The Hammer on the Rock

Studies in the Early Palaeolithic of Azraq, Jordan

Part ii

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CONTENTS

Part ii

THE SHESHAN SPRING GROUP

THE NORTHERN AND EASTERN SITES

STONE AGE EXPLORATION IN JORDAN. THE AZRAQ AREA, WITH SPECIAL REFERENCE TO C-SPRING

F. E. Zeuner,
with the co-operation of R. R. Pannell

EDITORS' NOTE

We join with D. Kirkbride in acknowledging with gratitude the permission given by Professor Zeuner's son, Dr. W. Zeuner, to publish this contribution. It is the one referred to by D. Kirkbride in the introduction to her contribution, above and consists of a series of notes or 'slips' such as one uses for a lecture (the actual diary in which all details were recorded was not available). These notes have been arranged into a coherent report by D. Kirkbride. They must have been written by Professor Zeuner around 1959 and were to have been included in the second part of a publication on Jordanian sites (Zeuner et al., 1957). Although some of his remarks have been overtaken by subsequent events and discoveries which he could not have forseen in I958, and should be read in this light, in fact his interpretation of the Acheulean site has been confirmed by more recent work there and his account gives us a unique view of the original features of C-Spring at Azraq while the work of excavation was in progress. We have therefore omitted only certain comments on matters now out of date, including references to works planned but never published and to appendices which are missing.

Since Part I of this contribution to Western Asiatic prehistory was prepared (Zeuner *et al.*, 1957), the Azraq area, already mentioned, has become particularly important. This is due to finds made mainly by Mr. R. R. Pannell of the Baker and Harza company, Amman, whose enthusiasm and active help are herewith gratefully acknowledged. A paper being prepared by Diana Kirkbride will announce the discovery of Acheulian sites of great interest, one of which was studied by her.

The second has been studied by the writer, and its chronological importance is set forth in the present paper. There are other Lower and Upper Palaeolithic sites, a microlithic site found by Barry C. Park, and a site of pictographs found by R. R. Pannell in Wadi er-Ratam.
Since the chronological sequence of the Azraq area is fairly clear and can be correlated with that of the Jafr oasis, the sequence of Jordanian industries is acquiring a solid backbone. (Sentence omitted)

The support of the Central Research Fund of London University and of the Academy of Sciences and Arts of Mayence is gratefully acknowledged.

OLDEST PALAEOLITHIC

The area west of Azraq consists of pebble desert on Cretaceous limestone. As in the Jafr area, the patination of the fragments of flint which cover the surface solidly, is very heavy, and blackish brown.

Beneath the surface a yellow sand or silt occurs comparable with that of Wadi el-Harith (Zeuner *et al.*, I957, p. 24) and with that composing the pebble desert terrace at Jafr (ibid, p. 19). It is the disintegration product of the limestone under the influence of a very arid climate.

But unlike the older two localities, it is here found covering the hills and hill-sides and thus is in a primary position. At Point 110 north of the Wadi er-Ratam track to Azraq, a search was made for implements.

Apart from a few coarse late and unpatinated material constituting a flaking site on top of the hill, the gravel proved to include the same Abbevillian type of abraded and heavily-patinated implements as at Jafr. (Sentence omitted)

At Azraq, the hilly gravel desert grades imperceptibly into a terrace, possibly subdivided into three terraces, covered with the same brown flint pavement, on which the Police Post stands. It appears that this terrace can be correlated with the corresponding desert gravel terrace at Jafr. Its height at Azraq is 528m. O.D.

The formation of the desert gravel was followed by a phase of deep erosion. A river system was eroded to a considerable depth below the present surface level. In Qa Mukheizin, a boring made by Mr. Pannel penetrated 90 metres of qa silts and other pan deposits. In Wadi Sirhan, 35km. south of Azraq, he found no less than 180 metres of silts limestones and gravel. (Sentence omitted). Only the uppermost levels of these deposits are available for study. One is in Wadi el-Harith (Zeuner *et al.*, 1957, site 81). Others are in Azraq itself and described in the following paragraphs.

ACHEULIAN

Acheulian sites are concentrated around the springs of Azraq. A new one, which may be mentioned in passing, is 'Ain el Beida, about 6 km. east of Azraq Druze village where a stray find of a single biface was made. Two other springs are of great chronological importance: Site II, Canal F, C-Spring, and Site I, Lion Spring. Apart from collections made on the spot, soil samples were taken and analysed in the Geochronological Laboratory of London University and a selection of the fossils collected by Miss Kirkbride and Mr. Lankester Harding were placed at my disposal, so that a fairly clear picture of the local conditions can now be put forward.

C-Spring

This lies about two kilometers south of the southern Shishan lake (which is artificial). It was mentioned by Kirkbride (1958) as Site II, Canal F, Spring C. A canal has been constructed leading to a reservoir to the east of Lion Spring. It is planned to continue it to Jebel Uweinid which has a cover of lava and yielded a microlithic post-Pleistocene industry.

At C-Spring, a square pit was dug which yielded plenty of water. The level of the industry is thus now submerged. The surface is an ancient qa surface, i.e. a temporary lake bed, but no longer flooded. Its height is about 505m. O.D. About 75 cm. of lake silts are present and weathered. The soil formed is difficult to identify owing to recent disturbance of the surface but related to the grey rendzina or the serosyem type, though it shows salt exudations and therefore may be classed as a ?solonetz soil. Owing to the proximity of the water-table, a pronounced Ca-horizon has formed at the depth of 75 cm. In places this crust is very solid and it has been mistaken for a limestone of the Cretaceous Belqa series, which, however, it is not. It is about 20 - 30 cm. thick and identical with the type called Kunkar in India where I have seen it attaining a thickness of up to ten metres in the neighbourthood of dug wells with a fluctuating water level. Below the carbonate crust follows a gritty, silty gravel which is peculiar in several respects. It is green and gritty, the grit consisting of angular fragments of flint, and it contains numerous larger pieces of flint nodules, all of which are sub-angular and provided with the deep brown patina characteristic of the millions of such pieces found on the surface of the desert nearby. Their derivation from higher desert terraces is thus evident. The patination must have taken place there, at a time before deposition at C-Spring.

In the Jafr depression, some 109 km. south of Azraq, this desert gravel forms a definite phase in the formation of the countryside and it is of a somewhat remote date. Abbevillian tools are incorporated in it, and Clactonian tools which are made from it bear the patination to a lesser degree (Zeuner *et al.*,1957, p. 27, site 72).

The Acheulian industry incorporated in the green gravel at Azraq is entirely fresh and the edges of the tools are so sharp that they cannot have been transported. The prehistoric site, therefore, must be *in situ.* This is borne out not only by the presence of many waste flakes, but by the situation of the site near an outcrop of Cretaceous limestone and chert cut by the canal about 400 metres north of C-Spring, where the chert nodules are of extraordinary size. near Spring B (Site II, Canal E, Spring B), only 30 metres north-west, tabular flint occurs, and this appears to have been the chief raw material from which the industry was made. The green gravel appears to lie in a filled and buried wadi bed. It carries plenty of good water, now sealed by the carbonate formation. In Acheulian times, therefore, the site represented a small cliff of Belqa limestone on the edge of the wadi.

The sealing of the gravel by silt and lime-crust explains its green colouration, the iron oxides being in a reduced condition. That this reduction has not affected the cortex of the larger brown flints, goes to show that it is a secondary phenomenon.

In addition to the flint implements, the gravel at C-Spring contained many animal bones which were collected by Mr. Pannell and Mr. Harding. They are in a very fragmentary state. This is due in part to breaking by man, to disintegration *in situ* through penetration with calcite, and to the effects of mechanical digging and finally exposure to extreme heat. Fortunately, large numbers of teeth have survived which could be reliably identified. The fauna is poor in species but very rich in individuals: Dromedary 44%; Large bovine 30%; Onager 29%; Rhinoceros 8%; Large Antelope 2%; Spec. indet. 1%. This information was furnished by Dr. J. Jewell (Clutton-Brock, l970).

From the approximate percentages here given it can be seen that the countryside near the wadi abounded in dromedaries and large bovines, as well as onagers. The dromedaries and onagers suggest an open environment, probably steppe composed of low shrubs and of grasses and sedges, whilst the bovines indicate proximity of water.

This fauna not only proves conclusively the Pleistocene age of the deposit, it is important also as being the first fauna of its kind reported from Arabia. Climatically it suggests open country of the savannah type with ample vegation, and with permanent water, either flowing or as water-holes. Whether this environment would have required more precipitation is not evident from the fauna. On the other hand moister conditions are suggested by the composition of the gravel.

The Acheulian industry is essentially a latish Acheulian, with many specimens carefully worked around the entire butt end. There are also a small number of Yabrudian flake tools present. Several specimens show opal glazing indicative of strongly alkaline conditions.

Following the formation of the green wadi gravel containing the Acheulian industry, a mud flat (qa) covered the deposits attaining a level some metres higher than the present one. From it a Levalloisian core with white patination was recovered, Its striking-platform is not typical of the Levalloisian culture, and it may therefore be considerably younger. Search for an industry in these beds would be worthwhile.

Subsequently, the general erosional level was lowered, and a wadi formed nearby which is still in a condition in which it can function, though this cannot happen often as the floor is covered with small sand dunes. Its base level is the present Azraq qa at c. 502m. O.D.

The sequence of events to be derived from C-Spring is therefore as follows:

i) Formation of desert gravel, several phases including the level of the Police Post (c. 528m.). Can possibly be correlated to the desert gravel of Jafr. Dry climate. Abbevillian and perhaps Clactonian.

ii) Wadi formation down to a low base level. Humid phase

iii) Filling of wadi with green gravel. Acheulian. Drier than before but possibly moister than today.

iv) Qa formation. Mud flats drowning older valleys. Dry phase.

v) New erosional period, base level in Wadi Sirhan lowered once more. Humid phase?

vi) General drying up to present conditions.

Lion Spring

This is one of the old spring groups of Azraq and lies less than four kilometres S.W. of C-Spring. The lower spring was natural but has been dug in connection with recent development operations. There is evidence for later occupation; Miss Kirkbride found a lunate on the surface on her previous visit and another on the occasion of my visit with her and Mr. Pannell. Lion Spring deserves a special investigation from the point of view of whether a Natufian-like industry is to be found here. The present paper, however, is concerned with the stratigraphy of the Acheulian. The most striking difference between C-Spring and Lion Spring is the absence of the Ca-horizon at the latter. This is most probably due to the natural and permanent character of this spring.

BIBLIOGRAPHY: See D. Kirkbride, this volume .

SURFACE FINDS FROM 'SITE C' AND OTHER SHESHAN SPRING SITES

Lorraine Copeland.

This report will briefly describe the artifacts recovered from Paleolithic sites in the Sheshan Oasis at Azraq which were found between 1956 and 1958 as a result of the construction of drainage canals by the engineering firm of Baker and Harza; the aim of their work was to measure the output of the Sheshan springs (Baker and Harza, 1958). Smaller springs and seeps were noted c.1 km south of the main springs, near the Main Canal, to which they were joined by the excavation of side canals (Fig. I). Paleolithic artifacts were thrown up in the sediments excavated from certain of these small springs, as described by D. Kirkbride (*infra*); one, Site C or C-Spring, was studied by F. Zeuner (*infra*). At the latter spring, a second Paleolithic site was discovered, 30m. to the south, by A. Garrard in l985. In order to distinguish between them we will refer to the one found by Baker and Harza in l956 and studied by Zeuner as 'C-Spring-BH', and the one found by A. Garrard as 'C-Spring-AG'; the latter is described in this volume by Hunt and Garrard.

Kirkbride has described her visit to another site, E (not yet certainly re-identified); this will be discussed below. A third site situated on a canal south of Canal F, which was visited by us in l984, is also described; it has been dubbed 'Crab Spring'.

The collections from the three spring sites now number over 160 artifacts, most of which have been divided between the Institute of Archaeology at Yarmouk University and the British Museum. The collections must be regarded as biassed in favour of distinct and 'good' pieces; it is not known how many other items have been picked up as souvenirs by tourists. Hence the artifacts can only be described and classified subjectively into the conventional typological groups.

C-SPRING-BH (SITE II, SPRING 'C', CANAL F); C. 115 ARTIFACTS

History of research.

The site is located as shown on Fig. 1 and is one of three springs on side Canal F; a square hole was excavated (Note 1) which now forms a small pool clogged with reeds (Fig. 8). Although all the artifacts are unstratified, many can be referred to the same Late Acheulean of Azraq Facies found in C-Spring-AG and Lion Spring. The rest are of considerable interest on two counts: firstly because of the possibility that some of them represent a Yabrudian industry, and secondly because some of them are Levantine Mousterian types, such as do not occur at nearby C-Spring-AG. A Yabrudian ambience was noticed by R.S. Solecki who passed through Azraq en route from Iraq. To him, some of the surface artifacts seen on the Baker Harza debris piles beside their side canals resembled that of Yabrud I, levels 25 - 11 (R. Solecki, personal communication, 1969).

Besides the artifacts recovered by Kirkbride in l956 and 1958, various other surface collections have been made over the years. Some pieces marked 'Spring C' are in the National Museum, Amman, presumably collected by G.L. Harding at the same time that he recovered the faunal remains which were later published (Clutton-Brock, l970 and this volume) Some black-patinated bifaces were found by A. Garrard in 1974 (Garrard & Stanley Price, 1975-77) and 1984. In 1982 our C.N.R.S. team visited the spring with Andrew Garrard and collected flakes and cores. Other collections were made in l984 since it had become clear that the Acheulean reported by Zeuner was not the only industry present; we hoped to discover if the Yabrudian did indeed occur at C-Spring. After we had left, C-Spring was destroyed by the excavation of a large fishpond, which effectively incorporated two other springs as well: Springs A and B, situated on the adjacent Canal E (cf. Kirkbride's account), as shown in Fig. 1.

However, in 1985 Andrew Garrard put down a sounding (C-Spring-AG) 30m from the original spring head near the eastern end of the fishpond. The *in situ* Acheulean knapping-floor he found at a depth of 3m. is described in this volume (Copeland, *infra* d; Hunt and Garrard, *infra*).

In 1986 our last visit to the springs produced a selection of Middle Paleolithic artifacts from the fishpond debris piles nearest to the erstwhile spring vent (Copeland & Hours, 1988). In addition, a group of bifaces was found on the debris piles at the eastern end of the fishpond, e.g. close to Garrard's sounding; it was observed that their attributes were similar to those of levels T - R of the latter sounding, rather than to the material of C-Spring-BH; the differences between the two groups will be discussed below.

Stratigraphic context.

As described by Kirkbride and Zeuner in this volume, the finds at C-Spring-BH were derived from layers seen in section of the eye of the spring during the engineering works (cf. Note 1). Zeuner has stated that the Acheulean, as well as the fauna (which included extinct animals such as *Dicerorhinos hemitoechus* and *Equus hydruntinus*) came from the lowest visible layer of greenish, rolled gravel. Later layers consisted of 'mud-flat/qa' sediments and a Ca horizon or lime crust; these layers were not mentioned by Zeuner as containing artifacts. In the opinion of Garrard and Hunt, some correspondence can be assumed between the layers at the two locii at C-Spring; Zeuner's rolled greenish gravel with Acheulean should equate with their levels T - R, his calcareous horizon with their layer M. The fauna of C-Spring-AG differs from that of C-Spring-BH in that some of the types (e.g. rhino and equids) are absent from the former.

Description of the artifacts.

Unlike the material of C-Spring-AG, which was very fresh with pale grey and mottled patinas ('PGM'), the spring-head surface artifacts had mixed conditions; many were weathered or had suffered from heat spalling (pot-lid fractures); they were also most often patinated to black, olive or dark grey (Note 2). They may be classified as follows:

Tools

- Bifaces (17)

Seven of these were found on the fishpond backdirt near the position of Garrard's sounding; as mentioned above, they resemble, in their freshness and pale grey and mottled patinas, the artifacts in his levels T - R. The silhouettes of five are shown on Figures 4 and 5 (the detailed drawings could not be completed in the field but it can be seen that their morphology is similar to that of the 10 pieces from C-Spring-BH). One of the black and dark grey-patinated pieces has two patinas - one black and one olive; it is unique in having a small trace of lustre at the base, indicating that it was once in contact with warm spring water (Note 3).

Except for the large lanceolate biface (Fig. 4, 5) which also has two patinas (black and grey), found on the Main Canal debris piles adjacent to C-Spring-BH, the bifaces as a whole are small-to-moderate in size, the smallest measuring 8.6 x 6.5 x 2.1cm. The amygdaloid variants (6 pieces, e.g. Fig. 5, 4 & 5) just outnumber the ovate variants (5 pieces, e.g. Fig. 4, 1 & 2). The unusual piece on Fig. 5, 6 has perhaps been reworked as a core, but is entirely black-patinated; it closely resembles a 'core-based biface' from Lion Spring (Harding collection; Copeland, *infra* b, Fig.4, 1).

- Bifacial racloirs (6)

Four of these are made on rough flakes and two on tabular slabs, one face on the latter being more finely retouched than the other (Fig. 3, 1 & 4). Similarly, the ones on flakes have flat scalar dorsal retouch but the ventral surface is roughly worked or thinned.

- Racloirs (16)

Pieces in this category can be divided up into two groups: those typifying the Levantine Mousterian and those which more resemble the types known in Yabrudian or Late Acheulean phases, with Qina and demi-Qina retouch. The collector-bias toward distinctive, large pieces is evident; the 'Yabrudian' group includes the transverse (4 pieces) and offset (5 pieces) sub-types (Fig. 2, 2 & 4; Fig. 3, 5; Fig. 5, 1 - 3). These have several overlapping ranks of scalar or resolved retouch designed to form long, straight or symmetrically curved, convex edges, often converging at acute angles (Fig. 5, 3); one racloir has an additional 'bec', degaged by two inverse notches.

Single convex edges can be long and steep (Fig. 2, 2). The blanks for such tools are usually massive non-Levallois flakes with pronounced bulbs, deriving from hard-hammer debitage methods; the pieces can be rocked from side to side on the bulb.

The other racloirs are made on more typical Levantine Mousterian flake types; two are single convex (Fig. 3, 3), one single straight, 2 are convergent convex and one is inverse (Fig. 6, 1). Only 4 are made on Levallois flakes.

- Borer and borer composite (2)

One has a notch, one is slightly laterally retouched; both are on Levallois flakes.

- Abrupt retouch (3)

One has slightly denticulated retouch, the others are finely retouched (Fig. 6, 4).

Debitage

- Cores (7)

These are varied as to shape, the largest shown on Fig. 6, 3. Two are unipolar, one for flat flakes, one for orthogonal blades (Fig. 7, 3); one is bipolar for similar blades and two are worked down or exhausted discs (Fig. 6, 2). Two are perhaps made on broken bifaces (Fig. 7, 1 & 2) to produce blades on the thickness (the 'Amudian' blade core type, resembling a burin, as in Fig. 7, 1). It is worth noting that a similar core came from Lion Spring (Harding collection), which has been drawn on Fig. 7 for comparison. Striking-platforms on the cores can be cortex, simply-faceted or plain. Only a handful of blades or flakes which would fit onto these cores were collected, and none of the cores seem to have produced the 'Yabrudian' flake types.

- Products (72)

Levallois and non-Levallois unretouched flakes are present in different percentages: 27 are Levallois - 2 triangular points, 16 flakes (either radially or axially-prepared) and 9 blades (Fig. 3, 6) and 45 are non-Levallois. The latter include 18 biface trimming-flakes (Fig. 3, 2 and Fig. 6, 5) and 11 flat or part-cortex flakes as well as two blades which could have been struck from prismatic orthogonal cores such as Fig. 7, 1 - 3, one an *outrepassée*.

The Levallois butts are 66% faceted, while plain or cortex butts predominate in the non-Levallois group.

Conclusion

Until the results of the work of 1988 at C-Spring-AG were known, it was difficult to interpret the evidence from C-Spring-BH or to explain the physical and typological differences between the artifacts of these adjacent sites. Now it becomes clearer that an Acheulean horizon, an in situ knapping-floor, stretched all the way between the two locii, although it petred out to the south according to the sections seen in nearby pits dug for agriculture (pers. com., A. Garrard). This would account for the presence of the bifaces and other types identical in style to those of the Late Acheulean of Azraq Facies in the Garrard sounding, (see Copeland, infra c). Garrard's work confirms the opinion of Zeuner, that C-Spring represented an in situ Acheulean site in a buried wadi channel.

The Middle Paleolithic material of C-Spring-BH may derive from deposits which also petred out beyond the immediate spring area, although it could correspond to the time of Garrard's layers P and Q, in which there were some of the same faunal types and hints, in the form of tortoise cores, of the Mousterian. In fact, Zeuner mentions that a Levallois core was found in the 'mud-flat/qa' silts, which he describes as following the Acheulean phase. Thus it seems that the typical Levallois flakes, triangular points and blades which occur on the surface and on the debris piles could represent a Levantine Mousterian phase which is either not present or present in disturbed or attenuated form in Garrard's sounding; this phase is dated elsewhere in the Levant to the late Last Interpluvial or early Last Pluvial (Hours, *infra*; Vandermeersch & Bar Yosef, in press).

If Late Acheulean and Levantine Mousterian phases of occupation clearly did occur at C-Spring-BH, the problem remains as to whether the Qina racloir group belongs to the former (i.e the Late Acheulean of Azraq Facies) or to another phase, such as the Yabrudian or Acheuleo-Yabrudian. This as known in e.g. Tabun E, Bezez C or Yabrud I and comes chronologically between the Late Acheulean and Mousterian stages. Or alternatively, could they represent a local variant of the Yabrudian?

Assignment to the Acheulean seems logical, yet Qina racloirs were either rare, present in rougher form or absent from the stratified soundings. One could imagine that the anomalies refer to differences in the use of the sites (a living area near the spring, rather than a knapping-floor?) and a tool-kit, oriented toward flake-tools with different functions (processing of food, dismembering of carcasses?). Differences in patina percentages could be attributed to the soil types in the vicinity of the spring.

If the heavy racloirs (and Amudian-like blade-cores such as on Fig. 7) represent a Yabrudian industry such as is known from other sites located in a band across the Central Levant from Tabun to El-Kowm, one might expect to find some of the other peculiarly Yabrudian traits, such as a high percentage of offset and transverse Qina racloirs on massive, hard hammer-struck flakes which occur at all Yabrudian sites (Copeland and Hours, 1983), and such as the presence (noted at Bezez and Hummal by this writer) of numerous very small 'thumb-nail' racloirs, abruptly retouched non-standard pieces, discs and short blades. Nothing like this is seen at the Sheshan sites. Furthermore, such heavy racloirs as were present did not have the characteristic 'crushed' and very symmetrical edges so typical of the Yabrudian. The same comments apply to the heavy racloir element present in the unstratified Harding collection from Lion Spring. As the illustrations of these (Copeland, *infra* b, Fig. 2, 6 & 7) show, the retouch is, again, not typically Yabrudian, although similar blank production-methods were evidently used and although similar sub-types (transverse; offset) were present. As to the bifaces present in both locii, since they are morphologically similar to types known in both the Evolved Late Acheulean and the Acheuleo-Yabrudian industries (e.g. Tabun F and E) they do not assist us to interpret the heavy racloir group.

As to the third possibility; could the evidence be hinting at a local variant, equivalent, even if not identical, to the Yabrudian or Acheuleo-Yabrudian of the other regions, probably post-dating the 'Late Acheulean of Azraq Facies' phase? Without more evidence it is impossible to be sure, so that for the present it seems that the question must remain in suspense. The matter has been discussed here in the hope that such evidence will eventually become available.

'E-SPRING' (SITE II, CANAL E, SPRING A AND B)

These springs are represented by seven artifacts: 3 bifaces, 3 flakes and a core, retrieved from the surface of the Baker Harza debris piles by D. Kirkbride. Although marked as 'E-Spring' it seems that 'Canal E' is meant. Canal E runs just to the north of Canal F, on which C-Spring was located; in 1984 these two springs were seen to form small pools of still water, clogged with reeds and other vegetation; they have now been destroyed by the construction of the fishpond mentioned earlier.

According to Garrard and Hunt, based on Kirkbride's description (*infra*) of the section at Spring B, the sediment sequence there may equate with certain levels in their sounding (Note 4).

Kirkbride's artifacts consist of the following:

- three bifaces, one a finely-made, intact limande in olive patina (Fig. 1, 2); another ovate, also finely faceted, in grey patina has traces of tranchet blows at the tip; the third is the lateral half of what was an ovate biface; it has equally fine faceting and has blacksh-grey patina.
- a double convergent convex racloir made on a thick cortex flake, with parallel and scalar retouch, in black patina
- a discoid core, almost unpatinated and very fresh.
- two flakes, one Levallois with radial dorsal facets, the other a broken non-Levallois flake with black patina.

This small sample seems to represent two of the same phases as are present at C-Spring-BH: the Late Acheulean of Azraq Facies and the Levantine Mousterian.

D-SPRING OR CRAB SPRING

This site does not appear on Baker & Harza's map of I966, but seems to refer to a spring on their Canal D, running to the south of Canal F, c. 1 km. east-south-east of the filtration bed hut. The site consists of a spring pool surrounded by mounds of excavated sediments, presumably the work of Baker & Harza. The pool opens into a large pond full of weeds (Fig. 9) and inhabited by a lively wildlife (frogs, crabs) and thence the water flows slowly towards the sabkha in a shallow channel. The water smells fresh. Fresh artifacts with brown or milky-white patina are seen eroding out of the spoil-heaps and washing down into a braiding wadi system, partly masked by silt dunes and salt-caked mud-flat sediments. The collection includes:

- one biface, a discoid or ovate, somewhat weathered, brown patinated;
- a 'slab-tool' or chopper, of a kind known from Lion Spring (Kirkbride sounding), also with brown patina.
- 3 possible biface trimming-flakes.
- a later Paleolithic group of 4 possible dihedral burins, a bladelet core or carinated scraper and several bladelets, all in grey patina.
- about a dozen unretouched flakes, blades and secondary-preparation elements such as crested blades; many had pot-lid fractures and were white patinated.

The spring was, apparently, occupied in several periods, including the Acheulean; it's presence was probably the reason for the location of Garrard's AZ.18, a Natufian site just I00m. to the south (Garrard *et al.*, 1987; 1988). Another mound can be seen on the track going in the direction of the Baker Harza earthwork reservoir. This was also visited in I985 and found to contain no spring but instead seemed to be occupied by small carnivores (foxes?), judging by the presence of bone piles in the entrances of burrows.

The Crab Spring and AZ.18 area has recently been developed for agriculture (an olive grove; A. Garrard, personal communication).

NOTES

1. To quote the report of Baker & Harza, In both B and C spring stone artifacts and the skeletons of animals, probably from the Upper Acheulean Period were found. These relics from the past were found lm below the present ground surface ..The disappearance of B and C Springs as such was probably the result of their being covered with alluvial clays. (Baker & Harza, 1958, 125).
2. For patina colours described with reference to the Munsell Colour Chart, see Appendix A in Copeland, infra d.
3. The subject of lustre is discussed in this volume by M. Shackley, and see also Copeland, infra a, footnote 2.
4. At Spring B Kirkbride's lowest layer, 6, could correspond to levels Q - P at C-Spring, with level 5 referring to N, 4 to M, 3 to L and l to K - A (A. Garrard, pers. com., 1988).

BIBLIOGRAPHY

BAKER JR., M. INC. & HARZA ENGINEERING CO, 1958. *Princess Alia Project: Definite Plan Report*. Amman, Hashemite Kingdom of Jordan Development Board.

CLUTTON-BROCK, J., 1970. The fossil fauna from an Upper Pleistocene site in Jordan. *Journal of Zöology*, (London). 161: 19 - 29.

COPELAND, L. & F. HOURS, 1983. Le Yabroudien d'el-Kowm (Syrie) et sa place dans le Paléolithique du Levant. *Paléorient* 9/1, 21 - 37

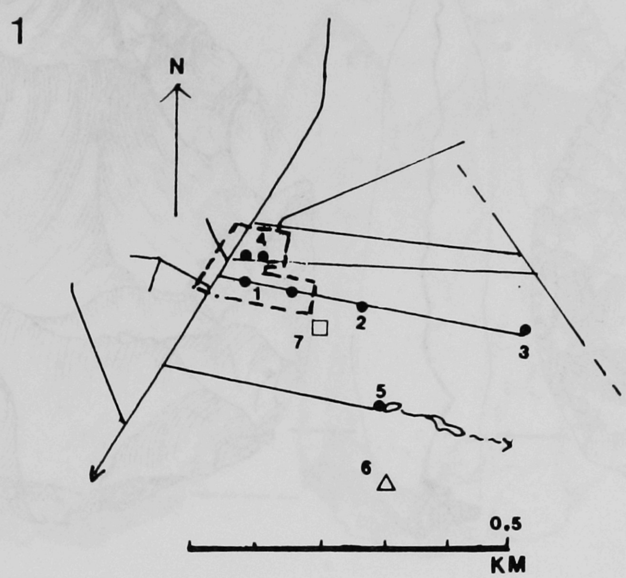
COPELAND. L. AND F. HOURS, 1988. The Paleolithic of North Central Jordan; an overview of survey results from the Upper Zarqa and Azraq, 1982-1986. IN A. Garrard & H.G. Gebel, eds., *The Prehistory of Jordan*. B.A.R. i.s. 398, 287-309.

GARRARD, A., A. BETTS, B. BYRD & C. HUNT, l987. Prehistoric environment and settlement in the Azraq Basin: an interim report on the l985 excavation season. *Levant* XIX, 8 - 25

GARRARD, A., A. BETTS, B. BYRD, C. HUNT AND OTHERS, l988. Summary of Palaeoenvironmental and Prehistoric Investigations in the Azraq Basin. IN A. Garrard & H.G. Gebel, eds., *The Prehistory of Jordan*. BAR i.s. 396 ii. 311 - 337

GARRARD, A. & N. STANLEY PRICE, 1975-77. A survey of prehistoric sites in the Azraq Basin,eastern Jordan. *Paléorient* 3, 109 - 126.

VANDERMEERSCH, B., & O. BAR YOSEF, in press. Evolution biologique et culturelle des industries et des populations du Levant de la fin du Paléolithique Intérieur au début du Paléolithique Supérieur. Conférence pre-print, Lyons 1988. (*Paléorient*,1989).



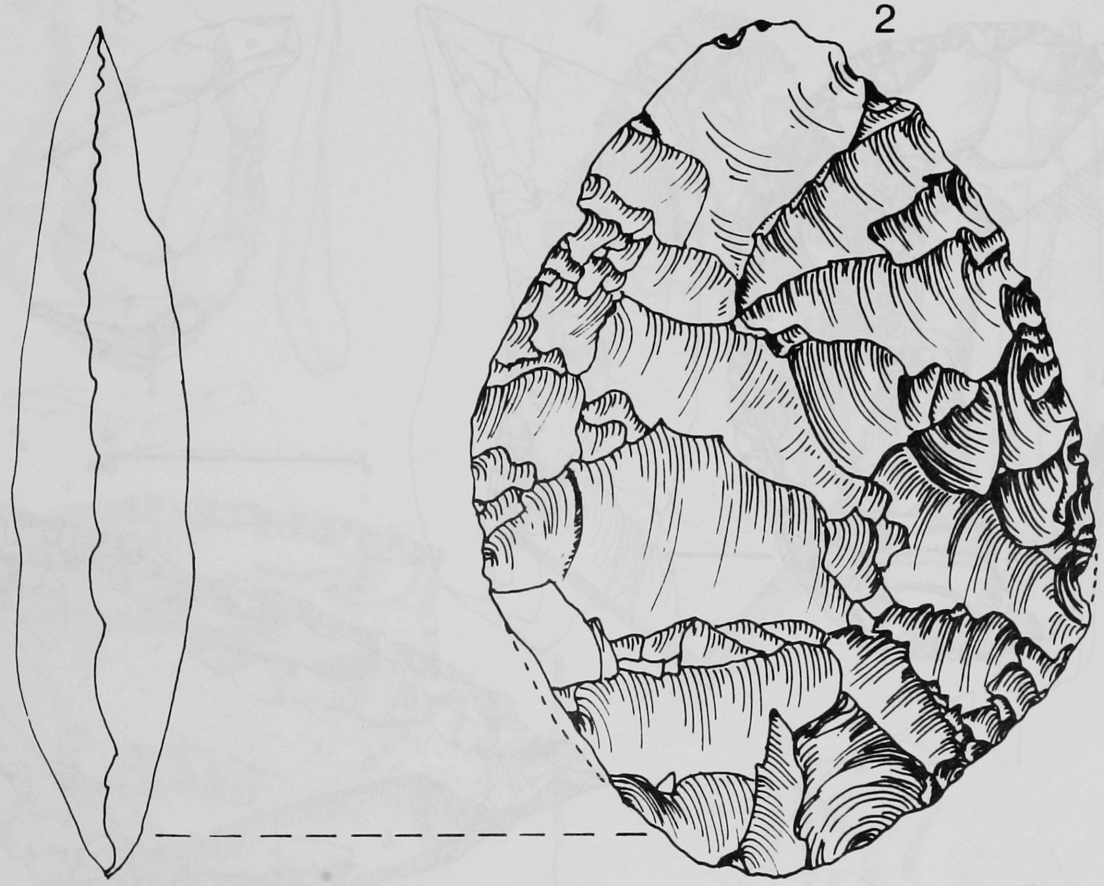


Fig. 1. 1, Sketchmap of the environs of C-Spring after 1984; dashed line = limits of new fishpond. Key: 1, C-Spring-BH; 2 and 3, Springs A and B on Canal F; 4, Springs A and B on Canal E ('E-Spring'?); 5, 'Crab Spring'; 6, AZ.18, Natufian site; 7, C-Spring-AG (Garrard sounding).

2, Limande or ovate biface from E-Spring, olive-grey patina on grey chert, 'perfect' profile.

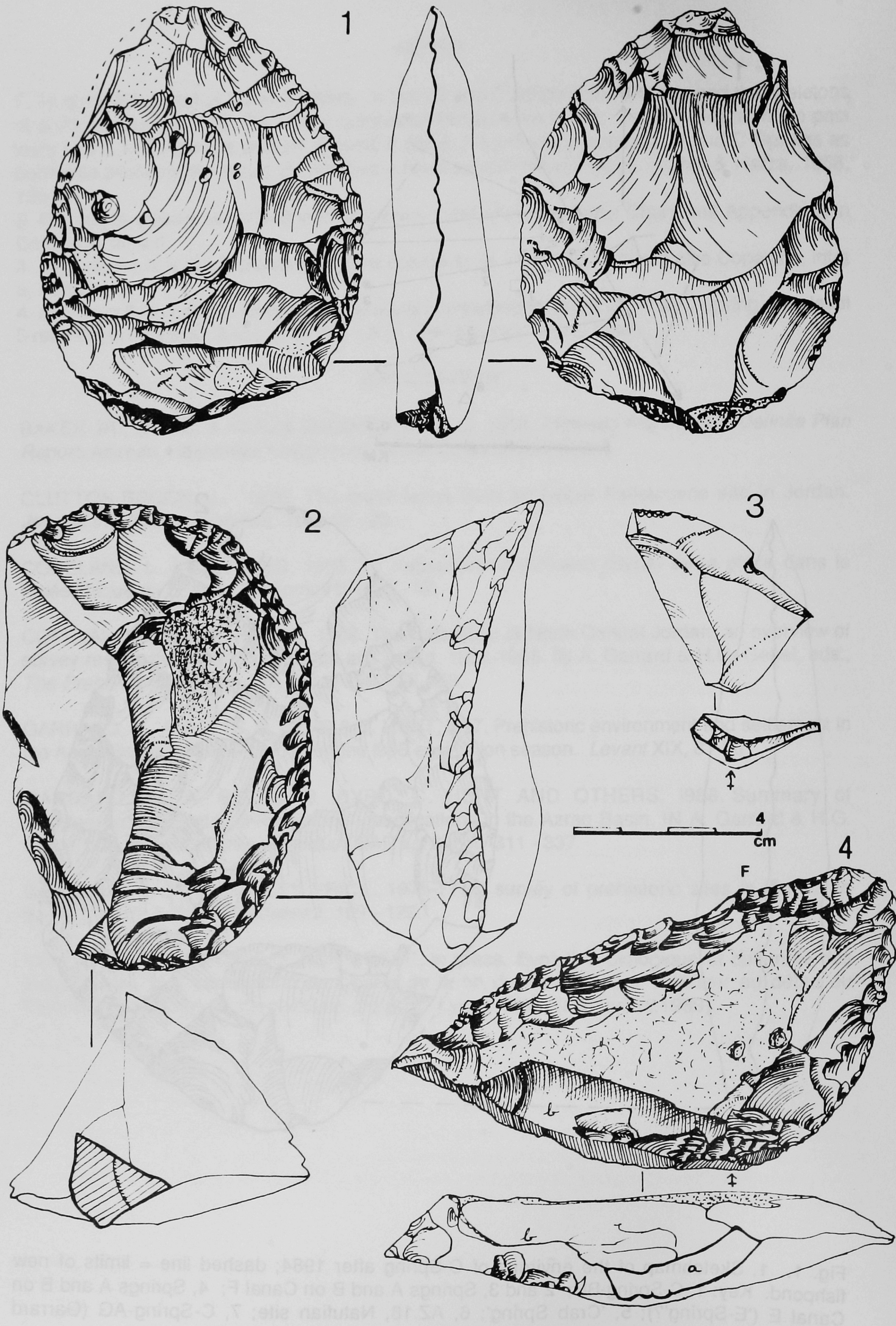


Fig. 2. 1, Subcordiform biface, thermally pitted; 2, single convex Qina racloir on a massive flake, 16 cm. working-edge; 3, pseudo-Levallois point (trimming-flake); 4, transverse straight Qina racloir with 'rocking-chair' bulb.

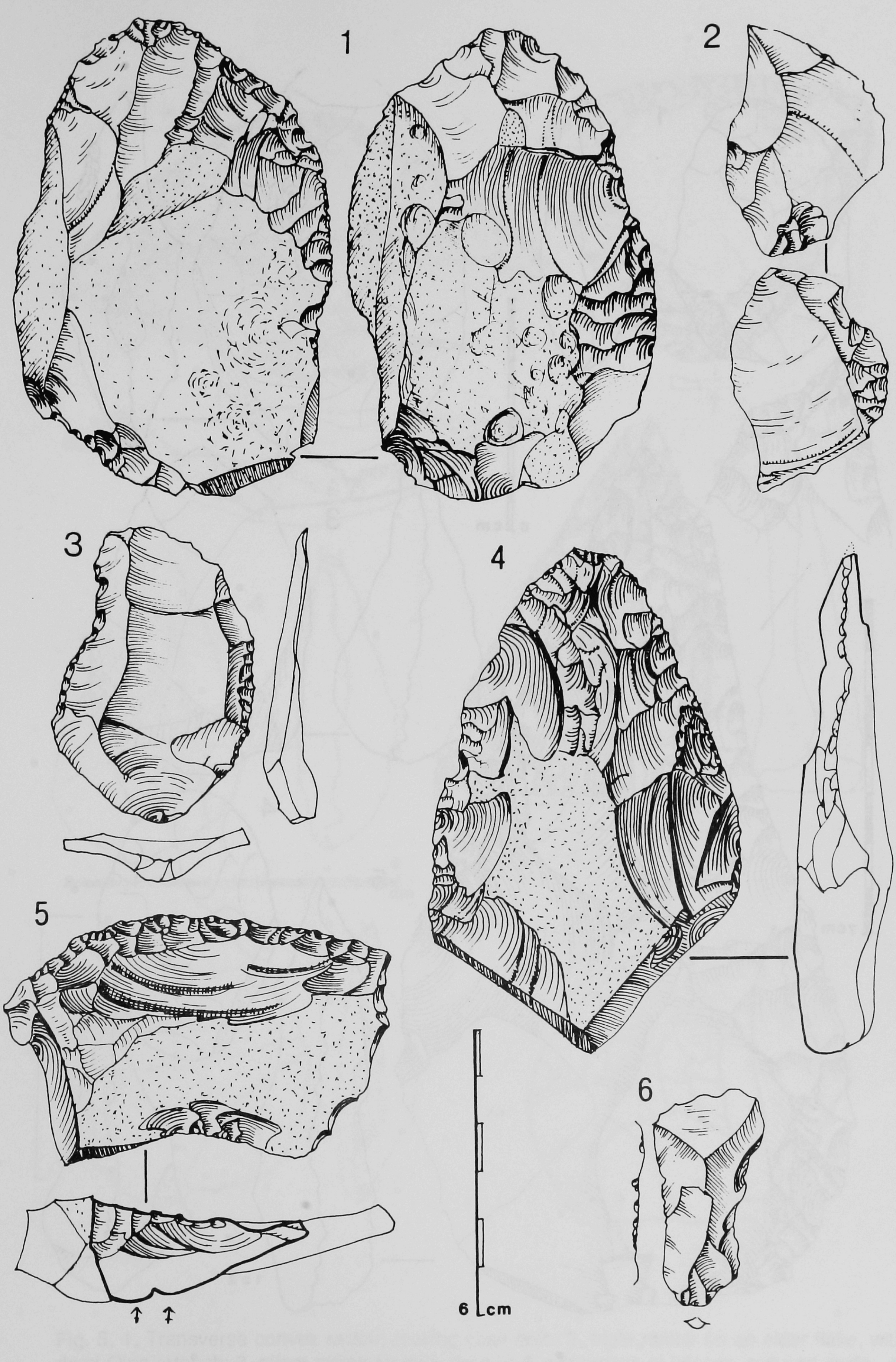


Fig. 3. 1, Bifacial racloir on a tabular slab, thermally pitted; 2, biface trimming-flake; 3, double racloir on a Levallois flake; 4, bifacial racloir on a tabular slab, v-shaped butt; 5, transverse convex racloir on a cortex flake; 6, Levallois blade.

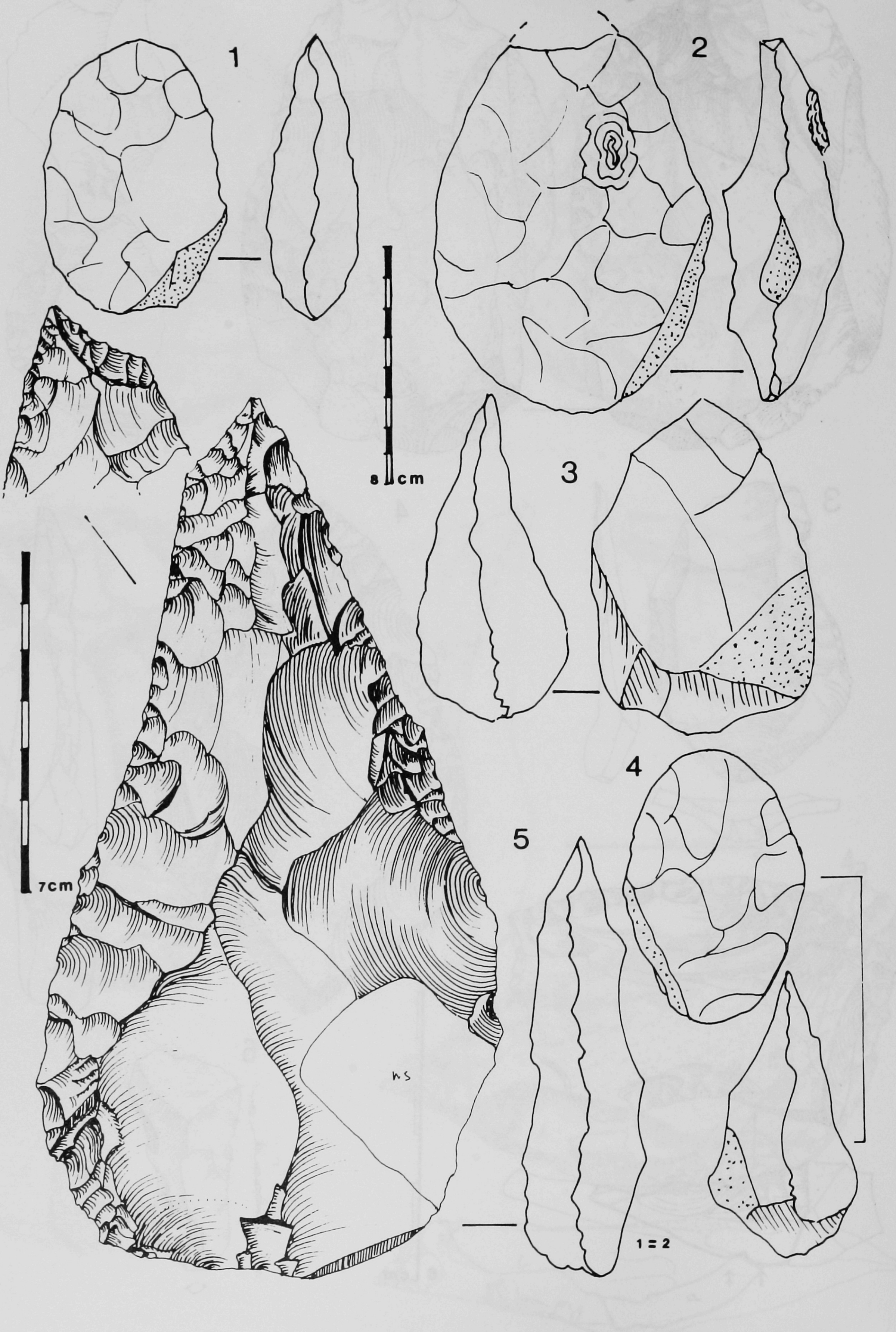


Fig. 4, Silhouettes of bifaces, on reduced scale: 1, Ovate, finely-flaked, dark grey patina, weathered; 2, ovate with geode, olive patina; 3, partial amygdaloid, cortex on each face, PGM patina; 4, small bifacial cleaver, rounded divergent tip, slight lustre on base, 2 patinas; 5, lanceolate from the Main Canal, tip reworked, 2 patinas (profile reduced to half-size).

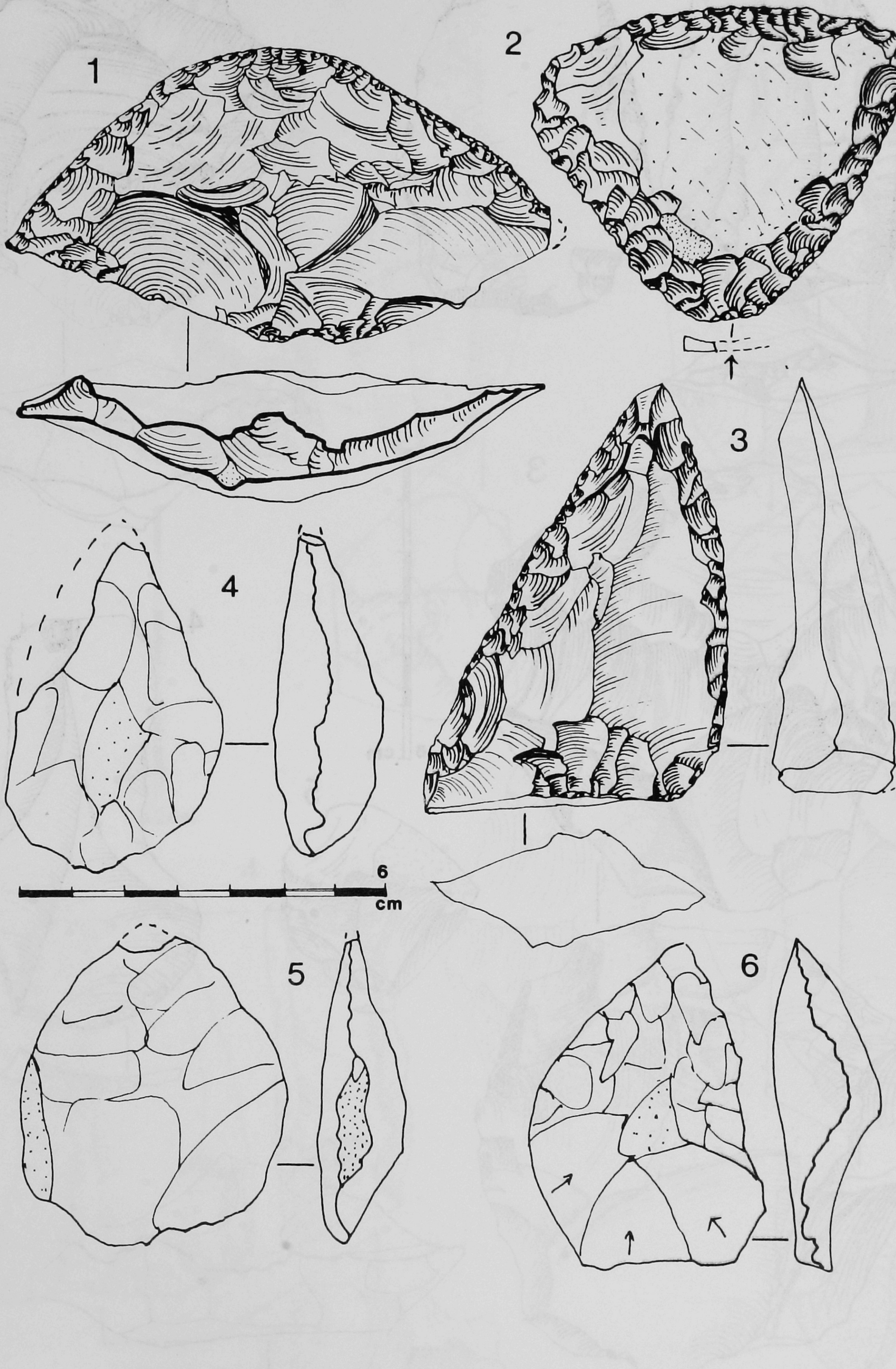


Fig. 5, 1, Transverse convex racloir, rocking-chair bulb; 2, triple racloir on an older flake, with demi-Qina retouch; 3, offset racloir on thick flake; 4-6, silhouettes of bifaces, reduced scale: 4, short amygdaloid, side of tip re-worked, grey chert; 5, atypical amygdaloid, base broken, PGM patina; 6, pointed ovate, black patina, either re-used as a core or re-worked.

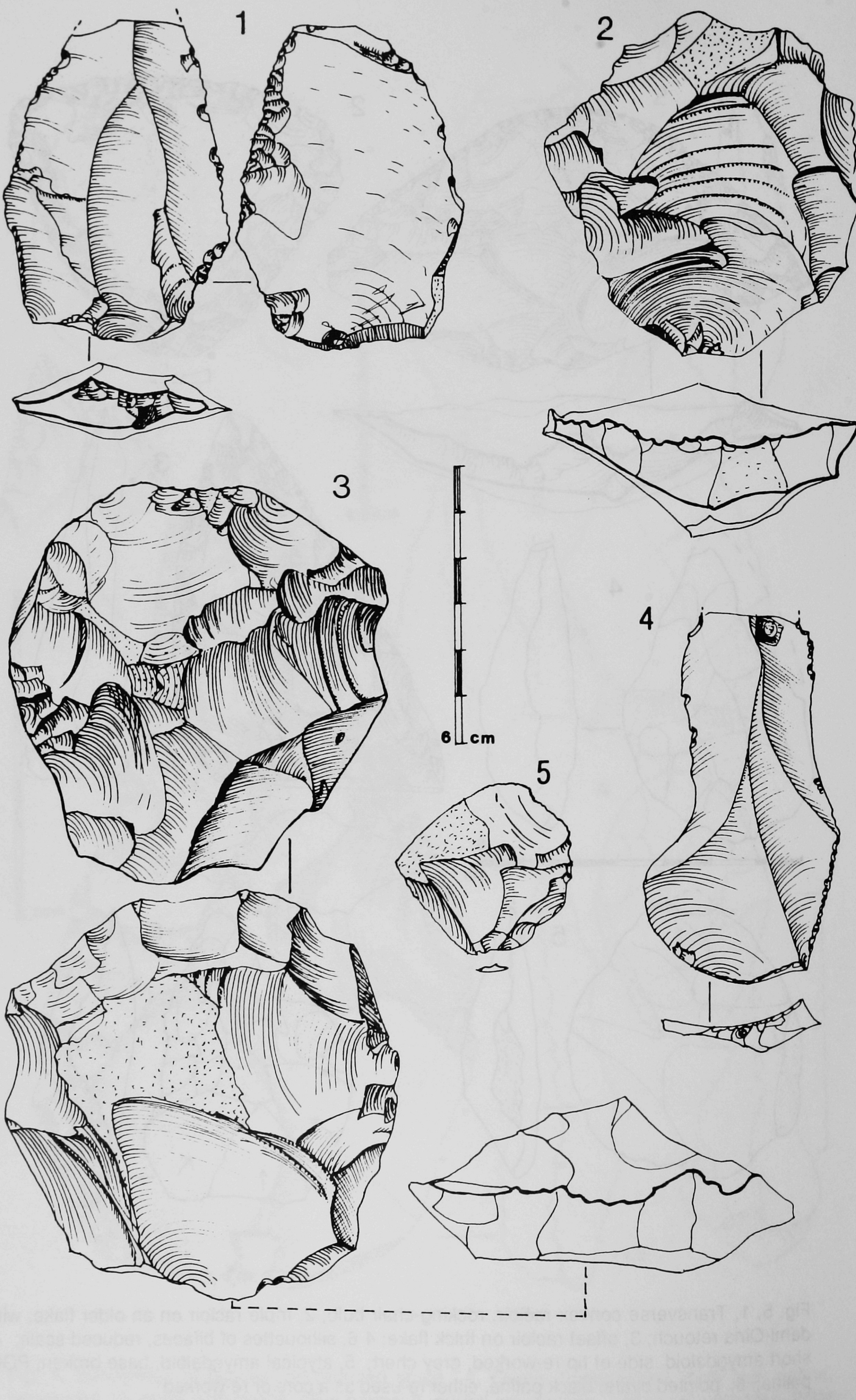


Fig. 6. 1, Inverse single straight racloir on a Levallois flake; 2, exhausted discoid core; 3, Mousterian discoid core, slightly lustred; 4, slightly retouched Levallois blade; 5, trimming-flake.

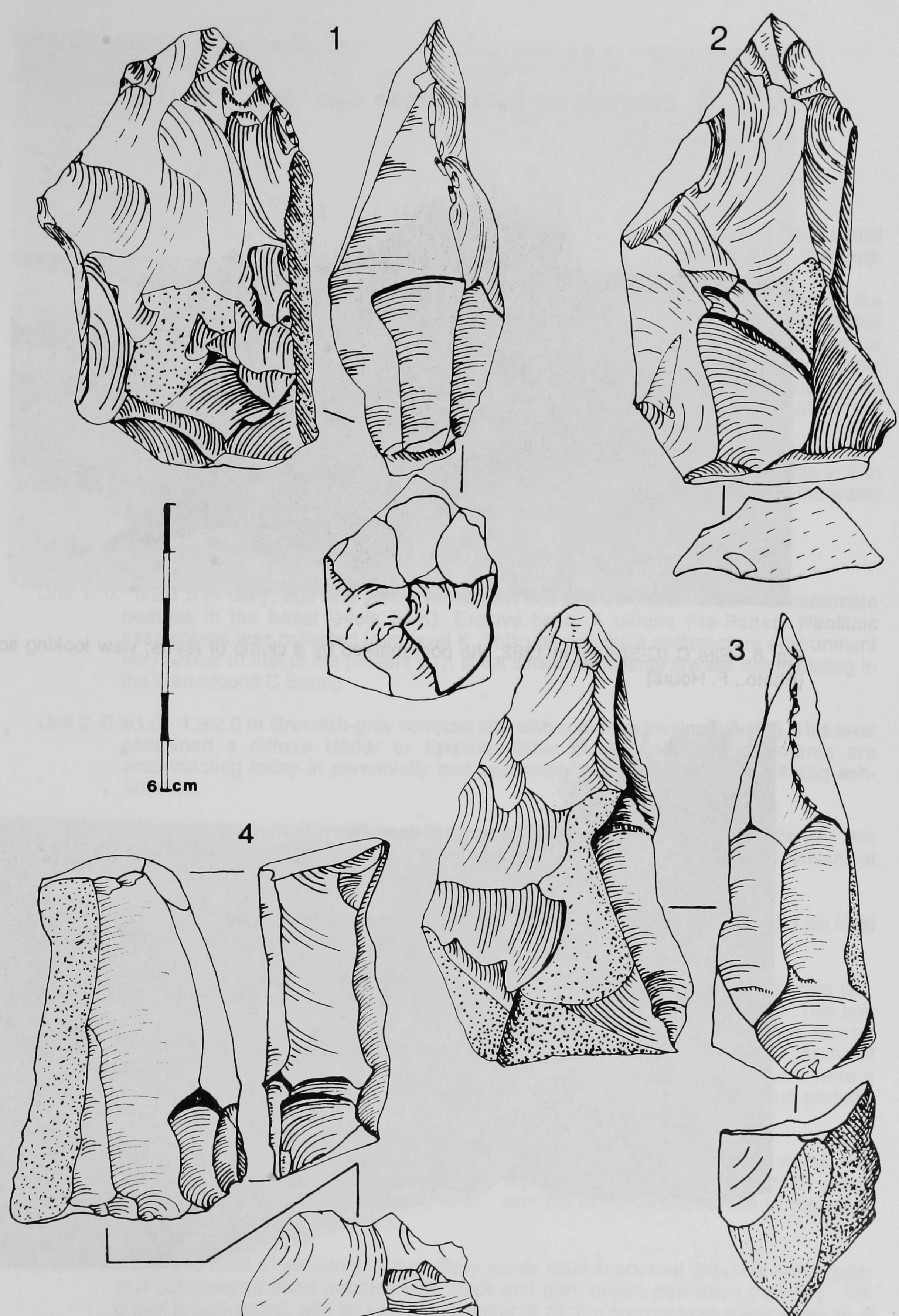


Fig. 7. 1, Unipolar core, perhaps made on a biface, blades struck off the thickness; 2, unipolar core with bifacial tip end (biface?), for flakes on 1 side, for blades from other platform; 3, for comparison, a similar blade core on a possible biface from the Harding Collection, Lion Spring;

Fig. 8. Site C (C-Spring) in 1982, the pool marked by a clump of reeds; view looking south. (Photo., F. Hours)

Fig. 9. The pool at 'Crab Spring', Azraq. (Photo., F. Hours).

THE 1985 EXCAVATIONS AT C-SPRING

Christopher O. Hunt and
Andrew N. Garrard.

During autumn 1985, as part of a programme of palaeoenvironmental investigation in the central Azraq Basin, a sounding was excavated in the vicinity of "C Spring", 1 km south of Biraket Qeissiyeh near Azraq esh-Shishan (figure 1). The original sounding at C Spring, dug for engineering purposes in 1956 (Baker and Harza 1958, Clutton-Brock 1970, Kirkbride - this volume, Zeuner - this volume) was located 30 m to the west of our cut, but had been destroyed by the digging of fish ponds in early 1985. The authors are grateful to Ghassan Ramahi of the Department of Antiquities in Amman for the supervision of the 1985 sounding.

Our trench began as a 3 x 3 m sounding, but was reduced to 3 x 1.5 m in area at 2 m below ground level at the top of level M (figure 2). The basal levels (Q-T) were below the water table and for this reason excavation was discontinued at 3.6 m.

The stratigraphy was as follows (figure 2)

Unit 1. 0 - 0.9/1.5 m Grey, buff and yellow windblown silts and very fine sands with carbonate nodules in the basal levels (H-K). Erosive base. A diffuse Pre-Pottery Neolithic assemblage was collected from level K. This unit reflects a sedimentary environment very similar to that of the present day, since similar sediments are still accumulating in the area around C Spring.

Unit 2. 0.9/1.5 - 1.9/2.0 m Greenish-grey compact silts with columnar jointing (level L). This level contained a diffuse Upper or Epipalaeolithic industry. Similar sediments are accumulating today in perennially and seasonally wet marshes around Azraq esh-Shishan.

Unit 3. 1.9/2.0 - 2.0/2.1 m Creamy, well-indurated calcrete horizon, passing laterally into blackened (manganese stained) indurated silts (level M). This horizon is the remains of a soil profile and reflects a major hiatus in sedimentation.

Unit 4. 2.0/2.1 - 2.5/2.6 m Greenish-grey compact silts with columnar jointing (level N). Like level L, this layer probably accumulated in a marsh.

Unit 5. 2.5/2.6 - 3.1/3.2 m Blue-grey sandy silts, fining upward, with traces of small-scale (20-50 mm deep, 1000-500 mm wide) scour and fill structures (levels P and Q). This unit contains fresh artefacts and poorly preserved bones and teeth of *Bos sp.*and *Camelus sp.*. The bedding of this layer is consistent with deposition by ephemeral braided streams. Analyses for pollen and diatoms proved negative, but there were a few badly corroded phytoliths, suggesting that the landscape was at least partially vegetated.

Unit 6. 3.1/3.2- 3.3/3.4 Blue-grey, becoming yellow-grey downward, layers of artefacts with some poorly preserved bones and teeth (species as above) with a matrix of sandy silts. Probably an *in situ* knapping floor, with silt in fill sedimentation in the voids between artefacts at a later date.

Unit 7. 3.3/3.4 m to base of section at 3.6 m. Grey sandy clast-supported gravel of subangular and subrounded chert pebbles with black and dark brown patination (level T). The gravel is well-sorted, with an average diameter of 15 mm and contains rolled artefacts. It is certainly of fluvial origin.

Observations in neighbouring pits and on the spoil heaps left by the digging of the fish ponds suggest that the upper part of the sequence (levels A-L and possibly as low as layer N) are very widespread and uniform and in most areas these horizons rest directly on bedrock. The lower units seem to rest in a narrow channel, presumably river-cut, in the bedrock. The bedrock surface seems to have considerable relief, but to rise generally towards the west.

The bedrock consists of sandy limestones with tabular flint layers. Early man seems to have exploited the flint layers around the ancient river channel and perhaps the precursor to C Spring as a water source, on the edge of the Azraq marshes of the time. Subsequently, the site was covered by marsh sediments.

A hiatus of very considerable duration then ensued. In the Upper or Epipalaeolithic marsh sedimentation resumed briefly. An erosive phase followed, before the area was covered by windblown silts in the Pre-Pottery Neolithic and up to the present day.

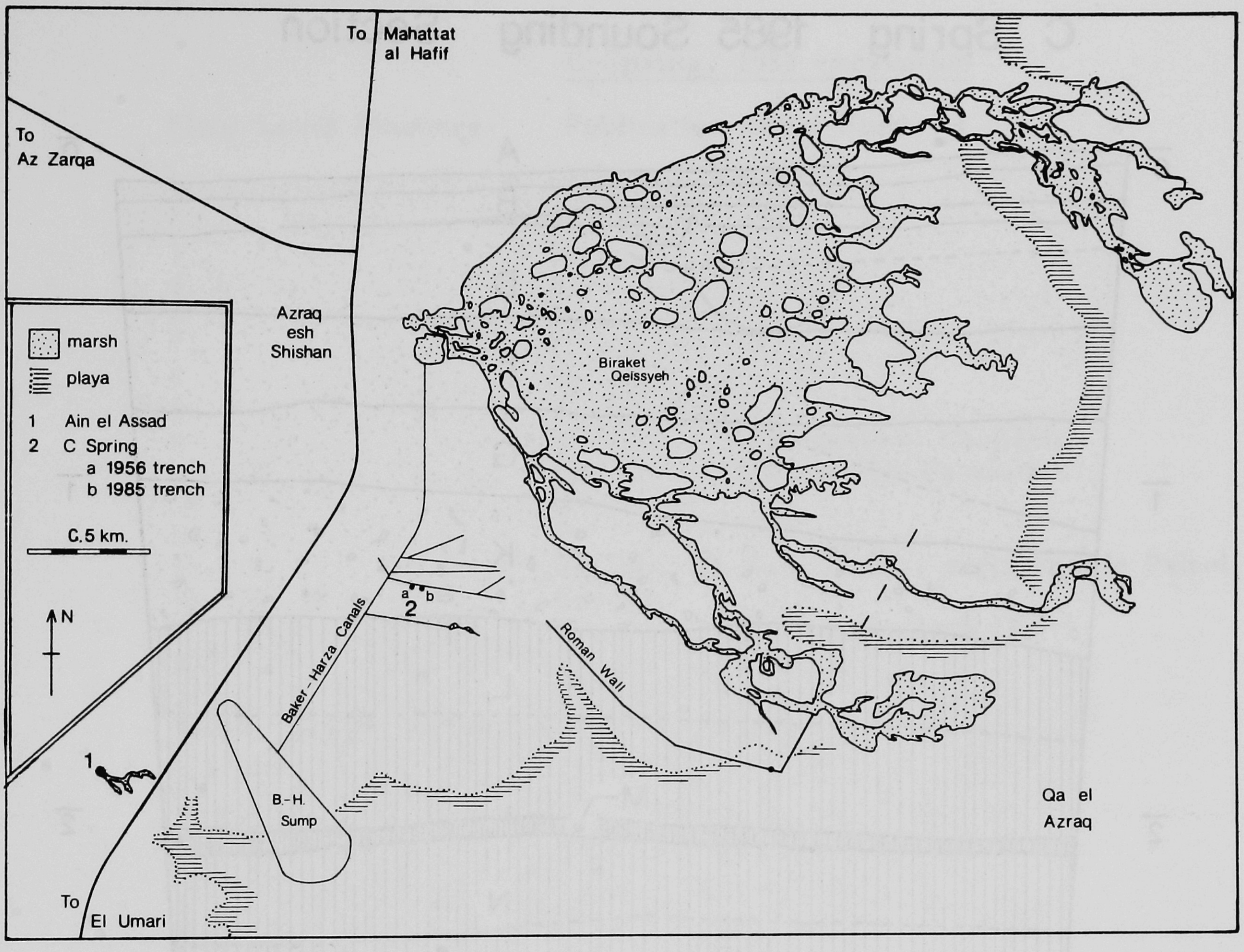

To Mahattat al Hafif
To Az Zarqa
Azraq esh Shishan
marsh
playa
1 Ain el Assad
2 C Spring
a 1956 trench
b 1985 trench
C.5 km.
N
Biraket Qeissyeh
Baker - Harza Canals
Roman Wall
B.-H. Sump
Qa el Azraq
To El Umari

Fig. 1

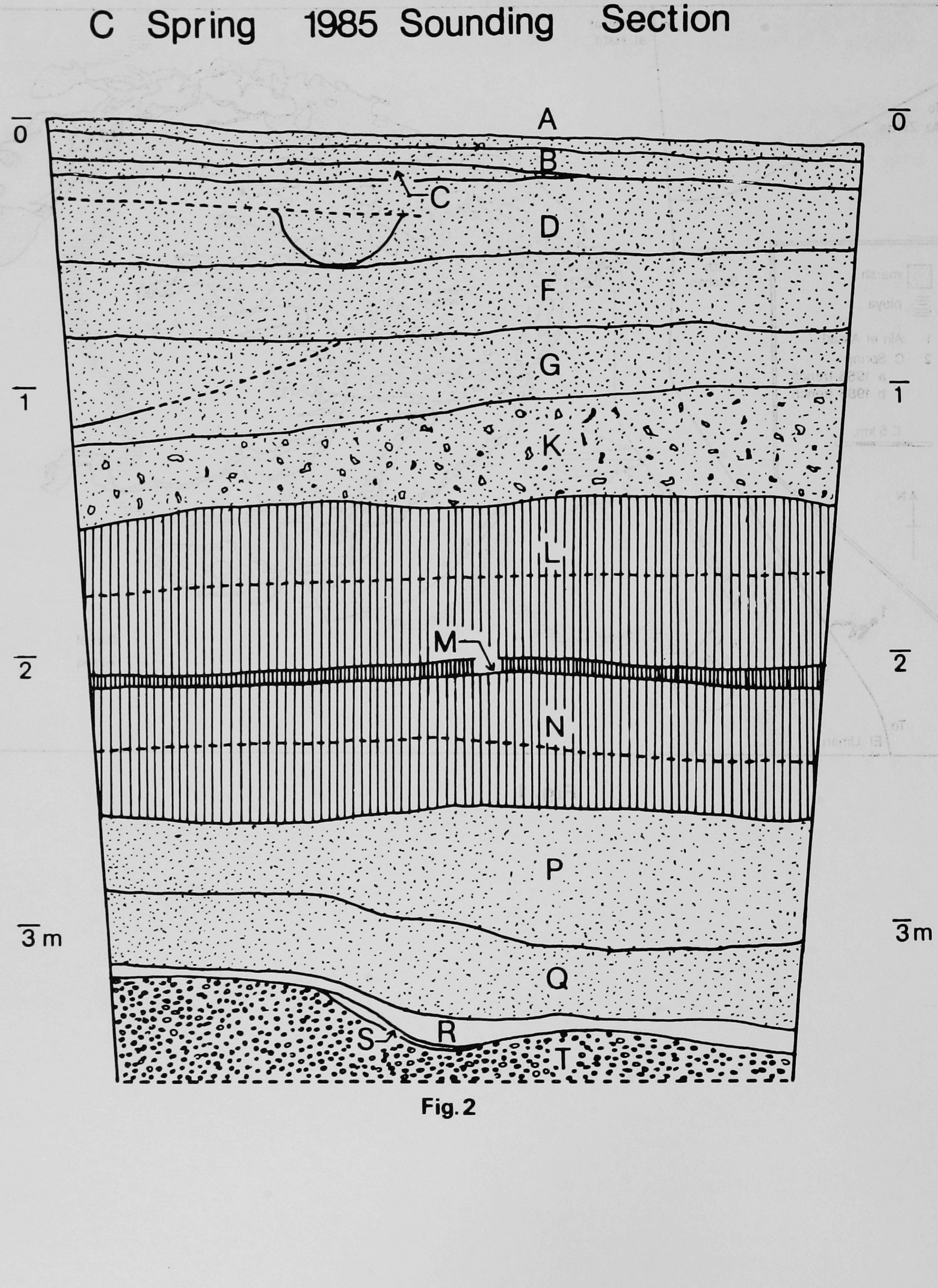

C Spring 1985 Sounding Section
0
1
2
3 m
0
1
2
3m
A
B
C
D
F
G
K
L
M
N
P
Q
R
S
T

Fig. 2

TABLE 1.

C-Spring, 1985 excavation

Field Level Numbers	Publication Level Numbers	
1	A, B	
2	C	
3	D	
4, 6	E	
9	F	
11	G	
5	H	
7	J	
8	K	(Pre-pottery Neolithic)
10, 12	La, Lb	(Upper/Epi-Paleolithic)
13	M	
14	N	
15	Pa, Pb, Pc	(late Lower, early Middle Paleol.)
16, 17, 18	Qa, Qb	"
19	R	(Late Acheulean floor)
20	S	"
21	T	
(3.5m. depth: water table)		

ANALYSIS OF THE PALEOLITHIC ARTIFACTS FROM THE SOUNDING OF A.GARRARD AT C-SPRING, 1985 SEASON

Lorraine Copeland

INTRODUCTION

The material to be described here consists of over 4,000 flint artifacts excavated by A. Garrard from a sounding at Azraq Oasis in 1985 (Garrard *et al.*, 1987). The site was located south-east of the Baker and Harza Canal, 30m. from the location of a spring pool and Paleolithic site known as C-Spring, one of the small springs and seeps which emerge to the south of the main Sheshan artesian springs at Azraq. It was not possible to excavate any closer to the spring itself (which is henceforth referred to as 'C-Spring-BH'), since it and two other neighbouring ones had been destroyed in 1985 by the construction of a large fishpond (Note 1).

