Published in Libyca 28: 43-121 (1975)

THE PREHISTORIC CULTURAL ECOLOGY OF CAPSIAN ESCARGOTIERES

Preliminary Results of an Interdisciplinary Investigation in the Chéria-Télidjène Region (1972-1973)

by

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INTRODUCTION

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During the late Pleistocene and Holocene the circum-Mediterranean region was occupied by a plethora of hunter-gatherer-collector groups who used microlithic tools and practised a form of subsistence which has been termed « broad spectrum » (1). The Capsian is one of these archaeological cultures.

Capsian sites are generally open-air mounds consisting of fire-cracked rock, lithic and bone artifacts, fragmentary mammalian remains, occasional human skeletons, and enormous numbers of land snail shells, all contained within a highly alkaline ashy matrix with abundant charcoal. These sites are usually refered to as escargotières although the Arabic word *rammadiyat* (sing. *rammadiya*) derived from the word for ash (*rumad*) or ashy color (*rumadi*) has also been suggested (2). Rockshelter and cave sites are also known but are less frequent.

Prehistorians generally interpret Capsian subsistence to have been heavily dependent on land snails as a source of animal protein despite admonitions to the contrary by a number of people with primary field experience. The latter usually emphasize the probable rôle of hunting and plant collection in addition to snail gathering.

Gobert (3) argued that :

« Rien n'autorise à l'affirmer, ni n'autorise à croire que l'escargot occupait la première place dans la cuisine capsienne ».

In the report on the Logan Museum investigations near Canrobert (now called Oum el-Bouaghi), Romer (4) observed that :

« It thus seems probable that differences between faunal materials in the various sites are to be attributed to differences in mode of life and hunting customs in the various human

(1) FLANNERY (K.V.). — *Origins and effects of early domestication in Iran and the Near East.* In, UCKO (P.J.) & DIMBLEBY (G.W.), (eds). — *The Domestication and Exploitation of Plants and Animals,* Chicago, 1969, pp. 73-100.

(2) GOBERT (E.G.). — *Les escargotières : le mot et la chose.* Revue Africaine, t. 81, pp. 631-645.

(3) *Ibid.*, p. 640.

(4) ROMER (A.). — *Mammalian remains from some paleolithic stations in Algeria.* Logan Museum Bulletin n° 5, Beloit, Wisconsin, 1938, p. 166.

groups occupying them, although it is possible that there may have been seasonal differences in the time of occupation of the various camps, and possibly some fluctuations during the total time occupied by the formation of the deposits ».

Inexplicably, both these suggestions appear to have been ignored by subsequent investigators and this is all the more difficult to understand given the very high density of Capsian sites remarked on by both Balout (1) and Vaufrey (2). The former noted the apparent prediliction of Capsian groups for site locations near springs, in (supposedly) good defensive positions, and at passes (3). He then went on to argue that these sites gave « ... l'impression d'une attitude d'envahisseurs, d'une insécurité collective et peut-être même particulière à chaque campement » (4).

Balout (5) concluded that :

« ... les Capsiens ne sont point grands chasseurs. Leur genre de vie sédentaire... doit se fonder, dès le Capsien supérieur, non seulement sur l'abondance inépuisable des mollusques, mais encore sur la cueillette sinon sur une agriculture rudimentaire ».

Vaufrey's view, in contrast to the above, was that the Capsians were :

« ... comme leurs prédécesseurs du Paléolithique ancien et moyen, des peuples chasseurs, dont les proies préférées étaient les Couaggas et les Bulades, mais ils complétaient leur régime par la capture de Rongeurs... par la récolte des escargots... par la cueillette des plants, des fruits et de graines... » (6).

We now know that the chronological distinction between the Capsien typique and the Capsien supérieur proposed by Vaufrey (7) is largely invalid. The radiocarbon dates for sites of both « industries » overlap in time (8). We can therefore legitimately use the generic term Capsian instead of Capsien supérieur when refering to the above quotation from Balout. If Capsian settlements were sedentary (i.e. year-round habitation sites) their density would imply population figures for Capsian groups well in excess of those accepted for very prosperous modern or prehistoric hunter-gatherers (9). A model of seasonal and/or intermittent occupation of these sites seems far more reasonable if land snails did, in fact, constitute an important source of protein in the Capsian diet. The question this implies might well have been answered before now if prehistorians had followed the prescient suggestions of Romer. Furthermore, with very few exceptions (10) the abundant palaeoecological information available in Capsian escargotières which could have been used to investigate this possibility, has been ignored and as a consequence explanation has stagnated.

Baker (11) had demonstrated and Morel (12) confirmed that the land snail species found in the escargotières were still extant in the same regions today. Morel alluded as well to their seasonal abundance, a fact well known for numerous land snails and especially for those arid-lands species whose survival may often be predicated on an ability to withstand long-term extremes of temperature and humidity by aestivating or hibernating. The archaeological implications of land snail seasonality for prehistoric subsistence patterns has been discussed by Reed (13) for the Zagros region and a bibliography compiled by Drake (14) contains other examples.

We decided to examine the implications of Baker's and Morel's data and Romer's suggestion by further fieldwork. We reasoned as follows :

a) if the land snails found in the escargotières are still extant today,

and if

b) they were therefore only available during certain seasons,

and if

c) modern ecological conditions are analogous to mid-Holocene ones,

(1) BALOUT (L.). — *Préhistoire de l'Afrique du Nord,* A.M.G., Paris, 1955, p. 397.

(2) VAUFREY (R.). — *Préhistoire de l'Afrique, T. I : le Maghreb,* Paris, 1955, p. 234.

(3) BALOUT (L.). — *Op. l.,* 1955, p. 398.

(4) *Ibid.*

(5) *Ibid.,* p. 431.

(6) VAUFREY (R.). — *Op. l.,* 1955, p. 413.

(7) *Id., Notes sur le Capsien.* L'Anthropologie, t. 43, 1939, pp. 456-483.

(8) GREBENART (D.). — *Le gisement capsien de Rabat près d'Ouled Djellal.* Libyca, t. 19, 1971, pp. 165-169.
ID., *Vues générales sur le peuplement capsien au Nord des Némencha : secteurs de Chéria, Télidjène et Rass el-Euch.* Libyca, t. 19, 1971, pp. 171-178.
CAMPS (G.), DELIBRIAS (G.) et THOMMERET (J.). — *Chronologie des civilisations préhistoriques du Nord de l'Afrique d'après le radio-carbone.* Libyca, t. 21, 1973, pp. 65-89.

(9) LEE (R.B.) et DEVORE (I.). — *Man the hunter.* Chicago, 1968.
HASSAN (F.A.). — *Determinants of the size, density and growth rates of hunting-gathering populations.* In, POLGAR (S.), (éd.), *Population ecology and social evolution.* Mouton, The Hague, 1975.

(10) MOREL (J.). — *Le Capsien de Khanguet el-Mouhaâd.* Libyca, t. I, 1953, pp. 103-119.
ID., *La faune de l'escargotière de Dra-Mta-El-Ma-El-Abiod (Sud algérien).* L'Anthropologie, t. 78, 1974, pp. 299-320.

(11) BAKER (F.C.). — *The mollusca of the shell heaps or escargotières of northern Algeria including comparisons with the recent fauna of Algeria.* Logan Museum Bulletin n° 5, Beloit, Wisconsin, 1938, pp. 185-266.

(12) MOREL (J.). — *l. l.,* 1953 et 1974.

(13) REED (C.A.). — *Snails on a Persian hillside.* Postilla, n° 66, Yale University, New Haven, 1962, pp. 1-20.

(14) DRAKE (R.J.). — *Molluscs in archaeology and the recent.* Vancouver, 1960-1962.

then

d) Capsian subsistence must have been adapted to account for this,

and if

e) land snails did form a major dietary element then Capsian escargotières were probably not occupied year-round.

Certain evidence suggested the possibility of transhumance by Capsian groups between the Tébessa and Négrine regions. In the latter, Balout (1) had demonstrated the presence of Capsion sites and emphasized the lack of barriers to movement via the SW-NE trending valleys. This possibility had also been suggested by Pond (2). Furthermore, Grébénart (3) had remarked on the absence (or at least the rareity) of land snails from sites with Capsian lithic assemblages in the Négrine and Ouled Djellal regions. We wondered, therefore, if Capsian groups might have moved between the two areas seasonally, concentrating their occupation of the Chéria region (and the High Constantine Plains in general) during periods of peak snail availability.

(1) Balout (L.). — *Op. l.*, p. 428.

(2) Pond (A.W.). & *al.* — *Prehistoric habitation sites in the Sahara and north Africa.* Logan Museum bulletin n° 5, Beloit, Wisconsin, 1938, p. 159.

(3) Grebenart (D.). — *l. l.*, 1971, p. 174.

To investigate this possibility, we first examined the Chéria and Ouled Djellal regions in July and August of 1972. On the basis of our observations, and largely due to the availability of an excellent gazeteer of Capsian sites in the Chéria region (4), we decided to concentrate further work there. We spent the period from June to November 1973 in Algeria investigating the geomorphology, palaeontology, palynology and archaeology of Holocene deposits and Capsian escargotières in the Chéria region. The results of this research are presented here, and while only preliminary, we think they are of sufficient importance to warrant publication now. We hope the reader will excuse those lacunae which are as unavoidable as they are regretted.

(4) Id. — *Le Capsien des régions de Tébessa et d'Ouled Djellal.* Travaux du L. A. P. M. O., Aix-en-Provence, 1975.

ACKNOWLEDGEMENTS

This research has been supported by grants from the Wenner-Gren Foundation for Anthropological Research (1972) and the Canada Council (1973-1974) to Lubell who received addition support in the form of a Sabbatical Leave from the University of Alberta in 1973. The authors express their gratitude to M. Mouloud Mammeri, Directeur, Centre de Recherches Anthropologiques, Préhistoriques et Ethnographiques and to Dr R. Ouahès, Directeur, Direction de la Recherche Scientifique, for permission to undertake this research project and for their help during two occasionally difficult field seasons. Our thanks as well to the following present and former staff of C.R.A.P.E. who gave freely of their time and advice and shared the results of their current research with us : G. Aumassip, C. Brahimi, A. Bouzenoune, M. Couvert, A. Mezhoud, O. Oussedik, C. Roubet and the late F.-E. Roubet. The Mayor of Chéria provided a municipal house (gratis) as field headquaters. The earlier work of D. Grébénart was an invaluable aid to our research.

