than Chalcolithique Moyen, although drawn from a tomb assemblage; de Contenson (1961) for the apparent stratigraphic priority of the Shuna Chalcolithique Moyen/Jericho VIII-related assemblage over apparently "Ghassulian-influenced" material from that site.

6 Hennessy (1967), for the impact of the Meser (and Gath) finds on the possible chronological overlap of the Ghassulian and the EBI; Lee (1973), for the early debate between Albright and Mallon.

7 North (1961), for the 1960 season at Ghassul; Lee (1973) and Bourke *et al.* (1995), for an evaluation of North's work.

conclusion that could only reinforce assessments which saw Ghassul as a late (if brilliant) manifestation of Chalcolithic culture.

Perrot's later work at Munhatta (1960-66) produced another meticulous dissection of suspiciously meagre debris layers (PERROT 1964, 1966), and another magisterial summary statement which sought to integrate all previously recognised Neolithic cultures into the one overarching regional sequence (PERROT 1968). More importantly for the Chalcolithic, Perrot contrasted the Palestinian Neolithic with the Ghassulian, and suggested that the Ghassulian displayed significant links with the northern Levantine Neolithic, only then becoming known from Braidwood's publication of the Chicago excavations in the Amuq (BRAIDWOOD and BRAIDWOOD 1960), Kirkbride (1969) and Copeland's (1969) surveys in the Lebanese Beqa'a, and Dunand's work on the Byblos Neolithic/Chalcolithic culture (DUNAND 1950, 1973).

Synthetic studies in the years immediately before Hennessy's return to Teleilat Ghassul consistently viewed the Ghassulian culture as either entirely foreign to the southern Levant, or containing a substantially foreign element.[1] In this way they accounted for the apparent gulf between the impoverished "Chalcolithique Moyen" of Megiddo, Beth Shan, Far'ah North and Shuna, and the Classic Ghassulian of the south Jordan Valley and the Negev.

The crucial development in research on the Ghassulian came with Hennessy's re-excavation of Teleilat Ghassul in 1967. Planned as a long-term project, excavations were interrupted after one season. Even so, Hennessy's findings were crucial and perhaps unexpected in the light of North's then recent pronouncements. Hennessy described a nine-stage sequence (whilst acknowledging that several others were still to be excavated), and outlined a clear cultural progression, with basal deposits characterised as a local manifestation of the south Levantine Neolithic. He concluded that the developmental sequence derived from a local Neolithic base, that it passed through discernible stages, and that these intermediary stages might well be associated with the apparently "non-Ghassulian" Chalcolithic assemblages at Tell esh-Shuna North and Ghrubba. The final flowering of the Classic Ghassulian was restricted to the upper four phases (A-D), which was to be associated with the Beersheban culture (HENNESSY 1969).

Synthetic studies in the decade after Hennessy's first season rapidly assimilated his viewpoint, and represent a sea-change in opinion. Moore had first commented on the Neolithic component of the basal Ghassulian assemblages, and over time developed an integrated perspective which viewed the south Levantine Neolithic and Chalcolithic cultures as sequential regional assemblages, predominantly the result of *in situ* development through time.[2] Summary works on the Ghassulian consolidated this view of cultural continuity over the Neolithic/Chalcolithic divide, stressing the undoubted accomplishments of the Ghassulian, without thereby divorcing it from its regional forebearers. Mellaart and Perrot dissented, and continued to advocate a foreign derivation for the Ghassulian, although Kenyon became less sure about foreign inspiration.[3]

With the exception of Hennessy's renewed fieldwork at Ghassul, research in the 1970s and 80s concentrated on the relatively sparsely populated northern Negev, with numerous survey projects concentrating on the lateral wadis to the north of the Besor/ Beersheba complex. In the more heavily populated areas to the north and east, the changed geo-political situation in some regions and the pace of industrial development in others combined to promote intensive survey at the expense of anything other than limited soundings at the many sites identified through this enforced industry. Field research came to be dominated by small-scale investigations, often only probes into short-life or single period sites. The impoverished assemblages resulting from this restricted sampling methodology has led to an unwarranted emphasis on minor ceramic differences in the definition of distinct cultures, promoting a tendency to overclassify trivial assemblage variations as distinct techno-cultural entities, rather than view all as minor variations of a single generalised regional culture.[4]

Evidence drawn from these poorly differentiated micro-cultures (the "Lodian", "Tsafian" and "Besoran", to name but three) promotes the view of a significantly more varied regional (and chronological) landscape than previous work seemed to suggest. However, the modern "fragmentation" perspective is more an artefact of sampling methodology and nomenclature out of control than an accurate reflection of a genuinely more varied cultural landscape. Matters of nomenclature and cultural

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1 Anati (1963), Mellaart (1965), de Vaux (1966), Hennessy (1967), and Perrot (1968), for general synthetic statements on the relative chronology of Chalcolithic Palestine, and the generally accepted foreign derivation of the Ghassulian.

2 Hennessy (1969) for the description of the basal layers as Neolithic, and Hennessy (1971), for Moore's role in this attribution; Moore (1973, 1978, 1982), for the development of the thesis of in situ development for the Ghassulian.

3 Elliot (1978) for a detailed summary statement on the Ghassulian, Hennessy (1982) on the Neolithic origins and in situ development of the Ghassulian. Mellaart (1975) and Perrot (1984) for the dissenting view on foreign derivation; Kenyon (1979) on the difficulties with both views.

4 For overviews of Chalcolithic research in the 70s and 80s, see Levy (1986) and Gilead (1988). A short review of Excavations and Surveys in Israel will suffice to illustrate the dominance of survey and sounding projects over multi-period area excavations.

definition in the Chalcolithic are of more than trivial concern, as the techno-typological characteristics and distinctiveness of the "pre-Classic" cultural entities are vital factors to be determined and agreed upon, before any consideration of potential socio-economic transformations in the lead-up to the final flowering of Ghassulian culture can begin.[1]

Whilst the tendency to view contemporary minor variations as distinct "cultures" is on the rise, the consensus view of the Classic Ghassulian as a foreign introduced culture would seem to be on the wane. Major synthetic statements on this point have (albeit tentatively) adopted Hennessy's view of the Ghassulian as a product of the south Levantine Neolithic, although the appropriate Neolithic affiliate is still at issue.[2]

However, whilst Gilead, Stager and Mazar have acknowledged the importance of Hennessy's Ghassul sequence in resolving outstanding chronological problems, all emphasise that a full evaluation of Hennessy's results awaits a more complete publication of his findings. As well, we feel that intensive study of the long "pre-Classic" sequence at Ghassul will prove vital in any assessment of the relative socio-economic distinctiveness of the many minor chrono-cultures currently entertained in the literature, as it will provide a firm illustration of what one may advance as "normal change through time" at one of the more important long-lived sequences relevant to our concerns, something the stacatto testimony of the ever-growing "survey and probe" database cannot provide.

Hennessy's crucial (and largely unpublished) "pre-Ghassulian" Chalcolithic sequence, first identified in 1967 and much enlarged in his return to the site between 1975-77, is central to the resolution of many current research problems, and is one of the major foci of renewed excavations at the site. This short report will outline the major features of Hennessy's discoveries between 1975-77, and integrate them with the first results of renewed excavations between 1994-1995, concentrating on what may be called the "pre-Ghassulian" levels at Teleilat Ghassul, before attempting a first assessment of the significant points to emerge from such a study.[3]

Sydney University Excavations at Teleilat Ghassul: a Stratigraphic Summary

Hennessy's University of Sydney Excavations (1975-77)

By the end of the 1967 field season, excavations in the westernmost trenches of Hennessy's main field of investigation (Area A) had progressed between two and three metres below the Tulayl 1/2 surface, reaching what Hennessy would call his phase D/E interface. All earlier material (Hennessy's phases E-I) was known from a narrow 1x1m probe into sterile approximately three metres further below.

When Hennessy returned to Ghassul in 1975, he renewed excavations in Area A, in the three westernmost trenches of the eight originally opened, these being least affected by the earthquake faulting and slippage which had so disrupted work in the central and eastern trenches in 1967 (Fig. 2). After extensive cleaning and cutting back of baulks, these three 5x7m trenches (A I-III) were all investigated during the 1975 field season, although work was hampered by the discovery of numerous fragments of a large collapsed wall painting, and limited to the exposure of a single phase of rectilinear "longhouse" architecture, the first of several "pre-Ghassulian" phases excavated over the next three seasons.

New fields were opened in 1975, most notably ten 5x5m trenches in Area E (Tulayl 5), where Hennessy identified the main sanctuary complex of the site (Fig. 3). Two 10x5m trenches were begun in Area F, equidistant between A and E, where surface finds suggested a potential metalworking area, and four 5x5m trenches were laid out in Area H, where well preserved architecture was visible close below the surface. The 1975 season concentrated on excavating the uppermost phases in all these areas (Fig. 1).

In the first of two seasons in 1977 (January-March), Hennessy continued explorations in two of the original three trenches in Area A, concentrating on the northern half of trench A III and a similarly truncated southern half of trench A II to the south (Fig. 2). Excavations uncovered two further

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1 For the Lodian, see Gopher (1993); for the Tsafian, Gophna and Sadeh (1988/89); the Besoran, Gilead and Alon (1988). For the disjunction between the "Clarkian" rigours advocated for cultural nomenclature, and what has become normal practice in the southern Levant, see Gophna and Gopher (1993), who are aware of current inadequacies; for the dangers inherent in a similar situation developing in Epipalaeolithic studies, see Edwards *et al.* (1996).

2 Synthetic statements such as Gilead (1988), Mazar (1990), Stager (1992) and Levy (1995) all accept Hennessy's view of the Ghassulian as the product of in situ development out of Neolithic origins. Gonen (1992) for a review of the many possible origins entertained for the Ghassulian; Goren (1990), for the view of the Qatifian as the appropriate source, Levy (1993) and Garfinkel (1993) for continuing doubts.

3 I take this opportunity to thank Emeritus Professor Hennessy for his permission to study material from his seminal excavations at Teleilat Ghassul, and for the detailed discussion of both his excavations and many of the issues raised below.

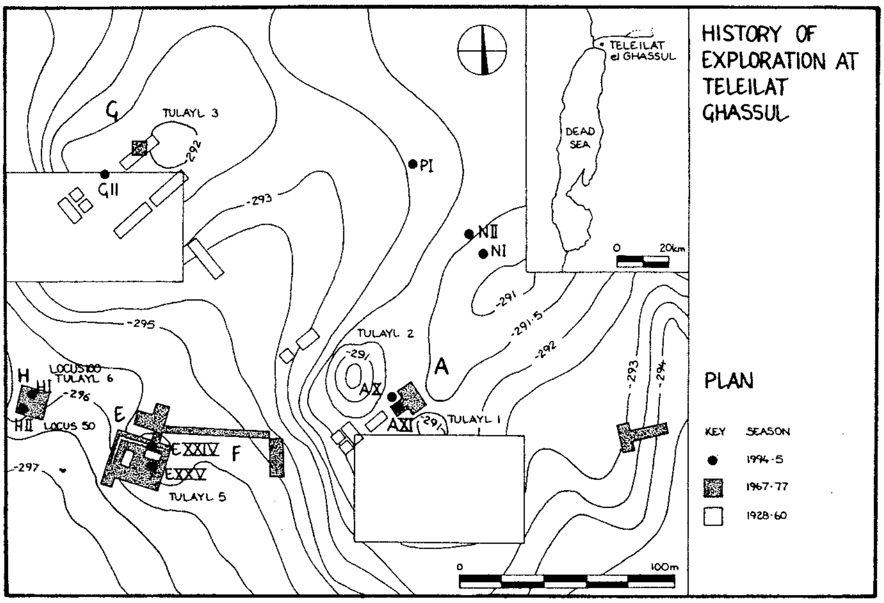

Figure 1. Plan of Teleilat Ghassul excavation areas. Showing Sydney University excavation areas in relation to Pontifical Biblical Institute fields.

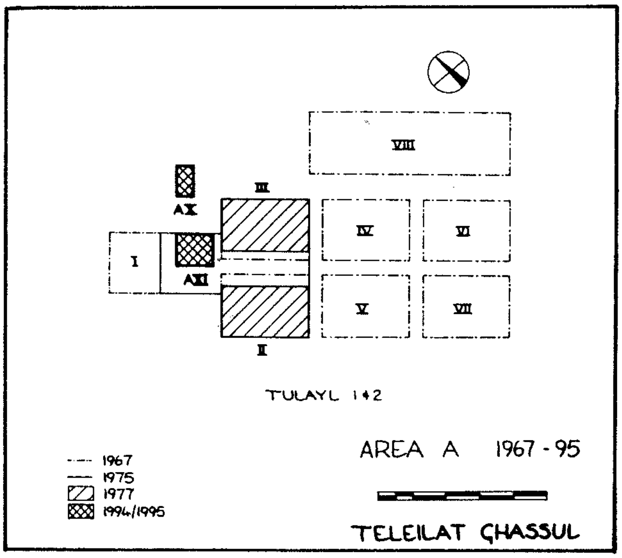

Figure 2. Plan of Sydney Area A. Showing original 1967 trench positions, and subsequent excavation areas in 1975/1977 and 1994/95.

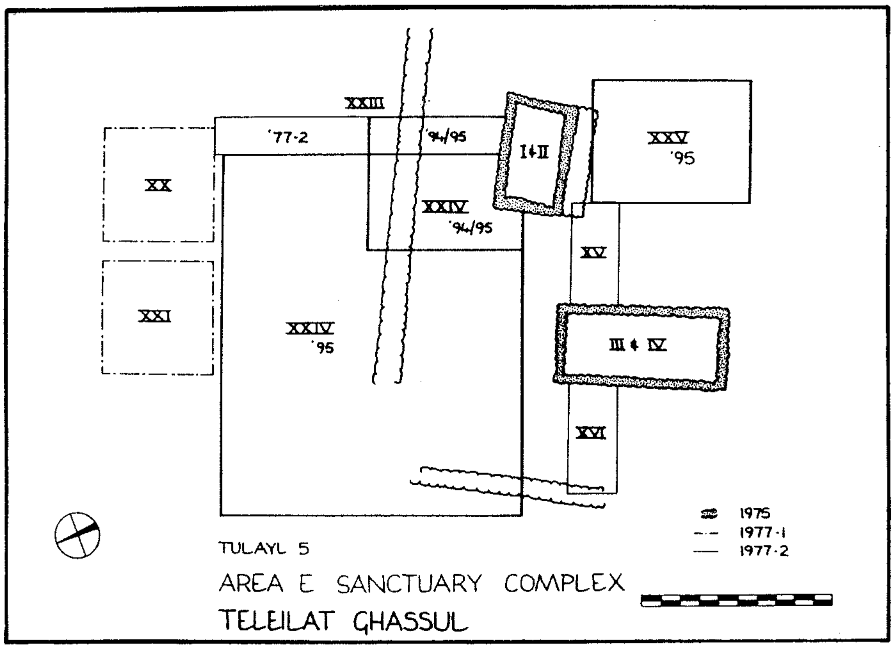

Figure 3. Plan of Sydney Area E. Showing original 1975/77 trenches in relation to 1994/95 excavation areas.

rectilinear "longhouse" phases of "pre-Ghassulian" Chalcolithic (Hennessy F-G). The discovery of a flint knapping floor was the highlight of excavations in A III.

As well, three new 5x5m trenches were opened to the west of the original 7x2.5m probe excavated as A XVI in 1967, and two phases of Late Chalcolithic architecture associated with stone paved floors and several well-built stone-lined bins discovered in the northernmost plot. In Area E, several of the 1975 trenches were continued, and three new trenches opened to the north of the Sanctuary temenos. All excavations still concentrated on the uppermost phases of occupation. A new area (G) was laid out to the north of PBI Field III, and at least two phases of Late Chalcolithic pits detected. Areas F and H were not worked in early 1977.

In the second of the 1977 seasons (September-November), the basal Chalcolithic and Neolithic deposits (Hennessy H-I) were excavated in the A II (south) and A III (north) probes. Beneath the rectilinear mudbrick and stone architecture of Phases F and G, both probes sampled over a metre of occupational debris layers and several phases of pits, associated with a number of shallow rounded pit-dwellings cut into the greenish-yellow river sands that lie at the base of the site.

In Area E, as well as opening another new trench and completing the excavation of the smaller of the two sanctuary buildings (Sanctuary B), areas of several trenches were carried down to sterile layers (Fig. 3). At least one earlier phase of architecture was detected in the two northernmost probes, as well as an earlier phase of large fire pits, separated off from the architecture by bands of sterile sand. The pre-sanctuary architecture (confined to the area north of the sanctuary temenos) appeared to be only slightly earlier in date than the sanctuary itself. The fire pits were earlier than any architecture in the area, but difficult to date. They were not found with diagnostic material, although Hennessy entertained the thought that they might be of a similar age to the basal deposits in Area A.

In Area F, three new (5x2.5m) trenches were opened to link Area F with the eastern edge of Area E. These were excavated into sterile sands, having sampled two distinct phases of architecture, preserved in the eastern half of F III and the western half of F V. Much of the intervening stratigraphy had been removed by a series of deep washouts which had cut through all deposits. Both phases of architecture were dated to the Late Chalcolithic period. The most noteworthy discovery was what appeared to be a painter's workshop in the structure uncovered in F V.

By the end of the second season in 1977, Hennessy had reached sterile in both A II and A III. Over the course of three seasons he explored more than three metres of "pre-Classic Ghassulian" occupational debris in this area. He had isolated five distinct phases (and many sub-phases) of "pre-Ghassulian" material. In Area E, he had reached sterile sand in a number of probes, but without discovering any similar depth or density of occupation. All architecture and associated materials from the Sanctuary and pre-Sanctuary phases was to be seen as Classic Ghassulian in date. In Area F, a similar two-phase Classic Ghassulian sequence had been explored. No earlier material was encountered in the three probes carried down to natural, although much material had been removed by extensive recurring deep washouts that had cut through this area on a number of occasions.[1]

Current University of Sydney Excavations (1994-95)

Changing research priorities, more refined sampling strategies, and numerous unresolved site-specific questions prompted renewed excavations at Teleilat Ghassul in 1994 (Fig. 1) (BOURKE *et al.* 1995). The first season had the quite limited aim of collecting detailed botanical and zoological samples from all phases of occupation at the site, whilst beginning the examination of the depth and complexity of occupation across the entire 20-25 hectare extent. Seven probes were initiated, four intentionally associated with Hennessy's main areas of excavation (A and E), and three placed in little explored regions of the western (H), and northwestern (G) reaches of the site. Excavation units were small (2x1m) column soundings, designed to facilitate rapid vertical stratigraphic sampling. Two (A X and A XI) were placed within (A XI) and immediately to the north (A X) of Hennessy trench A I (Fig. 2, Pl. 1:A-D); another two were placed to the north of Sanctuary B (E XXIII Deep Probe and E XXIV; Fig. 3 and Pl. 3:C-D), one within Hennessy Area H (H II; Pl. 4:A), and two southwest of Hennessy Area G (G II Locus 1-20) set in the northern face of PBI Field III.

In 1995 the seven column soundings commenced in 1994 were continued, and four were completed (A X, A XI, E XXIII and H II). Two new column soundings in the eastern regions were commenced (N I and P I), and that within the northeastern reaches (P I) completed (Fig. 1 and Pl. 2:A-B). Those in Areas G and N have not reached sterile layers, but are well into "pre-Ghassulian" layers, and should reach sterile at the end of another season. In all, five complete column samples

[1] Hennessy's three seasons of excavations between 1975 and 1977 remain unpublished in anything other than prelimi-nary form. A short privately produced report (HENNESSY 1977) and a summary article (HENNESSY 1978) were followed by statements on the origins of Ghassul (HENNESSY 1982) and the relationships with previous work (HENNESSY 1989). Several monograph length studies are being prepared, but full publication must await the completion of doctoral dissertations on the Ghassul sequence currently underway.

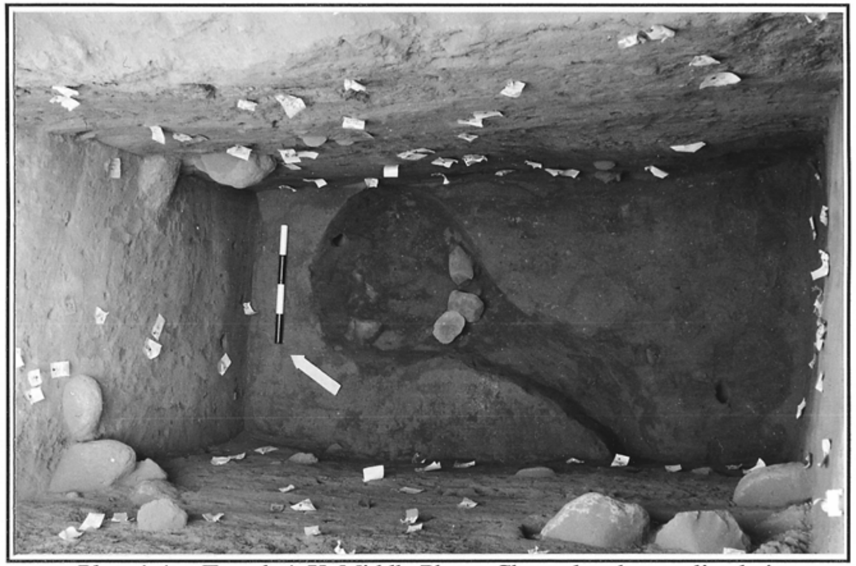

Plate 1:A. Trench A X, Middle Phase. Channel and stone-lined pit industrial processing installation.

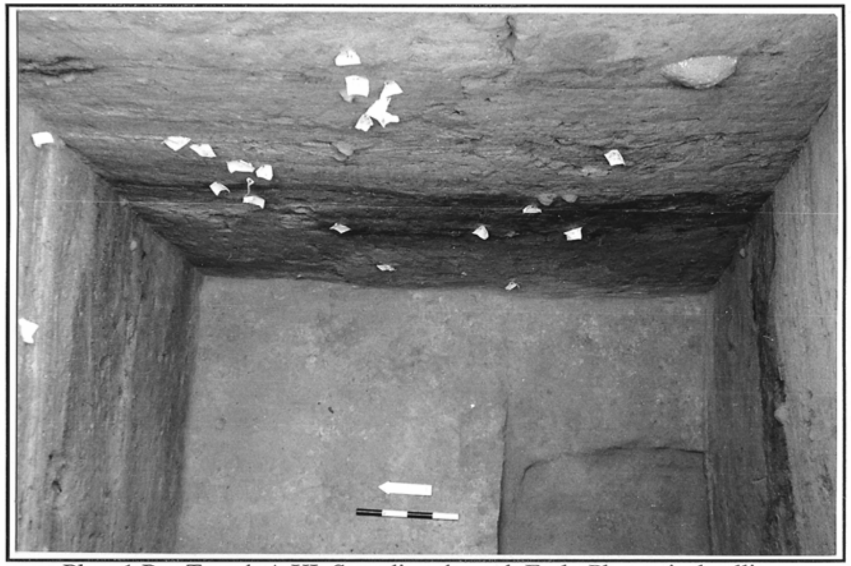

Plate 1:B. Trench A XI. Sounding through Early Phase pit-dwellings (black deposits in East Section) to sterile sand.

Plate 1:C. Trench A XI Extension. Postholes and pits associated with late Early Phase deposits.

Plate 1:D. Trench A XI Extension. Plastered surfaces associated with pit dwellings of Earliest Phase.


Plate 2:A. Trench N I. Middle Phase sondage in northeast corner.


Plate 2:B. Trench N I Sondage. Series of Middle Phase pits associated with post and stake holes (roofing and fencing?) and work surfaces.

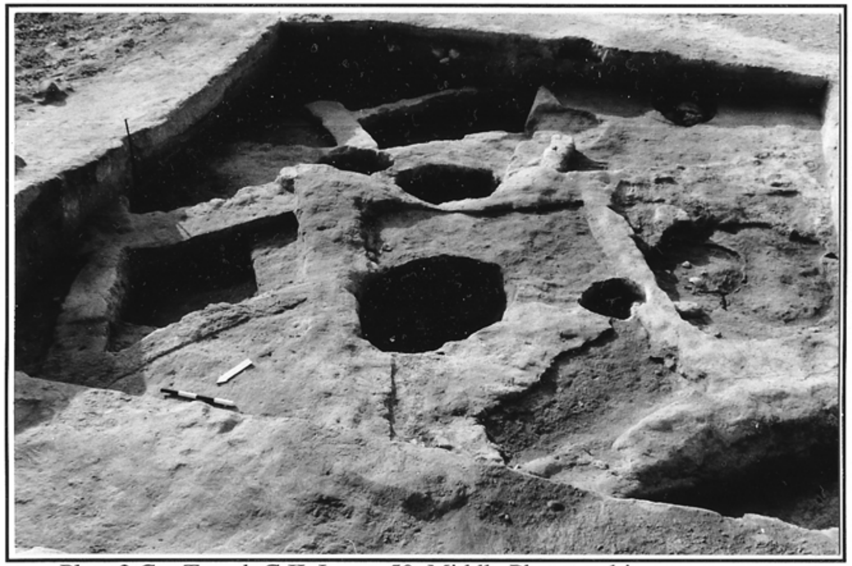
Plate 2:C. Trench G II, Locus 50. Middle Phase multi-room structure (storage facility?) and Late Chalcolithic pits.


Plate 2:D. Trench G II, Locus 50. Small plastered bin (?) showing extensive subsidence shattering of plaster surfaces.

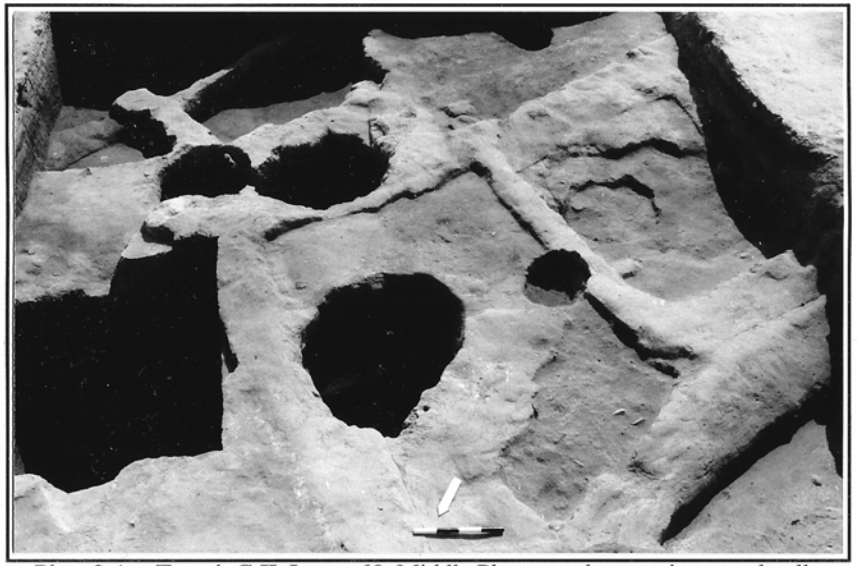

Plate 3:A. Trench G II, Locus 60. Middle Phase sondage against east baulk.

Plate 3:B. Trench G II Sondage. Subsidence faulting at base of sondage (burnt material is rich in flax).

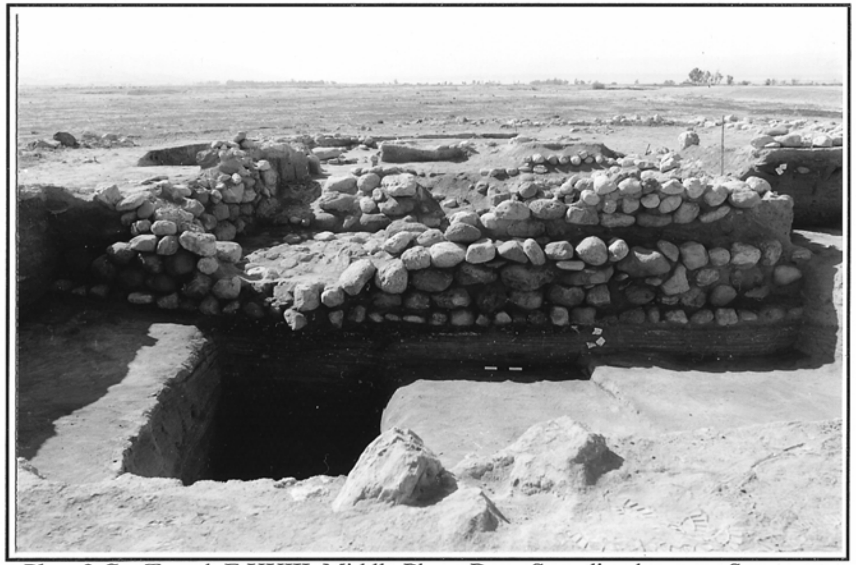

Plate 3:C. Trench E XXIII. Middle Phase Deep Sounding between Sanctuary B and Temenos Wall (note multiple phasing in Sanctuary B construction).

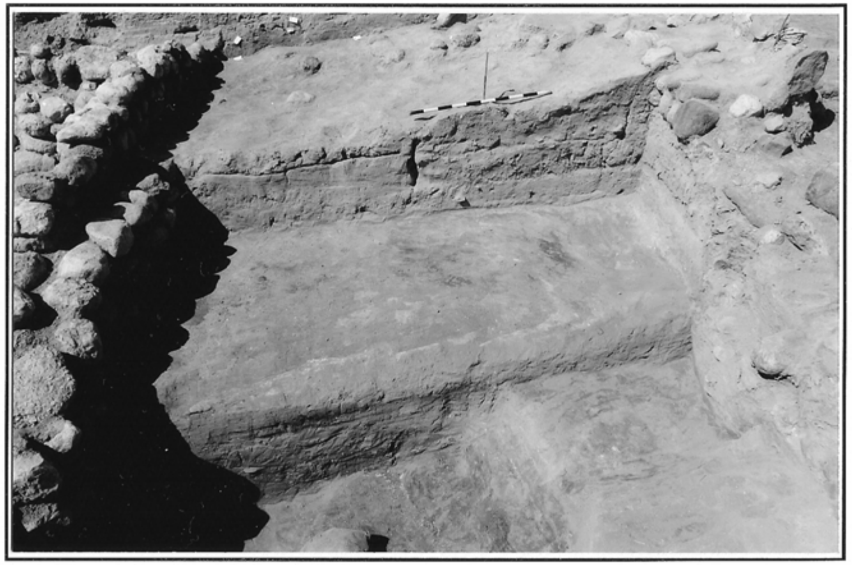

Plate 3:D. Trench E XXIII Deep Sounding and stepped area of Trench E XXIV to the west (all located between Sanctuary B and Temenos Wall).

Plate 4:A. Trench H II Deep Sounding. Late Chalcolithic walling in section, Middle Phase plastered surfaces below.

Plate 4:B. Trench H II Locus 100. Corner of Late Chalcolithic longhouse and exterior beaten surface along north wall exterior.

have been excavated, two in the central part of the site (Area A), one in the southwest (Area E), one in the west (Area H), and one in the north east (Area P). Probes in the northwest (Area G) and east (Area N) are nearing completion, and others in the south and southeast are planned (BOURKE 1997).

Results and Observations

Geological/Tectonic Activity

The role of geological/tectonic activity in the history of occupation at Ghassul is a matter of some controversy. Mallon and Koepell observed earth splits from time to time, but did not invest them with any particular significance. North certainly noted earth splitting, as he illustrated split lines in a number of very schematic sections. Hennessy claimed that the very clear evidence for extensive earthquake splitting was the key to unraveling the complex and subtly nuanced site history, and illustrated many examples of severe horizontal and vertical faulting. He suggested that tectonic activity played a major role in successive destruction/rebuilding episodes, and saw tectonic activity as the probable cause for the final abandonment of the site. Lee discounted most of Hennessy's observations, suggesting that the earthquake faulting was neither as extensive nor as severe as Hennessy had claimed. Whilst he grudgingly admitted that the high mounds of Tulayl 1 and 2 might well have been more disturbed than the PBI excavators had noted, he was categorical that such was not the case in the Tulayl 3 excavations.[1]

There is no doubt that severe vertical splitting badly fragments the upper two metres of stratigraphy on the two mounds in which occupation is most concentrated (Tulayl 1/2 and Tulayl 3), consistent with severe tectonic activity similar to that recorded in the Jordan Valley in 1927. Secondly, below the uppermost two metres of occupational debris in both high mounds, and in all other areas where stratigraphic buildup is less marked, there is little evidence for severe earthquake faulting, but minor stratigraphic slippage or subsidence is common. This results in widespread but minor horizontal cracking, and slight vertical slippage, consistent with subsidence due to basal sand bar compression.[2] However, nothing like the severe shattering of stratigraphy experienced in Hennessy's trenches A IV-VII, and in the upper levels of our Area G probes was encountered in areas where occupational buildup was less intense (Areas E, F, H, N). The quite separate effects of earthquake faulting and compression slippage should be differentiated. The latest strata on top of the highest mounds are likely to display severe faulting, whilst in low-lying areas effects are less pronounced. There is little disturbance of the earliest strata wherever they are found.

Occupational History: Site Magnitude and Internal Phasing

Earliest Phases [Hennessy H-I]

The earliest well defined phase of occupation at Ghassul lie at the base of the central mounds of Tulayl 1 and 2 (Hennessy Phase I). Hennessy exposed approximately 40m^2 of this horizon. The current expedition has added another 6m^2 exposure of identical material. Hennessy discovered one main phase of shallow semi-subterranean roundhouse constructions, with a few small stone installations and multiple phases of pits. The more limited exposures of the current expedition found fragments of two structures, and evidence for at least one major recutting/rebuilding of the structure exposed in A XI (Pl. 1:B-D). Fine sandy plastered surfaces were associated with the rebuilding phase. The current expedition's soundings to sterile in Areas H (west) and P (northeast) have failed to discover any early phase material, and there is no indication of such material in Area G (northwest). Hennessy's soundings in A XVI (southeast), Area F (central west), and Area E (southwest), also failed to uncover any early phase deposits. Present indications are that the earliest phase of occupation at Teleilat Ghassul is of a relatively restricted nature, and concentrated about the central Tulayl 1/2 mounding. It would seem to occupy an area of no more than 1-2 hectares at the most, and perhaps considerably less.

The second of the early phases of occupation at Ghassul (Hennessy Phase H) is poorly known. Hennessy exposed distinct occupational debris layers and a number of pits, but no structural remains in either of his Area A trenches (A II and III). An identical sequence was excavated in the A X and A XI probes of the current excavations. However, absence of architecture should not be taken to imply a break in occupation, as Hennessy's A III pit sequence is extensive, and implies continuity of occupation throughout the phase. Such an observation is in accord with results from the current expedition's A X and A XI probes.[3] The full extent of this phase remains unclear. Pottery from the base of our Area H probe may be associated, but was found in wash/fill deposits. There is a suggestion that some derived material from the deepest levels in the 1995 Area G Deep Probe (Pl. 3:A-B) is associated. Similar material came from the base of the 1995 Area E XXIII Deep Probe (Pl. 3:C-D). It seems likely that this material is associated with Hennessy's pre-Sanctuary "pit phase". No trace of Early phase material was found in the northeast probe (Area P), nor in Hennessy's southeastern probe (A XVI).

A conservative reading of the current evidence would see this second phase of the early settlement still concentrated about the central mound, with an area similar to that of the preceding first phase. There is some suggestion of a modest expansion to the west and northwest in this phase, although even an approximation of the size increase is not yet possible given the derived nature of much of the evidence.

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1 Hennessy (1969) for the role of tectonic activity in the history and ultimate demise of Ghassul; North (1961) Figs. 11 and 12 for split lines observed in 1960; Lee (1973) on Mallon and Koepell's observations, and the relative unimportance of earthquake activity in PBI Field III, a view we would strongly take issue with.

2 Webley (in HENNESSY 1969) first noted the role of basal sandbar compression in the splitting and crazing of the Ghassul stratigraphy. Hennessy's clearly illustrated earthquake damage is always most severe in the upper two metres of deposit, whilst the more minor effects of subsidence are observed throughout the sequence.

3 Micromorphological analysis (Fouad Hourani, Paris) of debris layers equivalent to Hennessy Phase H taken from trench A XI, confirms that deposits are occupational in nature, and that occupation was continuous from Phase I through to Phase G, without any apparent gap. I am grateful to Mr. Hourani for this information.

Middle Phases [Hennessy G-E]

Three distinct phases and numerous subphases of rectilinear mudbrick and stone architecture (approximately 2.5m of deposit) make up the "pre-Ghassulian" or Middle phase stratification in Area A, Hennessy Phases G-E. Although the restricted size of Hennessy's probes made it difficult to be certain of groundplan and layout, all structures appeared to be constructed of variously coloured (black through white, most commonly orange-brown through buff) neatly laid mudbricks, sometimes set on a single course of river stone foundations, but more often laid immediately onto a prepared earth surface. Occasional shallow foundation trenches are employed, but rarely. Structures are broadroom in plan where such can be determined. Thick white plastered floors are sometimes encountered, as are yellowish plaster-lined pits. Most structures have a number of floor surfaces preserved, and several sequences are extensive, with over twenty successive floor levels being traced over albeit limited areas (generally room corners). Fragments of painted wall plaster are associated with all phases of architecture, although the majority is monochrome buff or off-white in colour. However, the famous polychrome Processional Frieze was recovered from the main Phase F structure excavated in A III, attesting to the "pre-Ghassulian" flowering of this most spectacular of Ghassulian traits. A sufficiently large number of fragments of similarly executed polychrome painting make it clear that elaborate wall decoration was practiced throughout the "pre-Ghassulian" Chalcolithic phases in Area A.

The current excavations in Area G II have sampled over three and a half metres of occupational debris in and about PBI Field III. In 1994, two small (2x1m) probes (G II Locus 1-20) concentrated on intensive environmental sampling three distinct architectural phases and some 2.7m of occupational debris. In 1995, we examined an extended 5x5m area (GII Locus 50) of the fourth major architectural phase in the area, and one 1.5m square probe (G II Locus 60) sampled two phases of earlier material (Pls. 2:C-D, 3:A-B).[1]

Whilst the 1994 probes only sampled a small area of Late Chalcolithic material, the substantial mudbrick walls and fine plaster floors were in keeping with PBI findings in the area. The 1995 excavations were able to sample a coherent area of Middle phase material. Architecture consists of a double line of three small thin-walled bin-like structures (each approx 1.5m square) set against more substantial mudbrick walls, in what appears to be a larger rectilinear structure (Pl. 2:C). The function of the small bins is unclear, but botanical evidence is consistent with use as storage bins for animal fodder and flax. Beneath the "storage bin" phase in G II, a deep sounding sampled over 1.3m of earlier material, associated with at least one earlier phase of architecture. Only wall fragments were isolated in the sounding, but the familiar format of well built multicoloured mudbrick walls constructed directly on prepared earth surfaces is reflected in the probe. These earlier Middle phase levels are associated with substantial architecture, confirming the spread of intensive occupation to the northwestern region at this time.[2]

In the western region (Area H) of the site, we hope to examine as large an area of Late Chalcolithic architecture as time and resources allow, taking advantage of the exceptionally well preserved architecture immediately below the surface (Pl. 4:B). To this end, we have already scraped back a 28x11m area, planned the two distinct phases of Late Chalcolithic architecture immediately below the surface, and begun the excavation of three trenches to clarify the stratigraphy. Only the smallest (a 2x1m probe) has sampled the entire 3.4m sequence to sterile (Pl. 4:A). In this restricted sounding little can be said about architectural form except that five distinct phases of occupation are present. The top three are Late Chalcolithic in date, and the two lowest are of later Middle phase date. Although the area sampled is small, fragments of well constructed mudbrick walls, thick plaster floors and plaster-lined pits all suggest structures of substance. The limited evidence from the H II Deep Probe supports the more certain evidence from Area G, indicating widespread occupation of the western regions of the site in Middle phase times. It may well be that in the west at least, Ghassul achieved its full Late Chalcolithic extent during the Middle phases.

Probes into the north eastern (Area P) and central eastern (Area N) areas of the site are yet to reach substantial architecture of Middle phase date, although extensive occupational debris layers, numerous pits and post and stakehole constructions have been sampled. The 2.5m square P I sounding seems to have been placed on the edge of a large stone and mudbrick threshing floor, which

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1 North (1961) and Lee (1973) for PBI excavations in Field III. It seems likely that the PBI excavators removed all Ghassul IV material and exposed large areas of Ghassul III deposits, and in places removed some of the uppermost levels of this phase. This being the case, we would equate our 1994 GII probes with PBI Ghassul IVA-B and Upper III, our 1995 G II locus 50 "bin phase" with PBI Lower III, and (much more approximately) the material from the GII locus 60 Deep Probe with PBI Ghassul II deposits. The series of deep wells cut through the GII stratigraphy are part of a very late "pit phase" detected in surface scraping in 1994. This phase is likely to be post-Ghassul IV in PBI terms.

2 The correlation of PBI designations and Hennessy's Phases remains approximate. At present we would equate Hennessy Phase A- D material with that from the 1994 G II probes, the 1995 G II "bin phase" with Hennessy Phase E, and that from the 1995 GII Deep Probe with Hennessy Phase F.

had been relaid several times. This was the only structure encountered in the 3.5m deep sequence through predominantly Late Chalcolithic levels, although the earliest construction immediately above sterile sand may be late Middle phase in date. In Area N, the latest phases on the site were sampled across the full 5x5m extent of trench N I (Pl. 2:A), before a 2.5m square sounding sampled approximately 2m of earlier occupation without encountering architecture, although a clear sequence of fire and storage pits, plaster and rammed earth floors and lines of several post and stakehole constructions have been excavated (Pl. 2:B). A good deal of this material is Late Chalcolithic in date, but the earliest metre of deposit is of Middle phase date. Hennessy's sounding on the far south eastern edge of the site (A XVI) recovered extensive but exclusively Late Chalcolithic material in the two metres of deposit sampled.

All in all, the evidence from the eastern probes would favour a more modest expansion to the east of the central mound during the Middle phases. The more centrally located areas, such as the current expedition's Area N, were certainly heavily occupied in the later Middle phases. Indications from the PI and A XVI probes suggest that the north eastern and south eastern peripheries were densely inhabited only during the Late Chalcolithic period.

Ceramics (Figs. 4 and 5)

Hennessy proposed three broad periods of development in the ceramic sequence drawn from his Area A excavations. He was able to isolate distinct characteristics for each phase, but observed that all variation occurred within a single ceramic tradition, and concluded in favour of *in situ* development for the Ghassulian ceramic assemblage. Whilst current analyses might discern more phases, and group these slightly at variance to Hennessy's original propositions, the still preliminary ceramic analysis (based largely on material from Area A probes A X and A XI) strongly supports Hennessy's findings in their main thrust, that the ceramic assemblage is best seen as an evolving local tradition throughout its entire sequence. Distinctive fabric/form combinations can be isolated, and assemblages characteristic of specific occupational horizons proposed, but throughout the life of the site there is a clear continuity of tradition and technique in the assemblage as a whole. Beyond this observation, only preliminary observations are warranted as much of the material still remains to be fully processed.[1]

Earliest Phases [Hennessy H-I]

The pottery from the first of the two early phases is dominated by a fabric type that becomes rare in later material. Whilst the clay is a fine lacustrine type, the rarity of any filler larger than silt suggests an unmixed fabric with little pre-treatment. The fabric is coarse and "biscuity", and generally fired from a yellowish through to a greenish buff, often quite crumbly. In the second of the early phases, this fabric occasionally has small amounts of subangular calcite, limestone and shell filler added to the clay body. A second marl fabric, initially present in small quantities, becomes more prominent in the second of the early phases. It consistently employs subangular calcite, limestone and shell filler. Fabrics appear less "biscuity", which might suggest some limited pre-treatment of the clay and a more consistent firing temperature. Firing colour becomes more varied, with grey-cored pale brown through dark brown fabrics more common, although a small amount of reduced sooty black-cored material occurs from late in the second phase. As well, a reduced coarse variant of the normal yellowish-buff fabric with added quartzite filler occurs from late in the second phase, although too rarely to associate with a particular shape class. Throughout the early phases shape range is very restricted, consisting overwhelmingly of small and medium simple bowls, medium holemouth jars and squat narrow-necked jars. Towards the end of the early phases stump-based cornet cups appear, as do the first simple fenestrated stands. Fine variants of established forms increase in frequency as the early phase unfolds. Surface decoration is very rare.

Middle Phases [Hennessy E-G]

The fabrics of the Middle phases show considerable continuity with early phase material. The buff marl fabrics remain important but at a reduced incidence; a second ferruginous clay comes into prominence early in the Middle phases, and is increasingly employed on many of the smaller vessel

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1 The Classic Ghassulian ceramic repertoire is well known. Lee's (1973) extensive consideration of the PBI ceramic assemblages nonetheless treats them en bloc, without any attempt to isolate distinct phased assemblages. See Hennessy (1969) for the first successful demonstration of the existence of phased assemblages, Hennessy (1982) for proposed major phase divisions, and Hennessy (1989) for tentative correlations between his phasing and the original PBI stratigraphy. The following discussion of Ghassul ceramics owes much to the work of Ms. J. Lovell, Ceramic Registrar for the current Sydney expedition. Ms. Lovell is completing a Ph.D. on the Ghassul sequence, and definitive statements must await her conclusions.

forms. Firing colour varies more widely, as does firing temperature. As the Middle phases unfold the dominant Late Chalcolithic "hard red" ferruginous fabrics become a more significant part of the assemblage. These latter fabrics are fired brick red throughout, and a consistent proportion are over-fired to the point of vitrification. Firing temperature appears to be considerably higher on average and the firing gradient more pronounced, which might suggest a more consistent employment of what has been termed "proto-kiln" technology. Forms are more varied and rims more elaborate, with the appearance of churn and miniature churn forms, a number of bevelled-edge fenestrated stand variants, and elongated or "full" cornet cups a feature. However, the assemblage is still dominated by flat-based fine and coarse holemouth jars, fine and coarse simple bowls, and several varieties of necked jar. Within the increasingly differentiated form classes, a pattern of distinct fabric (coarse through very fine) and size (small, medium and large) classes begins to emerge, perhaps hinting at a more standardised production regime at a level beyond the household, although it is probably premature to speak of pottery workshops.

Late Phases [Hennessy Phases A-D]

The Late Chalcolithic or "Classic Ghassulian" assemblage has been well documented in a number of previous studies, and detailed characterisation is beyond the scope of this paper. Suffice it to say that the oxidised ("hard red") and reduced ("hard grey") variants of the iron-rich marl dominate the fabric assemblage, with perhaps a quarter to a third of the marl-rich variants fired to the point of vitrification. Hard red fabrics are commonly employed in small shape manufacture, and hard grey fabrics in storage jar and bowl production, although some crossover does occur. Form repertoire increases, with spouted bowls, fine cornets and rough-fluted goblets, elaborate rimmed holemouth and shortnecked jars, very large storage jars and bowls, and figurine attachments all featuring in a generally more varied assemblage. Self slips or variants of Hennessy's "Streaky Wash" (a thin white slip carelessly applied) dominate small vessel treatments, although a "streaky red" wash occurs on larger vessels occasionally. Painted decoration is generally restricted to careless red painted bands or neatly executed chevrons and pendant latticework triangles over a white slip, although rare "free field" red painted cornets occur in the latest levels. Overall, there is the impression of increased standardisation in fabric preparation and firing in comparison with the Middle phases. Shape repertoire is increasing varied in the smaller shapes, whilst storage vessels increase in overall size, and seem to be more highly fired. Standardisation in form, fabric and decorative regime becomes more marked, as does the incidence of slow wheel finishing of smaller vessel forms. It seems appropriate to consider at least some of this output to be the product of modest ceramic workshops.[1]

Subsistence

Archaeozoology (Fig. 6)

The Early phase sample is relatively small (432 large mammal NISP), but comparable in size to other published material. The large mammal assemblage is as follows: ovicaprine (74%), cattle (11%), pig (7%), gazelle (6%), others (2%). Over the course of the Early phases there is an observable increase in cattle and pig exploitation, and a sharp decline in gazelle use. As well, there is a noticable change in the age-patterning, with significantly greater numbers of aged ovicaprine and cattle in the later assemblages, presumably a reflection of greater secondary-product utilisation.

The Middle phase sample is larger (606 large animal NISP), and not greatly altered in composition from early phase norms, although ovicaprines (78%) and pig (10%) are more numerous, and there is a slight reduction in cattle numbers (8%). Otherwise, the tendency to retain aged animals (ovicaprines and cattle) is maintained, although it does not intensify. A small number of equids are present from the later Middle phase levels onwards.

The Late phase (Classic Ghassulian) sample is quite large (1464 large mammal NISP), and although composition does not alter in the early levels of the late phase (ovicaprine 78%, cattle 9%, pig 8%, gazelle 2%, others 3%), there is a noticable change in composition towards the very end of the period, with ovicaprine numbers much reduced (68%), and gazelle numbers greatly increased (17%), perhaps consistent with the much observed but little demonstrated climatic deterioration at this time.[2]

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[1] See Edwards and Segnit (1984) for preliminary investigation of Ghassulian petrography and Edwards (1993) for thoughts on the mode of production. Previous remarks on the fabric types at Ghassul owe much to the work of Drs. R. Segnit and I . Edwards (Deakin University), who are undertaking a petrographic analysis of the Ghassul material.

[2] For preliminary remarks on the Ghassul fauna, see Mairs in Bourke *et al.* (1995); further analysis will appear in the next preliminary report. See Grigson (1995) for a superb synthesis of the Chalcolithic database, but note that the figures on Ghassul, derived from Lee (1973), are selective and totally superseded by current analyses. I thank Mr. L. Mairs (Australian Museum, Sydney) for discussing the Ghassul faunal material with me.

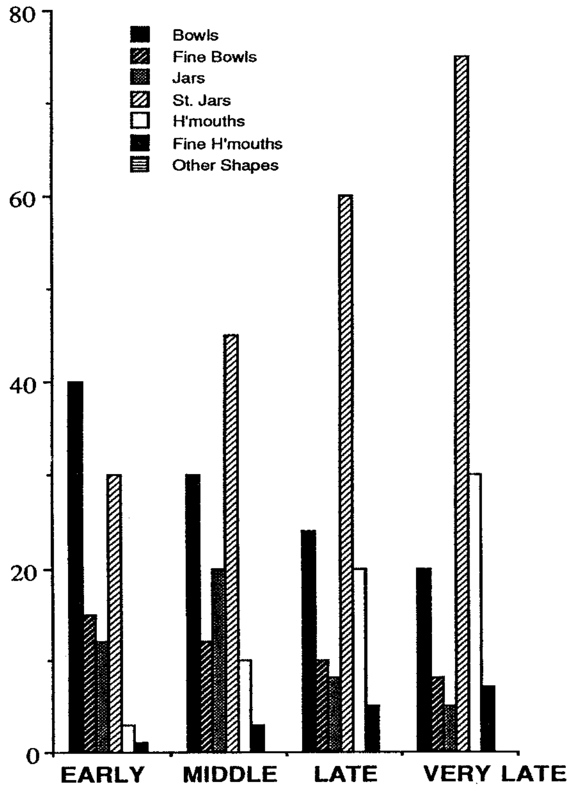

Fig. 4. Ghassul ceramics: fabric frequencies through time *<figures are proportional, not percentages>*.

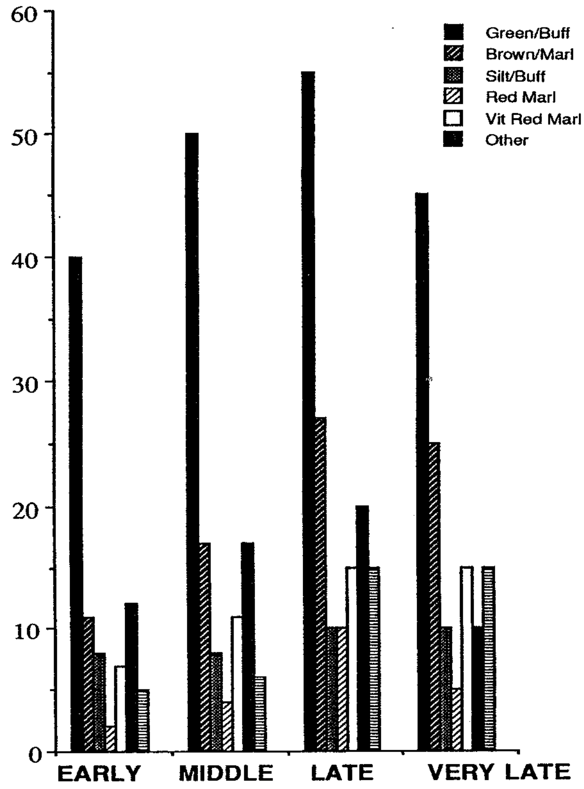

Fig. 5. Ghassul ceramics: shape utilisation through time *<figures are proportional, not percentages>*.

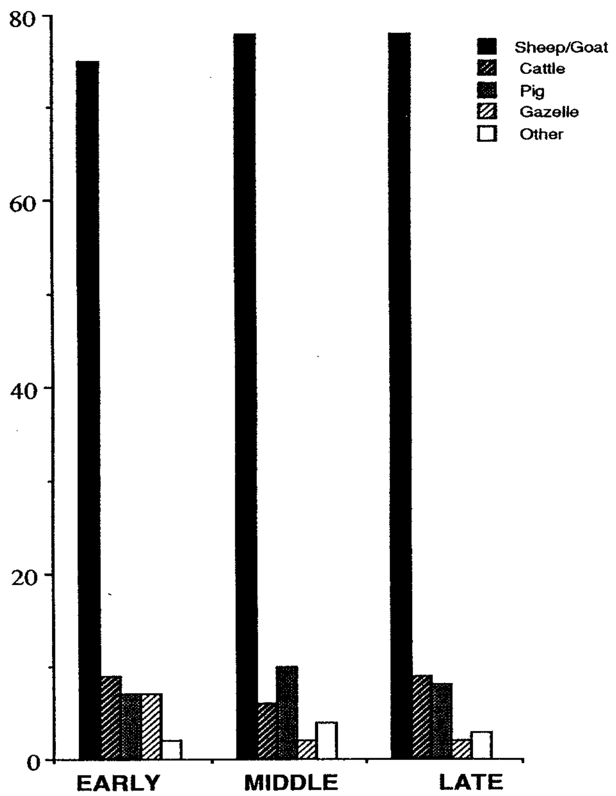

Fig. 6. Ghassul zoology: animal exploitation through time *<figures are percentages>*.

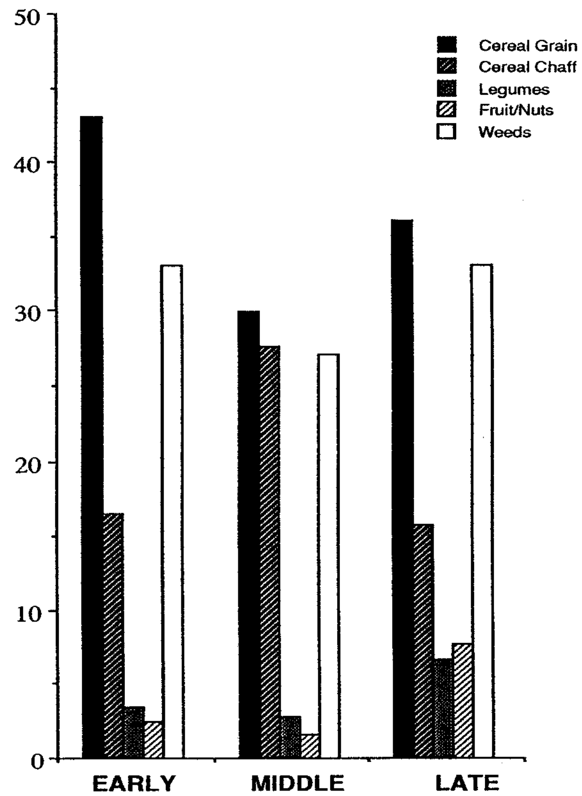

Fig. 7. Ghassul botany: plant exploitation through time *<figures are percentages>*.

Archaeobotany (Fig. 7)

In general, there is a preponderance of cereals in most samples, with barley more common than wheat in the Earliest phase samples, but changing through time such that by the end of Middle phases, wheat has come to dominate cereal products. As well, from this time a consistent if restricted presence of wheat waste products is noted in most samples. Throughout the sequence, the consistent presence of a restricted range of weeds, glume bases and a low incidence of basal nodes suggests increasing crop processing off-site, whilst the large quantity of culm nodes and grasses suggest collection of fodder crops. Overall, the botanical evidence suggests a diversified crop production from earliest times, with wheat, barley, legumes and olive the most important food crops.

Change from the Earliest through into the Middle and Late phases is not marked, but several points may be highlighted. There is a gradual increase in the incidence of more productive forms of wheat and barley from the Middle phases onwards. Legumes are an important supplementary presence by the Middle phases, as are fruit and nuts. Olive cultivation begins in the Early phases, and evidence for extensive olive oil production (and probable storage) grows from the Middle phases onwards, to become widespread by the end of the Late Chalcolithic. A number of samples from the late Middle phases are rich in flax, suggesting intensive exploitation from that time. There is growing evidence for fodder crop production by the end of the Middle phases, which increases through the Late Chalcolithic period.[1]

Relative and Absolute Chronology

Absolute Chronology

There are 12 ^{14}C dates from Teleilat Ghassul, one taken from the PBI excavations and poorly contexted, and 11 drawn from Hennessy's excavations, although the three Groningen dates were taken from standing sections by Neef some years after Hennessy's excavations had ceased. Hennessy's dates are well-contexted. The four samples processed by Lee and Neef are considerably less reliable, with stratigraphic location determined by absolute height measurements only.[2] The dates are provided in Table 1.

Five of Hennessy's dates (1-5 in Table 1) are relevant to our immediate concerns. SUA-732, from trench A III, is the earliest stratigraphically. It is taken from an occupational debris layer associated with a late subphase of Hennessy Phase G. Also from trench A III, SUA-734 is drawn from a small pit cut into fill layers either associated with the earliest subphase of Hennessy Phase F, or the latest subphase of Phase G. SUA-736, from trench A II, comes from occupational debris layers associated with early subphases of Phase G. SUA-738 and SUA 739 sample Hennessy's pre-sanctuary "pit phase" material from Area E. This earliest occupational debris from Area E, was detected in a number of locations below sterile banded deposits, which consistently divide this "pit phase" from the more substantial structures of the Sanctuary complex.

A number of publications have noted Hennessy's early dates, but generally without comment.[3] Gilead (1988) was first to note the implications for long-term *in situ* development, a view that Hennessy (1989) emphasised and Goren (1990) developed further. Levy (1992) outlined a similar claim for the length of occupation at Shiqmim, a view Perrot (1993) attempted to support for Beersheba, although Gilead (1994) is largely successful in rebutting such claims.

A comprehensive synthesis of southern Levantine Chalcolithic ^{14}C data has recently been published by Joffe and Dessel.[4] Their analysis seeks to divide the Chalcolithic into three discrete periods (Early, Developed and Terminal), based predominantly on ^{14}C data. Although they position Hennessy's early dates within their "Early Chalcolithic" phase, Joffe and Dessel were reluctant to comment on their cultural significance in the absence of detailed contextual data. We offer several comments by way of clarification.

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1 See Kislev (1987) for a limited Chalcolithic archaeobotanical survey, although the species listing for Ghassul is deficient, and superceded by present work. See Neef in Dollfus *et al.* (1988) and Neef (1990) for the importance of olive cultivation in the Jordan Valley; Galili and Sharvit (1994/95) and Carmi and Segal (1994/95) for early olive oil production in the Carmel region; Epstein (1993) for the importance of olive cultivation in the Golan; Zohary and Spiegal-Roy (1975) on the possible use of irrigation in the cultivation of Ghassul olives. I thank Ms. C. Hoppé (Sheffield), who has processed the current expedition's material, for discussing Ghassul archaeobotany with me.

2 I thank Em. Prof. Hennessy for permission to discuss the Sydney dates, and for permission to mention Neef's Groningen dates.

3 Weinstein (1984) first mentioned Hennessy's dates, but Gilead (1988) and Stager (1992) were the first to comment on their significance.

4 Joffee and Dessel (1995) for a comprehensive review and new scheme for the south Levantine Chalcolithic; Goren (1990) and Gilead (1990) for further discussion of the Neolithic/Chalcolithic transition.

Hennessy's early Ghassul dates do not sample material from his "Neolithic" strata. Hennessy's Area A assays provide a reliable date for the initial stages of what we have termed the "Middle phase" occupation (Hennessy G/F) at Ghassul, Joffe and Dessel's "Early Chalcolithic" phase. Hennessy's E X pit samples are possibly associated with slightly later Middle phase strata, but still well within Joffe and Dessel's "Early Chalcolithic" phase, reinforcing our impression that significant expansion to the west occurred quite early in Ghassul's history.[1]

Gilead's assemblage-derived three stage sequence for the Negev is broadly relatable to Joffe and Dessel's ^{14}C-based tripartite division, although the latters seem more willing to accept a lengthy multi-period occupation at Shiqmim. In turn, Gilead's tripartite Negevite sequence would seem to be broadly comparable by assemblage and date with our proposed tripartite division of the Teleilat Ghassul sequence.[2]

Goren has suggested that the early phases at Ghassul be related to the Qatifian, but comparative ^{14}C data would seem to deny this possibility. There is little to recommend Goren's argument in terms of ceramic analysis, notwithstanding the absence of good parallels between the basal Ghassul material and other Neolithic ceramic assemblages. If the association between the Qatifian, mature Wadi Rabah and Jericho VIII/PNB turns out to be acceptable, the sketchiness of ceramic parallels between these cultures and basal Ghassul would imply that the Jordan River delta was an effective barrier to significant east/west communications in the earliest settled phases at Ghassul.[3]

In the Middle or "pre-Classic" Ghassulian phases, it may well be possible to relate Gilead's Negevite "Besoran phase" to the substantial "Middle phase" occupation at Ghassul, although specific parallels are absent. There are a number of ceramic associations between Tell Tsaf (GOPHNA and SADEH 1988/89), Kataret es-Samra (LEONARD 1989) and Ghrubba (MELLAART 1956, LEONARD 1992), and the Middle phase occupation at Ghassul. However, whilst this might suggest a growing association between south Jordan Valley and Zarqa sites in the Middle Chalcolithic, links with the more northerly of the central Jordan Valley sites are rare. Recent ^{14}C assays from Shuna make it likely that the recently excavated Chalcolithic material from Shuna (and perhaps elements of the Abu Habil and Saidiyeh Chalcolithic) is contemporary with Middle phase Ghassul, but the dearth of specific cultural parallels may reflect the essentially separate developments of the north-central and south Jordan Valley Middle Chalcolithic cultures.[4]

Exactly how the Wadi Rabah culture might fit into this picture remains unclear due to the still poorly understood development and overall span of that culture. A loose association between Wadi Rabah ceramic types and Jericho VIII/PNB assemblages would now appear to be accepted, but the degree of contemporaneity is still at issue. The direct association of basal Ghassul and Jericho VIII/PNB remains difficult to demonstrate, making the significance of (albeit rare) burnished cera-

1 Although beyond the scope of this paper, it is worth noting that both Hennessy's well contexted Sanctuary A dates, and (less-assuredly) the assays obtained by Lee and Neef, whilst drawn from Classic Ghassulian strata, do not sample either the earliest Classic Ghassulian strata in Area A, or what we believe to be the latest stratified material on the site, drawn from the Area G "pit phase". Thus, the Classic Ghassulian sequence at Ghassul may begin earlier than present dates indicate, and occupation is likely to continue for some time after the latest dated sample, suggesting that Ghassul may be occupied into what Joffeeand Dessel term the "Terminal Chalcolithic".

2 Gilead and Alon (1988) and Gilead (1990) for the three-phase sequence for the Negevite Chalcolithic; Hennessy (1989) for the three-phase sequence at Ghassul.

3 Goren (1990) for the suggestion that basal Ghassul may be equated with the Qatifian, and for the suggestion that a Qatifian variant may succeed the classic Wadi Rabah assemblage; Joffee (1993), further to this. There is nothing in the basal Ghassul assemblage that would suggest a close relationship with the Qatifian, and the Ghassul ^{14}C dates would seem to deny close association. The vexed question of the relationship (if any) between the basal Ghassul assemblage and the Jericho Neolithic remains at issue, exacerbated by the lacuna in Jericho ^{14}C determinations covering the Pottery Neolithic period. Even so, the detailed analyses of Garfinkel (1992a, b) and Gopher and Gophna (1993) have failed to demonstrate any convincing association between Neolithic Jericho and Ghassul. I thank Ms. J. Lovell, who is preparing a new assessment of Kenyon's Jericho material, for discussing the Jericho Neolithic with me.

4 I thank Dr. G. Phillip for discussing the Shuna Chalcolithic and the ramifications of the recently obtained ^{14}Cdates from the site; for recent work at Shuna, see Baird and Phillip (1993), for Abu Habil and Saidiyeh Tahta, see de Contenson (1960a) and Leonard (1992). The appropriate cultural affiliation of the north/central Jordan Valley Chalcolithic sites remains controversial. Elements of the Chalcolithic material from Shuna, Saidiyeh and Abu Habil have been associated with the Pottery Neolithic of Jericho, the Middle Chalcolithic of Far'ah North, the questionably contexted material from Megiddo and Beth Shan, and the Latest Chalcolithic/ProtoUrban D material from Meser (for which, see LEONARD 1992) and yet viewed as a whole, the material from these sites lacks convincing associations. It may well be that the sequences at Shuna, Abu Habil and Saidiyeh span the entire Middle/Late Chalcolithic. A more careful stratigraphic separation of material (as that currently being produced at Shuna) is likely to resolve the question of affiliations. Based on Leonard's (1992) extensive listing of parallels, it would seem reasonable to suppose that relatively isolated Middle Chalcolithic settlements give way to Late Chalcolithic ones displaying increased contacts with the outside world.

mics in the Middle phase levels at Ghassul problematic, although their existence may suggest limited contact between Rabah-associated cultures and Middle phase Ghassul.[1]

Goren's suggestion that Qatifian-associated material succeeds the Rabah phases at Teluliot Batashi, might indicate the formation of a post-Rabah regional Chalcolithic entity, and provide an acceptable precursor to the Esdraelon/north-central Jordan Valley Chalcolithic cultures. Goren's further suggestion of an association between the Qatifian and the Jordanian Arabah/Feinan Chalcolithic sites may allude to the origins of settlement in this still-obscure region, although the local south Jordan Valley/East Dead Sea PNA-associated precursors would suit as well.[2]

Conclusions

There are a number of points to emerge from a consideration of the "pre-Ghassulian" phases at Teleilat Ghassul:

1. The earliest phases (simple semi-subterranean round houses) are difficult to associate with better-known assemblages. ^{14}C data would suggest that they are not associated with the Qatifian. If one accepts Kenyon's view of a multi-phase semi-subterranean roundhouse PNA culture succeeded by an equally extensive rectilinear PNB culture, this latter displaying a number of parallels with "classic"' Wadi Rabah culture, then the obvious issue is the relationship of PNA to basal Ghassul. In the absence of ^{14}C dates from these phases at Jericho and Ghassul, artefact comparisons are paramount. Lithics are similar, but pottery is not. If Dhra' and Wadi Shu'eib are to be associated with the PNA (something more observed than demonstrated), then the PNA may turn out to be a distinctive south Jordan Valley/east Dead Sea regional assemblage. However, ceramics from basal Ghassul are not particularly similar to those from PNA Jericho. Perhaps basal Ghassul is best characterised as a tightly localised PNA-associated variant contemporary with post-Yarmoukian occupation at Wadi Shu'eib and Dhra'.
2. There is as yet no evidence for inter-regional interaction during the Early phases at Ghassul. Faunal analysis suggests sheep/goat husbandry predominating, with an important hunting component. Cattle and pig become more important and age-class changes suggest secondary products "evolution" over the period of early settlement. Botanical evidence suggests barley cultivation dominant at the outset, but a slow movement towards wheat cultivation and olive exploitation over the course of the early phases.
3. There is little association between the architectural traditions of the Early and Middle phases at Ghassul. However, there is no stratigraphic gap between the two horizons, and occupation appears to be continuous. Middle phase lithic and ceramic assemblages display some links with the Early phase assemblages, but there are many new elements. Whilst there is no particular reason to dissociate the Early phases from the Middle, the degree of difference between assemblages seems relatively marked. The sample bias towards the Middle and Late phase assemblages in comparison with the Early assemblages (approximately in a ratio of 1:7:50) councils caution, as the relatively small sample from Early phases may be giving a false impression of cultural poverty.
4. Site size increases relatively suddenly in the Middle phases of occupation, and probably achieves a 10+ hectare extent by the end of the period. Minor elements in the ceramic repertoire display links with the painted traditions of the middle Jordan Valley (Tsaf), and the Zarqa headwaters (Samra), which probably reflect gradually widening horizons. This is consistent with a small but growing inter-regional interaction. Ceramic, lithic, groundstone and bone assemblages are within a distinct tradition from the outset of the Middle phases, and key elements of the classic Ghassulian assemblage (cornets, fenestrated stands, churns, chisels and scrapers) all feature with greater frequency as the Middle phases unfold. The elaborate wall painting techniques that are so much a feature of the classic Ghassulian are evident from the early Middle phases (Hennessy Phase F/G), as are the standard building techniques that later characterise Classic Ghassulian levels.
5. Husbandry practices become more distinctive in the Middle phases, with age-class data suggesting considerable secondary-product emphasis in sheep and cattle use. The contrary is indicated with pigs, which are consumed as meat when young. Hunting is no longer important, and equids are present in small but significant numbers for the first time. Plant exploitation changes gradually throughout the period with a growing emphasis on wheat and olive cultivation. Specialist crops

[1] Garfinkel (1992a and b) for links between Rabah and Jericho VIII/PNB; Moore (1973) for the very general association between PNB Jericho and basal Ghassul. This has never been convincingly demonstrated.

[2] Goren (1990) for the analysis of the Batashi assemblages, discussed further in Joffee (1993). It would seem that this suggestion could only work if the classic Rabah assemblage from Ein al Jarba is incorrectly dated; see Goren (1990) for observations on the origins of the Feinan "Neolithic" (NAJJAR *et al.* 1990). The suggestion has little to recommend it, with the local ceramic Neolithic culture detected at Dhra' (BENNETT 1980) and Wadi Shu'eib (SIMMONS *et al.* 1989) a better candidate, as recognised by Gopher and Gophna (1993), although doubts remain as to the wisdom of subsuming what seem to be quite varied assemblages into a single "Jerichoan/Lodian" culture.

such as flax are more common. There is evidence for significant crop processing offsite, and the production and storage of olive oil on site. Wheat, olive and flax cultivation would seem to be irrigation-assisted. There is a growing diversity in crop exploitation, and some suggestion of fodder-crop production.

6. The final flowering of the Classic Ghassulian, the Late Chalcolithic period at Ghassul, sees the site achieve its 18-25 hectare maximum, with significant expansion to the northeast, east, southwest and southeast. Special function zones become more marked in the Late Chalcolithic, with the Sanctuary complex the obvious highlight. Faunal and botanical evidence is consistent with significant crop processing and generalised domestic modes concentrated to the north and east, with storage and special function zones localised in the south (sanctuary) and central (storage) areas of the site. Ceramic and lithic elements display all the hallmarks of the well-known Ghassul IV assemblage, with special function ceramics and elaborate polished and retouched lithics indicating widespread specialised activities.
7. Late Chalcolithic husbandry practices are similar to Middle phase exploitation, although a small percentage of hunted species reappear in the assemblage. The evidence for significant climatic deterioration remains controversial, and recreational hunting activity may provide a viable alternative explanation for the relatively sudden increase in hunted species. Plant husbandry practices are relatively unaltered from the Middle phases, except for an increase in olive use and a growing emphasis on the more productive forms of wheat. Significant crop processing occurs offsite, and centralised storage of processed wheat, olive and flax products occurs.
8. Heightened inter-regional interaction occurs in Late Chalcolithic times, with small quantities of imported "Cream Ware" ceramic churns, fine olivine basalt vessels, copper tools, faience beads and alabaster maceheads appearing for the first time. However, the significance of inter-regional interaction in any socio-economic transformation remains unclear. By the end of the Late Chalcolithic phases, Ghassul was in more or less regular communication with Egypt via Feinan/Arabah and Beersheba, and less certainly, in infrequent communication with the inland regions to the north and east. The effect of a growing inter-regional interaction on the development of stratified Late Chalcolithic "pre-state entities" remains controversial. What is clear is that the collapse and dissolution of "Classic Ghassulian" culture follows rapidly on from the first phase of heightened contact with the "proto-state societies" to the north and south.[1]

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[1] Whilst Yoffee (1993) was undoubtedly right to criticise Levy's too-close association of Chalcolithic social organisation with an inadequately understood Hawaiian chieftainship, it is becoming clear that the constant refrain against any form of stratified or specialised society in the Late Chalcolithic southern Levant is equally contrived. Growing archaeological evidence for wealth inequality, elaborate cult practice and differential burial mode (Levy 1995) suggest the emergence of heightened levels of socio-economic complexity. Comparison with Amratian Egypt and Ubaid Mesopotamia is entirely appropriate, revealing many similarities. That the southern Levantine trajectory departed from those of Egypt and Mesopotamia is manifest; identifying the crucial elements in this departure is one of the central issues in south Levantine Chalcolithic enquiry.

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Specialization in the Chalcolithic in the Southern Levant

Susanne Kerner

Abstract: *The definition of the Late Neolithic and Chalcolithic periods and their chronological framework need further research. One difference can be seen in the degree of specialization in the society. Specialization can be defined as a regularized and permanent production system in which consumers and producers are dependent on each other. The division of independent and attached specialists is the most important, but other divisions into types of specialization are possible by the analysis of concentration, scale/composition and intensity. Specialization in the Chalcolithic period of the Southern Levant has been stated several times. The direct evidence for specialized production of pottery and stone tools is limited, but the indirect evidence in the form of standardization and efficiency is plenty. The copper mines and several remains of production give much better direct evidence for specialization in copper production.*

Zusammenfassung: *Die spätneolithische und chalkolithische Periode sind nicht eindeutig und klar voneinander abgegrenzt. Eine solche Abgrenzung könnte eher erreicht werden, wenn nicht nur die materiellen Funde in den beiden Perioden sondern auch die soziale und politische Organisation, die religiöse und wirtschaftliche Struktur definiert würden. Eine Möglichkeit die wirtschaftliche Organisation zu beschreiben, liegt in der Feststellung des Grades an Spezialisierung in der Gesellschaft. Spezialisierung schlägt sich in der Produktion von Gütern nieder. Spezialisierung kann in erster Linie in unabhängige und abhängige Produktion unterteilt werden, andere Unterteilungen richten sich nach dem Grad der Konzentration, der Größe bzw. Zusammensetzung der Produktionseinheit und Produktionsintensität. Zahlreiche Autoren haben das Vorhandesein von Spezialisierung im Chalkolithikum in der südlichen Levante konstatiert. Es gibt aber für die großen Gruppen Keramik und Steinwerkzeuge nur wenige direkte Belege dafür. Hier sind die Beweise eher indirekt und in der Standardisierung der Produkte und der Effizienz der Produktion zu suchen. Bei Metallfunden sind sehr viel mehr direkte Belege in Form von Kupfeminen, Schlacke, Schmelztiegeln etc. für spezialisierte Produktion zu finden.*

Introduction: Cultural and Social Development in the Chalcolithic

The Late Neolithic cultures, such as the Yarmoukian or other Pottery Neolithic entities, show certain similarities: a simply-shaped but often elaborately decorated set of pottery, stone-tools made more for hunting than agriculture (which is shown, for example, by the number and kind of arrowheads: ROSEN 1987: 301), sites which are relatively small and situated in areas with a good water-supply (LEVY and ALON 1987: 81), and few signs of specialization or larger public buildings. Some 2,000 years later this picture had changed dramatically: the Early Bronze Age II/III cultures had large cities (with smaller settlements in between) with huge structures like city-walls (Bab edh Dhra), temples (Megiddo), large areas for storage (Khirbet ez-Zeraqun), and pottery produced in large quantities, with nearly standardized shapes and sizes as statistics in Bab edh-Dhra have shown (SCHAUB and RAST 1989: 234).

The criteria described above are randomly chosen to show the obviously large development between 5500 and 3500 B.C. in the area (although it can hardly compete with developments in Mesopotamia, where we see the development of pristine states). This period of time, normally called the Chalcolithic period, needs to be researched further in order to understand this rather all-embracing change better. The Chalcolithic period has neither a very clearly defined beginning nor end: the separation of Late Neolithic and Early Chalcolithic periods is rather arbitrary and needs not only a clearer material base but also a better framework for the conditions which change (*i.e.*, not only a statement such as "Dark face burnished ware is Late Neolithic," but a description of how the political, economic, organizational, *and* material subsystems of a society change). The same is true for the end of the Chalcolithic period, which still needs a sharper separation from the Early Bronze Age.

There are two groups of evidence which could be looked at for the development of cultures: 1) direct evidence, consisting of physical and archaeologically recognizable features such as site settings, settlement pattern, burial customs, pottery wares and shapes, architectural features, existence of public buildings, and use of special or imported material; and 2) indirect evidence, which can be extracted from the material culture in terms of modes of subsistence, modes of production, social and political organization, existence of specialization and state of craftsmanship.

Specialization and Craftsmanship

Definition of Specialization

Specialization and craftsmanship are just two of several points where a clearer analysis and definition of the Chalcolithic could start. They will be examined here. The first step ought to be a usable and practical definition of the term specialization, of which several already exist: " behavioral and material variety in extractive and productive activities is regulated or regularized" (RICE 1981: 220), "degree of a craft specialisation is best determined as variability in output per capita for a given product within the population sampled" (TOSI 1984: 23), "the regular, repeated provision of some commodity or service in exchange for some other" (COSTIN 1986: 328). The most complete definition comes from Costin again "specialization is a differentiated, *regularized*, permanent, and perhaps institutionalized production system in which producers *depend* on extra-household exchange relationships at least in part for their livelihood, and consumers *depend* on them for acquisition of goods they do not produce themselves" (COSTIN 1991: 4, emphasis added).

All these definitions are based on one elementary fact: a certain surplus in a given society is one *sine qua non* condition for the existence of specialists. Without the surplus to feed specialists in the time when they produce goods for others, they could not exist. But the amount of necessary surplus should not be overestimated, because it depends on the kind of specialization (full-time specialists require a different amount of surplus than part-time specialists)[1].

Types of Specialization

Specialization is not a state production is in or not, but a gradual occurrence which can be measured, among others, in the ratio between producers and consumers. One of the most obvious differences in specialization -compared to generalized production - is the efficiency and standardization which is assigned into an artefact[2]. All societies have utilitarian goods and more prestigious items[3], which need to be treated differently. Utilitarian goods are produced in large numbers and are as much standardized and efficiently produced as possible (which is true for most utilitarian pottery), while prestigious goods, which carry social meaning of importance for the society, will be manufactured much more elaborately and with more care. The very fact that they carry social information might make it necessary to produce uniqueness in them, as Pollock has shown in her research about grave goods in Susa (POLLOCK 1983). It is clear that these two groups of goods require very different production systems and very different kinds of specialization.

Earle's differentiation of attached and independent specialists has proved to be very useful and practicable (BRUMFIEL and EARLE 1987: 5). Independent specialists produce utilitarian goods for everybody in their surrounding. They might encounter competition, which is certainly a reason for greater efficiency in production, but competition should not be overestimated as an incentive in a non-market oriented society. Independent specialists are dependent on their customers (as their customers are on them). Attached specialization develops out of the need of a society's elite to produce prestige items for themselves and a small circle of followers. The specialists who make these items produce them for the elite under the control of the elite. They work under very different conditions than the independent specialists. But both kinds of specialists might well produce both kinds of goods. In smaller societies only a small amount of prestige goods is needed, so the attached potter who produces a few highly elaborate vessels during the year might produce perfectly ordinary cooking pots for the rest of the time. Or an independent specialist for metal items might be called to produce a few highly prestigious items under closely controlled circumstances. This definition of independent and attached specialists was slightly changed by Clark and Parry, who enlarged the definition of "attached" until it contained all kinds of controlled production and without the close connection to

[1] The social organization and size of the respective society is also of importance for the volume of the surplus and the amount of labour for each member of the society.

[2] The execution of public works could also fall under the definition of specialization, but this will not be dealt with here.

[3] Clark and Parry call those items hypertrophic goods, which are made in conspicuous production (CLARK and PARRY 1165:293).

a ruling elite. But they also put more emphasis on the different conditions of production for elite items and utilitarian goods.

Further divisions of specialization can be made by different means. It can be divided by size and intensity of production into household production, workshop industry, large-scale industry, etc. (VAN DER LEEUW 1977) or by a mixture of size and controlling body: household production, individual workshops, nucleated workshops, manufactory, factory, etc. (PEACOCK 1982). So far Costin has made the most complex typology of specialication, which includes context, concentration, scale (composition) and intensity of its production (COSTIN 1991: Table 1.1). The eight types of production units including individual, dispersed workshop, community, nucleated workshop, dispersed corvee, individual retainer, nucleated corvee and retainer workshop are in one of two possible states in the above mentioned categories. The production units can either be attached or independent (context), nucleated or dispersed (concentration), foreign labour or kin-based (scale/composition) and part-time or full-time (intensity). The types created by Costin are closer to prehistoric organization than those of van der Leeuw and Peacock, who tried to incorporate very differently organized societies in their models[1].

Nearly all of these theoretical thoughts and typologies have been developed for societies and material from the New World. Very little research into specialization has been done concerning the cultures of the Near East and the southern Levant in particular. In the following I would like to reflect upon a few possible lines of thought.

Southern Levant, History of Research

Since the mid-eighties there has been a growing number of articles that all express the assumption that the Chalcolithic period was in some way or other characterized by specialization. The following is certainly not a complete list, but it tries to give an overview of different materials and artefacts. Specialization is assumed for different fields such as stone working: "However, the basalt industry ventured very soon upon its own independent line of development, as demonstrated by the variations of the legged bowls, so we may also assume the existence of specialized workshops ..." (AMIRAN and PORAT 184: 13). "There are good reasons for believing that these vessels represent prestige items, products of a specialized industry." (PHILIP and WILLIAMS-THORPE 1991: 51). It is also presumed for ivory objects: " .. they fit easily into the growing evidence for a specialist craft of ivory working in the Chalcolithic settlements of the Beersheba region." (MOOREY 1988: 182).

The hypotheses also go further to a general level of specialization: "The emergence of phosphorite artifacts in the southern Levant during the 4th millennium B.C. joins other aspects of craft specialization, amongst which metallurgy, ivory and basalt workmanship are best known." (GOREN 1991: 109); "Die Metallverarbeitung, die Herstellung und zunehmende Formenvielfalt der Gefäße und die Bearbeitung von Elfenbein deuten auf die Existenz von Spezialisten hin" (KERNER 1995:76).

But it was Levy who cultivated the idea of specialization as a characteristic of the Chalcolithic period. "Innovations in craft specialization are some of the hallmarks of the Chalcolithic period in Palestine." (LEVY 1994: 2 34); "The transition from egalitarian to chiefdom societies in Palestine can be clearly seen with the emergence of a wide range of craft specialization." (LEVY 1986: 89). Much less outspoken are Gilead and Goren: "Such a limitation could not support full-time professional potters in each area, and pottery making was probably only a part-time profession with a possible production of some vessels in the households for domestic use (GILEAD and GOREN 1989: 12).

All authors agree about the existence of specialization, but only a few authors have been more specific about the development, execution and characteristics of specialization (LEVY and SHALEV 1988: 363, ROSEN 1987). So in order to do more than just state the fact, two approaches are possible: 1) a more detailed list of the direct evidence which is available for the different crafts should be compiled and 2) a more detailed analysis of indirect evidence as outlined above should be executed. The main focus of the following will be on pottery.

Material Evidence

Pottery

Direct evidence for production and specialization of pottery could comprise wasters, firing installations (pits, kilns), scrapers, raw material (unworked clay, pigments) or stores with finished products. None of these have been reported[2].

Indirect evidence on the other hand is plentiful. Indirect evidence for specialization is growing efficiency and standardization. For pottery this could mean standardized shapes, surface treatment,

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1 Roman pottery production centers are hardly compatible to most prehistoric production units.

2 I would like to make it very clear that in my opinion this lack of reported direct evidence does not mean that there is no evidence, but only points towards omissions in older excavation reports and limitations of small scale excavations.

decoration, better quality of ware and form. But to have really indisputable results about the change in surface treatment, decoration, and general work which got invested in the production of a particular kind of ware, it would be necessary to count the treatment of either the entire pottery assemblage of a site or a statistically relevant section. Unfortunately, this is still not the case in most projects and has certainly not been in the majority of the earlier excavations. So we are only left with trends and tendencies.

The pottery in the Late Neolithic cultures is rather time-consumingly, often elaborately decorated and has relatively few shapes. The regional differentiation seems to be considerable (BOURKE *et al.* 1995: 36). Yarmoukian pottery is often painted *and* incised or slipped and incised (GARFINKEL 1992, KAFAFI 1993). In Munhata 2b 12.8% of the *entire* Late Neolithic pottery is decorated (Table. 1). The decoration consists nearly half of incision (herringbone design and others), 20% of painting, and less than 40% is slipped (GARFINKEL 1992: 319). In the Early Chalcolithic period (Munhata 2a) the percentage of decorated pottery is halved to 6.2%, and while most of the decoration consists of slips (over 80%), only 3.2% are incised and less than 1% painted (GARFINKEL 1992: 324). Slip should be considered primarily as a functional phenomenon and only secondarily as an aesthetic one.

Late Chalcolithic pottery shows a different pattern. Some of the shapes are highly specialized such as churns, cornets, and fenestrated bowls and chalices, all these having developed during the earlier Chalcolithic periods[1] and end with the Chalcolithic period. It is still very difficult to identify the function of these particular vessels, but it is generally assumed that churns imitate goat-stomachs and were used to produce butter (FOX 1995). This interpretation leaves the question about the decoration of these vessels open and it also does not explain the uneven distribution of churns in different sites.

Table 1. Munhata. Percentage of different kinds of decoration is given for decorated pottery = 100%.

	Decorated (total)	Incised (%)	Combed (%)	Painted (%)	Slipped (%)
Munhata 2b	12.8%	43.4	0.0	17.9	38.6
Munhata 2a	6.2%	3.2	8.3	0.4	86.4

But together with these highly specialized items exists a wide range of less dramatic but nevertheless specifically made shapes. The "real" holemouth jars, holemouth jars with large flaring rims, jars with necks and outflaring rims, large storage jars, small cups, small V-shaped bowls, and large V-shaped bowls. The whole functional range is there: individual, storage, and drinking vessels, cooking-vessels, production and transportation vessels. The pottery is surprisingly similarly made, the overwhelming majority were made from similar wares and the difference is only between a finer and a coarser version[2]. The shapes of V-shaped bowls in Pella and Tuleilat Ghassul are nearly identical, but the Pella bowls were made from a buff ware, while the Ghassul bowls were produced in a slightly harder reddish ware. In Ghassul the percentage of the red ware grows continuously towards the Late Chalcolithic period[3]. Despite this overall similarity, chemical analysis has shown that mostly local materials were used for the pottery production. The important notion is that pottery was produced on site from locally available material but shaped and decorated in an overall set of parameters. It is interesting to note that some sites have imported and locally made pottery (GILEAD and GOREN 1989: 7). While most sites have only one or two petrographic groups of pottery, Gilat and Ein Gedi have several different variants of pottery from different regions[4].

The decoration on late Chalcolithic pottery consists of painting, incisions and applications with the amount of decoration decreasing through time, but the picture is not uniform. Only very little information is published about the percentage of decorated material in the different assemblages. One of the few exceptions are the publications of Abu Matar and Bir Safadi (COMMENGE-PELLERINE 1987, 1990), but even here the analyst had to deal with a rather thinned-out pottery scope, which produce a much higher percentage of decoration than the entire pottery population would have shown. Only 18% of the pottery from Abu Matar and 36% from Safadi were kept and could be analyzed by Commenge-Pellerine. It is not explicit what the criteria of the choice for keeping were, but the information available points strongly towards a choice of rims, handles and bases to be kept and bodysherds to be thrown. This would unbalance the amount of decorated pottery greatly, because painting, applications and incisions on Chalcolithic pottery all tend to be just below the rim and around the handles. This is very obvious when the amount of decorated complete vessels from each

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1 Churns have been found in the middle levels of Abu Hamid (DOLLFUS and KAFAFI 1993: 248), fenestrated vessels are in the earliest Chalcolithic levels in Munhata 2a (Rabah).

2 So reported in Shiqmim, Pella and Abu Snesleh (LEVY and MENAHEM 1987: 320, MCNICOLL *et al.* 1982: 31, KERNER n.d.). The reports for Abu Matar and Bir Safadi contain five wares: two buff and two red wares as well as a cream ware, which needs to be treated separately.

3 Reported by Jamie Lovell during the Workshop on the 5th and 4th mill. B.C. in Jordan (Irbid, March 1996).

4 Gilat has locally made pottery and vessels most probably from Jordan (Dead Sea region), the Shepelah and Egypt.

site is compared with the amount of decorated sherds in the kept sherds from the same site: the complete vessels show a higher percentage of decoration (table 2). In order to get a percentage of decorated pottery for the entire assemblage, one needs to include the discarded pottery too. The pottery thrown away most probably included very little decorated material (see above), and it is here assumed to have not been more than 10%. If this assumption is correct, then the percentage of decorated pottery for the entire Safadi assemblage would be 19,8% and for Abu Matar 18% (Matar-all and Safadi-all in Table 2).

Other sites where information is available include Abu Snesleh, where less than 5% of the Chalcolithic pottery is painted (KERNER n.d.), and the Pella material from Jebel Sartaba which is similarly sparsely decorated. Most other sites yield only little information about the amount of painted pottery. The report of the first excavations in Tuleilat Ghassul reveals only that 200 pieces of pottery were painted, which should be less than 5%[1], but Hennessy's excavation showed that "Painted wares are very common in Phases A-B, less common in C-D and not present at all in the two lowest building phases." (HENNESSY 1969: 7). The pottery from Abu Hamid shows a similar tendency to the one described above, with more complicated decorations in the earlier levels (DOLLFUS and KAFAFI 1993)[2].

Table 2. Decorated pottery in Beersheba sites <* = *types of decoration as percentage of all decorated pottery; # = estimates*>.

Treatment	Matar Vessels	Matar Sherds	Matar All	Safadi Vessels	Safadi Sherds	Safadi All
	n = 257	n = 2,595	n= 15,193	n = 4,507	n = 22,736	n = 87,476
Undecorated	30.1	43.2	82.0#	47.3	52.3	80.2#
Decorated	69.9	56.8	18.0#	52.7	47.7	19.8#
Painted	55.2	42.2		44.8	38.2	
Painted*	77.6	74.2		86.5	77.6	
Reserved slip	1.1	0.8		0.3	0.7	
Reserved slip*	1.6	1.4		0.6	1.4	
Relief	8.2	8.6		4.6	6.5	
Relief*	11.5	15.1		8.8	13.2	
Relief and paint	5.4	5.2		2.0	3.8	
Relief and paint*	7.6	9.2		4.0	7.7	

But it is not only the amount of decoration that is important for the interpretation, it is also the kind of decoration. Specialization is a process of standardization and growing efficiency; in connection with pottery decoration, standardization can be measured by the variability of decoration and efficiency by the labour input necessary for the decoration. The necessary labour can be measured in gestures (HAGSTRUM 1985: 65). Each part of a design requires a gesture, therefore a structurally highly complicated design needs much more labour per vessel than a simple band of paint along the rim. There is a strong tendency towards less complicated designs in the Chalcolithic material compared with Neolithic material. So even if a growing percentage of vessels were painted with a simple band along the rim, the pottery is much more standardized and can be more efficiently produced than vessels which are first incised in different designs, then painted and finally polished.

The development goes from Munhata 2b with 12,8% of complicated decorated pottery to Munhata 2a with 6,2% and then proceeds to significantly less complicated decorated pottery in Abu Matar and Bir Safadi with under 20% and Abu Snesleh with less than 5% of the pottery being decorated. The information about Tuleilat Ghassul and Pella is so far not uniform.

Although hardly any information at all is available about direct evidence for specialization in pottery production, indirect evidence of more standardization and efficiency in the production process points towards specialized production. The large amount of common pottery would certainly be produced by independent specialists.

Stone Tools

Recently a lot of work has been done concerning the production and distribution of lithics or ground stone tools. Direct evidence for stone tool production includes hammer stones, flakers and punches, large amounts of finished products and debris such as blanks, cores and waste. It is difficult to establish the character of the stone tool production, because large amounts of only a few tools (a tool kit) could point towards the manufacturing of goods for which these particular stone tools are

[1] The report does not give exact figures concerning the pottery (MALLON *et al.* 1934: 124). Neuville declared the majority of the pottery to be decorated (MALLON *et al.* 1934: 113), but he defined decoration here mainly as slip or wash.

[2] It will be very interesting to see the final results from the new excavations at Tuleilat Ghassul and particularly from Abu Hamid, which should prove to be a key site for the development.

necessary -and not towards the manufacturing of the stone tools. Other tool frequencies are influenced by the subsistence mode of a site. Bearing this restriction in mind, examples for manufacturing fan-scrapers could be attested in Wadi Gaza A and Har Qeren 15 (ROSEN 1983, ROSHWALB 1981: 39).

Instead of actual workshops for lithic production, it might be again indirect evidence in the form of tool and debitage patterns, which help to establish specialization. Rosen divides the Chalcolithic sites of the Negev in two categories "1) occupation sites where a wide range of activities took place, and specialized technologies and tool types from only medium to low proportions of the lithic assemblage and 2) smaller, specialized function sites, whose lithic assemblages seem to reflect a more limited range of activities, with greater emphasis on specialized and sophisticated technologies". (ROSEN 1987: 298). He defines flake tools such as scrapers, borers, notches, denticulates and retouched flakes as typical for general domestic use, while bifacial tools, sickles, tabular scrapers, drills, and bladelet tools (microborers) stand for specialized work. Tools for domestic use were found in Horvat Beter, Shiqmim and Wadi Gaza O, while Wadi Gaza M, possibly Wadi Gaza B, Tuleilat Ghassul, Grar and sites in the northern Sinai have higher proportions of microborers[1] (GILEAD 1984: 8, 1989: 385; ROSEN 1987: 298) compared to the sites in the Beersheba valley.

Another promising idea might be the material analysis for specific flint tools, which so far has only been done to a very limited amount (GILEAD 1984: 9, ROSEN 1983). It shows that particularly tabular scrapers are imported to most sites. This cursory overview of flint tool production indicates a definite unbalance in tool distribution in different sites, but little has been proved concerning specialized production of specific tools.

Even less is known about the production of ground stone. Basalt vessels and fenestrated bowls, which could be prestigious items, and basalt tools (utilitarian items) are found in literally all Chalcolithic sites, including small sites like Abu Snesleh (LEHMANN *et al.* 1991) and in surface collections from Sinai and the Golan. If the bowls are prestigious items it is noteworthy that they appear everywhere[2]. The various source analyses of basalt (AMIRAN and PORAT 1984, PHILIP and WILLIAMS-THORPE 1993, WRIGHT *et al.* n.d.) are one way towards a greater knowledge of the means of production. But all analyses so far have been made from basalt bowls, none from basalt tools (grinders, pounders etc.). It would be very interesting to see if the sources for utilitarian items and prestigious items are the same.

But since Perrot reported that there were very few signs of on-site production of basalt vessels in Abu Matar (PERROT 1955: 78), not much more has been found. Now scanty remains of basalt chipping have been found in Abu Hamid (WRIGHT *et al.* n.d.), which could prove at least the finishing of basalt items on-site. It is presumed that basalt was transported there from its sources on the highland during the annual cycle of pastoralism (DOLLFUS and KAFAFI 1993: 246, WRIGHT *et al.* n.d.). It seems to be clear that prestigious items are not always made from the nearest basalt source (PHILIP and WILLIAMS-THORPE 1993), and for several sites, such as the Beersheba valley sites, sources are far away in Jordan or the Galilean hills (AMIRAN and PORAT 1984).

The limited evidence of the production of basalt items and the fact that several sites needed to procure their basalt products from far-away sources leads to the assumption that some sites closer to profitable basalt sources (around Kerak, in northern Jordan or less probably Wadi Dana[3]) might have specialized in basalt products[4].

Other research documented that some of the basalt vessels are actually made from phosphorite. These phosphorite vessels, which look remarkably similar to basalt items, were found only in a very limited range of sites, mainly in the Judean desert and a few sites in the Negev (GILEAD and GOREN 1989). Goren interprets them as imitations of basalt vessels in a region where basalt was probably expensive or difficult to obtain (GOREN 1991: 108).

Metal and Other Valuables

The implications of metalwork and religious art are in themselves so important and multi-layered that I will only mention them here without a comprehensive discussion. The objects of Chalcolithic art are of great interest: it is not only the use of imported and expensive material such as gold, silver and ivory, it is also the craftsmanship behind the objects that is remarkable. The precious metals were mainly worked into ingots (GOPHER *et al.* 1990), but copper was shaped into household items as well as into highly prestigious goods like those from the hoard find in Nahal Mishmar (BAR-

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1 Site M also contains beads and raw material for beads, it is therefore not clear which product was made (see above).

2 This overall appearance sets them apart from the basalt pillar figures, which are only known from the Golan and the immediate vicinity.

3 The Early Bronze Age vessels from Wadi Feinan were not manufactured from the basalt in Wadi Dana (PHILIP and WILLIAMS-THORPE 1993: 59).

4 See Muller about the difference between specialist and site specialization (MULLER 1984).

ADON 1980). It seems that there is a clear division between the production of tools on one side and prestigious items like maceheads, standards, and "crowns" on the other side. The tools were made from native copper and produced in an open mould and further shaped by annealing and hammering; the prestigious items were most probably made in "lost wax" moulds and consist of an alloy of arsenic copper (LEVY and SHALEV 1989: 358). Therefore, in the production of copper and basalt the same pattern is recognizable: both materials were treated according to needs, everyday items were made sufficiently well from locally available material, while more prestigious items were produced from - at least regionally - imported material using much better workmanship[1].

The direct evidence for metal production is much more substantial than for most other products. Metal ore, slags, crucibles and stone tools have been found in several sites (PERROT 1955: 79, LEVY and SHALEV 1987: 358, ADAMS and GENZ 1995), and the mines in Timna and Wadi Feinan contained the raw material.

Other groups of finds offer different perspectives. Neither the modes of production nor the meaning of the basalt pillar figures and stands from the Golan, the Huleh Valley and northern Jordan are completely clear (although see EPSTEIN 1975). Do they have a similar function in the north as for the mostly animal pottery figures in the south? Could it possibly be that basalt stands are religious items in individual households, while the pottery figures (*e.g.*, from Abu Hamid or Gilat) come from larger cities, which might have a more centralized cult, or is this just another regional difference?

Summary

Specialization can take on many forms; it can be very differently organized and the organization is largely dependent on the products. In the Chalcolithic period in the southern Levant the organization of the production of pottery, stone tools, basalt items and finds made of precious material all show a tendency towards specialization although on a low level, often only recognizable in either the marvelous workmanship of prestigious items or the standardization and efficiency of the utilitarian products. The four parameters of specialization (context, concentration, scale and intensity) all need further clarification. And in order to postulate different stages of specialization, compatible units need to be contrasted with each other (households or quarters or sites). Different parts of the society were differently organized, so not all items will have been produced under the same conditions. And the large regional differences in the Chalcolithic cultures might also have left traces here. But some degree of specialization is certain, and together with the evidence of trade (ivory and arsenic copper) and the necessary production of surplus for specialists, the basis is there to assume that Chalcolithic cultures were complex societies.

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[1] For a similar assumption see PHILIP and WILLIAMS-THORPE 1993: 61.

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Rock Rings: a Preliminary Report on Chalcolithic and EB I Settlement in the Wadi Hasa Drainage, West-Central Jordan

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Abstract: *This chapter is a preliminary analysis of the evidence for Chalcolithic and Early Bronze I settlement in the eastern third of the Wadi el-Hasa, west-central Jordan. A consideration of the chronological and typological difficulties encountered in distinguishing Chalcolithic and Early Bronze Age components is followed by an analysis of the spatial distribution of sites in the area. Artifactual and architectural site characteristics are presented and briefly compared with those of other penecontemporaneous south and central Levantine sites. It is tentatively suggested that Chalcolithic occupation in this environmentally marginal zone was concentrated along the arable floodplains of the Hasa and its major northern and southern tributaries, and that a shift toward a more transhumant adaption occurred during the EB I.*

Introduction

This study is a preliminary overview of the evidence for Chalcolithic and Early Bronze I settlement in the Wadi Hasa basin. The sample consists of 58 sites located by MacDonald's survey of the south bank (WHS) and 25 sites located so far by the ongoing North Bank Survey (MACDONALD 1988, CLARK *et al.* 1994). The following discussion will focus on the north bank sites for which complete data sets are available. Because the south bank ceramic and lithic collections were not available for analysis, discussion of these sites is limited to general location and temporal affiliation.

The Wadi Hasa North Bank Survey (WHNBS) has to the present time covered a total of about 48 km^2. In general the project attempts a full coverage survey of the Wadi Hasa and its northern tributary drainages. The WHNBS data set consists of site locational data, detailed site maps, and non-systematic surface collections. For a full discussion of the survey methodology and a general overview of survey results through the 1993 field season, see Clark *et al.* (1992, 1994).

For the purposes of this study, the topography of the survey area can be divided into three strata: (1) upland plateaux and hilltops, (2) fluvial terraces and (3) valley floors. Annual rainfall in the project area varies by elevation, from 200mm/year at the valley bottoms to 400mm/year on the plateau (FULMER 1989: 30-32). Although precipitation is sufficient to support numerous perennial springs in the higher western half of the drainage, permanent springs are much less common in the eastern Hasa, being confined to isolated locales near the confluence of major drainages. It is likely that springs were more numerous at certain intervals in the past, especially at higher elevations, although the distribution of these critical resources is presently only partially known (DONAHUE and BEYNON 1988, SCHULDENREIN and CLARK 1994).

Pottery from the WHNBS survey was originally classified by three project researchers at the conclusion of the 1992 and 1993 field seasons. Because of the known chronological difficulties with distinguishing Chalcolithic, Chalcolithic/EB I and EB I sherds in this region (ROTHENBURG and GLASS 1992: 145), the samples were also sent to an independent researcher for control purposes. The results of this comparison were discouraging in that the two classifications disagreed over 50% of the time, although there was general consensus on the broad temporal placement of the samples. The ambiguity surrounding the classification of Chalcolithic and Early Bronze I material outside of well-defined contexts is itself informative. Above all, it suggests a strong degree of cultural continuity between the two periods. As noted by Hanbury-Tenison (1986: 204), dramatic discontinuities in material culture patterns only occur with the advent of walled towns in EB II.

A more general problem with establishing a comprehensive ceramic chronology for this time range arises from the diversity of the ceramic material both within and between regions. Generally speaking, the Chalcolithic is notable for a much greater degree of regional diversity than is typical of earlier periods (LEVY 1986: 87). The traditional and unfortunate reliance on 'fossil types' for chronological purposes has only complicated the issue. Joffe (1993: 35) noted that

> "the overall consistency of the Chalcolithic material culture throughout the southern Levant has generally been minimized and stress has been laid on the presence or absence of certain fossil types . . . in the various regional assemblages. This variability should be regarded as evidence of the high degree of regionalism, rather than an expression of either chronology or relative levels of development."

This diversity has made it difficult to assemble a comprehensive ceramic chronology in many regions. In the Arabah and Sinai "locally developed, discrete ceramic and lithic traditions" made it easier to establish a chronological framework for the Chalcolithic and EB I because linked changes in metallurgical technology allowed for some independence from traditional artifact typologies (ROTHENBURG and GLASS 1992: 144). With the metallurgical center of Timna (Wadi Arabah) in such close proximity, it is difficult to imagine that local groups would have had inadequate pyrotechnology for ceramic production. Although some researchers have discovered trade wares from Arad in the Arabah, the local inhabitants of the area probably made most of their everyday ceramics themselves. If this were the case, the resulting ceramic typologies should be considerably more complex than those from areas with centralized production facilities.

Another chronological difficulty encountered in this analysis was that of extremely low artifact counts. Many architectural sites located by the WHNBS had absolutely no diagnostic surface artifacts whatsoever, and those that did often produced very small samples. Although sites were not generally systematically sampled, in many cases the grab sample included *all* artifacts that could be found in association with the sites. The aggregate effect of these problems makes it difficult to infer how representative our samples are, and renders our conclusions tenuous. In this paper, material from both Chalcolithic and Early Bronze I will be considered to represent a general Chalcolithic/EB I horizon. The primary temporal assignments for the WHNBS data are based on the second ceramic classification, which appears to be internally consistent. The analysis of south bank materials uses original data published in MacDonald (1988). Unfortunately, we have no way to ensure that the north and south bank classifications correspond.

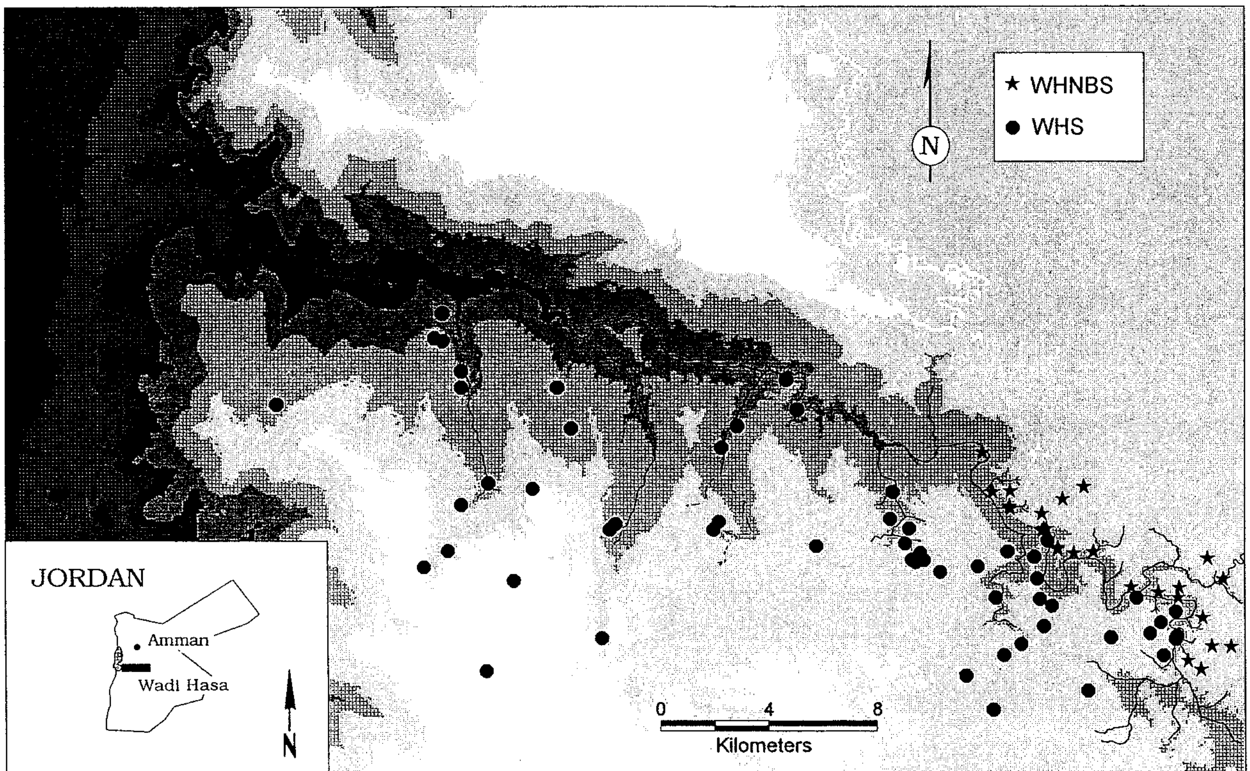

Fig.1. Chalcolithic and Early Bronze Age sites in the Wadi al Hasa.

Site locations were taken from original field maps and published reports (MACDONALD 1988, CLARK *et al.* 1994); site locations from this temporal horizon are presented in Fig. 1. Chalcolithic and EB I sites are relatively sparse throughout but increase in density in the eastern third of the drainage. Because the north bank survey has yet to match the areal coverage of the south bank survey, the true range of site distribution in the lower Wadi Hasa is as yet unknown. Consequently, our analysis will concentrate on what MacDonald refers to as the "eastern sample universe". Fig. 2 illustrates the locations of these sites, along with their associated ceramic proportions. Total ceramic counts for the north bank sites are presented in Table 1. Sites 125, 133 and 188 had no diagnostic ceramics, but they were associated with tabular flint scrapers, an artifact type supposedly linked to Chalcolithic and/or Early Bronze occupation (DOLLFUS *et al.* 1988). These sites have therefore been included in the analysis.

Table 1. Ceramic counts by period.

Site #	Cal.	C/EB I	EB I
57		57	
65			2
72		2	
74			3
180			11
199	2		1
209			3
329	1		2
342			18
366	1		
368			7

Site #	Cal.	C/EB I	EB I
385			2
396			10
399			37
434		1	13
467		1	1
479			7
493	2		7
505			2
511			3
513			3
527			2

Site Distribution

Most of the sites identified as Chalcolithic by the Wadi Hasa Survey were located in the drainages of the Wadis Ali and Ja'is (MACDONALD 1988), while the majority of the WHNBS occupations were situated along the Wadi Hasa proper and the adjoining lowland terrace formations of the eastern drainage. When taken together, the north and south bank sites appear to be arrayed into three loosely defined clusters distributed from west to east (Fig. 2). The westernmost group includes four purely Chalcolithic assemblages and falls along the lower courses of the Wadi Ali. The second group (those clustered around the Wadi Ja'is), dominated by EB I occupations, is concentrated near the confluence of the Wadi Ahmar and the Wadi Hasa. The distribution of some of these sites within this group is unusual, appearing to form a regular linear arrangement (*c.* 0,5km apart) on the uplands south of the Hasa and east of the Wadi Ahmar. Reasons for this arrangement are speculative, but it may be linked to a well-known traditional caravan route across the Wadi Hasa basin. The easternmost "site cluster" is also dominated by EB I pottery and forms a dispersed scatter across the terraces and tributary drainages of the upper Hasa.