Today, this spot is covered with sandy-silty sediments and is outside of the marsh and wetland area to which the main springs (one kilometer to the north) give rise. However, each of the subsidiary springs had, before destruction, formed its own minute oasis consisting of clumps of reeds and tamarisks around a small pool, as well as a ribbon of low vegetation bordering the shallow, winding channels along which the water flowed toward the centre of the Qa al-Azraq playa.

The stratigraphy of Garrard's 1985 sounding is described in the contribution of Hunt and Garrard to this volume. Following additional work at the site in 1988, which confirmed and refined the observations made in 1985, the field level designations have been changed from numbers to letters (see key in Hunt and Garrard, *infra*). The new system will be used here, and it supercedes the numerotation given in previous publications (Garrard *et al.*, 1987; Garrard *et al.*, 1988).

Briefly, at a depth of 3 - 3.5 m, alluvially-rolled flint gravel (level T) was found, apparently filling a buried shallow wadi course, and large numbers of very fresh Acheulean flint artifacts and poorly preserved faunal remains were found on top of the gravel in a matrix of silt (levels S and R). These materials were buried by blue-grey bedded silts (levels Q and P) containing sparse artifacts of Lower and Middle Paleolithic aspect as well as fauna (*Bos, Camelus*) and then by further layers N and M; the latter, a calcrete, is thought to indicate a hiatus and probable loss of sediments. In level L there appeared rare Late Paleolithic artifacts and in K some Pre-pottery Neolithic types occurred in fine aeolian silts.

This writer was asked to examine the lithic material recovered from the 1985 sounding by A. Garrard, and the work was carried out in 1986 at the British Institute at Amman for Archaeology and History; the present writer was accorded every facility and assistance for which she is most grateful.

METHOD

The methods of analysis, as well as the terminological definitions used, will follow those set out in this writer's report on the artifacts of a near-by site, Lion Spring (Copeland, *infra*, a). The characteristics of the assemblages in each level will be studied in turn, not only those culturally-produced, i.e. the techno-typological attributes, but also those produced after the artifacts were abandoned by their makers and users (such as physical condition, and the type and degree of patination). The assemblages of Levels T to P, considered to represent the Acheulian, will be compared internally and then compared to local Acheulean industries as well as other Levantine assemblages further afield.

Before embarking on the level-by-level descriptions, two aspects of the post-depositional features - patina and physical condition - will be discussed, since these aspects apply generally to all the assemblages of levels T to P.

Raw material and physical condition

The range of raw materials used for artifact blanks at C-Spring seems to have been much the same as that used at Lion Spring: pale beige-to-grey or opaque flint, often mottled or banded, often in alternating bands of cherty flint, with chert or cortex only near the surface. This material occurred in the form of tabular nodules or fragments of slabs of varying thickness deriving from seams in the Tertiary and Cretaceous limestones of the area. Wadi pebbles were also sometimes employed as blanks.

The earliest C-spring assemblages (levels T - R) were very unusual - if not unique - in the Near East; they were in such fresh condition that it would be possible to distinguish between degrees of freshness of the cutting edges of flakes and the facet-margins of all artifacts, for example by measuring microscopically the degree of damage or smoothing, using an 'abrasion index' as suggested by M. Shackley (1974). If the ability of the flake-edges to cut the fingers of the classifier is the criterion for 'mint fresh' then most of the unretouched flakes would fall into this category (the writer's scars have now healed). Many of the flakes have small nicks and 'utilisation facets'; however, without more time, and in the absence of equipment more sophisticated than fingers and naked eye, it cannot be said how much of this is due to trampling (of humans or animals) in antiquity. Given the care with which the artifacts were excavated and the protection from damage during washing and storage that they were accorded, it seems possible to rule out 'bag retouch' as the cause of these small retouches.

The appearance of the edges of the retouched flake-tools and bifaces is quite different; instead of being razor-sharp, as are most of the unretouched flakes, the tools are fairly blunt and some seem battered.

It seems, therefore, most unlikely that the levels T to R artifacts have been transported, unless by a negligible amount, although they may have moved (e.g. by deflation) within the sediments; they are regarded as forming an archaeological site *in situ* consisting overwhelmingly of knapping debris. The same cannot be said of the later material in levels P to K, which will be described later.

In marked contrast to the situation at Lion Spring, the artifacts were not lustred except for a small patch on one flake and on one biface. Therefore, if the conclusions concerning lustre origins reached by Meeks *et al.* (1980) are valid (see discussion in Copeland, *infra* a), we could assume that the C-Spring 1985 artifacts were not deposited in direct contact with warm spring water - an assumption reinforced by the position of the sounding, distant from the eye of the spring by some 30m., as well as by the fact that a few lustred artifacts did occur on the surface and debris piles in the immediate vicinity of the spring pool, found not only by Kirkbride and Zeuner but by this writer in 1982 and 1986.

Desilicified artifacts are rare and heat-spalling, though present, did not appear to be common, although, of the two forms most often present on artifacts left on hot desert surfaces ('curved splitting' in place and 'pot-lid fractures'), only the latter type occurred on about 5-10% of the artifacts, often on the cortex or older fracture-planes rather than on knapped facets. This is in contrast to the Acheulean artifacts at, e.g. Ain el-Beidha (Azraq) and at Wadi Qdeir C (El-Kowm), where heat spalling is characteristic (Copeland, *infra* e and Besançon *et al.*, 1981, 38).

Patina

With the advent of microscopy, through which it has been possible to determine the composition and microstructure of fractured flint, the origin and meaning of patination on artifacts is revealed as a subject of great complexity (Bradley & Clayton, 1987). Indeed, this writer (not a chemist) hesitated to enter here into the matter at all. However, since patina colours and their incidence had proved to be significantly different from one excavated level to another at Lion Spring, and since the prevailing colours in the C-Spring 1985 material seemed to differ from those in nearby C-Spring-BH, an attempt was made to determine the kinds, sequence and degrees of patination on the artifacts of the 1985 sounding.

So as not to interrupt the text, the experiment will be described in Appendix A, below. Patina frequencies (Table 8) show that between a half and a third of the artifacts of level R (42.9%) have become patinated to pale grey mottled (henceforth: PGM), that grey patinas increase upwards, and about a quarter are assumed to be more or less unpatinated or very slightly patinated. The rarity of black patinas is to be noted, as is the absence of deep chestnut brown tones. Although the origin and meaning of the patination must remain speculative, most experts consider that it is the chemical composition of sediments containing the flints which gives them their patination (cf. Rottländer, 1976; Besançon, 1979, 26, fn.3).

At C-Spring the combined evidence from the condition and patina studies confirms that the artifacts of levels S and R were deposited on a land surface (a wadi channel for Garrard and Hunt) not in contact with the spring. Some of the artifacts (e.g. the beige series) could have been quickly buried either by blown sand, waterbourne silt or by human or animal trampling, and were thus protected from edge-damage (and sub-aerial patination). However that may be, the artifacts are in fresher condition than are those of later lavels Q - P and Lion Spring as a whole, and the patina frequencies differ, not only from those at the latter site, but also from level to level at C-Spring, for as yet unknown reasons, as well.

LEVEL T

The basal assemblage consists of 333 pieces, of which 139 are flakes, two are cores and 192 are chunks or flake fragments ('waste'). The material was recovered from a deposit of alluvially rolled flint gravel at a depth of 3 - 3.5m at the point where further excavation was prevented due to flooding. The artifacts are in extremely fresh, even mint-fresh, condition but a few had pot-lids or were desilicified which, together with the white patinated group form 8% of the patina classes (see Table 8). The majority of pieces (73.93%) appear to be not only fresh but unpatinated; another 6.6% seem to be slightly patinated to brown. No black patinas were seen, and the PGM and grey/olive groups amounted to only 7.57% and 3.63% respectively (this may be compared to the frquencies in level 19, where PGM patinas form the largest group).

Of the two cores, one is a desilicified fragment and the other an exhausted core-base with bifacial side-preparation which probably produced broad flakes.

For definitions of the various flake-types which will be mentioned here, see the analyses of level 19 flakes, below.

Four of the 139 flakes are Levallois-like, one being a blade. This gives a Levallois index (IL) of 2.87 for level T, or an IL restricted (i.e. without the *éclats de taille*) of 9.09. The other flakes divide up into three groups: the small trimming-flakes (*éclats de taille*), deriving from biface- or core-preparation, form the largest, at 68.34%; 73 of these are small, less than 3 cm. long, while the other 22 grade into the ordinary 'Flat Debitage' flake class, as defined by Hours, 1979 (Note 2); the latter, often transverse in shape, and the other non-cortex class - Orthogonal debitage flakes - amount ot 18.07%.

Cortex and part-cortex flakes, including core-edge flakes amount to 8.63%. None were drawn but identical flake types are shown from level R on Fig. 2. There are 9 blades, giving a blade index (ILam) of 6.47 or 20.45 without the 95 *éclats*. The dimensions of the flakes are moderate, the largest measuring 7.2 cm. long.

The butts (see Table 8) of the larger flakes (excluding the 95 *éclats de taille* which had mainly shattered, plain or punctiform butts), were mainly plain, although a surprising percentage of 20.45 were faceted; however, the faceting was 'simple' in most cases (five technically dihedral butts (IFI) were also present). The IFs is somewhat higher than the faceting index of 15.36 in level R.

Three of the flakes are tools, all being racloirs: one is a bifacial racloir, almost a 'uniface', very thin at the tip, made on an offset flake with oblique-bulb. One is a double, biconvex racloir, with additional thinning at the tip on a cortex-flake, and the third tool is an alternate racloir on a trenchet flake (a type thought to be struck from a cleaver tip) with Quina retouch and removed butt (see Note 4 and level R for discussion of tranchet flakes).

Although without bifaces, the level T material is otherwise consistant technologically and typologically with the material of levels S and R above it, and represents, in all probability, the same industry, in spite of slight differences in some of the attribute frequencies (e.g. more unpatinated or beige-patinated pieces; more blades and faceted butts). The number of waste fragments and chunks, together with the number of trimming-flakes (287 out of 333 pieces) suggests that the level T assemblage is a kind of residue of the overlying levels S and R.

LEVEL S

This assemblage is smaller, with 10l pieces, coming from lenses of yellow silt above the gravels of level T.

The artifacts (as listed in Table 1) consist of one chopper, 63 flakes, 3 cores and 34 waste pieces. Compared to level T, Table 8 shows that there are fewer beige-patinated pieces (58.4l%), and more PGM pieces, the remaining patinas being olive or dark grey. No black or white pieces occurred. All the pieces are in fresh condition.

The cores consist of: one Levallois unidirectional core with faceted striking-platform for flat, narrow flakes; one prismatic core, also for narrow flakes, and a core-fragment.

There are 2 Levallois flakes (Fig. 2, 5) giving an IL of 3.l7, or (restricted) of 4.25. Cortex, part-cortex and core-edge flakes (Fig. 2, 1) amount to 44.44% and there are 19 'ordinary' flakes (Fig. 2, 2 & 4) and 14 *éclats de taille* (Fig. 2, 3). There are only three blades, which gives an ILam(restricted) of 6.38. The butts of the flakes are mainly plain (30%) or shattered/punctiform (25%), while faceted butts are rare giving an IFs(restricted) of 4.25, which is markedly less than the 20.45% of level T. There is one flake with removed butt (1.5%). The dimensions of the flakes are moderate, the largest, a transverse flake, measuring 10.0 x 8.8 x 2.2 cm. On the measured sample (two-thirds of the flakes) the width/thickness ratios mean (see Note 3) is 3.407,and the mean thickness is 1.5cm., indicating generally thick flake types, or relatively few *éclats de taille*.

The only core-tool is a minute (5.2 x 5.7 x 1.9 cm.) bifacial cleaver or small chopper with a sharp, 3-long edge, acute in profile. Three artifacts are rather atypical flake-tools. Two seem to be poor racloirs, one with an area of inverse retouch; another is a broken artifact with an area of nibbled retouch. In addition, the two Levallois flakes have a 'utilised' appearance, one having distal inverse nibbling ('Continuous Retouch').

Apart from differences in the ILam and IF (see Table 7), the level S assemblage does not differ markedly from those of levels R and T in general technology; typologically it resembles level T in having no bifaces.

LEVEL R

This is the level most rich in artifacts, with 2,896 pieces (Tables 1 and 2). A total of 10l cores, 62 bifaces, l6 other core-tools, c. 2,000 unretouched flakes, 84 retouched flake-tools and 768 chips, flake-fragments and chunks (*débris* for Bordes, referred to here as 'waste') were recovered from a small 3m x lm exposure overlying the gravels of level T. The artifacts formed a veritable layer of flint, 10 - 20 cm. thick at the base of the blue silt (level Q).

The material will be described in the conventional way and following the system of F. Bordes (1950; 1961), beginning with the technology (cores and flakes) followed by the typology (tools).

Because the sample is so large, each artifact category is separately described; readers who are not typologically-oriented may wish to skip these lists.

The condition and patina of the level R artifacts have already been discussed above. The edges of the unretouched flakes were mainly in mint fresh condition, as were the facet-margins, even on the retouched tools, although the edges on the latter group were more blunt even where not retouched. It must be stressed that the condition-categories were judged by eye inspection and they await further evaluation by microscopy. The most prevalent patina was PGM, as described earlier, and the percentage of beige artifacts (regarded as more or less unpatinated) is reduced in comparison with the underlying levels. For the first time, black patinas appear.

The cores

The 10l cores and their categories are listed on Table 1. As in the previous levels, the types are defined according to the method of F. Hours (in Sanlaville, 1979, pp. 31-35).

The main characteristic of the level R cores is the amount of bifacial working, which renders many specimens hard to distinguish from badly-made bifaces (e.g. Fig. 4, l); this is especially so when one end of the core in profile is thin and as sharp as a biface tip, e.g. Figs. 5, 1 & 6, 1. Similar forms have been reported from Ma'ayan Barukh (Ronen *et al.*, 1980).

The difference between 'Flat Debitage' and 'Levallois' cores is based on the fact that on the latter, an 'extra' preparation-process has been carried out, the creation of a distinct, vertical, striking-platform, while on the Flat cores, usually only the reverse face of the bifacially-worked piece is used as a striking-platform. In addition, the majority of Flat cores are transversally struck in relation to the greatest length of the piece, i.e. they are wider than long on the removal-blow axis, as on Fig. 6, 3 (this feature shows up well on the scattergram, Fig. 27). According to Bordes (1950, 21), a Levallois core should have the striking-platform on the longtitudinal axis, rather than, as here, on the transverse. Since transverse cores are a common form in the Acheulean, they are classed as a Flat Debitage sub-type.

Levallois cores (9) Figs 3, 3; 4, 3 & 7, 1

The tortoise-shaped Levallois cores are discoidal or oblong on the axis; one is made on a flake (Fig.4, 3). To be noted is the virtual absence of unipolar (or along-axis) preparation on these cores (Fig. 3, 2 shows the only (atypical) specimen). Also to be noted is the apparent frequency of failed or aborted attempts to remove good flakes, on even the most carefully prepared Levallois cores - a factor confirmed by the high numbers of 'failed' flakes present (see below). These comments apply also to the Flat cores. A sub-type, change-of-orientation' core, is shown on Fig. 3, 2, where the upper and lower faces were apparently used to strike off flakes, but on different axes.

Proto-Levallois cores (3) Fig. 3, 1

These are large, irregularly-shaped pieces with incipient striking-platforms; the drawn piece has fine flaking and may be unstruck.

Mousterian Discoid (7) Fig. 3, 3

These are well-known Middle Paleolithic types, with a peripheral, 'frilly' ridge; three are conical in profile, and 4 are biconical (as in the drawn piece).

Flat Debitage cores (17) Fig. 4, 1

Apart from worked out core-bases, this is the most common core-type. The majority grade into the exhausted discs when worked down, and into the Proto-Levallois (e.g. Fig. 6, l) categories when more carefully made. Thirteen are 'Acheulean Transverse' types, and are unifacially (Fig. 6, 3) or bifacially (Figs. 4, l & 6, l) made by radial faceting. As Fig. 27 shows, they are larger and thicker than other core-types in spite of the fact that none of them, in their present state, appear to have produced large or medium-sized, completely-edged flakes; the last removals are invariably either small flakes or 'accidents' (i.e. hinge-fractures, plunging-flakes etc. as in Fig. 6, l). This feature is surely to be seen in the context of the number of core-bases - one could assume that these did produce the required flake-types and that they could have been worked successfully until exhausted.

Orthogonal Debitage cores (8) Figs. 5, 4 & 8, 1

There are relatively few cores for prismatic, angular or elongated debitage; the products of the core were trapezoidal or triangular in section rather than flat (Fig. 8, l). Fig. 5, 4 shows a unique type, a prismatic blade-core, broken in half.

Globular cores (3)

These have polyhedric facets and 'wandering platform ridges' and the type is well-known in other Lower Paleolithic assemblages.

Exhausted discs or core-bases (22) Fig. 7, 2

These are numerous (25%). Nine (including the drawn piece) have cortex bases, on ll the bases are worked and similar to those on the Flat and Levallois cores, and two have plain (fracture-plane or flake-surface) bases. As the clustering of W/Th distributions shows (Fig. 27), they were worked down to a consistently thin state.

Amorphous cores (13)

These are less standardised pieces which were unclassifiable as any of the above categories.

Divers (l)

This was perhaps used as a kind of *tranchoir* or chopper.

Fragments (18)

Some of these verge on being 'chunks' of waste material, but all seem to have produced flakes. On the whole the impression is gained that the techniques of biface-preparation have been used to make cores for flakes. The presence of so many aborted (and presumably abandoned) cores indicates that the makers did not always succeed by this method in making 'good' flakes, even when they worked the piece additionally to make a true striking-platform. Nevertheless, the number of core-bases, already mentioned, the original form of which is unrecognisable, and the fact that 14% of the flake-tools were made on seemingly 'prepared' flakes, shows that some successful flakes could be produced.

The unretouched flakes

The level R assemblage contained over 2,000 flakes, l,949 of which were intact or nearly so. Many other flake-fragments were placed as waste (or debris) following the Bordean system and because it was known that the immediately-local flint is of very poor quality; it is full of inclusions and shatters easily when struck; small fragments are therefore not included in the following study. This was carried out by the same methods, and with the same definitions of the attributes and variables, as were used at Lion Spring (Copeland, *infra*, a).

The flake sample was originally divided into two by the excavators into 'Bagged' and 'Not Bagged ' groups. In the former, each flake had been carefully protected from 'bag retouch' by being placed in individual plastic sacks. It is envisaged that use-wear studies will be carried out on the bagged sample.

To make the sample more manageable, the unretouched flakes were divided at random into four samples. Two samples were completely classified as to patina and condition, type of flake, type of butt, dimensions, butt angle, etc. The others were classified as to patina, type of flake and dimensions. The results from each of the two groups were found to be generally consistant; in group l, the main morphological attributes of l,250 fully classified flakes are shown (Table 7), and the IFs and the frequencies of the other butt-types are taken from this total (it includes a small group of 22 'utilised flakes', kept separate as being of possible interest to use-wear analysts). The second group was also classified into flake-types. The totals of the two groups (l,949 pieces) were combined to construct Table l and the IL and ILam are based on this total. After removing the 6l2 biface-trimming-flakes, according to the Bordean system, from the total, the remaining l,337 flakes were used to compute the IL(restricted) and ILam(restricted), as shown on Table 7. Finally, c. l,000 flakes were used to compute the ordinal scale size-distributions, also shown on Table 7.

A common trait which can occur on all types of C-Spring flakes consists of a 'tranchet' facet on the ventral surface, set obliquely at an obtuse angle to that surface; as already mentioned, these are elsewhere regarded as cleaver finishing-flakes (Note 4). The facet can run the entire length of a flake and is usually wavy (see examples on Figs. 22, 1 & 22, 3). When the oblique ventral facet also runs into, or is opposed to, core-preparation retouch, for example on the inverse surface of a plunging-flake, the piece can resemble a flake tool, retouched inversely. These pseudo-tools (examples are shown on Figs. 8, 3 & 22, 3) are quite common in all classes of flakes at C-Spring. Many flakes show radial preparation on the dorsal surface.

However they are either 'failed' flakes such as plunging-flakes (where the other end of the core is carried away on the flake as in Figs. 7, 3 & 8, 4), flakes hinge-fractured at the tip, or core-edge flakes (where part of the striking-platform and lateral edge of the core (or biface) is carried away on the flake as in Figs. 8, 2 & 22, l); another form has a huge, plain, wide-angle butt without trace of the vertical platform-preparation mentioned above. Just as at Lion Spring, it is felt that such flakes, in spite of their radial dorsal faceting, are not Levallois but have been struck merely from the reverse side of bifaces or cores during bifacial working, with only minor (or no) 'true' platform preparation. We will describe each group of flakes in turn:

Levallois flakes (47)

There are 35 unretouched Levallois flakes, e.g. Fig. 9, l-4, and l2 other Levallois pieces used as blanks for retouched tools. The IL on 47 pieces is 2.41; the IL(restricted) is 3.5l (i.e. without the 6l2 biface trimming-flakes (*éclats de taille de biface*). This index is low, but higher than the 0.3-0.7 at Lion Spring. The Levallois class is confined to pieces which not only show prior shaping on the dorsal surface in the form of radial removal scar patterns, but also traces of the special preparation of the core's striking-platform, which is regarded as the final stage in the Levallois method (Tixier *et al.*, 1980; Bordes, 1950 and 196l).

Of the 35 unretouched pieces classed here as Levallois, the largest are those shown on Figs. 9, 1 & 4, the rest being medium-sized or small. Almost as many had plain butts (8) as had faceted butts (10) and many of these butts were wide-angled, with thick bulbs of percussion. Only two are slightly pointed (Figs. 9, 2 & 3). It will be appreciated that even these flakes could have been by-products of core-tool making rather than having been deliberately pre-formed; in fact, some of the flakes classed as Levallois (which have a distinct striking-platform) also have the 'tranchet facet' implying that they were struck on this platform from cleavers; this points up the highly subjective nature of the Levallois/non-Levallois division in the C-Spring industry. Other specimens which have been used as blanks for flake-tools are shown on Figs. 16, l & 22, 1).

Cortex and Part-cortex flakes (713)

These are the products of primary core-peeling of the raw flint nodule, as well as the secondary preparation of the cores; they form 36.73% of the flakes. Only 60 pieces are entirely covered with cortex but many more have partial cortex, as shown on Table I as do many of the core-edge flakes; these artifacts often appear Levallois-like in having radial dorsal facets (e.g. Fig. 22, 2).

Non-cortex ('ordinary') flakes (586)

These amount to 30.6% of the flakes. Of the non-cortex flakes, Flat debitage types greatly outnumber those made by Orthogonal debitage, as would be expected given the core-types prevalent. The Flat debitage flakes also appear Levallois-like when they have radial dorsal scar patterns. As already indicated, apart from some which could have been deliberately made for use as tool-blanks, these flakes grade in appearance, size and debitage into the *éclats de taille*.

Biface trimming-flakes (éclats de taille de biface) (612)

These are distinguished, as at Lion Spring, according to F. Bordes (196l) as the small oval, hexagonal or transverse flakes produced during the shaping and final finishing of cores or bifaces (he also notes that they are recognisable by their thinness, curvature, shattered or punctiform butts, traces of soft hammer working, and non-use as tools later; Bordes, 1950, 30-3l). In this study, an arbitary limit of about 3 or 4 cm. length divides them from the other non-cortex flakes. Typical specimens are shown on Figs. 4, 5 & 6. As with the 'ordinary' flat or orthogonal flakes, these small flakes can be divided into flat (e.g. Fig. 5, 2 & 3) and orthogonal types, the latter having core-edge or other faceting features on the dorsal surface (Fig. 6, 2).

The morphology of the flakes is varied, with ovoid, offset, transverse and 'square' shapes being the most common, and blade forms the least common, as can be seen on Fig. 28; the ILam(restricted) is 8.82. If blade forms are rare and rough in the assemblage, pointed forms are even less frequent; a few flakes could be regarded as pseudo-Levallois points, one being shown on Fig. 8, 2.

The butt chart (Table 6) shows that of the l,250 butts recorded the most important category (30%) is plain, with shattered/punctiform not far behind with 20%, and only l.l% had the butt removed by retouch. This is a fairly typical picture for an Acheulean industry and the frequencies are comparable to those at Lion Spring except that the faceting index (here at 15.36) is lower at the latter (4.9 - 8.0). However, it is worth noting that these butt frequencies contrast with those in the retouched tool group. Here, 27.2% of the flake-tools have removed butts, only 2.40 are shattered/punctiform. No tools were made on *éclats de taille*. There are also differences in the flake-type frequencies, the number of Levallois flakes used as tool blanks being higher, at 14.45%. These observations tend to confirm the assumption that some flakes were deliberately made for use as tool blanks and that others were not.

Butt angles ranged from 90 to 135 degrees but only half of the flakes (i.e. the cortex, plain, dihedral and faceted categories) could be measured. The most 'popular' angles were those between 105 and I20 degrees (58%) with fewer acute angles (of 100 to 90 degrees: 20%) or wider angles (125 - 135 degrees: 18%; examples of the latter are shown on Fig. 9, 2 & 4). These frequencies are also typical for an Acheulean industry, although the faceting index suggested that we could expect more angles nearer to the right angle.

The overall size of the flakes is recorded on Table 7. The lengths of the majority (I,06I pieces) were classed on an ordinal scale, the frequencies showing that about half of the flakes were 'small', as shown on Table 8 ; the two largest (both transverse flakes) measured II.5 x 13.0 x 6.4 and 8.0 x 15.9 x 3.5 cm. The *éclats de taille* are not included in the percentages (Note 5).

As a check and in order to establish the probable width/thickness ratio, an additional I24 flakes were randomly selected and measured as to greatest length, width and thickness (Fig. 28; this figure clearly shows up the general thinness of the flakes, irrespective of size). The mean W/Th ratio of this sample (also given in Table 7) is 4.440, which is closely comparable to the value at Lion Spring's upper levels (4.424). It differs from the ratio for the retouched tools, which is 3.014 on 82 pieces, i.e. the tools were made on thicker flakes. This is taken as another indication that the thinner flake component may not have been deliberately made for tool blanks and, rather, represents by-products of core- or core-tool making. On the other hand, level S flakes, retouched or not, were generally thicker (W/Th ratio: 3.407).

Summing up, the analysis of this large flake sample leads to the conclusion that at least two kinds of debitage techniques were being employed at C-Spring, each for a different purpose and having different results. Both hard (stone) hammers for cortex-peeling and required flake-making, and soft (bone or wood) hammers for final biface-shaping and finishing, would have been used, the latter probably more constantly. No pieces resembling hammerstones were present among the finds studied here but both limestone, flint and basalt pebbles and chunks of flint did accompany the artifacts.

Neither of the two techniques mentioned above seem to have been designed for the making of elongated, narrow flake forms such as was the case in the Desert Wadi Acheulean assemblages discussed *infra* and it will be recalled that orthogonal debitage and blade-cores were rare at 7.9%.

The Tools

The level R tools consist of 62 bifaces, 3 discs, 7 choppers and 84 retouched flakes, mainly racloirs and denticulates. Each category will be described in turn following the Bordean method although it was necessary to include some alterations and additions to Bordes' typelists to suit the material.

LEVEL R BIFACES (62). TABLE 2

A description of the formal categories, based on outline, will be followed by additional attribute analyses, shown in Tables 5, a - e), following the same method as was used at Lion Spring.

Discoid (5) Fig. 10, 1

These are mediuim-sized or small bifaces, subcircular in outline, grading into ovates. One may have been re-used as a core.

D-Shaped (3) Fig. 10, 3

This name was first used at Lion Spring by Rollefson (1980). It is reserved here for bifaces round or oval in outline except at the base, which is jagged and has a truncated appearance, giving the piece its 'D' shape. This form seems characteristic at Azraq, both at the spring sites and in the desert wadi surface-sites. One piece has a retouched, thick 'back', perhaps a backed knife. Two have cleaver-like tips.

Pointed Ovate (2)

These have ogival, rather than sharply pointed, tips and are widest at mid-point. On one the point may be due to damage.

Ovate (8)

This is a well-made and typical group, two having a large, lateral *méplat*, two having cleaver-like tips. One piece has an awl-like tip, caused, however, by damage.

Elongated Ovate (4) and Limande *(l) Figs. 10, 4; 11, 1 & 3*

These are very similar pieces, and one type grades into the other. Two of the elongated pieces have cleaver-like tips (ll, l)and one (10, 4) has a used and a fresh, unused edge. Two have large, lateral *méplats* (i.e. flat areas perpendicular to the two faces, which may be the remains of striking-platforms, e.g. Fig. 11, 3).

Subovate (8) Figs. 10, 2 and 11, 2

These are pieces with irregular oval outline, as in Fig. 10, 2; Fig. 11, 2 shows one of the few pointed bifaces in level R, but it may be a reworked core. Four pieces are classed as partial subovates, as they have either large amounts of cortex or natural-fracture surfaces; the fifth piece, more elongated than the others, has a cleaver-like tip.

Bifacial Cleavers (l6)

As classified here, bifacial cleavers have the tip made by transverse, sometimes opposed, blows onto both faces; they are made, not on flakes but on nodules or slabs. Almost all are ovoid in general shape, and therefore grade into ovates. They form 25% of the bifaces and can be divided into sub-categories according to the shape of the distal edge:

Straight tip (5) Figs. 12 and 13, 2

The drawn specimens are among the largest in the biface sample. They all have fairly large *méplats* near the base and a few have a sharply-edged base. The cleaver-edge on one smaller piece has been formed from the distal end of a facet on one face. One piece is unique among the bifaces in having a patch of lustre (stream-gloss). Fig. 13, 2 shows another unique piece with very narrow tip.

Straight/oblique tip (3) Fig. 14, 2

The drawn piece is unusual in having a divergent (wider than base) tip. On two pieces the tip is damaged and the third would be classed as an ovate were it not for the distinctive transverse facets forming the cleaver-edge.

Rounded (i.e. slightly convex) tip (6)

Two are elongated; one has a thick back and is only partially retouched. Another piece has two patinas and refreshed areas. The sixth piece seems to have been used as a core.

Unifacial (2)

One is straight-tipped, the other is round-tipped and both have cortex on the reverse face, with retouch only at the edges in one case.

Amygdaloid (3) Fig. 14, l

Both of the larger pieces are short and thick (e.g. 10.4 x 8.3 x 3.5 cm.). The drawn piece has an extremely thin and sharp tip. The second larger piece has one long and one short cutting-edges with a large lateral *méplat* which forms a virtual back. The third specimen is minute (5.5 x.4.4 x.l.6 cm.), but well-made.

Atypical Amygdaloid (3)

The general shape of this group is more irregular than that of the Amygdaloids proper, one being elongated, and two having poorly-worked bases as well as areas of cortex.

Backed (1)

One lateral side of an oval, irregularly-retouched piece is formed of a large *méplat*, forming a vertical back. The tip is damaged but resembles that of the cleavers.

Small bifacial piece (1)

An irregularly-shaped, although carefully-faceted, piece which may be a re-worked core-base (Note 6).

Divers (2)

One is a large, oval piece with tip broken off, and resembles pieces found in the Wadi Butm (see Besançon *et al.*, *infra*); the other is difficult to orient, but has good radial retouch on one face, a flat plane on the other with abrupt retouch forming a back.

Fragments (4)

These consist of a base, a tip and two sides, apparently all from ovate bifaces.

Attribute analysis of the bifaces

In addition to the formal classifications of the bifaces, other attributes were recorded as follows:

Raw material and blank

Two thirds (67%) of the bifaces were made of flint, 10 of chert and 9 of banded flint/chert. Of the 39 pieces where the blank form could be distinguished, almost all (28) were made from tabular slabs, five were made from nodules or pebbles, and three on older pieces or fragments. Only two may have been made on flakes, although this is not certain.

Types of tip

Table 5a shows that pointed tips are very rare, the two specimens forming 3.4% of the 58 recognisable tips. Ogival tips (Fig. 14, 4) are frequent at 3l% of the recognisable biface tips, but rounded tips dominate at 41.3% (Fig. 10, 3 & 4); this category includes the cleavers, which have straight/convex tips made by transverse blows, as in Fig. 13, 1.

Transverse blows at the tip are also present on the straight (Fig. 12), straight oblique (Fig. 14, 2) and accuminate (Fig. 13, 2) categories; this type of tip retouch forms 37% of the biface tip types.

Types of base

Table 5b shows that more than half of the bifaces with recognisable bases (56.8%) have fully edged bases (Fig. 14. 1), six having perfect semi-circle shape (this term was used by Stekelis and Gilead (1966) at Ma'ayan Barukh). The value rises to 63.7% if pieces with half the base edged are included. Another 22% have worked bases, on 6 of which the retouch resembles that seen on core-striking-platforms, as in Fig. 11, 1. Only 7 pieces have cortex butts (6%).

Types of cutting-edges

The frequencies on Table 5c show that 'two straight lateral edges' dominate at 42% (six of these have what amounts to 1,5 edges, the rest of the second side consisting of a *méplat*.

'Straight/sinuous' means slightly irregular but straight in the overall (Fig. 13, 2). The first two classes, together, form 70.4% of the bifaces. The S-twist feature is rarely present (4 pieces).

Types of face retouch

The dominant kind of face retouch (Table 5d) is the, often rippled, fine secondary or finishing retouch (Figs. 10, 4 & 14, 1) done with wood or bone hammer (63%); a total of 48% of the bifaces are retouched all over both faces. If another 8 specimens with mainly fine retouch (e.g. Fig. 11, 3) are added the value rises to 76%. None are in primary shaping condition although 10 specimens have fine retouch only at the edges, often with patches of cortex.

Step-scalar (resolved) retouch is common on small areas, e.g. at the side of *méplats*, i.e. opposed to what appear to be striking-platforms. Transverse retouch is uncommon except at the tips of the bifacial cleavers. Revolving or alternate lateral edge retouch is present on a few pieces, but much more frequent are radial scar patterns (Fig. 12).

Profile

Numerous pieces are flatter on one face than on the other, which is domed; this gives the piece a plano-convex or asymmetrically biconvex profile, as in Fig. 14, 1. The majority are biconvex, slightly biconvex, as in Fig. 12, or flat, as in Fig. 11, 3.

Dimensions

The bifaces are of moderate size (Table 5 d), 72% being under 10 cm. long; there is only one very large piece, perhaps 14 cm. long when reconstructed. The mean length amounts to 10.77cm., excluding fragments. The mean compares well with that at Lion Spring (10.29).

There are 26 'thin' specimens and 32 'thick', as defined by Bordes. Since tabular slabs form the principal raw material, the incidence of thick and thin categories which were determined by the presence of cortex on each face (i.e. natural thickness) was noted, as against thickness formed by retouch. It appears that almost the same percentage (c.25%) of thick bifaces are formed by retouch as are left thick naturally, and it is the same with the thin specimens (25% determined by tabular raw material and 23% achieved by all-over retouch).

The length/width and width/thickness frequencies are shown on Fig. 29. As can be seen, the lengths and widths are generally less than occurs on Desert Wadi Acheulean bifaces (cf. Copeland & Hours, *infra*), although the thicknesses are similar.

Other core-tools

Discs (3)

These are three small (e.g. 4.7 x 4.4 x 1.4 cm.), sub-circular, bifacially-worked pieces which may be worked down bifaces or even racloirs on re-used cores.

Choppers (13) Fig. 15

This group includes a rounded flint wadi pebble (5.5 x 5.0 x 0.9cm.) with one distal removal which may be accidental. The other 12 may be divided into various sub-groups:

a) Distal, with the chopping-edge on the supposed distal end of the nodule (5 pieces, one being unifacial). One has a divergent edge (Fig. 15, 1), i.e. wider than the base.

b) Distal and lateral, with L-shaped chopping-edge (3 pieces, one being unifacial).

c) Pointed, with a blunt point on the chopping edge (3 pieces, as in Fig. 15, 2 & 3); similar pieces occurred at Lion Spring.

d) Double-ended; one piece, with a unifacial end and a bifacial end.

The Retouched Flake Tools (84) Table 2

An attempt was initially made to classify the 84 retouched tools on flakes according to the well-known type-list of F. Bordes (1950), in order that comparative studies could be carried out. Given that Bordes' list was constructed to deal with Middle Paleolithic industries in France, it is not surprising that the list was not found to fit the material comfortably; it would have been possible to use it only at the expense of supressing certain features which cross-cut the

Bordean typological divisions and which, in fact, gave the industry its character. (The more 'African' terminology used by Ohel (1986) on Upper Galilee Acheulean material was also considered, but rejected for the same reason.) Three examples of such features are: the frequency of inverse (i.e. ventral surface) retouch, the presence of bifacial edges on flake-tools and the almost universal presence of composite, 'mixed', or multiple, tools. A list was therefore drawn up, generally keeping to Bordes' order, and using his principle of dominence (Bordes, 1961, 10-11). In this system a racloir takes precedence over a denticulate, so a piece with two areas of retouch, one a racloir and the other denticulated, would be classed as a racloir sub-type. At the risk of making the list too long, inverse (ventral surface) retouch was separated from pieces with obverse (dorsal surface) retouch, and given sub-type status, thus allowing the unusual incidence of this feature (e.g. 8% of the racloirs) to be highlighted. Several sub-types were also listed for the denticulates, notches, and end-scrapers.

Finally, the frequency of bifacial edges was allowed for by making this also a sub-type, only, however, when it was clear that the bifacial appearance of the edge was not due just to faulty knapping techniques (e.g. the edge or end of the core coming away on the flake).

The resulting classifications are still somewhat subjective and the definitions have had to be stretched. The list does not include the few Levallois unretouched flakes, which were described earlier.

Racloirs (39)

These form 46% of the flake-tools. The majority are distinctly 'non-Bordean' in style. Single racloir types are the most rare, while more typical are the transverse and bifacially-edged types. None are very large and only three are 'small'. At least 38% have Quina or demi-Quina retouch, usually rather roughly carried out, and without achieving the perfectly straight or convex crushed edges characteristic of Yabrudian assemblages. This Quina retouch occurs on thick flakes where the desired edge-shape is obtained by substantial retouch in ranks of flat scalar removals which become smaller, steeper and stepped (resolved) near the edge. The use of thick transverse flakes as blanks, and the heavy retouch carried out so close to the (usually large) bulb of percussion often allows the tool to be rocked from side to side (cf. the 'rocking-chair' effect as noted by Garrod and Bate at Tabun). Demi-Qina retouch (according to Bordes, not so steep or extensive) is similarly formed. At C-Spring, apart from a *rabot* and a *bec*, this kind of retouch is confined to the racloirs.

- Single racloirs (8) Fig. 16, 1

Three are convex, made on small flakes, the drawn one (although with a tranchet facet) being Levallois-like. Two have flat scalar retouch, the third is demi-Quina and also has inverse retouch, perhaps from core-preparation, at the distal end. Three are straight, one with Qina retouch; there are two concave specimens, both made on part-cortex flakes, one with Qina retouch.

- Double biconcave racloirs (2)

One is on a Levallois-like, radially-prepared flake, but has thinned (i.e. partly-removed) butt. The other is a composite tool with two concave areas of steep retouch and nibbled retouch at the distal end.

- Offset racloirs (3)

One is on a flake-fragment with Quina retouch, another possibly a reworked denticulate, the third being on a small core-edge flake with demi-Quina retouch.

- Transverse racloirs (6) Fig. 16, 2; 16, 3

One is straight, is made on a thick, triangular transverse flake with butt removed. The straight edge is made by ranked Quina retouch and this continues around the lateral side to the butt. Five are convex; four are made on triangular transverse flakes, the offset tip removed in two cases. One has Quina, two have demi-Quina retouch and two have additional inverse retouch forming a bifacial edge, as in the drawn piece, a non-Bordean type.

- Single inverse racloirs (Straight or Convex) (3) Fig. 18, 2

Two are made on core-edge flakes with flat scalar retouch on the inverse; the third is a cortex flake with additional 'nibbled' retouch on the ventral surface. The drawn piece could be seen as a very rough convergent.

- Double inverse racloirs (3) Fig. 17, 2

One of these is a triangular ('winged') transverse flake, one corner having convergent, inverse Quina retouch, the other having straight, flat and Quina dorsal retouch (Fig.17, 2). Another piece has transverse racloir retouch on one surface and lateral and distal retouch on the other. The third is a radially-prepared flake with distal Quina and lateral abrupt retouch.

- Composite inverse racloirs (3) Figs. 17, 3 & 18, 1

These pieces have three areas of retouch: an inverse racloir with either a notch, notches, or a denticulated area plus continuous retouch (one also has an area of bifacial retouch; Fig. 17, 3).

- Racloirs with thinned back (1) Fig. 17, 1

A large cortex flake with distal oblique inverse retouch and lateral core-edge, thinned by one large removal.

- Alternate racloirs (2)

Both are small flakes with an area of retouch on the inverse, continuing on the other face. One piece has an additional bifacial edge area and could be regarded as a composite; however it seems to have been reworked.

- Racloirs with bifacial edges (6) Fig. 20, l

These are pieces with variously-shaped, discontinuous, bifacial edges. The drawn piece has distal and proximal bifacial retouch on a flake with butt removed. One could be regarded as a convergent, 3 as convex and one as straight edged; in each case, the retouch is flat scalar on both faces, one face more heavily-retouched than the other except in the case of the convergent.

- Bifacial racloirs (1) Fig. 18, 3

A unique piece with all-over retouch, flat scalar as well as demi-Quina, on a large, rounded flake with plain butt; it is virtually a biface.

- Racloir fragments (1)

Part of a Quina racloir with butt removed.

End-scrapers (7)

- End-scrapers on flakes (3) Fig. 19, 2 and Inverse end-scrapers (2)

Three have scalar, semi-abrupt retouch at the tip of oblong flakes, one Levallois-like. Two seem to have been refreshed. Two have inverse retouch at the tip.

- End-scraper composites (2) Fig. 19, 1

These are made on oblong flakes, the drawn piece being Levallois. One is combined with a single convex racloir, the other with a denticulated area continuing down the lateral edge, possibly accidentally-broken.

- Massive scraper/steep-scrapers (2) Figs. 19, 3 & 4

Fig.19, 3 shows a large flake-scraper, partly bifacially-retouched distally, the blank being a part-cortex transverse flake. The steep-scraper or *rabot* has vertical, abrupt retouch on a very thick (and now short) flake (Fig. 19, 4).

Burins (2) Figs. 20, 2 & 3

Fig. 20, 3 shows an angle burin made on a part-cortex flake fragment; Fig. 20, 2 shows a truncation burin, struck on the thickness and along the width of a transverse part-cortex flake with a core-edge area as the spall removal-platform.

Becs, *Alternate burin and* Becs, Bec *composites (4) Fig. 20, 2 & 4*

Small points have been made on the distal ends of two small flakes, in one case with alternating inverse retouch.

In both composites the *bec* is combined with an area of racloir retouch on the inverse surface.

Denticulates (4), Inverse denticulates (2), Denticulate composites (3) Fig. 21, 1 - 4

These are small or medium-sized non-Levallois flakes with irregular or jagged edges in the form of large (as in Fig. 21, 3) or small 'teeth'. Fig. 21, 2 is made on an older, white-patinated cortex flake with natural back. Two have the 'teeth' on the inverse surface at the distal end of short flakes.

One composite is combined with a *bec*, another may be regarded as a double notch with continuous, nibbled retouch, and the third has various kinds of 'extra' retouch.

Notches (6) and Notches with continuous retouch (4) Fig. 22, 2

Two are lateral notches (one on a Levallois flake), four are more or less distally placed notches on irregular flakes, and four have additional areas of retouch. The aperture on four is 0.5 cm., on the other two it is wider.

Continuous retouch, abrupt or semi-abrupt (3) Fig. 22, 1

The drawn piece is a Levallois-like trranchet or cleaver flake with a slightly denticulated area of lateral retouch. Another is a core-edge flake with three areas of irregular retouch, some on the inverse, while the third is a tranchet flake with distal flat and semi-abrupt retouch.

Continuous Bbfacial edge retouch (3)

The drawn piece has a distal bifacial area but the lateral removals refer to core-preparation. The other two have varying amounts of minor bifacial retouch, usually of a different quality on each face (e.g. parallel, opposed to flat scalar). One has been refreshed.

Truncated-faceted flakes (l)

This small flake may be a splintered piece or a plunging-flake, but the bipolar removals seem to have been done after the detachment of the flake from the core (Note 7).

Naturally-backed knives (2)

One is on a larger part-cortex blade with 'utilisation retouch' on the cutting-edge. The other is a broken cortex flake, but the remains of the cutting-edge and tip are thin and sharp, with slight signs of utilisation.

Flake-chopper (1) and flake cleaver (1)

A massive part-cortex, core-edge flake has had its distal end roughly worked bifacially to a sinuous, chopping-tool-like, edge. The cleaver is a large flake with butt removed and a cleaver-like tip made on the proximal end.

The 'Waste'

This consisted of small flint pieces not classifiable as cores, although they appear to have been worked, as well as flake-fragments, all buttless, the two groups totalling 768 pieces.

The percentage of patina colours was the same as that for the artifacts, led by PGM; only 17 pieces were black and 6 were white-patinated (these percentages have already been included in the listed patina values (Table 8).

Assessment of Levels T - R

The artifacts in these levels closely relate to eachother typologically. To take level R, its tools clearly represent the Levantine Late Acheulean in that they include plenty of well-made bifaces (c. 40% of the 162 retouched tools) of moderate size, mainly with rounded tips, with evolved functional traits (straight edges, edged bases, fine-flaking etc.) and a good number (53.8%) of flake-tools such as massive scrapers and transverse Quina racloirs, most of standard late Lower Paleolithic type. Many flake-tools are less standardised and tend toward inverse and multiple retouch types.

The unusually high number (25%) of bifacial cleavers (which are unlike those of Jisr Banat Yakoub (Stekelis, 1970) in not being of lava, not made on flakes, and not being large) sets the assemblage apart from other Near Eastern Late Acheulean variants as is discussed below.

Technologically, the cores' negative scars show that numbers of flakes 'failed'; biface-like and radially-prepared forms dominate, elongated types being virtually absent; debitage seems to consist mainly of the by-products of core- and biface-making, but also includes flakes made expressly, it is assumed, as blanks for flake-tools (among which are the 14% Levallois flakes in fact so used as blanks).

Since the industry is of non-Levallois debitage and of non-Levallois facies in Bordean terms, the few Levallois pieces are not counted here as 'tools'. Since the retouched flake-tools slightly outnumber the bifaces, the facies may be referred to an evolved stage of the Late Acheulean, somewhat younger than the DWA of Copeland & Hours (*infra*).

LEVEL Q b

Level Q was the next horizon above R to contain artifacts; it consisted of grey-blue silt, which included poorly-preserved animal bones and bovid teeth (Garrard *et al.*, 1987; Hunt and Garrard, *infra*); because of its thickness it was arbitarily divided into two parts, b and a.

The Q b artifacts consist of 330 pieces: 11 cores, 215 flakes, 22 tools (7 of which are bifaces) and 79 debris. So far as can be seen by eye inspection, the artifacts are mainly in fresh condition. On a sample of 321 artifacts (i.e. excluding the 79 waste and the chert pieces), there is (in relation to the lower levels) a further progression of patina colours away from beige and toward dark grey/olive and PGM. Beige patinas drop to 6.49%, dark grey (28.1%):and olive (15.58%) combining to make 43.72% leaving PGM just dominating at 45.8%. White patinas amount to 3.71 and there are no black pieces.

The Cores (11) Fig. 23, I & 2

The sample is small, four of the 11 specimens being fragments; of the remaining seven, five are Levallois, representing a marked difference from the core frequencies dominant up to now. One is a classic Levallois tortoise-core (Fig. 23, 1), and three are probably related to the 'Galilee Core' type reported by Ronen *et al.* (1980) from sites in Upper Galilee characterised by transverse faceting on the underside (Fig. 23, 2); all are thin and have distinct striking-platforms, fairly well-faceted but not to the extent usually seen on the Middle Paleolithic cores of the Levantine Mousterian. The non-Levallois cores (one Orthogonal and one Flat Acheulean Transverse) are typical of the cores in the lower levels.

The unretouched flakes (215)

These are very similar to the flake component of levels T - R some with tranchet facets (e.g. Fig. 24, 4) some with core-edge features, but the impression is gained that even the 'ordinary' (non-cortex) flakes are biface trimming-flakes only somewhat larger (Fig. 23, 3). However, there are a few more 'good' flakes, the IL is slightly higher and the butt angle frequencies have changed.

There are seven Levallois flakes, two of which are blades, one an atypical point (Fig. 24, 2) and these give an IL of 3.04 if the *éclats de taille* are included or an IL(restricted) of 5.55 without them.

The majority of the non-Levallois component are *éclats de taille* (107) which form 49.76% and flat debitage flakes (55) or 25.58%, and only 19 were cortex or part-cortex flakes.

In all there are 15 blades, giving an ILam(restricted) of 11.90.

As to the butts, only 5.55 are faceted, which is the IFs on a sample of 126 (*éclats* excluded). As in the lower levels, the main butt-type is plain (24.6%) followed by shattered/punctiform (22.22%); however, the number of removed butts has risen to 6.34%. These values are affected by a good number of absent or unrecognisable butts (22%).

Most of the flakes are medium to small in size, only 3 pieces being over 8 cm. long (the largest measuring 8.3 x 3.5 x 0.8 cm.). In contrast to level R, the most 'popular' butt angles are those between 95 degrees and 105 degrees (64.7%) this is twice as frequent as before, while wider angles of 110-120 degrees form only 32.35%. The widest angles of 130-135 degrees (present in level R at 14%) are absent.

As to the width/thickness ratios, on 74 pieces measured for greatest length, width and thickness, the mean was 4.713, which indicates that the flakes are thinner on average in this assemblage than in the lower levels (the value may have been affected by the number of pieces mentioned above which seemed to represent larger *éclats de taille*).

The Bifaces (22) Fig. 24, 3

The seven bifaces (a discoid or D-shaped piece, 2 bifacial cleavers, 3 ovates and an amygdaloid) seem stylistically similar to, and as evolved as, those of level R, but five are small and the other two not large (the longest, the amygdaloid, measures 11.2.x 8.3.x 3.7 cm.; it is a typical, well-made specimen although the pointed tip is damaged). The D-shaped piece, with typical 'truncated' base, may be a re-worked discoid. All three ovates are small, one is more a subovate and of the two bifacial cleavers, the drawn piece is unusually thick at the base, while the second has an accuminate tip; since it has two patinas and pot-lid fractures, this piece seems to have been reworked from an older one.

The attributes of the bifaces are shown on Tables 5a-5e. In general they are evolved; the amygdaloid has a 'perfect semi-circle base'.

The Retouched Flake-tools (15) Fig. 24, 1

The inventory is given on Table 2. Besides the seven bifaces, there is one heavy-duty tool, an atypical *rabot* on a very large non-Levallois flake with a U-shaped scraping-edge. The other *rabot* may be seen rather as an atypical *limace*; it has Quina and demi-Quina retouch and is rather wide.

One of the three racloirs also has Quina retouch (Fig. 24, 1) and is a typically Yabrudian transverse type, made on a cortex flake with removed butt and two lateral *méplats*. Both the other racloirs have inverse retouch, one concave. The end-scraper is made on a part-cortex blade, also with inverse retouch. The other tools are rather poorly made, two are perhaps multiple tools (inverse notches with continuous retouch), another is a fragment with a bifacial edge (a pseudo-tool?) and the last has very slight 'utilisation retouch'.

Summing up, there are indications, even if slight, of technical differences in the level Q b assemblage in comparison with level R. There is slightly more of a Levallois ambience, the flakes are thinner on average, the ILam is higher and there are relatively more flake-tools. However, the industry seems stylistically little different from that of level R even though its stratigraphic position suggests that it should be of later date.

LEVEL Q a

This assemblage came from the upper division of level Q. It consists of 408 artifacts (4 cores, 5 bifaces, 302 unretouched flakes, 2 flake-tools and 97 waste pieces).

The debitage

The artifacts are apparently in fresh condition with one exception, which is a abraded biface, perhaps re-used. As to patinas, Table 4 shows that grey patinas are even more common, half the assemblage consisting of PGM pieces (51.22%) with only 7.84% being beige. In the waste there were 13 black-patinated pieces (3.18%).

The core sample is very poor, only one of the four pieces being distinct. It is an Acheulean Transverse type, such as was typical in the lower levels, having a bifacial cleaver-like sharp tip and, at the blunt end, step scalar and flat retouch (sketched on Fig. 25, I).

In the flake sample, the largest group is formed by the *éclats de taille* (55.56%). Apart from this, the number of 'good' flakes has risen, the 76 flat and orthogonal types outnumbering the cortex, part-cortex and core-edge flakes (54 pieces). The Levallois flakes, although not all typical, are slightly fewer than in Q b, the IL(restricted) being 2.98. There are 13 blades giving an ILam (restricted) of 9.70, which compares well with the Q b value of 11.90.

Morphologically, the flakes are generally comparable to those of the previous levels, that is, they are mainly small or medium in size (although there are a few large part-cortex specimens), some being tranchet flakes, others being hexagonal or winged, transverse or offset in outline. By an oversight the recording of the butts was not completed, the 10 recorded butts consisting of 5 faceted, 2 plain, 2 shattered and I removed.

There are 97 waste pieces, four large, the rest being medium or small in size.

The Tools

Of the five bifaces, 4 are atypical and may in fact be discoidal or oval cores; one of these is slightly abraded with battered edges; it is also unusual in having a brownish patina on beige raw material (this piece may have been curated from another location (Note 8). Another has a concave and a transversally-retouched convex face, and may, rather, be a re-worked Levallois core or a biface rough-out. The most typical specimen is a small elongated ovate with very fresh edges but damaged tip (Fig. 25, 3). The last piece is an atypically thick-based minute ovate (6.3 x 5.0 x 3.0 cm.).

The only two flake-tools consist of: an end-scraper on a large, non-Levallois flat debitage flake, wider at the distal end, and with lipped butt (Fig. 25, 2); a multiple tool, an inverse alternate racloir on a non-Levallois flake with removed butt. (The artifacts on Fig. 25 were rapidly sketched, without shading).

Summing up, the slight technological advance (higher ILam) seen in Q b is maintained in Q a, but the IL is no higher than in the earlier assemblages. There is little typological difference on the whole between the typology of Q b, Q a and R.

LEVELS P b AND P c

Level P artifacts came from a sediment described as grey silt of marsh origin which overlay the blue-grey silt of level Q (Garrard *et al.*, *ibid.*) The level has two sub-layers, P b and P c, as set out in Tables I and 2; the artifacts combine to form a total of 2II pieces (4 cores, 103 flakes, 2 bifaces and more than 100 pieces of waste.

The artifacts appear to be in fresh condition, no different on the whole from the material lower down; however, several pieces in P b had pot-lid fractures and a few (3%) were desilicified.

The prevailing patina colours are: PGM (42%) and dark grey (38%). There are no olive, brown or black patinas.

The debitage

The three intact cores are Levallois, one with classic tortoise-back shape; two are small, one medium-sized and all three have radial flaking-surface preparation although the striking-platforms are plain (2) or dihedral (1). Two have sharp, bifacial edges at the sides. The products could have been small, broad Levallois flakes.

However, of the 103 flakes, only two are Levallois, both in P b, giving an IL (restricted) of 5.71. The largest non-Levallois group is that of the *éclats de taille* (I6% of all 103 flakes). Except for five large, buttless, flat debitage flakes in P c, the flakes are medium or small in size. The 35 non-Levallois flakes are of the same types as seen in the lower levels; 9 are blades, which gives and ILam(restricted) of 25.71. Twelve have faceted butts, giving an IFs of 34.28. Both values are considerably higher than those for the lower levels, but the sample was extremely small.

The Tools

The only tools are two bifaces. One is well-made, a typical ovate with damaged tip, white-patinated and slightly desilicified. The other is a smaller, more irregular piece with trace of reworking (old patina).

Summing up, it is hard to decide whether the dominence of Levallois cores and the jump in the IFs and the ILam indicate a more Middle Paleolithic ambience in level P, or whether the small numbers of artifacts (except the *éclats*) in each category have distorted the percentages; it will be recalled that the lowest level, T, had an ILam (restricted) of 20.45. The presence of the bifaces suggests that level P is still part of the Late Acheulean, but one cannot rule out the possibility that they are re-used, older pieces, and that level P may relate more to the Middle Paleolithic which is known to exist close by at the location of the original site (C-Spring-BH), as evidenced by surface collections; on the other hand, the aforesaid collections consist of much more typical Levalloiso-Mousterian points, blades and flakes than are present in level P (cf. Note 1).

Assessment of Levels Q and P

Although similar conditions were noted, grey patinas had increased in these levels. The indications of change in level Q rest on an increased number of Levallois cores, the presence of a typically 'horse-shoe' specimen, a slghtly higher IL, thinner flakes and fewer very wide-angle butts.

Not all these advances are maintained, but the Levallois cores in level P would not be out of place in a Mousterian assemblage even though the IL is no higher than that of Q. The ILam and the IF have risen.

Nevertheless, the tools are the same on the whole as before, and suggest the Late Acheulean.

LEVEL L b

This small assemblage of 56 pieces was found in marsh clays above a calcrete layer, M (representing an unconformity according to the excavators). The layer was divided into four parts, the artifacts coming from sub-layers L b A, L b B and L b C (Table 3); the totals were combined, and the assemblage consists of: 4 burins, one end-scraper, one bladelet-core and more than 50 small blades and bladelets (one a crested blade: Fig. 26, 4).

The end-scraper is well made, on the end of a white-patinated, buttless, blade (Fig. 26, 1). One of the burins is carinated, possibly double, made on a thermally-split blade (Fig. 26, 3). Another is a polyhedric angle burin shown in Fig. 26, 2. The bladelet core (Fig. 26, 5) is a small, unipolar, single-platform type.

The assemblage could conceivably be Upper Paleolithic but given what is known from other sites in the vicinity (cf. Garrard *et al.*, *ibid*) it could equally well be early Epi-Paleolithic.

LEVEL L a

This level is in the upper part of the marsh clays mentioned above. The 101 pieces recovered came from seven sub-layers: L a A - L a H (Table 3). Combined, the artifacts consist of: one burin (*bec-de-flûte* type), 3 cores and a core-fragment (3 are for bladelets, one being double-ended), 3 core-refreshment elements (one a crested blade), 26 blades and flakes, 20 bladelets and 48 waste pieces, mainly bladelet fragments.

The condition of the artifacts is poor, many of the smaller pieces are desilicified or thermally-fractured. Virtually all are white-patinated with one or two blue-grey or beige pieces. Concretion was noted on some specimens.

Assessment of levels L b and L a

These levels clearly represent the Late Paleolithic or Epi-Paleolithic, but the tools are undiagnostic as to which phase. They are in poorer condition than the artifacts in the deeper assemblages. The excavations of Garrard *et al.* (1987) in the vicinity have shown that three phases took place in the oasis. Site AZ 17 has two Kebaran-like phases, one C.14-dated to

13,260 b. p. (Note 9) and Site AZ 18 had a Natufian occupation with burials, dated by Garrard to c. 12,000 B.C.

Levels L b and L a at C-Spring could refer to any of these phases, L b being the earlier.

LEVEL K

This is the last level to contain artifacts *in situ*, and these were found near the base of the aeolian silt accumulations of the uppermost levels. There are three assemblages, K A - K C.

The 33 artifacts are white-patinated, some being desilicified, one having a brownish patina. They are in somewhat better condition than those in level L b.

Among the finds in K A there is a well-made, tanged arrowhead made on a blade, with winged base, the tang and tip unfortunately broken off (Fig. 26, 7). The only retouch is on the notches which define the small wings at the tanged end. This is an early P.P.N.B. type of arrowhead, later types usually having pressure-flaked retouch on more of the surface (M. C. Cauvin, 1974). The wings, although small, suggest connections with the southern Levant rather than with the north; perhaps it was a Jericho Point, a type dating to just before 7,000 B.C. (Bar Yosef, 1981, 563). Also in K A are 25 undiagnostic flakes and fragments, only one of Epi-Paleolithic aspect.

In K B there are 2 blades (Fig. 26, 6), a bladelet fragment and an amorphous core. Only three chips came from K C.

On the strength of the arrowhead, level K should refer to the Neolithic, probably the early P.P.N.B. Early Neolithic sites of various types and in diverse locales are known elsewhere at Azraq, one (AZ 31) being C.14 dated to 8,350 b.p. (cf. Note 9), as described by Garrard *et al.*, 1987. Several arrowheads found at Lion Spring indicate an occupation there too (Rollefson, 1983); his Fig. 4, a & g show arrowheads with wings defined by notches above a tang, although another is more a P.P.N.A.-type of Khiyamian Point. Winged-base arrowheads are rare north of Azraq according to Betts (1986), although her Fig. 4, 35 may have incipient wings.

DISCUSSION

The sequence of layers in the 1985 sounding at C-Spring covers a long span of time and, although some phases seem to be missing, includes flint assemblages dating from the Lower Paleolithic to the Neolithic.

The best attested Paleolithic phase is that from the base of the sounding: layers S and R, which consisted of a 'river of fresh flint' overlying rolled fluviatile gravels (level T) in what is regarded as a buried wadi channel; the typology of the artifacts suggests an evolved Late Acheulean industry, with bifaces, bifacial cleavers, flake-tools and a large amount of unretouched debitage. According to the sections seen by Garrard and Hunt in pits dug for agriculture in the vicinity, the artifact spread does not extend much further south, and is confined to the buried wadi bed. The second sounding, put down in 1988 by Garrard and Hunt next to the first in order to clarify the stratigraphy, has added much valuable new information on the sediment layers, which can now be seen to have some equivalents in the sequence observed by Zeuner in 1958 at the original spring head site, C-Spring-BH. Instead of considering each site at C-Spring in isolation, therefore, it is now possible to see them in a broader perspective.

As described by Zeuner (*infra*) and discussed by Copeland (*infra*, c), the Late Acheulean artifacts of C-Spring-BH were found in a gravel (similar to that of Level T?), and sealed by a Ca horizon (similar to layer M in the 1985 sounding?). For Zeuner the site quite clearly represented an in situ Late Acheulean factory situated in a buried wadi channel. The inference is that at C-Spring, the Baker and Harza operations reached part of the same archaeological occurrance as was later unearthed further to the south by Garrard, and therefore we seem to have one occupation site stretching along the buried wadi from one locus to the other.

The extreme freshness of the artifacts indicates that they have either not been transported, or have been moved only to a negligeable degree, perhaps only by deflation within the wind-blown sediments which probably blanketed the surface of the wadi, as they do at the site today.

The Acheulean site can therefore safely be regarded as both archaeologically and geologically *in situ*, and it is the first and only site of this kind to be found in Jordan; at the only other Late Acheulean stratified site (Kirkbride's Lion Spring) the artifacts were found in the fluviatile gravels of the spring pool itself, and were therefore probably redistributed. *In situ* Late Acheulean sites are very rare in the rest of the Near East (Note 10) and none have produced such a quantity of artifacts from such a small area.

The typology and technology of levels T - R artifacts give us clear indications as to the use to which the site was put. The large number of tiny trimming-flakes, the number of cores, 'failed' or aborted flakes, and other debitage types suggests a factory site, mainly for the production of bifaces but also for flake blanks. It has already been noted that both hard and soft hammer (stone and bone) techniques of core reduction were employed.

One could suppose that the proximity of a perennial source of fresh water, (and the shelter of the flint outcrop mentioned by Zeuner), at a certain distance from the Sheshan swamp, provided an ideal flint-knapping site at which Acheulean man must have camped over a long span of time. The artifacts were probably produced on this spot by knappers ensconced along the dry wadi bed in which flint pebbles were available as hammerstones, and in which the spring itself may have emerged. Since it is clear that, at the time levels T - R were deposited, the site was not inundated, the local situation could have looked much as it does today except that the bedrock, and the outcrop of flint which had to be cut through by Baker and Harza, would have been more exposed then. As we know, the oasis swamps attracted large game animals and their predators, and besides hunting these, the C-Spring inhabitants also took steppe species (Clutton-Brock, 1970 and *infra*). Of course, without a wider exposure of the floor, some questions cannot be answered, such as whether the artifacts occur in concentrations of certain types (Note 11), whether the site was occupied seasonally or otherwise, and so on. The work of Toth and Schick (1986) has shown how much information as to hominid lifeways can be gained when a large, *in situ* exposure is available.

This writer has speculated (in press) as to why the way of life led by the Acheuleans at Azraq Oasis necessitated the use of bifacial cleavers and ovates at the expense of pointed types. Experimental work has shown that bifaces with convex edges are very efficient tools for butchering large (rather than small) mammals, and are better (except at making the initial incision into the hide) than the sharper, but more fragile flakes. However, according to Jones (1980) cleavers show no marked advantage over bifaces (except if they were to be used for skinning) since they have shorter working-edges. Toth (1987) has also demonstrated that each artifact type (sharp unretouched or blunt retouched flake, sharp-edged core or cobble) has its particular utility when used during the processing of carcasses.

In the chronological scheme for the Azraq Basin as a whole proposed by Besançon *et al.* (*infra*) the Acheulean of the springs is referred to their episode 5, an arid phase when the industry was deposited on a sheet of rolled wadi gravels which had been brought during the previous aggradation period of episode 4. This arid episode was followed by more humid episode 6 (which may correspond to levels Q and P), and then by a wetter one, episode 7, which the marshy sediments of level N may represent. Correlations between the Azraq Basin scheme (Table II of Besançon *et al.*) and the layers in the sounding are more difficult after this, due to the unconformity (level M) already mentioned (Note 12); this calcrete may correlate with a wet phase coming late in episode 8. There is thus some agreement concerning the Lower Paleolithic climatic chronology, and this tends to confirm a suggestion made earlier (Copeland, in press): that man could subsist at Azraq in arid periods as well as in moist ones - in other words, the Azraq springs rendered the Acheuleans independent of climatic fluctuations.

In terms of absolute dating, Copeland and Hours (1988) have speculated that the dry phase of the C-Spring knapping floor could refer to an interstadial such as that of Stage 7, dated to 250,000 - 195,000 years B.P. in the oxygen isotope scheme of Shackleton and Opdyke (1976), or even stage 9 (around 280,000 years). This dating is preferred to a later one since it incorporates the date of 230,000 years at Berekhat Ram, whose artifacts seem, as suggested below, somewhat similar to those of C-Spring (see also Copeland, in press).

The C-Spring facies will now be compared to other Near Eastern Late Acheulean assemblages.

COMPARISONS

The Late Acheulean of Azraq Facies (hereafter: LAAF)

The originality of the spring site Acheulean at Azraq was discussed by this writer (*infra a*) with special reference to Lion Spring. Since it differs in several important respects from Levantine Acheulean variants such as those defined by Gilead (1970), it was recently suggested that a separate facies name was warranted. The name 'Late Acheulean of Azraq Facies' (LAAF) was proposed by Copeland & Hours (1988) to designate the material of C-Spring T - R and of the Lower Paleolithic found by Kirkbride, Harding and Rollefson at Lion Spring.

In brief, essentially the same traits as are present at C-Spring occur in the artifacts of three different exposures at Lion Spring, 3 km distant: to take first that of Kirkbride, although the samples are fairly small, ovate shapes and rounded tips also dominate in the bifaces, half are finely flaked all over and 17% consist of bifacial cleavers, only another 17% being pointed types. The average length of the bifaces, amalgamated, is 10.29 cm. The flake tools are rare, the IL very low (less than l.0%), and there are one or two Quina racloirs; similar traits occur in the two unstratified collections of Harding and Rollefson, discussed in Copeland, *infra* a and b.

The attributes which distinguish the LAAF from the Late Acheulean of the earlier pluvial phases at Azraq (the DWA) are discussed in Copeland and Hours, *infra*.

If the C-Spring industry is accepted as a special facies, then the question arises as to where it fits into the regional Paleolithic sequence. Both the geomorphological and techno-typological indications suggest that the spring site Acheulean post-dates the DWA and the Bire Formation assemblages along the Zarqa (Note 13), but overlaps could be considered. For the moment, the C-Spring Acheulean could reasonably be regarded as having occurred in the later, rather than in the earlier phases of the Late Acheulean era, and as being the local equivalent of the Evolved Late Acheulean. Variants of this phase are known either with non-Levallois debitage, or with Levallois debitage (Note 14).

Regional comparisons

It was suggested above that many of the traits of the Late Acheulean of Azraq Facies differ from those of other Late Acheulean facies known from Levant sites to the west. In most of these, no differentiation can be made between 'early' and 'later' Late Acheulean periods, such as would correspond to our DWA and LAAF. Moreover, biface samples are differently composed. For example at the Jordanian site of Fjaje, a large surface station in Moab, there are only 5 cleavers (3% of the bifaces), at least half the biface sample consists of pointed types (amygdaloid, cordiform, lanceolate etc.) only a third are ovate (including *limandes* and cleavers). The Levallois index is high at c. 30%, half of the cores are Levallois types, there are numerous blade cores and opposed type prismatic cores (Rollefson, 198l).

The largest Late Levantine Acheulean surface site known in the Levant is Ma'ayan Barukh in Galilee where c. 6,000 bifaces have been collected. Here, too, 'early' as against 'later' Late Acheulean facies are not distinguishable, but in any case, judging by results of a recent sounding there, the category percentages of the l62 bifaces excavated differ considerably from those of both phases at Azraq: 82% are amygdaloids and other pointed biface types; ovates amount to only 7.4%, and bifacial cleavers are rare at l.8% (Ronen *et al.*, 1980). Although Ma'ayan Barukh has fauna (elephant) and seems by its technical attributes to be no more advanced than C-Spring, having low IL, IF, ILam, high number of removed butts, presence of biface-like cores etc. (e.g. Ronen *et al.*, *ibid*, Fig. 8, p.31.), it is not dated. A large surface concentration of bifaces on the nearby Yiron plateau in Galilee also consists mainly of amygdaloid/cordiform types (Ohel, 1986)

Even closer to hand, in the Zarqa valley survey sites, the composition of neither of the two Late Acheulean phases described there resembles that of the Acheulean at Azraq (cf. Note 13); instead, they have more similarities with the assemblage at Fjaje.

The most securely-dated Late Acheulean site in the region (Berekhat Ram in the Golan) has a very small biface sample, and although, judging by the published illustrations, it seems to be equivalent at least technologically to the LAAF, a much higher IL has been reported (Goren-Inbar, 1985). The site is embedded between two basalt flows, the upper one dated to before 230,000 years b.p. What is curious about Berekhat Ram is that it has an even larger number of *éclats de taille* in relation to only 4 bifaces. This no doubt has to do with site-use differences (such as might also occur at C-Spring, in as yet unexcavated areas.