Palynological analyses were supervised by Dr T. Habgood of the Palaeoenvironmental Laboratory, Department of Anthropology, University of Alberta. Sedimentological and geochemical samples were processed by the Soils Department, Universty of Alberta and interpreted by Hassan who was greatly aided by advice from Dr A. Hassan. Figures 2, 9, 10, 11, 12, 13 and 19 were drawn by I. Wilson, Cartographic Section, Department of Geography, University of Alberta.

Analysis of the lithic collections was primarily the responsibility of Close and Hassan with assistance from Lubell. Chippendale was instrumental in the study of modern land snail densities and first noticed the paucity of five-banded *Otala* spp. in modern assemblages. Elmendorf helped in all aspects of the research.

The senior author greatfully acknowledges the unstinting cooperation of all members of the project, but especially thanks Hassan, Close, Chippendale and Elmendorf for remaining in the field and completing work in progress when he and Gautier were forced to leave due to illness. Without their help this project would never have come to fruition. He also wishes to thank J. Rastoul of the Canadian Embassy in Algiers for succor at a particulary critical time.

Although the present report is very much a collaborative effort, with each of us contributing suggestions to the others, the major author(s) of each section are credited following the section title.

We dedicate this work to the memories of F.-E. Roubet and E. G. Gobert.

ENVIRONMENTAL SETTING

Eastern Algeria consists of two major biogeographical zones as defined by Quézel and Santa (1) on the basis of flora. To the north are the High Constantine Plains (H2) and to the south the Constantine Saharan Atlas (AS 3) which includes the Aurès and the Nemenchas. Essentially it is a region of plains bounded on the north, south and west by mountains. The region includes the major centers of Sétif, Constantine, Biskra and Tébessa (fig. 1). The elevation of the plains averages about 1 000 meters, with an undulating topography punctuated by elongate ridges which rise as musch as 500 meters above the plains.

The climate is semi-arid with cool, wet winters and hot dry summers. It falls within the steppe-grassland (BSk) of Köppen (2). Mean annual precipitation at Tébessa is 340 mm with a monthly minimum in July (8 mm) and monthly maximum in April (44 mm). Snow is common in winter. Mean annual temperature is 15° C with a mean monthly low of 5,6° C in January and mean monthly high of 25,6° C in July (3). The region is thus at or near the critical values for the limits of the grassland-desert boundary (4). As such, the ecological equilibrium of the region must be considered precarious and easily upset by anthropogenic disturbance. Such disturbance during the historic period is well documented within the circum-Mediterranean area (5) as well as in other regions of semi-arid climate (6). The introduction of mechanized wheat monoculture during the period of French colonization has had disastrous effects (7) which are readily visible today. Denuded slopes, rapid colluviation and marked degradation of stream beds are common. The density and size of Roman settlement in the region argues convincingly that the modern situation is mostly a recent phenomenon. For example, a shepherd living at the large Roman site on the the flank of Djebel El-Outed (where are there are numerous escargotières, fig. 2), told us he had to cross the Djebel El-Bib and go to Aïn Télidjène (a distance of about 10 km) to obtain water. It would appear that the water table has been lowered significantly since Roman times.

It is therefore unlikely that the modern vegetation patterns in this region bear any great resemblance to those of the historic or prehistoric past. The modern vegetation consists of a degraded steppe composed predominantly of grasses and shrubs such as alfa grass (*Stipa tenacissima*) and *Artemisia herba-alba* and *A. campestris*. In more humid habitats such as the courses of perennial wadis or near spring, poplar (*Populus alba*), willow (*Sadix pedicellata*), tamarix (*T. africana*), oleander (*Nerium oleander*), rushes (*Peganum harmala*) and various thistles all occur. On those slopes where some soil remains one can occasionally observe

(1) Quezel (P.) et Santa (S.). — *Nouvelle flore d'Algérie et des régions désertiques méridionales*. Paris, C.N.R.S., 1962.

(2) Butzer (K.W.). — *Environment and archaeology*. Chicago, 1971, pp. 73-75.

(3) Lebedev (A.N.). — *The climate of Africa, Part I*. Jérusalem, 1970.

(4) Langbein (W.B.) & Schumm (S.A). — *Yield of sediment in relation to mean annual precipitation*. American Geophysical Union Transactions, t. 39, 1958, pp. 1076-1084.

(5) Le Houerou (H.N.). — *North Africa : past, present future*. In, Dregne (H.N.), (ed.), *Arid lands in transition*, Washington, 1970, pp. 227-278.
Naveh (Z.) & Dan (J.). — *The human degradation of mediterranean landscapes in Israël*. In, Di Castri (F.). & Mooney (H.A.), (eds.), *Meditarranean type ecosystems*, New York, 1973, pp. 373-390.

(6) York (J.C.) & Dick-Peddie (W.A.). *Vegetation changes in southern New Mexico during the past hundred years*. In, Mc Ginnies (W.G.). & Goldman (B.J.), (eds.), *Arid lands in perspective*, Tucson, 1969, pp. 155-166.

(7) Paskoff (R.). — *Geomorphological processes and characteristic landforms in the mediterranean regions of the world*. In, Di Castri (F.) & Mooney (H.A.), (eds.), *Mediterranean type ecosystems*, New York, 1973, pp. 53-60.

stands of pine (*Pinus halepensis*), oak (*Quercus ilex*) and juniper (*Juniperus phoenicea*).

The economy in the area today is primarily a herding one with sheep and goat the principle crop. Small-scale farming provides many of the vegetables used locally although irrigation is required for adequate yields. Cereals are grown primarily on the plains between Tébessa and Constantine. This pattern is beginning to change with the introduction of modern cropping practices, communal agricultural operations, and large-scale irrigation as part of the agricultural reform program of the Algerian government. Efforts are also underway to terrace and reforest some slopes. Undoubtedly these activities will eventually destroy many of the remaining prehistoric sites in the region.

Wild fauna are rare, consisting primarily of hare, the occasional jackal, a few birds, some reported but very rare gazelle or antelope, and a range of terrestrial microfauna including gerbils, scorpions, and the same species of land snails found in Capsian escargotières.

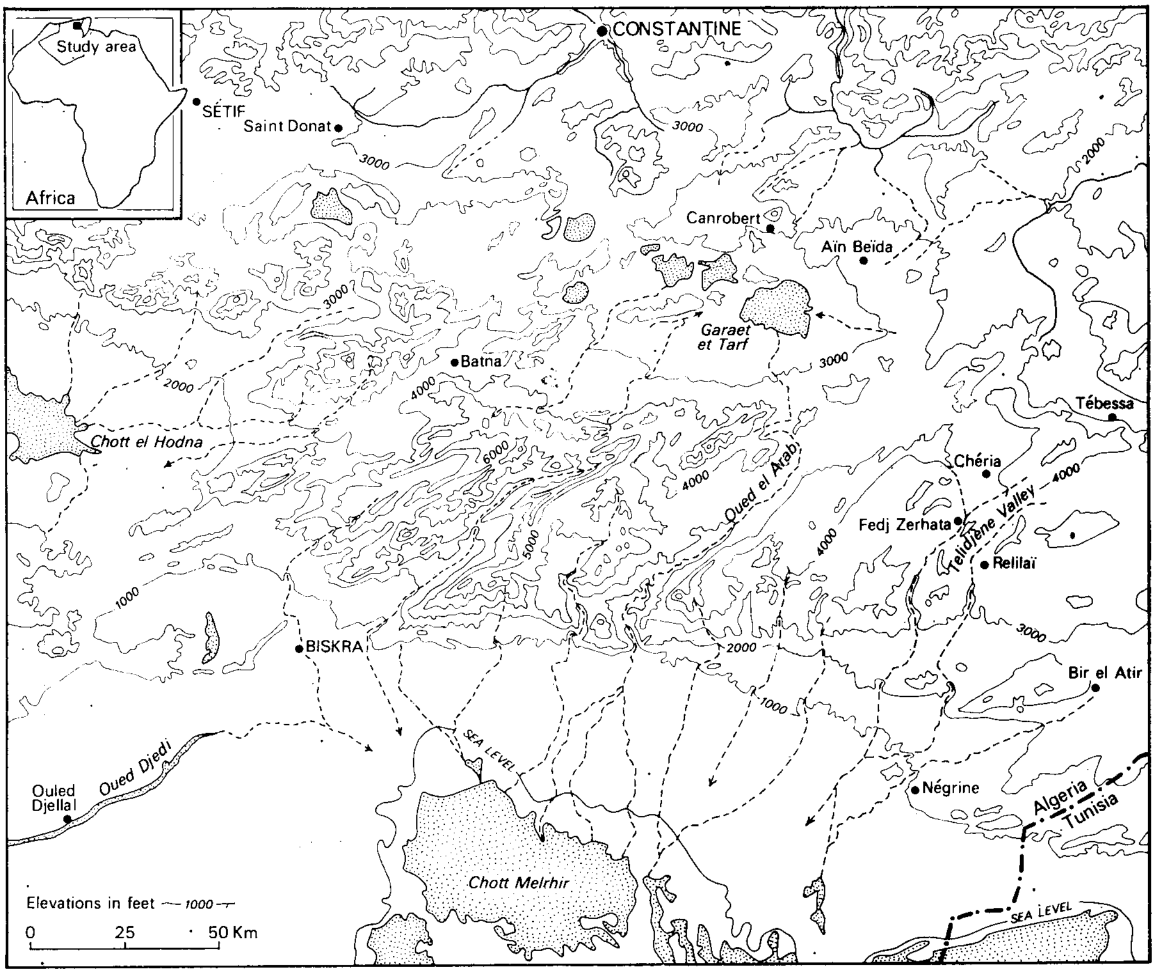

Fig. 1. — Eastern Algeria.

Water is available from springs, artificial wells of up to 20 meters depth, or perennial streams. It seems to be in reasonably plentiful supply although shortages do sometimes occur during the mid-summer.

