INVESTIGATIONS INTO THE STONE AGE OF THE PETRA AREA (EARLY HOLOCENE RESEARCH) A PRELIMINARY REPORT ON THE 1984 CAMPAIGNS

by
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Acknowledgements and Progress of Field Research

Two campaigns were carried out during spring and autumn 1984. While the spring season concentrated on completing information on the present vegetation cover and on a survey between Wadi Musa and Tayiba, objectives of the autumn season were to enlarge our basic supply of palaeoenvironmentally relevant samples from Early Holocene sites and to achieve further information on occupations during the Late Epipalaeolithic to the Late Pre-Pottery Neolithic B in the area. During the autumn season geological surveys were also conducted in order to localize flint resources.

We are deeply indebted to the Department of Antiquities, Amman and its Director-General, Dr. Adnan Hadidi, who supported our research with his advice and generous help.[1]

Differing from the spring campaign (J.M. Starck, H.G. Gebel), the investigations in the autumn season[2] concentrated on surveying the areas of al-Thugra/Naqb ar-Ruba'i, Wadi Sleisel/ Jabal Abu Suwwana, and Jabal Sumr at- Ṭayiba, with soundings in Thugra 1, Ba'ja 1 and Basṭa 1. The geological prospections[3] concerned the potential flint resource areas of c2 and c3 formations above 'Ain Braq /'Ain Ammoun/ 'Ain M'allaq south of Wadi Musa; c5-2 formations near jabal Abu Suwwana and Wadi Jurf Ibn Bakhit; and outcrops in the 'Ain Dhawi area (Fig. 2).

Many of the geomorphological processes and features causing the preservation and embedding of the Early Holocene sites are still imperfectly understood. The experience from previous field work showed that the difficult and incalculable relief of the Petra area, despite aerial photographs and good maps, meant that site location by systematic surveying was less successful than through repeated surveying in a geographically well-defined area around a camp near a tested site. On the other hand, the concentration on such areas led to a more intensive investigation of different ecologically and topographically restricted environments. This not only enabled us to use results from well-investigated regions

[1] The expedition also thankfully acknowledges the aid and support of Suleiman Farajat and Inyazi Shaba'an, who were appointed as representatives by the Department of Antiquities. Parts of the equipment and accommodation in Nazzal Camp, Petra were provided by the Department.

Excepting the geological survey, the projects were financed by the Special Research Division 19 (Tuebingen Atlas of the Middle East) through the Deutsche Forschungsgemeinschaft. The expedition expresses its sincere gratitude to the chairman of the Tuebingen Atlas, Prof. Dr. W. Roellig, for his support.

The artefact drawings were done by I. Raidt; the English of the manuscript was corrected by C. Gustavson-Gaube (Tell esh-Shuna excavation).

[2] Permanent members of the team were H.G. Gebel (Prehistorian; Director), J.M. Starck (Biologist; prehistory), B. Khoury and A. Mueller (prehistory). Finally, we thank our friends in Amman and in the Petra-area, especially Abdullah Ruweiri, Harun, Saba'a and Suleiman, who assisted in carrying out the soundings of Ba'ja 1 and Thugra 1.

[3] These surveys were made possible through the collaboration with the Director of the Department of Geology and Mineralogy of Amman University, Prof. Dr. H. Khoury. We should like to thank his infield collaborators, Dr. S. F. Helmdach and W. Zacher as well as Muhammad Salameh Husein and Amer Mare'e (graduate students) and Muhammad Muhtar (doctorate candidate).

to help describe similar but less known ones, but also permitted the characterization of different eco-geographic units. The following units were defined in 1984:

1. Steep slopes of the western limestone plateau (Eastern Arabian Plateau) with lines of springs/ springlets in its middle and upper parts (1300-1500 m.) and adjacent agriculturally used tali to the west (area chosen for investigation: along road between Wadi Musa and Ṭayiba).
2. Sandstone areas with subdued relief (950-1100 m in the north and ca. 800 m in the south), partly with playa-fillings, smaller and larger fields (areas chosen for investigation: al-Thugra region to the escarpment of Naqb ar-Ruba'i; Sabra and ad-Daman area revisited in Spring 1984).
3. Sandstone areas with dissected relief (600-1000 m.), with large agriculturally used plains in the upper parts of the drainage systems and steep-sided formations of weathered rock in the lower parts of the drainage systems (areas chosen for investigation: Wadi Sleisel, Wadi Baida, Jabal Qarun, and Wadi Jurf Ibn Bakhit).
4. Upper alluvial fans and outlets (250-650 m.) of major drainages into Wadi'Araba (area chosen for investigation: Wadi Khiara, Wadi Abu Khusheiba, Seil Wadi Musa, and Jabal Sumr at Tayiba).

The methods of field work on the sites remained comparable to those used in 1983. In order to achieve palaeoenvironmentally relevant samples, soundings and section cleanings were once again carried out in dumping areas of sites (Ba'ja 1 and Baṣṭa 1). Furthermore, systematic (Sunkh 1, Ba'ja 1) and non-systematic (Sunkh 1, Thugra 1, Wadi Sleisel 1, Ba'ja 1, 'Ain Tayiba, Abu Barqa, and Basta 1) surface collections were carried out, the latter being undertaken only on deflated/ eroded sites or parts of such sites.[4] Systematic surface collections were based on units of 32 square metre in the sites' grid system, collections being taken by each square meter in order to obtain control samples for the chipped industries deriving from the soundings.

From the *in situ* cultural layers of Ba'ja 1 and Baṣṭa 1 and the assorted and redeposited layers of Thugra 1, 10 cm. layers were arbitrarily excavated. Every object, bit of charcoal, etc. was sorted out by means of 4 mm. sieves and from the 4-1 mm. residue, 3 1 per 100 1 (1 square metre) were taken as a sample. All sediments removed were sifted and samples were taken for each layer from the sections. These soundings are archaeologically controlled sampling programs characteristic of a palaeoenvironmental survey and can not be considered as excavations in the general sense.

For each of the Late Epipalaeolithic and Early Neolithic sites, a locational analysis was carried out in which the data available in the field were collected and aspects such as site setting, possible network of territorial connections, distribution and accessibility of all biotic (present-day) and abiotic resources and catchment areas were described.

After preliminary differentiation of the major geo-botanical units of the area in 1983, a quantitative analysis of plant cover was undertaken according to the reconsidered geo-botanical units. This resulted in a detailed description of plant communities which characterize these units.

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[4] Collections were also undertaken at the following Pre-Epipalaeolithic and undatable sites:
— Thugra 2: flint artefacts, animal bones and teeth embedded into calitreras; undatable (c. 980 m, .56.7 N/.33-4 E)
— Sunkh 2: Playa-section with alternating layers of water-deposited gravels and sand; 4 layers contain Middle-Palaeolithic artefacts and bone splinters; systematically sampled (c. 970 m, .56-7 N/.33-4 E)
— Ra's as-Suleiman 1 and 2: Surface scatters of undatable flake industries, possibly containing also Middle Palaeolithic materials (c.960-1020 m, .55-7 N/.33-4 E)
— Naqb ar-Ruba'i: large surface scatters of Middle Palaeolithic artefacts (1000-1100 m, .55-7 N/.30-1 E)
— Jabal Abu Suwwana West: flaking grounds with undatable flake industries (c. 650 m, .62-3 N/.30-2 E)
The grid references in this article refer to the maps Jordan 1:50.000 Series K737.

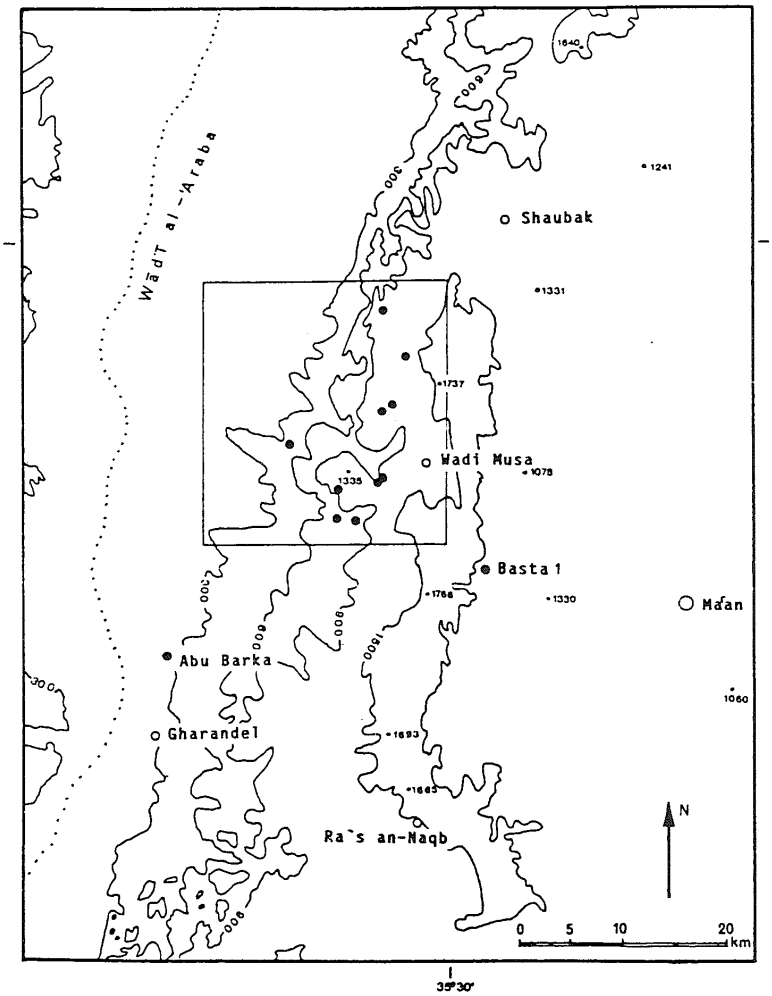

Fig. 1: (left) Area of investigation in Southern Jordan

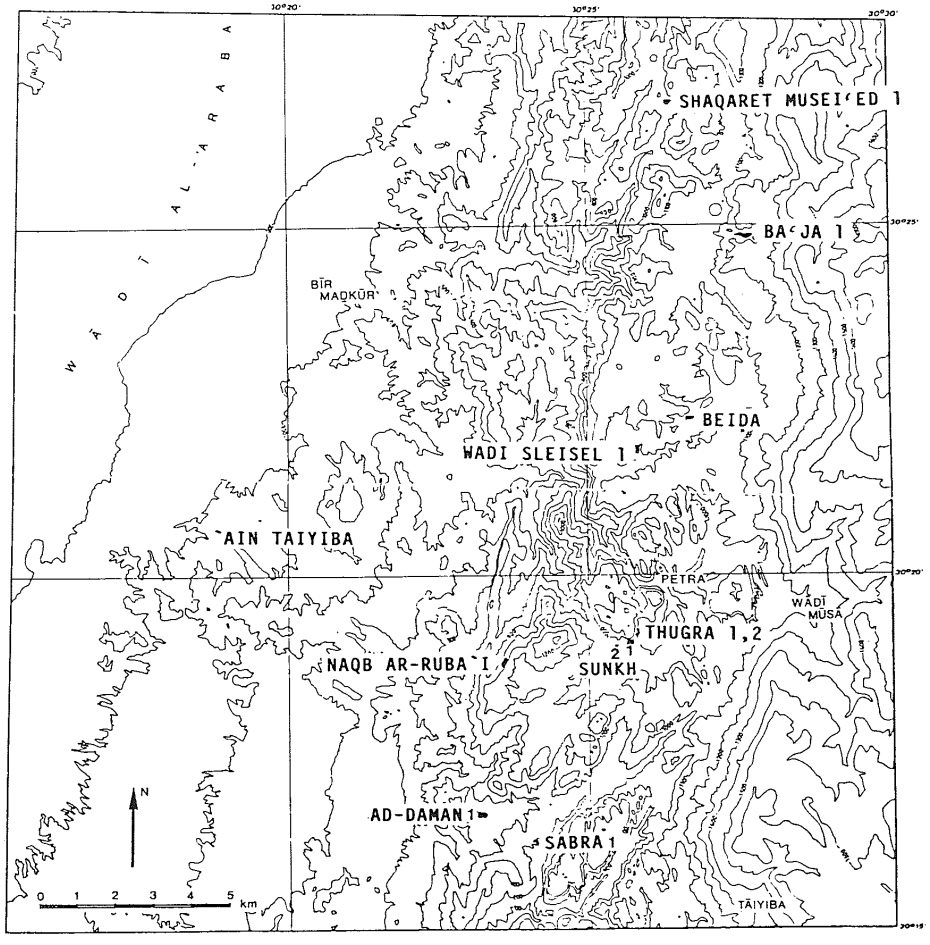

Fig. 2: (right) Survey area with location of sites mentioned.