It is clear that the general occupation density of the Wadi al-Hasa during the Chalcolithic and EB I periods was quite sparse, and it seems to have been concentrated in the eastern third of the drainage. The site distributions are heavily biased towards valley bottoms and lower terraces with a smaller set of occupations lying along upland ridges and plateaux. Taking the temporal assignments at face value, the proportional representation of sites from each period would seem to substantiate Joffe's claim (1993: 43) that settlement expanded greatly in this region during EB I.

Lithics

The longevity and intensity of human occupation of the landscape surrounding the Wadi Hasa has insured that all of the lithic samples are palimpsests of many different periods and reduction strategies. Excluding the obvious Middle and Upper Pleistocene "background" scatters common to these assemblages, the remaining WHNBS lithic materials from Chalcolithic and EB I site locations are dominated by what can be described as "expedient" reduction strategies. Well over 90% of the potentially "late" debitage was struck from multiplatform, multidirectional "polymorphic" flake cores. A small number of blades and bladelets are also represented in the sample, but in densities too low to be of analytical value.

The fact that few of what are traditionally considered "diagnostic elements" occur on these sites is unremarkable due to the ephemeral nature of the occupations and low overall artifact densities. In contrast to the late Paleolithic and Neolithic periods, Chalcolithic and EB I occupations left behind little evidence of intensive lithic exploitation or formal tool production. This pattern reflects a now

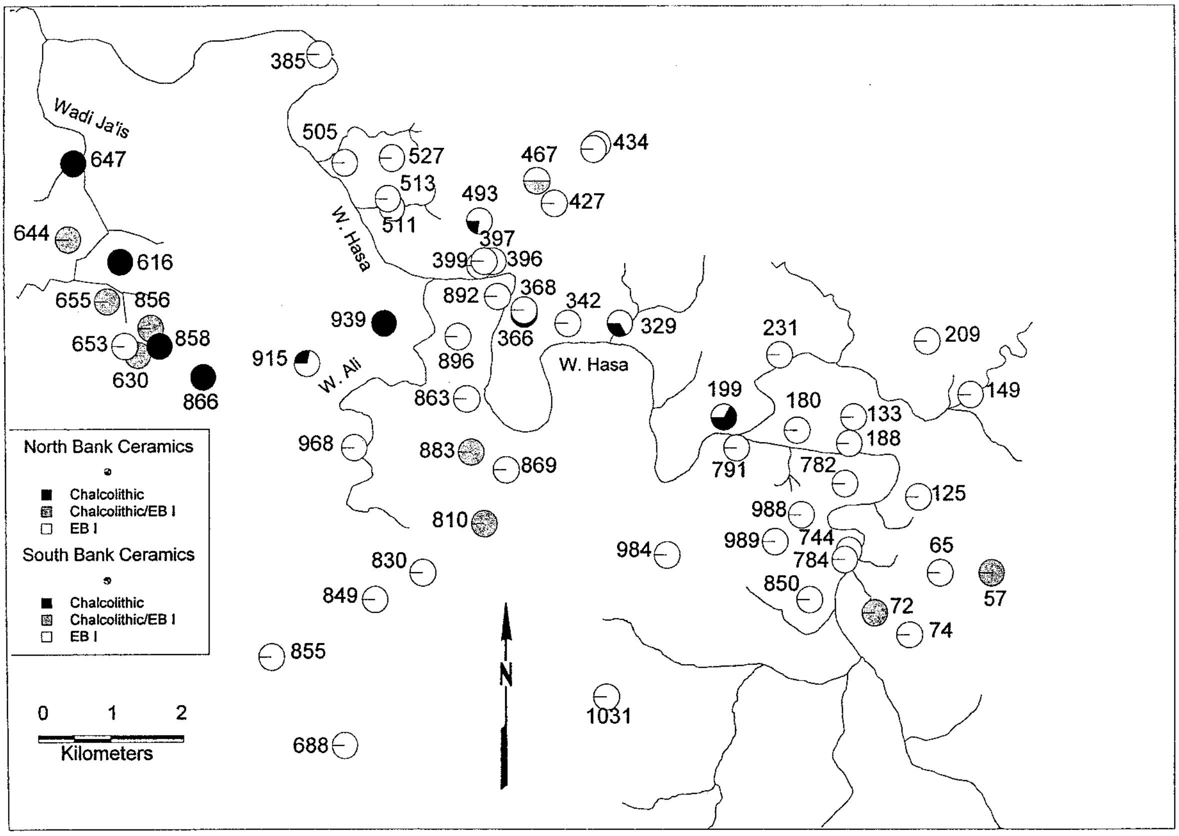

Fig. 2. East universe sites by ceramics.

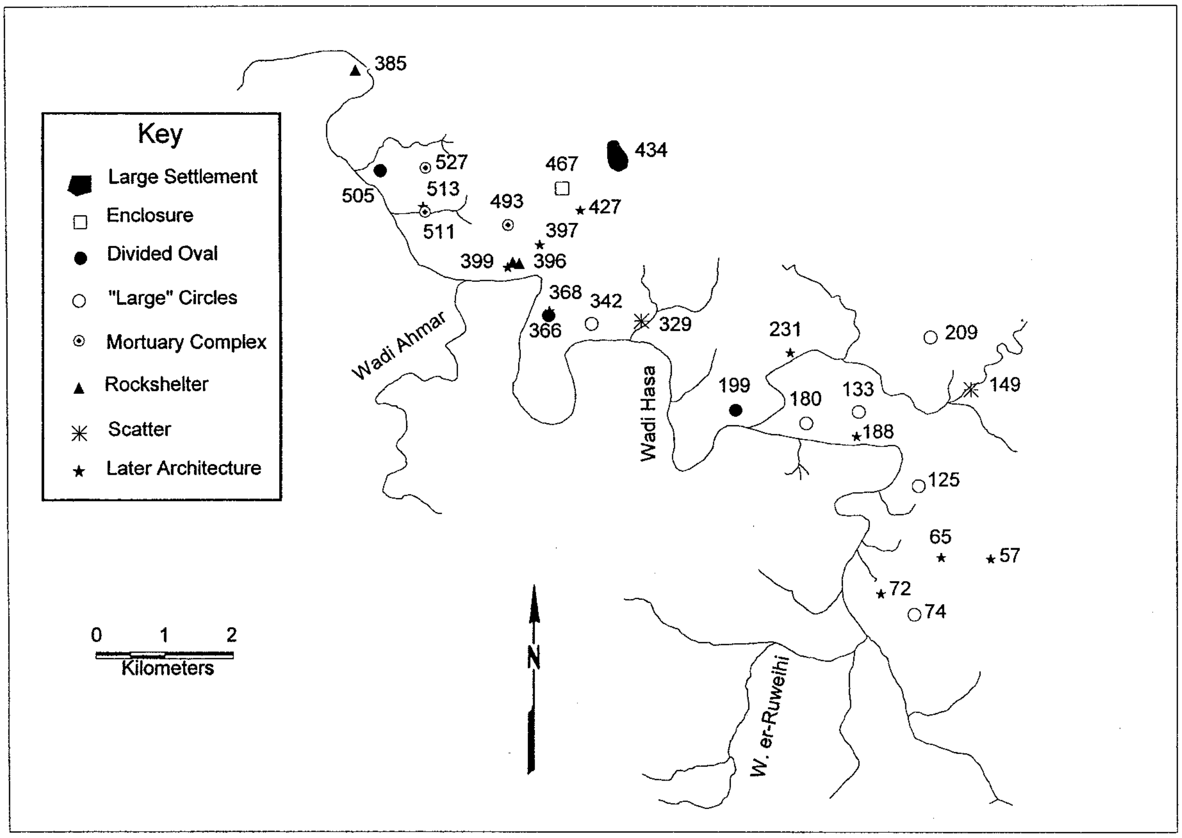

Fig. 3. Site classifications.

well-documented trend towards declining lithic density and typological diversity in post-Neolithic assemblages throughout the Levant (ROSEN 1996: 138). Despite the presence of numerous exposures of moderate to high quality chert in the eastern Hasa, there appears to be no evidence for the development of large blade technologies analogous to the "Proto-Canaanean" elements appearing in contemporaneous (?) Negev sites (ROWAN and LEVY 1994).

As previously noted, three sites contained artifacts traditionally thought to be "typical" of the Chalcolithic and EB I periods. Artifacts generally described as tabular scrapers were recovered from Sites 125, 133 and 188, none of which appeared to have corresponding architectural elements. These artifacts were manufactured on large, generally ovoid, cortical flakes with very flat bilateral sections. The flake blanks were marginally retouched on the dorsal surface with irregular squamosal percussion and pressure flakes. The working edges are uniform and have generally steep profiles. At least one of the artifacts displays edge crushing and unidirectional step fractures, suggesting heavy scraping use on a moderately yielding substrate. Other use-traces are more ephemeral, and in one case they seem to be consistent with the cutting and scraping of relatively soft materials. Although crude, these observations are generally consistent with the broad range of use-patterns observed by Rowan and Levy (1991) on tabular scrapers from the northern Negev site of Shiqmim.

The characteristics of blanks used in the manufacture of these tabular scrapers suggests that they were struck from a well-prepared platform on large chert nodules using direct hard hammer percussion. The chert in the three WHNBS scrapers is of excellent quality, suggesting that these artifacts might very well be secondary products from an unrelated manufacturing process dependent on careful material selection criteria. Chert nodules of the requisite dimensions of these flakes may occur in the Wadi Hasa, but they have not been observed to date and are likely to have been quite limited in their exposure. In any case these artifacts were not manufactured on-site and no appropriate reduction locales were found within the survey area, facts that support Rosen's contention that these artifacts were important regional trade items (ROSEN 1989: 202).

The reduction techniques reflected in the single exhausted bi-directional bladelet core recovered from Site 133 are also consistent with a Chalcolithic and EB I lithic assemblage. Interestingly, very few bladelets were recovered from the surface of this or any other Chalcolithic/EB I sites in the project area. Even if the effects of sampling bias are taken into account, it appears certain that bladelet technologies, although present, were secondary to the production and use of flake-based tools in all of these assemblages.

Because of small sample sizes and the impossibility of separating out elements belonging to later components, a careful analysis and examination of the lithic finds at these sites was not undertaken. However, some general statements can be made about the activities at these sites based upon these samples. The lithic industries of all the post-Neolithic sites in the eastern Hasa drainage appear to be dominated by flake-based industries utilizing locally available chert resources. Retouched tools are present at most of the Chalcolithic/EB I sites in the eastern Hasa, and they consist primarily of burins and edge-modified flakes. Unfortunately, the poor edge preservation of most of the surface finds made the assessment of tool and debitage use impractical, but it is very likely that simple flakes make up the bulk of the lithic tool kits at these small sites.

Aside from a small number of scattered bladelets and bladelet core fragments, there is little indication of specialized lithic production strategies or the manufacture of blade-based tool forms. No microliths, sickle blades, projectile points, or indicators of Caananean blade technology were recovered from any of the Chalcolithic/EB I sites in the WHNBS. The picture that emerges is one of short-term occupations that were definitely not dominated by activities that required the production and maintenance of extensive lithic tool kits. The paucity of compound tool elements and the complete absence of artifacts exhibiting sickle sheen in this sample might suggest that these locales were not associated with long term use by sedentary agriculturalists, but instead represent seasonal or even temporary residences of primarily pastoral or pastoral/horticultural groups. Needless to say, the interpretations are largely speculative in default of excavations or more thorough sampling at these sites.

Architectural Remains

Because of an incomplete WHS data set, it was only possible to analyze north bank architectural features. Although preservation of architectural features appears to be generally good, most sites in the Wadi Hasa project area were reoccupied during later periods. Without test excavations, it is difficult to ascribe dates to given structures. This problem is compounded by the persistence of some common architectural forms throughout the millennia. Although the chronological placement of several architectural forms (*e.g.*, circular domestic structures and tombs) presents methodological difficulties, it also is a testament to the persistence of lifeways in this region. Because of the difficulties in establishing a chronological framework from sparse samples unsupported by excavation, this analysis is intended to be preliminary, indicating directions for future research rather than presenting developed conclusions.

Of the sites located by the WHNBS, nine architectural sites belong to the Chalcolithic and Early Bronze I period and appear have no later artifactual material. Three multicomponent architectural sites were also included in the sample, as surveyors were able to differentiate in the field between "older" and "younger" phases at the site. A presentation of site classifications by architectural characteristics is given in Fig. 3.

By far the largest site having material from this general horizon was Khirbet ed-Daluq, Site 434. The site consisted of an extensive series of intermingled walls and circles covering an area of over 15,000m². Continuing occupation through late Islamic Mediaeval times has in all probability eradicated any Chalcolithic and Early Bronze I structures. However, the fact that significant proportions of Chalcolithic/EB I and EB I ceramics remained at this complex site suggests substantial early occupation.

Less than half a kilometer southwest of Site 434 lies Site 467, a large stone enclosure that produced both Chalcolithic/EB I and EB I ceramics. The enclosure consisted of badly disturbed walls surrounding a roughly rectangular area, 20x50m, that may have served as an animal pen. Later ceramics were also sampled in the vicinity, and the structure cannot be ascribed to the Chalcolithic/EB I time range with any certainty.

Of particular interest are the "divided oval" structures located by the WHNBS (Sites 199, 366, 505). These were roughly ovoid or rectangular structures, only one of which occurred at each site. All three buildings had datable material, but only two of them were associated with Chalcolithic sherds (Sites 199, 366). They are equally spaced along the drainage bottom and probably were domestic structures of some sort. It is worth remarking that they strongly resemble the "apsidal houses" found at numerous northern Palestine sites. Hanbury-Tenison (1986: 204) stated forcefully that oval or apsidal houses only occur in EB I contexts, but Braun (1989: 15) has ascribed them to a late Chalcolithic/Early Bronze horizon. Their resemblance to these northern forms may indicate a domestic architectural substrate with a very wide geographical distribution. Caution should be used in assigning these structures to functional categories in the absence of excavated data.

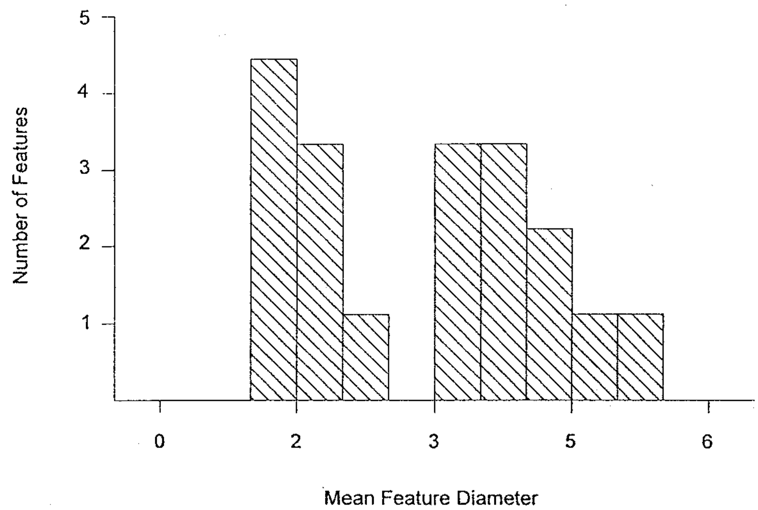

Fig. 4. Diameters of "open" circles.

Analysis of the Chalcolithic and Early Bronze I data from the WHNBS was beset by a bewildering array of circular features of every conceivable construction and diameter. The survey mapped 31 circular features in association with artifacts from this time range. By circular features we mean stone features which are nearly circular or semicircular in form. U-shaped or angular features are not included. Five distinct types of circular features were defined:

1) Small "*towers*" consisting of drystone walls several courses high. Only two of these were located in sites without later occupation, and their resemblance to known tomb forms from later periods (*e.g.*, Nabatean) makes them highly suspect. They are 1.5 and 2.8m in diameter, respectively.

2) *Pavements or platforms* were made of well-joined stones forming perfectly flat surfaces. These strongly resemble the "Full" (or Timnian) tombs reported by Rothenburg and Glass (1992: 142) in the western Arabah, but they may also have been threshing floors or platforms for dry storage. Two occur at sites we are interpreting as mortuary complexes and one at a site with large circular features. They vary in diameter from 1.7 to 2.7m.

3) *Rough stone cairns* are not difficult to understand in terms of function (*i.e.*, burials), but it is difficult to date them due to the persistence of this form into the present. Seven were found on sites

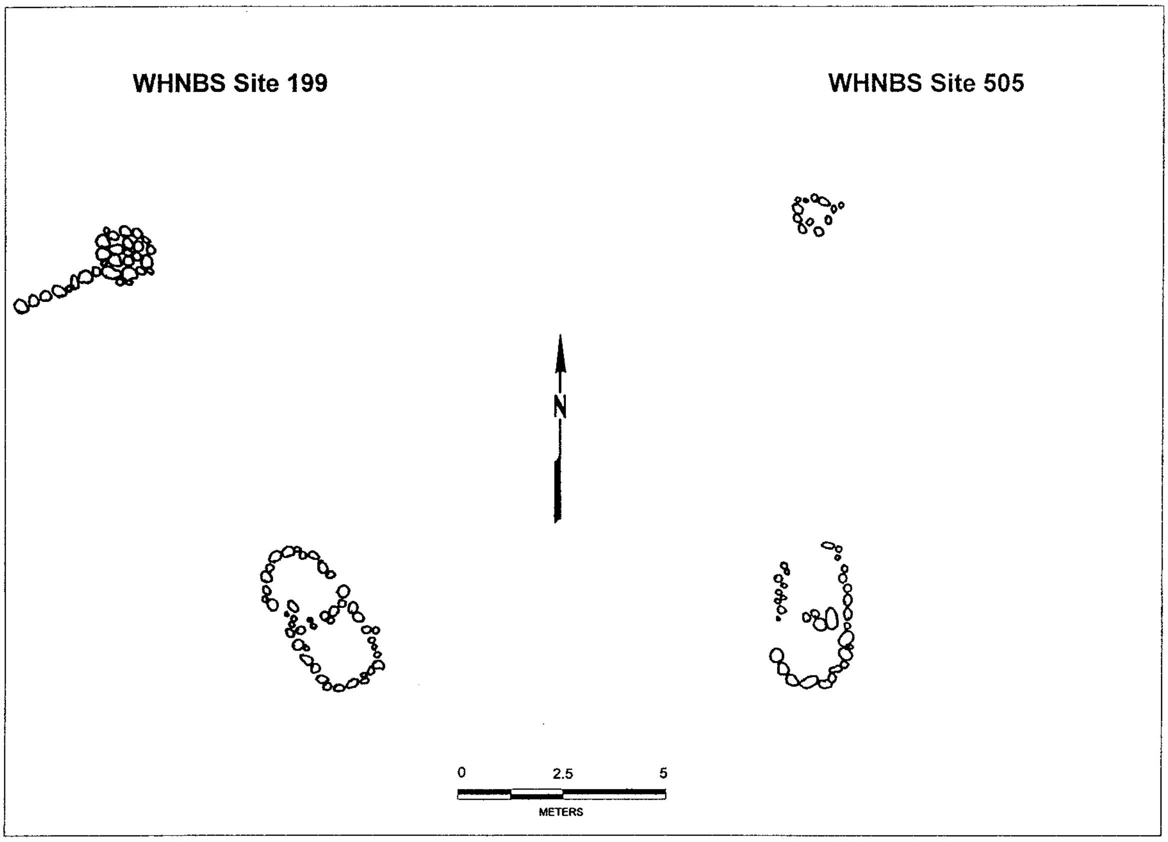

Fig. 5. Examples of "divided circle" structures.

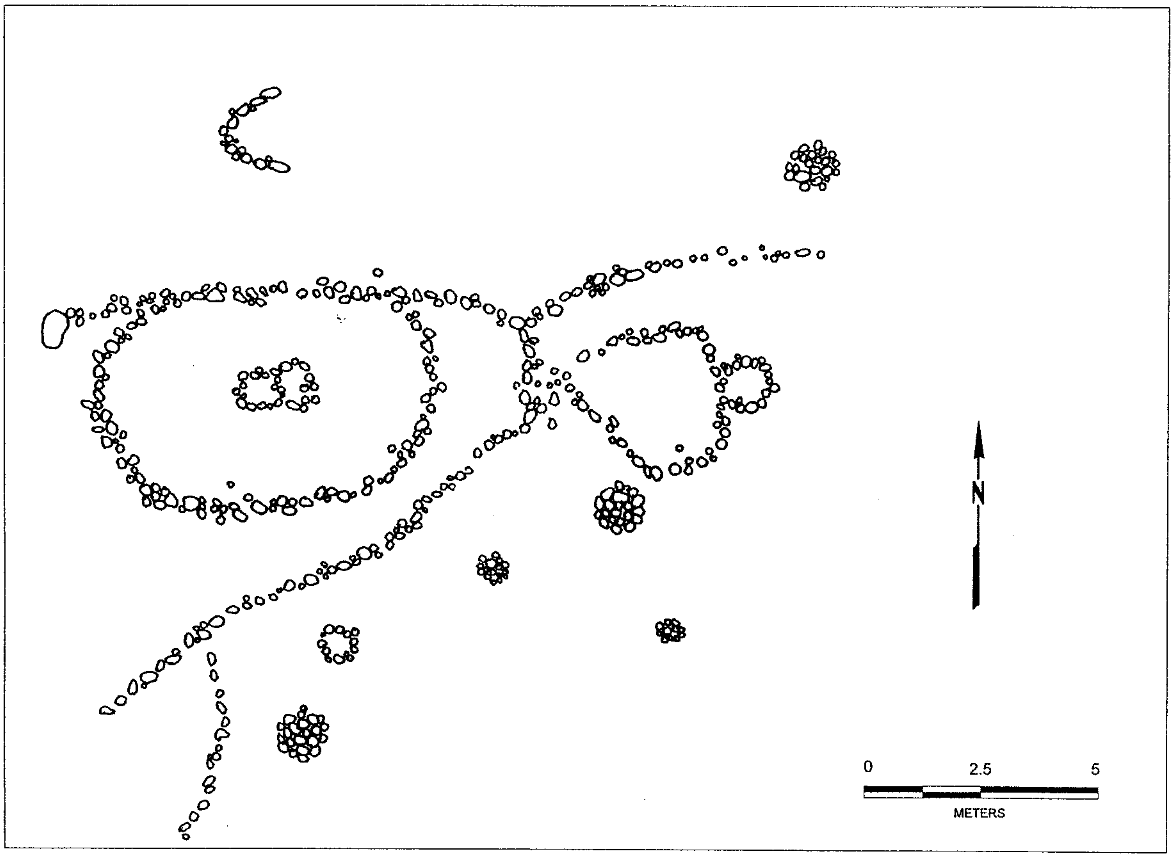

Fig. 6. WHNBS Site 511.

with associated Chalcolithic and Early Bronze I artifacts, varying in diameter from 0.8 to 2.2m in diameter.
4) One site (493) had a small collapsed *circle of standing stones*. It is interesting to note that this feature occurs at a site which appears to be a mortuary complex (see below).
5) *Open circles,* or rock rings with no visible interior features, come in a wide variety of sizes and present difficulties for interpretation. With a mean diameter of only 1.2m, many are clearly too small to have served as domestic structures and must have been tombs or storage facilities. In order to examine the variability of these features, diameters were measured from the field drawings, which are presented in Figs. 4-5. Although the sample size is small (n = 18), the diameters of these features are clearly bimodal, with a large break between 2.1 and 3.4m. It is notable that known burial forms listed above had a maximum diameter of 2.8m. Further excavation will be required to clarify the function of these structures. For the purposes of this study we are tentatively interpreting "smaller" circles as tombs and the "larger" ones (> 3.4m) as domestic structures on the basis of functional requirements and similarities to other architectural features in the Levant.

Large (>3.4m) circle sites are consistently associated with EB I sherds. They are comprised of two to four circular structures, often agglutinated in groups of two. Most of these features also have curved walls attached to the main structure that may have served as windbreaks or vestibules. Large circles differ qualitatively from small circles in these ways, as small circles never have these characteristics. Although it is difficult to draw many conclusions without excavated data, large circle sites would appear to have been domestic compounds, possibly with associated corrals, and probably served small groups of related individuals.

Interestingly enough, all of the "smaller" circles occur in association with only three sites (493, 527, 511). These three sites are characterized by unusual large oval constructions (15-26m) in association with two to seven small circular features. Chalcolithic pottery was found in association with these features only on Site 493, which was also the only one of these sites with later components. Later (Iron Age?) construction modified this site significantly. Site 597 is an extensive camp area with clearings and windbreaks, but most features were indistinct and badly disturbed. The best preserved of these structural complexes is Site 511, dated to the EB I on the basis of very sparse ceramic data (Fig. 6). We have decided to include this site here, as ceramics associated with Site 493 suggest that this architectural form might have persisted throughout the Chalcolithic/Early Bronze I horizon.

Features at these sites bear some resemblance to features at the Neolithic/ Chalcolithic mortuary complex at Bab edh-Dhra, which is located in the Ghor north of the confluence of the Wadi Hasa with the Wadi Arabah. This complex consists of regular linear arrangements of cist tombs covered with cairns. At the edge of the cairnfield was a large stone oval roughly 25m in diameter. Schaub inferred from the regular spacing of the tombs that tomb cutters were aware of the presence of previous tombs; either they were marked at the time or were only partially filled. Shaft diameters ranged from 1.2 to 1.3m (SCHAUB 1980: 46-47, HANBURY-TENISON 1986: 220).

As can be seen in Fig. 6, this general pattern is repeated in miniature at WHNBS Site 511. The smaller features ("tombs") are oriented N-S north in a line roughly tangential to the large oval structure. The site is very complex overall and includes terrace walls and currently unexplained features. Although we consider 511 to be a mortuary complex, clearly excavation will be required to confirm this.

Tombs in modern Bedouin societies serve as gathering places where territorial claims and group membership can be reasserted through religious beliefs and through the exchange of genealogical information (JOFFE 1993: 83-84). It is notable that all three of these complexes occur relatively close to each other and in the same "cluster" of sites that appear to contain domestic structures such as the "divided ovals" and Khirbet ed-Daluq (434).

In summary, three types of site architecture appear to date firmly to the Chalcolithic/EB I horizon in the Wadi Hasa drainage. "Divided oval" structures are evenly spaced along the wadi bottom and are thought to be small domestic units. "Large circle sites" are predominantly clustered in the eastern drainage and are generally associated with ceramics classified as EB I. They are thought to be either short-term domestic structures or corrals associated with adjacent residential camps. Sites interpreted as mortuary complexes are characterized by large oval constructions in association with numerous small circular features, occurring outside the wadi bottom within a limited area (Fig. 3).

Conclusions and Prospects

Chalcolithic and Bronze Age societies can be characterized by a mosaic of different historical trends and levels of complexity, distinguishable according to geomorphic zones of settlement (FALCONER and SAVAGE 1995: 52). Joffe (1993: 41-46) noted three broad and interrelated developmental trajectories of the Levantine Chalcolithic/Early Bronze I transition in the southern Levant. While the Mediterranean coastal plains are characterized by widespread collapse and abandonment of urban settlement, tell sites began to develop into large agricultural urban communities with intensive strategies further north around the Sea of Galilee. This period is also marked by a large-scale expansion of settlement in the mountains of Edom. These remains are usually interpreted as representing semi-nomadic or nomadic peoples. While the centers are relatively well understood, little work has been done in the mountains of Edom, where settlement expanded to unprecedented levels during Early Bronze I. Newly founded sites account for 92% in EB I, and 98% of them were abandoned by EB II (JOFFE 1993: 43). These generalizations are substantiated by the Hasa survey. Whatever happened in this region was as dramatic as it was short lived.

Throughout the central and southern Jordanian uplands, Chalcolithic/EB I sites appear to be dominated by light ceramic and lithic scatters occasionally accompanied by ambiguous architectural features. Although most of these sites occur in association with later materials, the relationship between the Chalcolithic/EB IA and the subsequent EB IB-EB II proto-urban transition is still poorly understood. Recent surveys on the Kerak Plateau, which adjoins the project area to the north, and the Madaba Plains have revealed a sparse scattering of Chalcolithic/EB I occupations centered along wadi bottoms (MILLER 1991: 307, IBACH 1987). In contrast, the southern Ghors and northeast Arabah Survey (SGNAS) reported numerous Chalcolithic/EB I sites along the mouths of the Hasa and adjacent drainages, suggesting a substantial occupation of the Dead Sea Plains on a seasonal, if not permanent, basis (MACDONALD *et al.* 1988, MACDONALD 1992, RAST and SCHAUB 1974, IBRAHIM *et al.* 1976). Although the exact relationship between these sites and the development of the EB I proto-urban tradition is unclear, it is appears likely that the transition was indigenous and local in character (SCHAUB 1982:73).

What is certain is that there is no clear evidence for large permanent settlements developing in the Wadi Hasa drainage during either the Chalcolithic or Early Bronze periods. The one possible exception is WHNBS Site 434. This site was sporadically occupied and reoccupied into historic times, and it is presently impossible to estimate the extent of the original Chalcolithic and Early Bronze I settlement.

The distribution of some Wadi Hasa site types may be correlated to the distribution of arable soils in wadi bottoms, a pattern similar to that seen in the region around Beersheva (LEVY 1986). It is notable that the "divided oval" sites identified by the survey were found exclusively along these bottom lands. Their resemblance to apsidal houses found in many places in the Levant suggests these may be domestic structures, although the duration and seasonality of occupation is presently unknown. One possibility is that prehistoric occupants practiced dry farming, abandoning and returning to their fields along the wadi bed much as modern Bedouin in the area do.

The "large circle" sites tentatively dated to the EB I are also probably domestic structures, but they differ in informative ways from "divided oval" sites in both construction and location. In terms of construction, circular domestic structures are strongly associated with nomadic societies (WHITING and AYRES 1968: 125). In terms of location, these structures seem to be concentrated in the eastern region, a good "halfway point" between the Ghor and the edge of the Arabian desert. Taken together, these factors suggest a shift to a more transhumant or pastoral adaptation in this area.

The EB I settlement expansion in Edom has been interpreted by some researchers as related to the control of trade routes linking copper sources in the Wadi Feinan to centers to the west and north (JOFFE 1993: 54). If the Bronze Age Levant can be conceptualized as a mosaic of interacting regional units (FALCONER and SAVAGE 1995: 49), there should be some indication of interaction at this larger scale. The sites tentatively identified as mortuary complexes by the WHNBS may be one such indication. Their strong resemblance to the cemetery at Bab edh-Dhra may suggest some degree of cultural continuity between these two areas.

More work needs to be done in order to arrive at a satisfactory understanding of the role of west Jordanian peoples in the widespread pan-regional changes that affected the Chalcolithic/Early Bronze Age Levant. Our experience has suggested that the resolution of the chronology may be the greatest obstacle to achieving this understanding. Adams (1978: 334) noted that semi-nomadic peoples are characterized by remarkably flexible, resilient adaptations; a broad spectrum economy and great mobility allow for a better chance of survival, if not relative prosperity. Consequently, they can withstand sweeping social and political changes. From this perspective, continuity in material culture patterns - rather than change - is to be expected, and chronological information must rely on archaeometric techniques rather than archaeological "index fossils". Although our hypotheses remain tentative at this stage, we hope to have the opportunity to conduct more systematic tests in this region in order to clarify some of these issues.

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Problems in Defining a Chalcolithic for Southern Jordan

Hermann Genz

Abstract: *Although a number of sites south of the Wadi el-Hasa have been dated to the Chalcolithic a detailed survey of the evidence reveals the weak foundations of these datings. As long as there are no stratified sequences, no convincing parallels with the Chalcolithic cultures to the north and west, and not enough radiocarbon dates, it is impossible to give an exact definition of the Chalcolithic cultures in southern Jordan. As a consequence, the term "Chalcolithic" should be used more carefully than hitherto, until a more advanced state of research might in the future enable better definitions for the later prehistoric periods in Southern Jordan.*

Zusammenfassung: *Obwohl eine Reihe von Fundorten südlich des Wadi el-Hasa als chalkolithisch angesprochen werden, zeigt eine genauere Untersuchung die Unsicherheiten dieser Zuweisungen. Solange weder längere stratifizierte Abfolgen, noch sichere Parallelen zu den chalkolithischen Kulturen im Norden und Westen, noch C-14-Daten in ausreichender Zahl vorliegen, ist es unmöglich, die chalkolithischen Kulturen des südlichen Jordanien genauer zu definieren. Demnach sollte der Begriff "Chalkolithikum" mit mehr Vorsicht als bisher angewendet werden, bis zukünftige Arbeiten ein klareres Bild der späteren Vorgeschichte Südjordaniens ermoeglichen.*

Introduction

A number of sites south of the Wadi el-Hasa have been termed Chalcolithic, although none of them shows evidence of the classic Beersheba-Ghassul assemblages characterized by cornets, churns, V-shaped bowls and painted decoration (COMMENGE-PELLERIN 1987, 1990; MALLON, KOEPPEL, and NEUVILLE 1934; KOEPPEL 1940). The absence of these "type-fossils" alone should not be overstated, since it is well known that Chalcolithic cultures are characterized by marked regional differences (KERNER 1995: 70*ff.*). The assemblages south of the Wadi el-Hasa, however, show almost no comparable material to the sites farther north and west. Due to the absence of long stratified sequences and radiocarbon dates, the definition for the Chalcolithic in this area is rather vague. The sites in southern Jordan that have been dated to the Chalcolithic are listed in Fig. 1[1].

Chalcolithic Sites in Southern Jordan

Seven Chalcolithic sites were found by the Wadi el-Hasa Survey along the southern side of the Wadi el-Hasa (MACDONALD 1988: 131); nine other sites could only be assigned to the Chalcolithic-Early Bronze Age (MACDONALD 1988: 135). Most of the sites consisted of sherd and lithic scatters, and few showed architectural features, which in most cases could not with any certainty be ascribed to the Chalcolithic. The pottery from these sites consisted of simple undecorated forms with holemouth jars and necked jars predominating.

Fourteen sites in the northern Wadi Araba were termed Chalcolithic, but only four (Sites 80, 129, 133 and 222) produced exclusively Chalcolithic finds (MACDONALD 1992: 30*ff.*, 56*ff.*). Once again, due to the difficulties in dating survey materials, many sites could be ascribed no more confidently than to the Neolithic/Chalcolithic or Chalcolithic/Early Bronze Age. Once more, most of the sites consisted only of sherd and flint scatters. One exception was site 133 with a well preserved circular building and a rectangular structure. Pottery was represented by such simple forms as holemouth

[1] This list is by no means complete; only the more important and better published sites have been selected.

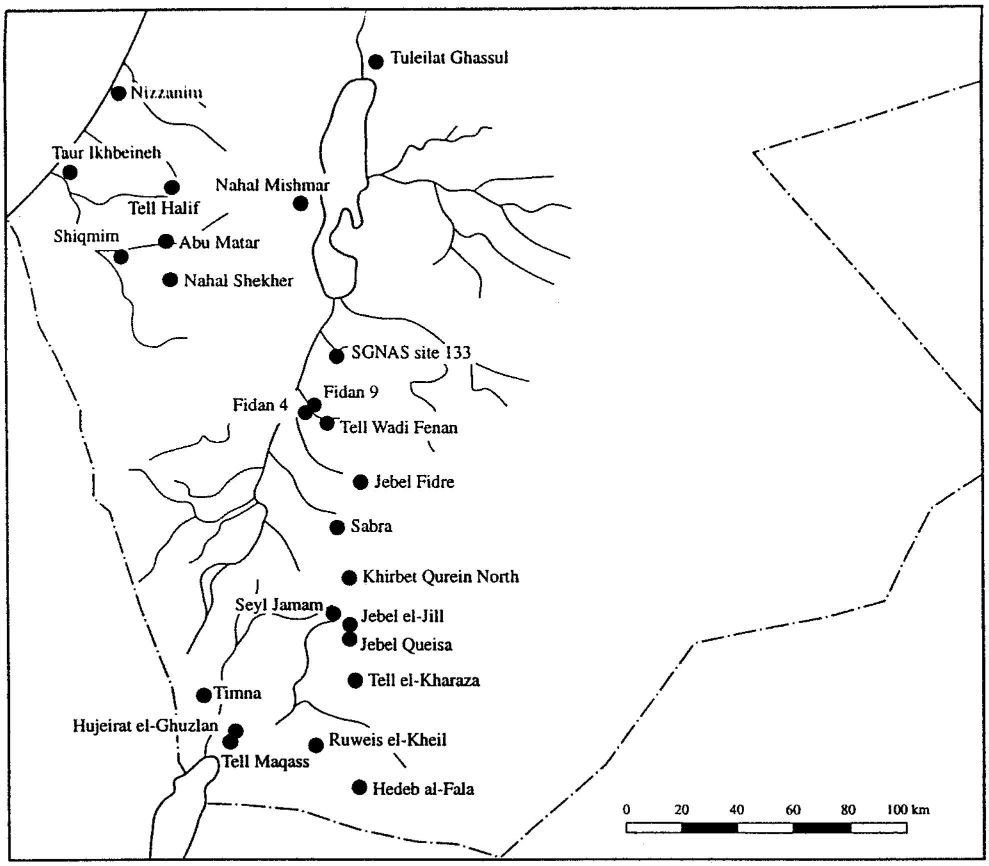
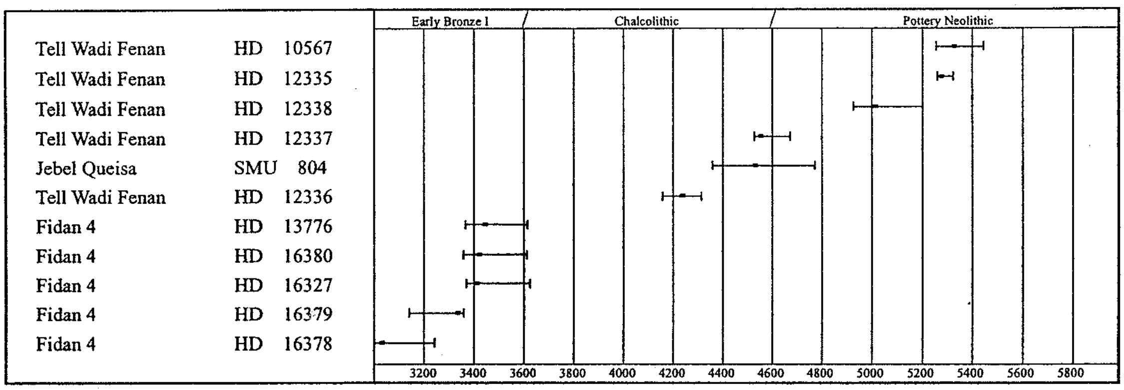


Fig. 1. Sites mentioned in the text.



	Sample	Uncal. B.P.	Cal. B.C.	1-sigma range	Source
Tell Wadi Fenan	HD 10567	6410+/-115	5327	5439-5254	NAJJAR et al. 1990, 32
Tell Wadi Fenan	HD 12335	6360+/-45	5279	5325-5261	NAJJAR et al. 1990, 32
Tell Wadi Fenan	HD 12338	6110+/-75	5017	5200-4931	NAJJAR et al. 1990, 32
Tell Wadi Fenan	HD 12337	5740+/-35	4557	4674-4531	NAJJAR et al. 1990, 32
Jebel Queisa	SMU 804	5720+/-149	4540	4770-4366	HENRY 1982, 439
Tell Wadi Fenan	HD 12336	5375+/-30	4234	4314-4160	NAJJAR et al. 1990, 32
Fidan 4	HD 13776	4685+/-50	3438	3604-3371	ADAMS/GENZ 1995, 19
Fidan 4	HD 16380	4702+/-35	3415	3615-3375	ADAMS/GENZ 1995, 19
Fidan 4	HD 16327	4718+/-25	3402	3616-3375	ADAMS/GENZ 1995, 19
Fidan 4	HD 16379	4576+/-45	3348	3365-3140	ADAMS/GENZ 1995, 19
Fidan 4	HD 16378	4422+/-50	3037	3255-2925	ADAMS/GENZ 1995, 19

Fig. 2. Radiocarbon dates for the later prehistoric periods of Southern Jordan.

jars and bowls, with bases bearing mat-impressions and with ledge-or lug-handles. Axes, tabular and end-scrapers, blades and borers occurred among the flint tools.

In the Feinan region a number of sites are known as Chalcolithic, including Chalcolithic mining areas at various sites in the Feinan region (HAUPTMANN 1989: 122; HAUPTMANN, WEISGERBER and KNAUF 1985: 71). The occupation site of Fidan 4, located on the southern bank of Wadi Fidan has ever since its discovery been dated to the Chalcolithic period (RAIKES 1980: 55 [site E]; HAUPTMANN, WEISGERBER, and KNAUF 1985: 167*ff.*, 185*ff.*; HAUPTMANN 1989: 122, 1991: 401; HAUPTMANN and WEISGERBER 1992: 62; MACDONALD 1992: 250 [sites 10 and 20] was more careful in assigning it to the Chalcolithic/Early Bronze Age). In 1993 the site was excavated as part of the Feinan Project by the German Mining Museum, Bochum, and the Department of Antiquities (ADAMS and GENZ 1995). The excavations produced the remains of a small village settlement with mainly rectangular architecture. The pottery consisted mainly of bowls, beakers, holemouth jars and necked jars. Ledge-, lug- and loop-handles all occurred. Coarse fabrics predominated; painted decoration was almost entirely absent, but impressed decoration frequently occurred below the openings of holemouth jars. Some bases show mat impressions. Among the lithics the high percentage of tabular flint tools is remarkable. Endscrapers, blades and other tools also occur. Evidence of metallurgy, bead manufacture and the production of mining picks was found. Five radiocarbon-dates were obtained (ADAMS and GENZ 1995: 19). Just opposite this site on the north side of the wadi a cemetery was investigated. Due to the lack of diagnostic finds, the cemetery has been assigned to the Chalcolithic or Early Bronze Age by the typology of the graves (ADAMS 1991: 181).

Chalcolithic finds consisting of a floor with a hearth and possibly a wall were also reported from Tell Wadi Feinan on top of a long sequence of Pottery Neolithic layers (NAJJAR *et al.* 1990: 35). Unfortunately, the finds from the Chalcolithic period are as yet unpublished. Five radiocarbon dates (NAJJAR *et al.* 1990: 32) include two that fall in the Chalcolithic (see Fig. 2).

The survey of the Petra region by the Naturhistorische Gesellschaft Nürnberg produced evidence for some sites dating to the Chalcolithic/Early Bronze periods, for instance near Sabra (LINDNER and ZEITLER 1990: 170) and at Jebel Fidre (LINDNER, GENZ, and GUNSAM n. d.), but again diagnostic pottery and lithic forms are too few to enable a secure attribution to the Chalcolithic period.

Khirbet Qurein North is situated on the Edomite plateau. The soundings undertaken in 1984 produced coarse pottery in simple handmade forms and flint-tools dated to the Chalcolithic (HART 1987: 87*ff.* and Fig. 5).

About 25% of all the sites discovered in a prehistoric survey in the vicinity of Ras an-Naqb showed a Chalcolithic component (HENRY 1982; HENRY *et al.* 1981, 1983: 7; HENRY and TURNBULL 1985). Only two sites have been published in any detail. Jebel el-Jill (Site J 14) included some curvilinear structures. Among the finds, lithics based on a microlithic flake technology dominated, but tabular scrapers were also found. Pottery was scarce, and the only diagnostic sherds were two holemouth rims (HENRY 1982: 438, HENRY and TURNBULL 1985: 49). The analysis of the faunal remains indicates that the economy was based on nomadic pastoralism (HENRY and TURNBULL 1985: 52). At Jebel Quiesa (Site J 24) circular structures were found. Layers A and B are attributed to the Chalcolithic (HENRY 1982: 438, HENRY *et al.* 1983: 15). A radiocarbon date from layer B gave a range from 4770-4366 cal. B.C. (HENRY 1982: 439 gave an uncalibrated date of 3770 ± 149).

The Aqaba-Ma'an Survey also attributed a number of sites to the Chalcolithic (JOBLING 1981, 1982, 1983). At Seyl Jammam an extensive flint scatter with tools dating from the Palaeolithic to the Chalcolithic was detected (JOBLING 1983: 188). At Tell el-Kharaza two small soundings undertaken in 1982 produced a sequence ranging from the Late Neolithic to the Middle Bronze Age (JOBLING 1983: 189*ff.*). Unfortunately no details about this very important sequence for the later prehistory for southern Jordan have been published. At Ruweis el-Kheil a complete holemouth jar with a ledge handle at the rim was found that was provisionally assigned to the Chalcolithic (JOBLING 1981: 110). A large site 400x250m with straight and curvilinear wall foundations attributed to the Chalcolithic was found at Hedeb el-Fala (JOBLING 1981: 109).

Tell Maqass just 4km north of the Gulf of Aqaba was discovered by T. Raikes. Excavations were begun in 1985 by L. Khalil (1988, 1992, 1995). Several phases were detected, and all of them showed evidence of rectangular stone architecture. Pottery forms consisted of bowls, basins, holemouth jars and necked jars. The last two types often have an applied and impressed band below the rim or around the neck. Ledge and lug handles were also found. The flint assemblage was dominated by blades, endscrapers and tabular scrapers. Evidence for metallurgical activities was found (KHALIL 1988: 104, 1992: 144*ff.*), and ornaments made of shell were also produced at the site (KHALIL 1992: 143*ff.*).

The site of Hujeirat el-Ghuzlan is situated just a few kms northeast of Maqass, and it is described as twice as large and of the same age as Tell Maqass (KHALIL 1992: 148, 1995: 77; SMITH and NIEMI 1994: 475). Except for Wadi Fidan 4, Tell Maqass and Jebel el-Jill all sites were explored only by surface collections or small soundings, and thus produced little diagnostic material.

The pottery published from sites ascribed to the Chalcolithic in southern Jordan consists mainly of simple, mostly undecorated forms like bowls and holemouth jars. (On the difficulty of dating holemouth jars see SEBBANE *et al.* 1993: 43*ff.*). Parallels to the Beersheva-Ghassul assemblages are few and restricted to the most simple shapes. Characteristic forms like churns, cornets[1] and V-shaped bowls and the use of painted decoration typical for the Chalcolithic cultures farther north and northwest are notably absent in southern Jordan.

In the south lithics are characterized by tabular scrapers, endscrapers, blades and axes, but a microlithic industry is also found (HENRY and TURNBULL 1985: 49. Microliths are also found at some sites in the Beersheva-Ghassul cultures, *cf.* GILEAD 1984), which show parallels to the Timnian industries in the Negev and Sinai. Most of these types, like tabular scrapers, lunates and transversal arrowheads, can actually be dated between the 6th and 3rd millennia (SEBBANE *et al.* 1993: 45, ROSEN 1989).

Radiocarbon dates are known only from the sites of Wadi Fidan 4, Tell Wadi Feinan and Jebel Queisa. While the date from Jebel Queisa and two others from Tell Wadi Feinan fit well into the Chalcolithic, the dates from Fidan 4 fall after the latest dates published for the Chalcolithic Period (JOFFE and DESSEL 1995, GILEAD 1995) and fit very well into the range for Early Bronze Age I dates (STAGER 1992: 50) (Fig. 2).

Chalcolithic Variability in the Southern Levant

We are thus left with a very unclear picture for the Chalcolithic in southern Jordan[2]. The published material, especially the pottery and the lithics, do not show any exclusive affinities to the Beersheba-Ghassul assemblages. How are these variations between the Beersheva-Ghassul assemblages and the Chalcolithic in southern Jordan to be explained?

Several factors - chronological, regional or socio-economic - are applicable.

As to chronological variations, the assignment of some assemblages to the Chalcolithic must now be questioned. This is certainly true for Fidan 4, where the radiocarbon dates clearly postdate the dates published so far for the Chalcolithic period. Although some general parallels can be found in the Chalcolithic repertoires for the pottery and lithic types from this site, the most convincing comparisons are to be found in Early Bronze IA assemblages from Jordan and southern Israel at sites such as Jawa (BETTS 1991) and Tell Halif (DESSEL 1991).

Only during recent years has a more thorough definition for the Early Bronze Age IA in the southern coastal plain been worked out, mainly due to the publication of sites such as Tell Halif (DESSEL 1991), Taur Ikhbeineh (OREN and YEKUTIELI 1992), Nizzanim (YEKUTIELI and GOPHNA 1994) and others (SEBBANE and AVNER 1993). This of course calls for a re-evaluation of sites attributed to the Chalcolithic-Early Bronze Age transition from the neighbouring regions. For the earliest phase of EB Ia the presence of strong Chalcolithic traditions has been stressed (YEKUTIELI and GOPHNA 1994: 182), and this can explain the difficulties in distinguishing between Chalcolithic and EB Ia assemblages, if radiocarbon dates are absent and diagnostic artefacts are few.

Thus Fidan 4, one of the main excavated sites in southern Jordan, should actually be dated to the beginning of the Early Bronze Age (HAUPTMANN and WEISGERBER n.d., ADAMS and GENZ n. d.). The artifacts from other sites like Tell Maqass and Khirbet Qurein North are very similar to the Fidan 4 material, so one may ask whether these sites would be better placed in the Early Bronze Age as well. The different chronological position of these sites could explain the differences in the artefact assemblages compared to the Chalcolithic.

Another possible explanation for this variation is a different socio-economic background. Whereas most of the excavated settlements of the Beersheva-Ghassul cultures are explained as having a sedentary population (GILEAD 1988: 418*ff.*, 1992: 34*ff.*; some sites described as herding stations have been explored though along the Nahal Shekher, see GILEAD 1992: 33), some sites in southern Jordan like Jebel el-Jill and Jebel Queisa point to a pastoralist economy (HENRY 1992). These sites are characterized by a dominance of ovicaprid bones (HENRY and TURNBULL 1985: 50*ff.*) and by a low artefact density. Mainly simple and undiagnostic features like holemouth jars and tabular scrapers were found, which are difficult to date exactly[3].

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1 "... possible remnants of a cornet ..." are mentioned by MACDONALD 1992: 58 from Rujm Khunezir.

2 HENRY *et al.* 1981: 117 and JOBLING 1982: 203 have addressed the problem of assigning surface material to certain periods due to the insufficient state of research in southern Jordan.

3 A good case for the difficulty of dating remains from pastoral communities has recently been made for the so-called Negbite ceramics. This simple, hand-made pottery, undoubtedly the product of a population with a nomadic background, was commonly dated to the beginning of the Iron Age, but new investigations have shown that it was actually produced from the Early Bronze Age through the Middle Ages (*cf.* HAIMANN and GOREN 1992).

The third factor, regionalism, certainly plays an important role in our interpretation of Chalcolithic cultures. Several different Chalcolithic cultures are known to have existed side by side in the Golan, for instance, and even within the Beersheva-Ghassul culture regional variations are known. For southern Jordan the evidence is yet too scarce to give a definition of a regional culture in the Chalcolithic, but the evidence from Jebel Queisa and Tell Wadi Feinan clearly shows that the area was settled in this period.

One of the main reasons for the search for Chalcolithic occupation in the copper bearing regions of the south was probably to explain the developed metallurgy found in southern Palestine. That people visited the Feinan and Timna areas in the Chalcolithic is proven by finds of ores from these regions in Abu Matar, Shiqmim and other places (HAUPTMANN 1989: 122*ff.*, 1991: 405), but no one necessarily lived in the ore-bearing areas. So far there is little evidence for Chalcolithic occupation in the Feinan region[1], the only findspot being Tell Wadi Feinan, from where no metallurgical remains have been reported. On the contrary, the finds of ore, slag and metallurgical installations show that the smelting of the copper took place in the settlements in the Beersheva region (SHALEV 1995: 636, HAUPTMANN and WEISGERBER n.d.). The ore supply could have been provided by mobile groups of the population[2] or even by occasional or regular expeditions to the copper regions[3].

In conclusion, it can be said that there is some evidence that southern Jordan was settled during the Chalcolithic, but for many sites which have been attributed to this period positive evidence of dating is still lacking. Sites should only be attributed to the Chalcolithic if there is undoubtable evidence for their dating, either by radiocarbon dates, by stratified sequences[4], or by clear typological comparisons to Chalcolithic assemblages from other, better explored regions. For the time being many of the so-called Chalcolithic sites in southern Jordan can only be ascribed to a longer time span, ranging from Pottery Neolithic to the beginning of the Early Bronze Age, or even later[5].

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1 The same is actually true for Timna. Chalcolithic occupational and smelting sites were claimed to have been found (e.g., Sites 29 and 39; ROTHENBERG 1972: 24; ROTHENBERG *et al.* 1978), but the dating evidence is not clear. SEBANE *et al.* (1993: 49) accept only a general dating to the 4th-3rd millennia for these sites. Rothenberg later realized the difficulty of exactly dating these sites and now attributes most of them to the early phase of the Sinai-Arabah Copper Age, which covers the Chalcolithic and Early Bronze Age 1 (ROTHENBERG and GLASS 1992: 143).

2 On pastoral nomadism, see LEVY 1983 and 1992. GILEAD (1992: 39) postulated that semi-nomadic herders were engaged in the exploitation of such minerals as turquoise from the Sinai.

3 On expeditions see SCHOOP (1995:78), with parallels drawn from ethnology.

4 For Tell el-Kharaza a sequence ranging from Pottery Neolithic to the Middle Bronze Age is reported, but no details have been reported yet (JOBLING 1983: 189).

5 Similar problems of dating sites with few diagnostic artifacts were encountered in Rothenberg's Arabah and Sinai surveys. Rothenberg suggested a revision of the Chalcolithic and Early Bronze Age into three phases (early, middle and late) of the Sinai-Arabah Copper Age (ROTHENBERG and GLASS 1992). Since this division is based mainly on different technological stages in the development of metallurgy, it is difficult to apply this system to sites without metallurgical remains. Also, the suggestion to date sites according to petrographic examinations of pottery is problematic, especially since a stratigraphic confirmation of his divisions is still lacking.

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The Chalcolithic - Early Bronze Interface in Jordan: Connections with Urbanism in Riverine Southwest Asia?

Jesús Gil Fuensanta

Introduction

Continous archaeological work in the Syrian and Turkish Euphrates regions to mitigate the impact on valuable sites from dam construction has given us a better framework of late fourth millennium interactions between southern and northern Mesopotamia. Thus, the evidence proved that identical cultural items from the "international" urban Uruk culture were shared in both Mesopotamian regions. The most prominent and commom elements are seen in architectural plans and decoration, administrative practices (including early written tablets and seals), iconography, pottery and related technology, and probably some socio-political concepts. On the other hand, less attention was paid by the "Mesopotamian sphere" researchers to late fourth millennium developments in the southwestern arid zones, due mainly to the less spectacular finds and records from the contemporary regional cultures.

Research conducted at various Chalcolithic/Early Bronze I-II sites in an arc from the Wadi Zarqa region to the Jebel Druze area has revealed presumably rapid urban-like development during a possibly contemporaneous span with the Euphrates sites. One group of excavated or surveyed sites, generally with local Early Bronze Ia date according the pottery parallels, are pertinent to this development. They include Tell Umm Hammad, Jawa, Jewel Mutawaq, Khirbet Umbashi, Hebariye, Leboueh, Mumasakhin and Maitland's Fort.

Northern Jordan and Southern Syrian Settlements

The Wadi Zarqa-Jebel Druze Early Bronze Ia settlements reflected a size generally up to 10ha, although in some cases (Jebel Mutawaq, Khirbet Umbashi, Mumasakhin) sites reached an occupation area over 20ha; the latter dimensions are not only exceptional for this early date in such dry regions, but they are as big as most of Uruk/Late Chalcolithic Upper Euphrates sites[1]. Furthermore, the siting of Zarqa-Druze walled settlements on hills suggests a military strategy that likely also involved some control over trade routes. There are no earlier parallels of fortifications for the Transjordanian region. In the Palestinian area, the earliest examples of fortifications appeared during Early Bronze IB/II[2], with wall thicknesses ranging between 1.5m-3m.

The concept of the fortified city has been proved in recent years not to be exclusively of the Late Uruk expansion in the Euphrates, Tigris and adjacent regions; instead, in those areas fortifications were present in earlier cultures of the early fourth millennium (*e.g.*, Late Ubaid). Two distant small sites related to the Late Uruk expansion, Hassek Höyük (Turkey) and Godin Tepe (Iran), displayed similar oval city-walls and built-space distribution[3]. To the contrary, a typical Uruk settlement

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1 The largest late fourth millennium upper Euphrates sites are found in the Syrian Khabur region: Tell Barri (20 ha.), Tell Farfara (106 ha), Tell Hamoukar (70 ha), and Tell Brak (110 ha). From the Syrian Jezireh to Euphrates sources region, the biggest known settlements seem to be Habuba Kabira, Syria (18 ha), Samsat (17.5 ha?), and Arslantepe, Turkey.

2 Cf. KEMPINSKI 1992a: 68. But note that elaborate gatehouses were present as early as the Late Chalcolithic in Palestine (e.g., En Gedi Sanctuary in KEMPINSKI 1992a: Fig.1). Fortified settlements were common in southern Palestine as early as EB1 (*cf.* Tell Ernani in KEMPINSKI 1978).

3 The oval city-wall seems very extensive at the end of fourth/beginning of third millennia in several regions of the Near East; the Arad Early Bronze II wall is a good example from the southern Levant region (*cf.* KEMPINSKI 1992a: Fig.9).

such as Habuba Kabira (Syria) had straight city-walls with rectangular towers and at least two gates; several outer sides of the wall were protected by a second thin-wall. The site of Leboueh yielded a triple-line fortified settlement with gates and rectangular towers (MAQDISSI 1984). The Jawa city walls, which are tentatively dated to the Early Bronze, had two gates of a very commom shape in Palestinian lands (also known in later periods; G.R.H. WRIGHT, pers. comm.), but which more resembled Habuba's city gates[1]. The rectangular towers begin to appear in Palestine in Early Bronze IIB (c. 2900-2800 bc), with thicknesses of 5 to 7m (KEMPINSKI 1992a: 69).

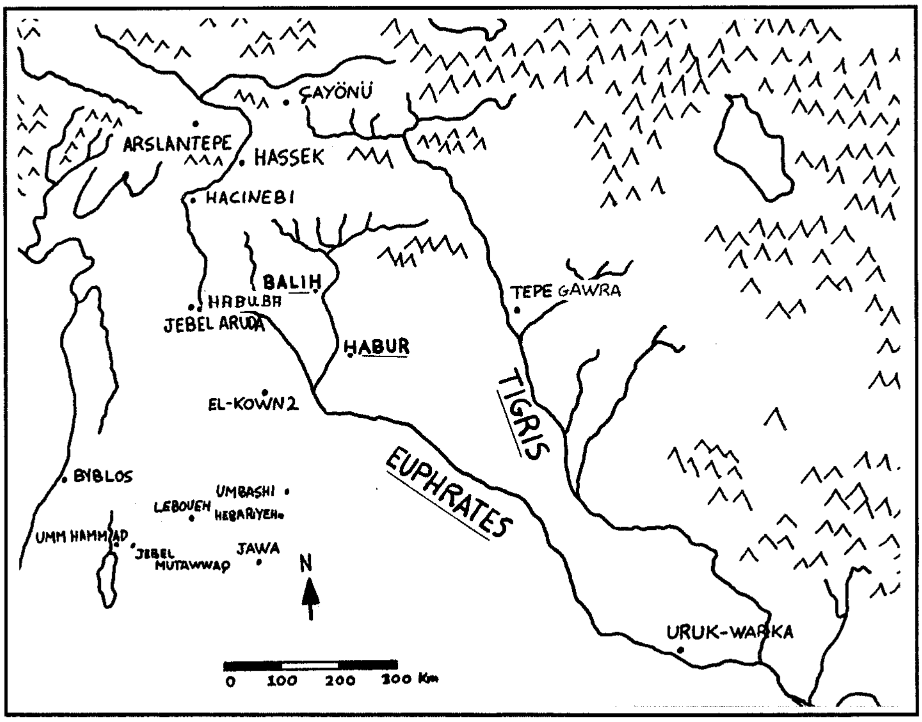

Fig. 1. Map of sited discussed.

Monumental or central public buildings are lacking in the archaeological record of northern Transjordan and southern Syria. But the En Gedi Chalcolithic Sanctuary in Palestine has strong analogies with third-millennium Khafaje Sin's Temple, which has been regarded as a reflection of Syro-Palestinian influence in Mesopotamia (KEMPINSKI 1992b: 55, Figs. 1-3). At Khirbet Umbashi a structure similar to the En Gedi Sanctuary and the buildings at Fasa'el (*cf.* PORATH 1992: 42, Figs. 5-6) was revealed, a result that strengthens the hypothesis of a powerful regional building tradition since Chalcolithic times that was still effective at the dawn of Early Bronze Age.

Dwellings or house-like installations present at Jordanian sites during the period suggest new concepts of planning. Two different building traditions co-existed at this time: the oval house and the rectangular one. The round plan has been regarded by some researchers (such as Helms) as a foreign (Syrian) intrusion into the Jordanian region at the beginning of Bronze Age. City-size settlements such as Jawa, Jebel Mutawwaq, Khirbet Umbashi, Umm Hammad, Leboueh, Hebariyeh and Mumasakhin yielded numerous examples of this plan-type; in several cases, including Umm Hammad (with some structures that resembled some southern examples, *e.g.*, HELMS 1984a: Fig. 6c, 7), Khirbet Umbashi, and Hebariyeh, there were also long-room plan houses. The long-room plan has been interpreted as the standard house during the Chalcolithic in southern Levant/Palestine region[2], an area whose influence on Jordan's first urbanization period must be regarded as more than just occa-

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Round city-walls were probably known to predynastic Egyptians according to the Narmer Pallete (KEMPINSKI 1992a: Fig.2).

1 The Habuba gates show two different entry concepts. The North Gate links with the direct access tradition present at Jawa UT1 (*cf.* HELMS 1981: Figs. 38, 41, 45) or the En Gedi Sanctuary (Fig. 47). On the other hand, Habuba's South Gate, with a more complex, double-chambered plan, ties in with the Jawa's UT 2 and 3 or LT4 gate types (HELMS 1981: Figs. 42, 45). However, the presence of a similar gates at both sites doesn't imply direct a connection between them: the double chamber gate was very common in Palestine from the Early Bronze Age through the Iron Age (WRIGHT 1985: Fig. 94).

2 *cf.* HELMS 1984a: 31. Open single long-room buildings had a strong presence in the region (e.g., Teleilat el-Ghassul, Golan Heights and Arad (*cf.* PORATH 1992). At Tell Judeida, in the Amuq Plain, there were long-rooms during Amuq H, which can generally be equated with the Early Bronze III of Palestine (AMIRAN 1978: 17).

sional. Long-room buildings of Palestinian-Jordanian type also appear in late fourth millennium Euphrates settlements (*e.g.*, Hassek), which is a reflection of a very extensive plan-type throughout the Near East during the period.

Sites from southern Palestine yielded a mix of round and rectangular plans, but in the north the round plan tradition is lacking. An Egyptianized urbanizing movement from southern to northern Palestine has been suggested (KEMPINSKI 1995: 58, Fig. 6), but Arad housing and built-space concepts (AMIRAN 1978: Fig. 2.4) seem more similar to the inspirations of Hama K (FUGMANN 1958: Fig. 19). The grill plan, so commom at late fourth millennium Euphrates sites[1] (*e.g.*, Jebel Aruda, Hassek Höyük), was present at Hama K (FUGMANN 1958: Fig. 45).

Underground structures seem typical phenomena of the southern Damascus region and Jordanian sites, including Leboueh, Khirbet Umbashi, Hebariyeh and Mumasakhin, most probably for dwellings and storage facilities in areas of harsh climatological and environmental conditions, thus explaining the need of water management systems at Khirbet Umbashi (*cf.* Dubertret and Dunand 1954) and perhaps at Jawa[2].

The use of pillars in structures from Jebel Mutawwaq (HANBURY-TENISON 1987) is reminiscent of the EBI Building 1072 at Tell el-'Areini (*cf.* NIGRO 1995: Table 1) from Palestine, which suggests a connection between the southwest riverine regions and Egypt in its building technique (*cf.* KEMPINSKI 1992a: 75). The pillar was also very extensively used in the Euphrates region during the first half of fourth millennium, as demonstrated at Arslantepe VII and Tell Brak Early Uruk levels (GIL FUENSANTA 1996).

Jawa, the most intensively excavated site in northern Jordan, shows an agglutinate plan with evidence of "inner segregation", as Habuba does. Agglutinate insulae occurred in the Near East beginning in the Neolithic period, and this conception was still very widespread during the Late Chalcolithic (Tepe Gawra) and the Uruk period in the Syrian Jezireh (Habuba and especially Aruda). But there are clear differences: urban planning at Jordan/southern Palestinian sites, such as Farah (KEMPINSKI 1992a: Fig. 12), had buildings with very different geometric expressions. In Jordan and southern Palestine less sophisticated cities were planned than in the upper Euphrates area (KEMPINSKI 1992a: 80), although Arad used broad, parallel streets in its arrangement (KEMPINSKI 1992a: 79) as did Habuba Kabira and Jebel Aruda in the Euphrates region[3]. Houses at Hama K suggest affinities with the less geometrically rigid examples from Habuba and Jebel Aruda.

The pottery repertoire of the Zarqa/Druze sites still show no strong and clear relationship with Uruk-Euphrates sites material. The Jordan/Syrian steppe ceramic connections point more towards the Hauran region in southern Syria and the Palestinian area (HELMS 1984a: 28*ff.*), with a strong local ceramic tradition with roots in the Neolithic period. However, a ledge handle sherd similar to Palestinian Late Chalcolithic examples appeared at Habuba Kabira South (SÜRENHAGEN 1979: Figs. 23-24), indicating a relationship of the Euphrates, probably through intermediaries, with the southern Levant[4]. Until now, the only certain Jordan/south Syrian ceramic parallel appears to be local Amuq/ Turkish Euphrates Late Chalcolithic pottery, and at the moment the best pottery referents, even if scarce, are the Hama and Palestinian/Levantine region materials of Early Bronze II-III date (HANBURY-TENISON 1989: 55).

Administrative practices are also evident in the Jordanian region beginning in the Chalcolithic/Early Bronze Age, as the seal impressions from Jawa and Umm Hammad suggest. The lack of Uruk glyptic iconography and political/religious symbols[5] in the Jordanian stamp seal impressions, while they are present in predynastic Egypt, supports even more strongly the notion of the absence of "Mesopotamian" peoples in southern Syrian and Jordanian regions.

Discussion and Conclusions

A vigorous regionalization of cultures in much of the Near East might have taken place during the fourth millennium in contrast to the "internationalistic" results effected by the Uruk culture in the Euphrates region. Town-sites in southern Syria and northern Jordan could have been part of a presumed "kingdom of Damascus" in the semi-arid steppe, as several researchers have suggested before (*cf.*

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1 This plan was used in southeastern Turkey since the PPN, as Çayönü shows. Southern Euphrates examples are known with an early date too, from Tell es-Sawwan and Oueili's Ubaid 0. The use of the grill plan continued in northern Mesopotamia and the Khabur area during third-millennium (Telul eth-Thalathat V, Tell 'Atij, Karrana 3).

2 The Chalcolithic of the northern Negev yielded evidence of subterranean structures used as residence and for storage (PORATH 1992: 40).

3 The dwelling designs at Godin Tepe also share a fair similarity with some Arad examples (*cf.* AMIRAN 1978, Fig. 2:5).

4 Despite the absence of hard evidence of Uruk presence on Levantine coast, some kind of contact occurred between the Syrian Jezireh Uruk peoples and Predynastic Egypt, judging by the finds in both areas (*cf.* MOOREY 1987).

5 One remarkable example is the absence of the typical Uruk eye-idols in areas south to Hama K (*cf.* FUGMANN 1958: Fig.37:4B603, Fig.46:4C623).

HELMS 1984b; MAQDISSI 1984; HANBURY-TENISON 1987, 1989). Such sites are examples of the very late fourth millennium integration of populations in fortified urban centers in various regions of Near East. The Jordanian sites reflect a strong cultural relationship with southern Syrian sites of the period.

Jordanian sites show a marked difference compared to Euphrates-region construction that involves building material: in Jordan basalt stones were mainly used instead of mudbricks, a reflection of how climate and restricted resources condition a region's inhabitants. It is hard to infer any exogenous influence in the development of local water systems for the period. Nevertheless, the sudden appearence of big "cities" in the region without a direct evolution from the Chalcolithic to Early Bronze Age is still a matter that needs to be explained.

A polemic for the research is the role played by the supposed growth of metallurgy in the area since the Chalcolithic period. In the last few decades investigations have indicated several possible foci for metal production in the Near East. Palestine and Sinai had a potential in this regard in ancient times because of a richness in local resources. While some have criticised the stress that Marfoe and his school place on the role of the metallurgy during fourth millennium (KEMPINSKI 1983: 236), metallurgical innovation seems to have existed during the period; currently the data suggest an interest of Uruk peoples in the search for metals. It is not clear if southern Anatolia was the main target of the Uruk "metal rush", and the presence of Uruk material south of the Orontes River and in the Syrian desert (in addition to Egypt) points to the possibility of a Uruk contact with Palestine. One hypothesis stresses a presumed importance of Egypt as a "land of gold" for the Uruk economic system (*cf.* MOOREY 1987). On the other hand, one of the main reasons for rejecting the idea of an Uruk society with a hunger for this metallurgical potential is the lack of Uruk material in the archaeological record of Palestine and Jordan, although evidence of an external Uruk network could dismiss this objection.

Contact between southern Palestinian Chalcolithic communities and Egypt is suggested by the material culture (the exchange of metal could have driven that process) and (Uruk?) urban development, which indirectly reached northern Palestine settlements, which in turn were in contact with early northern Jordanian EB sites. We must view these Jordanian settlements with material culture similar to northern Palestine as big villages in contact with foreign ideas.

The culture of northern Jordan EB sites seems to be a hybrid: the materials are Palestinian but the settlement size and planning are typically exogenous. Maybe we are not dealing with real cities but towns, interpreted in the same way as the typical cities of Palestine EB II. Some kind of social segregation could be inferred at Jawa, but in a way more similar to the Chalcolithic Euphrates villages (*e.g.,* Tell Abada), as the lack of monumental buildings indicates. The political ideology of northern Jordan was probably not very complex at the time - some kind of advanced chiefdom, perhaps. It may be that settlement size was due mainly as a strategy to cope with the climate: a concentration of people in a smaller space for more efficient collection and use of water. The choice of certain settlement patterns in different Jordanian regions during the Chalcolithic and EB1 is evidence of a variety of available options.

In any event, it is very interesting to see the parallel evolution of walled settlements in Jordan and the Uruk cities. Fortifications could have been influenced by settlements in Palestine, in view of the absence of such defensive features in southern Syria. (A city wall of the period has not been found for Hama, for instance).

The "internationalization" phenomenon began in the Near East in the fifth millennium with the expansion of the Halaf culture. But the picture elsewhere at the end of the fourth and beginning of the third millennia reflects a stable presence of regionalized cultures (including a regional culture in northern Jordan), maintained by a long tradition of foreign contacts that began in Neolithic period. This seems clear in northern Jordan, where its different sub-regions do not reflect a hard break in the settlement pattern during the second half of the millennium. Even if these southern Syrian and northern Jordanian sites didn't share a Mesopotamian riverine material culture (definite Uruk items still have not been found in Palestine or Jordan), several similarities in settlement pattern and concepts suggest some cultural contacts. To get a better picture of the process in the northern Jordan region, we need to strengthen research into the ancient phases of Uruk culture and its forerunner, the Ubaid, in their adjacent regions (Lebanese coast, Syrian Druze)[1]. Contemporaneous Euphrates/Tigris settlements and Jordanian sites show different cultures at dissimilar degrees of urbanization that might have maintained some cultural contact through an indirect kind of "middle-man trade"[2].

In conclusion, we see that there was at the time a different cultural tradition in Mesopotamia in

1 Perhaps the presence of such "foreign concepts" in northern Jordan could be a remnant of some Ubaid tradition, as the pictographic (?) motifs at Umbashi suggest.

2 I thank Carole Gillis (Götteborg University) for suggestions concerning this concept.

respect to northern Jordan, where cultural connections point more towards Palestinian relations. At our present state of research, it is difficult to infer any real and effective Mesopotamian influences.

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Notes on the Early Bronze Age Chipped Lithic Industry of Kataret es-Samra[1]

Mujahed Muheisen

Abstract: *A number of lithics samples were recovered from excavations and surface collections at Kataret es-Samra in the Jordan Valley. This paper presents an overview of the primary products and tools in those collections, with particular attention to the sickle blades and Cananean blades. When compared generally to other EB sites in Jordan and elsewhere, the Kataret es-Samra material fits comfortably in the EBI range.*

Introduction

The site of Kataret es-Samra is located a few kilometers southwest of Deir 'Alla. It was discovered during the Jordan Valley Survey (Site 126) carried out by M. Ibrahim, J. Sauer and K. Yassin (1976) in 1978, and excavation at the site was undertaken by Albert Leonard (LEONARD 1979, 1981, 1983, 1985). The site was divided into three areas, which contained the following pottery periods:

I. probably Neolithic/ Chalcolithic, EB, MB IIB-C, LB (dominant), few Iron
II. Chalcolithic/ EB I (dominant), EBII, MBII
III. Chalcolithic/ EB, LB (dominant) (with tomb)

The Late Chalcolithic/Early Bronze Age I chipped lithic industries from Kataret es-Samra are represented in two major collections from a) 15 excavated loci in Field I of Area I and b) the samples from surface investigations. The excavated loci (all excavated in 1985) include 101-107, 110, 114, 119, 124, 131, 133, 211, and 221. The surface collections comprise KS 85 ps 1-3 from the Ghassulian, TS 13.1-3,6; TS 14.1-3 from the earliest EB, and the typical EB collections KS 85.22.2,4, and 6.

The flint raw materials used at Kataret es-Samra come either from the wadi bed or from nodular flint beds in the limestone formations near the site. In addition, quartzite and basalt were flaked. The varieties of the flint exhibit the following colors: beige, white, brown and light brown, and black.

In the following, we present the analysis of the excavated loci and the surface collections separately. For the somewhat larger collections from Loci 114 and 101, we were able consider the primary and secondary production separately.

Analysis of the Excavated Samples

Locus 114

This locus contained the largest sample of the Chalcolithic/Early Bronze Age pieces among the lithic assemblages (*cf.* Table 1). The dominant raw material in this sample is a fine-grained nodular flint of a grayish-brown color. Among some flakes wadi gravels are attested as the raw material; no patina has been observed on any of the specimens studied.

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1 Editorial Note: This contribution is being published despite the fact that the final version of the originally proposed contribution (on Chalcolithic lithic traditions in the EBI period) ended up out of the chronological scope of this publication.

Primary Production

Cores (8): No complete cores were found. All the specimens are flake cores with the exception of a small prismatic core for the production of bladelets.

Core rejuvenation flake (1): proximal fragment.

Burin spalls (3): No special comments.

Blades (35): Blades are generally small and have plain striking platforms. Their lengths mostly range between 20-40mm, although about 10% are between 40-50mm.

Flakes (112): Most are very small (16-20mm) and irregular. They mostly have plain platforms, 10% have plain cortical platform remnants.

Table 1. Primary products and implements in Locus 114.

Primary Products	n	%	Tools	n	%
Cores	8	4.9	Endscrapers	1	4.2
Flakes	112	68.7	Burins	3	12.5
Blades	39	23.9	Notch/Denticulate	3	12.5
CTE	1	0.6	Truncations	1	4.2
Other	3	1.8	Retouched flakes/blades	6	25.0
Subtotal	163	100.0	Sickle blades	8	33.3
Debris	25	(11.8)	Celts	1	4.2
Tools	24	(11.3)	Chisels	1	4.2
Total	212		**Total**	24	100.0

Secondary Production

Celts (1) (Fig. 1:1): The piece (68x58x27mm) was made on a thick core and flaked on both faces. The left edge bears a tranchet scar and the right edge is less sharp. The convex distal end, cortical on one face, bears a Clactonian notch.

Chisels (1): It is trimmed roughly all over both surfaces, and the distal end shows the removal of flakes on both surfaces (30x18mm).

Sickle blades (8) (Fig. 1:2-4): One sickle blade has inverse retouch along the right side. It is lustrous and has signs of use on the right edge. Five sickle blades are rectangular in shape. They are backed on one side (left edge) and at the distal-proximal ends. They have steep direct retouch along the back and on both ends (proximal and distal). One sickle blade is backed on the left edge with abrupt retouch. The distal end has inverse retouch. The right edge bears gloss; the average size of the sickle blades is 45x14mm.

Retouched flakes and blades (6): Four flakes are directly retouched on the edge with a very fine retouch. One blade has an abrupt retouch on one edge, and another has a flat retouch on the right edge.

Truncated pieces (1) (Fig. 1:9): The flake is truncated on the proximal end (truncation is direct, straight, concave). The left edge has a flat retouch.

Notched and denticulated pieces (3) (Fig. 1:8): They have direct, straight, invasive, and more or less regular retouches. The edge is denticulated or has a notch on each side.

Burins (3) (Fig. 1:7): There is one dihedral burin made on a blade, one angle burin on a break and another one on a truncation.

Endscraper (1): It is made on a flake and has an unidentifiable shape. It is retouched on the distal end by retouch of scalariform character.

The flint industry in Locus 114 appears homogeneous. Two tool types are predominant in the assemblage: sickle blades and retouched flakes/blades. Primary production is dominated by flake production. The size of sickle blades and their types remind us of specimens from the terminal Chalcolithic.

Locus 101

Primary Production

Blades and Blade Fragments (4): One is complete and has a punctiform butt. Two are distal fragments. One is a fragment of a typical Cananean blade.

Flakes (27): The flakes are small and thin, but there are four thicker flakes which have larger plain striking platforms. One flake has a faceted butt, five have reserve cortical butts. Eleven flakes have knapping, six flakes are fragments. Some of these flakes are heat affected.

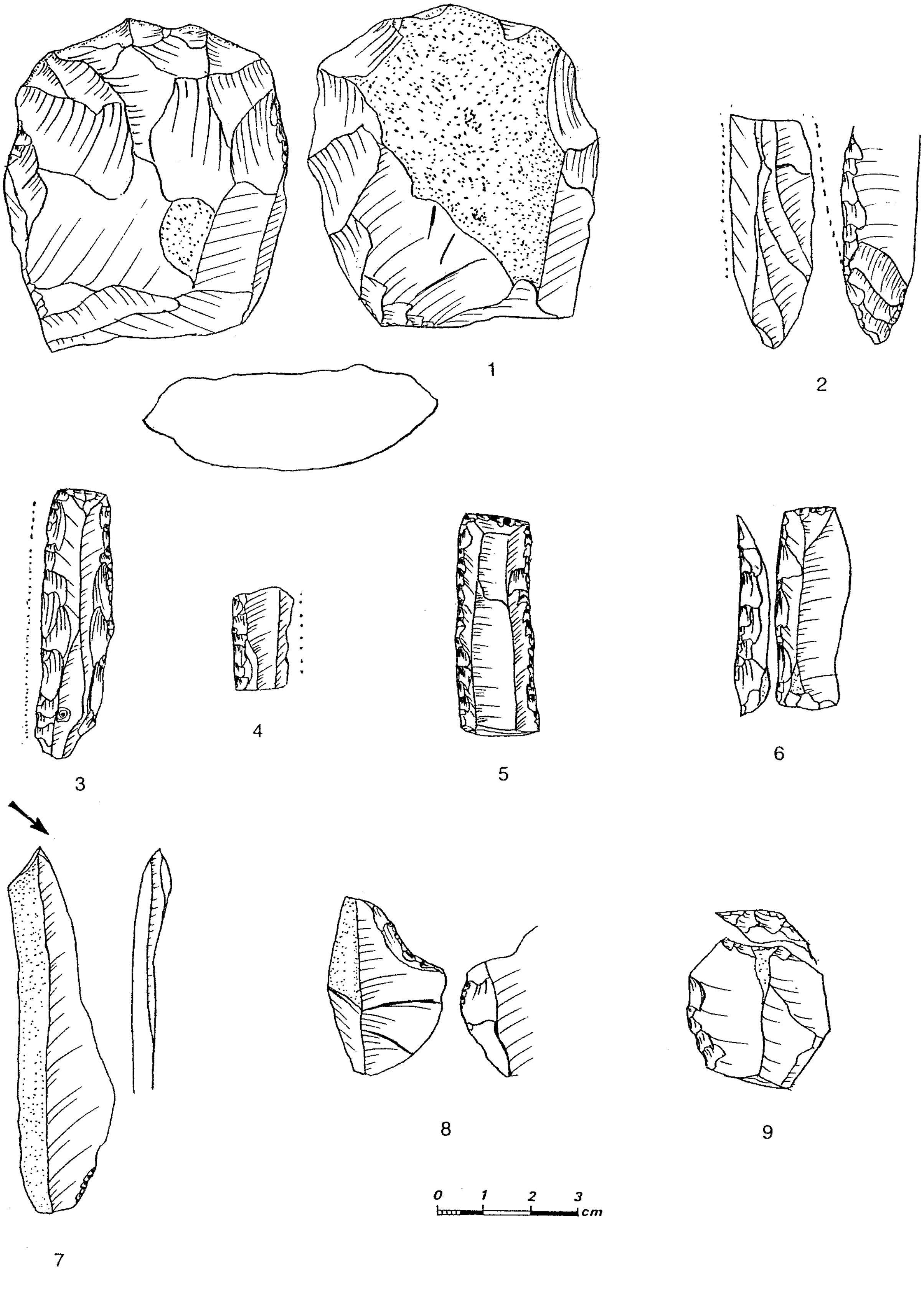

Fig. 1. 1 celt fragment, 2-4 sickle blades, 5-6 backed blades, 7 burin, 8 notched and denticulated piece, 9 truncated piece (1-9: all Locus 114).

Secondary Production

Sickle blades (5) (Fig. 2:2-3): Five are made on typical Cananean blades, and all of them are fragments. There is a wide range for length between 13-30mm. Four sickle blades are lustrous along one edge, which was sharpened by flat retouch or irregular denticulation. One sickle blade does not has a lustrous edge, but shows fine traces with denticulation in the other edge. One sickle blade is retouched along the back and across both ends with steep direct retouch.

Denticulated pieces (1): It is on a thick flake with deep retouch resulting in a denticulation along the right edge.

Notched pieces (1): It is on a thin flake with faceted butt a with shallow notch at the distal end.

Truncated pieces (1): A truncated Cananean blade with oblique direct abrupt retouch at the distal end.

Retouched flakes and blades (2): One blade with irregular inverse retouch, and one flake with non-continuous retouch on one edge.

Burins (1) (Fig. 2:1): Dihedral straight on a flake (55x24mm).

Endscrapers (1): One simple endscraper on a flake with irregular direct retouch (distal end).

Locus 102

Here were found three complete flakes with plain butts, two proximal blade fragments with punctiform platforms and one core rejuvenation flake. Two tools include one that is a backed blade with/direct irregular abrupt retouch on the left side (Fig. 2:4) and another that is a backed blade fragment with abrupt convex retouch at the left edge (Fig. 2:5).

Locus 103

A blade with a plain platform was found together with two small flakes and two pieces of debris.

Locus 104 (101-104 mixed)

Two of the 3 flakes found have plain platforms, the third has a cortical platform; they are big in size with lengths of 58-60mm and the widths of 35-47mm. The two tools are notches (one Clactonian) made on the distal ends of flakes.

Locus 105

Three artifacts were found: two primary crested blades and one angle burin on a break.

Locus 106

This locus provided 24 artifacts, including seven flakes, six bladelets, three pieces of debris and eight tools. The tools were comprised of a perforator, a dihedral burin (Fig. 2:6), an angle burin on a break, one angle burin on a truncation, three retouched flakes, and a blade with fine retouch.

Locus 107

In this locus four primary products were found: a bladelet with a punctiform butt, a flake, one blade with features of a Cananean blade, and a "normal" blade.

Locus 110

Here a used Cananean blade fragment was found.

Locus 119

The collection consists of one complete blade, a small thin flake and a small bladelet (truncated at the distal end by an abrupt direct retouch).

Locus 124

One complete Cananean blade with inverse retouch, one bladelet and one cortical flake came from this locus.

Locus 131

The sickle blade (43.5x14mm) has steep direct retouch along the right back and at the distal end. The left edge has very fine denticulation. (Fig. 2:9)

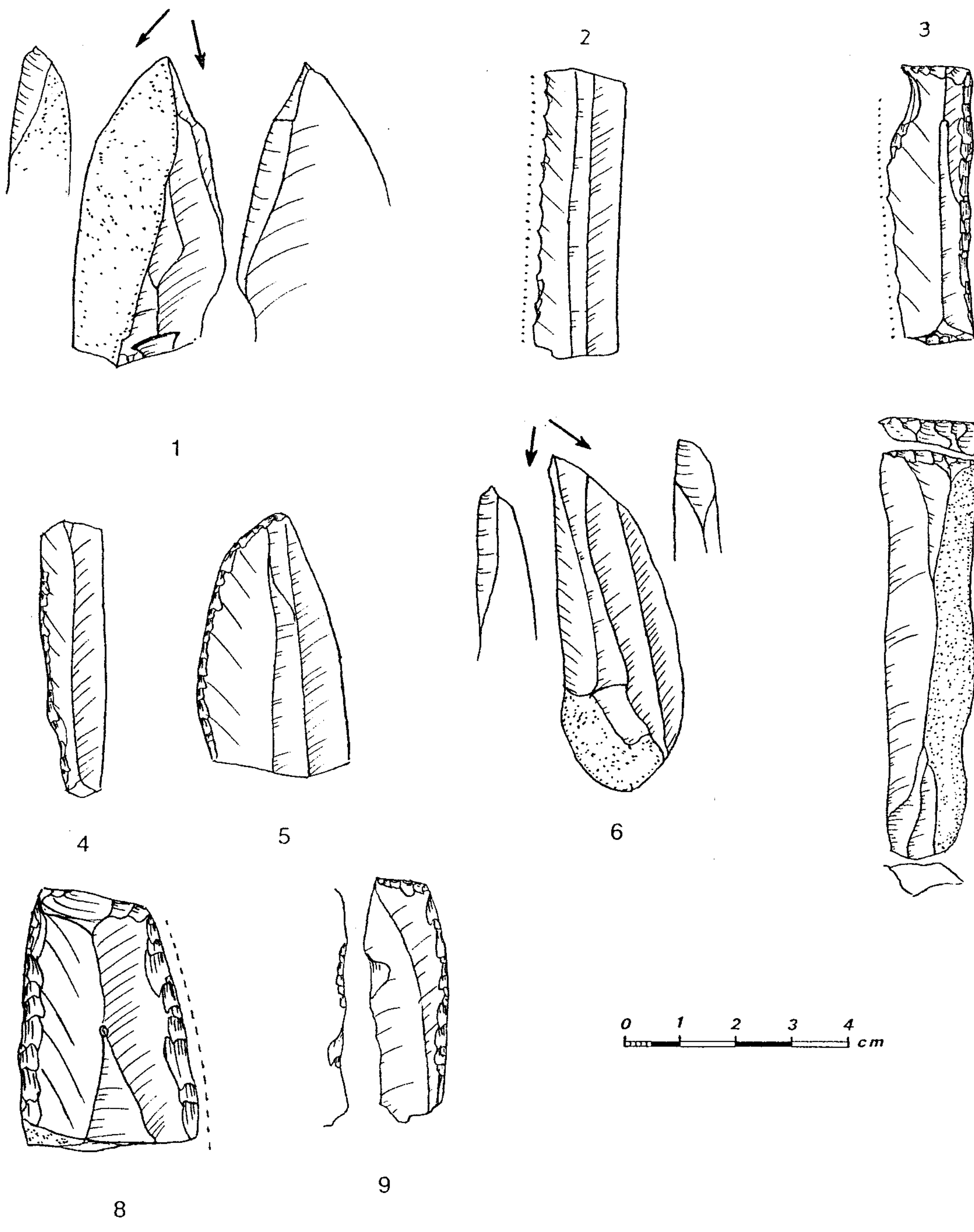

Fig. 2. 1 burin (I.1.08 Locus 101), 2-3 sickle blades (Locus 101), 4-5 backed blades (Locus 102), 6 dihedral burin (Locus 106), 7 truncated blade with steep retouch (Locus 133), 8 sickle blade fragment (Locus 211), 9 sickle blade with fine denticulation (Locus 131).

Locus 133

One truncated blade with steep direct retouch (the shape of truncation is slightly oblique, *cf.* Fig. 2:7), and two distal blade fragments were found.

Locus 221

Two sickle blades were found in this locus: one is lustrous at the right edge and backed-and-truncated at the left side, and the other one is a fragment with a lustrous right side.

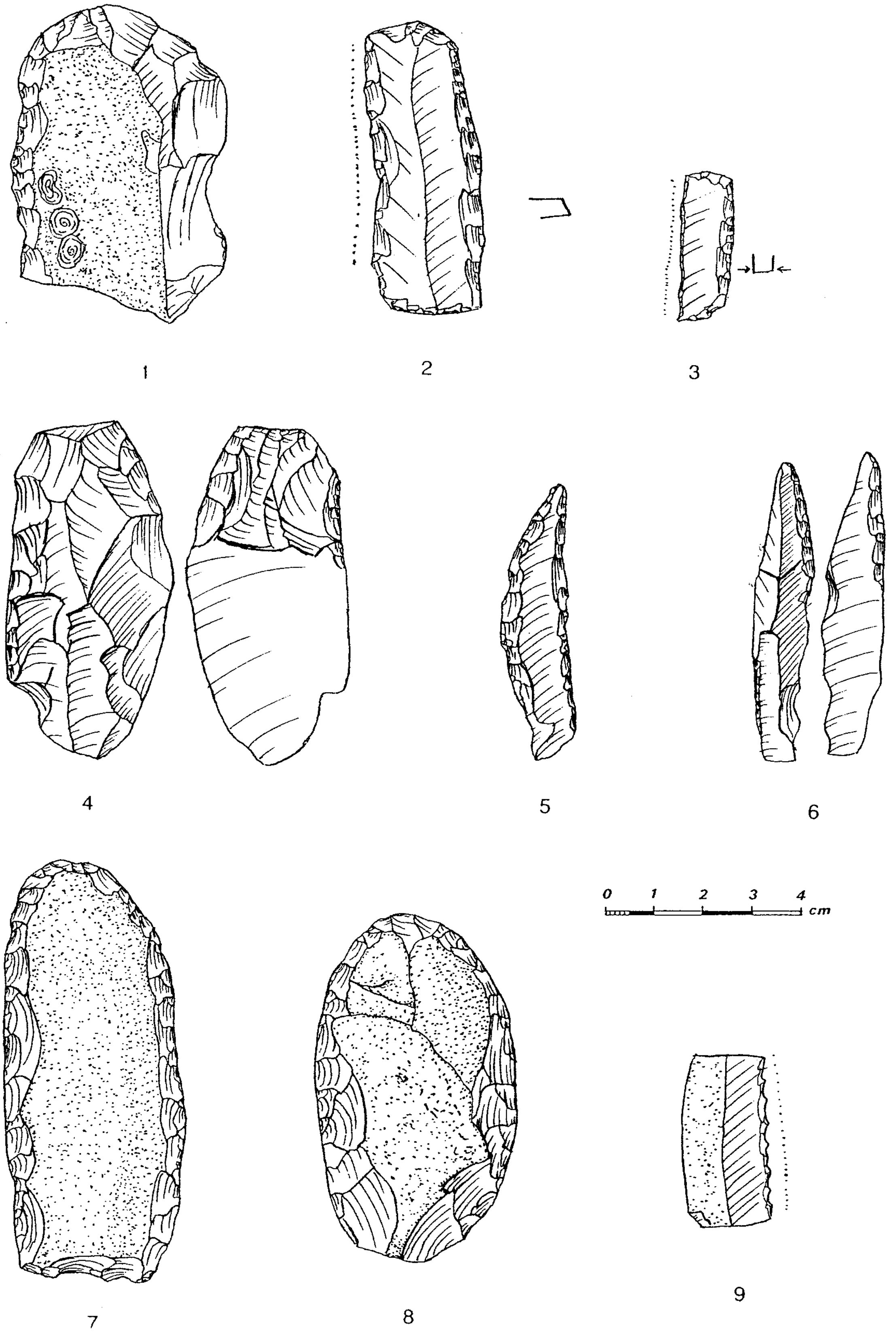

Fig. 3. 1 scraper (KS 85 ps 2), 2-3 sickle blades (KS 85 ps 2), 4 adze (KS 85 ps 3), 5 borer (KS 85 ps 1), 6 retouched blade (KS 85 ps 1), 7-8 scrapers (KS 85 ps 1), 9 sickle blades (KS 85 ps 1).

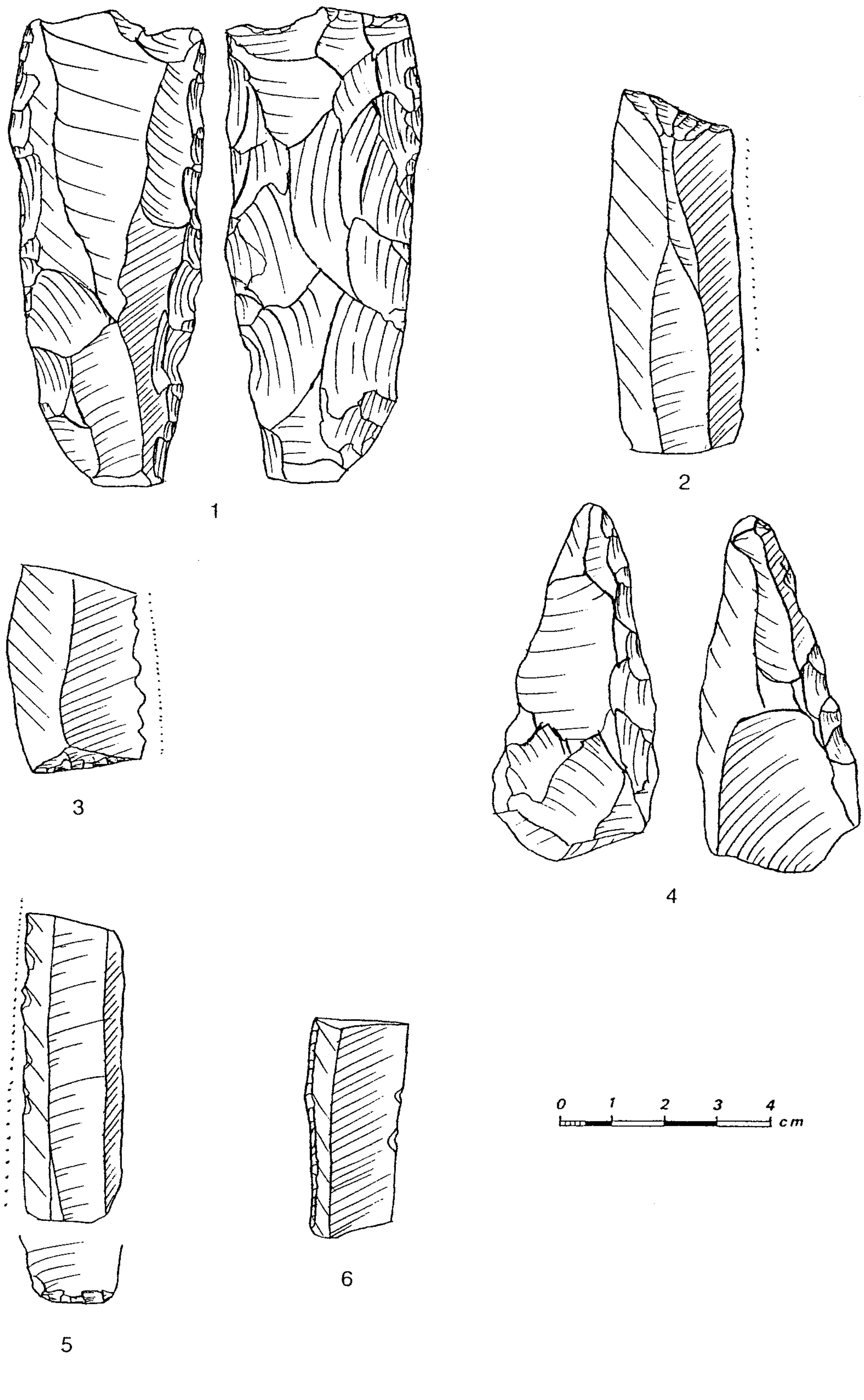

Fig. 4. 1 adze (KS 85 ps 2), 2-3 sickle blades (TS 13.6), 4 pick (KS 85 22.6), 5-6 Cananean blades (KS 85 22.4).

Locus 211

The sample contains two artifacts. One is a sickle blade backed-and-truncated at the right edge and oblique at the distal end; the left edge contains direct retouch with fine denticulation (Fig. 2:8). The remaining piece is a blade with plain butt.

Analysis of the Surface Samples

The surface collections can be grouped chronologically into clusters:

1. Ghassulian assemblages characterized by celts/adzes, fan scrapers, and sickle blades (with a rare Cananean blade (KS 85 ps 1-3);
2. earliest EB I assemblages, characterized by sickle blades (TS 13.1-3,6 and TS 14.1-3); and the
3. typical EB assemblages, characterized by Cananean blades (KS 85 22.2, 4, and 6).

Ghassulian Assemblages

KS 85 ps 1

Scrapers (2) (Fig. 3:7-8): Both are made on tabular flint. One is blade-shaped with cortex left on the upper surface (87x36x5mm.); the edges are convex and shaped by direct steep retouch, and the base is truncated with direct concave straight retouch. The other scraper is made on a flake with steeply retouched convex edges; cortex remains on the upper surface and the striking platform is faceted (70x40x40mm).

Adzes (1): This core tool is made by invasive bifacial flaking (80 x max. 42mm). The cross section is irregular, the sides are gently convex, and the distal and proximal ends are sharpened by two tranchet blows.

Sickle blades (2) (Fig. 3:9): One has an abruptly retouched back, the other edge shows signs of use and is lustrous (32x13.9mm). The other sickle blade has a lustrous edge that is retouched.

Retouched blades (1) (Fig. 3:6): It has alternate, irregular, continuous retouch. The distal end is pointed.

Borers (1) Fig. 3:5): Made on a blade, the point is formed distally by semi-abrupt retouch.

KS 85 ps 2

Adze (2) (Fig. 4:1): One adze measures 91x38mm; on the distal part there is longitudinal flaking and preparation for a tranchet blow. The adze is plano-convex in cross-section, and the working edge is virtually straight. The other adze is represented by a piece with bifacial retouch along the two edges. The working edge is slightly convex, and the cross section is lenticular.

Sickle blades (8) (Fig. 3:2-3): Six are backed and have direct abrupt retouch at the distal and proximal ends; gloss and wear traces occur on the remaining edge. For the other two, they have abrupt retouch along one edge while the other edge has wear traces and gloss. Most have a triangular section, and their lengths range between 27-55mm; the maximum width ranges between 14-21mm.

Endscrapers (2): One is made on a flake and has a semi-circular distal edge. The left edge has direct semi-abrupt retouch, and the right one has a Clactonian notch. The second endscraper is made on tabular flint, with cortex on the upper surface. The retouch of this end scraper is irregular.

Denticulated flake (1): The deep and irregular, non-continuous denticulation is on the left edge.

KS 85 ps 3

In this series we found two tools:

Adze (1) (Fig. 3:4): It is made on a thick flake and measures 64x33mm. One surface is prepared by invasive retouch on both edges. The other surface is only partially retouched at the distal end. The longitudinal section is slightly asymmetrical.

Pick (1): This heavy core tool, with whitish cortex in the central part of the piece, is pointed at one end and irregularly flaked along the distal end. The form of the distal end is rounded.

Earliest EB I Assemblages

TS 13.1-13.3

One entire sickle blade with rectangular shape was found (30x13mm); it is backed on the right edge with abrupt direct retouch. Both ends also have abruptly direct retouch; the left edge bears gloss.

TS 13.2

There are two tools; one is a sickle blade (42x12mm.) with irregular shape. The right edge has bifacial abrupt retouch, and the left edge bears signs of use and has lustrous marks. The longitudinal section of the distal end is triangular, but the proximal end has a trapezoid section. The second tool is a fan scraper made of tabular flint, retouched all along the periphery. It measures 53mm in length, 40mm in width and 17mm in thickness. About half of the upper part of the scraper is polished. The proximal end is formed by two opposite notches with an irregular flat retouch along the concave base.

TS 13.3

This collection includes one Cananean blade, some fragments of such blades, and a complete blade with partial direct retouch on the right edge.

TS 13.6

In this sample are three sickle blades. One has an oblique truncation with traces of wear on the left side. (Fig. 4:3) The second is a medial blade fragment; the left side is backed with direct abrupt retouch and the right edge has traces of wear and gloss. The third is represented by a blade fragment: its distal end has been directly truncated with abrupt retouch, and the left side shows gloss (Fig. 4:2).

TS 14.1

There are two sickle blades. Their size ranges between 52-73mm in length and 19-21mm in width. Both of them are backed on the right edge with direct abrupt retouch, and the left edge has gloss. One of them is truncated at the distal end with inverse irregular semi-abrupt retouch.

TS 14.2

There is one Cananean blade fragment with an inverse notch at the basal end.

TS 14.3

One sickle blade measures 70x27mm. The right edge has fine denticulated retouch with gloss and the proximal left edge has an inverse notch with semi-abrupt retouch.

Typical EB Assemblages

KS 85 22.2

There is only a fragment of a point with direct regular, abrupt retouch on both edges.

KS 85 22.4

This sample included three fragments of Cananean sickle blades. They have fine denticulated retouch on the left edge, which is glossy (Fig. 4:5-6). Their lengths range between 39-57mm, their widths range between 19-20mm. A fourth tool in the sample is a point with direct convex retouch along the two edges.

KS 85 22.6

The only tool was a pick made on a heavy core (65x25mm), pointed at the distal end and irregularly flaked along the edge (Fig. 4:4).

Conclusions

The chipped lithic industry of Kataret es-Samra is broadly comparable with that of EB I Bab edh-Dhra' and also with that of Khirbet ez-Zeraqoun. Especially the latter provides critical information on EB industries in general (MUHEISEN n.d.) Further comparisons can be made with materials from sites observed near the Wadi Shuneh North, and with the EB I artifacts from Wadi er-Rumman (KAFAFI 1985). And, of course, we can compare the industry of Kataret es-Samra with that of EB I Jericho (CROWFOOT PAYNE 1983), especially in terms of Cananean blades. Stratum IV of the site of Arad, dated to EBI-II (SCHICK 1978) has also close similarities. Late Chalcolithic elements such as found in Pella, Wadi Fidan, Magass-Aqaba (*e.g.*, KHALIL 1995), and sites from the Jerash

Region (HANBURY-TENSION 1986) occur, too. The industry of Tell Iktanu in the Jordan Valley also contains Cananean blades and tabular scrapers.

In Rosen's study (1982) on sickle blades, large blade types, especially the Cananean blade, are related to the EB I-II periods. The study of the flint industry of Ras Shamra indicates that by the end of the Late Bronze fan scrapers were absent, and we can assume that Cananean blades had disappeared also (COQUEUGNIOT 1991).

From all this information we may conclude that the industry of Kataret es-Samra fits into what we know of the Late Chalcolithic / Early Bronze Age I industries (end of 4th - 3rd millennium B.C.).

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Status, Perspectives and Future Goals in Jordanian Chalcolithic Research

Susanne Kerner

Problem N° 1: Chronology (Table 1)

Chronological Terminology

It is telling that six of the seven papers concerned with the Chalcolithic period either deal with the Late Chalcolithic and the EBA together (PAPALAS *et al.*, FUENSANTA, MUHEISEN, all this volume), or try and define the different phases of the Chalcolithic (BOURKE, GENZ, this volume). The two papers from the archaeometrical section, which are of importance here (REHREN, HESS and PHILIP and ADAMS, this volume), show a similar concern about the phasing and naming of the period, which is usually called the Chalcolithic. The uneasiness about the term Chalcolithic is also displayed by the avoidance of the word Chalcolithic in several of the titles of the above mentioned papers. This can also be seen in many recent articles (BOURKE 1997, DOLLFUS *et al.* 1988, PHILIP and REHREN 1996).

The problem is twofold: one reason to avoid the term Chalcolithic is rooted in its imprecise definition. The existing terminology in Jordan (and surrounding areas) is based on the European system of stone and metal ages developed by C. Thomsen and J.J. Asmussen (FINKELSTEIN 1996, WEIPPERT 1991).The use of this periodisation system is problematical in Europe and even more so in the Near East. The "Copper-Stone Age" supposedly meant a time period where stone was still the main material but copper was already being used for tools. The Chalcolithic period existed for its longest duration without any copper or other metal tools, and even in the latest Chalcolithic phases, where copper was in use in several sites, other contemporary sites never produced a single copper find. The use of copper is therefore not necessarily a chronological indicator, but an indicator of economic or social difference.

This periodisation system was supplanted in Mesopotamia by a system of consecutive periods each named after one of the sites where the material culture had been found first (Halaf, Samarra, Eridu, etc.). In Jordan (and also in Israel, Palestine, and parts of Syria) the older system has been kept, but increasingly site names have been used as period names, as in Bourke's paper that uses the term "Pre-Ghassulian" (this volume)[1].

The other reason to avoid the term Chalcolithic lies in its lack of a clearly defined beginning or end. It is a point of argument among various authors if the Wadi Rabah or Jericho PNB period is included in the Neolithic or in the Chalcolithic[2]. The problem of the beginning of the Chalcolithic period is partly dealt with in the papers by Bourke and by Lovell, Kafafi and Dollfus (this volume), where it is made clear that we still have to develop the structure in which to assess our material. The material evidence from the early periods in both sites (and others such as Jericho and Shiqmim) is obviously so different that we have considerable problems with the comparisons. Both Ghassul and Abu Hamid have been juxtaposed with Ghrubba. This site, close to Shuna South, was briefly excavated by Mellaart and showed a surprisingly rich body of painted pottery (MELLAART 1956). The

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1 Also see BOURKE for a list of site-names used as additional phase-names in Israel.

2 The clearest indication of the problematic division between the Neolithic and the Chalcolithic in this particular volume is the fact that the paper about the basal levels of Abu Hamid is set in the Neolithic section, but summarized here in the Chalcolithic section.

upper four of the 16 excavated layers were dated to the Ghassulian, while the lower 12 layers have always been described together as Neolithic, although one would expect a certain amount of internal development. The structure of the painted decoration displays a striking similarity to the incised and painted designs of the Yarmoukian Neolithic pottery. The evidence from Abu Thawwab (OBEIDAT 1995) and Abu Hamid (DOLLFUS *et al.* 1993, this volume) indicates a date for Ghrubba after the Yarmoukian and before Wadi Rabah.

The lowest level of Abu Hamid (LOVELL, KAFAFI and DOLLFUS, this volume) and the middle layers of Tuleilat Ghassul (BOURKE, this volume) have been compared with the Ghrubba material, while the middle level of Abu Hamid and the lowest layers of Ghassul have been compared to Wadi Rabah; clearly, it is not possible that both comparisons are valid. There is too little known about the decorated material from Ghassul for a final judgment, but it seems that the comparisons with Tsaf and Katareth es-Samra for Ghassul's middle layers should be preferred to the Ghrubba ones[1].

That opens the field for the difficult Middle Chalcolithic period, which so far can be defined with any certainty only in the Jordan Valley, where Tsaf, Katareth es-Samra and Abu Habil show clear signs of a period with distinctive painted pottery[2]. The Middle Chalcolithic period will be better defined (or abandoned) when the material from Shuna North, Abu Hamid and Ghassul, respectively, will prove if this particularly painted pottery constitutes its own horizon. Other areas in the region might have contemporary but very different material[3].

The Ghassulian has been taken for some time as a synonym for the Chalcolithic period. Bourke (this volume) gives a short overview about that discussion, and he makes it clear that the Ghassulian only includes layer IV from the early excavations (PBI) or layers A-C (and possibly D) from Hennessy's excavation at Tuleilat Ghassul. To clarify this should put a final stop to all tendencies to simply stick different cultural entities before the cultural sequence of T. Ghassul and so date them back to the Neolithic. It is also obvious that the Ghassulian as a time period needs further details to enable better comparisons between the northern and southern development from the Late Chalcolithic into the Early Bronze Age. After the initial proposition that the Early Bronze Age was caused by newcomers to the country (see HANBURY-TENISON 1986 for a summary), it is now generally accepted that the Early Bronze Age developed out of the Chalcolithic culture. The close connections between the Chalcolithic and Early Bronze Age material are visible in several different spheres, such as the pottery, ground stone tools and chipped stone-tools (see MUHEISEN, this volume). And while certain architectural features change (BRAUN 1989), others continue (FUENSANTA, this volume). The settlement pattern, however, changed between the two periods.

Table 1. Chronological Table

Phase	Munhata	Tab. Buma	Abu Thawwab	Abu Hamid	Ghassul	Abu Snesleh	Pella	Shuna North	Wadi Gaza	Period
classical Yarmukian	2b	x	I			x				Late Neolithic
Ghrubba/ Munhata		x	II	basal level	I H		XXXII?	I		
Wadi Rabah	2a		?	middle level	G F			I	O?	Early Chalcolithic
					D-E		?	II?	D, P	Middle Chalcolithic
Ghassulian				upper level	A-D	x	XIV+X XXII	III	A,B,D E,M,O	Late Chalcolithic
					A+	?			H	Early Bronze Age

The question of the dating of the area south of Wadi Hasa is another major problem in the Chalcolithic chronology. As Genz, Papalas *et al.* and Adams (this volume) point out, the chronological framework of the entire south of the country is anything but clear. Leaving the confusion about

1 Actually Ghassul F-G, was compared with Ghrubba and Ghassul D-E with Tsaf.

2 The structure and design of the decoration have always been compared to Ubaid material.

3 This is not the place to discuss the relevance of the Qatifian culture in depth, but it could be the contemporary (pre-Ghassulian) element in the eastern Negev. It is certainly not in one chronological slot with the lowest layers in Ghassul, as Goren has claimed (GOREN 1989, see also BOURKE, this volume).

the initial dating of Wadi Feinan aside[1], there are still considerable doubts about the existence of any clear Chalcolithic material in that area. Is it sheer bad luck that in an area which is so rich in Pre-Pottery Neolithic sites, so far hardly any sites from the Pottery Neolithic or Early Chalcolithic have been found, and only sites with a heavy leaning towards the EBA from the Late Chalcolithic have been excavated? Or is the regionalism so marked, that we simply do not recognize the southern variations (see Section 2)?