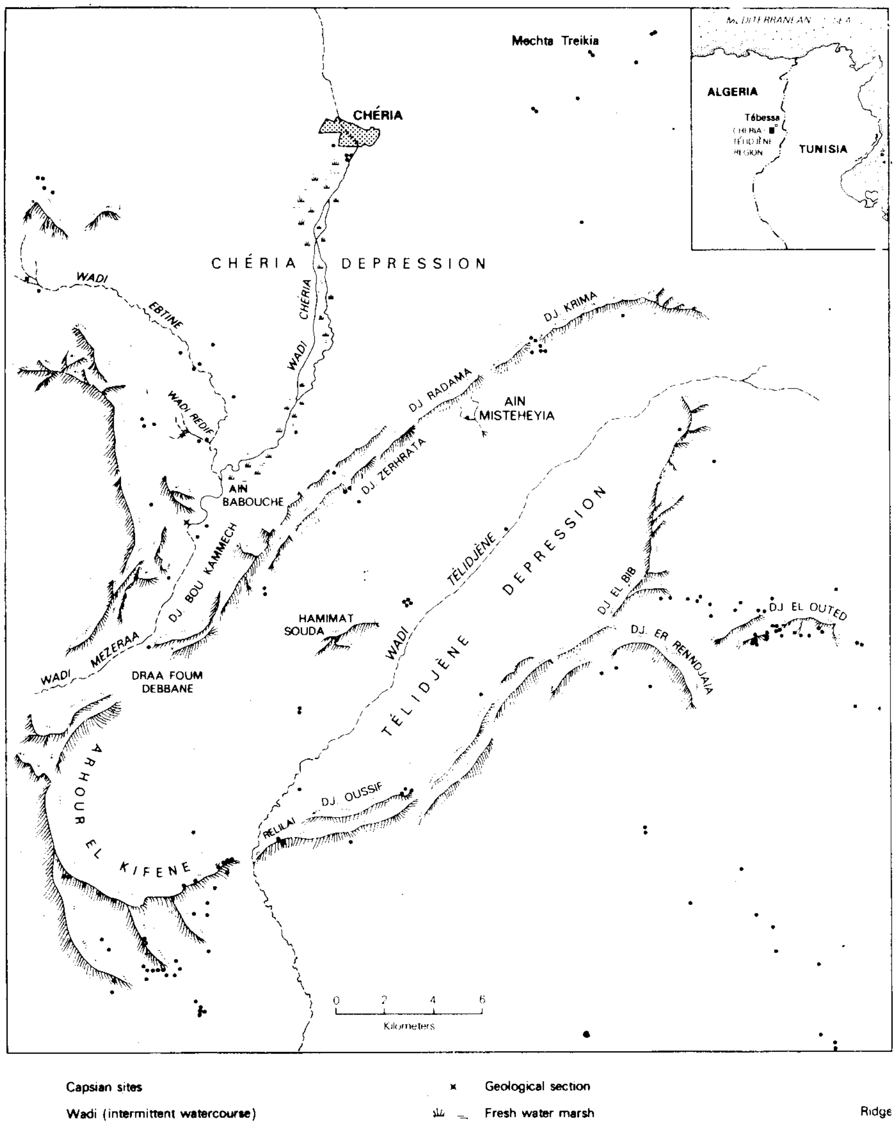

Fig. 2. — Chéria/Télidjène Region.

GEOLOGY AND GEOMORPHOLOGY OF THE CHERIA REGION

J.-L. Ballais

General Geomorphological Setting.

The region of Chéria is characterized by the juxtaposition of large SW-NE oriented depressions bounded by low narrow djebel systems of uplifted Eocene limestones. A series of five such depressions constitute the region of contact between the High Constantine Plains and the Nemenchas *sensu stricto.* From west to east they are : the Ounrhal depression, the Outa Guert-Outa Gassès depression, the Outa Zora-Outa Guibeur depression, the Chéria depression and the Télidjène depression. Our work has been confined to the latter two.

The Chéria depression is the largest (40 x 22 km) and most complex of the series. It is a large lobed syncline rising steeply to the north (Djebel Dokkane, 1 712 m) where the northern bounding ridges dominate the marshy Tébessa plain. The lobed outline of the depression is due to a succession of two synclinal undulations (Dj. Dokkane in the east and Dj. Treubia in the west) which are separated by the southern flank of an eroded anticline and traversed by the Chéria-Hammamet road. In the southern portion of the syncline the dips increase, forming the anticlines of Outa Guibeur to the southwest and Télidjène to the southeast. These anticlines are separated by a narrow syncline complicated by anticlinal folds near Aïn Babouche. Wadi Chéria-Mezeraa drains south through this syncline and disappears several kilometers downstream (fig. 2).

The Télidjène depression (28 x 8 km) is rich in Capsian sites (fig. 2), and has been the focus of our research. The basin is bounded by an escarpment of jointed Eocene limestone which rises to 1 380 m at Dj. Bou Kammech. In the center of the depression is an isolated assymetric *mont derivé,* the Hamimat Souda (1 183 m) formed of Lower Cretaceous sandstones and quartzites which dip gently to the east and more steeply to the west where they are affected by several faults. To the south of this the extensive zone of transversal faults of Outa Zora-Outa Guibeur is replaced by the diapiric zone of Draa Foum Debbane which is formed of conic hills with steep slopes eroded in Triassic salt-bearing clays and overlain by highly jointed dolomitic limestones with a brown patina. In the center of the depression, Wadi Télidjène has cut its bed into greyish-green marly clays of Upper Cretaceous-Paleocene age.

The origin of this relief is not yet fully understood. The hydrographic network and the formation of large depressions appears closely related to the anticlinal-synclinal alternation and the soft, thick Cretaceous marls capped by thin (25 m maximum) and very resistant Londinian limestones. It is also possible the modern topography results from fluvial downcutting of an older erosional surface. The hydrographic network agrees with the tectonic style and the general dip to the south. However, some streams show aberrant patterns, especially in faulted zones. The regularity in the altitudes of the djebels is also indicative of a former erosion surface. No definitive interpretation is possible at present for the geology of the Nemenchas is poorly known. The deposition of Miocene marine sediments to the west in the Aurès recorded by Lafitte (1) certainly does not agree with a transgression over a pre-Miocene surface.

(1) LAFITTE (R.). — *Les plissements post-nummulithiques dans l'Atlas Saharien.* Bull. Soc. Géol. France, 5e série, t. 19, 1939, pp. 135-159.

Pleistocene Landforms and Deposits.

No geomorphological or stratigraphic evidence for pre-Middle Pleistocene deposits (1) have been observed in the Chéria or Télidjène depressions As elsewhere in the Maghreb, the Middle Pleistocene appears to have been a period of intense morphogenetic change which destroyed earlier Quaternary deposits, and the absence of subsequent downcutting inhibited superposition of later deposits.

(1) We have used Middle Pleistocene and Upper Pleistocene instead of Tensiftian and Soltanian respectively. The latter two were originally proposed for Morocco by CHOUBERT & *al.*, C.R. Acad. Sci., t. 243, 1956, p. 504, but are no longer accepted by many workers because the type sections were poorly chosen : cf. BEAUDET & *al.*, Rev. Géogr. Phys. Géol. Dyn., t. 9, 1967, p. 269.

Therefore, the Middle Pleistocene pediment forms the main relief element in the depressions and can sometimes be traced almost to the center of the basins as an alignment of dissymetric cuesta-like heights. Upslope, a short and marked scarp between 30 and 50 meters high dominates the younger landforms and deposits (e.g. at Henchir Zoura in the southwestern part of the Télidjène Depression where the pediment truncates an anticlinal fold of Eocene limestone, fig. 2). Away from the scarp the surface slopes gently downwards and passes beneath Holocene deposits. Sometimes the Middle Pleistocene pediment is reduced to an isolated hillock (e. g. Koudia Mechouar immediately northwest of Chéria). It is always recognizable by its thin detritic cover of large rounded pebbles in a white calcareous crust which is powdery at the base but sometimes consolidated at the top.

The Middle Pleistocene pediment covers the greatest surface in the piedmonts. Near Aïn Misteheyia it forms a broad plain covered with *Stipa tenacissima.* The average slope is 5-6° but this increases to 10-12° at the contact with the base of the escarpment. The detritic cover is thin, consisting of 20 to 30 cm of flat unstratified pebbles in a hard calcareous matrix which is beige colored when freshly exposed.

Upslope, the Middle Pleistocene pediment passes into encrusted slope talus which masks the base of the escarpment, giving a regularized slope profile. A second and local type of breccia is found near the faulted anticlinal fold which is responsible for both the form of Garat el-Misteheyia and for the spring. This breccia is composed of limestone blocks in which fracture planes follow joints. The blocks are cemented onto the Eocene limestone.

The morphology of pebbles from the Middle Pleistocene detritic cover as well as from the slope talus deposits, indicate intense gelifraction during the formation of these landforms. Additional observations suggest a minor phase of tectonic activity contemporaneous with the Middle Pleistocene pediment. In the piedmont of Djebel Radama, we have observed folded deposits on the right bank of Wadi Hamaja about 200 meters downstream from a small quarry. These beds are between 2 and 3 meters thick. They are formed of well-stratified limestone gelifracts a few centimeters long, which dip upslope and are packed in a very consolidated calcareous matrix. The downstream dip is 30° to the east. Fifty meters upstream the deposit butts against the base of the escarpment at an angle of 10-15°. These beds are truncated by Middle Pleistocene detritic deposits which show evidence for cryoturbation at the base.

The lower deposits were, therefore, deformed by a folding phase which rejuvenated the syncline separating the small faulted anticline of Garat el-Misteheyia from Djebel Radama. It is impossible to accurately date this tectonic phase or the Pleistocene deposits affected by it. The folding may be intra-Middle Pleistocene following a period of dry climate which favored encrustation. The folding was followed by a phase of active frost weathering which furnished the clastics for the rill and sheet wash which truncated the earlier deposits. Alternatively, a long period of consolidation may have preceded the folding, in which case the folded deposits would be pre-Middle Pleistocene. Comparable Quaternary tectonic events are known. These include the Gafsa fault (1), the subsidence of the el-Outaya Plain (2), the tilting of the « Saletian » or « Amirian » pediment at Darza Arma southeast of el-Kantara due to rejuvenation of a post-Eocene fault (3), and the north flexure of the Aurès which affected all the Middle Pleistocene and pre-Middle Pleistocene deposits (4).