The question of a possible Yabrudian element is discussed in Copeland *infra* c; it is felt that, among other objections there are 'too many' bifaces and 'not enough' single convex racloirs in the assemblages (Note 15) while in levels T - R at C-Spring, single convex racloirs are virtually absent and bifaces form 38% of the tools. It is this writer's opinion that instead of being a Yabrudian element, the Quina racloirs form one of the components of the special evolved Late Acheulean variant we have distinguished above.

The problem of Levels Q to M

The stratigraphy of the 1985 sounding indicates that the knapping-floor was buried by yellow and then blue-grey sandy silts (levels Q and P) in which there were traces of mild fluviatile activity (Hunt and Garrard, *infra*). These levels contained some Acheulean but also a few Mousterian artifact types. Whether or not this is due to mixing by the wadi during the early Middle Paleolithic is an unanswered question, but the artifacts do not seem to represent much of a technical or typological advance over those in levels T - R except that Levallois cores are present; if not mixed due to wadi erosion, is a later period, one closer to the Middle Paleolithic, represented? If so, these levels may equate chronologically with Final Acheulean assemblages elsewhere having some similar traits, for example the Acheulean levels at Yabrud I, interspersed with Yabrudian (Rust, 1950). In any case these phases definitively ended when the marshes and spring pools became more swampy and eventually inundated the area (marsh silts of Level N).

A different climatic regime was perhaps in operation (during the Last Pluvial?) which caused loss of sediments in the area of the sounding (Level M and cf. Note 12). In the above-mentioned scheme of Besançon *et al.*, this would fall into their episodes 9 (very wet) which, in the desert wadis, saw an early Middle Paleolithic occupation (Qla - c) and later in episodes 12 and 13 (wet; the Levalloiso-Mousterian at Wadi Enoqiya). Industries of these phases seem to have been lost from the Garrard sounding which is somewhat puzzling since the 'missing' Middle Paleolithic is present on the surface of the debris piles from the fishpond excavation at C-Spring-BH (see discussion in Copeland, *infra* c).

The later levels L to K

Further local or environmental changes occurred before the present regime came into being. They would be included in episodes 15 - 17 of the scheme of Besançon *et al., infra*. For studies on recent sediments see Gilbertson *et al.* 1985.

As for the Epi-Paleolithic and Neolithic assemblages, as already discussed above, they refer to the now-well-known phases revealed by Garrard's work.

In conclusion, it can be said that the work at C-Spring has added immeasurably to the sum of knowledge about Jordanian prehistory. It has provided rare and valuable evidence of a stratified sequence of lithic assemblages, representing a span of time from the Lower Paleolithic to the Neolithic. The oldest consists of a very large sample from an archaeologically *in situ* Late Acheulean knapping-floor.

NOTES

1. For accounts of the original spring-site (more properly Site II, Canal F, Spring C of the Baker and Harza Engineering Company), see F. Zeuner (*infra*); some artifacts are described in Copeland, *infra* c; the faunal finds recovered by Kirkbride and Zeuner are discussed by Clutton-Brock, *infra*.)

2. See Chapter 2, pp. 31-35 in Sanlaville (ed.) 1979.

3. This compares well with the W/Th ratio mean for the Acheulean of Tabun; in Garrod's layer F it was 3.610 and in Jelinek's Unit XIV it was 3.210 (Jelinek, 1981, 276-8)

4. These are known in Europe to have been struck from the distal ends of cleavers to form the tranchet tip, e.g. in the Acheulean at Boxgrove, refitted by C. Bergman (Roberts *et al.*, 1986); see also a refitted cleaver-flake in D. Roe, 1981, Fig. 5, 41 (4). Similar flakes occur at near-by Lion Spring and, perhaps, at Berekhat Ram (Goren-Inbar, 1985, Fig. 8, 1 and 10, 1) where they are said to represent 'scraper-edge rejuvenation'. See also Ohel, 1979, Fig. 4, 10, 11.

5. The classification was subjectively done by eye, not by measuring. Tiny 'chips' are included in the *éclat de taille* class.

6. Small bifacial pieces, unclassifiable as standard biface types or cores, characterise the Final Acheulean in Syria (Hours, 1979, Fig. 2, 1).

7. For discussion of 'truncated-faceted' flakes as a type, see Newcomer & Hivernel-Guerre, 1974.

8. The nearest likely origin is Crab Spring, on an adjacent canal south-east of C-Spring (Copeland *infra* c).

9. Gowlett *et al.*, 1987, 135.

10. Examples are: Lion Spring (Kirkbride sounding), Tabun, Qatafa, Yabrud I, Berekhat Ram on the Golan (Goren-Inbar, 1985), Gharmashi Ib on the Orontes (Hours, 1980; Muhesen, 1985) and the Nadaouiyeh I spring mound, El-Kowm (Hours *et al.*, 1983).

11. See discussion of knapping concentrations in Newcomer and Sieveking, 1980.

12. Perhaps significantly, a similar loss was reported at Dakhla Oasis, an arid area with spring-mounds, during the Acheulean and Mousterian sequence (Schild and Wendorf, 1977, Fig. 51).

13. The evidence for an earlier phase in the Bire Formation and a later one at Khirbet Samra site 30 is discussed in Copeland & Hours (1988) and is based on the findings of Besançon *et al.* (1984).

14. E.g. non-Levallois at Gharmashi Ib (Muhesen, 1985) and Levallois at Joubbata (Goren, 1981).

15. Single convex racloirs often form the majority of racloir types at Yabrudian sites, e,g, they amount to 16% of the flake-tools at Hummal IB (Copeland & Hours, 1983) and c. 20% of the tools in Tabun E (Garrod & Bate, 1937) and in the D. and G. assemblages at Bezez (Copeland, 1983).

BIBLIOGRAPHY

BAR YOSEF, O. (1981). The Pre-pottery Neolithic Period in the Southern Levant. IN J. Cauvin & P.Sanlaville (Eds.) *Préhistoire du Levant* 55l-570 C.N.R.S., Paris.

BESANÇON, J. (1982). Les figures d'alteration des silex du Liban et leurs implications. IN J.Starkey & F. Hours (Eds.) *L'Archeologie du Levant*: Recueil R. Saidah. Maison de L'Orient, Lyon, p.26, footnote 3.

BESANÇON, J., L. COPELAND, F. HOURS, J. J. MACAIRE & P. SANLAVILLE (1984). The Lower and Middle Paleolithic of the Upper Zarqa area of Northern Jordan; 1982-3 survey results. *Annual of the Dept. of Antiquities of Jordan* XXVIII, 91-142.

BESANÇON, J., L. COPELAND, F. HOURS, S. MUHESEN & P. SANLAVILLE (198l). Le Paléolithique d'El-Kowm; rapport préliminaire. *Paléorient* 7/1, 33-55.

BETTS, A. (1986). *The Prehistory of the Basalt Desert, Transjordan: an analysis*. PhD Thesis, London University.

BORDES, F. (1950). Principes d'une méthode d'étude des techniques de débitage et de la typologie du paléolithique ancien et moyen. *L'Anthropologie* 54, l-2, 19-34.

BORDES, F. (196l). *Typologie du paléolithique ancien et moyen*. Bordeaux, Delmas.

BRADLEY, R. & C. CLAYTON (1987). The influence of flint microstructure on the formation of microwear polishes. M. Newcomer & G. Sieveking (Eds.). *The Human Uses of Flint and Chert*: Proceedings of the 4th Flint Symposium, Brighton, April 1983. C.U.P.

CAUVIN, M.-C. (1974). Flèches à encoches de Syrie: essai de classification et d'interprétation culturelle. *Paléorient* 2/2, 311-322.

CLUTTON-BROCK, J. (1970). The fossil fauna from an Upper Pleistocene site in Jordan. *Jrnl. Zoology,* London, 162, 19-29.

COPELAND, L. (in press). Environment, chronology and the Lower and Middle Paleolithic of the Azraq Basin. IN *Préhistoire du Levant II*: C.N.R.S. conférence, Lyon, 1988.

COPELAND, L. & F. HOURS (1979). Le Paléolithique du Nahr el-Kebir: Chapitre I, Méthodologie. IN P.Sanlaville (Ed.) *Quaternaire et Préhistoire du Nahr el-Kebir Septentrional.* C.N.R.S, Paris, 31-35.

COPELAND, L. & F. HOURS. (1983). Le Yabroudien d'El-Kowm (Syrie) et sa place dans le paléolithique du Levant. *Paléorient* 9/1, 21-37

COPELAND, L. & F. HOURS (1988). The Paleolithic of North Central Jordan: an overview of survey results from the Upper Zarqa and Azraq, 1982-1986. IN A. Garrard & H. G. Gebel (Eds.) *The Prehistory of Jordan: a 1986 Perspective.* B.A.R. i.s. 396, 286-309

GARRARD, A., A. BETTS, B. BYRD & C. HUNT (1987). Prehistoric Environment and Settlement in the Azraq Basin: an interim report on the 1985 excavation season. *Levant* XIX, 5-26

GARRARD, A. & N. STANLEY PRICE (1975-77). A survey of prehistoric sites in the Azraq Basin, Eastern Jordan. *Paléorient* 3, 109-126.

GARROD. D. & D. Bate (1937). The Stone Age of Mount Carmel, I. Clarenden Press, Oxford.

GILBERTSON, D., C. HUNT & S. BRADLEY (1985). Micropalae-ontological and palaoecological studies of Recent sediments from the Azraq marshes in the Jordanian desert. *Studies on the History and Archaeology of Jordan,* II, 347-352.

GILEAD, D. (1970). Handaxe industries in Israel and the Near East. *World Archaeology,* 2, 1-11.

GOREN, N. (1979). An Upper Acheulean Industry from the Golan Heights. *Quartär* 29/30, 105-131.

GOREN-INBAR, N. (1985). The lithic assemblage of the Berekhat Ram Acheulean site, Golan Heights. *Paléorient* 11/1, 7-28.

GOWLETT, J., R. HEDGES, I. LAW & C. PERRY (1987). Radiocarbon dates from the Oxford AMS System: datelist 5. *Archaeometry* 29/1, 125-155 (135-6).

HOURS, F. (1979). La fin de l'Acheuléen en Syrie du Nord: note préliminaire. *Paléorient* 5, 9-16.

HOURS, F. (1980). Sondages pratiques en 1979 sur le site de Gharmashi rapport préliminaire. Rapport d'activité, R.C.P. 476, 1980. *Recherches Anthropologiques au Proche et Moyen Orient* C.N.R.S., 90-102.

HOURS, F. (198l). Le paléolithique inférieure de la Syrie et du Liban: le point en question en 1980. IN J.Cauvin & P.Sanlaville (Eds.) *Préhistoire du Levant*, 165-184.

HOURS, F., J.P. LE TENSORER, S. MUHESEN, & I. YALCINKAYA (1983). Premiers travaux sur le site de Nadaouyieh I (El-Kowm, Syrie). *Paléorient* 9/2, 5-14.

JELINEK, A. (198l). The Middle Paleolithic in the Southern Levant from the perspective of the Tabun Cave. IN. J. Cauvin & P. Sanlaville (Eds.) *Préhistoire du Levant* 265-280.

JONES, R. (1980). Experimental butchery with modern stone tools and its relevance for Paleolithic archeology. *World Archaeology* 12/2, 153-165.

MEEKS, N., G. SIEVEKING, M. TITE & J. COOK (1982). Gloss and use wear traces on flint sickles and similar phenomena. *Jrnl. Archaeological Science* 9, 317-332.

MUHESEN, (1985). *L'Acheuléen Récent Evolué de Syrie*. British Archaeological Reports, int.ser. 248.

NEWCOMER, M. & F. HIVERNEL-GUERRE (1974). Nucléus sur éclat: technologie et utilisation par différentes cultures préhistoriques. *Bul.Société Préhistorique Français* 7l, c.r.s.m. 4, 119-128.

NEWCOMER, M. & G. SIEVEKING. (1980). Experimental flake scatter patterns: a new interpretative technique. *Jrnl. Field Archaeology,* 7/3, 346-352.

OHEL, M. (1979). An Acheulean lithic surface concentration at Baram, Israel. *Paléorient* 5, 207-218.

OHEL, M. (1986). Milking the Stones or an Acheulean Aggragation Locality on the Yiron Plateau in Upper Galilee. *Proceedings of the Prehistoric Society.* vol. 52, 247-280.

ROBERTS, M.B., M. BATES, A. CURRANT, R. MACPHAIL, A. MCCONNELL, R. SCAIFE, R. WHATLEY, J. HAYNES, C. BERGMAN & R. UNGER-HAMILTON (1986). Excavation of the Lower Palaeolithic site at Amey's Eartham Pit, Boxgrove, West Sussex. A Preliminary Report. *Proceedings of the Prehistoric Society.* vol. 52, 215-245.

ROE, D. (1981). *The Lower and Middle Paleolithic Periods in Britain*. London, Routledge & Kegan Paul.

ROLLEFSON, G. (1981). The Late Acheulean site at Fjaje, Wadi el-Bustan, Southern Jordan. *Paléorient* 7/1, 5-21.

ROLLEFSON, G. (1983). Two seasons of excavation at Ain el-Assad, Eastern Jordan, 1980-1981. *Bul. American School of Oriental Research* 252, 25-34

RONEN, A., M. OHEL, M. LAMDAN & A. ASAF (1980). Acheulean artifacts from two trenches at Ma'ayan Barukh. *Israel Exploration Journal,* 30, 1-2, 17-33.

ROTTLÄNDER, R (1976). The formation of patina on flint. *Archaeometry* 17, 106-109.

RUST, A. (1950). *Die Höhlenfunde von Jabrud (Syrien).* Neumunster.

SANLAVILLE, P. (Ed.). *Quaternaire et préhistoire du Nahr el-Kebir Septentrional.* C.N.R.S., Paris.

SCHILD, R. & F. WENDORF. (1977). *The Prehistory of Dakhla Oasis and adjacent desert.* Polska Akademia Nauk, Warsaw.

SHACKLETON, N.J. & N.D. OPDYKE (1976). Oxygen Isotope and Paleomagnetic Stratigraphy of Pacific Core V. 28-239; Late Pliocene to Latest Pleistocene. *Geologic Society of America, Memoire* 145, 449 464.

SHACKLEY, M. (1974). Stream abrasion of flint impliments. *Nature* 248, 501-2 London.

STEKELIS, M. (1960). The Palaeolithic Deposits of Jisr-Banat-Yakub. *Bul. Research Council of Israel,* Vol. 9, Section G, 2-3, 61-90.

STEKELIS, M. & D. GILEAD (1966). *Ma'ayan Barukh, a lower Palaeolithic site in Upper Galilee.* Centre for Prehistoric Research, Jerusalem.

TOTH, N. (1987). The First Technology. *Scientific American* 255/112-121.

TOTH, N. AND K. SCHICK (1986). The First Million Years; the archaeology of protohuman culture. *Advances in Archaeological Method and Theory,* 9, 1 - 96.

APPENDIX A

The Patina Experiment

Level R waste pieces were devoted to this exercise, and numerous chunks and fragments with patinas in the same range as those of the artifacts were broken with a hammerstone. The original colour of the raw material and its patina or patinas were recorded, and special attention was given to pieces with more than one patina so that the superposition sequence could be worked out. Chert and cortex materials, which did not change colour, were excluded from the experiment.

Before being broken, the following colours were present on the flint surfaces:

1) Pale grey, mottled, as well as greyish-blue-to medium grey. On the Munsell colour-chart the range was: 2.5 Y 7/7 (light grey); 7.5 YR 7/7 and 7.5 YR 8/8 (whitish-grey). This group will henceforth be designated 'PGM', for pale grey/mottled.

2) Beige and greyish-brown tones, some close to the range of the above: 2.5 YR 6/2, 7/2 and 5/2. Some pieces fell more into the slot: 10 YR 7/l-2 (light grey). A very few pieces approached, but did not reach, the chestnut shade (10 YR 5.2-8) so common at the other spring sites. This group will be referred to as 'beige'.

3) Olive tones such as 5 Y 4/l and 4/2 (olive grey), which graded into dark grey, hereafter called 'olive'.

4) Black or extremely dark grey, in the range of: 2.5 Y 2/0 and 3/0. As mentioned, the dark grey tones graded into deep olive.

5) White, sometimes in 'clouds' of milky bluish-white.

After numbered examples of all grades of these colours had been broken, the original colours, seen on the break surfaces of each piece, were recorded together with the colour of the eventual patination; the results were as follows:

1) The vast majority of specimens were originally light coloured or opaque, in shades of beige, grey, mottled or banded beige-grey etc. These shades became darker upon patination on the outer surface, only two exceptions being found to this rule: two medium-grey pieces became paler at the surface.

2) A few pieces were originally olive or dark grey. These latter were often patinated to black or darker grey, while originally-lighter coloured pieces patinated to deeper olive or muddy colours, often mottled.

3) No originally black or white colours were present and the chestnut tones so prevalent at Lion Spring, lower levels, were also absent.

4) All the above-mentioned original colours could become patinated to black or white, including pieces already patinated (in the case of white, on top of black or brown). No patina was superimposed on white and none except white was superimposed on black.

From the study of superpositions of one patina over another, the sequence seemed in the majority of cases to be: beige/opaque to brown or grey, then to PGM, dark grey, black or olive, and finally to white.

However, the problem pieces are those specimens which were originally olive or dark grey (i.e. having original colours identical to some of the patinas); without breaking each of these artifacts, it would be impossible to see whether they were patinated or not. Moreover, the beige pieces, slightly patinated to grey, were hard to tell from those originally pale grey and therefore unpatinated. For this reason, where half of the flakes were not clearly distinguishable as patinated or not, the data on patina frequencies can only be regarded as approximate. For what it is worth, however, the incidence of patinas in each of the C-Spring levels are listed in Table 8.

As we discovered, there are some differences, upwards from level to level, in patina frequencies at C-Spring, the general trend being away from beige and towards increased amounts of PGM and dark grey. In addition, the absence of chestnut-brown patinas and near-absence of black patinas (which do exist on artifacts at the original spring) needs explaining.

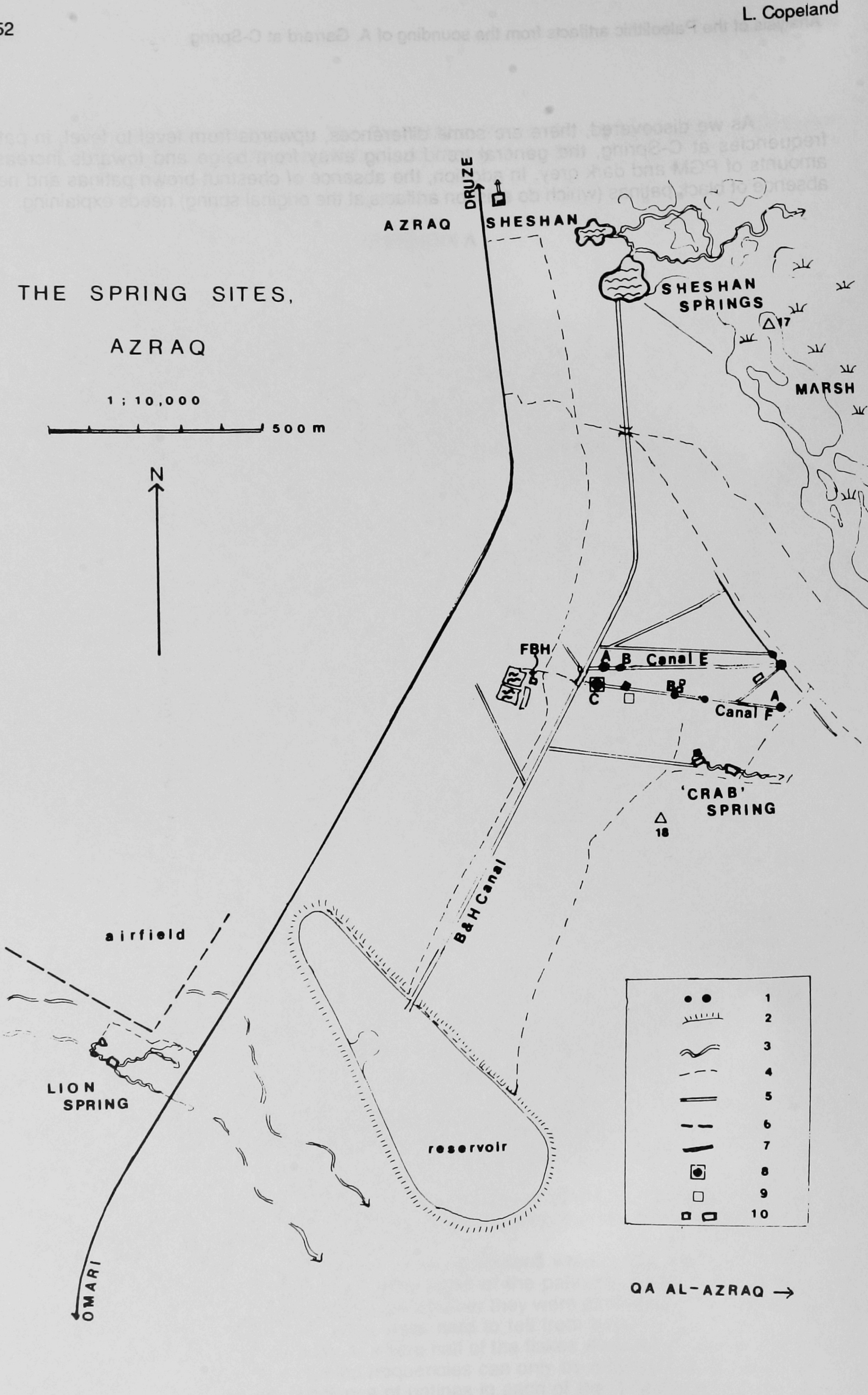


Fig. 1 Sketchap of the environs of C-Spring based on aerial photographs made in 1983 at 1:10,000. 1, springs and seeps; 2, earthwork reservoir; 3, wadi; 4, track; 5, canals made by Baker and Harza; 6, airfield perimeter fence; 7, main road; 8, C-spring pool; 9, Garrard's sounding; 10. pits dug by Baker & Harza; 17 and 18; sites excavated by Garrard; FBH. filtration bed hut.

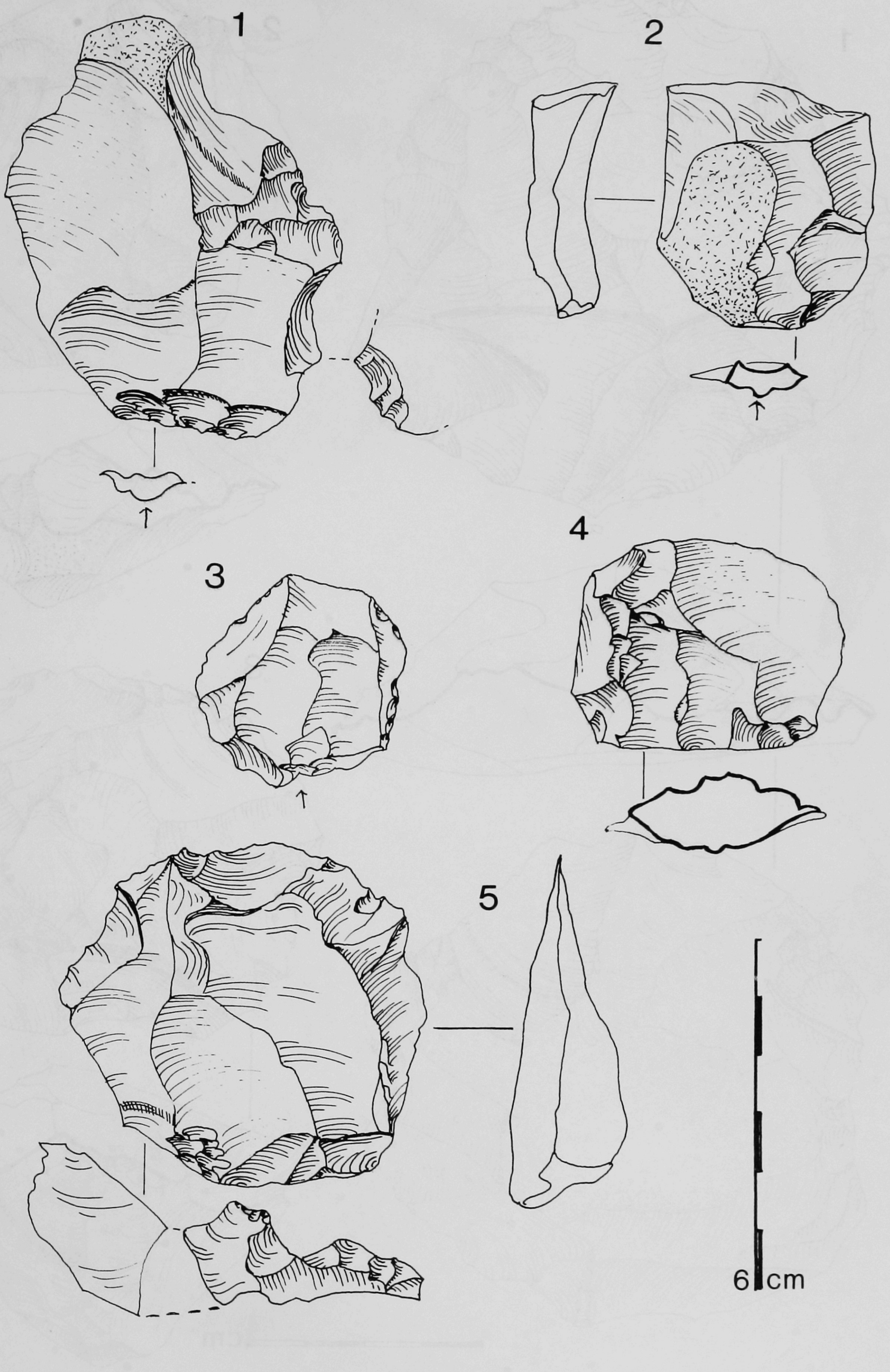


Fig. 2 Level S. 1, Brownish-patinated Levallois-like part-cortex flake; 2, unpatinated orthogonal preparation-flake; 3, biface-preparation flake; 4, grey-patinated, flat debitage transverse flake with large, plain butt; 5, Levallois-like core-edge, grey-patinated flake with wide-angle butt.

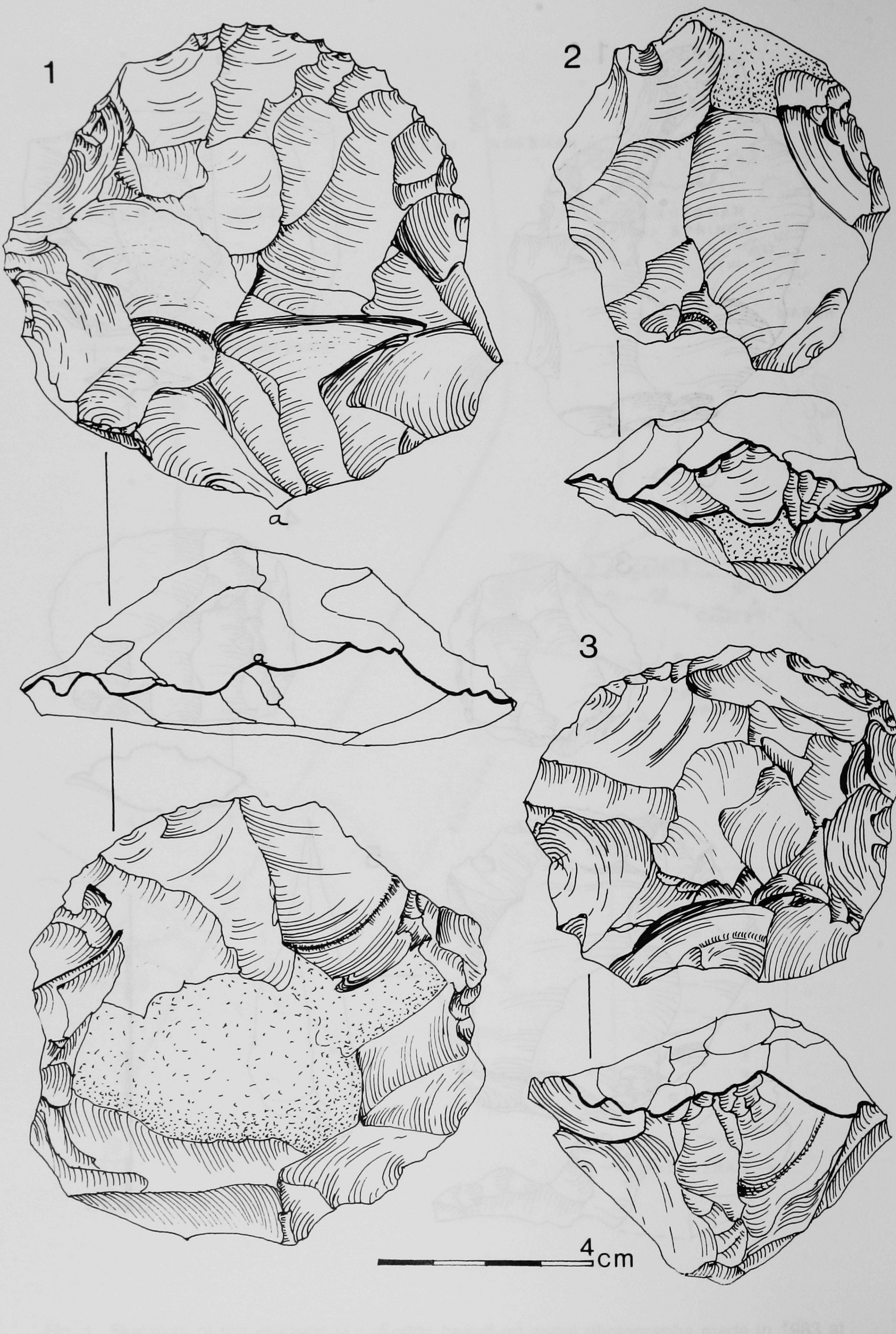


Fig. 3 Level R. 1, Three views of a proto-Levallois core; the middle view shows an almost-vertical, but plain, striking-platform; 2, atypical unipolar Levallois core with some radial side-preparation; 3, Mousterian discoid or biconical core, perhaps an aborted Levallois core

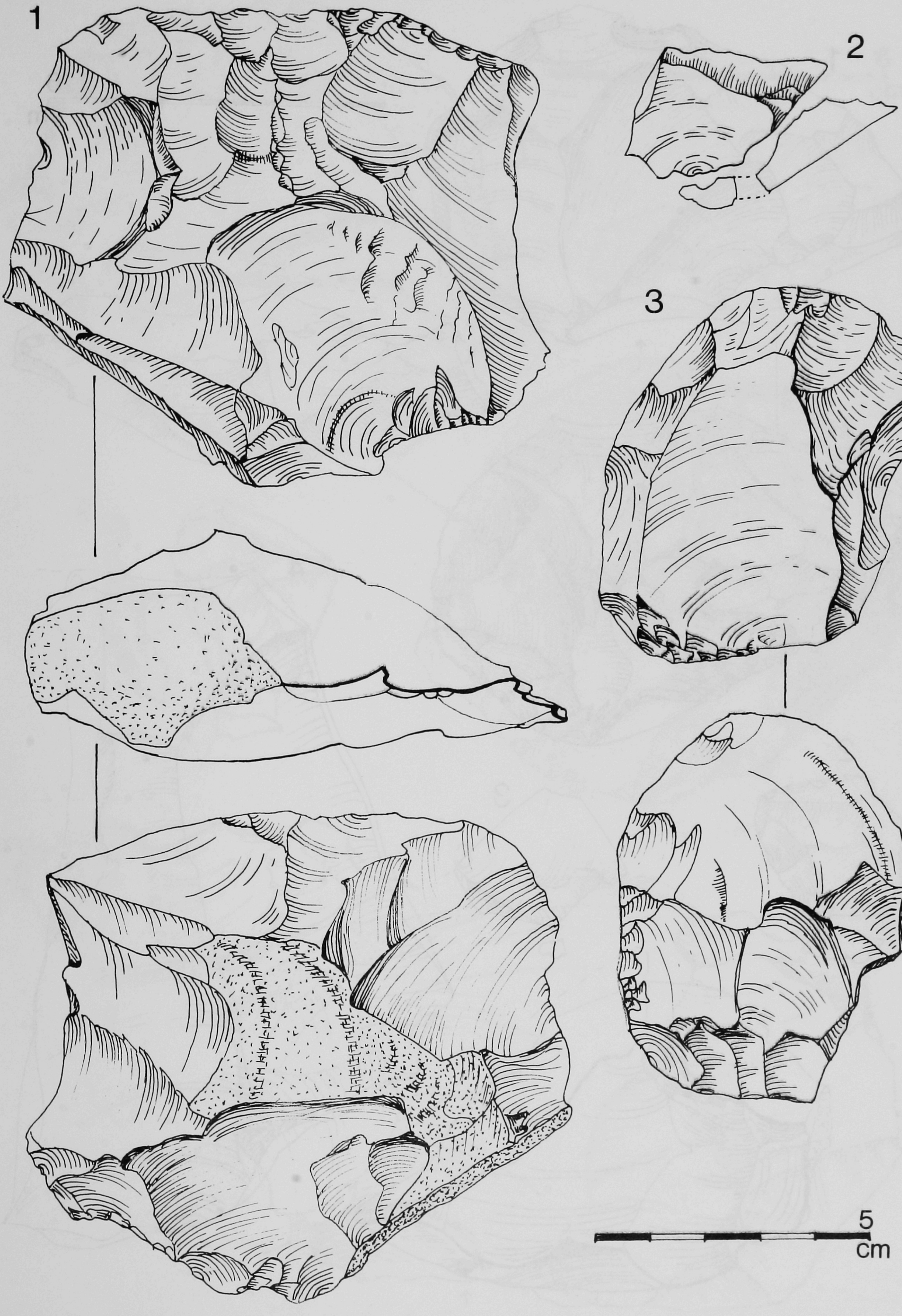


Fig. 4 Level R. 1, Three views of a flat debitage core with biface-like profile, no genuine striking-platform; 2, hexagonal type trimming-flake or éclat de taille; 3, Levallois core on a flake.

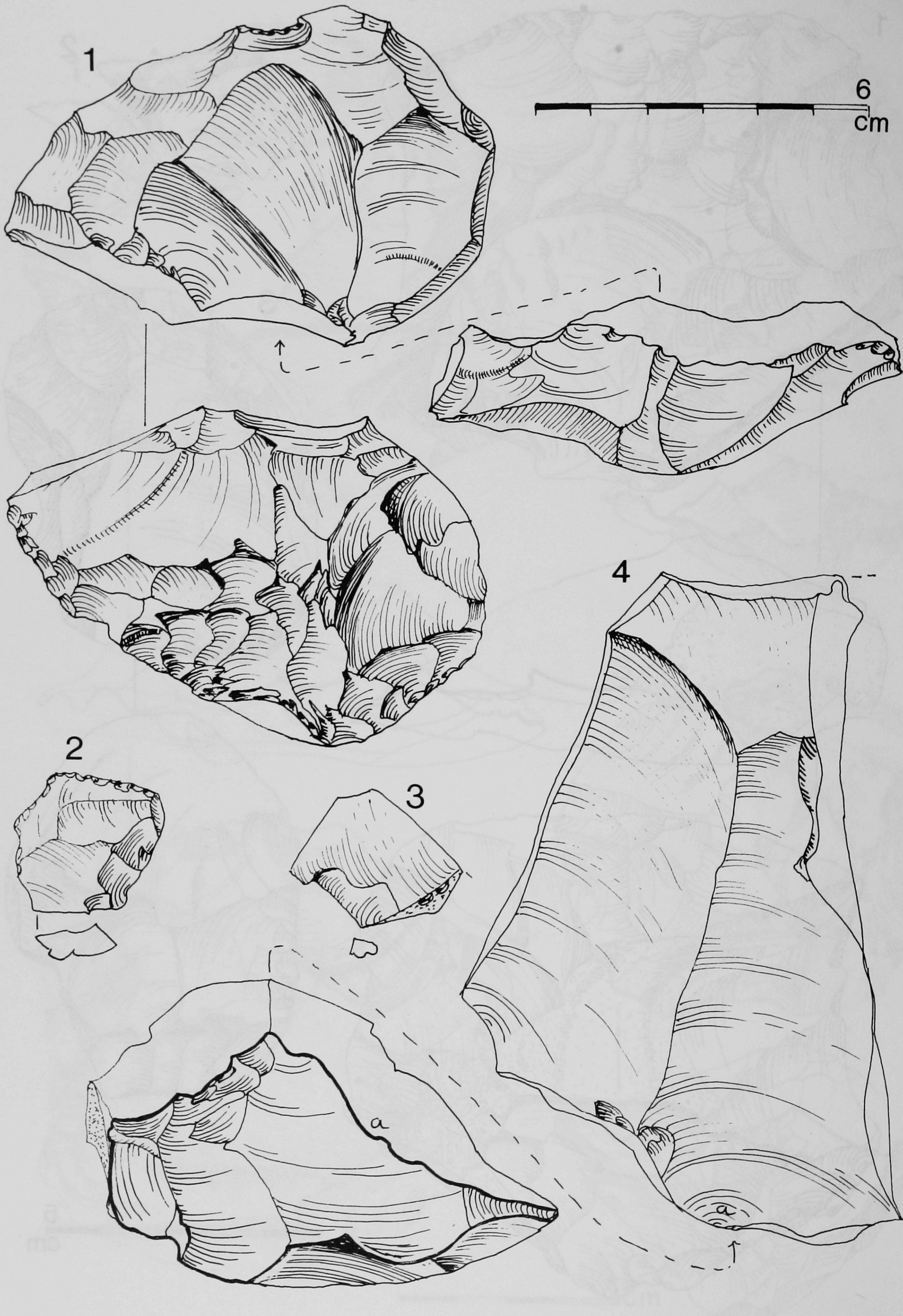


Fig. 5 Level R. 1, Acheulean transverse core; 2 & 3, biface trimming-flakes; 4, the left-hand half of a broken prismatic blade-core with simple faceted platform.

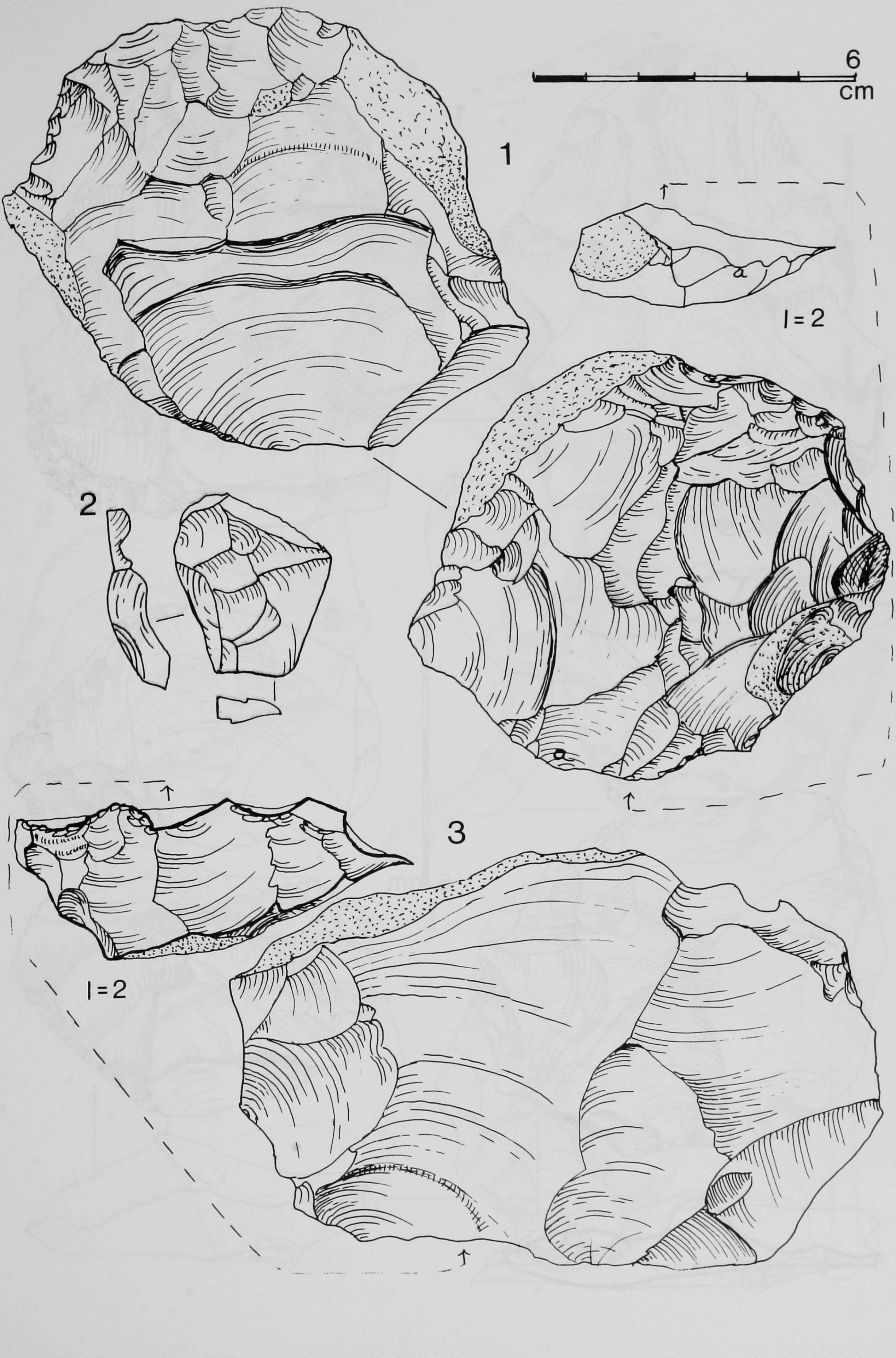


Fig. 6 Level R. 1, Transverse flat debitage core without a well-defined striking-platform (section drawn half-size); 2, hexagonal/orthogonal type of biface-trimming flake; 3, Acheulean transverse flat core, tending to proto-Levallois, with well-made striking-platform (section half-size).

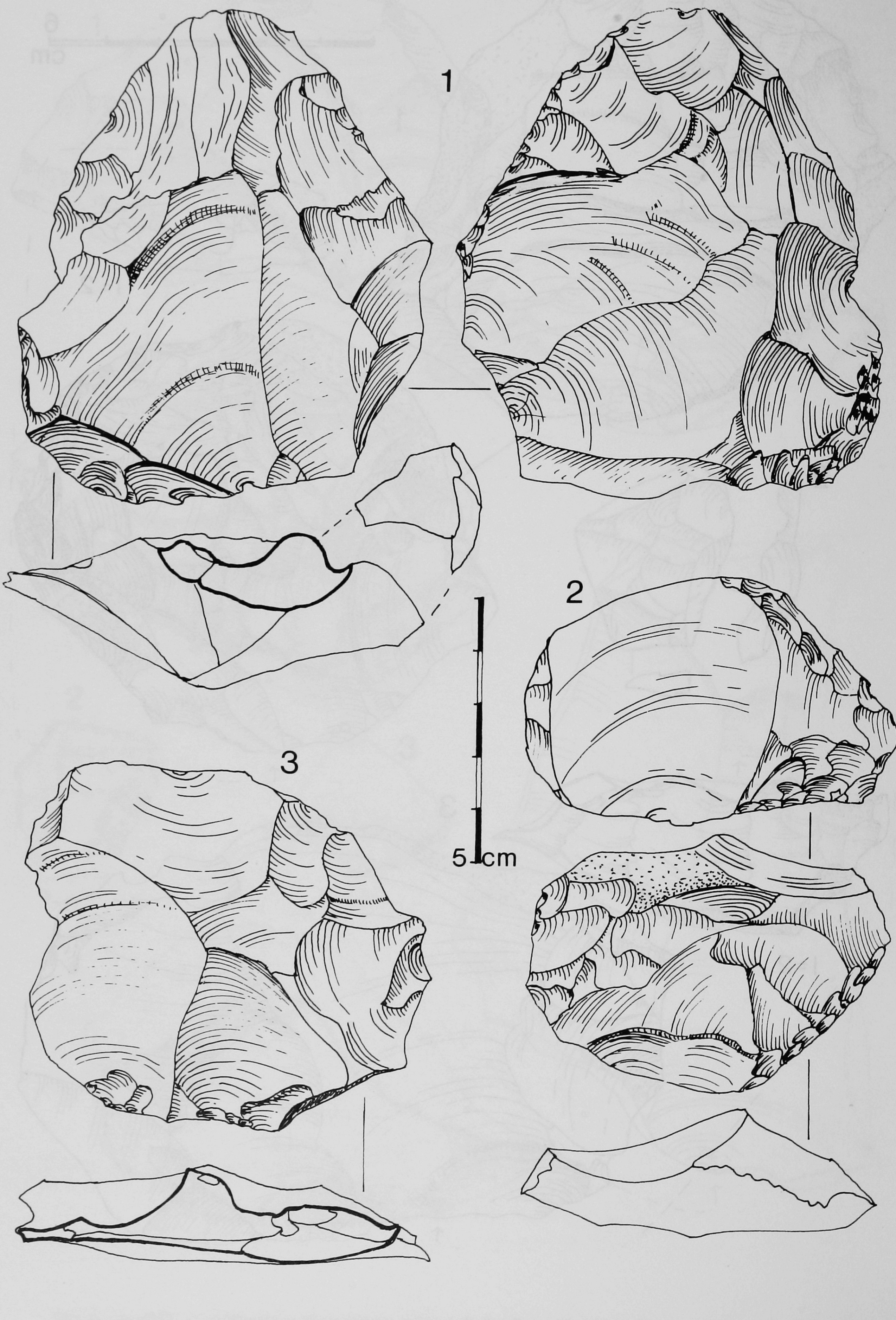


Fig. 7 Level R. 1, Flat debitage core, change-of-orientation type; 2, plunging-flake from a bifacially-prepared core; 3, exhausted core-base.

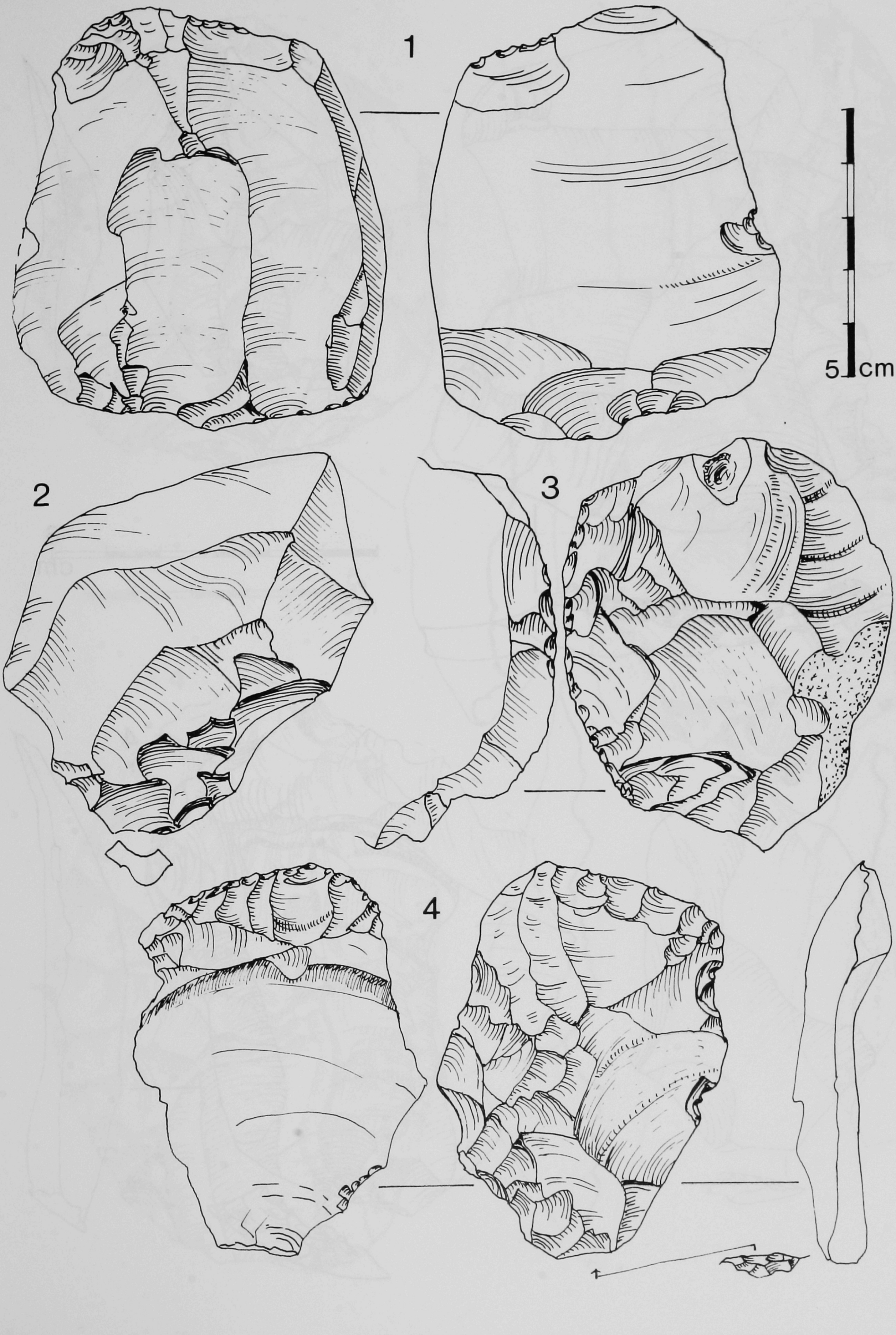


Fig. 8 Level R. 1, Either an orthogonal debitage core or a plunging-flake struck from one (the 'base' is a flake-surface); 2, pseudo-Levallois point; 3, pseudo-tool; 4, plunging-flake.

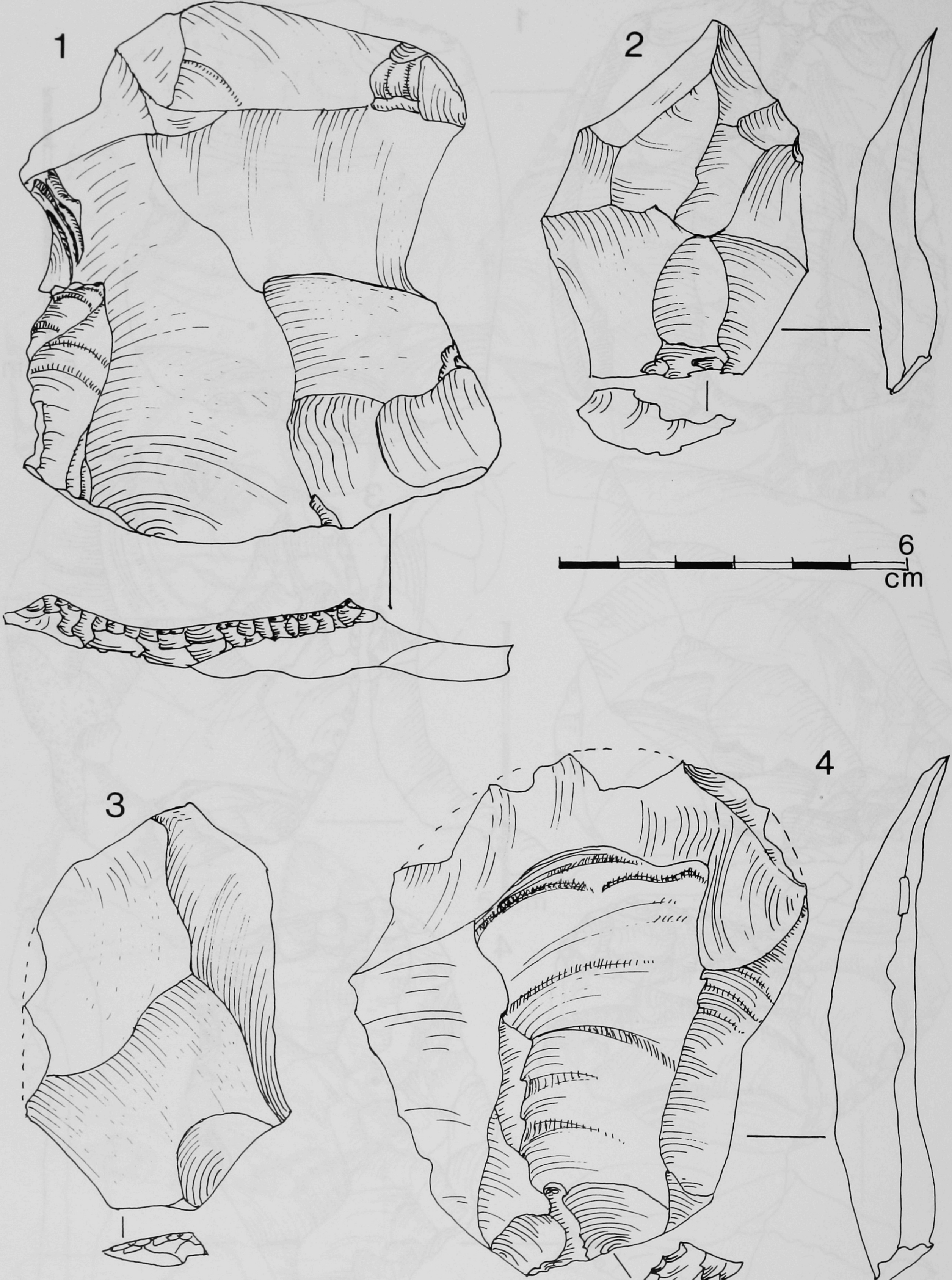


Fig. 9 Level R. 1, Levallois flake with butt faceting continuing as traces of core-preparation; 2, atypical Levallois point; 3, Levallois flake; 4, Levallois-like flake, very fresh but broken at the tip.

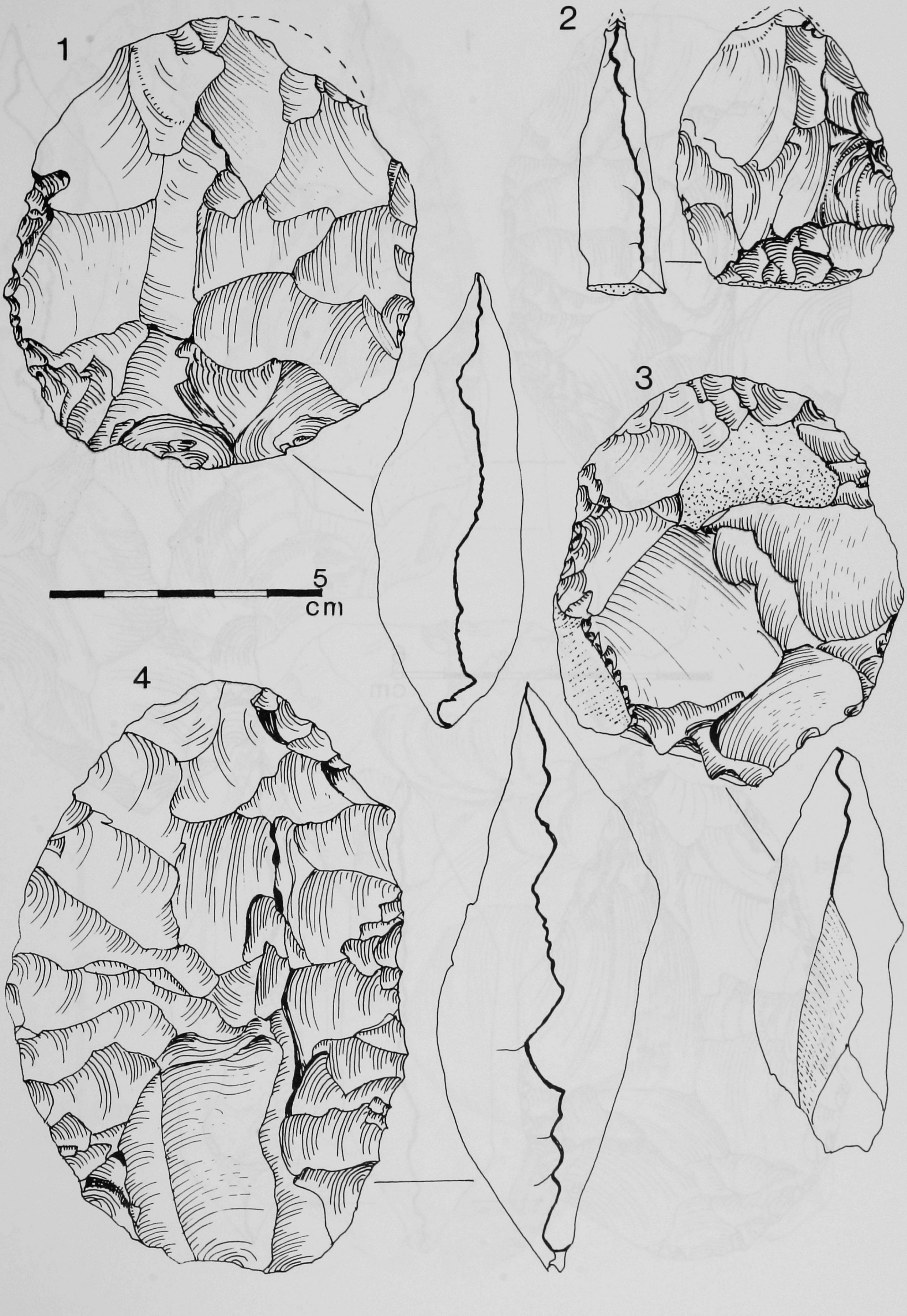


Fig. 10 Level R. 1, Discoid biface resembling a Levallois core, slightly lustred, abraded and black-patinated; 2, minute sub-ovate biface; 3, D-shaped biface with large *méplat*, brown patina; 4, elongated ovate biface, tending to a limande, with sharp, spikey edges (perhaps unfinished).

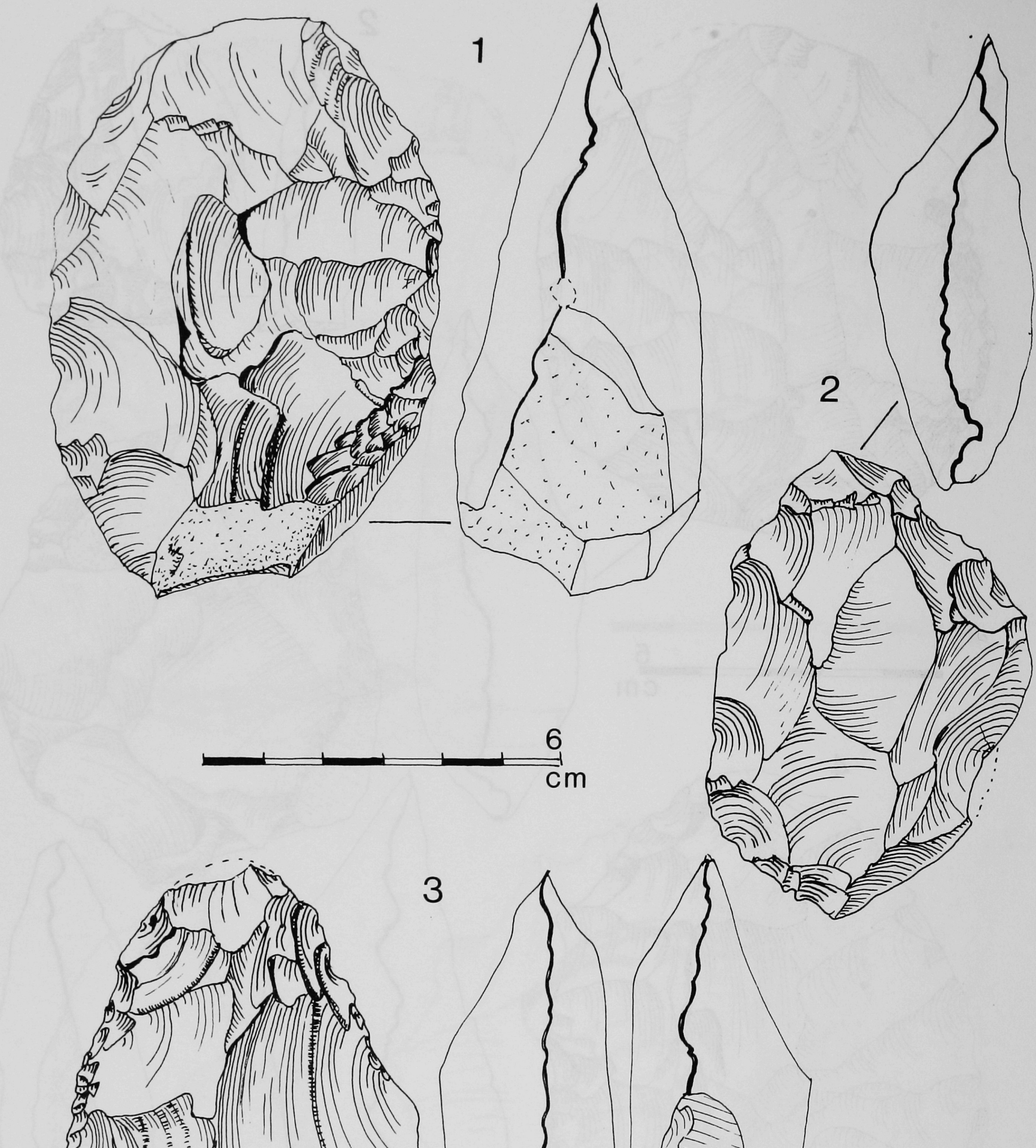


Fig. 11 Level R. 1, Bifacial cleaver with rounded tip, tending to an elongated ovate biface with lateral 'backed' area; 2, backed, pointed subovate biface or re-worked core; 3, small elongated ovate biface, with a large lateral *méplat* which gives a short cutting edge one side.

Fig. 12 Level R. 1, Four views of a slightly lustred bifacial cleaver with straight tip, made on a flint/chert slab with straight edges and 'revolving' retouch.

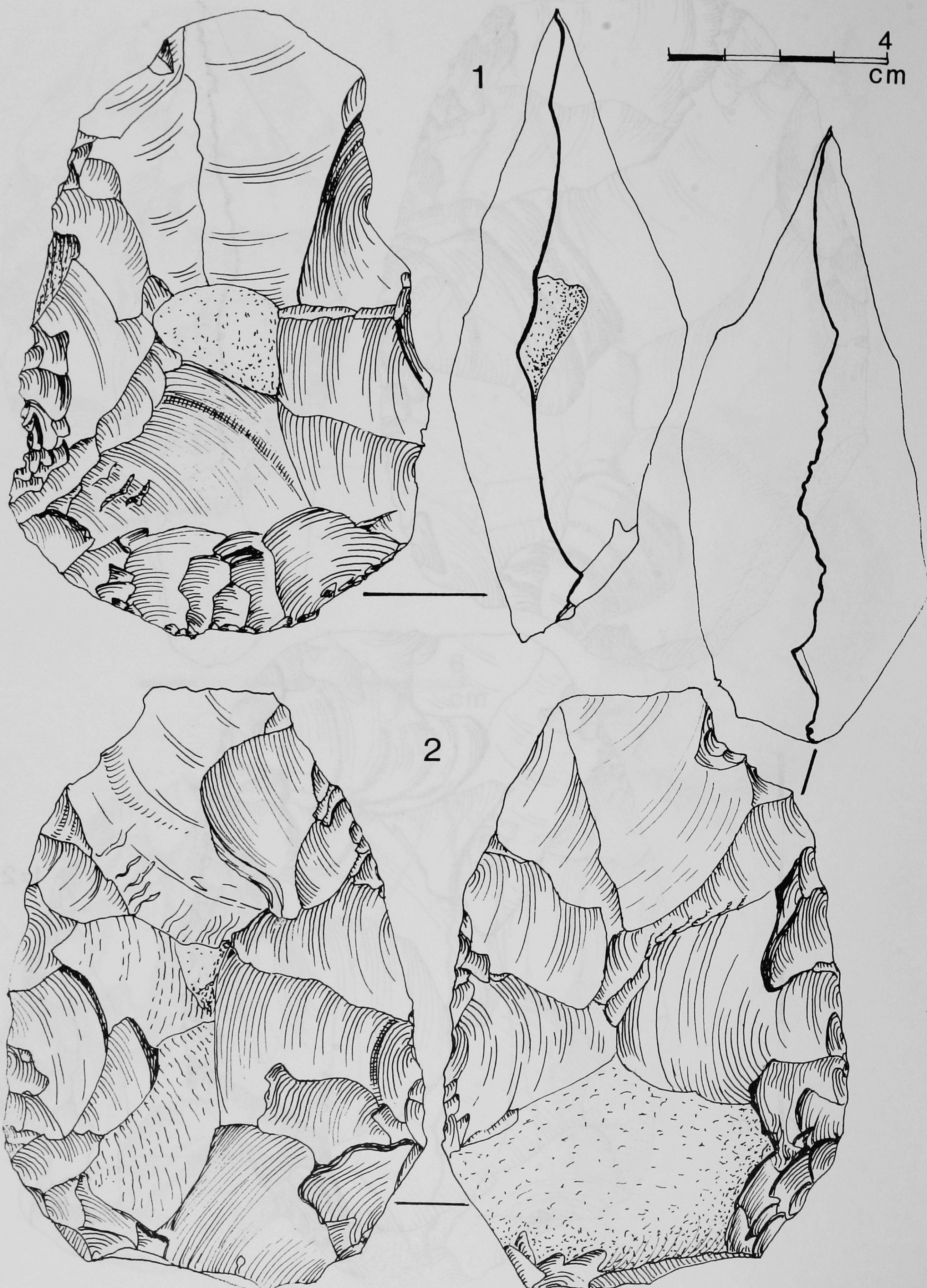


Fig. 13 Level R. 1, Elongated bifacial cleaver with rounded tip, and a kind of back formed by an abrupt fracture-plane; 2, bifacial cleaver with narrow, straight tip and radial, flat retouch on both faces.

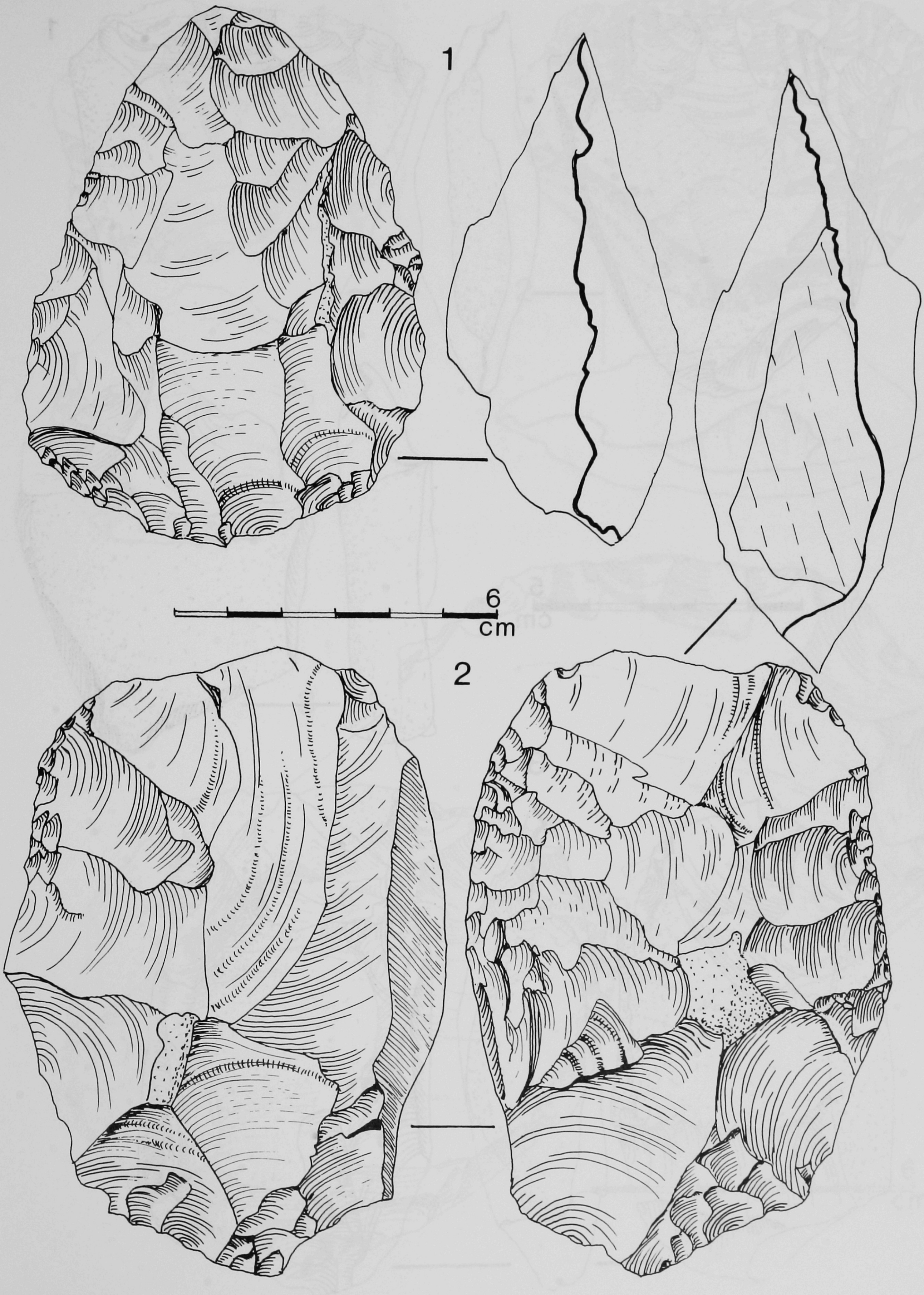


Fig. 14 Level R. 1, Amygdaloid biface, entirely retouched with one domed and one flat face, and thin, sharp tip; 2, bifacial cleaver with straight/oblique, divergent tip, made on a banded chert slab, two lateral *méplat*s (one cortex, one an older fracture-plane).