It was attempted to collect a complete herbarium for the areas between 400-1500 m.[5]

Notes on the Objectives of the Project

The aim of this research is the attempt to reconstruct the environmental conditions for the periods of early settlement and sedentarization in the Petra area (Late Natufian - Late PPNB, end of 10th - end of 7th Mill. B.C.), to receive insights into the settlement history during this time, and to understand patterns of interaction between man and his natural resources. According to these main objectives, work was concentrated on the following aspects:

Evidence of different environmental conditions than are present today based on various palaeoenvironmental resources (faunal, botanical, malacological, palynological, geomorphological, etc.);

Spatial distribution of abiotic and reconstructable biotic resources (possible woods, agricultural land, gazelle habitats, etc.; flint, building materials, minerals for ornaments, etc.);

Descriptions and comparisons of site settings and their catchment areas (locational and territorial analysis);

Network of possible territorial connections, accessibility of mineral resources;

Comparative analysis of flint technology and raw material exploitation (PPNB sites); and

Aspects of possible evidence for transhumance and seasonality of sites, insights into the PPNB settlement pattern, and materials of long-distance exchange.

Another objective of the project is to contribute to the discussion on the improvement of field and evaluation methods of palaeoenvironmental surveys for the Early Holocene of the Southern Levant.[6] With the data collected concerning the hydrology, climate, actual and potential vegetation cover, geomorphology and geology of the region, one may use the analysis of the palaeoenvironmental and archaeological samples to achieve a reconstruction of the Early Holocene environment and thus gain insights into its human exploitation.[7]

Topographical, hydrological and climatological aspects

In order to understand the following chapter on the recent vegetation cover, certain abiotic factors must be described. Basically, the area considered can be divided into three main zones which roughly

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[5] I would like to express my thanks to Dr. H. Kuerschner and prof. Dr. W. Frey of the Institut fuer Systematische Botanik und Pflanzengeographie, Free University of Berlin, who helped me to identify many of species mentioned in Fig. 4 (J.M. St.).

[6] The investigation also is an attempt to illustrate the relationship between the "theoretical input" and the "output" of modified questions and methods influencing further research. One should be well aware of the fact that such a multidisciplinary approach enables us to describe properly the limits of this research design. The basic problem is that we cannot consider our samples as representative, or rather, we sometimes do not know what they represent. This results in the methodological problem of how to ensure that the use or combination of information will not lead to misinterpretations. This is especially the case with contradictory information on the past environment from different palaeoenvironmental sources (bones, charcoals, etc.). Basic problems such as the selective preservation of pollen will not be solved and yet others require basic research, e.g., the land snails of Sabra 1 as a possible nutritional resource.

[7] The following specialists are involved: F. Frey/C. Jagiella, Free University of Berlin (charcoals); A. Hauptmann, German Mining Museum Bochum (mineralogy); H. Khoury/F. Helmdach, University of Amman (flint resources); H. J. Pachur, Free University of Berlin (geomorphology, sediments); T. Petney, Rhodos University, South Africa (land snails); D. Reese, New York (marine molluscs); O. Roehrer-Ertl, Muenchen (human remains); D. Schyle, University of Tuebingen (Sabra 1: Natufian chipped stone industry); J.M. Starck, University of Giessen (recent vegetation cover, small finds); H.P. Uerpmann/W. Soeffner, University of Tuebingen (faunal remains); W. van Zeist/R. Neef, University of Groningen (seeds, pollen).

follow the isolines of precipitation, temperature and evaporation, and the stepped succession of the geological formations.

The steep slope of the westernmost part of the Arabian Plateau (Unit 1, see above) and parts of the adjacent, eastern sandstone areas (Unit 2) receive the same amount of rainfall (Fig. 3). From the upper limestone horizons of the steep slope, numerous perennial and periodical springs emerge. The immediate vicinity of the springs is given over to irrigated tree plantations, vineyards and wheat stands. Large terraced rain-fed fields are found some distance away in trough-shaped "run-offs" and on crests in the lower and flatter parts of the steep slope. Whether these fields lie fallow or not depends on such aspects as physiographic setting and distance from the spring horizons, position in terraced trough or on a crest, matrix of the soil and, above all, on the amount of winter rainfall during the year.

Due to the water/ moisture storage capacity of the sandstone formations of Units 2 and 3, these regions show a rich pattern of ecologically distinct habitats. Swampy summer environments in gorge-like situations (with hydrophytic vegetation) contrast with dry desert conditions on playa fillings (with xerophytic vegetation) and make up the extremes of habitats found. In contrast to Unit 1, rainfall is less determining than the microtopographical circumstances with respect to the nature of Unit 2 and Unit 3 habitats. The main natural habitats observed are:

— sandstone clefts with no or minor sediment fillings
— moving substratum of rock fans
— large shady gorges (Siqs) with moderate climate
— wadi flats and low wadi terraces
— extremely dry playa fillings with incrusted surfaces and high discharge ratios and
— intermittent wadi flows and perennial or periodical springs.

The outlet of drainages into Wadi 'Araba and the upper parts of the alluvial fans and gravel flats of Unit 4 receive 0-150 mm. rainfall in dry years and 150-200 mm. in wet years. The morphology, ecology and climate of this area already resemble the very hot arid conditions of Wadi 'Araba and therefore cannot be compared with the units discussed above. In addition to the periodical water flows gushing into Wadi 'Araba, the alluvial fans with their high water table are the striking hydrogeographical features here. A distinct topographical phenomenon at the mouth of wadis draining into Wadi 'Araba are low wadi terraces resting on the alluvial fans. As they are not dated yet, they remain a problem for localizing Early Holocene sites.

Present-day vegetation cover (Fig. 3 and 4)

The components of the recent vegetation cover around Petra basically result from its setting in an area in which the Mediterranean, Saharo-Arabian, Irano-Turanian and Sudanian floral regions intrude upon each other. In addition, the Petra area offers so many types of different habitats (see above) that elements of all the four regions could be recognized here, causing the impressive diversity of species (Fig. 4). Classified according to formation the following main plant communities and their characterizing elements are described: Xero-mediterranean forests -1-, Artemisia steppes -2-, vegetation of rocky sandstone areas -3-, vegetation of playa fillings -4-, vegetation of desert wadis -5-, hydrophytic vegetation -6-.

1. On the limestone ridges north of Wadi Musa, from a height of 1200 m. upwards, the Mediterranean floral element becomes dominant. On the road between Wadi Musa, al-Hīsha (1500 m.) and Shaubak, open forests of oak (Quercus calliprinos) and pistachio (Pistacia atlantica) characterize the landscape. Quercus calliprinos, typical for the eastern Mediterranean oak forests, reaches its easternmost extension near Wadi Musa. The undergrowth of these forests also includes Irano-Turanian herbs, unusual for a Mediterranean pistachio -oak forest. The association of Quercus calliprinos - Pistacia atlantica in the area investigated belongs to the plant-sociological class of Quercetea

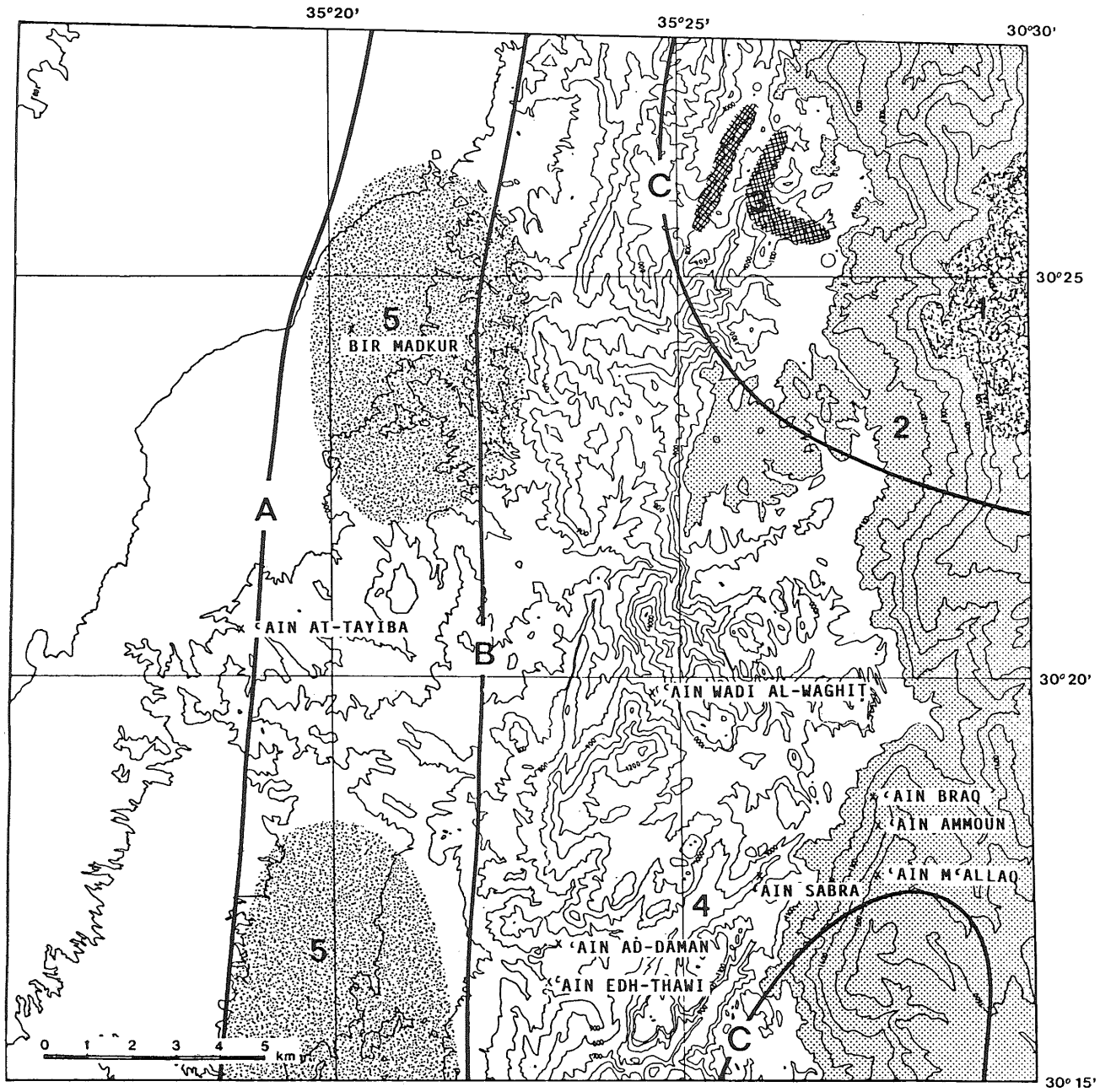

Fig. 3: Topography and ecological information on the survey area
A 100/150 mm. isohyetes (dry/wet years)
B 150/200 mm. isohyetes (dry/wet years)
C 200/300 mm. isohyetes (dry/wet years)
(A-C after: German Agency for Technical Cooperation 1977)
1 Xero-mediterranean forests
2 Steppes of Artemisia herba-alba.
3 Vegetation of rocky sandstone areas
4 Vegetation on playa surfaces
5 Vegetation of desert Wadis
* springs mentioned in the text

ACANTHACEAE
Blepharis ciliaris (L.)B.L.BURTT

ADIANTACEAE
Adiantum capillus-veneris L.