The Upper Pleistocene pediment is normally found downslope from the Middle Pleistocene pediment. Near the center of the depressions it usually passes beneath Holocene deposits. About 200 to 300 meters upslope from Aïn Misteheyia its contact with the Middle Pleistocene pediment is marked by a break in slope of 10-12° and a change in vegetation from *Stipa tenacissima* to *Artemisia herba-alba*. Below the escargotière the slope of the Upper Pleistocene pediment decreases to about 2-3° and is indistinguishable from the Holocene alluvial deposits which have a slope of 3°.

When complete, the Upper Pleistocene pediment is several meters thick and is composed of three units :

Upper unit : a thin bed of subangular pebbles in a fine beige-colored matrix.

Middle unit : a thick bed of light-orange fine silty and with unstratified rounded pebbles 1-2 cm long.

Lower unit : rare large angular pebbles and occasional reworked blocks of the older pediment.

A profile through the upper facies just below the Aïn Misteheyia escargotière in Wadi Hamaja reveals the following sequence :

0-30 cm : Dull orange (7,5 YR 7/4) loamy sand with small gravel and some larger (3 cm) flat angular pebbles.

30-90 cm : Small rounded pebbles in a pale orange (7,5 YR 8/3) sandy matrix encrusted with powdery calcium carbonate.

90-120 cm : Dull orange (7,5 YR 7/4) sandy loam with a few pebbles. The base extends below the present wadi bed.

As with the Middle Pleistocene pediment, the Upper Pleistocene one is associated with slope breccia. These are unencrusted, have an orange matrix, and have slightly eroded the rather regularized slopes.

Holocene Landforms and Deposits.

The Chéria and Télidjène Depressions contain well-developed Holocene deposits. The most important of these is the Chéria formation, consisting of terrace and slope deposits. Deposits of Roman age and later are inconspicuous.

The Chéria formation is complex and variable in extent. Upslope, the terrace and slope deposits are often continuous (even along smaller wadis) and vary from a few decimeters to 20 meters laterally. Deposits of the Chéria formation fill the center of the depressions and it is possible to distinguish several facies which result from differences in both topopgraphic position and lateral extension of the deposits.

The type section of the Chéria formation (fig. 3) is located on the right bank of Wadi Chéria-Mezeraa at the foot of Djebel Mezeraa at a point where the valley is only about 200 m wide. A section of 5,90 m is exposed, which reveals the following sequence from top to bottom. We have divided this into

(1) VAUFREY (R.). — *Les plissements acheuléo-moustériens des alluvions de Gafsa*. Rév. Géog. Phys. Géol. Dyn., t. 5, 1932, PP. 299-321.

(2) GUIRAUD (R.). — *Evolution post-Triasique de l'avant-pays de la chaîne alpine en Algérie d'après l'étude du bassin du Hodna et des régions voisines*. Nice, 1973.

(3) BALLAIS (J.-L.) et GUIRAUD (R.). — *Carte géologique d'El Kantara au 1/50 000*. Alger, 1973.

(4) BALLAIS (J. - L.). — *Etude comparative des glacis des piémonts nord et sud des Aurès*. Colloque sur les glacis d'ablation, Tours, 1974.

the four members which constitute this formation, and which are overlain by Roman deposits.

Roman Deposits :

— Dull yellow orange (10 YR 6/3) silt with carbonized roots and rare large landsnails : 44 cm.

— Dull yellowish brown (10 YR 5/3) silty lens containing a lens of flat subangular pebbles (5-10 cm), flat pebbles (5-6 cm) and subrounded pebbles (20-40 cm) as well as an irrigation channel with Roman potsherds : 46 cm.

Chéria formation, member 4 :

— Loamy clay (possible paleosol) divided in to a lower dull yellowish brown layer (10 YR 5/3) containing 11, 7 % loam and 38, 8 % clay ; a middle layer dull yellow orange (10 YR 6/4) in hue ; and an upper layer of greyish yellow brown (10 YR 6/2) color containing 27, 9% loam and 40,4 % clay with many large landsnails : 70 cm.

— Lens with flat, subangular, stratified pebbles (3 cm) in a dull yellowish brown (10 YR 4/3) loamy matrix : 10 cm.

— Dull brown (7,5 YR 5/3) loamy sand with non tabular and subangular pebbles (5 cm and 2-3 cm) and large landsnails : 32 cm.

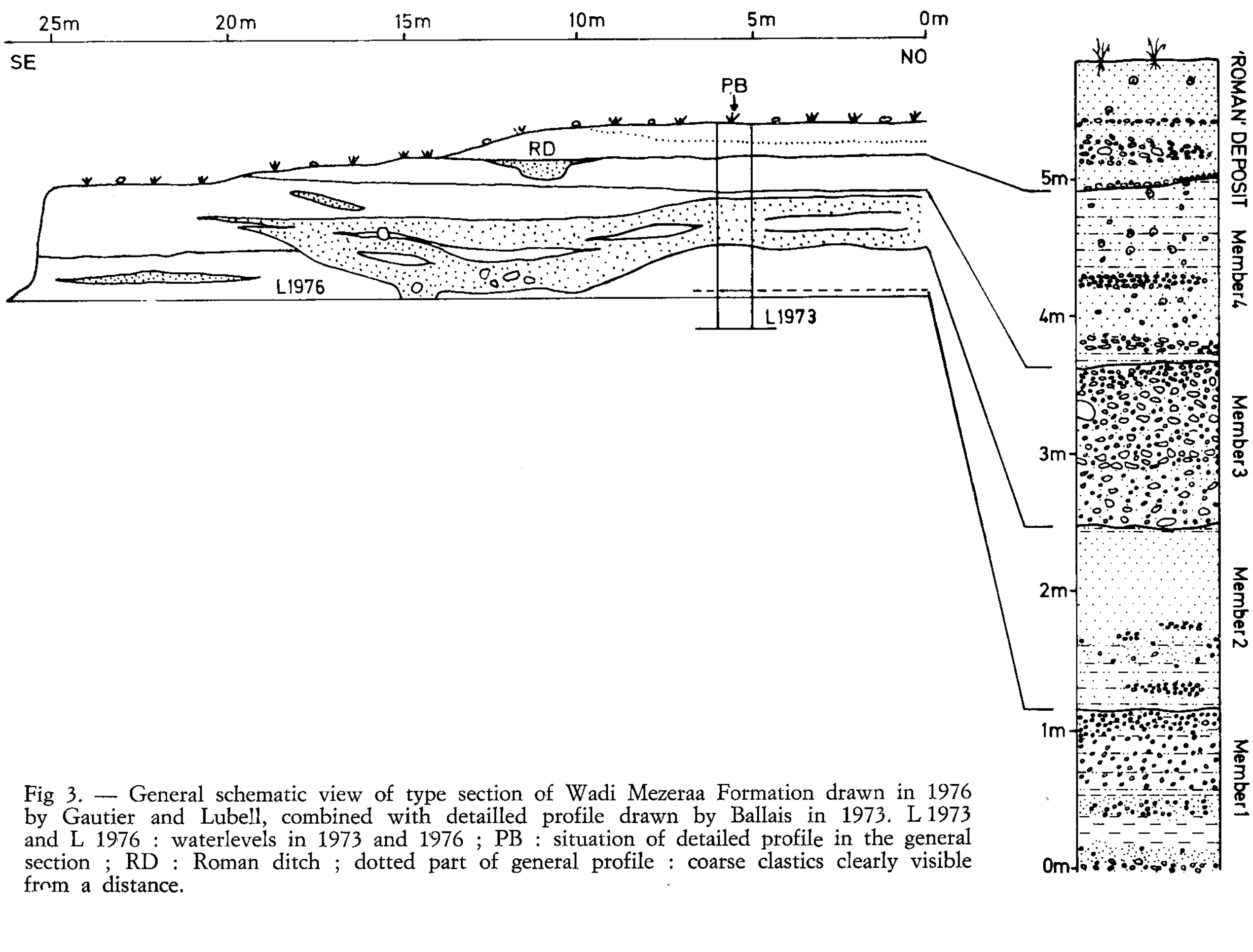

Fig 3. — General schematic view of type section of Wadi Mezeraa Formation drawn in 1976 by Gautier and Lubell, combined with detailled profile drawn by Ballais in 1973. L 1973 and L 1976 : waterlevels in 1973 and 1976 ; PB : situation of detailed profile in the general section ; RD : Roman ditch ; dotted part of general profile : coarse clastics clearly visible from a distance.

Chéria formation, member 3 :

— A lens of flat, subangular pebbles (0,3-5 cm) containing flint, in a dull yellow orange (10 YR 6/3) matrix which stratified but lacking clear orientation and includes small landsnails : 40 cm.

— A lens of subangular and occasional flattened pebbles (10 cm), small flat pebbles, some flint, and a large block (30 cm) in a coarse dull orange (7,5 YR 6/4) loamy matrix : 58 cm.

— A coarse deposit in a loamy dull orange (7,5 YR 6/4) matrix with many flat and rounded pebbles (2 cm) as well as smaller ones, some well-rolled unstratified large pebbles (8 cm) and some flint : 40 cm.

Chéria formation, member 2 :

— A clayey sandy dull orange (5 YR 6/3) deposit with bright brown (2,5 YR 5/8) iron oxide veins and stains of manganese oxide : 6 cm.

— A dull orange (5 YR 6/3) loamy deposit with ferruginous veins and small discontinuous lenses of flat angular pebbles (1-2 cm) at the base : 70 cm.

— A coarse lens of small flat subangular pebbles (1-5 mm), a few larger non tabular and rounded pebbles (2-4 cm), and some flint in a sandy loam matrix with ferruginous dull orange (7,5 YR 6/4) veins : 20 cm.

— A dull yellow orange (10 YR 6/3) deposit of loam, sand and clay with dull orange (5 YR 6/4) ferruginous veins, and a thin layer of 1 cm long gravels : 28 cm.