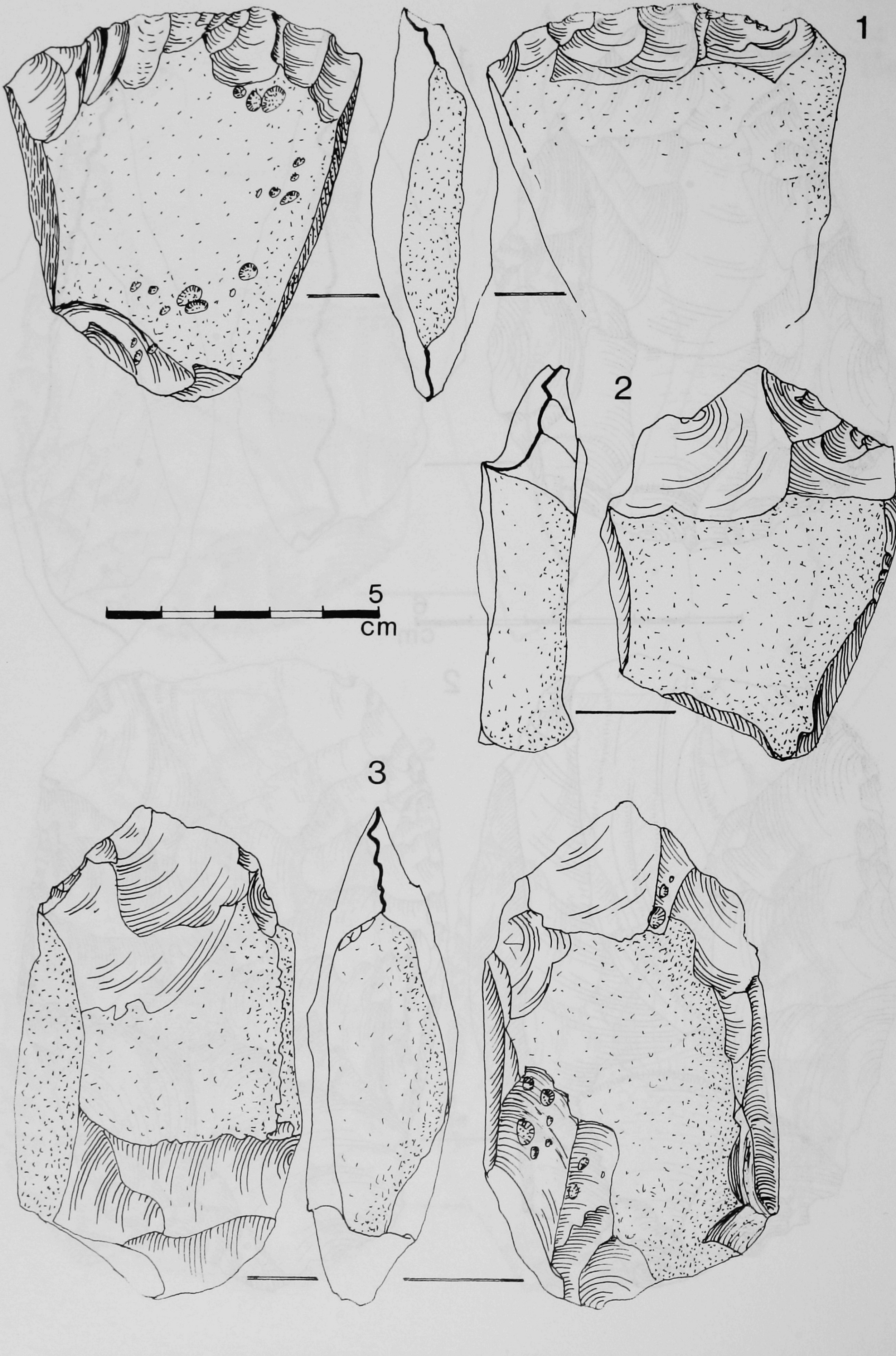


Fig. 15 Level R. 1, Chopper made on a thin tabular slab with convex, divergent chopping-edge; 2, pointed chopper on a slab, battered at the base; 3, pointed chopper on a slab with worked base.

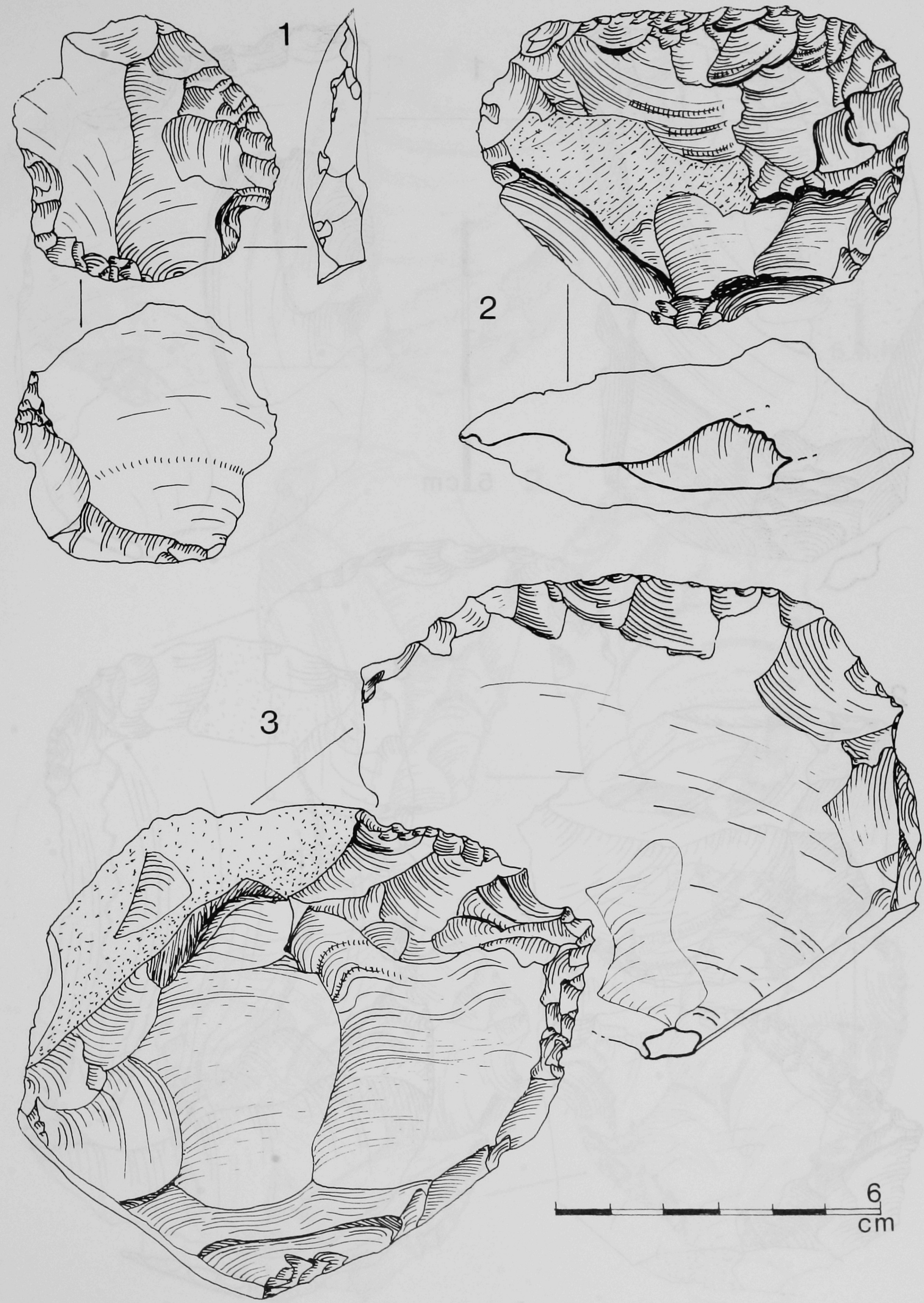


Fig. 16 Level R. 1, Single convex racloir on a cleaver-flake with additional notch and nibbled retouch, slightly abraded; 2, transverse straight racloir with Qina retouch and 'rocking-chair' profile; 3, inverse transverse convex racloir, tending to a double convergent, with some dorsal retouch.

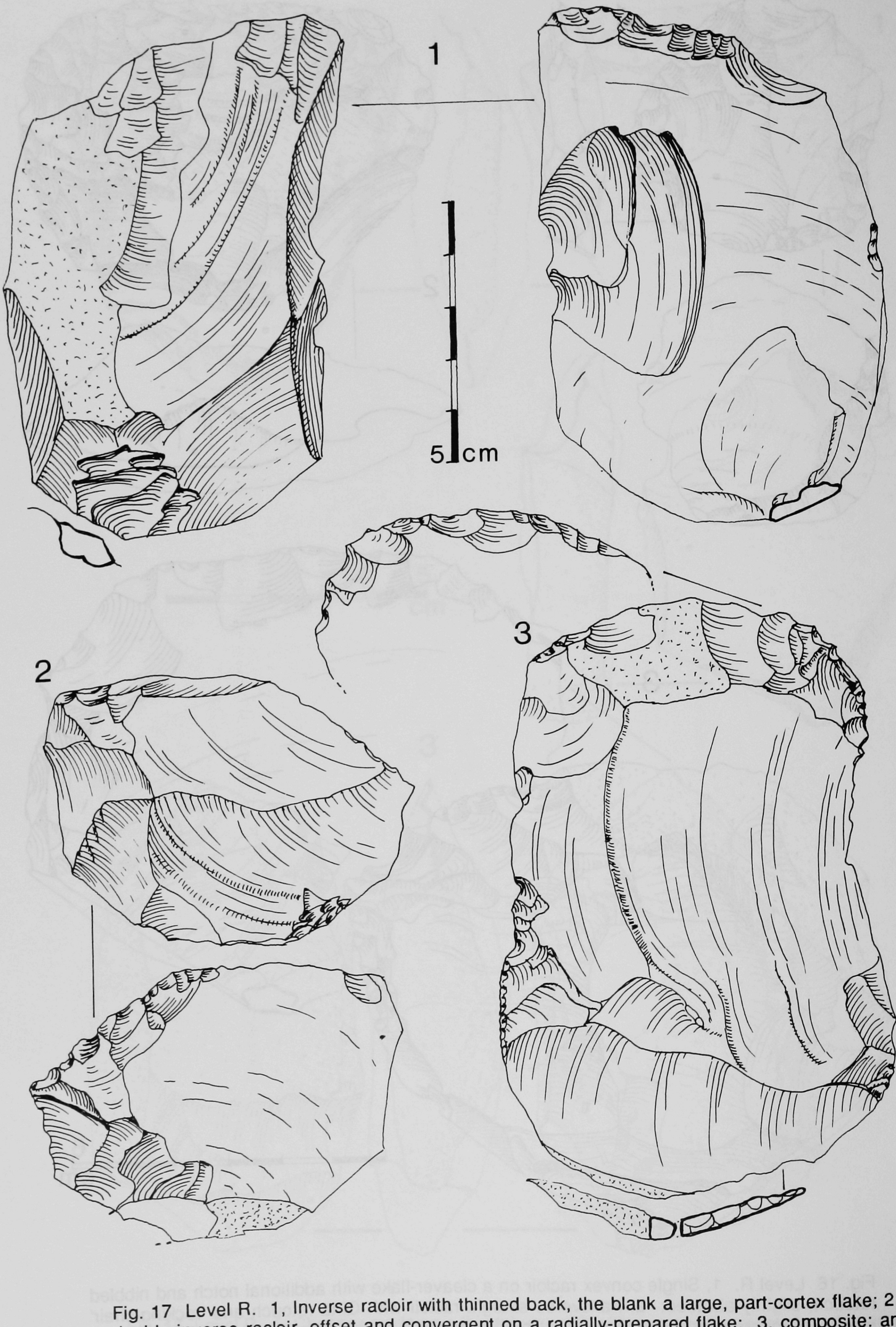


Fig. 17 Level R. 1, Inverse racloir with thinned back, the blank a large, part-cortex flake; 2, double inverse racloir, offset and convergent on a radially-prepared flake; 3, composite: an inverse racloir with bifacial distal edge, and a slightly denticulated dorsal edge.

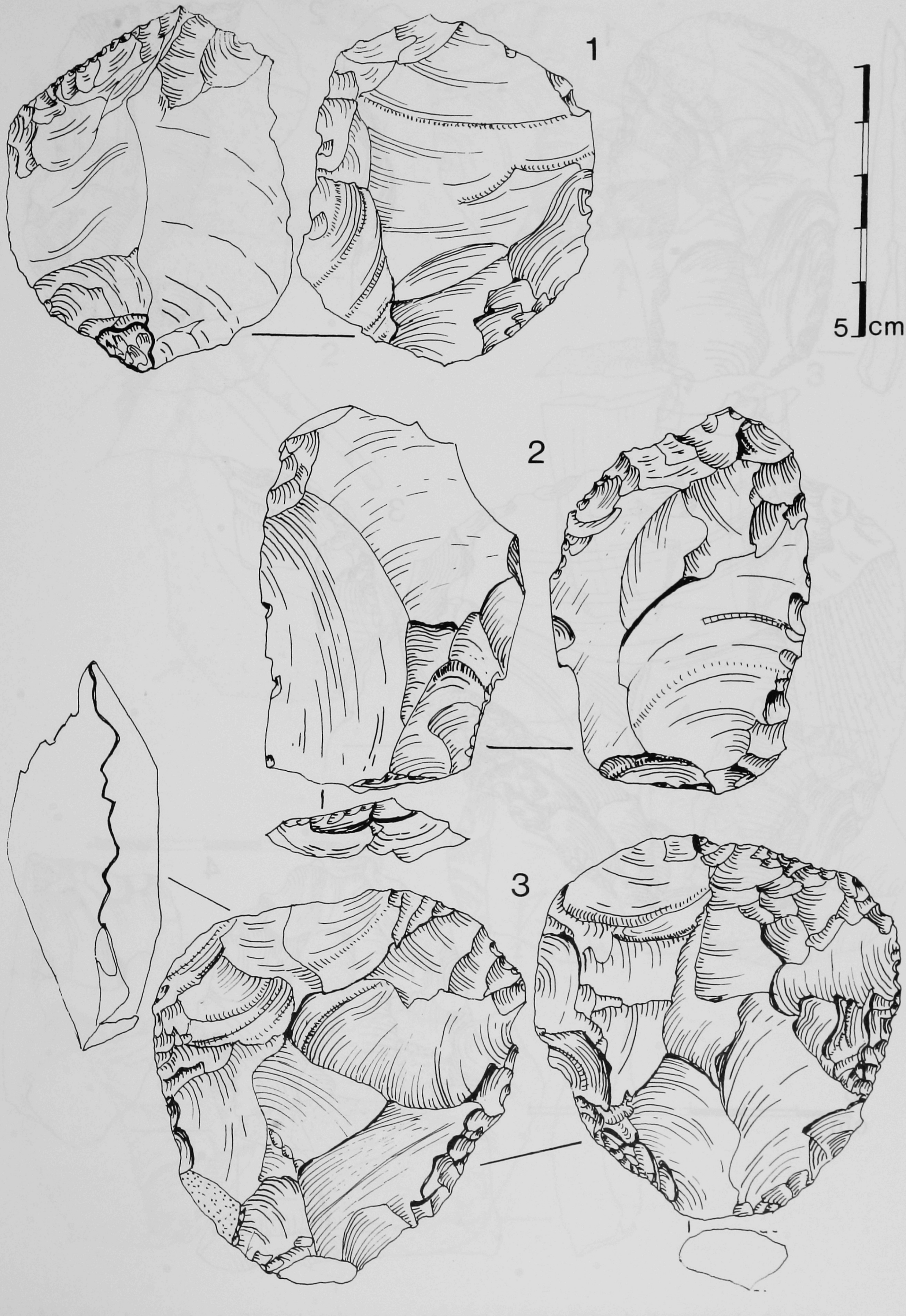


Fig. 18 Level R. 1, Composite: an inverse racloir with a denticulated dorsal edge; 2, inverse, semi-convergent racloir on a cleaver-flake with additional dorsal retouch; 3, bifacial racloir on a flake, retouched in Qina and demi-Qina style all over.

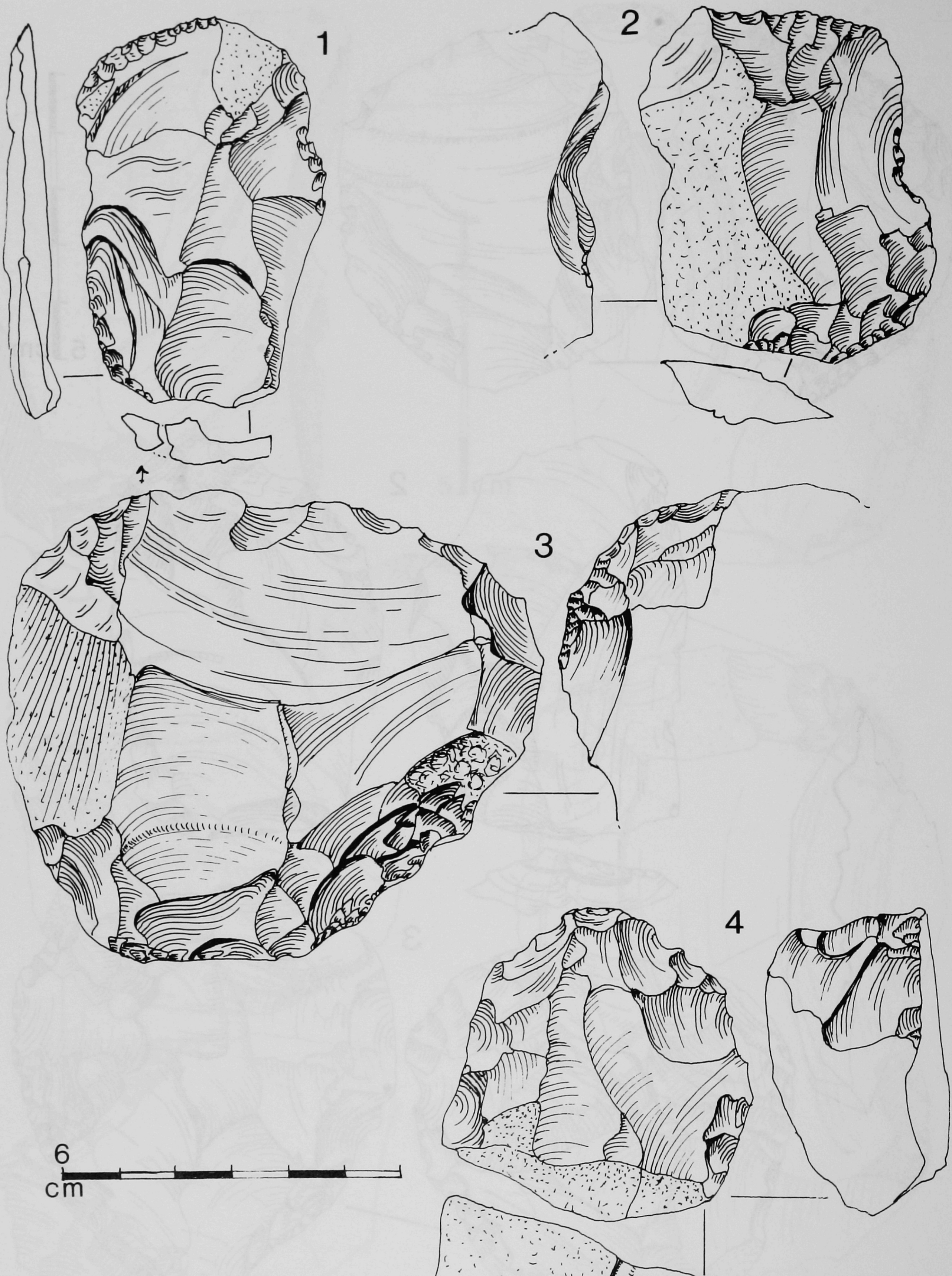


Fig. 19 Level R. 1, End-scraper composite on an atypical Levallois flake, retouched on one edge; 2, end-scraper on a non-Levallois flake, broken on one edge, with flat scalar, parallel retouch; 3, massive scraper on a large, radially-prepared flake with demi-Qina and flat retouch

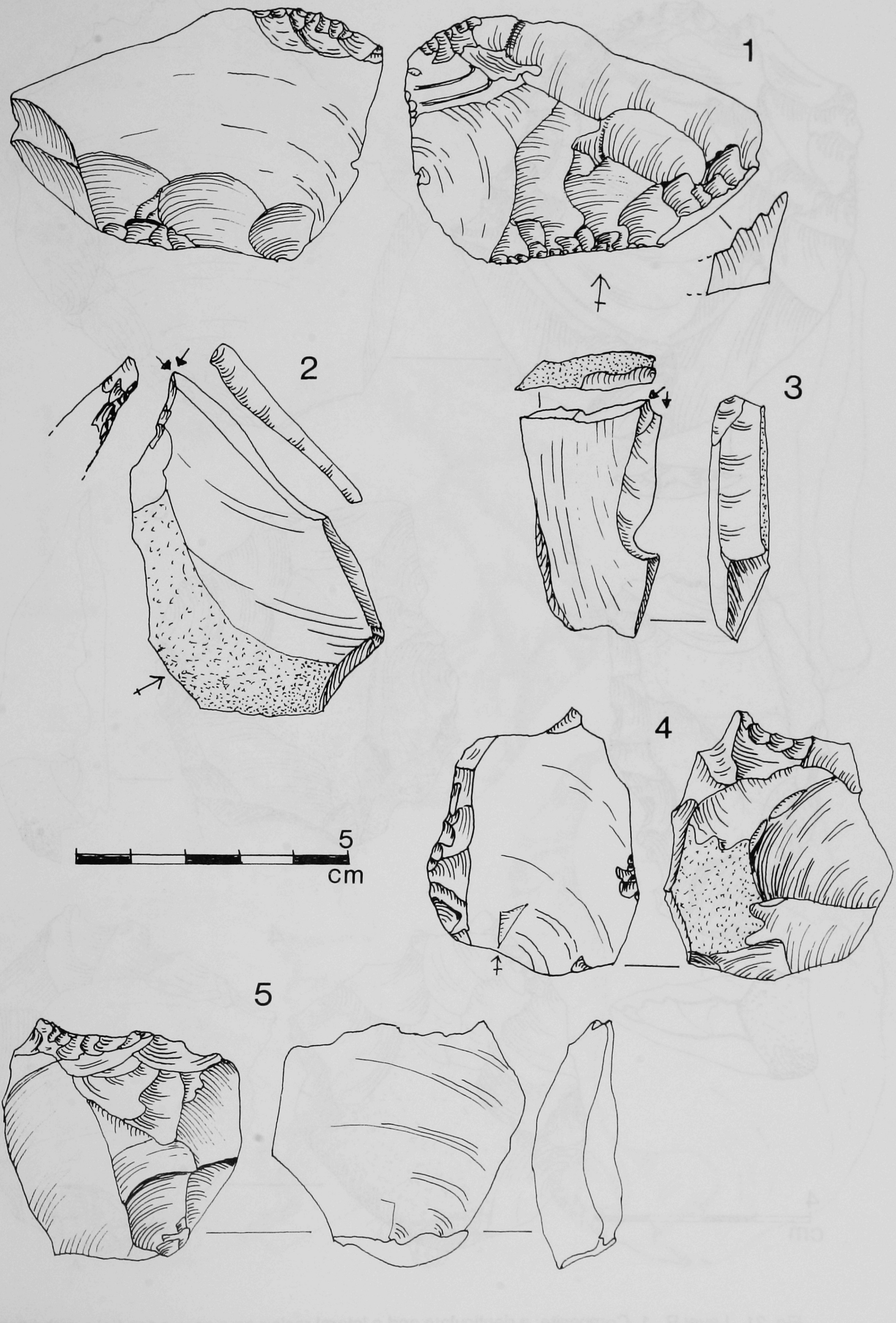


Fig. 20 Level R. 1, Bifacial racloir on a core-preparation flake, butt removed; 2, atypical truncation burin on a transverse core-edge flake with some nibbled distal retouch; 3, small angle-burin on a broken cortex-flake; 4, composite: a distal *bec*, an inverse racloir on the lateral edge of a core-edge flake with butt removed, and a thick, 'burinante' point; 5, *bec* made on the distal edge of a flat flake.

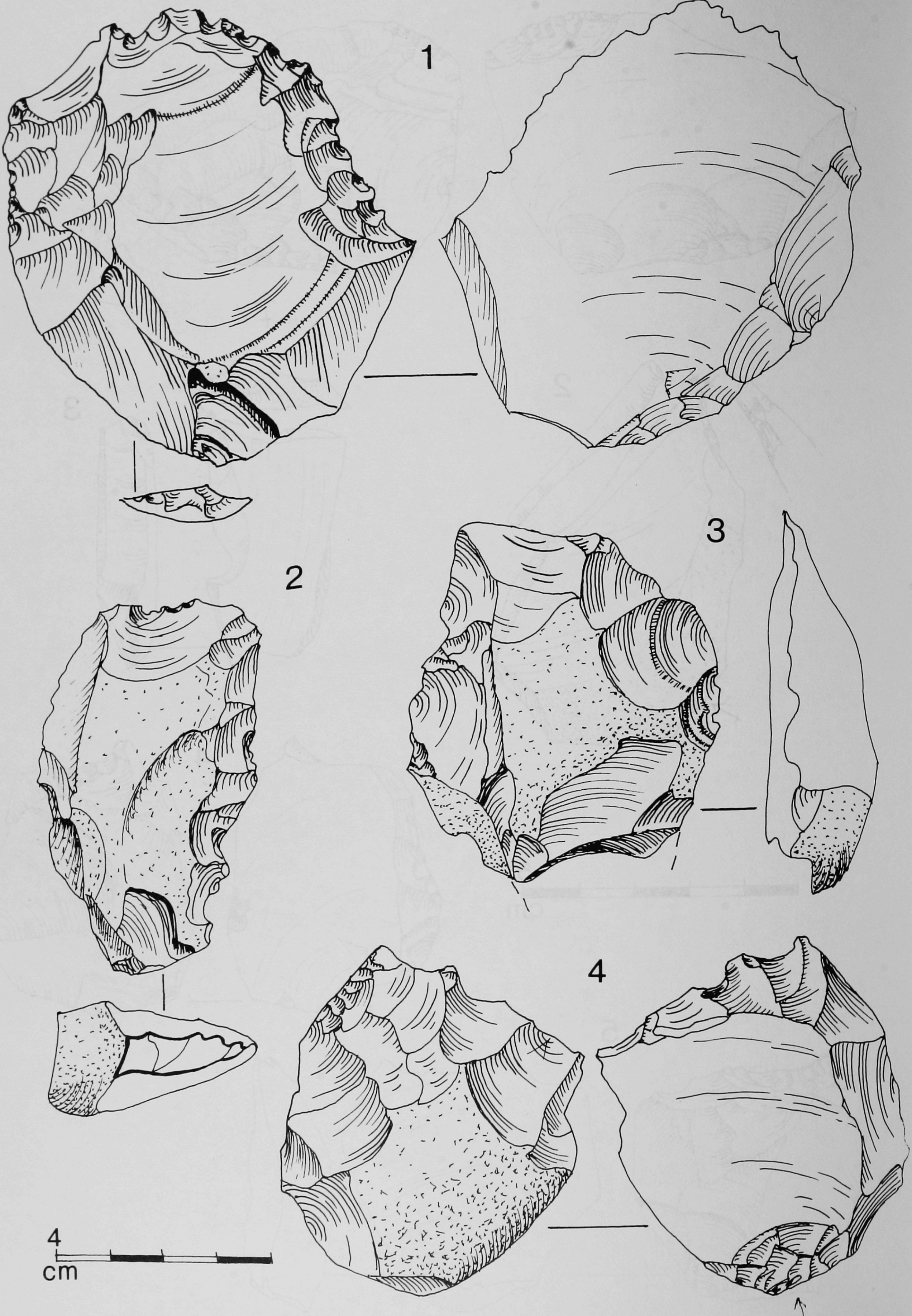


Fig. 21 Level R. 1, Composite: a denticulate and a lateral racloir on a core-edge flake with finely-faceted butt; 2, denticulate on a re-used cortex blade (a naturally-backed knife?); 3, denticulate with large, thick teeth and broad, paralled retouch on a cortex flake with butt removed; 4, inverse denticulate on a core-edge flake (the dorsal retouch derives from core-preparation, cf. 'pseudo-tool').

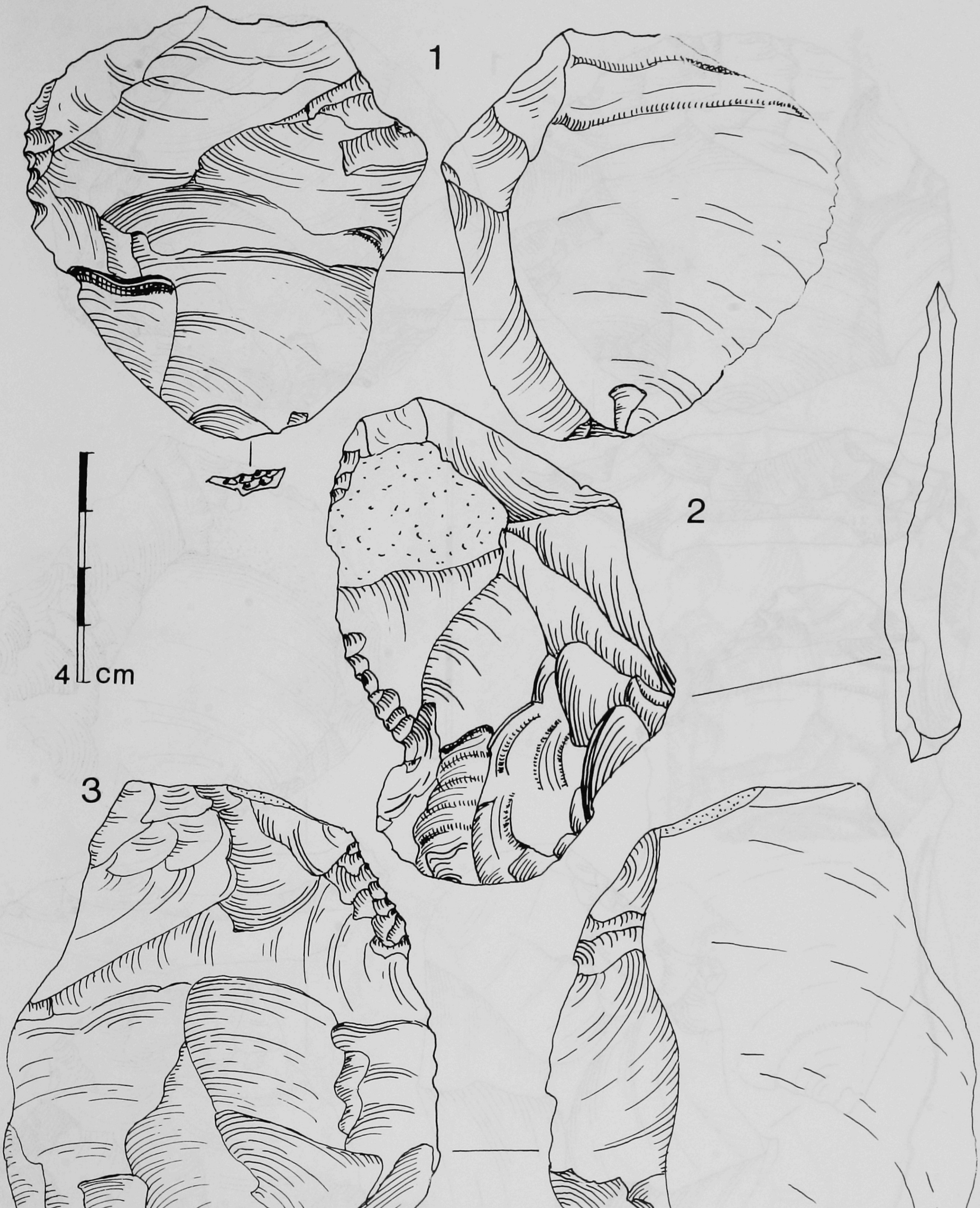


Fig. 22 Level R. 1, Continuous retouch, slightly denticulated, on a cleaver-flake; 2, notch with slight continuous retouch on a radially-prepared flake; 3, a 'pseudo-tool', a flake with pronounced ventral surface tranchet facet, and two areas of older biface- or core-preparation

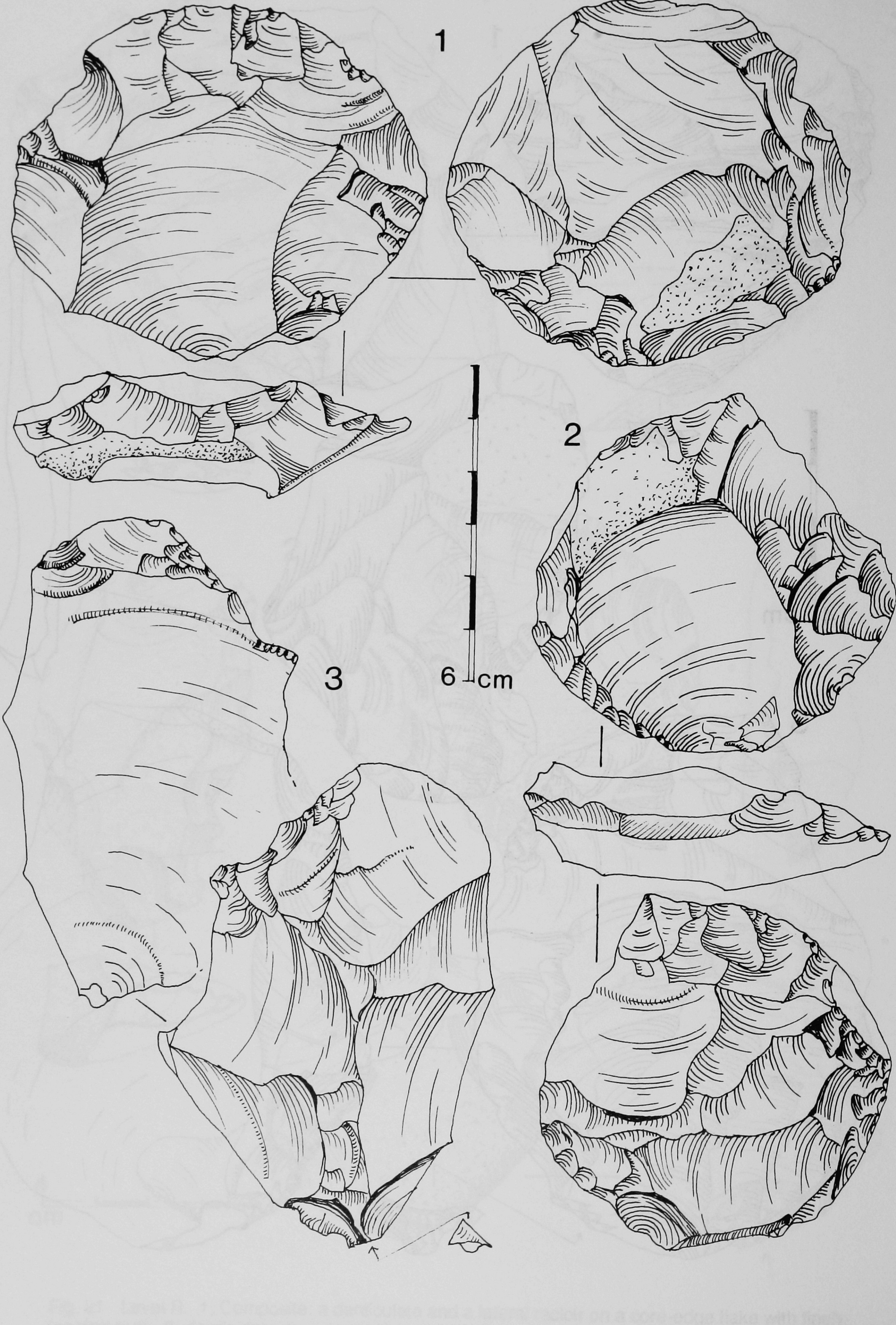


Fig. 23 Level Q a. Classic Levallois core for broad flakes; 2, Levallois core, 'Galilee' type, with transverse base retouch; 3, Levallois flake with alternating tip retouch, some bifacial.

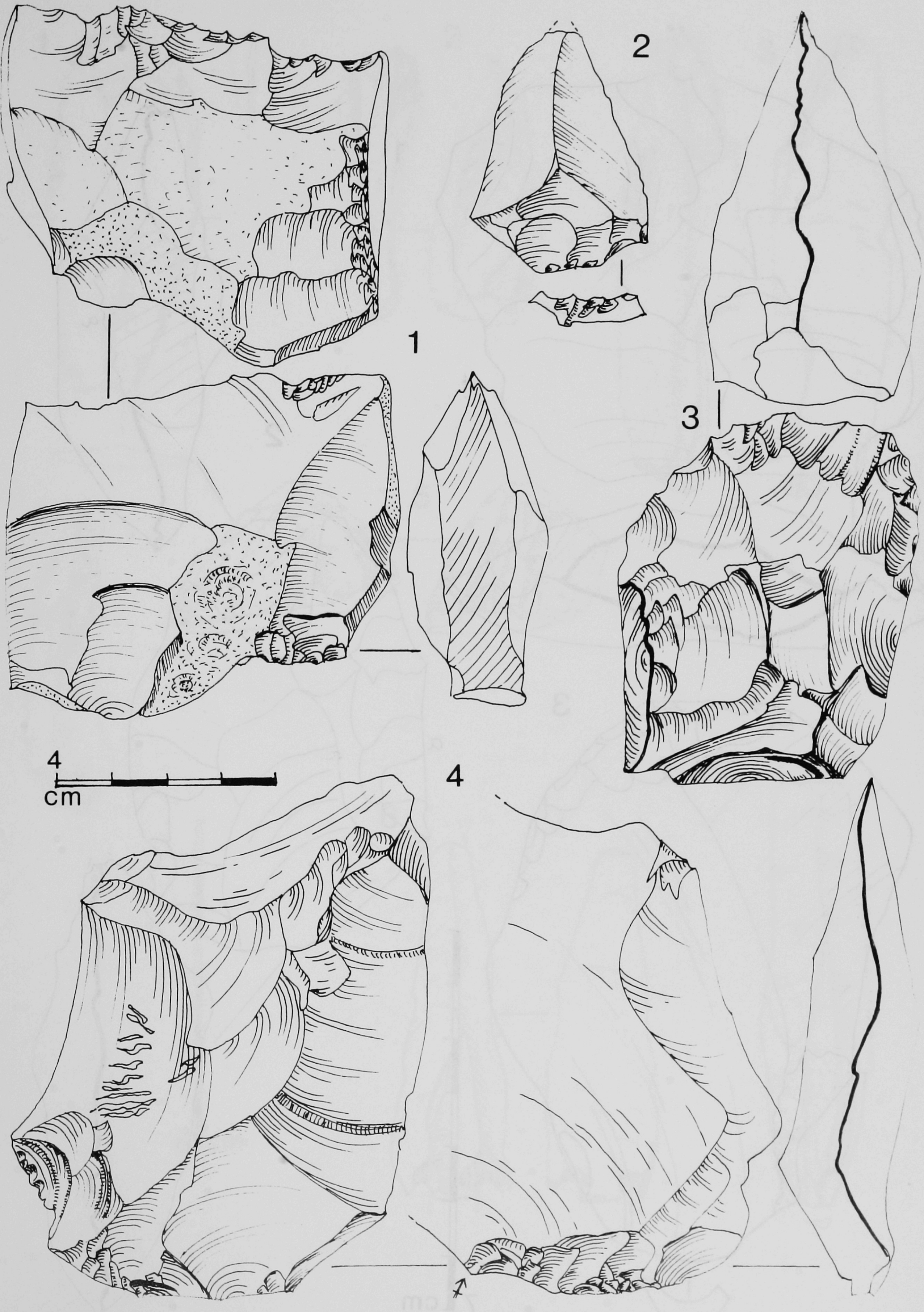


Fig. 24 Level Q a. 1, Transverse straight racloir on a non-Levallois flake with butt removed and *méplats* at each side; 2, atypical Levallois point; 3, atypical bifacial cleaver with 2 patinas and one side a straight cutting-edge; 4, large cleaver-flake with removed butt.

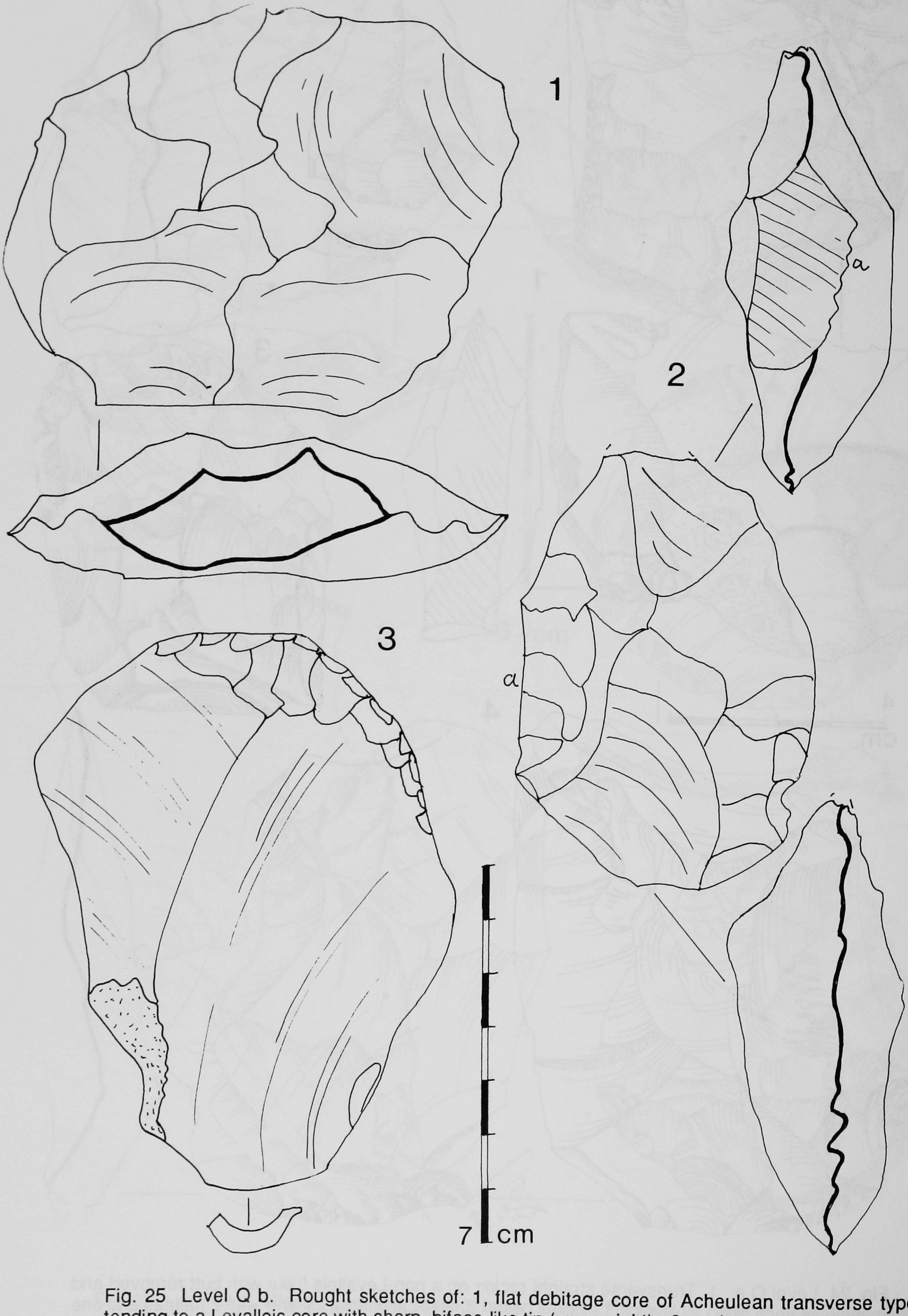


Fig. 25 Level Q b. Rought sketches of: 1, flat debitage core of Acheulean transverse type, tending to a Levallois core with sharp, biface-like tip (upper right); 2, end-scraper on a large, flat debitage flake with lipped butt; 3, elongated ovate biface with very fresh edges and damaged tip.

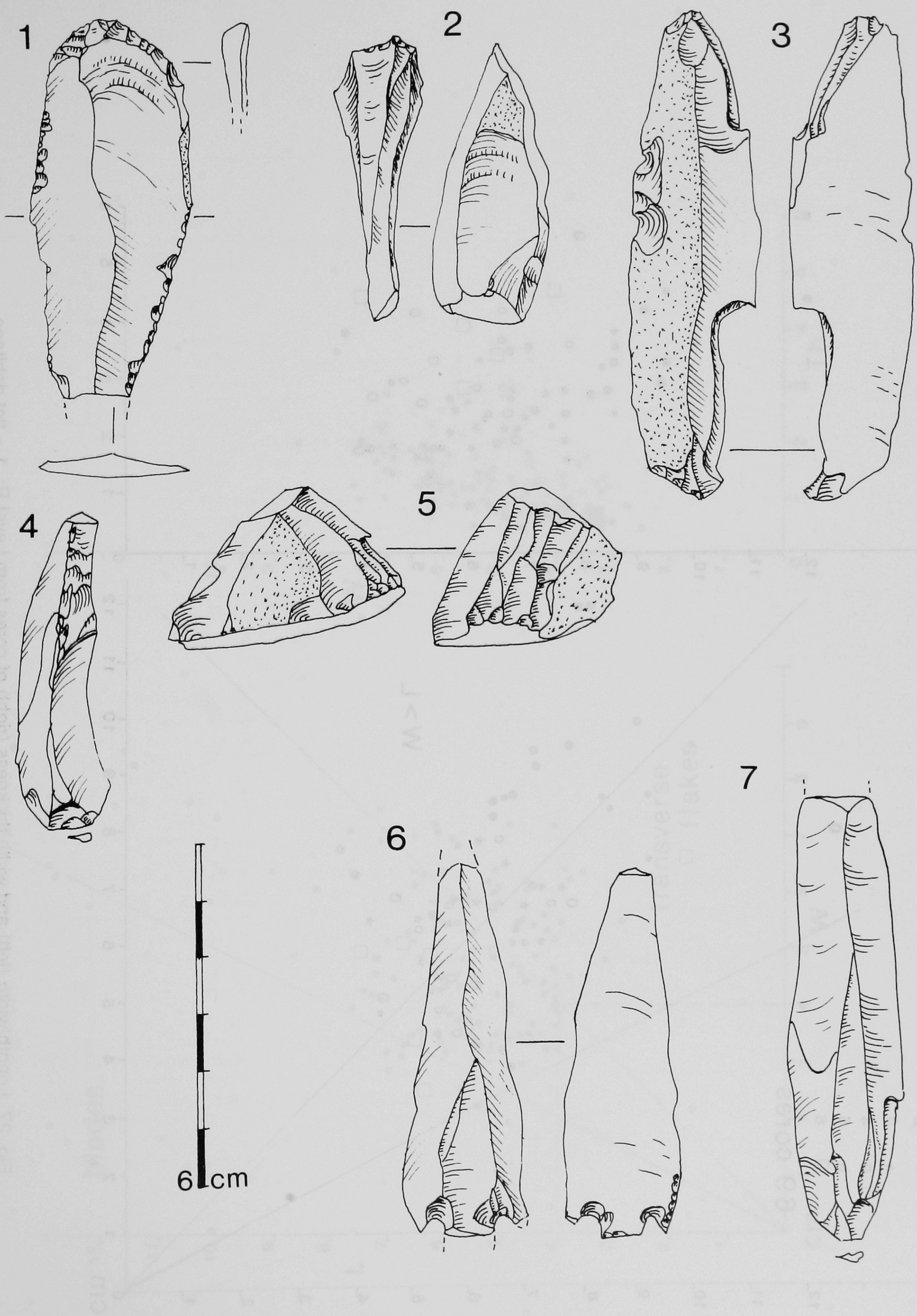


Fig. 26 Levels L and K. 1, End-scraper on a buttless blade (L b C); 2, polyhedric angle-burin on a thick flake (L b A); 3, carinated burin on a broken blade (L b C); 4, crested blade (L b C); 5, bladelet core (L b B); 7, blade (K B); 8, arrowhead with broken tang and incipient wings, white-patinated (K A).

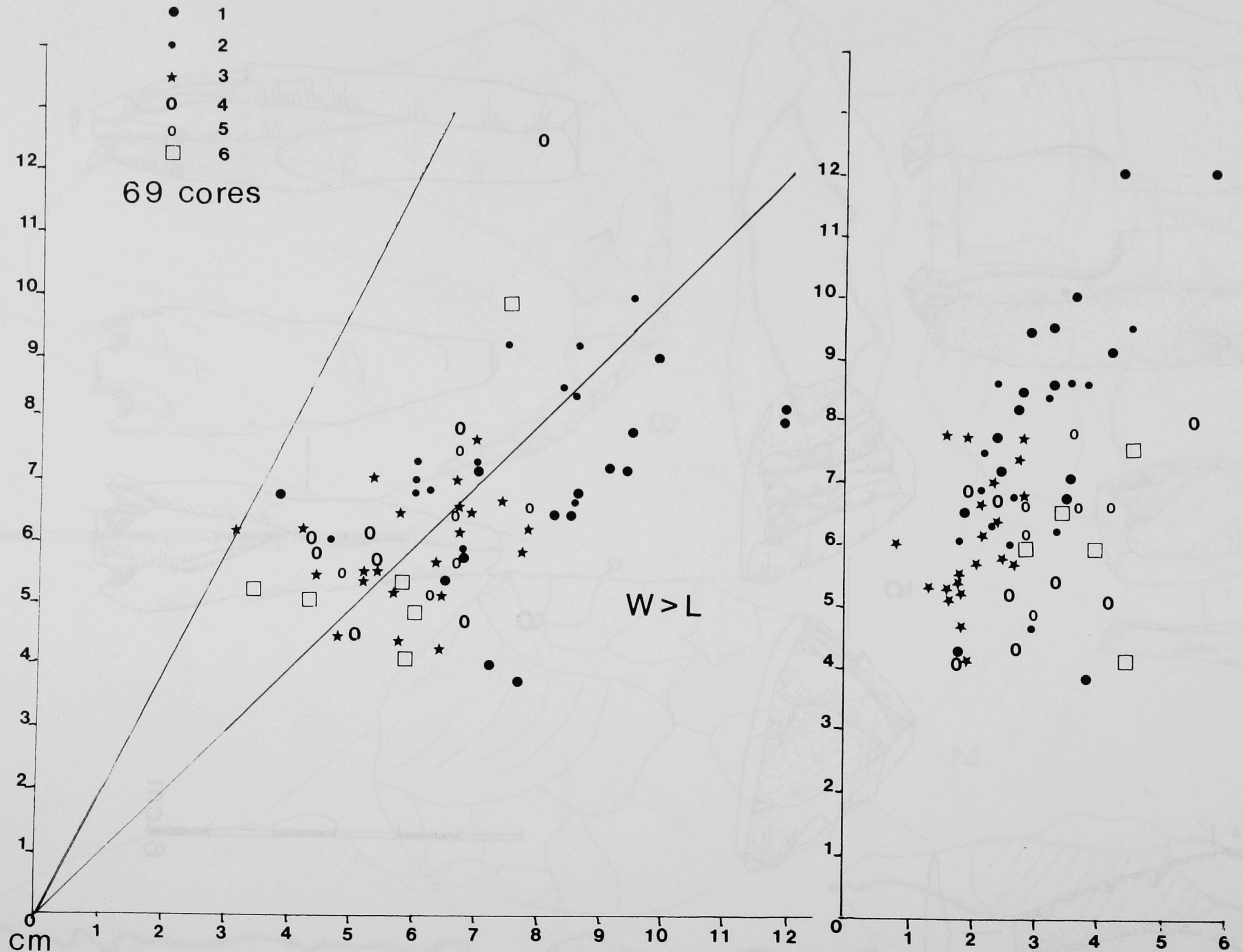


Fig. 27 Length/width (left) and width/thickness (right) of cores from Level R; 1 = flat debitage and Levallois; 2 = proto-Levallois; 3 unexhausted disc; 4 = orthogonal; 5 = Mousterian discoid; 6 = other core types. Note number of transverse specimens.

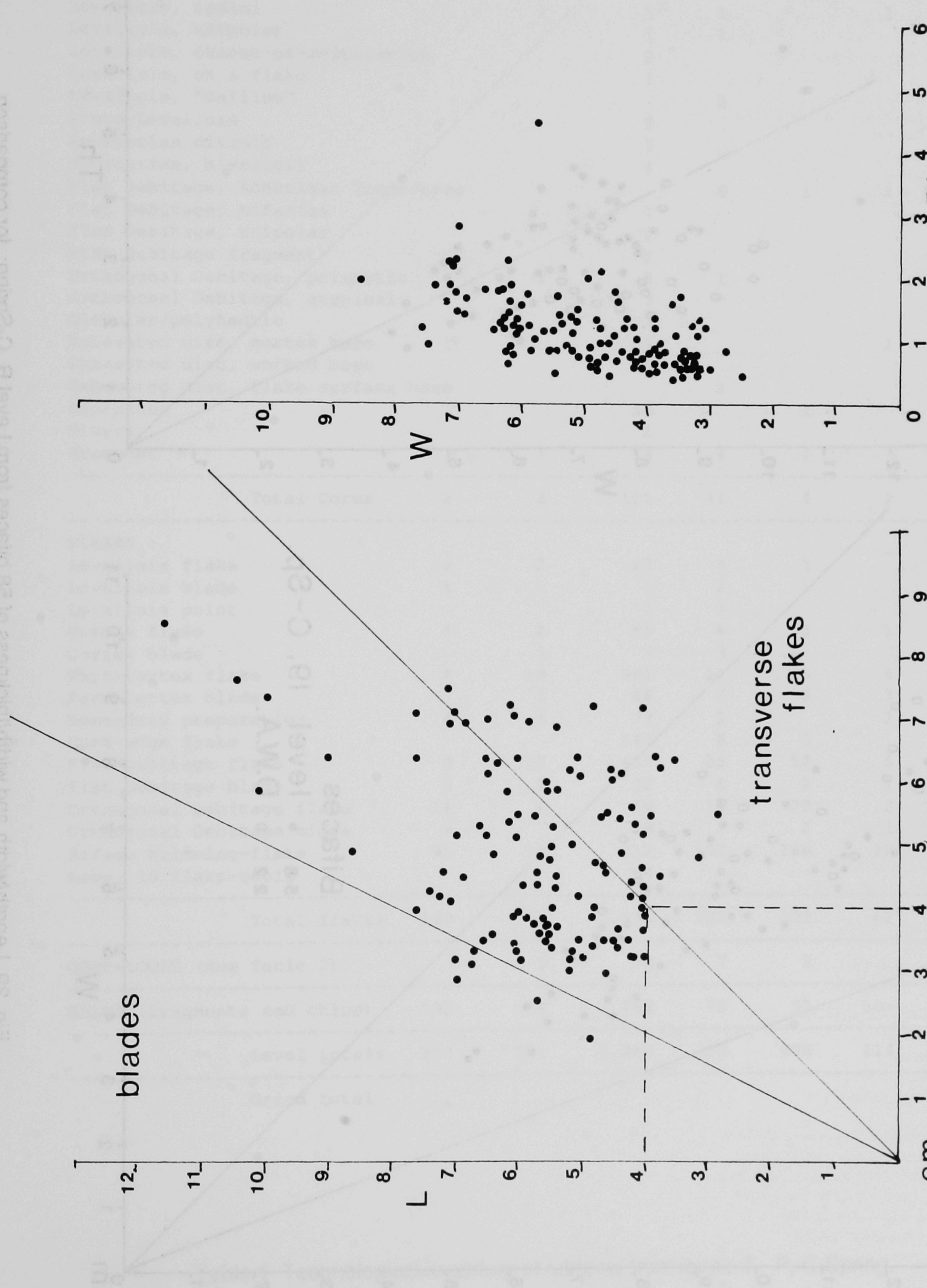


Fig. 28 Length/width and width/thickness of a sample of 124 unretouched flakes from Level R.

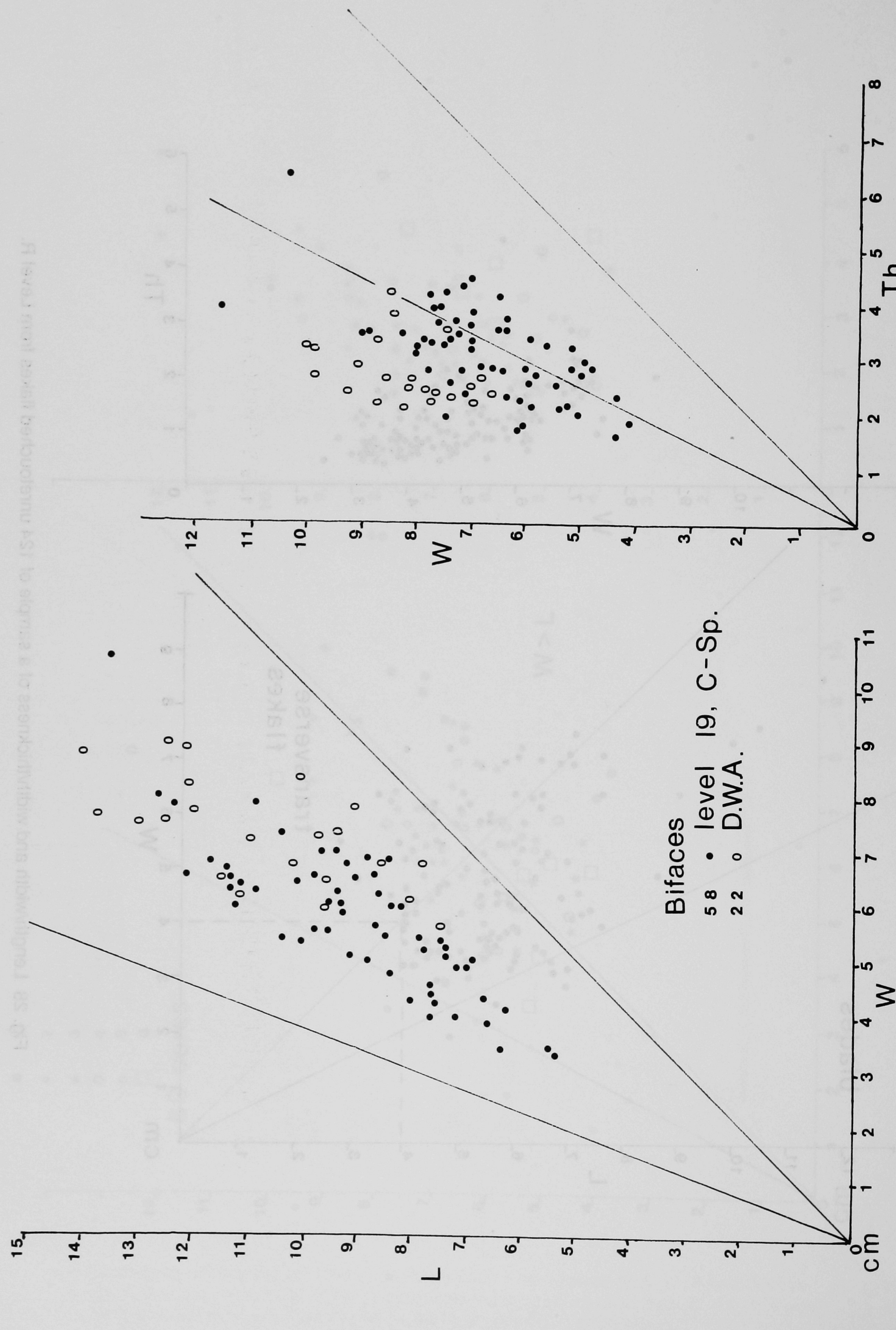


Fig. 29 Length/width and width/thickness of 58 bifaces from Level R, C-Spring; for comparison, 22 bifaces of the Desert Wadi Acheulean (DWA) from Wadi Butm are also represented.

TECHNOLOGICAL INVENTORY, C-SRPING

Debitage classes	Levels T	S	R	Qb	Qa	Pc	Pb
CORES :							
Levallois, radial		1	5	1		1	1
Levallois, unipolar			1	1			
Levallois, change-of-orientation			2				
Levallois, on a flake			1				
Levallois, "Galilee"				3			
Proto-Levallois			3				
Mousterian discoid			3				
Mousterian, biconical			4				
Flat Debitage, Acheulean Transverse				6	1	1	
Flat Debitage, bifacial			7				
Flat Debitage, unipolar			2				
Flat Debitage fragment			2				
Orthogonal Debitage, prismatic		1	5	1			
Orthogonal Debitage, atypical			3				
Globular/polyhedric			3				
Exhausted disc, cortex base	1		9			1	
Exhausted disc, worked base			11				
Exhausted disc, flake surface base				2			
Amorphous			13		2		
Divers			1				
Fragment	1	1	18	4	1		1
Total Cores	2	3	101	11	4	2	2
FLAKES :							
Levallois flake	3	2	27	4	3		1
Levallois blade	1		7	2	1		1
Levallois point			1	1			
Cortex flake	4	2	60	8	5	1	
Cortex blade		1	3	3			
Part-cortex flake	4	19	381	21	36	4	3
Part-cortex blade		1	48	4	8	3	
Secondary preparation	4	5	77	1		2	3
Core-edge flake			147	8	5		2
Flat Debitage flake	9	12	437	55	52	6	5
Flat Debitage blade	2	1	32	5	2	1	
Orthogonal Debitage flake	11	6	89	14	20	2	
Orthogonal Debitage blade	6		28		2	1	
Biface trimming-flake	95	14	612	107	168	42	28
Level 19 flake-tools			84				
Total flakes	139	63	2,033	233	302	62	43
CORE-TOOLS (see Table 2)		1	78	7	5		2
WASTE (fragments and chips)	192	34	768	79	97	50+	50+
Level totals	333	101	2,980	330	408	114	98
Grand total							4,364

Table 1 Technological inventory of artifacts from levels T - P, C-Spring.

Typological Inventory of Lower Paleolithic Tools

Tool Classes	Levels T	S	R	Qb	Qa	Pc	Pb
BIFACES: Discoid			5	1	1		
D-shaped			3				
Pointed ovate			2				
Ovate			8	2	2		
Elongates ovate			5		1		1
Limande			1				
Subovate			5	1			
Partial subovate			3				
Bifacial Cleaver (straight tip)		5	1				
(straight/oblique tip)			3				
(rounded tip)			6	1			
(unifacial)			2				
Amygdaloid			3	1			
Atypical amygdaloid			3				
Backed			2				
Small bifacial piece			1				
Divers/rough-out			1		1		1
Fragment			4				
Total bifaces	-	-	62	7	5	-	2
OTHER CORE TOOLS: Disc			3				
Distal chopper			5				
Distal/lateral chopper		1	3				
Pointed chopper			3				
Double chopper			1				
Pebble tool			1				
Total other core tools	-	1	16	-	-	-	-
RETOUCHED FLAKE TOOLS:							
Racloir: single convex		1	3-				
single straight			3				
single concave			2	1			
double biconvex	1						
double biconcave			2				
offset			3				
transverse straight			1	1			
transverse convex, Quina			1				
1/2 Quina			2				
transverse on bifacial piece			2=39				
inverse, single			3	1			
inverse, double			3				
inverse, composite			3				
with thinned back			1				
alternate	1	1	2				
bifacially edged			6				
-biface	1		1				
fragment			1-				
End-scraper			3	1	1		
Inverse end-scraper			2				
End-scraper composite			2				
Massive flake-scraper			1				
Steep-scraper/_rabot_			1	2			
Angle burin			1				
Truncation burin			1				
Bec			1				
Bec burinante alterne			1				
Bec composite			2				
Denticulate			4	3			
Inverse denticulate			2				
Denticulate composite			3				
Notch			6	1			
Notch with continuous retouch			4	2			
Abrupt continuous retouch				2			
Semi-abrupt continuous retouch		3	3				
Bifacial continuous retouch			3	1			
Truncated faceted flake			1				
Naturally-backed knife			2				
Flake chopper			1				
Flake cleaver			1				
Total flake tools	3	5	84	15	2	-	-
Total tools	3	6	162	22	7	-	2

Table 2 Typological inventory of Lower Paleolithic tools at C-Spring, levels T - P.

INVENTORY OF ARTIFACTS IN LEVELS L-K, C-SPRING

Artifact classes	LbA	LbB	LbC	LaA&B	LaC&D	LaF-G	K A	K B	K C
	Levels								
Debitage:									
Flake core				1					
Blade core									
Bladelet core		1				1			
Amorphous core								1	
Core fragment				1					
Flake				1					
Blade				1				1	
Bladelet		5	5	4	7	9		1	
Trimming element				1	1	1		1	
Fragment, chips		20	20		50	22		25	3
Tools:									
Arrowhead							1		
End-scraper			1						
Angle burin		1	1		1				
Carinated burin		1							
Polyhedric burin	1								
		Lb			La			K	
		56			101			33	

Table 3 Inventory of artifacts from post-Middle Paleolithic levels: L b, L a and K, at C-Spring.

Level R Unretouched flakes:

BUTT TYPES

FLAKE TYPES	Cortex	Plain	Dihedral	Faceted	Punctif./ Shattered	Removed	Absent	Broken/ Indetermin.	Sub-Total	Grand Total
Levallois flake	1	6	2	8	3	1		4	25	
Levallois blade		2		1	3			1	7	
Levallois point				1					1	
Total Levallois	1	8	2	10	6	1		5	33	33
Non-Levallois:										
Cortex flake & blade	13	17	4	6	8			1	49	
Part-cortex flake	31	71	19	33	45	5	2	20	226	
Part-cortex blade	6	17	4	4	8	1	2	3	45	
Secondary preparation	14	29	5	6	13		1	9	77	
Flat Debitage flake	29	85	36	50	42	6		38	286	
Flat Debitage blade	3	10	2	2	6		1		24	
Orthogonal Debitage flake	11	25	4	11	13	1		10	75	
Orthogonal Debitage blade	4	13	1	4	1			5	28	
Core-edge flake	13	34	8	26	9	2		10	102	
<u>Eclat de taille</u> (hexag.)	6	21	10	10	9	2	2	3	63	
<u>Eclat de taille</u> (flat)	12	32	17	29	89		6	34	242	
Total non-Levallois	142	375	110	182	243	17	15	134	1,217	1,217
Grand Total	143	382	112	192	249	18	15	139		1,250
Percentage of butt types	11.44	30.56	8.96	15.36 (IF)	19.92	1.44	1.20	11.12	100.00	

Table 4 Types of butt and types of flake on a sample of 1,250 unretouched blanks from level R, C-Spring.

BIFACES Types of Tip.	Levels R N°	R %	R Restricted N°	R Restricted %	-Qb- N°	-Qa- N°	-Pb- N°
Pointed	2	3.2	2	3.4			
Ogival	18	29.0	18	31.0	1	1	1
Rounded	24	38.7	24	41.3	3	4	1
Straight	8	12.9	8	13.7	1		
Straight/oblique	2	3.2	2	3.4			
Accuminate	2	3.2	2	3.4			
Reworked	2	3.2	2	3.4	2		
Unrecognisable	4	6.4					
Totals	62	99.8	58	99.6	7	5	2

Table 5 a Types of tip on **76** bifaces from C-Spring.

BIFACES Types of Base	Levels R N°	R %	R Restricted N°	R Restricted %	-Qb- N°	-Qa- N°	-Pb- N°
Edged	33	53.2	33	56.8	4	5	2
Half-edged	4	6.4	4	6.8			
Not edged: cortex	7	11.2	7	12.0	1		
worked	13	20.9	13	22.4	1		
meplat					1		
Flake butt	1	1.6	1	1.7			
Absent/unrecognisable	4	6.4					
Totals	62	99.7	58	99.7	7	5	2

Table 5 b Types of base on **76** bifaces from C-Spring.

BIFACES

Types of cutting-edge	Levels R N°	%	Restricted N°	%	-Qb- N°	-Qa- N°	-Pb- N°
Two lateral edges:							
Both straight	26	41.9	26	42.6	2	2	1
1 straight, 1 straight/sinuous	17	27.4	17	27.8	4	3	
1 straight, 1 sinuous	3	4.8	3	4.9			1
Both straight/sinuous	6	9.6	6	9.8			
1 straight/sinuous, 1 sinuous	1	1.6	1	1.6			
Both sinuous *	1	1.6	1	1.6	1		
One lateral edge:							
Straight	5	8.0	5	8.1			
Straight/sinuous	2	3.2	2	3.2			
Unrecognisable	1	1.6					
Totals	62	99.7	61	99.6	7	5	2

* Includes large fragments

Table 5 c Types of cutting-edges on **76** bifaces from C-Spring.

BIFACES

Types of face retouch	Levels R N°	%	Restricted N°	%	-Qb- N°	-Qa- N°	-Pb- N°
Primary, rough shaping					2		
Mainly primary	10	16.1	10	16.6			1
Mixed primary and secondary	4	6.4	4	6.6			
Mainly secondary	8	12.9	8	13.3		1	
Secondary, fine finishing	21	33.8	21	35.0	5	4	1
Secondary with cortex patches	17	27.4	17	28.3			
Unrecognisable	2	3.2					
Totals	62	99.8	60	99.8	7	5	2

Table 5 d Types of face retouch on **76** bifaces from C-Spring.

BIFACES

Dimensions	Levels R	Qb	Qa	Pb
Ordinal length scale:				
Very large: > 14.9 cm	1			
Large: 10-14.9 cm	15	1	1	1
Medium: 7-9.9 cm	35	3	3	1
Small: 6-6.9 cm	5	3	1	
Minute: < 6.0 cm	2			
Number in sample	58	7	5	2
Mean of the length in cm	10.77	8.28	8.8	10.1
N° of 'thick' bifaces < 2.35	32	5	4	2
N° of 'thin' bifaces > 2.34	26	2	1	
N° of bifaces	62	7	5	2
Biface Index	38.2	31.8	71.2	100.0

Table 5 e Data on the dimensions of the bifaces at C-Spring.

Level R, Retouched flake tools

FLAKE TYPES	BUTT TYPES Cortex	Plain	Dihedral	Faceted	Punctif./ Shattered	Removed	Absent	Broken/ Indetermin.	Sub- Total	Grand Total
Levallois flake			1	5	2	2		2	12	
Levallois blade										
Total Levallois			1	5	2	2		2	12	12
Non-Levallois:										
Cortex flake	1	2		1		2		1	7	
Cortex blade		1				1			2	
Part-cortex flake	1	6		3		5		2	17	
Part-cortex blade			1					1	2	
Flat Debitage flake	4	5	2			5		4	20	
Orthogonal Debitage flake	2		2			2	1	1	8	
Core-edge flake	2	6	1			6		1	16	
Total non-Levallois	10	20	6	4		21	1	10	72	72
Grand total	10	20	7	9	2	23	1	12		84
Percentage of butt types	11.90	23.80	8.33 (IFl)	10.71 (IFs)	2.38	27.38	1.19	14.28	99.97	

Table 6 Butt types and blank types used for 84 retouched flake-tools at C-Spring, level R.

) DIMENSIONS OF FLAKES, LEVELS T - P, C-SPRING

	T		S		R		Qb		Qa		P	
° measured for length, width and thickness:	34		41		124		74					
ean thickness in cm	0.929		1.534		0.860		0.986					
/Th ratio means	3.102		3.407		4.440		4.713					
° measured for greatest length:	44		41		1,061		74		102		35	
. large (more than 12 cm)					2	0.18%						
Large (more than 9 cm)			7		72	6.78%			15		5	
Medium (more than 6 cm)	10		24		400	37.70%	14		43		15	
Small (more than 3-4 cm)	34		10		587	55.32%	60		44		15	
Chips less than 3-4 cm (not included in %)	95		14		612		107		168		70	
Total flakes	139		63		1,949		233		302		103	
2) FLAKE INDICES	N°	%	N°	%	N°	%	N°	%	N°	%	N°	%
IL	4	2.87	2	3.17	47	2.41	7	3.04	4	1.32	2	1.94
IL (restricted)	4	9.09	2	4.25	47	3.51	7	5.55	4	2.98	2	5.71
ILam	9	6.47	3	4.75	118	6.05	15	6.43	13	4.30	9	8.73
ILam	9	20.45	3	6.38	118	8.82	15	11.90	13	9.70	9	25.71
IFl	14	31.80	7	11.11	304	24.32	17	13.49				
IFs (restricted)	9	20.45	2	4.08	192	15.36	7	5.55			12	34.28
IR	3	100.00	2	33.33	39	46.42	3	20.00	1	50.00		
N° in restricted sample:	44		47		1,250		126		134		35	
N° of retouched tools	3		6		84		15		2			

Table 7 Data on flakes of levels T - P, C-Spring; 1, dimensions; 2, indices.