ANACARDACEAE
Pistacia atlantica DESF.
Pistacia khinjuk

APIACEAE
Chaetosciandium trichospermum (L.)BOISS.
Eryngium creticum LAM.
Scandix stellata BANKS et SOL.

APOCYNACEAE
Nerium oleander L.

ARACEAE
Arum L.cf.orientale M.B.

ASCLEPIADACEAE
Caralluma aaronis
Caralluma europaea (GUSS.)N.E.BROW
Caralluma plicatiloba LAVRANOS
Periploca aphylla BOISS.

ASTERACEAE
Achillea santolina L.
Anthemis melampodinae DEL.
Anthemis nabateae
Anthemis tenuicarpa
Anvillea garcinii (BURM.fil.)DC.
Artemisia herba-alba ASSO
Asteriscus graveolens (FORSSK.)LESS.
Asteriscus pygmaeus (DC.)COSS.& DUR.
Atractylis carduus (FORSSK.)C.CHRIST
A.car.var.glabrescens (BOISS.)FEINBR.
Centaurea aryngioides LAM.
Centaurea pallescens DEL.
Chardinia orientalis (L.)O.KUNTZE
Cousinia dayi POST
Echinops glaberrimus EIG.
Filago palestina (BOISS.)CHRTEK & HOLUB
Ifloga spicata (FORSSK.)SCH.BIP.
Inula viscosa (L.)AIT.
Iphiona mucronata ASCHERS.& SCHWEINF.
Jasonia iphionoides (BOISS.et BL.)BOTSCH
Jasonia montana (VAHL) BOTSCH
Notobasis syriaca (L.) CASS.
Senecio glaucus L.

BORAGINACEAE
Alkanna strigosa BOISS.et HOHEN.
Anchusa milleri WILLD.
Anchusa ovata LEHM.
Anchusa strigosa BANKS & SOL.
Echiochilon fruticosum DESF.
Paracaryum rugulosum (DC.)BOISS.

BRASSICACEAE
Diplotaxis harra (FORSSK.)BOISS.
Erucaria boveana COSS.
Erucaria hispanica (L.)DRUCE.
Erysimum crassipes FISCH et MAY
Farsetia aegyptiaca TURRA
Matthiola aspera BOISS.
Moricandia nitens (VIV.)DUR.et BARR.
Raphanus raphanistrum L.
Sisymbrium officinale (L.)SCOP.
Zilla spinosa (L.)PRANTL.

CAESALPINIACEAE
Ceratonia siliqua L.

CAPPARACEAE
Capparis spinosa L.

CAPRIFOLIACEAE
Lonicera etrusca SANTI

CARYOPHYLLACEAE
Dianthus strictus BANKS.et SOL.
Gymnocarpus decandrum FORSSK.
Telephium sphaerospermum BOISS.

CHENOPODIACEAE
Anabasis articulata (FORSSK.)MOQ.
Atriplex halimus L.
Halogeton alopecuroides (DEL.)MOQ.
Hammada salicornia (MOQ.)ILJIN
Noea mucronata ASCHERS.et SCHWEINF.
Salsola volkensii SCHWEINF.et ASCHERS.
Suaeda aegyptica (HASSELQ.)ZOH.

CICHORIACEAE
Crepis hierosolymitana BOISS.
Hedypnois rhagadioloides (L.)F.W.SCHMITT
Launaea mucronata FORSSK.
Launaea nudicaulis (L.)HOOK.fil.
Picris damascena BOISS.et GAILL.
Reichardia tingitana (L.)ROTH.
Rhagadiolus stellatus (L.)GAERTN.
Sonchus maritimus L.

CISTACEAE
Helianthemum sancti-antonii SCHWEINF.
Helianthemum vesicarium BOISS.

CUCURBITACEAE
Bryonia cretica L. forma cretica
Citrullus colocynthis (L.)SCHRAD.

CUPRESSACEAE
Juniperus phoenicea L.

DIPSACACEAE
Scabiosa porphyroneura BLAKELOCK

EPHEDRACEAE
Ephedra alte C.A.MAY.

EQUISETACEAE
Equisetum ramoissimum DESF.

EUPHORBIACEAE
Euphorbia L.spec.

FABACEAE
Alhagi maureorum MEDIK.
Anagyris foetida L.
Astragalus bethlehemiticus BOISS.
Astragalus spinosus (FORSSK.)MUSCHL.
Astragalus tribuloides DEL.
Colutea istria MILL.
Hippocrepis unisiliquosa L.
Medicago laciniata (L.)MILL.
Onobrychis crista-galli (L.)LAM.
Onobrychis MILL.cf.koschyana FENZL
Ononis natrix L.
Ononis vaginalis VAHL
Psoralia flaccida NAB.
Retama raetam (FORSSK.)WEBB

FAGACEAE
Quercus calliprinos WEBB.

GENTIANACEAE
Centaurium spicatum L.

GERANIACEAE
Erodium guttatum (DESF.)WILLD
Erodium laciniatum (CAV.)WILLD.
Geranium rotundifolium L.

GLOBULARIACEAE
Globularia arabica JAUB.et SPACH.

JUNCACEAE
Juncus bufonis L.
Juncus rigidus C.A.MAY

LAMIACEAE
Ajuga chia SCHREB.
Micromeria BENTH.spec.
Phlomis platystegia POST
Teucrium polium L.

LILIACEAE
Asparagus L.spec.
Colchicum L.spec.
Ornithogalum L.spec.
Urginea maritima (L.)BAKER

LORANTHACEAE
Loranthus acaciae ZUCC.

MALVACEAE
Malva sylvestris L.

MIMOSACEAE
Acacia cyanophylla LINDLEY
Acacia tortilis
Acacia radianna SAVI.

MORACEAE
Ficus carica L.

NEURADACEAE
Neurada procumbens L.

OLEACEAE
Olea europea L.

PAPAVERACEAE
Papaver argemone L.
Papaver syriacum BOISS.et BL.
Roemeria hybrida (L.)DC.

PINACEAE
Pinus halepensis MILL.

PLANTAGINACEAE
Plantago afra L.
Plantago coronopus L.
Plantago ovata FORSSK.

PLUMBAGINACEAE
Limonium pruinosum (L.)O.KUNTZE

POACEAE
Avena ludoviciana DUR.
Avena wiestii STEUD.
Boissiera squarrosa BANKS.et SOL.
Bromus danthoniae TRIN.
Bromus fasciculatus C.PRESL
Bromus pulchellus
Cynodon dactylon (L.)PERS.
Heteranthelium piliferum HOCHST.
Hordeum geniculatum ALL.
Lophochloa hispida (SAVI)TACKH.
Melica jaquemontii DECNE ex JAQUEM.
Oryzopsis holciformis (M.B.)HACK.
Oryzopsis miliacea (L.)BENTH.et HOOK.
Panicum turgidum FORSSK.
Phragmites australis (CAV.)TRIN.
Polypogon monospeliensis (L.)DESF.
Stipagrostis ciliata (DESF.)De WINTER
Trachyina disticha (L.)LINK

POLYGONACEAE
Polygonum equisetiforme SIBTH.et SM.
Rumex cyprius MURB.

PRIMULACEAE
Anagallis arvensis L.

PUNICACEAE
Punica granatum L.

RESEDACEAE
Caylusea hexagyna (FORSSK.)GREEN
Ochradenus baccatus DEL.

RHAMNACEAE
Rhamnus dispermus EHRENB. ex BOISS.

ROSACEAE
Crataegus L.cf.aronia (L.)BOSC.ex DC.
Rosa L.cf.prunus

RUBIACEAE
Galium aparine L
Galium canum REQ.in DC.
Galium L.cf.murale (L.)ALL.

SALICACEAE
Populus euphratica OLIV.

SCROPHULARIACEAE
Kickxia acerbiana (BOISS.)TACKH.& BOULOS
Linaria haelava (FORSSK.)DEL.
Scrophularia hierochuntia BOISS.
Scrophularia nabataeorum EIG.
Verbascum fruticulosum POST
Veronica anagallis-aquatica L.

SOLANACEAE
Hyoscamus aureus L.
Lycium europaeum L.
Solanum sinaicum BOISS.

TAMARICACEAE
Reaumuria hirtella JAUB et SP.
Tamarix L.spec.

THYMELEACEAE
Daphne linearifolia HART
Thymelea hirsuta L.

URTICACEAE
Parietaria alsinifolia DEL.
Urtica pilulifera L.

VITACEAE
Vitis vinifera (cult.)

ZYGOPHYLLACEAE
Fagonia glutinosa DEL.
Fagonia mollis DEL.var.mollis DEL.
Peganum harmala L.
Zygophyllum dumosum BOISS.

Fig. 4: List of plants collected in the Petra area

calliprini and the order of Crataegion aroniae.

Juniperus phoenicea - Pistacia atlantica associations follow the oak at heights between 1400-1200 m. Like the oak, the juniper is an Eu-Mediterranean species, usually confined to the lower altitudes of the coast. However, here it appears together with plants typical of the Irano-Turanian steppe (Artemisia herba-alba vegetation). Artemisia vegetation extends further down to 1000 m. thus entering Unit 2 areas.

2. The Artemisia vegetation mentioned above, derives from the plateau where it forms the dominating type of plant cover. These steppe associations belong to the class of the Artemisetea herbae-albae mesopotamicae and are accompanied by the co-dominates Noea mucronata and Astragalus spinosus. We also identified them in Unit 1. They can also be found in the eastern parts of Unit 2 above 1000 m. (e.g., the upper Wadi Baida drainage system), where intrusive Saharo-Arabian elements (e.g., Anabasis articulata, Fagonia mollis) also occur.
3. The weathering of the steep-sided sandstone ridges of Unit 2 and 3 produces great amounts of erosional debris which build up tali fans. These shifting debris substrates are one of the most common habitats for the plant communities described below. Other habitats are clefts which are protected against heavy evaporation and can store water in the fine sediments. As in the larger, steep-sided Siqs, the shady conditions are responsible for less extreme temperature shifts.

   The tali fans are covered by Varthemia montana, Ajuga chia, Echinops glaberrimus and Ononis vaginalis, etc. In larger clefts, Pistacia khinjuk and Juniperus phoenicea can be detected, while small clefts are mostly occupied by Capparis spinosa. Broad Siqs like Siq Umm al-Hiran are often wooded with Pistacia atlantica, oak and juniper.

   Due to their accessibility and the herbaceous plant cover the tali fans are highly frequented as pastures, and have thus developed less differentiated communities. As a result of overgrazing, Urginea maritima migrates on to these tali, often founding monotypic communities.
4. The lower lying southern parts of Unit 2 with their vast playa fillings show the typical hot desert vegetation of the Saharo-Arabian region. Dominated by Anabasis articulata, Gymnocarpos decandrum and Fagonia mollis, this association can be classified as Anabasetum articulatum typicum. This community usually populates hammadas and other stony substrates with rainfall values below 100 mm. The reason why it appears near Sabra, ad-Daman and other parts of Unit 2 (c. 200 mm.) might be explained through the surface crust of playa, which causes rapid drainage. Where ploughing activities have been undertaken on playa surfaces, rain-fed agriculture can be carried out in wet years.
5. The vegetation of desert wadis cannot be confined to one geo-botanical unit. Depending on the season and whether the year is wet or dry, any type of surface water may appear. The typical vegetation of broad, gravel-covered wadi bottoms (e.g. Wadi Thawi) is Retama raetam and Zilla spinosa. The Retamo - Tamaricetea fluviatilia class is common for all wadis in Palestine. The number of associated species varies annually. In Wadi Dhawi, Ochradenus baccatus and some sparsely scattered Acacia tortilis show the changes of the diffuse vegetation which is influenced here by Sudanian elements from Wadi 'Araba.