Chronological Systems

It does not matter what a period is called as long as the terms are unbiased and free of judgment. This principle was one of the underlying objectives in Finkelstein's recent approach to a new periodisation (FINKELSTEIN 1996), and most probably on Moore's older terminology (MOORE 1978). But both were more interested in other periods than the Chalcolithic, and therefore their treatment of these 1,500 to 2,000 years is understandably short. That is not the case with Joffe and Dessel's recent suggestion for a redefinition of the Chalcolithic period (JOFFEE and DESSEL 1995). Although most scholars will agree with their traditional tripartite phasing of the period and be grateful for their compilation of an extensive list of ^{14}C dates, it was not helpful to introduce value-bearing terms like "developed" in the discussion[2]. Joffe and Dessel propose an "early" phase which includes the Wadi Rabah and related cultures, then have an equally long "developed" phase, which contains all sites and layers that have been so far called "late". Their "late" phase consists only of the very late ^{14}C dates from Nahal Mishmar. This periodisation includes not only the danger of being confusing (which "late" does one mean after all?), it also neglects the problem of the so-called Middle Chalcolithic, and it helps only little to solve the chronological problems we face at the moment.

Not the smallest of these chronological problems is the more general question of how to define an archaeological period. In the southern Levant it is still very common to date a site or a layer by looking at only one component, such as one special handle type or a few particular shapes or a change in the design of one type of chipped stone tool. For a secure and well-working framework of chronological entities, it will be necessary to include an entire assemblage with not only its material evidence, including pottery, stone, architectural forms and small finds, but also the underlying economic, social and religious organisation (see Section 5). The dating and definition of the Pre-Pottery Neolithic periods is more developed in this concern, as can be seen in several contributions in this volume.

Some attempts to analyse these forms of evidence come from the neighbouring Negev, where an unrivaled wealth of information is available from the Late Chalcolithic (GILEAD 1989, 1993; LEVY 1986; ROSEN 1987). But even there an argument continues about the chronological or social reasons for the differences in the material culture of the Wadi Beersheba and the Wadi Gaza sites (KERNER n.d.).

Problem N° 2: Regionalism

As already pointed out by Baird (this volume), regionalism started early in the region. In the Early Chalcolithic period the Wadi Rabah culture and the Jericho PNB culture are the most prominent representatives, but they are neither identical nor are they the only cultural traditions of the time. Jericho PNB (and Jericho VIII), Abu Hamid and Ghassul produced material which is similar, but so far it can not be very well aligned. Abu Hamid and Ghassul have the first wall-paintings, but no other site shows even a sign of such. Particularly the areas in the north (Golan and Hauran), the south (south of Wadi Hasa) and the east show a remarkable lack of similar material.

The same is true for the even less well defined Middle Chalcolithic period, which so far can only be found on both sides of the Jordan Valley. A probably contemporary culture, which shows only negative correspondence[3] to the Jordan Valley culture, can be found in the area of Qatif and Wadi Gaza (GILEAD 1990).

The Late Chalcolithic period shows very clear regional differences, although all these regions seem to share a cultural identity. Yoffe has described for the different Mesopotamian periods how an understanding of cultural identity can survive even political breakdowns (YOFFEE 1979). This cul-

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1 Gilead described Wadi Fidan material as Neolithic (actually Qatifian), which was taken up by others (GILEAD1990, GOREN 1990, ROTHENBERG and Glass 1992). It should be clear by now that Neolithic material comes from Tell Wadi Feinan (NAJJAR 1992) and Late Chalcolithic-EBA material comes from Wadi Fidan (GENZ, ADAMS, both this volume, see ADAMS for detailed description).

2 Terms such as"developed" or "mature" have been purposefully removed from the terminologies of the other Near Eastern regions.

3 The connecting negative evidence compared with the earlier Wadi Rabah culture consists of a very low percentage of burnished pottery and only modified bow-rim jars and concave vessels.

tural identity in the Late Chalcolithic can be seen in the general similarity of architectural features, pottery and stone tools. Identical pottery shapes were produced from local material. The northern Jordan Valley, middle Jordan Valley, southern Jordan Valley, Golan and northern plateau, central plateau and southern Jordan are all distinct cultural entities. The northern and middle Jordan Valley units include the east and west banks. Other units west of the Rift Valley are the western Negev, eastern Negev, Judean desert, coastal plain, northern region and the Judean and Samarian hills. There is close to nothing known about the eastern desert until the founding of Jawa.

The full Late Chalcolithic repertoire, with V-shaped bowls, jars with spouts, churns, cornets, basalt-bowls, pottery-figurines, violin-shaped stone figurines, and metal finds, exists only in the middle and southern Jordan Valley and the Negev. These areas also show distinct signs of larger cultic activities as shown by the buildings in Ghassul, Ein Gedi, and Gilat. The only large cemeteries (other than caves) are also found close to Ghassul and Shiqmim. The northern area and the eastern plateau however, display no churns, cornets, figurines, or metal-finds, while all other finds are identical[1]. The social-political implications of these differences will be examined further in Section 5.

The area south of Wadi Hasa is another problem because of its unclear chronology, as Genz (this volume) makes clear. As Papalas *et al.* (this volume) for Wadi Hasa and Henry for the Hisma-region (HENRY 1995) have shown, it is extremely difficult to date survey finds in the south to the Chalcolithic or Early Bronze Age. The V-shaped bowls, so recognizable in even the smallest sites (making up to 60% of the entire pottery repertoire in most areas) are hardly existent in the south of Jordan. In the entire excavation in 1998 at Magass, only one sherd that might have belonged to a V-shaped bowl was excavated.

The impression is gained that the different regions developed with very different speeds. While the Jordan Valley seems to be an early runner with its early painted pottery, wall-paintings and seals, the Negev region is by far the most developed area at the end of the period. The regions to the north and east seem to share a general cultural identity, but they did not develop to the same level of complexity.

Problem N° 3: Prestige Items, Ritual Items, and Specialization

Although not an important topic in the contributions for this volume, the discussion about prestige items, ritual and ritual or symbolic items, specialization and their relationships with social ranking or stratification is a vivid one. A clear concept of these topics should help to structure the ongoing debate. Prestige as an organising principle existed already in egalitarian societies, but it can appear in immaterial as well as material form (MÜLLER and BERNBECK 1996). In archaeology we are only able to deal with the material form in the shape of prestige items. These are characterized by expensive material, a complicated, secret or time-demanding production process and an elaborate decoration. Prestige-items should also have an irregular distribution pattern. Ritual items are much more difficult to recognize because everyday items can take on ritual meanings in certain, precisely ritual, contexts. Therefore they will not necessarily differ from everyday items, and thus may not show a special distribution pattern. And neither prestige items nor ritual items inevitably point to the existence of specialized production (KERNER, this volume).

Metal

The Chalcolithic is the first period in Jordan where copper was used as a metal and not only as an ore. The use of metal (gold and copper) starts relatively abruptly, but it might have been inspired by a growing experience in the fire-related production of pottery and even more so of lime-plaster. Copper production is two-fold and consists out of two different raw-materials. The nearly pure copper, which mostly comes from Wadi Feinan (and in smaller amounts probably from Wadi Timna) is mainly, but not exclusively, shaped into tool-like items. The other raw material is arsenic-rich copper, which also includes high percentages of either antimony or nickel and comes from outside the region[2] (TADMOR *et al.* 1995). This imported material is mainly but not exclusively shaped into elaborate items like mace-heads, maces, cylinders ("crowns) and other forms. By far the largest percentage of all metal finds came from the famous Cave of Treasures in Nahal Mishmar west of the Dead Sea (BAR-ADON 1980). The gold, or better electron, rings from Nahal Qanah (GOPHER and TSUK 1991) are the only gold-finds so far from the Chalcolithic period, but recently silver has been found in the Early Bronze Age levels in Shuna (PHILIP and REHREN 1996).

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1 But at least one earlier theory about even stricter cultural divisions between the regions has to be abandoned: the clay ossuaries, which were only known from the coast, exist in several other regions west of the Jordan river and co-exist with other forms of burial. The discovery of the cave in Peq'in has proven that under some circumstances, which we still cannot name precisely, items which are normally correlated with certain different regions can be found together (GAL *et al.* 1997).

2 The sources could be in the Caucasus, in northern or central Iran.

In Jordan, copper has been found in Shuna, Abu Hamid, Ghassul, Wadi Fidan, and Magass, and all of these finds are tools or tool-shaped items such as hooks, awls and chisels. Although mace-heads are a very frequent find at all those sites, not a single one made from metal has been found so far. The identification of the chisel-shaped articles as tools is questionable: although the shapes are suitable, the items are not hardened appropriately and would therefore not have been useful as chisels. The number of metal "chisels" is also very limited compared to their stone equivalents. Hauptmann put forward the hypothesis that those "chisels" might be ingots (HAUPTMANN n.d.). This hypothesis might be strengthened by the results from Shuna North, where there is clear evidence for on-site copper production. The EBA I copper finds are of arsenic-nickel copper and could be interpreted as ingots. If this were the case, Shuna might be a centre for copperworks from where the ingots were distributed to other sites, where they were worked into differing items. (REHREN, HESS and PHILIP, this volume).

It should be noted that all Chalcolithic metal finds in Jordan are non-prestige items. The influence of the development of metal-work on the society will therefore have been rather small (ROSEN 1993). The regions with the highest level of metal prestige items are the Negev and the Judean Desert. The results of recent research into the chemical composition of several metal finds, mainly from those areas, reflects in my opinion the existence of two at least spatially independent production cycles: a production of arsenic (and Sb or Ni) rich copper outside the excavated sites, where we have absolutely no signs for any such production before the EBA metal production in Shuna (see above), and domestic production inside settlements like Abu Matar, Abu Hamid and others, where mainly local copper (sometimes with recycled imported copper) was worked into tools and probably ingots. In order to get a more precise idea about those production processes, we will need many more analyses of copper, ore, and slag to prove their provenance and treatment.

Other Materials

Other objects that have been interpreted as prestige items include V-shaped basalt bowls. They most probably were produced from carefully chosen basalt, not necessarily from the nearest basalt source, but perhaps from better quality deposits (see KERNER, this volume, for a summary). They were produced in very limited numbers, and their distribution pattern is very even, insofar as they have been found in every site but without any recognizable intra-local patterns. So they should more probably be interpreted as a ritual item parallel to the Golan basalt stands, which have been interpreted by Epstein as household-altars (EPSTEIN 1975).

Recently V-shaped pottery bowls have been viewed as items with possible ritual meaning (ROUX and COURTY 1997) because they were traded from the Negev to several other sites including Abu Hamid and probably Ghassul. But I find it very difficult to interpret an item, which forms the majority (up to 60%) of all pottery-assemblages, as ritually associated.

Problem N° 4: The Most Numerous Artifact Class: Pottery

It seems to be 40 years too late to start discussing the treatment of pottery in excavations again, and still it seems to be necessary when one looks through recent publications. Large excavation reports appear without a single statistic about the wares or shapes or decoration of the pottery, and large amounts of uncounted pottery are still discarded (and these are not just the pieces smaller than $2cm^2$). Probably even more problematic is the difference in the precision of fabric description. Although several authors (RICE 1987, SHEPARD 1974) have published extensive summaries with relevant information and proven how important all those aspects are, it is still necessary to point out the need for explicit descriptions (see LOVELL, KAFAFI and DOLLFUS, this volume) that will enable meaningful comparisons[1]. From how many sites do we know: 1) if local material was used, 2) if the percentage of certain shapes changed over time, 3) if decorated and undecorated pottery was produced from the same material[2], 4) how decoration changed through time, or 5) what the percentage of wheel-finished pottery was?

Only precise descriptions of the exact nature of the material make comparisons possible[3]. Two exceptional instances of research into the possibilities of pottery-analysis enable us, for example, to discern trade patterns (ROUX and COURTY 1997) and to demonstrate specialized production (WATTENMAKER 1990). Statistical information about fabrics, shapes and decoration makes a sensible and detailed comparison between different layers possible (inter-local and intra-local), and only knowledge about the organization of production makes broader comparisons useful. With this

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1 Such discussions formed part of the conference about EB pottery (see LOVELL, KAFAFI, and DOLLFUS, this volume).

2 From Katareth es-Samra, for example, only the decorated pottery is known (LEONARD 1989), and nothing has been published about the 95% undecorated pottery.

3 A good example of the difficulties in comparing incompletely or very differently described material are the Early Chalcolithic assemblages from sites other than Munhata or Jericho (KERNER n.d.).

approach villages can be compared with villages and centres, if they existed, can be compared to centres. Research in Oaxaca Valley (FEINMAN 1985; FEINMAN, KOWALEWSKI and BLANTON 1984), which used information about the diversity of pottery production to create a picture of the political change in the valley including periods of stronger centralization and more dispersed production, could be a useful example.

All the above is valid for other material groups, too (see also ROSEN 1987 and BARBERAN, this volume), and attempts have been made in the recent years with chemical- and source-analyses of basalt and flint, as well as the growing amount of research into metal, to show how much clearer our understanding becomes when we know the basics.

Problem N° 5: The Social Organisation

State of Research

The nature and characterisation of chiefdoms has been the focus of several debates. Firstly, the very strict step-typologies of social and political development of the 60s and 70s were forsaken for a more flexible structure (e.g., JOHNSON and EARLE 1987, YOFFEE 1993). Chiefdoms were described as possible steps of development between tribal or big-man societies and states. But they were released from this confining condition as stepping-stones on the way to the state. Chiefdoms did not develop inevitably into states, and they were much more stable then they have been described in the past.

Secondly, several features of chiefdoms were reconsidered, and as a result of this reconsideration they were partly abandoned and partly restructured. While a chiefdom was originally supposed to be characterised by redistribution, warfare and an unstable nature, it has now been shown by several authors (EARLE 1987, FEINMAN and NEITZEL 1984, PEEBLES and KUS 1977) that chiefdoms can exist for long periods of time (up to 1500 years in Hawaii) without any distinct signs of the chiefs' redistributional functions and even be very peaceful for long periods. This gives a greater freedom to investigate the social system of the Jordanian (or the more general southern Levant) Chalcolithic, which continued for over 1500 years without any great signs of violence[1] and with little sign of strong chiefs who could have directed redistribution. The distinction in chiefdoms, which are either based on wealth or on staple-financing (D'ALTROY and EARLE 1985), gave us another tool with which the simple, non-wealth oriented organisation of the Chalcolithic chiefdoms could be explained.

Jordanian Chiefdoms?

Research into the social or political organisation of the Chalcolithic has not been one of the major concerns of Jordanian prehistory. It is mainly Thomas Levy who, following his excavation of Shiqmim in Wadi Beersheba, has suggested the interpretation of the social system of that particular region as a chiefdom. His supporting evidence includes a two-level settlement system, the development of specialized pastoralism, the importance of metallurgy, grave-goods for a small child as a sign of stratification and irrigation-systems (LEVY 1995). This is not the place to investigate all of Levy's arguments in detail, which are sometimes based on a single case or cannot be dated into the Chalcolithic with a great deal of certainty. But his general point, that we deal with a social system of emerging social difference, should be taken very seriously and looked at more closely.

I cannot fathom any considerable differences in the social structure of the Early Chalcolithic society, and we have too little material from the Middle Chalcolithic period for any statement concerning social (or in fact any other) organisation. The Late Chalcolithic period provides us with a different picture, although much more knowledge is necessary for more detailed interpretations. Most sites give a rather egalitarian impression in their architectural features and their material distribution, but a few signs of differences are recognizable. The house complexes in Ghassul as well as in Shiqmim and in the Golan have unequal sizes. In Ghassul the existence of wall-paintings might be an indicator as well. The cemetery at Shiqmim (and some graves at Ghassul) seems to show different degrees of labour involved in the construction of the graves (LEVY and ALON 1982)[2]. The development of craft specialization points to a society with a certain amount of functional differentiation or horizontal complexity, and horizontal complexity is normally tied together with vertical complexity (ROTHMAN 1991). At the end of the Late Chalcolithic period, particularly in the Negev, a more stratified society developed, which had one of its expressions in metal and probably also ivory prestige-items. The temple at Gilat with its rich cultic equipment might also be part of this development.

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1 City-walls became widespread features only in the later EBA.

2 It is not yet possible to postulate a clear correlation between grave-goods and the amount of labour for the graves themselves.

The social organisation of the Late Chalcolithic might have been a kin-based, group-oriented (EARLE 1987) chiefdom, which was for most of its time not organised on the basis of wealth and therefore neither showed signs of rich chiefs nor of explicit and large accumulations of wealth in societies in general.

Cult

The cultic beliefs and ritual habits of Chalcolithic populations have hardly been studied at all. The extended excavation of the temple area E at Ghassul will provide us with one more example where a complete assemblage associated with a Chalcolithic cultic building can be found (BOURKE 1997). If this assemblage is comparable with the material from Gilat and probably even Ein Gedi, it might be possible to draw more general conclusions about public cults. This could then in turn be juxtaposed with the evidence from other places, where more private ritual habits might have existed, reflected by such evidence as the basalt-stands from the Golan, hollow pottery-figurines from the Jordan Valley and the Negev (AMIRAN and TADMOR 1980, KAFAFI n.d.), basalt bowls from the entire region, and probably some other items of so far uncertain character.

Future Research

Several issues have been mentioned as being particularly worthy of further research or in need of a clearer definition. They include:

1. The main question of how to define a period, and as part of this issue the necessity to define a clear borderline between the Neolithic and the Chalcolithic.
2. The investigation of differences in the Late Chalcolithic material as either chronologically or socially caused.
3. As a particular problem, the Middle Chalcolithic Culture and its geographical boundaries.
4. The identification of the exact role of regionalism.
5. Questions relating to the economic organisation of the periods and particularly to the degree and kind of specialized production.
6. The interpretation of certain items as prestige items and the importance of them for the social organisation of the society as well as their role in the changes at the end of the period.
7. The question of the particular role of metal in the Late Chalcolithic society.
8. Comparisons between "public" and "private" cultic life and their material evidence.

For the most promising approaches in fieldwork and related studies, I can only repeat the points BAIRD (this volume) has made:

1. Area-based projects with intensive survey and catchment analysis.
2. Regional projects for specific questions.
3. More contextual and detailed information during excavations (which would enable intra-site variability studies[1]).
4. More systematic collections of environmental data.
5. Research in a restricted area in order to get a long, unbroken chronological sequence[2] and also a clear picture about the different types of sites.
6. Much closer cooperation with natural science research for provenance studies, information about specialisation, trade in cultic items, etc.

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1 As SMITH 1994 has done for an Aztec site.

2 Like the Deh Luran project (HOLE, FLANNERY and NEELY 1969).

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Tracking Activity Patterns Through Skeletal Remains: A Case Study from Jordan and Palestine

Jane Peterson

Abstract: *The transition to village agriculture represents a fundamental shift with profound implications for human social organization. The wealth of Natufian and Pre-Pottery Neolithic (PPN) skeletal material from the southern Levant provides a unique baseline from which to infer diachronic organizational change. Specifically, robusticity scores for muscle attachment sites are analyzed to track sexual labor divisions. The advent of domestication economies appears to entail increases in physically demanding tasks among both men and women. Fewer significantly different scores and decreasing lateralization among men are two trends that suggest a degree of convergence in habitual activities between the sexes during the PPN. Conversely, the Natufian population exhibits scores reminiscent of more sexually segregated labor patterns. These preliminary results underscore the potential of human skeletal material in discussions of prehistoric social issues, and should encourage researchers to improve sample size through careful excavation, documentation, and preservation.*

Introduction

The causes and consequences of the transition from foraging lifestyles to those dependent on farming and animal husbandry continue to be significant research domains for archaeologists throughout the world. Jordan plays a central role in these inquiries because it is here, in the southern Levant, where plant domestication led to the establishment of the first settled, agricultural villages. Researchers have long recognized that social restructuring should rightfully be considered among the forces crucial to the introduction and success of domestication economies (BENDER 1978, 1985; FLANNERY 1973; REDDEN 1978; SMITH 1976; STARK 1986). Unfortunately, attempts to identify an empirical basis for the social organizational component in this process are rare. This theoretical stalemate provided much of the incentive for this study (Peterson 1994).

At the level of household structure, there have been some important studies of Natufian and Neolithic social organization (BANNING and BYRD 1987, BAR-YOSEF and BELFER-COHEN 1991, FLANNERY 1972, HENRY 1989). Domestic architectural variability, labor system organization, task group composition, and sexual divisions of labor are among the topics discussed in these models. Several authors agree that changes in the size and shape of domestic architecture imply changes in residential, productive, and consumer groups (BANNING and BYRD 1987, FLANNERY 1972). For Flannery, circular hut compounds suggest a social organization similar to that of earlier hunter-gatherer bands, with single-sex task groups performing extractive tasks. The products of these sexually divided forays would then be widely shared among the entire group (FLANNERY 1972: 25, 31). In settlements with rectangular masonry/stone houses, he views the nuclear family as the basic unit of production and consumption (FLANNERY 1972: 42). More specifically, Pre-Pottery Neolithic B (PPNB) houses at 'Ain Ghazal and Jericho exhibit increases in size, differentiation of interior space, and remodeling consistent with the family-based, co-residential units (BANNING and BYRD 1987).

Changes in sexual labor divisions can be anticipated during these major organizational and adaptive shifts (BAR-YOSEF and BELFER-COHEN 1991, REDMAN 1978). Despite the fact that the sexual division of tasks is considered one of the most fundamental organizing principles of human groups, efforts to describe or reconstruct engendered labor patterns have tended to be entirely speculative, incomplete, or ignored (CRABTREE 1991, PETERSON 1994).

Recently, human skeletal remains have begun to provide some important data relative to habitual activities and sexually divided labor. Various measures of sexual dimorphism have been used to examine functional differences between and among groups in both Epipaleolithic and Neolithic groups (BELFER-COHEN *et al.* 1991; MOLLESON 1989, 1994; RATHBUN 1984; SMITH *et al.* 1984). Smith, Bloom, and Berkowitz (1984) document patterns of sexual dimorphism in numeral cortical thickness measurements (CCT) indicating that Natufian males had higher functional demands compared not only to Natufian females, but also males from later agricultural groups (MBI, Roman/Byzantine, and early Arab). These differences are most pronounced in the right arm, and are tentatively linked to launching projectile armatures during hunting (SMITH *et al.* 1984: 608). Female CCT values exhibit less pronounced diachronic change, suggesting less significant alterations in overall functional demands through time (Smith *et al.* 1984).

Rathbun synthesized the available stature data for human remains from Iran and Iraq. Compared to preagricultural, Bronze Age, and Iron Age groups, Neolithic populations exhibited the least sexual dimorphism (RATHBUN 1984). While acknowledging the variety of factors influencing stature, the author contended that the convergence of stature during the Neolithic may indicate less activity differentiation during that period (RATHBUN 1984: 146). Furthermore, female stature is more stable through time compared to male stature. Rathbun conjectured that male activity regimes may have undergone more pronounced changes through time than those of females (RATHBUN 1984: 147).

Among the Epipaleolithic and Neolithic inhabitants of Abu Hureyra, some task-specific activity inferences have been advanced. For example, Molleson (1994) linked the robusticity of *deltoid* and *biceps brachii* muscle attachment sites; bilateral symmetry in these muscle patterns; and degenerative changes in the spine, knee, and metatarsals to cereal processing activities using querns. Sex-specific patterning in this suite of skeletal characteristics led Molleson to suggest that cereal grinding was primarily the work of women and girls (MOLLESON 1994: 73). The author also identified sexually dimorphic patterns of dental grooving which she links to basketry production and the use of teeth as auxiliary hands (MOLLESON 1994: 74).

Several hypotheses regarding sexual labor patterns in the Natufian and Neolithic of the southern Levant can be formulated from these results. First, there is evidence to suggest that the sexual differences in functional demands during the Natufian were more pronounced than in the following periods. The relatively widespread ethnographic pattern of male hunting and female plant processing (MURDOCK 1937, MURDOCK and PROVOST 1973) may be contributing to this pattern. Changing labor demands associated with the production of domestic plant and animal foods result in less noticeable differences between males and females, although processing plant foods continues to be associated primarily with females.

This paper focuses on the potential of using musculoskeletal stress markers (MSM) on material from sites in the southern Levant as another line of data with which to test these hypotheses and clarify the nature of sexual labor divisions across the transition to domestication economies. MSM are distinct markings on cortical bone involving the attachment sites of specific muscles and ligaments. They have been correlated with habitual activities in a wide variety of studies. The analysis rests on the assumption that the degree of expression and type of marker are related directly to the amount and duration of habitual stress placed on a specific muscle (HAWKEY 1995). Reconstructions of prehistoric labor patterns in the southern Levant are explored by tracing gross patterns of muscle robusticity, identifying patterns of bilateral asymmetry, and looking for complementary patterns among synergistic muscle groups related to specific activities. In addition to reporting on the results of this study of Natufian and Neolithic skeletal material, recommendations and cautions in the applications of these methods are synthesized in light of the current literature on the subject.

Data and Methods

The examination of human skeletons for indications of life stresses has a long and colorful history. Studies have emerged from various fields, most notably from industrial medicine, sports medicine, and anthropological skeletal biology. Occupational stresses have been inferred from patterning in degenerative joint disease (MERBS 1983, TAINTER 1980); dental attrition (BARRETT 1977, LARSEN 1985, MERBS 1983), trauma (FARQUHARSON-ROBERTS and FULFORD 1980, LEVY 1968), diaphyseal dimensions (BRIDGES 1985, LARSEN and RUFF 1991, STIRLAND 1993), sexual dimorphism (RATHBUN 1984, TRINKAUS 1980), and MSM (HAWKEY 1995, KELLEY and ANGEL 1987, KENNEDY *et al.* 1986, PETERSON 1994, ROBB n.d.). Changes in bony architecture and surface markings have been used to make forensic identifications as well as to infer activities among archaeological populations.

The role of MSM to test specific archaeologically derived hypotheses in prehistoric contexts has increased recently (DUTOUR 1986; HAWKEY 1988, 1995; KENNEDY 1983; MOLLESON 1989, 1994; PETERSON 1994). Formal methodological standards for coding muscle attachments at various sites have been identified (HAWKEY 1988, ROBB n.d.). Studies have begun to show increased sensitivity to age-related variance (HAWKEY 1988, 1995, ROBB n.d.) and normal skeletal asymmetry (STIRLAND 1993). Important cautions have been expressed regarding the utility of MSM in archaeological studies, including 1) the importance of examining synergistic muscle groups vs. isolated muscles (STIRLAND 1993); 2) the limited nature of the archaeological and ethnographic records as bases for inferring the full task spectrum (HAWKEY 1995, PETERSON 1994, ROBB n.d.); 3) the degree of genetic isolation (HAWKEY 1995) and 4) the benefits of correlating MSM patterns with skeletal pathologies, particularly evidence for degenerative joint disease (MOLLESON 1989, 1994). Bearing these developments in mind, analyses of upper extremity MSM on Natufian and Neolithic groups from Jordan and Palestine were undertaken.

The skeletal material comes from five Natufian and eight Neolithic sites (Table 1). In order to improve sample sizes, Natufian and Neolithic collections were aggregated during most analyses. Within these samples considerable regional and temporal variability are present. Therefore an operating assumption of this study is that activity patterns within the two time period groups will be more broadly similar than between groups. The Kruskal-Wallis procedure, conducted to test for significant variability between MSM mean scores between sites, supported this assumption for most Natufian cases (PETERSON 1994). Unfortunately sample size constraints limited the applicability of similar tests among Neolithic sites.

A total of 106 skeletons was included in the study. These individuals represent a subset of the individuals examined. A variety of factors led to the exclusion of some skeletal remains. Poor cortical preservation (caused by natural processes, sometimes "rigorous" excavation and cleaning techniques, etc.) was clearly an important exclusionary factor. Individuals who exhibited evidence of healed fractures or severe degenerative joint disease on the upper appendicular skeleton were also excluded. These conditions might have had significant skewing effects on both activity level and degree of lateralization. Individuals for whom determinations of adult status and sex could not be made reliably were also removed from the sample (see Note). In the end, the Natufian sample consisted of 45 males and 27 females. The Neolithic sample is considerably smaller, consisting of 19 males and 15 females.

Five elements of the upper arm and shoulder were examined with reference to 22 distinctive muscle and ligament attachment sites (17 muscle insertion sites, 2 muscle origin sites, and 3 ligament sites on the clavicle, scapula, radius, ulna, and humerus). Insertion sites were emphasized because muscle contraction generally produces the maximum amount of pull at its insertion (KENNEDY 1989). Four flexor muscles originate from the medial epicondyle of the humerus, and four extensors from the lateral epicondyle. These common origin sites were considered adequate indicators of maximum muscle pull for these groups (HAWKEY 1995).

Two categories of MSM expression were scored: robusticity markers and stress lesions. Within each category, four grades were differentiated. Using a visual reference system devised by HAWKEY (1988) which identifies threshold criteria for each grade, inter- and intra-observer errors have proven negligible in a variety of studies ($p < 0.50$) (HAWKEY and STREET 1992, NAGY and HAWKEY 1993, PETERSON 1994).

Robusticity Category

Under normal mechanical stress, muscle contraction produces roughened, distinct patches at attachment sites (Plate 1:A-C). These markings are sometimes described as tuberosities, crests, and tubercles. Periosteum covers the entire bone and is well-supplied with blood vessels (WEINECK 1986). When regular, minor stress occurs, such as the "pull" at insertion sites during muscle use, the amount of capillaries supplying the affected area increases (WIRHED 1984). Increased blood flow stimulates osteonal remodeling where there is greatest muscle activity (HAWKEY 1988, LITTLE 1973). Enlargement, or hypertrophy, of the muscle attachment site results (WEINECK 1986).

Stress Lesion Category

Under certain conditions, continual microtrauma appears to result in a groove or furrow in the bone at the muscle attachment site (Pl. 2:A). In these cases the bone apparently responds by being resorbed more quickly than it is being laid down (HAWKEY 1995, KENNEDY 1989). These grooves often superficially resemble lytic lesions. The location and character of these lesions suggest that neither post-mortem erosion nor disease are responsible, but the aetiology of this MSM is currently not well understood (HAWKEY 1995).

For the purposes of quantitative comparison, each score for each site was measured ordinally on a scale ranging from no expression (0) to strong expression (3) for each MSM category. The total enthesopathy score was calculated by combining the scores for the robusticity category and the stress lesion category (possible score range = 0 through 6). Total mean scores for both males and females were calculated for each time period. Bilateral expressions were scored when individual skeletal completeness allowed, and these results provided the basis for the asymmetry analysis. Elsewhere right side scores were compared with right scores and left with left.

Plate 1:A. Examples of the robusticity category at the *biceps brachii* insertion site. Scores from left to right are: 1.0 = slight indentation at the site of attachment, but no well-defined surrounding margin of bone; 2.0 = roughening of the attachment site occurs with well-defined surrounding medial and lateral margins; 3.0 = ridges and crests forming around medial and lateral margins which form plateau-like tuberosity. Plateau may have deep indendations.

Plate 1:B. Examples of the robusticity category at the *triceps brachii* insertion site. Scores from left to right are: 1.0 = some roughening or slight striations along posterior margin of superior facet; 2.0 = posterior margin is well defined, with a sharp ridge present, but no cresting.

Plate 1:C. Examples of the robusticity category at the *deltoideus* insertion site. Scores from left to right are: 0 = Absent; 1.0 = slightly rounded, weak mound of cortex. The elevation is apparent to the touch, although no distinct crests or ridges have formed; 2.0 = the cortical surface is uneven, with a mound-shaped elevation that is more pronounced. Roughened ridge forming; 3.0 = well-developed, distinct ridge has formed with clearly visible lateral bulge.

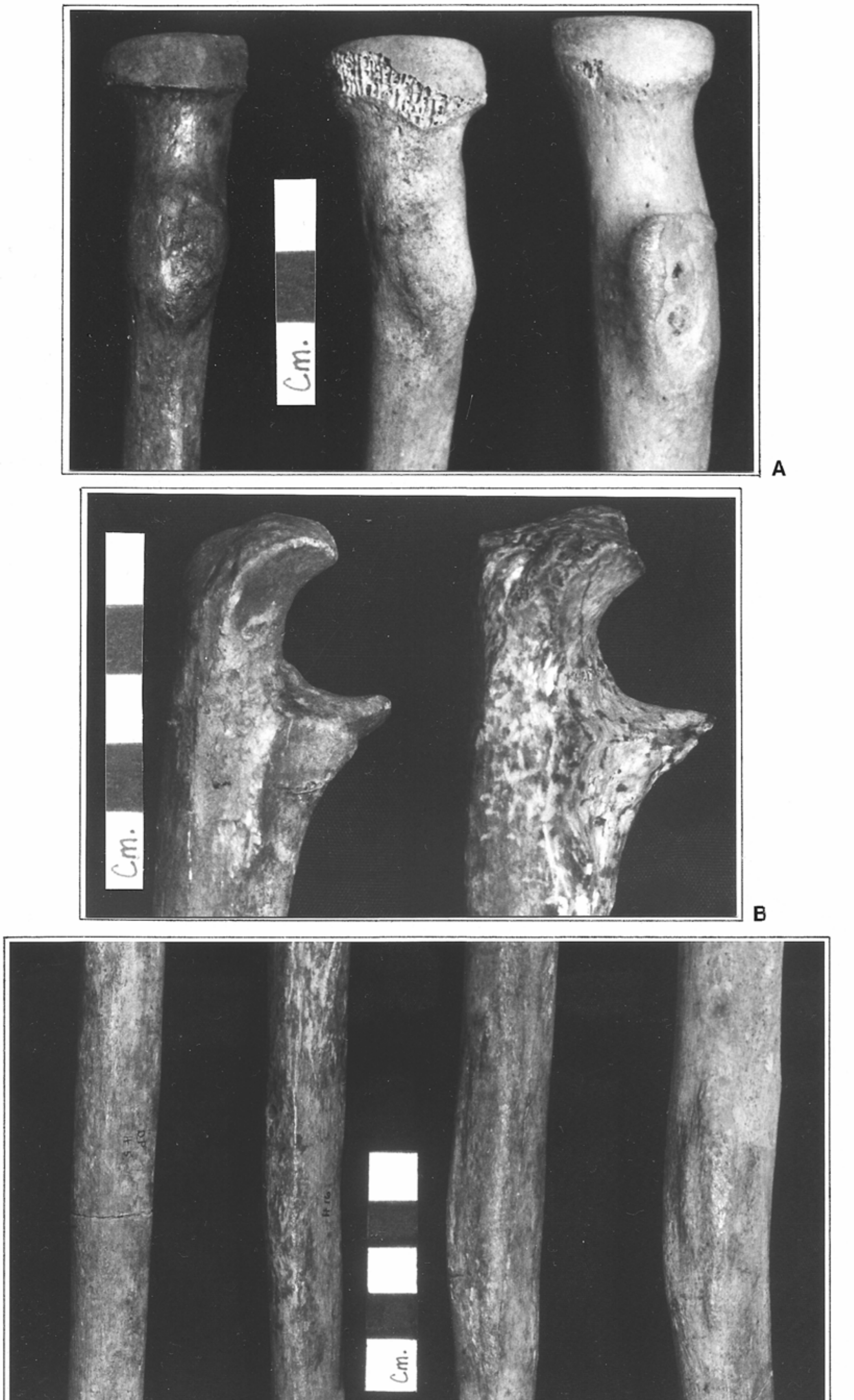
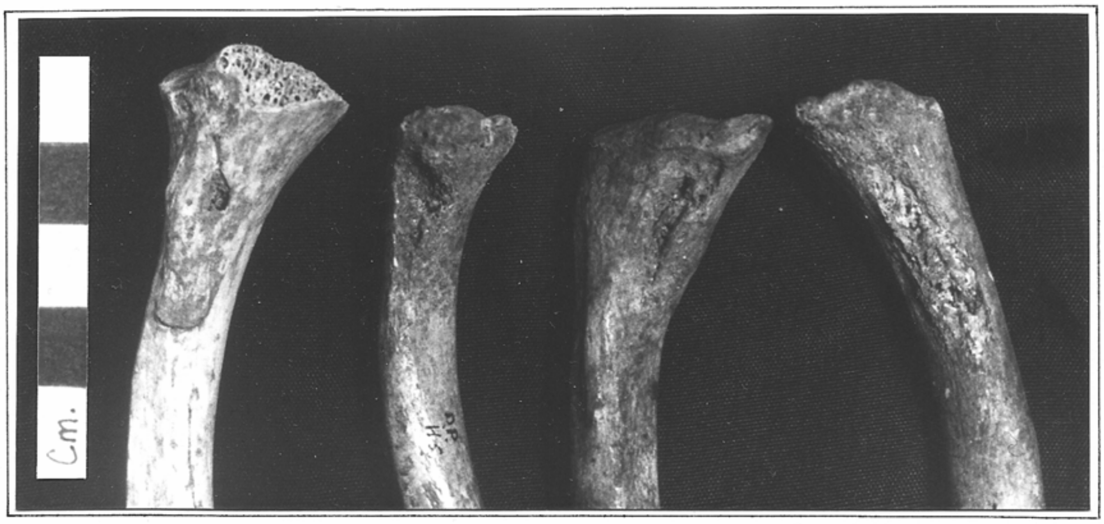
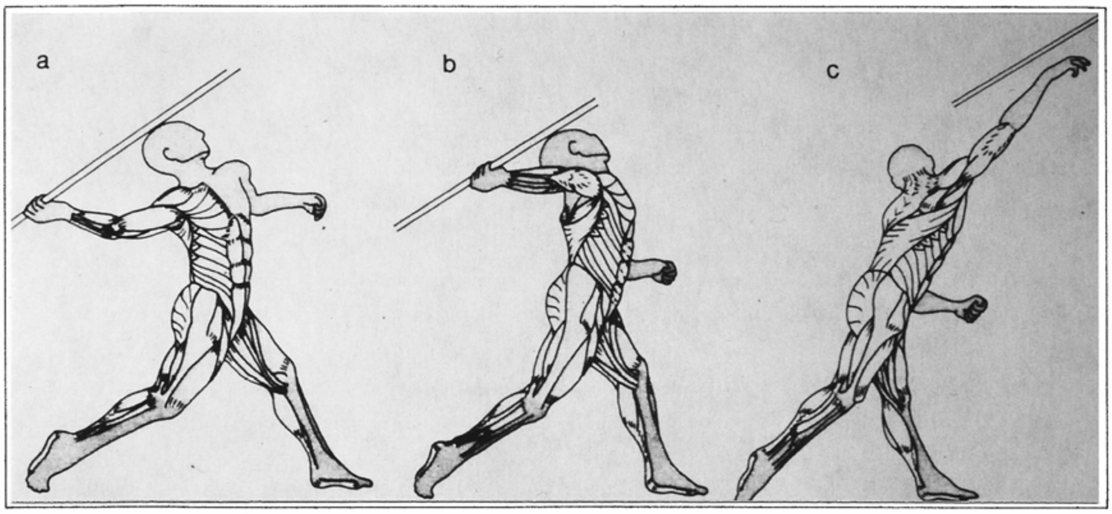


Plate 1.



A



B


C

Plate 2.

Plate 2:A. Examples of the stress lesion category at the costoclavicular ligament site. Scores from left to right are: 1.0 = shallow furrow in which pitting occurs giving cortex a lytic-like appearance. Furrow is less than 1mm in depth; 1.0 = ditto; 2.0 = the pitting covers larger surface area and varies from greater than 1mm, but less than 3mm in depth; 2.0 = ditto.

Plate 2:B. The muscles involved in javelin throwing (from WEINECK 1986:163).

Plate 2:C. Muscle posture associated with forward stroke in reciprocal grinding. The individual is a Piman woman grinding wheat on a metate (from RUSSEL 1980: 109).

Table 1. Inventory of skeletal sample.

Sites/Periods	Male Count	Female Count	Total
Natufian			
Hayonim Cave	12	5	17
Kebara	5	1	6
El Wad	10	6	16
'Ain Mallaha	12	9	21
Nahal Oren	6	6	12
Natufian Subtotal	45	27	72
Neolithic			
'Ain Ghazal	5	3	8
Newe Yam	1	1	2
Atlit Yam	3	3	6
Abou Gosh	2	1	3
Netiv Hagdud	1	1	2
Hatoula	4	2	6
Yiftahel	2	2	4
Horvat Galil	1	2	3
Neolithic Subtotal	19	15	34
TOTALS	**64**	**42**	**106**

Table 2. Patterns of bilateral asymmetry[1] in MSM scores by period and sex.

	Natufian		Neolithic	
Muscle/Ligament	Female	Male	Female	Male
Subclavius	100	108	100	92
Costoclavicular ligament	97	77	95	72
Trapezoid ligament	100	102	80	90
Conoid ligament	100	101	100	100
Trapezius	88	95	100	100
Pectoralis minor	100	100	100	100
Subscapularis	100	93	---	100
Supraspinatus	100	88	---	100
Pectoralis major	90	97	100	109
Latissimus dorsi	100	100	100	100
Teres major	100	104	100	100
Deltoideus	102	96	100	102
Coracobrachialis	100	100	100	112
Extensors, common origin	100	86	100	100
Flexors, common origin	100	100	100	100
Infraspinatus	100	100	---	100
Teres minor	100	100	---	100
Brachialis	100	95	100	100
Triceps brachii	100	87	100	100
Anconeus	100	100	100	100
Biceps brachii	100	99	92	100
Supinator	100	100	100	100
Pronator quadratus	100	100	100	100
Pronator teres	107	100	100	100

[1] Computed by $(X_L/X_R) \times 100$

Results

Asymmetry Analysis

Measurements of humeral asymmetry with reference to length, minimum midshaft diameter, maximum midshaft diameter, and least circumference were taken (PETERSON 1994), but this fell far short of the minimum number of observations needed to produce valid mean and standard deviation values (STIRLAND 1993). Thousands of years of time and the archaeological process simply had not preserved matching right and left humeri from a sufficient number of individuals. As an alternative, I examined the asymmetries present in the MSM scores. In general, the Natufian females exhibit bilateral asymmetries in far fewer cases than the Natufian males.

A total of twenty-seven (27) Natufian individuals were included in this analysis by virtue of the fact that they had seven or more bilateral attachment sites. Right side dominance was discernible in 63% of the sample (n=17); 7 per cent exhibited left side dominance (n=2); and 30% exhibited no clear side preference (n=8). Comparisons by sex indicate that females contributed to a proportionately larger degree to the unexpectedly large category showing no clear side preference.

Considering only the males (n=19), the percentage of handedness falls more closely within the range typical of modern populations. Sixteen individuals (84%) had MSM scores that suggested that right-side dominance in musculature, a single individual (5%) exhibited left-side dominance, and two individuals (11%) do not exhibit a clear pattern of side dominance. Females (n=8), in contrast, reflected a much higher percentage of cases with no clear side dominance. Six of the individuals (75%) demonstrated no clear side dominance in terms of muscle use. Left and right side dominance were present in single cases (12.5% each).

This scenario is reinforced when the individual asymmetry profile for each attachment site is considered. In cases where both left and right MSM could be scored, indices of bilateral asymmetry were calculated (Table 2). Patterns of right side muscle dominance are apparent in nine attachment sites for Natufian men, compared to three attachment sites for Natufian women. The Neolithic pattern documents a decrease in right-side bilateral asymmetry in males through time from nine to three.

Table 3. Mean MSM scores, ranked from most utilized to least utilized, for Natufian females, right side (except where noted).

MSM Score	Number of Individuals	Muscle/Ligament	Location
2.89	9	Pectoralis major	Humerus
2.50	11	Costoclavicular ligament	Clavicle
2.22	9	Biceps brachii	Radius
2.19	8	Teres major	Humerus
2.14	14	Deltoideus	Humerus
2.00	12	Conoid ligament	Clavicle
1.91	11	Brachialis	Ulna
1.83	3	Pectoralis minor	Scapula
1.54	11	Trapezoid ligament	Clavicle
1.37	4	Subscapularis	Humerus
1.33	3	Trapezius	Scapula
1.19	8	Pronator teres	Radius
1.18	14	Coracobrachialis	Humerus
1.17	6	Latissimus dorsi	Humerus
1.72[1]	9	Latissimus dorsi	Humerus
1.11	9	Extensors, common origin	Humerus
1.10	10	Anconeus	Ulna
1.07	14	Subclavius	Clavicle
0.94	9	Triceps brachii	Ulna
0.94	8	Supinator	Radius
0.91	11	Flexors, common origin	Humerus
0.75	2	Infraspinatus	Humerus
0.62	4	Supraspinatus	Humerus

Table 4. Mean MSM scores, ranked from most utilized to least utilized, for Natufian males, right side (except where noted).

MSM Score	Number of Individuals	Muscle/Ligament	Location
2.90	21	Pectoralis major	Humerus
2.58	19	Costoclavicular ligament	Clavicle
2.43	23	Deltoideus	Humerus
2.24	21	Biceps brachii	Radius
2.02	20	Brachialis	Ulna
1.83	23	Conoid ligament	Clavicle
1.81	8	Pectoralis minor	Scapula
1.70	10	Subscapularis	Humerus
1.67	15	Teres major	Humerus
1.60	19	Trapezoid ligament	Clavicle
1.57	20	Triceps brachii	Ulna
1.53	18	Anconeus	Ulna
1.62[1]	21	Anconeus	Ulna
1.45	10	Trapezius	Scapula
1.45	19	Extensors, common origin	Humerus
1.41	11	Pronator teres	Radius
1.36	14	Latissimus dorsi	Humerus
1.32	11	Supinator	Radius
1.30	20	Flexors, common origin	Humerus
1.25	24	Subclavius	Clavicle
1.17	20	Coracobrachialis	Humerus
1.17	6	Supraspinatus	Humerus
0.94	8	Infraspinatus	Humerus

[1] Left side

Neolithic females hold stable at three right-side bilateral symmetries.

Behaviorally, asymmetry patterns in MSM scores suggest that men and women may have had different demands with regard to bilateral tasks, especially during the Natufian. The male pattern suggests habitual activities that were more lateralized than the female pattern. Overall, female musculature appears to be much more symmetrical. A trend towards decreasing lateralization among males through time can be observed.

Mean MSM Comparisons

In addition to the degree and pattern of muscle lateralization, comparisons of mean MSM scores can provide information with regard to different activity levels and tasks when examined by sex and period.

Natufian

A cursory examination of Tables 3 and 4 indicates that for several important weight-bearing muscles, *e.g., pectoralis major* and *biceps brachii,* males and females have similar MSM means and rank order scores. From this perspective, labor demands appear to be parallel. But when the largest rank order differences (Table 7) are combined with statistically significant differences ($p < 0.050$) between males and females (Table 8), several observations regarding gender-specific activity patterns emerge. Five muscle attachment sites scored significantly higher for Natufian males: *deltoideus, triceps brachii, anconeus, supinator* and the flexors (Table 8). I would suggest that all five muscles are synergistically related in connection with a throwing motion, which involves the displacement of the forearm resulting from medial rotation of the arm at the shoulder, arm extension, and sudden shifts from forearm supination to pronation (KENNEDY 1983) (Pl. 2:B).

Supporting this reconstruction, Kennedy (1983) specifically related patterns of robusticity at *supinator, anconeus,* and *triceps brachii* muscle attachment sites among terminal Pleistocene hunter-gatherers in central India to habitual throwing activities. Furthermore, Dutour's study of Neolithic Saharan populations pointed out that the flexors of the hand and wrist are also substantially involved in launching hand-held projectiles (DUTOUR 1986). Involvement of *deltoideus* is also well documented (HAWKEY 1988, WEINECK 1986). Furthermore, *triceps brachii* and *anconeus* are two of the muscles that represent two of the largest differences in MSM rank order scores between men and women. In these respects the Natufian MSM profile is highly compatible with an activity system in which throwing activities fell primarily to males. The most pronounced differences typically involve the right side scores (Table 8).

Hunting is one important throwing activity for which there is ample archaeological evidence from the Natufian, both in terms of faunal assemblages (EDWARDS 1991, HENRY 1989) and chipped stone tools suitable as weapons (ANDERSON-GERFAUD 1983, VALLA 1987). Based on this evidence, I would advance the hypothesis that Natufians continued to make use of hand-delivered spears and/or atlatl-propelled dart technology in much of their hunting.

The only muscle site that scored significantly higher among Natufian females was *latissimus dorsi*, responsible for rotating the arm inward and pulling the raised arm down (Table 8). Given the difficulties for inferring motions from isolated muscles, the rank order scores can be consulted to identify other muscles that may be important synergistically (Table 7). *Teres major* and *coracobrachialis* stand out in terms of high rank order scores for Natufian females. *Teres major* assists *latissimus dorsi* in drawing the humerus down and backward, when previously raised. When the arm is in a fixed position, these muscles work in tandem to draw the trunk forward (GRAY 1974). *Coracobrachialis* draws the arm forward and inward and assists in stabilizing the shoulder joint. One labor intensive activity that matches the actions suggested by this muscle group is reciprocal grinding. Other authors have associated similar muscle development patterns, especially *teres major* and *latissimus dorsi,* among proto- and prehistoric Native American females to processing maize with mano and metate (HAWKEY 1988, HOOTON 1930) (Pl. 2:C).

Interestingly, querns and their accompanying hand stones occur only sporadically in Natufian ground stone assemblages. Among the sites contributing skeletal material to this study, only Hayonim Cave and 'Ain Mallaha had querns/grinding slabs or hand stones (WRIGHT 1992). Female mean scores for *latissimus dorsi* and *teres major* on both right and left sides are consistently higher among individuals from those sites compared to the total Natufian sample (PETERSON 1994). This observation lends support to the link between elevated *teres major* and *latissimus dorsi* MSM scores and reciprocal grinding.

Another group of Natufian tools, with a wider distribution among our sample of sites (including Kebara, El Wad, Mallaha, and Hayonim Cave), are bone tools described as spatulas, spatulates, or lissoirs (CAMPANA 1989, GARROD and BATE 1937, PERROT 1966, TURVILLE-PETRE 1932). These objects have been functionally assigned as skin or hide rubbers. The tools have broad, uniformly curved wear surfaces that are well-polished and have faint striations. Experimental evidence

Table 5. Mean MSM scores, ranked from most utilized to least utilized, for Pre-Pottery Neolithic females, right side.

MSM Score	Number of Individuals	Muscle/Ligament	Location
2.43	7	Deltoideus	Humerus
2.42	6	Pectoralis major	Humerus
2.33	9	Biceps brachii	Radius
2.00	2	Trapezius	Scapula
2.00	4	Pectoralis minor	Scapula
1.94	9	Brachialis	Ulna
1.92	6	Costoclavicular ligament	Clavicle
1.92	6	Trapezoid ligament	Clavicle
1.92	6	Teres major	Humerus
1.72	9	Anconeus	Ulna
1.67	6	Conoid ligament	Clavicle
1.62	8	Supinator	Radius
1.58	6	Pronator teres	Radius
1.50	3	Latissimus dorsi	Humerus
1.36	7	Triceps brachii	Ulna
1.30	5	Extensors, common origin	Humerus
1.25	2	Subscapularis	Humerus
1.25	2	Supraspinatus	Humerus
1.00	7	Coracobrachialis	Humerus
1.00	5	Flexors, common origin	Humerus
0.93	7	Subclavius	Clavicle
0.75	2	Infraspinatus	Humerus

Table 6. Mean MSM scores, ranked from most utilized to least utilized, for Pre-Pottery Neolithic males, right side.

MSM Score	Number of Individuals	Muscle/Ligament	Location
2.86	7	Pectoralis major	Humerus
2.71	12	Biceps brachii	Radius
2.64	11	Costoclavicular ligament	Clavicle
2.50	10	Deltoideus	Humerus
2.38	13	Brachialis	Ulna
2.36	7	Teres major	Humerus
2.10	5	Latissimus dorsi	Humerus
1.83	9	Trapezoid ligament	Clavicle
1.83	12	Pronator teres	Radius
1.75	2	Subscapularis	Humerus
1.72	9	Conoid ligament	Clavicle
1.70	10	Anconeus	Ulna
1.62	12	Supinator	Humerus
1.50	3	Trapezius	Scapula
1.50	3	Pectoralis minor	Scapula
1.50	2	Supraspinatus	Humerus
1.44	8	Triceps brachii	Ulna
1.35	13	Subclavius	Clavicle
1.30	5	Flexors, common origin	Humerus
1.25	6	Extensors, common origin	Humerus
1.17	9	Coracobrachialis	Humerus
1.00	2	Infraspinatus	Humerus

Table 7. Largest differences in rank order scores for periods between sexes.

Muscle/Ligament	Rank Score[1] Female	Rank Score[1] Male	Rank Difference
Natufian			
Latissimus dorsi[2,3]	**20.0**	9.0	11.0
Coracobrachialis	**10.0**	2.5	7.5
Triceps brachii[2*]	4.5	**12.0**	7.5
Teres major	**19.0**	14.0	5.0
Anconeus[2]	7.0	**11.0**	4.0
Neolithic			
Latissimus dorsi	9.0	**16.0**	7.0
Extensors, common origin	**7.0**	3.0	4.0

[1] Bold type indicates higher MSM score
[2] MSM scores are significantly different ($p \leq .050$) using Mann-Whitney test
[3] calculated using left side MSM scores

demonstrates that axial strokes applying compressive force against a soft, or yielding, surface produce similar wear (CAMPANA 1989). Ethnographic accounts of the motions involved in scraping and cleaning hides laid out on the ground surface (STEINBRING 1966) are consistent with repetitious bilateral movements that draw the arms downward and in toward the body. Perhaps the significantly higher female score for *latissimus dorsi* combined with high rank order scores for *teres major* and *coracobrachialis* are related to processing animal hides as well as grinding cereals.

Neolithic

Turning to the Pre-Pottery Neolithic, the most clearly discernible trends include substantial decreases both in the number of MSM scores indicating statistically significant differences between males and females (Table 8) and large rank order score differences (Tables 5-7).

Only *brachialis*, a flexor of the forearm, is significantly higher for men. Forearm flexion can clearly be associated with a range of tasks. In order to narrow this range, it may be important to note the higher rank score for *latissimus dorsi* among Neolithic males. As previously mentioned, *latissimus dorsi* can be related to pulling the raised arm downward, making it the principal muscle involved in downward, striking blows (GRAY 1974, WEINECK 1986), especially in conjunction with forearm flexion. An increase in repetitious downward motions associated with the evidence for plant domestication suggests two tentative activity reconstructions: soil cultivation and felling trees.

Several new types of large, heavy tools make their first appearance, in any significant numbers, during the Pre-Pottery Neolithic (PPN). Axes, adzes, chisels, and picks are shaped using uni- and bifacial flaking, as well as grinding and polishing. Ground and polished axes are considered a "type fossil" of the aceramic Neolithic in general (WRIGHT 1992). Axes and adzes are typically viewed as implements for felling trees and working wood. Picks, narrower and more pointed in profile, tend to be associated with cultivation. Timber would have been increasingly in demand for both architectural uses and as fuel for heating, cooking, and plaster production (ROLLEFSON *et al.* 1992: 468). Higher MSM mean scores for *brachialis* and *latissimus dorsi* may indicate that male participation in these cultivation and clearance tasks was higher than female participation.

Within our Neolithic sample, there are no cases of significantly higher female MSM scores. The extensors exhibit higher rank order scores, but these are difficult to interpret in isolation. Overall, the MSM patterns seem to indicate a convergence in muscle utilization levels, with perhaps a higher labor investment in timbering and tillage by males.

It would be extremely helpful to be able to assess site/regional variability in MSM patterns within the Neolithic sample. For instance, do the sites with the highest number of ground stone tools provide any evidence regarding increased cereal processing activities? Conversely, among the sites relying heavily on pulses, are these patterns diminished? Do individuals from coastal sites have different musculature patterns than inland populations? Are there MSM patterns consistent with use of the composite bow at sites without domesticated animals? Being able to examine data with reference to these economic and geographic parameters would undoubtedly prove interesting, but the current data set is not amenable to subdivision.

Changes Through Time

Diachronic trends in the MSM data set provide another window into changes in sexual labor organization. In both female and male groups there are indications that the Neolithic adaptation may have placed higher demands on the upper body musculature. Several studies from North America provide an interesting context for this part of the study. An increase in activity levels across the transition from foraging to farming economies was documented for Archaic and Mississippian populations in northwestern Alabama, based primarily on changes in humeral diaphyseal dimensions (BRIDGES 1985, 1989, 1991). However, conflicting results indicating a decline in physical demands over time in prehistoric Georgia suggests that this pattern may not be generalizable (LARSEN and RUFF 1991). In general, the southern Levantine data seem to parallel the reconstruction of increased labor demands posited by Bridges.

Males

That the only instances of significantly different mean MSM scores involve increases for the Neolithic population, suggests an overall increase in male muscle demand through time (Table 9). Interestingly, *latissimus dorsi* and *brachialis* continue to contribute substantially to MSM patterning between the groups. To reiterate, these are the muscles jointly responsible for the forceful downward blows and forearm flexion possibly related to felling timber and tilling soil. This reconstruction is consistent with the temporal pattern as well. Clearly, these tasks would have produced increased labor demands during the Neolithic relative to the Natufian.

Table 8. Summary of significant differences in MSM scores for periods between sexes using Mann-Whitney Test.

Muscle/Ligament	Side	U	Z-stat	2-tail p[1]	High Score
Natufian					
Deltoideus	R	99.5	-2.05	.04	Male
Flexors, common	R	58.5	-2.22	.03	Male
Triceps brachii	R	30.0	-2.98	.002	Male
Anconeus	R	47.0	-2.16	.03	Male
Anconeus	L	64.5	-2.12	.03	Male
Supinator	R	23.5	-1.89	.05	Male
Latissimus dorsi[2]	L	4.0	-2.74	.006	Female
Neolithic					
Brachialis	R	25.0	-2.41	.01	Male

[1] corrected for ties
[2] excludes El Wad

Table 9. Summary of significant differences in MSM scores for sexes between periods using Mann-Whitney Test.

Muscle/Ligament	Side	U	Z-stat	2-tail p[1]	High Score
Women					
Anconeus	R	19.5	-2.22	.03	Neolithic
Supinator	R	10.5	-2.35	.02	Neolithic
Men					
Latissimus dorsi	R	9.0	-2.57	.01	Neolithic
Latissimus dorsi	L	16.0	-2.77	.006	Neolithic
Brachialis	R	71.5	-2.30	.02	Neolithic

[1] corrected for ties

Table 10. Largest differences in rank order scores for sexes between periods.

Muscle/Ligament	Rank Score[1] Natufian	Rank Score[1] Neolithic	Rank Difference
Females			
Coracobrachialis	**10.0**	3.5	6.5
Supinator[2]	4.5	**11.0**	6.5
Costoclavicular ligament	**21.0**	15.0	6.0
Anconeus[2]	7.0	**13.0**	6.0
Conoid ligament	**17.0**	12.0	5.0
Triceps brachii	4.5	**8.0**	3.5
Males			
Latissimus dorsi[2]	7.0	**16.0**	9.0
Pronator teres	8.0	**14.5**	6.5
Extensors, common origin	**9.5**	3.0	6.5
Triceps brachii	**12.0**	6.0	6.0
Conoid ligament	**17.0**	12.0	5.0
Supinator	6.0	**10.0**	4.0
Teres major	14.0	**17.0**	3.0

[1] Bold type indicates higher MSM score
[2] MSM scores are significantly different ($p \leq .050$) using Mann-Whitney test

A reduction in the rank order score for *triceps brachii* (extends forearm), extensors (assist in extending elbow), and the conoid ligament (limits backward rotation of the scapula) during the Neolithic may be related to a decrease in the throwing motion, previously posited to explain patterning in Natufian MSM scores (Table 10).

Females

A pattern of increased labor input during the Neolithic is suggested by the female sample as well, in that the only significant MSM mean score differences involve higher Neolithic scores (Table 9). Both *anconeus* and *supinator* were scored significantly higher for the Neolithic sample compared to the Natufian. *Supinator, anconeus, and triceps brachii* are ranked consistently higher among Neolithic females as well (Table 10). These indicate an increase through time in habitual activities involving forearm extension and supination. Several muscles related to the stabilization of the shoulder joint exhibit higher rank order scores compared to their Neolithic counterparts. The conoid ligament limits the backward rotation of the scapula, while the costaclavicular ligament limits the elevation of the clavicle.

Conclusions

During the Natufian, asymmetry and MSM indices indicate some interesting, sexually dimorphic patterning. Females tended to have a higher degree of bilateral symmetry in MSM expression. Grain and hide processing are two activities that 1) are compatible with the bilateral requirements, 2) have been documented archaeologically and 3) correspond to the synergistic muscle group identified through rank score and mean comparison analyses. The Natufian males appear to have had higher functional demands on a suite of muscles that act synergistically in right-arm throwing motions. This specific reconstruction can be corroborated with a number of previous studies and patterns of right side lateralization as well.

The MSM data correspond to the CCT results previously reported for Natufian groups (SMITH *et al.* 1984), and lend further support for a male hunting scenario. The female patterns also correspond to Molleson's results from Epipaleolithic Abu Hureyra, suggesting that cereal processing was accomplished primarily by females. However, the limited distribution of reciprocal grinding tools encouraged me to extend the activity reconstruction to include hide processing as another activity potentially contributing to the musculature patterning.

Subsistence tasks during the Natufian appear to have been sexually divided relative to several primary activities. Other strenuous, habitual activities, such as burden-bearing, may well have been shared. For example, a number of important weight-bearing muscles have a very similar rank and similar mean scores in males and females, *e.g., biceps brachii* and *pectoralis major.*

These labor patterns appear to undergo substantial changes during the Neolithic. MSM mean score and symmetry analyses document a degree of convergence between males and females. For example, bilateral muscle activity among males appears to increase through time. The number of muscles having significantly different MSM mean scores between the sexes decreases noticeably. The only potential gender-specific pattern suggested by the data may reflect the relatively high participation of males in timbering and soil tilling.

In terms of previous studies, these data complement Rathbun's stature analysis, which documented a decrease in sexual dimorphism during the Neolithic (RATHBUN 1984). Based on the present state of these analyses, Molleson's evidence for female cereal processors is more difficult to assess (MOLLESON 1989, 1994). A more detailed examination of patterns of degenerative joint disease and trauma may well prove informative, which would be a logical follow-up to these analyses.

This study is an attempt to expand our models of the transition to domestication economies by focusing more explicitly on social organizational variables. MSM analyses identified several shifts in both general workload trends (increasing functional demands and bilateralism through time) and activity-specific reconstructions. Natufian activity divisions in the southern Levant appear to mirror several well-documented ethnographic trends. First, there is strong evidence for male participation in hunting (MURDOCK 1937, MURDOCK and PROVOST 1973). Female activities may have focused more on processing animal and (probably) plant products.

A good deal of variability has been compressed into the Neolithic sample because of sample size limitations. Overall, the MSM results suggest a convergence in male and female musculature with fewer significant differences between the sexes and decreasing lateralization in the males. Both male and female scores document within-sex increases in muscle demands. During this transitional period, one could conjecture that many economic activities might have been widely shared as experimentation with organizing the new productive tasks associated with increased reliance on domestic plants and animals grew. The workload demands of procuring resources to build and refurbish substantial houses, tend domestic animals, and carry out the multiplicity of agricultural chores were certainly not borne by one sex group. Instead both men and women jointly participated in a number of strenuous activities related to the new agropastoral lifestyle.

Recommendations

With these synthetic comments in mind, it is appropriate to reiterate a few cautionary notes regarding the use of musculoskeletal stress markers in both reconstructing of gross labor patterns and advancing activity-specific hypotheses. First, it is always important to reassert that prehistoric sexual divisions of labor should not be viewed primarily as incipient forms of our own, modern structures. It is only reasonable to expect that prehistoric adaptations may well have arrived at labor solutions for which no ethnographic analogs remain. Second, economic tasks may not have been the only strenuous activities making up the full spectrum of Natufian and Neolithic daily life. Ceremonial and recreational activities can also be strenuous (*e.g.*, wrestling, drumming, etc.). And finally, in order to refine these results and gather additional information with which to test these hypotheses, access to appropriate human skeletal remains is essential.

Prehistoric human skeletal material from Jordan sites is a terribly important archaeological resource. Specialized excavation, *in situ* documentation, and field preservation are necessary to insure maximum information yield. It is important to incorporate individuals with baseline bioarchaeological training into excavation teams, particularly at sites where human remains are anticipated. Furthermore, human bone has special packing, curation, and storage requirements. Accommodating the unique needs of human osteological material is crucial if we are to actualize its full potential in reconstructing past behavioral systems.

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A First Note on New Localities of Pleistocene Mammals in Jordan. Preliminary Results of Field Research in 1995

Wilfried Rosendahl, Michael Schmitz, and Main A. Hiyari

Abstract: *During field research in 1995, sediments and sediment cycles were observed with regard to their content of Neogene and Pleistocene vertebrates, especially mammals, in various areas of Jordan. One of the main foci turned out to be the Lisan marls, deposited within the ancient Lake Lisan, extending north of the recent Dead Sea to the south of the Wadi Araba. In addition, the sediments of Ghawr al Katar series, wadi sediments at the eastern flank of the Jordan rift and the Pleistocene layers of the arid regions of the Azraq and Jafr Basins were also evaluated in detail. New finds of Pleistocene mammal bones were made in the Lisan marls, north of the Dead Sea and in sediments of Wadi al Hasa and Jurf ad Darwish. Both wadis are located at the eastern flank of the Jordan Rift.*

During October and November 1995 a team of German paleontologists and a speleologist, funded by the German Research Foundation (DFG, Bonn, Germany) and supported by the Natural Resources Authority (NRA, Amman, Jordan) started a research program on Neogene and Pleistocene vertebrates along the Jordan Valley and in the Jafr and Azraq Basins. In this context, the paleobiogeographical distribution of fossil mammals in the younger sediments of the Jordan Rift, one of the probable biogeographic junctions between Africa, Europe and Asia, was of special interest.

Although only a few Neogene and Pleistocene vertebrate remains, especially mammals, were reported from Jordan, the first phase of the programm in 1995 was to test if there basically was a chance for the preservation of vertebrate remains in the evaluated sediments.

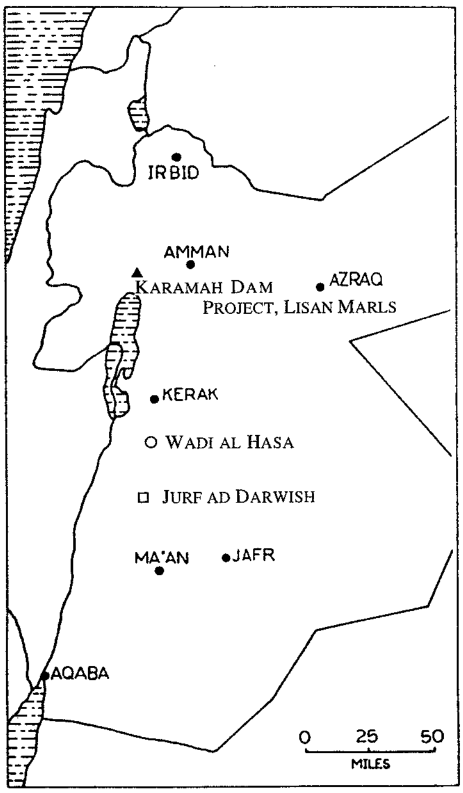

Fig. 1. Location of the sites discussed: Lisan marls in the area of Karama Dam Project, Wadi al Hasa, and Jurf ad Darwish.

Localities (Fig. 1)

Lisan Marls

The sediments of the Lake Lisan were deposited during the Pleistocene period (BENDER 1968). The total thickness of the sequence varies from the north to the south. In the area around the Karamah Dam Project north of the Dead Sea the Lisan marls occur with 90m thickness, whereas the sediment layers south of the Dead Sea and within the Lisan Peninsular reach some hundred meters. But the facial and stratigraphical characters of the sequence continue to be more or less the same along the whole area that was in-vestigated. Generally the sediment cycle of the Lisan marls in the area of Karamah started with the so-called "Lower Laminites", sections containing silt and mudstone layers.

Plate 1:A. *Sus* sp., juvenile, fragment of mandible.

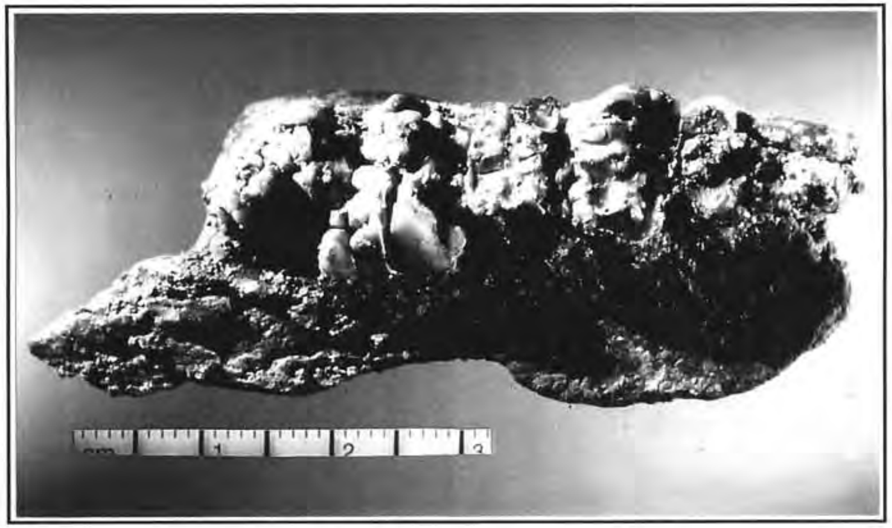

Plate 1:B. *Sus* sp., adult, fragment of maxillaria.

Plate 1:C. "Lisan Marls" in the area of the Karama Dam Project.

Plate 1:D. Location in the Wadi al-Hasa.

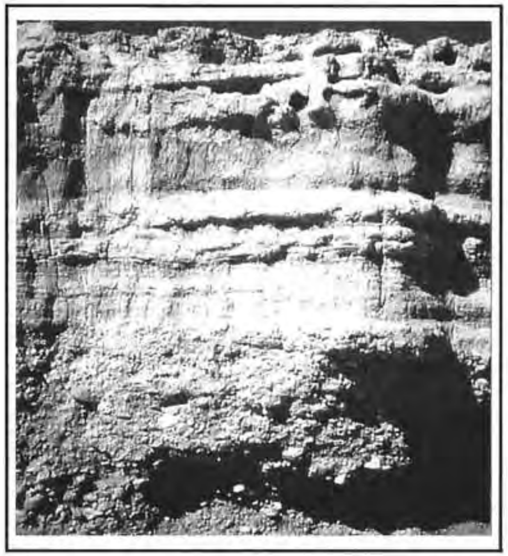

Plate 2:A. Location of Jurf ad-Darwish.

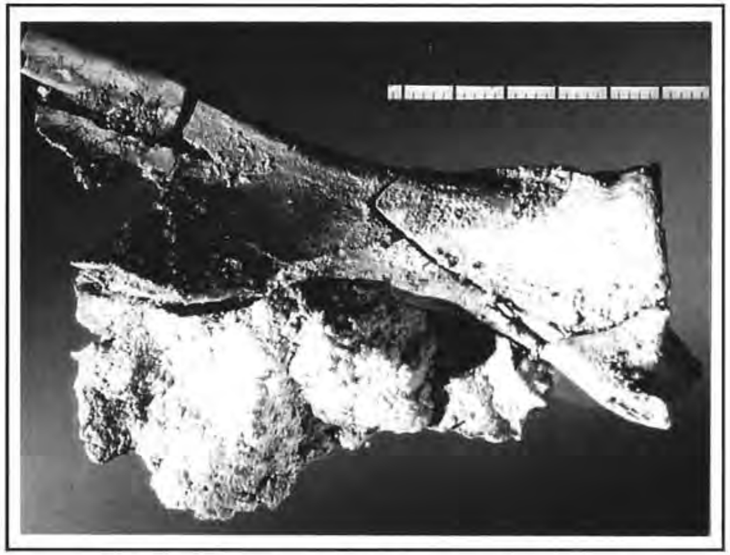

Plate 2:B. *Alcelaphus* sp., scapula (almost complete).

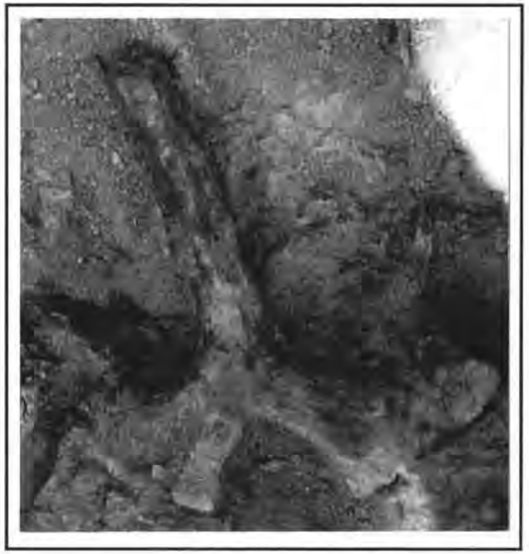

Plate 2:C. Large mammal (Wadi al-Hasa), vertebrae.

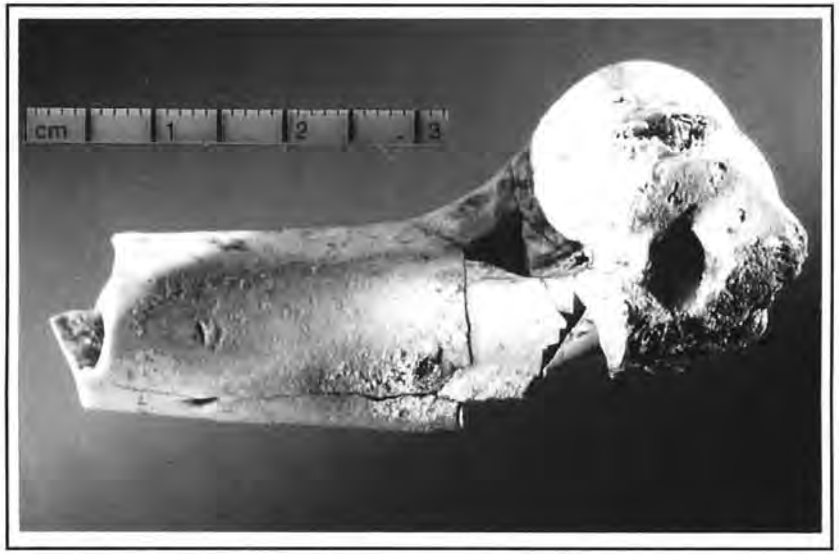

Plate 2:D. *Alcelaphus* sp., humerus fragment.

Plate 2:E. Possibly *Hippopothamus* sp., part of a large vertebrae.

The "Middle Clays" follow above this sequence. The "Middle Clays" are covered by the siltstone beds of the "Main Laminites". The siltstones of the "Main Laminites" are intercalated with numerous aragonite and gypsum horizons. The top of the Lisan Marls is made up by a unit called the "Upper Clay".

While the Main Laminites are characterised by the abundance of evaporites, the "Middle Clays" consist of sandstones with interbedded channels filled with coarse grained sands and gravels. Iron crusts and plant remains are very frequent; molluscs and vertebrate remains occur from time to time.

Besides some undeterminable bone fragments, the upper and lower jaw from *Sus* sp. (Pls. 1:A-B) were discovered in the area of the Karama Dam Project (Pl. 1:C). Also a vertebra and one isolated tooth from a rodent were collected. A more detailed study of the Lisan marls in future could surely bring more information about the Pleistocene fauna of Jordan and the paleoecology of the Lake Lisan itself.

Wadi Sediments at the Eastern Flank of the Jordan Rift

During the field trip two wadis at the eastern flank of the Jordan Rift were observed in detail: the Wadi al Hasa (Pl. 1:D) and Jurf ad Darwish (Pl. 2:A). Both are situated in the southern part of Jordan, between the cities of Karak and Ma'an.

The Wadi al Hasa, which cuts the eastern plateau from Mahhattat al Hasa to Ghawr as Safi, meets the Jordan Valley a few kilometers south of the Dead Sea. Along the margins of the Wadi al Hasa, sediment cycles of various thicknesses are exposed, not mentioned by BENDER (1968). The NRA called our attention to this formation, which was determined to be a Pleistocene lake deposit by their mapping division. The eastern plateau is covered by basalt layers with an isotope age of about 9 million years in this area. Since that time meandering streams cut the Wadi al Hasa as they flowed into the subsiding Jordan Rift system. Thus, the formation of the Wadi al Hasa is closely related to the taphrogenesis of the Jordan Rift itself. Considering this, the preliminary dating of the so called "lake deposits" must be tested by further investigations.

However, these sequences, which are characterised by interbedded yellow, green and grey colored thin laminated siltstones, yielded vertebrate fossils in great abundance. Though the discovered fossil remains were disarticulated, the skeletons were, as far as we could recognise, almost complete. Excavated cranial and postcranial bones indicate at least two individuals attributable to *Alcelaphini* sp. (Pls. 2:B,D), and huge vertebrae from a big mammal (Pls. 2:C,E) probably originate from *Hippopothamus* sp. The mammal remains were found in different stratigraphical horizons and were accompanied by flint artefacts, which were found in situ.

A comparable situation was encountered in a wadi close to Jurf ad Darwish. The sediment layers in this area were recently investigated in detail by the mapping division of the NRA as Pleistocene lake deposits. The sediment layers along these sections are composed of differently grain-sized ocher- to yellow- colored sandstone beds with intercalated volcanic rocks. These units unconformably overlie Neogene gravels. Several stone tools were discovered together with a few fragments of indeterminable postcranial bones of larger mammals and teeth from *Equus* sp. Most of the collected stone tools show characteristically large areas of cortex.

For further scientific research programs the "lake sediments" of Wadi al Hasa seem to be especially important because of the high content of mammal fossils and the occurrence of stone tools within the same layers. This could hint to a living floor of Pleistocene humans. But the areas along the Jordan Valley exposing Lisan marls and the sediments of Jurf ad Darwish should also be considered.

Acknowledgements: During the entire field campaign the German team was furnished with all necessary logistic help (*e.g.*, field camps, camping facilities, mapping geologists) by the NRA. Moreover the NRA also provided the possibility for many helpful discussions on special problems and questions resulting from the field work. We would like to thank them heartily for all this kind support.

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An Analysis of the Faunal Assemblages from Two Pre-Pottery Neolithic Sites in the Wadi Fidan, Jordan

Jane E. Richardson

Abstract: *Faunal assemblages from the Pre-Pottery Neolithic B of Jordan have great potential to shed light on the issues of animal domestication and the possibility of climatic deterioration and agricultural crisis. The analysis of the animal bones from one late PPNB site and one final PPNB site from the Wadi Fidan, Jordan have been researched with these questions in mind. Four scenarios are presented and tested against the data. The suggestion is that ovicaprids were indeed domesticated at these sites but that by the final PPNB environmental stresses necessitated a return to the hunting of gazelle. It is possible that we are witnessing the failure of an early mixed farming system.*

Introduction

The Pre-Pottery Neolithic B encompasses a vital period of Jordanian prehistory. In the early Neolithic most ovicaprids are believed to have been in their wild state, but by the beginning of the Bronze Age ovicaprids are deemed to be domesticated creatures. The PPNB, therefore, has the potential to shed some light on this domestication process. The occupation of the southern Levant at this time also witnessed a dramatic abandonment of settlements. This hiatus has been related to climatic deterioration and also to agricultural crisis. Perhaps it was the newly arrived domesticated herds that had such a dramatic impact on the region's fragile environment.

Two sites located in the Wadi Fidan, Jordan, were excavated in 1989 and 1990. These are referred to as Site A, a *late* PPNB settlement, and Site C, a *final* PPNB settlement (Pl. 1:A). Site A is located on a short plateau along the northwest side of the Fidan Gorge (ADAMS 1991), and excavations of a single structure revealed a hearth, an oven and cleared plaster floors (Pl. 1:B). Site C, on the south bank of the Wadi near its western end, is approximately one and a half kilometers to the southeast of Site A. Site C produced bones from a terraced structure where the floor levels of the two main rooms were at different heights. Stone foundations had been sunk over a metre below the floor surface (Pl. 1:C). Both sites were dated through reference to their flint assemblages (Adams, pers. comm.).

The animal bones from these two sites were made available for analysis. The methods used in this study, the results produced and a discussion of the findings are presented here. Finally, the animal bones from Sites A and C are interpreted as indicators of cultural change and possible environmental deterioration. These sites appear to witness the revolution in food procurement from hunting to herding, as well as subsequent environmental stresses, whether due to an increase in the human population, an over-exploitation of resources, a deterioration in the climate or a combination of these.

Methods

The faunal remains were retrieved with the aid of dry sieving using an 8mm mesh. This ensured that the vast majority of bone fragments were recovered from the excavated area. The two sites were analysed as discrete units, although a number of important contexts were extracted and analysed separately.

Identification of elements was facilitated by a reference collection, but the availability of single specimens of goat and gazelle skeletons prevented an informed consideration of species variability or even sexual dimorphism. The separation of sheep and goats was achieved with reference to Boessneck (1969) and according to Payne (1969, 1985) for the metrical differences between sheep and goat metapodials and for the separation of deciduous teeth. Horn cores were identified to species accor-

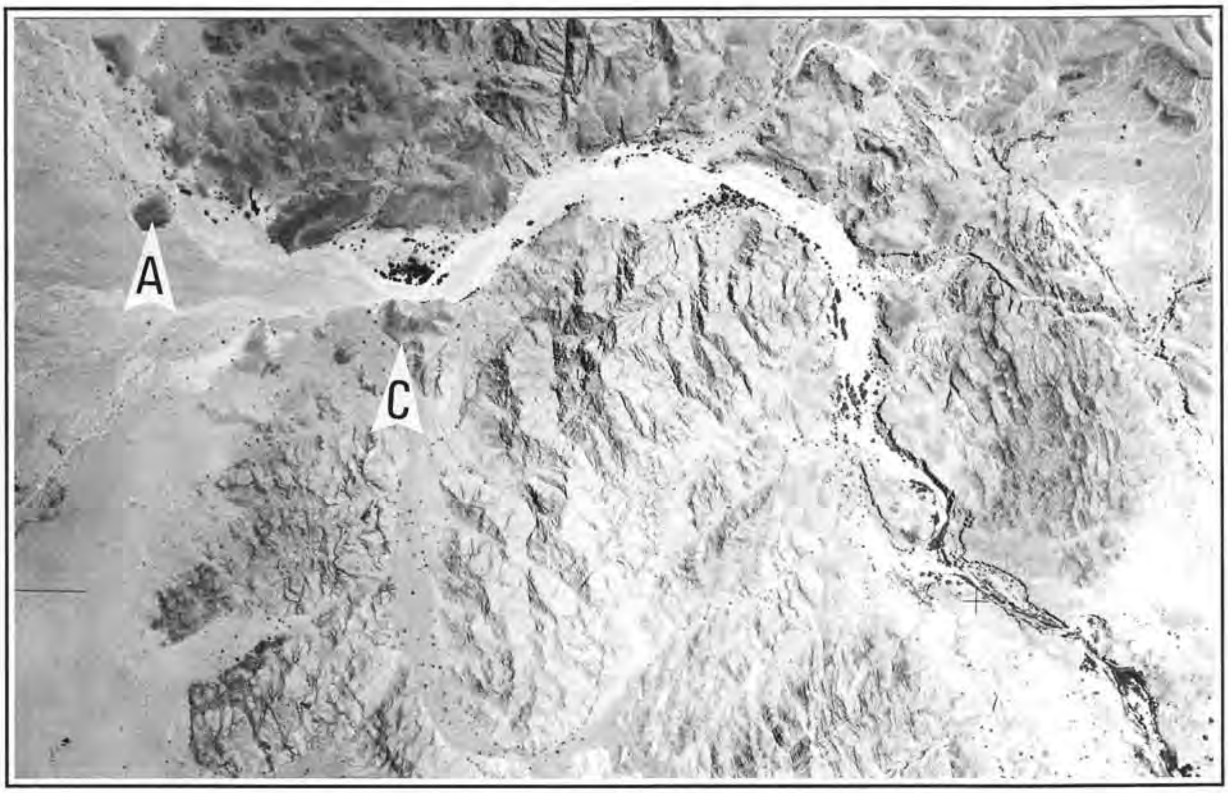

Plate 1:A. Aerial view of the Wadi Fidan and Sites A and C.
<The wadi runs from its source in the east to the plain in the west (left)>.

Plate 1:B. Excavations at Site A. Structure with clean plaster floors and an oven (Context 17).

Plate 1:C. Excavations at Site C. Structure with floors at different levels and evidence for deep foundations.

ding to the descriptions of Hole, Flannery and Neely (1969). For the genera *Capra* and *Gazella* it was possible to identify three species based on horn core remains. Five *Capra nubiana* were separated from *C. aegagrus* with reference to Hecker (1975) and Harrison (1968), and three *Gazella dorcas* were isolated from the gazelle horn cores using the descriptions and illustrations of Harrison (1968), Tchernov *et al.* (1986-87) and Davis (1980).

The identification of an ulna and astragalus from *Dama mesopotamica* was made with the aid of reference material. For the ulna the olecranon was too long to belong to an ovicaprid, and more importantly failed to turn outwards into a prominent processus anconeus as with sheep and goats. This straight and large olecranon matched most reassuringly with *Cervus* and fallow deer in particular. The astragalus, despite being burnt and somewhat decayed, was significantly larger than any other astragalus assigned to sheep and goat. The bone was ultimately recorded as *cf. Dama mesopotamica* since the planter side of the articular surface of the calcaneum remained flush with the side of the bone. This identification represents a very southerly find of the species. *Dama mesopotamica* is absent from Beidha and Basta (UERPMANN 1987, BECKER 1991).

An unusual discovery was the distal humerus of a large cat from Site A. This has been identified as *Acinonyx jubatus* with reference to morphological and metrical distinctions (WALKER 1985). Previous evidence for cheetah from the Pre-Pottery Neolithic comes from a rock drawing at Kilwa (HATOUGH-BOURAN and DISI 1991).

As the surviving dental record was highly fragmented, epiphyseal data provided the most informative ageing results. For the ages of epiphyseal fusion for sheep and goats the figures of Silver were used (1969). Fusion data for gazelle was obtained from the work of Davis (1987). The fusion data for goats and sheep has been modified by dividing the sheep/goat fusion information proportionally between *Capra* and *Ovis*. This step was necessary as the immature bones in particular were likely to be identifiable only to the ovicaprid category. The assumption is that the sheep and goat samples already reflect the true proportions of these species.

All dental, cranial and post-cranial elements were recorded in terms of a minimum number of anatomical units. The recording of bone zones, here the proximal and distal halves, allows for the separate analysis of these units and helps reduce the possibility of counting a single bone twice. A bone fragment count for each element and species was also noted.

Taphonomic issues were addressed by recording states of fragmentation and preservation (whether burnt or gnawed). Butchery evidence was recorded using the illustrations and codes of Binford (1981).

It was possible to take a number of measurements from a range of goat and gazelle bones. The measurements used were the greatest breadth of the distal end of the humerus; the breadth of the proximal end of the first phalanx; the greatest and least diameter of the horn core base (VON DEN DRIESCH 1976); the length of the first phalanx; and the minimum shaft width of this bone (HECKER 1975). The metrical data were investigated to determine the presence or absence of domesticated animals. This could be achieved either through the identification of two discrete groups or through an increased range of variability. It is necessary to appreciate that a number of different scenarios can lead to the single set of results (GRAYSON 1981). Comparative data from PPNB Beidha as well as from a number of Upper Palaeolithic, Natufian, Chalcolithic and Bronze Age sites were used (HECKER 1975).

Results

Tables 1 and 2 record the fragment counts for each element and species. Tables 3 and 4 detail the minimum number of anatomical units for each species. From these data three percentages were calculated for each species at each site (Tables 5 and 6).

At Site A ovicaprids dominate the assemblage. The ratio of goats to sheep appears to be approximately 2:1. The percentages for cow suggests that this species was a useful dietary source, with gazelle, a much smaller animal, producing less in the way of useful caloric value. This exploitation of animals is not dissimilar to that identified at Basta (BECKER 1991), although gazelle is less heavily utilised at Site A. The remaining mammalian genera at Site A are *Equus*, *Canis*, *Vulpes* and *Felis,* as well as *Acinonyx jubatus* and *Dama mesopotamica*; all were present in low numbers.

The faunal assemblage from Site C indicates that over time gazelle had increased significantly although ovicaprids still dominated. The ratio of goats to sheep rose to approximately 3:1. The frequency of cow fell slightly, while *D. mesopotamica* and the genera *Equus*, *Erinaceus* and *Lepus* are still represented by low values.

The fusion data are recorded in Figs. 1-6 and Table 7. For sheep and goats the scapula, proximal radius, pelvis and distal humerus are included in Stage 1; first and second phalanges are in Stage 2; distal metapodials and distal tibia in Stage 3 and proximal humerus, proximal femur, proximal tibia, proximal ulna, calcaneum, distal radius and distal femur in Stage 4. For gazelle the distal humerus and proximal radius were used to calculate Stage 1; the scapula and first phalanx for Stage 2 and the pro-

Table 1. Site A: Species versus element (fragment counts).

	Horse	Cow	Sheep/ Goat	Sheep	Goat	Sheep/ Goat/ Gazelle	Gazelle	Canid	Fox	Cat	Fallow Deer	Cheetah
horn		6	3	2	24		5					
acoustic meatus				2		20						
occipital condyle			3	2		4						
maxilla		1										
mandible			3			5						
mandibular hinge		1	17			1						
mandibular tooth		1	16			16						
atlas			18			1						
axis			13									
scapula			6	5	7	7						
prox. humerus			12	1	1	4	2					
distal humerus		1	38	8	6	5	1					1
prox. radius		3	33	3	3							
distal radius		3	16	1	5	1						
ulna		1	20			1			1		1	
prox. metacarpal		2	17	2	10	2						
distal metacarpal	1	2	23	9	22							
semi-lunaire			2		2							
scaphoid		1			1							
cap. trap.		1			1							
pelvis	1	2	23	7	6	11						
sacrum			1			1						
prox. femur		2	21	4	1	4						
distal femur			14			8						
prox. tibia		2	10	1	1	5	1	2				
distal tibia		2	5	3	5	9						
prox. metatarsal		2	12	3	3	2	2					
distal metatarsal		4	17	7	7	1	4					
prox. metapodial			1		6	1						
distal metapodial												
astragalus			11	2	8	3						
calcaneus		3	7	4	15	1	1			1		
navicular cuboid		1		2	3	1				1		
first phalanx		5	26	8	25	1	1		1			
second phalanx		1	5	6	19							
third phalanx		1	17	2	7	1	1					
Total	2	48	411	82	188	116	18	2	2	2	1	1

Table 2. Site C: Species versus element (fragment counts).

	Horse	Cow	Sheep/ Goat	Sheep	Goat	Sheep/ Goat/ Gazelle	Gazelle	Fallow Deer	Hedgehog	Hare
horn		4	2	1	16	14	11			
acoustic meatus						11				
occipital condyle						7	2			
maxilla			1			2				
mandible			1		1		4		1	1
mandibular hinge			6				6			
mandibular tooth			4			6				
atlas			2				2			
axis			3				2			
scapula		3	6	2	3	3	3			
prox. humerus			2		1	6	8			
distal humerus			14		4	7	14			
prox. radius			1	2	2	1	5			2
distal radius					1		3			
ulna			7				2			
prox. metacarpal			4	2	8	2	1			1
distal metacarpal			2	2	3	1				1
semi-lunaire			3	1			2			
scaphoid			1		1		1			
cap.trap.				2	1	2				
pelvis			6	2	2	9	5			1
sacrum						4				
prox. femur	1		10	3	4	5	12			
distal femur			6			6	8			
prox. tibia		1	2	3		8	5			3
distal tibia			5		1	3	2			
prox. metatarsal			10		1	1	3			3
distal metatarsal			13	1	6	2	9			3
prox. metapodial										
distal metapodial			3		3	3	1			1
astragalus		1	2		2	3	8	1		
calcaneus			5	2	6	1	7			
navicular cuboid					3	3	5			
first phalanx		1	15		21	1	14			
second phalanx			4	3	11	1	5			
third phalanx			2	4	8	2	8			
Total	1	10	142	30	109	114	158	1	1	16

Table 3. Site A: Species versus element (minimum number of anatomical units).

	Horse	Cow	Sheep/ Goat	Sheep	Goat	Sheep/ Goat/ Gazelle	Gazelle	Canid	Fox	Cat	Fallow Deer	Cheetah
horn		3	3	1	14		3					
acoustic meatus				1		13						
occipital condyle			2	1		4						
maxilla		1										
mandible			3			5						
mandibular hinge		1	9			1						
mandibular tooth		1	12			10						
atlas			18			1						
axis			13									
scapula			3	3	4	4						
prox. humerus			6	1	1	2	2					
distal humerus		1	22	6	5	3	1					1
prox. radius		2	18	2	2							
distal radius		3	8	1	3	1						
ulna		1	11			1			1		1	
prox. metacarpal		1	9	2	6	1						
distal metacarpal	1	1	13	5	12							
semi-lunaire			1		1							
scaphoid		1			1							
cap.trap.		1			1							
pelvis	1	1	13	6	4	5						
sacrum			1			1						
prox. femur		2	15	4	1	2						
distal femur			7			4						
prox. tibia		2	6	1	1	4	1	1				
distal tibia		1	4	2	3	5						
prox. metatarsal		2	5	2	3	1	2					
distal metatarsal		2	10	4	4	1	2					
prox. metapodial			1		3	1						
distal metapodial			1									
astragalus			7	1	4	3						
calcaneus		3	4	3	12	1	1			1		
navicular cuboid		1		1	2	1				1		
first phalanx		1	3	1	3	1	1		1			
second phalanx		1	1	1	3							
third phalanx		1	1	1	1	1	1					
Total	2	33	230	50	94	77	14	1	2	2	1	1

Table 4. Site C: Species versus element (minimum number of anatomical units).

	Horse	Cow	Sheep/ Goat	Sheep	Goat	Sheep/ Goat/ Gazelle	Gazelle	Fallow Deer	Hedgehog	Hare
horn		2	2	1	9	9	6			
acoustic meatus						6				
occipital condyle						4	1			
maxilla			1			1				
mandible			1		1		2		1	1
mandibular hinge			4				3			
mandibular tooth			3			4				
atlas			2				1			
axis			3				1			
scapula		2	3	1	2	2	2			
prox. humerus			2		1	4	6			
distal humerus			8		2	5	7			
prox. radius			1	2	1	1	2			2
distal radius					1		2			
ulna			6				1			
prox. metacarpal			2	1	4	1	1			1
distal metacarpal			2	1	2	1				1
semi-lunaire			2	1			1			
scaphoid			1		1		1			
cap.trap.				1	1	2				
pelvis			3	1	2	4	3			1
sacrum						2				
prox. femur	1		6	2	3	3	7			
distal femur			4			3	5			
prox. tibia		1	1	2		5	3			2
distal tibia			3		1	2	3			
prox. metatarsal			5		1	1	2			1
distal metatarsal			8	1	3	2	5			1
prox. metapodial										
distal metapodial			2		2	2	1			1
astragalus		1	2		1	2	6	1		
calcaneus			3	2	3	1	6			
navicular cuboid					2	2	3			
first phalanx		1	2		3	1	2			
second phalanx			1	1	2	1	1			
third phalanx			1	1	1	1	1			
Total	1	7	84	18	49	72	85	1	1	11

ximal femur, proximal tibia, calcaneum, distal metapodials and distal radius for Stage 3. From Figs. 1 and 2 it is apparent that for Site A a high proportion of juvenile ovicaprids were killed although more sheep survived their first year. Few animals survived into maturity (post-30 to -42 months) but more sheep survived to this age or beyond compared to other animals. At Site C both sheep and goats survived their first year in much greater numbers than at Site A, and goats in particular reached adulthood in increased numbers (Figs. 4-5).

Table 5. Site A: relative abundance of species.

	A	B	C
Horse	0.2	0.4	1.5
Cow	5.5	6.5	4.5
Sheep/Goat	47.2	45.4	32.8
Sheep	9.4	9.9	9.0
Goat	21.6	18.5	20.9
Sheep/Goat/Gazelle	11.9	15.2	19.4
Gazelle	2.1	2.8	4.5
Canid	0.2	0.2	1.5
Fox	0.2	0.4	1.5
Cat	0.2	0.4	1.5
Fallow Deer	0.1	0.2	1.5
Cheetah	0.1	0.2	1.5
Sheep/Goat + Sheep + Goat	78.2	73.8	62.7

Table 6. Site C: relative abundance of species.

	A	B	C
Horse	0.2	0.3	2.4
Cow	1.7	2.1	4.8
Sheep/Goat	24.4	25.5	19.0
Sheep	5.2	5.5	4.8
Goat	18.7	14.9	21.4
Sheep/Goat/Gazelle	19.6	21.9	21.4
Gazelle	27.1	25.8	16.7
Fallow Deer	0.2	0.3	2.4
Hedgehog	0.2	0.3	2.4
Hare	2.7	3.3	4.8
Sheep/Goat + Sheep + Goat	48.3	45.9	45.2

A Relative percentage of species calculated from the total fragment count

B Relative percentage of species calculated from the total number of minimum number of anatomical units

C Relative percentage of species calculated from the highest number of a single anatomical element. Values taken from Tables 3 and 4

Table 7. Sites A and C: fusion data for sheep, goats and gazelles.

SITE A	**SHEEP**			
	Stage 1	Stage 2	Stage 3	Stage 4
Fused	28	17	4	11
Unfused	46	13	22	32
% Fused	38	57	15	26
	GOAT			
Fused	22	37	5	12
Unfused	49	90	109	87
% Fused	31	29	5	12
	GAZELLE			
Fused	2	1	4	
Unfused	-	1	4	
% Fused	100	50	50	
SITE C	**SHEEP**			
	Stage 1	Stage 2	Stage 3	Stage 4
Fused	8	4	3	-
Unfused	2	-	3	16
% Fused	80	100	50	-
	GOAT			
Fused	6	35	9	9
Unfused	5	6	12	9
% Fused	55	85	43	50
	GAZELLE			
Fused	8	27	64	
Unfused	-	-	8	
% Fused	100	100	89	

The fusion data for gazelle at Site A is limited to only 12 bones, and this affects the usefulness of this information (Fig. 3). The data for Site C, however, represent 107 bone ends, and they indicate that very few juveniles and young adult gazelles were killed by the site's inhabitants (Fig. 6). It is apparent from the fusion data that the ovicaprids were treated to a different slaughter pattern than the gazelles. Juvenile ovicaprids were utilised while juvenile and even sub-adult gazelles were ignored.

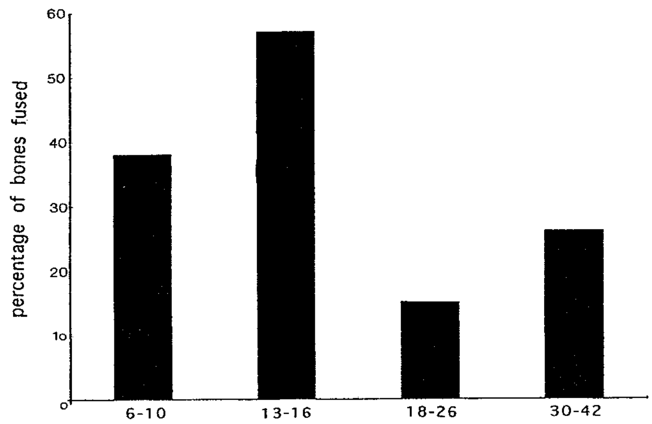

Fig. 1. Site A: Modified sheep fusion data (sample = 173 bone ends).

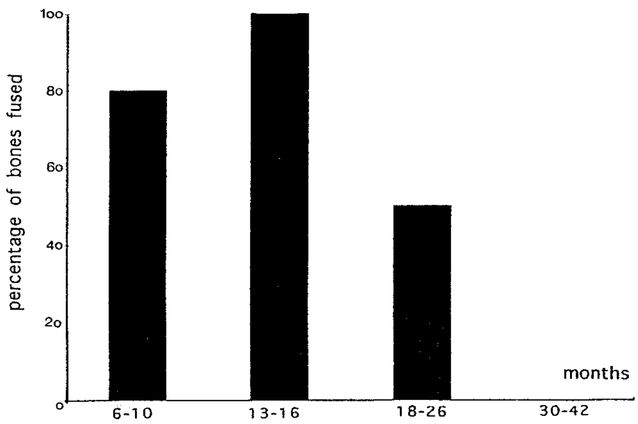

Fig. 4. Site C: Modified sheep fusion data (sample = 36 bone ends).

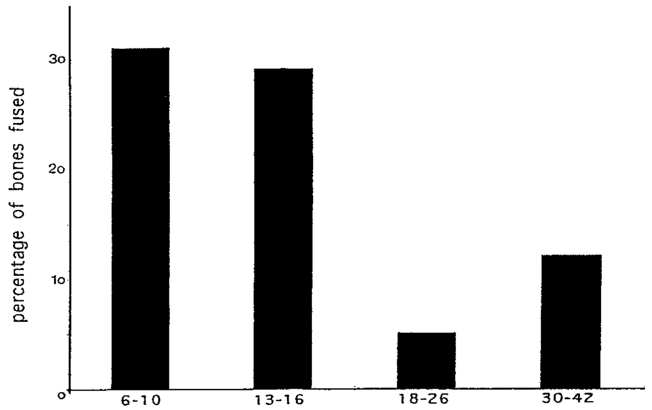

Fig. 2. Site A: Modified goat fusion data (sample = 411 bone ends).

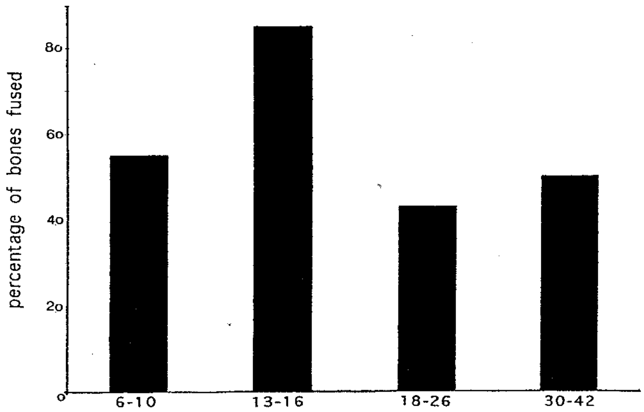

Fig. 5. Site C: Modified goat fusion data (sample = 91 bone ends).

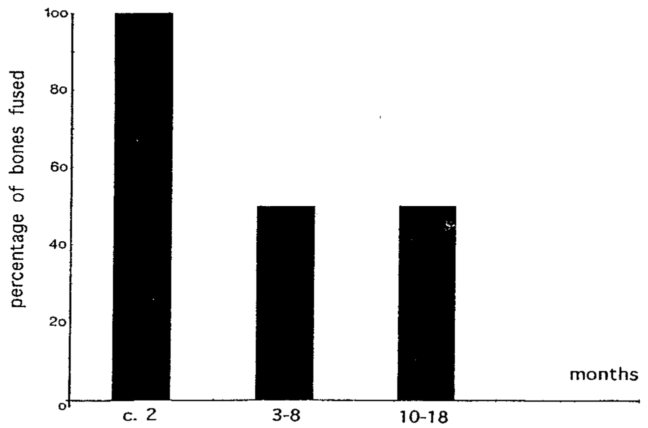

Fig. 3. Site A: Gazelle fusion data (sample = 12 bone ends).

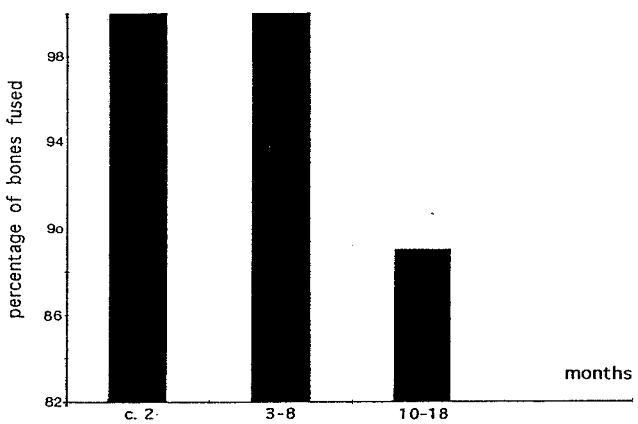

Fig. 6. Site C: Gazelle fusion data (sample = 107 bone ends).

The Wadi Fidan sites provided very few sexually dimorphic bones for sheep, goats and gazelles. The two sites appear to show that there were slightly more female ovicaprids, while the gazelle numbers are dominated by males (Tables 8-9).

The butchery evidence indicates that the limb bones were separated across all the major joints. The humerus radio-cubitus joint was the most frequently marked. Only one bone, an ovicaprid radius, provided evidence of filleting. The other taphonomic factors, burning and canid and rodent gnawing, indicate that the goat, sheep and gazelle remains faced the same degrading processes, which makes a comparison of the two sites of interest. The results show that every form of post-mortem damage was more intensive at Site C (Table 10). The exceptionally high levels of burning at both sites is also significant.

Table 8. Site A: Sex data.

	Female	Male
Goat pelves	1	1
Sheep pelves	2	1
Gazelle horn	1	0

Table 9. Site C: Sex data.

	Female	Male
Goat pelves	2	0
cf. Capra nubiana horn	3	2
Sheep pelves	2	1
Gazelle pelves	1	1
Gazelle atlas	1	1
Gazelle horn	2	8

The metrical data from the Wadi Fidan sites and the comparative data are provided in Tables 11-15. The measurements for goat horn, first phalanx length and minimum shaft width show an overall decrease in size over time. The evidence from the measurements of the distal width of the goat humeri is inconclusive, yet it is significant that the gazelle distal humeri indicate that no size decrease in wild populations occurred over this time.

Table 10. Sites A and C: Bone preservation.

	Site A (%)	Site C (%)
Canid gnawed	0.6	0.8
Rodent gnawed	23.7	41.3
Burnt	20.8	44.1
Unaffected	60.1	36.3

Table 11. Site A: Goat horn measurements (mm).

Site	Cave of Antelias	Ksar Akil	El Khiam	Beidha	Beidha	Fidan	Jericho
Date	Upper Palaeolithic	Upper Palaeolithic	Natufian	PPNB I-III	PPNB IV-V	late/final PPNB	Bronze Age
Sex data	males	males and females					
Medio-lateral range	18.0-22.5	15.0-27.0	21.0-22.0	16.3-47.1	16.9-37.5	17.7-21.9	
Medio-lateral mean	20.8	22.5	21.5	28.9	22.4	19.8	24.9
Anterior-posterior range	38.0-41.0	24.0-38.0		21.0-70.5	23.8-62.5	26.3-29.3	
Anterior-posterior mean	39.5	33.8	32.0	41.0	32.5	27.8	39.7

The results from the analysis of a number of important contexts are recorded in Table 16. Gazelle, sheep and goat bones were identified in the three occupation deposits from Site A (contexts 14, 15, 16). Contexts 14 and 15 were recorded during excavation as containing much burnt bone and charcoal, and indeed over 50 percent of the bone from these contexts was charred. This is over twice the percentage for burnt bone from Site A as a whole (*cf.* Table 10). The third occupation deposit (context 16) displayed no sign of burning. An oven (context 17) and a hearth (context 19) were also analysed from Site A, but very few bones were identifiable and only one bone showed evidence of burning.

Table 12. Sites A and C: Goat distal humerus (mm).

Site	El Khiam	Beidha	Beidha	Beidha	Beidha	Beidha	Beidha	Fidan	Fidan	Tell Arad
Date	Natufian	PPNB VI	PPNB V	PPNB IV	PPNB III	PPNB II	PPNB I	late PPNB	final PPNB	Chalcolithic
Distal width range	29.0-33.0	27.7-36.0	26.9-40.0	25.5-45.0	26.0-41.0	26.3-42.0	30.9-36.4	30.0-33.5	28.2	28.5-36.2
Distal width mean	31.0	32.0	32.1	33.8	34.2	33.0	34.0	32.5	28.2	30.5

Table 13. Site C: Gazelle distal humerus (mm).

Site	Beidha	Beidha	Beidha	Fidan
Date	PPNB VI	PPNB IV-V	PPNB I-III	final PPNB
Distal width range	23.2-24.2	22.8-26.7	22.5-27.2	26.4-29.0
Distal Width mean	23.6	24.1	24.6	27.7

Table 14. Sites A and C: Goat first phalanx length (mm).

Site	Jericho	Munhatta	Beidha	Beidha	Beidha	Fidan	Fidan	Tell Arad
Date	PPN	PPN	PPNB IV-V	PPNB II-III	PPNB I	late PPNB	final PPNB	Bronze Age
Length: range	37.1-50.4	47.5-52.8	35.2-49.0	31.0-48.2	36.0-49.7	35.0-39.8	34.0-37.1	30.0-41.0
Length: mean	45.1	50.4	42	41	40.8	37.4	35.25	36.3

Table 15. Sites A and C: Minimum shaft width (mm), goat first phalanx. (F = fused, UF = unfused).