PATINA COLOUR	T N°	T %	S N°	S %	R N°	R %	Qb N°	Qb %	Qa N°	Qa %	P N°	P %
Unpatinated/beige - grey	244	73.93	59	58.41	558	21.20	15	6.49	39	7.84	5	10.00
Dark grey - olive	12	3.63	14	13.86	874	33.23	101	48.72	164	40.19	19	38.00
Pale grey mottled (PGM)	25	7.57	28	27.72	1,130	42.96	106	45.88	209	51.22	21	42.00
Black					37	1.40			3	0.73		
White/desilicified	29	8.78			31	1.17	9	3.89			5	10.00
Brown	20	6.06										
Total in sample	330	99.9	101	99.9	2,630	99.9	231	99.9	408	99.9	50	100.00

Table 8 Frequencies of patina colours in levels T to P at C-Spring.

A RECONSIDERATION OF THE FOSSIL FAUNA FROM C-SPRING, AZRAQ

Juliet Clutton-Brock

INTRODUCTION

The Acheulian site of C-Spring is one of a group of Palaeolithic sites discovered in the vicinity of Azraq, about 97 km east of Amman in Jordan. The surrounding country forms the edge of the Wadi Sirhan which stretches south for about 320 km. The basal stratum is Upper Cretaceous and is overlain by fluviatile gravels containing the Palaeolithic industry.

The present land surface is an ancient lake bed or 'qa' and the site at C-Spring was found as a result of mechanical excavations carried out by the American Aid Commission as part of a large-scale irrigation scheme in the 1950s. A square pit, dug to obtain water with bulldozers and dredgers, revealed a stratified series of deposits which was described by Zeuner (see Chapter 8, this volume). It was from this sounding that a quantity of animal remains and flint implements were retrieved by Mr Pannell and Mr Lankaster Harding, and later Zeuner brought the collection to London for study, by kind permission of the Museum in Amman.

For the sake of clarity the sequence of events in which the fossils and artefacts were deposited is summarized here, as it was interpreted by Zeuner :

1. On the surface of the Upper Cretaceous limestone, a desert gravel was formed, indicating dry conditions at an ancient period.

2. This was followed by a humid phase leading to erosion which caused the formation of the wadi.

3. A period that was drier than the previous phase but probably moister than the present day. The wadi was filled with gravel deposits which are green from reduction of iron oxides. The fossils and artefacts were retrieved from this level.

4. A continuation of the drier phase with the formation of 'quas' that filled the older valleys. A 'qa' is a mud flat that is formed as a result of the drying up of a very large, shallow and seasonal lake.

5. There was probably a humid phase when down-cutting of the wadi occurred as a result of erosion.

6. A dry period leading to the present semi-desert conditions.

The flint tools and the animal remains were in a very fresh condition and were quite unabraded, so that they appeared to be *in situ*. The bones were, however, in a fragmentary condition due partly fo the effects of penetration by calcite in the ground and also to their mechanical excavation, but many of the teeth had remained intact.

A total number of 139 animal bones and teeth was retrieved from this first sounding at C-Spring. They were identified to seven species of ungulates and were described in detail in Clutton-Brock (1962, 1970), with measurements of each element being included in the earlier work (1962). After they had been studied, Zeuner arranged for the animal remains to be returned to the Museum in Amman, with a proportion being kindly donated to the Department of Palaeontology, British Museum of Natural History. For the present review, summaries are given below for each species, in systematic order :

ORDER PERISSODACTYLA

***Dicerorhinus hemitoechus*, extinct rhinoceros**

This extinct rhinoceros was represented by ten teeth, possibly from a single animal for the teeth were all unerupted except for one worn milk tooth. There were six upper cheek teeth and four lower but no surrounding jaw bone and other bones of rhinoceros. Whether from one or several individuals, the teeth are from a young animal only a few months old.

Two species of rhinoceros of the genus *Dicerorhinus* were common in the Middle and Upper Pleistocene. Zeuner (1934) (in a work that was to become a classic example of deductions that can be made from fossils about functional morphology) showed from studies of the skulls and teeth that *Dicerorhinus merckii* (now named *Dicerorhinus kirchbergensis*) was a forest-living, browsing species while *Dicerorhinus hemitoechus* was a grazing species living in savanna and steppe. It is clear from the presence of equids and camel in the fauna of C-Spring that the environment was grassland rather than forest so it may be assumed that the species of rhino was *Dicerorhinus hemitoechus*. Both rhinos appear to have moved into Europe during warm phases of the Pleistocene but both species have been recorded as being totally extinct before the Last Glaciation. The Sumatran rhino, *Dicerorhinus sumatrensis*, the only living representative of the genus, is only distantly related to the extinct species (Guérin, 1982).

***Equus hemionus*, Asiatic wild ass**

Seventeen teeth and one first phalanx were identified as belonging to this Asiatic wild ass, representing at least two individual equids. The teeth are all high-crowned, little worn, and without roots so they must be from young adult animals, less than five years old when they died.

Remains of *Equus hemionus* have been found on many Pleistocene sites in western Asia. In the Mount Carmel caves this equid first appears in Tabun level E (Bate, 1937). It used to be assumed that *Equus hemionus* was the only species of wild ass to be found in prehistoric contexts in western Asia but since the identification by Ducos (1986) of a metatarsal bone of a wild *Equus africanus* from the early Holocene at Tell Muraibit in Syria the picture appears to be more complicated. It may be that the range of the so-called African wild ass, *Equus africanus* extended into western Asia. It cannot therefore be stated with certainty on the evidence of the few teeth from C-Spring that the equid represented is a hemione rather than a true ass. However the characteristics of the patterns of the cheek teeth indicate that the equid is certainly an assinine rather than a caballine or a zebroid equid. This is shown, in the upper cheek teeth, by the long oval protocones, and, in the lower teeth, by the pointed lingual sinus and by the external sulcus which does not penetrate the neck of the metaconid and metastylid.

In these characters the teeth ascribed to *Equus hemionus* from C-Spring agree in every respect with those identified from Tabun, Mount Carmel by Bate (1937) and with the equid teeth from the recent excavations of the Middle Palaeolithic site of Far'ah II in the Negev, Israel, identified by Gilead and Grigson (1984).

The single bone of an equid, a first phalanx, from C-Spring also conforms closely to the proportions of this element in Recent *Equus hemionus*.

***Equus hydruntinus*, extinct equid**

Three teeth from C-Spring were so much smaller than those identified as *Equus hemionus* that it was concluded they must be from a different equid. The only very small equid that has been identified from Upper Pleistocene sites in western Asia is the enigmatic *Equus hydruntinus*. This used to be known as the 'European wild ass', but following more recent work it seems that fossils of this equid may represent a relict form of the more ancient *Equus stenonis* group. A description is given of *Equus hydruntinus* together with its distribution in western Asia in Uerpmann (1987). The finds at C-Spring, Azraq and at the Palaeolithic site of Yabroud in Syria appear to represent the eastern extremity of its range.

ORDER ARTIODACTYLA

Camelus dromedarius

Bones and teeth of camel were greater in number than those of any other species from C-Spring, there being 29 cheek teeth (representing five individuals, including one juvenile) and 29 parts of bones as well as many small fragments that could be identified as camel. Despite their bad state of preservation it was possible to assess the size of the bones and it could be seen that the camels had been rather small animals, no larger than the modern dromedary, which is rather smaller than the living Bactrian camel and a lot smaller than the fossil *Camelus thomasi*. Remains of this camel have been identified from Pleistocene sites in North Africa and from the Middle Palaeolithic site of Far'ah II in the Negev (Grigson, 1983). The metatarsal bone of *Camelus thomasi* from this site has a proximal width of more than 84 mm while a comparable bone from C-Spring has a proximal width of 61.2 mm.

Very few Upper Pleistocene sites in Africa or western Asia have so far produced remains of camel. Besides those mentioned, there were a few camel remains identified from the Middle Palaeolithic cave of Douara in Syria. The bones were the same size as a modern dromedary with a metatarsal bone having a proximal width of 64.5 mm (Payne, 1983). Other sites ranging in period from the Middle Palaeolithic to the Bronze Age are listed in Uerpmann (1987).

Because of the anomalies and scarcity of finds of camel from Pleistocene and early Holocene sites in Africa and western Asia a project has been set up by Caroline Grigson in collaboration with the Accelerator Unit at the Oxford University Research Laboratory to try to obtain radiocarbon dates for camel remains from as many sites as possible. A number of dates has been obtained but the project has been hampered, as when dating animal remains from many sites in this region, by the reduction of collagen in the bones due to the harsh climatic conditions to which the deposits have been subjected. A sample of camel bone from C-Spring was submitted for dating, as part of this project, and the date obtained was 3340+/-200 BP (1390 BC) [lab.no OxA-961] (see Hedges *et al*., 1987). It is probable that this very surprisingly late date is a false result due to the very small amount of collagen (1.6 mg/g) that could be obtained from the sample. This could either be residual collagen or it could be intrusive from the surrounding carbonate in which case it is irrelevant to the true date of the fossil.

On the other hand the possibility that the camel bones are of relatively recent date and were intrusive into the assemblage containing the teeth of the extinct *Dicerorhinus hemitoechus* cannot be entirely repudiated, taking into account their mechanical excavation.

Two other surprisingly recent dates have been obtained on camel bones that appear to be definite intrusions. The first was from a camel bone from the Upper Pleistocene site of

Mugharet-el-Emireh (Bate, 1927) which yielded a date of 840+/-120 BP (AD 1110) [lab. no OxA-963] from 33.2 mg/g of collagen. The second was from a recently identified camel bone from level Tabun C of Mount Carmel (Payne and Garrard, 1983). This date is 1060+/-70 BC (AD 890) [lab. no OxA-962], with the bone providing 76.6 mg/g of collagen (see Hedges *et al*, 1987).

These relatively modern dates for two bones that had been presumed to have originated in secure Palaeolithic contexts must call into question the whole dating of these faunal assemblages. As is well known there is always a danger of intrusion in cave deposits and a number of radiocarbon dates from sites in different parts of the world have recently highlighted the necessity for individual specimens to be dated before they are singled out as key elements in archaeozoological research.

In their discussion on the camel bone from Tabun, before it was dated, Payne and Garrard (1983) made the comment that, 'It is tempting to suggest that the smaller *Camelus* from Tabun, Azraq and Douara Cave was the foreunner of the modern *Camelus dromedarius* ; but the long gap between these Middle Palaeolithic fossils (before 40,OOO bp) and the earliest reported domestic camels (after 5000 bp) requires explanation'.

An explanation, suggested to me by Caroline Grigson, could be that all camel remains from the so-called Pleistocene levels of Tabun, Douara, and Azraq are Holocene intrusions, and that the only Pleistocene camel in Africa and western Asia was the very large form which has been named *Camelus thomasi* ; however see 'Discussion' below.

Like so many other species of mammal, the camel may have undergone a reduction in size at the beginning of the Holocene, as a result of climatic and ecological change, so that the true sequence was from the large *Camelus thomasi* in the Pleistocene to a smaller, wild *Camelus dromedarius* in the Holocene to domesticated *Camelus dromedarius* in the Bronze Age.

The existence of a wild dromedary in the early Holocene used to be merely presumption but it is now known that there was a small wild camel living in Arabia before the advent of the domesticated dromedary because an early rediocarbon date has recently been obtained from a camel bone retrieved from the Red Sea site of Sihi (Grigson *et al.*, in press). The date is 8200+/-200 (6250 BC) [lab.no OxA-983] and this bone provides the earliest definitive evidence for the progenitor of the domesticated dromedary.

Bos primigenius

Forty two cheek teeth from C-Spring could be identified as coming from *Bos primigenius*, representing at least four individuals of which one was a juvenile with newly erupted teeth. There was also one first phalanx, one second phalanx, one magnum and one part of a talus.

As stated by Gilead and Grigson (1984) in their description of the animal remains from Far'ah II, the aurochs (*Bos primigenius*) was present on virtually all Upper Pleistocene sites in North Africa and the Middle East and it must have been a very common animal. They comment further that there was very little, if any, change in size in the remains of *Bos primigenius* from the Acheulian to at least the end of the Pleistocene and that the aurochs was smaller animal in the Levant than in Europe. A lower third molar from Far'ah II had a length of 49.2 mm, while those from C-Spring measured 42.9, 46 and 48 mm.

Bovidae Incertae sedis

In the former descriptions of the faunal remains from C-Spring (Clutton-Brock, 1962, 1970) a single tooth was tentatively ascribed to a species of *Boselaphus*. This identification was based on the size of the tooth, a lower, newly-erupted, second molar, which was bovid but too small to be *Bos primigenius*. The tooth was about the same size as that of a large ibex (*Capra ibex*) or tahr (*Hemitragus* sp.) but it could not have come from either of these caprines because of the presence of a well-developed accessory pillar on the labial side of the tooth which is never found in the Caprinae.

The tooth does indeed closely resemble a lower second molar of the nilgai, *Boselaphus tragocamelus*, but equally it could have come from a small, young domestic bull or cow (*Bos taurus*). If the likelihood of intrusive elements has to be considered, as a result of the small size of the camel remains as well as the aberrant radiocarbon date, then an identification of *Bos taurus* must be put forward as a possibility.

At the present day the bovid tribe of Boselaphini contains only two species, both found only in India. They are the nilgai, *Boselaphus tragocamelus* and the four-horned antelope, *Tetraceros quadricornis*. There is very little information available on the fossil history of these bovids but the distribution of the nilgai was wider during the Pleistocene and it is not inconceivable that it should be found in western Asia.

Alcelaphus buselaphus

Two cheek teeth could be identified as coming from a hartebeest, and one proximal end of a radius may also be ascribed to this antelope.

The hartebeest is an African antelope which, today, is found only south of the Sahara. However, in former times the species *Alcelaphus buselaphus* was widespread throughout Egypt, Sudan, and the Near East. Remains of *Alcelaphus sp*. have been described from Far'ah II by Gilead and Grigson (1984) and the prehistoric sites in North Africa and western Asia that have yielded remains of hartebeest are listed by Uerpmann (1987). As this author has pointed out, there is no evidence for any species other than *Alcelaphus buselaphus* at these sites and for this reason the remains from C-Spring, Azraq have been ascribed to this taxon.

DISCUSSION

The seven species of ungulate that have been identified from C-Spring indicate a savanna environment, or a semi-desert with seasonal water to which herds of animals could migrate. The high proportion of juveniles suggests that the animals were killed during summer, perhaps at a drinking place. No evidence of butchery or gnawing was found on the remains but this is not surprising as the majority of the elements are teeth.

When they were first excavated the stone tools from C-Spring were in a very fresh and unweathered condition and Zeuner concluded that they represented a late Acheulian industry and that the animal remains came from the same context. Later workers have suggested that the fauna is of Levalloiso-Mousterian age and in my previous discussions I equated the assemblage with levels E to C of Tabun on the basis that the five ungulates, *Dicerorhinus* sp., *Equus hemionus, Equus hydruntinus, Bos* sp., and *Alcelaphus* sp. were all identified from these levels by Bate (1937). She concluded that grasslands predominated in the Mount Carmel region at this period which also accords with the findings of Gilead and Grigson (1984) for the Middle Palaeolithic site of Far'ah II in the Negev.

Re-examination of the faunal remains has failed to provide any further evidence for the dating of the assemblage. Indeed the problem has become more complicated with the possibility of there being intrusive elements of different periods. The extinct rhinoceros, *Dicerorhinus hemitoechus*, is unquestionably of Middle to Upper Pleistocene age, but the camel and small bovid could belong to the Holocene. However, a recent sounding at C-Spring, under the direction of Andrew Garrard, has produced further remains of camel together with razor-sharp, unweathered Acheulian implements so it really seems improbable that the camel bones collected by Zeuner were intrusive, despite the anomalous radiocarbon date of 3340 +/- 200 BP (Garrard, pers. com.)

Unfortunately, unless new techniques are developed, it looks as though the radiocarbon dating of unburned animal bone (even using the accelerator mass spectrometer which only requires tiny amounts of collagen) is not going to be successful in establishing chronologies for the early periods in those regions where the harsh climate destroys all protein in the bone.

Originally I stated that some of the bones from C-Spring were charred, but looking again at the sample in the British Museum of Natural History, it could be that I mistook a black chemical staining for burning. However, if some bones (now in the Museum at Amman) were charred it would be advisable to try to date these as the carbon survives with burning and more accurate results can be achieved with accelerator dating of burnt bone.

Rather few Palaeolithic sites have been excavated in the Near East over the last thirty years, since I first examined the animal remains from C-Spring, but the process of building up a picture of the environment and fauna of the Pleistocene period has made considerable progress. In particular, we now realize the extent to which the Near East formed a melting-pot for the faunas of Europe, Africa, and Asia before human beings began to affect their distributions.

The combination of careful excavation, accurate identification of animal remains, and the obtaining of a wide spectrum of radiocarbon dates whenever possible, should enable the fossil history and distribution of such species as the camel to be reconstructed with some precision. There is still, however, far to go.

Acknowledgement

The ideas put forward here on the possibilities of size change in camel in the Upper Pleistocene and Early Holocene derive from discussions with Dr Caroline Grigson (Odontological Museum, Royal College of Surgeons) and I am very grateful to her for her helpful comments which will be enlarged upon in her forthcoming publication on her camel-dating project.

BIBLIOGRAPHY

BATE D. M. A., 1937. Palaeontology : The fossil fauna of the Wadi El-Mughara caves. In D.A.E. Garrod and D. M. A. Bate ,*The Stone Age of Mount Carmel, Excavations at the Wadi El-Mughara I*, 137-240. Oxford : Clarendon Press.

CLUTTON-BROCK J., 1962. *An Analysis of Mammalian Faunas from Prehistoric Sites in India and Western Asia* . Ph. D. thesis, University of London.

1970. The fossil fauna from an Upper Pleistocene site in Jordan. *Journal of Zoology,* London 162, 19-22.

DUCOS P., 1986. The equid of Tell Muraibit, Syria. In R. H. Meadow and H. P. Uerpmann (eds). *Equids in the Ancient World*, 237-245. Wiesbaden : Dr Ludwig Reichert Verlag.

GILEAD I. & GRIGSON C., 1984. Far'ah II a Midlle Palaeolithic open-air site in the northern Negev, Israel. *Proceedings of the Prehistoric Society* 50, 71-97.

GRIGSON C., 1983. A very Large camel from the Upper Pleistocene of the Negev desert. *Journal of Archaeological Science* 10, 4, 311-316.

GRIGSON C., GOWLETT J. A. J. & ZARINS J., in press. The dromedary in Arabia - a direct radiocarbon date, calibrated to the seventh millennium BC. *Journal of Archaeological Science.*

GUERIN C., 1982. Les Rhinocerotidae (Mammalia, Perissodactyla) du Miocène terminal au Pleistocène supérieur d'Europe occidentale comparés aux espèces actuelles : tendances évolutives et relations phylogénétiques. *Géobios* 15, fasc. 4, 599-605.

HEDGES R.E. M., HOUSLEY R. A., LAW I. A., PERRY C., GOWLETT J. A. J., 1987. Radiocarbon dates from the Oxford AMS system; archaeometry datelist 6. *Archaeometry* 29, 2, 289-306.

PAYNE S., 1983. The animal bones from the 1974 excavations at Douara Cave. In K. Hanihara and T. Akazawa (eds) *Paleolithic Site of Douara Cave and Paleogeography of Palmyra Basin in Syria*, 1-108. The University Museum, the University of Tokyo, Bulletin N°21.

PAYNE S. & GARRARD A., 1983. *Camelus* from the Upper Pleistocene of Mount Carmel, Israel. *Journal of Archaeological Science* 10, 3, 243-248.

UERPMANN H.-P., 1987. *The Ancient Distribution of Ungulate Mammals in the Middle East.* Wiesbaden : Dr Ludwig Reichert.

ZEUNER F.E., 1974. Die Beziehungen zwischen Schädelform und Lebensweise bei den rezenten une fossilin Nashornern. *Bericht (über die Verhandlungen) der Naturforschenden Gesellschaft zu Freiburg i. Briesgau* 34, 21-80.

'GLAZED' (SILICA COATED) FLINT ARTIFACTS FROM THE AZRAQ BASIN, EASTERN JORDAN

Myra Shackley

The sporadic occurence of lithic artefacts with such shiny surfaces that they appear to have been varnished or glazed has been noted for some time and, to date, 8 arid-area sites in the Near East and north Africa have been recorded together with 3 locations south of the Sahara (Shackley 1988). Since the artefacts are visually extremely striking, much speculation has taken place concerning the nature of the shiny coating including wind or water burnishing (Lamplugh, 1906), subaerial friction gloss (Caton Thompson, 1956) and silica precipitated from surrounding groundwaters (Meeks *et al.*, 1982).

Glazed artefacts are generally to be found in spring mound sequences which result from Pleistocene and recent episodes of changing hydrostatic pressures in an artesian basin where water is forced through bedrock to produce a spring-mound of assorted debris. The glazed flint artefacts at Azraq (Jordan) are found in a desert oasis in a now saline lake basin where permanent springs have been occupied since Lower Palaeolithic times. The Azraq springs are powerful, discharging 2 million gallons/day of warm, slightly saline water derived from subsurface basalts (Ionides, 1939). During irrigation projects in 1958 two of these springs were enlarged and at Ain el-Assad ('Lion Spring') a classic Late Acheulean industry made on flint was revealed 2-3 m below the surface at one location (Kirkbride, this volume). Glazed pieces were found in the lowest layer of the deposits but, significantly, typologically similar materials recovered from the nearby C-Spring in the Azraq oasis were fresh and unglazed, undoubtedly because the C-Spring artefacts were found some distance from the spring stratified, at a depth of 3 m on a dry land surface rather than in spring mound deposits (I am indebted to Lorraine Copeland for this information).

Fig. 1 shows one example of the glaze, a smooth siliceous coating over a natural backed knife from Azraq, Jordan, illustrating the fact that the glaze thickly coats the artefact, obliterating any marks occasioned in its fabrication, use or post-depositional abrasion. It may extend over one or both faces, be even or patchy, thick or a mere trace of gloss and accumulates most deeply in the hollows of flake scars. At Azraq the glazed artefacts were unabraded and *in situ* and, if the glaze was removed by hydrofluoric acid, the flake scars were shown to be still in mint condition suggesting that the glaze was not the result of an abrasive process. Various laboratory tests were completed on the Azraq material and the results compared with glazed pieces from comparable sites (Shackley, 1988). The glaze was found to be an amorphous silica coating with a conchoidal fracture and hardness of 7.5. Examination under the Scanning Electron Microscope (SEM) with Energy Dispersive X-Ray (EDAX) spectroscopic analysis of composition confirmed that the edges of glazed pieces remained very sharp (Fig. 2) and showed that the thickness of the glaze generally varied within the range 57-227 µm, though reaching as little as 1 µm in pockets. Althought a clear boundary between object and glazed coating could be seen at high magnification (Fig. 2) little chemical difference existed as both object and glaze were siliceous, the glaze overwhelmingly (>99,9%) composed of silica, with very small quantities of iron and aluminium.

These results confirm that the glaze is a silica coating, not a friction gloss and not related to wind or water abrasion (contradicting Masson, 1982) or to the development of desert varnish. Its formation is due to the special conditions found in artesian spring sites (confirming the suggestion of Meeks *et al.*, 1982) and results from localised dissolution and precipitation of silica at or near the object's surface, possibly combined with the precipitation of silica from interstitial groundwaters at the conditions of elevated temperature and pressure found within active artesian springs.

The mechanism by which the silica is precipitated is highly complex but it has been suggested that archaeological material buried in spring mound sediments through which water heavily saturated with silica is circulating freely at raised temperatures and near neutral pH, may acquire a surface glaze as a result of silica recrystallisation from porewaters (Fournier, 1973), with the objects themselves acting as a source of some of the silica. It is difficult to gain any idea of how long the glaze takes to form as it has been observed on pieces from Acheulean to Epi-Palaeolithic date. At some sites in southern Africa glazed Acheulean pieces had been re-used in the Middle Stone Age but their original glaze had not subsequently re-formed. The formation rate would seem likely to depend on local hydrological conditions rather than the age of the object which does not produce any potential for using the glaze as a dating phenomenon. The existence of glazed objects at Azraq, therefore, directly reflects previous interesting and complex groundwater conditions which result in the *in situ* precipitation of silica onto the Late Acheulean artefacts. Analysis has confirmed that the glaze is unrelated to the erosion or redeposition of the artefacts, which has some bearing on stratigraphic interpretation.

Acknowledgements

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BIBLIOGRAPHY

CATON THOMPSON G.,1956. *Kharga Oasis in Prehistory* (London).

FOURNIER R.D.,1973. Silica in thermal waters. In *Proc. Symposium on hydrological chemistry and biochemistry*. (ed. C. Clarke, US Geological Survey), 123-139.

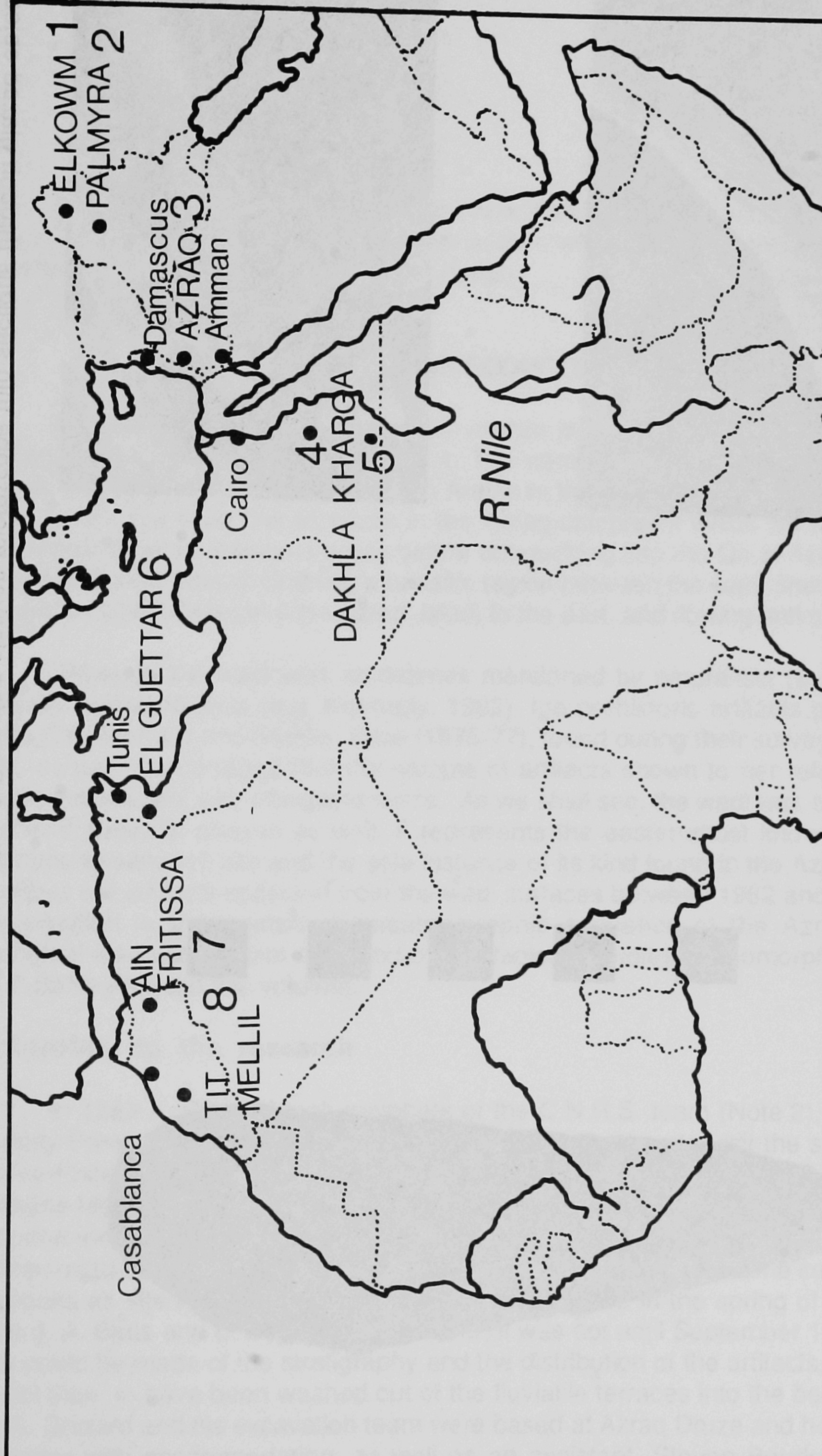
IONIDES M.G., 1939. *Report on the water resources of Transjordan and their development.* Govt. of Transjordan, publication of the Crown Agents for the Colonies (London).

LAMPLUGH G.W. 1906. Notes on the occurrence of stone implements in the valley of the Zambesi, around the Victoria Falls. *J. Anthrop. Inst.*, 3, 156-169.

MASSON A., 1982. Les pièces lustrées des sources d'El Kowm (Syrie). *Cahiers de l'Euphrate*, 3, 141-147.

MEEKS G. W., SIEVEKING G. de G., TITE M. S. & COOK J., 1982. Gloss and use-wear traces on flint sickles and similar phenomena. *Journal of Archaeological Science*, 9, 317-340.

SHACKLEY M.L., 1988. Hot springs and "glazed" flints : a controversial phenomenon observed on spring-mound artefacts in the Near East. *Levant* , 20, 119-126.



Map 1; Location of eight sites in the Near East and North Africa with 'glazed' flints.

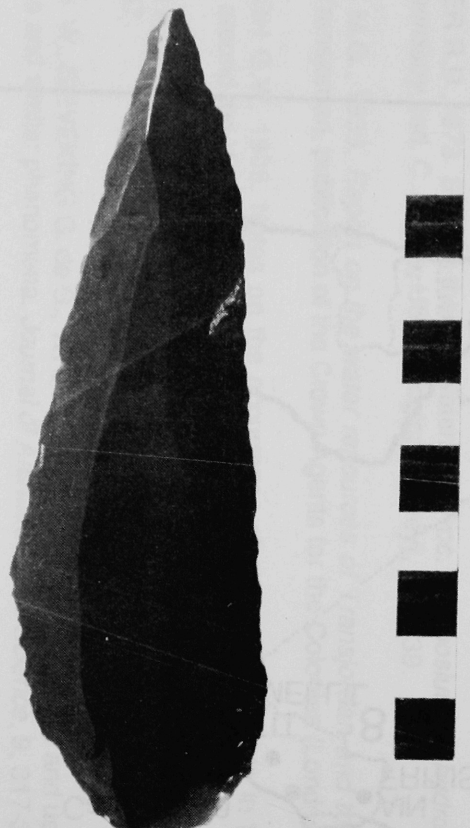


Fig. 1 Glazed natural-backed knife from Azraq, Jordan, showing the smooth siliceous coating which has developed especially thickly over the point.

1

2

Fig. 2 Scanning electron microscope thin sections through glazed objects. Flakes have been fractured at right angles to the surface and the scale is shown in µm.

(1) Smooth quartz glaze over the interior of a broken flake (Azraq).

(2) Comparable glazed flake from spring-mound site of Ain Hummal (Syria, Shackley 1988) with bar showing the thickness of the glaze.

THE LITHIC INDUSTRIES OF WADI ENOQIYYA

Francis Hours

Note: This report was translated from the French and the tables and bibliography completed by L. Copeland after the death in I987 of the author, who has not, therefore, been able to correct any omissions or mistakes she may have made.

INTRODUCTION

The Wadi Enoqiyya in north-east Jordan is located in the northern part of the Azraq drainage basin, map ref. 3534.2 - 295.4. The name of the wadi (spelt differently by various authors, e.g. Onqiya or Inokiya) refers in Arabic to the bottleneck shape of the middle part of its valley. Unlike the other desert wadis in the Azraq catchment which we have studied (Note 1), which traverse wide limestone areas before debouching into the Qa al-Azraq (the central playa) this one is a short stream draining a basaltic region between the watersheds of Wadi Rattama to the west and Wadi Hassan (also called Jalad) to the east, and flowing entirely over the basalt (Fig. 1).

Although the wadi was sometimes mentioned by naturalists (e.g. Nelson, 1973) and Classical archaeologists (e.g. Kennedy, 1982), the prehistoric artifacts present in it were first reported by Garrard and Stanley Price (1975-77), found during their survey of 1974. Copeland, in the same report, judged that the sample of artifacts shown to her referred to a Levalloiso-Mousterian industry with elongated forms. As we shall see, the wadi was also sparsely occupied in other Paleolithic phases as well. It represents the easternmost known instance of a large Levantine Mousterian site and the sole instance of its kind found in the Azraq Basin. This report describes the artifacts collected from the wadi surfaces between 1982 and 1986, and evaluates their position in the overall chronostratigraphic sequence of the Azraq Basin, based on typological links with Levant sites and on the regional studies of geomorphologists J. Besançon and P.Sanlaville (see this volume).

Background to the research

In 1982 A. Garrard took members of the C.N.R.S. team (Note 2), at that time studying the early Paleolithic and geomorphology of northern Jordan, to visit the site he had found with Stanley Price in 1974, their site AZ 16. When it was confirmed that the artifacts were indeed Levantine Mousterian, Garrard (whose work was mainly concerned with the later Paleolithic and Holocene industries) asked the present writer to take over the study of the site. Consequently, our team made a larger collection during a stay at Azraq Druze the same season (recorded in our notebooks as site AZ 127); another collection was made in the spring of 1984, assisted by A. Garrard, A. Betts and L. Copeland. However, it was not until September 1984 that a systematic study could be made of the stratigraphy and the distribution of the artifacts, all of which seemed, up until then, to have been washed out of the fluviatile terraces into the bed of the wadi. At that time A. Garrard and his excavation team were based at Azraq Druze and he generously provided this writer with accommodation, as well as an assistant, Steven Bourke (who produced the sketchmap, Fig. 2) and the services of two workmen to clean the sections. In 1985 he also brought Dr. Christopher Hunt to examine the sediments and to take soil and sediment samples (the latter's reports are expected to appear in this volume). The support and encouragement of

A. Garrard and his team, and especially the good work done by Steven Bourke, are very gratefully acknowledged here.

Apart from studying the fluviatile terraces (see below), we made a systematic collection from 31 recorded surface locii, attempting to retrieve all the visible flint artifacts, no matter whether fragmentary or intact. This resulted in a 'bag' of some 6,000 artifacts to be added to the some 1,000 odd previously collected. The entire collection was studied at the British Institute in Amman for Archaeology and History in 1984 and 1985, assisted by L. Copeland, who provides the illustrations, and by A. Minzoni-Deroche in 1985. At the conclusion of the classification of the artifacts, the material was given, with the permission of the Department of Antiquities, to the Institute of Archaeology of Yarmouk University at Irbid, in charge of Dr. M. Muheisen.

An interim account of the industries was presented in 1986 at the Tubingen workshop organised by H.G. Gebel and A. Garrard (Copeland and Hours, 1988). The present account forms the final report.

The physical and environmental setting

The following comments should be read in the light of the findings of the geomorphologists who examined the valley in 1982 and 1986 (Besançon *et al.*, this volume, and Besançon & Sanlaville, in press).

As mentioned, the wadi flows through a basaltic zone on the northern fringe of the Azraq Basin. These basalts are the result of pre-Quaternary lava flows from dykes and volcanoes in the Jebel Druze region, which covered an already-peneplaned surface of Cenozoic limestones (Bender, 1974). Erosion over the millennia has worn the basalt plateau into an irregular surface of boulders interspersed by small and large depressions filled with fine sediments. Precipitation from Jebel Druze (a high rainfall area) percolates southward via fissures in the basalts and wells up in perennial springs at their margins. The local rainfall is sparse (less than 100mm per annum) and falls, sometimes torrentially and briefly, in winter and spring, when the whole valley is almost continuously moist.

The course of the wadi may for convenience be divided into three sectors:

Qa Enoqiyya

It is a small, partial (because it has an outlet) sabkha or playa (cf. alveole) of irregular shape at the head of the valley (Fig. 26). The wadi rises here as a result of the entry into it of several feeders, disposed like the fingers of a glove (upper right on Fig. 1), which flow in winter after rain from an altitude of c. 540m. a.s.l. to the floor at 525m. a.s.l. Apart from these tributaries, the qa is watered from a second source: the perennial springs and seeps from below the basalts. At the time of our first visit in the autumn of 1982, the basin was an arid plain floored with fine clayey silts and sands, scrub vegetation in hummocks and traversed by shallow dry wadi channels. At the next visit, in springtime, the situation was somewhat improved, the floor containing marshy areas, the wadi flowing (Fig. 29), if sluggishly, and there were pools of pale green water (Fig. 26) around the springs. However by 1986 most of the pool and marsh water had ceased to exist, probably due to the tapping of the supply upstream at the head of the basin, where wells have recently been bored, pumps installed and farms established.

The scene is dramatically different from that of 12 years ago described by Nelson, when the basin was a wetland and marsh supporting aquatic fauna (amphibians, crustaceans, fish and even leeches: Nelson, 1973). Nelson further noted the abundance of avian life, including game birds (Partridge; Bustard) and Little Owls (indicating the presence of small rodents). This gives us an idea of the natural state of the basin in the past, when prehistoric groups and the game they preyed on exploited the water sources in the valley. Even the surrounding basalts seemed to have been traversed by game animals, if one is to judge by the presence on them of several stone structures, seen on air photographs by e.g. Riley (1982): kites (gazelle-traps), corrals and other forms are described by Helms and Betts (1987, Fig. 8). Some of these have been sketched in on our map, Fig. 1.

Very few artifacts were found in the qa area, perhaps because of burial in the silty fill, but one of the few geologically *in situ* pieces (a Mousterian racloir) was found embedded 2.5m.

deep in a terrace section at site 243 of the geomorphologists (p.c. J.Besançon and P. Sanlaville). In contrast to the basin floor, the adjacent basalt bluffs contained a sparse scatter of flints of mixed ages.

The bottleneck, Areas A - D.

In order to flow downstream, the waters collected in the qa are obliged to pass through the narrow bottleneck between basalt bluffs, about 2 - 400m. wide, for a distance of under I km. Our archaeological work was confined to this sector (Figs. 1 and 2) which we subdivided into three areas, A, B and C, as well as a fourth (D) at the lower end of the qa and two small concentrations (E and F) on the adjacent basalts.

The modern road to Baghdad utilises the narrowest point to cross the wadi but the building of the roadbridge has not markedly altered the configuration of the wadi bed. It was at first thought that the artifacts were present in the latter due to such disturbance, but this appears not to be the case; the geomorphologists have pointed out that this stretch is not condusive, in its natural state, to the formation of river terraces, since the constricted spates can only rework and wash out into the bed any sediments trapped in the narrows. However that may be, there is an extraordinary concentration of surface artifacts occurring for a distance of c. 0.5 km. upstream and c. 1 km. downstream of the bridge; no *in situ* pieces were found in Areas B and C, and only in Area A, where the valley begins to widen, were a handful of artifacts found in the terrace deposits. Two springs were noted: Ain Enoqiyya, just before the bottleneck, forming temporary pools in Area C (seen in Fig. 26) and another, now dug out and dry, in Area B (Fig. 2). The wadi bed contains basalt rubble, flint artifacts and sandy silt forming mudpans interspersed with scoured areas. The western bank of Area B is marked by a line of vegetation: reeds and tamarisk trees; on the eastern side there are low xerophytic shrubs growing in silty reddish-pink sand. Area B extends from the bridge to about 250m. downstream.

The downstream area

By the time it reaches that point the wadi is incising a channel c. 1.5 m. deep in an ancient alluvial fill with several members, apparently some 7m. deep at the most downstream point of study (Fig. 27). Here the wadi bifurcates into an eastern and a western branch (Area A) which produced artifacts in the channel beds for c. 250m. more downstream. The vegetation consists of scrub and low shrubs. The spot where the channels diverge is marked by a 'bone-pool' containing mineralised faunal remains (equid and camel; see 'Discussion') as well as artifacts. About 3 km. beyond Area A the wadi is deflected towards the western flank of its valley by an influx of alluvia from the more powerful Wadi Jalad, which enters the Azraq lake basin from the north-east. According to the geomorphologists, artifacts still occur sporadically in this zone, for example 25 artifacts found at their site 203 included Lower and Middle Paleolithic types.

Downstream, the combined sediments of the two wadis cover the floor of a kind of gulf on the northern shore of the central Qa; this is today gradually being built up and farmed, but development ends at the edge of the central sabkha (Qa al-Azraq) in a welter of sandy-silty dunes and hummocks. Slightly to the east in a region known as Al-Bayda or El-Beidha, springs emerge near the foot of the basalt cliffs and several more prehistoric sites are known to occur there (see Copeland, this volume).

One resource, however is entirely lacking in the Enoqiyya valley: flint from which to fashion artifacts; all the flint material now present has been brought there, presumably from the neighbouring limestone regions, e.g. Wadi Rattama to the west or Jebel Usaykhim to the east.

The Stratigraphy

In September 1985, this writer and Steven Bourke studied the fluviatile terrace sections exposed in Areas A and B. Seven sections were cleaned, photographed, samples taken for analysis by C. Hunt (Note 3) and, in the case of Section II, artifacts retrieved). The stratigraphy differed slightly from section to section (Figs. 15 - 20); only the uppermost 1 - 2m. were visible and some layers seen in one section were missing from another, but the general pattern seemed to be as shown in Section II (Fig. 16): aeolian material occurred on the surface, often held by vegetated nebkas. Under this were laminated pink silts, sometimes overlying clay (Section III) but usually overlying sand (Sections II, V(2), and VII) or gravels (Sections I and IV). Usually the lowest visible layer was a grey or blue-grey clay. The sections are illustrated in Figs. 15 - 20, 28 and 29.

Apart from the two Levallois flakes found at the base of Section II layer 3 and the two later Paleolithic artifacts found in the overlying layer (Fig. 11, 1 - 4), the deposits seemed to be sterile.

In 1986 J. Besançon, B. Geyer and P. Sanlaville studied the wadi terrace exposures and well sections upstream (e.g. their site 243) and similar features in the downstream 'gulf', e.g. their sites 202 - 207, as described in their report (*infra*). They were able to observe that an additional gravel layer underlay the lowest layer visible in our sections. In their interpretation of the Enoqiyya climatic sequence, the geomorphologists were able to draw upon their study of the long Last Pluvial (Qfl) sedimentological succession in the Basin as a whole; their findings are summarised from the base upwards as follows:

- the grey-green or grey-blue clays are attributed to a plenipluvial phase, Qlb, succeeding the gravels of a catapluvial phase, Qla, (pluvial becoming arid).
- the overlying silts of Qlc, sometimes with concretions, seem to be absent except in Section IV, layer 4, VI (upstream) and Section V2, where the concretions occurred in layer 3; this phase was fairly dry (episode 11, catapluvial; see their Table II).
- the sands of our layer 3 in Sections II and III, and layer 2 of VII and V (2) are attributed to Qld, episode 15, a fairly dry period.
- finally, they refer the pink laminated silts (layer 2 of Sections I, II and III, and layer 1 of Section IV to the Holocene, perhaps of P.P.N.B date, episode 18 being very dry (Besançon *et al.*, this volume).

In spite of a good geomorphic sequence of Last Glacial sediments, the terrace sections were able to contribute little to the problem of the original position of the archaeological material concentrated in the bottleneck, i.e. as to whether the artifacts in Areas A - D were derived from further upstream in the qa area, or whether the Mousterians in fact occupied the narrows where the artifacts are now found.

According to the above-mentioned morphoclimatic scheme of Besançon *et al.* (this volume) the destruction of the vegetation cover which holds uncemented sediments in place normally occurs in very arid climatic phases. The point in time when the material in Areas A - C was washed out may, therefore, have been during the early Holocene, for example in the 'hiatus palestinien' of the 6th Mil. but it could equally well have been earlier.

ANALYSIS OF THE ARTIFACTS

Of the 7,587 pieces collected, a small number seemed to be clearly not Middle Paleolithic. The first task, therefore, was to separate the collected material as far as possible into three groups, based on typology: Lower Paleolithic (bifaces, lustred flakes; Note 4); Levantine Mousterian (Levallois flakes, racloirs etc.) and Post-Middle Paleolithic (e.g. blades struck off by punch technique, tool-types such as end-scrapers, burins; bladelet cores; tool-types diagnostic of particular phases, such as lunates, Kebara Points, arrowheads etc.). This left large numbers of pieces, mainly unretouched, fragmentary or in the form of chips and debris, which could not be reliably assigned to one or other of these groups. Since the number of Lower Paleolithic pieces was very small and that of the Post-Middle Paleolithic relatively sparse, it was arbitrarily assumed that the bulk of the doubtful material was probably of Middle Paleolithic date. The resulting breakdown of artifacts according to Paleolithic periods is as follows:

- Lower Paleolithic artifact types: 30 specimens (0.4%).
- Middle Paleolithic artifact types: 6,128 specimens (81.84%)
- Post Middle Paleolithic artifact types: 1,329 specimens (17.75%)
- Total artifacts: 7,487

The Lower Paleolithic

At least 30 pieces can be considered to belong to the Lower Paleolithic. Twelve are tools, 10 are debitage and 9 of these have the characteristic lustre (cf Note 4); at Enoqiyya the only lustred pieces are bifaces and heavy, non-Levallois flakes with yellow-brown or dark patina.

Cores (3)

Two, both flat debitage cores, are lustred. One seems to be a re-used biface, another is a pointed biface tip, reworked in antiquity to a prismatic core, both phases of working having the same deep brownish-white patina. All three came from Area C.

Flakes (7)

One is retouched, 6 cm. of bifacial edge, and seems to be a biface refreshment-flake rather than a bifacial racloir. The other six are lustred, having large, wide-angle plain or cortex butts. Four are part-cortex flakes of irregular shape. The remaining two are trimming-flakes (Fig. 3, 5), another showing radial dorsal facets (Fig. 3, 4).

Bifaces (12) Fig. 3, 2 & 3

Nine came from Area C, two from Area A and one each from Areas B and D. From the much larger number of bifaces found in Area C we infer that the main area occupied by the Acheuleans was the wetland and pool area, rather than the wadi valley.

The bifaces are typologically mediocre, only three being well made. They consist of an elongated ovate or bifacial cleaver (Fig. 3, 2), a subovate piece, a D-shaped piece, 4 amygdaloids, 2 atypical amygdaloids, a lanceolate on a flake (Fig. 3, 3) a small bifacial piece and a uniface on a tabular slab.

The mean length of the group (lengths reconstructed when possible for broken tips) is: 8.12 cm.

Two are in fresh condition, 1 is rolled, the rest are 'smoothed' or weathered. Four have dark patinas, 6 have chestnut patinas and 2 have grey-blue mottled patinas.

Nine have straight edges, but only two have a basal edge; there are also only four with fine soft-hammer flaking.

Biface fragments (7)

Two of the four tip fragments appear to be from lanceolates, one being lustred. One piece seems to be the basal half of an ovate biface with worked edge, and the remaining two are bifacially worked fragments, one reworked into a bladelet core. All show evidence of fine flaking, and in 3 cases of straight edges.

Heavy-duty Tools (1) Fig. 3, 1

An offset Quina racloir on a thick, older tabular slab fragment, from Area C.

In spite of the lack of refinement, the generally small size of the bifaces and the presence of the D-shaped and cleaver-like specimens relate this group to the Late Evolved Acheulean of the nearby Azraq springs. However the emphasis on pointed rather than ovate or rounded tips differentiates this group from that of e.g. C-Spring, Azraq and makes it more similar to the Lion Spring group (Copeland, this volume).

In sum, this small group seems to form part of the Late Acheulean occupation of Azraq, the next nearest site being Ain el-Beidha. It is assumed that the Acheuleans visited the upper Wadi Enoqiyya on account of its pools and wetland. They seem to have worked flint there, judging by the presence of cores and trimming-flakes, all of which had to be brought to the spot. However, their traces are remarkably sparse in comparison with the abundance of such artifacts at the other sites. Either the valley was not continuously occupied, or we have not yet found the main part of the Acheulean site.

The Middle Paleolithic

A total of 6,128 artifacts could be of Middle Paleolithic date, but, as mentioned already this includes much fragmentary and indeterminate 'waste', the age of which is not clear. If this group of 2,338 pieces is set aside, there remain 3,790 pieces, more clearly Middle Paleolithic, to consider (the figure quoted in Copeland and Hours, 1988 included some of the indeterminate material and hence is superceded).

Each artifact was first analysed technologically and then classified typologically by the usual Bordean methods, after which the results were tabulated. At first the samples for each season in each collection-area were kept separate, marked a - e in 1982 and A - E in 1984. However the analyses showed very clearly that the 1982 collections from each area were more selective than were those from the more intensive 1984 work. For example, in 1982 Area C produced only 6% fragments while these amounted to 36% in 1984; there was a heavy bias toward 'good' Levallois pieces in 1982, the Levallois points in Area C amounted to 13% in 1982 but to only 6% in 1984 while only 3% cores were found there in 1982 as against 14% in 1984. Finally, relatively more large pieces and blades came from the 1982 collections. It was therefore decided to amalgamate a with A, b with B etc., in the hope of arriving at a truely representative sample from each area (Table 1).

Raw material and Blank type

No basalt or limestone artifacts were found. The raw material seems similar to that found in the Cenozoic limestone hills to the west: pale or opaque, good quality flint as well as coarser chert, both kinds occurring in thin, sometimes thick, tabular seams. The kind of blank was difficult to determine except from a number of cores where cortex remained; it included rolled pebbles, tabular slab fragments and older pieces with patinated fracture-planes.

Physical condition

Three categories of damage due to percussion were observed: relatively fresh (although not mint fresh) with edges and dorsal ridges undamaged, at least to the naked eye; weathered (*émoussé*) with dorsal ridges smoothed and some breaks at the thinnest edges; rolled, that is with edges battered and dorsal ridges clearly damaged.

Instances of desilicification seemed to be rare. A random sample (bags with even numbers from the 1984 collections) gave the results shown in Table 2. This shows that there is a slightly higher (c. 5% as against c. 2-3%) amount of damage in the most downstream area, A. Given that the wadi's course is short to this point, and that the sediments are fine, the low number of rolled pieces is hardly surprising. The overwhelming number (2/3) of fresh pieces may indicate that the artifacts have either not been transported far or that they have only recently been disturbed.

Thermoclastic fracturing was also monitored: at least 10% of the artifacts were thermally damaged (pot-lids as in Fig. 8, 9). It was noted that thermal fracturing occurred most often on white-patinated pieces, presumably having taken place at the surface, and it seems to be virtually absent on pieces with honey-brown, blue-grey or dark patinas.

Patina

The patinas on the Middle Paleolithic artifacts (Table 3) were somewhat different from those seen in the non-basaltic zones; the degree of patination was never great, 'desert varnish' and deep black patinas being absent. The prevailing colours were light yellow-red, honey brown or whitish-yellow, often occurring in 'clouds', or pinkish white; division between these tones is somewhat subjective.

It was also clear that damage (due both to percussion and thermal fracturing) and patina were closely correlated: on light beige raw material the fresh pieces were mainly unpatinated, the slightly patinated pieces were weathered and the abraded pieces were the ones with white patinas. Therefore, patination seems to have commenced with a yellowish tinge, becoming whitish in clouds, and finally a uniform white. As mentioned already, thermal damage correlates with certain patina types, and it could be suggested that white patination and pot-lid fractures occurred sub-aerially while the darker patinas without thermal fractures could be the result of chemical alteration within sediments, either humid or dry.

We observed that, on the whole, although the pieces most clearly referable to the Middle Paleolithic were white patinated, at the same time patina and state of conservation seemed to occur independently of the age (Middle Paleolithic or later) of the artifacts. This may indicate that these effects began on both groups at the same time (post-Würm?).

The distribution of patinas from three areas is shown in Table 3: more dark and fewer white patinated pieces occurred in area C (8% as against 20 - 30%), and percentages for slight patinas rise to 45% in C, which is much higher than in A or B. If the suggestion made above that white patinas indicate open air exposure and dark ones represent humid contexts, some of the Area C pieces (12%) were probably dropped in the marshy soils and pools of the erstwhile wetland and qa.

Technological analyses

Sixteen debitage categories were distinguished, as set out in Table 1.

- The Cores (377) Figs. 4 & 5

The ratio of cores to products was greater in Area C (13%) than in A or B and greatest in D (19%). This perhaps means that cores, as with the bifaces mentioned above, being heavier than flakes, were less easy to transport.

Table 1 shows the frequencies of nine core categories according to area. Worked down, Exhausted Discs are dominant in all areas (32%, Fig. 5,5), followed by Discoid Mousterian (14%, Fig. 5, 4) ; together these form nearly half the cores. Amorphous and fragmentary cores (22%) are also numerous. These values surely reflect the absence of local flint raw material in the Enoqiyya valley. The reduced dimensions of this group of cores is shown on Fig. 12 ; only one of the 98 illustrated was over 8 cm. long (Fig. 4, 2), the average L/W being 4x4 cm with thicknesses rarely exceeding 4 cm. (N.B. Because of clustering of sizes, Area B cores are not shown on Fig. 12).

The remaining cores are of the classical Levallois types for flakes (Fig. 5, 1), blades (Fig. 4, 4) or points (Fig. 4, 1), prepared either radially or (more often) by unipolar (Fig. 5, 2) or bipolar methods ; some Flat debitage (Fig. 4, 2 ; 7%) or Prismatic (5,3%) types are also present. Faceted striking platforms are common, most being the 'simple-faceted' type (Fig. 5, 2). Only eleven of the problematic 'core-on-a-flake' specimens (Fig. 5, 5) are counted as cores (the rest, as explained later, as special tools) ; Fig. 5, 3 closely resembles the type but is not made on a flake.

- The Products

The 'Waste' (2,338)

This consists of *éclats de taille* (very small trimming-flakes), chips (unclassifiable worked fragments) and *déchets/débris* (flake fragments). Although outnumbered by the latter, the large number of *éclats de taille* shows that flint was frequently knapped on the spot (Table 1).

- Flakes, blades and points (3,413)

Table 1 lists the various product categories from the four areas. When amalgamated, the totals show that ordinary (banal) non-Levallois, non-cortex flakes predominate at 32.34% followed by secondary preparation (part-cortex) flakes at 28.50%, primary preparation (cortex) flakes being rather rare at 13%, but with Levallois types amounting to 22.79%. Only 3.3% represented core-edge, refreshment or crested types. The various forms are shown on Figs. 6-8.

The percentage of blades (defined as flakes whose length was twice their width) was hard to establish because so many pieces were tipless. Because it is assumed that blade forms are more susceptible to trampling or transportation damage than are flakes, many of the tip or butt fragments may represent broken blades.

In 1982 the blade index was estimated to be c. 18.9, using more or less intact Levallois pieces or pieces which were certainly blades before breakage. However, blades in the 1984 samples amounted to only 14% of the Levallois element. The overall impression given by the assemblages is that they are quite laminar, but once measured and plotted on a scattergram, it becomes clear that this is due to the large number of narrow flakes, the L/W of which fall very close to the L = 2W line. In fact, flakes predominate.

Fig. 13 represents a selected sample of 100 intact Levallois pieces from Areas A, B and C; it seems to illustrate the comment made above that in a sample selected for completeness, blades would be under-represented (only 13 are present), and the same can be said of Levallois points, especially the elongated ones. Of the nine complete triangular Levallois points present in this sample, five are elongated.

The scar removal patterns on the Levallois flakes in the Fig. 13 sample were examined; the 97 determinable patterns were present as follows:

Bipolar, 35 specimens (36.08%)
Unipolar, 45 specimens (46.39%)
Centripetal, 17 specimens (17.52%)

Total, 97 specimens (99.52%)

This illustrates the dominance of the along-axis core-preparation and removal patterns; unipolar or one-axis patterns outnumber the bi-directional ones. Examples of the more rare centripetal patterns are shown on Fig. 6, 1-4 and 6-7

The dimensions of the Levallois flakes are seen to be moderate, in length as well as width and the thicknesses fall in a dense cluster as seen in Fig. 13. The Levallois flakes are in general thin and often delicate; their W/Th ratio means show an interesting progression from Area C to Area A: 4.90 on 62 pieces from Area A, 4.60 on I19 pieces from Area B and 3.72 on a small sample of 21 pieces from Area C (Note 5).

As to the non-Levallois element, Fig. 14 shows that the 'ordinary' non-cortex flakes were dimensionally close to the Levallois ones.

A group of part-cortex blades, mentioned above, is also shown on Fig. 14. They may represent the naturally-backed knife class, struck from either along-axis Levallois cores, 'Levallois *Sommaire*' or prismatic cores.

- Flake butts

Ten categories were distinguished: cortex, plain, faceted (convex or straight), dihedral, punctiform, linear, removed, damaged/unidentifiable, truncated-faceted (Table 4). Since the butts of cortex and part-cortex flakes were recorded only in 1984, this sample is biased toward the Levallois and ordinary flake elements.

Fully a third of the butts were finely faceted as shown in many specimens in Figs. 6 - 8: '*chapeau de gendarme*' forms were present on some Levallois points (e.g. Figs. 7, 3 and 11, 6); faceted and dihedral together form just under half of the butts. An amount, unusual in the Levantine Mousterian, of removed butts is to be noted. Together with the truncated-faceted category, these amount to 12 - 15% of the butts. Examples of removed butts can be seen on Figs. 6, 8 and 9, 4 & 6.

Table 4 shows that the proportions vary little from area to area; however, fewer butts were damaged in Area C (because transported less?).

To sum up the technological data so far gained, two of the conventional technical indices can be based on averages from the area counts: the Levallois index is 22.79 and the Strict Faceted Index is 35.43, with the Enlarged Faceting Index at 44.95.

The Blade Index (ILam) is more problematic, if blades are to be regarded as under-represented. Taking all aspects of the recorded data into account, the ILam of the Levallois element falls somewhere between a minimum of 13.4 (as on Fig. 13) and a maximum of 18.04 (as indicated by the highest ILam of the 1982 collected samples which were biased in favour of good and intact pieces. As a working hypothesis it can be considered as approximately 15. Unretouched blade forms are shown on Fig. 8. Fig. 14 shows that Non-Levallois blades were rare except for a special group of naturally-backed knives from Area C.

The refinement index of the flakes (W/Th ratio mean) averages 4.68 in Areas A and B, which is comparable to the figure of 4.63 for Unit I/Tabun C (Jelinek, 1981), but the (less transportable?) Area C flakes are thicker.

The Middle Paleolithic tools

The tools are classified in the conventional way based on the Bordean system (Table 5). The 'real' list (1,356 pieces) includes the unretouched Levallois element, types 1 - 3; the 'essential' percentages (505 pieces) exclude these as well as the 'various continuous retouch' types, but the two non-Levallois unretouched types, pseudo-Levallois points and naturally-backed knives, are also excluded; these are included in the non-Levallois ordinary flakes, and, when small, as trimming-flakes. Our essential list, then, contains only retouched tools and many 'truncated-faceted flakes' which are here regarded as a tool-type.

The number of burins, end-scrapers, borers and knives is a minimum. Given the presence in the assemblages of many Upper Paleolithic or later tools, even these pieces could date to the post-Middle Paleolithic.

- Levallois flakes (624) and blades (34)

The main features of their morphology and technology have been discussed above. Representative types are drawn (Figs. 6 and 8). The flakes, as shown in Table 6, form 46% of the real list. Blades form 2.5% but because of the number of broken pieces this is a minimum value.

- Levallois points (80)

An effort was made in 1984 to distinguish between short broad-based points (15 specimens: Fig. 7, 1 & 6) and elongated points (22 specimens, Fig. 7, 3 & 7). In 1982 this distinction had not been made for the 43 specimens collected ('undifferentiated' on Table 5). It is possible that elongated points (or points on blanks close to blade length) originally slightly outnumbered the short forms.

Together the points form 5.89% of the real list or 10.84% of the whole Levallois element of 738 pieces; once again, given the amount of breakage, these are minimum values.

The Levallois element (738 pieces) gives an ILTy of 54.39 based on the 1,356 tool total.

- Retouched Levallois points (26)

These form 5.41% (essential) or 1.91% (real) of the tools. The retouch occurs most often at the proximal end where it is abrupt as in Fig. 7, 1 & 5, or near the distal end, as in no.2, where it is scalar. When the retouch is delicate and discontinuous, and perhaps 'podolithic', as in Fig. 7, 3, the piece is not counted as a Retouched Levallois point; when more substantial, as in Fig. 11, 9, the piece is classed as a racloir.

As with the Levallois blades, many tips are broken and perhaps there were originally more elongated than short specimens.

- Mousterian Points (40) and Soyons Points (2)

At 7.92% (essential) and 2.94% (real) the number of Mousterian Points and Soyons Points (the latter having the retouch on the inverse) is unusually high for a Near East assemblage. The variation in sizes, shapes, blank form and debitage can be seen on Fig. 9. Most of the blanks seem to be Levallois or unipolar flat flakes. Thinned butts are common (Fig. 9: 2, 3 & 6), as is offset debitage (e.g. nos. 2, 5 & 6). Some specimens are small (1 & 4), others are large (7), some oval (3), cordiform (1) or triangular (2 & 5) with either delicate (4) or substantial (3 & 7) scalar retouch. The tip ends are thin and sharp.

- Racloirs (230)

The predominant tool-type at Wadi Enoqiyya, racloirs form 45.54% of the essential total. The most numerous types are single convex (20.29%), and single straight (10.29%). Double types together form only 8.11% and offset and transverse racloirs are scarce at c. 2%. There is a wide variety in the blanks, sizes and debitage techniques, a representative group being shown on Figs. 10 and 11. The retouch is most often delicate flat scalar in a single rank (Figs. 10, 6 & 11, 9).

- Notches (31)

These form 6.13% of the essential list. They are usually formed by small, abrupt retouch facets, sometimes (as on Fig. 6, 1) on the inverse.

- Denticulates (62)

These are more numerous, amounting to 12.7% of the essential list but they are an undistinguished group; some have been formed by reworking racloirs (Fig. 11, 8).

- End-scrapers (9)

Only nine specimens made on clearly Middle Paleolithic blanks (e.g. Fig. 11, 6) are included, forming 1.78% of the essential list.

- Burins (4)

Only four burins are regarded as Middle Paleolithic, all on truncations or oblique lateral retouch; they form 0.79% of the essential list.

- Borers (7)

These form just 1.3% of the essential list; none are typical, most seeming to resemble more the *bec burinante alterne* type.

- Splintered pieces (22)

The drawn piece (Fig. 6, 8) is a truncated-faceted flake which has been re-used and crushed on the inverse. There are several similar specimens.

- Backed knifes (10)

Only those on the most clearly Middle Paleolithic blanks were included, forming 1.98% of the essential list. The retouch is usually abrupt but some pieces grade into racloirs (as in Fig. 10, 3).

- Truncated-faceted flakes (39)

These are flakes which have been altered, after having been struck off the core, by the formation of distal and proximal striking-platforms, from which small flakes are struck off. They occur frequently at Wadi Enoqiyya (7.2%) in two forms: either they are without lateral retouch (Fig. 6, 7), or the platforms have been secondarily struck onto a retouched tool, such as is shown on Fig. 6, 5. The piece on Fig. 10, 7 is somewhat of a hybrid; it seems to be a racloir made on a flake struck from a core-base, re-worked in truncated-faceted style at the distal end (Note 6).

- Various continuous (direct or alternate) retouch (103)

These pieces amount to 7.59% of the real list or 19% of the essential list. The drawn piece (Fig. 6, 1) is on a Levallois flake.

- Various continuous inverse retouch (10)

The retouch is usually less substantial than that shown on the inverse racloir, Fig. 11, 5. These pieces form 0.73% of the real list or 1.98 of the essential list.

- Tayac point (1)

A thick point, perhaps the result of reworking a Mousterian Point.

- Divers (22)

These are mainly atypical or composites of the above types; they form 4.35% of the essential list.

Summary of results: Middle Paleolithic

To sum up the typological classification, apart from the unretouched Levallois artifacts, the Wadi Enoqiyya assemblages contain typical and well-known Mousterian types of retouched tools, including numerous Mousterian Points and a more rare type, the Soyons Point. The racloirs also form a distinctive class, giving a racloir index of 45.54 (essential) or 16.89 (real). They are most often light-duty types, the flat scalar retouch usually just skimming the surface of the blank.

Indications of an early phase of the Middle Paleolithic, e.g. Quina retouch and Yabrudian racloir types, are rare-to-absent (the transverse racloir on Fig. 10, 2 is unique).

An early form of Levantine Mousterian, such as was present along the wadis in the Azraq Basin, does not seem to be present.

Furthermore, types associated elsewhere with transitional Levantine Mousterian-to-Upper Paleolithic (such as Emireh Points or chanfreins) are also absent. Although there is always the chance that several different phases of occupation are incorporated into the present collections, they give a strong impression of homogeneity; indeed, the industry as a whole seems remarkably similar to that of Tabun B (Garrod & Bate, 1937), which is characterised by the presence of some elongated, but mainly broad-based, triangular Levallois points, oval and narrow flake-types, and a proportion of centripetal dorsal preparation of the cores.

The Post-Middle Paleolithic

A total of 1,329 artifacts were classified as referring to neither the Lower nor to the Middle Paleolithic. They consisted of types known elsewhere to occur in Upper Paleolithic - to - Neolithic phases, such as bladelet cores, burins, end-scrapers as well as blades and bladelets made by punch technique, core-tablets and crested blades. Clearly post-Pleistocene types (arrowheads, lunates, naviform cores and sickle elements) are also included.

Condition and patina

The material was generally in a good state of preservation; in Area A, on a sample of 213 pieces, 41.3% were classed as 'fresh', 52.5% as 'weathered' and only 6.1% as 'rolled'. Even fewer rolled pieces occurred in Area B (3.19%, 1982 collection). In fact there was little real difference between the 'weathered' and 'fresh' categories.

The same kinds of patinas occurred as were noted in the Middle Paleolithic, and the proportions differed only slightly (cf. Table 3).

More (13.8%) were 'unpatinated' than in the Middle Paleolithic, virtually none (0.35%) had double patina and fewer had completely white patinas (14.8%). Otherwise, as in the Middle Paleolithic, yellow-brown and slightly whitened patinas (28.72% and 30.85% respectively) dominated (Table 6).

Distribution

In contrast to the earlier occupations, the post-Middle Paleolithic element, which forms 17% of the collections as a whole, seems to be concentrated in Area B, below the bridge and around a spring which some have seen flowing, but which is today dried-up. For example, the material is abundant, forming half (54.42%) of the total number of artifacts assigned to the post-Middle Paleolithic; two-thirds (67.7%) of the total of 91 cores occur in Area B. The material consists mainly of bladelet cores, burins, borers, end-scrapers and a few Aurignacian or backed blades, but it is probable that the smallest pieces (such as bladelets which would have been produced from the bladelet cores) are greatly under-represented. Burins slightly outnumber end-scrapers in Area B, (38% to 29%) and there is a wider variety of other types (composites, notches, denticulates etc.) than in the other areas, as shown on Table 7.

General remarks on post-Middle Paleolithic artifact types

- Cores (135 specimens)

The bladelet cores were essentially of two kinds: one was of 'steep-scraper' type (Fig. 21, 5), i.e. for bladelets or small blades, some having the characteristic 'twisted-nose' known from the Upper Paleolithic of El-Wad (Garrod & Bate, 1937); both unipolar (Fig. 21,3) and bipolar (Fig. 21, 2 & 6) categories occurred.

The other cores were of polyhedric or amorphous shape, often with crossed axes (Fig. 24,2), for small products: flakes or bladelets (Fig. 21,7). The P.P.N.B. naviform type of blade core was also present: 3 specimens (2 sub-types: Fig. 25, 1 and 5).

- Products (1,194 specimens)

The unretouched material was selected on subjective bases from a large quantity of debitage. The most clearly post-Middle Paleolithic artifacts can be divided into two groups: (1) thick blades with triangular section and lipped, sometimes lozengic, butts and (2) thin blades, slightly arched or twisted, with punctiform, linear or small plain butts (Fig. 22,3 & 6). Some of the larger blades had the proximal ventral surface scar on the butt characteristic of the P.P.N.B. (Fig. 25, 7). Most of the flakes were selected because they formed the blanks for tools of Upper Paleolithic - to - Neolithic type. The 8% of bladelets shown on Table 6 is probably a minimum, given the difficulties of collecting small artifacts from fine silty sediments.

- Tools

Of the 392 amalgamated tool-types from Areas A - D on Table 6, burins (31.36%) and end-scrapers (31.87%) dominate in about equal proportion:

(1) End-scrapers on flakes or blades

These are mainly well-made, on blades or short and thick flakes: the latter include thumb-nail, ogival, nosed, shouldered (Fig. 22, 5 & 8) and carinated types (Fig. 22, 6) characteristic of the Aurignacian, but these are much more rare than the less diagnostic end-of-blade scrapers, some of which could be Epi-Paleolithic or Neolithic; several of them are also retouched laterally (Fig. 22, 1 & 2; Fig. 23, 2 & 4). Several are double (Fig. 23, 4) and a limiting notch is seen on several of the flake-scrapers (Fig. 22, 9 & 10).

(2) Burins

These are well-made and include varieties typical of the Levant Late Paleolithic or early Holocene industries, mainly made on flakes and fragments rather than on blades. The majority are dihedral types: rightangle (Fig. 23, 7 & 10), *bec-de-flute* (Fig. 23, 11), carinated and flat carinated (Fig. 23, 8 & 9), *busqué* (Fig. 24, 5) and nucleiform predominating. The more rare truncation burins included the Neolithic 'Kharana burin' on a concave notch (2 specimens). Both doubles and composites (with end-scrapers, racloirs, denticulates or borers) also occurred in small numbers.

(3) Borers

The 14 borers are thick and atypical (Fig. 23, 1), one being more a bec.

(4) Backed blades (3 specimens: Fig. 24, 1) and Aurignacian blades (3 specimens: Fig. 22, 3).

These are rare but typical.

(5) Epi-Paleolithic types

There are 14 retouched bladelets; e.g. a scalene triangle, some backed bladelet fragments (Fig. 24, 4), a backed and truncated bladelet (Fig. 24, 6), a double-truncated bladelet, a lunate with Helwan retouch (Fig. 24, 7).