   The vegetation of minor drainages, runnels and rillets is usually the same as the surrounding area (e.g., playa rillets), but Retama raetam and Thymelea hirsuta may differentiate these.
6. While the natural vegetation of the spring horizons of Unit 1 and the waterholes of Unit 4 (Bir and 'Ain Tayiba, Bir Madhkur) was destroyed by cultivation, the springs in the remote sandstone areas (Wadi Sabra, 'Ain Dha-

wi, and 'Ain ad-Daman) still reflect an almost undisturbed hydrophytic vegetation. Here Nerium oleander, Phragmites Communis and Tamarix spec. prevail. Co-dominates are Juncus gerardii, Inula viscosa and Polygonum equisetiforme. The dense stands of Nerium oleander and Phragmites communis,. as well as Populus euphratica trees in 'Ain Dhawi, show the interference in plant communities of the Phragmitetea and the Populetea.

Physiographic setting and description of sites[8]

The following describes seven of the Late Epipalaeolithic and late PPNB sites investigated in 1984.

Ba'ja 1 (c. 1120-1160 m; 67-8 N/ .36-7 E): This site is a large, Late PPNB village with terraced houses in a rather odd physiographic setting today.[9] It can only be reached through a Siq, which is sometimes as narrow as two metres. The Siq is blocked by fallen rocks at several spots, so that the site can only be reached today by mountaineering across the almost vertical blockings, which may reach heights of 6 m. Leaving the upper part of the deeply incised Siq, one reaches an intramontane terrace on which the settlement is situated. The settlement extends approximately 10.000 square metres[10] thus occupying the entire terrace. Characteristic of the major terrace is its amphitheatre-like form where a complicated system of curvilinear retaining walls created the plots for the terraced housing. The walls are sometimes built from limestone which is not available locally, where the dominant material is tabular sandstone. Some of the walls are curvilinear, but rectangular houses seem to be the common type. In the flat upper part of the settlement humic soil between the walls may indicate gardens and/ or enclosures [11] Although the site today is only accessible through the Siq, high erosion rates may well have destroyed an eastern access. Primitive wooden constructions to cross the Siq might also be expected[11] No water resources are in the immediate vicinity of the site today. Apart from numerous large water pools in the depressions of the Siq, fed today from the sandstone and gravel beds until April and even May in wet years. in the dry season water must have been obtained from spring horizons of the eastern limestone ridge. If the oak-wooded Siq would not be blocked today, the protected setting of the site could be reached from the Siqs' entrance in only 10 minutes. The nearest farming catchment area, the plain of Wadi al-Jabu/ Umm al-Alda (c. 3 square kilometres) is situated near this entrance.

Thugra 1 (980-1000 m; .56-7 N/.33-44 E): The site overlooks the eastern part of the Wadi al-Waghiṭ drainage system and is a slope resting against the steep-sided southeastern edge of the al-Barra sandstone massif. Nearby, a smaller talus cone emerges from a run-off. The slope stratigraphy was built up by waterlaid fine gravel and sand with possible eolian components. Artefacts of an unidentified Late Epipalaeolithic are concentrated in certain layers only and must derive from a fluvially-eroded site. Bits of charcoal associated with the findings suggest that the material was not transported far. The slope area is covered by large sandstone blocks with calcicrusts. This proves that the blocks were covered with fine-grained material, indicating that slope sediments had been at least one metre higher than today, a situation most likely earlier than the embedded Epipalaeolithic finds and the surface scatters of Post-PPNB artefacts ("Shepherd-Neolithic"?).

Sunkh 1 (960-980 m; .56-7 N./33-44 E): The artefact concentrations of this late

[8] The spelling of sites and localities in this report follow the map Jordan 1:50.000. the correct transliteration of site names can be seen from Figures 2 and 3.

[9] Ba'ja 1 was originally found by M. Lindner, Naturhistorische Gesellschaft Nuernberg, who drew our attention to it. We warmly acknowledge Dr. Lindners helpful information concerning other localities as well.

[10] Baida's preserved size is approximately 6000-7000 square metres

[11] H.J. Pachur, Geomorphologisches Laboratorium der Freien Universitaet Berlin, personal communication.

Natufian site (c. 12.000 square metres) are found in and on the sandy topsoil of a gentle slope at the southwestern foot of the al-Barra massif. In the lower parts of the site, the sandstone bedrock has been exposed. In the central part, with its most dense artefact distributions, the former surface has been reduced by water and wind. No in situ cultural layers were found. Associations of artefact groups indicate a certain preservation of spatial distribution. The site overlooks the upper Wadi al-Waghit drainage system which created the spur-like setting of the site's lower parts through minor dissections. As in the case of Thugra 1, the next permanent spring is found in Wadi al-Waghiṭ.

Wadi Sleisel 1 (1000-1040 m; .61-2 N/.33-4 E): Artefact concentrations of an unidentified Late Epipalaeolithic and Middle Palaeolithic were found on shallow erosional debris or on the exposed sandstone bedrock of a northern slope of Wadi Sleisel. No anthropogenic sediments could be traced. Again calcicrusts give evidence of the denudation of slope sediments.

'Ain Tayiba (300 m; .59-60 N/.22-3 E): The site was found during a survey for the re-localization of Bir at-Tayiba.[12] Few, widely dispersed artefacts of a late PPNB type were distributed on the gentle slope south of the spring. All of the scatters were collected. Sediments were almost completely eroded from the limestone bedrock. No structures or cultural layers were encountered, also no pottery.

Abu Barqa (c. 300 m; .33-4 N/.71-2 E): South of the Wadi Abu Barqa outlet into Wadi 'Araba, at a spot noteworthy for a huge dune blown against the westernmost sandstone ridges, the surface site of Abu Barqa was found on an alluvial fan.[13] In front (west) of the dune there is an area of c. 20.000 square metres, covered with thousands of blades. Part of this blade-yielding surface has probably been covered by the dune which has disarranged the spatial distribution of artefacts by moving across the alluvial fan. Parts of the find area are deflated, showing stone pavements. It was not checked whether the site is in the neighbourhood of a flint resource.

Basta 1 (1400 m; .34-5 N/.74-5 E): The late PPNB village of Basta 1 is situated next to a major spring on the western part of the plateau, characterized by vast, treeless fields. The topographic setting and the exact dimensions of the site are difficult to investigate, as the modern village and its historical predecessors almost completely cover the Neolithic site. At many places in the present-day village building activities have cut into the Neolithic layers. These suggest an areal extent larger than Ba'ja 1. The layers investigated are on the northern slope above the well-watered spring area. It was not possible to estimate the depths of the cultural layers here. It also remained unclear whether a Pottery Neolithic settlement was situated on the same slope further down.

Soundings and section investigations

Soundings were done in Ba'ja 1 (SI) and Thugra 1 (SI and SII), existing sections were cut back in Ba'ja 1 (SII and SIII) and in Basta 1 (SI).

In Ba'ja 1, sampling activities were concentrated on the sloping rubbish layers of the westernmost edge of the settlement (Fig. 6). Three square metres were excavated in arbitrary layers along a smaller cut which created a control section. The depth of each square varies, according to the contour of slope surface, between 1.0 and 0.2 m. Between the topsoil (A) and the weathered surface of bedrock (E) three light to dark grey cultural layers succeed each other (B-D). While B consists of highly consolidated dusty/ashy material with larger stones (c. 15 cm.), heavily-sintered flints and bones,[14] C shows a lesser degree of consolidation. Precipitated

[12] D. Kirkbride's description of this site's setting (Kirkbride 1966) contradicts the situation at Bir aṭ-Ṭayiba, but can well be identified with the setting of 'Ain Ṭayiba.

[13] We thank Amiereh Belal, Technische Universitaet Braunschweig, who found the site and helped us during the surface collection.

[14] Among the animal bones recovered, a fairly large number are jaws from the Syrian hyrax (H.P. Uerpmann, personal communication).

lime cemented the fine gravels and limestones of lens F. The dark sandy material of D is less compact, indeed almost loose, with a higher content of charcoal. Artefacts and animal bones are considerably incrusted here too. Artefacts and sediments of D are cemented into the weathered surface of bedrock (E).

SII and SIII are section cleanings in the housing area of Ba'ja. SIII seems to be the filled and levelled inner part of a room (consolidated layers of fine grained sediment with charcoals). A wall of a later structure crosses these fillings. SII is a succession of four stony layers, containing red-stained plaster particles and fallen stones. It is most likely a section through the debris of a ruined house partly eroded by the steep slope. SII and SIII indicate a building layer of more than one metre depth.

Two soundings were cut into the slope sediments of Thugra 1. While the layers of SII in the middle part of the slope reached bedrock after 40 to 60 cm. and consisted of less consolidated sand and erosional sandstone debris, the stratigraphy of SI differs significantly. SI (3 square metres) touched the steep-sided edge of the al-Barra massif and reached a depth of 1.1m. to 1.8m. *In situ* Epipalaeolithic cultural layers expected underneath the hillwash were not encountered here. The section shows phases of higher sedimentation rates and less surface water. Underneath the debris and roots of the topsoil, alluvial depositions are interrupted by lens-shaped embeddings of the fine gravel, probably formed through eolian influence. Especially the lenses are consolidated by calcium carbonates. This succession remained the same throughout the sequence investigated.[11]

A section, establihed by a bulldozer cut through a late Aceramic Neolithic rubbish area, was cut back for 30 to 50 cm. in Basṭa 1 (Fig. 5). Except for the topsoil, Layer F (blackish, very loose fine grained sediment), and G (almost merely ashes) Layers and Lenses B-E and H consist of similar dusty and sandy sediments. These layers differ only in their degree of (partial) consolidation by carbonates, proportions of plaster, distribution and size of stones. The layers give the impression of a rather mixed accumulation of building debris, artefacts and kitchen refuse. A human skull was found in the lower part of Layer B.[15]

Late Epipalaeolithic industries

The only properly datable site of this period found in 1984 is the late Natufian site of Sunkh 1.

The deposits of Sounding I in Thugra 1[16] obviously were built up by eroded layers of an Epipalaeolithic site, but unfortunately did not contain any diagnostic implements. Only the cores from the sounding and surface show similarities with those from Sunkh 1. The surface find of a Helwan-lunate might be another indicator. A deposition of eroded Sunkh 1 layers in Thugra 1 can be excluded topographically. Wadi Sleisel is the third site of an unidentified Late Epipalaeolithic.

Among the geometric microliths of Sunkh, rectangles and lunates with normal abrupt retouch dominate the Helwan-segments and triangles. Lunates may be as small as 11.5 mm. Among the numerous non-geometric tools, all kinds of steep-retouched bladelets and flakelets appear, often with notches, rows of notches or denticulations. Micro-piercers on bladelets and flakelets seem to be common. The most frequent tools among the larger implements are also steep-retouched; some of these flakes and blades show reverse retouching. Notched pieces and blades with almost square sections resulting from steep retouches along both edges occur often. The second common class of tools

[15] The skull is from that of a roughly 8 years old boy with an anomalous denture. He was struck dead by two knocks resulting from different instruments. The body or rather the head decomposed before deposited into Layer B (O. Roehrer-Ertl, Zoologische Staatssammlung Muenchen, personal communication).

[16] M. Lindner, Nuernberg drew our attention to this site, which he named al-Barra.