Chéria formation, member 1 :

— A deposit similar to the underlying one but denser and less coarse in a matrix of loam, clay and sand : 20 cm.

— A deposit of flattened, subangular pebbles (at least 1 cm long), small rolled pebbles and some larger ones, in a dull brown (7,5 YR 6/3) loamy matrix : 38 cm.

— A dull brown (7,5 YR 5/3) clay with ferruginous veins : 4 cm.

— A gravel deposit with small rounded and sometimes flattened pebbles in a sandy matrix with dull orange (5 YR 7/3) stains : 16 cm.

— A dull yellow-orange (10 YR 6/4) clay : 22 cm.

— A gravel deposit with non tabular or subangular pebbles in a sandy matrix with ferruginous stains : visible thickness of 18 cm.

Deposits below this are of unknown depth as they are obscured by the modern wadi bed.

We have obtained a single radiocarbon date from member 2 of 5 839 ± 95 B.P. (I-7 693). The sample consisted of small spiriform land snail shells of an unidentified species found today in moist wadi bank habitats. This date may be too recent because these snails may have incorporated dead carbon (derived from older carbonates and present in the moist soil) during shell building.

Profiles comparable to the type section have also been observed in the piedmonts. The section at Mechta Treïkïa in the Chéria Depression reveals the following sequence (fig. 4).

Roman Deposit :

— Coarse deposit derived from the Upper Pleistocene pediment : 40 cm.

Fig. 4. — Section through the Chéria Formation at Wadi Redif showing escargotière reworked into alluvial sediments.

Chéria formation, member 4 :

— Fine deposits containing loam ; a lens of discontinuous stringers of small pebbles and large snail shells separated by a fine orange lens from a lower lens of flat pebbles (5 cm) and nontabular pebbles (7-10 cm).

Chéria formation, member 3 :

— Coarse deposits with a transitional zone at the base (70 cm) formed by two coarse lenses alternating with two fine lenses with horizontal bedding. These are followed by 70 cm of coarse lenses formed of rolled limestone pebbles (5-10 cm) long, flint, and some apparently reworked quartzite in a matrix which is very encrusted with calcium carbonate.

Chéria formation, member 2 :

— Fine deposits, 30 cm thick, consisting of brownish loam with a few pebbles, many landsnails reworked from escargotière deposits. This overlies a comparable grey deposit.

Other sections in the piedmont have been studied at Wadi Redif, Wadi Ebtine, Mechta Treïkïa, and Wadi Hamaja. The latter will be described in the report on geology and geomorphology of the Aïn Misteheyia locality (see below). At both Mechta Treïkïa and Aïn Misteheyia the sections contain reworked material from Capsian sites. At Wadi Redif, an entire escargotière has been undercut by a former course of the wadi, reworked into the alluvium, and subsequently exposed in section (fig. 4).

The preceeding descriptions suggest that the Chéria formation can be tentatively divided into four members : member 4, an upper deposit of fine clastics which are sometimes mixed ; member 3, a deposit of coarse clastics which overly disconformably ; member 2, a lower deposit of fine clastics containing many landsnail shells and reworked escargotière materials ; and member 1, the basal deposit of coarse clastics which is of unknown depth.

We have been unable to identify these four member at all the localities studied. In those instances where the Holocene alluvial cover is thin, or where only fine deposits occur, a four part division is impossible. For example, at Aïn Misteheyia local factors seem to obscure the general picture. In the depressions, the absence of marked downcutting has inhibited the development of exposures appropriate for study. We have observed only one such section in Wadi Ebtine (fig. 5) where the following sequence recorded :

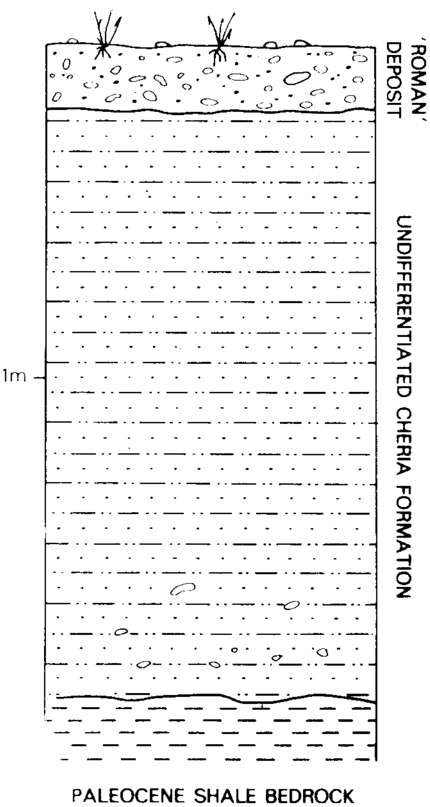

Fig. 5. — Section through the Chéria Formation at Wadi Ebtine.

Roman Deposits :

— Reworked material from the Upper Pleistocene pediment containing abundant small (6-7 mm) rolled subangular pebbles as well as some larger (3 cm) ones and a few flints in a dull brown (7,5 YR 4/4) sandy silt matrix of 16 cm thickness.

Chéria formation, undifferentiated fine facies :

— Highly calcareous orange (7,5 YR 7/6) coarse, angular, blocky deposit of sand (55 %), clay (24, 2 %) and silt (20 %) : 92 cm.

— Dull yellow orange (10 YR 7/4) sands (51,2 %) and clay (33,25 %) with blocky structure : 13 cm.

— Orange sand (7,5 YR 6/6) with silt (12,2 %) and clay (20,7 %) and rare, mostly subangular small pebbles (3 to 5 mm) as well as some larger ones (4 cm) : 40 cm.

Bedrock (Upper Cretaceous) :

— Variegated clays (58,5 % clay, 25,95 % silt) with calcite crystallizations.

Associated with the Chéria formation and terrace are alluvial fans and talus debris. The former are only seen in mountainous areas and are therefore almost absent in the Chéria region. However, well defined alluvial fans can be observed in the tributaries of Wadi Chéria-Mezeraa where, on the left bank facing the type section of the Chéria formation, one such fan overlies member 2 deposits (which contain reworked material from an escargotière) and is interstrafified with member 3 deposits. Another, similar situation was observed a short distance upstream on the right bank.

During the deposition of the Chéria formation and terrace, the mountain slope profiles were affected by only minor changes. However, the type section of the Chéria formation contains, in member 1, large fallen angular blocks derived from the limestone escarpment which are tipped towards the wadi bed. Slightly downstream, on the opposite bank, is a collapsed rockshelter containing Capsian deposits. Comparable blocks can also be seen in member 3 deposits. Further upstream, on the same bank, a high vertical north facing cliff dominates the Chéria terrace. Both downstream and upstream this cliff passes into regularized Late Pleistocene slopes which have hardly been affected by subsequent rill wash. At the foot of the cliff, a stabilized talus cone contains limestone blocks of several cubic meters which are lying flat and are incorporated into the Chéria formation deposits. These blocks have destroyed another Capsian site.

It is clear, therefore, that larger clastics were supplied by both upstream and lateral sources during the deposition of members 1 and 3 of the Chéria formation. It should also be noted that post-Pleistocene calcareous encrustations are exceptional and limited. The terrace is never encrusted, but where an escargotière rests partially on pre-Pleistocene calcareous strata (e. g. the ridge site above Aïn Misteheyia), snail shells, stones and artifacts are cemented into a calcareous matrix of cultural deposits which fill joints in the underlying bedrock limestone.

Recent Terraces (post-Roman) :

Recent terraces are of very limited extent. In the small piedmont wadis, only a discontinuous bench of a few decimeters occurs above the actual wadi channel. It is formed of large subangular gravels with almost no matrix. These recent terraces have been cut into the Chéria formation and form part of the modern floodplain. They are sometimes colonized by vegetation.

Recent terraces are better developed in the major wadis where downcutting has been more extensive. Immediately downstream from the type section in Wadi Chéria-Mezeraa two terraces colonized by willows are visible above the flood plain. The upper terrace begins at water level and rapidly attains an elevation of 2 to 3 m. It is an ablation terrace cut into the fine blackish deposits of member 2 with, perhaps, a thin alluvial cover about 50 cm thick consisting of flat (IF = 2,04) and subangular (IR = 107) limestone pebbles (fig. 8). This deposit is sometimes stained with iron and manganese oxides and contains an intercalated level of fine deposits (1).

The lower terrace, at about 50 cm, is discontinuous and is still functional during floods as indicated by stringers of pebbles without pattern or matrix derived from the major bed.

(1) Cf CAILLEUX (A.). — *Distinction des galets marins et fluviatiles.* Bull. Soc. Géol. France, 5e série, t. 15, 1945, pp. 374-404.

Holocene morphogenesis :

By the end of the Pleistocene general but irregular downcutting occured. In the upper reaches of the depressions this erosion is sometimes down to the base of the Upper Pleistocene deposits. It is generally accepted that these Upper Pleistocene deposits formed under a cold, humid climate by areal erosion and frost weathering in an open landscape. The downcutting, therefore, indicates a change to warmer and drier climate with reduced mechanical weathering (especially frost heaving) and more concentrated flows of greater erosive power.

The Chéria formation and terrace developed in the downcut areas which formed during this erosional phase. They correspond to a renewed phase of mechanical disintegration which was sufficiently important to inhibit further downcutting and provoke alluviation. This general picture can be refined on the basis of the differences observed in the four members of the Chéria formation.

The deposits of member 1 are poorly known because they are generally below the level of the modern floodplain. They appear to indicate vigorous mechanical disintegration, most probably due to gelifraction.

Member 2 is composed of both coarse and fine deposits. The coarse clastics are characterised by flat limestone pebbles (IF = 2,58). The histogram of flattness (fig. 6) shows a principal maximum (25 %) between 1,5 and 2,0 with a second maximum (15 %) between 2,5 and 3,0 and a third (7 %) between 4, 0 and 4,5. Gelifracts formed by micro-gelivation and mostly of Late Pleistocene age, as well as material derived from macro-gelivation and rock fall (probably also of Late Pleistocene age but possibly earlier) are present. The histogram for indices of rounding (fig. 7) shows only one maximum (33 %) between 50 and 100 with 23 % below 50 and 17 % between 100 and 150. This indicates that the pebbles are mostly reworked from the Upper Pleistocene pediment by very powerful flows.