(6) Neolithic tool-types

One rather atypical tanged arrowhead (Fig. 25, 3), a possible arrowhead fragment and two possible sickle elements seem to belong with the group of P.P.N.B. naviform cores, mentioned above. A wide blade segment with two snaps may belong here as well (Fig. 25, 7); it is a type known from pottery Neolithic contexts elsewhere.

(7) Flake with incised cortex

A cortex flake was seen to have groups of scratches on its cortex upper face (Fig. 30). Incised lines on cortex pieces are described from P.P.N.B. sites by Betts (1986, Fig. 4. 17).

Discussion of post-Middle Paleolithic material

There is no trace of the early Upper Paleolithic which follows on from the Middle Paleolithic, such as Transitional (Emiran) or the later Ahmarian blade/bladelet industries with retouched points, known from Lebanon (Ksar Akil Phase B) and the Negev. Such an absence is matched in other Near Eastern regions, e.g. El-Kowm.

Later Paleolithic and Neolithic material is present and the following is an estimate as to which Late Quaternary and early Holocene cultural phases (such as Aurignacian, Athlitian, Kebaran, Geometric Kebaran, Natufian, P.P.N.B.) are represented among the surface materials described above. It is based on what is known of the typological traits of the above industries at other Near Eastern sites.

The main problem with the 'comparative typological dating' of surface material is that artifacts which are diagnostic of only one Paleolithic phase are very rare; once invented, the so-called 'Upper Paleolithic' tool-types (end-scrapers, burins and borers) continued to be fashioned long after the end of the Pleistocene. Thus it is usually impossible to know how many discrete phases of occupation are represented.

However, we do have the advantage at Azraq that the material can be compared to that at stratified and often dated local sites.

Furthermore, it is also true to say that some phases within the Levantine late Paleolithic are characterised by certain stylistic traits and by the presence of 'diagnostic' sub-types. For example it is generally accepted that nosed and shouldered flake-scrapers and other flake-scraper variants with neat, laminar proximal retouch typify the Aurignacian (or Antelian), Phases 3 and 4 of Neuville's scheme, at cave sites such as El-Wad, Kebara, Ksar Akil, Antelias and Hayonim (Note 7). It would also appear that the subsequent Athlitian phase (5 of Neuville) is characterised by the presence not only of the numerous carinated and flat-carinated burins (which continue from the Aurignacian) but also a variety of polyhedric burins grading into cores, steep-scrapers etc., seen at e.g. El-Wad C, Kebara D1, Ksar Akil (Aurignacian C; for references see Bergman, 1987).

The presence of numerous and varied bladelet cores (including the typical twisted-nose type, which produces twisted bladelets) is another trait of the late Levantine Paleolithic and Epi-Paleolithic. In the well-known cave and shelter sites already mentioned these grade into pieces which could be classed as burins when thin or steep-scrapers when thick. At the end of the phase they seemed more degenerate in, e.g., the lowest (very early Kebaran?) levels III and IV at Jiita II (Hours & Loiselet, 1975-77).

All these characteristic scraper, burin and core types are present at Enoqiyya, especially in Area B.

The Upper Paleolithic

On the basis of these criteria it seems safe to say that Enoqiyya was visited by Aurignacian and later (Athlitian?) hunters during the c. 30,000 - 20,000 year time span. This era has produced two dates: 32,000 and 28,000 b.p. at Ksar Akil (Bergman, *ibid*). Although El-Wad points (another early Aurignacian type-fossil e.g. at El-Wad and Ksar Akil; Note 7) are absent, they are also absent in Late Aurignacian levels at Hayonim (Belpher-Cohen & Bar Yosef, 1982) and Kebara D2 (Ziffer, *ibid*).

Up to now the only Upper Paleolithic sites reported from the Azraq Basin are in Wadi Jilat (e.g. Jilat 9, although dated to a final stage: 21,150 b.p.); first reports indicate that Jilat 9 is a non-microlithic industry with end-scrapers but few burins (Garrard *et al.*, 1987). It does not seem to resemble any well-known Levantine facies, or the material of Enoqiyya as a whole.

The Epi-Paleolithic

Except for the presence of the bladelet cores, traces of the Epi-Paleolithic are surprisingly rare in the Enoqiyya collections: only a dozen or so microliths were found. Although this could be a result of collecting problems, in our experience of surveying at Azraq, microlith sites are perfectly recognisable in surface contexts (cf. Qa Jashsha; Copeland, this volume, e), so that their scarcity at Enoqiyya could well be real. In any case, the very wide variety of microlith types, not only at Azraq (Garrard *et al.*, 1986 and 1987), but in the whole of the Near East, makes it impossible on the basis of such a small sample to assign 13 of the 14 retouched bladelets to any particular facies. Only the lunate with its Helwan retouch could be regarded as most probably Natufian. This culture is known to have existed both in the nearby oasis (AZ.18 of Garrard) and further East (at Khallat 'Anaza: Betts, 1986), while the two truncated bladelets might refer to a Geometric Kebaran, such as that which occurred at Jilat 6 or 8 or at Azraq 17 in the Sheshan marsh. On the basis of Jilat and Uweinid C-14 dates (Gowlett *et al.*, 1987), these various phases of occupation could have taken place towards the end of the Last Pluvial, the Kebaran-like variants from c. 17,000 - 15,000 B.P. and the Natufian at about 12,000 B.P.

The Neolithic

Wadi Enoqiyya contains Neolithic artifacts which should refer to the P.P.N.B.; this is not surprising since several sites (including some large habitation sites) of this era are already known in the Basin and even in the steppe areas and the basalt 'Black Desert' to the East. Jilat 7 is dated to 6,700 - 6,500 B.C. Closer to Enoqiyya is Azraq 31, dated similarly (Gowlett *et al.*, *ibid*). Both contain naviform blade-cores and tanged arrowheads. The single leaf-shaped, tanged arrowhead (Fig. 25, 3) at Enoqiyya is not very typical of those at AZ.31, in that the tang is not so well retouched, but more similar forms have been recovered at Lion Spring (Rollefson, 1982) and C-Spring (Copeland, this volume). No doubt the P.P.N.B. hunters were attracted to Enoqiyya by the game frequenting the wetland and springs, but there are not enough artifacts to suggest that it was one of the large habitation sites.

The presence of a Kharana burin (Fig. 25, 4), the 'type fossil' of the so-called 'Burin Sites' (Betts, 1986), dated at one site (Jebel Naja) to 5,600 B.C., suggests that the wadi was also visited in the 6th Mil. This is also indicated by the number of stone structures present on the basalt in the immediate vicinity; similar ones have been referred to the 'Burin Neolithic' (Betts, 1988, Helms and Betts, 1987 and Garrard *et al.*, 1987).

An artifact with incisions on the cortex (Fig. 30) is undated but may be similar to pieces from P.P.N.B. sites reported by A. Betts (1986, Fig. 4, 17).

GENERAL CONCLUSIONS CONCERNING THE ENOQIYYA LITHIC INDUSTRIES

This report has dealt with the lithic industries at Wadi Enoqiyya, as known from the surface collections made between 1982 and 1984. Many of the questions posed by the results of the above analyses cannot be answered except by excavation, provided that a stratified locus could be found; therefore one can only draw the most general conclusions.

Occupation seems to have begun during the Penultimate Pluvial complex or Last Interpluvial, just as in the other spring sites; the small sample probably represents the local Late Evolved Acheulean our 'Late Acheulean of Azraq Facies' (Copeland and Hours, 1988).

The Wadi Enoqiyya evidently provided a suitable spot for a base camp, intensively-used (whether seasonally or otherwise) in the Middle Paleolithic, probably during the first part of the Last Pluvial. There are several indications (proportions of heavy versus light, or damaged versus undamaged, pieces etc. in each area) that the original site was at the start of the bottleneck (Area C). Alternatively, the very concentration of artifacts (and faunal remains, if they date to the same period) around the 'bone-pool' could suggest the presence of a large camp in the immediate vicinity (Note 9).

In this writer's judgement the material could well belong to a late phase in the Levantine Mousterian time span; while there is no proof that it is all of one phase, it seems similar to assemblages such as the Levalloiso-Mousterian of Tabun B. Traces of a similar period of occupation may be present around the Azraq Basin, but so far the sites are unexcavated or disturbed.

No other large concentrations are known in the steppe areas; Betts reports (1986, 372) only a scatter of material in the Black Desert; some sites are reported from Wadi Hasa but they contain a bladey industry with Levallois Points reminiscent of that in Tabun D (Lindly and Clark, 1987). To the north, no other large Middle Paleolithic site is known between Azraq and Jerf Ajla (Palmyra).

Possibly after a gap in occupation during the early Upper Paleolithic, makers of a typical Aurignacian tool-kit visited Enoqiyya, and these were perhaps followed by occupations during the Athlitian phase. The greatest concentration of artifacts occurs around the Area B spring. Similar sites have not been reported elsewhere in the Basin (although Jilat 9 may contain a related facies) and indeed none are known on the desert fringes up to the time of writing. Apparently the wadi was not especially attractive either to early or late Epi-Paleolithic folk except for occasional visits. The visitors may have come from the large Kebaran-related sites occurring around the edge of the Qa al-Azraq and its springs. In the case of the Natufians, they could have come either from sites in the vicinity such as AZ 18 of Garrard near C-Spring or alternatively from sites in the basalt (as we know from Betts' work in the Black Desert, the Natufians were seemingly able to adapt to life there).

The 7th - 6th Mil. denizens of the Basin (P.P.N.B. and 'Burin Neolithic') also frequented Enoqiyya but apparently did not settle, at least in the wadi valley itself.

If the above chronology is correct, one could suggest that it was in the most humid Last Pluvial periods that the wadi was most intensely occupied, but this is by no means certain. Such a model would still leave unexplained the apparent quasi-absence of the Epi-Paleolithic although there is some evidence from both Garrard's work at Jilat and that of Besançon and Sanlaville at Enoqiyya that dry/wetter oscillations occurred during the Epi-Paleolithic, with a wet phase around 14,500 b.p. (Garrard *et al.*, 1987; Besançon, Geyer & Sanlaville, *infra*, cf. Episode 16 on Table II). See also the analyses of the soil samples and their interpretations (Hunt and Garrard, *infra*).

Finally, if the cultural interpretations put forward here are valid, Wadi Enoqiyya has contributed data on two periods of occupation at Azraq which have up to now been absent or not clearly present there or anywhere in the adjacent regions: a late Levantine Mousterian of Tabun B ambience and an Aurignacian/Athlitian phase in mid-Upper Paleolithic (c. 30,000 - 20,000 years B.P.?)

NOTES

1. E.g. Wadis Rattama, Kharana, Janab/Mushash and Butm; Copeland & Hours, *infra*.
2. The C.N.R.S. team consisted of J. Besançon and P. Sanlaville, geomorphologists, L. Copeland and F. Hours, prehistorians, with the assistance of J.J. Macaire in 1982 and B. Geyer in 1986.
3. Soil samples from each layer are reported on, *infra* by Hunt and Garrard.
4. Glaze-like lustre on flints from spring contexts is characteristic of Lower Paleolithic assemblages in Azraq. See discussion of the subject in Copeland, a, this volume.
5. It was noted that at Tabun the flakes became progressively thinner through time (Jelinek, 1981) at Tabun, but a similar progression has not been noted at such sites as Wadi Hasa 634, Ain Difla (Lindly & Clark, 1987) or Qafzeh and Kebara (p.c. Bar Yosef, 1986)
6. Although discussed in the literature since first noticed by Schroeder (1966), the function of truncated-faceted flakes is not yet known. Some authors list them as 'cores on flakes' (Newcomer and Hivernel-Guerre, 1974) but it is hard to regard the tiny flakes removed as being useful tools. If they are the result of a need to thin the ends of the flake for hafting, the method in fact leaves jagged edges, as seen in Fig. 6, 5.
7. The term 'El-Wad Point' is used here according to the definition (first as Font Yves Point by Garrod) at the London Terminology Symposium of 1969, to refer to the small, twisted blade/bladelets with retouched points known at e.g. El-Wad. In recent years the term has been mistakenly applied to a different artifact type, a larger, straight blade point, at sites in the Southern Levant; this type of point refers to an earlier Upper Paleolithic phase equivalent to 'Ksar Akil Phase B'.
8. Indeed, these are listed as 'Aurignacian Scrapers' in a recent re-evaluation of the Palestinian sites (Ziffer, 1975). See: Antelias (Copeland and Hours, 1971); Hayonim (Belpher-Cohen & Bar Yosef, 1982); El-Wad (Garrod and Bate, 1937); Ksar Akil (Bergman, 1987).
9. Mineralised teeth of *Equus asinus/hemionus* and *Camelus sp.* occur between the bridge and the 'bone pool', but they are clearly derived and it is not known to which prehistoric phase they refer (A. Garrard, pers. com., 1988); thus, a report will not be included here.

BIBLIOGRAPHY

BELPHER-COHEN, A. & O. BAR YOSEF,1982. The Aurignacian of Hayonim Cave. *Paléorient* 7, 19 - 42.

BENDER, F., 1974. *Geology of Jordan.* Berlin, Borntraeger.

BERGMAN, C., 1987. *Ksar Akil, Lebanon: a technological and typological analysis of the later Paleolithic levels of Ksar Akil; Volume II, Levels XIII - VI.* British Archaeological Reports i.s. 329.

BESANÇON, J. & P. SANLAVILLE, in press. L'évolution géomorphologique du Bassin d'Azraq (Jordanie) depuis le Pléistocène Moyen. Colloque Intnl. C.N.R.S., *Préhistoire du Levant 2*, Lyon, 1988.

BETTS, A., 1988. The Black Desert Survey. Prehistoric sites and subsistance strategies in eastern Jordan. IN A. Garrard and H. G. Gebel, eds., *The Prehistory of Jordan: the state of research in 1986.* British Archaeological Reports i.s. 396 ii, pp. 369 - 391. See also *Levant* 1983-1985, vols. XV - XVII.

COPELAND, L. & F. HOURS, 1971. The Later Upper Paleolithic material from Antelias Cave, Lebanon, levels IV - I. *Berytus* 20, 57 - 138.

COPELAND, L. & F. HOURS, 1988. The Paleolithic in North-Central Jordan: an overview of survey results from the Upper Zarqa and Azraq, 1982-1986. IN A. Garrard & H.G. Gebel., eds., *The Prehistory of Jordan; the state of research in 1986.* British Archaeological Reports i.s. 396 ii, 287 - 309.

GARRARD, A., A. BETTS, B. BYRD & C. HUNT, 1987. Prehistoric environments and settlement in the Azraq Basin: An interim report on the 1985 excavation season. *Levant* XIX, 5 - 26.

A. GARRARD, B. BYRD & A. BETTS, 1986. Prehistoric environment and settlement in the Azraq Basin: an interim report on the 1984 excavation season. *Levant* XVIII, 5 - 24.

GARRARD, A. & N. STANLEY PRICE, 1975-77. A survey of prehistoric sites in the Azraq Basin, Eastern Jordan. *Paléorient* 3, 109 - 126.

GARROD, D. & BATE, D., 1937. *The Stone Age of Mount Carmel I.* Oxford, Clarendon Press.

GOWLETT, J., R. HEDGES, I. LAW & C. PERRY., 1987. Radiocarbon dates from the Oxford AMS system: datelist 5. *Archaeometry* 29/1 135-136

HELMS, S. & A. BETTS, 1987. The Desert 'kites' of the Badiyat esh-Sham and North Arabia. *Paléorient* 13/1, 41-68.

HOURS, F. & J. LOISELET, 1975-77. Calcul par ordinateur et techniques de fouilles: Précisions sur le Kebarien Ancien de Jiita (Liban). *Paléorient* 3, 151 - 180.

JELINEK, A., 1981. The Middle Paleolithic in the Southern Levant from the perspective of the Tabun Cave. IN J. Cauvin & P. Sanlaville, eds., *Préhistoire du Levant*, 265 - 280.

KENNEDY, D.L.,1982. *Archaeological explorations on the Roman Frontier in N.E. Jordan.* British Archaeological Reports, i.s. 134.

LINDLY J. & G. CLARK, 1987. A Preliminary Analysis of the Mousterian Site of 'Ain Difla (WHS 634) in the Wadi Ali, West-Central Jordan. *Proceedings of the Prehistoric Society* 53, 279 - 292.

NEWCOMER, M. & F. HIVERNEL-GUERRE, 1974. Nucleus sur éclat: technologie et utilisation par différentes cultures préhistoriques. *Bul.Soc. Préhist. Française* 71, c.r.s.m. 4, pp. 119 - 128

NELSON, B., 1973. *Azraq, Desert Oasis.* London, Allen Lane.

RILEY, D.N., 1982. Appendix C; antiquities recorded by old photographs taken by the Royal Air Force near Azraq Duruz. IN D.L.Kennedy, *Archaeological Explorations on the Roman Frontier in N.E.Jordan.* British Archaeological Reports i.s. 134, 345 - 355.

SCHROEDER, B., 1966. The lithic material from Jerf Ajla: a preliminary report. *Ann.Arch.Arabes de Syrie*, XVI/2, 201 -210

ZIFFER, D., 1978. A re-evaluation of the Upper Paleolithic industries at Kebara Cave and their place in the Aurignacian culture of the Levant. *Paléorient* 4, 273 - 294

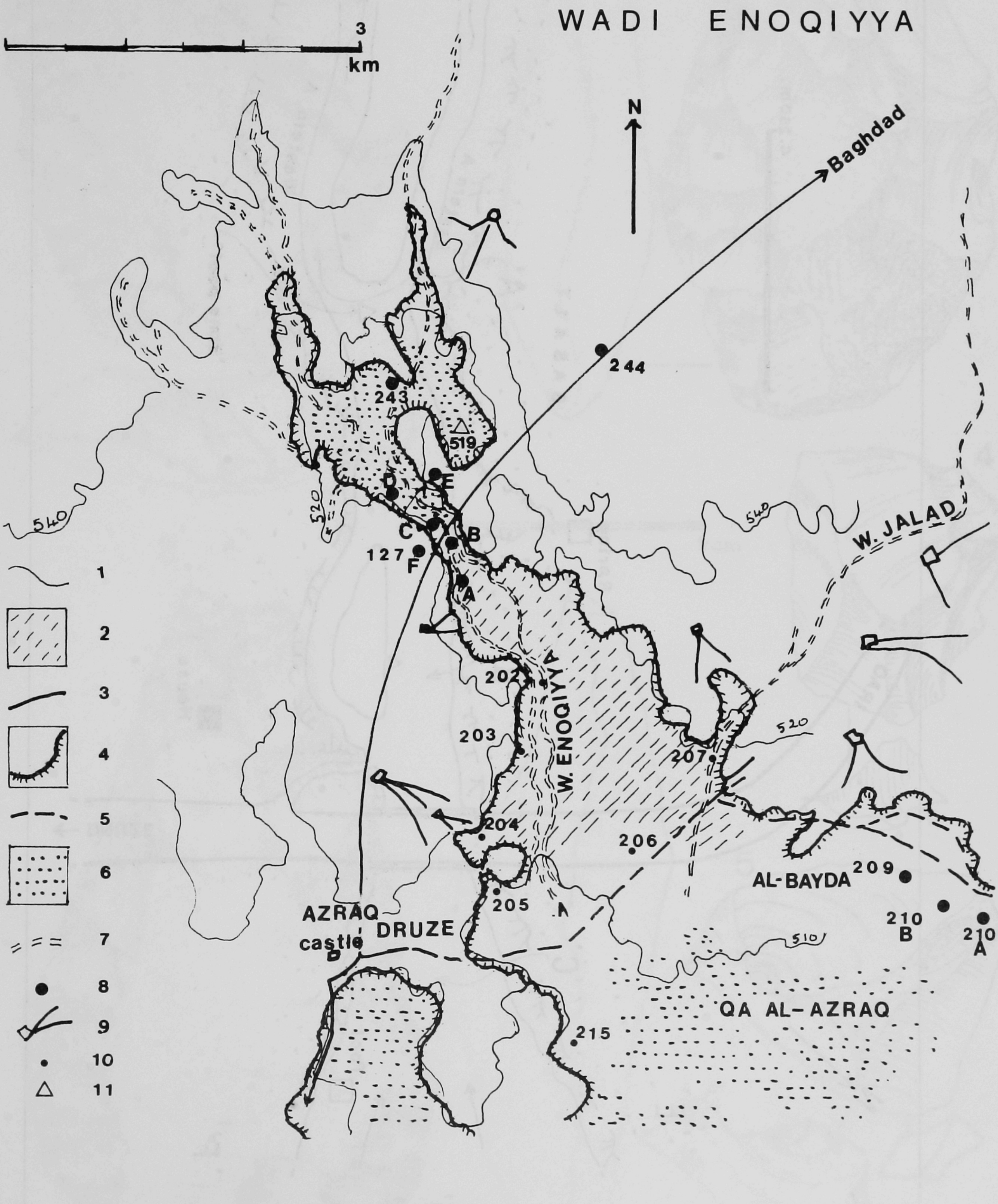


Fig. 1. The Wadi Enoqiyya and environs: 1, contours; 2, fluviatile sediments; 3, approximate position of new road to Baghdad; 4, limits of basalt plateau; 5, unpaved roads; 6, depressions filled with fine sediments, marshy around spring pools; 7, wadi courses; 8, artifact collection points; 9, kites; 10, geomorphological sites or sections; 11, benchmark.

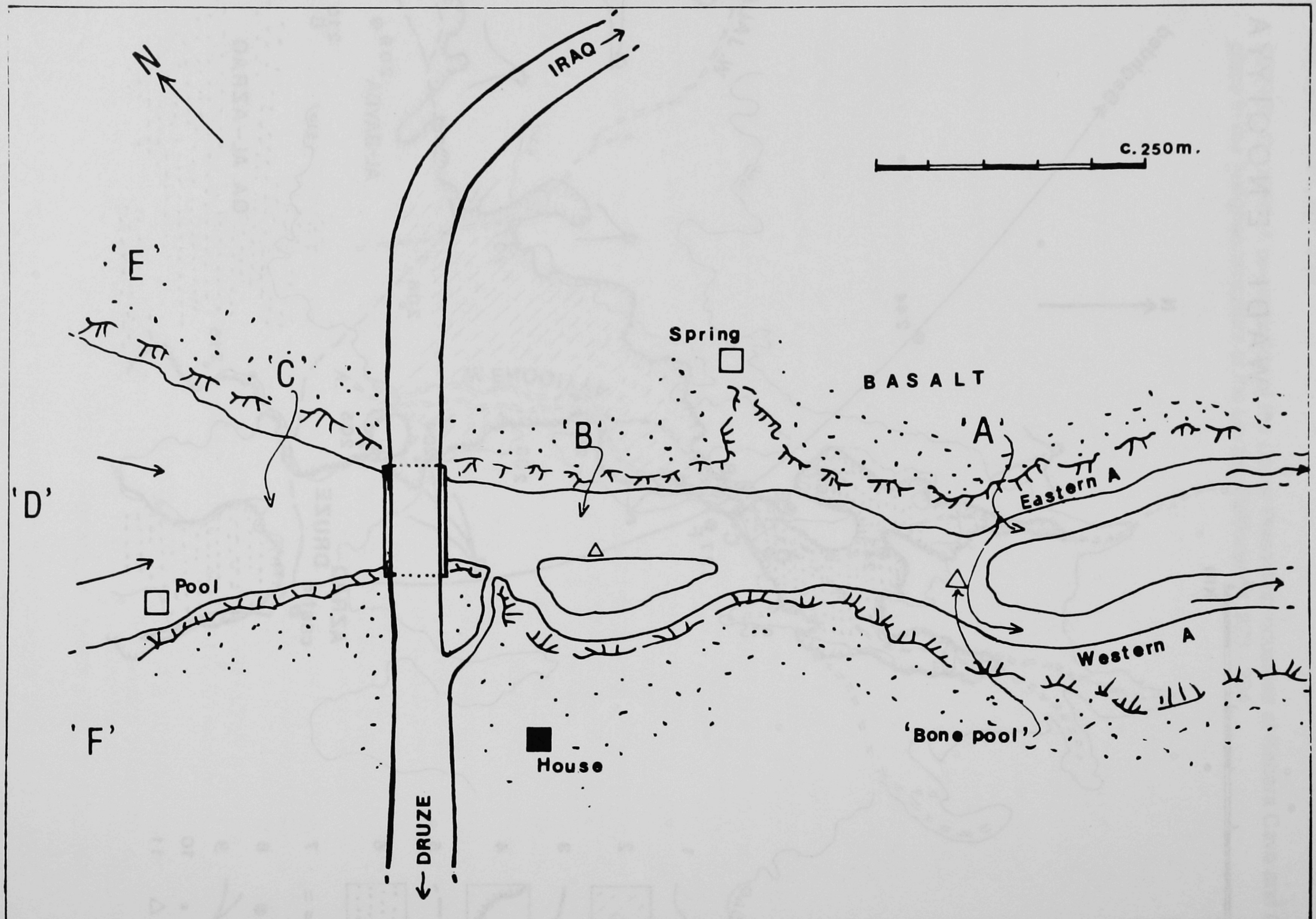


Fig. 2. Sketchmap of Site 127 (Wadi Enoqiyya), Areas A to F. The scale is approximate, especially in the north-south direction. The small open triangle marks the position of Section I.

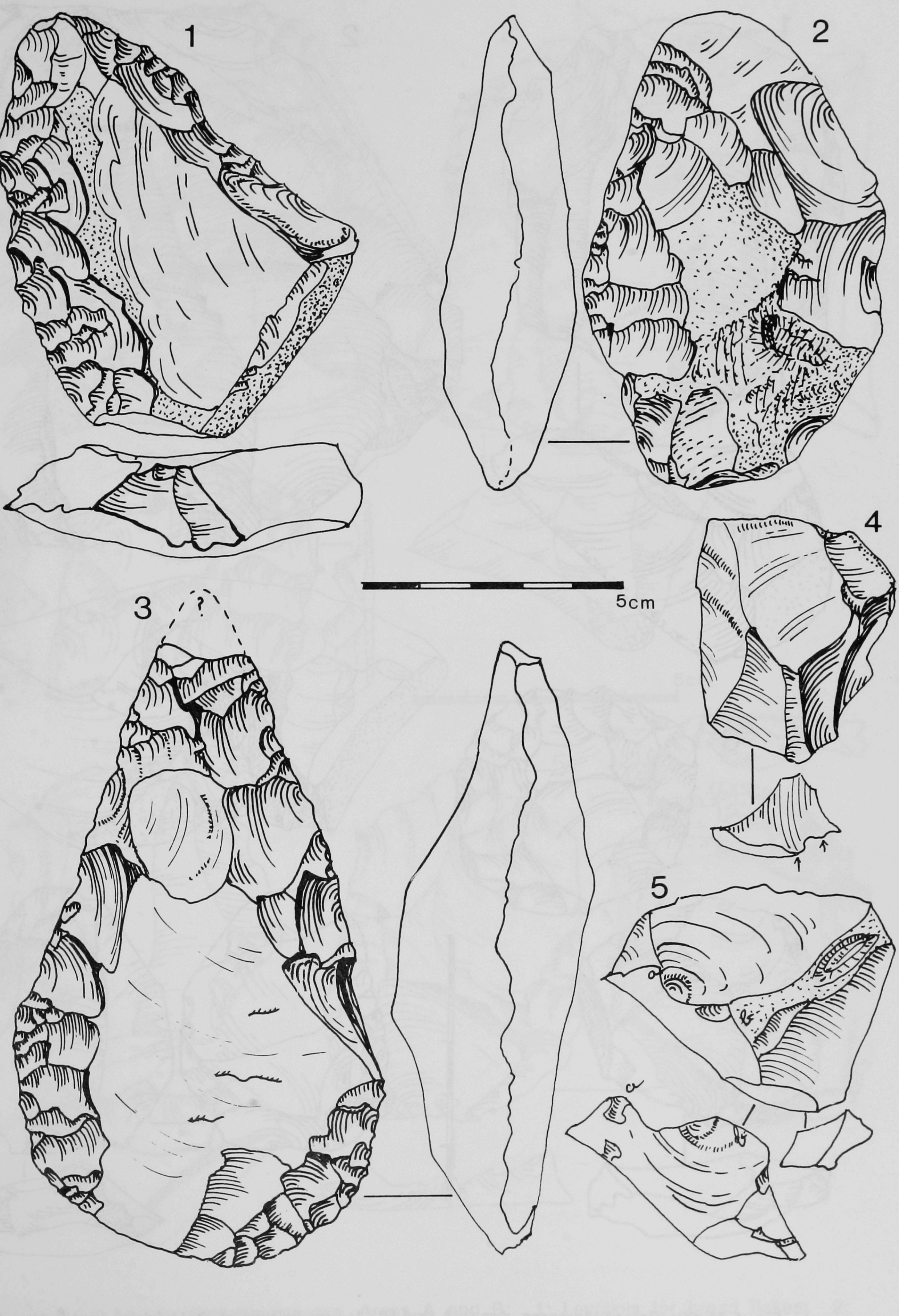


Fig. 3. Lower Paleolithic artifacts: 1 - 4, Area C; 5, Area D.1: Qina racloir; 2: Subovate biface with cleaver-like tip; 3: Lanceolate biface on a flake; 4: Lustred flake; 5: Lustred core-edge flake.

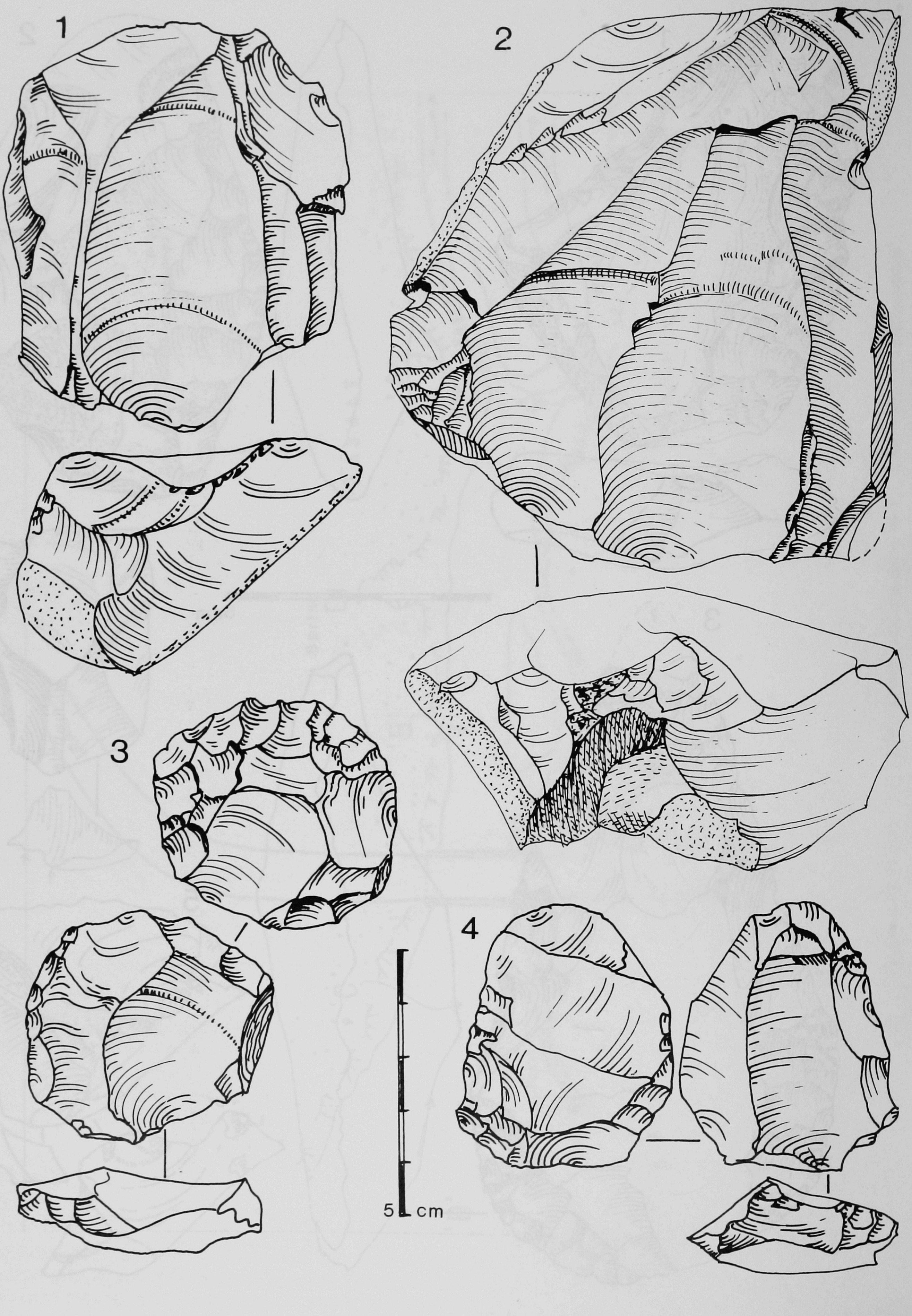


Fig. 4. Middle Paleolithic cores, Areas A and B: 1: Levallois point; 2: Unipolar for blades; 3: Levallois tortoise; 4: Levallois for small blades (note transverse basal preparation as at Qalta, El-Kowm).

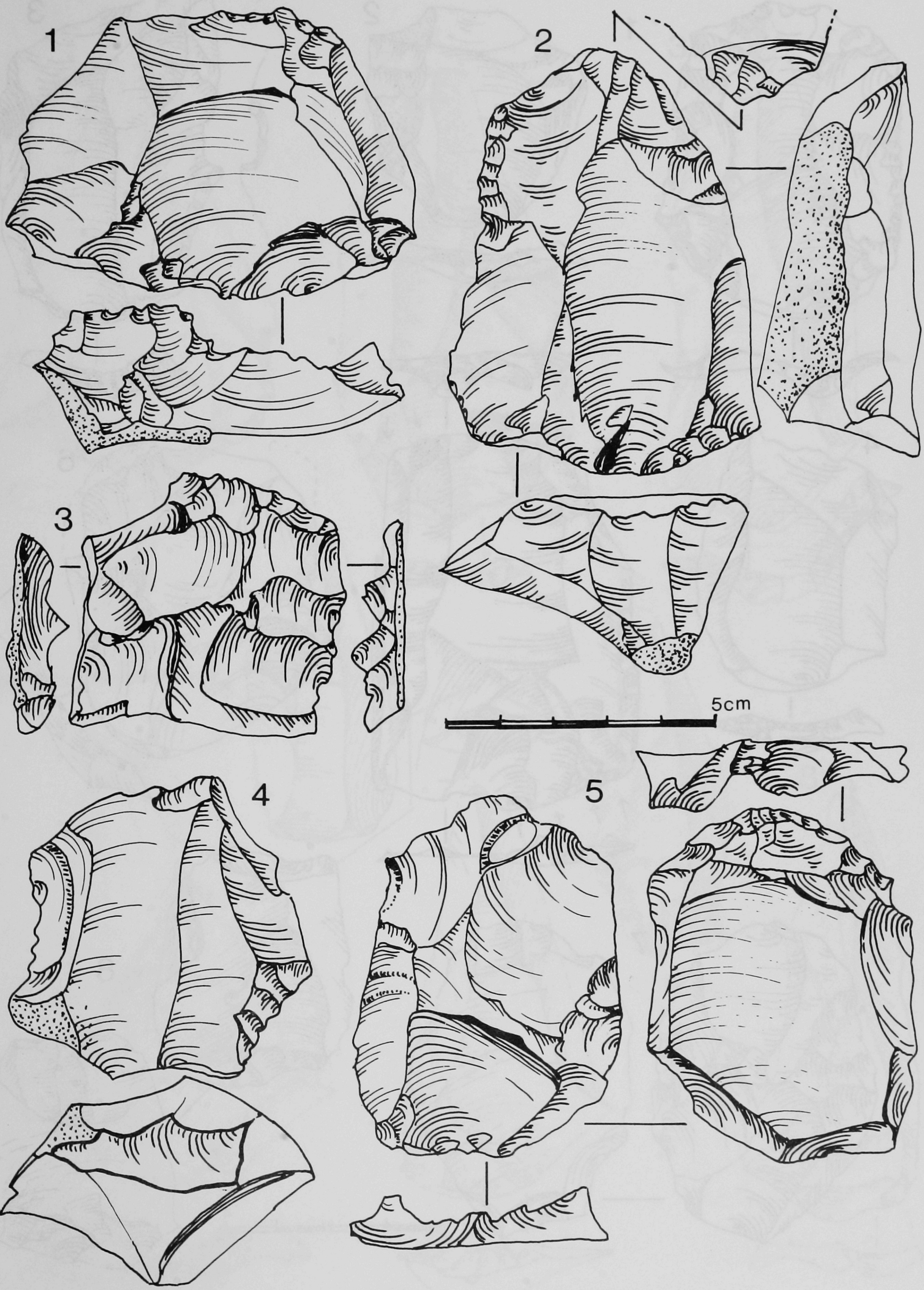


Fig. 5. Middle Paleolithic cores, Areas A and B: 1: Levallois for broad flakes; 2: Bipolar/prismatic for blades; 3, Exhausted bipolar; 4: Mousterian discoid; 5: Exhausted disc, on a flake.

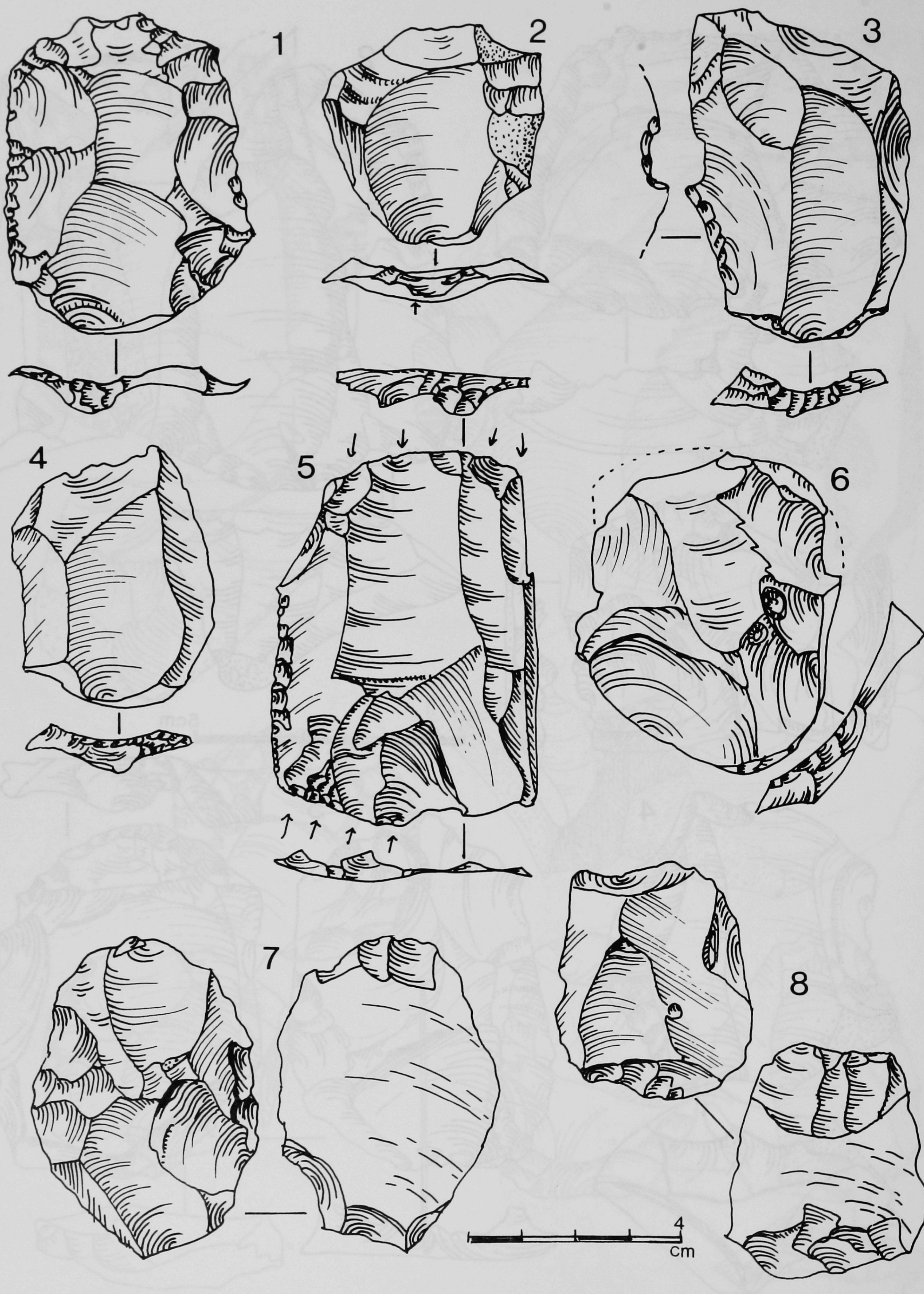


Fig. 6. Middle Paleolithic flakes, Areas A - C: 1 & 6: Broad Levallois flakes with radial preparation, no. 1 with lateral retouch and no. 6 with core-edge facets; 2: Atypical Levallois flake; 3: Broad Levallois flake, no. 3 with inverse notch; 4: Slightly retouched truncated-faceted flake, drawn to show both dorsal and ventral removals; 8: Splintered piece with inverse crushing, probably a truncated-faceted flake.

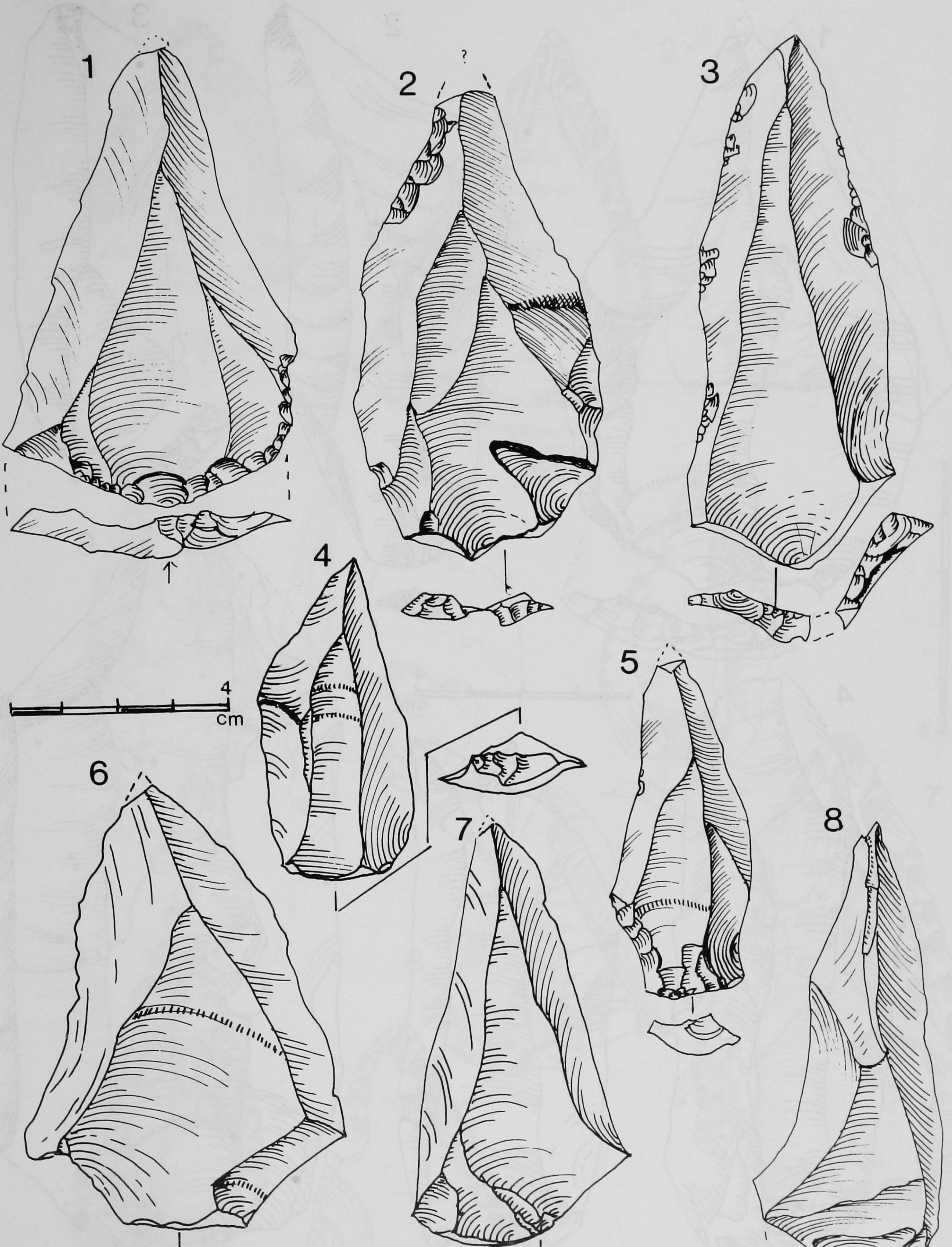


Fig. 7. Middle Paleolithic points, Areas A - C: 1 & 6: Broad-based Levallois points; 2 & 5: Retouched elongated triangular points (?); 3 & 7: Elongated Levallois points; 4: Levallois point; 8: Atypical Levallois point, tip slightly damaged by impact.

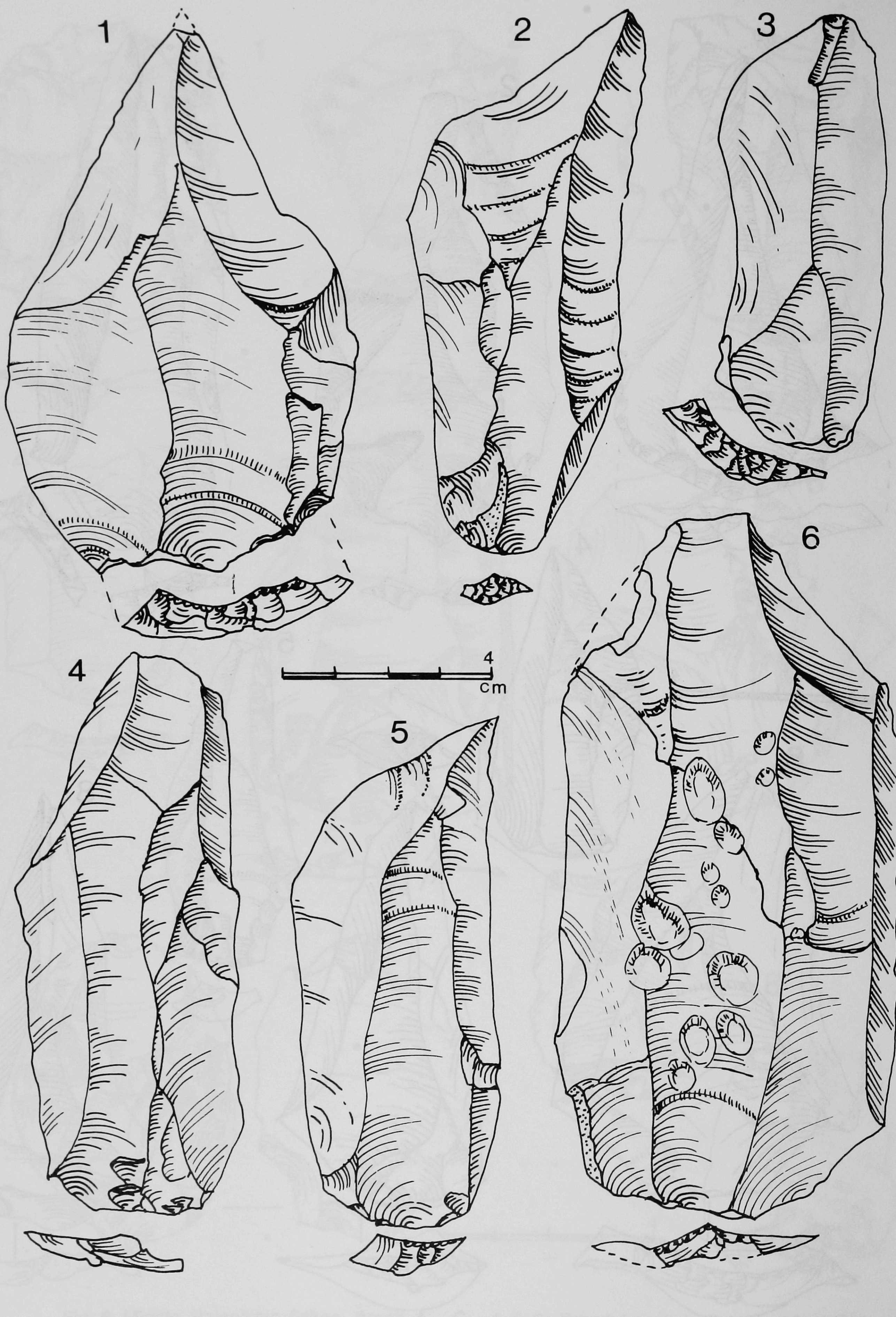


Fig. 8. Middle Paleolithic blades, Area B. 1: Elongated but broad Levallois point; 2, 3, 4 and 6: Levallois blades, no. 6 with thermal fractures; 5: Pointed Levallois blade.

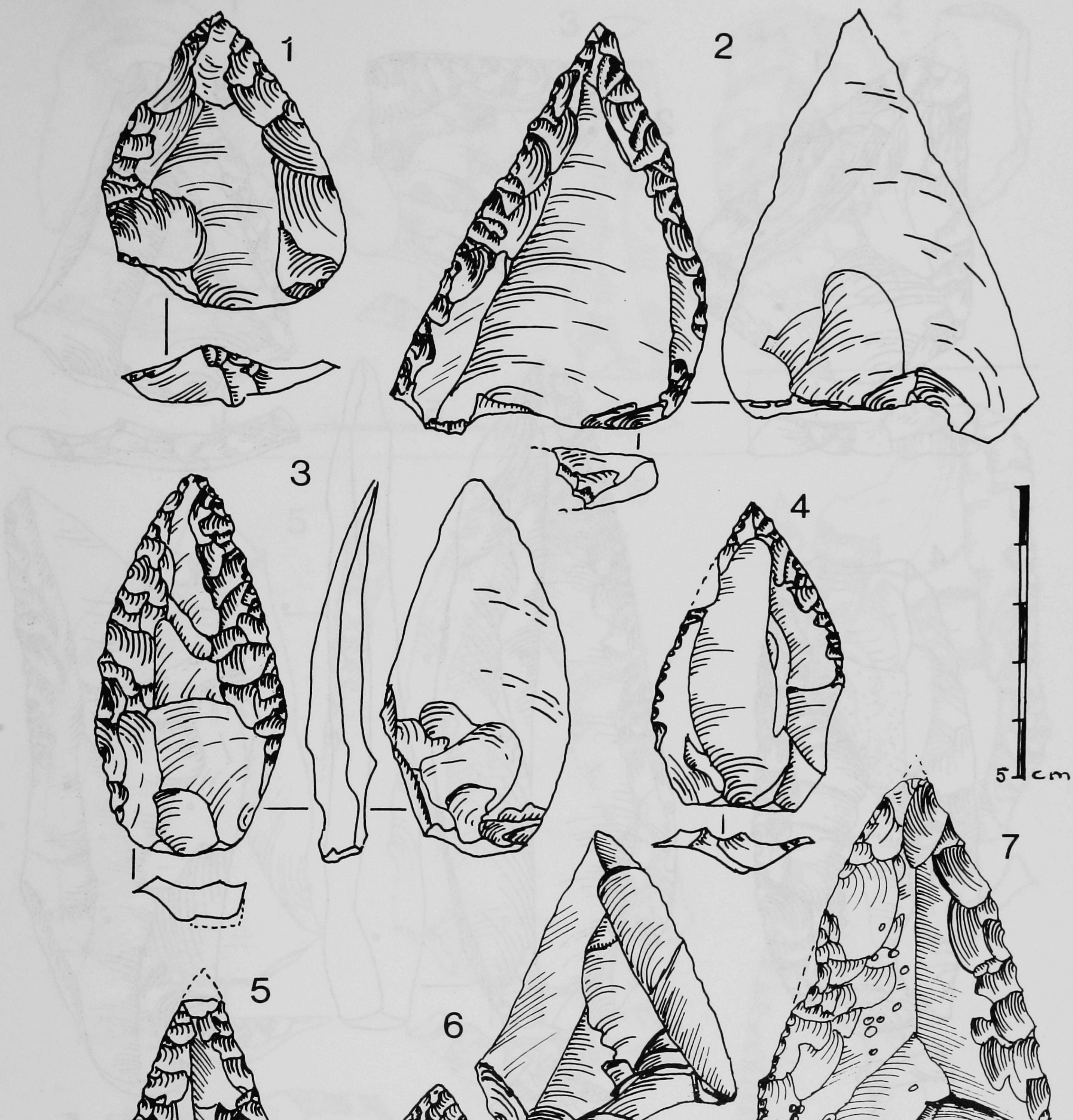


Fig. 9. Middle Paleolithic tools, some retouched points, Areas A - C: 1: Short Mousterian Point; 2: Mousterian Point on offset flake with removed butt; 3: Oval Mousterian Point with thinned butt. 4: Small Mousterian Point tending to a convergent racloir; 5: Mousterian point on a thick, offert flake; 6: Soyons Point; 7: Large Mousterian Point (or convergent racloir?) on a Levallois blank, thermally damaged.

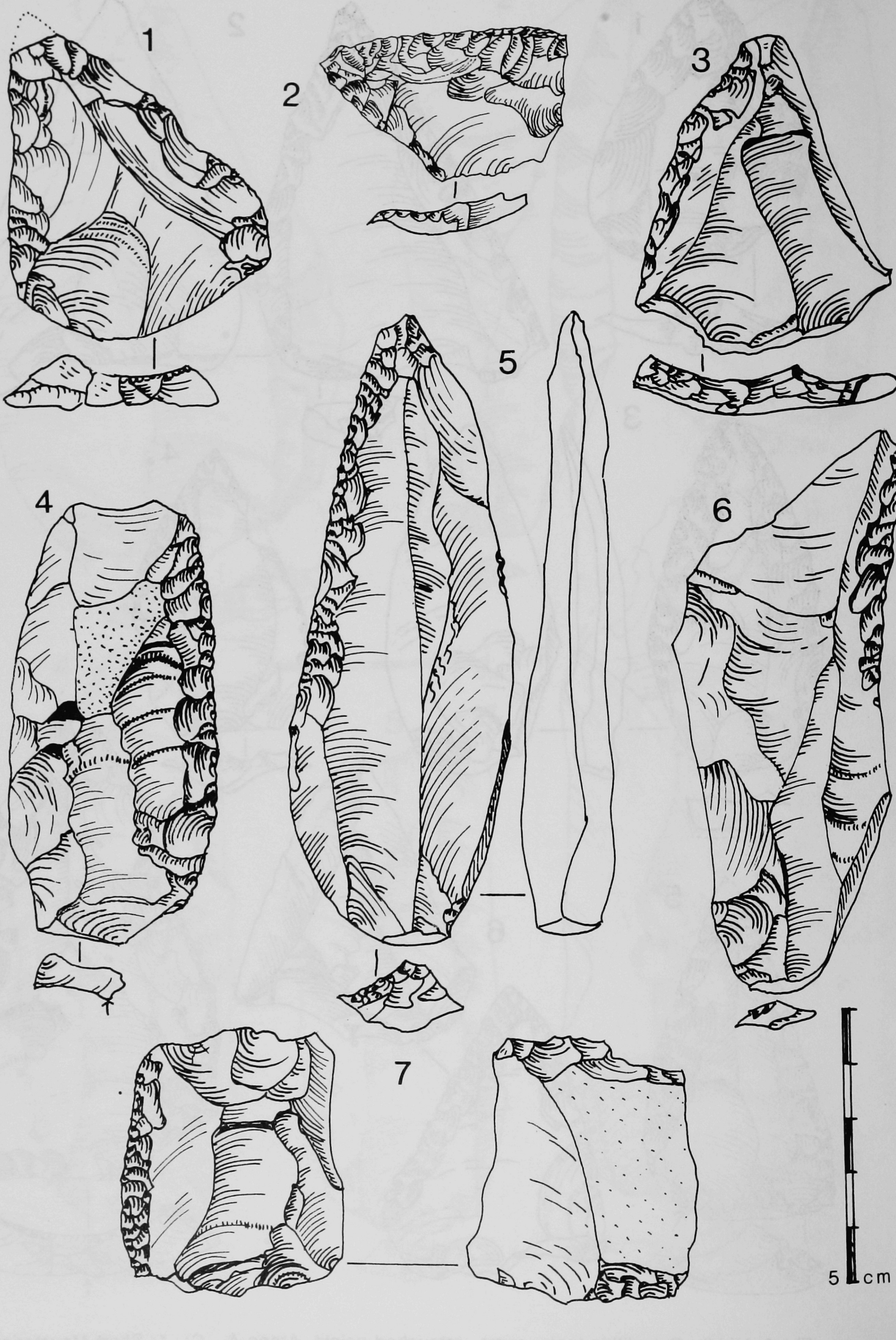


Fig. 10. Middle Paleolithic tools, Areas A and B: 1: Offset racloir; 2: Transverse racloir; 3: Backed knife; 4: Single straight racloir; 5: Single straight or convergent racloir on a Levallois blade; 6: Single concave racloir; 7: Single convex racloir on a flake struck from a core-base

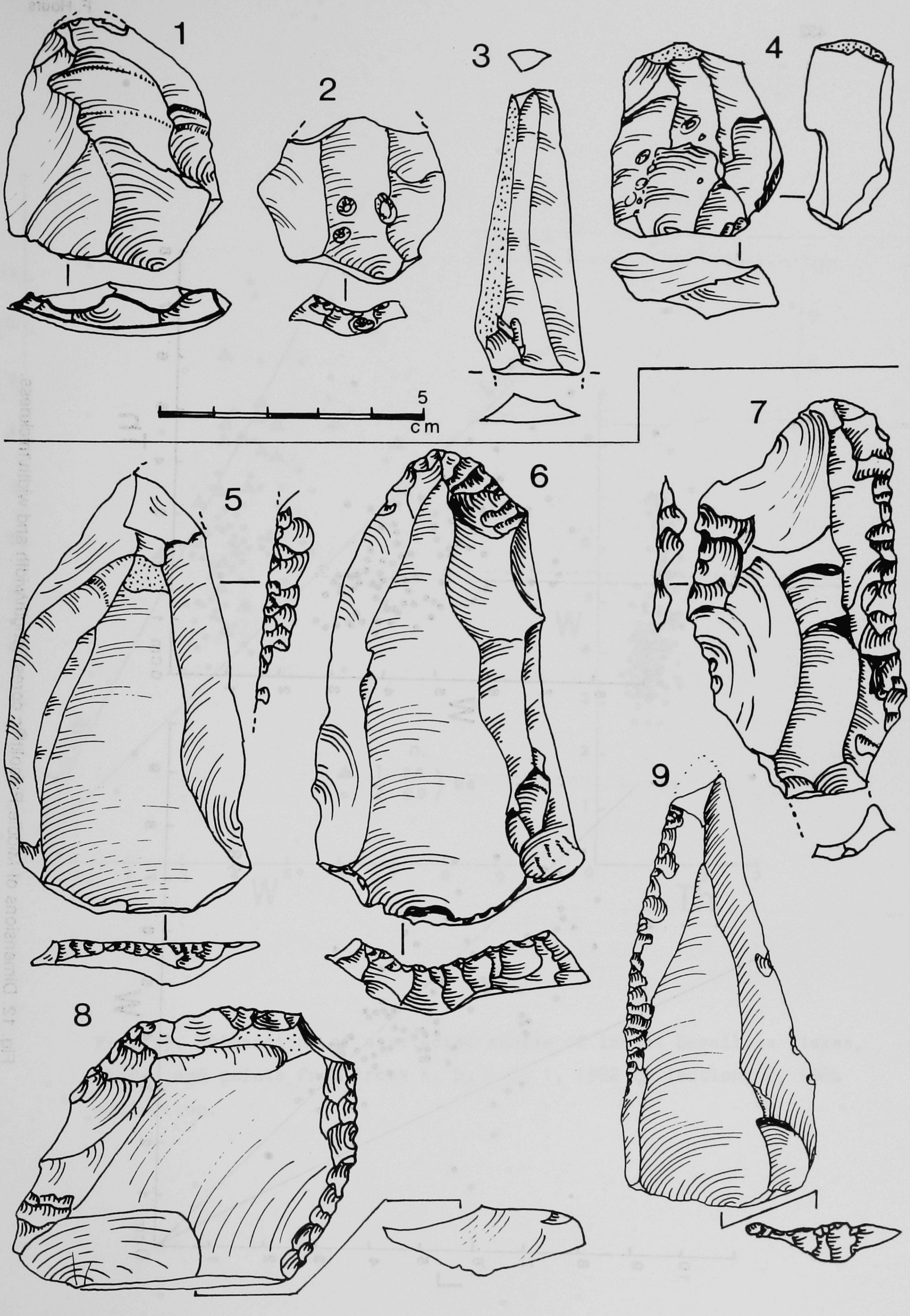


Fig. 11. Middle Paleolithic, 1 - 2 and 5 - 9; Post-Paleolithic, 3 & 4. 1 and 2: *In situ* Levallois flakes, Section II; 3 & 4: *In situ* artifacts from base of upper layer 2, Section II: a blade and a small blade/bladelet core; 5: Inverse racloir on a Levallois flake with plain butt; 6: End-scraper on a Levallois blank; 7: Single racloir on a core-edge flake blank; 8: Denticulate on a non-Levallois blank; 9: Single convex racloir on a Levallois (point?) blank.

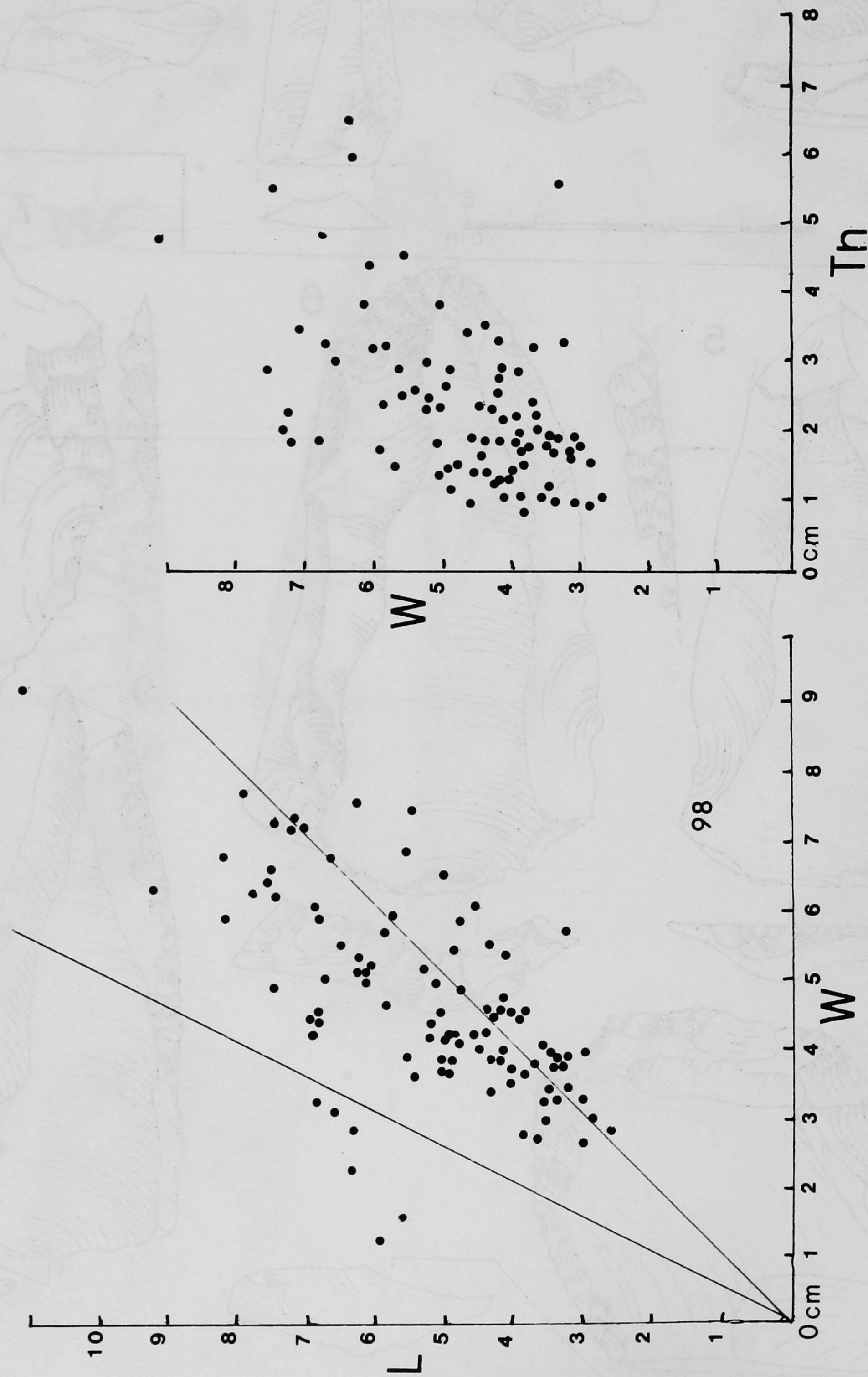


Fig. 12. Dimensions of Middle Paleolithic cores: length/width and width/thickness.

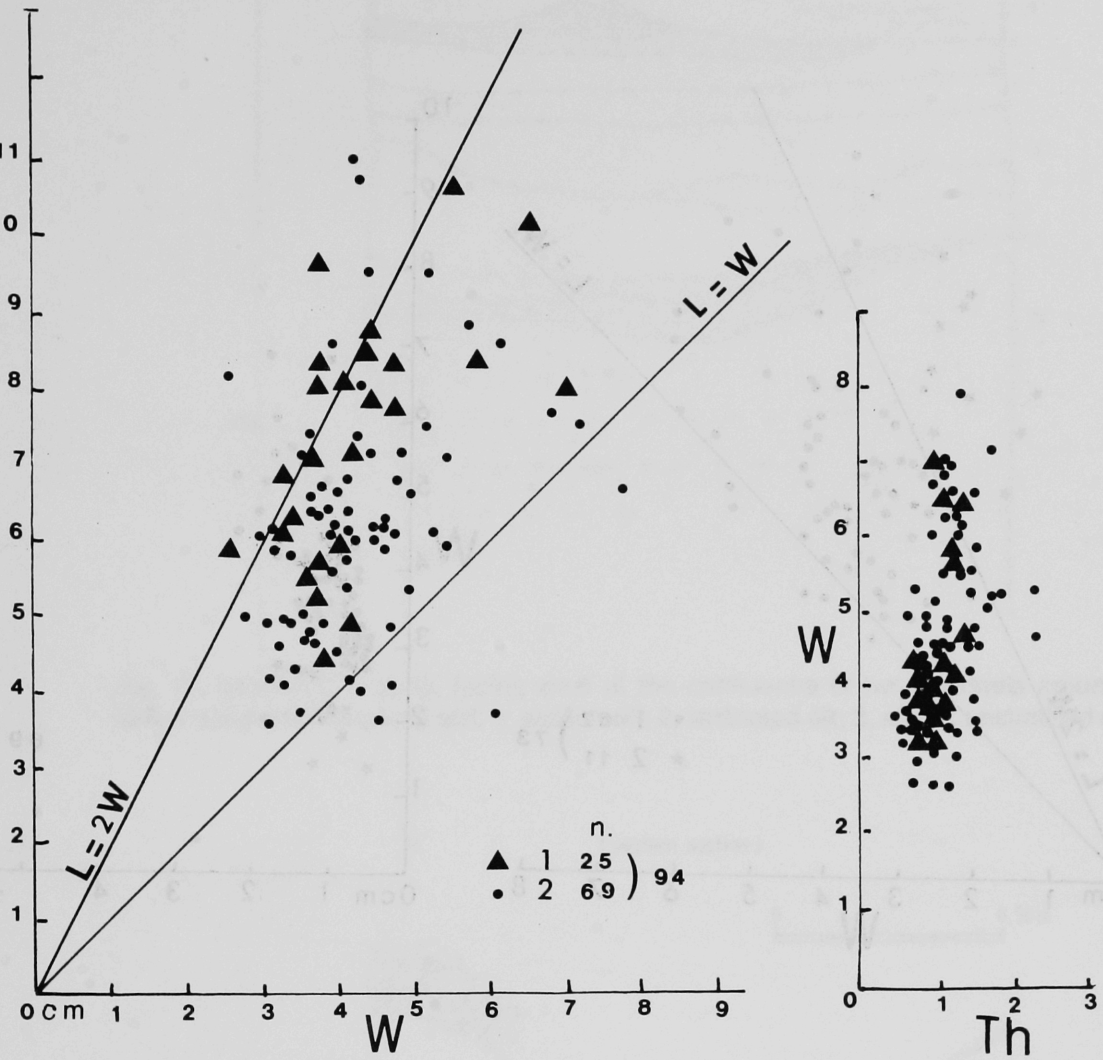


Fig. 13. Dimensions of a selected sample of intact Levallois flakes, blades and points from Areas A, B, & C; 1, 1982 collection; 2, 1984 collection.