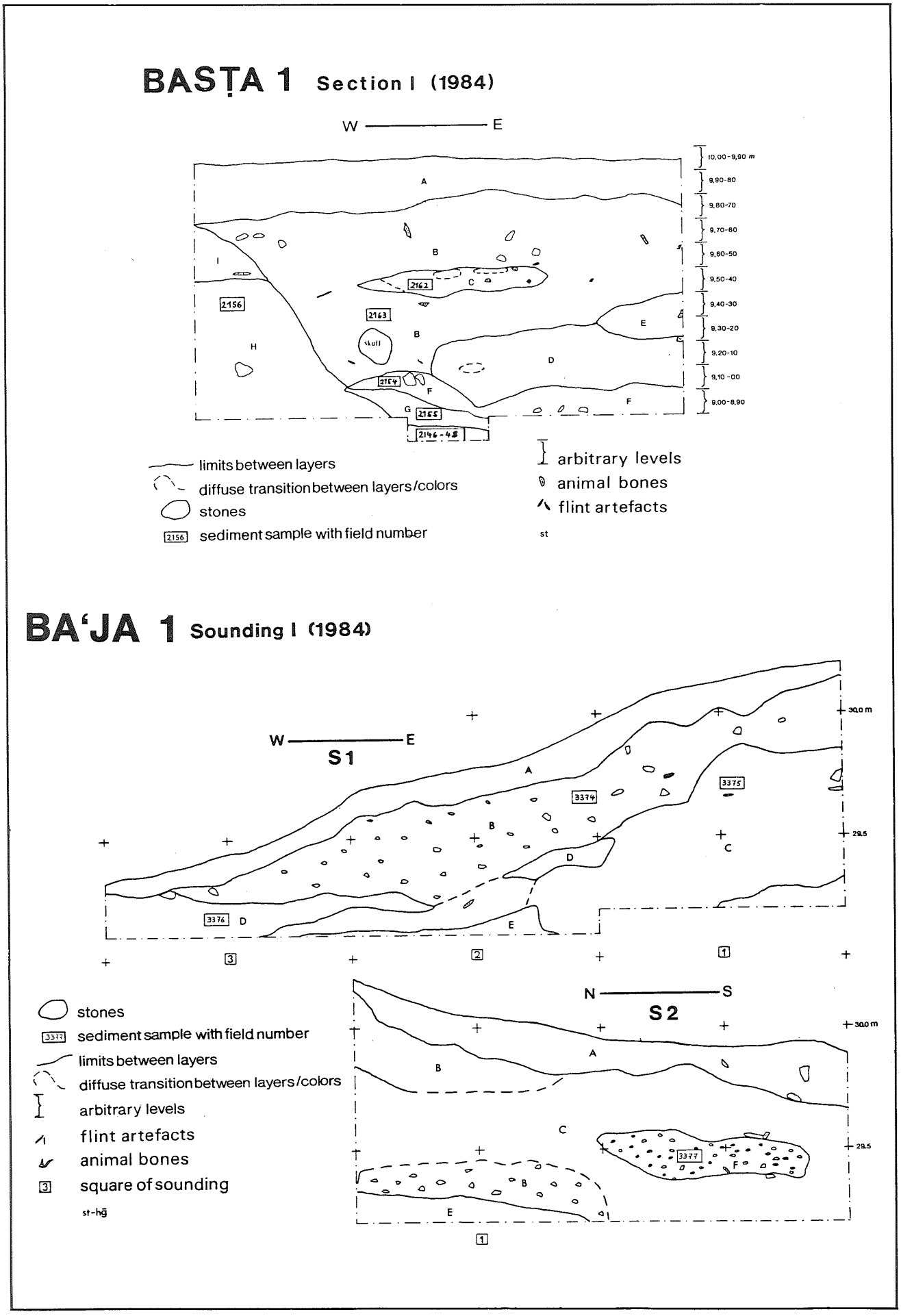

Fig. 5: (top) Basṭa 1: Section drawing of Section 1

Fig. 6: (bottom) Ba'ja 1: Section drawings of Sounding 1

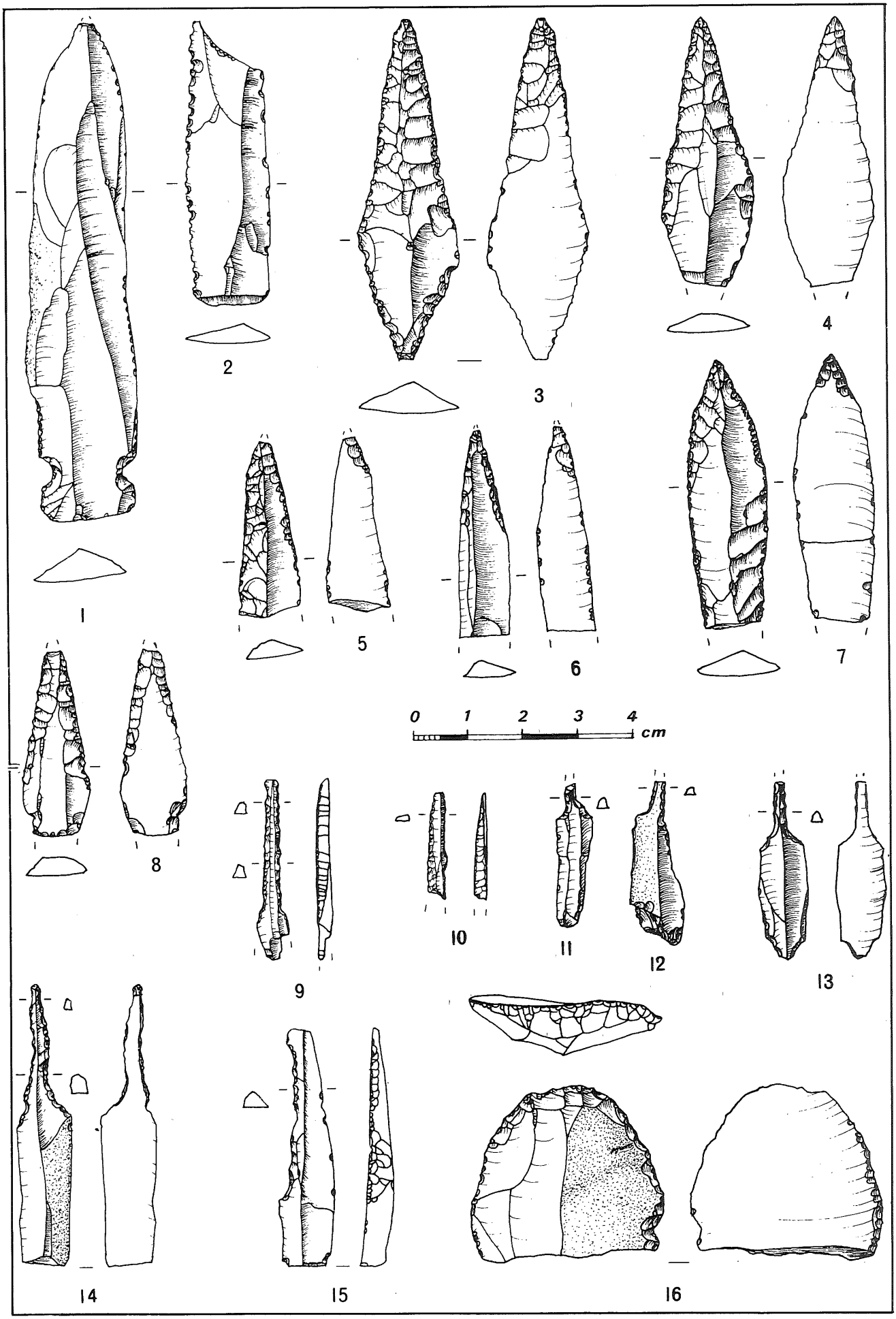

Fig. 7: Basța 1: 1 flint knife with notches; 2 denticulated blade; 3-8 fragments of arrowheads; 9-14 borers; 15 unfinished borer; 16 scraper

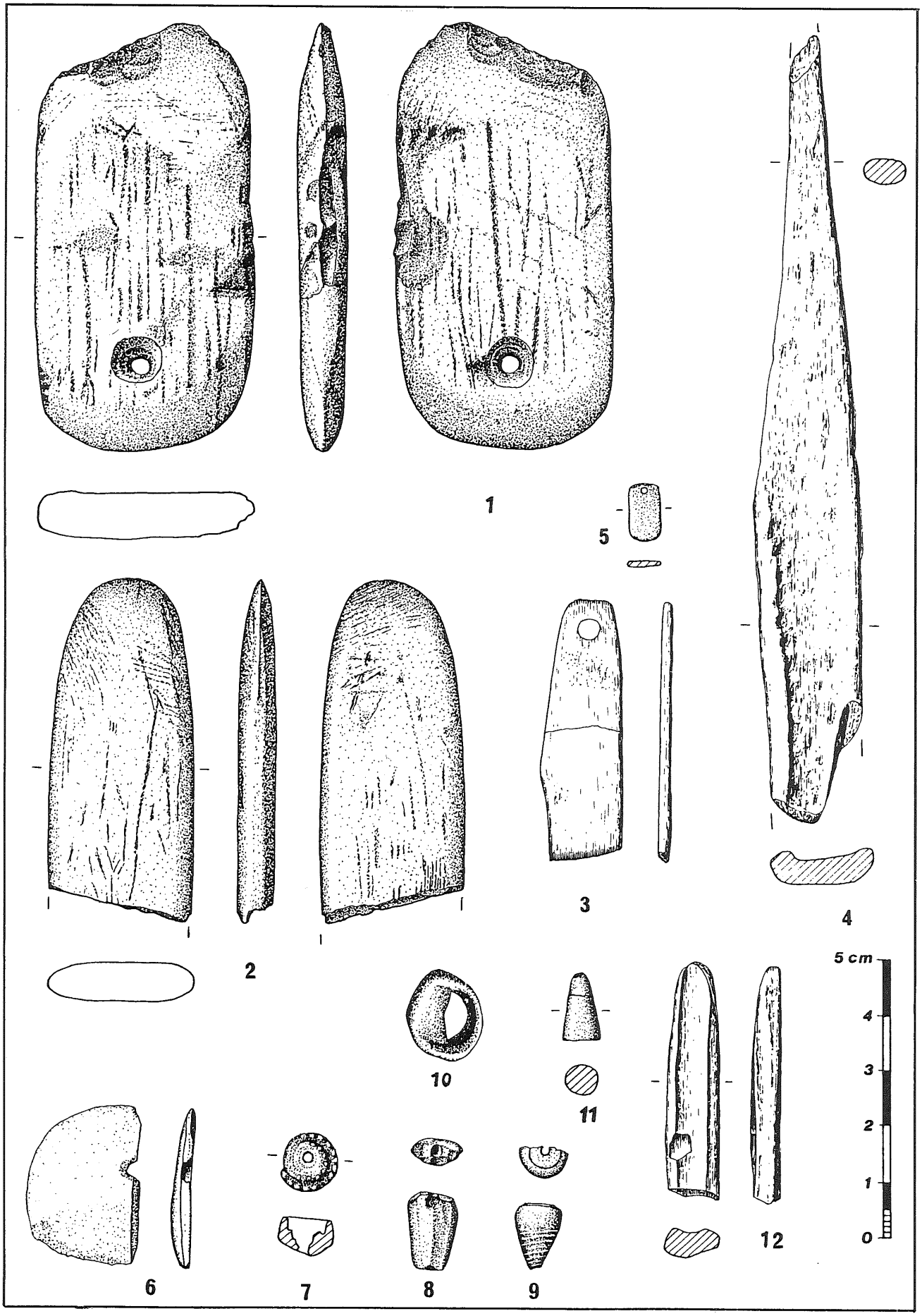

Fig. 8: Basta 1: 1-2 sandstone artefacts (wet stones, palettes); 3 bone pendant; 4 fragment of a pointed bone tool; 5 pendant of malachite; 6 mother-of-pearl ornament; 7 bead of marine mollusc; 8 unfinished bead of malachite; 9-10 fragments of marine mollusc beads; 11 object of unknown function; 12 polished bone implement.