Site	Beidha	Beidha	Fidan	Fidan
Date	PPNB IV-V	PPNB II-III	late PPNB	final PPNB
Min. shaft width range	9.5-15.0 (F/UF)	8.3-15.0 (F/UF)	8.4-12.8 (F/UF) 8.7-12.8 (F)	9.6-10.9 (F)
Min. shaft width mean	11.7 (F/UF)	11.5 (F/UF)	9.6 (F/UF) 10.75 (F)	10.18 (F)

A hearth (context 17) was given particular attention from Site C. Of the 81 bones identified as gazelle, goat, sheep and cow, 53 showed signs of burning and 42 were gnawed. The amount of burnt bone from this context exceeds the average percentage for Site C as a whole (*cf.* Table 10) and contrasts with the low levels of burning from the hearth and oven of Site A. The levels of burning at both sites are too high to be related to cooking activities alone. It appears that significant and systematic burning of the animal bone took place. This may be related to the hygienic disposal of domestic waste, but a ritualistic form of activity cannot be discounted. The two storage bins excavated at Site C contained very little bone waste and no bones identifiable to species. This precludes any helpful comment on their usage.

Table 16. Sites A and C: Important deposits.

Site A	**Bone count**	**Number of burnt bones**
Species		
Context 14 - occupation deposit		
Gazelle	0	0
Goat	4	3
Sheep	3	1
Sheep/goat	5	2
Context 15 - occupation deposit		
Gazelle	1	0
Goat	6	3
Sheep	6	3
Sheep/goat	7	5
Context 16 - occupation deposit		
Gazelle	0	0
Goat	7	0
Sheep	14	0
Sheep/goat	24	0

Site A	**Bone count**	**Number of burnt bones**
Species		
Context 17 - oven		
Gazelle	0	0
Goat	3	0
Sheep	1	0
Sheep/goat	2	1
Context 19 - hearth		
Gazelle	1	0
Goat	1	0
Sheep	0	0
Sheep/goat	1	1
Site C		
Context 17 - hearth		
Gazelle	43	25
Goat	20	16
Sheep	3	3
Sheep/goat	12	9
Cow	3	0

Discussion

The significance of both Wadi Fidan sites lies in 1) their occupation at a time that witnessed a dramatic revolution in food procurement from hunting and gathering to the domestication of plants and animals, and 2) their occupation during a period when the southern Levant saw a significant abandonment of settlements. Consequently, these two sites have the potential to shed further light on an important and controversial period of Jordanian prehistory.

Here four possible scenarios are presented that may account for the observed data: 1) Sites A and C were occupied by hunters and gatherers; 2) Site A was occupied by hunters but by the final PPNB the inhabitants of Site C were managing domesticated herds of sheep and goats; 3) Sheep and goats were kept as domesticated animals at both Sites A and C. By the final PPNB, however, the secondary product milk was being used. An increase in the hunting of wild resources provided meat supplements or 4) Sheep and goats were kept as domesticated animals at both Sites A and C, but by the final PPNB environmental stresses necessitated a return to hunting to support a failing mixed farming system.

1) Sites A and C were occupied by hunters and gatherers.

Evidence for the capture and control of ovicaprids is apparent with a change in the gross size of recently domesticated animals (HECKER 1975). The population structure of domesticated species is also seen to vary from that of wild populations (LEGGE 1972, BECKER 1991), and one species is often seen to dominate the faunal assemblage. In prehistoric Jordan the contribution of goats appears to supersede the value of gazelles at the majority of sites (HORWITZ 1987, LEGGE, and ROWLEY-CONWY 1987; KÖHLER-ROLLEFSON *et al.* 1988; *cf.* GARRARD *et al.* 1988). But the definitive identification of the domestication of animals is offset by the possibilities that a) this early shift may reflect a dietary change in hunter preferences, b) size diminution may have been be dictated by climatic changes and c) variation in the population structure of hunted animals is greater than has often been thought (UERPMANN 1978, TCHERNOV and BAR-YOSEF 1982).

Nevertheless, the metrical analysis of the distal humeri of goats and the data from the *Capra* first phalanges (Tables 12, 14 and 15) do indicate a decrease in size over time. If climatic factors, and not human interference, were influencing gross size, then this size diminution should be mirrored in the bones of gazelle. The assumption is that gazelle represents a wild species under no human control (BERRY 1969, JARMAN 1969, BOESSNECK and VON DEN DRIESCH 1978, DAYAN and SIMBERLOFF 1995, *cf.* LEGGE 1972, COPE 1991). A comparison of the Wadi Fidan gazelle data to that of Beidha indicates that no size diminution occurred in this species (Table 13). This suggests that there was some human manipulation of the goat herds.

Similarly, the population structure of goats and sheep has been compared to that of gazelles (Figs. 1-6 and Tables 8-9). This avoids the difficulties of identifying a typical herding structure, if such a structure existed, and instead allows the comparison of populations believed to be under some human control to a species that is considered to be wild. In addition, any change in population structures over time was noted. This is preferable to comparing a single population to an "illusionary" herding norm (MEADOW 1989). Even a cursory comparison of the age-at-death profiles (Figs. 1-6) highlights a very different slaughtering strategy for ovicaprids as compared to gazelles.

These data suggest therefore that the treatment of ovicaprids was very different to that of the gazelles and lend weight to the suggestion that goats, if not all the ovicaprids, were under some form of control in PPNB Wadi Fidan, and that hunting was no longer the only source of meat.

2) Site A was occupied by hunters but by the final PPNB the inhabitants of Site C were managing domesticated herds of sheep and goats.

Although there is some evidence for the domestication of animals at Site A, there is a perceptible difference in the population structure of the ovicaprids from Site A to Site C. The fusion data for the ovicaprids indicate that there was a tendency over time for the kill-off strategy to shift from an immature population to a more adult based system (Figs. 1, 2, 4 and 5). It is possible that the ovicaprid population at Site A was a hunted population under stress with the characteristic dominance of immature animals. In contrast, the population of Site C was a stronger, more well-established herd with an age structure that had shifted towards a more mature population. Perhaps by the final PPNB, the inhabitants had the herd under a more productive form of manipulation.

While this suggestion may be a valid interpretation of the ovicaprid population structures, it fails to account for the difference in the hunted gazelle population and the proposed hunted ovicaprid herd at Site A. The dominance of ovicaprids in the Site A assemblage may also be indicative of a controlled herd (BAR-YOSEF 1981) as the domesticated animals usurp the dominance of hunted resources.

3) Sheep and goats were kept as domesticated animals at both Sites A and C. By the final PPNB, however, the secondary product milk was being used. An increase in the hunting of wild resources provided meat supplements.

If the variation in ovicaprid population structures at Sites A and C cannot be accounted for in terms of wild versus domesticated herds, perhaps the usage of the herds changed over time. By the final PPNB the juvenile kill-off could be restricted to the surplus infant males, unnecessary for breeding requirements and unwanted consumers of the ewes' and nannies' milk. The strategy of Site C may therefore have involved the utilisation of a valuable secondary product resulting in the presence of mature milk producers.

The introduction of secondary products has traditionally been placed somewhere in the Chalcolithic to the Bronze Age (DUCOS 1978, 1984). The capacity of early domesticates to produce enough milk to make its use effective and the human ability to ensure its availability at the expense of the suckling animals have been seriously questioned (MCCORMICK 1992). What cannot be disputed is that if the necessary requirements for milk utilisation were available, the earliest herders would have exploited a resource that outstrips meat in its food value (DAVIS 1984, KÖHLER-ROLLEFSON 1992) and provides a more or less continuous food source (PAYNE 1972). It is possible that the increase in the hunting of *Gazella* (*cf.* Tables 6 and 7) may have been necessitated by the decrease in the availability of a prime domesticated meat source.

4) Sheep and goats were kept as domesticated animals at both Sites A and C, but by the final PPNB environmental stresses necessitated a return to hunting to support a failing mixed farming system.

From the metrical and population data, it is evident that sheep and goats were under some form of human control. One indicator of domestication - a shift of emphasis from gazelle to ovicaprids (BAR-YOSEF 1981) - is less apparent for the final PPNB in the Wadi Fidan. A comparison of the bone data from Sites A and C indicates that the relative frequency of sheep and goats falls over time while the abundance of gazelle increases markedly (Tables 6 and 7).

It is possible that the Wadi Fidan people -their land affected by environmental change or demographic alterations - may have chosen or were forced into a return to hunting (RICHARDSON 1993). Becker (1991) suggested that vegetation depletion with the introduction of ovicaprids may have led to an increased reliance on the old methods, and Köhler-Rollefson (1988) believes that the early cultivation of crops and the keeping of goat herds did not make for a successful farming community. The floral evidence from the Wadi Fidan indicates that free threshing wheats and cultivated barley were in use (Colledge n.d.), and the faunal data indicate the manipulation of ovicaprid herds. It is possible, therefore, that we are witnessing the beginnings of a mixed farming crisis and the need to return, at least in part, to wild resources. A number of PPNB sites in the southern Levant underwent abandonment, a phenomenon that has been related to the inherent weaknesses of the newly adopted system of mixed farming in an area of environmental marginality. It is possible that this crisis may have been exacerbated by a deterioration in the climate (ROLLEFSON and SIMMONS 1988, KÖHLER-ROLLEFSON 1989), and the palynological evidence from the Huleh Basin suggests a corresponding period of desiccation (BOTTEMA and VAN ZEIST 1981, VAN ZEIST and BOTTEMA 1982).

Conclusion

The sites of the Wadi Fidan occupied an area believed to be at the very centre of plant and animal domestication (BENDER 1975). The late PPNB Site A was settled by a population that cultivated cereals and maintained mixed sheep and goat herds. The "culturally controlled" animals were exploited primarily, if not solely, for their meat resources. The hunting of gazelles provided an additional but secondary meat supply.

In the final PPNB cereal crops were still under cultivation and ovicaprid herds remained under human control. A significant return to the hunting of *Gazella* may indicate an increase in the human population with the land's carrying capacity for domesticated herds having been surpassed. This crisis would have been aggravated further if there was already competition for land for crop growth and grazing. Alternatively, a deterioration in climate with prevailing desertic conditions may have lead to a reduction in the numbers of domesticates, with a necessary increase in the utilisation of the arid tolerant *Gazella dorcas* and *Capra nubiana*. A continuation of any of the following - further population increase, a failure to combine crop growth and herding or a decline in environmental resources - may ultimately have caused the abandonment of the area.

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The Fauna of 'Ain Ghazal, a Major PPN and Early PN Settlement in Central Jordan

Angela von den Driesch and Ursula Wodtke

Abstract: *The present study analyzed 33,000 animal bones excavated from 'Ain Ghazal during the 1993-95 campaigns. The material belongs to five periods of occupation including two successive Pre-pottery Neolithic B phases, a transitional Pre-Pottery Neolithic B/C phase, the Pre-Pottery Neolithic C phase, and the Pottery Neolithic occupation of the Yarmoukian culture. Altogether, this represents 1,500 -1,700 years of animal exploitation at 'Ain Ghazal. The identified fauna includes mountain species such as wild goats and grassland/open forest species such as wild cattle, mountain gazelle, wild boar, badger, honey badger, hare and others. True forest inhabitants such as red and fallow deer are completely absent. In the 'Ain Ghazal fauna there is also evidence for steppe species such as onager and wild ass, Dorcas gazelle and bustard. The major part of the faunal remains comes from sheep and goat. The domestication of wild goat can be traced from the beginning of the occupation. For sheep it is obvious that the settlers introduced the domestic sheep from outside, at the latest during the transition from the Middle to the Late PPNB. The increasing proportions of sheep and goat to the PPNC clearly show that ovicaprine husbandry was practiced successfully at the site. Together with the possible keeping of cattle and possibly pig as well as the dog, animal husbandry played a major role in the human diet of 'Ain Ghazal.*

Introduction

'Ain Ghazal has a prominent place among the many Pre-Pottery Neolithic settlements in the Levant. It is one of the rare sites that provided a continuous occupation from the Middle Pre-Pottery Neolithic B (MPPNB) through the earliest Pottery Neolithic, the so-called Yarmoukian culture (KAFAFI 1993). 'Ain Ghazal is also a unique settlement in which the transition from the PPNB into the Pottery Neolithic occurred. This phase, still aceramic, is called the PPNC (ROLLEFSON and SIMMONS 1986, 1987). 'Ain Ghazal is a singular source for the study of the Neolithic Revolution, that period characterized by the cultivation of plants and the domestication of animals.

The site is located at the northeastern edge of Amman on the sometimes steep slopes west and east of the perennial Zarqa River. The landscape around 'Ain Ghazal, today a development area (see Fig. 1), is dominated by steep, stony, poorly vegetated hills (Plate 1:A). The valley bottom is only 150m wide. The former gallery forests must have been small strips to the left and right of the river. With interruptions, excavations were carried out by Prof. Gary Rollefson ('Ain Ghazal Research Institute) and Prof. Zeidan Kafafi (Institute of Archaeology and Anthropology, Yarmouk University) in collaboration with the Department of Antiquities since 1982. Many reports from these investigations have appeared (*e.g.*, ROLLEFSON *et al.* 1992, 1993, 1994; SIMMONS *et al.* 1988; KAFAFI and ROLLEFSON 1995). The excavation revealed important insights into the culture and economy as well as interesting aspects of ritual burial practices (*e.g.*, ROLLEFSON *et al.* 1989) and religious views (*e.g.*, ROLLEFSON 1983, 1986; KAFAFI and ROLLEFSON 1995) of the former inhabitants.

An immense amount of animal bones has been excavated since 1982, and they testify to the animal segment of the economy, man-animal relationships including hunting activities and domestication processes, as well as the former environment. The material excavated from 1982-1989 has been presented in many reports (*e.g.*, KÖHLER-ROLLEFSON 1988, 1989a, 1989b, 1989c; KÖHLER-ROLLEFSON *et al.* 1993), including an unpublished honor's thesis (Wasse n.d.). All of these publications, which entail detailed results, are either preliminary or focus on selected aspects, for instance on

Plate 1:A. Environment of 'Ain Ghazal excavation area.

Plate 1:B. Bone sample from Square 3300.

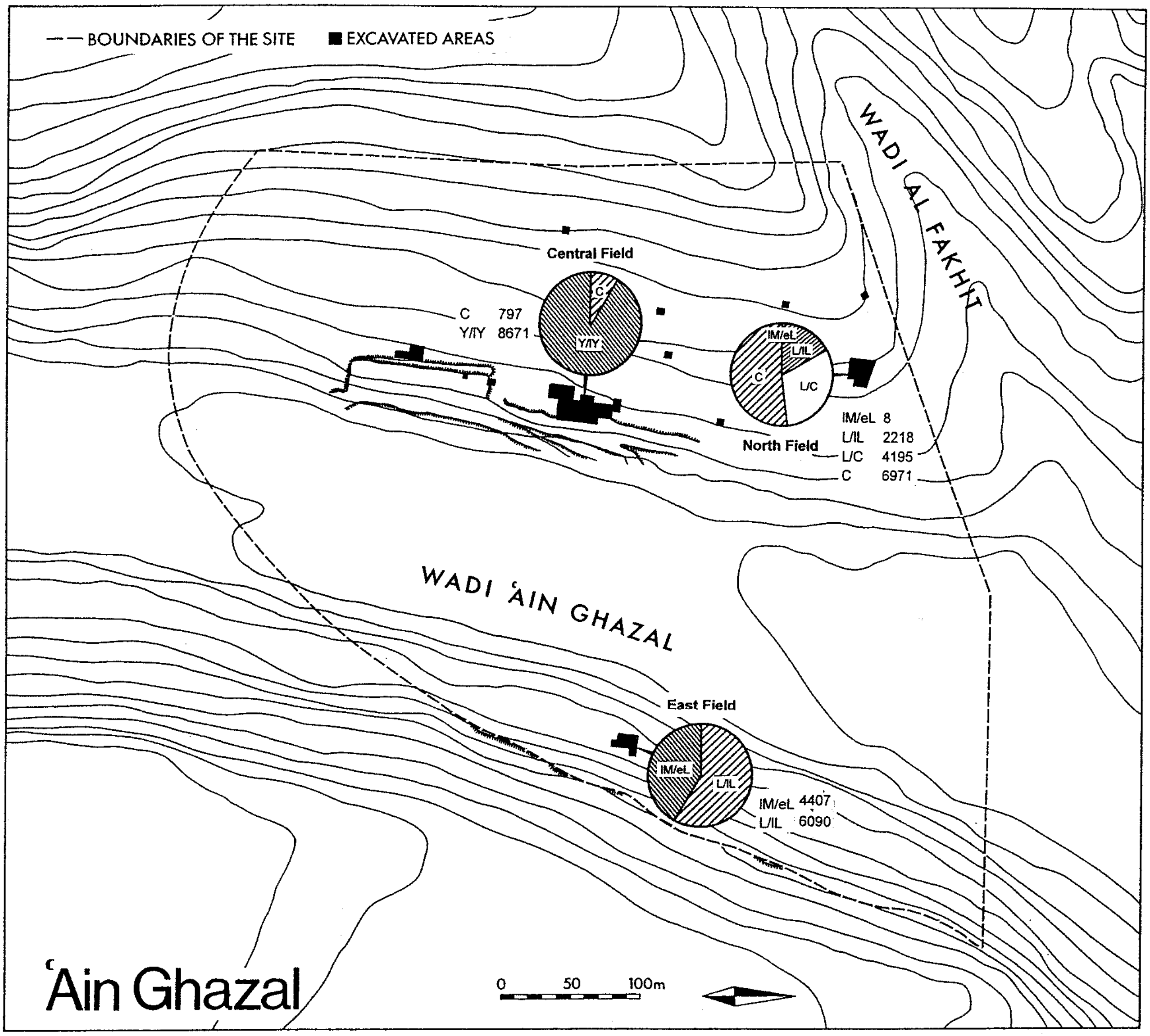

Fig. 1. Map of site. Quantitative distribution of bone finds from 1993 to 1995 excavations in the various fields.

goat husbandry or domestication. Up to now no complete documentation of the animal bones from 'Ain Ghazal according to the standards of archaeozoological analysis had been undertaken. This study analyzes the unpublished bone remains from the 'Ain Ghazal field seasons of 1993-1995[1] according to methods as applied in the Institut für Paläoanatomie in Munich for years (see below).

Chronology

The animal remains studied up to 1989 derived from large-scale excavations on the western slopes of the Zarqa Valley, including the North, Central and South Fields (Fig. 1). According to information from Köhler-Rollefson *et al.* (1993), this material comes from layers dated as follows:

Middle PPNB (MPPNB)	7.250 - 6.500 bc
Late PPNB (LPPNB)	6.500 - 6.000 bc
PPNC	6.000 - 5.500 bc
Yarmoukian (Y)	5.500 - ?5.000 bc

[1] For the analysis, von den Driesch stayed in Irbid, Jordan, during August 1995. We thank Prof. Rollefson for providing the material for analysis and for the information on the chronology of the units; and Prof. Kafafi, Director of the Institute of Archaeology and Anthropology, Yarmouk University, for his extremely kind hospitality.

The earliest identified layers fall into the Middle PPNB.

In 1993 new trenches were opened on the steep eastern bank of the valley, named the East Field. The remains analyzed by us from the 1993-1995 seasons comes from three large areas (Fig. 1): Central Field (CF, Square numbers 3XXX to 4XXX), North Field (NF, Sq. numbers 5XXX), and the East Field (EF, E 12-14, F 11-14). This material does not give evidence for the site's earliest phase (MPPNB), but there is a transitional phase from the latest MPPNB to the early LPPNB. The following chronological order was provided by the director of the excavations for the faunal analysis:

Late Middle - Early Late PPNB	(lM/eL)
Late PPNB- latest LPPNB	(L/lL)
Late PPNB - PPNC	(L/C)
PPNC	(C)
Yarmoukian	(Y)

The material presented here is unevenly distributed among these phases in the excavations areas CF, NF, EF (Fig. 1).

For the Yarmoukian occupation the excavators distinguished between an early (Yarmoukian) and a late phase (Late Yarmoukian). Due to the small number of specimens (n = 882) from the Late Yarmoukian, this subdivision was not used. The same is true for the separation of the "late" LPPNB and the "latest" LPPNB.

Characterization of the Finds

A total of 33,357 specimens was inspected, of which 13,006 (or just less than 40%) were not identifiable (Table 1). The majority of the bones represent mammals; bird bones are extremely rare (21 from 20,329 identifiable bones). As for other species to be expected at the site, we have evidence of tortoises and some snails and other mollusks.

The specimen totals vary from phase to phase. The bones identified according to vertebrate species are distributed as follows:

	lM/eL	L/lL	L/C	C	Y/lY	Total
n	3,121	4,331	2,786	4,989	5,102	20,329
%	15.4	21.3	13.7	24.5	25.1	100.0

The last two phases at the settlement are the richest.

The bones from all the layers are extremely small and fragmentary (Plate 1:B). Some bear the marks of flint knives, others are burned. This fragmented material from the aceramic Neolithic is at first somewhat astonishing, for there is no reason to shatter the bones since no pots were available for cooking them. The meat, at any rate, was not roasted on the bone, which would have resulted in more burned bone fragments. It appears likely that the meat was removed from the bone and cooked on hot stones. It is also imaginable that meat portions were packed into clay and baked in the fire before the meat was separated from the bones for consumption. The fragmented material, however, shows that the inhabitants were trying to remove marrow, which was either eaten raw or cooked. Bones with meat still on them may have been cooked in other vessels than pottery, for example specially treated leather sacks.

The high rate of calcareous encrustation of the bones in the PPNC and Yarmoukian phases is striking. In these layers the bones were covered by a gray crust up to 3mm thick, which was problematic for species identification but even more so for weight determinations. In order to avoid inflated measurements, the thickness of the calcareous crust was subtracted from the measurement. Whenever the encrustation was too massive, the bone to be measured was placed for a few seconds in dilute hydrochloric acid then rinsed with water to remove the crust without damaging the bone.

Methods

The material was identified as far as possible at the Institute of Archaeology and Anthropology in Irbid, measured, weighed and recorded. The determination of certain specimens was undertaken in Munich using our comparative collection. The handwritten data were transferred to a special archaeozoological program, the so-called "Ossobook" from the University of Basel, and processed statistically afterwards.

There are two opinions concerning bone determinations from settlement excavations. One holds that all skeletal parts as well as all fragments, if possible, should be considered; the other maintains that one should concentrate on the most distinguishable skeletal parts. Generally one neglects to identify most of the bones of the trunk. In extreme cases only special, characteristic bones are identified.

These approaches reduce further the interpretation possibilities, which are already limited by the high state of fragmentation. With long experience, it is quite possible to identify vertebrae, rib fragments, and other small bones, such as carpals, tarsals, and sesamoids. The bone counts in Table 1 thus refer to all the skeletal parts.

In contrast to the above statement, it is often difficult to distinguish between sheep and goat remains, especially when bones are fragmented as in these samples. Only well-preserved skull fragments, mandibles, and articular ends of long bones and calcanei, tali, and phalanges are attributable. Still, the percentage of determinable sheep-goat bones in the material is sufficient (Table 2) for secure statements on the occurrence and frequencies of both species at the site, including their size developments.

The possibility of confusing gazelle bones with those of sheep and goat is virtually nil. But only in rare instances can the different gazelle species be distinguished. The same is true for wild equids (onager and wild ass; see below), and there are also difficulties for the occasional dog and jackal bones.

Measurements are necessary for the complete documentation of animal bones, especially for materials from settlements where domestication processes are in effect. The techniques of measuring, the standard reference points, and the orientation of the bones follow the standards defined by von den Driesch (1976). Due to bad preservation, measurements for individual skeletal parts are rare, so absolute measurements were converted to LSI values (Logarithmic Size Index) in order to be independent from conventional comparisons. The LSI method calculates the difference of measurements from those of any particular "standard animal" in logarithmic form. In this way measurements from various skeletal parts can be summarized so that statistically significant data can be presented (SIMPSON 1941, MEADOW 1984). However, it is also necessary to document the absolute measurements independently.

Age determinations were calculated according to tooth eruption and wear of mandible and maxilla as well as epiphyseal fusion of the limbs. As a reference for this process, we used the results of Davis (1980, 1982) for gazelles, of Bull and Payne (1982) for wild boar, and of Bullock and Rackham (1982) for goats in combination with the results of Habermehl (1975) and Silver (1963). Investigations concerning the development of the dental system and the postcranial skeleton of the aurochs do not exist, so instead the information for late maturing domestic cattle was applied (MEITINGER 1983). In the tables the tooth status was recorded as follows: - (not erupted); +/- (process of eruption); +/o (erupted but not worn); + (slightly worn); ++ (medium wear); +++ (heavy wear). The counts and designation of the teeth follow von den Driesch (1976). Pd (*Dens praemolaris deciduus*) means milk premolar.

For the limb bones, - means epiphyses not closed; +/- closing; and + closed.

For ruminants, the basis for sex determination in this study are the horn cores, the canines (if present) for the equids and pigs, as well as the pelvis for uniparous animals (*cf.* LEMPPENAU 1964). It is unnecessary to discuss here the criteria for sex determination of skeletal elements; they are well known among specialists. These are in all cases absolute criteria, although it is problematic to determine sex of bones based on size for animals with clear sexual dimorphism (*e.g.*, aurochs and goats). This is particularly sensitive in our case, since we must expect domestic and wild forms at the same site.

In general, bone weights are evaluated from trash deposits for understanding the importance of the individual species for human intake of animal protein. The varying degree of calcareous encrustation of the bones through the sequence (see above) reduced the quantitative information, and the weights could only be considered within each phase. The calculation of the minimum number of individuals (NMI) was omitted due to the high fragmentation rates.

On the one hand we can demonstrate an on-site domestication process for the aurochs (*Bos primigenius*) and wild goat (*Capra aegagrus*), but on the other hand the wild forms were continuously attested at the site. Therefore, we did not distinguish domestic and wild forms for these species. Aurochs/domestic cattle and wild goat/domestic goat are genetic units throughout the occupation. Due to difficulties of determination, we treated the group "sheep or goat" in the same way, although no wild sheep were found at 'Ain Ghazal.

Ovis/Capra

The wild sheep *Ovis orientalis* and the wild goat *Capra aegagrus* have not been part of the indigenous fauna of Jordan for a very long time (HARRISON 1968: Figs. 155*ff.*). Most likely they were extinct there as early as the Bronze Age (*e.g.*, VON DEN DRIESCH and BOESSNECK 1995: 85*ff.*). Today wild goats inhabit "the Taurus Mountains of Turkey, the mountains of Kurdistan, Azerbaijan and Armenia (with an extension into the central Caucasus), all the mountains of Iran, the Kopet Dağ in Soviet Turkmenia, and Pakistani Baluchistan" (UERPMANN 1987: 113). During earlier prehistoric times they were distributed down into the southern Levant. Everywhere where rocky, stony habitats

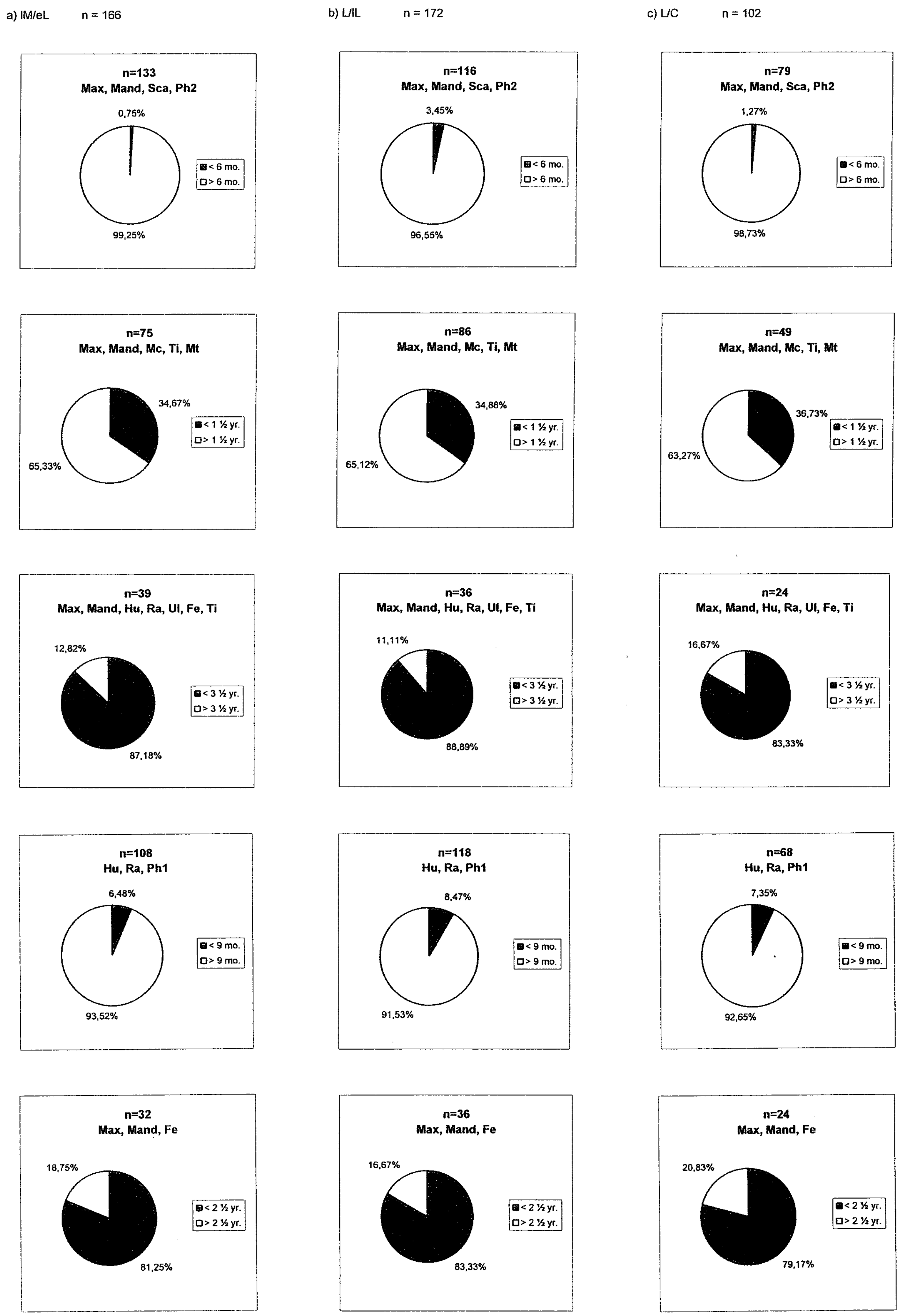

Fig. 2. *Capra.* Age Distribution.

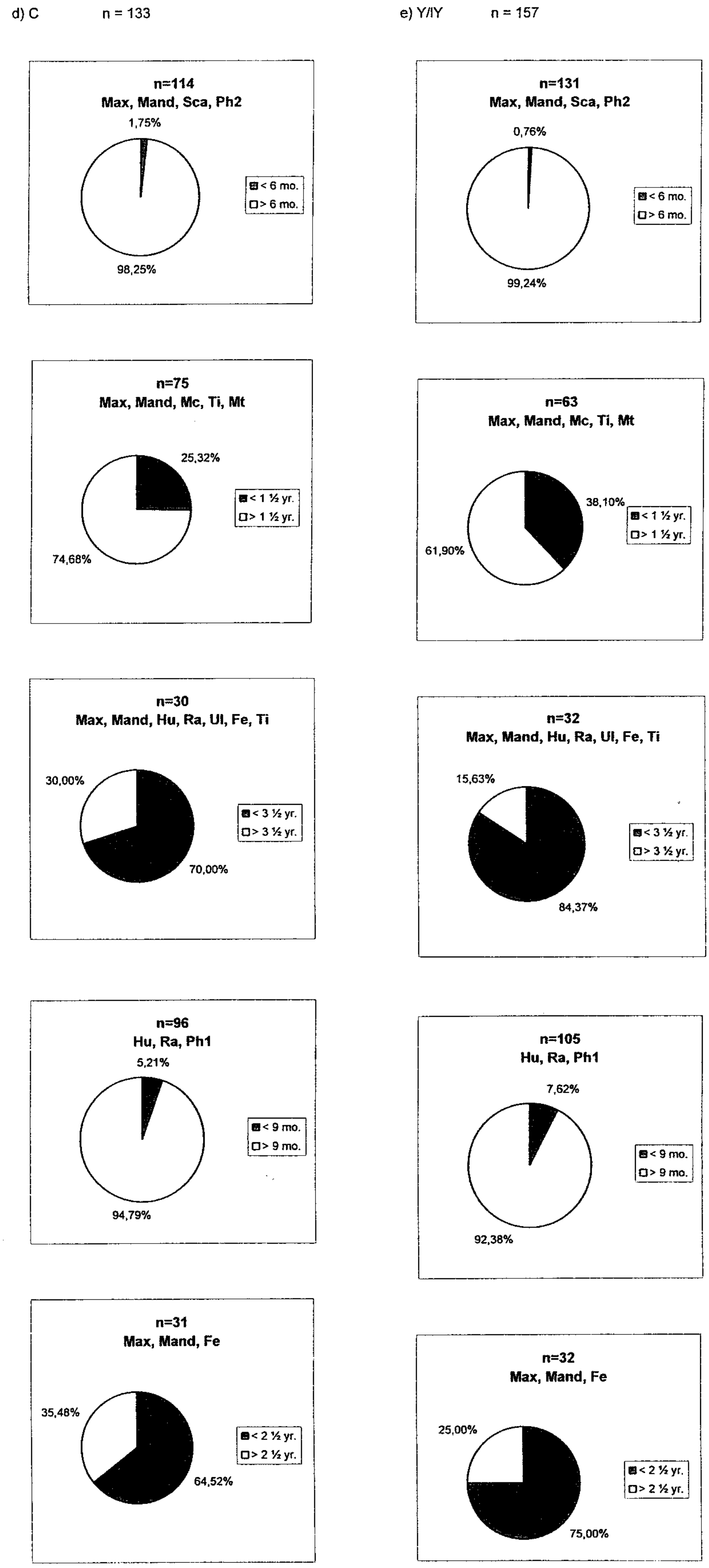

Fig. 2. *Capra.* Age Distribution (cont. 1).

existed, wild goats occurred (UERPMANN 1987: Table 25a, Fig. 52). Early Neolithic 'Ain Ghazal fell within the distribution area of this species.

According to Harrison (1968, Fig. 154) we should expect for 'Ain Ghazal another type of wild goat, the Nubian ibex *Capra ibex nubiana*; it is distributed particularly in the mountainous regions of the Arabian Peninsula from the Sinai to the Hadramaut (UERPMANN 1987: 118). Weiler (1981: 59) and von den Driesch and Boessneck (1995: Table 5.21) describe its bones from Tell Hesban, among which is a characteristic horn core. Near Hesban, where the mountains drop steeply into the Jordan Valley, this high mountain species had an ideal biotope; this is in contrast to 'Ain Ghazal, where the relief is more hilly but less steep and rocky.

Although the ibex skeleton shows all the important characteristics of a goat skeleton (BOESSNECK, MÜLLER, and TEICHERT 1964; BOESSNECK 1969), several significant morphological differences can be reported. In addition to the differences attested for the horn cores (which themselves are different for males and females), they are distinguishable by the articular ends of the long bones when preserved well. Ibex bones also seem to show, in some respects, characteristics of sheep bones. In the analyzed assemblages neither horn cores nor postcranial bones gave any indication of ibex at 'Ain Ghazal.

The presence of the Near Eastern wild sheep, which has a very limited distribution today (HARRISON 1968), is reported for several early Neolithic sites in the southern Levant (UERPMANN 1987: Table 27a, Fig. 58), *e.g.*, for Jericho in the Jordan Valley. Becker (1981: 66) expected the autochthonous presence of *O. orientalis* at Basta. If the wild sheep (still) was present near 'Ain Ghazal, an on-site domestication of the animal appears possible. We will discuss this problem together with the bone sizes.

Bones from sheep and goat (total: 16,056 specimens) form the largest group among the animal remains in 'Ain Ghazal. Their percentages increase during the aceramic occupation:

	IM/eL	L/IL	L/C	C	Y/IY
n, O/C	2,407	3,237	2,263	4,147	4,002
%O/C	77.1	74.7	81.2	83.1	78.4
n, *Ovis*	26	102	115	204	204
% *Ovis*	7.4	24.0	38.7	44.7	39.2
n, *Capra*	324	323	182	252	316
%, *Capra*	92.6	76.0	61.3	55.3	60.8

Sheep and goat are represented in the material from the earliest phases onwards. Goats were far more frequent than sheep at the beginning, but sheep bones increased gradually and reached their highest proportion in the PPNC. This interpretation is based on the assumption that the unidentified material contains the species in the same ratio as the identified material, which can be taken for granted.

The skeletal distribution of both species represents what is normally encountered in trash deposits (Table 2). The skeletal distribution is uneven because of the great degree of fragmentation of the skulls and long bones and because of the undeterminable loss of such small bones as sesamoids and phalanges. The material is dominated by the fragments of large, marrow-containing long bones, individual teeth and vertebra fragments. From the bones it cannot be determined whether complete skeletons were brought to the site or only parts of skeletons.

The age distribution of sheep and goat is illustrated in Figs. 4 and 5 rather than in the table. This is because in mammals, tooth eruption and epiphyseal fusion occur in phases. Age distribution shows that the percentage of young animals is persistently extremely high. Depending on the archaeological period, goats killed when they were fully mature range from 11 to 30% of the assemblage. The percentage of goats aged under 2.5 years at death amounts to 64.5% to 83%. The percentage of goats younger than 1.5 years falls between 25.3% to 38%. This killing pattern appears typical for a herd of sheep and goats kept under human care. It is usual to slaughter animals before the beginning of the dry season when fodder becomes scarce, and by killing mostly young animals, the chances for breeding animals to survive the times of scarcity increase. If one assumes that wild goats were present in the vicinity of 'Ain Ghazal throughout the year, and hunters had the opportunity to kill immature animals, this would not be a sufficient to explain the high preponderance of young animals in the bone material. It was during the PPNC the percentage of mature goats was highest at 30% (Fig. 2).

Fig. 3 lumps all the entire O/C sample together, and this basically reflects the same development except that there is even a higher percentage of juveniles. Interestingly, the previously mentioned situation for the PPNC does not obtain here, although this might be statistically suspicious because of the nature of the sample.

For the sex distribution of goats (Fig. 4a), the values are statistically secure, whereas in the case of sheep, the sample is very small except in the PPNC (Fig. 4b). In the lM/eL the remains of male goats predominate, but males and females are approximately equal in the LPPNB, and by the PPNC the percentage of females declines again. During the Yarmoukian the proportion of female goats climbs significantly. Because of sexual dimorphism, it is important to know the sex distribution in order to assess size development. The relatively small numbers of goats that can be sexed is much lower in the PPNC and Yarmoukian due to the calcareous encrustations on the bones.

The LSI values were compared with those from Pleistocene goats from Hayonim Cave (DAVIS, pers. comm.[1]), which were dated to the Aurignacian and can be safely assigned to the wild goat. According to Uerpmann (1979: 103*ff.*), Near Eastern wild goats are subject to a north-south size decrease. Goats in areas where summers are dry remain smaller than those where vegetation is richer, as in the mountains of the north. This is why Hayonim Cave was chosen as a point of reference because it occupies a similar biotope. One can't dismiss the possibility that size differences may be related to time and that being much older, the Hayonim Cave specimens may be chronologically distinct. On the other hand, it is also problematic to use goat measurements from a contemporaneous site, because during the PPNB all wild goats of the southern Levant were already manipulated by humans. Whatever the case, the goat measurements in the earliest layers (lM/eL) were distinctly smaller than those from Hayonim. The higher values are still in the range of variation of wild goats, but all the lower values are definitely within the size range of domesticated goats. There is a higher degree of variability in the lM/eL sample than for the true wild goat (Fig. 5). Size decrease continued until the L/C phase. In the PPNC the average size as well as variation increased again. During the Yarmoukian size once again decreased (*cf.* Table 3).

Surely the size developments are related to the changing proportions of male and female animals. But the fact that minima as well as maxima decrease makes it clear that continued size decrease reflects a domestication of the local goat. Size decrease was interrupted only in the PPNC (see below). This might be related to the crisis that settlement was undergoing at this point, reflected as well in the material culture (KÖHLER-ROLLEFSON 1988; 1989; ROLLEFSON and KÖHLER-ROLLEFSON 1993). Whatever the reason may have been for the worsening of the living situation at the settlement at this time, it looks as if the inhabitants either increased the hunting of wild goats or started to catch young wild goats to replenish domesticated populations.

Size development among sheep proceeds quite differently as is evidenced by the LSI values (Fig. 6 and Table 3): there is no size change at all. Not even the high proportion of female animals in the Yarmoukian influences the median values for this period (Fig. 4a).

Figs. 7 and 8 demonstrate the size relationships for *Ovis* and *Capra* based on distal ends of metatarsals and metacarpals. Both figures are based on the data of Becker (1991: Fig. 3) for sheep and goats from Basta. Since the distal ends of goat metapodials are wider than those of sheep, there is more variation in the former than the latter. Distinct sexual dimorphism in the goat is also evidenced. The presence of three clusters indicates that at Basta as well as 'Ain Ghazal, wild and domesticated goats occurred simultaneously. In the sheep there is less variation, but the densest cluster is found on the left side of the scattergram for both sites. Only a few sheep metapodials from 'Ain Ghazal and Basta are similar to wild sheep from Turkey. In this case it is legitimate to use the wild sheep from Turkey for comparison, since according to Uerpmann (1979: 97*ff.* and esp. Diag. 2) there is barely any size variation between northern and southern wild sheep. Since the sheep of 'Ain Ghazal and Basta had not been domesticated very long, and thus were still relatively large, the largest values should represent male domesticated sheep. Therefore, it cannot be demonstrated that wild sheep existed at neither Basta nor 'Ain Ghazal.

Moreover, we can assume that the sheep at 'Ain Ghazal were domesticated from the very beginning. Since wild sheep probably did not occur locally, the animals must have been imported from elsewhere as domesticates. This observation tallies with the fact that the proportion of sheep, which was initially very small, steadily increased through time (see above and Table 1).

Gazella

The site falls within the distribution area of two species. Apart from the mountain gazelle *Gazella gazella* (GROVES 1969: 54 and Fig. 1; LANGE 1972: 227*ff.* and Fig. 8; UERPMANN 1987: Fig. 42), *G. dorcas* also occurs (HALTENORTH and DILLER 1977: 99, LANGE 1972: 215*ff.* and Fig. 6, KUMERLOEVE 1967: 337*ff.*, UERPMANN 1987: Fig. 44). The Persian goitered gazelle (*G. subgutterosa*) need not be considered as it is native to the northern mountain regions of the Fertile Crescent. The only evidence for this species in the Levant listed by Uerpmann (1987: Fig. 47) is based on an assumption by Weiler (1981: 42) and von den Driesch and Boessneck (1995: 88*ff.*) for Tell Hesban (also *cf.* CLUTTON-BROCK 1971: 46*ff.*).

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[1] We thank Simon Davis for providing us with these data.

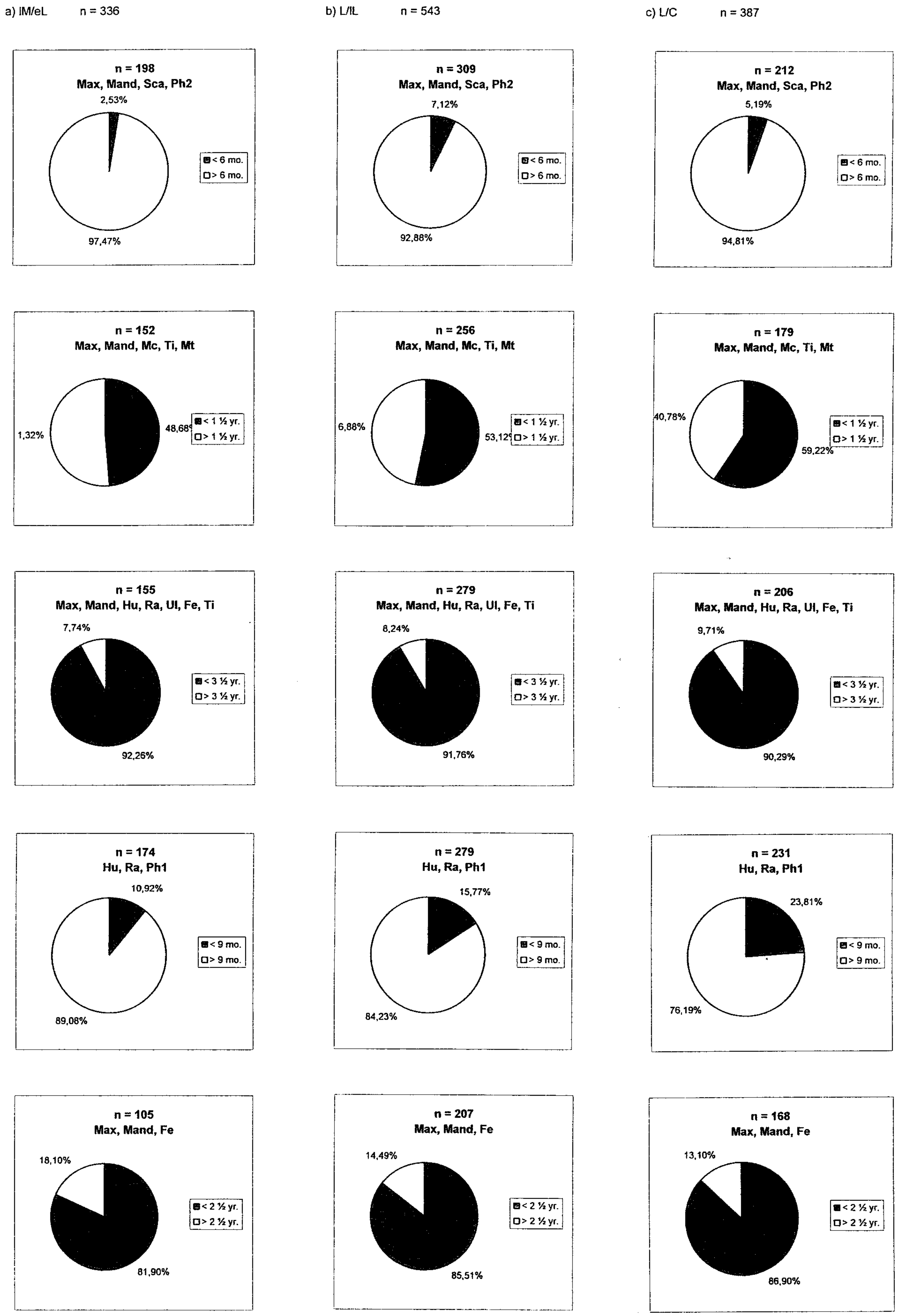

Fig. 3. *Ovis/Capra.* Age distribution.

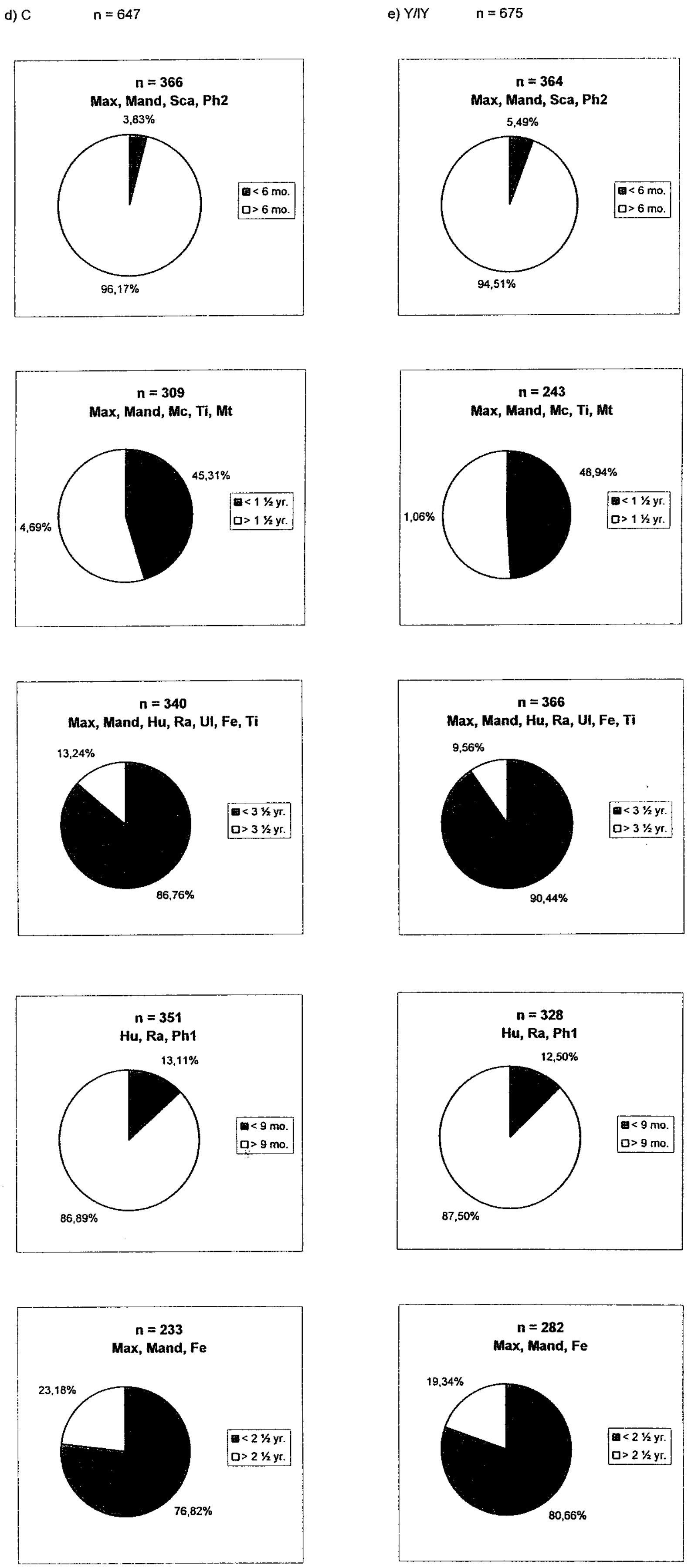

Fig. 3. *Ovis/Capra.* Age distribution (cont. 1).

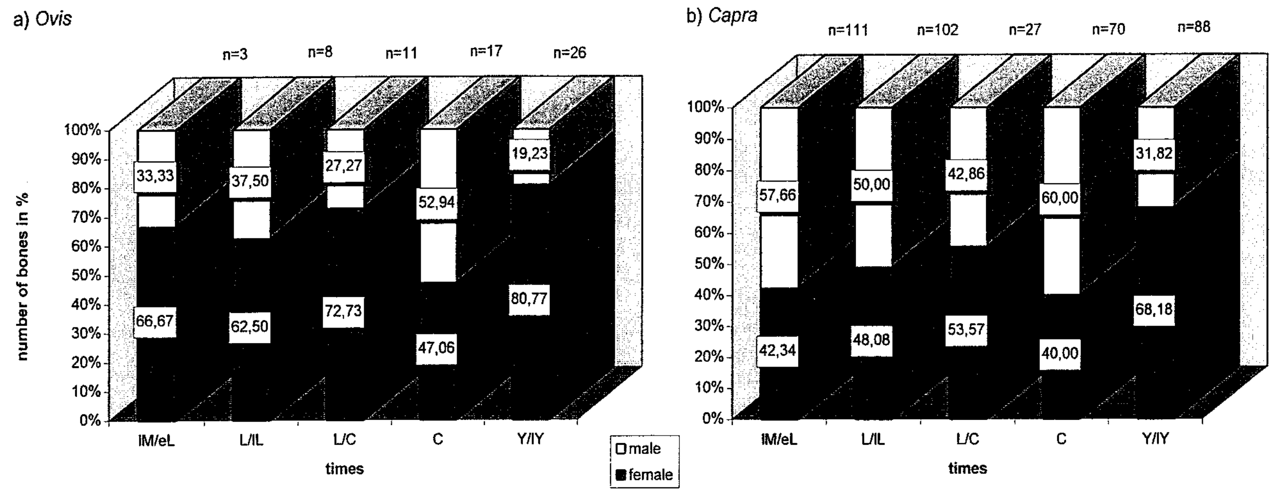

Fig. 4. *Ovis/Capra.* Sex distribution.

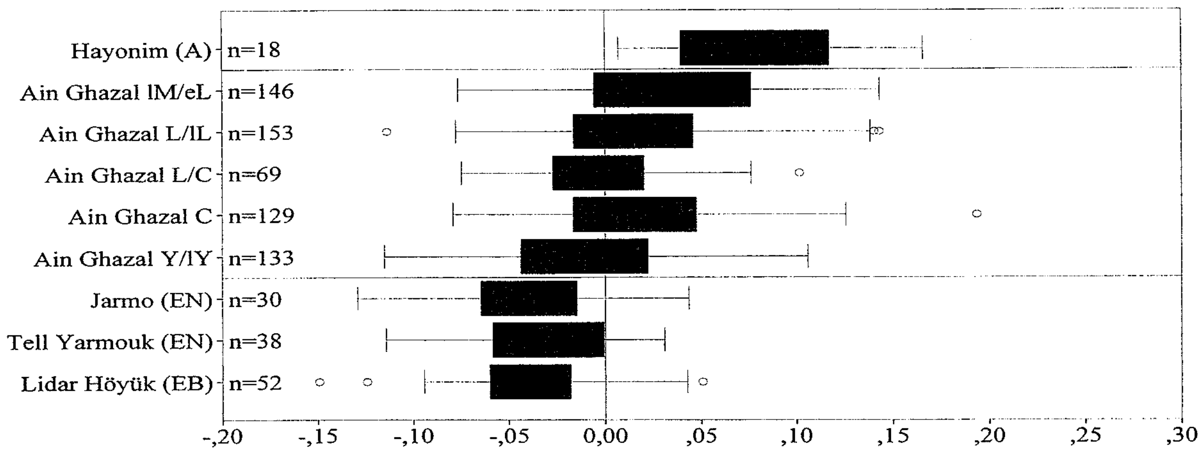

Fig. 5. *Capra.* Bone size development through times (A=Aurignacian; EN=Early Neolithic; EB=Early Bronze Age).

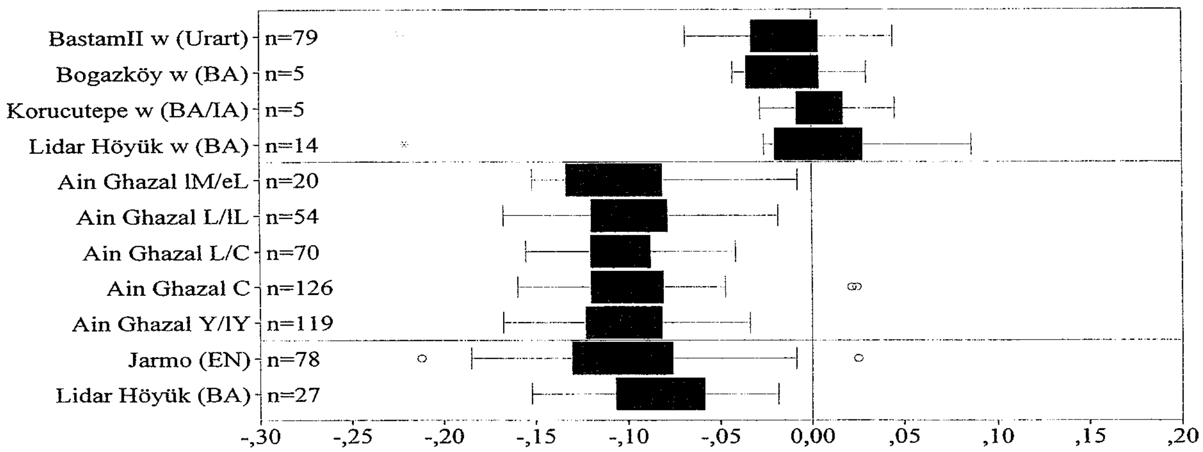

Fig. 6. *Ovis.* Bone size development through times (Urart=Urartarian; BA=Bronze Age; IA=Iron Age; EN=Early Neolithic; w=wild)

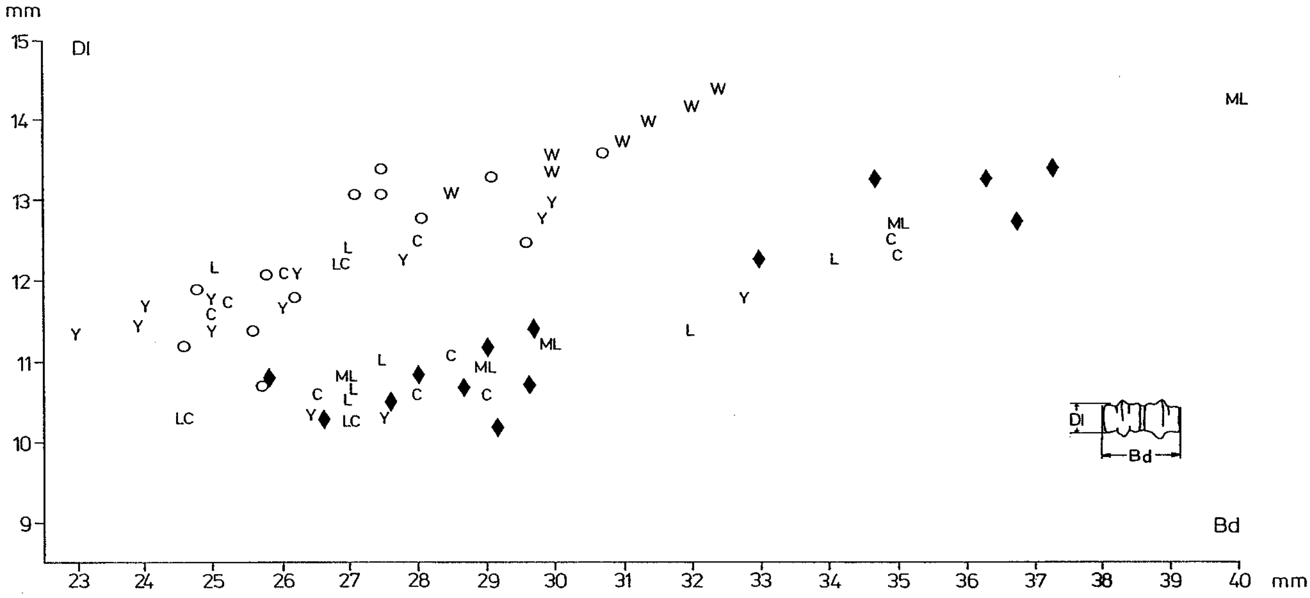

Fig. 7. Plot of distal metacarpi, showing the goat-sheep discrimination (Bd=distal breadth; Dl=lateral diameter).

O Ovis from Basta
L, C, Y in between circles *Ovis* from different layers of 'Ain Ghazal
W prehistoric *Ovis orientalis* from Turkey

◆ Capra from Basta
M, L, C, Y in between rhombs *Capra* from different layers of 'Ain Ghazal
after BECKER 1991, Fig. 3 with alterations

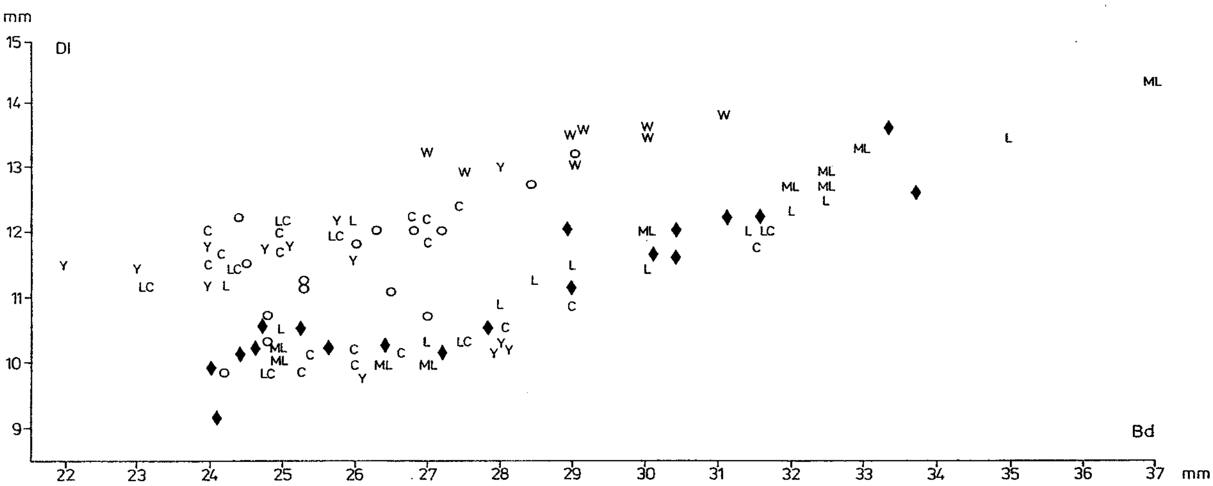

Fig. 8. Same plot as Fig. 9 for distal metatarsi.

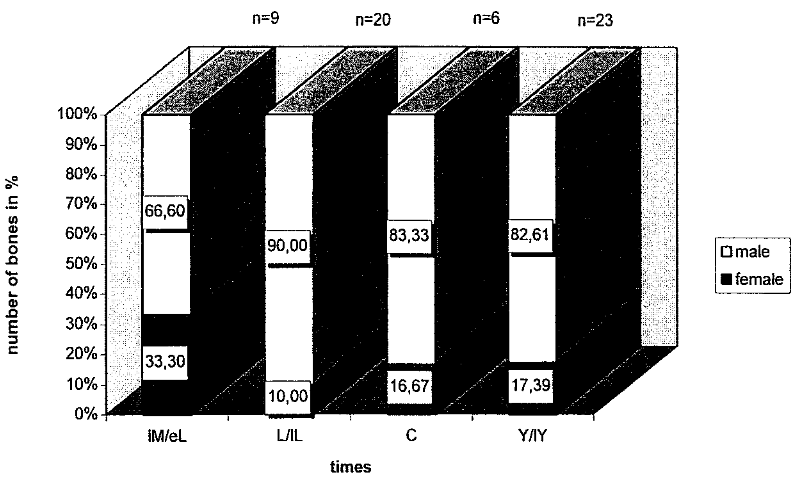

Fig. 9. *Gazella.* Sex distribution based upon horncores, skulls and pelvic bones.

Mountain and Dorcas gazelles can only be distinguished on the basis of their horn cores, especially for male animals. Postcranial material cannot be separated. But the Dorcas gazelle is the smallest of the Near Eastern gazelle species (see below).

The horns of male Dorcas gazelles are lyre-shaped with numerous transverse ridges, and viewed from the side they are S-shaped. The horns of the male mountain gazelle are angled more steeply, and the caudal edges of the core as seen from the side show a more open curvature than the Dorcas gazelle. Horncore fragments cannot be distinguished, so it is necessary to lump them together although both species are represented (Table 7).

Female *G. dorcas* and *G. gazella* also have horns. The female Dorcas gazelle has straight spear-shaped horns that are less developed than in the males, whereas the female *G. gazella* has less developed and much shorter horns.

It is well-known that gazelles undertake long migrations determined by the wet and dry season cycle. But it is not known how the migrations took place during the Palestinian Neolithic. Both species now have protected status and they do not occur around the area of the site. From African gazelles such as the Dama gazelle, it is known that during the rainy season they withdraw deeply into the Sahara and re-emerge during the dry season to their traditional territory. Since mature males sometimes roam alone, seasonal territoriality might obtain for this species. Unfortunately, few details are known for the behaviour and migratory patterns of *G. dorcas* and *G. gazella.*

Baharav (1974, cited by DAVIS 1983:56), who investigated gazelle populations in the eastern Galilee, noticed that herds contained a higher proportion of juveniles in the summer than in the winter. This seasonal difference was caused by two factors: 1) the birthing time in spring and 2) higher juvenile mortality in winter. For the interpretation of archaeological material, this would imply that a high percentage of juvenile remains was due to the hunting of gazelles during the summer and a small proportion would indicate hunting during the winter (DAVIS 1983). But if one must assume that two species are present, as is the case for 'Ain Ghazal, this theory no longer applies, since it is possible that the two species visited the vicinity of the site at different times of the year. For instance, the mountain gazelle could have turned up during the rainy season when the Dorcas gazelle withdrew to the south, since the latter species is more adapted to the desert, as is known from Egypt. Possibly neither of the species was present at certain times of the year. Perhaps the age and size determinations can provide clues (see below). Judging from the identifiable horn cores, *G. gazella* seems to have been far more frequent than *G. dorcas.*

As has already by noted Köhler-Rollefson (*e.g.*, 1989b) for the 1982-1989 finds, gazelle bones form the second most frequent category at 'Ain Ghazal, although much rarer in comparison to sheep and goats. The following absolute and relative numbers were noted in the different archaeological periods for the overall sample of 1,336 gazelle bones:

	lM/eL	L/lL	L/C	C	Y/lY
n	214	410	173	194	345
%	6.8	9.5	6.2	3.9	6.7

Gazelle remains peaked in the latest phase of the PPNB; during the PPNC they diminished by almost 50%, and in the Yarmoukian, gazelle hunting increased again.

The skeletal distribution is shown in Table 4. Except for "small bones", such as carpals, *Os malleolare* and sesamoids, parts of the skeleton are evenly distributed. The relatively high representation of skull fragments and horncores (n = 35) as well as phalanges (n = 36) during the LPPNB is due to a cache of gazelle horn cores and foot bones from a house in the North Field (see below).

Remains of adult animals predominate (Tables 5 and 6). There is a total of 41 jaw bones (Table 4), of which two were from animals less than three days old (Yarmoukian), two others of less than one month (Yarmoukian), and five less than six months old (two from lM/eL and three from the L/C). Six individuals were certainly a year old (one each in the lM/eL, LPPNB, and PPNC and three in the Yarmoukian). Three jaws are from gazelles around 1.5 years old (one each in the LPPNB, PPNC and Yarmoukian). Altogether 23 animals were fully mature (*i.e.*, over 18 months; five in the lM/eL, six in the LPPNB, three in the PPNC and nine in the Yarmoukian).

Analysis of the long bones (Table 6) indicates a smaller proportion of juveniles. This is due to taphonomic reasons (BOESSNECK and VON DEN DRIESCH 1979: 63, 98). It is a general phenomenon that jawbones reflect a higher proportion of juveniles than the long bones do, regardless of time and place. We will refrain from presenting a summary of both components, as was done for the O/C samples, since the reader can draw his/her own conclusions from Tables 5 and 6.

In summary, the age determination reflects hunting of gazelles during the summer and the beginning of autumn, as long as one assumes that the majority of births took place in January. That would mean that the six- and 18-month old gazelles were killed in late summer and the infants were born in the second birthing season in July-August (HARRISON 1968).

The sex determination in Fig. 9 is skewed since the larger horncores of male animals are better preserved and the finds of pelvic bones are rare. Because two species of different size might be represented, it is not possible to sex bones on the basis of size differences.

Fig. 10 contrasts the measurements of humeri (BT) and tali (GL1) of the 'Ain Ghazal gazelles with those from other Jordanian sites, including LPPNB Basta and Tell Hesban (Iron Age to medieval). The gazelle bones from 'Ain Ghazal are larger than those from Tell Hesban. If one uses the measurements from Tell Hesban, about 50km to the south, as a standard, then one might conclude there is a size decrease over time. But this is not so since the gazelle bones from contemporaneous Basta are also smaller (Fig. 10). Davis *et al.* (1994) could not demonstrate a size decrease for gazelles since the Pleistocene. The distribution of measurements in Fig. 10 (also see Table 7) therefore must be interpreted as follows: at 'Ain Ghazal there were mostly mountain gazelles; in Tell Hesban there were more Dorcas than mountain gazelles; and in Basta Dorcas gazelles dominated almost exclusively. This would correspond to the natural distribution of these species. These interpretations are supported by the information in Figs. 11 and 12, which incorporate bone measurements from African Dorcas gazelles (PETERS 1986). The measurements of the modern male Dorcas gazelles overlap the smallest measurements from 'Ain Ghazal.

Cache of Gazelle Bones from the North Field

An extensive collection of gazelle bones was recovered from a thick ash layer on the floor of a house in Sq. 5718/5918 in the North Field; they are more or less intensively burned. They were found together with two burned horncores of female goats and numerous burned seeds. Present were 12 frontals with horncores of male *G. gazella*, 10 totally disintegrated metatarsals, along with tarsal bones (talus, calcaneus, and other tarsals), 22 posterior first phalanges, 22 posterior second phalanges, and 18 third phalanges. They all indicate the presence of at least six gazelles.

About this find Rollefson wrote: "The large house in squares 5718-5918 had two stories, at least in the western half of the building. Inside rooms 1-2 and 5-6 there is evidence of the collapse of the upper story into the lower one after a catastrophic fire. Mixed with dirt and stones were many pieces of burned clay that still had the impressions of ceiling beams, as well as many pieces of thick, red-painted floor plaster that could only have come from the upper floor. With all this rubbish there were enormous quantities of charred lentils (more than a quarter million just in the small amount of dirt that has been floated by R. Neef, D.A.I., Berlin), indicating that the room(s) above were used for storing lentils. Presumably the charred animal bones (gazelles) were also stored in the same upper rooms as the lentils" (pers. comm.) This seems to indicate that gazelle skins still possessing horns and feet served as containers for the lentils in this house.

SUS

With 1,262 specimens, pig bones represent the third most common group in the faunal sample. The importance of pig decreased over time, which is especially shown by Yarmoukian compared to PPNC values.

	IM/eL	L/IL	L/C	C	Y/IY
n	286	313	160	332	171
%	9.2	7.2	5.7	6.7	3.3

Table 8 illustrates the distribution of skeletal elements. The skeleton is more or less completely represented, but here also the small bones are underrepresented. A compilation of ages based on the teeth (Table 9) and epiphyseal fusion (Table 10) illustrates a high percentage of juvenile bones, much higher than for sheep/goat. In the entire bone assemblage, only two represent fully adult animals (in late MPPNB or early LPPNB). The majority, which depending the period is between 92% to 97.5%, died before the age of three years. The proportions of suckling and weaned piglets (under 1 year) range between 15 - 40% (Fig. 7). Such high values of young pigs have been found at many PPNB sites. Rosenberg *et al.* (1995: 5*ff.*) interpret the many juvenile pigs at Hallan Çemi Tepesi, an aceramic settlement in Anatolia, as follows: "This pattern of consumption is similar to that found by one of the authors (Redding) at sites in Egypt, Iraq and the Levant that yielded domestic pigs." The authors refer to the very early domestication of pig in Hallan Çemi. "The present day economic importance of sheep and goats in the Near East has tended to foster the implicit presumption that they were the earliest animals domesticated in that area." But the authors think that it was the pig instead that first became domesticated.

But it is quite problematic to determine the domestication of pig simply from the many juvenile bones. Wild pigs live in herds and multiple couples. Because often double births are produced in a

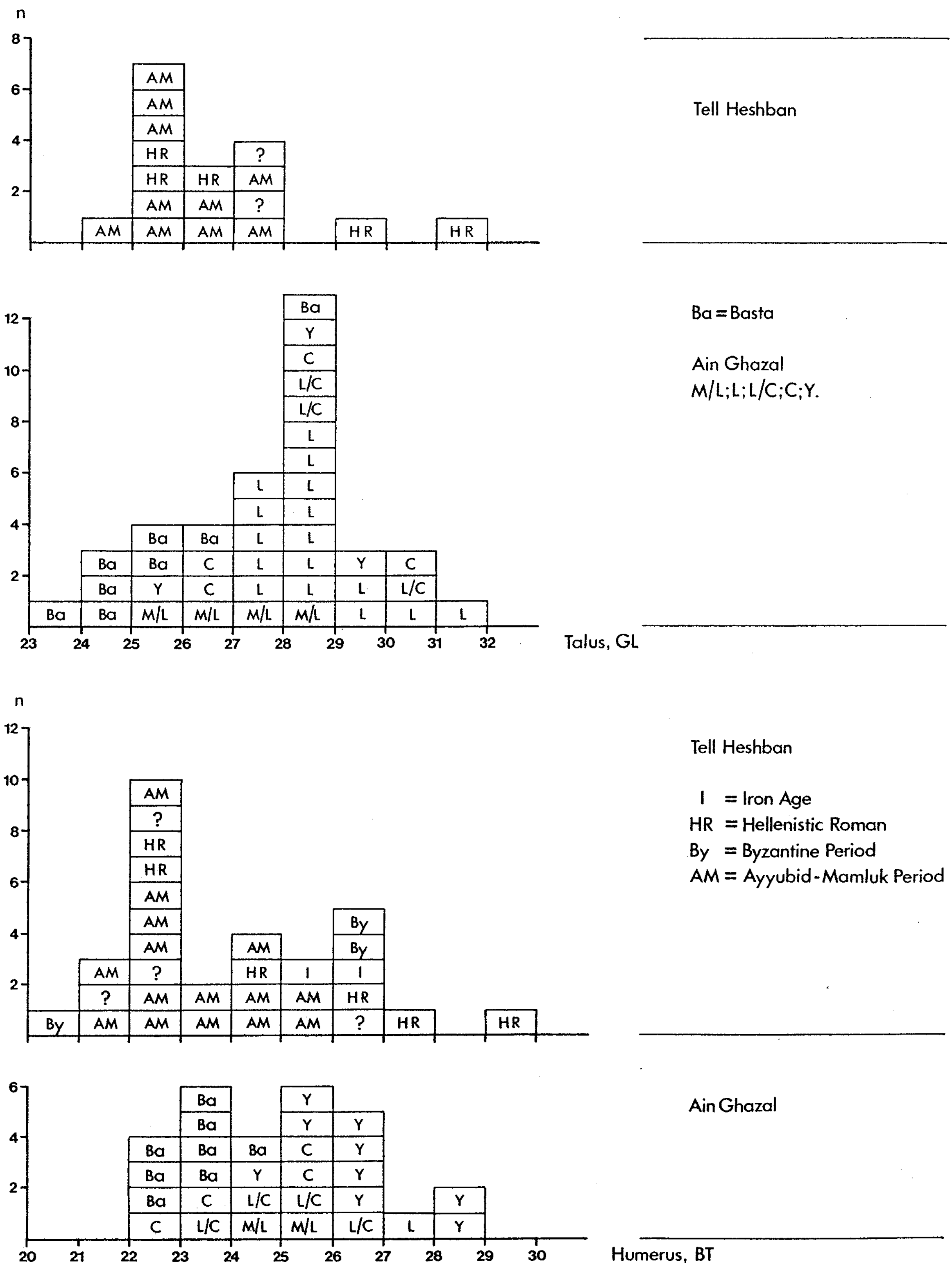

Fig.10. *Gazella.* Size distribution of humeri and tali.

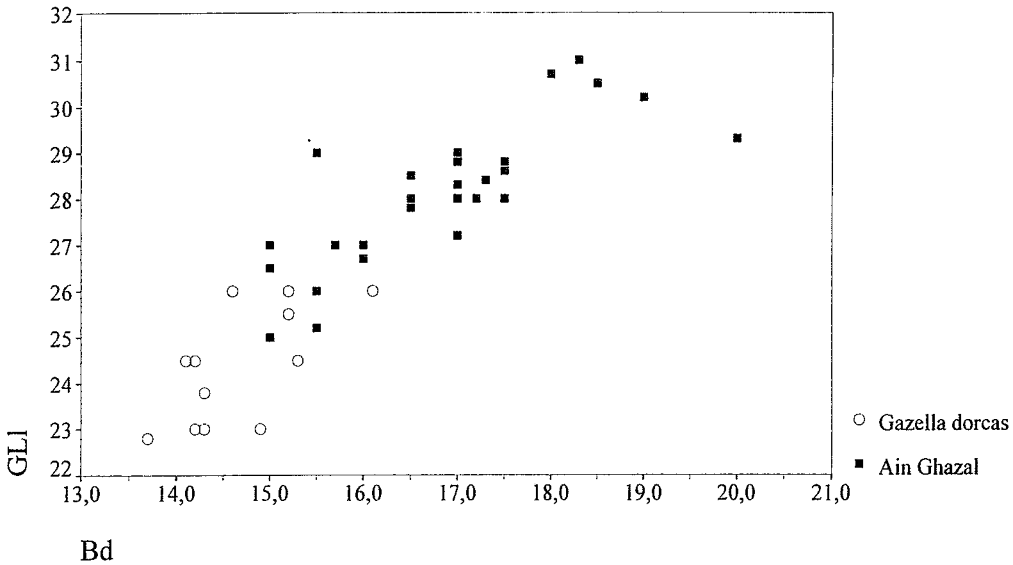

Fig. 11. *Gazella.* Size distribution of tali from 'Ain Ghazal in comparison with *G. dorcas.*

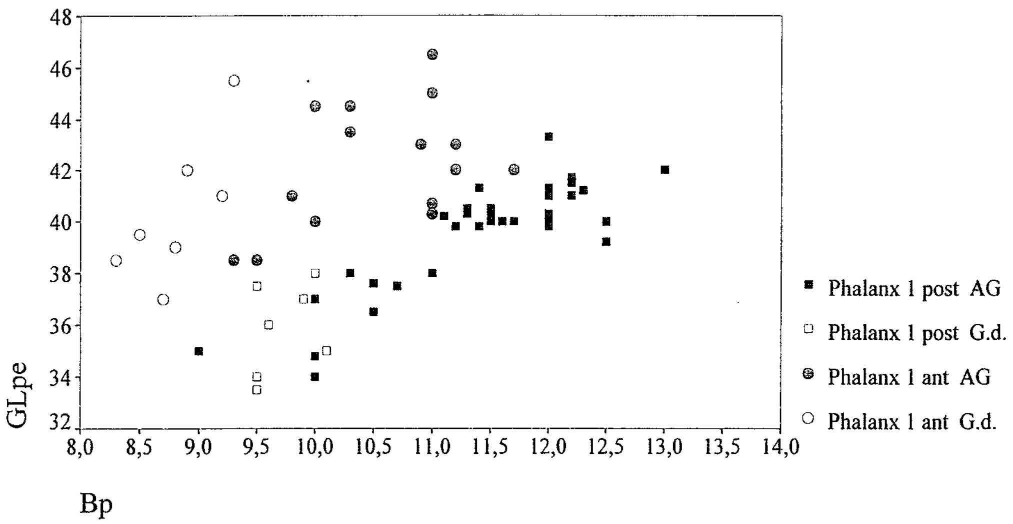

Fig. 12. *Gazella.* Size distribution of phalanx 1 from 'Ain Ghazal in comparison with *G. dorcas* (G.d.=*Gazella dorcas* (wild spec.); AG=Ain Ghazal).

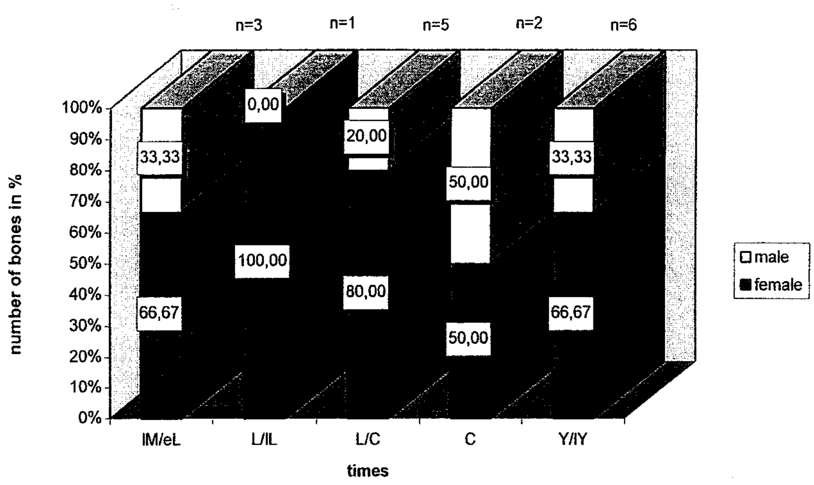

Fig. 13. *Sus.* Sex distribution.

single year, the wild pig population consists of different age classes. The proportion of juveniles (suckling pigs, weaned pigs, and two-year-olds) thus is naturally large.

In his reanalysis, Benecke (1993) found that 75% of the wild pigs were 10-13 months old in Mesolithic and Neolithic rockshelters of the southern Crimea. "The high proportion of bones of animals only 10-13 months old among the pigs, as well as the appearance of bones of individuals only a few days or a few weeks old, could indicate that spring was the main season for the hunters to go on hunting expeditions. All in all, the results of studies on pig population structure at rockshelters and grottoes in southern Crimea, therefore, are more in favor of a specialized exploitation by hunting than by controlled keeping and exploitation of pigs as domestic animals" (BENECKE 1993: 237). Young pigs certainly are easier to kill than adults. The Mesolithic and Neolithic pig bones of the Crimea therefore have been falsely interpreted as the bones of domesticated pigs.

The case at 'Ain Ghazal may have been similar to the Crimea. Wild pigs have to drink water at least once a day. They were easy prey if hunters knew the watering places at rivers. The overrepresentation of wild sows also supports for such an interpretation of the findings (Fig. 13).

According to the explanations offered earlier, only limited measurements are available for juvenile and subadult pigs (Table 11). The measurements from 'Ain Ghazal represent relatively small animals as compared with the selected "standard animal" (a wild boar from Bulgaria). However, wild pigs in semiarid regions happen to be smaller than those from the palearctic regions (*cf.* DAVIS 1987: 70*ff.*). Thus we have included, in addition, a series of measurements for wild pig from nearby Hesban (WEILER 1981: Table 27). They also represent slightly larger animals, but we must stress that the pig bones from Hesban, contrary to those from 'Ain Ghazal, are from adult animals.

At first the LSI distribution gives the impression that the pig bones of these samples have a slightly reduced size (Fig. 14). The stark size reduction in the L/C sample clearly relates to the many immature pig bones. For instance, two scapulae and four proximal radial ends, whose epiphyses were already fused at the age of about one year, derive from this period. Here in contrast to other samples, not a single measurement comes from bones that are definitely older than two years. In the PPNC the average size of bones increases, and the variation has the broadest range. The average size of pig bones decreases again slightly in the Yarmoukian, but without a drop in the overall variation. We should not make any decisions relevant to pig domestication based on this slight size change, especially if we have only a small number of measurements. A solution to the problem is also not brought nearer by reference to information about pigs from other aceramic Neolithic sites, such as Mureybet, Çayönü, and Nevalı Çori. Furthermore, in Çayönü Early Bronze Age pig bones seem to have been considered in the size calculation (SCHACHNER, pers. comm.). After consideration of all the scanty measurements and the high proportion of animals below two years of age, as well as the quantitative decline of bones in the Yarmoukian sample, it is impossible to identify domestic pig at 'Ain Ghazal for certain.

BOS

The ancestor of domestic cattle - the aurochs *Bos primigenius* - lived in the early Holocene throughout the moderate and Mediterranean parts of Europe and in the moderate zones of Asia. Even if we must expect a much larger bovid in north and northeast Africa, namely the Savannah buffalo (*Syncerus caffer*), recent investigations (GAUTIER 1968, MARKS *et al.* 1987) have made clear that the distribution of aurochs also reached the Nile and Atbara Valleys from Egypt to Sudan.

Therefore we had to expect the presence of this large bovid for 'Ain Ghazal. We could find no evidence for the bison (*Bison bonasus*) or the Indian wild buffalo (*Bubalus* sp.). Until recent times, bison lived in the Caucasus. Subfossil remains were identified in the Neolithic layers of Jarmo in northern Iraq (STAMPFLI 1983), in later deposits of the Keban area in eastern Turkey (BOESSNECK and VON DEN DRIESCH 1976), as well as at the late prehistoric site of Lidar Höyük on the Turkish Euphrates (KUSSINGER 1988: 154). Disregarding Uerpmann (1982), who postulates Indian wild buffalo for the Halaf period in northern Syria, the water buffalo (the domesticated form of the Indian wild buffalo) seems to have been introduced into the Near East in the first millennium (BOEHMER 1975). The steppic character around 'Ain Ghazal in the PPNB was not a suitable habitat for this water-loving beast. Thus we can concentrate on the aurochs exclusively.

Aurochs inhabited Middle European gallery forests and open deciduous forests. This idea of its habitat need not necessarily be valid for the Levant. "Here the aurochs is less an inhabitant of the dense forest but more a grazing animal in open landscapes with sufficient grass cover, but not necessarily dense arboreal vegetation. This is also illustrated by the combined community of aurochs with explicit steppic habitants such as gazelle and onager" (UERPMANN 1979: 125). Subsequently, the aurochs could be found in areas that also served as habitation areas for early Neolithic settlers, and that is also the case for 'Ain Ghazal.

The distribution of the total of 828 identified cattle remains throughout the phases is as follows:

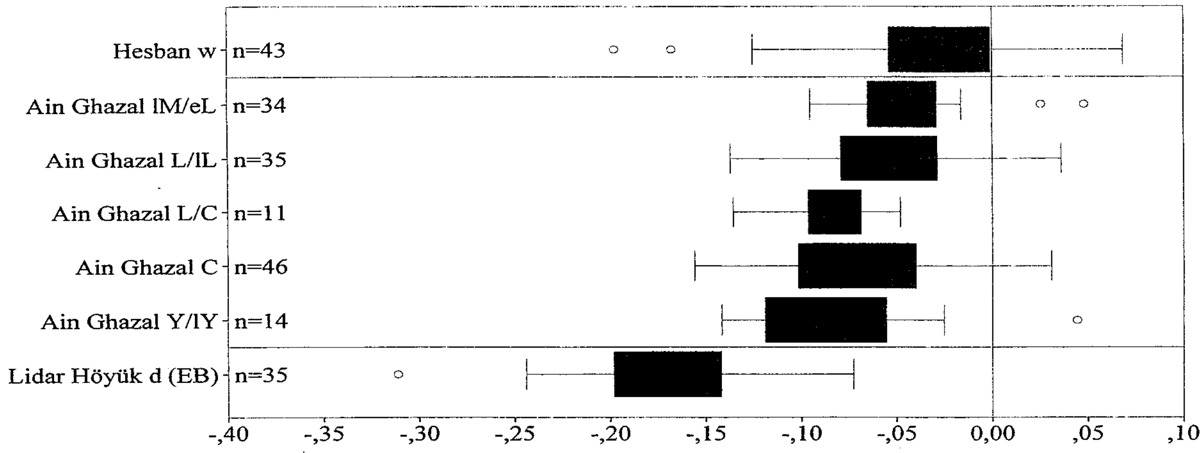

Fig. 14. *Sus.* Bone size development through times (EB=Early Bronze Age; w=wild; d=domesticated).

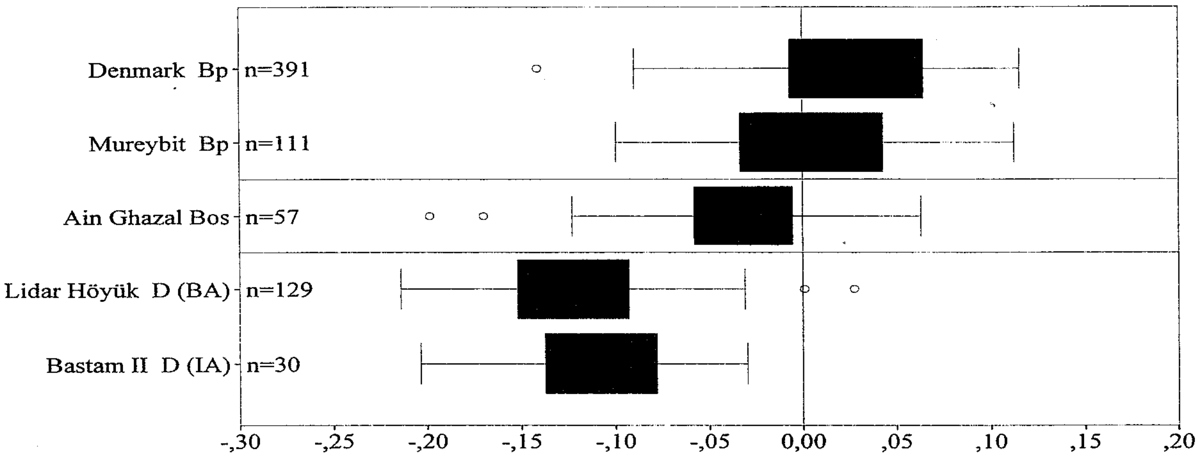

Fig. 15. *Bos.* Bone size of *Bos* from 'Ain Ghazal compared to *Bos* from other sites (Bp=*Bos primigenius*; D=domestic cattle; BA=Bronze Age; IA=Iron Age).

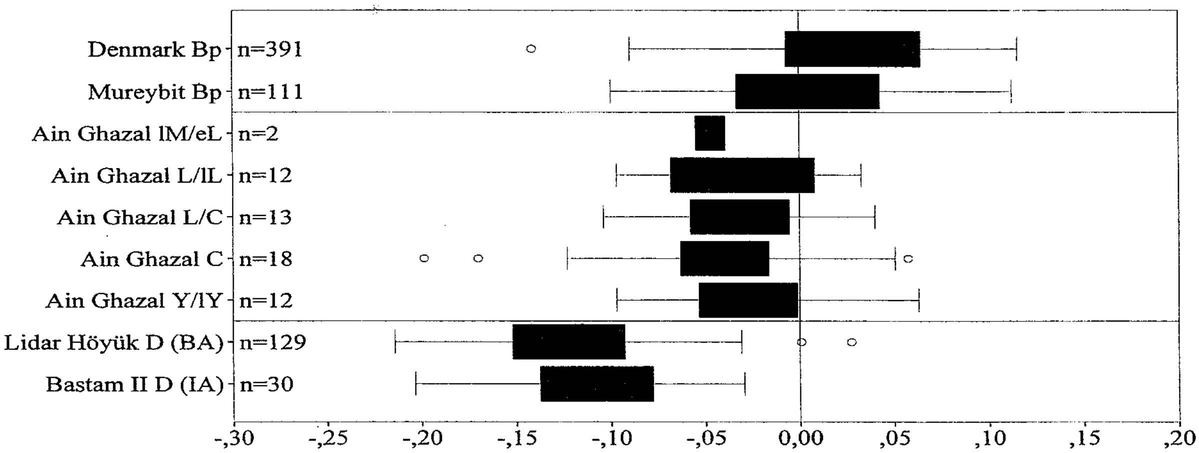

Fig. 16. *Bos.* Bone size development through times (Bp=*Bos primigenius*; D=domestic cattle; BA=Bronze Age; IA=Iron Age).

	IM/eL	L/IL	L/C	C	Y/IY
n	104	163	122	188	251
%	3.3	3.8	4.4	3.8	4.9

In general, we can recognize an increase of the proportion of cattle bones through time. The skeletal distribution is provided in Table 12.

As is always found with such early assemblages, the cattle bones in the samples from 'Ain Ghazal are much more fragmented than the sheep / goat bones, which renders it more difficult to calculate size and age at death. The rare teeth remains, mostly single ones and often from the middle of the tooth row, indicate juvenile (1-2 years), subadult (2-3 years) and adult (over 3 years) animals (Table 13). Tooth remains of very young, infantile animals do not exist. This impression is supported by the postcranial bones (Table 14). Among the limb bones, those from 1.5-year-old animals and beyond dominate. The proportion of three year old aurochs /cattle is always more than 30% except for the Yarmoukian; it is only in the Pottery Neolithic of 'Ain Ghazal that more bones of young animals seem to exist.

It is difficult to determine the size of the cattle due to scanty reliable measurements, since the preservation is bad. Often those bones that fuse early had to be measured, such as distal humerus, proximal second phalanx or those without epiphyses (centroquartals, proximal metacarpals and metatarsals or the third phalanx) (Table 15). Thus it was difficult to estimate if bones of still young animals were measured which would have - during their ontogenetic skeletal development - still reached larger sizes by appositional growth. Because of the calcareous incrustations the strength (adult) or porosity (juvenile) of bones could not be used as a means to determine age.

For the size presentation using the LSI values (Figs. 15-16) we contrasted the 'Ain Ghazal records with other aurochs populations from Denmark (8th millennium bc, DEGERBOL and FREDSKILD 1970) and from Mureybet (9/8th millennium bc, DUCOS 1978). The measurements from the Ullerslev-Urkuh (DEGERBOL and FREDSKILD 1970) served as an additional reference. Both the populations have similar values, although on average the North Syrian aurochs are somewhat smaller. For the bovines of 'Ain Ghazal the size distribution is as follows: in average they are, independent of their chronological origin, smaller than the aurochs of Mureybet. They only fall slightly below the Mureybet minima, and do not reach at all the maxima of Mureybet (Fig. 15). The mean values fluctuate in the different phases (Fig. 16); interestingly in the Yarmoukian the LSI average is highest. The smallest bones were found in the PPNC. We have to emphasize that the two smallest measurements, which are out of the normal range of variation, stem from two third phalanges; these are not very reliable for size determination and may have come from young animals.

If we presuppose similar sizes of aurochs in Mureybet and 'Ain Ghazal, we can infer that the villagers of 'Ain Ghazal had already captured aurochs calves and tried to breed them in the settlement in the PPNB. The descendants of these animals no longer attained the sizes of their wild relatives. We certainly can suppose that people with experience in goat domestication and breeding sheep and goats were able to try domesticating aurochs. That this process took a long time and had setbacks, that aurochs calves again and again escaped or died, and that eventually this process at the end was not successful, is evidenced by the high proportion of young animals and the measurements for the Yarmoukian, in which bone sizes increase again.

Becker (1991: 66*ff.*) also found "large sized" and "small sized" bones of *Bos* together at Basta and concluded that domestic cattle occurred in the LPPNB of the southern Levant. Other early findings of *B. taurus* are recorded from Bouqras and Tell es-Sinn in Syria (CLASON 1977, 1980, doubted by GRIGSON 1989), and from Umm Dabaghiyah in Iraq (BÖKÖNYI 1973, 1978). The cattle remains from the PPN layers at Jericho have the same sized as in the Pottery Neolithic layers (CLUTTON-BROCK 1971: 46).

These considerations demonstrate that "also by the conditions of early husbandry there was the possibility to domesticate the aurochs without a severe change of its living conditions. Sudden morphological changes then would not be expected, and with much greater likelihood than for sheep and goats (and pigs) we could expect early domesticated cattle populations to be morphologically not different from wild ones" (UERPMANN 1979: 126).

Equus

As with the gazelles, the equids from 'Ain Ghazal consist of at least two species, the Half-ass or onager (*Equus hemionus*) and the African wild ass (*Equus africanus*). Secure evidence for the migration of *E. africanus* from north and northeast Africa, which are parts of its home territory, into the Levant is rare (UERPMANN 1987: Fig. 9, Table 3a). This might be due to the fact that the bones are the same size as those of onager, and in the case of high fragmentation rates in disposal areas of settlements, the distinctions between the two are not clear. However, its appearance in the Near East cannot be ruled out anymore after many morphological comparisons (*e.g.*, DUCOS 1970, 1975, 1978,1986; UERPMANN 1986, 1991; MEADOW 1986; BECKER 1991).

A third equid species, the European wild ass (*E. hydruntinus*), is also claimed for the Levant by several authors. It is "of small size and gracile build. It was thought to be related to the asses by Stehlin and Graziosi (1935), who described this species in great detail and called it the European wild ass. It may well be the case that this animal was not at all closely related to any of the living forms, but that it rather was the last remnant of an extinct group of Pleistocene equids known as the *Equus stenosis* group" (UERPMANN 1987: 32). *Equus hydruntinus* is suspected at several paleolithic sites in Israel, *e.g.*, En Gev (DAVIS 1972, 1974, 1980a) and Kebara Cave (DAVIS 1977). In the Holocene the animal does not seem to be represented anymore, so we will not consider its presence at 'Ain Ghazal.

Checking through the 'Ain Ghazal equid assemblages and the comparison of better-preserved specimens with equid bones of known species attribution also did not attest the presence of the true wild horse, *E. ferus*. Thus, for the following descriptions and interpretations, only the Half-ass and the African wild ass are to be considered.

Below we present the identified specimen counts and percentages of the equid bones in the separate phases (see also the skeletal distribution in Table 16).

	IM/eL	L/IL	L/C	C	Y/IY
n	55	119	42	98	251
%	1.8	2.7	1.5	2.0	4.9

The table shows that the hunting of solidungulates more than doubled in the Yarmoukian compared to earlier phases.

All of the jaws were found broken, the teeth had fallen out, and their surfaces were rather eroded. Most teeth are from permanent dentition. The extremely poor preservation permits only a few teeth to be used to determine patterns of enamel folds. In these cases they are more ass-like (see DUCOS 1978: 37). Among the postcranial bones, there is again a predominance of adult animals, but in each phase occasionally the bones of young animals are represented, *e.g.*, four half-year olds, four one-and-a-half year olds, and one three-and-a-half year old.

Table 17 presents the individual measurements of equid bones. Placing the 'Ain Ghazal measurements in a scattergram results in two size clusters, just as measurements from other sites in the Near East do (Figs. 17-20). The smaller bones from 'Ain Ghazal are close to the measurements of equid bones from Mureybet (DUCOS 1978) and of bones from various early domestic asses from the Near East; the larger ones resemble onager bones from Uch Tepe (BOESSNECK 1987). Ducos thinks that the equids from Mureybet belong to the wild ass: "Tout au long de cette description, on a noté de nombreux caractères qui excluent totalement l'attribution de l'Equidé de Mureybit à l'Hémippe...On retrouve sur les dents, notamment pour les murailles externes des jugales supérieures, le protocône, la troisième molaire supérieure, les styles, le noeud double aux dents jugales inférieures la vallée externe, des caractères nettement asiniens... C'est pourquoi nous ferons de l'Equidé de Tell Mureybit un Asinien" (DUCOS 1978: 37; see also DUCOS 1986: 238).

How should these two size classes be interpreted? Ducos (1978: 37) stated that the dimensions of the Mureybet equids exceed the measurements of skeletal material of extinct subspecies *E. hemionus hemippus*, stored in museums in Vienna, Boston and Paris. The museum specimens are taken to represent the latest, pre-extinction animals and therefore they are expected to be quite small. But we must also consider that the museum samples are dominated by females. However, this subspecies are viewed as the smallest of the Half-ass subspecies (see also BOESSNECK 1976). But this all certainly was not the case in the 7th and 6th millennia, as the evaluations of Boessneck (1987) and Ziegler (n.d.) and others attest, for example. We must suppose that in these times the Half-ass was in general larger and stronger than the wild ass. According to this view, the larger bones from 'Ain Ghazal must be from the hemiones, the smaller from the true wild ass. Because more of the smaller bones were measured, the impression appears to be that at 'Ain Ghazal the African wild ass was more frequent than the Half-ass. We can't be more precise about the quantitative relationship of both wild equids, and also the tentative species attributions in Table 17 should not be taken to be correct because of the heavily fragmented state of the material, in which not even a complete metapodial exists.

Uerpmann (1991: 16) reexamined the Natufian equids from Ras en-Naqb in Jordan and found that "contrary to the opinion of Turnbull, who has ascribed all the equid remains to *Equus hemionus*, there is evidence that most of them belong to *E. africanus*, although the onager seems to be present as well".

If two types of equids are attested at a site the question has to be raised - as in the case of gazelles - whether they were sympatric species or whether they occurred in the area in seasonally different periods. It is well known that equids migrate seasonally, dependent on environmental factors. One is

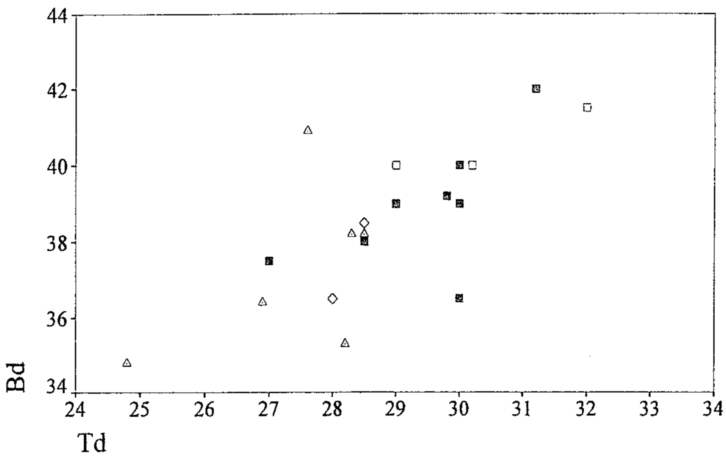

Fig. 17. *Equus*. Size distribution of distal metacarpus (H=*Hemionus*; D=domestic donkey; EBA=Early Bronze Age).

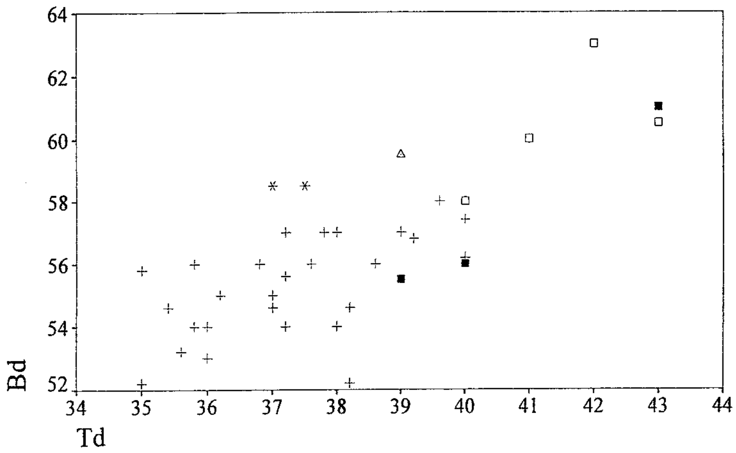

Fig. 18. Equus. Size distribution of distal tibia (H=*Hemionus*; D=domestic donkey; W=wild donkey).

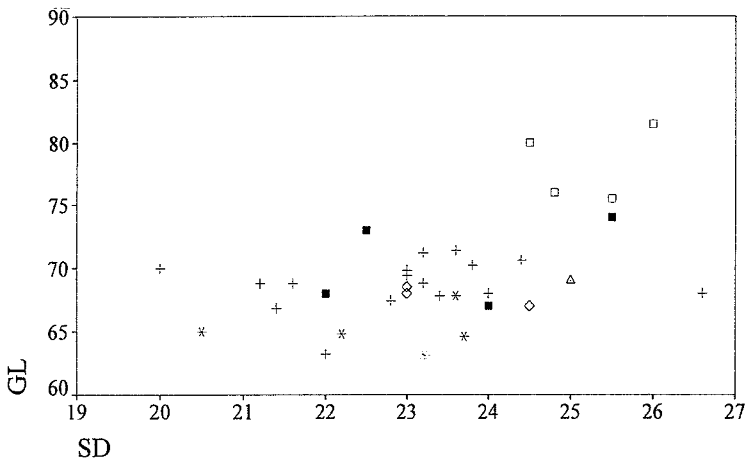

Fig. 19. *Equus*. Size distribution of phalanx 1 post. (H=Hemionus; D=domestic donkey; W=wild donkey; EBA=Early Bronze Age).

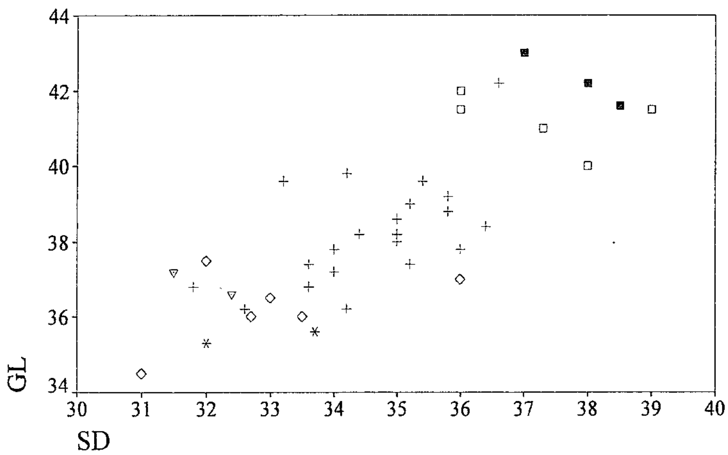

Fig. 20. *Equus*. Size distribution of phalanx 2 ant. (H=Hemionus; D=domestic donkey; w=wild donkey; EBA=Early Bronze Age).

tempted to think that during the dry periods the African wild ass stayed near 'Ain Ghazal, while the Half-ass entered the area during the short rainy period and the wild ass wandered southwards. It is also possible that both species stayed together in the area at certain periods of the year. But since no recent observations on their behavior in territorially overlapping regions exist, this assumption cannot be proven, and it is impossible to draw conclusions on seasonal hunting.

Domestic Dog

Since the description of the Natufian burial in 'Ain Mallaha containing a dog (DAVIS and VALLA 1978), the domestic dog should be expected everywhere in the Near Eastern Aceramic, including 'Ain Ghazal. Rightly, the finding of an old human in a burial stretching his hand over a 5 month old canid deserves the interpretation that humans tried at this early time to tame the wolf. Similar new findings from Israel support this (TCHERNOV and VALLA 1997).

At 'Ain Ghazal 49 canid bones were found that are too small for wolf and too large to be jackal (Table 1); thus they were attributed to the domestic dog. Domestic dog is attested in all of the layers, being more frequent in the Pottery Neolithic. The oldest period (lM/eL) yielded only a single bone, an ulna shaft of a medium-sized dog. The L/lL samples yielded ten bones: four upper cranial fragments, two canines, two ulnas, one tibia (Bd 22.7mm) and one phalanx. The loci of the L/C samples yielded five secure bones of dog: one lower canine, one ulna shaft, one tail vertebra, one fifth metacarpal, and one second phalanx. The eight canid bones from the PPNC include one neck vertebra, one canine fragment, one humerus proximal end (Bp 31mm), one tibia shaft, one talus (GH 22.5, GB 16.5mm), one calcaneus, and two first phalanges.

The 25 bones from the Yarmoukian period are distributed as follows: one skull fragment, four mandibles, six vertebrae, two humeri (Tp 40; Bd 31.2mm), one radius shaft, one pelvis, one talus (GH 25; GB 16mm), one calcaneus (GL 44.3; GB 16.5mm), six metapodials and two first phalanges. The measurements of the mandibles are found in Table 18.

Considering all the bones, one must understand that from the beginning the 'Ain Ghazal bones were larger than medium-sized hunting dogs (*Canis familiaris intermedius*) and smaller than a German shepherd *(C. familiaris inonstranzewi).*

Finally, we present some information on a group of dog /jackal bones (n= 11). These are insignificant bone fragments that do not permit size determination or are bones that fall within the size distribution of jackal but which cannot be further specified. Among them there is the anterior section of a spinal column with the first four vertebrae from Square 3679 of the Central Field, Yarmoukian phase. It is interesting that these vertebrae were found in their proper anatomical order, since they bore calcareous encrustation. The *Dens epistrophei* was fixed obliquely in the atlas, and the caudal surface of the atlas joint and the cranial of the epistropheus (= axis) were displaced. It appears that someone had simply twisted the neck of the animal. In this case it is a pity that we can't determine whether it is a domestic dog or a jackal.

Wild Carnivores and Other Small Mammals

Köhler-Rollefson (1989a 1989b) and Köhler-Rollefson *et al.* (1993) found in the MPPNB from earlier excavation seasons a 10% share of small carnivores. This high percentage for this category came from Sq. 3082, which is the interior of an MPPNB house. The author explains: "On the other hand, some of the other houses from this period hardly produced any small mammal remains. Very tentatively, this could indicate some degree of economic specialization, *i.e.*, that some people remained hunters while others obtained their animal products from goat husbandry. Alternatively, this circumstance could mirror personal food preferences rather than occupational specialization; this would be an indication of an exchange system within the community" (Köhler-Rollefson 1989b, 23).

In the material from the 1982-1989 seasons, the proportion of small mammals in the later phases of the PPN decreased dramatically, "possibly indicating the elimination of a broad range of echo-niches by the middle of the 7th millennium" (KÖHLER-ROLLEFSON *et al* 1993: 96). A comparable low percentage is found in the Pottery Neolithic as well.

In our material too, this class reaches only 0.3 - 1.6% (Table 1).

	lM/eL	L/lL	L/C	C	Y/lY
n	37	71	16	16	45
%	1.2	1.6	0.6	0.3	0.9

Although here there is an observed general decrease in small game hunting, in comparison with the MPPNB, we prefer not to interpret this as a "depletion of the surroundings of the site of game by the advent of the Yarmoukian period" (KÖHLER-ROLLEFSON 1989b, 23) because the species continued to be found in the site. Furthermore, the presence of large game, such as aurochs, wild boar, gazelle, Half-ass and wild ass in considerable quantities make it clear that these animals used to pasture near the site until the end of the 6th millennium.

Contrary to this, we would consider the abundant evidence for the small and medium-sized carnivores, as well as the other small mammals of the MPPNB, is a consequence of specialized hunting. Carnivores certainly were hunted for their fur, and meat exploitation was a secondary aspect. Possibly the inhabitants of the house in Square 3082 focused on hunting such animals, processing their fur to supply the rest of the settlement with this material.

In the early phases of the PPN of the Levant, we can see an intensive hunt for fur-bearing animals. "The increase in small mammals, such as fox and hare, in the PPNA" (of Hatula in Israel) "is noteworthy" (DAVIS 1991: 384). Also in Nevalı Çori there were high percentages of fur-bearing animals, especially fox and hare (in the oldest Phase 4 of the PPNB they reach 10%. VON DEN DRIESCH n.d.), although the percentage decreased during the occupation. A farming community concentrating on the domestication of goat, aurochs and eventually pig certainly would not continue to engage in trapping small mammals because there is sufficient meat and leather available through animal husbandry. Thus the decline in the hunt of fur-bearing animals at 'Ain Ghazal is better explained by socioeconomic changes in the village.

Concerning individual species, among the carnivores there is only one specimen representing a large cat, the leopard *Panthera pardus*. It is the proximal part of an ulna from the North Field's Square 5919 LPPNB layers. The bone represents a small animal, but leopards in Palestine indeed were smaller than those in the northern and African regions (*cf.* HARRISON 1968: 306). The leopard, which lived in the mountainous highlands and the steppic areas, must have been more frequent than the one bone reflects, especially because of the large gazelle herds around 'Ain Ghazal.