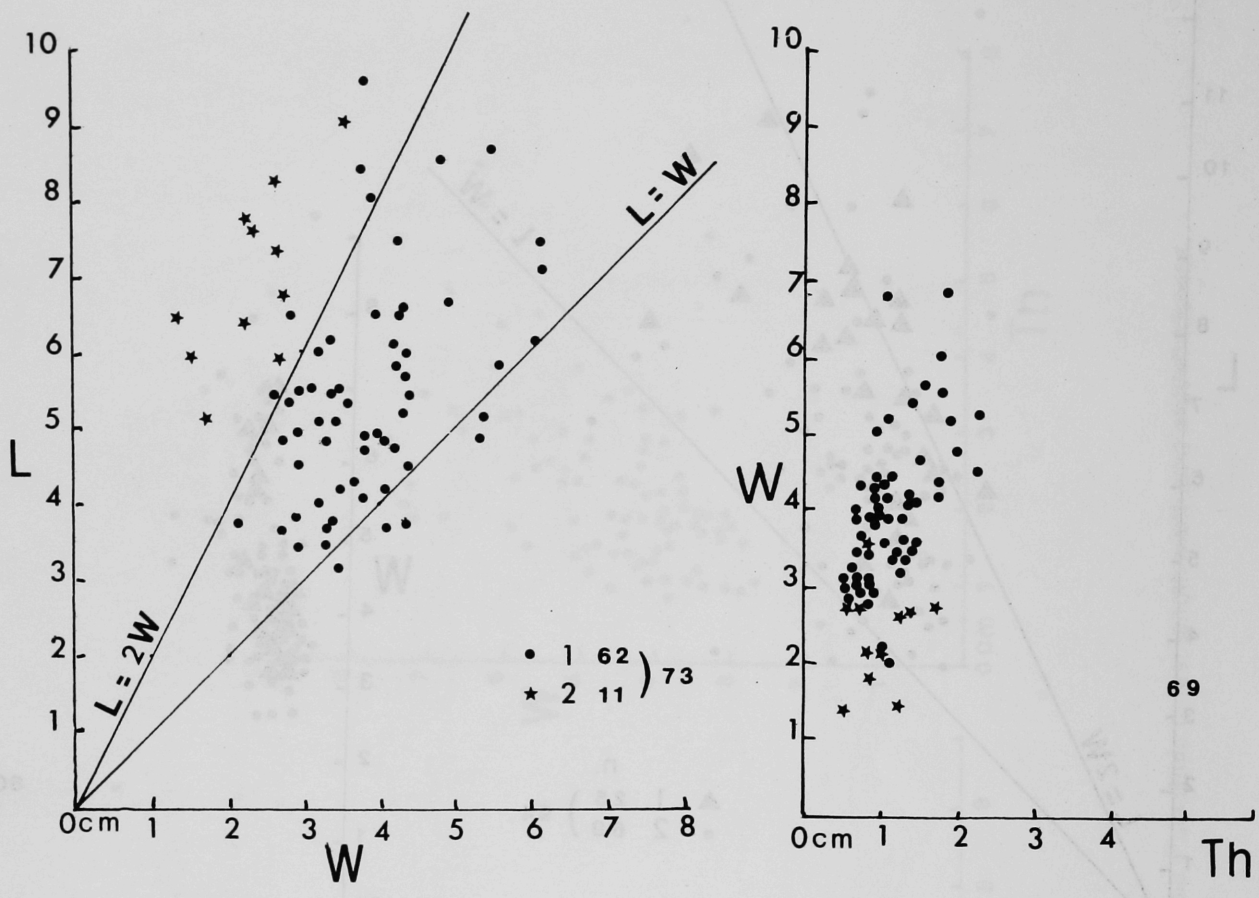


Fig. 14. Dimensions of non-Levallois flakes and blades; 1, non-cortex flakes; 2, part-cortex blades.

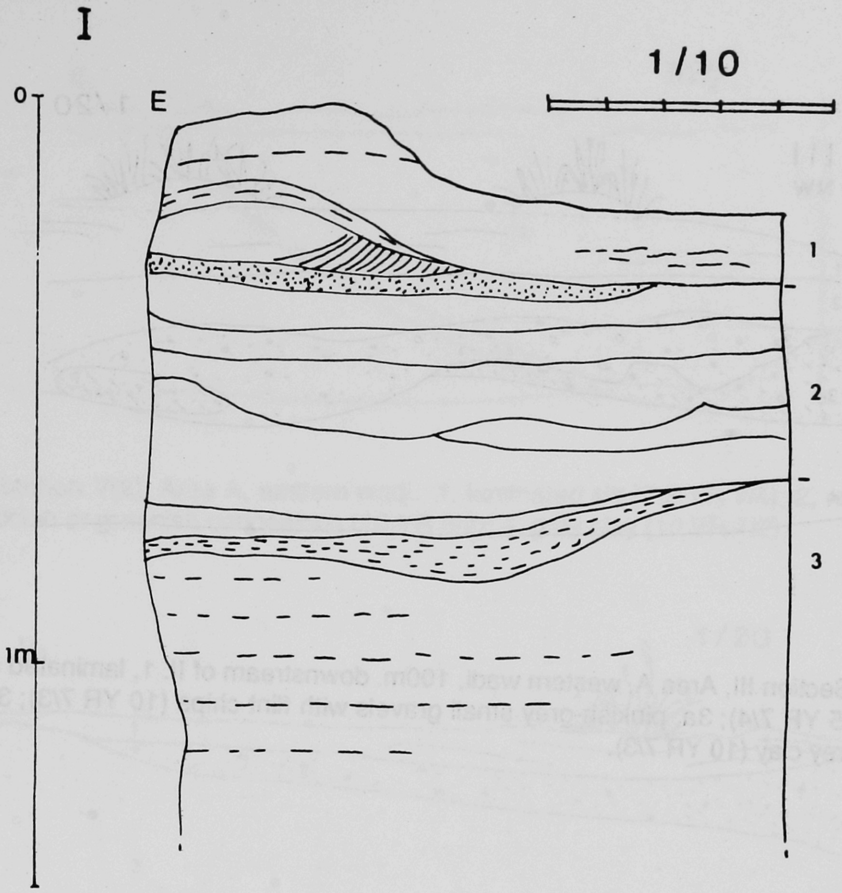


Fig. 15. Section I, Area B, facing west at the confluence of two channels around an island. Below a superficial layer of soil: 1, aeolian silt; 2, laminated silt; 3, sterile, unstratified clay.

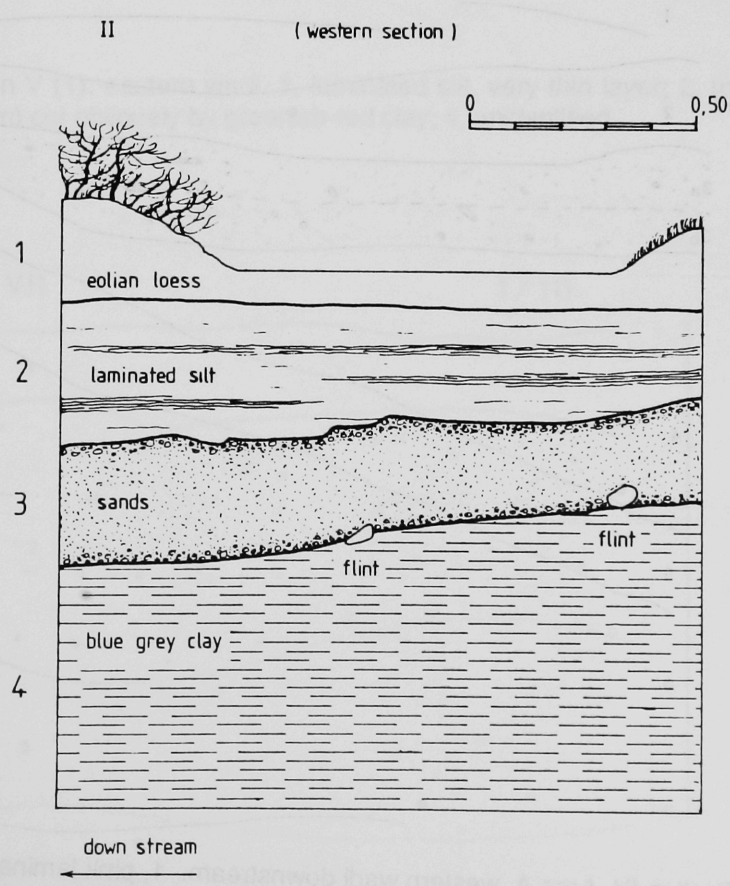


Fig. 16. Section II, Area A, 50m. south of I, eastern channel, facing west. 1, aeolian silt, loess (5 YR 7/4); 2, laminated silt (7.5 YR 7/4), two artifacts (blade and bladelet-core); 3, unstructured sandy clay (7.5 YR 8/4), two artifacts (Levallois flakes); 4, blue-grey clay (10 YR 6/3), Qlb?

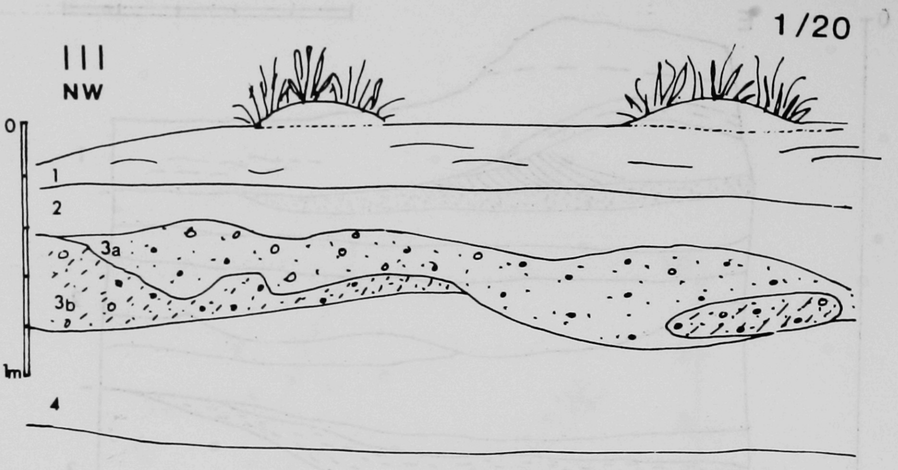


Fig. 17. Section III, Area A, western wadi, 100m. downstream of II. 1, laminated silt (7.5 YR 7/6); 2, silt (7.5 YR 7/4); 3a, pinkish-grey small gravels with flint chips (10 YR 7/3); 3b, same, 10 YR 8/3; 4, grey clay (10 YR 7/3).

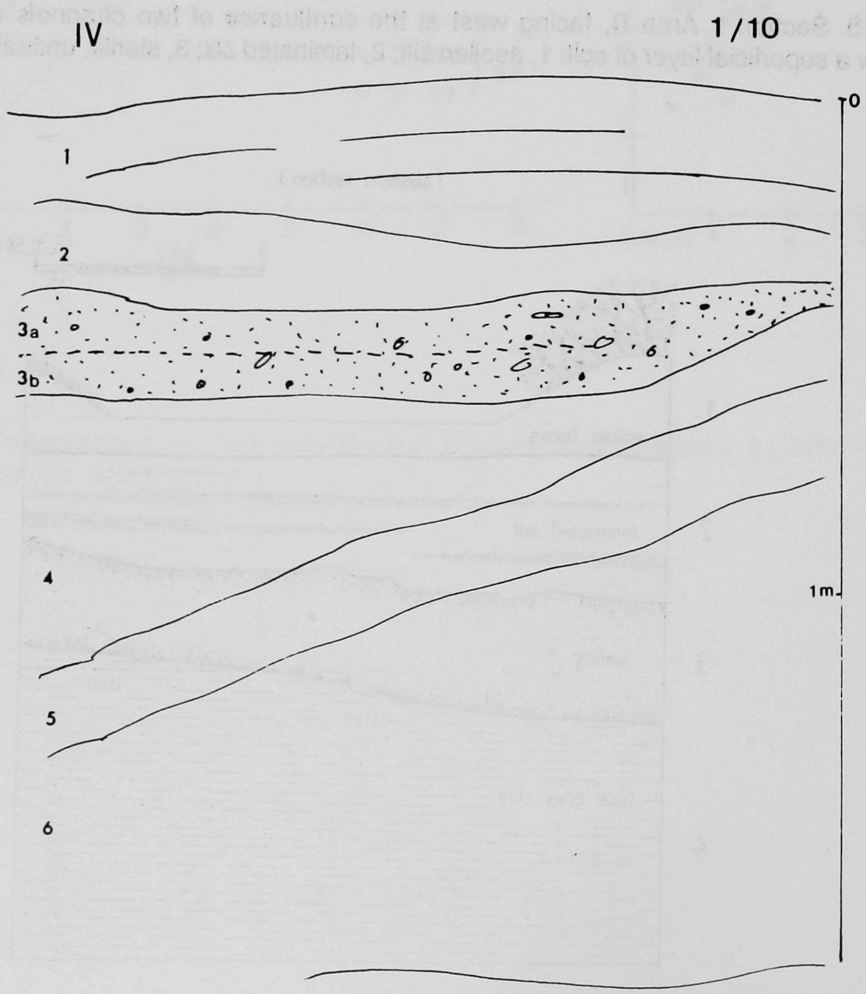


Fig. 18. Section IV, Area A, western wadi downstream. 1, pink laminated silt (5 YR 6/6); 2, pink clay (7.5 YR 6/4); 3a, sand with small gravels (7.5 YR 8/6), Qlb; 3b, same, = YR 7/2; 4, grey clay (10 YR 6/4); 5, whitish gravels (10 YR 8/1), crossing obliquely; 6, compact grey clay (10 YR 5/2). N.B. 4-6 may be the same member.

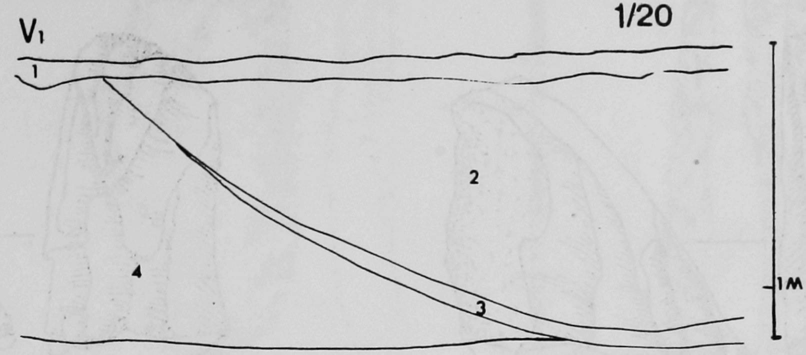


Fig. 19a. Section V(2), Area A, eastern wadi. 1. laminated silt (7.5 YR 7/4); 2, red clay (7.5 YR 6/4); 3, reddish or greenish concretions (10 YR 8/2); 4, grey clay (10 YR 7/2).

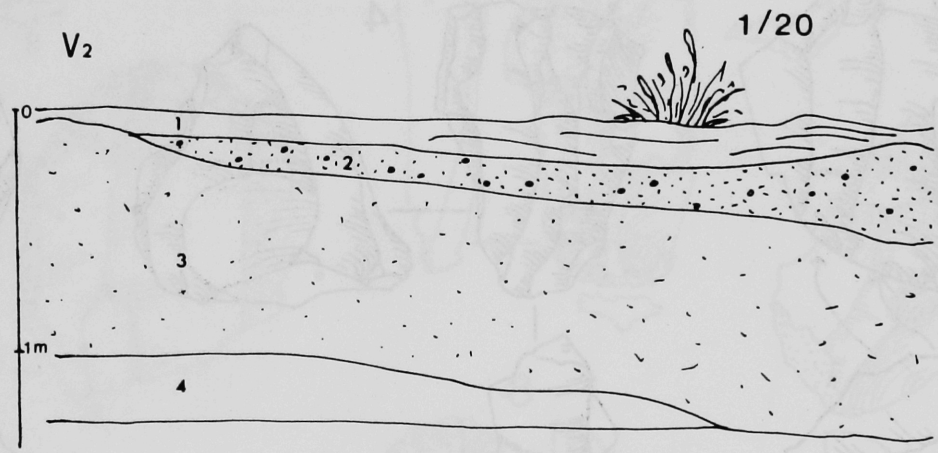


Fig. 19 b. Section V (1). eastern wadi. 1, laminated silt, very thin layer; 2, (downstream) grey clay; 3, (upstream) cut obliquely by greenish-red clay; 4, unidentified.

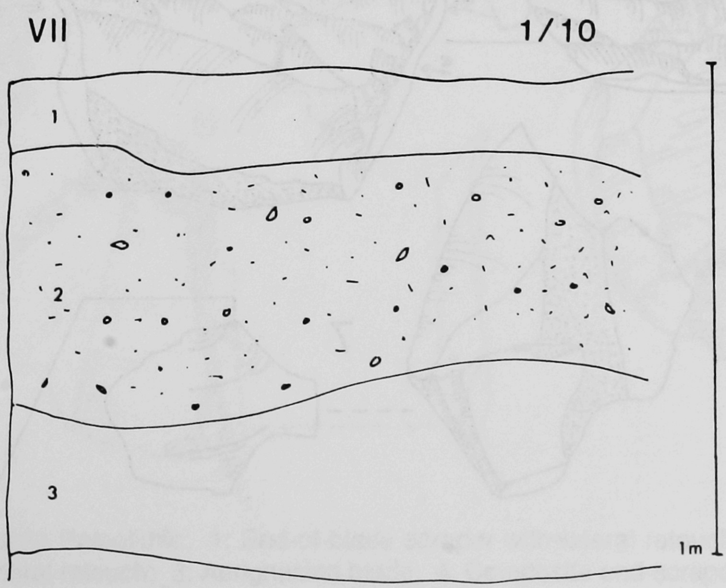


Fig. 20. Section VII. 1, undifferentiated clay (10 YR 6/4); 2, gravels (5 YR 7/4); 3, compact grey-green clay (5 YR 5/3).

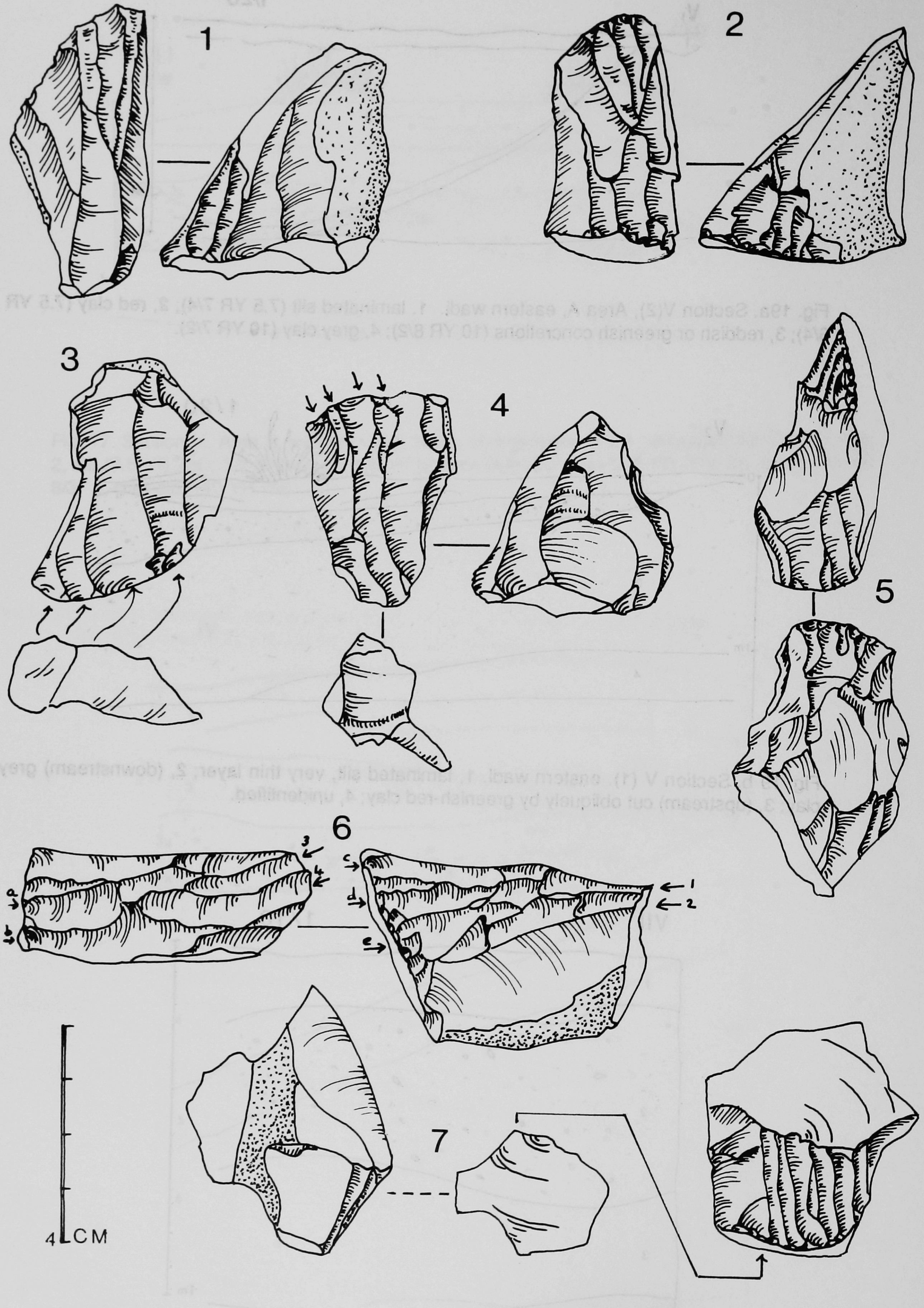


Fig. 21. Post-Middle Paleolithic: 1: Unipolar bladelet core; 2: Bipolar bladelet core; 3 & 4: 'Twisted-nose' bladelet cores; 5: Bladelet core with crossed axes; 6: Bipolar bladelet core, narrow, keeled type; 7: Core-tablet?

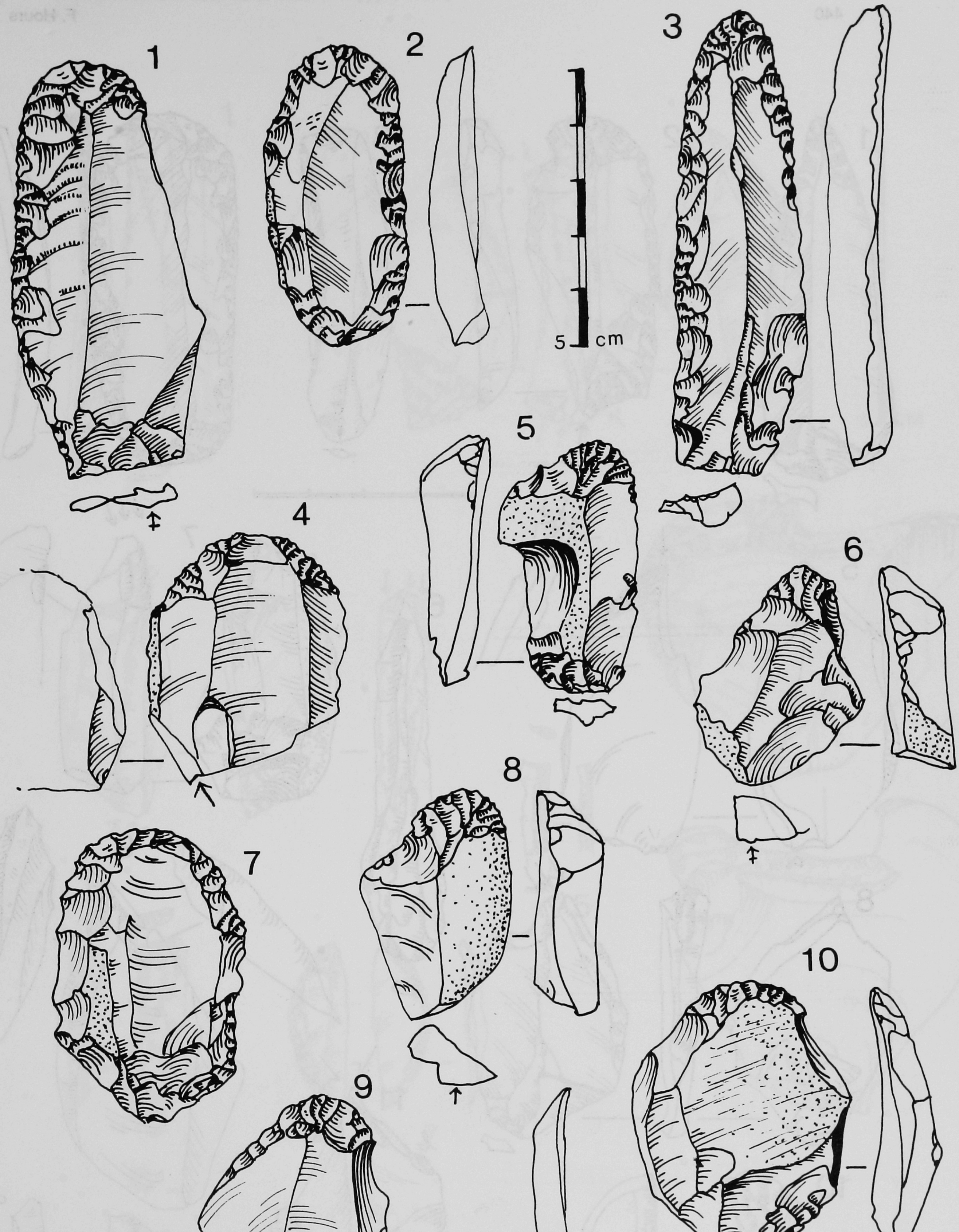


Fig. 22. Post-Middle Paleolithic: 1: End-of-blade scraper with lateral retouch; 2: End-of-blade scraper with bilateral retouch; 3: Aurignacian blade; 4: Composite end-scraper/dihedral burin; 5 and 6: Nosed scrapers; 7: Flake-scraper with lateral retouch; 8: Shouldered scraper; 9 & 10: Flake scrapers with limiting lateral notch.

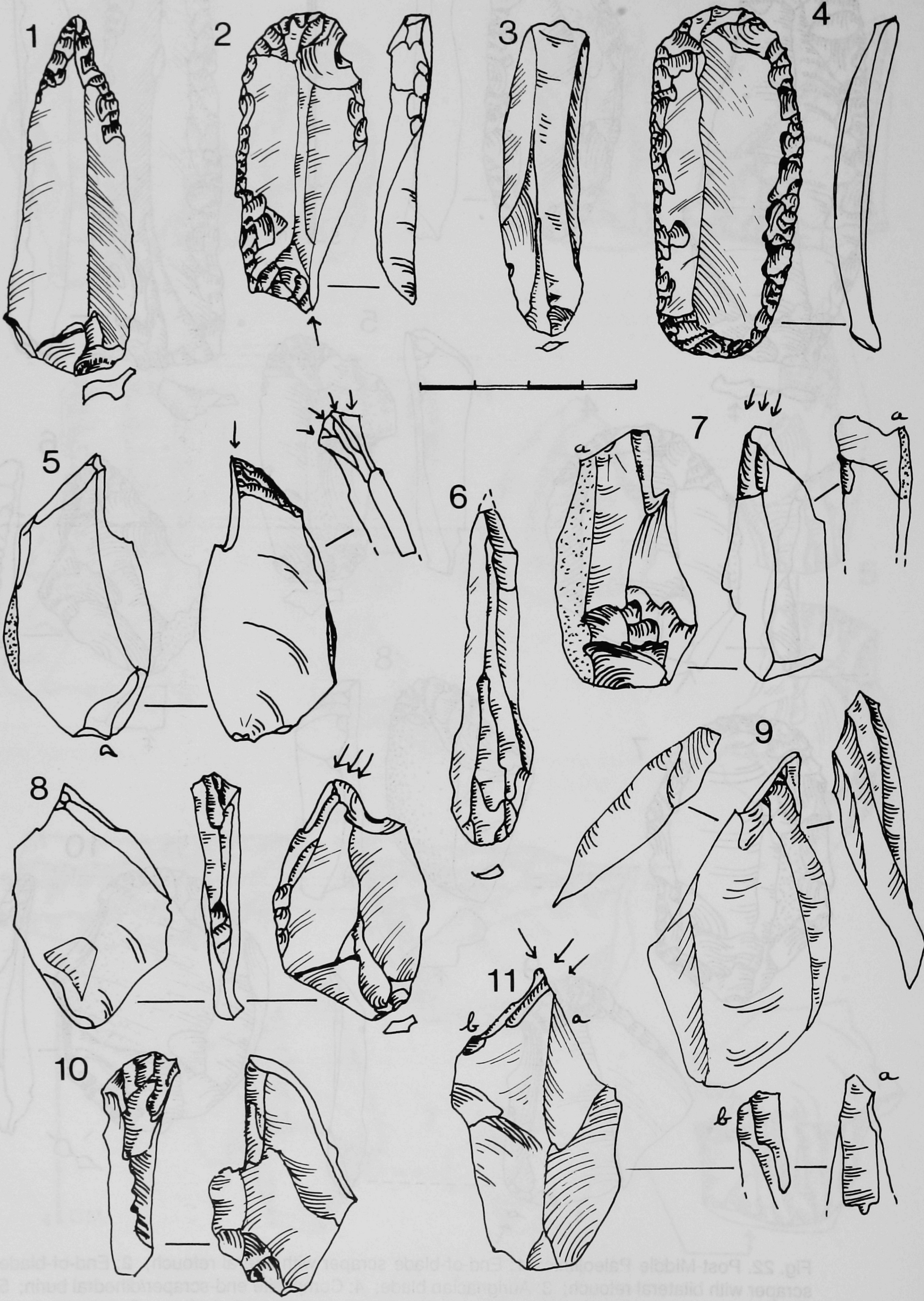


Fig. 23. Post-Middle Paleolithic: 1: Borer; 2: Composite end-scraper/burin on truncation; 3: Blade, Upper Paleolithic type with blunt tip; 4: Double end-scraper; 5 and 7: Polyhedric angle burins, oblique/straight (*busqué*); 6: Blade, Upper Paleolithic type, pointed tip; 8: Polyhedric burin on a 'Clactonian' notch with stop-notch; 9 and 10: Flat carinated burins; 11: Axial dihedral burin (*bec-de-flute*).

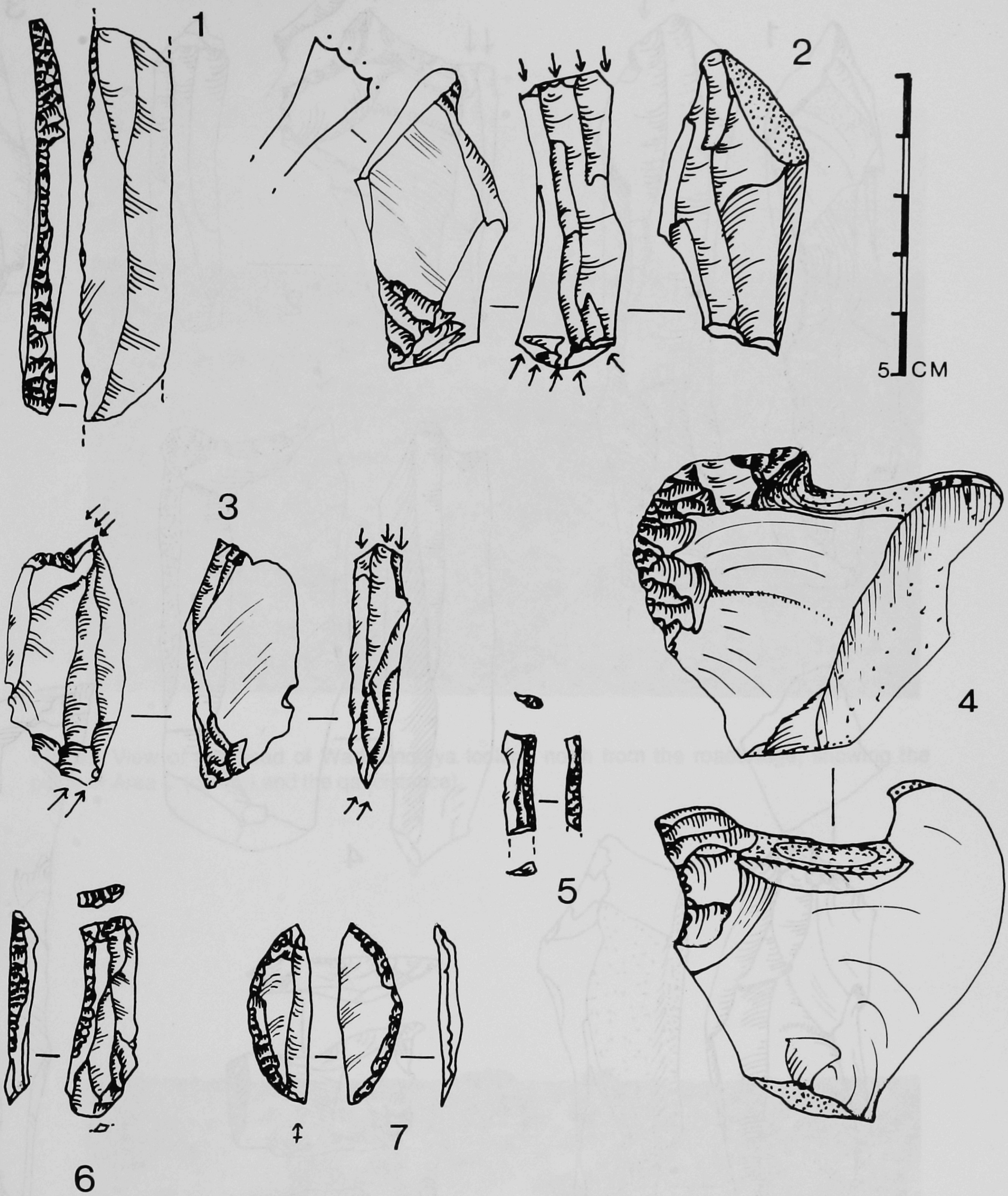


Fig. 24. Post-Middle Paleolithic: 1: Backed blade fragment.2. Bipolar bladelet core with crosses axes; 3: Narrow bipolar bladelet core or double burin? 4: Bladelet fragment with abrupt backing. 5: Composite scraper and *busqué* burin; 6: Backed and truncated bladelet; 7: Lunate with Helwan retouch.

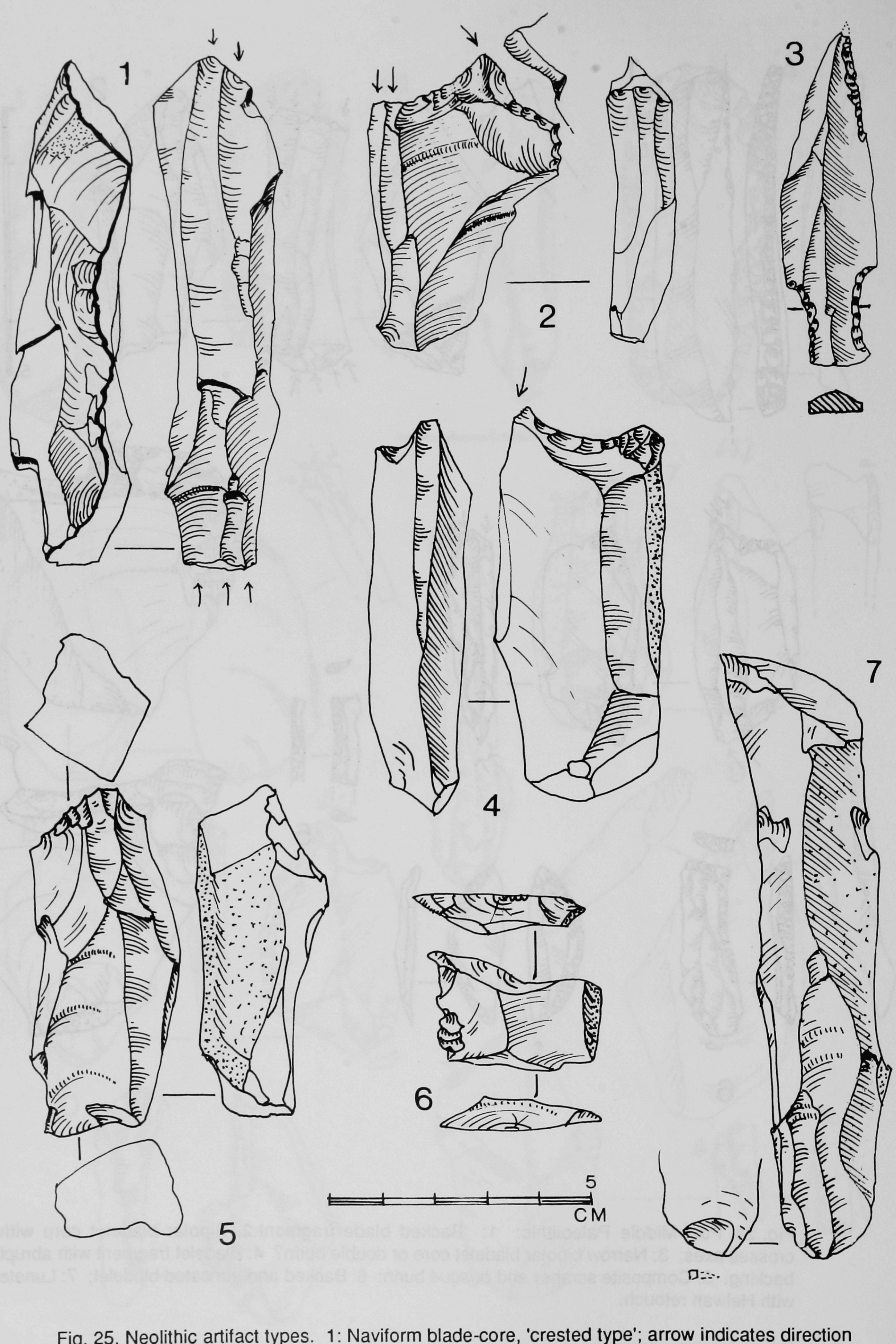


Fig. 25. Neolithic artifact types. 1: Naviform blade-core, 'crested type'; arrow indicates direction of removals; 2: Double truncation burin; 3: Tanged leaf-shaped arrowhead; 4: Kharana Burin'; 5: Naviform blade core with unprepared base, showing boat-shaped profile and 2 striking-platforms; 6: Blade segment with two truncations; 7: Blade with dorsal scar on butt, typical of PPNB debitage.

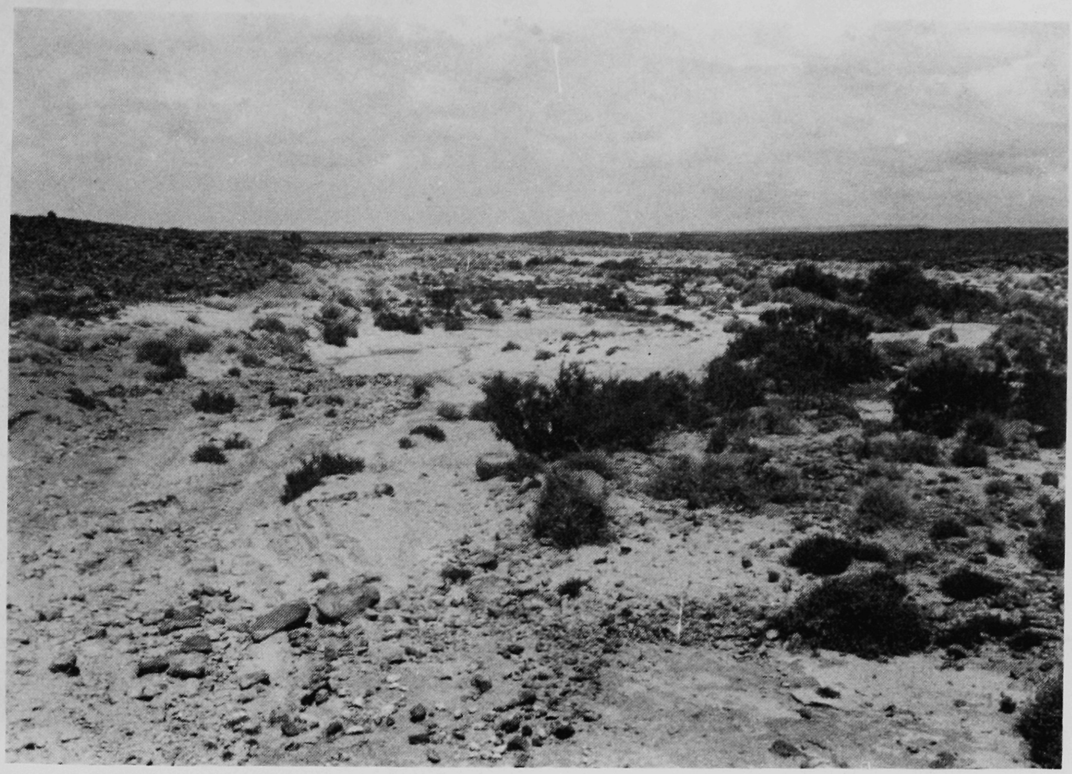


Fig. 26. View of the head of Wadi Enoqiya looking north from the roadbridge, showing the pools of Area C (centre) and the qa (distance).

Fig. 27. Wadi Enoqiya, Area A in the spring of 1985, view downstream showing results of winter erosion and redistribution of sediments.

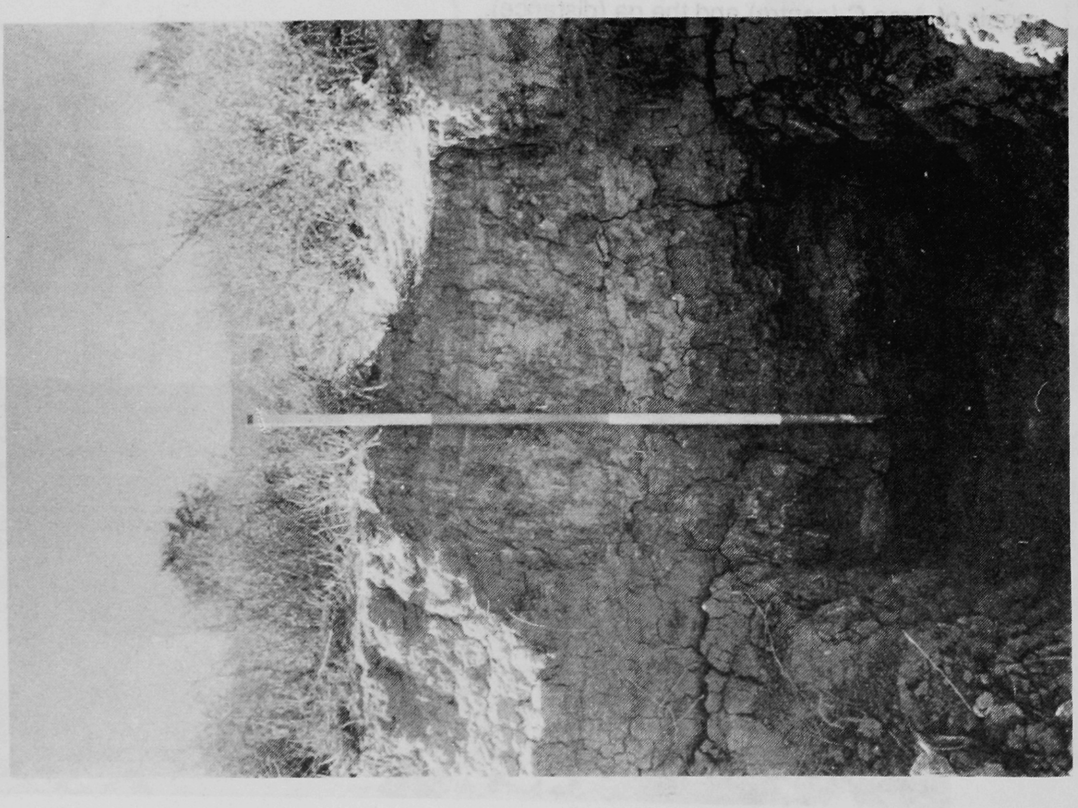


Fig. 28. Wadi Enoqiya, Area B, Section I, during excavation.

Fig. 29. Wadi Enoqiya, part of Section I after cleaning.

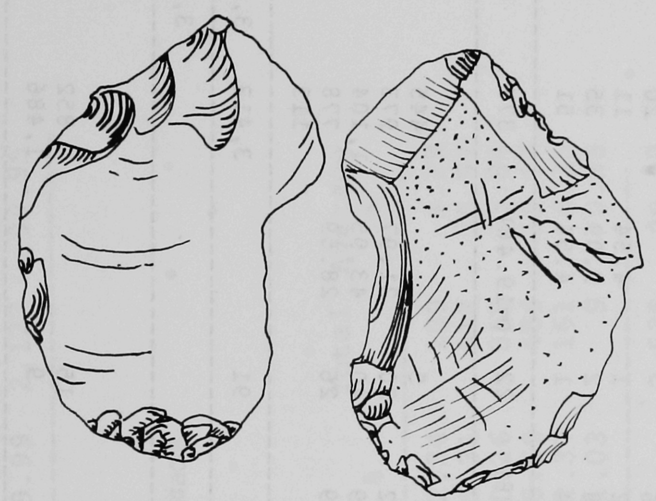


Fig. 30. Flint flake with incised marks in the cortex.

TECHNICAL INVENTORY:	AREA A N°	AREA A %	AREA B N°	AREA B %	AREA C N°	AREA C %	AREA D N°	AREA D %	Sub-total	Total	%
CORES:											
Exhausted disc	23	31.08	60	31.25	31	34.83	7	31.81	121		
Discoid Mousterian	15	20.27	28	14.58	9	10.11	4	18.18	56		
Flat	9	12.16	12	6.25	8	8.98	1	4.54	30		
Levallois for flakes	9	12.16	29	15.10	5	5.61	5	22.72	48		
Levallois for points	1	1.35	2	1.04	1	1.12	1	1.54	5		
Prismatic	6	8.10	7	3.64	7	7.86			20		
On a flake	1	1.35	8	4.16	1	1.12	1	4.54	11		
Amorphous	4	5.40	21	10.93	8	8.98	2	9.09	35		
Fragment	6	8.10	25	13.02	19	21.34	1	4.54	51		
TOTAL CORES	74	(=8.96)*	192	(=5.4)	89	(=13.28)	22	(=19.46)	377	377	
PRODUCTS:											
Primary preparation	9		300		48		5		445		13.03
Secondary preparation	266	35.41	523	26.28	164	28.22	20	21.97	973		28.50
Non-cortex flakes	204	27.16	591	29.69	269	46.29	40	43.95	1,104		32.34
Levallois flakes/blades	153	20.37	509	25.57	90	15.49	26	28.59	778		22.79
Other	36		67		10				113		3.31
TOTAL PRODUCTS	751		1,990		581		91		3,413	3,413	
TOTAL SAMPLE										3,790	
* = % of cores per area											
"WASTE"											
Trimming-flakes	551		74		212		15		852		
Debris and chips	233		1,107		137		9		1,486		
TOTAL "WASTE"	784		1,181		349		24		2,338	2,338	
SAMPLE PLUS "WASTE"										6,128	

Table 1.Technical inventory of the Middle Paleolithic of Wadi Enoqiya.

Condition category	AREA A N°	AREA A %	AREA B N°	AREA B %	AREA C N°	AREA C %	Total	Average %
Fresh	535	62.50	630	67.52	247	68.99	1,412	66.33
Weathered	272	31.70	284	30.43	98	27.37	634	29.93
Rolled/abraded	49	5,72	19	2.03	13	3.63	81	3.79
Total	856	99.92	933	99.98	358	99.99	2,127	99.95

Table 2.The condition of Wadi Enoqiya Middle Paleolithic artifacts.

Patina colour	AREA A N°	AREA A %	AREA B N°	AREA B %	AREA C N°	AREA C %	Total	Average %
Unpatinated	20	4.90	75	4.90	14	2.34	109	4.29
Light (yellow; brown)	83	20.34	558	36.49	271	45.31	912	35.97
Slightly whitish	151	37.00	526	34.40	181	30.26	858	33.84
White	125	30.63	309	20.20	52	8.69	486	19.17
Dark	28	6.86	59	3.85	74	12.37	161	6.35
Double patina	1	0.24	2	0.30	6	1.03	9	0.35
Totals	408		1,529		598		2,535	99.97

Table 3.The patinas on Wadi Enoqiyya Middle Paleolithic artifacts.

Butt category, flakes	AREA A %	AREA B %	AREA C %	Average %
Cortex	3.84	4.70	5.08	4.54
Plain	23.62	22.17	21.01	22.26
Faceted	33.79	35.56	36.94	35.43
Dihedral	10.43	10.35	7.79	9.52
Punctiform	1.92	0.80	2.03	1.58
Linear	2.19	4.07	7.79	4.68
Truncated-faceted	2.19	2.30	1.69	2.06
Removed	11.26	10.46	14.23	11.98
Indeterminate	10.71	9.51	3.75	7.79
	99.45	99.20	100.25	99.64
N° in sample	364	956	295	1,615

Table 4.Butt types on Wadi Enoqiyya Middle Paleolithic artifacts.

MIDDLE PALEOLITHIC TOOL TYPES	AREA A	AREA B	AREA C	AREA D	TOTAL	Average % Real	Average % Essential
Levallois flake	97	433	78	16	624	46.00	
Levallois Point: short	2	7	2	4	15	1.10	
elongated	5	13	3	1	22	1.62	
undiffer'td*	26	16		1	43	3.17	
Levallois blade	19	8	5	2	34	2.50	
Retouched Levallois Point	5	14	4	3	26	1.91	5.15
Mousterian Point	7	28	5		40	2.94	7.93
Soyons Point	1	1			2	0.14	0.39
Racloir, single straight	8	34	10		52	3.83	10.31
convex	29	48	16	9	102	7.52	20.23
concave	6	4	5	1	16	1.17	3.17
doulbe biconvex	3	9	3		15	1.10	2.97
straight &/or strt/convex	2	12	2		16	1.17	3.17
transverse	2	3	2		7	0.51	1.38
convergent	4	5	1		10	0.73	1.98
offset	2		2		4	0.29	0.79
inverse		1	1		2	0.14	0.39
other/divers		2		1	3	0.22	0.59
fragment		2	1		3	0.22	0.59
Notch	4	23	2	2	31	2.28	6.15
Denticulate	13	40	5	4	62	4.57	12.30
End-scraper	2	3	4		9	0.66	1.78
Burin		4			4	0.29	0.79
Borer		7			7	0.14	1.38
Splintered piece	1	15	1	5	22	1.62	4.36
Backed knife		10			10	0.73	1.98
Truncation/truncated-faceted	5	27	5	2	39	2.87	7.73
Continuous retouch, direct	26	59	12	6	103	7.59	
inverse	1	7	2		10	0.73	
Tayac Point	1				1	0.07	0.19
Divers & composites	6	13	1	2	22	1.62	4.36
REAL TOOL TOTAL	277	848	172	59	1,356	99.45	
ESSENTIAL TOOL TOTAL	101	304	70	29	504		100.1

* = undifferentiated

Table 5.Inventory of Middle Paleolithic tool-types, Wadi Enoqiyya.
* = undifferentiated.

POST-MIDDLE PALEOLITHIC TECHNOLOGICAL INVENTORY	All Areas, 1982	Area A	Area B	Area C	Area D-F	Totals
<u>Debitage</u>						
Cores; Blade	1		15	2		18
Bladelet	5	6	50	6		67
Polyhedric, flake	1	3	19	2		25
Other	4*	6	7	6	2	25
Flakes; Non-cortex	6	15	49	19		89
Primary/secondary	5	45	138	8	1	197
Blades; Regular	34	69	214	50	9	376
Irregular, crested	29	27	8	7	7	78
Primary/secondary	19	21	90	7	1	138
Bladelets	14	27	42	26	7	116
Fragments	8	30	47	9		94
Debris & various by-products	17	5	63	21**		106
TOTAL DEBITAGE	143	254	742	163	27	1,329
	*: naviform			**: 4 tablets		
<u>Tools</u>						
End-of-blade scraper	4	7	40	9	4	64
Flake-scraper	2	10	21	7		40
Double end-scraper	1		2	1		4
Side scraper			4			4
Nosed scraper	1	2	3			6
Carinated/core-scraper			8			8
Burin on truncation/notch	4	2	17	1	2	26
Rightangle dihedral burin	2	2	17	6	1	28
Oblique/axial " "	2		21			23
Nucleiform burin	3		9			12
Carinated/flat carin. burin	1	3	16			20
Beaked burin (busquée)	2	1	8	2	1	14
Double burin			7			7
Borer/bec		2	11	1		14
Composite	1		7	4		12
Aurignacian/backed blade			5		1*	6
Truncated piece			9			9
Notch		1	9			10
Denticulate		2	2			4
Backed bladelet	1	1	3	3	1	9
Truncated bladelet			2	3		5
Geometric (Lunate)		1				1
Various retouch, divers	3	10	23	13	5	54
Divers	1**		5	2		8
Arrowhead	1		1			2
Sickle element		1	1			2
TOTALS TOOLS	29	45	251	52	15	392
	**: rabot			*: backed		

Table 6.Inventory of post-Paleolithic artifacts, Wadi Enoqiyya.

The Hammer on the Rock
L. Copeland & F. Hours
B.A.R. Intern. Series

SURFACE FINDS FROM NORTHERN AND SOUTHEASTERN SITES

Lorraine Copeland

In 1986 a C.N.R.S. team carried out a geomorphological and prehistoric survey in parts of the Azraq drainage basin which had not been visited in previous seasons (Note 1). Some locales proved particularly interesting from an archaeological viewpoint: the Ain el-Beidha area (marked on the 1:50,000 map as Al-Bayda) to the north-east (Fig. 1), the Wadi Rajil embouchure to the east and the south-eastern sector of the depression (Fig. 7) where Qa Omari forms an independent drainage system as described by Besançon *et al., infra*. The sites were briefly mentioned in a recent overview (Copeland and Hours, l988) and at the Lyons conference of l988 (Copeland, in press). This report will give the archaeological details to complement the geomorphologists' conclusions. As the illustrations show, time in the field ran out before some of the drawings could be completed.

THE AL-BAYDA AREA

The name may be the same as that of one of the sites, better known as Ain el-Beidha (the white spring); the appelation may refer to the local white Cenozoic chalky marl bedrock underlying the basalt and seen to the east. The marl and the basalt have been worn by erosion in two successive stages into a pediment or glacis sloping from 520m. to 510m. asl. Immediately to the north the area is covered by the basalts on which some 'kites' and corrals are present, while to the north-east, around a Roman fort (Qasr Ain el-Beidha; Kennedy, 1982) the basalts are lower and more patchy. Between the basalt and the sabkha a strip of terrain is now being invaded by modern aeolian dunes; these are in process of burying older generations of fixed Pleistocene dunes (Besançon *et al., infra*). A series of springs emerges here, some of which have produced the prehistoric sites which will be described below. On the fringe of the sabkha to the south, a large Epi-Paleolithic site (AZ. 32, not studied by us) was located in 1985 by A.Garrard and F. Hours; its stratigraphy has been described by Garrard and Hunt, this volume. Further to the south lies the sabkha, Qa al-Azraq with its salt pans, worked by the villagers of Azraq Druze.

Site 137, Ain el-Beidha (3529.7 x 300.5 ; 509m)

The site is on a knoll containing a spring which has given rise to a small oasis - a clump of palms and some tamarisks on the edge of the sabkha, 6 km east of Azraq Druze (Fig. 10). As Kennedy (1982) notes, it may be the pleasant spring where Gertrude Bell rested (Note 2), but water is barely flowing today, probably because of agricultural pumping in the vicinity. There are several pits, apparently dug without success to find the water table.

Paleolithic artifacts were found by D. Kirkbride on the knoll surfaces during a visit to this spring in 1956 (Kirkbride, *infra*). She collected a pointed ovate handaxe in a chestnut brown patina which seems characteristic of the area. We visited the site in l984 (our site AZ.137) in company with A. Garrard, when a surface collection of c. 50 artifacts was made from the surface to the east and south of the palm clump (left background, Fig. 10). The artifacts from the spring may be sorted typologically into the following three groups:

Lower Paleolithic

- Four bifaces and a biface fragment; two are elongated ovates or limandes (Fig. 2, 2), one is a broken bifacial cleaver (Fig.2, 1) and the fourth a partial ovate. All have chestnut brown patina and are (or were) quite large (c. 12 - 15 cm. long. Two (Fig. 2, 1 and Fig. 11) have been severely thermally-fractured by 'curved splitting' (see below), rather than by the more usual 'pot-lid' fractures.
- Another possibly Lower Paleolithic piece may be a refreshment-flake from a large racloir, or a 'backed knife' (Fig.2, 4).
- a bifacial single straight racloir.

Middle Paleolithic

The patina (white or beige) and condition (fresh with pot-lids e.g. Fig. 4, 4) of 12 pieces was different and artifacts consisted of:
- Three Levallois and exhausted discoid cores.
- Three flakes (Fig. 2, 3).
- Three racloirs, one with a demi-Qina edge, another transverse.

Post-Middle Paleolithic

- 20 blades of 'Upper Paleolithic' type and some flakes, including 3 end-scrapers, an angle burin and a borer.
- 21 Epi-Paleolithic and/or Neolithic types consisting of bladelet cores, a tablet, a naviform core and a backed bladelet.

The origin of thermal fracturing of flint objects has been discussed in the literature (e.g. by Sieveking & Clayton, 1986); it is not clear why 'curved splitting' should be present here and not at the other spring sites where there is just as much moisture (Note 3).

Although the bifaces clearly refer to the Late Acheulean *sensu lato*, they are larger on average, and in a different patina, when compared to those of C-Spring and Lion Spring near Sheshan, 12.5 km. distant. An intriguing question is raised: does this material refer more to the DWA than to the other Acheulean spring sites? With such a small sample it is impossible to answer one way or the other. The later material is similar to that known from other spring sites (Garrard *et al.*, 1988).

Site 210A, Al-Bayda South (3529.8 x 300 ; 515m)

1 km west of Ain el-Beidha, also between the basalt and the sabkha, south of the track to Azraq Druze, is another site, marked by a line of 4 casuarina trees, other vegetation and a well shaft lined with basalt boulders, presumably enclosing the eye of an erstwhile but now dried up spring. Some of the boulders forming the sides of the shaft were made of travertine. No water was visible. It is almost buried by dunes and the surface is disturbed by attempts to find the water table. Artifacts are widely strewn across the southern and western foot of the dune; they are mainly of Middle Paleolithic typology but also include some Lower Paleolithic pieces. They are thought to derive in some fashion from the older, buried dunes of Pleistocene age. The earlier dune is ascribed to episode 1 in the Penultimate Pluvial complex, while the later one of these early dunes is assigned to episode 5, a very arid phase of erosion in the basin, preceeding a wetter, then a vey wet phase (episodes 6 and 7 of Besançon *et al.*). The material collected can be sorted into the following two typological groups:

Lower Paleolithic,

- Nine bifaces, 3 without tips (Fig. 3, 2), 2 being pointed tip fragments. One limande is of 'museum quality' (Fig. 3, 1) and there are also 2 lanceolates, 2 amygdaloids (Fig. 3, 4), a bifacial cleaver and an ebauche or incomplete core. Four are (or were) large (12 - 16 cm. long), two smaller (8 and 10 cm. long). Their patina is honey beige, chocolate or greyish, and four have pot-lids or other fractures.

Middle Paleolithic:

- 36 retouched tools consisting of Mousterian points or racloirs; at least 9 of the 28 racloirs have a Yabrudian ambience in being bifacial (Fig. 4, 5), offset (Fig. 4, 1, 2 & 4) or transverse (no. 3) on non-Levallois Qina or demi-Qina flakes; the other racloirs are more typically Levantine Mousterian, e.g. single convex (8 specimens) or double straight/convex or biconvex (7 specimens).

- 74 unretouched flakes and blades; 25 are Levallois (4 points; Fig. 3, 3), 4 blades and 49 non-Levallois flakes, blades and preparation elements. Although no cores appeared in this collection, the debitage showed that Levallois unipolar, bipolar and radial preparation methods had been used; 40% of the butts were faceted.

The Lower Paleolithic seems similar to that at Ain el-Beidha, but the Middle Paleolithic has links with both Wadi Enoqiyya in the Levantine Mousterian element, and with Lion Spring (Harding collection) and C-Spring (Kirkbride collection of 1956) in the racloirs of Yabrudian ambience (for comparison, see illustrations in Copeland, *infra*, d). At the latter sites the flake-tools are provisionally regarded as belonging to the evolved 'Late Acheulean of Azraq Facies', however.

Site 210 B, Al-Bayda North (3529.9 x 299.7 ; 515m)

At the western end of the same dune as at Site 210 A is another spring in a similar location, but nearer the basalt bluff. This site was marked by ruined huts on the dune crests, a casuarina and tamarisks. A sample of 138 artifacts was collected from the surface of a silty dune sloping towards the sabkha. This time the spread consisted mainly of Upper Paleolithic tool-types and bladelets with a trace of Middle Paleolithic. The patina was light brown. Two groups can be distinguished:

Middle Paleolithic

A classic Levallois tortoise-core, an exhausted disc, 2 racloir fragments and 3 Levallois flakes represent the Mousterian.

Upper Paleolithic or later

The material recovered in 1986 is illustrated on Fig. 5 and consists of:
- 15 end-scrapers (12 on blades) some quite large and often on part-cortex blades or on flakes; one is double (Fig. 5, 4).
- 9 angle-burins: 3 bec-de-flute (Fig. 5, 7), 2 carinated (nos. 6 & 8) and 4 polyhedric on chunks.
- 4 retouched blades and 2 retouched bladelets.
- a large rabot, steeply retouched around a heavy chert flake (very fresh).
- 50 small unretouched bladelets and blades, 40 core-preparation blades, crested blades etc., and 6 flakes.
- 5 blade/bladelet cores (Fig. 5, 9), 2 with 'twisted nose' of Aurignacian ambience.

Given that the microlithic element may be under-represented in the collection, made in soft sediments, it is difficult to say whether the assemblage refers to the Upper Paleolithic, Epi-Paleolithic or even a Neolithic culture, or to all three; Garrard's work elsewhere in the basin has shown that similar tool-types occur in all these phases. Similar material also occurs in Wadi Enoqiyya, where some elements are thought to be Late Aurignacian (Hours, *infra*).

Site 209, Al-Bayda Dune (3530.0 x 299.4 ; 515m)

This site seems to be without a spring unless one has been already buried by the dunes. It occurs half a kilometer west of Site 210 B. At the base of the dune artifacts and some bones are spread over the silty sediments; 25 flints were collected by the geomorphologists:

Paleolithic

An excellent limande biface (Fig. 6, 1) and a broken amygdaloid (Fig. 6, 3) and a pointed tip (Fig. 6, 2) represent the Acheulean, while 4 flakes and 2 racloir fragments may be Middle Paleolithic.

Post-Middle Paleolithic

- Seven retouched tools: 4 end-scrapers (one double), a double truncation burin (Fig. 6, 5), a retouched blade segment and a notch.
- fifteen unretouched debitage blades, bladelets and core-refreshment elements as well as a bipolar blade core.
- a fragment of a bifacially retouched arrowhead (Fig.6 , 4); this represents the Neolithic, probably the P.P.N.B., such as is known at nearby sites, e.g. Garrard's AZ 31.

With the exception of the arrowhead, the Post-Middle Paleolithic artifacts cannot be clearly dated to a particular phase.

The finds from the four Al-Bayda sites suggest that the northern springs could have been inhabited from the Acheulean to the Neolithic. The former gives the impression of being a little different from the Late Acheulean of Azraq Facies at the Sheshan spring sites (see Copeland, *infra* d) but the samples are small. The Middle Paleolithic has clear links with Wadi Enoqiyya, as does the 'Upper Paleolithic' element (Hours, *infra*), which could refer either to the Aurignacian or the various later facies (Kebaran; Natufian) known from elsewhere in the basin (Garrard *et al.*, 1988). Similarly the Neolithic could refer to either the P.P.N.B. or to the 'burin Neolithic' of slightly later date (Note 4). cf. the kites and corrals present on the adjacent basalts.

THE WADI RAJIL AREA

The Rajil is a large and important eastern tributary of Qa al-Azraq. Its delta and the floor of a proto-sabkha on the adjacent Wadi Dughaylat al-Harbi are now extensively cultivated with the aid of pumped water, showing that the soils are fertile.

Site 231, Wadi Dughaylat al-Harbi (3505.4-6 x 319.7 ; 521m)

About 11 km. south-east of Ain el-Beidha, on the eastern fringe of the Qa al-Azraq sabkha, beside a new track to the Wadi Rajil, some gravel quarries occur between the Rajil and Dughaylat al-Harbi embouchures.

Only 2 man-made artifacts were found, a very rolled flake, perhaps Levallois, with a plain butt, and a partial biface/chopper or core; the latter may represent derived Lower Paleolithic.

Site 251, Wadi Rajil terrace (3516.3 x 308.8 ; 530m)

On the surface of the Würm (Qf2) terrace described by Besançon *et al.*, c. 16 km. south-east of Ain el-Beidha, and upstream from the Rajil delta proper, four artifacts were found where the same track as at Site 231 crosses the W. Rajil.

Two are very rolled flakes, one with faceted and the other with indeterminate butts, a heavy blade with cortex butt of DWA appearance, and a battered biface or core. They, too, may represent a derived Lower Paleolithic.

The interesting possibility - that the Lower Paleolithic continues into the eastern Jordanian region - cannot for the moment be confirmed.

THE QA AL-OMARI AREA

During their investigations of the southern rim of the Azraq depression, the geomorphologists found 3 artifact-bearing sites in the Qa Jashsha area, south of the Old Police Post on the track to Faidat al-Dihikiya. Qa Jashsha is a small basin or alveole, its floor perched at 526m. altitude, hollowed out of the course of a wadi flowing north into the Qa al-Omari, the independent sabkha south-east of Qa al-Azraq (Besançon *et al.*, *infra*). Although without vegetation, and without trace of flint *reg* or *hamada*, this locale is watered by wells; a travertine sheet c. 1m thick overlies the limestone bedrock and can be penetrated. The water table in a well, Bir el-Mshamnet, stood at c. 2m. below the surface when seen in use for watering flocks in l986 (the 1: 50,000 map marks this water as 'undrinkable'). Xerophytic vegetation, however, is quite abundant further downstream in Qa al-Omari (which can hardly be called a sabkha) and other wadi beds. Water-worn pebbles in the shallow beds of these wadis flowing into the qa indicate that there is (or was in the past) sometimes sufficient rainfall to roll them and to form fluviatile terraces.

Site 237, Qa Jashsha North (3501 .9 x 336.2 ; 528m)

About 2.25 km south-west of the Old Police Post, on a low hilltop of marly limestones and the worn remains of travertine sheets, are several ruined megalithic structures, mainly rectangular, made from travertine slabs. This site was examined in the hope that the travertine slabs so exploited might refer to a Neolithic culture such as is known at Wadi Jilat 7 and 26 of Garrard *et al.* (in press).

No flints were observed and the sherds present seemed to be Roman - Islamic (p.c. S. Hart, 1986). The 1: 50,000 map places several Islamic cemeteries in this locale, which is on a direct route from Azraq to Wadi Sirhan (hence the position of the Old Police Post).

Site 238 A and B, Qa Jashsha (3501.7 x 336.0 ; 527m)

About 400m south of Site 237 beside the central one of three outlet wadi courses flowing from Qa Jashsha north towards the Old Police Post, a 'structural butte' or *ghara* produced two different artifact assemblages:

Site 328A

On the surface of the south-western slopes 97 apparently Epi-Paleolithic artifacts of flint and some chalcedony, with whitish beige patinas, were collected. They are classified as follows:
- 6 end-scrapers, one large (Fig. 8, 5), one double and one a composite with a dihedral burin (Fig. 8, 4).
- 4 retouched bladelets: one is a La Mouillah Point (Fig. 8, 1) and 3 are abruptly backed (nos. 2 & 3).
- one carinated burin on a chunk.
- one chopper on a pebble.
- a 'tile-knife' fragment (Fig. 8, 7).
- 6 cores: 3 unipolar for bladelets (Fig. 8, 6 & 8), one pyramidal and 2 bipolar for blades (Fig. 8, 9).
- one small disc.
- 5 core-tablets or crested blades.
- 17 large and wide blades and blade fragments.
- 22 smaller 'Upper Paleolithic' type blades.
- 21 flakes and fragments.
- 12 bladelets and fragments.

There are clear links between this assemblage and the assemblages at Garrard's sites in the western drainages; La Mouillah Points are known at Jilat 6 and Uweinid 14 and 18, for example, which is assigned to the 'Early Epi-Paleolithic', and C.14-dated to between 20,000 and 15,000 years B.P. (Byrd, in press).

However, Qa Jashsha 238A is the most easterly occurrance of this kind so far known.

Site 238B

On the flat summit of the butte, an assemblage occurred consisting of short, thick flakes and blades struck from cortex-covered small, rounded, darkly-patinated wadi pabbles. Similar pebbles were seen along the adjacent low wadi terrace. A total of 64 pieces were kept, none of which were retouched, with the exception of a possible steep-scraper (Fig. 9, 6). The other artifacts include:

- 7 cores for flakes, including exhausted discs and change-of-orientation types (Fig. 9, 5).
- 4 core-refreshment elements and one crested flake.
- 18 short and thick flakes with lateral cortex (Fig. 9, 1 - 3)
- 11 flakes with distal cortex.
- 15 non-cortex flakes (Fig. 9, 4).
- 4 blades.
- 4 cortex flakes.

The flake butts were either plain or cortex, though some were shattered or punctiform. No other material of this sort was found by us anywhere in the basin. It somewhat resembles certain assemblages, equally patinated, found near Maan by surveyors such as T. Parker (1988) or A. Killick (in preparation) and regarded as post-Paleolithic or Recent.

Site 239, Qa Jashsha South (3499.8 x 335.6 ; 530m)

On the southern side of Qa Jashsha, 1 km to the south-west of Site 238, a transversal dolomitic limestone butte projects into the alveole, with steep slopes barely negotiable by our vehicle. On its flat summit was an Epi-Paleolithic assemblage similar to that at Site 238A, but this time with a deep brown patina similar to that of the indeterminate assemblage from Site 238 B. It is not clear, however, whether the position of the assemblage on the summit of the butte has led (as at 238B, also on the summit) to the formation of deep brown (but not 'desert varnished') patinas, and if so, why the 238A patinas (on the slopes) were different.Thirty artifacts were kept, consisting of end-scrapers, burins, blades, bladelets and bladelet cores. Typologically, the material refers to 238A and its correlates in Wadi Uweinid and Wadi Jilat, dating to the Epi-Paleolithic as already noted. Since two similar sites occurred so close to each other, it is probable that others could be present in the surrounding area. The Qa Jashsha area, largely unsurveyed archaeologically, appears to have supported Late Paleolithic populations. The travertine sheets (some of earlier date than others) are thought to have been laid down in wet phases such as mid-Last Pluvial episodes 13 - 14 of Besançon *et al.*, as per their *Tableau II, infra*,

NOTES

1. See Copeland & Hours, *infra* and Besançon *et al.*, *infra*.
2. Kennedy, 1982, 187.
3. Sieveking and Clayton (1987, 239) discuss the moisture content of flint as the cause of spalling during freeze/thaw conditions and mention the curved paths along stress lines followed by some fractures.
4. See Betts, 1988.

BIBLIOGRAPHY

BESANÇON, J. & P.SANLAVILLE (in press) L'Evolution géomorphologique du bassin d'Azraq (Jordanie) depuis le Pléistocène Moyen. C.N.R.S. conference pre-print, Lyon, I988 (*Paléorient*, I989)

BETTS, A. (in press) The Pre-pottery Neolithic B period in eastern Jordan. C.N.R.S. conference pre-print, Lyon, 1988 (*Paléorient*, 1989).

BYRD, B. (in press) Late Pleistocene assemblage diversity in the Azraq Basin. C.N.R.S. conference preprint, Lyon, 1988 (*Paléorient*, 1989)

COPELAND, L. (in press) Environment, chronology and Lower-Middle Paleolithic occupations in the Azraq Basin, Jordan. C.N.R.S. conference pre-print, Lyon, 1988 (*Paléorient*, 1989).

COPELAND, L. (in preparation) *Flint artifacts from the Udruh Survey Region, Southern Jordan.* IN A. Killick, in preparation (Udruh report).

COPELAND, L. & F. Hours (1988) The Paleolithic of North-Central Jordan, an overview of survey results from the Upper Zarqa and Azraq, 1982-1986. IN A. Garrard & H.G. Gebel (eds.) *The Prehistory of Jordan*, BAR 396 ii. 287-309.