The fine deposits of member 2 are composed primarily of brownish silty sands and clays which are rich in organic matter, snail shells, bone, aritfacts and fire-cracked rock derived from Capsian sites. Pieces of charcoal from fine deposits of member 2 in Wadi Chéria-Mezeraa have been tentatively identified as *Quercus ilex* and *Cupressus sp.* (Bouzenoune *in litt.*). It appears that fine deposits of member 2 were deposited under conditions of reduced frost weathering by slow and regular flows which transported fine clastics derived from both escargotières and soils forming under an open Mediterranean woodland. The climate was apparently cooler and more humid that at present, especially during the summer.

The downcutting which followed the deposition of member 2 reached 4 meters at Wadi Chéria-Mezeraa and 2 meters at Wadi Redif. As during the post-Pleistocene downcutting, linear incision predominated and was facilitated by the easily eroded fine deposits of member 2. Although less pronounced than the earlier phase, this mid-Holocene period of downcutting certainly indicates a new phase of contracted flows and, therefore, a more arid climate.

A renewal of mechanical weathering marks member 3. This histogram of flatness (fig. 7) has a median comparable to member 2 (IF = 2,52) but the distribution is different. The principal maximum between 1,5 and 2,0 is attenuated 19 % and 18 % of the pebbles fall between 2,0 and 2,5. The second maximum is more pronounced (18 %) and the third about the same with 6 % between 4,0 and 4,5. Apparently frost weathering provided a fresh supply of pebbles. This renewal of mechanical weathering and deposition of coarse materials is confirmed by the presence of alluvial fans and talus deposits.

The above interpretation is confirmed by the histogram of rounding (fig. 7). The median increases (IR = 96) and a unimodal distribution is more pronounced with 39 % between 50 and 100, only 16 % between 0 and 50, and 20 % between 100 and 150. There is, in other words, a shift to greater roundness which suggests a colder climate with more freeze/thaw cycles, decreased evaporation, and stronger flows. Some increase in precipitation may be indicated as well.

Member 4 is marked by a sharp decrease in flattening of limestone pebbles (IF = 2) and a unimodal histogram distinct from the previous ones (fig. 7). Thirty percent of the pebbles are between 1,5 and 2,0 with 20 % between 1 and 1,5 and 21 % between 2 and 2,5. This distribution can be unquestionably interpreted as a result of reduced micro-gelivation. The decrease in roundness

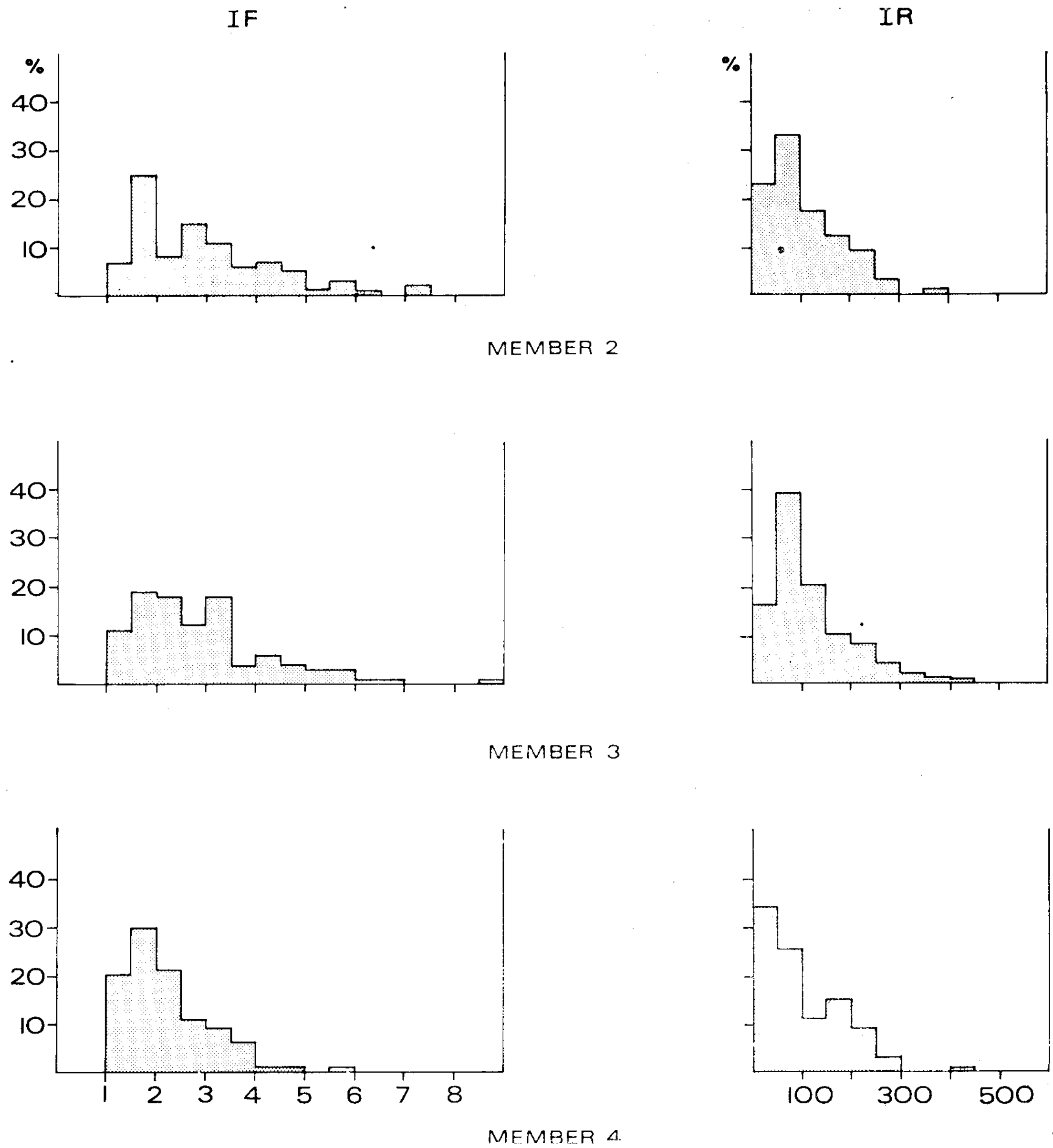

Fig. 6. — Histograms of Indices of Flattening (IF) and Rounding (IR) of Limestone Pebbles from the Chéria Formation, Type Section.

is not as pronounced (IR = 85), but nevertheless, the histogram (fig. 7) becomes bimodal with a marked maximum between 0 and 50 (34 %), with 25 % between 50 and 100 and 15 % between 150 and 200, indicating low capacity flows and micro-gelivation and reworking. As a whole, member 4 is indicative of higher temperature, decreased micro-gelivation, increased evaporation and reduced flows. The climate was, however, drier than during the deposition of member 2.

A downcutting phase follows the Chéria formation and preceeds the deposition of the upper recent terrace. It is more pronounced than the intra-Chéria phase but less than the phase which preceeds the Chéria formation. This post-Chéria downcutting is in all likelihood due primarily to the indirect influence of human interference which will be discussed in the following section.

The morphoscopic study (fig. 7) of the upper recent terrace shows a histogram of flattening comparable to that of member 4 (IF = 2,04). It is unimodal with 33 % of the pebbles between 1,5 and 2, 13 % between 1 and 1,5, 20 % between 2 and 2,5, and only 5 % above 5. Roundness is more pronounced than in the Chéria formation (IR = 107) and the histogram is bimodal with 26 % of pebbles between 0 and 50 and 21 % between 100 and 150. Both histograms indicate a diminution in the supply of fresh material which is due to the disappearance or reduction of micro-gelivation, the reworking of older deposits, and increased stream competence.

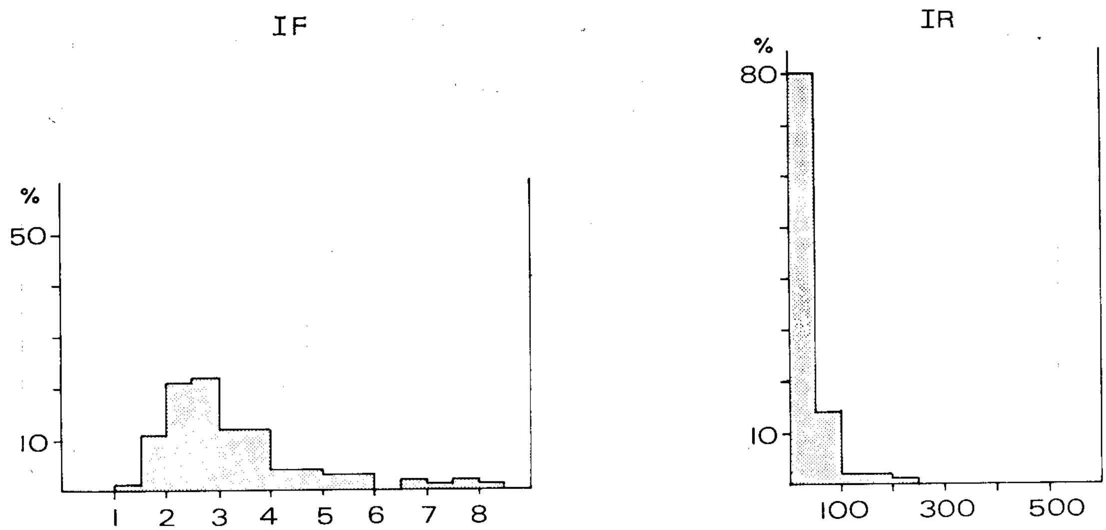

Fig. 7. — Histograms of Indices of Flattening (IF) and Rounding (IR) of the Upper Recent Terrace in Wadi Chéria-Mezeraa.