The Palestinian wolf *Canis lupus* reflects the basic rule: the warmer the environment, the smaller the subspecies (*cf.* DAVIS 1987: Fig. 3:10). The four bones from 'Ain Ghazal are fragments, but they clearly differ from the size of dogs. Only one carnassial from the PPNC was measurable. Its length is 26.0mm, its width 10.5mm. From the same layer but from a different locus comes a mandibular condyle. The LPPNB yielded two remains of wolf: a fragmented calcaneus and a radius shaft.

All the other material comprises medium-sized and small mammals, of which the jackal, the badger, and the honey badger are the largest and heaviest. All these carnivores in addition to hares and hedgehogs can be caught with traps and slings.

The red fox is the most common carnivore in all the periods (Table 1 and 19). The bones are relatively small (Table 20); their size refers to the very small subspecies today called *Vulpes vulpes palaestina* (HARRISON 1968: 206*ff.*). The measurements in Table 20 show the small size of the red foxes at 'Ain Ghazal. Their sizes also differ clearly from those of the Sand fox, *V. rueppelli*, of which only one bone was found, an ulna shaft from the L/C. Davis (1977a) found out that red foxes in Israel became smaller in the transition from the Pleistocene to the Holocene, which "is correlated with a temperature change of 8-9°C. Since fossil Israeli foxes show a 1mm change in the length of M1 from the Kebaran to the Pre-Pottery Neolithic periods, I suggest an 8-9°C temperature elevation in Israel for that time period, *i.e.*, around 11-12,000 years ago" (DAVIS 1977a: 350).

The wild cat *Felis silvestris* was smaller in the Natufian and the early Neolithic than in the Pleistocene; in the 1993-95 material from 'Ain Ghazal it is the second most common small carnivore (Table 1). The complete reference for the 18 specimens found is: lM/eL: one mandible, one rib, two ulna shafts, one McIII, one Mt IV; L/lL: two mandibles, one tibia, one adult and one juvenile calcaneus; L/C: one mandible, one McIII; PPNCC: one proximal fragment of a radius, one proximal part of an ulna, one proximal end of a tibia; Y/lY: one pelvis, one MtIII. The measurements are found in Table 21.

Bones of the badger *Meles meles* are quite common, while the ratel *Mellivora capensis* is represented by only three unmeasurable bones: one epistropheus fragment (lM/eL), one thoracic vertebra (LPPNB) and one humerus (Yarmoukian). The skeletal parts of the badger are: L/lL: two mandibles, one juvenile ulna; L/C: one femur (distally loose epiphysis), one tibia shaft; PPNC: one distal end of a humerus; Yarmoukian: one skull, one mandible, one neck vertebra, one rib, one humerus shaft, one proximal end of a radius, one pelvis. In addition, bones of the jackal *Canis aureus* (two mandibles, one McV), the caracal *Felis caracal* (one first phalanx), and a small form of the Beech marten *Martes foina* (one radius) are present.

Of the other small animals the hare *Lepus capensis* is quite common in the assemblages: lM/eL: one mandible fragment, two humeri, two pelves, one tibia; one MtIV; L/lL: two mandibles, one humerus, two radii, two femora, one tibia, one talus, three posterior phalanges; L/C: one calcaneus; Yarmoukian/ late Yarmoukian: one scapula, one humerus, one tibia, one calcaneus. As expected, the bones evidence small hares (Table 21).

Among the hedgehog bones we have one specimen of the dry habitats, the Long-eared hedgehog *Hemiechinus auritus* (one mandible from the Yarmoukian layers of the Central Field). Seven bones stem from the Eastern hedgehog, *Erinaceus concolor*, a relative of the European hedgehog (three mandibles, one maxilla, two ulnae, one tibia).

Birds

Only 21 bird bones were identified in the material (Table 1). These bones of course do not reflect the bird fauna of the 'Ain Ghazal environment. It cannot be judged if this meager evidence indicates that bird hunting was not in the interest of the inhabitants. It is especially strange that the frequent and tasty partridge *Alectoris graeca* is only attested by one bone. However, bird bones are less resistant than mammal bones. The dogs living in 'Ain Ghazal might have, together with the jackal and other carnivores, carried the bird remains out from the garbage areas. There should be no doubt that the residents of 'Ain Ghazal were interested in the bird meat and feathers, as this is the case with the fur-bearing animals. They should have been able to hunt birds. We have in the assemblage nesting birds of gallery forests (Gray herons, Imperial eagles, Long-legged buzzards, Tawny owls) and a typical steppe inhabitant, the Great bustard. The measurements of the bird bones are presented in Table 22.

Testudo

The only species represented in the material is the Moorish tortoise (*Testudo graeca*). Parts of two carapaces were found, and two humeri came from the L/C in Sq. 5919. All bone evidence indicates small individuals. The Palestinian subspecies is called *T. graeca terrrestris* (WERMUTH and MERTENS 1961: 210). This subspecies is smaller than the northern subspecies *T. g. ibera* (for example, in Turkey). The high vaulting of the shell is characteristic for it, but from the fragments, this cannot be determined.

The Animal Remains in the Light of Meat Consumption

Despite the various degrees in calcareous encrustations on the bones of the different occupational periods, the percentages of weights (Fig. 21) indicate the importance of the animals in relation to consumption during the periods. Between 47-55% of the meat came from sheep and goat. Aurochs, wild boar and the equids constituted 25% of the lM/eL diet, 35% in the LPPNB, a strong 30% in the PPNC, and again 35% in the Yarmoukian period. At the end, the meat of equids increased in importance while pig meat decreased in popularity. Due to their smaller size in comparison to the pig, gazelles were always a less important source of meat except in the LPPNB. Even in the Yarmoukian, when there were twice as many gazelle bones as pig bones, the weights of the bones from both groups were about the same (Fig. 21).

Conclusions

At the end of the Aurignacian, temperatures increased in the Levant, and climate became drier (CLUTTON-BROCK 1970: 27, *cf.* LIEBERMANN 1993: Fig. 2). Many species of this "Upper Pleistocene" became extinct: rhinoceros, Thomas' giant camel, European wild ass, wild horse, hartebeest, red deer, and others (DAVIS *et al.* 1988). Davis *et al.* stated that it was not climatic change but overhunting of large game by an increased population during the Mousterian to the Epipaleolithic that led to the extinction. Man began to hunt smaller game, especially gazelle, that, due to the drier conditions after the end of the Paleolithic, populated the Levant in giant herds. "A large increase in the ratio of gazelle to fallow deer in the Upper Paleolithic-Natufian probably reflects increasing aridity 12,000-10,000 years ago" (DAVIS *et al.* 1988: 103).

Between the 9th to 6th millennia bc further climatic oscillations can be detected that shifted the vegetational zones. Abundant precipitation in the Mesolithic caused an expansion of the forested zones with more than 300mm precipitation per year; the open forest zone and the adjacent steppes received 150mm per year. Most Mesolithic sites lie in the highest precipitation zone or in the open-forest zone" (MOORE 1989: 78).

According to this view, during the Natufian prior to the arrival of the first settlers, 'Ain Ghazal must have been at the edge of the forested zone/open forest zone. These conditions, with enough precipitation (200-300mm annually), were sufficient for dry farming for the first inhabitants at the end of the 8th millennium bc. The identified fauna fully reflects such a biotope. There are mountain inhabitants, such as the wild goat, open-forest/grassland inhabitants like wild cattle, mountain gazelle, wild boar, badger, ratel, wild cat, hares, and others. Clear forest inhabitants such as the red and fallow deer are completely missing if one excludes three bones of red deer that could have been traded into the site for bone tool manufacture (Table 1). Moreover, 'Ain Ghazal yields evidence of steppic species such as Wild and Half-ass, dorcas gazelle, and the Great bustard.

"Three thousand years later, with a decrease in precipitation, the forest and the open forest/ steppe retreated and the steppes expanded. Even settlements in favored steppic settings were abandoned" (MOORE 1989: 78). The settlement of 'Ain Ghazal in the 7th and 6th millennium bc was more and more influenced by a desert climate. While many Levantine settlements were abandoned at

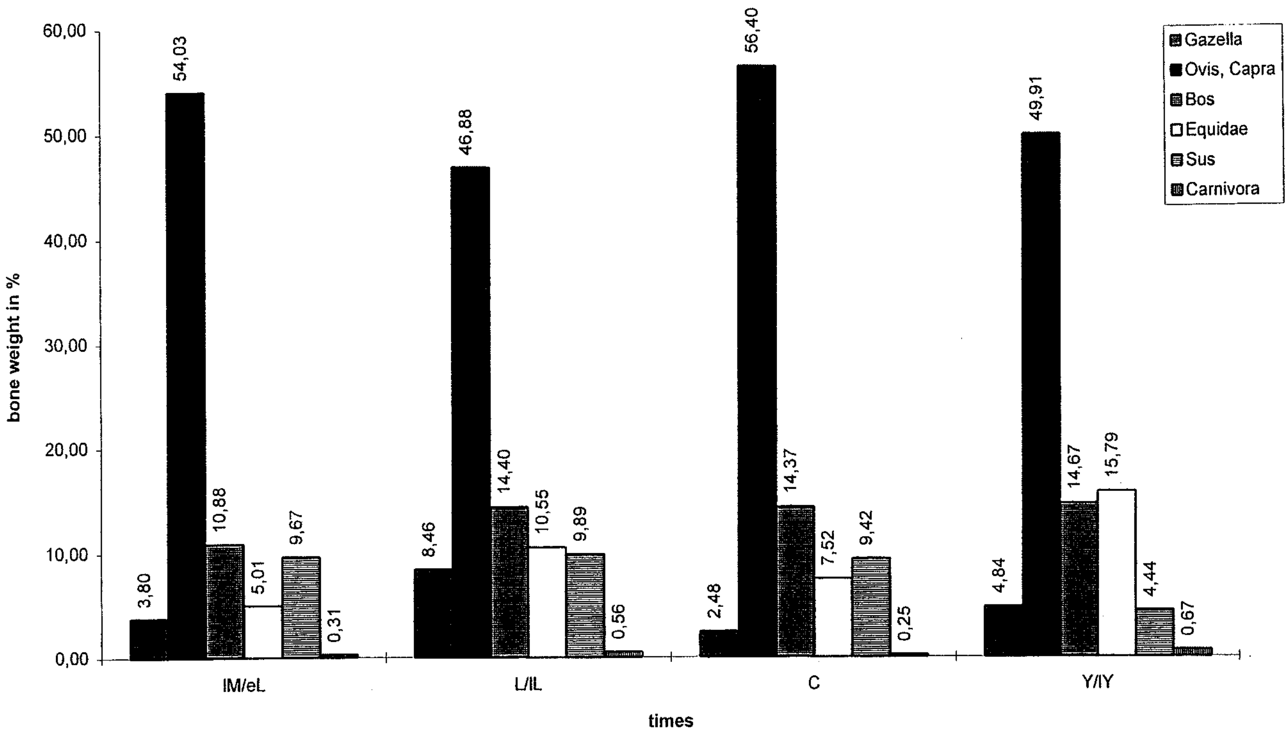

Fig. 21. Bone weight in % through times.

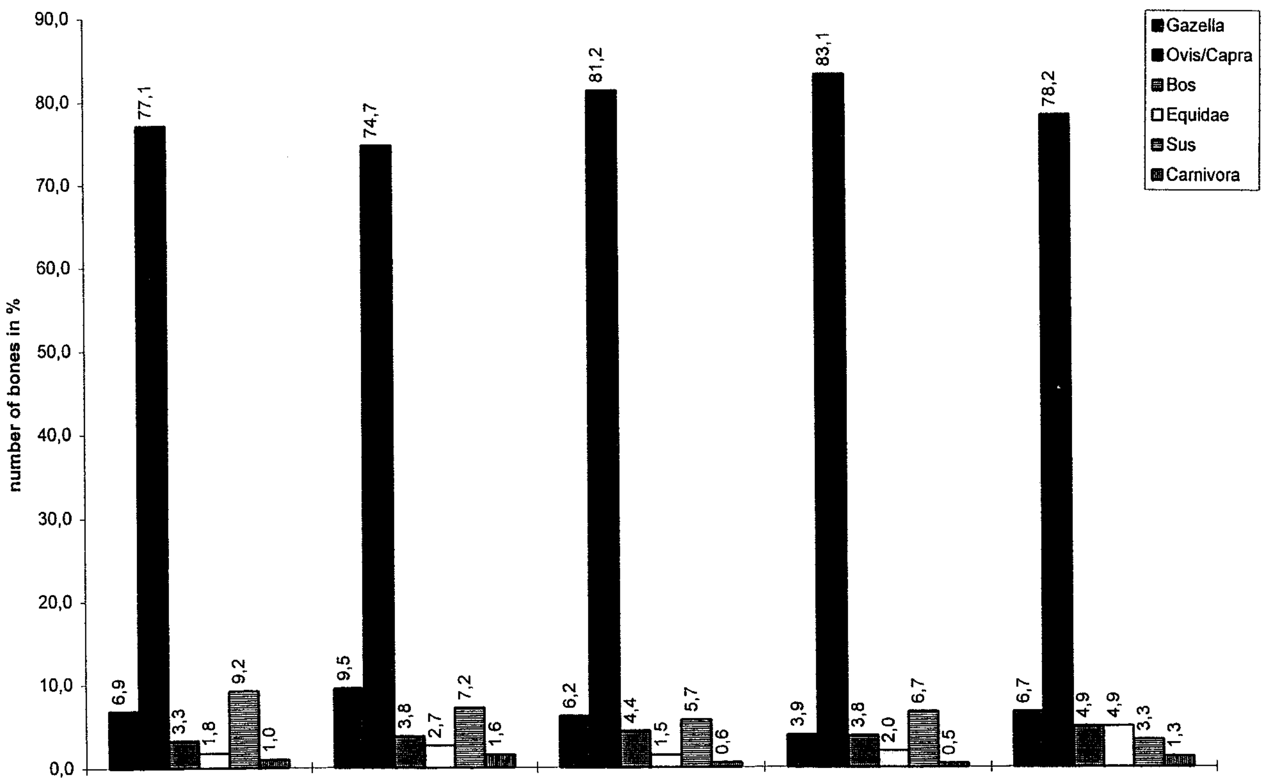

Fig. 22. Number of bones in % through times.

the end of the PPNB, 'Ain Ghazal remained as one of the rare exceptions and its occupation continued into the Pottery Neolithic. Despite the increase in arid conditions, the perennial Zarqa River provided a sufficient base for sheep-goat husbandry and the presence of game. But the golden age at the beginning of the occupation had obviously elapsed. Population decreased, the settlement shrank, and a set of changes that can be interpreted as impoverishment could be observed archaeologically.

"There is no stratigraphic evidence of interruption in the habitational succession recorded throughout the areas excavated at 'Ain Ghazal, but there are clear 'breaks' in terms of lithic technology/typology, architecture, and ritual, particularly noticeable between the PPNB and PPNC" (ROL-LEFSON and KÖHLER-ROLLEFSON 1993: 34). "The relatively simple arrangement of spacious rooms in the MPPNB became surrounded by a network of small square storage rooms by the end of the LPPNB, similar to the patterns at LPPNB Basta. In the Yarmoukian, the one and two-roomed houses were a temporary return to the open and simple arrangement of the earlier MPPNB, with the principal differences that the Pottery Neolithic dwellings were smaller overall and had floors of mud or *huwwar* plaster. Final Yarmoukian structures were flimsy, temporary hut-like structures used evi-dently on a seasonal basis by pastoral nomads, returning to the former agricultural settlement" (ROL-LEFSON and KÖHLER-ROLLEFSON 1993: 36).

"In view of the broad and deep exposures of PPNC deposits, the few recovered human and animal figurines indicate that they played a minor role in the daily life of PPNC inhabitants, at least in comparison with their PPNB forebears, a substantial difference in terms of displaying ritually associated symbolism" (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 38).

How are these developments reflected in the animal remains? We have to consider, when judging the finds, that our phases cover large periods of time, *e.g.*, 500 years, which do not show smaller fluctuations and details. We would need more material to define more subdivisions.

As explained above, efforts to domesticate the wild goat could be traced from the beginning of the occupation. At the latest, during the transition from the MPPNB to the LPPNB, the settlers of 'Ain Ghazal obtained domestic sheep from outside. Ducos (1993), who has identified a similar development in the Damascus basin, cannot rule out that the sheep arrived from the northern area of the Levant or Anatolia. He believes that tame goats were also introduced into the southern Levant from there. This hypothesis cannot be accepted for 'Ain Ghazal due to the osteometric data (see above).

The increasing proportions of sheep and goat at 'Ain Ghazal show that their husbandry was successful. Together with dogs and possibly wild cattle and pigs kept in captivity, sheep-goat husbandry constituted the major part of the subsistence, amounting to at least 75% of the bone counts.

It is during the decline of the settlement in the PPNC that the percentages of the small ruminants were highest, although we can trace a return to wild goat hunting by the increase of goat bone sizes. The intensification of hunting most likely had its origins in a general decline of living conditions. This decline continued in the Yarmoukian as evidenced by an increase of gazelle and especially equid hunting, animals that were in closer proximity to the site due to increasing aridity; wild boar ac-cordingly were reduced due to destruction of the fringe forest (Fig. 22). Small animals especially were hunted. The principle element of the village economy in the Yarmoukian continued to be sheep and goat and, to a certain degree, possibly, cattle husbandry as well as a consequent higher proportion of (herding) dogs. Sheep husbandry, which at first was rather unimportant, increased considerably until the PPNC (from 7.4 to 44.7%), but decreased slightly in the Yarmoukian (39.2%).

Rollefson and Köhler-Rollefson (1993: 39) interpret these changes as follows: "Goat/sheep husbandry was disarticulated from the village setting, at least on a partial basis, whereby a substantial part of the 'Ain Ghazal population left the settlement with their goats and sheep for months at a time, returning to the village (and their resident relatives) after the grain harvest, thus initiating a specialized and organizationally separate subsistence strategy". This hypothesis cannot be supported by our archaeozoological research on these particular samples.

The deleterious effects of pasturing, especially by goats, on plant cover is well-known. Intensive goat husbandry over many centuries can lead to ecological catastrophe, especially if this happens in conjunction with a reduction of precipitation and decline in soil fertility. At Abu Hureyra, an early Neolithic village in Syria, plant remains indicate that the vegetation cover was reduced during the existence of the settlement. "Obviously pastures were heavily degraded, and the natural subsistence and fuel sources were overexploited to a great extent. Most likely this also reduced the woodlands, in a period in which climatic change accelerated the same process" (MOORE 1989: 79). For 'Ain Ghazal, no analysis of plant remains are available so far, but developments in faunal exploitation prove that the inhabitants of 'Ain Ghazal suffered the same fate that struck the residents of the other Neolithic villages in the Levant centuries before. The ecological situation forced them to leave the village by the end of the 6th millennium in order to find a new existence in more favorable environments.

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Appendix: Tables 1- 22

(Pages 542-556)

Table 1. Species list and numeric distribution in the phases.

	IM/eL	L/IL	L/C	C	Y/IY
Mammals					
Cervus elaphus	-	-	2	-	1
Bos primigenius and cattle	104	163	122	188	251
Gazella gazella and *Gazella dorcas*	214	410	173	194	345
Domestic sheep	26	102	115	204	204
Ovis/*Capra*	2057	2812	1966	3691	3482
Capra aegagrus and domestic goat	324	323	182	252	316
Sus scrofa	286	313	160	332	171
Equus hemionus and *Equus africanus*	55	119	42	98	251
Vulpes vulpes	20	46	8	8	24
Vulpes rueppelli	-	-	1	-	-
Canis lupus	-	2	-	2	-
Canis aureus	1	-	-	1	1
Canis aureus or dog	2	1	-	-	8
Dog	1	10	5	8	25
Panthera pardus	-	1	-	-	-
Felis caracal	-	-	-	-	1
Felis silvestris	6	5	2	3	2
Meles meles	-	3	2	1	7
Mellivora capensis	1	1	-	-	1
Martes foina	-	-	-	1	-
Lepus capensis	7	12	1	-	4
Spalax ehrenbergi	-	-	-	-	2
Erinacaeus concolor	2	1	2	-	2
Hemiechinus auritus	-	-	-	-	1
Birds					
Ardea cinerea	3	-	-	-	-
Aquila heliaca	2	1	-	-	-
Milvus migrans	1	2	-	-	-
Buteo rufinus	3	1	-	-	1
Alectoris graeca	1	-	-	-	-
Otis tarda	-	2	1	-	-
Strix aluco or *Strix butleri*	-	-	-	2	-
Corvus corone cornix	1	-	-	-	-
Testudo graeca	4	1	2	4	2
Molluscs					
Melanopsis	-	-	1	3	12
Unio sp.	-	-	-	-	2
Unio crassus	-	-	-	-	1
Crabs					
Crab, *Potamon sp.*	2	1	-	-	-
Sum	3123	4332	2787	4992	5117
Unidentified	2976	2292	1408	2776	3554
Total	6099	6624	4195	7768	8671

Table 2. *Ovis/Capra*. Skeletal distribution.

	IM/eL			L/IL			L/C		
	Ovis	O/C	Capra	Ovis	O/C	Capra	Ovis	O/C	Capra
Procc. cornuales	-	-	10	-	-	16	1	1	10
Cranium	1	76	2	2	105	8	3	75	4
Mandibula	-	68	3	6	138	2	-	127	-
loose Dentes	-	27	-	-	134	-	-	61	-
Hyoid	-	-	-	-	2	1	-	1	-
Atlas	1	12	2	-	23	4	-	13	4
Epistropheus	-	9	4	1	18	7	3	15	2
other Vertebrae	-	360	4	-	355	3	-	249	6
Costae	-	201	-	-	273	-	-	174	-
Sternum	-	13	-	-	4	-	-	4	-
Scapula	3	110	8	10	166	11	3	82	7
Humerus	2	129	27	7	211	24	12	160	18
Radius	1	187	14	7	242	11	8	165	8
Ulna	-	26	5	1	28	2	-	22	2
Carpalia	-	23	-	1	21	-	-	8	-
Metacarpus	4	95	39	15	108	33	9	69	25
Pelvis	2	104	4	5	165	-	6	132	5
Femur	1	169	6	1	242	4	-	173	7
Patella	-	8	-	-	6	-	-	4	1
Tibia	1	238	9	5	340	16	5	251	10
Os malleolare	-	5	-	-	1	1	-	-	-
Talus	6	13	17	19	17	25	17	15	6
Calcaneus	1	33	13	7	18	15	9	31	3
other Tarsalia	-	12	10	-	13	9	-	4	2
Metatarsus	1	92	32	3	103	34	12	66	23
Phalanges	2	47	115	12	79	97	27	64	39
Total	26	2057	324	102	2812	323	115	1966	182

	C			Y		
	Ovis	O/C	Capra	Ovis	O/C	Capra
Procc. cornuales	1	1	15	1	-	27
Cranium	2	146	4	6	110	14
Mandibula	1	185	3	1	255	7
loose Dentes	-	127	-	-	88	-
Hyoid	-	-	-	-	1	-
Atlas	1	33	1	2	8	5
Epistropheus	3	42	11	4	12	7
other Vertebrae	-	374	3	1	215	2
Costae	-	338	-	-	605	-
Sternum	-	3	-	-	4	-
Scapula	10	197	8	16	175	21
Humerus	20	315	27	20	233	37
Radius	16	337	13	19	346	12
Ulna	-	53	2	2	35	5
Carpalia	-	17	-	-	3	-
Metacarpus	20	144	24	25	118	34
Pelvis	7	195	4	20	135	12
Femur	1	377	3	2	338	4
Patella	-	7	2	-	-	-
Tibia	14	505	19	8	620	10
Os malleolare	-	-	-	-	1	-
Talus	33	19	23	10	11	8
Calcaneus	10	44	10	10	34	21
other Tarsalia	-	19	1		1	1
Metatarsus	30	130	24	25	96	24
Phalanges	35	83	55	32	38	65
Total	204	3691	252	204	3482	316

Table 3. *Ovis/Capra.* Bone measurements.

Horncore *Ovis*

	GD base	LD base	basal circ.
L/C	17,5	12,5	56,0
C	25,0	17,3	73,0
Y	22,5	16,0	65,0

Horncore *Capra*

	GD base	LD base	basal circ.
IM/eL	27,0	-	110,0
L	34,5	25,0	97,0
L	35,5	23,5	103,0
L	-	45,0	180,0
IL	37,0	-	-
C	30,5	-	-
Y	32,0	20,0	90,0
Y	35,0	20,0	96,0
Y	36,0	23,5	103,0
Y	41,0	26,5	107,0
Y	41,0	27,0	120,0
Y	58,0	39,5	160,0

Neurocranium *Ovis*

	B cond. occ.	H f. mag.	B f. mag.
IL	50,0	20,5	19,0
C	48,0	-	-

Neurocranium *Capra*

	B cond. occ.
C	64,0

Atlas *Ovis*

	GLF	BFcr	BFcd
C	45,0	49,0	42,0
Y	43,5	-	-

Epistropheus *Ovis*

	BFcr	SBV	LCDe
L/C	52,0	-	-
C	45,0	-	-
Y	41,0	26,0	-
Y	-	-	57,0

Viscerocranium *Ovis/Capra*

	L ch. r.	L molar r.
Y	68,0	-
Y	72,0	-
Y	73,0	48,0

Mandibula *Ovis*

	L ch. r.	L molar r.
IY	82,5	53,0

Mandibula *Capra*

	LM3	BM3
IM/eL	25,0	-
IL	23,8	9,6
C	25,0	10,0
Y	23,0	9,5
Y	23,5	9,0
Y	27,0	10,0

Mandibula *Ovis/Capra*

	L ch. r.	L molar r.	L M3	B M3
IL	-	-	23,5	-
IL	-	-	26,5	9,5
L/C	-	-	23,5	8,0
L/C	-	-	24,5	8,2
C	-	-	24,5	8,5
Y	68,0	-	24,0	-
Y	77,0	51,0	26,0	9,0
Y	80,0	54,0	23,0	8,5
Y	-	50,0	-	-
Y	-	52,5	24,0	9,0
Y	-	-	24,0	9,0
IY	78,0	56,0	26,0	8,5
IY	-	38,0	21,5	8,0
IY	-	45,5	23,5	10,0
IY	-	-	23,0	9,5
IY	-	-	24,2	9,8

Atlas *Capra*

	GL	GLF	BFcr	BFcd
IL	-	48,5	52,5	49,0
L/C	-	55,5	-	-
Y	72,0	55,0	-	-
Y	-	-	-	46,0

Epistropheus *Capra*

	BFcr	SBV	LCDe
IM/eL	46,0	-	-
IM/eL	46,0	-	-
IM/eL	50,0	-	-
L/C	43,0	-	-
C	46,0	33,0	63,5
C	50,0	-	65,0
C	57,0	51,0	-
C	60,0	-	-
Y	41,0	-	-
Y	42,5	25,0	-
Y	43,0	23,0	-
Y	43,0	-	-

Table 3: cont. 1. *Ovis/Capra.* Bone measurements.

Scapula *Ovis*

	SLC	GLP	LG	BG
IM/eL	-	32,3	26,0	21,0
IM/eL	19,2	33,0	26,0	22,0
IM/eL	19,7	35,0	29,0	23,3
L	-	29,0	-	17,5
L	19,0	32,0	27,0	19,0
L	21,2	36,2	27,0	23,0
L	22,5	37,0	29,0	22,8
L	20,5	-	-	-
IL	23,0	37,0	31,0	23,0
L/C	-	33,0	26,0	19,0
L/C	-	34,7	24,5	21,0
L/C	22,0	36,0	28,0	21,5
C	-	34,0	28,5	22,5
C	-	35,0	28,0	23,0
C	22,0	37,0	28,5	22,5
C	23,0	37,0	28,5	24,0
C	-	37,5	30,0	24,0
C	19,5	-	-	-
C	21,0	-	-	-
Y	-	30,8	26,5	20,0
Y	18,0	33,0	27,0	20,2
Y	19,5	33,0	27,5	21,5
Y	22,0	33,0	26,5	20,7
Y	20,0	33,0	26,5	20,0
Y	22,3	34,5	27,0	22,2
Y		36,0	28,0	24,2
Y	20,5	36,0	29,0	24,0
Y	23,0	37,0	31,5	-
Y	-	38,5	30,5	24,5
Y	-	39,0	31,0	22,0
Y	21,5	-	-	23,0
IY	25,0	-	32,0	23,0

Scapula *Capra*

	SLC	GLP	LG	BG
IM/eL	22,0	34,0	28,0	22,0
IM/eL	-	36,0	29,0	22,0
IM/eL	27,0	43,5	36,0	29,0
IM/eL	22,5	-	-	-
IM/eL	26,5	-	-	-
IM/eL	28,5	-	33,0	28,5
L	-	30,0	25,0	20,0
L	-	33,5	25,5	20,5
L	-	34,0	28,0	22,0
L	22,2	35,5	28,5	23,5
L	24,0	37,0	29,0	26,0
IL	22,0	34,0	26,0	22,0
IL	21,2	-	28,5	21,8
IL	22,5	35,0	28,0	21,5
IL	25,0	-	-	-
L/C	20,0	-	-	-
L/C	26,0	-	-	-
L/C	23,0	37,5	29,0	25,5
L/C	19,8	31,5	26,0	22,0
L/C	-	34,0	28,5	22,2
C	19,0	30,0	25,5	20,0
C	20,0	31,0	24,0	20,5
C	20,0	33,0	25,0	20,4
C	20,0	34,0	27,5	21,0
C	-	38,0	-	26,0
C	21,2	-	-	22,0
C	23,0	-	-	-
Y	16,0	28,0	22,2	18,8
Y	16,2	28,0	22,2	19,5
Y	20,0	29,5	25,0	21,0
Y	18,2	30,0	24,2	20,8
Y	18,5	30,0	24,0	20,0
Y	19,0	31,0	26,0	21,0
Y	20,0	31,0	26,0	22,0
Y	19,0	34,0	27,0	23,0
Y	20,0	-	27,0	21,8
Y	20,0	-	-	21,0
Y	21,5	-	-	24,0
Y	22,0	-	-	-
Y	25,0	-	-	-
IY	25,5	38,0	31,0	26,0
IY	22,0	-	-	-

Humerus *Ovis*

	BT
IM/eL	28,5
L	29,0
L	30,0
L	30,0
L	31,0
L	32,0
L/C	29,0
L/C	30,0
L/C	30,0
L/C	30,2
L/C	31,0
L/C	31,0
L/C	31,0
L/C	31,5
C	28,5
C	29,8
C	29,8
C	30,2
C	31,0
C	31,0
C	31,5
C	32,0
C	32,0
C	34,0
C	35,0
Y	29,0
Y	29,0
Y	29,8
Y	29,8
Y	30,0
Y	30,0
Y	30,0
Y	30,8
Y	31,0
Y	31,0
Y	31,8
Y	32,0
Y	32,5
Y	33,0
Y	36,5
IY	31,0
IY	31,0

Table 3: cont. 2. *Ovis/Capra*. Bone measurements.

Humerus *Capra*

	BT
IM/eL	30,0
IM/eL	30,0
IM/eL	30,3
IM/eL	31,0
IM/eL	31,5
IM/eL	32,0
IM/eL	33,2
IM/eL	34,5
IM/eL	36,5
IM/eL	37,5
IM/eL	37,5
IM/eL	38,5
IM/eL	40,0
L	31,5
L	29,0
L	31,0
L	32,0
L	33,0
L	34,0
L	35,0

Humerus *Capra*

	BT
L	36,0
IL	30,5
IL	31,0
IL	31,5
IL	31,5
IL	42,0
L/C	29,0
L/C	29,5
L/C	30,0
L/C	30,0
L/C	30,0
L/C	31,0
L/C	31,0
L/C	31,0
L/C	32,0
L/C	32,0
L/C	32,7
L/C	33,0
L/C	33,0

Humerus *Capra*

	BT
L/C	31,0
C	28,0
C	29,0
C	30,0
C	30,0
C	31,5
C	32,0
C	32,0
C	32,5
C	33,0
C	33,0
C	33,0
C	34,0
C	35,0
C	35,5
C	37,0
C	37,5
C	38,0
C	38,5

Humerus *Capra*

	BT
Y	27,0
Y	29,0
Y	29,0
Y	29,7
Y	29,8
Y	30,0
Y	30,2
Y	31,5
Y	32,0
Y	32,5
Y	33,0
Y	33,0
Y	34,0
Y	34,0
Y	36,5
IY	28,2
IY	28,7
IY	29,0
IY	33,5

Radius *Ovis*

	GL	Bp	BFp	SD	Bd
IM/eL	-	-	-	-	29,0
L	163,5	-	-	16,5	28,5
L	-	31,8	30,0	-	-
L/C	-	30,8	29,0	-	-
L/C	-	32,0	30,0	-	-
L/C	-	32,5	31,0	-	-
L/C	-	34,0	31,0	-	-
L/C	-	35,0	33,0	-	-
L/C	-	-	-	-	30,0
L/C	-	-	-	-	30,0
C	-	30,8	29,5	-	-
C	-	31,0	29,5	-	-
C	-	32,0	-	-	-
C	-	32,5	31,0	-	-
C	-	33,5	31,5	-	-
C	-	35,0		-	-
C	-	35,0	32,5	-	-
C	-	36,5	34,0	-	-

Radius *Ovis*

	Bp	BFp	Bd
C	-	-	28,5
C	-	-	30,0
C	-	-	31,5
C	-	-	32,5
Y	29,3	27,5	-
Y	30,0	29,0	-
Y	30,0	28,0	-
Y	30,5	28,0	-
Y	31,0	28,5	-
Y	32,3	30,0	-
Y	33,0	31,8	-
Y	33,8	33,0	-
Y	34,0	32,0	-
Y	34,0	32,5	-
Y	-	-	29,0
Y	-	-	30,2
IY	29,7	27,2	-
IY	32,0	30,0	-

Radius *Capra*

	Bp	BFp	Bd
IM/eL	31,0	30,0	-
IM/eL	33,0	30,0	-
IM/eL	34,0	-	-
IM/eL	36,0	34,5	-
IM/eL	37,0	36,0	-
IM/eL	41,5	39,0	-
IM/eL	43,0	41,0	-
IM/eL	-	-	32,0
L	29,7	28,5	-
L	30,0	29,0	-

Radius *Capra*

	Bp	BFp	Bd
L	33,0	31,5	-
L	34,8	33,7	-
L	35,0	33,0	-
L	36,5	34,5	-
L	40,0	38,0	-
L	40,0	-	-
L	41,0	38,5	-
L/C	-	-	31,0
C	30,0	28,5	-
C	33,0	32,0	-

Table 3: cont. 3. *Ovis/Capra*. Bone measurements.

Radius *Capra*

	Bp	BFp	Bd
C	34,0	33,0	-
C	37,2	35,5	-
C	-	-	26,0
C	-	-	29,5
C	-	-	30,0
C	-	-	31,0
C	-	-	32,0
C	-	-	33,5

Radius *Capra*

	Bp	BFp	Bd
Y	28,5	28,0	-
Y	31,2	30,0	-
Y	34,0	33,0	-
Y	36,5	35,8	-
Y	37,0	35,0	-
IY	38,5	37,0	-
Y	-	-	29,5
Y	-	-	38,0

Ulna *Capra*

	SDO
IM/eL	27,0

Metacarpus *Ovis*

	Bp	SD	Bd
IM/eL	22,3	-	-
IM/eL	23,0	-	-
IM/eL	23,0	13,0	-
IM/eL	-	-	25,0
L	24,0	-	-
L	25,0	-	-
L	26,0	-	-
IL	24,0	-	-
IL	-	-	27,0
L/C	21,0	12,8	-
L/C	22,5	-	-
L/C	23,0	-	-
L/C	25,0	-	-
L/C	-	-	26,7
C	22,0	13,5	-
C	22,0	-	-
C	23,0	-	-
C	23,0	13,5	-
C	23,2	-	-
C	25,0	-	-
C	25,0	-	-
C	26,0	17,0	-
C	26,2	-	-
C	-	-	25,5
C	-	-	25,5
C	-	-	28,0
C	-	-	26,0
Y	22,0	13,0	-
Y	22,5	-	-
Y	23,5	-	-
Y	25,0	-	-
Y	25,0	15,5	-
Y	-	-	23,0
Y	-	-	23,8
Y	-	14,0	24,0
Y	-	-	25,0
Y	-	-	26,0
Y	-	-	26,2
Y	-	-	27,8
Y	-	-	30,0
IY	-	-	25,0
IY	-	-	29,8

Metacarpus *Capra*

	GL	Bp	Dp	SD	Bd
IM/eL	-	24,5	-	-	-
IM/eL	-	24,5	-	-	-
IM/eL	-	25,0	-	16,5	-
IM/eL	-	25,0	-	17,0	-
IM/eL	-	27,0	-	-	-
IM/eL	-	27,5	-	-	-
IM/eL	-	30,0	-	-	-
IM/eL	-	-	-	-	27,0
IM/eL	-	-	-	-	29,0
IM/eL	-	-	-	-	30,0
IM/eL	-	-	-	-	35,0
IM/eL	-	-	-	-	40,0
L	106,0	22,8	-	14,8	27,0
L	-	25,0	-	-	-
L	-	25,0	-	-	-
L	-	29,5	-	20,0	-
L	-	29,8	-	19,8	-
L	-	30,0	-		
L	-	30,0	-	20,0	-
L	-	34,0	-	-	-
L	-	-	-	-	27,0
L	-	-	-	-	32,0
L	-	-	-	-	34,2
IL	-	25,0	16,5	-	-
IL	-	27,0	-	-	-
IL	-	29,5	19,5	-	-
L/C	125,0	30,0	-	20,0	-
L/C	-	28,8	-	19,5	-
L/C	-	-	-	-	24,5
L/C	-	-	-	-	27,0
L/C	-	-	-	-	27,5
C	-	24,5	-	-	-
C	-	26,0	-	16,5	-
C	-	-	-	-	26,5
C	-	-	-	-	28,0
C	-	-	-	-	28,5
C	-	-	-	-	29,0
C	-	-	-	-	35,0
C	-	-	-	-	35,0
Y	-	22,0	-	-	-
Y	-	24,0	-	-	-
Y	-	24,5	27,0	-	-
Y	-	26,0	-	-	-

Table 3: cont. 4. *Ovis/Capra*. Bone measurements.

Metacarpus *Capra*

	Bp	Bd
Y	-	26,3
Y	-	27,5
Y	-	32,7
IY	28,0	-

Pelvis *Ovis*

	LA
L	29,0
L	32,5
L	34,0
L/C	28,0
L/C	31,0
Y	28,0
Y	28,0
Y	30,0
Y	30,0
IY	26,5
IY	30,0

Pelvis *Capra*

	LA
Y	24,0
Y	27,5
Y	32,0

Femur *Ovis*

	DC	Bd
IM/eL	21,0	-
C	-	40,0

Femur *Capra*

	Bd
L/C	39,0
L/C	40,5
L/C	41,5
Y	44,0

Tibia *Ovis*

	Bp	Bd
IM/eL	-	26,2
L	-	24,7
L	-	26,2
L	-	26,2
L	-	27,0
L	-	27,5
L/C	-	25,0
L/C	-	26,5
L/C	-	28,0
L/C	-	28,5
L/C	-	28,5
C	-	24,0
C	-	25,0
C	-	25,5
C	-	25,6
C	-	25,8
C	-	26,0
C	-	26,5
C	-	26,5
C	-	26,7
C	-	27,0
C	-	27,0
C	-	27,5
C	-	27,8
C	-	30,5
Y	41,0	-
Y	-	26,0
Y	-	27,0
Y	-	27,0
Y	-	27,8
Y	-	30,0
IY	-	27,5
IY	-	27,5

Tibia *Capra*

	Bd
IM/eL	27,0
IM/eL	27,5
IM/eL	27,5
IM/eL	29,5
IM/eL	32,0
IM/eL	32,0
IM/eL	33,0
L	25,5
L	25,7
L	26,0
L	26,0
L	26,0
L	26,0
L	27,5
L	27,7
L	29,0
L	29,5
L	29,8
L	30,0
IL	28,5
IL	29,5
L/C	23,0
L/C	25,0
L/C	25,5
L/C	26,0
L/C	27,5
L/C	28,0
L/C	28,5
L/C	30,0
C	23,0
C	24,0
C	25,5
C	26,0
C	26,0
C	26,5
C	26,5
C	27,0
C	27,5
C	28,0
C	31,0

Tibia *Capra*

	Bp	Bd
C	-	31,0
C	-	31,5
C	-	31,5
C	-	31,5
C	-	32,0
C	-	32,0
C	44,0	-
Y	43,0	-
Y	-	23,5
Y	-	25,0
Y	-	25,0
Y	-	25,6
Y	-	27,0
Y	-	28,0
IY	-	27,0

Tibia *Ovis/Capra*

	GL	Bd
IM/eL	-	27,0
IM/eL	-	29,0
L	-	28,0
IL	-	28,5
L/C	-	28,8
C	-	-
C	-	27,5
C	-	29,5
Y	-	26,0
Y	-	26,5
Y	-	26,5
Y	-	27,0
Y	-	28,5
Y	-	30,5
Y	225,0	-

Table 3: cont. 5. *Ovis/Capra*. Bone measurements.

Talus *Ovis*

	GLl	GLm	Bd	Dl
IM/eL	28,5	27,0	17,5	16,0
IM/eL	30,5	29,0	20,0	17,0
IM/eL	31,0	28,5	20,0	17,3
IM/eL	32,2	30,2	20,5	17,5
IM/eL	33,0	32,0	21,0	18,3
IM/eL	34,0	32,0	21,2	19,0
L	28,0	27,0	17,0	16,0
L	29,3	28,0	19,7	17,3
L	29,5	28,0	18,8	16,5
L	30,0	28,2	18,5	17,0
L	30,0	27,8	19,5	17,0
L	30,0	29,0	19,5	27,5
L	30,0	28,5	20,0	17,0
L	30,2	28,8	19,5	17,5
L	31,0	29,0	19,0	17,5
L	31,0	28,8	20,0	17,0
L	32,0	29,5	19,7	17,5
L	32,5	30,5	20,5	19,0
L	-	31,0	19,8	-
IL	28,5	28,2	19,0	17,0
IL	32,6	31,0	22,0	19,0
IL	33,0	31,0	21,0	19,0
L/C	28,0	27,3	17,5	16,0
L/C	29,0	28,0	18,0	16,3
L/C	29,0	28,5	18,5	16,5
L/C	29,0	28,5	20,0	17,8
L/C	29,0	28,0	20,2	17,0
L/C	29,7	28,5	18,2	17,3
L/C	30,0	29,0	19,0	17,0
L/C	30,0	29,0	19,8	17,2
L/C	30,5	29,5	20,0	19,0
L/C	30,8	28,8	21,0	17,3
L/C	31,0	29,0	20,5	17,5
L/C	31,0	29,5	-	17,0
L/C	31,5	30,5	20,5	18,0
L/C	32,0	30,0	20,5	18,0
L/C	32,0	30,0	20,5	18,7
L/C	34,0	33,0	22,5	20,0
C	27,2	27,0	18,8	16,0
C	28,0	26,8	18,0	16,0
C	28,0	26,7	18,0	16,2
C	29,0	28,5	18,5	17,0
C	29,0	26,5	18,8	16,5
C	29,0	27,0	19,0	16,8
C	29,0	28,0	19,5	17,0
C	29,0	28,0	19,8	16,5
C	29,5	28,0	20,0	17,5
C	30,0	28,0	18,5	16,0
C	30,0	28,5	19,0	17,0
C	30,0	29,0	19,0	17,2
C	30,0	29,0	19,5	17,3
C	30,0	29,5	20,0	18,0
C	30,0	29,0	20,0	17,0
C	30,0	29,0	20,0	17,3
C	30,0	29,0	21,0	17,3
C	30,8	29,5	20,0	16,3
C	31,0	30,0	19,8	17,2
C	31,0	29,5	20,0	17,2
C	31,0	-	-	18,0
C	32,0	30,0	19,7	18,8
C	32,0	31,0	21,0	18,0

Talus *Ovis*

	GLl	GLm	Bd	Dl
C	32,5	30,5	19,5	18,0
C	32,8	31,0	20,0	18,0
C	33,0	30,2	21,0	19,8
C	33,0	32,0	21,0	19,0
C			27,0	
Y	28,0	27,0	18,5	16,3
Y	29,0	28,0	17,2	16,0
Y	29,0	27,2	18,5	17,0
Y	30,0	29,0	18,5	17,0
Y	30,0	29,0	19,0	17,0
Y	30,0	29,0	19,2	17,0
Y	31,5	30,0	21,0	19,5
Y	31,8	30,0	21,0	17,8
Y	32,2	30,3	20,5	18,8
IY	31,0	29,0	20,0	18,2

Talus *Capra*

	GLl	GLm	Bd	Dl
IM/eL	29,5	27,0	19,2	16,2
IM/eL	29,5	27,5	19,5	16,0
IM/eL	30,2	29,0	19,0	17,0
IM/eL	30,5	29,0	-	17,0
IM/eL	31,0	28,0	19,7	17,0
IM/eL	31,0	29,0	19,5	17,2
IM/eL	31,0	29,0	20,5	17,0
IM/eL	31,5	30,0	22,5	17,2
IM/eL	32,0	30,5	22,0	18,0
IM/eL	32,5	30,5	21,0	18,0
IM/eL	32,5	31,5	24,0	18,0
IM/eL	33,5	31,0	22,5	18,0
IM/eL	35,0	-	-	18,5
IM/eL	35,5	32,5	23,0	20,0
IM/eL	-	28,5	19,0	-
IM/eL	-	31,0	-	-
L	27,2	26,0	17,0	15,0
L	28,5	27,0	18,0	15,2
L	29,0	27,0	18,0	15,0
L	29,8	27,5	19,0	17,2
L	30,0	28,5	19,0	16,5
L	30,2	27,2	20,0	17,0
L	30,5	28,0	20,0	17,0
L	30,7	-	-	16,5
L	31,0	28,5	20,0	16,3
L	31,0	29,0	21,0	17,0
L	32,0	30,0	21,0	17,2
L	32,5	29,0	20,5	17,0
L	32,5	30,0	20,0	18,0
L	33,0	29,0	23,0	18,5
L	33,0	31,5	22,2	18,5
L	33,2	-	21,5	19,0
L	33,3	31,0	22,0	18,5
L	33,3	31,0	23,0	18,5
L	34,0	32,5	-	18,0
L	34,7	32,0	24,0	20,0
L	35,0	33,0	23,8	18,8
IL	31,2	28,5	20,5	17,5
IL	33,0	-	23,0	18,0
L/C	28,8	26,0	19,0	16,7
L/C	29,5	27,5	19,0	15,5
L/C	29,5	27,8	19,0	16,0
L/C	32,0	30,0	19,5	16,5

Table 3: cont. 6. *Ovis/Capra*. Bone measurements.

Talus *Capra*

	GLl	GLm	Bd	Dl
L/C	33,0	30,3	28,0	22,0
C	29,0	26,0	18,0	15,5
C	29,0	28,0	18,2	16,0
C	29,5	29,0	18,0	15,5
C	30,0	27,0	18,0	15,0
C	30,0	28,0	20,0	17,0
C	30,5	29,0	21,5	17,0
C	30,8	28,5	19,0	17,0
C	31,0	27,5	19,2	17,0
C	31,0	29,0	-	-
C	31,5	28,7	19,5	17,0
C	32,0	29,0	21,5	17,5
C	32,0	30,0	20,5	18,5
C	32,0	30,0	28,8	21,5
C	32,0	30,5	21,0	17,0
C	32,0	-	21,7	17,8
C	33,0	31,6	22,8	18,0
C	34,0	32,0	22,5	19,5
C	34,8	31,0	23,0	19,0
C	-	30,0	22,0	-
C	-	30,5	-	-
C	-	-	19,0	16,0
Y	26,5	24,7	18,0	14,0
Y	27,0	24,5	16,0	14,0
Y	28,0	26,0	19,0	16,0
Y	28,0	26,7	18,5	16,0
Y	28,6	27,5	19,0	15,3
Y	29,0	27,5	20,5	16,0
Y	29,3	28,0	18,5	16,6
IY	31,2	28,2	22,2	17,3

Centrotarsale *Capra*

	GB
IM/eL	24,0
IM/eL	24,2
IM/eL	24,8
IM/eL	25,0
IM/eL	25,0
IM/eL	27,0
IM/eL	27,0
IM/eL	29,5
L	22,5
L	24,0
L	24,5
L	25,0
L	28,0
L/C	26,0
L/C	26,0
Y	25,7

Calcaneus *Ovis*

	GL	GB
L	59,5	20,5
L	62,0	21,5
IL	64,0	22,0
L/C	54,3	20,0
L/C	62,5	21,5
L/C	63,5	21,0
L/C	65,5	21,5
C	57,5	20,5
C	58,5	20,2
C	60,5	19,8
C	65,0	21,0
Y	54,0	18,8
Y	56,5	19,0
Y	57,5	19,2
Y	59,0	18,0

Calcaneus *Capra*

	GL	GB
IM/eL	68,5	25,0
IM/eL	71,5	25,0
L	59,0	20,0
L/C	60,0	21,0
L/C	68,5	-
C	52,0	18,0
C	54,5	18,8
C	55,0	19,0
Y	56,7	20,5
Y	59,0	21,0
Y	61,0	22,0
Y	61,0	22,5
Y	64,0	22,0
Y	65,0	22,0
Y	65,0	22,5
IY	55,5	19,0

Metatarsus *Ovis*

	Bp	SD	Bd
IM/eL	22,8	-	-
L	23,0	-	-
L	-	-	24,0
L	-	-	26,0
L/C	21,0	-	-
L/C	22,0	-	-
L/C	22,5	-	-
L/C	-	-	23,0
L/C	-	-	24,0
L/C	-	-	25,0
L/C	-	-	25,8
C	20,0	-	-
C	20,0	12,0	-
C	21,5		-
C	22,0	12,5	
C	22,0	-	-
C	22,5	-	-
C	23,2	-	-
C	-	-	24,0
C	-	-	24,0

Metatarsus *Ovis*

	GL	Bp	SD	Bd
C	-	-	-	24,2
C	-	-	-	25,0
C	-	-	-	25,0
C	-	-	-	25,5
C	-	-	-	27,0
C	-	-	-	27,0
C	-	-	-	27,5
Y	140,0	-	12,0	24,5
Y	162,5	21,3	13,2	25,0
Y	-	20,0	11,2	-
Y	-	20,0	-	-
Y	-	22,0	13,0	-
Y	-	22,0	-	-
Y	-	-	10,2	22,2
Y	-	-	-	23,0
Y	-	-	-	24,0
Y	-	-	-	25,5
Y	-	-	-	26,0
Y	-	-	-	28,0
IY	-	-	-	24,0

Table 3: cont. 7. *Ovis/Capra*. Bone measurements.

Metatarsus *Capra*

	GL	Bp	SD	Bd
IM/eL	117,0	26,2	17,0	30,0
IM/eL	-	20,5	14,0	-
IM/eL	-	22,0	-	-
IM/eL	-	24,0	-	-
IM/eL	-	-	-	25,0
IM/eL	-	-	-	25,5
IM/eL	-	-	-	26,5
IM/eL	-	-	-	27,0
IM/eL	-	-	-	32,0
IM/eL	-	-	-	32,5
IM/eL	-	-	-	32,5
IM/eL	-	-	-	33,0
IM/eL	-	-	-	37,0
L	-	19,2	-	-
L	-	21,0	13,0	-
L	-	23,5	-	-
L	-	-	-	25,0
L	-	-	-	27,0
L	-	-	-	28,0
L	-	-	-	29,0
L	-	-	-	30,0
L	-	-	-	31,6
L	-	-	-	32,0
L	-	-	-	32,5
IL	-	21,0	-	-
IL	-	-	-	28,5

Metatarsus *Capra*

	GL	Bp	SD	Bd
IL	-	-	-	35,5
L/C	-	20,0	-	-
L/C	-	-	-	25,0
L/C	-	-	-	27,5
L/C	-	-	-	31,5
C	-	19,0	-	-
C	-	20,0	-	-
C	-	21,0	-	-
C	-	22,0	-	-
C	-	23,0	-	-
C	-	-	-	25,2
C	-	-	19,0	25,5
C	-	-	-	26,0
C	-	-	-	26,0
C	-	-	-	26,5
C	-	-	-	28,2
C	-	-	-	29,0
C	-	-	-	31,5
Y	-	18,0	-	-
Y	-	20,0	-	-
Y	-	-	-	26,2
IY	133,5	22,5	14,2	28,0
IY	-	23,5	-	-
IY	-	-	-	28,0
IY	-	-	-	28,0

Phalanx 1 *Ovis*

	GLpe	Bp	SD	Bd
IM/eL	39,0	13,0	10,0	13,0
L	34,0	11,5	9,5	11,0
L	37,5	13,8	11,0	13,2
L	38,0	11,2	8,0	10,2
L	38,0	-	-	12,5
L	41,5	13,0	11,0	12,7
L/C	35,0	11,5	9,2	10,5
L/C	37,5	12,0	9,0	11,0
L/C	38,0	12,0	8,5	11,1
L/C	39,0	12,3	9,0	11,0
L/C	41,0	13,0	10,7	13,0
L/C	42,3	13,0	10,2	12,3
L/C	42,5	12,5	9,0	11,0
L/C	43,0	12,6	10,0	12,0
L/C	44,0	13,0	11,0	12,2
C	36,0	11,0	8,2	10,5
C	36,0	11,5	9,0	10,7
C	37,5	12,0	10,0	12,5
C	38,0	11,8	8,4	10,3
C	39,0	11,0	8,7	10,5
C	39,0	12,8	9,2	10,3
C	39,6	11,5	9,0	11,0
C	40,0	12,0	9,0	10,8
C	40,5	13,5	11,0	13,0
C	41,0	14,0	10,5	13,0

Phalanx 1 *Ovis*

	GLpe	Bp	SD	Bd
C	44,5	12,0	10,0	12,0
C	49,0	16,3	13,7	15,4
C	-	-	-	12,0
C	-	-	-	13,2
Y	36,0	10,5	8,2	10,0
Y	36,0	11,0	8,7	10,0
Y	36,0	12,0	10,0	11,5
Y	36,0	12,5	10,0	12,0
Y	37,5	12,0	8,5	11,3
Y	39,0	13,0	10,2	12,5
Y	40,0	11,5	10,0	11,0
Y	40,0	12,5	10,2	12,0
Y	44,0	-	11,5	13,0
Y	46,0	13,0	10,0	12,0
Y	-	13,5	-	-
Y	-	-	-	12,2
Y	-	-	-	13,0
Y	-	-	-	18,0
IY	36,0	12,0	-	12,0
IY	36,2	12,0	9,8	12,0
IY	38,5	13,0	10,0	12,0

Table 3: cont. 8. *Ovis/Capra.* Bone measurements.

Phalanx 1 *Capra*

	GLpe	Bp	SD	Bd
IM/eL	37,0	12,5	10,0	12,0
IM/eL	38,0	12,0	9,2	11,8
IM/eL	38,0	12,0	10,0	12,0
IM/eL	38,0	12,2	10,0	11,6
IM/eL	38,0	13,2	10,0	12,5
IM/eL	38,0	14,0	11,0	14,0
IM/eL	39,2	-	13,0	14,0
IM/eL	39,5	13,2	10,3	12,0
IM/eL	39,5	14,0	12,2	14,2
IM/eL	40,0	13,5	10,2	12,5
IM/eL	40,0	13,5	10,5	12,5
IM/eL	40,0	14,0	11,5	14,2
IM/eL	40,2	14,0	12,8	15,0
IM/eL	40,3	13,6	10,5	12,0
IM/eL	40,5	15,0	13,0	15,0
IM/eL	40,6	13,5	11,0	12,5
IM/eL	41,0	11,3	9,0	11,0
IM/eL	44,5	17,0	15,0	16,5
IM/eL	46,0	18,0	15,0	18,0
IM/eL	47,0	16,0	13,0	16,0
IM/eL	47,0	18,5	14,5	17,0
IM/eL	48,0	18,5	14,6	17,0
IM/eL	49,0	16,0	13,0	15,0
IM/eL	-	16,0	-	-
IM/eL	-	17,0	-	-
IM/eL	-	17,0	-	-
IM/eL	-	18,0	-	-
IM/eL	-	-	-	15,0
IM/eL	-	-	-	16,0
IM/eL	-	-	-	16,5
IM/eL	-	-	-	16,8
IM/eL	-	-	-	17,0
IM/eL	-	-	-	18,0
L	35,5	13,8	10,2	12,5
L	36,0	11,5	9,0	11,0
L	36,5	13,0	10,0	11,5
L	36,7	14,0	12,0	13,6
L	37,5	13,8	11,0	13,2
L	40,0	13,5	11,0	13,0
L	41,0	15,7	12,5	14,5
L	41,5	13,8	11,5	13,8
L	42,5	16,0	12,5	15,5
L	43,0	27,0	13,3	15,0
L	45,0	17,0	14,5	-
L	-	14,5	-	-
L	-	15,5	-	-
L	-	17,2	-	-
L	-	17,2	-	-
L	-	18,7	-	-
L	-	-	-	12,0
L	-	-	-	13,8
L	-	-	-	15,0
L	-	-	-	15,5
L	-	-	-	16,5

Phalanx 1 *Capra*

	GLpe	Bp	SD	Bd
L	-	-	-	18,5
IL	38,0	13,5	10,8	13,0
IL	40,5	13,0	11,0	13,5
IL	41,0	15,0	11,2	13,3
IL	42,0	14,0	10,8	-
IL	-	14,0	-	-
IL	-	18,0	-	17,0
IL	-	-	-	13,0
L/C	36,5	12,5	11,0	11,9
L/C	37,0	11,8	10,2	12,3
L/C	37,0	12,0		12,0
L/C	37,0	13,0	10,0	13,0
L/C	37,3	13,0	10,5	11,2
L/C	37,8	11,2	10,0	11,3
L/C	38,0	12,0	10,0	13,2
L/C	39,0	14,0	11,0	12,5
L/C	40,0	12,5	10,3	14,5
L/C	41,0	14,5	12,0	14,0
L/C	42,0	14,0	12,0	14,5
L/C	45,0	14,5	12,2	-
L/C	-	17,0	-	12,2
L/C	-	-	-	14,0
C	27,0	15,0	12,0	13,5
C	38,0	14,0	12,0	14,2
C	42,0	14,8	11,8	13,8
C	42,8	15,0	11,4	14,5
C	43,0	14,5	12,0	15,0
C	45,5	17,0	13,0	16,0
C	46,0	16,0	-	-
C	47,0	16,3	14,2	16,0
C	47,5	15,5	12,2	-
C	-	17,0	-	15,0
C	-	-	-	16,0
C	-	-	-	13,0
Y	25,0	13,5	12,0	13,0
Y	26,0	17,0	12,0	10,0
Y	34,0	11,2	9,0	12,0
Y	34,0	12,0	9,5	12,0
Y	34,0	12,8	10,0	13,8
Y	34,0	13,5	10,5	10,2
Y	34,3	11,3	9,0	11,0
Y	35,0	11,0	8,8	10,5
Y	35,0	11,8	8,5	11,0
Y	35,0	12,5	9,8	13,0
Y	35,0	12,5	11,0	12,3
Y	35,0	-	10,0	-
Y	36,0	-	8,0	14,0
Y	36,2	14,0	11,2	13,0
Y	36,5	14,0	11,8	11,0
Y	37,0	12,0	9,3	12,0
Y	38,0	12,0	10,0	14,0
Y	39,0	12,5	11,5	12,0
Y	39,0	-	10,2	13,5
Y	40,5	13,5	12,0	-

Table 3: cont. 9. *Ovis/Capra.* Bone measurements.

Phalanx 1 *Capra*

	GLpe	Bp	SD	Bd
Y	42,0	14,5	12,3	13,8
Y	42,5	13,7	11,0	12,5
Y	43,0	16,7	15,0	16,5
Y	-	15,5	-	-
Y	-	-	-	13,2
Y	-	-	-	14,0
Y	-	-	-	18,0
IY	34,5	13,2	11,0	13,0
IY	36,6	13,5	11,7	12,5
IY	38,5	14,0	11,5	14,2

Phalanx 2 *Ovis*

	GL	Bp	SD	Bd
IM/eL	25,6	11,2	8,0	9,0
L	25,0	11,0	7,5	9,0
L	25,0	12,0	8,5	10,0
L/C	21,0	11,0	9,0	10,0
L/C	21,5	10,9	7,9	8,5
L/C	22,0	10,5	9,0	9,0
L/C	23,0	12,0	8,7	9,5
C	22,0	11,0	7,5	8,0
C	22,0	11,0	7,8	8,3
C	23,0	11,5	8,0	10,0
C	23,5	11,0	7,2	8,2
C	24,0	12,5	9,0	9,2
C	27,8	12,0	8,2	10,0
Y	21,2	10,7	7,8	9,0
Y	22,2	13,0	9,0	10,8
Y	23,0	12,3	9,2	10,0
Y	23,8	12,5	8,0	9,2
Y	24,0	12,0	8,0	8,5

Phalanx 2 *Capra*

	GLpe	Bp	SD	Bd
IM/eL	22,0	12,0	8,0	10,0
IM/eL	23,0	13,8	11,0	11,5
IM/eL	23,5	12,0	9,2	10,0
IM/eL	24,5	14,0	10,2	11,0
IM/eL	25,0	11,2	7,5	-
IM/eL	25,0	13,0	9,0	9,5
IM/eL	25,0	14,0	11,0	12,0
IM/eL	25,2	11,8	8,5	9,5
IM/eL	25,5	13,0	9,0	10,0
IM/eL	25,5	13,2	9,3	10,0
IM/eL	26,0	12,0	9,0	10,0
IM/eL	26,0	14,0	10,0	11,2
IM/eL	28,0	18,0	12,3	14,3
IM/eL	28,3	17,0	12,5	13,0
IM/eL	28,5	15,7	11,2	12,5
IM/eL	28,5	17,3	12,0	14,0
IM/eL	28,5	17,5	12,5	14,2
IM/eL	29,0	16,8	12,5	13,5
IM/eL	29,0	18,0	14,0	-

	GLpe	Bp	SD	Bd
IM/eL	29,5	15,0	11,5	13,0
IM/eL	29,5	17,5	13,0	14,0
IM/eL	30,0	15,0	10,9	11,5
IM/eL	30,0	17,5	12,2	13,8
IM/eL	31,0	14,2	10,5	12,0
IM/eL	31,0	16,0	11,0	13,0
L	21,8	14,0	10,0	10,2
L	23,0	14,0	10,2	11,0
L	24,0	11,8	8,5	10,0
L	24,0	12,0	8,5	10,0
L	24,0	13,0	10,0	10,3
L	24,0	-	10,0	10,5
L	24,8	15,7	11,0	12,0
L	25,0	12,5	8,3	10,0
L	25,0	14,0	10,0	11,5
L	25,0	16,5	11,5	12,0
L	25,5	14,0	9,5	11,0
L	25,8	12,0	9,2	10,2
L	26,0	14,0	10,5	11,0
L	27,5	13,7	12,0	-
L	29,0	17,0	13,0	14,0
L	29,5	13,7	10,7	11,5
L	29,5	15,2	10,8	11,5
L	30,0	15,2	10,5	12,0
IL	24,0	13,5	10,5	11,0
IL	24,8	13,0	9,7	10,8
IL	25,7	-	8,0	9,3
L/C	22,0	12,0	8,5	10,0
L/C	22,2	13,5	10,0	10,5
L/C	24,0	13,0	9,8	10,5
L/C	24,0	14,0	9,5	10,0
L/C	25,0	13,2	9,5	10,3
L/C	27,0	13,5	9,4	10,5
L/C	27,0	16,7	12,6	13,0
C	20,0	12,0	9,3	-
C	22,0	13,0	9,8	10,8
C	23,0	11,8	8,0	9,5
C	23,0	12,5	9,2	10,0
C	23,0	14,0	10,0	11,0
C	24,0	12,2	8,2	9,3
C	24,5	13,5	10,0	11,0
C	25,0	16,5	12,0	13,0
C	25,0	-	-	-
C	26,0	12,5	8,8	10,0
C	27,0	13,5	9,0	-
C	28,5	15,0	10,3	12,0
C	29,0	17,2	14,0	-
C	29,0	18,0	13,0	13,5
C	29,5	15,2	10,5	12,0
C	-	17,5	-	-
C	-	-	-	16,0
Y	22,0	13,8	10,5	11,0
Y	22,5	11,2	9,0	9,8
Y	23,0	12,6	9,0	10,0

Table 3: cont. 10. *Ovis/Capra.* Bone measurements.

Phalanx 2 *Capra*

	GLpe	Bp	SD	Bd
Y	23,5	14,0	10,3	11,5
Y	24,0	14,2	10,2	-
Y	24,5	13,0	9,0	-
Y	25,0	11,8	8,0	-
Y	25,0	12,5	7,0	9,0
Y	26,0	15,5	11,7	12,5
Y	26,0	15,5	12,0	13,0
Y	26,5	15,0	11,0	-
Y	27,0	13,8	10,2	11,5
Y	27,5	17,0	12,5	13,5
Y	29,7	15,3	11,0	12,5
IY	24,0	13,0	9,5	10,0

Height in withers, *Ovis*
(according to Teichert 1975)

Radius (factor 4,02)

	GL		
L	163,5	657,3	66 cm

Metatarsus (factor 4,54)

	GL		
Y	140,0	635,6	64 cm
Y	162,5	737,8	74 cm

Height in withers, *Capra*
(according to Schramm 1967)

Metacarpus (factor 5,75)

	GL		
L	106,0	609,5	61 cm
L/C	125,0	718,8	72 cm

Metatarsus (factor 5,34)

	GL		
IM/eL	117,0	624,8	62 cm
IY	133,5	712,9	71 cm

Table 4: *Gazella.* Skeletal distribution.

	IM/eL	L/IL	L/C	C	Y/IY
Proc. corn.	7	7	-	2	14
Cranium	11	28	7	11	24
Mandibula	9	12	1	8	22
Atlas	1	1	-	4	2
Epistropheus	6	1	3	2	4
other Vertebrae.	22	27	11	20	12
Costae	9	15	4	3	24
Scapula	8	13	5	12	15
Humerus	8	12	11	10	31
Radius+Ulna	12	18	9	16	20
Carpalia	-	-	1	-	-
Metacarpus	18	38	21	24	25
Pelvis	1	7	4	1	9
Femur	16	33	17	9	48
Tibia/Os malleolare	25	26	21	15	40
Talus	5	17	3	8	4
Calcaneus	8	18	3	7	6
other Tarsalia	4	14	1	2	2
Metatarsus	19	37	25	16	21
Phalanges	25	86	26	24	22
Total	214	410	173	194	345

Table 5. *Gazella.* Age distribution based on tooth eruption.

Maxilla	IM/eL	L/IL	L/C	C	Y/IY	Age n=26
M1 +	1		3			< 6 mo.
M2 +/-	1					6 mo.
M1 ++	1					12 - 15 mo.
M3 +/-					2	12 - 15 mo.
M3 o		1				15 mo.
M1 ++/+++		1		1		15 - 18 mo.
M3 +/o					1	15 - 18 mo.
M2 ++				1		> 18 mo.
M3 +	2	3		1	2	> 18 mo.
M3 ++	1			1	3	> 18 mo.

Mandibula	IM/eL	L/IL	L/C	C	Y/IY	Age n=15
Pd4 +/o					1	< 3 days
Pd4 +					1	< 3 days
M1 +/-					2	< 1 mo.
M1 ++				1		12 - 15 mo.
M3 +/-					1	12 - 15 mo.
M1 +++	1					> 18 mo.
M3 +	1	3			3	> 18 mo.
M3 ++					1	> 18 mo.

Table 6. *Gazella.* Age distribution based on epiphyseal fusion.

n = 292	IM/eL	L/IL	L/C	C	Y/IY	Age
Humerus d-						< 2 mo.
Humerus d+	3	3	6	3	11	> 2 mo.
Radius p-						< 2 mo.
Radius p+	1	3		2	5	> 2 mo.
Scapula d-				1		< 6 mo.
Scapula d+	2	4	4	5	7	> 6 mo.
Ph1 p-		2		1	1	< 8 mo.
Ph1 p+	9	30	10	11	6	> 8 mo.
Tibia d-	1	1				< 10 mo.
Tibia d+	4	5	2	2	5	> 10 mo.
Mc d-	2	2	1	2	1	< 16 mo.
Mc d+	4	15	4	12	7	> 16 mo.
Femur p-						< 16 mo.
Femur p+	1	4			1	> 16 mo.
Mt d-	1	2	1	3	1	< 16 mo.
Mt d+	5	11	6	4	1	> 16 mo.
Calc p-	3			4		< 16 mo.
Calc p+	3	5	2	3	2	> 16 mo.
Humerus p-						< 18 mo.
Humerus p+		1		1		> 18 mo.
Radius d-	1	1	1		1	< 18 mo.
Radius d+		2		3	1	> 18 mo.
Ulna p-		1				< 18 mo.
Ulna p+		2				> 18 mo.
Femur d-	1	1			2	< 18 mo.
Femur d+	1	2		1	3	> 18 mo.
Tibia p-						< 18 mo.
Tibia p+	1		2			> 18 mo.

Table 7. *Gazella*. Bone measurements.

(G.g. = Gazella gazella; G.d. = Gazella dorcas; m = male; f = female)

Horn core

			GD base	LD base	bas.circ.	out.curv.
IM/eL		f	9,00	8,00	32,00	-
IM/eL	*G.g.*	f	9,00	8,50	26,00	-
IM/eL	*G.g.*	m	32,00	23,50	95,00	-
L		m	26,20	21,50	84,00	-
L	*G.g.*	m	30,00	23,00	90,00	-
L		m	30,00	23,00	91,00	-
L		m	30,00	24,00	92,00	165,00
L		m	31,00	21,00	93,00	-
L	*G.g.*	m	31,50	22,00	94,00	160,00
L		m	32,00	22,00	95,00	195,00
L	*G.g.*	m	32,00	22,00	92,00	180,00
L	*G.d.*	m	32,50	20,20	91,00	-
L		m	33,20	-	97,00	-
C	*G.d.*	f	9,00	8,00	33,00	-
C		m	31,50	22,50	95,00	-
Y		m	26,00	21,50	82,00	-
Y		m	28,00	20,50	84,00	-
Y		m	32,00	22,00	95,00	-
Y		m	33,00	25,00	102,00	165,00
Y		m	36,00	25,00	102,00	-
Y		m	36,00	26,00	103,00	-
Y		m	37,50	28,50	110,00	190,00
IY		m	31,00	26,50	95,00	-
IY		m	32,00	21,00	90,00	-
IY		m	33,50	23,50	98,00	150,00

Viscerocranium

	L ch. r.	L prem r.	L mol. r.
Y	56	21,2	35,5
Y	62	-	38,5

Atlas

	GLF	BFcr	BFcd
L	49,00	48,00	-
C	39,00	-	-
C	43,00	42,50	38,50

Epistropheus

	BFcr	SBV
IM/eL	38,00	-
Y	31,80	17,50

Mandibula

	L ch. r.	L prem r.	L molar r.	H Crown	L M3	B M3
L	-	-	-	22,00	18,00	6,70
IL	-	-	39,50	20,00	17,00	6,20
L/C	-	-	-	17,00	15,50	7,00
Y	-	-	-	-	13,20	5,20
Y	-	-	-	-	16,00	6,50
Y	47,50	-	-	-	-	-
Y	-	20,50	-	-	-	-

Scapula

	SLC	GLP	LG	BG
IM/eL	-	29,50	24,00	20,50
IM/eL	14,80	-	23,50	19,00
IM/eL	17,00	31,00	25,00	22,20
L	-	27,50	24,00	20,70
L	17,30	31,00	25,20	22,50
L	16,20	-	-	20,20
IL	17,50	31,00	26,50	24,50
L/C	14,60	30,00	25,00	21,00
L/C	17,00	31,00	25,00	22,50
L/C	16,00	31,50	26,00	22,50
L/C	-	-	24,00	22,00
C	18,50	-	-	23,50
C	-	30,00	24,00	21,00
C	18,00	32,00	27,00	23,00
C	15,30	-	-	-

Scapula

	SLC	GLP	LG	BG
Y	12,50	-	-	-
Y	15,00	28,00	22,50	19,00
Y	15,50	30,00	24,00	20,00
Y	16,50	-	-	20,50
Y	17,00	-	25,00	-
Y	18,00	-	26,00	22,00
IY	17,00	-	-	-

Table 7: cont. 1. *Gazella*. Bone measurements.

Humerus

	Dp	BT	Bd
IM/eL	-	24,50	27,00
IM/eL	-	25,50	27,50
L	42,00	-	-
IL	-	27,00	-
L/C	-	23,50	25,00
L/C	-	24,80	27,00
L/C	-	25,00	28,00
L/C	-	26,00	29,00
C	-	22,50	-
C	-	23,50	26,00
C	-	25,00	28,50
C	-	25,00	28,00
Y	-	24,60	28,00
Y	-	25,00	27,00
Y	-	25,00	28,00
Y	-	26,00	28,00
Y	-	26,00	-
Y	-	26,00	29,00
Y	-	28,50	-
IY	-	26,50	29,50
IY	-	28,50	32,00

Metacarpus

	Bp	Bd
IM/eL	-	19,50
IM/eL	-	23,00
IM/eL	-	21,00
L	-	19,00
L	21,00	-
L	20,00	-
L	24,50	-
L	-	24,00
L	-	20,60
C	-	22,20
C	-	23,00
C	-	21,20
C	-	20,00
Y	-	21,50
Y	-	23,50
Y	-	22,00

Tibia

	Bp	Bd
IM/eL	36,20	
IM/eL	ʼ	24,20
L		24,50
L		21,50
IL		21,00
IL		23,00
C		24,50
Y		24,00

Radius

	Bp	BFp	Bd
L	27,50	26,00	-
L	-	-	22,00
L	-	-	26,00
C	-	-	24,50
C	-	-	25,00
Y	28,00	26,00	-
Y	-	-	25,00
Y	-	-	25,00
IY	26,70	24,00	-

Ulna

	DPA	SDO
IL	21,00	17,00
IL	23,00	17,50

Phalanx 1 ant.

	GLpe	Bp	SD	Bd
IM/eL	40,30	11,00	8,30	9,00
IM/eL	42,00	11,70	8,50	9,20
L	42,00	-	7,50	9,00
L	46,50	11,00	8,50	9,70
L	47,00	-	9,00	10,00
L/C	43,50	10,30	8,00	9,00
L/C	44,50	10,30	8,60	10,00
L/C	45,00	-	7,00	8,70
C	44,50	10,00	7,80	9,50
C	43,00	10,90	7,50	9,00
C	45,00	11,00	8,20	9,80
C	46,50	11,00	8,00	9,20
C	-	-	-	9,00

Phalanx 2 ant.

	GLpe	Bp	SD	Bd
L/C	23,50	9,50	15,80	18,00

Pelvis

	LA
IM/eL	22,50
IY	27,00
IY	27,00

Femur

	DC
IL	18,20

Calcaneus

	GL	GB	LT
IM/eL	55,80	19,00	-
IM/eL	61,00	20,30	-
IM/eL	-	-	41,00
L	54,50	17,00	-
L	57,70	18,50	-
L	59,00	-	-
L	63,00	20,00	-
L/C	56,50	-	-
C	57,00	18,50	-
Y	55,50	19,00	-
Y	57,80	19,30	-

Table 7: cont. 2. *Gazella.* Bone measurements.

Talus

	GLl	GLm	Bd	Dl
IM/eL	25,00	23,00	15,00	14,20
IM/eL	26,70	25,00	16,00	15,00
IM/eL	27,80	26,00	16,50	15,00
IM/eL	28,80	26,20	17,50	16,00
L	27,00	-	16,00	15,00
L	27,00	-	15,00	14,50
L	27,00	24,70	15,70	14,50
L	27,00	25,50	16,00	15,50
L	27,20	26,50	17,00	15,30
L	28,00	26,50	17,50	15,80
L	28,00	26,00	16,50	15,50
L	28,00	25,60	16,50	15,00
L	28,00	26,00	17,00	15,00
L	28,40	26,00	17,30	15,30
L	29,00	26,50	17,00	16,00
L	30,50	27,50	18,50	17,00
L	31,00	29,00	18,30	16,20
L	-	27,50	17,90	-
IL	28,30	27,00	17,00	-
IL	28,60	26,70	17,50	16,00
IL	29,30	27,50	20,00	16,00
L/C	28,00	26,50	17,00	15,40
L/C	28,50	26,00	16,50	15,00
L/C	30,70	28,50	18,00	17,00
C	26,00	24,00	15,50	14,70
C	26,50	24,80	15,00	14,30
C	28,80	26,30	17,00	16,00
C	30,20	27,50	19,00	17,00
C	-	-	16,00	-
C	-	-	17,50	-
Y	25,20	23,50	15,50	14,00
Y	29,00	26,30	15,50	18,50
IY	28,00	26,00	17,20	15,20

Metatarsus

	Bp	SD	Bd
IM/eL	19,50	-	-
IM/eL	-	-	20,70
IM/eL	-	-	20,00
L	19,20	11,00	-
L	20,00	-	
L	22,00	-	-
L	-	-	21,00
L	-	-	23,50
L	-	-	24,00
L	-	-	26,50
IL	-	-	21,00
L/C	20,00	-	
L/C	-	-	25,00
C	-	-	24,20

Phalanx 1 post.

	GLpe	Bp	SD	Bd
IM/eL	36,70	-	7,50	9,00
L	37,50	10,70	7,50	9,00
L	39,20	12,50	8,70	9,50
L	39,80	11,20	8,80	11,20
L	40,00	-	8,00	9,00
L	40,00	12,50	8,20	9,30
L	40,50	11,30	7,50	8,80
L	41,50	12,20	8,50	9,20
L/C	34,00	10,00	6,50	8,00
L/C	35,00	9,00	6,00	8,00
L/C	37,00	10,00	6,70	8,00
L/C	40,30	12,00	7,00	9,00
L/C	41,00	12,20	8,50	10,00
L/C	42,00	13,00	8,80	10,00
C	38,00	10,30	7,00	8,50
Y	34,80	10,00	7,00	8,80

Centrotarsale

	GB
IM/eL	19,00
L	20,00
L	20,30
L	21,00
L	21,00
L	21,20
L	22,00
L	22,20
L	23,00
L	23,20
C	22,50
Y	24,00

Phalanx 2 post.

	GLpe	Bp	SD	Bd
C	21,20	8,20	6,30	7,60

Phalanx 3 post.

	DLS	Ld
L/C	24,00	19,00
L/C	25,00	20,60

Table 7: cont. 3. *Gazella.* Bone measurements.

Phalanx 1 ant./post.

	GLpe	Bp	SD	Bd
IM/eL	36,00	-	7,00	8,50
IM/eL	40,00	10,00	8,20	8,50
IM/eL	40,30	11,30	8,00	9,20
IM/eL	40,50	11,50	8,00	9,00
IM/eL	-	10,00	-	-
IM/eL	-	-	-	8,50
L	37,60	10,50	7,00	8,50
L	38,00	11,00	7,90	9,00
L	38,50	9,50	7,00	8,20
L	39,80	11,40	8,30	9,00
L	39,80	12,00	8,30	9,70
L	40,00	11,50	8,50	9,30
L	40,00	11,60	8,00	9,80
L	40,00	11,70	8,30	0,00
L	40,20	11,10	8,10	9,20
L	40,20	11,50	8,00	9,20
L	41,00	9,80	7,50	9,00
L	41,20	12,30	9,00	10,00
L	41,30	11,40	8,50	10,00
L	41,30	12,00	8,00	9,00
L	41,70	12,20	8,50	10,30
L	43,30	12,00	8,70	10,00
L	-	10,50	-	-
L	-	10,60	-	-
L	-	9,50	-	-
L	-	-	-	18,80
L/C	43,00	11,20	8,50	10,00
C	38,50	9,30	6,50	8,50
C	40,00	12,00	9,00	11,00
C	40,70	11,00	7,50	8,50
C	41,00	12,00	8,20	9,20
C	42,00	11,20	8,00	9,40
C	-	11,00	-	-
Y	36,50	10,50	7,00	9,00
Y	-	-	-	7,00
Y	-	-	-	9,80
Y	-	-	-	10,00
IY	34,00	10,00	7,70	9,00
IY	-	9,70	-	-

Phalanx 2 ant./post.

	GLpe	Bp	SD	Bd
IM/eL	20,20	8,50	6,00	7,50
IM/eL	20,30	8,90	6,30	7,50
IM/eL	20,70	9,00	6,00	8,00
IM/eL	21,00	8,50	7,30	8,30
IM/eL	21,70	9,50	6,50	7,70
IM/eL	-	9,10	-	-
L	20,70	8,50	5,50	6,20
L	21,70	9,00	6,60	7,70
L	22,00	9,50	6,50	7,50
L	22,80	9,00	6,90	7,90
L	23,00	10,00	7,30	8,60
L	23,20	9,00	6,00	7,50
L	23,50	9,20	6,50	7,50
L	23,50	9,20	6,00	7,50
L	23,90	9,10	6,50	8,30
L	24,00	10,00	7,30	8,40
L	24,00	9,50	7,40	8,70
L	24,00	10,00	7,00	8,50
L	24,00	10,20	8,00	9,20
L	24,30	10,00	7,30	8,50
L	24,30	10,00	6,80	8,40
L	25,00	10,30	7,20	8,80
L	25,00	10,00	7,00	8,50
IL	22,20	9,20	6,60	8,00
IL	22,50	9,60	6,20	7,50
L/C	22,50	10,50	7,00	7,50
L/C	22,70	10,00	7,30	8,50
L/C	23,00	9,80	7,00	8,50
C	22,20	8,80	6,30	8,00
C	23,00	9,00	5,70	7,30
C	23,50	10,00	7,20	9,00
C	24,00	10,00	7,50	8,20
Y	21,60	9,00	6,20	8,00
IY	19,60	7,50	5,00	6,70
IY	21,00	8,90	6,20	-

Phalanx 3 ant./post.

	DLS	Ld
IM/eL	25,20	21,00
IM/eL	25,50	20,80
IM/eL	29,00	25,20
L	25,60	21,00
L	27,20	23,50
L	27,60	23,20
L	28,50	24,00
L	29,00	-
L	29,30	25,50
L	29,80	25,60
L	29,80	25,50
L	29,80	25,30

Phalanx 3 ant./post.

	DLS	Ld
L	30,00	25,00
L	30,00	25,00
L	30,20	25,50
L	30,20	25,00
L	30,30	24,60
L	30,50	26,00
L	31,00	26,00
L	31,00	26,50
L	31,00	27,50
L	32,00	27,00
IY	28,00	23,00

Table 8. *Sus*. Skeletal distribution.

	IM/eL	L/IL	L/C	C	Y/IY
Cranium	18	47	29	61	28
Mandibula	20	28	28	27	22
Atlas	1	2	3	6	2
Epistroph.	2	1	-	3	4
other Vertebrae	28	25	8	27	11
Costae	22	21	4	20	9
Scapula	10	14	15	26	10
Humerus	14	25	5	24	8
Radius+Ulna	20	19	12	14	13
Carpalia	8	5	1	2	5
Metacarpus	10	15	5	14	5
Pelvis	11	14	8	15	13
Femur	7	12	3	6	3
Patella	-	1	-	1	-
Tibia	11	5	3	12	3
Fibula	4	4	-	4	-
Talus	8	1	1	10	3
Calcaneus	10	11	3	10	1
other Tarsalia	6	1	1	4	2
Metatarsus	21	13	12	15	5
Metapodia	13	13	8	6	6
Phalanges	42	34	11	25	18
Sesamoid	-	1	-	-	-
Total	286	312	160	332	171

Table 9. *Sus*. Age distribution based on tooth eruption.

Maxilla	IM/eL	L/IL	L/C	C	Y/IY	Age n=27
Pd4 +	1	1				3 - 6 mo.
M1 +/-			1			ca. 6 mo.
M2 -			1			6 - 9 mo.
M1 +		1		1	1	9 - 12 mo.
M2 +/-					1	9 - 12 mo.
M2 +/0					1	1 - 1fl yr.
M3 -			1	1		1 - 1fl yr.
M2 +	1	3	1		2	1fl - 2 yr.
M3 +/-		1		2	1	1fl - 2 yr.
P +/-				1	2	1fl - 2 yr.
P 0			1			1fl - 2 yr.
P +				1		ca. 2 yr.

Mandibula	IM/eL	L/IL	L/C	C	Y/IY	Age n=34
Pd4 +/-					1	neonat - 3 mo.
Pd4 +		1		1		3 - 6 mo.
M1 -				2		3 - 6 mo.
M2 -		1				6 - 9 mo.
M1 +	1		3	1	2	9 - 12 mo.
M2 +/-					1	9 - 12 mo.
M2 +/0		1		1		1 - 1fl yr.
M3 -	2	1	1			1 - 1fl yr.
M1 ++	1					1fl- 2 yr.
M2 +			1	1	1	1fl - 2 yr.
M3 +/-		4	2	1		1fl - 2 yr.
M3 +					1	2 - 3 yr.
M3 ++	1					> 3 yr.
P ++					1	> 3 yr.

Table 10. *Sus*. Age distribution based on epiphyseal fusion.

IM/eL		< 1 yr.	< 1¼ yr.	< 2 yr.	< 3 yr.	< 3½ yr.	> 1 yr.	> 1¼ yr.	> 2 yr.	> 3½ yr.
Scapula	n=5	2					3			
Humerus	n=4		1		.			3		
Radius	n=5	1				1	2			1
Ulna	n=4				4					
Metacarpus	n=5			1					3	
Femur	n=3				1	1				1
Tibia	n=7			2		2			3	
Metatarsus	n=8			7					1	
Metepodium	n=8			7					1	
Phalanx 1	n=4			2					2	
Phalanx 2	n=8						8			
Total	n=60	3	1	19	5	4	13	3	10	2

L/IL		< 1 yr.	< 1¼ yr.	< 2 yr.	< 3 yr.	< 3½ yr.	> 1 yr.	> 1¼ yr.	> 2 yr.	> 3 yr.
Scapula	n=4						4			
Humerus	n=16		6					10		
Radius	n=4	1				2	1			
Ulna	n=3				2					1
Metacarpus	n=4			3					1	
Femur	n=7				1	5				1
Tibia	n=3			1					2	
Metatarsus	n=2			2						
Metapodium	n=10			9					1	
Phalanx 1	n=6			4					2	
Phalanx 2	n=3						3			
Total	n=62	1	6	19	3	7	8	10	6	2

Y/IY		< 1 yr.	< 1¼ yr.	< 2 yr.	< 3½ yr	> 1 yr.	> 2 yr.	> 3 yr.
Scapula	n=5	4				1		
Humerus	n=1		1					
Radius	n=1				1			
Ulna	n=1							1
Metacarpus	n=3			1			2	
Femur	n=2				2			
Tibia	n=3			2			1	
Metatarsus	n=4			3			1	
Metapodium	n=5			2			3	
Phalanx 1	n=5			2			3	
Phalanx 2	n=2					2		
Total	n=32	4	1	10	3	3	10	1

C		< 1 yr.	< 1¼ yr.	< 2 yr.	< 3½ yr	> 1 yr.	> 1¼ yr	> 2 yr.	> 3 yr.
Scapula	n=12	5				7			
Humerus	n=15		6				9		
Radius	n=4				1	3			
Ulna	n=1								1
Metacarpus	n=8			7				1	
Femur	n=3				3				
Tibia	n=4			1				3	
Metatarsus	n=4			3				1	
Metapodium	n=3			2				1	
Phalanx 1	n=6			2				4	
Phalanx 2	n=5		1			4			
Total	n=65	5	7	15	4	14	9	10	1

L/C		< 1 yr.	< 1¼ yr.	< 2 yr.	< 3 yr.	< 3½ yr.	> 1 yr.	> 1¼ yr.	> 2 yr.
Scapula	n=3	1					2		
Humerus	n=2		1					1	
Radius	n=6					2	4		
Ulna	n=1				1				
Metacarpus	n=3			3					
Femur	n=3					3			
Tibia	n=2					1			1
Metatarsus	n=4			3					1
Metapodium	n=1			1					
Phalanx 1	n=1								1
Phalanx 2	n=2						2		
Total	n=28	1	1	7	1	6	8	1	3

Table 11. *Sus*. Bone measurements.

(d = domesticated; w = wild; m = male; f = female; juv = juvenile)

Maxillary teeth

	LM2	BM2	LM3	BM3
IL	24,0	17,5		
C	26,0	20,0		
C	24,0	18,0		
C			32,0	20,0

Mandibular teeth

		LM3 - M1	LM3	BM3
IM/eL	w	74,5	38,5	16,7
L	w	-	38,5	17,0
L/C	w	-	38,0	17,0
L/C	w	-	39,5	-

Epistropheus

	BFcr
IL	45,0
Y	46,0
Y	50,0

Scapula

		SLC	GLP	LG	BG
IM/eL		26,5	-	-	-
IM/eL	juv	22,0	32,5	30,0	22,5
IM/eL		26,8	42,0	-	27,0
L		25,0	-	-	-
L		25,0	36,0	31,0	24,0
L		-	38,5	33,5	24,5
L		26,0	-	-	-
L/C	juv	23,0	37,0	30,2	26,0
L/C		25,0	-	-	-
C		26,5	39,0	34,5	-
C		24,5	37,0	33,0	25,0
C		24,5	-	-	-
C		-	35,5	31,0	24,8
C		-	42,0	34,0	29,5
C		-	39,0	33,5	24,0
Y	w	32,0	-	34,0	31,0

Humerus

		BT	Bd
IM/eL		36,5	
IM/eL			43,0
L		38,5	
L			42,0
L		34,5	44,0
L	w	-	46,0
L	juv	-	42,0
L	w	-	49,0
IL	w	-	43,0
IL	w	-	44,0
L/C	w	36,0	42,5
C		37,0	44,0
C	juv	32,5	42,0
C	juv	33,0	40,0
C		35,0	43,5

Ulna

	DPA	SDO	BPC
IM/eL	44,0	34,0	-
IM/eL	41,0	32,0	-
L	43,0	32,0	24,5
C	34,0	-	22,0
Y	38,5	-	24,0

Radius

		Bp	Bd
IM/eL	w	34,5	-
IM/eL	w	33,0	-
L	w	34,0	-
L		-	35,0
L/C	juv	30,0	-
L/C	juv	31,5	-
L/C	juv	27,0	-
L/C	juv	31,3	-
C	w	32,0	-
C	juv	29,0	-
Y		-	36,5

Pelvis

	LAR	LA
IM/eL	-	38,0
C	33,0	36,0

Calcaneus

	GL	GB
IM/eL	85,0	27,0
C	92,0	26,0

Tibia

		Bd
IM/eL	w	33,7
IM/eL	w,f	31,5
L	w,f	30,0
C	w	34,2
C	w,f	30,0
C	w,f	31,0

Metapodia

	GL	Bd	Mc / Mt
Y	94,5	24,0	Mc III
C	75,0	16,0	Mc IV
IM/eL	62,0	10,0	Mt II

Table 11: cont. 1. *Sus*. Bone measurements.

Phalanx 2

		GL	Bp	SD	Bd
C	w	25,0	18,0	15,0	16,5
IM/eL	w	27,0	18,0	14,8	15,2
IM/eL	w	25,7	17,5	14,5	15,0
IM/eL	w	27,0	19,8	15,8	18,0
IM/eL	w	26,5	19,0	15,3	17,0
IM/eL	w	26,0	20,0	15,5	17,0
IM/eL	w	26,5	17,6	14,8	15,3
L	w	27,0	20,0	16,2	18,0
L	juv	23,0	17,0	14,0	15,0
L	juv	22,0	17,0	14,0	15,2
L/C	juv	22,0	16,3	13,5	15,0
L/C	w	25,0	16,5	14,0	15,0
C	juv	23,5	19,0	16,0	18,0
C	w	33,5	18,0	13,5	15,2
Y	juv	23,0	15,5	12,2	-

Phalanx 1

		GLpe	Bp	SD	Bd	ant / post
IM/eL		37,0	-	-	-	?
IM/eL		38,5	20,0	15,3	18,0	a
L		38,5	18,7	13,2	16,2	?
L		38,8	21,8	16,5	28,0	a
L/C		36,0	19,0	14,0	16,0	a
C		34,5	18,5	12,0	15,0	a
C	w	44,0	23,0	19,0	20,0	p
Y		37,0	16,2	12,2	15,0	p

Talus

		GLl	GLm
IM/eL	w	45,0	40,0
IM/eL	w	-	39,5
IM/eL	w	47,0	42,0
IM/eL	w	44,0	40,0
IM/eL	juv	40,0	-
L	w	49,0	43,0
C	w	46,0	-
C	w	47,5	43,0
C	w	48,0	42,0
C	w	44,0	-
C	w	45,0	40,0
C	w	45,0	40,0
C	w	45,0	-
C	w	48,0	42,5
C	w	51,0	45,0
C	w	-	39,2
Y	w	45,0	-
Y	juv	43,0	-

Height in withers
(according to Teichert 1975, corrected factors)

Talus (factor 17,9; corr. fig. 23)

	GLl			
IM/eL	45,0	828,5	83 cm	
IM/eL	47,0	864,3	86 cm	
IM/eL	44,0	810,6	81 cm	
IM/eL	40,0	716,0	72 cm	juv
L	49,0	900,1	90 cm	
C	46,0	846,4	85 cm	
C	47,5	873,3	87 cm	
C	48,0	882,2	88 cm	
C	44,0	810,6	81 cm	
C	45,0	828,5	83 cm	
C	45,0	828,5	83 cm	
C	45,0	828,5	83 cm	
C	48,0	882,2	88 cm	
C	51,0	935,9	94 cm	
Y	45,0	828,5	83 cm	
Y	43,0	792,7	79 cm	juv

Metacarpus III (factor 10,72; corr. fig. 28,7)

	GL		
Y	94,5	984,3	98 cm

Metacarpus IV (factor 10,53; corr. fig. 29,4)

	GL		
C	75,0	760,3	76 cm

Table 12: *Bos.* Skeletal distribution.

	IM/eL	L/IL	L/C	C	Y/IY
Proc. corn.	2	-	-	1	2
Cranium	9	12	6	19	20
Mandibula	7	15	11	24	25
Hyoid	-	-	-	1	-
Atlas	-	-	-	2	1
Epistropheus	-	-	-	1	1
other Vertebrae	7	18	14	9	18
Costae	13	20	8	14	24
Scapula	5	5	7	8	11
Humerus	5	7	6	7	12
Radius+Ulna	4	14	10	14	27
Carpalia	2	1	1	2	1
Metacarpus	5	12	13	29	15
Pelvis	1	7	2	6	7
Femur	6	7	9	3	7
Tibia/Os malleolare	12	14	6	9	23
Talus	1	2	-	3	3
Calcaneus	1	1	1	-	2
other Tarsalia	1	-	1	3	2
Metatarsus	4	6	9	16	18
Phalanges	15	22	17	16	32
Sesamoid	4	-	1	1	-
Total	104	163	122	188	251

Table 13. *Bos.* Age distribution based on tooth eruption.

Maxilla	IM/eL	L/IL	L/C	C	Y/IY	Age n=9
M1 +					1	ca. 1½ yr.
M3 +	2			1	1	2½ - 3 yr.
M1 +++				1		3 - 5 yr.
M2 ++				1		3 - 5 yr.
P ++				1		> 5 yr.
P +++	1					>> 5 yr.

Mandibula	IM/eL	L/IL	L/C	C	Y/IY	Age n=17
Pd4 ++					2	6 - 18 mo.
M1 +		1				ca. 1½ yr.
M2 +/0			1			ca. 1½ yr.
Pd4 +++					1	1½ - 2¼ yr.
M2 +		1				1½ - 2¼ yr.
M1 ++		1	1		1	2¼ - 2½ yr.
M3 +/0	1					2¼ - 2½ yr.
M3 +		2	1	1	2	2½ - 3 yr.
M3++				1		> 5 yr.
M3 ++/+++	1					> 5 yr.

Table 14. *Bos.* Age distribution based on epiphyseal fusion.

IM/eL		< 1½ yr.	< 2½ yr.	< 3½ yr.	> 2 yr.	> 4 yr.
Femur	n=1			1		
Tibia	n=2		1			1
Phalanx 1	n=4				4	
Phalanx 2	n=2	2				
Total	n=9	2	1	1	4	1

L/IL		< 2 yr.	< 3½ yr.	< 4 yr.	> 1¼ yr.	> 1½ yr.	> 2 yr.	> 2½ yr.	> 3½ yr.	> 4 yr.
Humerus	n=1					1				
Radius	n=5			3	1					1
Metacarpus	n=2							2		
Femur	n=4		3						1	
Tibia	n=2							2		
Metatarsus	n=1							1		
Phalanx 1	n=4	2					2			
Phalanx 2	n=7					7				
Total	n=26	2	3	3	1	8	2	5	1	1

L/C		< 2½ yr.	< 4 yr.	> 1¼ yr.	> 1½ yr.	> 2 yr.	> 2½ yr.	> 3½ yr.	> 4 yr.
Humerus	n=3				3				
Radius	n=3		1	1					1
Metacarpus	n=3						3		
Femur	n=3		1					2	
Tibia	n=3	1					2		
Metatarsus	n=2						2		
Phalanx 1	n=3					3			
Phalanx 2	n=4				4				
Total	n=24	1	2	1	7	3	7	2	1

C		< 1½ yr.	< 2½ yr.	< 4 yr.	> 1¼ yr.	> 1½ yr.	> 2 yr.	> 2½ yr.
Humerus	n=2					2		
Radius	n=1				1			
Ulna	n=1			1				
Metacarpus	n=5		2					3
Femur	n=1			1				
Metatarsus	n=3							3
Phalanx 1	n=3						3	
Phalanx 2	n=6	1				5		
Total	n=22	1	2	2	1	7	3	6

Y/IY		< 2 yr.	< 2½ yr.	< 4 yr.	> 1¼ yr.	> 1½ yr.	> 2 yr.	> 2½ yr.	> 4 yr.
Humerus	n=1								1
Radius	n=4			2	2				
Ulna	n=1								1
Metacarpus	n=3		2					1	
Metatarsus	n=1							1	
Phalanx 1	n=12	3					9		
Phalanx 2	n=6					6			
Total	n=28	3	2	2	2	6	9	2	2

Table 15. *Bos.* Bone measurements.

(d = domesticated; w = wild)

Horncore

	Circ.Basis	GD base	LD base
Y	174,0	57,0	49,0

Humerus

		BT
L/C	d	77,0
C	w	105,0

Radius

	Bd
IL	86,5

Ulna

	DPA
Y	74,0

Metacarpus

		Bp	Dp	Bd	Dd
L	w	69,0	-	-	-
L/C	w	68,0	40,5	-	-
L/C	w	-	-	80,0	-
L/C	w	-	-	69,0	-
C	w	-	-	82,0	-
C	w	-	-	72,0	-
C	d	65,0	38,5	-	-
C	d	65,5	38,0	-	-
C	d	-	-	55,0	33,0
Y	d	-	-	-	31,5
IY	w	-	-	73,0	-

Talus

		GLl	GLm	Dl	Bd
IM/eL	w	76,0	70,0	42,0	48,0
C	w	80,0	72,0	42,5	50,0
C	w	76,0	70,5	42,0	47,0
Y	d	74,0	68,0	41,0	-

Metatarsus

		Bp	Bd	Dd
IL	w	-	72,0	-
L/C	w	-	71,0	-
L/C	d	-	62,0	-
C	w	64,0	-	-
C	w	-	68,0	38,5
Y	d	-	66,0	38,0

Mandibula

		LM3 - M1	LM3	BM3
IM/eL	w	-	42,5	17,5
L	w	-	42,0	15,0
IL	d	100,0	41,0	14,0
L/C	d	-	40,0	15,0
L/C	d	-	38,0	13,5
Y	d	-	40,0	15,0
Y	d	-	39,0	15,5

C2+3

	GB	GD
L	43,5	29,5

Centrotarsale

		GB
IM/eL	d?	61,0
C	d?	61,0
Y	d	54,0

Tibia

		Bd
L/C	d	69,0

Table 15: cont. 1. *Bos.* Bone measurements.

		GLpe	Bp	SD	Bd	ant / post
IM/eL	w	-	37,0	-	-	?
IM/eL	w	-	-	-	33,5	?
IM/eL	d	62,0	32,0	-	-	p
IM/eL	d	-	-	-	26,5	?
IL	w	65,0	-	-	-	?
IL	w	-	36,0	-	-	p
L/C		63,0	-	-	-	p
L/C	d	-	-	-	30,0	?
C	w	65,0	-	-	-	a
C	d	-	31,0	-	-	?
C	d	-	28,2	-	-	p
Y	w	64,0	38,0	33,0	36,0	a
Y	w	-	36,7	-	-	?
Y	w	-	35,6	-	-	a
Y	w	-	-	-	36,5	?
Y	d	-	31,2	-	-	a
Y	d	-	31,2	-	-	?
Y	d	-	28,0	-	-	?
IY	w	68,0	40,0	33,5	37,0	a
IY	w	-	35,0	-	-	?

Phalanx 2

		GL	Bp	SD	Bd	ant / post
L	w	46,0	-	-	-	?
L	w	46,0	37,5	31,0	32,0	a
L	d	38,0	-	-	23,0	p
IL	w	46,5	38,5	32,8	36,0	a
IL		42,3	31,6	25,4	25,0	p
IL	d	41,0	30,0	25,0	26,0	p
IL	d	40,0	-	-	-	a
L/C	w	-	-	-	33,0	a
L/C		44,0	-	-	34,5	a
L/C		44,5	35,0	30,8	31,0	a
L/C	d	39,0	29,5	22,2	23,5	a
C	w	48,0	33,0	28,5	30,0	?
C	w	45,0	33,5	28,0	28,5	a
C	w	-	-	-	29,2	?
C		43,0	-	27,0	-	a
C	d	-	29,7	-	-	?
Y	w	50,5	40,0	33,0	33,5	p
Y	w	48,0	39,0	32,5	35,5	a
Y	w	45,0	34,0	28,5	30,0	a
Y	d	39,0	32,0	27,2	-	a
Y	d	38,8	26,5	22,5	24,0	p
IY	w	49,6	37,5	30,0	34,5	?

Phalanx 3

		DLS	Ld	MBS	ant / post
L	w	95,0	69,0	35,0	a
L	d	71,5	59,0	-	p
L/C	w	78,0	63,0	31,0	a
L/C	d	58,0	45,0	-	?
C	d	59,0	49,0	-	p
C	d	58,5	46,2	20,0	a
Y	w	92,0	68,0	36,5	p
Y	w	85,5	65,0	32,0	?
Y	d	62,0	48,5	21,0	?

Table 16. *Equus*. Skeletal distribution.

	IM/eL	L/IL	L/C	C	Y/IY
Cranium	2	5	4	8	10
Mandibula	3	11	2	9	23
Atlas	1	-	-	2	3
Epistropheus	1	-	1	2	3
other Vertebrae	7	13	6	15	28
Costae	1	2	2	4	35
Scapula	2	3	1	3	8
Humerus	1	7	6	6	15
Radius+Ulna	12	9	3	10	30
Carpalia	1	1	-	1	2
Metacarpus	2	13	2	7	10
Pelvis	4	1	2	4	10
Femur	6	16	2	5	18
Patella		1	1	-	-
Tibia	6	14	4	5	29
Talus	1	3	1	4	-
Calcaneus	-	1	1	3	1
other Tarsalia	-	1	-	-	-
Metatarsus	-	5	1	1	7
Metapodia	-	4		2	4
Phalanges	4	9	3	7	17
Sesamoid	1	-	-	-	-
Total	55	119	42	98	251

Table 17. *Equus*. Bone measurements.

(E.a. = Equus africanus; E.h. = Equus hemionus)

Neurocranium

	B cond.occ	H for.mag.	B for.mag.
Y	69,0	35,0	29,0
Y	69,0	31,0	-

Mandibula

	LM3	BM3
IM/eL	25,0	11,0

Epistropheus

	BFcr
IY	72,0

Humerus

		BT	HTm
L	*E.a.*	59,5	-
C	*E.a.?*	61,5	38,5
C	*E.a.?*	61,0	40,0
Y	*E.h.*	63,0	38,5
Y	*E.a.?*	60,5	40,0
Y	*E.a.*	60,0	41,5
IY	*E.h.*	63,8	41,0
IY		-	38,5

Viscerocranium

	LM3	BM3
L/C	23,0	19,8
Y	25,0	20,0

Atlas

	BFcr	BFcd	GLF	GB	
C	80,0	-	80,0	-	
Y		-	-	76,0	-
IY		76,0	73,5	76,5	120,0

Scapula

		SLC	GLP	LG	BG
IL	*E.h.*	55,0	74,0	48,0	41,5
IL	*E.a.*	49,0	69,5	41,0	37,0
Y	*E.h.*	54,0	-	-	-
Y	*E.h.*	54,0	74,0	45,0	42,0

Ulna

	BPC	DPA	SDO
L	34,0	55,0	45,0
IL	-	54,5	39,5

Table 17: cont. 1. *Equus*. Bone measurements.

Radius

		Bp	BFp	Bd	BFd	Td
IM/eL	*E.h.*	-	-	63,0	53,0	38,0
IM/eL	*E.a.*	-	-	58,5	50,5	-
L	*E.a.*	64,4	60,0	-	-	-
C	*E.a.*	-	-	60,2	51,5	36,0

Metacarpus III

		Bp	Dp	SD	Bd	Dd
IM/eL	*E.a.*	-	-	-	38,0	28,5
L	*E.h.*	-	-	-	42,0	31,2
L		-	-	-	39,0	29,0
L	*E.h.*	-	-	-	37,5	27,0
IL	*E.a.*	-	-	29,5	39,2	29,8
IL	*E.a.*	-	-	-	39,0	30,0
C	*E.h.*	42,0	27,5	-	-	-
C	*E.a.*	-	-	-	36,5	30,0
Y	*E.h.*	44,0	31,7	-	-	-
Y		-	-	-	38,0	-
IY	*E.h.*	-	-	-	40,0	30,0

Os carpale 3

	GD
C	36,5
Y	37,3

Pelvis

	LA	LAR
C	56,0	52,0
C	55,0	51,5
Y	58,0	54,0

Femur

		Bd
L	*E.a.*	72,0

Tibia

		Bd	Dd
IM/eL	*E.h.*	61,0	43,0
C	*E.a.*	56,0	40,0
C	*E.a.*	55,0	39,0
Y[1]	*E.h.*	72,0	47,5

[1] not in Fig. 15

Talus

	GH	GB	LmT	BFd
L	50,0	49,5	40,0	49,3
L	46,0	50,0	40,5	47,0
IL	48,5	49,0	38,0	40,0
L/C	49,0	50,5	-	48,0
C	53,0 -	-		50,5
C	50,0	-	-	-
C	- -		50,0 -	

Calcaneus

		GL	GB
IL	*E.a.*	86,0	41,0
C	*E.a.*	90,0	39,0

Metatarsus III

	Bp	Dp	Bd	Dd
L	41,0	36,0	-	-
L	-	-	38,5	30,0
IY	-	-	-	24,0

Phalanx 1

		GL	Bp	Dp	SD	Bd	ant./post
L	*E.a.*	68,0	39,5	29,2	22,0	31,5	p
C		-	40,5	29,0	-	-	p
Y	*E.a.*	75,7	41,0	30,0	26,0	36,5	a
Y	*E.a.*	73,0	40,0	29,2	22,5	32,0	p
IY	*E.h.?*	83,0	42,5	33,0	27,2	39,0	a
IY	*E.a.*	76,0	-	30,2	26,3	36,6	a
IY	*E.a.*	74,5	42,5	-	24,2	36,0	a
IY	*E.h.?*	74,0	40,5	30,0	25,5	37,0	p
IY	*E.a.*	67,0	-	27,8	24,0	32,5	p

Phalanx 2

		GL	Bp	Dp	SD	Bd	ant./post
IM/eL		36,5	36,0	24,8	32,0	33,0	?
L	*E.a.*	41,6	43,0	28,0	38,5	40,5	a
IL		38,5	39,0	26,5	35,0	37,0	?
C		37,0	35,0	25,0	30,5	31,5	p
C		37,0	-	26,0	-	38,0	p
Y	*E.a.*	42,2	24,0	30,0	38,0	40,0	a
Y		41,0	42,0	28,5	37,0	38,0	p
Y		39,0	38,0	25,3	34,0	37,5	p
IY	*E.h.*	43,0	42,2	35,0	37,0	-	a

Table 18. Dog. Measurements of mandible. All specimens are without teeth, and all come from Yarmoukian layers.

Length of tooth row	72,5	78,0	76,0	72,0
Length of molar row	35,2	-	36,5	37,0
Length of premolar row	38,5	-	41,0	39,5
Length of M1-Alveolus	21,0	23,0	22,0	22,0
Reconstruction of the Basal length according to DAHR (1937)	166,3	182,2	176,4	164,8

Table 19. *Vulpes vulpes.* Skeletal distribution.

	IM/eL	L/IL	L/C	C	Y/IY
Cranium	-	3	1	1	1
Mandibula	3	9	-	-	8
Vertebrae	3	11	1	-	-
Costae	-	2	2	1	3
Scapula	1	1	-	-	-
Humerus	3	1	-	-	1
Radius/Ulna	4	-	1	1	2
Metacarpus	1	2	-	-	1
Pelvis	1	5	1	1	1
Femur	1	1	-	-	2
Tibia	1	1	2	-	2
Tarsus	-	3	-	2	1
Metatarsus	1	4	-	1	2
Phalanges	1	3	-	1	-
Total	20	46	8	8	24

Table 20. *Vulpes vulpes.* Bone measurements.