GARRARD, A. (in press) Environment, settlememnt and subsistence during the Late Pleistocene and Early Holocene in the Azraq Basin. C.N.R.S. conference pre-print, Lyon, 1988 (*Paléorient*, 1989)

GARRARD, A., A. BETTS, B. BYRD & C. HUNT (I988) Summary of Palaeoenvironment and Prehistoric Investigation in the Azraq Basin. IN A. Garrard & H.G. Gebel (eds.) *The Prehistory of Jordan*. BAR 396 ii, 311 - 337.

KENNEDY, D.L. (1982) *Archaeological explorations on the Roman Frontier in north-east Jordan.* BAR 134.

PARKER, S.T. (1987) *The Roman Frontier in Central Jordan: interim report on the l*imes arabicus *project*, 1908 - 1985. BAR 340.

SIEVEKING, G., & C. J. CLAYTON (1986) Frost shatter and the structure of frozen flint. IN G. Sieveking and M. B. Hart, eds., *The Scientific Study of Flint and Chert*. Proceedings, 4th Intnl. Flint Symposium. Cambridge University Press.

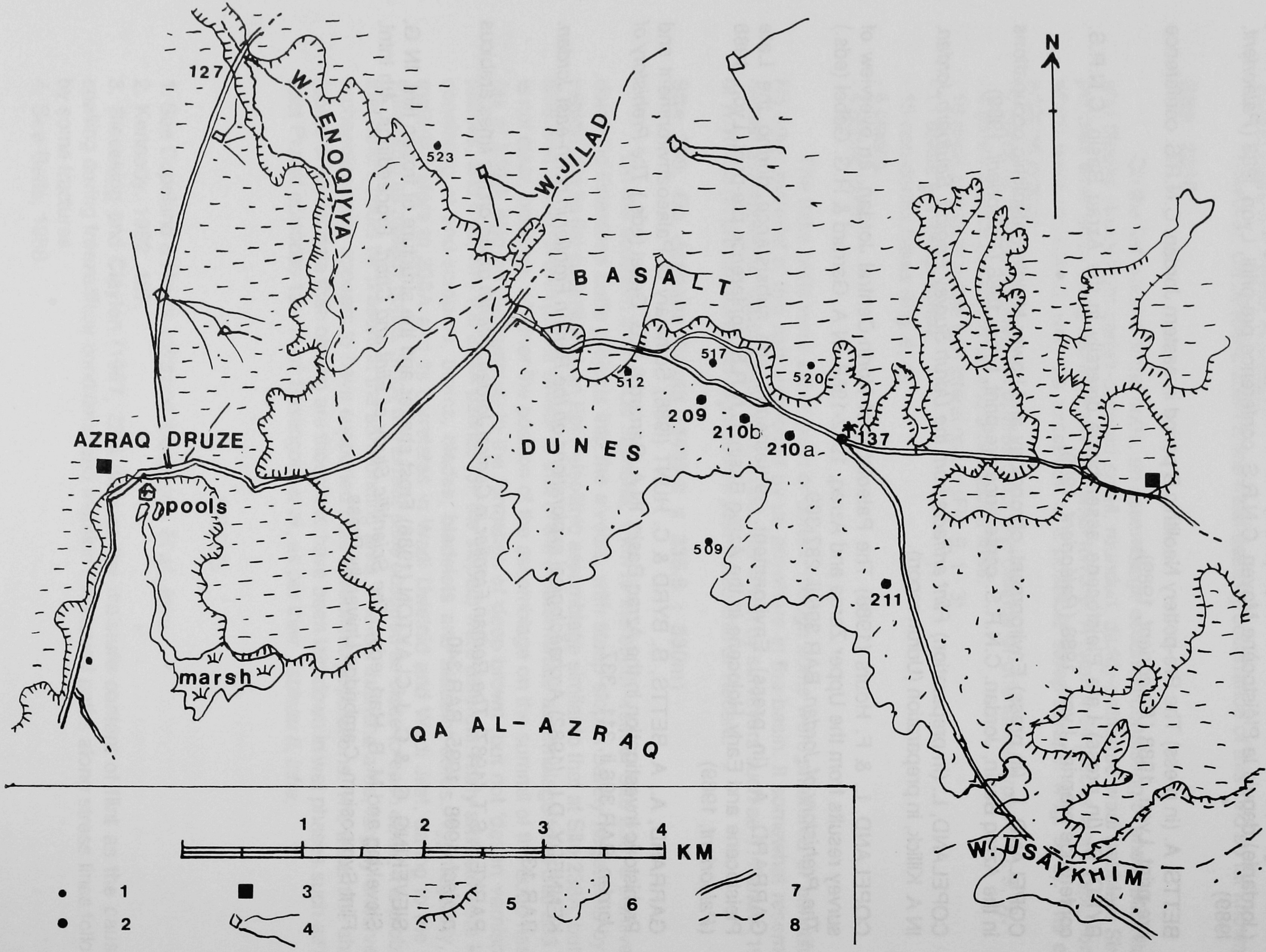


Fig. 1. Sketchmap of the Al-Bayda area, north of Qa al-Azraq. 1, altitude in metres; 2, archaeological sites; 3, castle ruins; 4, 'kites' (gazelle traps); 5, basalt plateau; 6, aeolian dunes; 7, roads; 8, wadis.

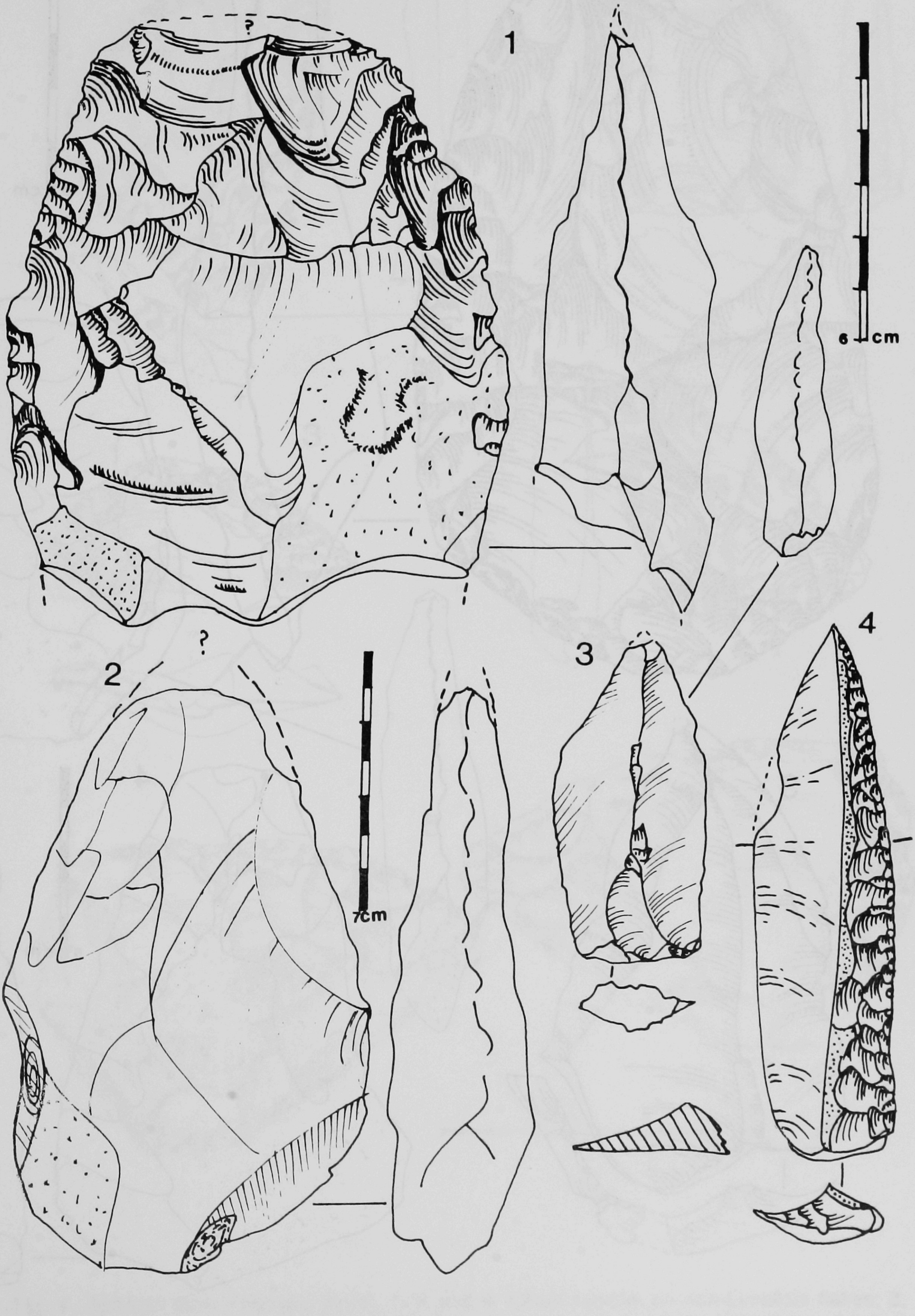


Fig. 2. Artifacts from Ain el-Beidha. 1. Bifacial cleaver, broken by heat spalling; 2, sketch (in reduced scale) of limande biface with broken tip; 3, flake-blade with plain, wide-angle butt; 4, racloir refreshment flake or backed knife.

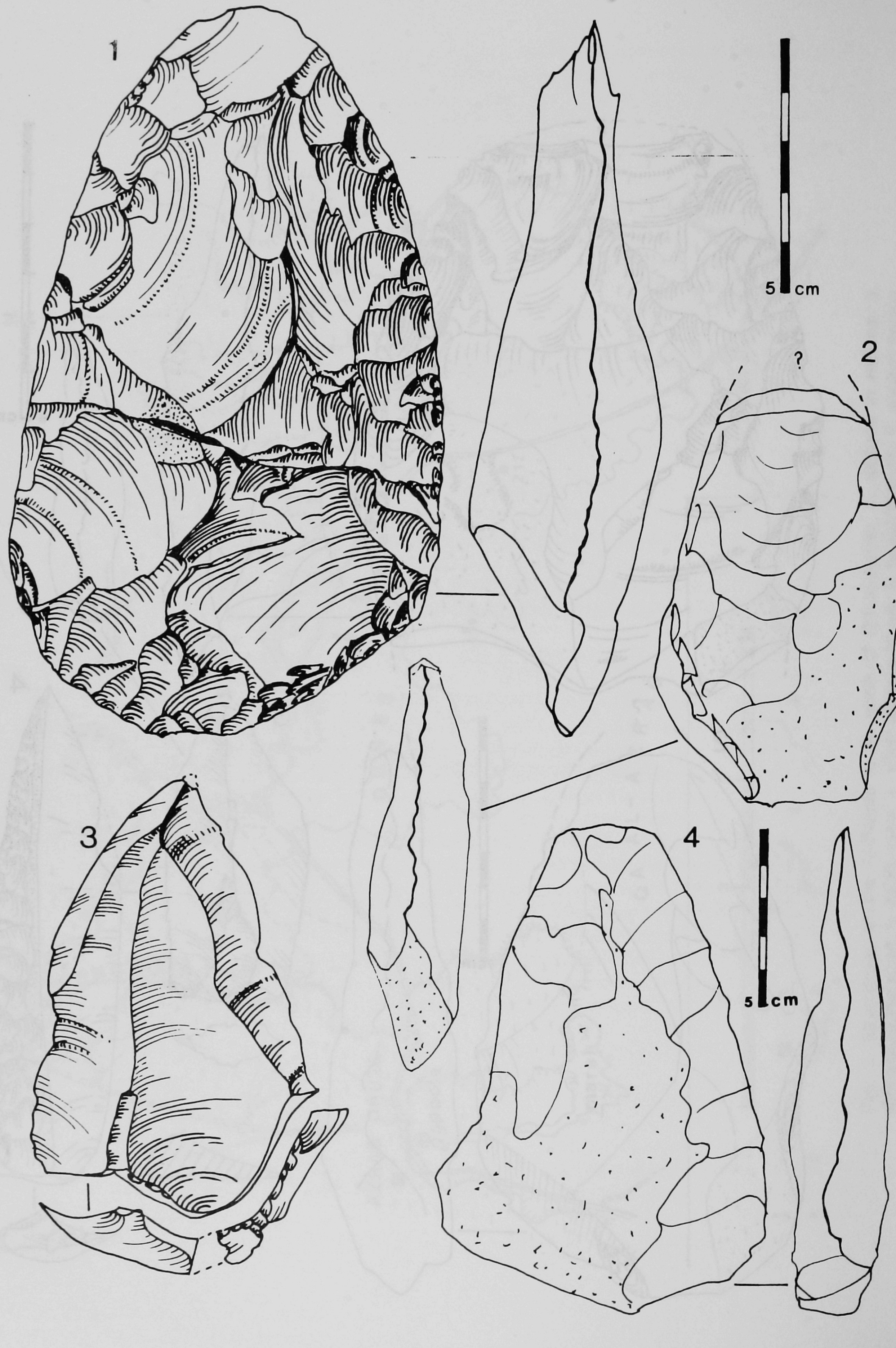


Fig. 3, Artifacts from Al-Bayda South. 1, Limande biface with re-worked tip; 2, sketch (in reduced scale) of broken bifacial cleaver; 3, broad-based Levallois point; 4, sketch (in reduced scale) of partial amygdaloid biface with cleaver-like tip.

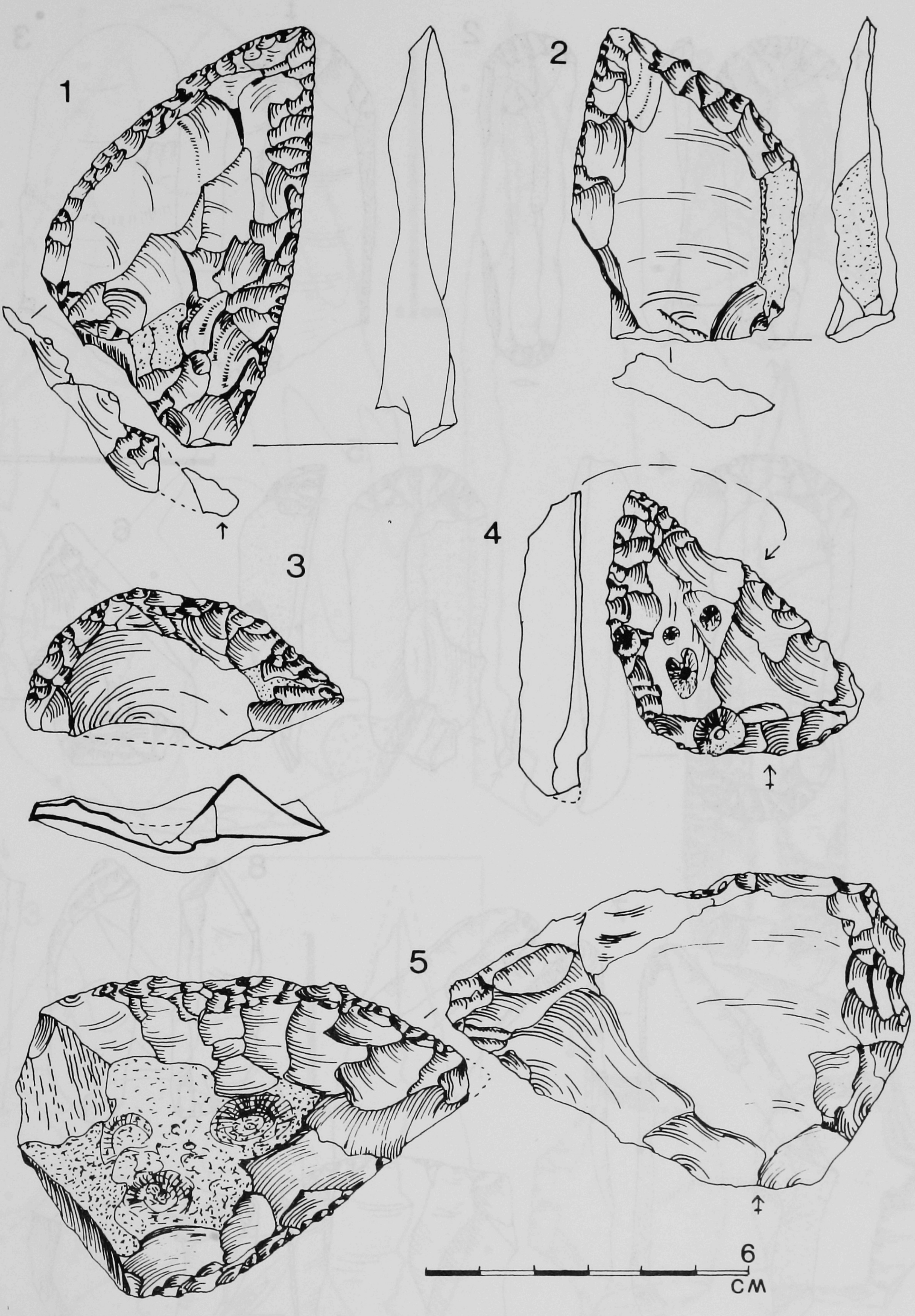


Fig. 4. Artifacts from Al-Bayda South. 1, 2 and 4, Offset racloirs on non-Levallois flakes; 3, transverse convex racloir with demi-Qina retouch; 5, bifacial racloir on thick flake with butt removed; nos. 4 and 5 have thermal pits.

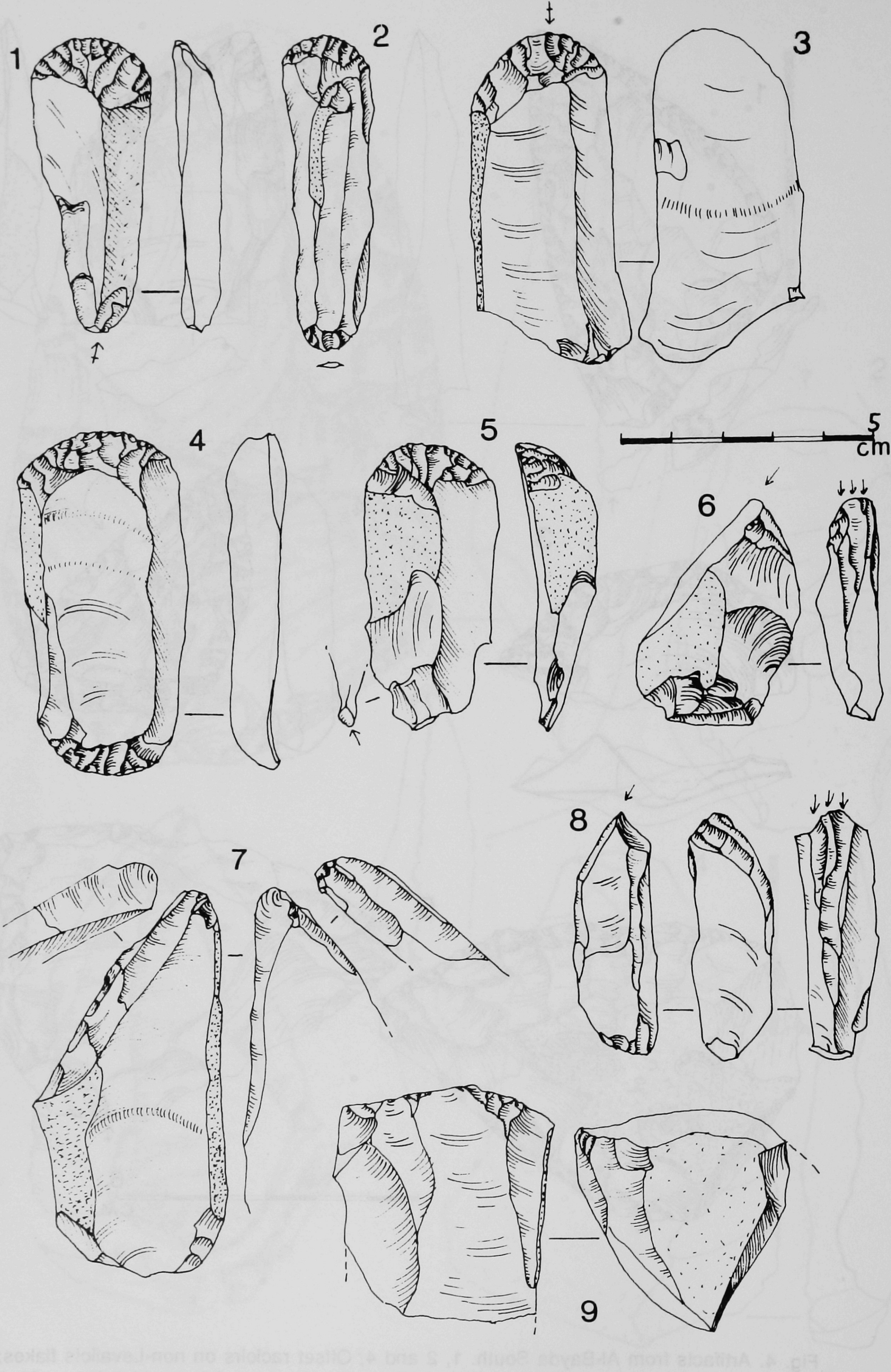


Fig. 5. Artifacts from Al-Bayda North. 1 & 3, End-scrapers on blades; 4, double end-scrapers on blades; 5, end-scraper on cortex flake; 6 & 8, carinated burins; 7, polyhedric bec-de-flute burin; 8, broken blade/bladelet core.

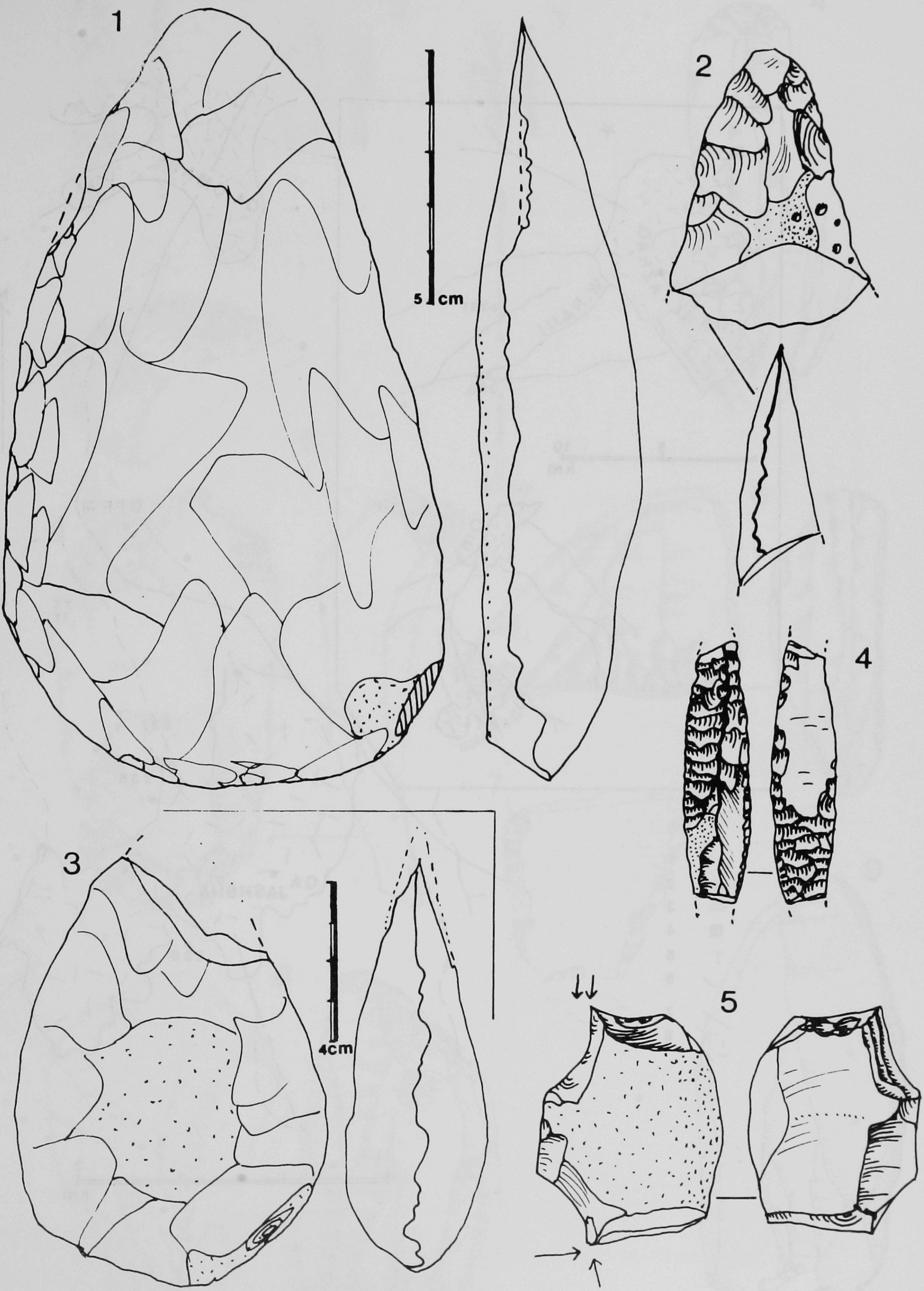


Fig. 6, Artifacts from Al-Bayda Dune. 1, Sketch, with schematised retouch, of amygdaloid biface; 2, tip of pointed biface; 3, sketch in reduced scale of broken amygdaloid biface; 4, fragment of bifacially-retouch arrowhead; 6, double burin, one end on a truncation or notch.

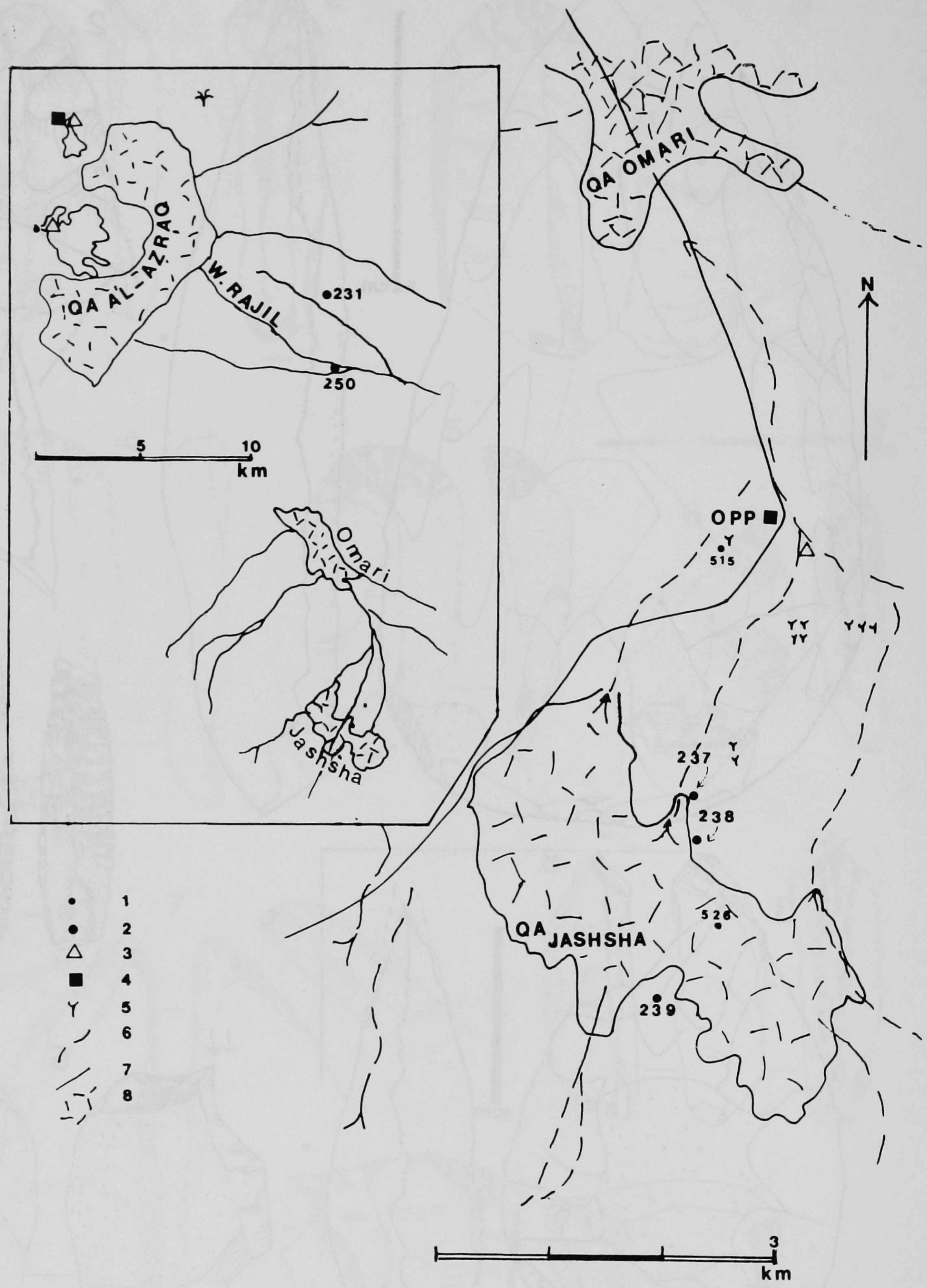


Fig. 7. Sketchmap of the Qa Jashsha area with (inset) the Wadi Rajil delta area. 1, altitude; 2, archaeological site; 3, OPP = Old Police Post; 4, Azraq Druze castle (in the inset); 5, cemetery; 6, wadi; 7, track; 8, sabkha or qa.

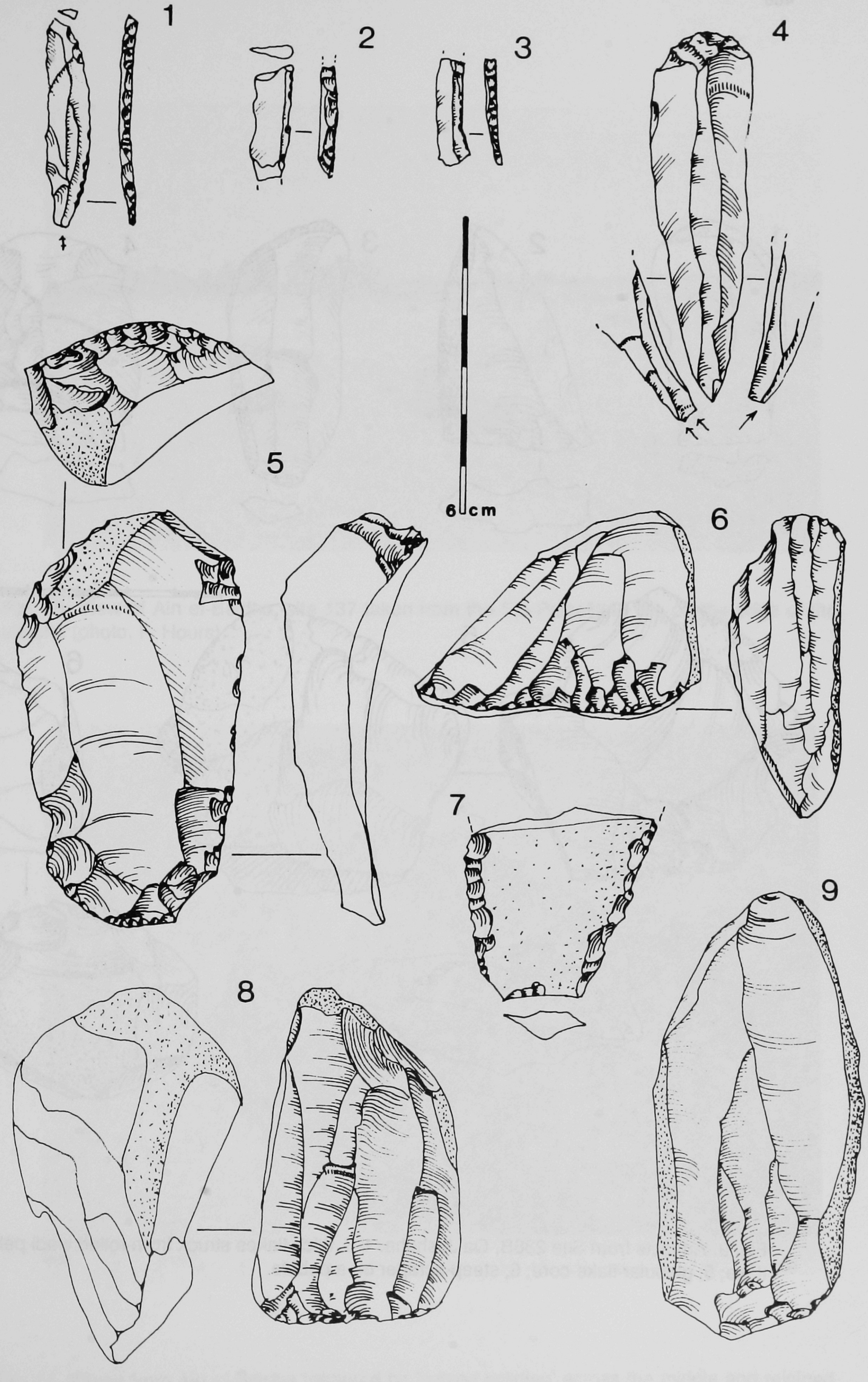


Fig. 8. Artifacts from Site 238A, Qa Jashsha. 1, La Mouillah Point; 2 & 3, backed bladelet fragments; 4, composite end-scraper/dihedral burin; 5, large double end-scraper; 6, bladelet core; 7, 'tile-knife' fragment; 8, bladelet core, slightly twisted; 6, bipolar blade core.

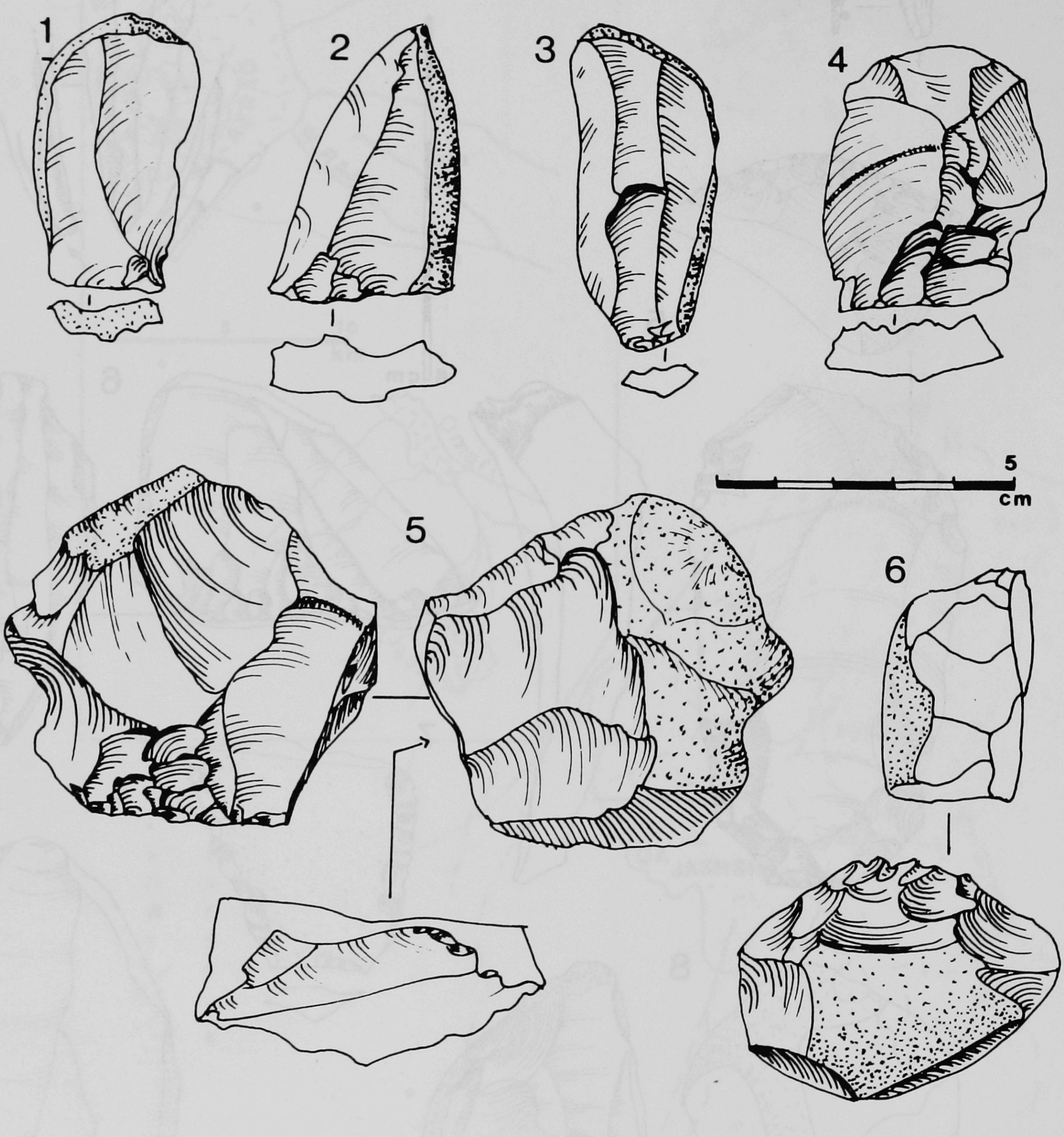


Fig. 9. Artifacts from Site 238B, Qa Jashsha. 1-3, thick flakes struck from rolled wadi pebbles; 4, flake; 5, globular flake-core; 6, steep-scraper on a pebble.

Fig. 10. View of Ain el-Beidha, site 137 taken from the Epi-Paleolithic site on the edge of the sabkha (photo. F. Hours).

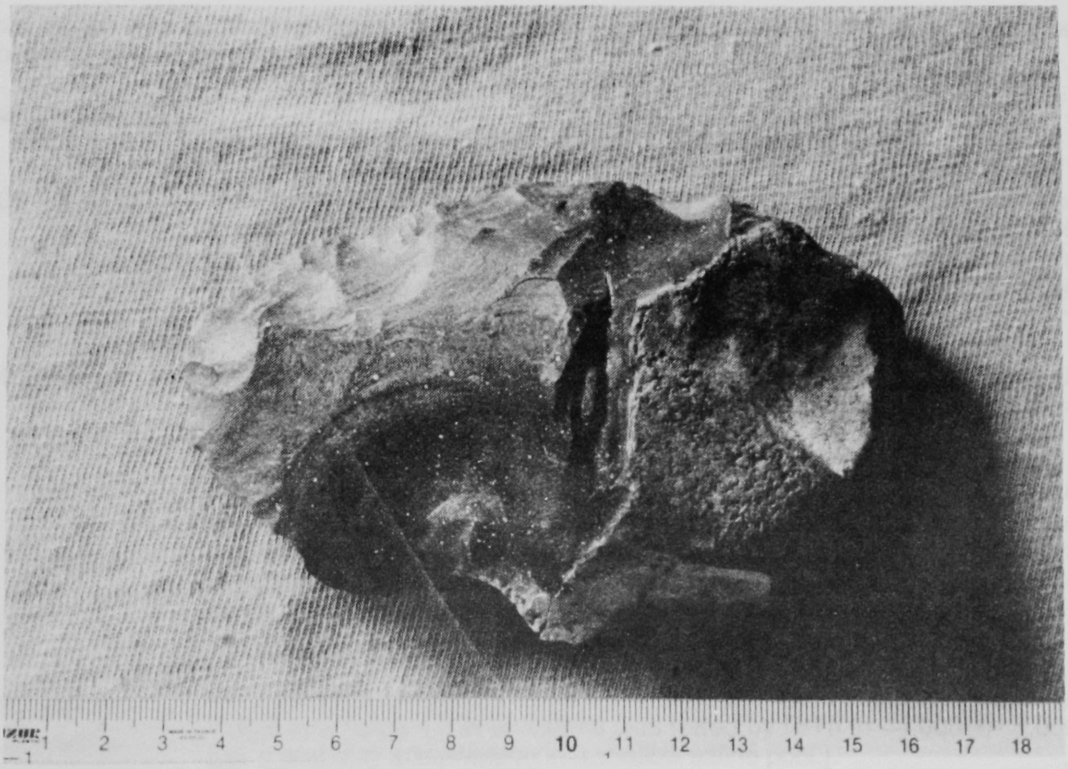


Fig. 11. Biface from Ain el-Beidha fractured by 'curved splitting' across the middle and rejoined (photo. F. Hours).

The Hammer on the Rock
L. Copeland & F. Hours
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NOTES ON THE SEDIMENTS OF SOME PALAEOLITHIC SITES AT AZRAQ, JORDAN

Christopher Hunt

AIN EL-BEIDA

Introduction

Dr. A. Garrard and I visited this site for a period of 1-2 hours. Fieldwork was concentrated on areas of outcrop (named Azraq 32 by A. Garrard) where Epipalaeolithic artefacts were weathering out. A cursory inspection did not disclose any outcrops with *in situ* Lower or Middle Palaeolithic artefacts.

Geomorphology

Ain el-Beida is a spring on the northern margins of Qa el-Azraq. It rises on a low bench cut in chalky limestones overlain by Quaternary deposits. The Quaternary deposits were partially eroded by a gully system at one time, but are now covered by a thin sheet of aeolian silty sand.

Stratigraphy

A small trench was cut through one of the gully sides, some 20 m SW of the spring. It showed the following sequence (Fig. 1).

Top of the sequence

1- 0 - 0.05 m Unconsolidated pale brown silty sand. (Recent blown sand.)

2- 0.05 - 0.40 m Pale grey limestone with *Phragmites* casts, much disrupted by salt and gypsum growth and showing disruptive nodular structures in the top 0,05 m. (This is a freshwater limestone, that accumulated in a shallow pool in which reeds grew. The nodular structures at the top are probably the result of later calichification).

3- 0.40 - l.60 m Olive-grey silts, showing sublaminar structures typical of the interstratal growth and dissolution of evaporite minerals, Calcareous nodules and artefacts occur in the top 0,05 m of the unit.

(The silts are similar to those accumulating today in saline mud flats which are seasonally flooded, on the margins of the reed beds of the Azraq marshes, The calcareous nodules in the highest part of the silts might suggest an episode of dessication and incipient soil formation. It was during this relatively dry phase that the site was exploited by early humans: the Epi-Paleolithic population of Azraq 32).

4- l.60 - l.80 m Very pale grey limestone (travertine) with abundant voids and traces of ?algal structures. (This limestone was dated by U/Th to 44,000 +/- 5,000 b.p. It probably accumulated in a shallow saline pool.).

Base of sequence.

NOTE. The U/Th date was provided courtesy of Dr. Andrew Herczeg, Research School of Earth Sciences, Australian University, Canberra, through the good offices of P. Macumber.

The stratigraphy reported here seems to be traceable over an area of several hundred square metres, though pits between Ain el-Beida and Azraq Druze show stratigraphies made up exclusively of green and grey silts.

Conclusions

The sequence reported here throws no light on the Lower and Middle Palaeolithic artefacts that have been reported as surface finds at Ain el-Beida. Many of these finds have been lying on the surface of the lower limestone (A. Garrard, pers. comm.), presumably because they have been thrown out of the spring vent during operations to clear it. The sequence does, however, provide a context for the Epipalaeolithic industry at Ain el-Beida. The sequence can be interpreted as a (probably incomplete) climatic sequence. The lower limestone was probably laid down in a saline pool, about 40,000 years ago. The presence of a pool probably reflects enhanced spring flow and therefore probably increased rainfall or vastly decreased evapotranspiration, or both, The silts reflect a period of clastic sedimentation on mudflats and diminished spring flow. These two factors together probably reflect aridity and an abundance of mobile sediment in the landscape. The top of the silts and the artefact horizon probably reflect a hiatus in sedimentation, with carbonate nodules forming above the watertable during a period of intense dessication. This period of dessication, during which a lack of water (and thus waterlain sediment) reaching the site may have led to deflation, was followed by enhanced spring flows and limestone deposition, probably in perennial standing water. This probably took place during a humid period. The calichification in the upper part of the upper limestone probably reflects another period of aridity and low water tables. Some time after this arid phase, the local base level fell, perhaps as the result of neotectonics and slight deformation of the basin, perhaps as the result of the lo ss of considerable quantities of sediment by deflation in the central Qa. The relatively elavated surface of the Quaternary deposits was then incised by gullies. Later, blown silty sand mantled the site.

AIN EL-ENOQIYA

Introduction

I visited this site on two occasions, both with Dr. A. Garrard, spending a total of about 4 hours on the site.

Geomorphology

At Ain el-Enoqiya, the Wadi Enoqiya is a more-or less flat floored trough, with steep but not vertical sides where basalt is nearly continuously exposed. The floor of the wadi is incised by a number of anastomosing channels. Between the channels, low irregular dunes of fluvial silt have accumulated around vegetation.

Stratigraphy

The channel sides showed a fairly uniform stratigraphy: a typical section is described below **(Fig. 2)**.

Top of section

0 - 0,l m	Pale orange-brown trough cross-bedded sandy silts and slightly sandy silts. Erosive base.(Modern silt dune).
0,l - 0,3 m	Pale orange-brown slightly sandy silts, laminated at the top, massive below, with occasional PPN artefacts, Sharp discontinuity. Neolithic or later waterlaid silts. (The horizontal laminations reflect horizontal accretion from fairly quiet water, perhaps a pool. The lack of disturbance to the laminations and their perfect preservation suggests a lack of vegetation at the time and a lack of subsequent pedogenesis.)

0,3 - 0,45 m	Dark grey-brown becoming paler downwards; slightly sandy silt with a columnar structure and traces of illuvial clay on ped (soil aggregate) faces and a few root traces; passes into next layer.
0,45 - 0,7 m	Mid brown matrix-supported and occasionally clast-supported sandy silty gravel with rare Middle and Upper Palaeolithic artefacts and mineralised bone fragments and teeth of *Equus asinus/hemionus* and *Camelus sp.* Erosive base. (These two layers are fluvial in origin, but have been substantially modified by pedogenesis. The mixed artefact assemblage suggests deposition at some time in or after the Upper Palaeolithic, The soil profile must have developed in humid conditions.)
0,7 - 0,85 m	Dark grey, mottled orange-brown and brown, slightly sandy clayey silt with occasional decomposed pebbles of basalt; blocky texture with illuvial clay skins to peds, some root channels, very occasional Middle Palaeolithic artefacts. Passes into
0,85 - l,15 m	Dark greenish-grey to bluish-grey, mottled black and orange-brown, clayey silt; columnar structure with some clay skins to peds. Base unseen. (These two layers are probably marsh silts, which were strongly affected by soil formation before the deposition of the overlying gravels. The highest levels of the soil profile, which must have contained most of the Middle Palaeolithic artefacts, was stripped by the river, so that only the lowest part of the archaeological layer remains *in situ*. The marsh silts were probably laid down in a seasonally or perennially wet environment, most probably during a humid episode. The development of a soil profile would require a hiatus in sedimentation and some measure of vegetation. The mottles probably reflect gleying and therefore a seasonally high water table. The Middle Palaeolithic occupation therefore probably took place during a major humid episode, in a relatively well-vegetated landscape.)

Conclusions

The Middle Palaeolithic occupation at Ain el-Enoqiya probably took place during a humid episode, in a well-vegetated landscape. There was then a hiatus of considerable duration, during which there must have been considerable climatic change. Sediments which were laid down at this time were subsequently lost by erosion. The gravels probably reflect an arid phase with sediment movement during the Upper Palaeolithic. The river bed was scoured and Middle Palaeolithic artefacts were thus incorporated into the gravels. A humid phase followed, during which a soil profile developed. During the Pre Pottery Neolithic, further alluvial silts were spread over the floodplain, during a time of aridity. In recent times, the Wadi Enoqiya has scoured a number of channels in the floor of the valley and deposited silt amongst the thorn bushes which stand on 'islands' of older sediments.

WADI RATTAMA

Introduction

I spent two days mapping in the Wadi Rattama, concentrating my efforts in the quarries in the lower part of the wadi, not far from the Rest House.

Geomorphology

The Wadi Rattama lies along the line of the Basalt/Tertiary limestone contact with the north slopes of the wadi in basalt and the southern slopes in limestone. Bedrock is patchily exposed, especially on the steeper northern flank of the valley.

Two major terrace surfaces may be distinguished in the Wadi Rattama. For convenience, they are called the 'high' and the 'low' terraces. The 'high' terrace contains evidence for several cycles of aggradation and incision in the quarry sections. Its surface lies, at the quarries, 3,5-4,0 m above the wadi floor, though it decreases downstream and eventually plunges below more recent sediments. This surface is covered by a sheet of dark brown patinated gravel. Two large 'spreads' of artefacts, including many large flakes, and a few large flake cores and Acheulean bifaces were found on the surface of the 'high' terrace. The artefacts are lightly patinated, which suggests that they are young relative to the age of the heavily patinated land surface they lie on. Artefacts from these spreads have clearly been carried (along with much sediment) down gullies eroded in the front of the 'high' terrace and incorporated in substantially younger gravels, I followed such a 'trail' of artefacts from gravels on the wadi floor, up a gully and to one of these 'spreads' on the terrace surface.

The 'low' terrace contains evidence for a single cycle of aggradation, Its surface lies around I,5 m above the floor of a network of channels scoured into the terrace.

Stratigraphy

'High' Terrace, section 3 (Fig 3)

Terrace surface

I 0 - 0,2 m	Reddish brown becoming pale reddish brown structureless sandy silty gravel, with a line of dark-brown patinated angular gravel at the top, One rather battered, lightly patinated flake of Mousterian type was found on the surface. (This horizon formed as the result of the disruption of the underlying sediments by salt and plant roots. The fines have been lost, by deflation, from the surface gravel layer).
2 0,2 - up to 0,9 m	Pale reddish-brown trough cross bedded matrix-supported and occasionally clast-supported silty and sandy gravels, with rare lenses of laminated silts and of stony clayey silt, occupies channels cut into underlying horizons. (This is a fluvial gravel, laid down by a braided, ephemeral river. The predominance of matrix-supported gravels suggests deposition from very short-lived flows, while the braided bedforms suggest a lack of binding vegetation and much mobile sediment in the landscape. Together, these factors suggest aridity).
3- 0,2 - 0,8 m	Pale reddish-brown stony silt, darker in colour to the top, with abundant small carbonate nodules and a discontinuous laminar calcrete horizon at 0,6 m (this, incidentally, cut by the overlying fluvial gravels). Occasional lenses of silty sand and silty gravel. Weak columnar structure. Erosive base. (This horizon is colluvial in origin and a soil profile had developed upon it before incision and the deposition of the overlying fluvial gravels. The calcrete horizon probably reflects an ancient groundwater level, while the columnar structure and carbonate nodules probably formed above the water table. The widespread movement of colluvium implies an abundant sediment supply - in this case including a fair amount of silt of aeolian origin - and a lack of binding vegetation on local slopes, together with occasional heavy, but short-lived rainfall. The sand and gravel lenses represent small 'washouts'. The subsequent soil profile development would have required some input from vegetation and the calcrete horizon would have required a permanent water-table at that height. A wetter phase thus followed before the deposits were incised and the overlying gravels were laid down.)
4- 0,8 - up to 1,6 m	Pale reddish-brown trough cross bedded matrix-supported and occasionally clast-supported silty and sandy gravels. Erosive base, (A fluvial deposit, rapidly laid down by ephemeral braided streams in a largely devegetated landscape with abundant mobile sediment available for erosion).

5- I,0 - I,8 m Pale reddish-brown stony silt with carbonate nodules. Base unseen. (A colluvial horizon, showing signs of later soil profile development above the water table. Again, an abundant sediment supply, a lack of binding vegetation and an arid climate with occasional 'cloudbursts', followed by a wetter phase during which pedogenesis occurred before subsequent incision and river gravel deposition, is suggested.)

Base of section.

'High' Terrace, Section 6 (Fig.4)

Terrace surface

1- 0 - 0,2 m Reddish-brown to pale reddish-brown structureless sandy, silty gravel, with a line of dark-brown patinated angular gravel on the surface. A large spread of lightly-patinated crude flakes and a few flake cores was found on the terrace surface some 3-30 m behind this section. (This layer formed as the result of salt and plant roots disrupting the underlying deposits. The fines have been lost from the surface layer by deflation).

2- 0,2 - 0,3 m Pale reddish-brown silty sand, occupying a series of shallow scours incised into the underlying deposits.
(A series of small gully-fills containing waterlaid sediment).

3- 0,2 - 0,4 m Pale reddish-brown stony silt occupying an irregular channel incised into the underlying deposits (An ancient gully containing mudflow deposits).

4- 0,2 - 0,7 m Dark reddish-brown, becoming paler downwards, slightly clayey silt with weak columnar jointing and at least three discontinuous laminar calcrete horizons. Passes into underlying layer.(Fluvial overbank sediments, on which a soil profile has formed and calcretes reflect stillstands in the water-table within the sediments).

5- 0,5 - 1,1 m Pale reddish-brown imbricated, clast-supported trough cross bedded gravel. Erosive base (gravels of a braided river).(The relatively well-sorted gravels are consistent with more steady flows than were reponsible for the deposition of most of the gravel units in the Rattama, though the trough cross bedding is consistent with a river that underwent major changes in discharge regime).

6- 1,0 - 1,7 m Dark reddish-brown, becoming paler downward, slightly clayey silt with weak columnar jointing and some small carbonate nodules. Base unseen, but erosive in part into unit 7. (Soil profile developed upon fluvial overbank silts).

Units 2-6 above occupy a channel incised into the following unit.

7- 0,2 - 2.8 m Pale reddish-brown trough cross-bedded matrix supported silty and sandy gravels. Base unseen. (Gravels of an ephemeral, braided stream).

Base of section

The deposits of sections 3 and 6 can be seen and followed in a series of minor exposures towards the centre of the wadi, and upstream and downstream from the gravel pits. Near the centre of the wadi, these sediments appear to pass downwards into essentially similar, but lithified sediments. Most of the lithified sediments are cobbly gravels, but section 4 showed a more complex stratigraphy.

'High' Terrace section 4 (Fig 5).

The top of section 4 lies some 3 m below the surface of the 'High' terrace.

Terrace surface

I- 0 - 0,25 m	Pale grey, heavily cemented clast-supported, imbricated gravel, Erosive base (fluvial gravel, heavily cemented by calcrete).
2- 0,25 - 0,3 m	Red-brown lightly cemented silts with occasional carbonate nodules. One indeterminate flake was found in this horizon. Passes into
3- 0,3 - 0,5 m	Pale reddish-brown silty sand, with carbonate nodules in the upper part and traces of plane lamination in the lower part. Base unseen (These two horizons appear to be fluvial overbank or slackwater sediments, on which developed a soil profile, prior to the deposition of the overlying gravel).

Base of the section

The 'Low' terrace

Most of the 'islands' of the 'low' terrace showed very similar stratigraphy, with silts overlying gravels, though the exposures varied considerably in depth, A typical section is given below.

'Low' Terrace section 5 '(Fig 6)

Terrace surface

1- 0 - 0,4 m	Pale reddish-brown to yellow-brown laminated sandy silts, with occasional lenses of fine gravel. Occasional terrestrial molluscs and horizons of root casts. Very rare flint flakes and small blades. Passes down into underlying layer (Fluvial overbank sediments).
2- 0,4 - 1,5 m	Pale reddish-brown imbricated sandy gravel, showing tabular bar core structures, passing laterally and vertically into fine sandy gravels with scour and fill structures (Gravels of a braided river).

Base of section

Conclusions

The 'High' terrace is a composite feature, since underlying its surface are gravels that were laid down during at least three episodes of aggradation, separated by periods of incision and in some cases soil formation. The episodes of aggradation were probably periods of aridity, while the episodes of incision and soil formation were probably periods of slightly more humid climate. The bulk of the Acheulean artefacts found in this part of the Wadi Rattama quite clearly post-date the formation of the terrace surface, since they can be traced back to 'spreads' of lightly patinated artefacts lying upon the heavily patinated terrace surface. A single crude, indeterminate flake was found *in situ* in the gravels of the 'High' terrace. All of the deposits of the 'High' terrace were laid down by ephemeral braided streams or by slope processes, in environments characterised by much mobile sediment and little binding vegetation. All have been affected to some extent by groundwater calcrete formation at various times. The calcretes reflect high water tables within the sediments and may be linked to the episodes of pedogenesis also seen within the sequence.

The 'Low' terrace is considerably later; the indeterminate small blades it contains suggest deposition some time after the start of the Upper Palaeolithic. The depositional environment again was an ephemeral braided river flowing through a landscape with little vegetation. The absence of a soil profile developed on these deposits is consistent with an age younger than the latest humid episode in the Azraq Basin, which on present knowledge (Garrard *et al.*. in preparation) would seem to have come to an end shortly before I4,5000 BP.

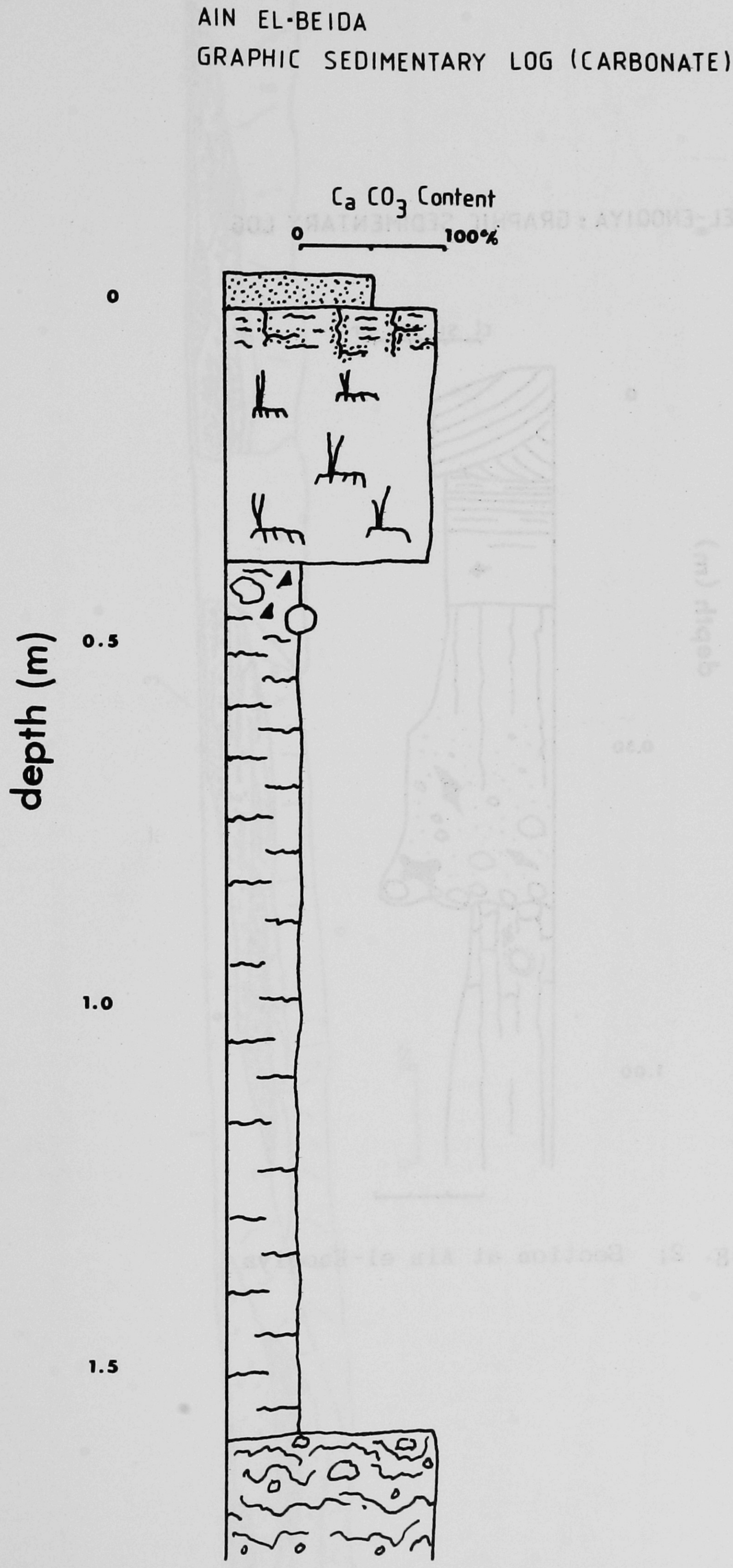

Fig 1; The sequence from the sounding at Azraq 32, near Ain el-Beidha.

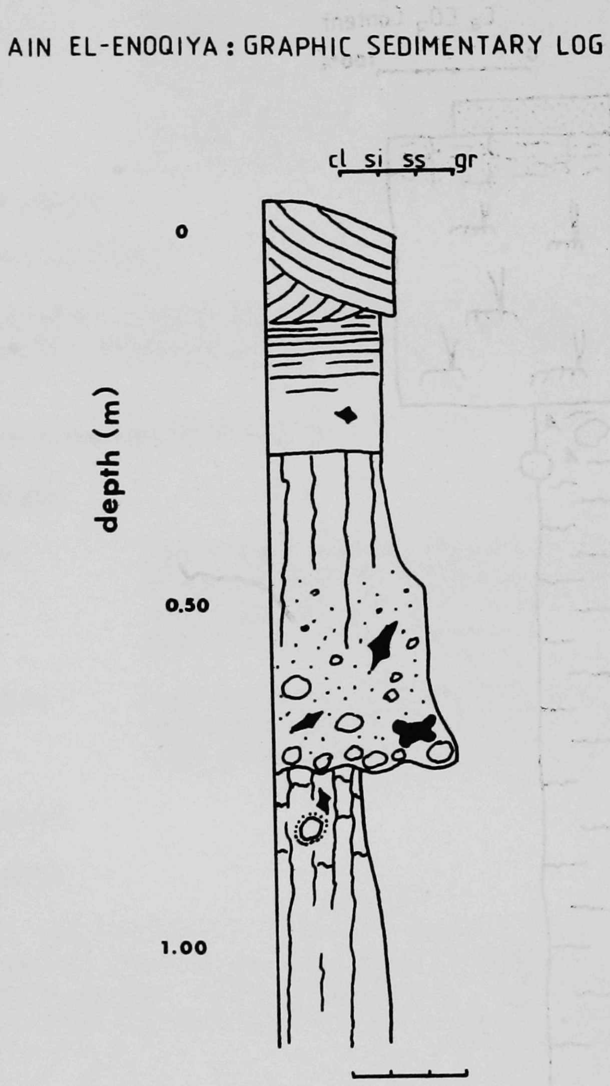

Fig. 2; Section at Ain el-Enoqiya

Fig. 3 : Wadi Rattama section 3: 1, terrace surface; 2, roadway; 3, calcrete; 4, mudflow; 5, talus; 6, quarry floor.

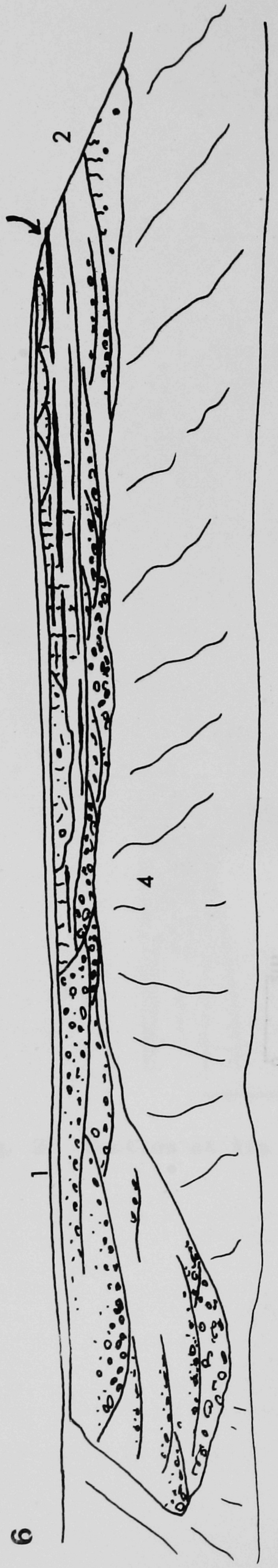

Fig. 4 : Wadi Rattama section 6: 1, terrace surface; 2, terrace front; 3, calcretes; 4, talus; 5, quarry floor.

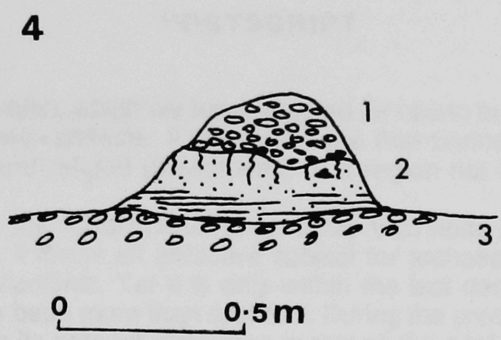

Fig. 5 : Wadi Rattama section 4 : 1, cemented gravels; 2, soil profile on laminated sands; 3, unconsolidated wadi floor gravels.

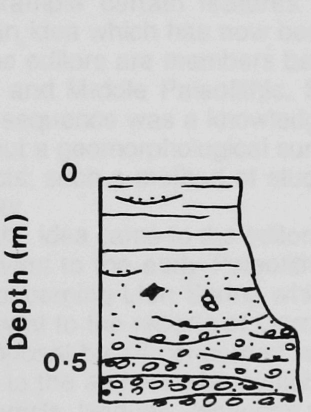

Fig. 6 : Wadi Rattama section 5, graphic log.

POSTSCRIPT

The words of Jeremiah, which we have adapted for use in our title to this volume, put us in mind of rocks: prehistoric artifacts. It was our hope that truths (the Word) might emerge through study of these, and related phenomena, in a region not far from that known to the Prophet.

Perhaps because the Azraq Basin is an entity with finite topographic limits yet with diverse ecological niches, it forms an attractive subject for archaeological studies, particularly those dealing with the Paleolithic. Yet it is only within the last decade that research into the prehistory of the basin has been more than sporadic. During the preceeding and post-War years there was more interest in its present state than in that of the past, cf. the many studies of its resources and potential for development, carried out by F.A.O. personnel and other bodies. It could be said that prehistoric research began as a by-product of these studies; a case in point is the work of Baker and Harza engineers at the central oasis springs. This produced in 1956 the first stratified evidence of the Lower Paleolithic in Jordan, as was recognised by Gerald L. Harding, the Director of Antiquities. Most of the information gained until then had been from surface finds, often isolated, or from artifacts which, although described in detail (e.g. the Henry Field survey results, classified by Dorothy Garrod), came from sites whose context was unclear. The earliest excavation to take place was that in the Wadi Dhobai by John Waechter and his team; this gave a hint as to the richness of the Stone Age material which could be unearthed in the steppic fringes of the basin.

The first systematic prehistoric archaeological project to be initiated was that of Andrew Garrard in 1976, the initial stage of which was his reconnaissance survey with Nicholas Stanley Price. Garrard's project aims were to study the subsistance economies and settlement patterns of human groups during the switch from hunting and gathering to food production - i.e. the Upper Paleolithic, Epi-Paleolithic and Neolithic periods, which took place in the later phases of the Last Pluvial and in the early Holocene. In the event, these periods have been spendidly illuminated by the work he has done in the Basin since 1982.

Knowledge of the earlier Paleolithic remained sparse, very little having been published in detail (an exception being the work of Gary Rollefson at Llon Spring); sometimes the evidence had been misinterprated, for example certain features were taken to represent a high Pleistocene lake-level at 530 m, an idea which has now been rejected. However, in 1982, the French C.N.R.S. team of which the editors are members began to focus on the study of these early periods, namely the Lower and Middle Paleolithic. Since we believed that the key to understanding the archaeological sequence was a knowledge of the Quaternary chronology of the basin as a whole, we carried out a geomorphological survey of fluviatile and other deposits, especially those containing artifacts; such a method of study had already produced results in Lebanon, Syria and the Zarqa Valley.

In 1985, during this work, the idea came to the editors of assembling into one volume all the information then to hand relevant to the early Paleolithic of the Azraq Basin. This would include some unpublished data concerning Llon Spring which had recently come to light, and the volume would form a complement to the reports of Garrard and his associates on the later periods. The response to this proposal by all concerned was enthusiastic, and collaboration generously given. We are grateful to the authors who contributed the results of their own work, and especially to the geomorphologists Jacques Besançon and Paul Sanlaville, who agreed to expand their study of the Basin in 1986. Their identification of the context of the many artifact-bearing sites has been of fundamental value in our interpretations of the artifacts, while their proposed scheme for the environmental changes in the Middle and Late Pleistocene, based on recurring 4-phase morphoclimatic cycles, has brought a new perspective to the chronology of the Paleolithic in Jordan.

Equally fundamental has been the valuable work done at C-Spring by Garrad and Hunt, and we are fortunate to have been able to incorporate the results of their most recent sounding of 1988; this has shown that Azraq Oasis contains a site unique in the Near East - an *in situ* Late Evolved Acheulean knapping-floor found c. 3 m below the present surface, containing thousands of still razor-sharp flint artifacts; this seems to have been sealed in by marsh clays and thus preserved, probably by an expansion of the Sheshan marshes at the start of a pluvial episode.

In our view, thanks to the unstinting co-operation and pooling of knowledge of the specialists concerned (the C.N.R.S. and Garrard personnel often worked fruitfully together, or for eachother), the combined contributions to this volume have brought a clearer idea as to the Lower and Middle Paleolithic periods in the Azraq Basin. If the evidence for human occupation of the basin before the 'Penultimate Pluvial' remains ambiguous for the moment, we now know that the oasis and western steppe was clearly inhabited by successive groups of Late Acheulean hunters, possibly since about 400,000 BP. We know that *in situ* artifact sites of this and later (i.e. Mousterian) periods exist, and can be found not only around the springs but in the desert wadi terraces. The available artifact samples are large enough to show where the lithic industries resemble those of the Levant and in what respects they are distinct. As the studies of the faunal remains (of extinct and now regionally absent species), the pollens and the sediments have shown, these sites can also produce environmental data. Thus, the work at Azraq described here has, we hope, made less marked the contrast between the wealth of information for later prehistory and that for the earlier phases.

Of course, the work done so far is not nearly enough. There are no absolute dates, large areas remain *terra incognita*, not all aspects of the known sites can be addressed (since much material is from the surface), and there are gaps in the cultural succession; for example the Mousterian is almost entirely known from redistributed material, and the earliest Upper Paleolithic is so far missing. Conclusions must, therefore be regarded as tentative. The way forward seems clear: prehistorians in future should surely exploit the data so far gained, continue the surveying and study of already-identified sites, and above all, carry out more excavations in the hope of 'filling the gaps' and obtaining, by hook or by crook, some absolute dates. Furthermore, it is essential that the work be done as soon as possible; the evidence is being progressively destroyed as modern development of the basin continues apace in the form of roadworks, well-digging, irrigation agriculture and the like; indeed, part of the unique site at C-Spring has already disappeared under a new fishpond.

It remains for me to express my gratitude for the invaluable help of Paul Sanlaville and his staff at the Maison de l'Orient, who stepped in during and since the last illness of the senior editor, Francis Hours, and thus ensured the publication of this work.

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