Holocene Chronology :

Member 2 of the Chéria formation is tentatively dated at 5 839 ± 95 B.P. (I-7693). This represents an average date for the upper part of the member. Member 1 of the Chéria formation is indirectly dated by the three radiocarbon dates from Aïn Misteheyia at between ca. 9 500 and ca. 6 500 B.P. (table 22), which is consistent with the latest published synthesis on North African Chronology (1). Most of the material reworked from Capsian sites is found in member 2 deposits. Moreover, large frost-wedged blocks contemporaneous with member 3 have destroyed several Capsian sites in Wadi Chéria-Mezeraa. From this, we

(1) CAMPS (G.), DELIBRIAS (G.) et TOMMERET (J.) — *l. l.*, 1973.

conclude that deposition of member 1, and the lower part of member 2 were probably contemporaneous with the period of Capsian occupation in this region.

Members 1 and 2 are separated from the upper members of the Chéria formation by a marked erosional disconformity which cannot be dated at present. Member 3 cannot be dated as well, but a terminal (Roman age) date can be inferred for the stabilized surface of member 4 (cf. paleosol in type section ?).

Apparently similar deposits have been observed elsewhere in Algeria. Guiraud (1) has described hydromorphic deposits in the Hodna basin as « Soltanian II ». These appear similar to the deposits of member 2 and the designation « Soltanian II » should be dropped as it refers to Holocene deposits rather than Upper Pleistocene ones.

(1) Guiraud (R.). — *Op l.*, 1973.

The fill of the irrigation ditch exposed in the type section of the Chéria formation (fig. 3) contains potsherds, some of which are typical Roman *terra sigillata.* Other remains of Roman occupation in this region are abundant, and among them are a number of dams still standing in wadis or exposed in wadi banks. One of the latter, exposed in profile a few meters upstream from the type section of the Chéria formation, is constructed of large uncemented, dressed limestone blocks 4 meters above present floodplain. Another crude dam can be seen 1 meter above present floodplain on the right bank of the Wadi Redif a few meters upstream from the section containing the reworked escargotière (fig. 10). A second dam constructed of small dressed stones built on Eocene limestone bedrock is still standing some fifty meters further upstream.

The evolution of the hydrographic system during Roman times can be retraced as follows. Initially, the topographic surface in the depressions was several decimeters lower than today. In the piedmonts, the wadis were shallow, but their regular régime permitted the construction of dams and decantation basins for water storage and regulation of supply. A phase of intensive erosion followed, destroying many escargotières and causing partial colluviation of the pediments which denuded slopes and filled the depressions with sediments that also choked the irrigation channels. At Sidi Aïch in the Soummam Valley, a one meter thick deposit of beige silty colluvium covers a little valley paved with Roman tile so this phase of siltation does not appear to be confined to the Chéria region. Following this phase of alluviation and colluviation, generalized downcutting leading to the modern topography commenced. It destroyed many of the dams and has had marked results as, for example, in Wadi Chéria-Mezeraa where the downcutting has reached 6 meters. This degradation phase been interrupted at least twice by phases of very minor aggradation or, simply, cessation of downcutting.

Despite the brevity of this period (less than 2 000 years), climatic variation may be partially responsible for the late Holocene evolution of the landscape. Aridification may have partially destroyed vegetation, leading to sheetwash soil erosion and downcutting. However, it is far more likely that this evolution is related to human occupation and interference. Roman agriculture in the basins and sheep-goat herding on slopes has resulted in pronounced denudation of the vegetation cover which has not been allowed regenerate during post-Roman times. The density of gullies, the existence of dams, and the density of Roman and pre-Roman sites in localities rarely inhabited today indicates the importance of this human interference, which is well documented elsewhere in the circum-Metiderranean region. Deforestation resulted in the erosion of the thin soil cover, and since neither vegetation nor soils provided effective deterrents to runoff, streams became directly controlled by the pluvial régime and the surplus energy available was, and still is today, used for downcutting.

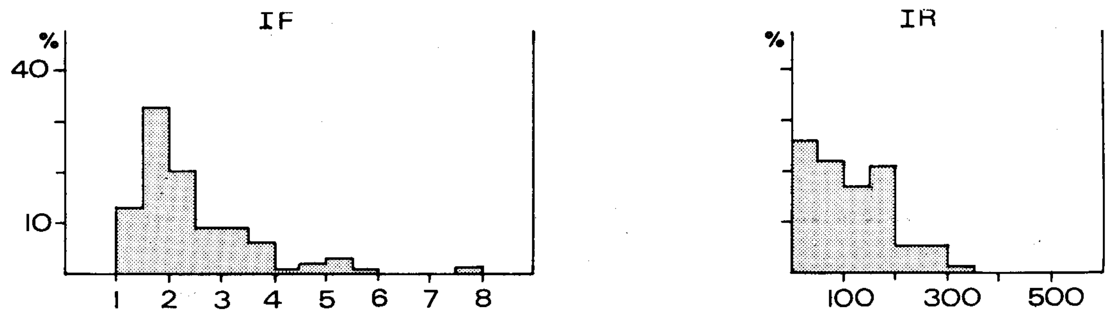

Fig. 8. — Histograms of Indices of Flattening (IF) and Rounding (IR) of recent gelifracts collected in the rockshelter at Relilaï.

The younger terraces indicate two minor episodes during which the supply of clastics was increased due to reworking of older deposits by erosion of wadi banks or, perhaps, short periods of gelifraction. Today, gelifraction is restricted primarily to north-facing cliffs and rock shelters. At Relilaï, for example, a sample of rockfall shows a unimodal distribution for flattening (22 % between 2,5 and 3) and the indices of rounding are between 0 and 50 in 80 % of the specimens measured, with a median of 40 (fig. 8).

The morphogenesis, lithostratigraphy and prehistoric/historic sequence in the Chéria region is summarized in Table 1. At this time it is impossible to draw firm correlations with either the Holocene sequence in Europe or with the tentative climatic curve established for Algeria (1). It should be noted, monetheless, that members 1 and 2 of the Chéria formation suggest a change from drier to more humid climate and that this seems to correspond to a similar trend noted by Couvert which is dated between ca. 9 000 and 8 000 B. P. Furthermore, geochemical, sedimentological and radiometric evidence from Aïn Misteheyia (see below) suggest a similar age for member 1 and contain evidence for an interval of drier climate which may correspond to a similar period noted by Couvert during the same period.

(1) COUVERT (M.). — *Variations paléoclimatiques en Algérie : traductions climatique des informations paléobotaniques fournies par les charbons des gisements préhistoriques, note préliminaire.* Libyca, t. 20, 1972, pp. 45-48.

GEOLOGY AND GEOMORPHOLOGY OF THE AIN MISTHEYIA LOCALITY

F. A. Hassan

The Aïn Misteheyia escargotière (7° 45' 54" E, 35° 11' 39" N) is located in the Télidjène Depression at an elevation of 1 100 meters a.s.l. on the foot slope of Garat el-Mistehevia, an outlier of Djebel Radama (fig. 9). The site is 1,5 km east of Fedj Radama Kebir and 3 km west of Fedj Krima where there are six other escargotières. The southern periphery of the site hase been truncated by Wadi Hamaja which joins Wadi Mohamed downslope from the site (fig. 10). Both wadis originate at seasonal springs located at the base of the djebel. Aïn Misteheyia is a perennial spring located between them and just northeast of the escargotière. A second escargotière (the ridge site) is located at the top of Garat el-Misteheyia (fig. 9).

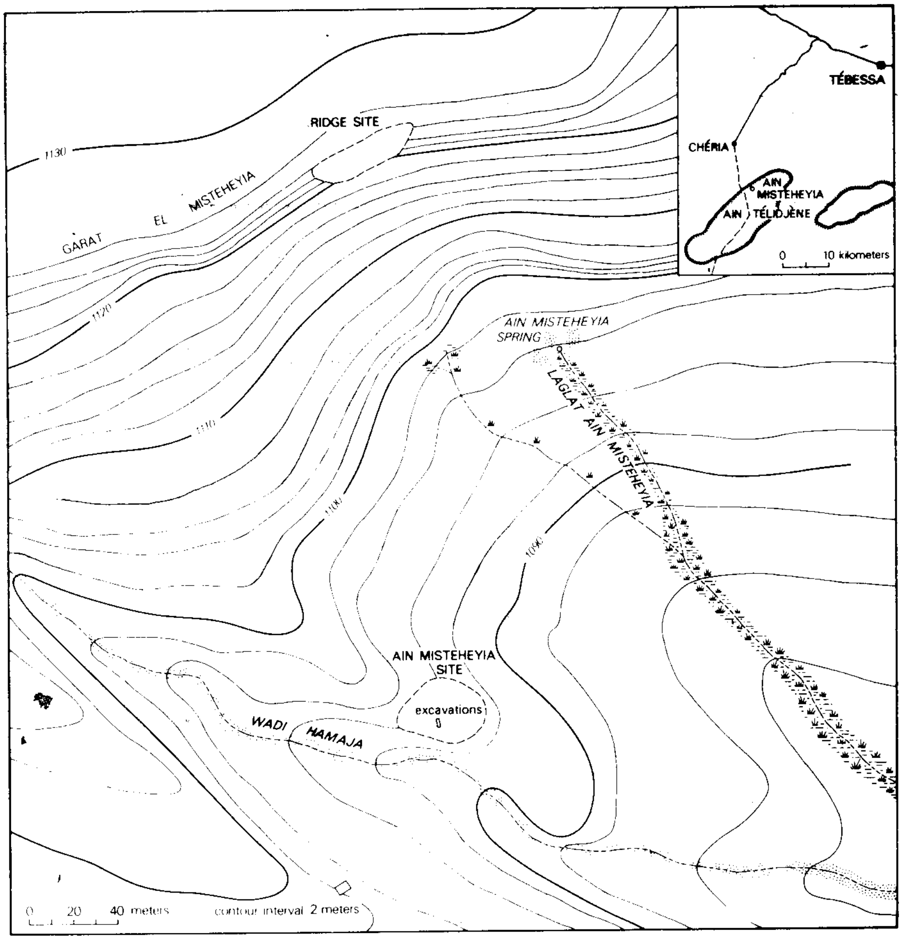

Fig. 9. — Topographic location map of Aïn Misteheyia.