Viscerocranium

	LMR
IL	12,5

Mandibula

	LCR	LMR	LPR	LM1	BM1
L	51,2	23,5	28,0	13,5	5,0
L	-	26,0	-	14,8	5,3
L	-	25,0	-	14,2	-
L	-	23,5	-	14,0	-
Y	55,7	24,0	32,0	14,0	5,0

Scapula

	SLC	GLP	LG	BG
IM/eL	14,7	16,0	14,0	9,6
IL	-	17,0	15,0	-

Radius

	Bp	SD
IM/eL	10,0	7,5
IM/eL	10,0	7,2
IM/eL	10,0	-

Humerus

	Bp	Dp	SD	Bd	GLC
IM/eL	16,3	19,0	-	-	-
IM/eL	-	-	-	16,5	-
L	-	21,5	7,0	17,0	102,0

Metacarpus III

	GL	Bd
L	40,3	5,0

Pelvis

	LA	LAR
L	-	12,0
C	13,0	12,5

Femur

	Bp
Y	23,0

Tibia

	Bp	Bd
IL	-	14,3
L/C	19,0	-
Y	-	13,5

Calcaneus

	GL	GB
L	26,8	10,5
L	28,0	11,0
Y	27,5	11,2

Table 21. Small and medium sized mammals. Bone measurements.

(C.a. = Canis aureus; E.c. = Erinaceus concolor; F.s. = Felis silvestris; H.a. = Hemiechinus auritus; L.c. = Lepus capensis; M.m. = Meles meles)

Mandibula

		LCR	LPR	LM1	BM1
Y	*C.a.*	-	34,0	-	-
Y	*E.c.*	24,0	-	-	-
IM/eL	*F.s.*	22,2	-	9,8	-
L	*F.s.*	21,6	-	7,8	4,0
L	*F.s.*	20,0	-	8,3	4,3
L/C	*F.s.*	22,5	-	9,0	-
Y	*H.a.*	16,8	-	-	-
L	*M.m.*	-	-	14,7	-
Y	*M.m.*	37,6	-	15,8	-

Humerus

		Bd
IM/eL	*L.c.*	10,0
IM/eL	*L.c.*	10,2
IL	*L.c.*	9,2
Y	*L.c.*	10,0
L/C	*E.c.*	10,0

Radius

		Bp
C	*F.s.*	7,9

Pelvis

		LAR
Y	*F.s.*	11,8

Femur

		Bd
L	*L.c.*	17,0
IL	*L.c.*	14,5

Tibia

		Bp	Bd
C	*F.s.*	20,5	-
L	*L.c.*	-	12,7

Calcaneus

		GL	GB
Y	*L.c.*	27,0	9,0

Metatarsus IV

		GL	Bd
IM/eL	*F.s.*	58,0	6,0
IM/eL	*L.c.*	47,2	5,0

Table 22. Bird Bones. Measurements

(A.c. = Ardea cinera; A.g. = Alectoris graeca; A.h. = Aquila heliaca; B.r. = Buteo rufinus; C.c. = Corvus corone; O.t. = Otis tarda; S.a. = Strix aluco)

Coracoid

		DL	Lm	BFb
IM/eL	*A.g.*	-	-	8,0
L	*M.m.*	42,0	39,0	-

Radius

		Bp	Bd
IM/eL	*B.r.*	7,2	10,0
IM/eL	*A.c.*	-	9,7

Carpometacarpus

		Bp
IM/eL	*B.r.*	17,2

Femur

		Bp
IM/eL	*M.m.*	12,5

Tibiotarsus

		Bd	Dd
IM/eL	*A.h.*	19,2	14,5
IM/eL	*A.h.*	17,5	-
C	*S.a.*	10,0	-
L	*O.t.*	18,0	18,3

Tarsometatarsus

		Bd
IM/eL	*C.c.*	7,0

H.G.K. GEBEL, Z. KAFAFI, and G.O. ROLLEFSON (eds.), *The Prehistory of Jordan, II. Perspectives from 1997.* Studies in Early Near Eastern Production, Subsistence, and Environment 4 (1997). Berlin, *ex oriente.*

Proto-Élevage, Pathologies, and Pastoralism: a Post-Mortem of the Process of Goat Domestication

Ilse Köhler-Rollefson

Introduction

Our knowledge about the origin and spread of caprovine domestication has expanded and firmed up significantly in recent years, thanks to the retrieval and analysis of substantial archaeofaunal samples from several key sites in the Near East. At least one interesting new theory about the scenario precipitating the origin of animal domestication at this particular juncture in human evolution has been proposed (UERPMANN 1996). In addition, the various parameters regarded as diagnostic for a state of domestication have been discussed *in extenso* (*e.g.,* HORWITZ 1989).

It is therefore ironic that the precise meaning and content of the term "domestication" continues to prove elusive and successfully resists a definition acceptable to all. This status quo is reflected in the different interpretations of the goat remains from PPNB sites in the southern Levant. The community seems to be polarized between one camp that accepts the goat as domesticated without any caveats during this time period and another that pronounces the then prevailing stage of human-goat relationships as representing a preceding phase of "*proto-élevage*" (DUCOS 1994), "cultural control" (HECKER 1975) or "incipient domestication" (HORWITZ 1989). This developmental stage is defined as a situation in which humans already controlled animals, but did not yet manipulate them genetically.

Proto-Élevage or Domestication ?

In earlier reports on the fauna of 'Ain Ghazal, its PPNB goat population was described as domesticated (KÖHLER-ROLLEFSON 1992, KÖHLER-ROLLEFSON *et al.* 1989, ROLLEFSON *et al.* 1985). This assessment was founded on the analysis of the material from the 1982 season, which stemmed from the earliest known phase of occupation of the site, the MPPNB (8300-7500 BC). It was based on three standard diagnostics: numerical predominance, high proportion of juveniles and a notable frequency of pathologies. The fairly large size of the goats, as well as the absence of changes in horncore morphology during this period, were also noted. On the basis of the faunal information, together with associated contextual data and ethnographic evidence, a model was also proposed for the development of incipient nomadic pastoralism on the Transjordanian plateau by the PPNC period. This interpretation has been criticized by DUCOS (1994), who holds that the PPNB goat remains from 'Ain Ghazal only reflected "*proto-élevage,*" and that pastoralism in Jordan was not an indigenous development, but introduced by immigrant sheep herders from the north.

New research by A. Wasse has clarified some of the earlier uncertainties of 'Ain Ghazal's faunal record in regards to the presence of sheep (see WASSE, this volume). It has been confirmed that in the earliest phase of occupation goats were of overwhelming economic importance. It has also been revealed that they were gradually eclipsed by sheep and only represented 14.2% of the ovicaprid population when 'Ain Ghazal's permanent occupation came to an end in the Yarmoukian Pottery Neolithic period. His attempt to reconcile the two theories by arguing that the arrival of sheep with their particular behavioral characteristics facilitated the inception of migratory pastoralism is entirely plausible.

What is at issue here is the claim for goat domestication in the PPNB in general and at 'Ain Ghazal in particular, as well as the implications of the term "*proto-élevage*" in its various manifestations. Proto-élevage and its synonyms have been coined to deal with a perceived need to subdivide the process of domestication into stages. The point I want to emphasize here is that evidence for genetic

Plate 1:a. Example of a large contemporary circular stone structure erected to protect goat kids from cool night temperatures.

Plate 1:b. Example of a small contemporary circular stone structure erected to protect goat kids from cool night temperatures <*The scale is one meter long.*>.

Plate 1c. Example of pathological deformity: total fusion between the three MPPNB goat phalanges with heavy growth around articular surfaces <*depicted on left; normal goat phalanges on right*>.

Plate 1:d. Example of pathological deformity: ring-like bone growth around the lateral surfaces of two matching MPPNB goat first phalanges, almost certainly due to pressure on bone caused by tethering.

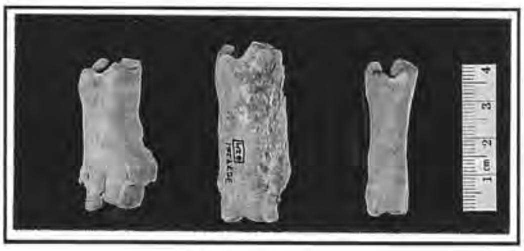

Plate 1:e. Example of pathological deformity: two deformed MPPNB goat first phalanges <*healthy phalange on right*>.

Plate 1:f. Example of pathological deformity: fusion between MPPNB goat second and third phalange with resulting immobility of the joint <*depicted on left, healthy phalanges shown on right*>.

manipulation, although it represents an essential component of domestication, should not be made its cardinal criterion. It is suggested that other parameters can be more pertinent indicators and serve the purpose of determining domestication much better from a practical viewpoint than morphological change.

The Process of Domestication

Archaeozoological theory has witnessed a succession of theories about the nature of domestication and its concomitant processes. Initially, the keeping of domesticated animals was thought to represent a fundamental contrast to hunting, providing food security and a relatively easy life. This assessment was challenged by studies of contemporary hunter-gatherer societies that revealed that they spend much less time on food procurement than pastoral and agrarian societies (LEE 1968).

In the late 1960s and early 1970s the theory was advanced that domestication developed out of herd following and was the end-product of gradually intensifying man-animal relationships (HIGGS and JARMAN 1969). A similar perspective was adopted by Hecker (1975), and this evaluation also seems to be shared by HORWITZ (1989) in her four stage model of (1) specialized hunting, (2) incipient domestication, (3) domestication and (4) husbandry.

The scenario of domestication as a gradual development from hunting has been rejected by Uerpmann, who remarked that "herd following of specialized hunters will only have made the animals shyer and will certainly not have turned them into domesticates - not to speak of the fact that it is physically impossible for human hunters to follow a herd of wild sheep or goats closely in their extremely broken natural habitats in Southwest Asia" (UERPMANN 1996: 231). He emphasized that the behavioral characteristics of these species preadapt them to companionship with humans, and he suggests that goat and sheep domestication occurred more or less automatically and without conscious human action, a result instead of a particular "constellation of environmental, biological and social factors".

The various theories about the process of domestication aside, there is no doubt that it must have entailed one essential step: the isolation of a part of the population from the rest by human manipulation. In the words of DAVIS (1987: 126) domestication implies "the separation of a breeding stock from its wild forebears". If we endeavor to conjure before our mental eyes the actual steps and procedures involved in this initial and crucial process of spatial separation, important insights into the process and practical implications of domestication can be gained. For this we turn to the ethnographic record.

Confinement

Isolation could have only been achieved through some means of confinement. Unless there is a rocky environment that provides natural opportunities for corralling, such as in the environs of the PPNB site of Beidha, animals can be confined either through penning or by way of tying them up around the neck or the feet ("tethering").

Most pastoralists, including the Bedouins of the area, practice both methods. During the night, sheep and goats are usually penned into stone corrals. Tying up goats using loops around the neck is a method that is practiced during milking and when it is necessary to temporarily restrict the young animals from roaming around. For penning, fairly high walls need to be built, especially for goats. In many parts of the world it is customary to strengthen them with brush and scrub (Pl. 1:a-b).

Goat kids are sensitive to cold temperatures and require careful protection during the winter. For this purpose, Bedouins often place young goats into round stone structures with a diameter barely exceeding their body length, which is covered with a sheet of metal. Even during summer nights, goat kids are often kept in the tent; it is the custom to curtain off about a third of the available space as a shelter for goat kids. In parts of India, too, goat kids are often taken into the already crowded houses at night time when temperatures are low. For many ethnic groups in Africa as well, it is routine that the women keep the very young stock in their huts (SCHINKEL 1970).

Bonding

From the above observations, it is obvious that traditional cultures live in very close quarters with their animals. In Bedouin encampments, it can be observed that while adult goats are out on pasture, goat kids roam around the tent and constitute a constant nuisance by stealing food, chasing chickens and jumping on top of the tent. They respond impressively to the human voice, coming when called but not always leaving when dismissed. The custom of separating the kids from their dams in the first days of their lives to keep them from suckling too much milk seems to have the built-in effect of imprinting them on their herders, especially the little girls who treat them very affectionately and handle them much as European children play with dolls.

The suckling by women of young animals is documented for many hunter-gatherer, horticultural and agricultural societies (SERPELL 1989, pers. observ.). Such a nursing relationship is assumed to have played a crucial role in the domestication process (UERPMANN 1996). But even without the actual nursing of goat kids by women, we can infer that confinement and the close cohabitation with humans would have led to a tame goat population kept in captivity within the span of only one generation.

Effects of Confinement on Herd Composition

Once animals became isolated, they needed to be provided with feed on a regular basis. There are various ways this could have happened. Maybe food was brought to the confined animals. Perhaps confinement of the goat kids was sufficient to ensure that their mothers returned every evening on their own. In any case, to manage a confined goat population would have required a considerable amount of work on a daily basis and certainly much higher labor inputs than hunting. We can therefore be certain that male goats were culled as soon as they reached a reasonable size. The isolated group would therefore have had an age-profile in which not more than 50% (the female part of the population) reached maturity. Confinement would thus have had an *immediate* effect on the archaeological bone sample, with 50% of the bones deriving from juvenile animals. Furthermore, the elimination of male goats before maturity would have also resulted in the elimination of fused bones from male goats in the deposited bone sample, entailing an immediate decrease in the size variability as well as a reduction of the average size (KÖHLER-ROLLEFSON 1989).

The validity of this argument is confirmed by the ethnographic record. Goat herds kept by Jordanian Bedouin contain not more than one mature male goat for 30-50 females of breeding age. In Sudanese goat herds an almost total absence of male goats above 15 months of age was observed. "Fertile females made up 49.8% of the flocks[1]. The early slaughter of male goat kids can be explained by the need to provide increasing grazing opportunities when grazing becomes scarce, and also by the fact that young animals provide the best goat meat." (DAHL and HJORT 1976: 89)

Inbreeding

The initial confined "founding stock" would have been very limited in number. Even if no mature male goats were kept, reproduction could have been maintained by the juvenile males, prior to their slaughter. There is need to distinguish between physical "maturity" in terms of bone development and "reproductive potential", since male goats are sexually potent from the age of *c.* 6 months. Such a situation would have fostered inbreeding. Together with parasitic infestations, which are likely to occur in confined animals, and with incipient milking (MEADOW 1989), this might be another causative factor for the size diminution associated with domestication.

Selective Breeding

Selective breeding for certain traits - considered the hallmark of domestication by some scholars - would have occurred much later, once the confined population was sufficiently large to leave some leeway for selection. Comparatively little is known about the breeding strategies of modern pastoralists and indigenous people, but it seems that the majority of them practice selection only via the male animal and not through their female stock (KÖHLER-ROLLEFSON 1993, SLAYBAUGH-MITCHELL 1995). Outside herd-book registered breeds, selective pressure is thought to be exerted mainly by environmental conditions. Animal breeding experts even have stated that "most livestock populations in developing countries have not been subjected to man-directed selection" (TIMON 1993). This evaluation does not do justice to the ethnographic record, since it is known that some pastoral cultures select for criteria regarded as "irrational" by outsiders, such as certain colors or markings, shape of the horns, length of the tail (SCHINKEL 1970). There is little doubt that "rational" criteria, including good health and freedom from disease, milk yields, and the ability to walk long distances are of greater significance (BAYER 1989).

One of the problems with using selective breeding for particular traits as a criterion for domestication is the fact that the length of the latency period is uncertain. It has been suggested that it requires 30 generations for morphological changes to occur (BÖKÖNYI 1976). It is therefore unclear when selective breeding for specific traits (hair-wool quality, milk quantity, body size, etc.) started to play an appreciable role in herding practices.

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[1] The remaining 50.2% of the population was composed of immature male and female kids.

Milking and the Role of Women

If Neolithic women nursed young goats, then it is also likely that they reversed the concept to use goats directly or indirectly as wetnurses for human babies, especially if many women died in childbirth[1].

From modern pastoralists it is known that they often allocate two teats to the young animal while milking the other two teats for their own purposes. When milking began remains obscure; solid evidence only starts with the appearance of pictorial records from Egypt and Mesopotamia. While systematic milk production may indeed have taken a considerable time to develop, it is likely that "incipient" or sporadic milking may have occurred at the beginning of "domestication".

For these various reasons, it seems highly likely that women were prime movers in establishing a close relation with goats and sheep. This situation certainly holds true today. In smallholder livestock systems all over Africa and Asia, the care of goats and sheep, as well as milking in general, is the women's domain, and they (the women) often also own these animals (JOWKAR and HOROWITZ 1991).

Animals as Property

There is a strong likelihood that in the metamorphosis from hunted game to livestock, goats and sheep passed from the male domain into the female domain, and this has tantalizing implications for PPNB and later gender relations and social structures. One of the crucial differences between hunting and herding is the fact that while hunted animals usually "belong" to no one in particular and represent "common property" at most, domesticated animals belong to individual people (INGOLD 1980). One could therefore justifiably infer that women were, in fact, the first livestock owners. Possibly representing one of the more significant types of property at this stage of human cultural evolution, goat ownership could have been involved in the processes of social stratification evidenced in other aspects of 'Ain Ghazal's material culture, symbolized, perhaps, in one of the types of clay objects regarded as precursors of currency (*cf.* SCHMANDT-BESSERAT 1992).

Reconsidering the Evidence for Goat Domestication from MPPNB 'Ain Ghazal[2]

Relative Frequency

As has been mentioned above, goats comprise more than 50% of the identifiable MPPNB animal bone fragments. This places 'Ain Ghazal among those southern Levantine sites where the shift from gazelle hunting as the prime source of animal protein to the exploitation of goats took place during the PPNB period, including Abu Gosh (DUCOS 1978), Beisamoun (DAVIS 1978), Jericho (CLUTTON-BROCK 1979), El Khiam (DUCOS 1968), Beidha (HECKER 1982) and Basta (BECKER 1991). By contrast, the faunal spectra of many contemporaneous sites such as Nahal Oren (NOY *et al.* 1973), Yiftahel (*cf.* HORWITZ 1989: 171), and sites in the Negev Desert (TCHERNOV 1976) and eastern Jordan (GARRARD *et al.* 1994: Table 7, BETTS 1988) continued to be dominated by gazelles, and the animal exploitation pattern resembled more closely that of the preceding PPNA and Natufian periods.

Horncore Morphology

For reasons that still elude us, goat populations that underwent domestication experienced changes in the shape of their horncores. While male *Capra aegagrus* generally have scimitar shaped horns with a quadrilateral cross-section, helically twisted horns are typical for domestic individuals. Concomitantly, the medial surface of the horncore changed from flat to concave: untwisted horns with an almond or lozenge shaped cross-section are considered indicative of incipient stages of domestication (ZEUNER 1955, REED 1960, HOLE *et al.* 1969). The few preserved larger fragments of horncores from 'Ain Ghazal from this period are straight with no indication of twisting, and there is only minimal evidence of medial flattening. (Unfortunately, many of the horncores were crushed post-depositionally).

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1 Such deaths seem to be reflected in both the MPPNB and PPNC periods (ROLLEFSON 1984: 11, ROLLEFSON and KAFAFI 1994: 30).

2 The information presented under this heading is based exclusively on the faunal material from the 1982/83 seasons that can be dated into the MPPNB period. It is an extract of a paper entitled "Goat husbandry in Jordan from a diachronic perspective" that was presented at a workshop on Ancient Mediterranean Foodsystems held at the ASOR meetings in 1983. It was to be included in the proceedings of this workshop, but unfortunately this planned volume was never published.

Age Composition

The harvest profile of the 'Ain Ghazal population was established from epiphyseal fusion following the method applied by Hole, Flannery and Neely (1969) and later by Wapnish, Hesse, and Oglilvy (1977), where groups of epiphyses that fuse at approximately the same age are lumped together as fusion stages. The following fusion stages can be distinguished:

- Fusion stage 1: scapula, acetabulum, proximal radius, distal humerus
- Fusion stage 2: phalanx I and II
- Fusion stage 3: distal tibia
- Fusion stage 4: distal metapodia
- Fusion stage 5: proximal humerus, proximal femur, distal femur, proximal tibia, distal radius, proximal ulna

The fused percentages of the elements comprising each fusion stage was plotted against the unfused proportion. The resulting culling pattern is shown in Fig. 1. For fusion stage 1, 92% of the bone elements were fused, as were 81% of the elements of fusion stage 2. The curve then drops steeply in fusion stage 3, at which 59.5% of the epiphyses are closed, and there is only a small decline to fusion stage 4 (57.5% fused). At the last stage (5) only 44% of the bones were fused. This indicates that 56% of the animals had been killed before they reached maturity. Unfortunately, the translation of fusion stages into absolute ages is problematic, since a great degree of variation due to genetic as well as exogenous factors (nutrition and climate) exists in the ages at which epiphyses fuse. Modern improved breeds develop much more quickly than primitive breeds or feral or wild populations. In the past archaeozoologists (*e.g.*, HOLE *et al.* 1969, HECKER 1982) have used the data provided by Silver (1969) and Schmid (1972) for domestic sheep populations, but these vary as much as three to four years (for the later fusing epiphyses) from the data provided by Noddle (1976) and Bullock and Rackham (1982) for feral goats.

For this reason, no correlation between fusion stages and absolute age is attempted here. It is sufficient to say that the survivorship curve for the PPNB goat population from 'Ain Ghazal displays great similarity to the one established for the sheep/goat population from the Ali Kosh phase (*c.* 8,750-8,000 bp) in the Deh Luran plain (HOLE *et al.* 1969). The goat survivorship curve is also dramatically different from the one for the 'Ain Ghazal gazelles (Fig. 1). However, gazelles apparently fuse relatively earlier in their lifespan (DAVIS 1980), so direct comparisons are not warranted.

Size Change and Decrease in Size Variability

In an earlier paper (KÖHLER-ROLLEFSON 1989) it was stated that the goat population of 'Ain Ghazal did not experience any change in regards to minimum size between the PPNB and the Pottery Neolithic. While the data this was based on have shown to be flawed since the measured sample contained a high proportion of sheep bones (WASSE, this volume), the argument itself has not been dispelled. This implies, importantly, that archaeological bone samples show changes that do not necessarily reflect populational differences as genetic distinctions, but that they may instead reveal the results of decreased bone dimensions as a consequence of the removal of mature male contributions to the bone samples. Expressed in a different way, population size decrease does not necessarily reflect a decline in the average size of animals in comparison to the "standard" wild animal, but can be explained by the fact that size measurements do not include the contribution of males, presumably slaughtered before reaching maturity.

Pathology

An interesting aspect of the 'Ain Ghazal assemblage is what appears to be an unusually high frequency of pathological changes on goat phalanges (*cf.* CHAPLIN 1971). The lesions consist mainly of varying degrees of arthritic deformities, ranging in severity from a slight inflammation of the bone to a condition that dramatically reduced an animal's mobility (Pl. 1:c-f). There is also one case of a healed radius fracture. Both phenomena imply human protection of diseased or wounded goats from predatorial animals.

In one case two first phalanges belonging to the same individual show ring-like bony growth around the shafts that must have been caused by prolonged pressure or tension on the fetlocks. There is a strong likelihood that the pathological development was the consequence of tethering (*i.e.*, securing the animal by tying a rope around its fetlock). In another example, proliferation around the articular surfaces has led to complete synostoses of phalanges that completely immobilized the joints. While minor bone growth outside the joint surface does not necessarily affect an animal's well-being, synostoses would have resulted in considerable impairment of an animal's mobility.

Conclusion

If we regard selective breeding for certain physical traits as the defining criterion for domestication, then it is indeed a long and drawn-out process that can be subdivided into various phases. The problem with this approach that it is very uncertain how long and how many generations of selective breeding it took to precipitate morphological change, and whether purposeful selection was even a feature of early breeding efforts. By contrast, the most significant step of the domestication process, *i.e.* genetic isolation of a founding stock from the wild population through confinement, resulted in an immediate reflection in the archaeological record, with a concomitant change in the age profile, a decrease in size variability, and possibly pathological changes. For all practical purposes, it would be beneficial to agree on these criteria as practical and time-sensitive indicators of the process of domestication.

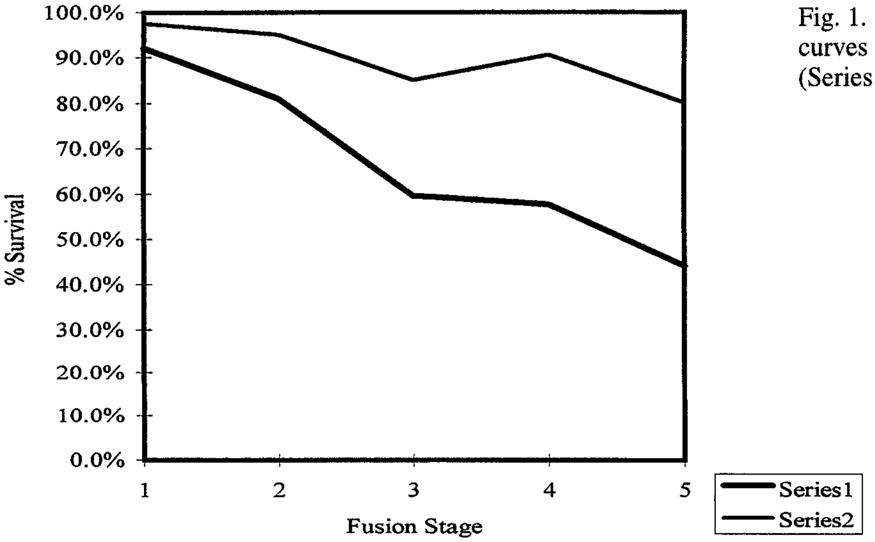

Fig. 1. Comparison of survivorship curves for goats (Series 1) and gazelles (Series 2) from MPPNB 'Ain Ghazal.

But these parameters are also not infallible, because by coincidence they can also occur in the wild, though with a lesser degree of likelihood. It would therefore make sense to start looking for other kinds of circumstantial evidence, such as remains of structures that might have been used for confinement and for the accumulation and use of dung.

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The 'Ain Ghazal Dog: a Case for the Neolithic Origin of *Canis familiaris* in the Near East

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Abstract: Canis familiaris *remains from the PPNB stratum at 'Ain Ghazal give morphological evidence for the Neolithic domestication of the dog in the Near East. These data strengthen the argument that the dog was domesticated during the 7th millennium bp as an important component of the "Neolithic Revolution".*

Introduction

Canine domestication has been a long-standing and intriguing topic for Near Eastern researchers. The ubiquitous human involvement with dogs, both as pets and as hunting and herding animals, has peaked our curiosity about the genesis of this association and the events that led to the domestication of canids. Recent research has focused on the initial appearance in the archaeological record of the "first" dog and is concerned primarily with this issue: was the domestication of the dog part of the "Neolithic Revolution" package, or was it foreshadowed by the singular domestication of canids by Natufian hunters and gatherers (*cf.* UERPMANN 1987)? While it is important to consider such intangibles as the fundamental nature of people and the complexity of human and animal relationships, ultimately the question must be settled with evidence from the archaeological record.

The following discussion proposes that domestication of the dog very likely was a Neolithic, and not an Epipaleolithic, phenomenon. Problems exist concerning the antiquity and species identification of Natufian "dogs," for example, but a new canid mandible from the PPNB stratum of 'Ain Ghazal, Jordan, is unquestionably assigned to *Canis familiaris*. This specimen gives further credence to existing data that attest to the domestication of canids during the Neolithic.

Domestication

The difficulty of defining domestication has been greatly eased in recent years by a general agreement among researchers to adhere to a biological definition, one that reflects the essential genetic nature of the domestication process. Domestication implies human control of a species' breeding behavior, including artificial selection by humans for certain desired characteristics by isolating individuals from wild populations (DAVIS 1987, BÖKÖNYI 1989, HORWITZ 1989).

Use of a biological standard reduces conflicting interpretations of the archaeological record by requiring visible osteomorphological changes over time as proof of the genetic manipulation that is implied by domestication; this proof is particularly vital for identifying domesticated canids. It is important to note that several relationships between humans and canids do not fit this requirement. For example, keeping tamed wild canids as "pets" that continue to breed with wild mates does not constitute domestication. "Canine commensalism", like that described for the dingo and Australian Aborigines (GOULD 1980, *cf.* VALLA 1995a), is an interesting human-animal relationship, but commensalism alone does not reflect domestication (*cf.* SERPELL 1989) since no genetic manipulation is involved.

The precursor to the domestic dog is generally held to be some subpopulation of *C. lupus*, but which subspecies is the ancestor of *C. familiaris* in the Near East is debatable. The evolutionary history of the dog in the Near East is therefore unclear. The evidence from 'Ain Ghazal helps to clarify this issue.

Plate 1. Left mandible of *Canis familiaris* from LPPNB level of 'Ain Ghazal. *Upper*: buccal view; *center:* occlusal view; *lower*: lingual view. Note the dental overlap, small diastema, crowding of the tooth row, and foreshortened muzzle.

The 'Ain Ghazal Dog Remains

Three mandibles attributable to *C. familiaris* were recovered from archaeological deposits at 'Ain Ghazal in 1988. One of these, a well preserved specimen with a nearly intact tooth row, is from a Late PPNB layer dated to between 8,500 and 9,000 bp.[1] The second specimen comes from an early PPNC (*ca.* 7,900 bp) context, and a third from deposits of the Yarmoukian Ceramic Neolithic period (sometime after 7,500 bp). In view of its temporal priority and excellent state of preservation, the following discussion is confined to the LPPNB example.

The LPPNB specimen is a nearly complete left mandible from a small adult canid (Pl. 1). Small portions of the symphysis, angular process, mandibular condyle, and coronoid apex are missing, but the body of the mandible is remarkably well preserved. The canine tooth is present, as well as the tooth row from the second premolar through the first molar. The tip of the canine is missing, but the premolars and M_1 are in very good condition with well-maintained cusp morphology. The metaconid on the M_1 is small and does not protrude lingually (Pl. 1), a characteristic that distinguishes the wolf-dog line from that of the jackal (TURNBULL and REED 1974, DAVIS and VALLA 1978). Morphometric data are provided in Table 1.

Table 1. A comparison of metric data (mm) for the three 'Ain Ghazal canid mandibles.

Locus	PPNB/ #3275	PPNC/ #4452	Yarmoukian/ #3078
$C-M_3$	64.1	-	-
P_1-M_3	61.0	-	-
$P_2.M_3$	56.9	-	-
M_1-M_3	31.6	-	-
$P_1.P_4$	30.7	32.5	38.0
P_2-P_4	27.0	29.7	33.6
M_1 length	20.3	20.3	-
$P_1.M_1$	49.0	53.2	-
P_4 alveolus	9.71	0.4	11.8
$P_4.M_1$	28.6	-	-
Crowding Index	**0.71**	**-**	**-**

Generally speaking, osteological separation of the dog from the wolf line is problematic, particularly if a single aspect rather than a cluster of complementary features is used in the diagnosis. Fortunately, a number of characteristics have been recognized as diagnostic of dog domestication that, as a set, are reasonably valid (*cf.* LAWRENCE 1967, TURNBULL and REED 1974, OLSEN 1985, DAVIS 1987). The 'Ain Ghazal LPPNB mandible exhibits these characteristics. Compared to the regional wolf subspecies in the southern Levant (*C. l. pallipes* and *C. l. arabs*), it is smaller in size and extremely short in length, two attributes that are associated with the domestication process. These changes led to tooth crowding and an overall reduction in tooth size, features that are readily apparent in the LPPNB mandible from 'Ain Ghazal (Table 1).

Crowding of the teeth is often measured by the degree of dental overlap between the lower fourth premolar and the first molar. An index of overlap (M_1 crown length divided by alveolar length from P_4 to M_1) was computed to compare the degree of overlap of modern dogs from Palestine and Egypt with wolves and with a Natufian canid (DAVIS and VALLA 1978). Wolves yielded values from 0.62 to 0.67 (mean 0.65), and the Natufian specimen produced a value of 0.67. The 'Ain Ghazal mandible, with a crowding index of 0.71, has a greater degree of crowding than that reflected by all of these values, including that of the modern Near Eastern dogs.

First molar length is also a standard used to measure the reduction in tooth size in the process of dog domestication (DAVIS 1981). M_1 measurements of some recent and fossil canids, and of the 'Ain Ghazal LPPNB canid are provided in Table 2. The values in the table show that the 'Ain Ghazal canid fits within the *C. familiaris* range.

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1 All dates use lower-case "bp" and are uncalibrated. A sample of bone from this specimen was submitted for AMS analysis to the Radiocarbon Accelerator Unit, Oxford University, but the meager collagen content of the bone proved too inadequate for dating (R.E.M. HEDGES, personal communication 1991). Bone from Near East contexts is notoriously difficult to date due to the deleterious effects on collagen of the depositional environment and severe climate extremes (*cf.* GOWLETT and HEDGES 1987, WEINER and BAR-YOSEF 1990).

Table 2: Comparison of the length of the lower carnassial (M1) measurements from recent and fossil canids *<measurements in mm>.*

Source	n	Mean	Range
Recent Wolves			
C. lupus			
Turkey[a]	11	27.8	29.5-26.1
Europe[a]	9	28.9	32.2-26.7
C. l. pallipes			
Middle East/India[b]	18	24.4	26.8-22.5
Zagros/Iraq[c]	26	24.6	-
C. l. arabs			
Arabian Peninsula[a]	7	23.5	24.2-22.0
Saudi Arabia[d]	7	23.2	23.8-22.0
Recent Jackals			
C. aureus			
Turkey/Levant[a]	15	18.4	19.9-16.3
C. a. lupaster			
Egypt[a]	11	21.5	24.3-20.3
Recent Dogs			
Egypt[d]	2	23.1	23.4-22.7
Fossil Dogs/Wolves			
'Ain Ghazal (Neolithic)	2	20.3	20.3-20.3
Çayönü (Neolithic)[e]	2	21.75	21.7-21.8
Palegawra (Natufian)[c]	1	21.9	-
Hayonim (Natufian)[d]	1	22.2	-
Ein Mallaha (Natufian)[d]	1	22.6	-

[a] PAYNE 1983 [c] TURNBULL and REED 1974 [e] LAWRENCE 1967
[b] S. DAVIS, pers. comm. 1991 [d] DAVIS and VALLA 1978

Other significant features of domestication (*e.g.*, DEGERBØL 1961, LAWRENCE 1967, OLSEN 1985, TURNBULL and REED 1974) are also apparent in the LPPNB 'Ain Ghazal mandible. The alveoli for the premolars are close together, producing a shortened series. The diastema between the canine and the P_1 alveolus is quite small compared to local wolves and jackals. The jaw is deep and heavy midway on the horizontal ramus and convex on the inferior margin. The tooth row bends sharply up posterior to M_2 so that the alveolus for M_3 is embedded in the ascending ramus (Pl. 1). All of these features typify the foreshortened, thick muzzle of the domestic dog.

The data clearly demonstrate that the LPPNB canid mandible is from *C. familiaris*; it is manifestly and irrefutably "dog", and one of the oldest known examples of this species that we have from the Near East. It is also, however, one of several dogs that have been found in Neolithic deposits as part of the Neolithic domestication pattern. But what of the claims of earlier examples of dogs, particularly from the Natufian deposits in northern Israel?

Other Fossil "Dog" Remains

Probably because of the long-held special relationship between humans and dogs, interest in the origins of the dog has had a long history. Accelerated archaeological research since the 1950s has necessitated periodic reevaluations and reassessments as new data emerged and new criteria were developed (*e.g.*, CLUTTON-BROCK 1962, 1969; OLSEN 1985; DAYAN 1994). Energies concentrated on two contemporaneous lines of research: assigning proper canid status to archaeological specimens and palaeontological assessment of the evolution of the wolf-to-dog line. Purported *C. familiaris* remains from the Natufian levels of El Wad Cave (Mount Carmel), Kebara Cave, and from Zuttiyeh and Shukbah caves remain controversial (*cf.* CLUTTON-BROCK 1962, DAYAN 1994). There is no irrefutable evidence for the presence of dog remains in the Proto-Neolithic level at Jericho (*cf.* CLUTTON-BROCK 1969, DAYAN 1994). The status of the Palegawra Cave canid in northeastern Iraq, once considered to be the oldest dog specimen in the world (dated to *c.* 12,000 bp), has been strongly challenged on two bases. Olsen (1985: 73) considered it to be an "aberrant wild canid" in view of its wolf-like characteristics. Uerpmann's (1987) evaluation of the ungulates from the site noted that the canid mandible was associated with domestic goats that probably were of Neolithic age, making the presumed Epipaleolithic age doubtful.

The "special relationship" between humans and canids has been cited as one link in the process of dog domestication. Ein Mallaha and Hayonim Terrace in Israel produced burials containing human and canid remains that stressed this relationship, for example (DAVIS and VALLA 1978, DAVIS 1987). However, the canid buried with a human at Mallaha is a juvenile of dubiously described as a domestic "puppy"[1] (*cf.* OLSEN 1985). Material from this site and from Hayonim was described as morphologically wolf-dog, with M_1s somewhat smaller than those of wolves, but the singular nature of this attribute is inconclusive. Osteometric data are not yet available for two canids recently found interred with three humans at Hayonim Terrace (VALLA 1995a, 1995b). However, all of the specimens from 'Ain Mallaha and Hayonim Terrace were judged to be dogs on the basis of their burial associations with humans.

The burial of tamed wild animals, for ritual and ostensibly for other reasons, is well known from ethnographic and archaeological examples in the Old and New Worlds. Ritually buried raptors, turtles, badgers, cervids, antelope, and bears strongly suggest that pets were kept and that totemic animals were revered in prehistory (HEIZER and HEWES 1940). Animals may have been buried with humans for a number of reasons that have no connection to domestication. For example, human remains were found interred with gazelle and aurochs skeletons at PPNB Kfar Hahoresh (GORING-MORRIS 1991, GORING-MORRIS *et al.* 1994-5) and with gazelle and wild boar at 'Ain Ghazal. A child and a roe deer were found buried together at the second-to-fourth century site of Ondrochov-Lipova in Slovakia (VÖRÖS 1986), and a burial of a bear cub and child was found in a Late Prehistoric California site (COWAN *et al.* 1975). The special nature of the latter burial is underscored by the po-

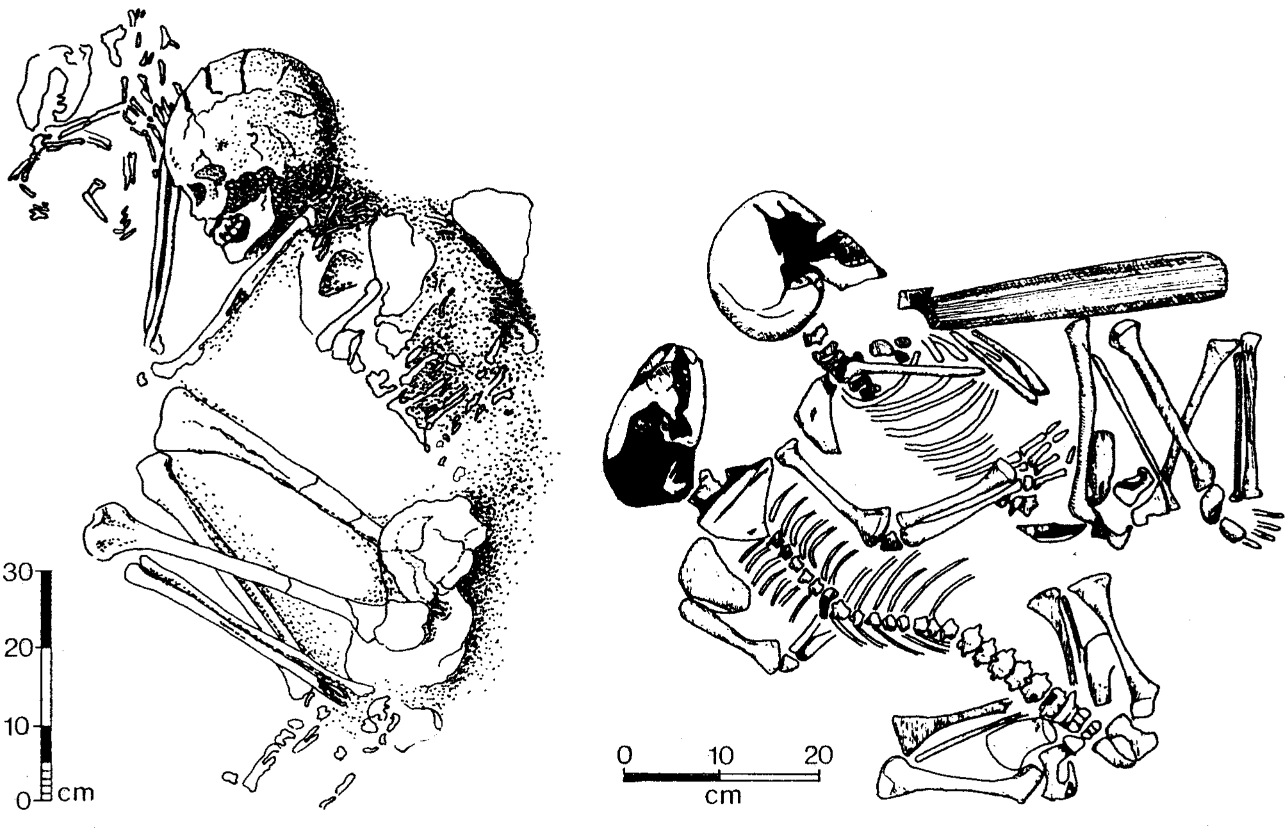

Fig. 1. Archaeological examples of humans buried with animals. *Left:* Natufian burial of a juvenile canid and adult human at Ein Mallaha, Israel (adapted from DAVIS and VALLA 1978: 208); *right:* burial of a bear cub and a child at the Late Prehistoric Hotchkiss site in central California (after COWAN *et al.* 1975: 27).

[1] Although the osteological material was acknowledged to be ambiguously wolf-dog, a "special relationship" synonymous with domestication was implied by using the term "puppy" to refer to the juvenile canid (DAVIS and VALLA 1978). Young pet dogs are, in modern Western society, "puppies". Young wild wolves are often called "pups", but in scientific studies the latter are generally referred to as "juveniles".

sition of the bear, which was placed in the grave with its forepaw over the child. The similarity of this burial to the Mallaha human-canid burial is evident (Fig. 1), but surely domestication of neither bear nor canid is implied by these contexts.

The Natufian examples cited above are problematic, for none show certain morphological evidence of the results of the domestication process. Additionally, they do not necessarily prove that tamed wild animals played a special role in the lives of late Epipaleolithic families. The faunal material from aceramic Neolithic sites is more convincing, including the evidence from 'Ain Ghazal, Çayönü (LAWRENCE 1967) in Turkey, and LPPNB Basta in southern Jordan (BECKER 1991). Hajji Firuz Tepe in Iran yielded *C. familiaris* bones (MEADOW 1983), as did Shams ed-Din Tannira in northwestern Syria (UERPMANN 1987) and perhaps Jarmo in northern Iraq. At the last site, faunal remains earlier assigned to "dog" in levels dated to between 8,500 and 9,000 bp have been reassessed a number of times, and their status remains uncertain.

Conclusions

The research at Palegawra Cave and Jarmo reflects difficulties in assessing affinities when regional evolutionary sequences are not clear and when distinguishing morphological features are not readily apparent. Species determinations have been guided by assumptions that a larger ancestral wolf form led to both the smaller domestic dog line and to the two small wolf subspecies in the Near East, *C. l. pallipes* and *C. l. arabs* (*cf.* DAVIS and VALLA 1978, LAWRENCE and REED 1983). Therefore, past analyses of specimens often were based on size differences alone rather than on a complement of osteological traits. Recent studies have shown, on the other hand, that there was considerable variability in canid populations at the end of the Pleistocene (*cf.* DAYAN 1994), including a decrease in general sizes of species (DAVIS 1981). Size diminution in *C. lupus* remains, especially notable at Douara Cave in Syria (PAYNE 1983), is strong enough to suggest that a small wolf subspecies ancestral to the modern *C. l. arabs* was the likely forerunner of domestic dogs. Because of their morphological similarities, differentiating these species archaeologically is problematic (*cf.* DAYAN 1994, CLUTTON-BROCK 1995). The small size alone, then, of the Natufian specimens from Israel may relate to a taming of this wolf subspecies in a process that led eventually to dog domestication.

The LPPNB mandible from 'Ain Ghazal is clear evidence that the process of dog domestication had come to fruition by the end of the 7th millennium bp. The Neolithic dogs from 'Ain Ghazal, Çayönü, Basta, Shams ed-Din Tannira and other budding PPN towns reflect a cultural environment permeated with sedentism and domestication, an environment different from that of the Natufians. While some Natufians may have tamed and kept wolf pups even to maturity, it is unlikely that the Natufians would have genetically controlled only one animal species, kept it isolated, selectively bred it, maintained it and cared for its population. Although it was not impossible, such behavior clearly would be a marked case that would require irrefutable documentation, and currently this is not the case. While canid pets may have existed in the Epipaleolithic, we cannot go beyond this supposition.

What does exist, however, are abundant data that reflect genetic manipulation of Neolithic resources, a manipulation that included the dog and that ultimately encompassed a wide variety of plants and animals. It is reasonable to conclude that the domestication of the dog occurred in this context, and that the dog became a special feature of the human landscape and economy during the PPNB as the well-known family friend and helper, an important part of the Neolithic pattern of living.

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Preliminary Results of an Analysis of the Sheep and Goat Bones from 'Ain Ghazal, Jordan

Alex Wasse

Abstract: *This report describes the separation of a part of the ovicaprid sample from 'Ain Ghazal into proportions of sheep and goat. A shift from* 'proto-élevage' *of goat to ovicaprid husbandry based predominantly on sheep was identified as occurring between c. 6500 and 6000 b.c. The significance of this shift is discussed in the context of general patterns of faunal exploition at 'Ain Ghazal and in the region as a whole, and in terms of the current debate on the origins of pastoralism in the central and southern Levant. In particular, the relative merits of Rollefson and Köhler-Rollefson's (1993) 'Incipient Migratory Pastoralism' model, PERROT (1993) and DUCOS' (1993a) 'Northern Migrant Pastoralism' model are considered in light of this data from 'Ain Ghazal.*

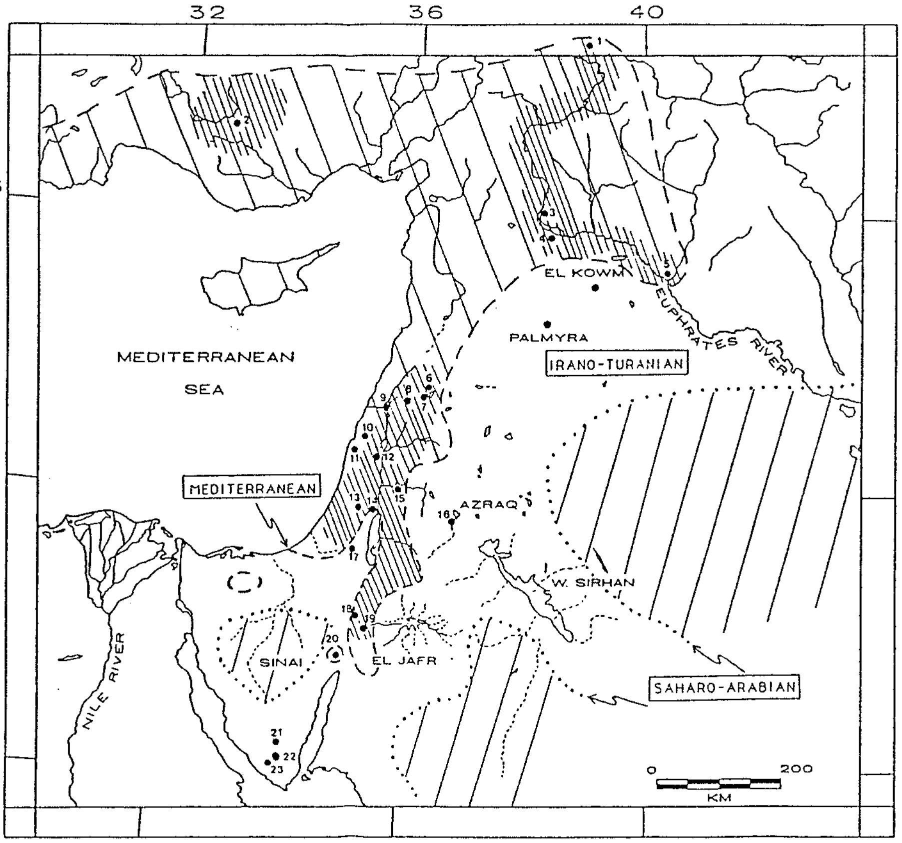
Zusammenfassung: *Dieser Beitrag untersucht die unterschiedlichen Anteile von Schaf und Ziege in einem Teil der Ovicaprinen-Proben von 'Ain Ghazal. Für die Zeit zwischen 6500 und 6000 b.c. wurde ein Wechsel von Ziege im Zustand der* 'proto-élevage' *auf Schaf-/ Ziegenhaltung mit vorherrschender Schafhaltung festgestellt. Die Bedeutung dieses Wechsels wird im Kontext der allgemeinen Tiernutzungsmuster von 'Ain Ghazal und in der Gesamtregion diskutiert, besonders aber vor dem Hintergrund der aktuellen Debatte um die Ursprünge des Pastoralismus in der zentralen und südlichen Levante: Das 'Incipient Migratory Pastoralism'- Modell von Rollefson und Köhler-Rollefson (1993), das des Beitrags PERROT 1993 und des 'Northern Migrant Pastoralism' von DUCOS 1993a werden aus der Sicht der 'Ain Ghazal- Daten betrachtet.*

Introduction

This report presents the results of a study of some of the sheep and goat bones from 'Ain Ghazal, Jordan, and places them in the context of the current debate on the origins of pastoralism in the central and southern Levant. Neolithic 'Ain Ghazal was a large permanent farming settlement located on the banks of the Wadi Zarqa at its confluence with two major tributary wadis and lies in the north-eastern suburbs of present-day Amman; Fig. 1 gives the location of most of the sites mentioned in the text. The river Zarqa, a stream which flowed along the wadi bed until the 1950s, is fed by a number of springs in the Amman area, including 'Ain Ghazal itself. The site lies on the edge of a range of heavily dissected low mountains which extend to the north, west and south, whilst to the east and north-east the countryside opens out into more gently undulating hills. Today this more open area to the east lies on the 250mm isohyet, and is thus "near the limits of dry farming, consisting generally of open dry grassland" (ROLLEFSON 1984: 3); however, the tops of the low hills around the site are able to support rainfall agriculture. In addition, garden areas are found in many of the surrounding wadi beds, which until recently supported a population of wild boar. The site also lies on the modern boundary between the Mediterranean scrub and Indo-Turanian steppe phytogeographical zones, placing a wide variety of natural resources within its catchment.

The site was discovered during the construction of the new 'Amman - Zarqa road in the 1970s. Nine seasons of rescue oriented excavations have taken place since 1982. Occupation at 'Ain Ghazal is thought to have continued uninterrupted for over 2000 years, from 7250 - *c.* 5000 b.c. Four cultural horizons, The Middle Pre-Pottery Neolithic B (MPPNB), the Late Pre-Pottery Neolithic B (LPPNB), the Pre-Pottery Neolithic C (PPNC) and the Yarmoukian Pottery Neolithic, have been identified, although it should be stressed that there is as much continuity as differences between its various phases. The results of excavations at 'Ain Ghazal are synthesised by Rollefson *et al.* (1992).

On the basis of over 4000 identifiable bones collected during the 1984 season at 'Ain Ghazal, Köhler-Rollefson *et al.* (1988: 429) produced a list of species present in their stratigraphic context.



Reconstructed distribution of Mediterranean vegetational belt during the ninth millennium b.p. and the distribution of the major excavated Early Neolithic sites:

1 Çayönü, 2 Çatal Höyük, 3 Mureybit, 4 Abu Hureira, 5 Bouqras, 6 Tell Aswad, 7 Tell Ghoraife, 8 Tell Ramad, 9 Beisamoun, 10 Yiftahel, 11 Nahal Oren, 12 Munhatta, 13 Abu Gosh, 14 Jericho, 15 'Ain Ghazal, 16 Azraq, 17 Nahal Hemar, 18 Beidha, 19 Basta, 20 Nahal Issaron, 21 Wadi Tbeik, 22 Ujrat el-Mehed, 23 Wadi Jibba.

Fig. 1. Map of the Levant in the 9th millennium bp (from: BAR-YOSEF and BELFER-COHEN 1991).

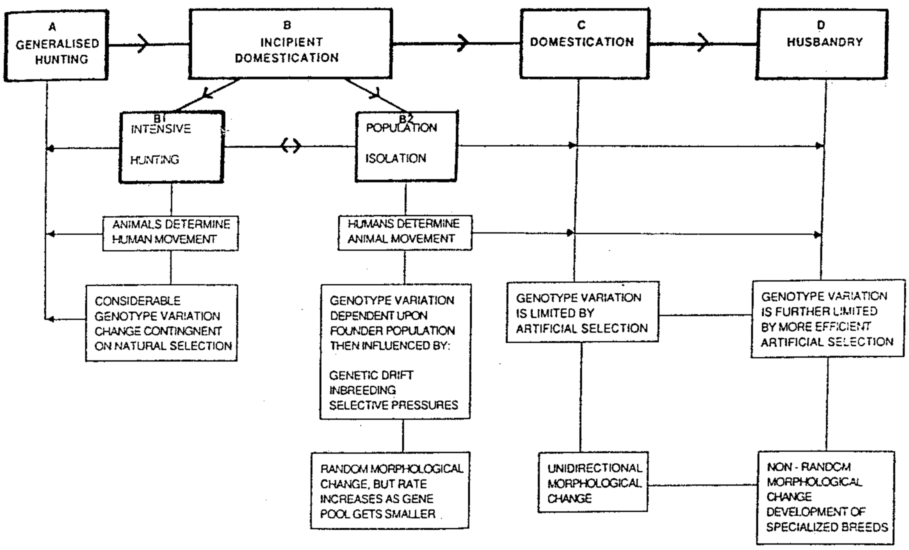


Fig. 2. Horwitz's (1989) four-part model of ovicaprid domestication.

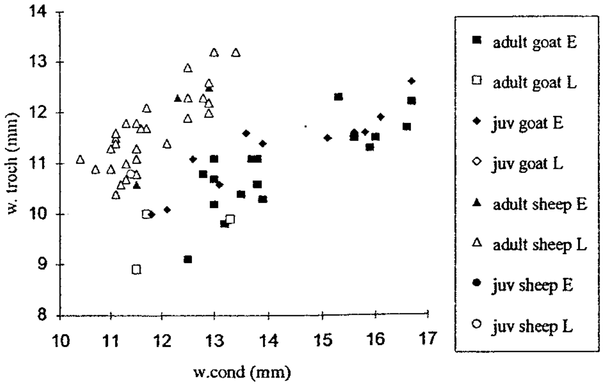


Fig. 3. Separation of 'Ain Ghazal sheep and goat metacarpals (after PAYNE 1969)
<E(arly) refers to MPPNB and LPPNB; L(ate) refers to PPNC and Yarmoukian>.

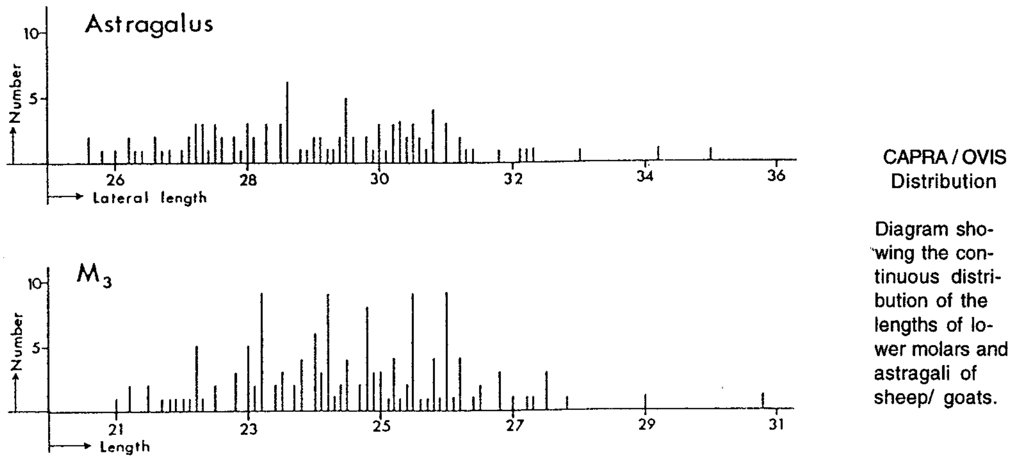


Fig. 4. Third molar and astragalus length from ovicaprids of Jarmo (from: STAMPFLI 1983).

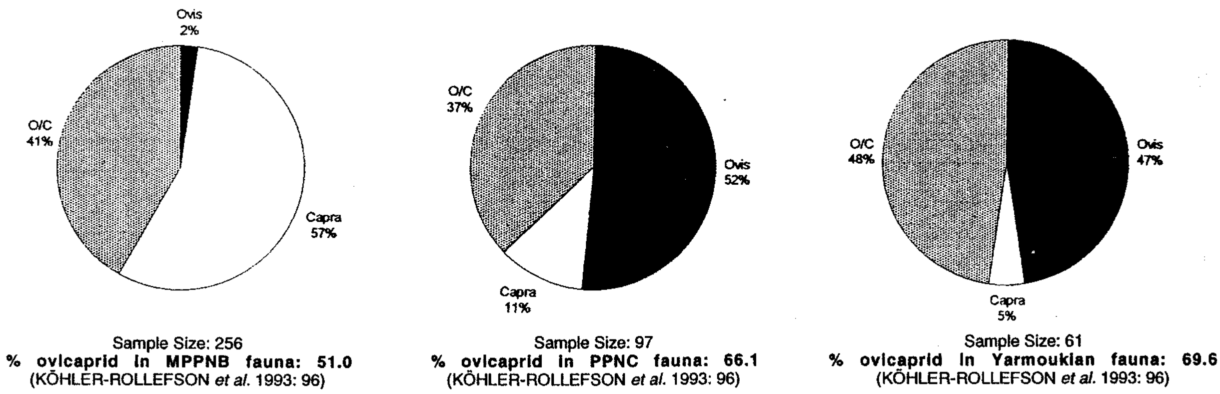


Fig. 5. Species representation by phase (excluding LPPNB).

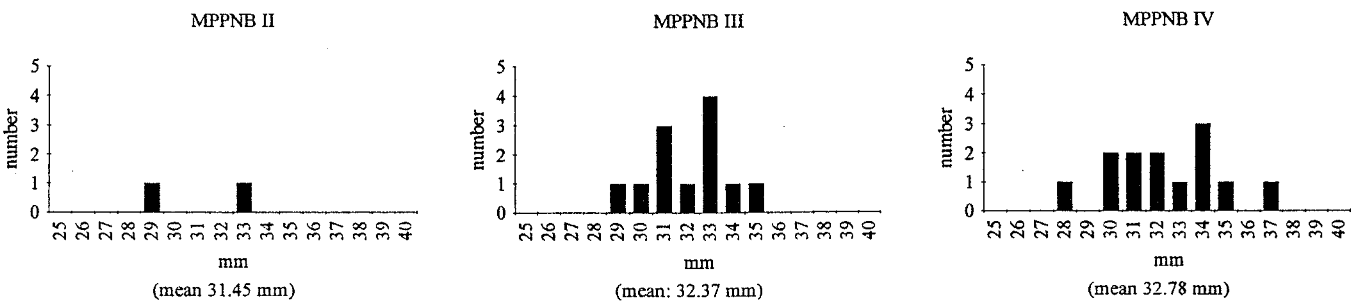


Fig. 6. 'Ain Ghazal goat astragalus Gli by MPPNB architectural sub-phase.

No attempt was made to separate the goat and sheep remains, which were grouped together in the ovicaprid category. This report was updated with the addition of subsequent data by Köhler-Rollefson *et al.* (1993), although the goat and sheep remains were still grouped together. This latter report, together with the separation of the sheep and goat remains presented here, represents the current state of knowledge about the fauna from 'Ain Ghazal.

There is no evidence for the domestication of ovicaprids in the central and southern Levant at the beginning of the first phase of occupation at 'Ain Ghazal, but by the time of the site's abandonment a separate pastoral social and economic sector is thought to have emerged. 'Ain Ghazal is therefore potentially important in piecing together the developments which led to the evolution of subsistence strategies which have dominated the region up to the present day. Two theories have been put forward concerning the origins of pastoralism in the central and southern Levant. One argues that it evolved locally, exploiting ovicaprids native to the region (ROLLEFSON *et al.* 1993). The other argues that it was introduced, with sheep, from the northern Levant (DUCOS 1993a and PERROT 1993). In both cases these developments are thought to have occurred at the end of the 7th millennium b.c.

The aims of this report are therefore to establish relative proportions of goats and sheep for the main cultural phases at 'Ain Ghazal, to assess the domestic status of the 'Ain Ghazal goats and sheep during each of the main cultural phases and to examine the data thus gained in the context of the current debate on the origins of pastoralism in the central and southern Levant[1].

Methodology

The sheep and goat bones examined were collected over the six seasons of excavation at 'Ain Ghazal between 1982 and 1989. During this period over 700m of deposits were examined, representing approximately 0.5% of the total area of the site. The MPPNB is represented by *c.* 200m^2 of exposures, the LPPNB by *c.* 60 m^2, the PPNC by *c.* 200 m^2 and the Yarmoukian by *c.* 450m^2. However, in terms of the volume of sediment excavated, "subjectively the MPPNB and Yarmoukian periods are roughly equivalent, with the LPPNB and PPNC much smaller." (ROLLEFSON *et al.* 1992: 445)

The sheep and goat bones examined for the preparation of this report consist of the entire sample excavated between 1982 and 1989 which had been previously sorted into "ovicaprid" or "small ruminant" categories. A large quantity of bone, particularly from PPNC and Yarmoukian contexts, await this preliminary sorting owing primarily to a hard calcareous concretion characteristic of these levels which has slowed down preliminary sorting and also hindered the separation of goat and sheep in those samples which were available for study. None of the bone from the 1993, 1994 or 1995 seasons, which include a large quantity from LPPNB layers, was examined.

Most bones represent refuse from human consumption; the degree of fragmentation was therefore relatively high and burning and cutmarks were prevalent. As burned and heavily fragmented specimens had to be excluded from metrical analysis, the number of measurements taken was relatively small in comparison with the total number of specimens available.

In an osteological study of the Soay sheep Clutton-Brock *et al.* (1990: 17-42) examined the reliability of the now widely used criteria of Boessneck (1969) in distinguishing sheep from goats. This study identified the skeletal elements and morphological characteristics with which a reliable identification could be made. The Soay, as a primitive domestic sheep, was felt to be more representative of the earliest Levantine domestic sheep than modern improved varieties. On the basis of this study, a sub-sample of 646 specimens was taken of the ovicaprid remains from 'Ain Ghazal, consisting of the skeletal elements described as being predominantly sheep-like in the Soay, according to the criteria of Boessneck (1969) and displaying very few goat-like characteristics. The bones thus selected were: the proximal and distal humerus, the calcaneum, the astragalus, the distal metacarpal and the second and third phalanges.

In addition to those criteria of Boessneck described by Clutton-Brock *et al.* (1990) as being reliable in the Soay, the criteria of Prummel and Frisch (1986) and Halstead (n.d.) were employed where appropriate. The separation of metacarpals on the basis of the morphological criteria above was tested by the application of Payne's (1969) metrical separation using metacarpal trochlear width vs. condyle width (Fig. 3). The initial identification was confirmed in every specimen. In those samples which had only been sorted to "small ruminant" level (ovicaprid and gazelle), gazelle was separated from the ovicaprids according to Buitenhuis (1988), Martin (n.d.) and Garrard (pers. comm.). NISP (Number of Identified Specimens) was used throughout as a measure of relative species abundance.

A major problem in the positive identification of goat and sheep remains is that there is a often a considerable overlap between goat-like and sheep-like characteristics and measurements (see Fig. 4). A large proportion of bones therefore have to remain in the Ovicaprid category; a successful identifi-

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[1] In this report "ovicaprid" refers to sheep and goats in general, whereas "Ovicaprid" refers to those bones that could not be identified to species level.

cation can only be made on the basis of several characteristics and/or measurements for each specimen.

As the ovicaprid dental remains from 'Ain Ghazal were unavailable for study it was necessary to rely solely on the less precise and potentially problematic data from epiphysial fusion sequences to reconstruct the age structure of the 'Ain Ghazal ovicaprids. Amongst ovicaprids there is considerable variation in the age at which the various epiphyses have been observed to fuse, depending on species, state of domestication, nutrition and sex (NODDLE 1974). A difference of three to four years between domestic sheep and feral goats has been documented in the later fusing bones (KÖHLER-ROLLEFSON 1983: 9). No further estimate of age can be made once all elements have fused. Furthermore, whereas a fused bone consists one element, an unfused bone consists of two - a shaft and an epiphysis. A count of the proportion of fused to unfused bones will therefore lead to an over-representation of the unfused bones. There are also considerable difficulties associated with the preservation, recovery and identification of the bones, particularly epiphyses, of juvenile individuals.

To minimise the effect of these biases and to allow comparison with a survivorship curve previously produced by Köhler-Rollefson (1983; *cf.* KÖHLER-ROLLEFSON, this volume) from the gazelle remains from 'Ain Ghazal, the same methodology, outlined below, was used.

Although the age at which a single skeletal element fuses varies between individuals, the sequence in which the various skeletal elements fuse is constant across a population. Gazelle display a similar sequence of fusion to ovicaprids, but this is achieved more quickly than in ovicaprids owing to the more rapid maturing of this animal (DAVIS 1980). Each stage probably represents a broadly similar level of maturity in goat and gazelle. Elements fusing at approximately the same time are therefore grouped together and treated as Fusion Stages 1 to 5, which are described below.

Fusion Stage 1: Scapula, Acetabulum, proximal Radius, distal Humerus
Fusion Stage 2: Phalanges I and II
Fusion Stage 3: distal Tibia
Fusion Stage 4: distal Metapodials
Fusion Stage 5: proximal Humerus, proximal Femur, proximal Tibia, distal Radius, distal Femur, proximal Ulna

To avoid over-representation of the proportion of unfused bones, this count was calculated on the basis of the number of epiphyses or diaphyses, whichever was the higher. Fused bones were subject to a straight count.

A series of measurements were taken on the 'Ain Ghazal ovicaprid sub-sample to assess size change in the goat and sheep populations and to assist in the separation of the species. Abbreviations refer to measurements described by von den Driesch (1976) and Payne (1969).

Results

For the puposes of this article the results of the analysis of the 'Ain Ghazal faunal assemblage presented by Köhler-Rollefson *et al.* (1993), which did not attempt to separate the sheep and goat remains, is taken as being representative of the MPPNB, PPNC and Yarmoukian phases. This has allowed the separation of the sheep and goat remains attempted here to be expressed as a percentage of the faunal assemblage as a whole (Table 2).

There is an effective hiatus in the faunal sample excavated between 1982 and 1989 which dates to the LPPNB period; this is a consequence of the rather limited exploration of this phase during these seasons. Future work will concentrate on the faunal sample excavated since 1993, much of which is from LPPNB loci. The LPPNB ovicaprid sample examined here consisted of 10 specimens, only six of which were identifiable to species level, and is therefore too small to provide any meaningful information. It has therefore been excluded from this analysis.

The relative abundance of Ovis, Capra and Ovicaprid during the MPPNB, PPNC and Yarmoukian are laid out in Fig. 5; total counts for each sub-phase are laid out in Table 1. It should be noted that these sub-phases are architectural, not temporal. They therefore give no more than a rough indication of variation within the main cultural phases.

Species representation

It is now clear that goats were present at 'Ain Ghazal from the beginning of its occupation and that they were predominant during the MPPNB, comprising 95.5% of the identifiable ovicaprid sample. However the importance of the species was in sharp decline by the PPNC, being reduced to 18.0% of the same, and by the Yarmoukian had dwindled to only 10.3%. The wild goat, *Capra aegragrus,* is post-cranially extremely difficult to distinguish from the Nubian ibex, *Capra ibex nubiana*; whilst it is therefore impossible, without study of the horncores, to confirm or deny the presence of the latter species at 'Ain Ghazal, it must be considered unlikely as its early Holocene range appears to have been restricted to the extreme south of the Levant, at sites such as Ujrat el-Mehed, Wadi Tbeik and Beidha.

The presence of six sheep bones in MPPNB loci, representing 4.5% of the identifiable MPPNB ovicaprid sample, remains difficult to interpret. Although the PPNC and Yarmoukian at 'Ain Ghazal are characterised by extensive pit digging and excavation, which may have resulted in the intrusion of later sheep bones into MPPNB layers, several of these sheep bones were found in good MPPNB loci. The first clear evidence for the extensive exploitation of sheep at 'Ain Ghazal appears at the beginning of the PPNC, from sub-phase S-IV onwards. Sheep constituted 82.0% of the identifiable PPNC assemblage, displacing goat from its former pre-eminence, and maintained a similar level, 89.7%, into the Yarmoukian.

The percentage of the ovicaprid sample which could not be identified to species remained relatively stable throughout the sequence, fluctuating between 37.11% and 47.54% of the ovicaprid sample as a whole. As the bones selected for analysis were those identified as being the more distinctive by Clutton-Brock *et al.* (1990), it is probable that only 50% or 60% of most archaeological ovicaprid remains can be identified to species level.

Wild or Domestic Status?

As goats and sheep feature so strongly in the faunal record of 'Ain Ghazal it is important to establish whether or not they were wild: *Capra aegragrus* and *Ovis orientalis,* or domestic: *Capra hircus* and *Ovis aries*. Two criteria for domestication were examined, namely: size reduction and demographic change. It was not possible during the course of this study to examine the morphology of the horncores, which is considered another reliable indicator of wild or domestic status in ovicaprids. Owing to the shift from goat to sheep, which occurred in the faunal record between the end of the MPPNB and the beginning of the PPNC as described above, it was not possible to obtain a sequence of data for either species which covered the whole sequence of occupation at the site and still maintained a sufficient sample size. For this reason, two separate sets of data were examined: the MPPNB goats and the combined PPNC - Yarmoukian sheep.

No appreciable size reduction of goats occurred across the sub-phases of the MPPNB (Fig. 6); it is therefore unlikely that there was any change in the status of goats during the MPPNB. For this reason metrical data for the sub-phases of the MPPNB was grouped together into one MPPNB sample

Table 1. 'Ain Ghazal ovicaprid species counts by architectural sub-phase.

	Ovis	Capra	O/C
MPPNB I	0	3	1
MPPNB II	1	10	9
MPPNB III	1	67	40
MPPNBIV	2	61	49
MPPNB V	0	0	0
MPPNB	2	3	7
LPPNB	1	5	4
LB/PPNC	4	1	6
PPNC V	0	0	0
PPNC IV	14	5	7
PPNC III	16	4	10
PPNC	20	2	19
Early Yar.	2	0	3
Late Yar.	3	1	1
Yar.	21	2	25
Mixed	21	75	55
No Locus	16	20	24
Total	646		

Table 2. Species representation at 'Ain Ghazal by phase (KÖHLER-ROLLEFSON *et al.* 1993: 96), incorporating the goat/sheep/ovicaprid ratios from the ovicaprid sub-sample studied here as percentages of Köhler-Rollefson's sample.

Taxon	**% MPPNB**	**% LPPNB**	**% PPNC**	**% Yarm**
O/C	21.1	28.3	24.5	32.6
Capra	28.7	35.4	7.5	4.5
Ovis	1.2	7.1	34.0	32.6
Gazella	15.5	6.6	8.6	6.4
Bos	8.3	5.7	7.1	6.7
Sus	5.9	12.4	13.3	9.0
Equus	0.1	1.5	3.0	6.0
Cervid	0.1	0.0	0.0	0.0
Cervid?	0.0	0.0	0.1	0.0
Sm. Carn.	7.6	0.1	0.0	0.1
Vulpes	2.9	0.7	0.4	0.3
Felis	0.7	0.3	0.0	0.0
Canis	0.2	0.2	0.1	0.3
Meles	0.0	0.1	0.0	0.0
Martes	0.0	0.0	0.1	0.1
Lepus	2.1	0.2	0.3	0.3
Spalax	0.0	0.1	0.0	0.3
Herpestes	0.0	0.0	0.0	0.0
Rodent	0.8	0.0	0.2	0.4
Insectvr.	0.3	0.0	0.0	0.1
Aves	1.9	0.4	0.0	0.2
Testudo	2.5	0.8	0.5	0.3
Reptile	0.1	0.1	0.0	0.0
Vivirr.	0.0	0.0	0.0	0.0
Amphib.	0.0	0.0	0.0	0.0
Fish	0.0	0.0	0.0	0.0
Crab	0.0	0.0	0.0	0.0
Total	**100.0**	**100.0**	**99.8**	**100.1**
n. (NISP)	7031	914	2571	1559

for comparison with other material. Metacarpal trochlear width / condyle width and Astragalus GLi and were compared with data prepared by Horwitz (1989: 166-167) from a variety of Levantine sites (Figs. 7a-b and 8). In both cases the 'Ain Ghazal data fall within the range of wild goat, *Capra aegragrus*.

The survivorship curve for the MPPNB goats is shown in Fig. 9. As sheep appear in only minimal numbers during the MPPNB, the Capra and Ovicaprid samples were combined to make up a sufficient sample size to generate a survivorship curve. This survivorship curve is compared with that of gazelle, produced by Köhler-Rollefson (1983) from a random sample of PPNB gazelle from 'Ain Ghazal. This enables the survivorship curve of the goats to be compared with that of a species known to have been wild.

As the distal tibia were not examined, no survivorship percentage for goats was available in Stage 3. This accounts for the break in the survivorship curve for this species.

A far higher percentage of goats were being killed at a young age than was the case for gazelle: by Stage 1 28.6% of goats were dead, as opposed to only 2% of gazelle and by Stage 2 the survivorship levels are 37% and 5% respectively. After this stage both species show a gradual decline in survivorship; approximately 55% of goats and 80% of gazelle were reaching full maturity.

Notwithstanding a smaller sample size for the PPNC and Yarmoukian sheep, no size reduction appears to have occurred during the sub-phases of the PPNC and Yarmoukian (Fig. 10); it is therefore unlikely that there was any change in the status of sheep during this period. Consequently the metrical data were grouped into one combined PPNC - Yarmoukian sample for comparison with other data. Humerus BT from 'Ain Ghazal were compared with data from Chalcolithic Bir es-Safadi (GRIGSON 1987: 122) (Fig. 11) and Metacarpal Bd from 'Ain Ghazal were compared with data from Late Neolithic Wadi Jilat 13 (POWELL n.d.: 26) and Early - Middle Bronze Age Jericho (CLUTTON-BROCK 1979: 153) (Fig. 12). All comparative data are derived from sheep described as domestic. The 'Ain Ghazal sheep measurements correspond well with those from the domestic sheep, although the range of variation is higher. Owing to an insufficient sample size it was impossible to construct a survivorship curve for the PPNC - Yarmoukian sheep.

Regarding *Changes in goat exploitation at 'Ain Ghazal between the Early and Late Neolithic, a metrical analysis* (KÖHLER-ROLLEFSON 1989a)

By comparing measurements of the ovicaprid remains, at that time thought to have consisted entirely of goats, from 'Ain Ghazal for the Early (PPNB) and Late (PPNC-Yarmoukian) Neolithic, Köhler-Rollefson (1989a: 141) identified a "distinct decrease in median size between the two phases (with) no change in minimum size", in other words, a decrease in variability. By comparing these measurements with Uerpmann's (1979) "standard goat" measurements, it appeared that the larger than "standard" individuals - *i.e.* possible males - were being eliminated in the later period. As immature bones were excluded from Köhler-Rollefson's metrical analysis, it was argued that the later sample appeared to consist predominantly of adult female goats.

In Fig. 13a-b goat, sheep and ovicaprid Astragalus GLi obtained as part of this analysis of the 'Ain Ghazal ovicaprid sample are combined into a single pseudo-goat sample for the MPPNB and PPNC-Yarmoukian periods and are compared with Uerpmann's "standard goat" Astragalus GLi to illustrate Köhler-Rollefson's argument.

However, if the same sample is separated into its goat, sheep and Ovicaprid elements (Fig. 14a-b) and the MPPNB sample, as it consists almost entirely of goats, is compared with Uerpmann's "standard goat" measurement whilst the PPNC-Yarmoukian sample, which consists predominantly of sheep, is compared with Uerpmann's "standard sheep" measurement, it is clear that the changes observed result not from the elimination of larger than "standard" goats, but from larger than "standard" sheep. It would therefore appear that the later sample consists predominantly of adult female sheep. Furthermore, Fig. 3, showing the results of Payne's metrical method of separating sheep and goat metacarpals, clearly shows an absence of juvenile sheep during the PPNC and Yarmoukian periods compared to the level of juvenile goats during the preceding MPPNB period.

Discussion

To summarise, two main factors have emerged from this study of the sheep and goat bones from 'Ain Ghazal. Firstly, the MPPNB identifiable ovicaprid sample is dominated by goat, which constitutes 95.5% of the sample and which displays no clear morphological evidence for domestication. There is no evidence for the extensive exploitation of sheep, either wild or domestic, during this period. Secondly, the combined PPNC and Yarmoukian ovicaprid sample is dominated by domestic sheep, which comprise 85.6% of identifiable bones, with goats reduced to 14.2% of the same.

Sheep are absent from the most recent MPPNB sub-phases, IV and V, but are present in considerable numbers in the earliest PPNC sub-phase, S-IV. The period between these phases, the LPPNB

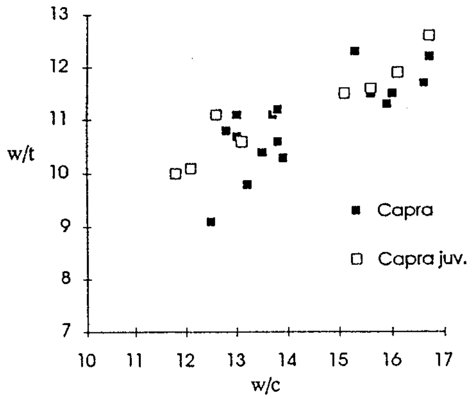
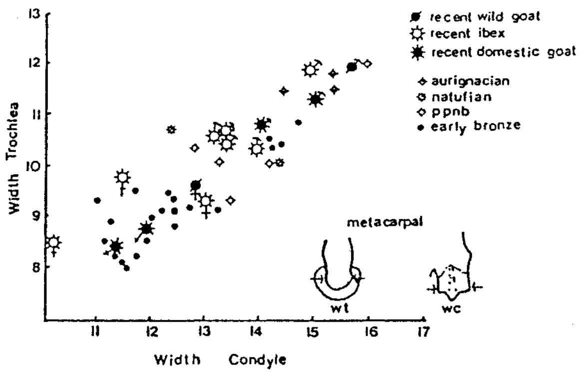


Fig. 7a. MPPNB 'Ain Ghazal goat metacarpal w/cond.-w.troch (mm).



Scattergram of male and female goat distal metacarpals (using measurements defined by PAYNE 1969 from a series of Levantine sites showing the absence of significant metrical changes between the PPNB and earlier periods. Data from DAVIS 1981 and unpublished data, Kolska Horwitz.

Fig. 7b. Goat metacarpal w/cond.-w.troch (mm) from a series of Levantine sites (HORWITZ 1989).

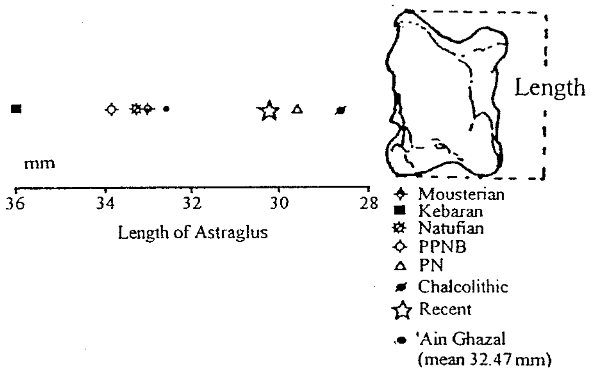


Fig. 8. Comparison of MPPNB 'Ain Ghazal mean goat astragalus Gli with that from a series of Levantine sites (after HORWITZ 1989).

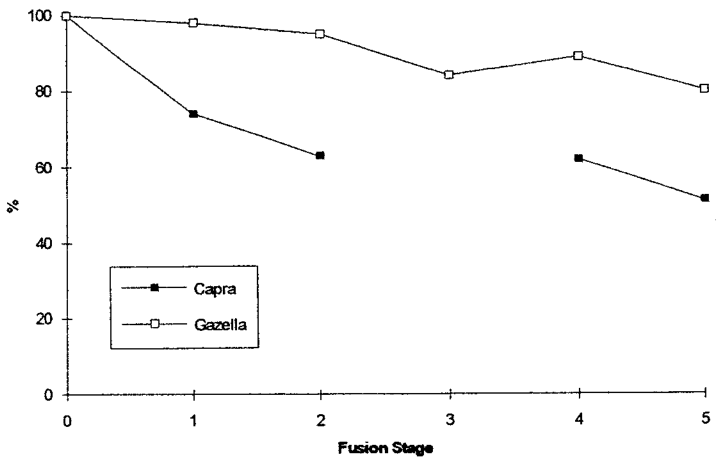
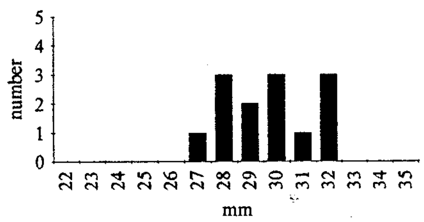
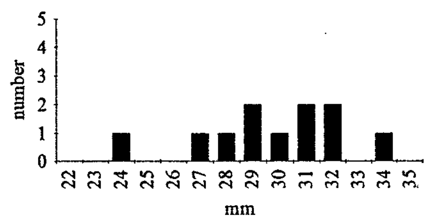


Fig. 9. Survivorship curves for MPPNB 'Ain Ghazal goat and gazelle.



(mean 30.28 mm)



(mean 30.20 mm)

Fig. 10. 'Ain Ghazal sheep humerus DT by phase <*left: PPNC, right: Yarmoukian*>.

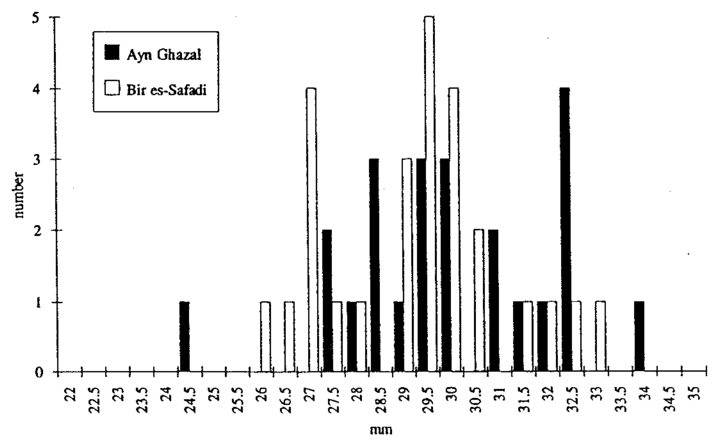


Fig. 11. Comparison of PPNC-Yarmoukian 'Ain Ghazal sheep humerus DT with data from Chalcolithic Bir es-Safadi (GRIGSON 1987).

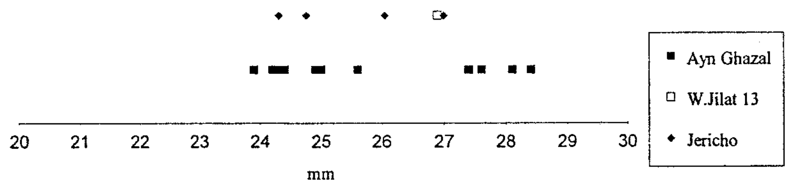


Fig. 12. Comparison of PPNC-Yarmoukian 'Ain Ghazal sheep metacarpal Bd with data from Late Neolithic Wadi Jilat 13 (POWELL 1993) and Early/Middle Bronze Age Jericho (CLUTTON-BROCK 1979).

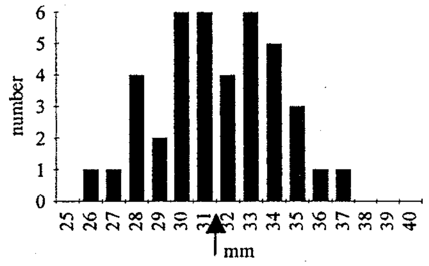


Fig. 13a. MPPNB 'Ain Ghazal "goat" astragalus Gli *<arrow represents Uerpmann's "standard" for goat>.*

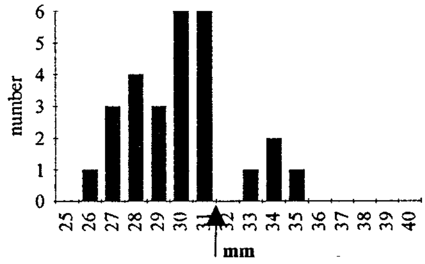


Fig. 13b. PPNC-Yarmoukian 'Ain Ghazal "goat" astragalus Gli *<arrow represents Uerpmann's "standard" for goat>.*

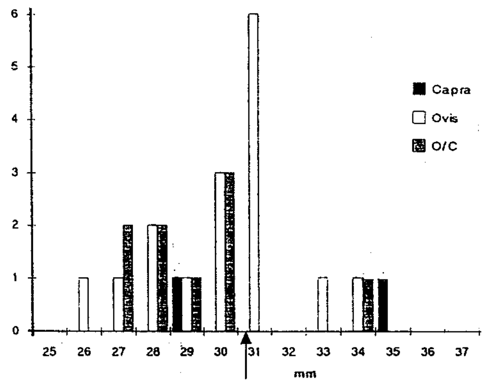


Fig. 14a. MPPNB 'Ain Ghazal goat, sheep and ovicaprid astragalus Gli *<arrow represents Uerpmann's "standard" for goat>.*

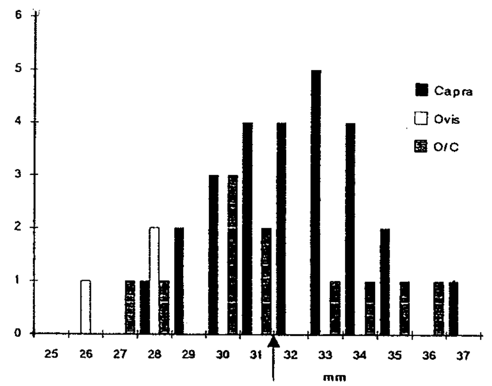


Fig. 14b. PPNC-Yarmoukian 'Ain Ghazal goat, sheep and ovicaprid astragalus Gli *<arrow represents Uerpmann's "standard" for sheep>.*

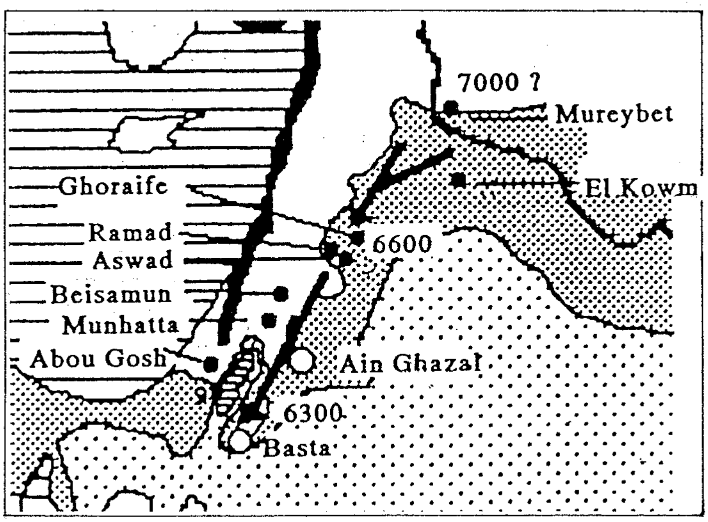


Fig. 15. Site locations and possible diffusion of domestic sheep (DUCOS 1993).

(c. 6500-6000 b.c.), has had only limited investigation at 'Ain Ghazal and has consequently yielded an ovicaprid sample of only 10 specimens. The nature of the change from goat to domestic sheep remains unclear, and all that can be said with certainty is that it occurred between *c.* 6500 and 6000 b.c.

The results outlined above are of considerable interest with regard to the early Holocene distribution of wild goat and wild sheep and to human exploitation of these taxa during the Neolithic.

Early Holocene Distribution of Wild Sheep and Wild Goat

The favoured habitat of the wild goat is craggy, mountainous terrain (GARRARD 1984: 125). During the period in question it appears to have had a widespread distribution throughout the Fertile Crescent, wherever such terrain was to be found; "in addition to its present range, the wild goat occupied more extensive territories during the Early Holocene and at the end of the Pleistocene. The most conspicuous extension of its former range reached south along the Levantine shore of the Mediterranean well into Palestine and the Transjordanian highlands" (UERPMANN 1987: 114). Wild goats feature in the faunal assemblages of Natufian Mallaha and Beidha and Protoneolithic Jericho (HECKER 1982: 228). This long history of goat exploitation in the southern Levant argues strongly against the species being introduced from outside, and all the evidence points towards it thriving in the cooler, more mountainous areas of the region as a native species.

The results from 'Ain Ghazal support such a contention. Ovicaprids comprised 53.1% of the PPNB sample from the 1984 season (KÖHLER-ROLLEFSON *et al.* 1988: 429). This study has suggested that these consisted of morphologically wild goats which formed part of the faunal assemblage from 'Ain Ghazal from the earliest periods of the site's occupation. Furthermore, when one considers that the Wadi Zarqa upstream from 'Ain Ghazal forms a "relatively steep sided, canyon-like feature" (ROLLEFSON 1984: 3) it would appear likely that these goats were living in the vicinity of the site.

Wild sheep appear to have had a more restricted range than the wild goat during the early Holocene. The earliest evidence for sheep exploitation is confined to southern Anatolia and the Zagros mountains, where the earliest sheep domestication took place in the early 7th millennium b.c. Sites such as Hayaz Höyük, Çafer Höyük and Çayönü in southern Anatolia and Ali Kosh, Ganj Dareh and Asiab in the Zagros mountains have yielded both wild and domestic sheep remains (DUCOS 1993a: 168). In the central Levant "despite extensive excavations of terminal-Pleistocene and early-Holocene sites in northern Israel, central and northern Jordan and southern Syria, no remains of wild sheep have been found which date to before 6,500 b.c." (GARRARD *et al.* 1996). Limited numbers of sheep bones have, however, been identified on a number of sites in the southern Levant such as Wadi Judayid (HENRY and TURNBULL 1985), Abu Salem, Ramat Harif and Rosh Horesha (DAVIS *et al.* 1982), Hatoula (DAVIS 1985) and Jericho (CLUTTON-BROCK 1979). A case can therefore be made for the existence of a population of wild sheep in the extreme south of the Levant which was probably isolated from the more extensive population in northern Syria, northern and eastern Iraq, Turkey and Iran (GARRARD *et al.* 1996). The limited numbers of sheep bones found on sites predating 6,500 b.c. make it unlikely that this population was subject to any form of human exploitation other than occasional hunting (DUCOS 1993a: 168).

The results from 'Ain Ghazal again support such a contention. The absence of sheep at 'Ain Ghazal for the first 1000 years of its occupation, followed by their introduction in large numbers at some point between *c.* 6500 and 6000 b.c., suggests that sheep were not locally domesticated. Sheep also appear late in the faunal assemblages from the Aswad, Ghoraife, Ramad sequences at *c.* 6500 b.c. (DUCOS 1993a) and from Basta at *c.* 6300 b.c. (BECKER 1991) and Jilat 13 at *c.* 6000 b.c. (POWELL 1993).

Developments in Caprine Exploitation at 'Ain Ghazal During the Neolithic

MPPNB

The faunal remains from MPPNB 'Ain Ghazal are typical for the period in the central and southern Levant. Sites such as Jericho, Yiftahel, Munhatta, Aswad, Ghoraife and Beidha are all characterised by "broad spectrum" hunting, with goats subject to *proto-élevage* forming a large proportion of the faunal remains. According to Horwitz (1989) animal exploitation over the Early, Middle and Late phases of the PPNB was characterised by a shift from generalised hunting to incipient domestication, which is thought to have evolved as a response to sedentism "enabling humans to store meat on the hoof and have a continuous source of readily available meat" (KÖHLER-ROLLEFSON 1989b: 203). In terms of species exploitation this meant that the reliance on gazelle hunting typical of PPNA sites such as Gilgal, Hatoula, Jericho and Nahal Oren (HORWITZ 1993: 172) had to give way to a more intensive exploitation of a species better suited to develop a closer relationship with humans.

Goats were ideal as they "live in herds with loose sex structure, are polygamous, non-territorial, adaptable in diet (both grazing and browsing) and to some extent in habitat (and) have a high annual productivity of young as well as good meat yields" (GARRARD 1984). As a result they became the preferred species on the bulk of sites in the 'moist steppe corridor' of the central and southern Levant. Two factors were probably involved in this development. Firstly, this area was probably part of the natural habitat of the wild goat, therefore the species was already present to be exploited. Secondly, as animal domestication is thought to have evolved in response to sedentary farming, it is not surprising that the animal most suited to undergo this process became predominant in the region where the earliest agricultural sites are located. It was only on sites situated in the woodland zone and the drier steppe to the west and east that hunting of local wild species remained predominant throughout the PPNB. For example, gazelle was the dominant species at Nahal Oren (HORWITZ 1993: 36), as were gazelle, wild onager and hare at Jilat 7 (GARRARD *et al.* 1988: 47-48).

Garrard *et al.* (1996) have argued that the more dispersed pattern of settlement in these areas, which were also less suited to farming, may have resulted in the greater survival of wildlife. This ready availability of game was probably a major factor in the continuation of hunting in these areas. In contrast, over-hunting of game in the more densely settled areas lying within the range of the wild goat could well have forced an increasing reliance on goat *proto-élevage.*

At least two parallel subsistence strategies may therefore have operated in the central and southern Levant during the MPPNB: *proto-élevage* of goats in the areas where the species was present and continued hunting of wild species in those areas where it was not.

At 'Ain Ghazal during the MPPNB approximately half the animal remains came from goats and the rest came from hunting a range of over 50 wild species (see Table 2). The heavy dependence on a local goat population of limited mobility suggests a highly sedentary and organised way of life. For three reasons it is suggested that the MPPNB goats from 'Ain Ghazal were morphologically and probably behaviourally similar to the wild goat:

1. The early Holocene range of the wild goat would probably have included the 'Ain Ghazal area.
2. A previous examination of the horn cores by Köhler-Rollefson revealed no morphological differences from the wild form. These "were typical for *Capra aegragrus* in regards their size and scimitar shape, with no signs of twisting or lateral compression." (KÖHLER-ROLLEFSON 1983: 6)
3. Measurements taken on the MPPNB 'Ain Ghazal goat bones during the course of this study revealed no sign of size reduction, either from the wild "standard", which would have indicated the introduction of previously domesticated goat to 'Ain Ghazal, or across the sub-phases of the MPPNB, which would have suggested progressive goat domestication at the site itself. Indeed, there is nothing to suggest that the MPPNB 'Ain Ghazal goats were in themselves any different from *Capra aegragrus.*

The goat remains themselves therefore suggest human exploitation of a zoologically wild animal. However, there is other evidence to suggest that this exploitation was different to that of a wild population subject to generalised hunting.

Köhler-Rollefson (1983: 6-7) has identified an abnormally high level of skeletal pathologies, particularly of the lower limb bones, in the 'Ain Ghazal goat population which are thought by Köhler-Rollefson (1989b: 204) to have been the result of penning and tethering (also see KÖHLER-ROLLEFSON, this volume). The 'Ain Ghazal goats were therefore being exploited in a manner that "on the one hand exposed (them) to a higher chance of the development of bone diseases, but also resulted in a higher survival rate for diseased goats" (KÖHLER-ROLLEFSON 1983: 7) than would have been the case in a normal wild population.

The survivorship curves for goat and gazelle reveal a contrast in slaughter patterns. Substantially more young goats were being killed than young gazelle. Only *c.* 55% of goats, as opposed to *c.* 80% of gazelle were surviving into maturity. The gazelle curve differs radically from the normal mortality rate in a wild population, where *c.* 50% of animals reach adulthood (BAHARAV 1974). The fact that *c.* 80% of gazelle at 'Ain Ghazal were adult can be ascribed to a hunting strategy based primarily on the slaughter of prime meat animals. The survivorship curve for goats reveal that a proportion of immature individuals were being slaughtered in addition to prime meat animals. As yet there is no conclusive evidence for the exploitation of secondary products, such as milk or wool, during the Neolithic. It must therefore be assumed that the 'Ain Ghazal goats, as well as the gazelle, were being exploited for meat. The taphonomy of the bones supports such a contention (see Methodology, paragraph 3).

This difference in survivorship may have resulted not from the goats being exploited for secondary products but from differences in behaviour between the two species. At least some species of Middle Eastern gazelle underwent migrations; in the case of *Gazella subgutturosa* this may have involved distances of hundreds of kilometers (LEGGE 1987: 91). This species was one of those exploited at 'Ain Ghazal during the PPNB (KÖHLER-ROLLEFSON 1988: 425). Goats, however, have very small home ranges; these are seldom more than 25 km^2 (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 40). The sheer volume of goat bones at MPPNB 'Ain Ghazal indicates the continued presence of large numbers of goats in the area. In order to avoid overkill of a localised wild goat population, the inhabitants of 'Ain Ghazal would probably have had to practise conservation measures which could be viewed as a form of cultural control. In Jordan today only three or four male goats are required to maintain a stable population in a herd of up to 150 animals (KÖHLER-ROLLEFSON 1983: 12-13); most males are slaughtered before they reach maturity. It is therefore possible that a proportion of goats superfluous to the maintenance of a stable population (*i.e.*, young males) were being targeted during the MPPNB at 'Ain Ghazal. As gazelle were much less localised it would have been less damaging to focus primarily on prime meat animals. Furthermore, whilst an immature goat may usefully be exploited for meat, this is not the case for gazelle owing to the difference in size between the two species.

Cultural control of morphologically wild animals has been described by Ducos (1993a: 164) as *proto-élevage* or "une exploitation controllée et raprochée d'un animal maintenu dans son biotope et son éthologie naturels." Ducos also suggests that this represents the status of goats on all sites in the southern Levant where the species dominated the faunal assemblages but displayed no morphological characteristics of domestication.

Horwitz, after consideration of osteological, cultural and biological evidence, has proposed a linear four phase model of the domestication process, with particular reference to caprovines (HORWITZ 1989: 173 and see Fig. 2). This model progresses through phases of Generalised Hunting, Incipient Domestication, Domestication and Husbandry. A focused and highly selective hunting strategy characterises the phase of Incipient Domestication, ending in the isolation of a part of the wild population. The term Domestication is reserved for the following phase and is characterised by the artificial selection of animals for breeding. It should be noted that the morphometric changes associated with domestication would not necessarily occur until this phase. Drawing on data from the southern Levant, Horwitz has concluded that it is highly unlikely that artificial selection occurred in this area until the end of the LPPNB (6000 b.c.) at the earliest, although the possibility of cultural control/ *proto-élevage* in earlier periods is not ruled out.

In terms of this model the *proto-élevage* of goats characteristic of MPPNB 'Ain Ghazal would represent Incipient Domestication. The frequency of pathologies in the goat population suggests that Population Isolation (sub-phase B2) may have been achieved. However, it should be mentioned that 'Ain Ghazal represents a "null case"' in the progressive development of goat domestication. At some point between *c.* 6500 and 6000 b.c. the process was cut short and the species largely replaced in the faunal record by sheep, which had undergone the full domestication process to Husbandry elsewhere.

LPPNB

At *c.* 6500 MPPNB "broad spectrum" hunting, heavily reliant on *proto-élevage* of goat, was predominant over most of the central and southern Levant. By 6000 b.c. it had been replaced by a strategy relying on a few domestic species: sheep, goat, pig and cattle. The LPPNB is crucial in understanding the nature of this shift and is unfortunately rather poorly sampled, not only at 'Ain Ghazal, but over the region as a whole. A sample of *c.* 100,000 animal bones has been collected from LPPNB Basta and represents one of the best sets of faunal data available for the period. Domestic goats and sheep comprise 76.4% of the faunal assemblage from the beginning of the site's occupation at *c.* 6300 b.c. (BECKER 1991: 62). It is not yet clear whether the cattle and pig remains represent wild or domestic animals (BECKER 1991: 66). If it is assumed that they did not, 78.4% of the bones from Basta came from domesticates (BECKER 1991: 63).

The sequence from Aswad and Ghoraife (DUCOS 1993a) also suggests that the LPPNB was a period characterised by a decline of hunting and its replacement by an increased reliance on domestic animals. At MPPNB Ghoraife I, gazelle and morphologically wild goat comprise *c.* 60% of the faunal remains (DUCOS 1993a: 159), in accordance with typical MPPNB subsistence strategy. At LPPNB Ghoraife II cattle and pig both increased from their Ghoraife I representation (DUCOS 1993b: 43), domestic sheep and goat comprise *c.* 50% of the faunal remains and gazelle is reduced to 6.49% (DUCOS 1993a: 159). Additional, though indirect, evidence for the decline of hunting in the LPPNB comes from Abu Ghosh and Beisamoun, where ovicaprids greatly outnumber gazelle (HORWITZ 1993: 36) It should be stressed that continued hunting of wild species existed in parallel with these developments outside the natural range of the goat.

At 'Ain Ghazal, the diminution of the 'broad spectrum' was apparently underway by the LPPNB (see Table 2). Rollefson has suggested that domestic cattle, pigs and possibly sheep may have been introduced in this phase (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 36), although it should again be emphasised that the faunal sample as a whole is very small.

PPNC and Yarmoukian

It has only recently been established that settlement continued uninterrupted in the same localities in the central and southern Levant between the postulated collapse of PPNB culture at the end of the 7th millennium b.c. and the emergence of the Pottery Neolithic at *c.* 6500 b.c. So far only a limited number of PPNC sites have been investigated and even fewer faunal reports published. Nevertheless, there do appear to be some general trends in the pattern of faunal exploitation across the region that are reflected in the faunal assemblage from 'Ain Ghazal. Apart from mentioning that Yarmoukian subsistence patterns, both at 'Ain Ghazal and at sites such as Tell Abu Thawwab and Tell Wadi Feinan (KAFAFI 1993) appear to display a slightly increased reliance on domesticates and a slightly reduced range of wild species compared with the PPNC (see Table 2), the period will not be discussed further. This is because, generally speaking, they differ little from the general pattern of PPNC subsistence, suggesting that the crucial developments had already taken place. It should be noted in passing that the decline in the importance of goat continued during the Yarmoukian at 'Ain Ghazal.

The collapse of "broad spectrum" hunting appears to have continued into the PPNC over much of the central and southern Levant. At Ramad I, for example, domestic sheep and goat comprised *c.* 70% of the sample, a rise of *c.* 20% from their LPPNB representation at Ghoraife II. Gazelle, wild equids and birds were all reduced from their LPPNB levels (DUCOS 1993a: 159). The status of cattle and pig at Ramad I remains uncertain. Goat and sheep were also present in the semi-arid zone at Final Neolithic (PPNC) Azraq 31 Area C (BAIRD *et al.* 1992: 25), Jilat 13 and Jilat 25 (GARRARD *et al.* 1994: 98), although at lower frequencies than appears to have been the case further west. Even after the introduction of presumably domestic ovicaprids to these sites, hunting of gazelle, hare and fox continued to be important. By the PPNC sheep appear to have been introduced over much of the central and southern Levant; at Ramad, 'Ain Ghazal and Jilat 13 and Jilat 25 sheep clearly outnumber goats.

At 'Ain Ghazal the PPNC saw a reduction in the number of hunted species represented and a corresponding increased reliance on domesticates, predominantly ovicaprids, which increased from *c.* 50% in the MPPNB to *c.* 70% in the PPNC, but also with smaller quantities of cattle and pig (see Table 2). It has now been shown that the PPNC ovicaprids were dominated by sheep, which comprised 52% of the ovicaprid sample, with goats greatly reduced from their MPPNB predominance to 11%. Two lines of argument suggest that these sheep emerge at 'Ain Ghazal in a fully domesticated state.

Large quantities of sheep appear suddenly in the sequence at 'Ain Ghazal between *c.* 6500 and 6000 b.c., in an area where there is only limited evidence for the species existing in its wild form. The appearance of a species outside its natural range is generally taken to be a reliable indicator of domestication (CRABTREE 1993: 215).

The means of measurements taken during the course of this study on the sheep bones compare well with those from animals thought to be domestic, although the range of variation is higher. It is nevertheless clear that the 'Ain Ghazal data are not grossly larger than the domestic comparative data, which would have been expected if the 'Ain Ghazal sheep represented a wild population.

The PPNC and Yarmoukian goat sample consisted of only 14 specimens. Subjectively, when compared with MPPNB specimens, these bones were smaller and less pronounced in their goat-like characteristics. Whether this genuinely reflects size reduction in the goat population at the same time as the introduction of domestic sheep to the site, or whether it is merely a bias induced by the small sample size, remains uncertain. Significantly, desert species such as wild onager and the Desert Monitor lizard first appear at 'Ain Ghazal in the PPNC (KÖHLER-ROLLEFSON 1988: 429).

Incipient Migratory Pastoralism or Northern Migrant Pastoralism?

The heavy reliance on goats documented at many PPNB sites in the central and southern Levant suggests that the 7th millennium b.c. was characterised by an increasing specialisation in goat exploitation, albeit predominantly in those areas supporting a wild population during the early Holocene. The shift from *proto-élevage* of goat to husbandry of sheep by the beginning of the 6th millennium b.c. now revealed at 'Ain Ghazal and elsewhere is of considerable interest to the current debate on the origins of pastoralism, the ultimate ovicaprid specialisation, which is thought to have occurred at around the late 7th and early 6th millennia b.c. (see ROLLEFSON and KÖHLER-ROLLEFSON 1993, PERROT 1993, DUCOS 1993a).

Rollefson and Köhler-Rollefson. (1989; 1993) and Köhler-Rollefson (1988, 1989b) have argued convincingly that the collapse of PPNB culture in the central and southern Levant at the end of the 7th millennium b.c. was at least partially the result of local environmental degradation resulting from prolonged practice of the standard MPPNB subsistence package. Although pollen diagrams and deep-sea cores remain equivocal regarding macro-environmental change at the end of the 7th millennium b.c., there is a strong case for localised environmental degradation around 'Ain Ghazal.

Rollefson and Köhler-Rollefson have argued that the typical MPPNB subsistence package became untenable after a certain population threshold had been reached in a given area. In response "one or several of these exploitation strategies had to be given up or done elsewhere" (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 40). An expansion of 'Ain Ghazal from less than five ha to *c.*

12ha characterised the last half of the 7th millennium b.c.; this growth could have brought the site's population over the critical threshold.

Köhler-Rollefson has argued that livestock husbandry was "the component of human subsistence activities that could most easily be removed beyond the immediate vicinity of the settlement" (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 40) and into the semi-arid zone to the east where seasonal vegetation could have been exploited by the flocks. Drawing heavily on ethnographic parallels, a "fluctuating village" model has been constructed for subsistence activities at 'Ain Ghazal in the 6th millennium b.c. In this model it is suggested that subsistence at 'Ain Ghazal was split into agricultural and pastoral components, as a means of removing the goats from the environs of the site at the critical stages of crop growth. Inhabitants involved in the pastoral sector would have exploited the semi-arid zone with the flocks in autumn, winter and spring, returning to the site in summer for the flocks to take advantage of permanent summer water and crop by-products. Inhabitants involved in agriculture would have remained at the site year-round, tending crops free of the menace presented by goats.

Three sets of data have been cited (ROLLEFSON and KÖHLER-ROLLEFSON 1993: 40, ROLLEFSON 1993: 98) in support of this model:

1. Ovicaprids first appear in the eastern desert of Jordan at *c.* 6000 b.c. at roughly the same time that desert species first appear in the faunal record at 'Ain Ghazal. It is suggested that this represents an increased involvement on the part the inhabitants of sites such as 'Ain Ghazal in the semi-arid zone.
2. The duality seen in architecture and burials at PPNC 'Ain Ghazal (see ROLLEFSON and KÖHLER-ROLLEFSON 1993: 36-38) has been described as representing agricultural and pastoral components of the same population. In addition, it has been suggested that the "corridor buildings" represent semi-subterranean storage bunkers used by the pastoralists during their long absences from the site.
3. Dhabba marble, which has a source in the steppe to the south-east of Wadi Jilat, replaced malachite from Wadi Feinan as the predominant exotic stone at 'Ain Ghazal from the beginning of the PPNC.

In contrast to the local evolution of pastoralism in the central and southern Levant proposed by Rollefson, Perrot (1993) and Ducos (1993a) have suggested that it was introduced to the region, from the north, during the LPPNB. It is argued that this new strategy was apparently based on sheep husbandry and "originated from beyond the middle Euphrates, where it seems to take hold with the beginnings of sheep domestication. It is imported via the Syrian Djezireh." (PERROT 1993: 9)

This view of pastoral origins is based on the fact that although sheep husbandry is first documented at the beginning of the 7th millennium on sites lying within the main area of distribution of early Holocene wild sheep, namely, in southern Anatolia and the Zagros mountains, there is a delay before it can be documented further to the south. Domestic sheep dating to the early to mid 7th millennium b.c. have been identified at Abu Hureyra (LEGGE 1996) and Mureybit (DUCOS 1993b: 43), but do not appear in the central Levant until *c.* 6500 b.c., at Ghoraife I and not until *c.* 6300 b.c. in the southern Levant at Basta (Fig. 15). Furthermore, there appears to be noticeable size reduction of the goat population in the Damascus basin in the late 7th millennium. It has therefore been suggested that the emergence of goat husbandry, as opposed to *proto-élevage*, in the region was in some way associated with the arrival of domestic sheep and mixed sheep and goat husbandry from the north (DUCOS 1993a: 164).

A southward diffusion of herders and sheep has been proposed to account for the emergence of pastoralism in the central and southern Levant. The absence of sheep at LPPNB sites in Galilee, such as Munhatta, Abu Ghosh and Beisamoun, may indicate a diffusion of domestic sheep staying within the moist steppe, which lies between the Mediterranean scrub and Indo-Turanian steppe phytogeographical zones and which has also been termed the Levantine Corridor (BAR-YOSEF and KISLEV 1989). The focus of sheep on sites such as 'Ain Ghazal, which lie in this moist steppe area, may indicate that availability of grazing was influential in determining the path of its advance. Ducos (1993a: 169) has argued that this southward movement was perhaps prompted by the necessity of searching for pasture once sheep were taken out of their natural environment.