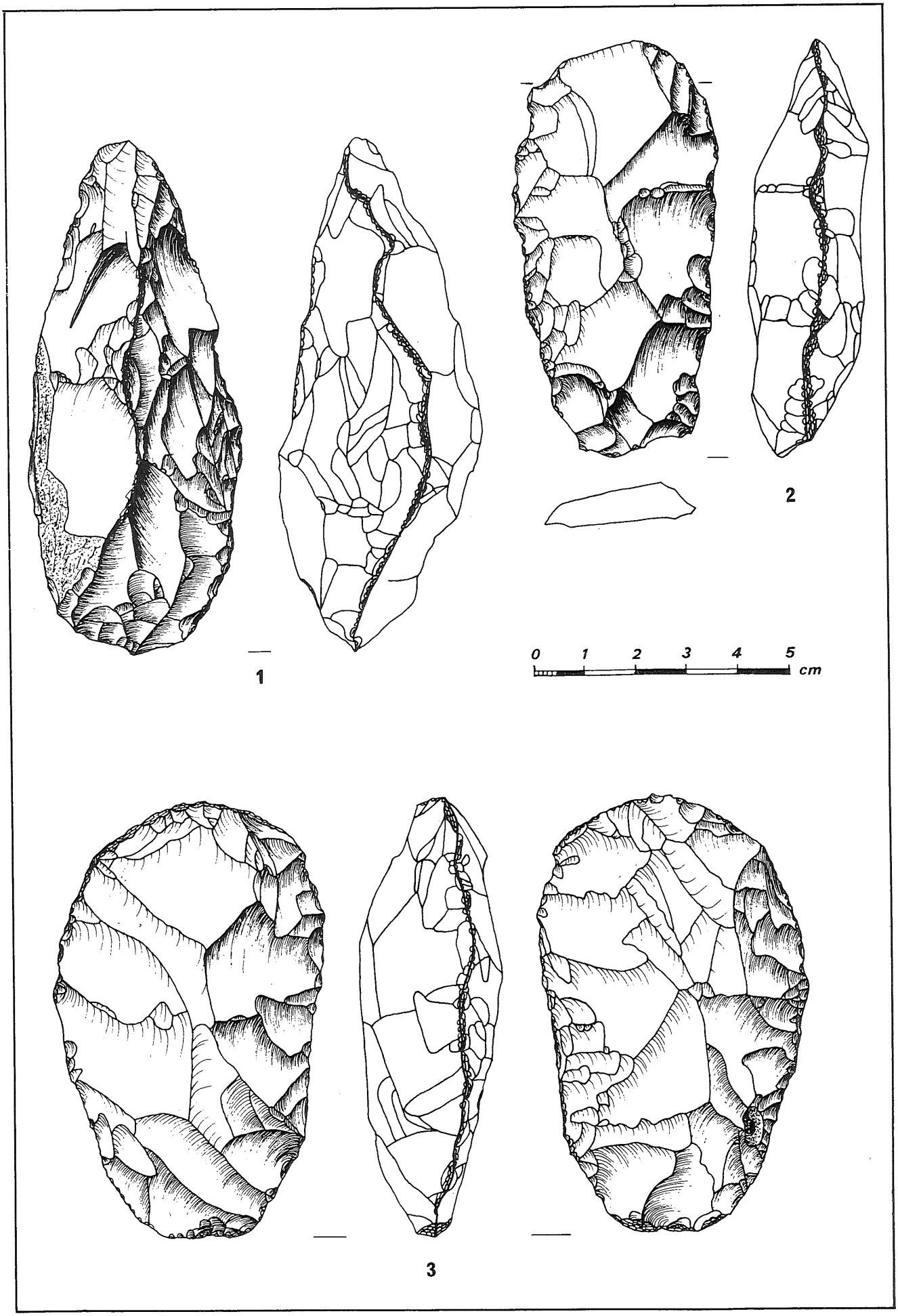

Fig. 9: Basța 1: 1 pick-like instrument; 2 celt
Ba'ja 1: 3 celt

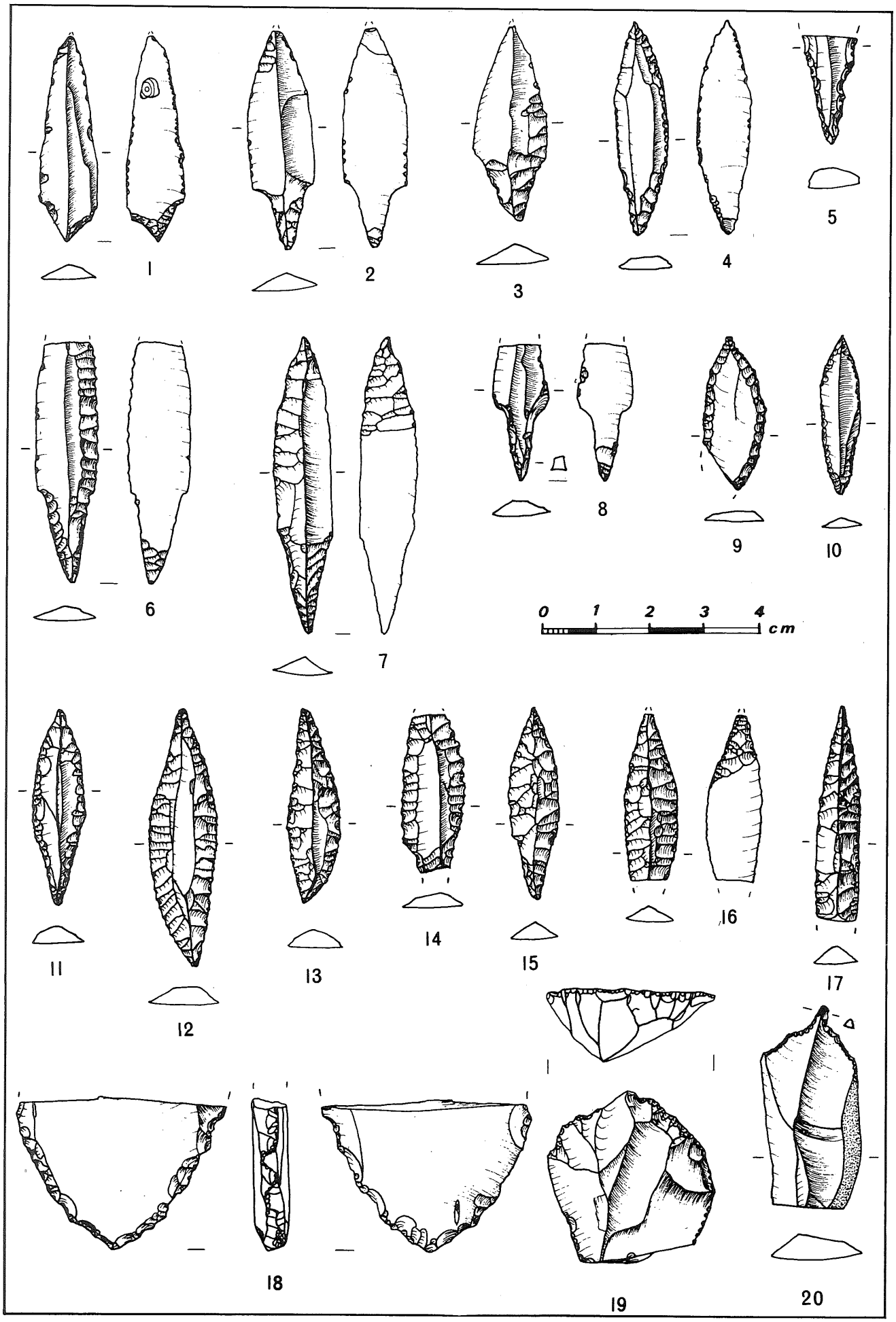

Fig. 10: Ba'ja 1: 1-17 fragments of arrowheads; 18 fragment of debris with S-like working edge; 19 fragment of a core tablet used as scraper; 20 borer

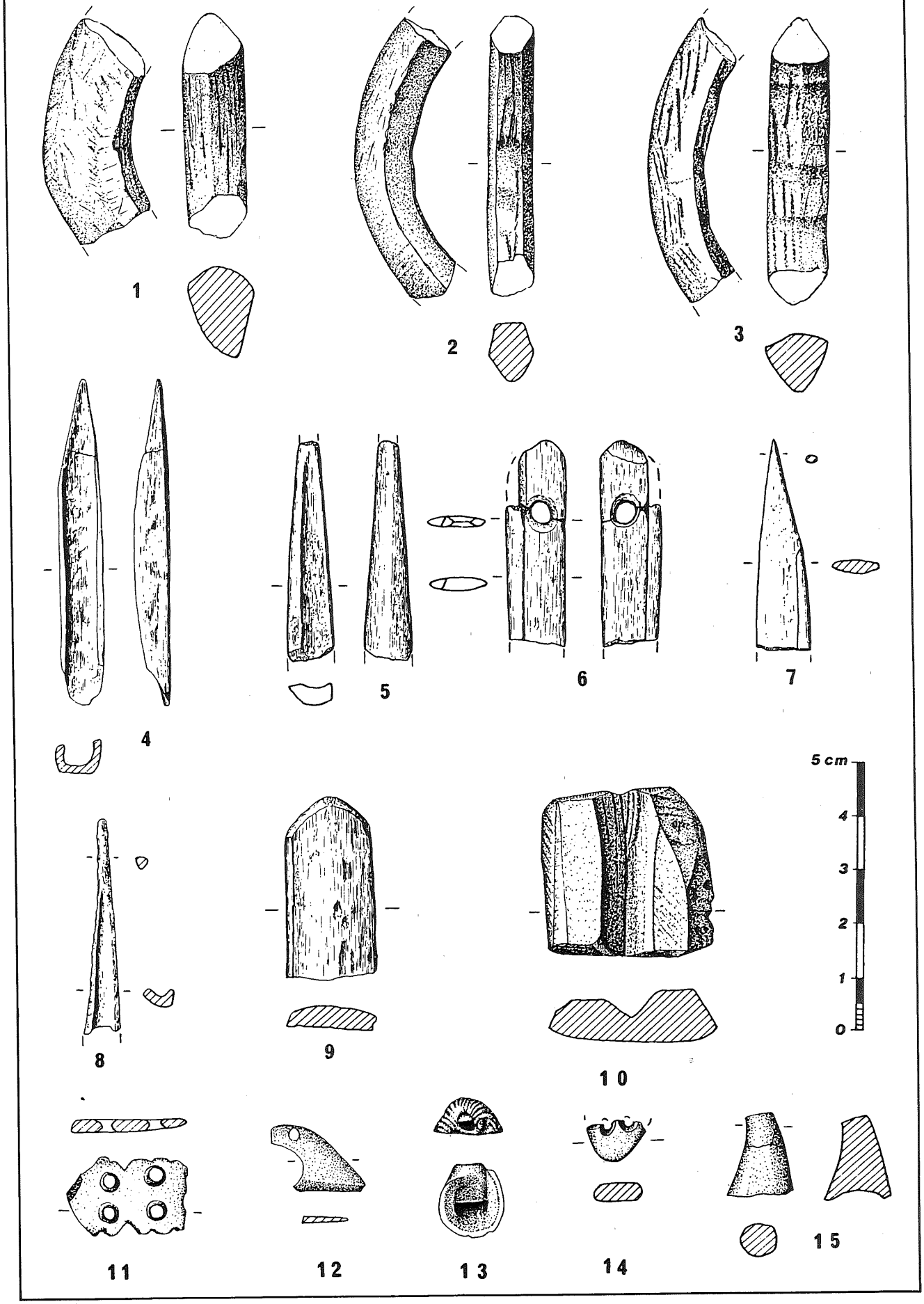

Fig. 11: Ba'ja 1: 1-3 fragments of sandstone rings; 4-9 fragments of various bone tools-ornaments; 10 "grooved stone"; 11-12 mother-of-pearl ornaments; 13 bead of a marine mollusc; 14 fragment of a terracotta figurine.