The parallel existence throughout much of the LPPNB of northern herders practising sheep husbandry and sedentary communities practising *proto-élevage* of goat has been envisaged. To this should perhaps be added the communities who had maintained a hunting strategy over the 7th millennium b.c. in, for example, the Wadi Jilat (GARRARD *et al.* 1988: 47-48). A complex set of human relationships probably existed in the late 7th and early 6th millennia b.c. in the central and southern Levant.

By *c.* 6000 b.c. sheep husbandry appears to have replaced *proto-élevage* of goat over much of the region. Domestic sheep also appear in more limited numbers at sites such as Azraq 31 and Jilat 13. A distinction has therefore been made between 'primary pastoralism' practised by intrusive groups from the north and "secondary pastoralism" adopted by the inhabitants of many sites in the region by the end of the LPPNB (DUCOS 1993a: 170).

Conclusions

This study of the goat and sheep bones from 'Ain Ghazal has resulted in the addition of significant new data to the previous work of Köhler-Rollefson on the faunal remains from the site. The shift from probable *proto-élevage* of goat to husbandry of sheep between the MPPNB and PPNC now identified at 'Ain Ghazal is highly relevant to the current debate on the origins of pastoralism in the central and southern Levant.

It is probable that aspects of both Rollefson's "Incipient Migratory Pastoralism" and Perrot and Ducos' "Northern Migrant Pastoralism" models are relevant to the beginnings of pastoral specialisation at the site. The case for environmental degradation in the vicinity of 'Ain Ghazal in the late 7th millennium seems undeniable, as does the probable role of goats in that process. Although the heavy reliance on ovicaprids in the PPNC and Yarmoukian suggests that pastoralism was a subsistence strategy practised at the site, the fact that *proto-élevage* of goat was replaced by husbandry of sheep, probably before the goats had completed the full domestication process, suggests that pastoralism did not evolve locally. The appearance of domestic sheep at 'Ain Ghazal between *c.* 6500 and 6000 b.c. instead supports Perrot and Ducos' suggestion that sheep and pastoralism were introduced as a package to the central and southern Levant during the LPPNB. Human control of the movements of domestic caprines, which is the basis of nomadic pastoralism, in the southern Levant seems to be inextricably linked to the introduction of domestic sheep.

Sheep are far easier to control than goats, tending to cluster together rather than spreading out across the landscape (DUCOS 1993a: 169); this makes them preferable to goats in areas supporting crop cultivation. Sheep are therefore easier to move from one place to another as their flocks are more cohesive, although the addition of a few goats improves leadership and tends to keep the animals moving (LANCASTER F., pers. comm.)

This may be one of the reasons why goat exploitation in the southern Levant during the MPPNB seems not to have gone beyond *proto-élevage*. However, it should be noted that a number of researchers do not rule out the possibility that full goat domestication occurred independently in the south Levant by *c.* 6500 b.c. (GARRARD, pers. comm. and LEGGE 1996). A larger sample of LPPNB and PPNC goat bones is required before the relationship between the introduction of the sheep-based pastoralism to the region and the development of goat husbandry can be clarified. Nevertheless, sheep, goats and presumably pastoralism were introduced as a package to the Wadi Jilat area by *c.* 6000 b.c., providing a *terminus ante quem* for the process.

The introduction of "primary pastoralism" to the region is less interesting than the reasons why it might have been adopted as "secondary pastoralism" by the inhabitants of villages such as 'Ain Ghazal. The problems of determining ethnicity from material culture are well known and prevent effective resolution of the problem in an area where it has been proposed that several groups of people were pursuing similar subsistence activities. The Köhler-Rollefson's "fluctuating village" model is one example of how "secondary pastoralism" may have operated in practice.

It is noticeable how *proto-élevage* of goat in the MPPNB was confined to those areas which would probably have supported a wild population during the early Holocene. These areas are also those which were better suited to arable farming (GARRARD 1984: 126) and consequently more densely settled. Sites in areas climatically and/or topographically less well suited to arable farming, such as the Mount Carmel region of Palestine (GARRARD 1984: 118) or the semi-arid zone in Jordan did not develop a relationship with animals that went beyond generalised hunting until after *c.* 6000 b.c. and their settlement density was much lower.

When ovicaprid husbandry, based predominantly on sheep, was introduced to the central and southern Levant, probably during the LPPNB, the two zones outlined above varied in their responses to the arrival of this technological innovation. In areas that had been practising *proto-élevage* of goat in an agricultural context during the 7th millennium b.c., ovicaprid husbandry appears to have replaced this earlier subsistence strategy. In areas which had maintained a hunting strategy throughout the 7th millennium b.c. ovicaprid husbandry was adopted as an adjunct to PPNB practice and not as its replacement. In short, this innovation appears to have been better received in the former zone.

Three factors were possibly involved in this varied response:

1. The longer history of closer man - animal relationships in those areas that had practised *proto-élevage* of goat.
2. The more ready availability of game in the less densely settled areas that had maintained a hunting-based subsistence throughout the 7th millennium b.c.
3. The environmental degradation resulting from prolonged *proto-élevage* of goat in an agricultural context.

For the first time ovicaprid husbandry allowed humans to closely control the movements of potentially destructive animals, thus allowing agriculture and pastoralism to exploit separate zones as suggested by Rollefson and Köhler-Rollefson. (1993: 40). This would make environmental degradation one of the key incentives to replace PPNB subsistence strategies in areas which had practised *proto-élevage* of goat. In contrast, Lancaster and Lancaster (1991: 135) have argued that a heavy reliance on ovicaprid husbandry in the semi-arid zone is impractical unless the animals were exploited for milk. Lacking environmental degradation as an incentive to replace 7th millennium subsistence strategies with an innovation that, if it is assumed that milking was unknown in the Neolithic, failed to offer any real advantage, it is not surprising that the response of inhabitants of sites such as Jilat 13 to ovicaprid husbandry was rather more half-hearted.

The well documented evidence for the presence of domestic sheep at Basta as early as *c.* 6300 b.c. may well prove to support the suggestion that villages such as 'Ain Ghazal adopted "secondary pastoralism" in response to environmental degradation resulting from MPPNB subsistence strategies. "I would not be surprised if one day it turned out that signs for pastoralism show up in Basta earlier than in 'Ain Ghazal, due to the fact that Basta lies right on the edge of the vast steppe eventually leading over to the deserts of the Arabian peninsular. In this sense Basta lies much more in a threshold area than 'Ain Ghazal" (NISSEN 1993: 182).

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Animal Remains From 'Ain Rahub

Abdel Halim al-Shiyab

Abstract: *The site of 'Ain Rahub in Jordan has produced a small number of fragmented bones. Because bone fragmentation is so high, I was only able to identify 19.8% of the material. Eight species of animals came from the Final Natufian (*Equus caballus, E. hydruntinus, E. hemionus, Bos primigenius, Gazella gazella, Capra aegagrus, Sus scrofa, *and* Canis lupus*), with* G. gazella *the most numerous. Five species came from the Yarmoukian component (*E. caballus, B. taurus, G. gazella, S. scrofa *and* V. vulpes*), with* B. taurus *dominant and also representing the only domestic species. The greater quantity of animal bones during the Final Natufian period compared with the Yarmoukian suggests that the site was more heavily occupied in the Final Natufian period, and the absence of Caprinae or Ovinae in the Yarmoukian period indicates that the site was used only as a camp for hunting wild animals.*

Introduction

The site of 'Ain Rahub is situated about 13km northeast of Irbid, on the lower terrace of the west bank of Wadi er-Rahub (Fig. 1; MUHEISEN *et al.* 1988) (Fig.1). The altitude of this site is 410m above sea level and the annual precipitation is about 400mm. Today the plateau on both sides of Wadi er-Rahub is cultivated in cereals and watermelon. The climate of this area is typical of that of the Mediterranean region, which is cool in winter and hot in summer. This site was first discovered by Z. Kafafi and S. Mittmann in 1983, and identified as Epipalaeolithic. 1984 H.G. Gebel visited the site with S. Mittmann and assigned the surface finds to the Late Natufian. No surface indication hinted to the existence of Yarmoukian layers. Excava-

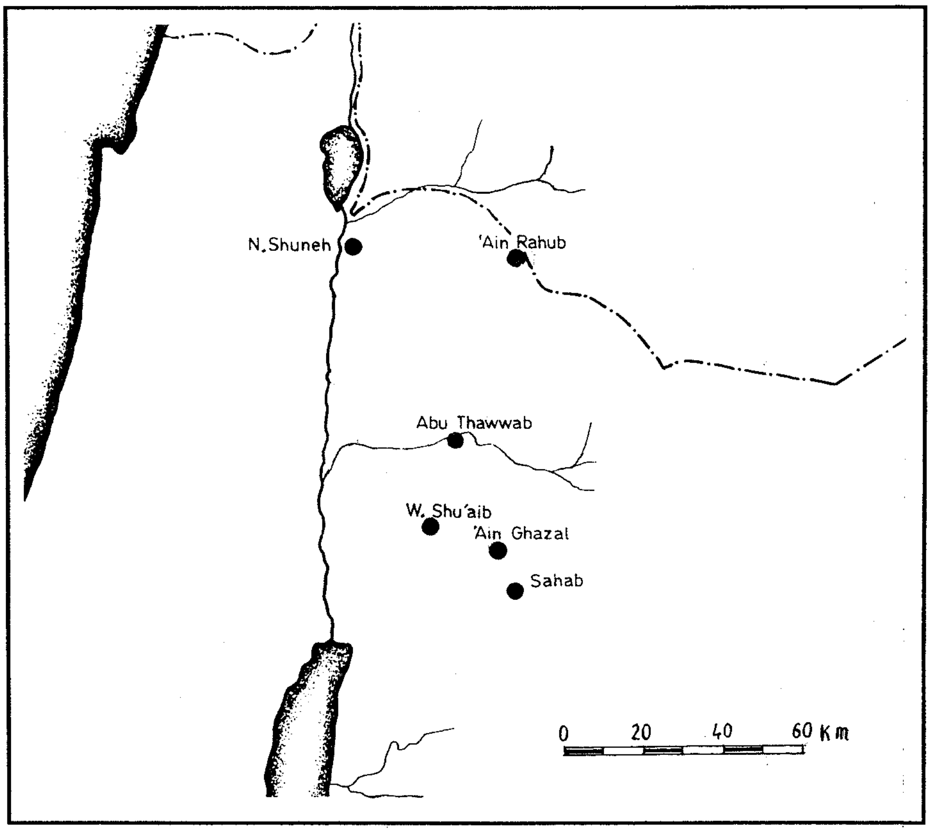

Fig. 1. Location of 'Ain Rahub in northern Jordan, and other Late Neolithic excavations.

tions were begun in 1985 as a joint project between Yarmouk University and the University of Tübingen[1]. Fieldwork showed that 'Ain Rahub actually was occupied during two periods: the Final Natufian and the Yarmoukian. The Yarmoukian was found embedded in the colluvials of the slope, and could not be traced on the surface.

Composition of the Material

1500 bone fragments were recorded from 'Ain Rahub, and 297 of them were identifiable; 240 of these came from the Final Natufian and 57 fragments came from the Yarmoukian. These numbers are very small, reflecting the high percentage of fragmentation, which is 80.2%. The fragmentation indicates to me that the majority of the faunal bone fragments were discarded by human after consumption. Furthermore, 2% of the material was completely carbonized.

The Final Natufian faunal assemblage is dominated by the remains of gazelles (*Gazella gazella*), which compose 60.42% of the identifiable specimens. In the Yarmoukian domestic cattle dominated (*Bos taurus*) at 42.11%.

Material Identified From the Final Natufian

Bovinae

Bos primigenius: Seven milk teeth, one upper premolar, three upper molars, seven incisors, six lower molars, one distal extremity of a scapula (glenoid cavity), one distal extremity of a humerus, two capitatotrapizoids, one proximal extremity of a tibia, one complete astragalus, one complete calcaneum, one cubonavicular, four first (proximal) phalanges, four second (middle) phalanges and six third (distal) phalanges.

Caprinae

Capra aegagrus: Horns, two milk teeth, one upper premolar, one upper molar, one lower premolar, five lower molars, four distal extremities of scapulae, one humerus, one metacarpal, one tibia, one patella, three astragali, two calcaneae, one cubonavicular, two first phalanges, one second phalange.

Antilopinae

Gazella gazella: One upper premolar, seven upper molars, one incisor, two lower premolars, eight lower molars, two distal extremities of scapulae, nine distal extremities of humeri, five distal extremities of metacarpals, one femur, three distal extremities of a tibia, 18 astragali, five calcaneae, six cubonaviculars, 23 first (proximal) phalanges, 31 second phalanges and 13 third phalanges.

Equidae

Equus hydruntinus: One upper second molar.

Equus hemionus: Two upper milk teeth, one upper second premolar, two upper premolars/molars, one upper third molar, one lower second premolar, five lower premolar/molars, one lower third molar, three first phalanges, and one second phalange.

Carnivores

Canis lupus: One upper first molar, one upper third molar, one fragment of mandible supporting canine, four premolars and one first molar.

Table 1. Percentages of animals in the Final Natufian layers of 'Ain Rahub.

Species	n	%
Bos primigenius	46	19,16
Capra aegagrus	27	11,25
Gazella gazella	145	60,40
Equus hemionus	18	7,20
E. hydruntinus	1	0,41
Canis lupus	3	1,25
Total	**240**	**100**

Table 2. Percentages of animals in the Yarmoukian layers of 'Ain Rahub.

Species	n	%
Equus caballus	4	7,00
Bos taurus	24	42,11
Gazella gazella	18	31,58
Sus scrofa	5	8,77
Vulpes vulpes	6	10,53
Total	**57**	**100**

[1] The co-directors were M. Muheisen of Yarmouk University and H.G. Gebel, then at the University of Tübingen.

Material Identified From Yarmoukian

Bovinae

Bos taurus: Six milk teeth, three lower molars, three fragments of metacarpals, four astragali, one cubonavicular, one first phalange, and six third phalanges.

Suidae

Sus scrofa: Five fragments of mandible.

Antilopinae

Gazella sp.: 18 various fragments.

Equidae

Equus caballus: four first phalanges.

Carnivores

Vulpes vulpes: One distal extremity of a humerus, one ulna, one tibia, two astragali and one calcaneum.

Discussion

A major problem that faces archaeozoologists is the state of bone preservation. The bones of all members of the faunal groups tend to be highly fragmented in archaeological sites because of processing to take out the bone marrow. The morphological discrimination between different species depends on those scarce finds that are well-preserved for identification. For best analytical results, we need to look at comparative material from both contemporaneous sites and from modern collections. The author examined bone samples from 'Ain Ghazal (PPNB) and Jericho (PPNB) and relied on published accounts for collections from the following sites: Wadi Judayid (Natufian), Jebel Qafzeh (Natufian-Khiamian; BOUCHUD 1974), 'Ain Mallaha (Natufian), and Tell Mureybet (Natufian; DUCOS 1978).

Bovinae (*Bos primigenius* and *B. taurus*)

Aurochs (*B. primigenius*), the ancestor of domestic cattle (*B. taurus*), was exterminated from the world in 1627 (UERPMANN 1987, CLUTTON-BROCK 1989). At 'Ain Rahub the materials from the Final Natufian were very fragmented and sometimes highly carbonized. The measurements of these bones are very large and similar to those from 'Ain Ghazal and Jericho, but they are somewhat smaller than those from Wadi Judayid, Jebel Qafzeh, 'Ain Mallaha and Tell-Mureybet. According to Bökönyi (1978), Davis (1981), and Bouchud (1987), the reduction in the size of the animals started at end of Upper Pleistocene due to a rise in global temperature. I have noticed that the reduction in the size of *B. primigenius* started at the end of Late Pleistocene, and I found that those animals recovered from the Early Natufian are bigger in size than those from 'Ain Rahub, which are the same as in the Neolithic. This kind of animal was hunted and played a very important role in the economy by providing a large quantity of meat for the Natufians. In the Yarmoukian period, *B. taurus* was not only very important, it was also the most numerous animal in the sample.

Antilopinae (*Gazella gazella*)

Gazelle were the most important and interesting animals for humans during the Natufian period. Because of their small size and their nature to live in groups, they may have been easily controlled and certainly were hunted in big numbers. Gazelles dominated other animals in all Natufian archaeological sites in the Middle East, and in 'Ain Rahub it comprised 60.42% of the identifiable remains. Most of the fragments are from juveniles, which indicates that if the Natufians did not actually control the gazelle, they were aware of the seasonal time of birth, which usually occurred at the end of April. The measurements are the same as found in 'Ain Mallaha (BOUCHUD 1987), 'Ain Ghazal and Jericho (CLUTTON-BROCK 1979). There is a dramatic reduction in the number of gazelle bones during the Yarmoukian period (to only 31.58%), which mirrors a shift to other small animals like domestic goat and sheep.

Caprinae (*Capra aegagrus*)

Post-cranial bone fragments of small ruminants (sheep and goat) are difficult to discriminate to species level because of their close similarity. The bone fragments identified at 'Ain Rahub morphologically belong to a species of Caprinae, and from the morphology of horn core, these fragments refer to the wild goat (*C. aegagrus*). Actually, this type of animal prefers to live in the mountains and is usually endemic to this region of the Middle East (DUCOS 1968, BOUCHUD 1987).

The size of these bones from 'Ain Rahub is similar to those from Wadi Judayid (HENRY *et al.* 1985), 'Ain Ghazal, and Shams ed-Din Tannira (UERPMANN 1982) and a little bit smaller than those from 'Ain Mallaha and Munhata (DUCOS 1968). Also, I found that Caprinae were not important to the human populations in Jordan until the MPPNB (*e.g.*, at 'Ain Ghazal), when it dominated all other animals and was probably being domesticated (KÖHLER-ROLLEFSON *et al.* 1988).

Equidae

Equus hydruntinus

This species of Equidae was not domesticated because of its dangerous character. It originated in Europe and is characterized by its small size. It has been recorded in southern Europe and the Middle East from the early Upper Pleistocene to the Late Neolithic (STEHLIN and GRAZIOSI 1935, TCHERNOV 1984, FAURE and GUERIN 1987). At 'Ain Rahub I identified only one well-preserved upper second molar which is typical of *E. hydruntinus*.

Equus hemionus

This animal is common in Jordan, Syria and Palestine. It is a difficult problem to distinguish it from other species such as *E. asinus*. In the Middle East Equidae were very important during the Late Pleistocene, playing an essential role in the economy because of its large size for producing meat (UERPMANN 1982). 'Ain Rahub produced only a few isolated teeth, which are well preserved. The morphology of the double buccle of the teeth and the form of the diaphysis of the first phalange, which is long and cylindrical, suggest that these bones belong to the hemione type. Their size is a little bit larger than the teeth of *E. asinus*. When I compared these materials with *E. hemionus hemipus* (Syrian type) and *E. h. onager* (Iranian type), I noticed that the size of *E. h. hemipus* is smaller.

Equus caballus (not domesticated)

Four complete phalanges were discovered in the Yarmoukian period. It is easy to discriminate between their size and forms. Eisenmann and de Giuli (1974) and Eisenmann (1981) mentioned that the middle of the shaft of the first phalange is very solid and the distal supra articular tuberiosities are very developed and situated far away from the distal extremity.

Carnivores

Canidae

Canis lupus

In the absence of the skull, it is difficult to distinguish between *C. lupus* and *C. aureus*. Because *C. lupus* is more frequent in the region and larger in size than *C. aureus*; at 'Ain Rahub, the morphology of these faunal remains indicates they belong to *C. lupus*. The measurements are larger than those found at 'Ain Mallaha (BOUCHUD 1987) and 'Ain Ghazal (personal observations).

Vulpes vulpes

Red fox is present in the Middle East from Middle Pleistocene until today (KURTÉN 1965, TCHERNOV 1984, FAURE and GUERIN 1987). During the Yarmoukian period at 'Ain Rahub, I identified five bones of one individual red fox; its size is similar to those found in 'Ain Ghazal.

Suidae (*Sus scrofa*)

The presence of wild boar (*Sus scrofa*) is not frequent at 'Ain Rahub. I found only five fragments of mandibles that morphologically belong to the European group. When I compared these fragments with *S. scrofa* already studied at 'Ain Mallaha (BOUCHUD 1987) and 'Ain Ghazal, I noticed that the size and the morphology of these materials are homogeneous.

Table 3. Percentages of animals in other Natufian sites compared with 'Ain Rahub.

Site	Mallaha	Hayonim	Wadi Hammeh 27	'Ain Rahub
precipitation	600-700	600-800	200	400
Gazella sp.	54,5	83,2	65,7	60,40
Bos sp.	6,6	0,0	0,4	19,16
Capra sp.	4,9	0,5	6,2	11,25
Dama sp.	10,7	14,2	0,4	0,00
Equus sp.	0,3	0,0	0,7	8,10
Canis sp.	2,9	0,0	0,7	1,35
varia	20.1	2.1	25,9	0.0
Source	BOUCHUD 1987	BAR-YOSEF and TCHERNOV 1967	EDWARDS *et al.* 1988	

Conclusions

The site of 'Ain Rahub has produced a small number of fragmented bones, most of them from the Final Natufian. In this period, the identified animals were wild, and gazelle was present in large quantity. The abundance of phalanges and the proximal and distal extremities of long bones suggest that the hunters of the Natufian population did not have any special killing or butchering methods.

To understand the ecology and the economy of this site, a comparison was made with three Natufian sites in Jordan and Palestine: Wadi Hammeh 27, near Pella in the Jordan Valley (EDWARDS *et al.* 1988, EDWARDS 1991); Hayonim, near the sea and west of Galilee (BAR-YOSEF and TCHERNOV 1966) and 'Ain Mallaha in the Huleh Basin in the northern Jordan Valley (BOUCHUD 1987). These sites are different in their geographical situation, climate and vegetation. The author found that gazelle was always the most important animal, although the percentage of gazelle started to decrease in the Final Natufian. There is a corresponding increase in *Bos* sp. and *Capra* sp., which leads me to think that when people started to become sedentary, they began the process of domesticating cattle and goat. Concerning the Cervidae, the author noticed that *Dama sp.* is present in all three of the other sites with different percentages but absent at 'Ain Rahub; this may mean that near the end of the Natufian Cervidae had become rare, perhaps even disappearing in the 'Ain Rahub area. Thus, the economy of this period must have been based on gazelle hunting.

For hunting societies in older periods such as the Lower, Middle and Upper Pleistocene, the word "occupy" has only a limited range of implications, for hunting groups normally could live at a particular site for only relatively short periods of time. But by the Natufian and Yarmoukian period many things had changed, and the various connotations of "occupying" a site can have widely different meanings. So the sense of the term "occupy" in the Natufian period should mean "living" at the site, while for the Yarmoukian it should refer to a use of the site for only limited periods.

In Muheisen *et al.* (1988), I am not certain what is meant by the word "occupy" (especially for the Yarmoukian period). If it is used for the Yarmoukian in the sense of a permanent residence, then there is no problem. If the Yarmoukian occupation is considered by the excavators as permanent, I would prefer to say that this was not the case, but that instead 'Ain Rahub was used at certain times as a base camp for hunting animals. (There is no mention of any architecture in the site, for example). The absence of goat or sheep supports this hypothesis. Concerning the predominance of *B. taurus* among the faunal remains at 'Ain Rahub, I think Yarmoukian people used domestic cattle as a means of transport, and that they killed them once they could find nothing to hunt. I think also that the high percentage of juvenile gazelle during this period suggests that man came to the site at the end of April to hunt young gazelle. The presence of Aurochs (*Bos primigenius*), European donkey (*Equus hydruntinus*), and wild boar (*Sus scrofa*) signals climatic circumstances around 'Ain Rahub that were more humid and a lusher vegetation than today.

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Status and Perspectives of Archaeobotanical Research in Jordan

Reinder Neef

In this contribution a brief overview will be given of the results achieved in archaeobotany in Jordan up to the present time. It will focus mainly on the combination of these results and the general suitability of Jordan for agriculture without going into detail. From the general information on the published botanical material and the ecological settings of the sites, considerations as to the future perspectives and goals in archaeobotany in Jordan appear most rewarding.

Status (Table 1)

Miller (1991) recently gave an overview of the archaeobotanical results from the main sites in the Near East. Since this publication, nothing very substantial has been published in this field from Jordanian sites with the exception of the important results of Colledge on Natufian and Neolithic sites in the subarid and arid zones of Jordan (COLLEDGE 1994, GARRARD *et al.* 1996). Most other publications have presented only preliminary results. A compilation of all the archaeobotanical reports on the analysis of seeds, fruits, wood, etc., on the most important crop plants, fruit- and other trees, and shrubs published from Jordanian sites is presented in Table 1. The sites listed in this table are shown in Fig. 1.

For a country as small as Jordan, there is remarkable variation in landscapes and bioclimatological zones. The present climate of Jordan, with its dry hot summers and its rainfall during the cold season in winter and early spring, is typically Mediterranean. In Fig. 2 a subdivision in bioclimatological zones of this climate reflects the calculation of the rainfall/temperature quotient (Q) according to Emberger (1952). The subdivisions are after Long (1957) and partly modified after Kürschner (1986). Q is plotted against the mean minimum temperature of the coldest month (m), being January. The climatic dates are taken from Alex (1985) and the NAJ (1984). The sites plotted in the figure are not fixed because there are almost no direct climatic dates available for the sites. Rainfall, etc. can also differ substantially over a few kilometers, such as at the edges of the highlands of the Jordan Valley or at the eastern plateau. Sites lying close to each other have almost the same climatic setting, but one should keep in mind that the data used here are based on the present climate. The results from PPNB sites 'Ain Ghazal and Basta (NEEF n.d.), for instance, suggest better climate conditions compared to the present, which is in accordance with the compilation on climatic data by Sanlaville (1996).

The shaded areas in the topographical setting of the sites in Fig. 1 represent those areas where the average annual precipitation is above 200mm. The absolute minimum of rainfall is 200mm for dry-farming, depending on local factors as the water-carrying capacity of the soil, exposure, and dew, all of which can influence the microclimate. Another aspect that can interfere with the annual rainfall is the time period in which the rain occurs. Heavy showers can release more than 50mm rain an hour, which means that a lot of water is lost as runoff, and on slopes this can cause severe soil erosion. For Syria, Wirth (1971) mentions that on well-developed soils with a favorable distribution of the precipitation during the winter months, barley develops well at 200mm and wheat at 250mm of precipitation. But in these areas, at the fringe of the possibility of dry-farming, annual rain fluctuations are relatively very large; for instance, the standard deviation of rainfall over 25 years at the 200mm isohyet, which lies just south of Deir 'Alla, is between 50 and 75mm (NAJ 1984).

Wirth (1971) calculated that only in those areas with a precipitation level higher then 400mm there where was a small risk for dry farming. This includes sites as 'Ain Ghazal, Tell Irbid and Jerash. More than 90% of Jordan, however, lies in the arid zone, with less than 200mm. This means that

Table 1. Archaeobotanical data from Jordanian sites. Number of seeds, fuits, etc.: x unknown, 1, + 2-10, ++ 11-1000, +++ 101-1000, ++++ > 1001, i ear fragment, n naked barley, w wood, sp. no identification on species level.

Nr. (fig. 1)	SITE		Hordeum sp.	Hordeum distichum	Hordeum vulgare	Triticum sp.	Triticum monococcum	Triticum mono-/dicoccum	Triticum dicoccum	Triticum aestivum/durum	Panicum miliaceum	Pisum sativum	Lens culinaris	Vicia ervilia	Vicia faba	Cicer arietinum	Lathyrus sativus	Trigonella foenum-graecum	Linum usitatissimum
22	Wadi al-Hammeh 26	Natufian																	
14	Iraq ed-Dubb	Natufian																	
14	Iraq ed-Dubb	PPNA	+ i		+			i					sp.+		cf.+				
17	Jilat 7	PPNB, early/middle			x (n)	i	x						sp.x	cf.x					
3	Ain Ghazal	PPNB, middle/late		x			x		x			x	x	x	x	x			
10	Beidha	PPNB, middle	x	++++	n		x		x i				sp.1	cf.1					
6	Azraq 31	PPNB, late			+ i					1 i									
9	Basta	PPNB, late	++ i	++		++	1	i	i	i		sp.++	sp.+	sp. +					
10	Ba'ja	PPNB, late							i										
12	Dhuweila	PPNB, late																	
32	Wadi Fidan A	PPNB, late	+ i		+ i		x	i		i									
32	Wadi Fidan C	PPNC	+ i		+ i		x	1 i		1 i			sp.1						
2	Abu Thawwab	Neolithic, late		x					x			x	x						
8	Tell Wadi Fenan	Neolithic, late																	
4	Ain Rahub	Neolithic, late		x			x												x
17	Jilat 13	Neolithic, late	x		x (n)	i	x						sp.x						
1	Abu Hamid	Chalcolithic			x					x		x	x			x	x		x
25	Teleilat Ghassul	Chalcolithic																	
32	Wadi Fidan 4	Chalcolithic																	
22	Pella	Chalcolithic		++								++	++			++			
28	Tell esh Shuna North	Chalcolithic, late																	
15	Jawa	Chalcolithic/ EB I			x		x			x		x	x	x		x			
2	Abu Thawwab	EB I																	
8	Barqa el-Hetiye	EB																	
8	Fenan 16	EB																	
8	Fenan 9	EB																	
18	Khirbet Iskander	EB																	
24	Sahab	EB																	
8	Wadi Khalid	EB																	
35	Zeraqun	EB I/II																	
7	Bâb edh-Dhrâ	EB I-IV	++++			+++					sp. +	sp.++	sp.++	sp. 1		+			++
26	Tell el-Hayyat	EB II-III		x								x							
21	Numeira	EB III	++++			+++						sp. +	sp. +	sp. +	sp. +	+++			+
31	Tell Nimrin	MB	x							x		x	x	x	x				x
26	Tell el-Hayyat	MB II		x								x							
22	Pella	Bronze Age		+									+	+	1	+			
11	Deir 'Alla	Late Bronze		++++						++++		+++	+	++++		++			+++
30	Tell Irbid	Late Bronze/Early Iron																	
19	Mazar	Iron Age																	
34	Umayri	Iron Age, 11th cent.																	
11	Deir 'Alla	Iron Age, early		++++ i	+++ i				i	++++ i		++	+++	+++	1	1	+	++++	++++
5	Araq el-Emir	Iron Age I											sp. 1						
8	Barqa el-Hetiye	Iron Age I																	
8	Fenan 5	Iron Age II																	
27	Tell el-Husn	Iron Age II											+++	1			+++		
31	Tell Nimrin	Iron Age II	x							x		x	x	x	x				x
22	Pella	Iron Age		+++						+++		++	++			1			+++
29	Tell Hesban	Iron Age	+		+	+				++			sp. +						
11	Deir 'Alla	Iron Age, 8-5 cent. BC		++++	++					++++	x	+	+	+					++++
20	Mughayir	Iron Age, 5-4 cent. BC																	
8	Khirbet el-Jariye	Iron Age																	
8	Khirbet en-Nahas	Iron Age																	
33	Udruh	Iron Age/Roman		x						x									
23	Petra, Ez Zantur	Nab./Late Roman			x								x						
22	Pella	Hell	+ i							++			1						
29	Tell Hesban	Hell	++		++	+				++		sp.1	sp. +	+++			+		
29	Tell Hesban	Roman	+		+	+				+			sp. +	+					
13	el-Lejjun	Roman			x							x	x						
8	Fenan 1	Roman																	
16	Jerash	Roman to Umayad																	
5	Araq el-Emir	Hell./Roman/Byz.																	
22	Pella	Byz	++ i							++ i		++	++		+	+			
13	el-Lejjun	Byz.			x	1						x	x						
29	Tell Hesban	Byz.	++		++	+				++			sp.++	++					
22	Pella	Umayad	i		+					++ i		+	+			1			
8	Fenan 2	Mameluk																	
8	Fenan 6	Mameluk																	
22	Pella	Mameluk		+++						++			+						
13	el-Lejjun	Isl./Ott.			x	x						x							
			barley	two-rowed barley	six-rowed barley	wheat	einkorn wheat	hulled wheat	emmer wheat	naked wheat	common millet	garden pea	lentil	bitter vetch	broad bean	chickpea	grass pea	fenugreek	flax

Table 1 cont. Archaeobotanical data from Jordanian sites. Number of seeds, fuits, etc.: x unknown, 1, + 2-10, ++ 11-1000, +++ 101-1000, ++++ > 1001, i ear fragment, n naked barley, w wood, sp. no identification on species level.

Sesamum orientale	Cuminum cyminum	Olea cf. europea	Vitis vinifera	Punica granatum	Ficus spp.	Phoenix dactylifera	Ziziphus spp.	Pinus sp.	Quercus (ithaburensis/calliprinos s.l.)	Pistacia spp.	Amygdalus sp.	Juniperus phoenicea	Haloxylon persicum	Acacia spp.	Tamarix spp.	Populus/Salix	Fraxinus	
									w		w							Willcox 1992, Colledge 1994
					+++					++	1							Colledge 1994
					+++					++	+							Colledge 1994
					x					+								Colledge 1994, Garrard et al. 1988, 1994, 1996
					++++				w ith	x								Rollefson et al. 1985, Neef 1997
					+				x	xx								Helbaek 1966, Colledge 1994
																		Colledge 1994, Garrard et al. 1996
					++				w cal	+++w	++ w	w			w	w(P/S)		Neef 1987, in press
					x					x w		w						Gebel et al. this volume
																		Colledge 1994, Garrard et al. 1996
					w					+								Colledge 1994
					w					1								Colledge 1994
										x	x							Kafafi 1988
							w											Frey, Gerlach & Kürschner 1991
									w ith									Muheisen, Gebel, Hannss & Neef 1988
					x					x								Colledge 1994, Garrard et al. 1994, 1996
		+++ w			x													Neef 1988
		+++ w				x												Zohary & Spiegel-Roy 1975, Neef 1990
															w			Engel 1992
		++ w							w		1 w					w(P/S)		Willcox 1992
		++++ w																Neef 1990
			x						w									Willcox 1981
		x																Neef 1990
										w			w	w	w			Engel 1992
		w							w cal			w	w		w			Baierle et al. 1989
		w					w		w cal	w		w	w	w	w			Baierle et al. 1989, Engel 1992
		++ w																Neef 1990
		w																Neef 1990
												w						Engel 1992
		++ w																Neef 1990
		++	+++		++++	1	++			+								McCreery 1979, 1980
		x																Metzger 1984
		+	+++		+++					+								McCreery 1979, 1980
		x	x		x													Flanagan & McCreery 1990
		x																Metzger 1984
		w	1				w		w		w					w(P/S)		Willcox 1992
		1 w	+						w ith						w	w(P/S)	w	Zeist & Bakker-Heeres 1973, Neef 1989
		++ w																Neef 1990
		x w																Neef 1990
		x	x															Clark et al. in Bikai & Egan 1997
		w	+++	+++	+++ w				w ith						w	w(P)		Zeist & Bakker-Heeres 1973, Neef 1989
		1																McCreery 1982
															w			Engel 1992
													w		w			Baierle et al. 1989
			1															Leonard 1987
		x	x		x													Flanagan & McCreery 1990
		+ w	++ w	++		1	w		w	w	+ w					w(P/S)		Willcox 1992
			+															Gilliland 1986
x	++++	+++ w	+	+++		x w	+		w ith/cal		+				w	w(P)	w	Zeist & Bakker-Heeres 1973, Neef 1989
		1 w																Neef 1990
		w				w				w			w	w	w			Engel 1995, Baierle et al. 1989
		w				w	w			w		w	w	w	w			Steinhof 1994, Engel 1993, Baierle et al. 1989
		+ w	x		x					w		w			w			Neef 1985, 1990
		x	x		x	x												Karg 1996, 1992
		+							w							w(P/S)		Willcox 1992
		+	+															Gilliland 1986
																		Gilliland 1986
		x	x															Crawford 1987
													w	w				Baierle et al. 1989
		x																Neef 1990
		1	+			1												McCreery 1982
		+	+	+	+	+ w	w	w		++						w(P/S)		Willcox 1992
		x	x			x												Crawford 1987
		++	++		+													Gilliland 1986
		1	++		+ w	+ w	1 w	w	w	++	1				w	w(P/S)		Willcox 1992
									w cal			w						Baierle et al. 1989
		w							w cal			w			w			Baierle et al. 1989
							w		w	w	w					w(P/S)		Willcox 1992
		x	x															Crawford 1987
sesame	cumin	olive	grape-vine	pomegranate	fig	date palm		pine	oak (deciduous/evergreen)	pistachio	almond	Phoenician juniper			tamarisk	poplar/willow	ash	

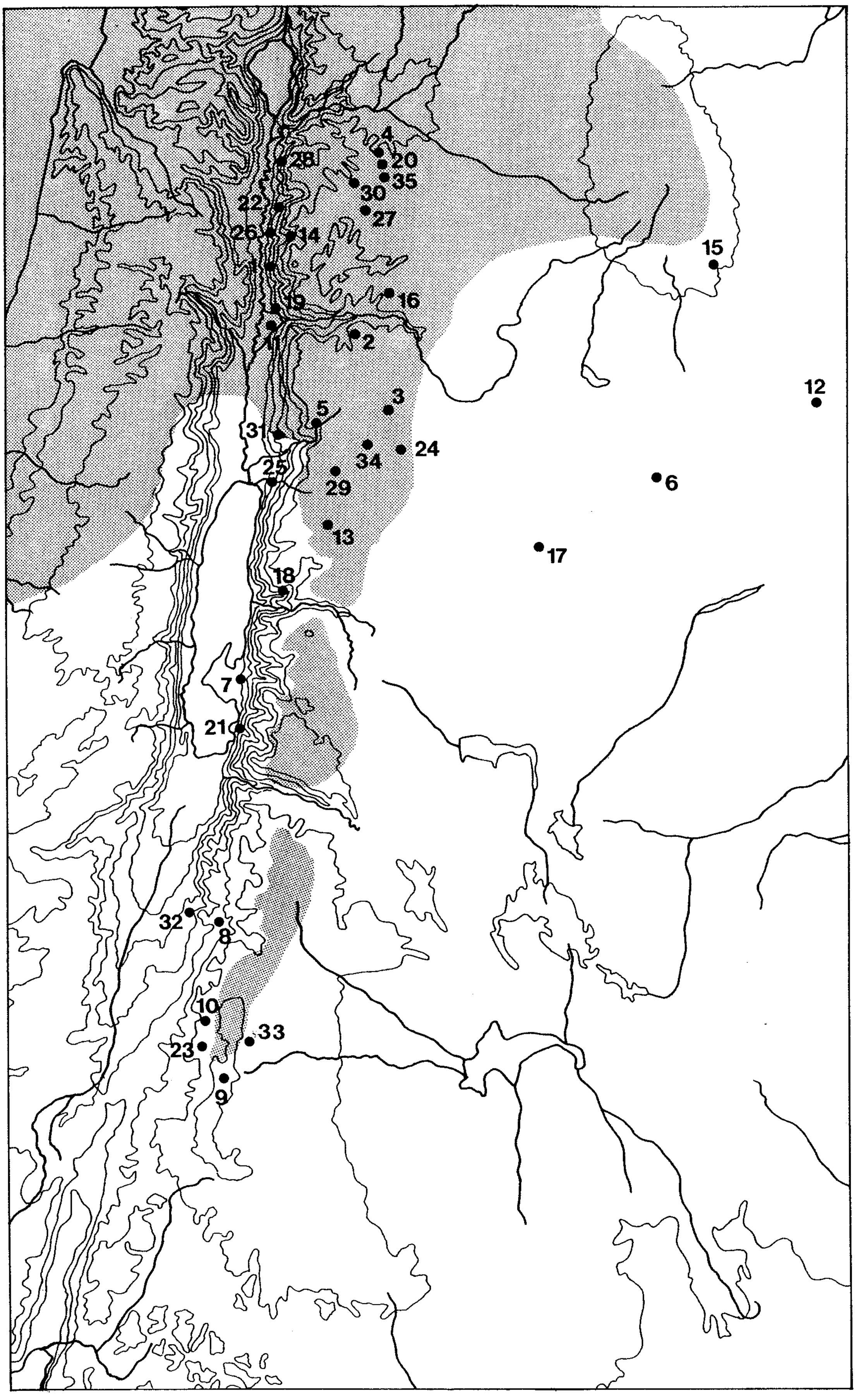

Fig. 1. Geographical setting of sites (for site designations, refer to Table 1; shaded areas: average annual precipitation > 200mm).

without different forms of irrigation, only 10% of the country is suitable for less marginal agricultural farming.

Because the rainfall variability is so great over such a small distance, vegetation types change quite dramatically over a short stretch. This means that people in the southern highlands and at the fringes of the northern highlands always lived in the vicinity of bioclimatological zone borders that offered potentially diversified subsistence strategies. One should keep in mind, however, that the land suitable for rain-fed agriculture in the southern highlands extends principally no more than 3-10kms east-west as the crow flies. This implies, for instance, that modern as well as prehistoric farming in Beidha, Basta, Udruh and Petra can and could never be reliably based on rain-fed crops alone.

For agricultural purposes the fertile terra rossa soils, covering most of the highlands, are most important. But they become unstable when winter rains start after a period of drought. When the vegetation cover has been removed or deteriorated by overgrazing, these soils are consequently very susceptible to erosion. This susceptibility is worsened by the steepness of the slopes on the Jordanian plateau. Terracing can stop or at least slow down this process, but continued erosion will result in almost bare rocky limestone hills.

Erosion problems play a larger part in the northern part of the Jordanian plateau, north of the Wadi Zarqa (BEAUMONT *et al.* 1985). No archaeobotanical information is available from the area around Ajlun, which lies, quite exceptionally for Jordan, in the subhumid bioclimatological zone and which is now the main area in Jordan for olive tree cultivation. South of the Wadi Zarqa the plateau forms a hilly landscape with less dramatic height differences. This region stretches down to the Wadi Mujib, with Madaba as a centre, which was under favourable circumstances, together with the flat plains around Irbid and Husn, the local grain belt for the Romans. The preliminary rich results from sites lying at present in the temperate, moderately arid bioclimatological zone confirm that since the Neolithic ('Ain Ghazal), this was a favourable area for farming in Jordan.

Before the construction of the East Ghor Canal in the Jordan Valley in 1956, irrigation agriculture in Jordan was never practiced on a large scale. The modern canal gets its water from the Yarmouk River, a perennial tributary of the Jordan River. Major irrigation agriculture, outside the Jordan Valley, can be found nowadays near the oasis of Azraq and south of the Dead Sea near Safi. There are numerous small wells and wadis in these areas. In the immediate vicinity of these water sources, irrigated gardens have been worked since prehistory. Only a few archaeological sites lie in a favorable region for formerly large scale irrigation agriculture, such as Mazar and Deir 'Alla in the Jordan Valley, where it was easy to flood the fields with water from the Zarqa River, also a perennial tributary of the Jordan River. The first evidence for irrigation agriculture in Jordan comes from sites in the warm, arid bioclimatological zones near the Dead Sea (Teleilat Ghassul, Bâb-edh-Dhrâ and Numeira). Even the favorable current climatic conditions would not be enough for the rich crop plant remains from these sites.

Perspectives

Although much work on botanical remains has been done in the last 30 years, the results also show clearly some deficits at the present time. Most of the reports on the archaeobotanical results from sites in Jordan have appeared as preliminary contributions or appendices of archaeological reports. Practically, this means that statements based on these results can only be limited, since there is almost no proper description nor quantification of the material examined. The main problem is that most excavations in Jordan are already working on a financially marginal basis and cannot employ permanent bioarchaeologists. Bioarchaeology is a time-consuming effort that depends on a large reference collection of plant or animal remains. Clearly, archaeological projects should include adequate funding for bioarchaeological research from the beginning of the research.

Another problem is that for several larger assemblages, the results are not available because for several reasons final publications are still in press (*e.g.* 'Ain Ghazal, Abu Hamid, Basta).

For archaeobotanists it should be standard that not only diaspores such as seeds and fruits of the botanical assemblages should be examined, but also plant tissue from vegetative storage organs and wood. In some Neolithic sites there is evidence for the exploitation of vegetative storage organs, like roots and tubers (COLLEDGE 1994). In areas such as Jordan, where there is a lack of pollen-bearing sediments to give a reliable picture of the vegetational and climatic history, the analysis of charcoal from archaeological sites can be of particular interest for our knowledge and understanding of the environment of the site during its occupation. In general, charcoal remains give us an insight on the arboreal vegetation in direct proximity to the site (WILLCOX 1991). Therefore, charcoal analysis should be a standard procedure alongside the analysis of other botanical remains. Of course, one has to consider that before the wood arrives at a site, a human selection process had taken place already. Long-distance transport of substantial amounts of timber in Jordan would have been rare, but it cannot be excluded in the case of important buildings or in the case of wood-consuming activities such as copper smelting near the mines in the Feinan area (*cf.* ENGEL 1992).

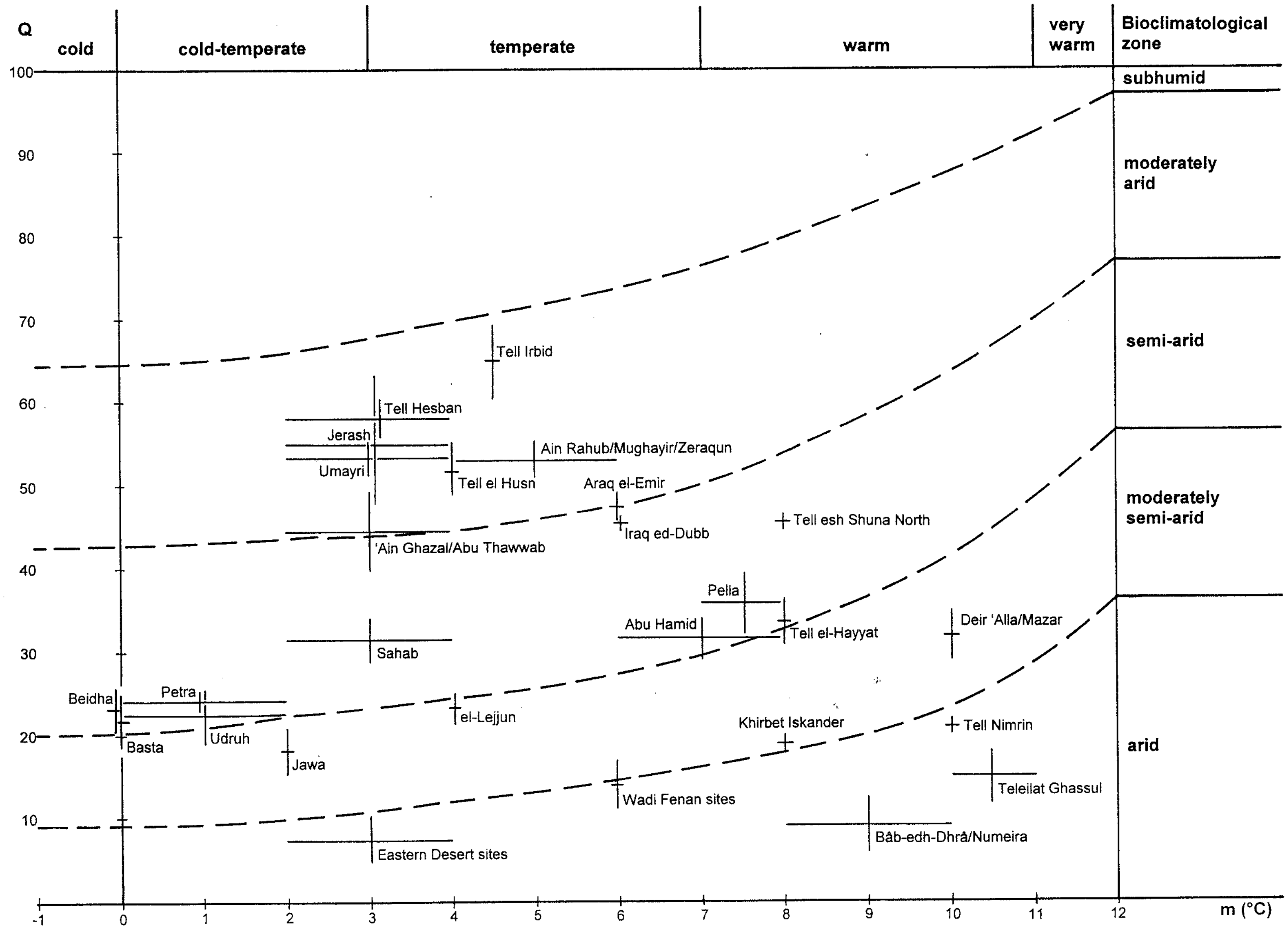

Fig. 2. Present bioclimatological setting of sites.
Q rainfall/ temperature quotient according to Emberger, m mean minimum temperature of coldest month.

An archaeobotanist on-site is not a guarantee of success. There is a major effort among archaeobotanists working on material from Epipalaeolithic and early Neolithic sites relating to the emergence of crop cultivation. However, many of these sites contain no evidence (or only poor botanical remains, as at PPNB Wadi Shu'eib, and Natufian 'Ain Rahub). The earliest cultivated plants of Jordan were retrieved from the PPNA site of Iraq ed-Dubb. But beyond this, the earliest evidence for cultivated crop plants comes from the site of Jilat 7 in the eastern desert (EPPNB, COLLEDGE 1994). More sites with domestic crop plants are reported from M- and LPPNB sites like 'Ain Ghazal, Beidha, Azraq and Basta. But macroremains are still fragmentary for all periods, especially the post-Byzantine era, not only for the beginning of agriculture.

Looking at the different climatological zones and landscapes in Jordan, there is a complete gap in the archaeobotanical information from the subhumid bioclimatological zone (Ajlun region), from the arid zone in the South and Southeast (Aqaba, Ram, El Jafr region) and from the semi-arid zone in the southern highlands (Kerak, Tafila and Shaubak region).

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The Future of Archaeozoological Research in Jordan

Ilse Köhler-Rollefson

The assignment of providing pointers for future archaeozoological research and even framing a "research policy" is certainly a great honour, but it is also quite a challenge. As is the case with all disciplines playing detective in the past - be it history, archaeology or paleontology - there are limitations to determining which questions must be tackled next. Whereas a scientist investigating living animals or contemporary livestock systems can say to himself "this is what we need to know", and then purchase all the equipment and even the animals needed to carry out a systematic observation or a controlled experiment, faunal analysts depend very much on chance and good luck, the more so as they are usually just adjuncts of archaeologists who decide where to put in the spade. Archaeozoological routine often consists of making the best of very scant remains; in order to satisfy the curiosity of the excavator, rather sweeping statements may sometimes be made on the basis of rather wobbly datasets. In cases where only very small faunal samples have withstood the test of millennia, there is no way of deducing how accurately they reflect the actual occurrences at the former settlement. It may take years before hypotheses and interpretations can be supported with finds from other sites. On the other hand, some sites rather resemble gold mines and produce data-sets that are so extensive that they can be pondered over for decades and be interpreted in many different ways.

The selection of papers presented in this volume fittingly reflect this haphazard nature of archaeological evidence. Of the seven contributions on archaeozoological aspects, one reports on paleontological finds without settlement context, one on the Natufian/Yarmoukian site of 'Ain Rahub, another one on two PPNB assemblages from the Wadi Fidan, whereas four focus on different aspects of the Neolithic site of 'Ain Ghazal.

The site of 'Ain Rahub, near Irbid in northern Jordan, produced only a small quantity of identifiable bones which provide little more than a brief glimpse into the ecology of the site and the economy of its occupants during two different periods. Notable are Shiyab's claims for the presence of *Equus hydruntinus* in the Natufian period and for *E. caballus* in the Yarmoukian period, which do not tally with earlier inferences about the distribution of these species. *Equus hydruntinus*, the European Wild Ass, is thought to have become extinct in the Near East by the end of the Pleistocene; its final Pleistocene occurrence is thought to have been at Ein Gev (UERPMANN 1987); its southernmost find comes from Azraq C-Spring where it is dated to the Middle Paleolithic. *E.s caballus* usually refers to the domestic horse, for whom existence at this point in time and space there has been no previous indication; even its wild progenitor *E. ferus* is thought to have been present in the area only during the Pleistocene.

Excavations at two PPNB sites in the Wadi Fidan in southern Jordan provided somewhat more substantial faunal remains of about 875 identifiable bones at Site A, dated to the Late PPNB, and about 580 bones from Site C, dated to the Final PPNB. Richardson observes that at the latter site gazelle are relatively more significant than at the earlier Site A, and that the importance of sheep/goats declines over time. She offers several different scenarios to explain this situation, apparently favouring the interpretation that environmental degradation and vegetation depletion due to herding of ovicaprids may have forced people to return to hunting. It would have been helpful and more convincing if this hypothesis could have been supported by brief references to other aspects of the two sites, such as architectural remains or botanical data. The possibility that the these settlements were occupied by different social or even ethnic groups pursuing different subsistence strategies by choice can not be ruled out. Somewhat puzzling is the reference in the tables to "Horse" bones without any further details. A short explanatory note on likely species identification or why this was not possible would have been useful.

The remainder of the reports focus on the animal bone remains from 'Ain Ghazal, a Neolithic settlement that, together with Basta, has exponentially increased the material evidence on which to base hypotheses and conclusion about this stage in human development and human-animal relationships. The faunal remains that were unearthed from 'Ain Ghazal during ten seasons of excavations have been studied by a probably unprecedented number of archaeozoologists, representing not only different nationalities, but also different disciplinary backgrounds.

Von den Driesch and Wodtke, exemplifying the Munich school of palaeoanatomy, present a complete report on the entire faunal sample recovered during the 1993, 1994 and 1995 seasons. As they rightly emphasize, theirs constitutes the first complete account of a subsample of the 'Ain Ghazal zoological remains, including a full set of measurements, as well as age and sex determinations. Their analysis is based on about 20,000 bone fragments identifiable to species that derived from the LPPNB, PPNB/PPNC transition, PPNC and Yarmoukian periods.

Remains of Ovicaprids dominate the sample, composing between 74% and 83% during the various time periods. Both sheep and goats are present during all the archaeological phases represented in this subsample, with the proportion of sheep increasing from 7.4% in the LPPNB to 44.7% in the PPNC and slightly decreasing to 39.2% during the Yarmoukian. A detailed sex, age and metrical analysis of the goat bones reveals interesting fluctuations in the population structure. During the PPNC there appears to be an increase in the proportion of male as well as mature animals which is interpreted as possibly indicating a temporary reversal to hunting or the renewed capture of wild goats. This observation may parallel to some extent the increased importance of hunting at the Wadi Fidan site during the PPNC occupation. In regards to the sheep population, it is noted that there are no corresponding changes in size, although some variations of the population structure can be observed over time.

Earlier assumptions that 'Ain Ghazal's pig population was also domesticated are neither supported nor refuted. The authors make the valid point that, given the particular population structure of *Sus scrofa,* a high proportion of juveniles can not be interpreted *a priori* as indication of domestication and that any such claims should be substantiated by metrical arguments. The sample of mature and measureable bones being very small, it is not possible to make any statements on the status of domestication. In regards to cattle, domestication attempts are tentatively suggested. Two equid species, *Equus africanus* and *E. hemionus* were identified.

The report by Alex Wasse (representing the British zooarchaeological tradition) on the sheep and goat bones from 'Ain Ghazal singles out a crucial but extremely complex issue for closer scrutiny: early patterns of sheep/goat exploitation and the developments that led from "*proto-élevage*" to husbandry. The basis of his study are the bones excavated during the first six excavation seasons at 'Ain Ghazal from 1982 through 1989. Hence, his material is isolated from the samples reported on by von den Driesch and Wodtke. Furthermore, it spans a longer time period, since it also entails a collection of bones from the MPPNB (although the LPPNB is underrepresented), and his samples also derive from different spatial contexts.

Nevertheless, it is striking that his results differ rather dramatically from those of von den Driesch and Wodtke in regards to the frequency of sheep bones. Wasse postulates that goats had been largely replaced by sheep by the Yarmoukian period, in contrast to von den Driesch's statement that sheep and goat were of almost equal importance at that stage. At this stage it is impossible to evaluate whether these different assessments are due to problems of sheep/goat separation, if they reflect spatial variations or if sampling errors are in effect.

This quandary aside, Wasse's reconciliation of two conflicting hypotheses on the origin of pastoralism in Jordan advanced by Ducos (1993) and Perrot (1993) on one hand, and by Rollefson and Köhler-Rollefson (1993) on the other, has much to recommend it. However, it is not quite clear to me why sheep and pastoralism should necessarily have arrived as "a package" from the north and why pastoralism could not have evolved locally. His implication seems to be that the arrival of easily herdable sheep brought into the area by Syrian pastoralists enabled the inhabitants of 'Ain Ghazal - who previously had depended on more difficult -to control- goats - to take up migratory pastoralism.

However, a north-south migration route does not make any sense as an adaptation to seasonal variations in water and pasture supplies. From the ethnographic record we know that Jordanian pastoralists migrate in an east-west direction, converging to the well watered highlands during the summer and dispersing into the eastern desert or the Rift Valley during the winter rainy season. It is therefore unlikely that sheep were introduced in the area in the course of normal pastoral migrations. If they came from the north -as seems likely - then this would have happened through traders or by migrating groups that were seeking a permanent relocation or new homeland.

The debate on goat/sheep/origin of pastoralism has certainly received plenty of fuel through these new findings and hypotheses. As I argue in my own contribution, the whole process of domestication needs to be thought through much more thoroughly and from a more practical angle. I am uncomfortable with making genetic manipulation or selective breeding the criterion of domestication and feel that these terms need to be clearly defined. The isolation of animals already entails genetic manipulation by interfering with the gene flow; inbreeding must have been rampant at this stage. Selective breeding however is an entirely different matter. In the beginning of animal husbandry, there would have been hardly any scope for selective breeding, since animals kept in captivity were rare. We know from the ethnographic record that even modern pastoralists usually do not select consciously among their female animals: selective pressure is exerted by the environment much more than anything else.

The final contribution by Quintero describes an unusually well preserved dog mandible dated to the LPPNB period. In this paper it is argued that the PPNB witnesses the first biological evidence for dog domestication.

In summary, the archaeozoological contributions in this volume highlight the following questions as deserving of more rigorous attention and thought:

1. The distribution of equids
2. The question of pig domestication during the PPNB
3. The process of goat domestication and especially the situation in the PPNC: why would there have a possible reversal to hunting at this stage?
4. The sheep dilemma.

Some of these questions may be clarified in part by a reanalysis of the already available materials, but others may have to wait until additional faunal samples become available. Nobody would argue that the fundamental level of all archaeozoological analysis will always be palaeoanatomical, the first order of business must be to arrive at an accurate taxonomic identification of all available material. This approach is exemplified and emphasized in the paper by von den Driesch and Wodtke, and this is the level of analysis at which all zoological questions will be answered, such as the former distribution ranges of the various equid species and relative proportions of sheep and goat bones. But a zoological framework does not suffice when it comes to answering cultural queries and discussing such multifaceted phenomena as "domestication". Is adherence to a cultural or a biological definition of domestication more appropriate ? Is a high proportion of juvenile pigs sufficient to postulate domestication ? Did animal ownership, which surely followed in the footsteps of domestication, lead to social stratification and/or occupational specialization ? Questions of this nature can only be answered by a determined effort to envision and mentally reenact the whole process of domestication and the different guises it may have taken in different species.

For the purpose of achieving this approach, I would like to prescribe every archaeozoologist a big dose of participatory observation - of walking over to the next Bedouin encampment, watching the way the animals are handled and utilized, and of putting him- or herself into the shoes of the pastoralist who depends on them for a living. When going back to the bone table, these images must be invoked to conjure up a living past. Such a mindset would also create an additional angle of analysis for faunal remains which is the *development of animal husbandry techniques*. While architecture, stone tools, grinding stones, pottery and many other artifact classes are routinely examined from the perspective of their technological development, such a perspective has never been explicitly applied to the evolution of animal husbandry, although it represents an activity that requires a large body of specialized knowledge, an extensive range of skills and even appropriate social structures to be successful. The type of animal husbandry practiced by Bedouins today or in the recent past is the contemporary expression of many thousands of years of experimentation and adaptations that had their roots in the Neolithic period. For prehistorians the Near East represents the hearth where some of the most important livestock species were domesticated and from where they dispersed into the rest of the world. But this area also gave rise to a classic animal based or pastoral society, the Bedouins whose culture has left an enduring imprint on the social fabric, ethics, and value system of the whole region, and whose roots may well go back into the PPNC period when the first cracks in the mixed economy become evident.

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Provenance and Technology of Late Neolithic Pottery From Wadi Shu'eib, Jordan

Ziad al Saa'd, Nizar Abu-Jaber, and Sana' Bataineh

Abstract: *This study deals with the scientific analysis of a collection of late Neolithic pottery sherds excavated from the archaeological site of Wadi Shu'eib, a major Neolithic site in central Jordan. A combination of scientific techniques including petrography, geological mapping, X-ray diffraction, thermal analysis and scanning electron microscopy were utilized to obtain information about the provenance and technology of the studied pottery. The comparison between the mineralogical composition of the pottery and the local geology led to the conclusion that the pottery was locally manufactured at the site using available raw materials. The thermal analysis and the scanning electron microscopy results prove that the studied pottery was low-fired between 600-700C° in an open pit.*

Introduction

The study of pottery from prehistoric sites in Jordan has attracted the interest of a large number of archaeologists world-wide. However, most studies carried out on this pottery centered on the analysis of vessel morphology to construct a chronological framework for the excavated sites. In addition, the determination of the provenance of the excavated pottery has attracted the interest of many archaeologists. They have tried to resolve the question of pottery provenance by developing an elaborate system of classification based largely upon form and decorative styles (DUNNELL 1978). In addition to the temporal and spatial dimensions of ceramic analysis, recent years have witnessed the introduction of the technological dimension. This is concerned with processes and materials used in making pottery. A wide range of scientific techniques have been utilized for that purpose (COLTON 1953, SHEPARD 1963, PEACOCK 1970, FRECHETTE 1971, GOFFER 1980, HUGHES 1981, OLIN and FRANKLIN 1982, RICE 1987).

Scientific study of ancient pottery can provide a great deal of information; it can contribute to our understanding of the nature of the raw materials that were used in pottery production and the particular technological or decorative properties that may have led to their selection. It can also help in the elucidation of the methods by which clays were prepared, shaped, finished and fired (PEACOCK 1970, HUGHES 1981, RICE 1987). Archaeologists' questions concerning places and regions of origin, the discovery of exchange and commercial routes and manufacturing techniques of pottery can be answered by using scientific techniques.

This study deals with the scientific analysis of pottery materials unearthed from Wadi Shu'eib, a large and important Neolithic site in Jordan. Questions regarding raw materials, provenance, technology, fabrication and firing of this pottery have been tackled by using a combination of analytical methods. Thin section microscopy (petrography) and X-ray diffractography (XRD) were carried out to perform mineralogical analysis and to sort the studied pottery into classes according to their overall petrographic character. Also refiring experiments were combined with the mineralogical temperature scale method and scanning electron microscopy (SEM) for the estimation of the original firing conditions of the pottery samples. It was hoped that the conducted analyses would yield information on the provenance and technology of pottery production at that time.

Archaeology of Wadi Shu'eib

Wadi Shu'eib is located on the eastern side of Jordan Valley. (Fig. 1) It is approximately 20km west of Amman and 8km south of Salt and is cut by the Salt-Shuna road. This area receives about

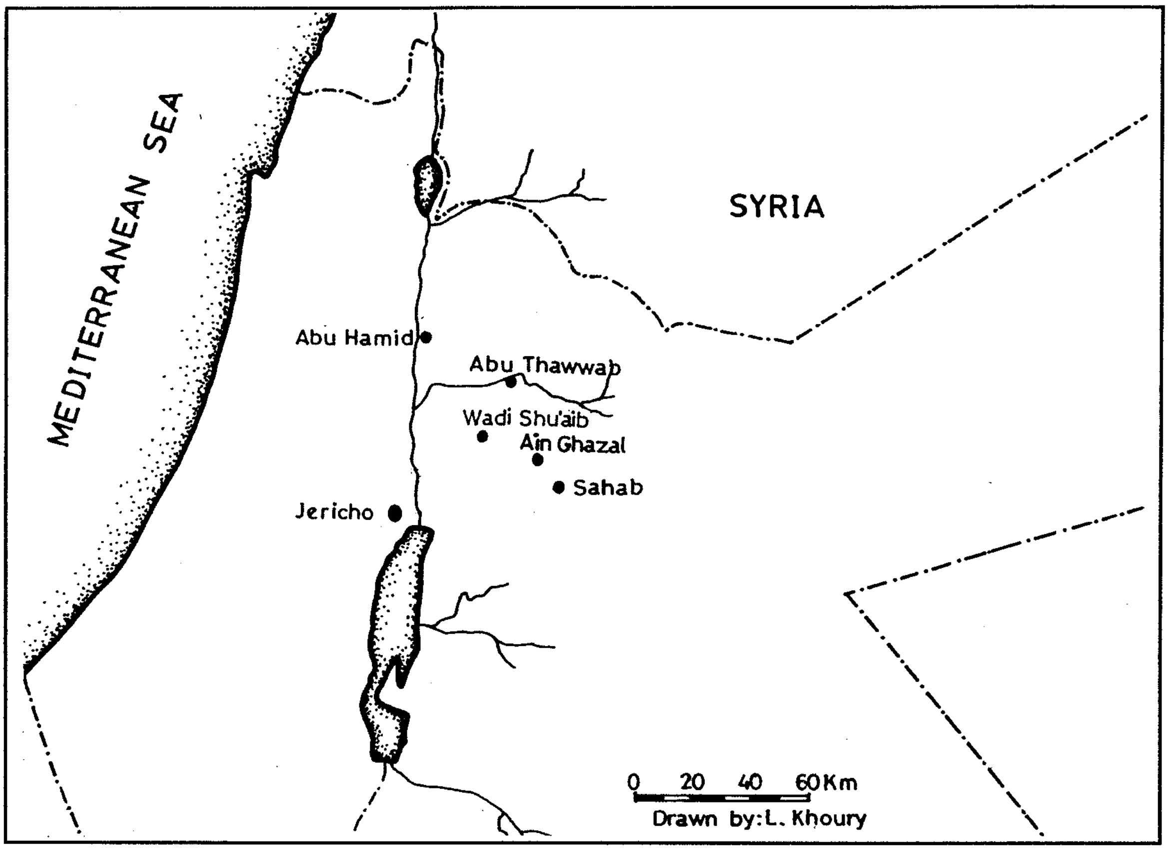


Fig. 1. Map showing the location of Wadi Shu'eib.

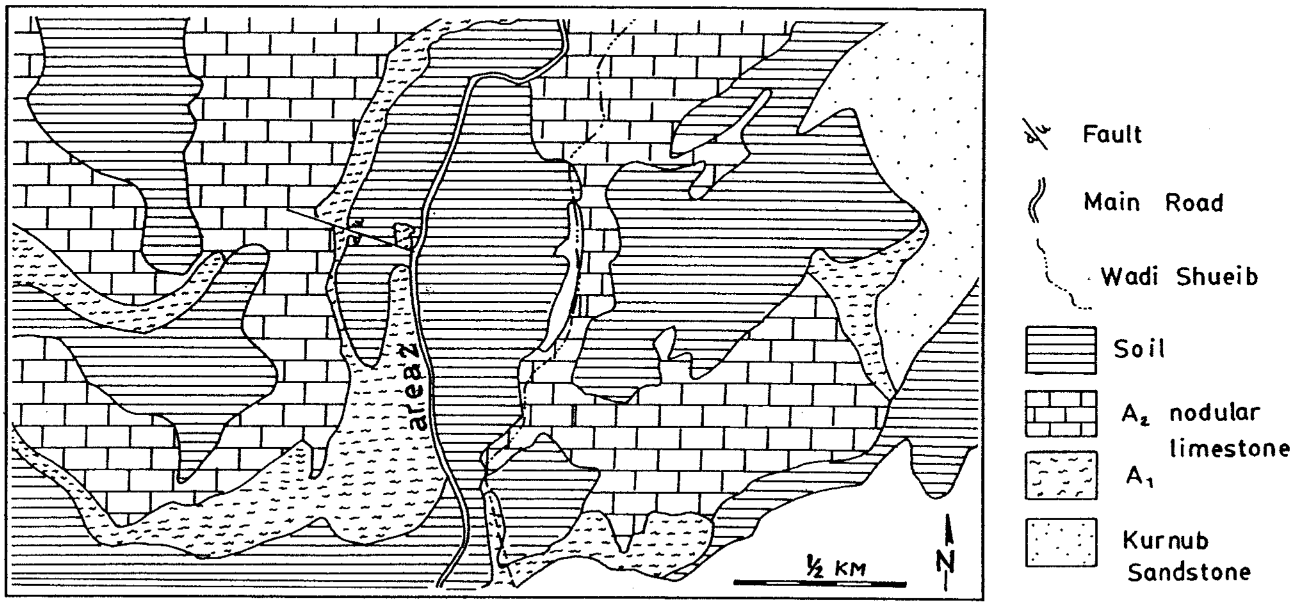


Fig. 2. Geological map of Wadi Shu'eib.

400mm of rainfall during the year (BEAUMONT 1986). Much of the site is today under cultivation, with tobacco being the main crop grown. A number of springs occur less than a kilometer from the site (TA'ANI 1992).

Wadi Shu'eib is considered to be one of the most important archaeological locations in Jordan because its position is almost exactly midway between two of the most famous Neolithic centers known in the Near East: Jericho and 'Ain Ghazal. This settlement is considered to have been one of the largest agricultural villages during Neolithic period (SIMMONS *et al.* 1989).

As an archaeological site Wadi Shu'eib was discovered by Diana Kirkbride in 1950 (ZEUNER 1957). Because this site had never previously been professionally investigated, a joint team from Yarmouk University, the Desert Research Institute, and San Diego State University undertook limited test excavations at Wadi Shu'eib during the summer of 1988 and 1989. These excavations consisted of three separated areas, labeled area I, II and III, along the Salt-Shuna road cut, and each area was excavated to at least 4m below the present ground surface (SIMMONS *et al.* 1989).

These areas (I, II, and III) contain substantial Neolithic deposits which including Yarmoukian and Jericho types of Pottery Neolithic, as well as Pre-Pottery Neolithic B (PPNB) and Pre-Pottery Neolithic C (PPNC) materials. These cultural deposits include gray ashy sediments mixed with rubble, flint artifacts, building remains and ceramics.

Styles of Wadi Shu'eib Pottery

A considerable ceramic assemblage was recovered from Wadi Shu'eib and consisted of Yarmoukian and Jericho Pottery Neolithic A specimens. The Yarmoukian pottery consists mostly of bowls and jars, and is characterized by herring bone incisions, sometimes accompanied with red paint. The Pottery Neolithic A shards consist of bowls and small jars decorated with red or red-brownish paint on a creamy slip and is characterized by very coarse ware with straw temper. These two Pottery Neolithic assemblages at Wadi Shu'eib may be contemporaneous based on their associations within the same loci (SIMMONS *et al.* 1989). This study concentrates on Yarmoukian type pottery due to its abundance.

Geology of the Study Area

The geological framework of Jordan has been extensively studied by a number of workers (*e.g.* BENDER 1974). At Wadi Shu'eib, most of the outcrop consists of Upper Cretaceous limestone and marls deposited in a near-shore continental margin setting. However, there are outcrops of Lower Cretaceous fluvial sandstone and kaolinite about three kilometers from the study area near the town of Mahis (KHOURY 1986). These sedimentary rocks were relatively deformed as a by-product of Tertiary tectonism along the Dead Sea Rift, resulting in the so-called Wadi Shu'eib structure. Fig. 2 is a geological map of the area around the excavation site (BATAINEH 1996).

Materials and Methods

For the purpose of this study, twenty pottery sherds were carefully selected from the pottery assemblage excavated from area II of the site. These sherds were all dated based on the stylistic analysis to the Yarmoukian period. The selected sherds came from various locations (rim, base, handle and body sherds) of recognizable pottery vessels, such as bowls, cups, and cooking pots as shown in Pl. 1.

Petrographic analysis was done by examining thin sections under an optical (Swift and Son) microscope using the standard polarizing transmitted light techniques. Heavy minerals were separated from both the pottery as well as the stream sediments from the main wadi bottom. The heavy minerals were separated using bromoform of specific gravity 2.9. Then these separated fractions were mounted on a glass slides and analyzed under polarized transmitted microscope.

The XRD analysis (random, oriented and gycolated) was performed with a Philips diffractometer, model Tw-1929. The Cu_a radiation was obtained by exciting at 30 kV and 20 mA.

The estimation of the initial firing conditions was done by a combination of different techniques; refiring of pottery sherds with monitoring of color change was employed to obtain a rough estimation of initial firing temperature. Eight pottery sherds were selected and each one was broken into five fragments. Each fragment was refired in an electric kiln in the laboratory at different temperatures ranging from 500C° to 900C° with 100C° increments for two hours. After that the color of the original sherd was compared with the color of the refired fragments in order to determine the range of temperature where the marked changes occur.

Scanning electron microscopy (SEM) and X-ray diffractometry (XRD) were used for the determination of the initial firing conditions. Twelve pottery sherds were selected for this study. The pottery sherds were cleaned from the extraneous materials and then by using a mini drill around 100 mg sample was taken from each sherd. Portions of these samples were heated in an electric kiln under

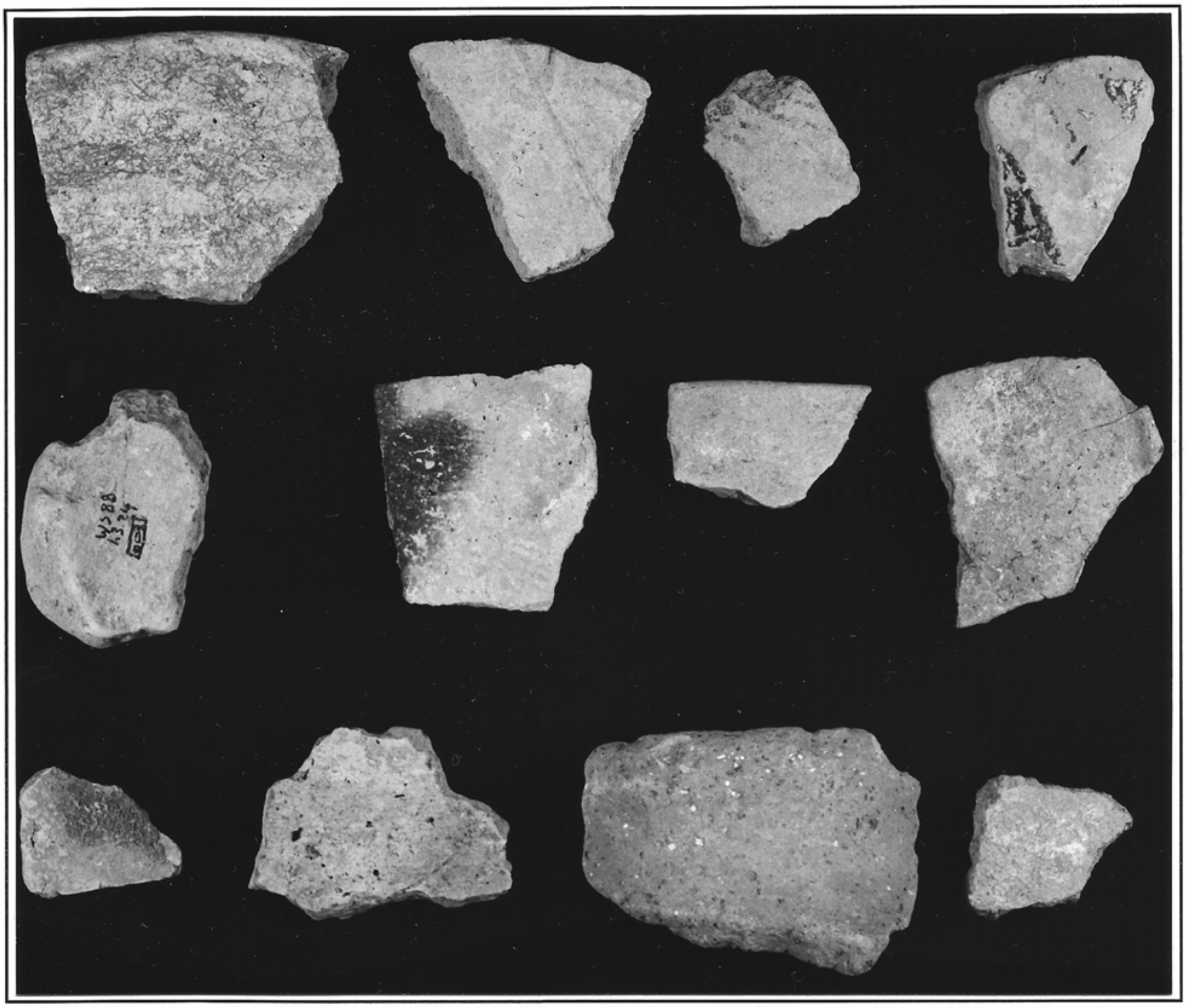


Plate 1:a. Some of the pottery sherds in the sample.

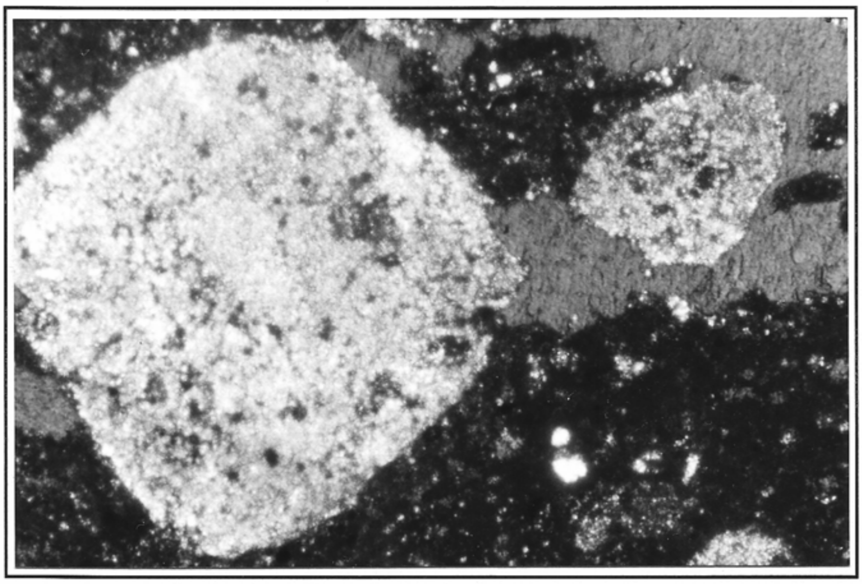


Plate 1:b. Photomicrograph showing an angular calcite grain (40X, XPL)

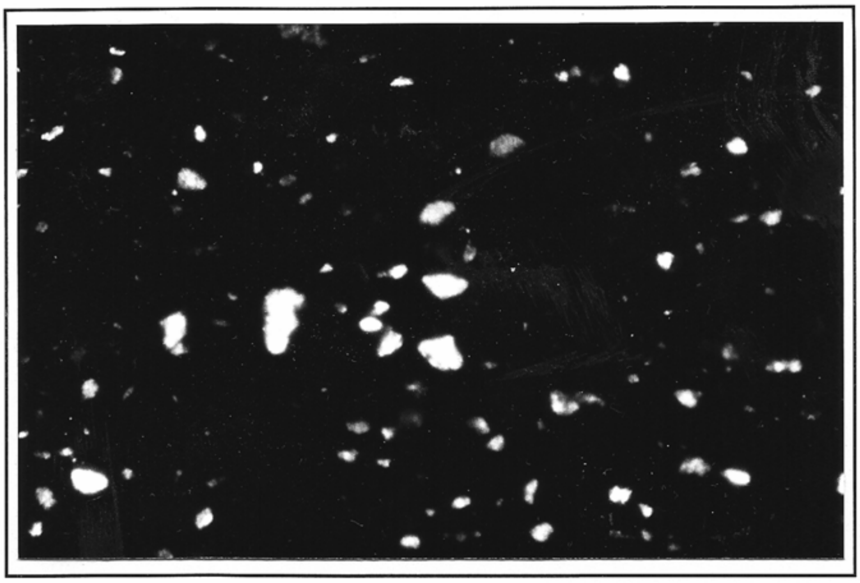
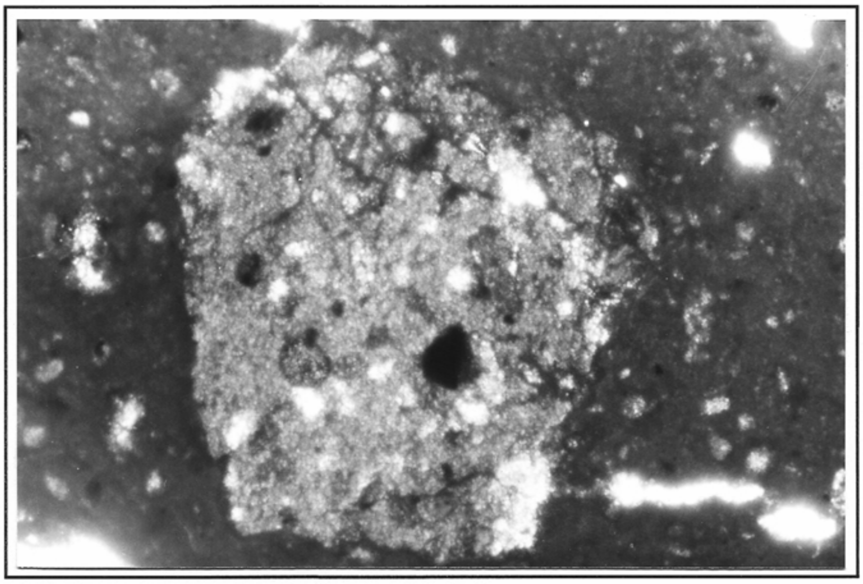


Plate 2:a. Photomicrograph showing clay matrix with quartz grains (40X, PPL).

Plate 2:b. Photomicrograph showing an ancient crushed pottery fragment (grog) (100X, PPL).



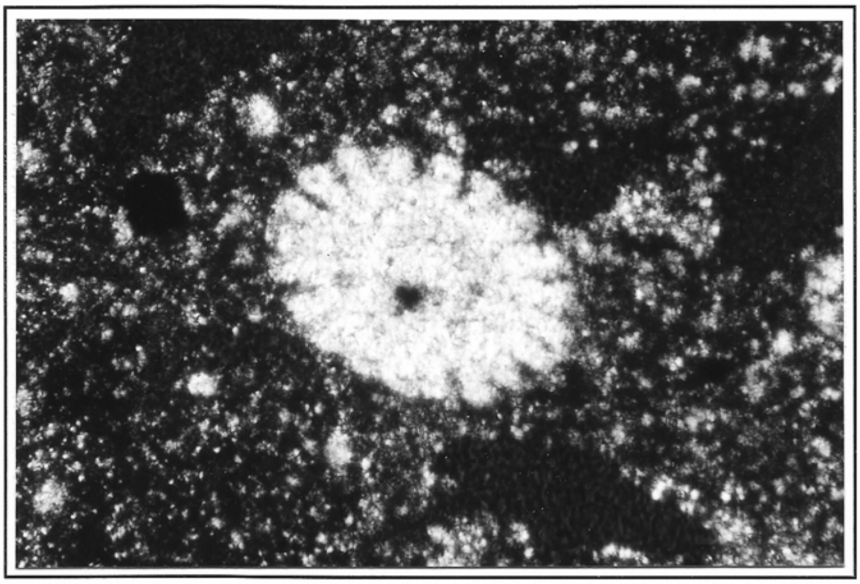


Plate 2:c. Photomicrograph showing clay matrix with fossil shell fragments (100X, PPL).

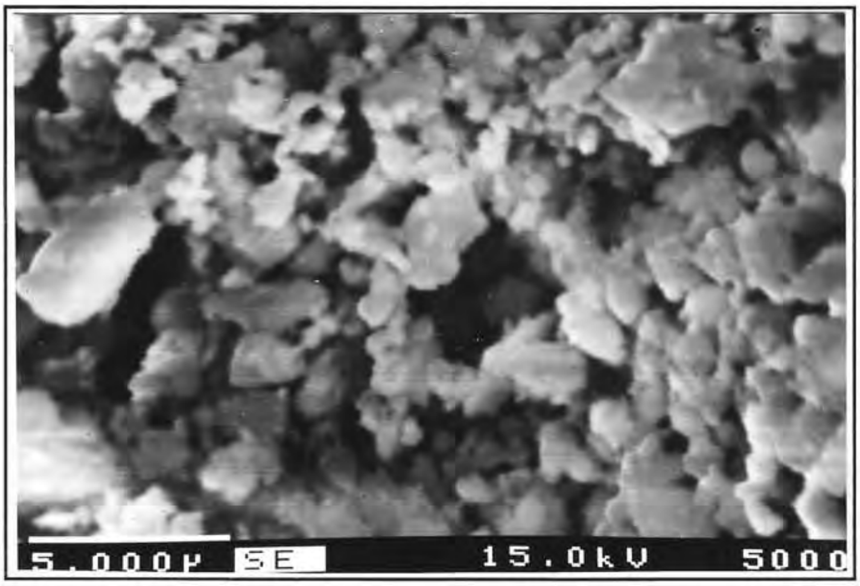
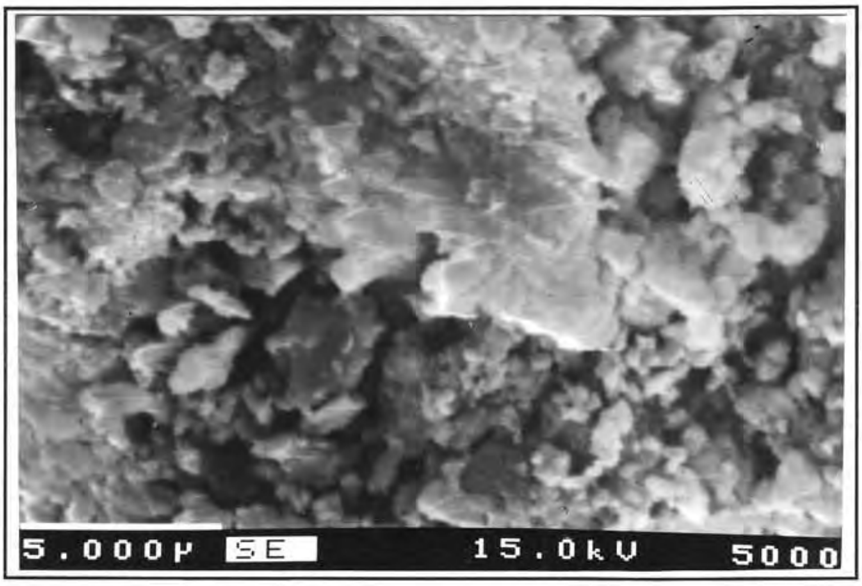
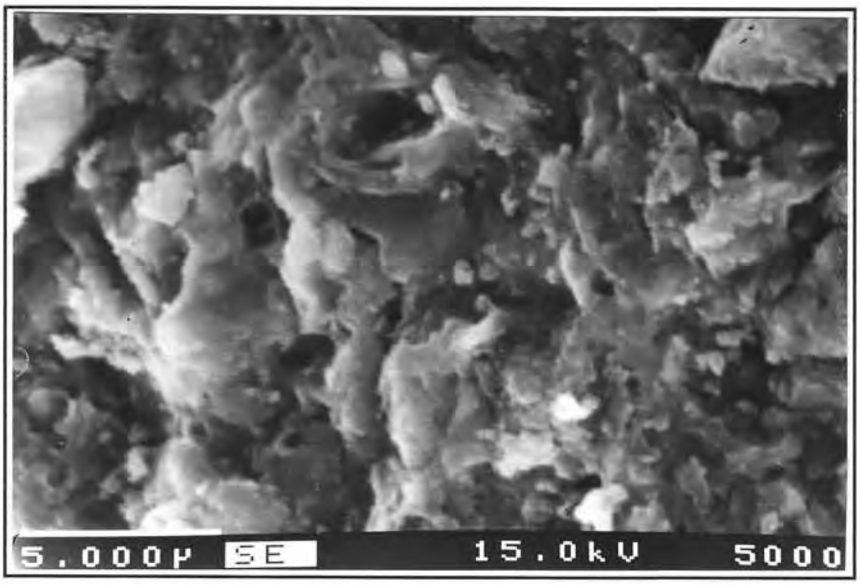


Plate 3:a-c. Scanning electron photomicrographs of pottery samples showing

a original sample,

b sample after re-firing at 600 C°,





c sample after re-firing at 800 C°.

oxidizing atmosphere at temperatures of 750, 800, 850, 900, 950, 1000, 1050, and 1100C° for 3 hours at each temperature. Each heated sample was divided into two parts, one used for collecting the X-ray diffractograms and the other used for the SEM investigations. The samples were studied under SEM CAMECA SU30, using secondary electron image.

Results and Discussion

The mineral assemblages of the studied sherds are composed predominately of calcite, quartz, ancient crushed sherd (grog) and chert as shown in Plates 2a-b and 3a. They also contain small quantities of some other materials. This includes dolomite, feldspar, iron oxide, shell fragments (Pl. 3b), and anhydrite. The thin sections of most of the samples show the presence of voids of irregular shapes and varying sizes. This indicates that organic materials were used as temper or that the clay used by the potter contained organic matters which were burnt out during the firing. Organic matter might have been deliberately added by the potter or present naturally in the clay. Heavy minerals separated from the pottery include zircon, tourmaline and rutile.

The mineral assemblages occur with different sizes, shapes and amount. Most calcite particles present in the studied samples are of angular shape indicating intentional addition by the potter while most quartz is of rounded shape indicating that quartz was a natural component of the used clay. Grog or crushed sherds of various sizes are abundant. This was added by the potter to the clay to improve its workability by reducing shrinkage and warping. The low abundance and the rounded shapes of the particles of dolomite, feldspar and iron oxide indicate that these were probably present as impurities in the clay rather than a deliberate addition by the potter. The wide variation in the grain sizes of the mineral inclusions in the studied pottery indicates that sieves were not used by the Neolithic potters at Wadi Shu'eib. The mineral inclusions are randomly distributed and show no orientation within the same thin section which indicates that the studied pottery was hand modeled (BATAINEH 1996).

The analysis and identification of temper to identify local or foreign production of ceramic is a powerful method (MAGGETTI 1982). The method is based on the assumption that ancient potter used local material for tempering their clay. The temper of a local pottery must therefore reflect the geology of the site. Therefore the comparison of the nature of the temper fragments with the local geology can lead to the identification of the provenance of pottery.

All the temper materials identified in wadi Shu'eib pottery can be derived from the area in the vicinity of the site and therefore these tempers directly reflect the geology around the site. Quartz and feldspar could be derived from sandstone, whereas calcite, dolomite and chert could be derived from limestone. The heavy minerals separated from the nearby stream sediments contain the same assemblage separated from pottery (BATAINEH 1996).

The mineralogical compositions of the studied sherds determined by petrographic examination, XRD and heavy mineral separation clearly indicate local manufacturing of the pottery. Moreover, the availability of high quality raw clay from the Lower Cretaceous Kurnub Formation in the vicinity of the site confirms the local production of pottery at Wadi Shu'eib. Other raw materials needed for pottery manufacturing (water and fuel) were also available.

Firing temperatures and firing conditions of ancient ceramics are of great archaeological significance. They can provide valuable information on the technological capabilities of the ancient potters (ROBERTS 1963, TITE 1969, HEIMANN and FRANKLIN 1979). This information is essential for the reconstruction of the ancient technology used for pottery kilns building and firing. Therefore, a combination of different approaches and methods were used in this study the retrospective estimation of firing conditions.

The results of the refiring tests in terms of color observations are given in Table 1. By comparing the color of the original sherds with the color of the refired fragments, it was noted that there was little to no change in color of fragments refired to 600C° or less, but a clear change occurred in those refired to 700C° and above. This result indicates that the original firing temperature was in the range between 600-700C°.

The XRD patterns of the pottery fragments refired up to 700C° (Fig. 3) show the same mineral assemblages of the original sherds. As the temperature increased some changes in the mineral compositions of the samples have been observed (Fig 3). The peaks which correspond to calcite become weak at 750C° and almost disappear at around 800C°. XRD patterns for fragments which were refired to 800C° show the absence of calcite, which indicates that the original firing temperature was exceeded. This confirms that the initial firing temperature was below 700C°.

The firing temperature of pottery could be estimated by observing at high magnification the micro structure changes which occur in clay during advance heating. Pl. 3 shows microphotographs of fresh fracture surfaces of unfired pottery sherd and of a number of pottery sherds refired at various temperatures. The microphotographs clearly show that the degree of continuity and interconnection within the clay matrix increases with the increase of firing temperature. By comparing the internal morphology of the original unfired sherd with the fired sherds it is clear that no change in the degree of vitrification is noticed until the firing temperature exceeds 700C°. Above 700C° clear changes in internal texture are observed due to the onset of vitrification (BATAINEH 1996).

Table 1. Results of refiring of pottery sherds at different temperatures.

Sample number	Sample code	Color change at 500C°	Color change at 600C°	Color change at 700C°	Color change at 800C°	Color change at 900C°
S_1	14.C	no	little	slight	partial change	extensive change
S_4	17	no	no	slight	partial change	extensive change
S_6	11.A	no	no	slight	partial change	extensive change
S_2	24	no	little	slight	partial change	extensive change
S_8	14.F	no	little	slight	partial change	extensive change
S_{10}	14.G	no	no	slight	partial change	extensive change
S_{17}	4	no	little	slight	partial change	extensive change
S_{20}	22.B	no	little	slight	partial change	extensive change

Table 2. Relation between the color of cross sections of sherds and firing conditions.

Sample number	Sample code	Description the cross section of the sherd fragment	Organic matter	Atmospheric condition
S_1	14.C	has a cross section of uniform color	no	oxidizing condition
S_2	24	has a sharply defined oxidized zone adjacent to the surface	yes	reducing condition
S_3	14.A	has a black cross section	yes	reducing condition
S_4	17	has a sharply defined oxidized zone adjacent to the surface	yes	reducing condition
S_5	3.B	has a sharply defined oxidized zone adjacent to the surface	yes	reducing condition
S_6	11.A	has a cross section of uniform color	no	oxidizing condition
S_7	14.B	has a cross section of uniform color	no	oxidizing condition
S_8	14.F	has a sharply defined oxidized zone adjacent to the surface	yes	reduced, cooled rapidly in air, reduced again cooled again
S_9	14.E	has gray core, distinct from the color of the surface, incomplete oxidation of the carbon	yes	oxidizing condition
S_{10}	14.G	has a sharply defined oxidized zone adjacent to the surface	yes	reducing condition
S_{11}	2.B	has a cross section of uniform color	no	oxidizing condition
S_{12}	2.A	has a cross section of uniform color	no	oxidizing condition
S_{13}	14.D	has a cross section of uniform color	no	oxidizing condition
S_{14}	1.B	has gray core, distinct from the color of the surface, incomplete oxidation of the carbon	yes	oxidizing condition
S_{15}	6.A	has gray core, distinct from the color of the surface incomplete oxidation of the carbon	yes	oxidizing condition
S_{16}	3.A	has a cross section of uniform color	no	oxidizing condition
S_{17}	4	has a cross section of uniform color	no	oxidizing condition
S_{18}	22.A	has a cross section of uniform color	no	fully oxidizing condition
S_{19}	6.B	has a black cross section	yes	reducing condition
S_{20}	22.B	has gray core, distinct from the color of the surface, incomplete oxidation of the carbon	yes	oxidizing condition

The atmosphere of firing is indicated by macroscopic examination of freshly broken fragments. Fragments with a black exterior are considered to have been fired in a reducing atmosphere, whereas sherds with a light colored exterior are considered to have been fired in an oxidizing atmosphere.

Table 2 shows the description of the cross sections of twenty sherd fragments. Eleven cross sections of freshly fractured sherds show uniform color. This is an indication that these sherds were fired under oxidizing atmosphere. Three sherds have a black core, distinct from the surface color. The black core is due to the incomplete burning out of the organic inclusions of the pottery. This indicates firing in a partially oxidizing atmosphere. The remaining sherds show gray to black cross sections

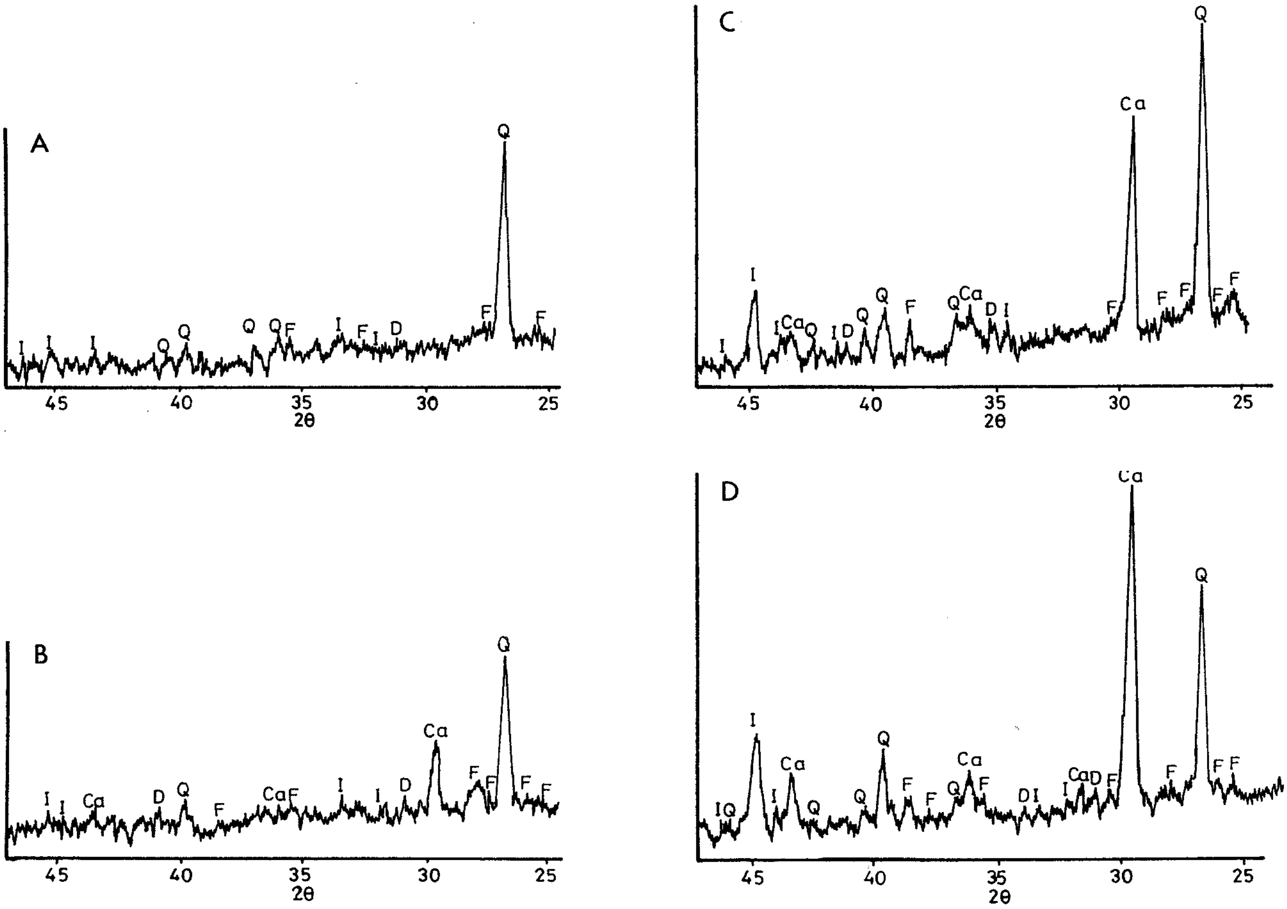


Fig. 3. X-ray diffractograms of a pottery sample.
A original, B refired at 600C°, C refired at 700 C°, D refired at 800 C°
(Ca: calcite, Q: quartz, D: dolomite, F: feldspar, I: iron oxide).

which indicates firing under reducing atmospheres. It is clear that the studied sherds are derived from pottery fired under variable conditions. This in addition to the relatively low firing temperature strongly indicate that open pit firing was the technique used by the Neolithic potters at Wadi Shu'eib.

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Fourth Millennium BC Copper Metallurgy in Northern Jordan: The Evidence from Tell esh-Shuna

Thilo Rehren, Karsten Hess, and Graham Philip

Abstract: *Metalworking debris, including broken ceramic vessels and metal prills, was recovered from a late fourth millennium BC context (late EB I), at Tell esh-Shuna in northern Jordan. Contrasting shapes, supported by differing evidence for the application of heat, suggested that the material included examples of two different types of vessel, interpreted as crucibles and moulds. The latter were intended for the production of small rectangular copper ingots, rather than specific types of tool. Chemical analysis of the metal revealed this to consist of copper, containing around 2 wt % arsenic and nickel. The impurities indicate that the metal is unlikely to have derived from any of the copper deposits known in the southern Levant. This metal is different from the low impurity copper employed in the production of utilitarian artefacts during the EB I period, but bears a close resemblance to some of the nickel-arsenic rich metal used in the production of both tools and 'prestige' items during the preceding Chalcolithic. The unique nature of the Shuna assemblage suggests that the copper industry of the EBA may be rather more complex than has hitherto been assumed.*

Zusammenfassung: *Die laufenden Ausgrabungen in Tell esh-Shuna in Nord-Jordanien erbrachten aus einem Kontext des späten vierten Jahrtausends (Späte Frühbronzezeit I) eine Reihe metallurgischer Abfälle, zumeist technische Keramik und kleine Metalltröpfchen. Die Keramik ist anhand unterschiedlicher Formen und Hitzeeinwirkung zwei verschiedenen Typen zuzuordnen, die als Tiegel bzw. Gußformen interpretiert werden. Letztere dienten vermutlich eher der Produktion flacher rechteckiger Bleche als dem Guß bestimmter Werkzeuge. Chemische Analysen der Metallfunde weisen sie als Kupfer mit Nickel- und Arsengehalten bis zu je zwei Prozent aus. Dies und die übrigen Verunreinigungen machen es unwahrscheinlich, daß das Metall aus einer der bekannten Lagerstätten der südlichen Levante stammt. Zugleich ist das Metall zu unterscheiden von dem relativ reinen Kupfer, aus dem die Mehrzahl der zeitgleichen Werkzeuge hergestellt wurden; vielmehr ähnelt es dem Nickel-Arsen-Kupfer, das während des Chalkolithikums sowohl für Werkzeuge als auch für Prestige-Objekte gelegentlich Verwendung fand. Die bislang einmalige Zusammensetzung der Funde aus Shuna deutet darauf hin, daß die Kupferindustrie der Frühbronzezeit vermutlich komplexer war als bislang angenommen.*

Introduction

Excavations at Tell esh-Shuna (N) in the north Jordan Valley (Fig. 1) between the years 1991 and 1994 produced clear evidence, in the form of ceramic vessels and metal prills, for the high temperature working of copper on-site. We present here some initial results arising from laboratory work on this material, and some remarks on the implications of the new evidence. A full description will appear in the final excavation report.

Archaeological Context

The metalworking remains come mainly from context 149, a rich rubbish deposit, which produced ceramics characteristic of the later EB I period, including numerous fragments from large jars bearing band slip decoration, a fragment of sheet silver (PHILIP and REHREN 1996; REHREN, HESS, and PHILIP 1996), animal bone and carbonised material (see plan in PHILIP and BAIRD 1993: 20, Fig. 3). Four radiocarbon accelerator dates were obtained on short-life samples retrieved from this deposit. Expressed at two standard deviations, these fall between 3400 and 2900 cal. BC, confirming the date in the later EB I period suggested by the ceramics. The nature of the deposit, which is the uppermost of several such midden layers, suggests that it was formed over a relatively short period of time, and the combination of metalworking debris with broken pottery and animal bone suggests that the metallurgical remains were not, at least in this particular instance, treated separately from domestic waste.

In addition to the material recovered by the current project, comparable evidence was retrieved during the 1984-85 excavations at the site, with small, rectilinear, chaff-tempered vessels recorded as being excavated alongside "fragments of copper and slag" from context EIII Locus 12 (GUSTAVSON-GAUBE 1985: 52; Fig. 15, 76a-78). Although identified by the excavator as a large pit, this deposit is almost certainly a continuation to the north of the rubbish deposit of which our context 149 represents the topmost layer. The correlation between the recent excavations and those of GUSTAVSON-GAUBE will be treated in detail in the final excavation report, but the close proximity of the excavation areas of the two projects is evident in BAIRD and PHILIP (1994: Fig. 1). The number of fragments, deposited within a relatively short period, provides evidence for the existence of significant metallurgical operations at the site.

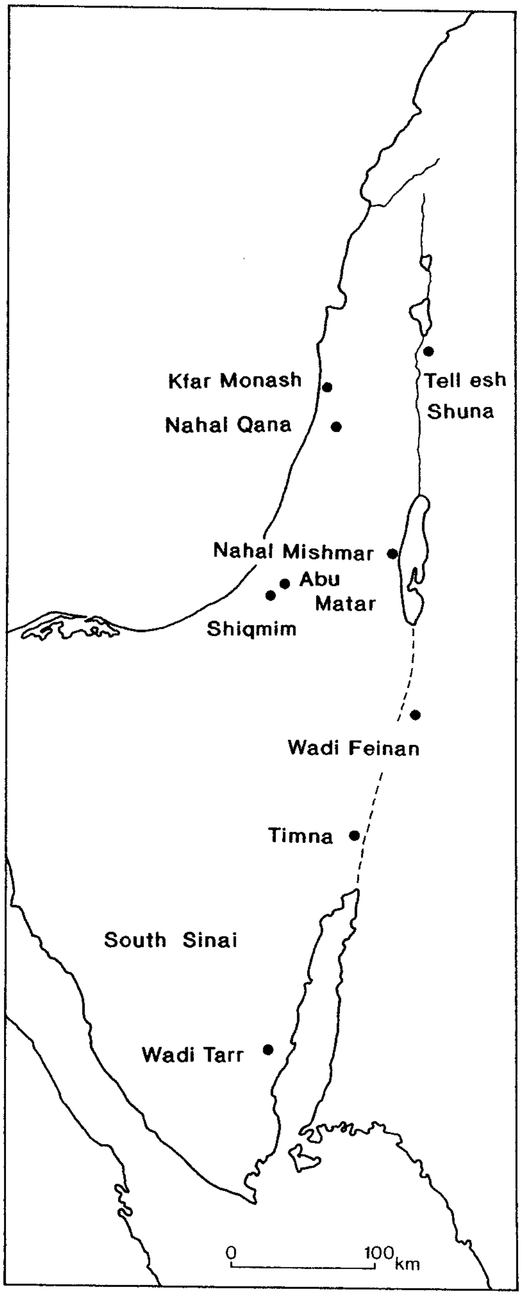

Fig. 1. Map of the Jordan Valley area and the Sinai, giving the locations of sites relevant to this study.

The Ceramic Evidence: Description

The material consisted of around forty fragments of clay vessels which would appear to have been used for the working of copper, and a number of small, corroded metal fragments. Those ceramic fragments large enough to permit the identification of their original shape seem to belong to vessels of two different types which we have identified as crucibles and moulds.

Crucibles

A number of fragments come from open vessels of rounded shape with curving sides. All were handmade in a coarse, light brown, chaff-tempered fabric containing occasional large mineral inclusions. Some fragments show signs of heavy vitrification on the interior surface and bear the remains of copper trapped within (Pl. 1:1-2). In some cases the entire surface is covered by green corrosion products. The original thickness of the crucible fabric is hard to determine. Some fragments measured 2cm in thickness, but in many instances only the vitrified inner surface was preserved, since the more friable, less highly-fired external part of the ceramic body had crumbled.

Moulds

Around ten fragments appear to come from small, rectilinear vessels with flat bases and straight sides (Fig. 2, Pl. 1:3-4). Vessel breadth is variable, with some quite narrow and others rather broader. The vessels were handmade, in a light brown, chaff-tempered fabric with a grey core in some instances. The exterior surface is usually roughly smoothed-off, while the vessels have a slightly curved internal profile. Several examples bear traces of copper adhering to the interior surface. Blackening, on both internal and external surfaces of some moulds, indicates burning. These vessels generally show a more carefully finished surface than the crucibles described above, and they were provisionally identified as moulds for the casting of small, rectangular metal blanks.

While the walls of these vessels appear thinner than might be expected in moulds, TITE *et al.* (1990: 173), discussing calcareous clays, make the point that "a temperature of 1100°C is typically reached at a depth of 5mm after the surface has been maintained at 1150°C for about two hours," suggesting that the relatively thin walls would appear to present no physical problems. In fact, relatively thin walls may have been beneficial, since they could be dried more easily than thicker clay blocks. As the presence of even small amounts of moisture are deleterious for casting, this may have been of great significance to early metalworkers.

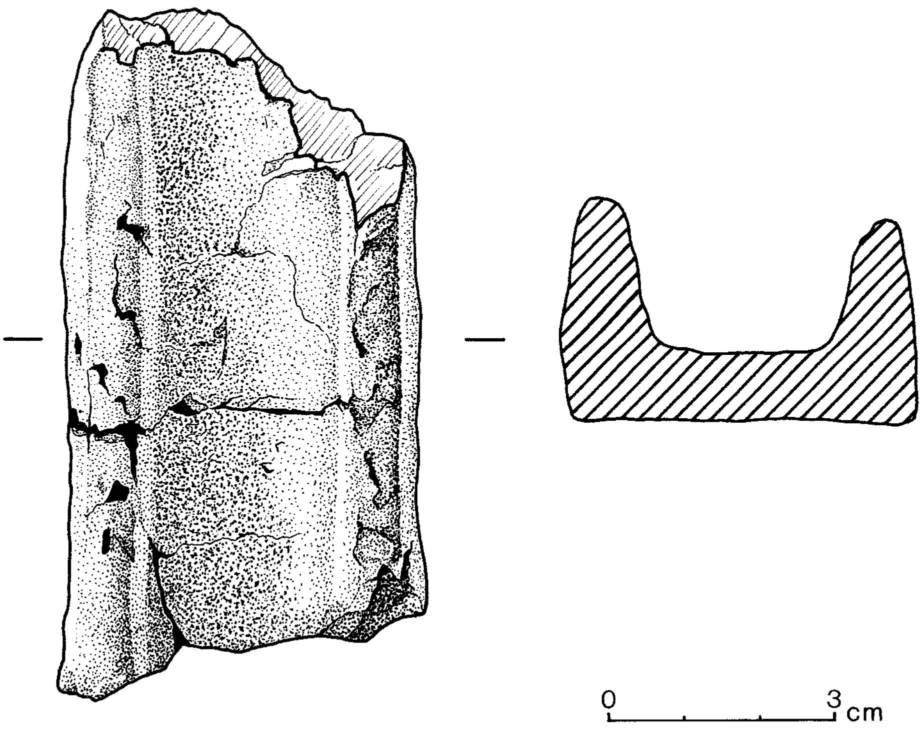

Fig. 2. Drawing of a mould fragment from Tell esh-Shuna (Sample 149: 234).

Support for the division of the material into two categories on the basis of vessel morphology comes from their physical characteristics, in that there are significant differences between the temperature effects visible at the inner surfaces of crucibles and moulds. In the case of crucible fragments, the clay appears highly fired particularly at the inner surfaces where it is often black, showing evidence of bloating through vitrification. It would appear that the crucibles were heated from above to such a degree as to cause the partial collapse of the ceramic structure. The inner surface is often rich in green stains, which result from trapped and subsequently corroded metallic copper. Other areas however appear almost unchanged. The moulds in contrast show little, if any, sign of vitrification, and they have only occasional small specks of green corrosion products adhering to their internal surfaces.

A petrographic study of the ceramics from Shuna has indicated that these vessels represent the only examples of chaff-tempered fabrics recorded from the EB I occupation at the site (ROWAN, pers. comm.). Thus, the metalworking vessels were produced in a fabric differing from those of the contemporary Shuna pottery repertoire.

Laboratory Analysis

Crucibles

Chemical analysis has shown that the material of the crucibles was not of a particularly refractory nature. The main constituents are silica at around 50 wt %, and lime and alumina at about 10 wt % each. The oxides of iron, potassium, phosphorous, magnesium and titanium range, in decreasing order, from five to one percent by weight. The high concentration of lime is noteworthy, indicating that this is a calcareous clay, while the relatively moderate levels of alumina and silicia indicate that the fabric will have only limited refractory properties. TITE *et al.* (1990) report the use at Timna of calcareous clays mainly for crucibles, while the other refractory ceramics, used for tuyeres and furnace linings, were found to have less than five wt % CaO. The alumina content, however, was considerably higher than that noted in the examples from Shuna, ranging from 15 to 20 wt % in most cases (TITE *et al.* 1990: 160). In this case, both calcareous and non-calcareous clays were found to be sufficiently refractory to permit their use in copper smelting. In the case of the Shuna crucibles, when in use the limits of thermal stability of the ceramic were apparently reached at the inner surfaces, while the main body of the vessels remained unaffected, thus ensuring their integrity. Thus, the material used at Shuna was sufficiently stable to work in practice, if less than ideally suited for high temperature operations. The phosphorous content found in the Shuna ceramic, averaging two wt % P_2O_5, is notable, but it does not necessarily represent the original clay chemistry. FREESTONE *et al.* (1985) were able to correlate convincingly the degree of vitrification of ceramic with its ability to accumulate phosphorous from the surrounding burial environment. Fuel ash produced during crucible use represents one possible source of such phosphorous.

Upon examination under the petrographic microscope, the fabric was seen to be of coarse, heterogeneous texture. Occasional grains of quartz are irregularly distributed, suggesting little preliminary working of the clay prior to vessel formation. From inner surface to core, vitrification of the matrix decreases, texture changes from a totally vitrified, mostly glassy, dense siliceous "slag", through an intermediate area of glassy, pumice-like appearance with numerous circular vesicles, to a typical ceramic texture with burnt-out chaff (Pl. 1:5). The zone of total vitrification of the ceramic can attain several millimetres in depth, but it is often restricted to less than one millimetre. Areas of extensive vitrification are usually rich in oxidised copper compounds trapped within the dense glassy body. Oxidation seems more pronounced closer to the surface, while prills buried deep within the vitrified ceramic appear less oxidised.

Several copper prills trapped within crucible fragments from context A149 (380/254 IV/264 and 540) were analysed by WDS, which demonstrated a compositional range between, but also within, individual fragments. Some prills consist of pure copper, whereas others contain variable amounts of nickel and arsenic in solid solution (see Table 1). The varied compositions of the metal prills found within the ceramic is not unusual (see *e.g.*, HOOK *et al.* 1991: 68, CRADDOCK 1995: 256), but accurate reconstruction of the composition of the charge is not possible. In almost all cases the copper prills contain cuprite inclusions and are surrounded by a solid cuprite rim (Pl. 1:6). Quite often, such cuprite aggregates are themselves surrounded by a thin coating of tenorite, the more highly oxidised, bivalent copper oxide. The needle-shaped, mixed iron-copper oxide delafossite, frequently but not massively occurring in copper-rich areas, is interpreted as a reaction product of the iron content of the ceramic with the oxidised metal charge of the crucible, but it may also, in part, contain iron introduced with the copper.

Table 1. WDS-Analyses of copper droplets trapped in crucible fabric. SEM-WDS spot analysis of sound metal prills trapped in ceramic fragments. The elements lead and tin were sought, but not found.

sample	Cu %	Ni	As	Fe
149:254	98	0.5	0.6	-
149:254	98	0.4	0.5	-
149:254	99	0.5	0.5	0.1
149:254	100	-	-	-
149:254	100	-	-	-
149:540	97	0.4	0.3	0.4
149:540	98	0.3	0.3	0.4
149:540	96	1.1	0.5	0.1
149:540	98	0.9	0.3	0.7
149:540	100	-	-	-
149:264	98	0.1	-	0.1
149:264	98	0.3	-	0.3
149:264	99	0.4	-	0.2
149:264	100	-	-	-
149:264	100	-	-	-

The features observed both on macroscopic and microscopic scales are consistent with the melting of copper in shallow, open crucibles. The heat was apparently generated inside the vessels by burning charcoal, possibly with a subsidiary air supply through blow pipes. External heat production, *i.e.*, heating from the bottom by placing the crucibles on a bed of hot charcoal, can be excluded on the basis of the very clear temperature profile within the fabric, which shows vitrification on the inside only.

The process conducted was essentially non-slagging and apparently carried out under relatively highly oxidising conditions. The composition of the vitrified ceramic is, within the limits of analytical error, identical to that of the unvitrified material, except for the greater copper content of the former. There is no indication of the enrichment within the vitrified surfaces of FeO, MnO, or MgO, all typical impurities of Jordanian copper ores (HAUPTMANN *et al.* 1992), arguing against a metallurgical process involving these ores. The only indication of metallurgical activity is the dross trapped in the vitrified ceramic. Oxidising conditions are evident from the composition of this dross, *i.e.*, the ubiquitous presence of cuprite in the copper prills, and further augmented by the widespread rims of tenorite around the copper-cuprite agglomerates as well as the delafossite in the neighbouring fabric. Such structures are well known from burnt copper and copper alloys (*e.g.*, NORTHOVER and REHREN 1992), and are typical for copper melting under real, *i.e.*, non-ideal conditions (WHEWELL *et al.* 1996).

Table 2: Analyses of detached metal samples (ICP-ES and WDS). Three ICP-ES analyses of *c.* 50 mg samples in each case are given including trace elements. The first two samples are individual prills containing sufficient sound metal for analysis, while the last (467: 20) was a highly oxidised lump of cinder. The ICP data of this sample are recalculated to 100 wt % metal excluding typical soil elements, *i.e.*, sodium through to iron; the original data included about 30 wt % of such soil contaminants, and reached a reasonable total only when all elements were calculated as oxides. The WDS data of all samples are from single spots in metallographic mounts and cover the main elements only. Lead and tin were sought, but not found (but *cf.* Pl. 2:2).

sample	Cu %	Ni	As	Fe	Pb	Sn	Zn ppm	Co	Sb	Bi	Te	Se	Ag	Au
451:12	95	1.38	1.39	0.11	0.12	0.06	29	72	560	270	13	210	22	24
451:12	94	1.9	2.1	0.1										
451:12	97	2.6	1.6	0.1										
149:90	82	1.01	2.04	0.19	0.08	0.21	23	48	370	140	11	300	<3	18
149:90	96	1.5	3.2	0.2										
149:90	96	1.9	1.1	0.3										
149:90	97	2.2	0.8	0.3										
149:58	99	0.3	-	-										
149:58	99	0.6	-	-										
460:16	94	4.6	2.2	-										
460:16	94	5.1	0.9	-										
460:16	94	5.9	0.5	-										
467:20	95	1.8	2.0		0.3		250		380	7000			480	
467:20	97	0.1	0.2	-										

While the evidence of the moulds and crucibles clearly indicates the melting and casting of copper at Shuna, the absence of slag from context 149, despite intensive sieving, does not necessarily rule out the possibility of smelting operations. Under certain conditions the practice of slag-free smelting of pure ore (malachite for example) in a crucible is possible, and although this cannot be demonstrated in this particular instance, the possibility should be borne in mind.

Metal Prills and Fragments

The amount of metal recovered from the workshop debris is limited. A few isolated metal prills were recovered from other contexts (A 451, 460, 467), but refractory material was restricted to context 149. Unfortunately, the lack of copper-base artefacts from secure EB I contexts at the site prevents the comparison of metalworking remains with finished products.

The largest prill recovered measures 1.8cm in diameter, while the copper remains attached to the moulds or trapped within vitrified crucible surfaces were almost invisible to the naked eye. Only two prills (A451:12, A149:90) were large enough to produce an uncorroded, sound metal core suitable for ICP-ES analysis. These, along with two other samples (A460:16, A149:85), were then mounted for metallographic investigation. All samples are highly oxidised and contain significant proportions of cuprite and tenorite, as well as sulphide inclusions. The microstructure of these samples indicates the presence of alloying elements (Pl. 2:1-3), which on analysis turned out to be arsenic and nickel, which are present in the range of one to two percent, and which attain more than five percent in interstitial enrichment zones (Table 2). Minor amounts of iron, lead, and tin are also present (0.1 to 0.2 percent = 1000 to 2000 ppm), while antimony, bismuth and selenium were found, by ICP-ES, in the 100 ppm range. A significant difference between the isolated prills and the metal trapped within the crucibles is the occurrence of sulphide inclusions only in the former. EDS analyses of the sulphide inclusions gave, besides the predominant copper sulphide, considerable amounts of selenium

Plate 1:1. Section through crucible fragment 149: 375. The maximum thickness is 2cm. Note the heterogeneous ceramic and the vitrification of only the top layer.

Plate 1:2. SEM micrograph of a cross section through the upper part of a typical crucible fragment, with vitrified top layer (light right), bloated (vesicles are black) and copper-rich (white inclusions) inner surface. The inner, less heated ceramic preserved its original structure (BSE image, Sample 149: 254).

Plate 1:3. Fragment of a ceramic vessel, identified as a mould, possibly used for casting metal sheet (Sample 149: 234. Photo: A. Opel, Deutsches Bergbau-Museum).

Plate 1:4. Fragment of a narrower mould of the same coarse tempered fabric. The internal surface is relatively smooth, despite the generally rough appearance of the fabric (Photo: A. Opel, Deutsches Bergbau-Museum).

Plate 1:5. SEM micrograph of a crucible fragment with a thin, vitrified and bloated copper-containing inner surface which developed from a coarse tempered ceramic. The depth of vitrification is about 2mm, and the copper content is concentrated at the immediate surface (BSE image, Sample 149: 254).

Plate 1:6. SEM micrograph of a partly oxidised copper prill containing a euhedral cuprite inclusion (light grey) and a rim of copper corrosion products including cuprite (light grey) and atacamite (almost black phase between the cuprite seam and the metal core). The prill is trapped in ceramic which appears black here due to high contrast printing. The formation of well crystallised cuprite within the metal is evidence for a hot oxidation of the metal, while the atacamite is due to cold weathering during burial (BSE image, Sample 149: 264).

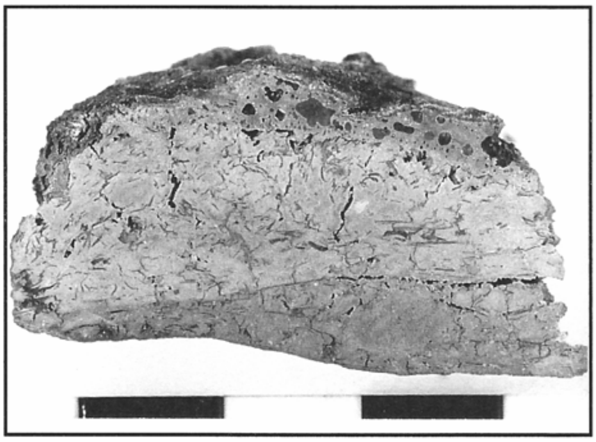

Plate 1:1

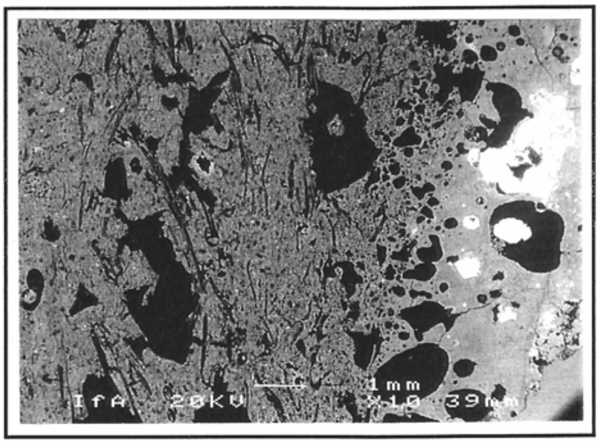

Plate 1:2

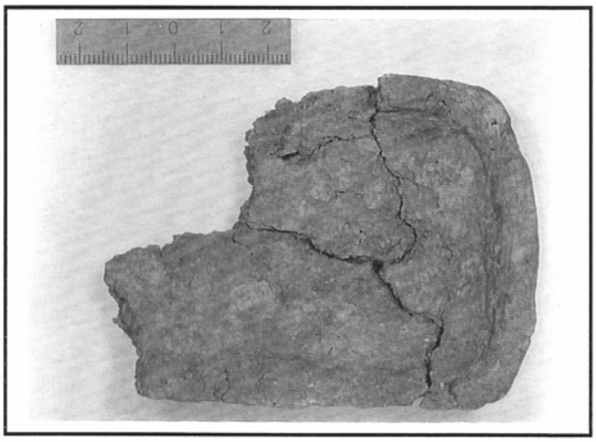

Plate 1:3

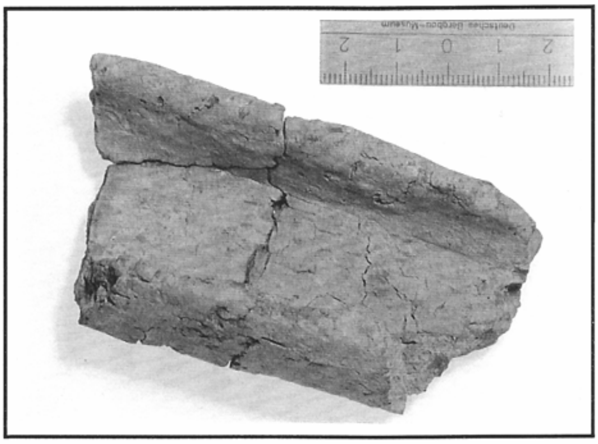

Plate 1:4

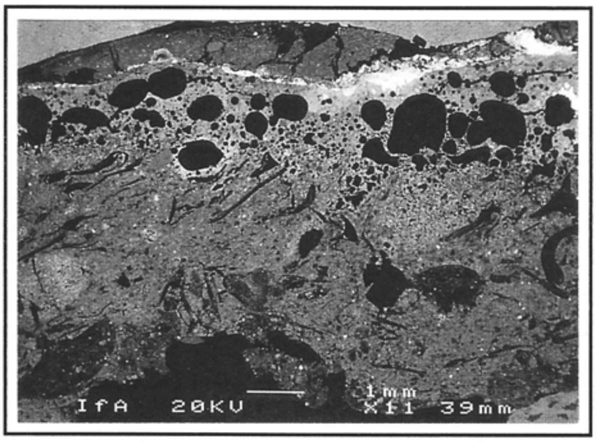

Plate 1:5

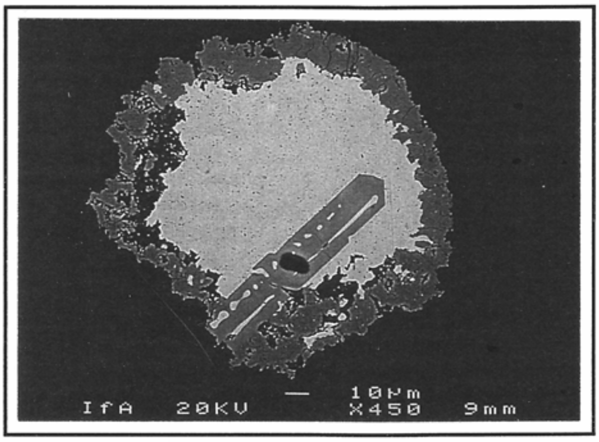

Plate 1:6

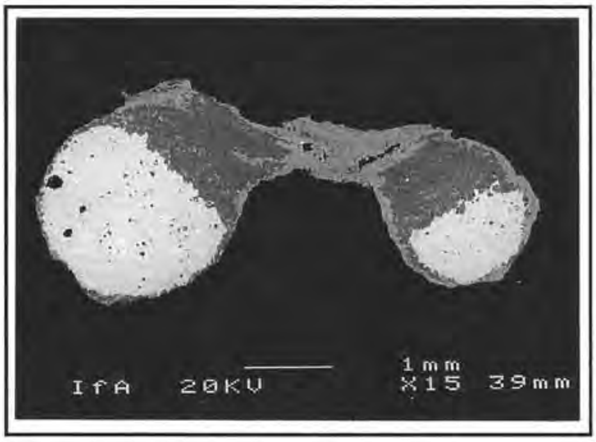

Plate 2:1

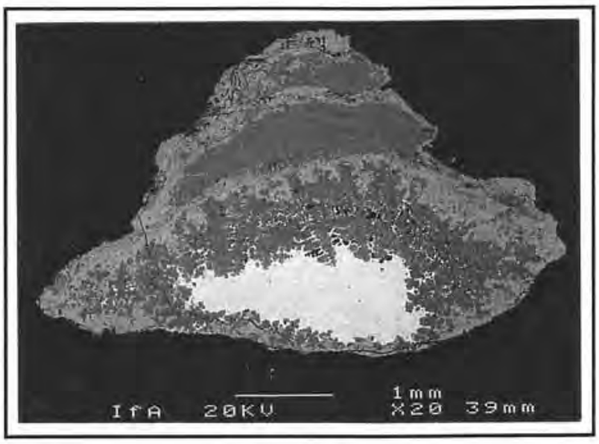

Plate 2:2

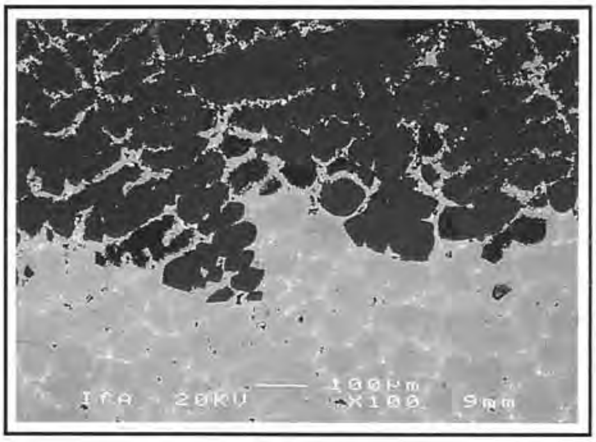

Plate 2:3

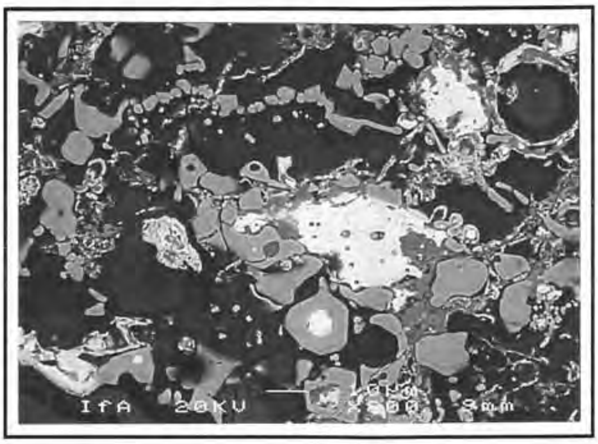

Plate 2:4

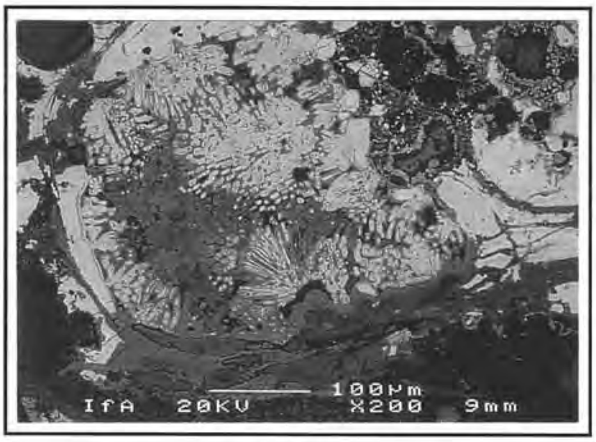

Plate 2:5

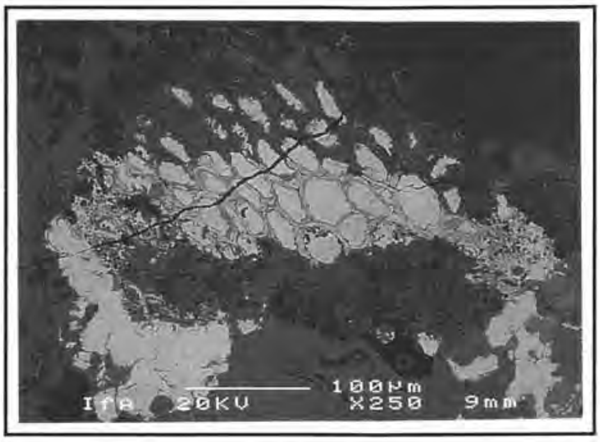

Plate 2:6

Plate 2:1. SEM micrograph of a twin metal prill showing corrosion in progress. Sound copper metal appears light, while tiny lead particles in the metal are bright white. The copper contains traces of nickel (see Table 2). (BSE image, Sample149: 58)

Plate 2:2. SEM micrograph of a large, isolated metal prill with typical as-cast dendritic structure. The main, dendritic phase is copper (white), while the corrosion transformed most of the metal into cuprite and atacamite. For details of the structure see Plate 2:3 (BSE image, Sample 149: 90).

Plate 2:3. Detail SEM micrograph of the central part of the prill shown in Plate 2:2, showing the structure-preserving corrosion. Note the interstitial network of arsenic- and nickel-enriched alloy (lighter grey) and the lead particles (white) (BSE image, Sample 149: 90).

Plate 2:4. SEM micrograph of nickel oxide phase ('bunsenite', light grey isometric grains), often containing a core of metallic copper (white, lower centre) and surrounded by copper/cuprite aggregates (light grey to white, centre). The matrix is copper chloride and silicates. The morphology of the bunsenite indicates its formation under high temperature conditions (BSE image, Sample 467: 20).

Plate 2:5. SEM micrograph of residual or 'ghost' as-cast structure, consisting of cuprite but mimicking the original metal. The darker grey and dark phases are various copper corrosion products and soil contaminants (BSE image, Sample 467: 20).

Plate 2:6. SEM micrograph of residual or 'ghost' as-cast structure similar to Plate 2:5, but coarser (BSE image, Sample 467: 20).

and tellurium. This is not unexpected as both elements tend to concentrate in the sulphide phase during hot oxidation (REHREN 1991).

A somewhat larger sample (A467:20), measuring 2.5 by 1.0 by 0.8cm, with colors ranging through various shades of green, with occasional specks of red and black, attracted attention as a possible piece of ore. Unlike the other metal samples, this came from a context belonging within the early phase of the EB I occupation at the site (BAIRD and PHILIP 1994: 116-7). It was found to contain, in addition to metal, about 25 wt % silica, 6 wt % lime, 3 wt % alumina, and 2 wt % each P_2O_5 and MgO. The bulk of this sample is made up by oxide phases, but for sake of comparison the chalcophile elements are quoted as recalculated to 95 wt % copper metal. The main phase is cuprite, partly transformed to malachite and atacamite, with interspersed siliceous phases. Some secondary covellite occurs disseminated through the sample. Frequently, the cuprite is associated with xenomorph to euhedral crystals of a nickel oxide phase, bunsenite, and some residual metallic copper (Pl. 2:4). Microprobe analysis of this copper metal is included in Table 2.

Due to the copper preserved in some larger cuprite grains, a residual as-cast dendritic texture occasionally visible in the sample (Pl. 2:5-6), and the morphology of cuprite and bunsenite grains, it was concluded that this sample represents dross or cinder from the hot oxidation of a metal rich in arsenic and nickel, *i.e.,* of a metal similar to the prills found in other contexts. Oxidation probably occurred at high temperature, but below that of the melting point of the metal, or the dendritic structure would not have been preserved. Oxidation may well have taken place in a workshop hearth, although alternative possibilities such as accidental burning cannot be ruled out. Malachite and atacamite are apparently secondary corrosion products of this material, while the silica, alumina and so on are soil contaminants. On balance, the fragment does not represent a piece of ore.

Interpretation

The Composition of the Metal

The compositions of cinder and metal prills trapped in the refractory ceramics are not identical to that of the whole charge. There are good parallels for this situation with the observation by STOS-GALE (1989) of considerable variability within the composition of metal prills trapped in copper smelting slag. Similar findings have been made in the case of Roman crucibles which were definitely used only once (REHREN n.d.). CRADDOCK (1995: 286) has suggested that the bulk of a crucible charge will be somewhat lower in arsenic than the average prills derived from it, but the basis for this statement remains open to debate. In our opinion, the smaller and more oxidised prills seem to contain lower levels of impurities than the larger examples, suggesting a fire-refining effect rather than the working of several separate metal types. This is most apparent from the sulphur content of the prills investigated, with sulphide inclusions occurring in the larger prills only. Furthermore, cuprite agglomerates found in the crucibles analysed in this study often contain isometric grains of mixed iron-nickel oxide, while the surrounding copper is almost free from nickel, indicating the preferential burning of nickel over copper.

The exact relationship between isolated prill compositions and the bulk chemistry of the charge remains open and could only be established through extensive experimental and archaeometallurgical work. For the time being, we believe that both the arsenic and nickel contents of the copper worked at Shuna lay in the range of two percent, *i.e.,* similar to the compositions of the larger prills, rather than the lower concentrations found in the fire-refined prills trapped in the crucible fabric. Considering the wide variations in composition within the material analysed, and the likelihood of some divergence between these and the composition of the original melt, we hesitate to stretch the evidence any further.

However, copper containing similar concentrations of arsenic and nickel is widespread in ancient western Asia and is generally considered an unintentional product, consequent upon the use of mixed ores (PERNICKA 1990: 48, CRADDOCK 1995: 285f) rather than the result of deliberate alloying. Other elements of interest are iron, lead and tin, present at the 0.1 percent level, and antimony, bismuth and selenium, found in the range of a few hundred ppm (see Table 2). This makes the metal relatively impure in comparison with that derived from the major copper deposits in the southern Levant, *e.g.,* Feinan and Timna (*cf.* HAUPTMANN *et al.* 1992) and suggests the use of a more complex, sulphide-containing ore (see below).

Melting or Smelting?

We have from Shuna clear evidence for the hot working of copper in crucibles in a situation within which there is no trace of any type of furnace slag. It remains to be established however, whether we have evidence for melting and casting only, or for so-called "slagless" smelting, in which the crucibles would have served as reaction containers for smelting ore. The vitrified, copper-rich surface material of the Shuna crucibles is indistinguishable in composition from the unreacted underlying fabric except for the copper content, *i.e.,* there is no contribution of typical slag-forming ore components to the composition of the crucible "slag". Given the lack of criteria permitting the clear distinction of crucible smelting slags from melting slags, it is not possible to say whether both smelting and melting, or melting alone, were being carried out at Shuna. On balance, we are not inclined to argue for local smelting at the site, a situation rendered even less likely by the fact that the ore is probably not local to the southern Levant.

It is clear that during the Chalcolithic period copper ores were being transported to settlement sites in southern Palestine (HAUPTMANN 1989, SHALEV 1991) where they were smelted locally in crucibles (CRADDOCK 1995: 126f). However, the recent suggestion that there existed a clear division between transport of ores in the Chalcolithic, and the smelting of ores at the mining sites during the Early Bronze Age (SHALEV 1994: 633) may be too rigid. This division may fall rather between Chalcolithic/EB I and EB II/III as originally suggested by HAUPTMANN (1989: 131-2). Current excavations at Wadi Fidan 4, a site on the east side of the Wadi Arabah, indicate small-scale, on-site copper smelting dating to the second half of the fourth millennium BC (ADAMS and GENZ 1995: 14; see in particular note 3, radiocarbon dates). The dates from this site fall within EB I according to a recent review of fourth millennium BC radiocarbon chronology (JOFFE and DESSEL 1995: 512), placing Wadi Fidan 4 broadly contemporary with the EB I occupation at Shuna. Future comparison of the composition of the copper worked at this site, located near the Feinan copper deposits, with the evidence from Shuna, some 150km northwards will be most interesting.

Investigation of late EB I metalworking debris from Tell esh-Shuna in northern Jordan produced good evidence for the melting in open crucibles of copper, rich in arsenic and nickel. The melting was apparently carried out under conditions such that a fraction of the copper was burnt and transformed into cuprite and tenorite. Such conditions are deemed typical of poorly controlled melting operations (WHEWELL *et al.* 1996), where the charcoal cover is insufficiently dense to prevent partial oxidation of the metal. It is worth noting that the draught from blow pipes can result in localised oxidising conditions alongside increased temperature, which in turn promotes the fusion of the ceramic surface and the incorporation within this of oxidised copper.

There is no evidence for smelting at Shuna, while melting and casting are apparent. However, a crucible smelting technology would have resulted in a poorly separated, virtually slag-free mixture of copper and copper oxide, which had to be further melted in order to produce a copper ingot. Such a process would leave traces little different from those of melting copper and hence cannot be excluded entirely.

The Origin of the Metal

There are no known copper sources in the vicinity of the north Jordan Valley (BENDER 1968). The nearest copper ores are those of the Wadi Arabah (Timna on the western side, and the Feinan region on the east), which played a major role as a copper producing region during the Early Bronze Age (HAUPTMANN *et al.* 1992). These copper deposits were being exploited by the Chalcolithic period and material transported to more distant sites such as Shiqmim and Abu Matar in the northern Negev (SHALEV and NORTHOVER 1987; HAUPTMANN 1989; GILEAD *et al.* 1991: 175; SHALEV 1991, 1994). As a result of intensive field and laboratory research (ROTHENBERG 1990, HAUPTMANN *et al.* 1992), the ore deposits of the Arabah and the metal derived from them are fairly well characterised, and have been described as "generally rather pure. Sb, Bi, Se ... are near or below the detection limit in the range of 10 µg/g ... Ag and Sn are mostly below 100 µg/g. As, Co, Ni, and Zn are an order of magnitude higher ..." (HAUPTMANN *et al.* 1992: 21). Furthermore, the "very low contents of arsenic, antimony, and silver set the Feinan copper distinctly apart from metal smelted from complex sulphidic ores. The metal can also be clearly distinguished from any deliberately or unintentionally produced arsenic or tin alloys. It is therefore not difficult to differentiate between the Feinan copper and the Cu-As and Cu-Sb alloys found at Nahal Mishmar and numerous other Chalcolithic sites in Palestine, which are believed to have been imported from regions farther north ..." (HAUPTMANN *et al.* 1992: 23). On present evidence, Feinan seems unlikely to have been the source for the copper used at Tell esh-Shuna. Timna, on the western edge of the Arabah, is geologically identical to Feinan, and the copper derived from the two is indistinguishable in composition (HAUPTMANN *et al.* 1992 with additional references; HAUPTMANN *et al.* n.d.).

The other well-known copper sources in the southern Levant are located in south Sinai, and these ores have been the subject of a recent investigation (HAUPTMANN *et al.* n.d.). With the exception of Wadi Tarr, all analysed occurrences were very poor in typical trace elements, and, if smelted, would have resulted in a copper metal with arsenic and nickel well below 100 ppm, again too low to represent a likely source for the copper from Shuna. The mineralisation of Wadi Tarr, with its copper arsenides and native copper (ILANI and ROSENFELD 1994), can itself be ruled out as a possible source for the Tell esh-Shuna metal on the grounds of its low nickel, antimony and tin contents.

No copper sources are presently known from Jordan (BENDER 1968) that would match the high levels of nickel, arsenic, bismuth etc. found in the metal prills from Tell esh-Shuna. However, arsenic-nickel-copper objects are found widely throughout western Asia (PERNICKA 1990: 88), but in the light of possible metal trading and recycling, speculation regarding the "source" of the material from Shuna may be inappropriate at the present time.

The Shuna Copper-Working Industry and its Implications

Contrasting the lack of evidence for extensive metallurgical activity from EB I sites with the wide distribution of metal artefacts throughout all parts of Palestine, ILAN and SEBBANE (1989: 144), argued that not only extractive metallurgy, but also the production of metal artefacts was concentrated in the vicinity of the mining areas during the EB I period. The evidence from Shuna indicates that this was not the case, and that copper was indeed being worked within settlements in the north. This latter view is in conformity with the greater degree of continuity between Chalcolithic and EB I settlements observed in northern as opposed to southern areas (JOFFE 1993: 43-46), and the large size of some of the late EB I settlements in the former region (GOPHNA 1995: 273). However, there are aspects of the Shuna metallurgy that require further consideration.

The shape of the moulds indicates that they were not designed for casting tools in near-finished form. While they may have been intended to produce blanks for subsequent hammering into the required final shapes (tools such as axes, adzes and chisels would seem most likely), it is difficult to see why this would have been the case. Many EBA axes have flaring sides (see BRAUN 1997: 93, Fig. 11:3; SHALEV 1994: Fig. 3:13-14), and their formation from simple rectangular ingots would have required hammer-shaping of the sides, as well as the usual hammer-hardening of the cutting edge. Casting of a general purpose "pre-form" might make sense if a smith was using a single re-useable stone mould for the repeat production of approximate forms intended for hammer-finishing. However, in the case of clay moulds, the re-use argument is less relevant, and the simplest option would surely have been to design individual moulds to produce the exact shape required. This suggests that the moulds were specifically intended for the production of small rectangular ingots. These may have been intended for redistribution, as metal 'stock', or as a basis for further working. For example, the moulds may have been designed to produce relatively thin, flat castings which would have been subsequently hammered out to form copper sheet. The presence of more than eight hundred pieces of copper sheet in the Kfar Monash hoard in the form of ridged plates (HESTRIN and TADMOR 1963: 284) should be noted. Similar copper "plaques" have been reported from a number of other EBA sites (SHALEV 1994: 635), stressing the importance of sheet working at this time.

The fact that only moulds for "ingots" have been found at Shuna, (this applies to both the recent excavations and those of the mid-1980s), rather than a combination of these along with moulds for casting specific forms of tools, suggests that the material from context 149 provides evidence for specialised copper working rather than general purpose metalsmithing. In that case we might see Shuna, a large late EB I settlement, located at the junction of several important routes (see PHILIP and BAIRD 1993: 13), as a prominent node in the distribution system for copper.

The copper-arsenic-nickel alloy in use at Shuna appears to be rather different from that employed for utilitarian EB I artefacts which was generally quite low in impurities (BEN TOR 1975: 24, BRAUN 1997: Table 11:3, SHALEV 1994: 635). However, occasional artefacts containing high quantities of both arsenic and nickel but low in antimony are reported as occurring in the Chalcolithic Nahal Mishmar hoard. While few in number (SHALEV and NORTHOVER 1993: Table 1, maceheads 61-226, 61-278; TADMOR *et al.* 1995: Table 2, macehead 61-391), their presence alongside the more numerous and better documented antimony-arsenic-rich copper artefacts is intriguing. Furthermore, several of the artefacts high in arsenic and antimony also contained nickel at greater than one percent, (SHALEV and NORTHOVER 1993: Table 2, crown 61-179, vessel 61-162; TADMOR *et al.* 1995: Table 2, macehead with bosses 61-105). It has recently been suggested that a distinct nickel-arsenic-rich copper alloy existed alongside the better known antimony-arsenic-rich copper employed for Chalcolithic metalwork (TADMOR *et al.* 1995: 142).

This situation has interesting implications for the evidence from Shuna. As far as can be established at present, the copper used for the bulk of EB I metal tools, is similar to that employed on most Chalcolithic tools, *i.e.*, low in impurities generally. However, the copper from Shuna, which is estimated to have contained both arsenic and nickel at around 2 wt %, is more akin to the arsenic-nickel-rich metal employed in the Chalcolithic. It is of course possible that the metal used at Shuna is the result of a recycling process, within which at least some earlier 'prestige' metalwork had been included. However, the fact that the sample from context 467, which lies within the early phase of EB I occupation at Shuna, is similar in composition to the material from the late EB I context 149 (Table 2), suggests that the material from the midden does not represent a 'one-off' situation - a single recycling episode - but is indicative of a long-term pattern involving the use of copper containing significant quantities of arsenic and nickel.

The fact that the copper used in utilitarian artefacts during the EB I period appears to have differed little in composition from that used in the Chalcolithic (SHALEV 1994) suggests a degree of continuity between the metalworking industries of the two periods. It is possible that despite the apparent importance of the Feinan copper deposits, alternative systems of copper acquisition, through which material of rather different compositions were obtained, continued in operation beyond the end of the Chalcolithic period. The presence of a copper macehead in the EBA Kfar Monash hoard (HESTRIN and TADMOR 1963: 283, Fig. 13), a form more usually associated with Chalcolithic "prestige" metalwork, may hint at the continuance of at least some aspects of Chalcolithic metallurgy into the second half of the fourth millennium BC.

Admittedly, the impressive arrays of "prestige" metalwork found at such Chalcolithic sites as Nahal Mishmar (BAR ADON 1980), and Nahal Qana (GOPHER and TSUK 1991: xxvi) are no longer apparent during the EBA, but we should be alert to the possibility that we are witnessing less a change in the material in circulation than a shift in the pattern of its deposition, thus reducing the archaeological visibility of "prestige" material (for further discussion of this topic see PHILIP n.d.). It is perhaps worth noting that two of the adzes from the Kfar Monash hoard were reported by KEY (1963) as containing nickel at greater than 1000 ppm. However, reanalysis of artefacts from Nahal Mishmar analysed by Key (SHALEV and NORTHOVER 1993, TADMOR *et al.* 1995), has cast doubt upon the reliability of his data. A new archaeometallurgical investigation of the material from Kfar Monash is urgently required.

It has been argued elsewhere that the significance of the prestige metalwork of the Chalcolithic period may have resided in its silvery colouring (PHILIP and REHREN 1996: 141), perhaps itself linked to pre-existing high-status associations of silver which was almost certainly obtained from the north. An origin in eastern Anatolia, the Caucasus, or Iran has recently been suggested for the antimony-arsenic-rich copper used in the production of "prestige" metalwork (TADMOR *et al.* 1995: 141). In that case, the presence of copper and silver at EB I Shuna (PHILIP and REHREN 1996; REHREN, HESS and PHILIP 1996), both probably originating in the north, might indicate a continued acquisition of metals from that direction, thus contrasting with the much purer copper from sources in Jordan employed for utilitarian metalwork (HAUPTMANN *et al.* 1992, TADMOR *et al.* 1995: 137).

We might suspect, therefore, that copper was involved in more than one system of distribution during the EB I period, a situation not so different from that posited for the Chalcolithic (SHALEV 1991, 1994), where the lack of "leakage" of the distinctive "prestige" copper into the strikingly "pure" metal used for utilitarian metalworking has already attracted comment (TADMOR *et al.* 1995: 136-137).

Conclusions

A range of metallurgical debris, consisting of refractory ceramic and metal prills, was recovered from a secure late EB I context at Tell esh-Shuna. The refractory ceramic is made from calcareous clay and can be readily distinguished from local domestic pottery by its general coarseness and the presence of chaff temper. Initial examination showed that the refractory properties of the clay, although limited, were just sufficient for the required function. The ceramic vessels comprise two distinct groups, rectangular moulds and rounded crucibles. No fragments of tuyeres or furnace lining have been recovered. Macroscopic and microscopic investigations clearly demonstrated the melting and casting of copper metal at the site. There is no clear evidence for on-site smelting, although this remains theoretically possible, as such a process may have left little trace (see above). On balance however, we are not inclined to argue for local copper smelting at Shuna.

The present study, centering on crucibles and metal prills, has been able to characterise the worked metal as an impure, though not deliberately alloyed, copper, probably derived from a complex sulphide-containing ore. This type of nickel-arsenic rich metal is not unique, for copper objects high in arsenic and nickel are known from late Chalcolithic and Early Bronze Age contexts in a region including southeastern Turkey, the Levant, Mesopotamia and the Caucasus (PERNICKA 1990: 85*ff.*). It may be related to the metal used in the manufacture of Chalcolithic prestige items (SHALEV and NORTHOVER 1993; SHALEV 1991, 1994; TADMOR *et al.* 1995), and it appears rather different from the copper employed for the production of utilitarian items during both the Chalcolithic and EB I periods (SHALEV 1994, HAUPTMANN *et al.* n.d.). The corpus of Chalcolithic prestige metalwork appears quite variable in composition, even within individual hoards like that from Nahal Mishmar (SHALEV and NORTHOVER 1993, TADMOR *et al.* 1995), thus precluding a simple interpretation of the underlying metal supply. While no convincing ore source for this type of metal has been put forward yet, it is unlikely to have originated in the southern Levant. The evidence from Shuna therefore raises a number of issues relating to the degree of continuity between metallurgical practices in the Chalcolithic and EB I periods, which have hitherto been seen as sharply contrasting.

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INAA-Analysis of Late Pre-Pottery Neolithic Rings from Basta

Maria Thaís Crepaldi Affonso and Ernst Pernicka

Kurzfassung: *Flache Schmuckringe aus Stein treten im akeramischen Neolithikum der Levante recht häufig auf. Sie bestehen mehrheitlich aus Kalk- oder Sandstein. Nur in Basta wurden Ringe aus einem mörtelähnlichen Material gefunden, das kürzlich als Ölschiefer identifiziert wurde. In dieser Arbeit wird versucht, die Herkunft dieses in dieser Periode selten gebrauchten Rohstoffes zu ermitteln. Zu diesem Zweck wurden 13 Fragmente aus Basta mit instrumenteller Neutronenaktivierung (INAA) analysiert und mit Proben aus dem einzigen Ölschiefervorkommen der Region, das Ausbisse an der Tagesoberfläche zeigt, nämlich El Lajjun, c. 100km von Basta entfernt, verglichen. Die Ergebnisse zeigen, daß die entsprechenden Spurenelementmuster ähnlich sind und daß das Rohmaterial der Ringe tatsächlich mit großer Wahrscheinlichkeit von El Lajjun stammt. Diese Vermutung wird durch die Tatsache verstärkt, daß die Ringe mit bituminösem Material gefüllte Foraminiferen enthalten, die bisher nur im Ölschiefer von El Lajjun gefunden wurden.*

Abstract. *Flat stone rings are relatively common in the Late Pre-Pottery Neolithic of the Levant. They consist mainly of sandstone or limestone. Only at Basta rings made of a plaster-like material have been found that has recently been identified as oil shale. This work attempts to identify the provenance of this material that was rarely used in that period. For this purpose 13 fragments from Basta have been analysed by instrumental neutron activation (INAA) and compared with samples of the only occurrence of oil shale in that region with known outcrops, namely El Lajjun, at a distance of about 100km from Basta. Results show that the trace element patterns are similar and that the raw material of the rings indeed most likely derives from El Lajjun. This finding is corroborated by the fact that the rings contain foraminifers that are filled with bituminous material, a feature so far only observed at the deposit of El Lajjun.*

Introduction

Stone rings represent a group of artifacts that occur in early Neolithic to Chalcolithic settlements in Mesopotamia, eastern Anatolia and the Levant. They are also known from areas around the Mediterranean, such as the Rhone estuary, Italy as well as from the eastern Adriatic coast (STARCK 1988). The earliest occurrence of stone rings was reported from Karim Shahir, upper Pelegwara and Mureybit II (second half of the 9th millennium and early 8th millennium BC). Evidence from 'Ain Ghazal suggests that there this artifact type belongs to the very late PPNB and Early Pottery Neolithic contexts (GEBEL and STARCK 1985).

This paper describes analyses carried out by neutron activation of thirteen stone rings and fragments from Basta and of six samples of possible raw materials deriving from the same region. The rings, originally described to consist of "plaster-like material", have actually been fabricated from a sedimentary rock. It seems that only a single type of rock was worked with a standard production technique. The main goal of the analysis was to see whether all rings and fragments had indeed the same chemical composition and could thus derive from the same geologic occurrence and, if possible, to identify its exact location.

The archaeological samples were kindly provided by Bo Dahl Hermansen of the Carsten Niebuhr Institute of Near Eastern Studies, University Copenhagen and Hans Georg Gebel, Seminar für Vorderasiatische Altertumskunde, Free University, Berlin. Geological samples were obtained from Dr. Heinz Hufnagel, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany; Josef Hamarnieh, National Resources Authority, Amman, Jordan; and Dirk Flöder, Firma KHD-Humboldt-

Wedag, Köln, Germany; this assistance is gratefully acknowledged. The analyses were carried out at the Max-Planck-Institute for Nuclear Physics, Heidelberg.

Archaeological Situation

The settlement of Basta is situated on the western Arabian Plateau about 20km NW from Ma'an, at an altitude of 1420-1460m in a semi-arid cold region of southern Jordan. Many fragments of rings of bracelet size were found in late Pre-Pottery levels (7th millennium bc). They consist of different kinds of raw material: mainly of sandstone, but also of limestone and sporadically of a plaster-like material ("raw material comparable to white ware?") (STARCK 1988). The great number of such stone rings and fragments indicates common use and mass production (GEBEL, pers. comm.). All specimens exhibit the same pattern of surface incisions, independent of their mineralogical and chemical composition: usually there are horizontal and parallel incisions on the inner faces, while the outer faces exhibit tangential-oblique ones. The shape of the cross-sections, on the other hand, can be classified into several groups, including pentagonal (in most cases), trigonal, round, oval, hexagonal and "other" (Fig. 1). Usually the exterior edge is more or less acute while the inner one is perpendicular to the flat diameter or slightly convex (STARCK 1988: Fig. 1).

The inner diameters of the rings are independent of the raw material and the cross-sections. They vary from 40 to 90mm, showing a distributional peak at about 70mm Their thickness varies from 2 to 12mm, with a clear peak in the distribution at 3mm (STARCK 1988).

The first rings excavated in Basta during the 1986 season (GEBEL *et al.* 1988) -that time and prior to an mineralogical analysis- were tentatively considered as made of a "plaster-like material". In that case they would have represented a particularly unusual group of artifacts, because this kind of material had not been used for the production of rings at any other site in the Near East (STARCK 1988). However, mineralogical analysis has shown that they were actually made of a natural sedimentary rock, the so-called oil shale or oil schist, that occurs at various locations in Jordan (AFFONSO and PERNICKA n.d.).

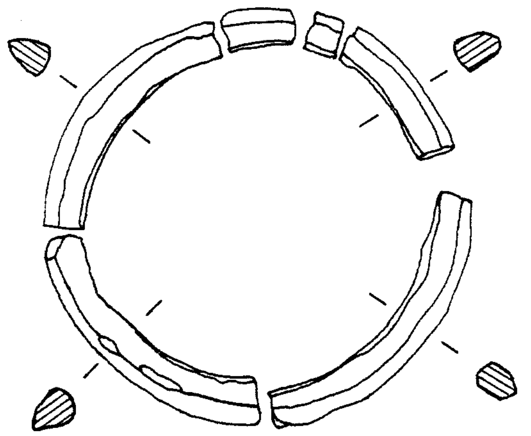

Fig. 1. Sketch of a late Pre-Pottery Neolithic stone ring from Basta, originally classified as of "plaster-like material". All pieces bear traces of red coloration <*Scale 1:1; after STARCK 1988*>.

Oil-Shale

The oil shale in Jordan belongs to the marine Chalk-Marl Unit of the Upper Maastrichtian, and it petrographically consists of a bituminous chalky marl (a fossil-rich clayish limestone) containing mainly planctonic foraminifers, such as Globigerinae, and minor fish debris and characteristic bright and fine-grained phosphatic inclusions. Its appearance can vary from brown or brownish-black to grey, sometimes with a typical bluish-white thin weathering layer. The matrix of the rock consists of fine-grained clay minerals with carbonates, mainly calcite. The bituminous material is composed of bituminite, a pre-bitumen material consisting of an amorphous substance (HUFNAGEL pers. comm.), with the mineral wurtzelite (a hardened bitumen) as a minor component (JACOB 1983). The bituminous substance is disseminated through the matrix filling its pores and cracks. In some cases it replaces calcite as the filling of foraminifer shells (HUFNAGEL 1984: Pl. 1-1). The mean calorific value of the oil shale ranges up to 5.6 kJ/kg (ABU-AJAMIEH *et al.* 1989).

Bituminous limestones are usually found as stratiform and synsedimentary deposits of elongated flat lens-like shapes that occur underground or near the surface. The usually thin and weakly stratified layers are predominantly horizontal with rare faults. The thickness of the bituminous layers varies from less than 10 to more than 170m (ABU-AJAMIEH *et al.* 1989) and they do not contain massive sterile intercalations. Hufnagel (1984) describes 23 major occurrences of bituminous limestones in the Levant, mainly concentrated along the Desert Highway from Amman to Aqaba east of the Jordan Valley (Fig. 2). They are mostly subsurface deposits with an overbunden of more than 10m. The deposits of El Lajjun, Jordan, and Nabi Musa, Israel, are the only known occurrences with outcrops and are therefore the most likely sources of the raw material for the Neolithic stone industry of Basta. Small outcrops have also been reported in the southern part of Jordan, but they have not yet been investigated.

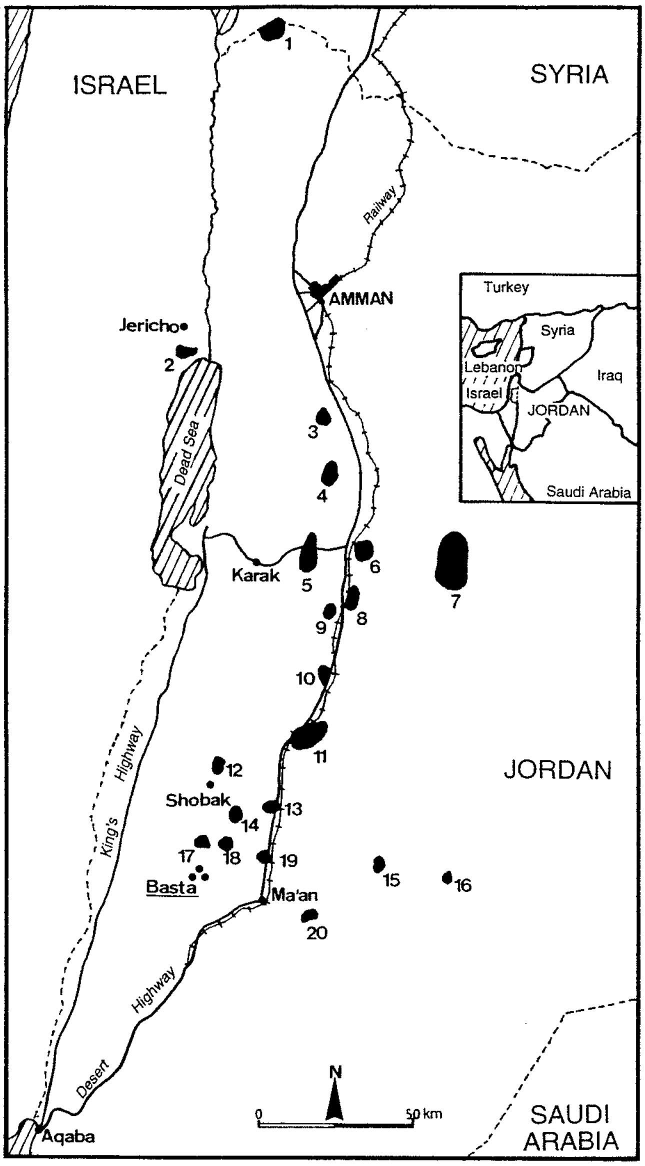

Fig. 2. Oil shale occurrences along the Jordan Valley (after ABU-AJAMIEH *et al.* 1989, simplified): 1 Yarmouk, 2 Nebi Musa, 3 Wadi eth Thanat, 4 Wadi Sudeida, 5 El Lajjun, 6 Qatrana (Siwaqa), 7 Attarat Umm Ghudran, 8 Sultani, 9 Wadi Geith, 10 El Hasa, 11 Jerf Ed Darwish, 12 Shobak, 13 Ishush, 14 Wadi Arja, 15 El Jafr-West, 16 El Jafr-East, 17 Udruh, 18 Wadi Ueina, 19 Wadi Jhurdan, 20 East Ma'an.

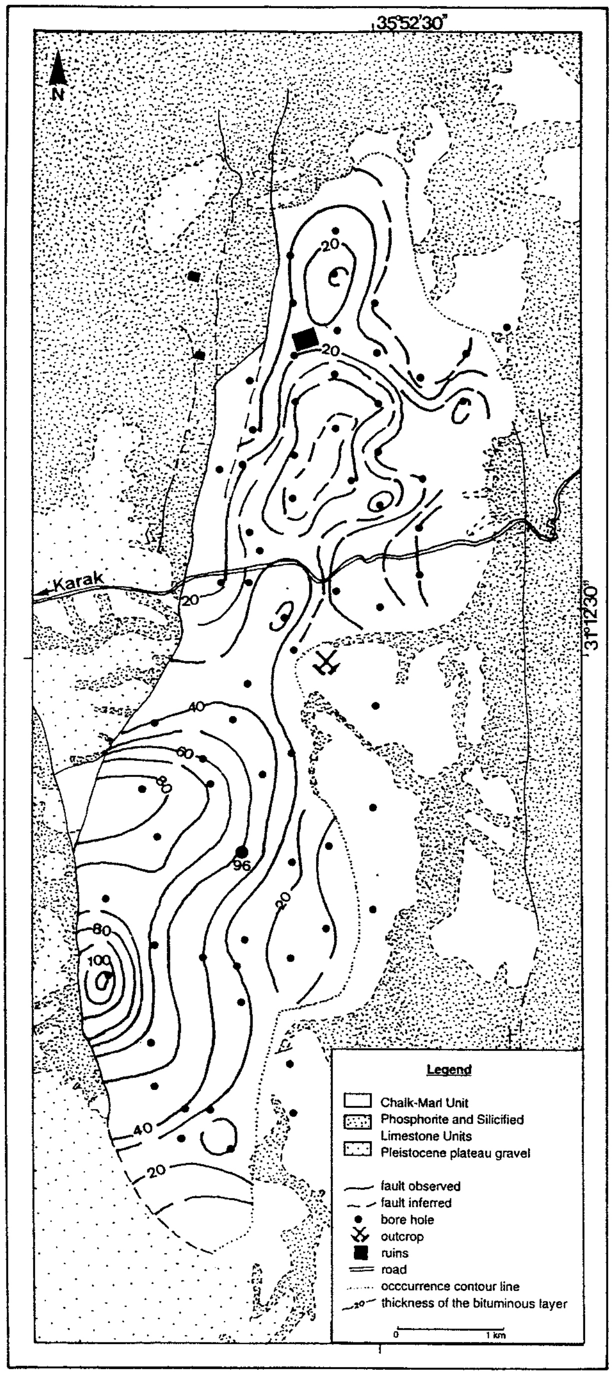

Fig. 3. Geological map of El Lajjun with its bituminous sequence.

The Deposit of El Lajjun

The deposit of El Lajjun, situated half way between Basta and Amman about 100km north of Basta, extends over an area of about $20km^2$. It has the shape of an elongated body with its main axis perpendicular to the road that connects the towns of Karak and Qatrana (Fig. 3). The thickness of the bituminous limestone reaches up to 110m with an average overbunden of 15-62m. The mean oil content is 10.5% by weight with a mean calorific value of 5.480 kJ/kg.

Typical for the oil shale of El Lajjun is the occurrence of foraminifers filled with bituminous material instead of calcite (Pl. 1:a-b). It also contains planctonic algae up to 200 µm in size and sporadically very small humic and other continental particles that resemble charcoal. The principal mineralogical components are calcite and somewhat less quartz, accompanied by kaolinite and apatite with sporadic feldspar, muscovite, illite, goethite and gypsum. Dolomite was only detected in particular carbonatic layers that occur inside the bituminous sequence (HUFNAGEL 1984).

The only outcrop of this deposit is located near its centre, in the Wadi Arbid. It is large, and the rock splits in thin layers that can be easily collected (Pl. 2:a-b).

Analysis

Thirteen fragments of stone rings made of carved oil shale (originally classified as "plaster-like material") and six samples from the deposit at El Lajjun have been analysed using instrumental neutron activation analysis (INAA). The samples from El Lajjun, kindly offered by Dr. Heinz Hufnagel, BGR Hannover, were collected by drilling during investigations carried out in the 1980s in the course of a joint project of Jordan and Germany to evaluate the most important oil shale deposits as possible energy resources. The samples EL 96-I through EL 96-V are from different depths of the same drill hole number 96 (see Fig. 3), namely from 23-29m, 33-39m, 39-45m, 48-54m and 57-65m, respectively. Sample EL-AVE represents an average of the deposit. It was prepared as a mixture of all samples from all drill holes from various depths.

The samples were crushed in an agate mortar to a grain size of less than 50 µm. Aliquots of about 60-100 mg of the artifact samples and 100-150 mg of the geological samples were exposed to a neutron flux of $6x10^{12}$ neutrons/cm2.s for four hours in the TRIGA reactor at the German Cancer Research Center in Heidelberg. After a decay time of five days, four measurements of the gamma spectrum were carried out during a period of about 2 months that yielded quantitative results of 23 elements. The contents of cerium, neodymium, and samarium that are interfered by induced fission of uranium were corrected using production rates determined from uranium standards in each irradiation. The values of barium, lutetium and zirconium had very large errors due to this correction, so they are not included in Table 1.

Result

Elemental concentrations of all samples are summarized in Table 1. According to cluster analysis, all artifacts are rather similar, which indicates a common source of raw material. The artifact samples 11215.4, 11215.5, and 11215.6 form a particularly close sub-group (group R), and we suggest that they may actually be different parts of the same ring. This is corroborated by the similar shapes and dimensions of the corresponding fragments.

Fig. 4 illustrates the variation of trace element concentrations normalized to Sc and to the mean value of group R, represented in logarithimic scale. The grey area indicates the variance of the samples of El Lajjun, the dark grey one the variance of the stone rings (samples "ohne Nr.", 1.217, 11208.3, 11211.1, 1211.6, 11208.7, 11208.6, 11208.1, 11202.11, 11221) from Basta. The samples EL-IV and EL-V deviate considerably from the average sample of the same deposit, showing high variation of some trace element concentrations within the vertical profile of the same deposit. It is noteworthy that the pattern of the ring fragments is generally similar to that of the El Lajjun samples that are close to the surface. Their difference is even smaller than the variability observed within the deposit. This suggests that the raw material of all rings was probably collected within a small area of the deposit or, at least, that they belong to a single sedimentation layer.

Since the samples consist more or less of a mixture of rather pure carbonate and silicates that contain practically all of the so-called lithophile elements, we normalized all concentrations to the lithophile element that was most precisely analysed, namely Sc. Thus, the elemental pattern of the silicate phases of the samples can be compared without the dilution effect that results from the presence of various amounts of carbonates. But even then there are two elements (Ni and As) whose concentration ranges in artifacts and rock samples do not overlap, and two (Zn and Sb) where the concentration ranges in ores are much larger. This is probably due to the fact that these four elements tend to be enriched in sulfide phases that are known to occur in the bituminous limestones of El Lajjun. Sulfidic

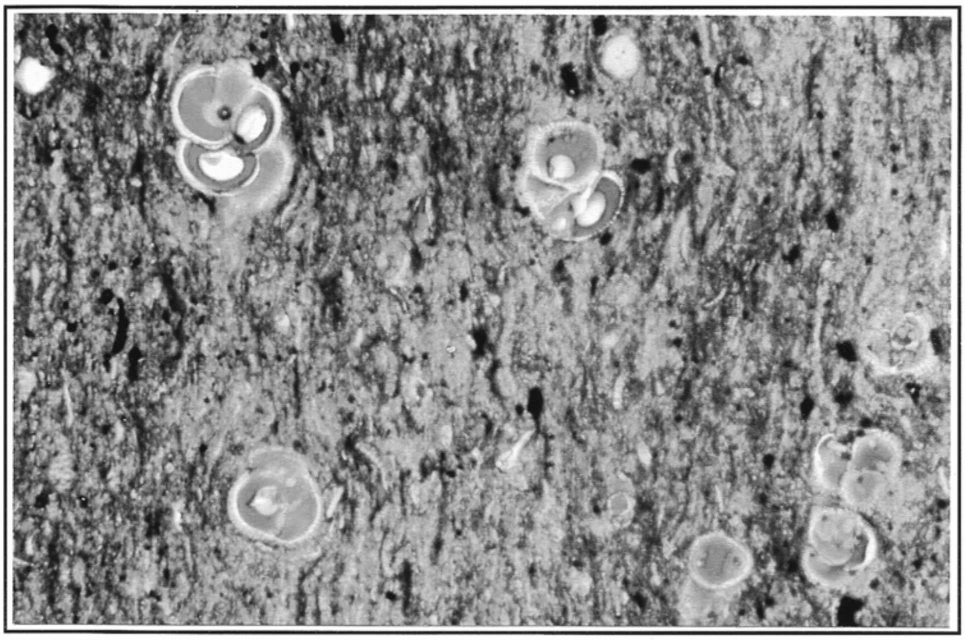

Plate 1:a. Thin section of ring Sample 11208.1 in transmitted light, plane polarized, at a magnification of 100X. The photograph shows the general microscopic appearance of an oil shale. Note that the foraminifera (mainly Globigerinae) are filled with red and hardened bituminous material and the clear and fine stratification of the sediment.

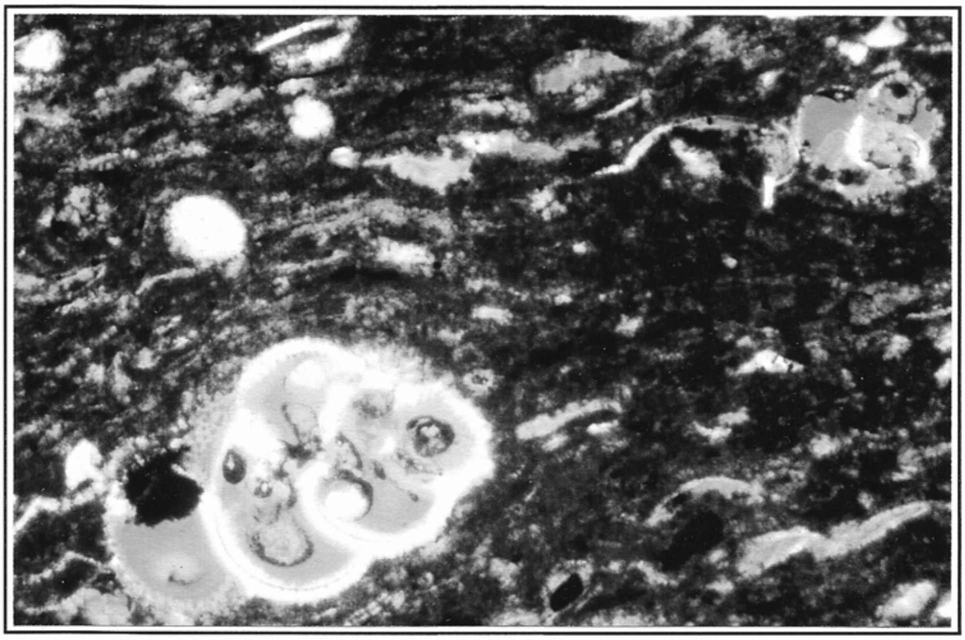

Plate 1:b. Thin section of an oil shale from El Lajjun in transmitted light, plane polarized, at a magnification of 160X. Note the similarity with the thin section of Artifact 11208.1 (Plate 1:a). The foraminifera are also filled with bituminite and wurtzelite instead of calcite.

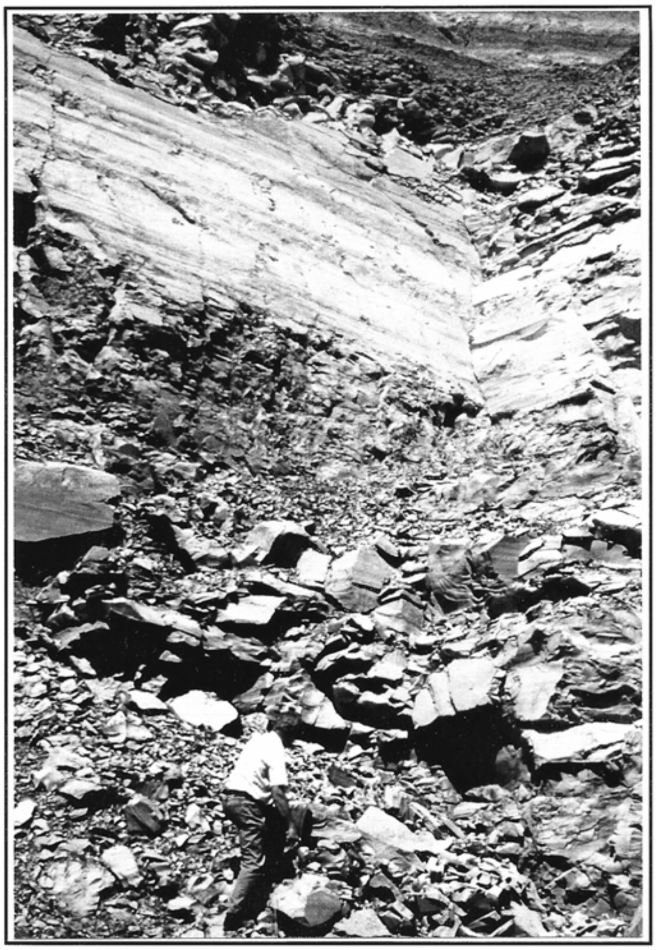

Plate 2:a. Outcrop at El Lajjun. Detail of the bituminous layer.

Plate 2:b. General view of the outcrop of bituminous limestones at El Lajjun. The buff coloured sterile layer covers the dark brown bituminous sequence.

Table 1. Trace element concentrations (in ppm) of the stone rings from Basta and the oil shale from El Lajjun.

	Na	K	Sc	Cr	Ni	Fe	Co	Zn	As	Rb	Sb	La	Ce	Nd	Eu	Sm	Tb	Yb	Hf	Ta	Th	U
Stone rings																						
ohne Nr.	882	3260	4,57	464	39,5	8550	3,25	101	5,1	9,7	0,72	11,9	14,8	9,7	0,49	1,64	0,38	1,56	0,74	0,18	1,51	22,4
11215.4	1040	4970	7,23	606	52,7	17000	3,96	166	19,2	16,9	2,32	16,3	21,8	11,0	0,67	2,38	0,51	1,75	1,08	0,27	2,46	31,1
1.217	963	3870	6,35	535	64,7	13100	4,08	165	10,3	13,3	1,31	15,2	19,3	12,2	0,62	2,25	0,48	1,81	0,90	0,20	2,11	32,3
11215.6	1002	4790	7,29	628	60,7	17310	4,29	200	12,1	16,0	2,01	15,9	21,4	11,4	0,66	2,33	0,45	1,68	1,00	0,26	2,51	31,1
11215.5	1006	4740	7,20	605	56,7	16000	4,03	174	11,8	16,4	2,14	16,2	21,6	11,1	0,66	2,42	0,47	1,73	1,10	0,28	2,48	31,7
11208.3	1091	4280	5,98	614	39,2	12370	3,61	209	14,5	15,1	1,89	15,4	20,0	13,6	0,59	2,19	0,47	1,83	1,03	0,26	2,18	30,2
11211.2	969	3840	5,16	556	59,8	10220	3,62	158	8,9	12,5	0,91	13,8	17,4	9,8	0,53	1,97	0,41	1,62	0,88	0,20	2,01	30,4
1211.6	983	3740	5,55	541	49,0	10170	4,02	163	5,3	12,4	0,79	13,6	16,7	16,8	0,53	1,81	0,41	2,15	0,80	0,20	1,75	26,0
11208.7	947	3570	5,38	491	49,5	10250	4,68	114	7,6	10,7	1,19	14,6	18,5	15,6	0,55	1,85	0,41	1,68	0,85	0,20	1,85	22,0
11208.6	1010	3810	5,74	512	54,0	11300	4,53	117	10,7	12,3	1,33	14,4	17,4	14,7	0,57	2,11	0,45	1,76	0,99	0,24	1,99	23,6
11208.1	926	3820	6,04	554	70,8	11500	5,00	157	8,0	12,4	0,89	13,4	16,7	12,6	0,52	1,88	0,41	1,97	0,85	0,22	1,97	24,9
11202.11	788	3430	4,87	410	47,5	9220	3,54	104	6,4	10,2	1,21	11,9	15,3	11,6	0,51	1,81	0,40	1,84	0,69	0,18	1,59	19,0
11221	1000	4450	6,08	530	75,6	13030	5,15	136	10,7	14,3	1,21	14,8	18,7	13,0	0,58	2,05	0,43	2,24	0,98	0,21	2,27	34,2
Deposit El Lajjun																						
EL-AVE	739	2880	5,15	422	159,3	9670	2,84	281	18,4	10,8	2,45	14,0	16,3	10,4	0,58	1,87	0,43	1,8	0,83	0,19	1,77	20,2
EL96-I	640	2650	8,00	359	129,0	17230	4,83	161	24,6	12,8	1,21	15,5	21,8	16,1	0,68	2,37	0,48	1,56	0,93	0,29	2,72	17,1
EL96-II	987	3420	8,17	442	164,4	13930	4,26	263	23,9	14,8	1,62	18,9	22,9	16,2	0,81	2,66	0,56	2,23	1,00	0,27	2,71	28,0
EL96-III	931	3030	6,38	347	124,5	11570	3,44	198	23,3	12,3	1,54	16,1	20,0	14,6	0,67	2,31	0,49	1,97	0,93	0,22	2,24	25,9
EL96-IV	1271	1820	3,87	383	171,2	7580	2,14	665	25,4	11,5	3,06	10,5	12,3	8,6	0,41	1,29	0,32	1,33	0,77	0,17	1,58	29,4
EL96-V	929	3480	4,73	497	184,1	6900	2,84	464	19,7	11,4	2,39	11,7	14,0	9,5	0,47	1,59	0,37	1,55	0,72	0,16	1,59	24,2

Table 2. Mean chemical composition of the oil shale from El Lajjun, Sultani and Jerf Ed Darwish <*after HUFNAGEL 1984;* L.O.I. = *loss on ignition*>.

	Main components (weight-%)									Trace elements (ppm)									
Occurrence	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**MgO**	**CaO**	**P_2O_5**	**SO_3**	**L.O.I.**	**Total**	**As**	**Cu**	**Mo**	**Ni**	**Sr**	**U**	**Zn**	**Ba**	**Cr**	**V**
El Lajjun	16,13	3,77	1,51	0,85	30,43	3,31	4,83	38,10	98,93	-	92	73	167	1015	29	451	113	431	162
Sultani	26,26	2,87	1,12	0,95	26,30	3,48	4,38	33,00	98,36	17	115	94	139	707	25	649	46	267	268
Jurf ed Darawish	9,30	3,76	1,55	0,28	38,73	1,53	4,37	39,50	99,02	10	68	20	102	1187	17	190	35	226	101

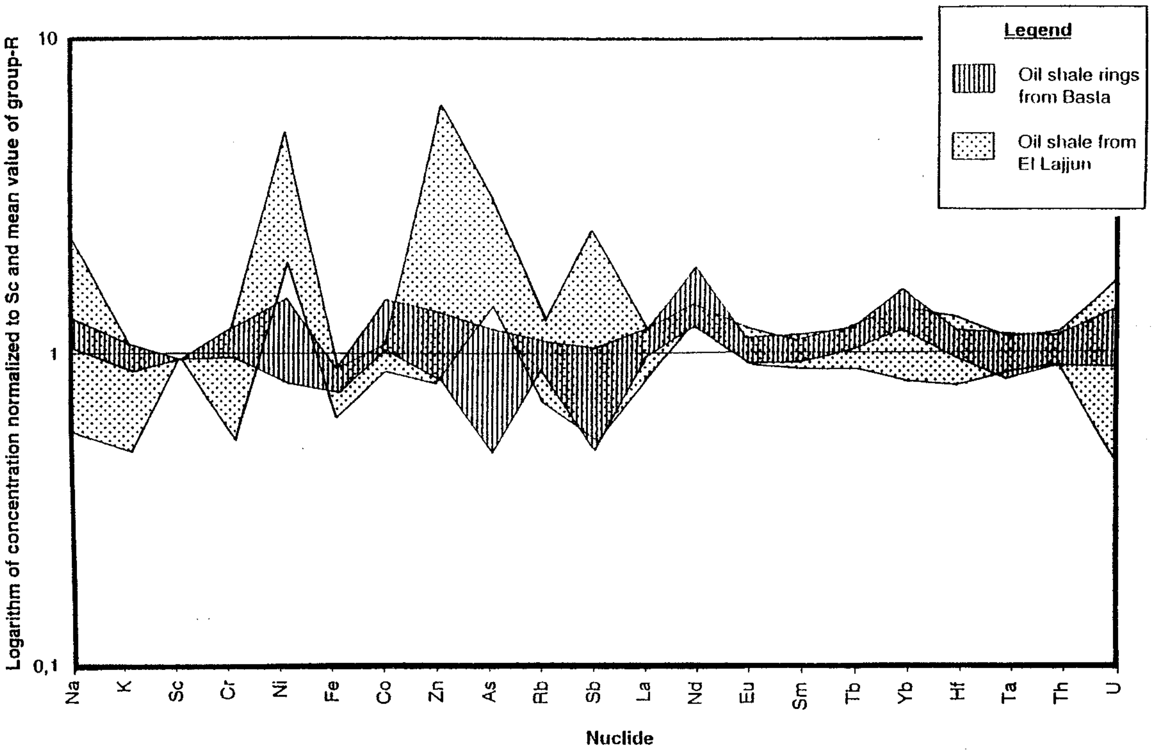

Fig. 4. Trace element pattern of stone ring fragments from Basta and of oil shale samples from El Lajjun.

minerals, like pyrite, have been frequently observed as acessory minerals in these oil shales (HUFNAGEL 1984). However, they are irregularly distributed on the microscopic as well as on the macroscopic scale. This could easily explain the discrepancies observed. Furthermore, of the stone rings only small samples of less than 100 mg were taken and analysed, whereas the rock samples were average samples from drill holes taken at intervals of 6m. Thus the original rock samples comprised several kilograms and are therefore much more representative of the average composition of the deposit at a certain depth.

Unfortunately, about a third of the sulfur content detected in the samples of El Lajjun is associated with organic phases (HUFNAGEL 1984) and partly correlated with bituminous material (AFFONSO and PERNICKA n.d.). Therefore, bulk sulfur concentrations that are available cannot be related to the concentrations of the chalcophile elements.

Table 2 shows the mean chemical composition of bituminous limestones from El Lajjun, Sultani, and Jerf ed Darwish analysed by X-ray fluorescence (HUFNAGEL 1984). These deposits were also investigated within the scope of the technical cooperation between Jordan and Germany in order to evaluate the possibilities oil shale as an energy resource. The deposits Sultani and Jerf ed Darwish have no outcrops and can, therefore, not be considered as possible sources for the Neolithic stone industry. They are included here only to serve as examples of the compositional range encountered among different deposits of similar age and similar formation history. The oil content is rather variable within the deposits and can therefore not be used as identification parameter. At Jerf ed Darwish, for example, the oil content varies between 1.1 and 14.9%, depending on the sedimentation layer (ABU-AJAMIEH *et al.* 1989). The distinctively larger chromium concentration of El Lajjun compared with the other deposits could be confirmed by INAA. It offers the possibility to differentiate the deposits, although it would be desirable to have more parameters at hand. In any case, it is satisfactory to note that concerning the chromium content, El Lajjun resembles the artifacts closest of all deposits regarded in this context.

Conclusions

Instrumental neutron activation analysis of 13 late Pre-Pottery Neolithic stone ring fragments from Basta, consisting of carved oil shale, have shown that their trace element patterns are quite similar, indicating that their raw materials derive from a single geologic source. Furthermore, there is also reasonable chemical similarity between the artifacts and the bituminous limestone deposit of El Lajjun. Although other deposits in Jordan and Israel cannot be definitely excluded as possible sources on present evidence, El Lajjun is considered to be the most likely one because it is the only known deposit east of the Jordan valley that is exposed to the surface. In addition, comparison of the chromium contents of the artifacts and of samples from three bituminous limestone deposits in Jordan seems to favour El Lajjun as best compositional match, and foraminifers partially or totally filled with bituminite and wurtzelite, as they have been observed in the artifacts, have so far only been found in sedimentary rocks from El Lajjun (HUFNAGEL, pers. comm.).

The bituminous limestone deposit of Nebi Musa, on the western side of the Jordan Valley, could be an alternative source for Basta, although it is also more distant. Unfortunately, as yet no samples could be obtained from that deposit so that its potential remains unclear. The deposit of Wadi Arja, originally suspected to be the most likely locality used due to its proximity (AFFONSO and PERNICKA n.d.), must be deleted from the list of possible source regions, because it was detected only by exploration drilling and has no known outcrops at the surface. It was thus certainly not accessible in the Neolithic period. An oil shale outcrop has also been reported in the region of Shobak (HUFNAGEL, pers. comm.), but it has neither been precisely located nor investigated in any detail. Accordingly, there were no samples available that could have been considered in the present study.

The fact that Basta is the only settlement in the Levant where rings made of carved oil shale have been found in great numbers could lead to speculations that there may have been a small outcrop of this type of rock in the vicinity that does not exist anymore or that was too small to be found within the scope of a large-scale geological survey. However, the geology of the area surrounding of Basta is dominated by hard sandstone layers within a sequence of marls, silicified marls, calcareous sandstones and limestones. Highly fossiliferous limestones and phosphorites that are usually associated with oil shales were not observed, confirming the suggestion of El Lajjun as the most likely source of oil shale used for the production of carved stone rings.

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On Early Copper Metallurgy in the Levant: A Response to Claims of Neolithic Metallurgy

Russell Adams

Abstract: *This article summarises evidence for early copper metallurgy in the Levant and reports on recent findings from the area of Feinan in southern Jordan, including the fourth millennium site of Wadi Fidan 4, which has yielded significant new evidence for early copper technology in the context of a habitation site. The article also rebuts recent claims by the Timna research group of Benno Rothenberg and John Merkel, who have recently attempted to support theories of Neolithic metallurgy at Timna, by comparison of Timna materials to Wadi Fidan 4, through the use of now outdated and erroneous publications which refer to Wadi Fidan 4 as a "Qatifian" or late Neolithic site.*

Introduction

The origins of copper metallurgy in the Near East can be traced to Anatolia, where the use of native copper (naturally occurring metallic copper) to form copper artefacts can be dated to the eighth millennium BC at Çayönü Tepesi (BRAIDWOOD and ÇAMBEL 1981). The later development of copper-smelting is suggested as early as the sixth millennium BC at Çatal Hüyük on the basis of confirming slags (MELAART 1967).

In contrast to this, the first use of copper ores in the Levant appears with the Neolithic use of these ores for the forming of beads and ornaments as well as cosmetics and dyes in the Pre-pottery Neolithic cultures of the region, as shown by finds at Jericho, Nahal Hemar and Yiftahel, to name but a few sites. However, it was not until much later, in the fifth millennium, that copper began to be smelted in the Levant.

The Earliest Evidence for Copper Metallurgy

The earliest evidence of copper metallurgy in the Levant falls within the dates of the Chalcolithic period. Documentation for this activity has come from numerous sites of the period, but by far the most significant early finds came from the excavations of Jean Perrot at the sites of Tell Abu Matar, Bir es-Safadi and Horvat Beter in the Beer Sheva basin of the northern Negev Desert. Ores, slags and crucibles from these sites provided ample proof of a developed metallurgical industry in the context of a village based economy. In the last few decades, a growing corpus of data has emerged from other Chalcolithic sites in the region to supplement these early finds. They include considerable material from other Negev sites (Shiqmim and Gilat) as well as a growing corpus of copper artefacts from the Jordan Valley (Tell Abu Hamid and Tuleilat Ghassul) and from cave sites in Israel (Nahal Mishmar, Nahal Qanah, and Peqein Cave).

The chronology of the Chalcolithic period, its origins in the Late Neolithic, and its relationship with the first phase of the Early Bronze Age have been considerably debated in recent years. It is now largely agreed that the Chalcolithic spans the majority of the fifth millennium and the first half of the fourth millennium BC. Recently Joffe and Dessel (1995) proposed a subdivision of the Chalcolithic period into "early" (c. 5000-4500 BC), "developed" (4500-3700 BC) and "terminal" (3700-3500 BC) phases (to replace the less helpful terms of "early", "middle" and "late"), and they have gained broad support for this effort from the archaeological community.

The largest portion of the evidence for early copper metallurgy comes from the "developed" phase of the Chalcolithic (4500-3700 BC). While many sites of this period now attest to the presence of copper artefacts and secondary production, only a very few reflect primary production or smelting activities[1].

In fact, the evidence for smelting seems to be confined not only to the southernmost portion of the Levant, but also to a specific geographic locality centering around the Nahal Beer Sheva. The reasons for this restricted development of metallurgy are not yet clearly understood, but they may in part have to do with the regional nature of Chalcolithic cultures, their socio-political structures and interactions, and the role of emerging elites and their control of resources.

In contrast to the habitation sites, significant amounts of research into the major copper bearing regions of Timna, Sinai and Feinan have so far produced no convincing evidence of Chalcolithic extractive metallurgy. At Timna, persistent attempts to demonstrate that Chalcolithic copper smelting occurred at Site 39 have not been wholly accepted (*cf.* ROTHENBERG 1990, MUHLY 1984). Aside from the doubts expressed over the method of dating Site 39, there is also the fact that there is a complete lack of evidence for other similarly constructed or dated smelters in the region. Equally, there is no corroborative evidence for such copper smelters from the other two main areas of Feinan and Sinai. If Timna Site 39 is indeed to be taken as a Chalcolithic smelting furnace, it is unique and was not apparently replicated. It seems, on the basis of the evidence for early mining activities at Timna, that there is little doubt that copper ores were mined there during the Chalcolithic period, but there seems to be no evidence of either extensive habitation or smelting activities for this period in the immediate vicinity of the Timna copper deposits[2]. It seems likely, and there is now a general consensus among objective scholars, that the ores mined at Timna and Feinan during the Chalcolithic period were transported to the village sites throughout southern Israel and Jordan (as evidence from Tell Maqass indicates [KHALIL 1988; 1990]), where the ores were smelted and copper products manufactured in a domestic setting.

Copper Production at Feinan

Investigation of the copper deposits at Feinan, the geological "twin" of Timna on the eastern side of the Wadi Arabah, was begun comparatively late. This area in fact was not easily accessible from the Jordanian side of the border until the improvements to the Wadi Arabah highway during the late 1970s. One of the earliest "explorers" was the road engineer Thomas Raikes, whose interest in archaeology led to some of the earliest discoveries in the western Feinan catchment at Fidan and the awareness that the region contained a large number of pre- and protohistoric sites ranging from the Neolithic through the Early Bronze Age (RAIKES 1980).

Work by a team from the Deutsches Bergbau-Museum (hereafter DBM) in conjunction with the Department of Antiquities of Jordan was initiated at Feinan in 1985 to recover information concerning the earliest phase of copper metallurgy from the Jordanian side of the Wadi Arabah through examination of the ore deposits, mines, slag deposits and remains of smelting and occupational sites in the area. This project, now nearing its final publication, has been successful in detailing specific aspects of ancient mining, smelting and production activities. The DBM project has revealed important aspects regarding the sources, chronology and technological features of ore mining and smelting for the Feinan sites, and it has managed to trace the entire history of copper exploitation in the region through the archaeological remains (HAUPTMANN 1989, 1991, 1992).

In 1989 the Wadi Fidan Project began an examination of the late prehistoric occupation of several sites in the westernmost portion the Feinan drainage in the vicinity of Wadi Fidan. The main focus of this project was to explore the relationship of the many late prehistoric and protohistoric sites in the vicinity with both the developing copper industry in Feinan and the emerging urban societies to the west.

Both the Feinan and Fidan projects added to the body of data already known from previous work at Timna. Hauptmann's earlier studies of the Timna ore sources were now supplemented and clarified by his work on the ore deposits in the Feinan region, as well as through the excavation of a number of datable archaeological sites. These sites included not only the mines themselves, but also sites for dressing of the ores, smelting sites, and finally habitation sites with *in situ* deposits. The additional information to what had already been known about early phases of metallurgy from the Timna project allowed reconstruction of both the technological development of metallurgy, as well as the

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1 In the case of the earliest discoveries (Tell Abu Matar and Bir es-Safadi), although extensively excavated, they have not been thoroughly examined for their importance to early metallurgical practices. This situation is beginning to be rectified with renewed research on the finds from several of the early Perrot excavations (J. GOLDEN, pers. comm.) The evidence from Shiqmim is quite the opposite, since it is one of the few sites adequately investigated by a comprehensive scientific programme of research.

2 This is less than surprising given the availability of both fuel and water resources in the area. The eastern Wadi Arabah, in contrast, seems to have been the preferred location for more extensive occupation, no doubt due to the presence of numerous natural springs and oases.

establishment of a chronology alongside these advances. The work also stimulated increased research on these early periods and into the nature and rate of societal development (ADAMS n.d.).

The earliest work of the DBM project was published in brief preliminary reports throughout the early stages of the work. In 1985, one plate of ceramics was published from a site named Wadi Fidan 4 (HAUPTMANN *et al.* 1985), a site visited earlier by Raikes (1980, his Site E) and reported to be a Chalcolithic/Early Bronze Age site in the Wadi Fidan. Two articles (GILEAD and ALON 1988, GILEAD 1990) took this information out of context to support theories of the late Neolithic-Chalcolithic transition in the southern Levant and to support the possibility of widening a localised coastal development in the Late Neolithic into a regional phenomenon.

Wadi Fidan 4

Recently the site of Wadi Fidan 4 has been excavated and a preliminary report published (ADAMS and GENZ 1995). The site consists of a series of rectilinear mud brick and pisé buildings that form a small nucleated village complex built on an isolated plateau above the Wadi Fidan.

The material culture of the site has been difficult to date on a stylistic basis alone, for there are no close comparisons to either mainstream Chalcolithic or Early Bronze Age cultures (see GENZ, this volume). Both the flint and ceramic assemblages have elements that could be attributed to either period. In particular, the flint technology has both extensive numbers of tabular scrapers and crude blades, but there are also typical Canaanaean blades indicative of a late fourth millennium date. The ceramics are no more helpful in that they provide no clear basis of comparison to more widely known typologies from less marginal regions. The village complex did provide extensive evidence of developed metallurgy as well as material reflecting long distance trade in marine shells.

The aspects of the metallurgy on this site are worth mentioning in further detail. Evidence from Area D, a small walled courtyard of a rectilinear house, contained the remains of several small oval to circular "ovens" constructed of pisé. The oven bottoms, as well as the general courtyard in which they were found, contained extensive amounts of ash. Although absent in the oven bottoms, the courtyard produced numerous fragments of small ceramic crucibles for smelting or melting copper, several of which were partially reconstructed. These crucibles, slagged only on the interior bowl-like depression, appear to be the remains of smelting/melting activities carried out within the courtyard. The ovens, as the most likely place of this activity, were sampled for the ash content, which revealed that the ash was in all likelihood the remains of animal dung (John Meadows, pers. comm.).

The site produced a series of calibrated radiocarbon dates from two locations on the site, which confirm a mid- to late fourth millennium BC date, and together with the inability to directly compare the pottery to the established ceramic chronology for other regions, they suggest the material culture of the site would best be described as of transitional "Chalcolithic/Early Bronze Age" date (*cf.* ADAMS and GENZ 1995). If however, we adhere to the revised chronology established by Joffe and Dessel (1995), the site falls completely within the range of the Early Bronze Age I (GENZ and ADAMS n.d.). It is clear, therefore, that the site of Wadi Fidan 4 is not a Neolithic-Chalcolithic transitional site, as had been suggested by Gilead and others, but rather a much later Early Bronze Age I site, with a regional ceramic repertoire and material culture.

Reports of "Neolithic" Metallurgy

Rothenberg and Merkel have argued for a "Neolithic" metallurgy at Wadi Fidan 4, with which they compare their data from sites at Timna (ROTHENBERG and MERKEL 1995a, 1995 b). Even though the Timna researchers had been given advance drafts of the forthcoming publication of the Wadi Fidan 4 interim report (ADAMS and GENZ 1995), which provided clear evidence of the late date of the site, they relied instead on articles that had been rebutted (GILEAD and ALON 1988, GILEAD 1990). Subsequent publications and presentations also take no notice of the available published data on Wadi Fidan 4 (ROTHENBERG and MERKEL 1995a, 1995b) and insist on a "Neolithic" dating of this site.

The Origin of the Confusion

Despite the clear dating evidence now from Wadi Fidan 4, it has been difficult to place the site, its culture, and metallurgy firmly within the overall technological developments of the late prehistory of the southern Levant. The fact that Wadi Fidan 4 does not fit neatly into established ceramic chronologies, with the absence of what Genz refers to as "type-fossils" for the period (GENZ, this volume), along with the general paucity of comparable material from southern Jordan or elsewhere, have complicated the situation considerably.

The overall picture of developments in the late fourth millennium of the southern Levant are complex, and attempts to demonstrate how the radiocarbon chronology supports the cultural data, and the ceramic chronology in particular, is often difficult. The debate over where to "draw the line" in distinguishing Chalcolithic and Early Bronze Age cultures, and hence where to place Wadi Fidan 4, is just one of many problems for interpreting the evidence for culture and chronology (*cf.* GILEAD 1994, JOFFE and DESSEL 1995). Understanding how societies in marginal areas, such as that at Wadi Fidan 4, relate to more central areas and more widely spread cultural developments, is equally difficult. Continued debate over the extent of the regionality of Chalcolithic culture and possible continuity or discontinuity of cultural development with the Early Bronze Age are also far from being conclusively determined. It now seems clear, however, that societal developments in these periods were much more complicated than had formerly been believed.

The Neolithic Evidence from Feinan

While recent research has been able to close the perceived "gap" between the Chalcolithic and Early Bronze Age, the change from the Late Neolithic to the Chalcolithic is still poorly understood. An emerging body of evidence in the southern Levant is gradually providing clarification for this development, but it will be some time before this transitional phase from the Late Neolithic is adequately defined.

The confusion over the ceramics from the site of Wadi Fidan 4 and other sites in the Feinan region as being "Qatifian", which lead to Gilead's misconceived placement of Wadi Fidan 4 at the beginning of the Chalcolithic period, was due almost exclusively to the similarities of the pottery from Wadi Fidan 4 to the ceramics from sites in the Nahal Besor region, including Qatif Y-3 and P14. The pottery had a "crude, grit tempered and unevenly fired" nature, with several forms of similar type (GILEAD 1990: 60). Gilead's comparisons were incorrect, however, and the result of not having seen the broader picture of ceramic development in the entire region of southern Jordan. The material he saw from Wadi Fidan 4, both from publications and personal inspection, was seen out of context.

While clearly there are both technical and stylistic similarities between some of the pottery from Wadi Fidan 4 and Qatif, there are at the same time significant differences. Some of these differences are in part due to the difference in chronology, with Wadi Fidan 4 falling hundreds of years later than the Qatifian sites. If Gilead had been aware of the dating of Wadi Fidan 4 and was also able to see the Late Neolithic ceramic tradition from which the Wadi Fidan 4 potters emerged, it would have clarified the nature of what seems to be a truly regional style[1].

The Neolithic in the Feinan region is represented by several large Pre-Pottery Neolithic sites[2] and the Pottery Neolithic site of Tell Wadi Feinan (NAJJAR *et al.* 1990). This site, excavated in 1988 and 1990 as part of the DBM project, revealed an extensive buildup of several occupational phases throughout the Pottery Neolithic that formed a small "tell", observable in the modern wadi section in the site's northern side. The phases included rectilinear houses constructed of pisé and mudbrick over stone foundations, and the site yielded considerable ceramic and flint assemblages. The phases extend from the mid-6th to the mid- 5th millennium BC as shown by the radiocarbon dates. The most recent date (HD 12336), from an ash deposit overlying the last Neolithic phase, does not belong to an architectural phase but dates to the last quarter of the 5th millennium, within the range of dates for the Beer Sheva Chalcolithic culture. Although this Pottery Neolithic site yielded evidence of the use of copper ores (most likely for decoration and pigmentation), there is no indication of any kind that these ores were smelted to form metallic copper.

Table 1: Radiocarbon dates from Tell Wadi Feinan.

Reference	Provenance	Depth	14C ages BP	14C ages cal. BC cal. 1s
HD 12336	Square A, loc. 8	-1.05 m	5375 ± 30	4330-4165
HD 12337	Square A. loc. 23	-1.40 m	5740 ± 35	4675-4575
HD 12338	collapsed section	approx. -2.00 m	6110 ± 75	5210-4910
HD 10567	Profile B (1986)	-2.50 m	6410 ± 115	5520-5270
HD 12335	Profile B (1988)	-2.50 m	6360 ± 45	5345-5240

The latest phase at Tell Wadi Feinan, corresponds well with the dates of developed metallurgy within the major sites of the Beer Sheva Basin. However, the absence of evidence for any copper

1 This relationship between the Qatifian ceramic technology and the local Neolithic/Chalcolithic repertoire in the Feinan region will be explored in a forthcoming publication by R. Adams and Y. Goren.

2 The Pre-Pottery Neolithic sites are represented by two in the western end of the Wadi Fidan, Site A and Site C, both excavated by the Wadi Fidan Project in 1990, and the Site of Gwair 1, excavated by M. Najjar in the Wadi Gwair in 1993 under the auspices of the Joint DBM/Department of Antiquities of Jordan Feinan Project.

smelting from Tell Wadi Feinan - a site in the centre of one of the major copper producing regions in the Levant - casts doubt over the probability of copper smelting technology at Feinan during this early period.

Conclusion

In summary, the overall picture of the early development of copper metallurgy in the southern Levant, although far from complete, is beginning to take shape. In particular, new evidence from the Chalcolithic and the Early Bronze Age has extended our knowledge considerably, and our understanding of technological questions related to procurement, transportation, smelting and secondary production of the copper has advanced significantly. Other questions concerning the role metallurgy played in society and what effect it had on broader developments and emerging "elites" are yet to be conclusively resolved, and much work remains to be done on these social aspects of metallurgy. In particular, little is still known about the earliest phase of the Chalcolithic period, its association with the Late Neolithic and how and when copper metallurgy was first introduced into the Levant. Based on the current evidence, it is safe to conclude that there is no proof that copper metallurgy in the Levant began in the Neolithic.

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Status, Perspectives and Future Goals in Archaeometric Research in Jordan

Ziad al-Saa'd

Introduction

Jordan, due to its unique geographical situation, has been a meeting place of many nations and cultures throughout antiquity. Jordan's heritage is extremely rich and varied, spanning around a million years from the Early Acheulian to the Islamic periods. Therefore the archaeology of Jordan has attracted a lot of attention and has been the focus of extensive research since the beginning of this century.

The past few decades have witnessed a surge in archaeological excavations all over Jordan undertaken by different national and international teams. This has resulted in the accumulation of vast quantities of archaeological material of different types and dates. Although many studies have been carried out on the excavated material aimed to throw light on their cultural meaning, most of these studies have been confined to what is present on the surface of these materials and to what can be seen with the eyes of the archaeologists. No one realises better than a thoughtful archaeologist that this approach has severe limitations in deducing vital details and, in fact, that the interpretations are not always free of ambiguity. Important and badly needed information regarding various aspects such as the provenance, raw materials, manufacturing techniques and absolute dates of archaeological materials have been overlooked. Due to the severe limitations of the stylistic and typological approach, archaeologists have increasingly, especially in the past few decades, adopted a wide-ranging multidisciplinary approach in their study and interpretation of cultural remains. Natural sciences have been integrated with archaeology to maximise the quantity and quality of extracted information from archaeological materials. This field of study has diverse facets and has in recent years taken on sufficient stature to warrant a distinguishing title: *archaeometry.*

This paper is devoted to discussing the status of archaeometric research in Jordan and the present standards compared to those in the rest of the world. The intention is not to provide a summary or an overview of the archaeometric research that has been so far published about materials excavated from Jordan, but the focus of this paper will be on the progress and advancements that archaeometric research in Jordan has so far achieved. The negative and positive aspects of that research will be emphasised. The problems that hinder archaeometric research in Jordan will be discussed with focus on the future prospects of that research.

Past Achievements and Current Status of Archaeometric Research in Jordan

In recent years archaeometry has made great progress through the work carried out in the laboratories of many countries. The number of archaeologists using analytical techniques to help to answer relevant archaeological questions is rising, and the field of archaeometry is making significant inroads into the realm of mainstream archaeology. Although archaeometry has successfully integrated with archaeology in many countries, multidisciplinary archaeological research has been slow to be adopted in Jordan. Despite the enormous increase in the amount of excavated archaeological materials and the many open questions that need to be resolved, a very small number of scientific and technological studies on these materials have been carried out. Even this small number of studies has been, in most cases, performed outside of Jordan and by non-Jordanian archaeologists. Despite the fact that Jordanian archaeologists have access to outside expertise in a range of skills and techniques, a large number of them have strongly felt that their career was going well enough without all those scientific methods, and they just want to go on doing what they have been doing.

It is quite useful at this stage, before proceeding in this exploration, to mention the main areas of archaeometry. Then I will consider briefly the past achievements, current status and future prospects for each area. The main areas of archaeometry are: scientific analysis of artefacts, absolute dating, geophysical surveying and remote sensing, the study of man and his environment and mathematical and computational analysis.

Most archaeometric research that has so far been carried out on Jordanian materials is in the area of artefact analysis. The main feature of this research is that it is widely scattered. Most of this work centered on the analysis of a small number of objects of different types (tools, weapons, ornaments, domestic utensils), contexts and dates. No systematic research has been developed on any of these materials. For example, one of the earliest studies on pottery is the study of Edwards and Segnit (1984) about the pottery technology at the Chalcolithic site of Teleilat Ghassul. This study has remained an isolated effort in that direction since it has not been followed by more studies to reveal the various aspects of the technological advancements in pottery manufacturing achieved in Jordan during the Chalcolithic period. Some scattered work has also been done on pottery of other ages with the aim of determining provenance and manufacturing technology (NEWTON and PRAG 1995, FISCHER and TOIVONEN-SKAGE 1995, MASON and AMR 1995). However, the diversity of pottery types and forms produced in Jordan during different periods make such efforts of little significance. Much more well planned and systematic studies on different types of pottery of different dates should be done. This is the only approach that allows an accumulation of knowledge about the identity and source of the raw materials and the techniques used in manufacturing different types of pottery in Jordan. This systematic accumulated knowledge is the only way to obtain a comprehensive and deep understanding of the extent of trade and exchange of pottery between different cultural groups and centres and of the technological developments that each group and centre contributed.

Excavations in Jordan have brought to light a rich heritage of glass materials that belong to different cultures. These materials are the products of various industries and crafts. Though glass objects are common features, they have been traditionally neglected by archaeologists. Only shapes and colours of glass objects have been found worthy of reporting by archaeologists. Often archaeologists have recorded the glass objects without any reference to mode of fabrication. Recently, various types of scientific methods have been utilised for the solution of various archaeo-technological problems related to ancient glass in Jordan. Various studies have been made to elucidate the origin, composition, probable raw materials and methods of production and fabrication. These studies throw some light on the ancient Jordanian glass technology, especially in the Byzantine and Islamic periods (AL-SAA'D 1994, 1996a; AL-SAA'D and MUHEISEN n.d). Although these studies have broken new ground for the scientific study of ancient glass, they will be of no significance if this line of research is not continued. Sustained efforts are needed to systematically study more glass samples from early up to recent periods. This will enable us to obtain a large body of analytical results that could be statistically evaluated. Only when this goal is attained will an understanding of the development of ancient glass technology in Jordan can be reached.

The development of ancient Jordanian metallurgy has attracted the attention of many researchers. Modern scientific techniques have been applied to study metal objects and the debris of early metal smelting and smithing. This type of research, especially the work conducted by a team from Deutsches Bergbau-Museum (DBM) in conjunction with the Department of Antiquities of Jordan in the Feinan area, improves to a large extent our information about copper smelting technology in the area in the Chalcolithic and Early Bronze Age (HAUPTMANN 1989, 1991; HAUPTMANN *et al.* 1992). Despite significant progress, the overall picture of the early development of copper metallurgy is far from complete. Much work remains to be done to resolve many open questions concerning the development of early mining technology. There are no clear-cut answers to many questions concerning different issues, such as the development of smelting and smithing techniques, ore trade and scale of production during different periods. More extensive and rigorous research has been done on the western side of Wadi Arabah at Timna. Detailed reconstruction of the copper smelting process was performed based on the excavated remains. This led to a better comprehension of various aspects of copper metallurgy and production.

Early developments in iron metallurgy in Jordan have received very little attention. Our knowledge of the scale of production and employed smelting and smithing techniques at different periods is still crude. Scientific analysis of excavated metal objects can reveal important information about the technical capabilities of early metal workers. This area of study has attracted little attention. Some scattered work has been done on metal objects of different nature and dates (PIGOT and MCGOVERN 1982, KHALIL 1988, AL-SAA'D and SARI 1994, AL-SAA'D 1996b). This work is highly important but not sufficient. Unless pursued with vigour it would have little significance.

Much work is needed to reveal the range of metal alloy composition used in Jordan at different times. Also little knowledge has been gained about the development of techniques used for shaping and fabrication of ancient metal artefacts. Jordan has enormous quantities of coins from the Hellenistic period up through the Ottoman period. Information regarding the basic formulations, the level of the technical capability of the ancient coin makers, trade contacts among different minting centers and hints about the prevailing economic conditions could all be obtained by the scientific study of coins. Most studies concerning ancient coins in Jordan are purely descriptive and approach coins from a purely stylistic point of view. They do not go beyond what is present on the surface of the coin. Most numismatic studies have been limited to the examination of the designs, legends, mint marks, dates and denominations. In most of these studies little attention has been given to the coin as a monetary unit. Since coins are the most important, if not the only, source of information about significant monetary and economic changes, their intrinsic value should be equally considered. The coin's composition should be studied and analyzed side by side with the study of surface details. It is quite obvious that research in the area of artefact analysis has been poorly focused and has not centered around clearly defined, attainable objectives with a clearly stated time scale. This is due to the lack of vision, co-ordination, well-trained personnel, funds and possibly commitment. There are no in-depth archaeo-technological studies on any type of archaeological materials.

Anther important area of archaeometry is geophysical prospecting and remote sensing. These techniques have proved to be of significant value in assessing the location both of archaeological sites themselves and of buried features within these sites. Although some foreign archaeologists have applied some of these techniques in their excavations in Jordan, most Jordanian archaeologists have little idea about the potential and limitations of modern surveying techniques. Although scientific dating of archaeological materials, especially radiocarbon dating, has been frequently used by many archaeologists working in Jordan to date archaeological materials and sites, classical relative methods of dating remain the main source for establishing the chronological sequence. Most dating is based on written records and on the stylistic and typological study of pottery. Many of Jordanian archaeologists have no great faith in scientific dating and report high discrepancies in the results they obtained using these methods. From my experience and observations, this has to do more with problems in sampling rather than in the techniques themselves. Most archaeologists are not aware of the precautions that must be taken when collecting appropriate samples for dating.

The study of man and his environment is now a crucial component of archaeological studies. Environmental studies can provide essential information on past landscapes, climates, soil fertility, flora and fauna. The interaction between man and his environment has not been given the attention it deserves by Jordanian archaeologists. In most excavations focus is given to artefacts and structural remains. In these cases no scientific analysis of soils and sediments, pollen and plant microfossils, animal bones and mollusc and insect remains are performed. However, in the rare cases when such analysis is done, it is performed by non-Jordanian archaeologists and, in most cases, outside Jordan.

The study of man himself has attracted some attention. Recently, an academic program in physical anthropology was established at the Institute of Archaeology and Anthropology, Yarmouk University. However, most research done so far has been primarily concerned with the examination of skeletal remains to obtain information on the physical stature, sex, age at death and diseases suffered. Very little research has been done on the application of modern approaches on the study of skeletal remains such as trace element analysis of bones, stable isotope analysis and DNA sequence identification (SARIE 1995).

Mathematical techniques from statistical methods through artificial intelligence and expert systems to databases have been increasingly applied in archaeological studies, especially in the classification of artefacts and artefactual assemblages. Such techniques are not normally used by Jordanian archaeologists. Most of them have little idea about the potentials of mathematical and computer techniques in archaeological studies.

Recent Developments in Archaeometry in Jordan

Based on the previous discussion, it is quite clear that Jordan is not coping with the great momentum of advances in archaeological methods and techniques. Archaeometric research in Jordan is still in its infancy and needs to be institutionalised. On that ground, the Institute of Archaeology and Anthropology at Yarmouk University has recently introduced archaeometry as an academic discipline. Courses in scientific dating, modern techniques of surveying, ancient technology, material science, scientific analysis of artefacts, archaeogeology and archaeometallurgy are being provided. A new course in experimental archaeology will be introduced. Three laboratories equipped with the basic facilities in various archaeometric areas have been established. A coordinated and systematic research approach on well-focused topics has been initiated.

There are many active lines of research being conducted about pottery, glass, coins, metals and archaeometallurgy in addition to the active research in conservation of archaeological and monumental remains. Analytical results on various types of archaeological materials have been accumulated with the ultimate aim of creating a data base for each type of material.

Future Prospects

Having surveyed the negative and positive aspects of archaeometric research in Jordan, as I see them, I now want to discuss the major problems that hindered the development of that research. The future prospects of archaeometric research in Jordan depends to large extent on how we can tackle such problems. Suggestions to overcome such difficulties will be presented with a personal view of the main areas in which fundamental archaeometric research is required.

The major problem that hinders the progress of archaeometric research in Jordan is the lack of communication between archaeologists and scientists. One can feel that a high cultural fence stands between the two groups. Although there is an increasing number of archaeologists who show appreciation of what archaeometry can provide, there is still a considerable number of archaeologists who feel threatened and therefore are antagonistic toward the newly introduced approach. It is quite clear that an improved dialogue between scientists and archaeologists is necessary and a collaborative atmosphere between the two groups should be established. This is the only way to ensure that the archaeologist asks the appropriate questions of the scientific technique being applied and that the scientists provides the data that the archaeologist requires.

To achieve this goal it is necessary to train both groups so they can have a meaningful exchange with each other. Archaeologists must be trained to understand the potentials and limitations of the application of science to archaeology. Conversely, scientists must be trained to understand the aims, methodology and underlying framework of archaeology. To ensure that archaeometric research is on the right track and is fulfilling its objectives, this research must be centered around clearly defined and attainable objectives. Limited topics of strategic importance should be defined, then research should be performed in a systematic, thorough and detailed manner. This is much better than doing poorly focused and scattered research and trying to solve all the problems in one go.

Since it has been quite recently introduced to Jordan, archaeometric research needs to be established and pursued in all directions. However, there are some areas that are of strategic importance where rigorous archaeometric research is essential. First and foremost comes research into the study of artefacts. Different types of analytical techniques should be applied to artefacts of different types and dates such as flint, pottery, glass, metals and organic materials to accumulate analytical results on these artefacts. The accumulated data should be used to obtain information in three main areas. First the determination of provenance of these artefacts by characterising and locating the natural sources of the raw materials used to make artefacts. The overall scale of production and the overall pattern of distribution from each of the production centres associated with different materials should be established. This is quite essential to understand the patterns of trade and exchange of these artefacts. Second, the identification of the materials and techniques used to make the different types of artefact. Third, the determination of the ancient function and usage of these artefacts. Bone and other skeletal remains have been excavated in large quantities from most Jordan archaeological sites. This material is of prime importance, especially when excavated from Palaeolithic and Neolithic contexts. The application of isotope geochemistry is an area of immense potential. Dietary reconstruction studies from chemical and stable isotope analysis of bones are of great importance and should be vigorously pursued. The ecological approach of studying the cultural developments include areas of research that have the potentials for some of the most exciting scientific achievements in the future. Stable isotope techniques, for example, can be used to reconstruct paleoclimatic conditions which could be efficiently used to explain many cultural changes.

Due to the limitations of the classical surveying and excavations methods, research is essential in exploring the potential of various types of remote sensing techniques, geophysical and thermal prospecting techniques and ground probing radar techniques for locating archaeological sites and in discovering buried features in these sites. Less fundamental but equally important research is required in the areas of scientific dating and in the application of modern mathematical and computation methods to archaeological problems. For example, the establishment of a master sequence for tree ring dating (dendrochronology) of different tree species is a line of research that is worth pursuing.

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