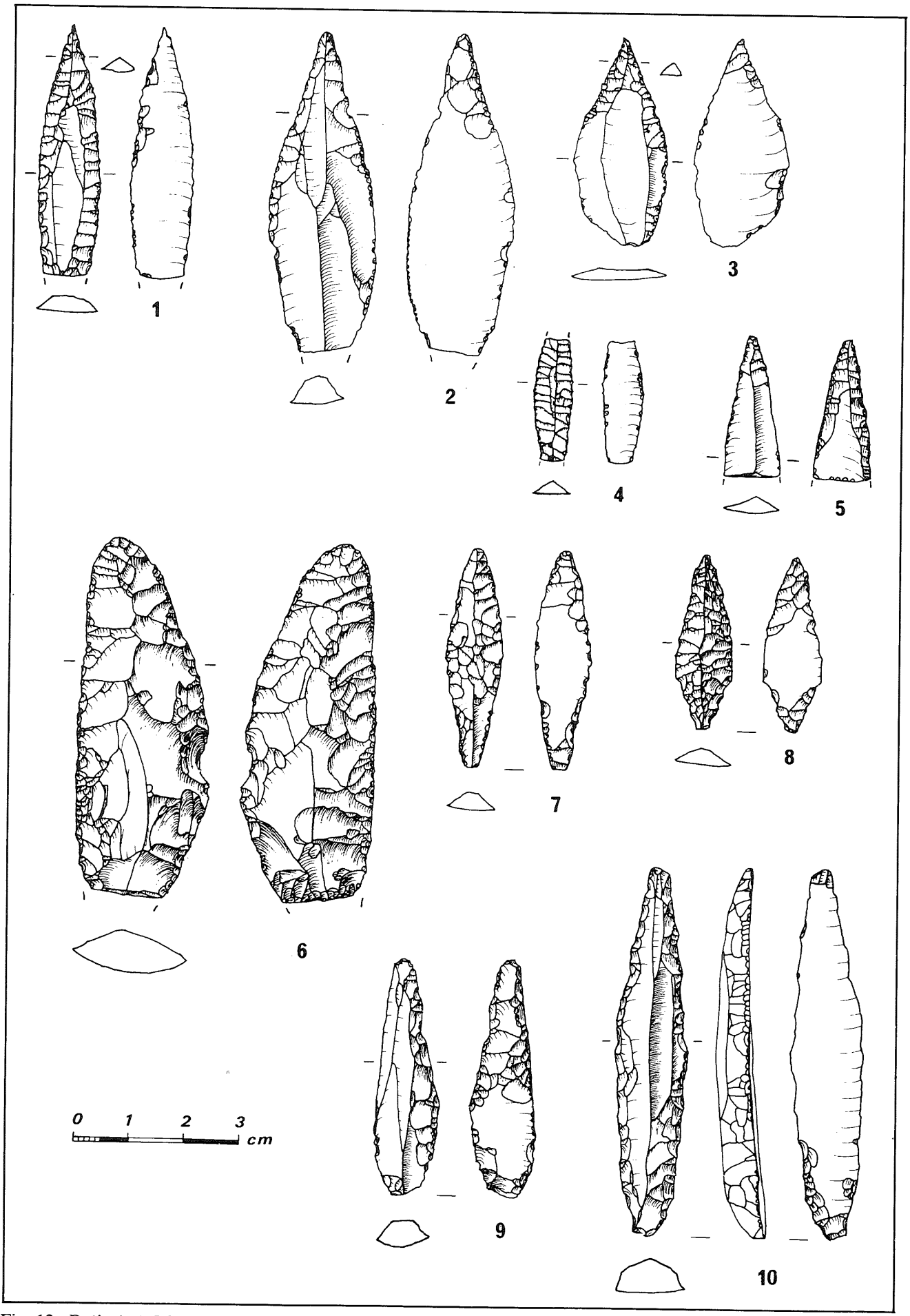

Fig. 12: Ba'ja 1: 1-5 fragments of arrowheads from surface collections Abu Barqa: 6 bifacially worked "knife", bearing desert varnish; 7-8 arrrowheads.
'Ain Tayiba: 9 arrowhead; 10 blade with steep retouches along edges.

are endscrapers made on cores, core fragments, flakes, and blades, which form a rather heterogeneous group. The working edges tend to be convex, although almost straight ones appear as well. Obviously many of the given-up bladelet/blade cores with angles under 80° between the striking platform and the core surface were reused as scrapers after shaping the former edge of core. Sometimes such pieces are difficult to separate from cores. End-of-blade scrapers made on thinner blades often show semi-steep retouches. Thick, broken blades and flakes with trapezoid and triangular sections and primary core tablets were prefered for most of the scrapers. Obverse edge retouches on endscrapers are well-represented. Fig. 13 shows a selection of the core types attested. In addition, several cores with opposed striking platforms were found, which also show the common tendency of cores towards acute angles between platform and core surface. The characteristic feature of hinges in the waste material is also well-attested with the cores.

The Thugra 1-industry (or possibly industries) from Sounding 1 and the non-systematic surface collection do not seem to differ from the Sunkh material. Only the heavy-duty tools typical for a late PPN, the irregular flake cores, and blades with striking angles around 90° from the surface suggest another occupation after the Epipalaeolithic. In contrast to the undamaged edges of artefacts from the sounding, the surface material bears modern retouch. Bullet-shaped bladelet cores and other micro-cores were found together with bipolar blade cores and blade cores with one platform. Again, most of them show the acute angle. The amorphous flake cores mentioned above do not occur in the sounding, as they do not on Sunkh as well. Thick blades and flakes for producing the endscrapers are well attested. Backed bladelets/ blades are rare from both the surface and the sounding and only one Helwan-lunate was found on the surface.

The surface collection from Wadi Sleisel provided only a limited number of artefacts. Bladelet core seem to be rare. Again, the acute angle between striking platform and blade core surface is apparent and the endscraper on thick blades is the most common tool. Only one lunate with normal abrupt retouch and several backed bladelets were found.

Up until now, three relative-chronologically easily datable Natufian sites are known (Baida, Sabra 1, Sunkh 1) from the Petra area. Thugra 1 and Wadi Sleisel may also belong to this Late Epipalaeolithic context. The status of chronological discussion (Fig. 14) recognizes the absence/ presence of bifacially retouched lunates (Helwan-segments) as the major feature to distinguish between an Early and a Late Natufian (Bar-Yosef 1981b, 1983; Henry 1981). A statistically-based comparative analysis of Natufian technologies has not yet been published and Natufian sites from Eastern Jordan are rare and inadequately published (see Gebel 1984, 1985). By using the dating features approved by current research, we know for the Petra area two (Baida, Sabra 1), possibly three (Thugra 1) Early Natufian sites. In contrast, only one secure Late Natufian-related site (Sunkh 1) can be mentioned. Sunkh 1 and the Natufian layers of Sabra 1 yield Helwan-lunates and lunates with bipolar/ abrupt retouch. Provided that we do not have a disturbed Late Natufian in Sabra too, we can expect both sites to range between the older and later Natufian.[17]

Late Aceramic Neolithic industries

The four late PPNB industries sampled in 1984 show some interesting features not attested with the slightly earlier industries of ad-Daman 1, Shaqarat Musei'ed and Baida.

The blade-industry of Baṣta 1 contains a high number of large thick blades with triangular sections. It seems, that they prefered greyish tabular flint, which can be found in all aceramic assemblages of the area and is the dominating raw material in the Abu Barqa collection. In general they

[17] Isolated lunates with normal abrupt retouch occur in Khiamian layers of Sabra as well.

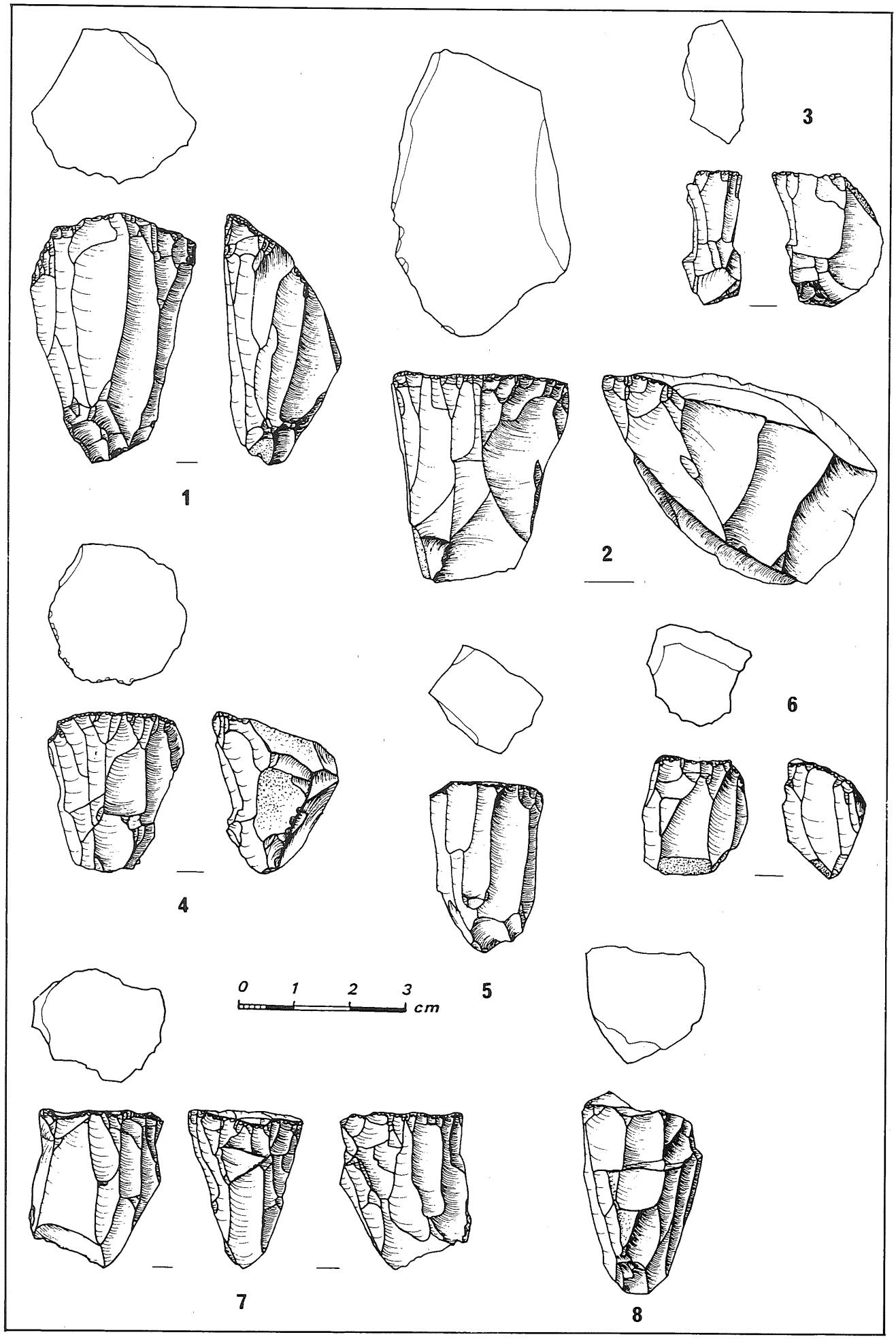

Fig. 13: Sunkh 1: 1-8 cores (surface finds)

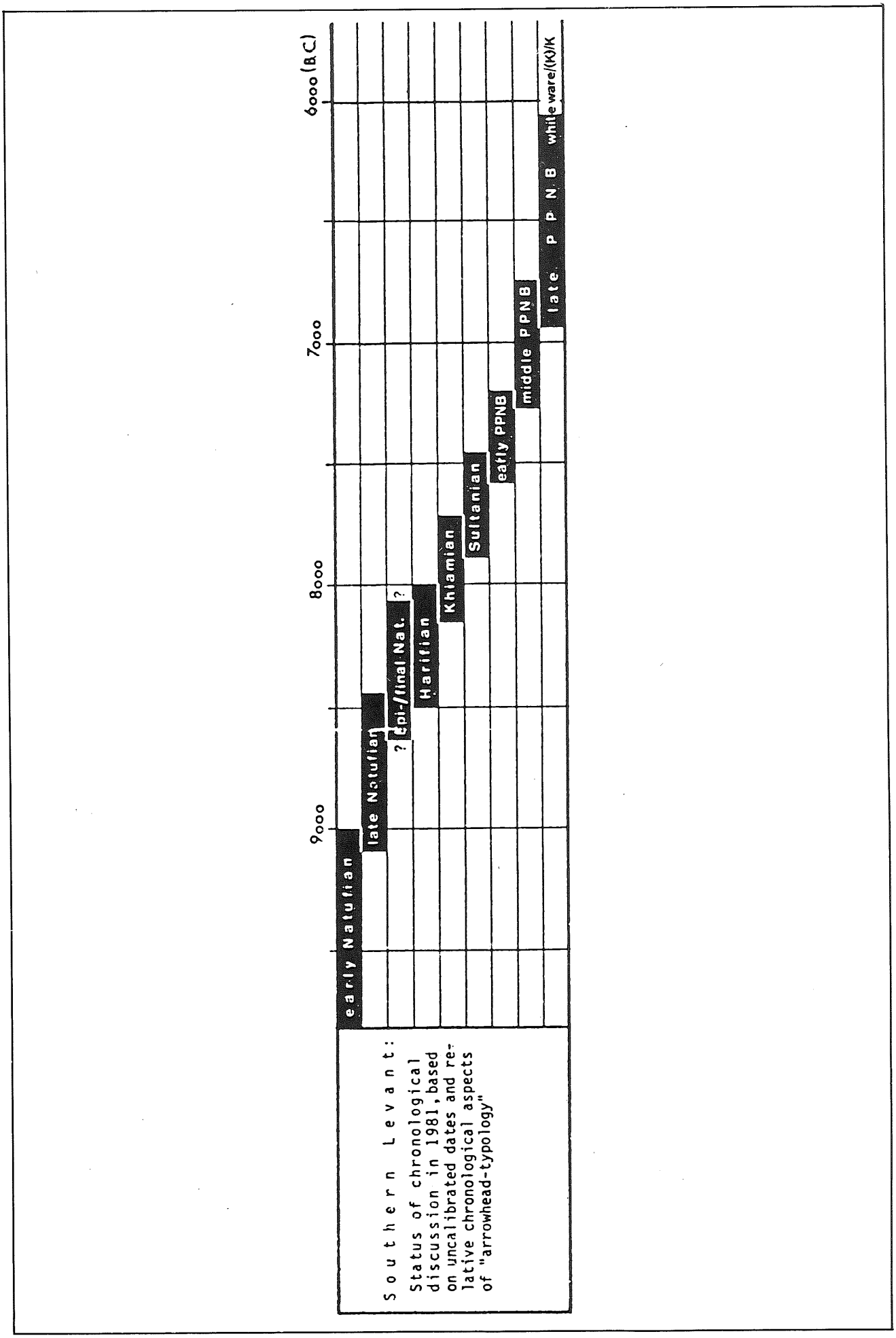

Fig. 14: Current status of chronological discussion (from: Gebel 1984)

were manufactured by a punch. Their sizes range between 7 and 12 cm. Both intentional and use retouches can be observed. The types of retouches, their position and the length of retouched parts of edges do not show a distinct pattern. This group of implements is also well represented in Baida (Mortensen 1970: type E2), where they provisionally are classified as "knifes". No cores of these blades were found, and large secondary crest blades are attested. Among the diagnostic tools, Byblos-like arrowheads (Fig. 7.3-4) and "bead drills" (Fig. 7.9-15; Mortensen 1970: type B7) are common. No Amuq-type arrowheads or arrowheads with overall bifacially pressure-flaking were observed. Denticulated blades are rare as is sickle gloss. Many heavy duty tools were found, among which picks and celts (Fig. 9.1-2) dominate. Quartzite was used quite often as raw material; the arrowhead of Fig. 7.3 is made of a reddish-pinkish quality of quartzite.

The most frequent tool found in Baṣṭa 1 are arrowheads, which can be classified into at least 8 types (Fig. 10; 12.1-5), among which Amuq-like arrowheads can be distinguished. Another striking type is that of Fig. 10.12-13, which has a tendency of non-symmetrical S-curved edges. Notched arrowheads are missing as they are in Basta 1. Only one piece was found in the lower parts of SI with a retouched base and retouches along the edges. It does not fit into the group Mortensen type A1. Also it is quite small and it would not be unexpected in a Khiamian context. Except for a foliate of a type like Rhotert 1938: 143.2 from the surface, no bifacially overall pressure-flaked implements were found. As with Basta, numerous celts (Fig. 9.3), picks, adzes, etc. were found on the surface. A striking number of cores reused as hammering stones is attested. All types of cores known from Baida are represented in Baṣṭa. Quite strange is the surface evidence of a few cores like Fig. 13.1. Again the use of quartzite is attested by many scattered on the surface.

The diagnostic pieces of Abu Barqa are illustrated in Fig. 12.6-8. The bifacially pressure-flaked knife Fig. 12.6 is the only desert varnish bearing piece encountered in the Petra area. The type of desert varnish is different from that on some of the large blades accompanying this find. It is presumed that this piece was brought here from desert surroundings, e.g., the arid flanks of the Arabian Plateau. From here similar material is known (Kilwa 19/ Jabal Tubaiq, Rhotert 1938).[18] The thousands of blades scattered on the surface show different patination. Not all are retouched. The first impression of the site is that it is a blade manufacturing site. All size classes are represented, although that of 7-13 cm. dominates. The number of cores is small compared with the amount of blades. Cores with dimensions like the large thick blades with triangular sections are missing. Similar to Basta, the tabular greyish flint is the prefered raw material and the retouched material shows different types of retouches, position of working edges, etc...

Also the few artefacts from the surface site of 'Ain Ṭayiba have a rather high proportion of large blades. The steep retouched blade Fig. 12.10 might be a projectile point. Except for the arrowhead Fig. 12.9 only a scraper and a few retouched blades were encountered.

New evidence (Kafafi 1982, Rollefson 1984, Rollefson et. al. 1984, Rollefson/ Kafafi 1984, Taute 1981), well-dated arrowheads types from other Levantine sites, and the arrowhead sequence of Baida (Mortensen 1970) support a potential date of terminal PPNB for the industries described above. Even an early 6th millennium for 'Ain Tayiba and Abu Barqa cannot be excluded. For the time being, it appears less important to collect more assemblages from permanent PPNB sites than to describe their primary production technologically and statistically. The industries of non-permanent sites of the latest PPNB should be found and compared with the results from the village inventories.

[18] The author's work on surface sites in Abu Dhabi and Oman (H.G.G.) revealed the same type of implements with desert varnish.

This approach would help to identify the Post-PPNB occupations in the area.

Small Finds

Assemblages of ornaments, ground and polished stone utensils and bone implements were found in comparatively large quantities in the Late PPNB rubbish layers of Ba'ja 1 and Basta 1.

An outstanding group of artefacts are the sandstone rings of Ba'ja (Fig. 11.1-3). Carved out of locally available tabular sandstone,[19] their interior diameter ranges from 40 to 72 mm., their exterior diameter from 50 to 90 mm. The cross-sections also vary considerably in shape, not only from specimen to specimen, but also from fragment to fragment. In many cases a tendency towards an obtuse angle for the inside and a rounded shape for the exterior face was observed. One limestone specimen was grooved around its outer face. These roughly round rings show technologically interesting features and allow the reconstruction of their production technique[20]. The high concentration of fragmented pieces in the sounding indicates common use and mass-production. These ornaments are usually considered to be bracelets, worn on the wrists and ankles, but other functions, e.g., their use as pendants worn beneath the throat[21] cannot be excluded. Evidence from 'Ain Ghazal suggests that this type of artefact belongs to the very late PPNB and Early Pottery Neolithic[22].

Similar to Basta, the Ba'ja small finds are within the range of PPNB small find inventories already known. The rich bone industry of Ba'ja (Fig. 11.4-8) comprises many types of pointed implements and pendants. The use of carved and perforated mother-of-pearl objects must have been quite common (Fig. 11.11-12), and were presumedly sew-on ornaments or toggle loops. The clay object (Fig. 11.15) may represent a figurine fragment (animal horn?). No stone vessels were found in the sounding, section cleanings or on the surface of Ba'ja. The ground stone industry also seems to have been limited to one certain type of grinding slab and mano-pestles are rare and no mortars of the Baida/Shaqarat Musei'ed-type occur.

Except for the two sandstone palettes, all objects illustrated in Fig. 8 were derived from the section investigation of Basta 1. Not illustrated but noteworthy of mention is a fragment of a small bone hook. Again several marine molluscs ornaments prove the existence of an exchange network with the Red and Mediterranean Sea. A token-like object of unidentified material (Fig. 8.11) remained the only one of its kind so far found on the sites we investigated. Among the "surface finds" in front of the bulldozed section, a large number of heavy duty ground stone tools were found. Like the Ba'ja grinding slabs, those from Basta are oval to lens-shaped, often with butt ends. The working platform is slightly curved longitudinally and the bottom is rounded or has an obtuse angle in its transversal section. The manos tend to be ashlar-shaped. Mortars do not occur and pestles are rare. Digging stick weight-like stone rings with biconical central perforations (compare Lechevallier 1978: Fig. 105.12) are well-represented. A limestone vessel with a diameter of c. 35 cm. was found along with a limestone plate (com-

[19] The fine-grained raw material containing iron-oxide must derive from the Lower or Upper Cambrium (Mohammad Abu Safat, Universitaet Erlangen, personal communication).

[20] J. M. Starck, in preparation.

[21] G.O. Rollefson, personal communication. Drilled pieces may also attest their re-use as evidence from Jarmo suggests (Moholy-Nagy 1983: 296). Apart from 'Ain Ghazal (Rollefson et. al. 1984: Fig. 6; Rollefson 1984: Fig. 3) this unique type of ornament is known from PNA-contexts of Jericho (Kenyon and Holland 1982: 557, 559, Fig. 226).

[22] In 'Ain Ghazal, these rings are mostly made of limestone and appear in the late PPNB, the final PPN and the Yarmoukian layers. It is the impression of the excavator that they are concentrated in the final PPN layers, which significantly differs from the preceeding PPNB in terms of lithic technology and typology, domestic animals, burial practices, etc. (G. O. Rollefson, personal communication). The fact that these artefacts apparently do not appear in Baida, Beisamoun, Abu Gosh and other PPNB sites may indicate that they are an Early Pottery Neolithic-related element.

pare Lechevallier 1978: Fig. 32.12, 19; 104.13).

Preliminary Conclusions and Summary

While the spring campaign completed work on the collection and recording of the recent vegetation cover, the autumn season concentrated on enlarging our palaeoenvironmental sampling basis. Relevant samples were taken from soundings in Ba'ja 1 and Basta 1. In addition, samples from the main flint/chert resources were collected in order to classify resource areas and exploitation with the lithic findings.

Four eco-geographic units are distinguished and characterized by their plant communities. Basic information is given on the xero-mediterranean forests, Artemisia steppes, vegetation of rocky sandstone areas, vegetation of playa surfaces and desert wadis, and hydrophytic vegetation. The sites investigated in 1984 are described by their physiographic setting, outward appearance, sampling and sounding methods, section investigations, and findings - three Epipalaeolithic sites (Sunkh 1: Late Natufian; Thugra 1 and Wadi Sleisel: unidentified Natufian) and four terminal PPNB sites (Basṭa 1, Ba'ja 1, Abu Barqa, 'Ain Ṭayiba).

As the analysis on the palaeoenvironmental samples is not yet completed only general conclusions can be drawn for the 10th to 7th millennium occupations investigated in 1983 and 1984. After the excavations of Baida were finished, several new Late Epipalaeolithic and Late PPNB sites were located. While both periods are rather well-attested in the Petra region, only Sabra 1, strikingly enough for a period of more humid conditions, is known for the Early Aceramic. Sultanian and Early PPNB sites were not encountered up to now. Possibly the occupational history of the area is reflected in the Baida stratigraphy: after the Early Natufian of the 10th millennium (Fig. 14) a dune developed on which the Middle/Late PPNB settlement of the 7th millennium rests.

For the Natufian, the Petra area still lacks a true Late Natufian site. The three secure sites are Early Natufian or Early Natufian-related. (Sunkh 1, Sabra 1, Baida). This would coincide with rather secure evidence for a moist 10th millennium and the onset of a drier phase from 9000 for the Southern Levant (Bintcliff 1982). None of the Natufian sites seem to have stone architecture.

The climate in the earliest Holocene (from 8300 onwards) again turned wetter and possibly was even moister than today. Up until now this has not reflected in the settlement history of the Petra vicinity. The Khiamian Sabra 1 seems to be a camp site without solid installations.

The most extensive occupation in terms of pressure on biotic resources is evidenced for the period of increasing arid conditions during the second half of the 7th millennium (Fig. 14). Large Middle and Late PPNB villages appear then disappear with the end of the 7th millennium. Shaqarat Musei'ed, ad-Daman and Baida may well flourish at the same time. The results from the surveys also give evidence for the "Hiatus Palestinienne" in the Petra area. Further research should concentrate on this period, which was possibly already met in 'Ain Ṭayiba and Abu Barqa.

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