We have mapped sixteen sections along these two wadis (figs 10 & 11). Four stratigraphic units have been identified as follows, from top to bottom :

Unit IV. — Pale brown disturbed top soil with scree gravel and plant roots.
Unit III. — Dull yellowish-brown colluvial silt.
Unit II. — Yellowish-brown to greyish-brown gravel and alluvial silt.
Unit I. — Yellowish-orange to pale dull orange clastic calcareous sediment.

At the base of the escargotière, where it is truncated by Wadi Hamaja, a section through these four units is exposed which reveals the following succession from top to bottom (fig. 12).

Unit II is represented by well-stratified and well-sorted subrounded to sandy silt containing reworked cultural material and scree gravel with numerous roots and root casts. It has a maximum thickness of 20 cm.

Unit III, averaging 30 cm in thickness, is a dull yellowish-brown (10 YR 5/3) silt with angular scree gravel and cultural material scattered throughout.

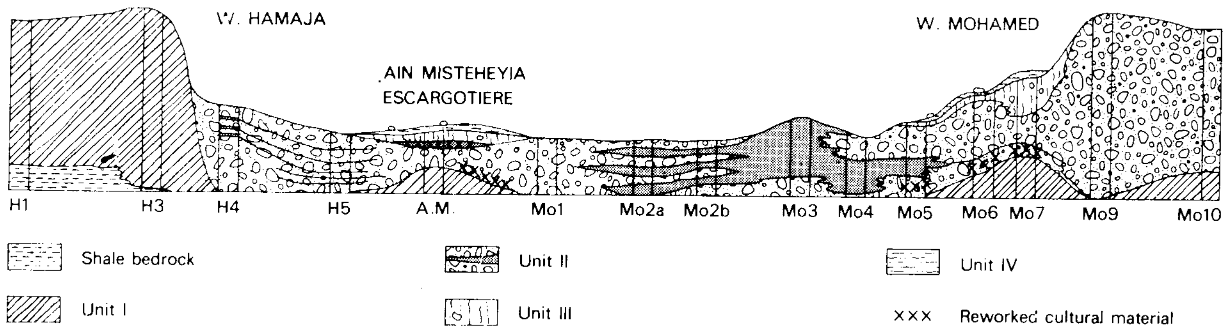

Fig. 10. — Geological sections in Wadis Hamaja and Mohamed in the vicinity of Aïn Misteheyia.

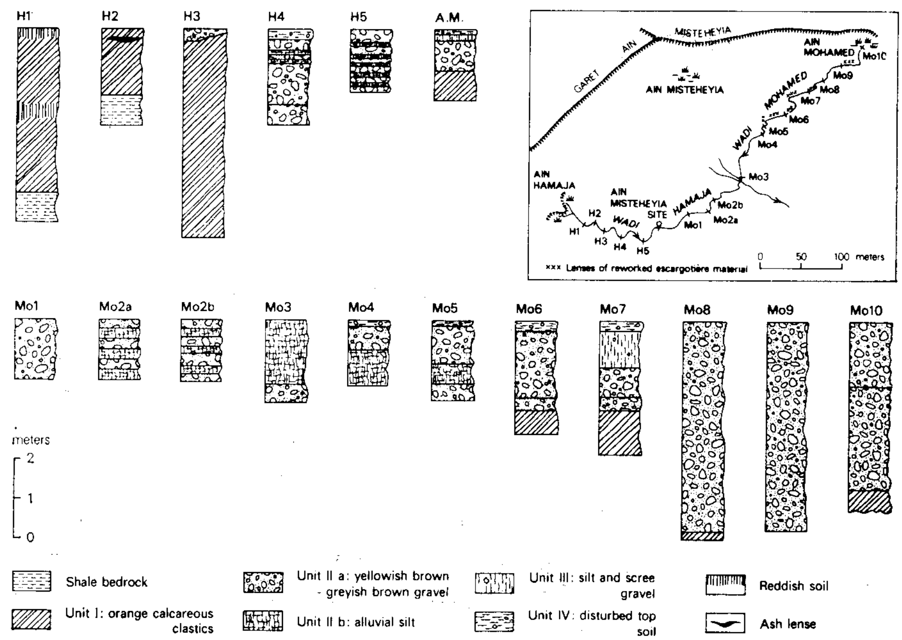

Fig. 11. — Schematic cross-section showing relationship of sections investigated in Wadis Hamaja and Mohamed near Aïn Misteheyia.

Unit II is represented by well-stratified and well-sorted subrounted to subangular gravels with thin intercalations of alluvial silt in the following succession from top to bottom :

f. Bright yellowish-brown (10 YR 7/6) medium gravels with lenses of coarser gravels at the base and in the middle : 30 cm ;

e. Greyish-brown (10 YR 5/3) loamy silt : 10 cm ;

d. Bright yellowish-brown (10 YR 7/6) fine gravels : 50 cm ;

c. Greyish-brown (10 YR 5/3) loamy silt : 10 cm ;

b. Bright yellowish-brown (10 YR 7/6) coarse gravels : 20 cm ;

a. Bright yellowish-brown (10 YR 7/6) fine gravels : 50 cm.

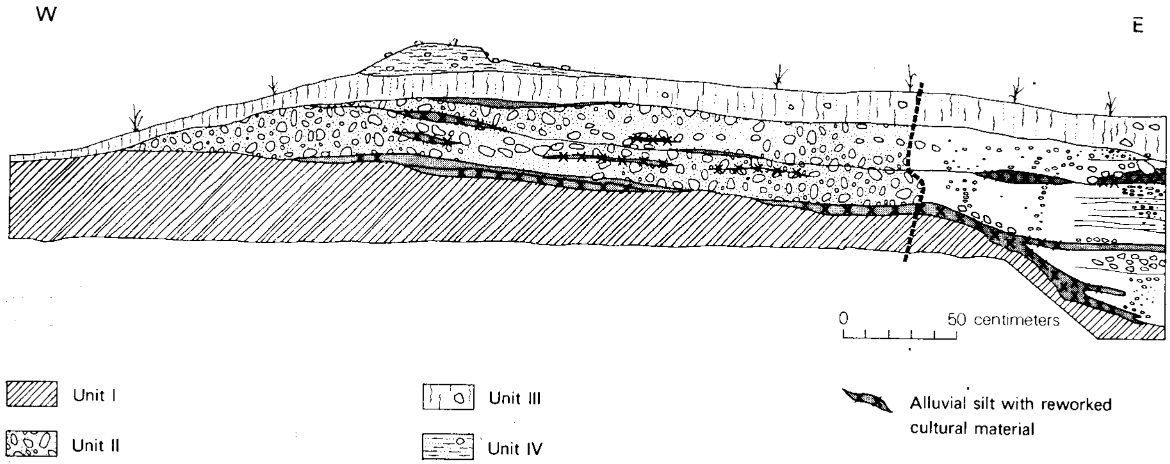

Fig. 12. — Geological Section through deposits exposed where Wadi Hamaja truncates the Aïn Misteheyia escargotière.

Lateral variation is marked, especially in the loamy silt layers which are discontinuously intercalated. Also present are two zones of thin, greyish-yellowish-brown (10 YR 5/2) lenses of material reworked from the escargotière. The lowest of these is the best developed, consisting of a discontinuous layer (maximum thickness 10 cm) lying unconformably on the irregular surface of Unit I and intercalated with layers (a), (b) and (c). The upper zone of reworked cultural consists of three lenses between 1 and 5 cm thick which are intercalated with layers (d), (e) and (f). The overall thickness of Unit II varies between 70 and 150 cm.

Unit I extends below the present stream bed to an unknown depth. Its upper surface is highly irregular and slopes upwards away from the wadi bed (where a 2 m section is exposed) towards the site (where the top of Unit I is 3 m above the wadi floor). The unit disappears 20 m downstream from the site. The sediments of Unit I are light yellowish-orange (7,5 YR 8/4) and consist of unistratified small calcareous gravels which are generally less than 2 cm in diameter which are intercalated with layers of larger gravels. The grains are flat with abraded edges.

In addition to the Aïn Misteheyia section, we mapped fifteen other sections in Wadis Hamaja and Mohamed (fig. 10) to investigate the extent and nature of lateral variations in this area. The stratigraphic relationships of these sections are described here and are illustrated in figure 10 and 11.

The base of Unit I is exposed only at one locality (sections H1 & H2 west of the escargotière) where it overlies the variegated foliated Paleocene shales used by the local inhabitants for manufacturing pottery. The maximum exposed thickness of Unit I is 5 meters (H1 & H3). The lithology is characterized by abundant unstratified and ill-sorted limestone clasts which are generally between 1 and 2 cm in diameter and are contained in a clayey and sandy calcareous matrix which ranges from orange to yellowish orange (7,5 YR 6/6 to 10 YR 6/6) in color. The sediments at this locality consist of a lower 2 meters of coarse clasts (1 to 2 cm diameter) followed by a layer of fine sandy material (c. 1,5 m) which is overlain by a layer of coarse clasts with a few large (5 to 10 cm diameter) gravels.

At H1, two reddish zones are exposed, one at about the middle of the section and a second truncated one at the top which may be paleosols.

In the eastern section of Wadi Mohamed (Mo 6, Mo 7, Mo 8, M 10), Unit I is represented by bright yellowish-brown (Mo 10 : 10 YR 5/6) to orange (Mo 7 & Mo 8 : 7,5 YR 6/6) fine clastic calcareous sediments which contain numerous soft, white, friable « chalky » nodules.

Unit II is a complex deposit composed of bright yellowish or greyish brown (10 YR 5/2, 5/3, 7/6 and 7,5 YR 7/6) well stratified gravels and silts. Which lie unconformably on the eroded surface of Unit I. Lateral and vertical variation are pronounced.

At the escargotière and for about 180 m to the east, Unit II consists primarily of gravel with a few thin lenses and bands of silt. Five silt lenses (5 to 25 cm thick) are visible at H5, none at Mo1, and three at Mo2 where each is about 30 cm thick. Further east at Mo3 and Mo4, the silt lenses grade into a thick (90 to 130 cm) silt layer which tapers off to 50 cm at Mo5 where the silt is sandwiched between bright yellowish-brown (10 YR 7/6) gravels. At Mo6 these gravels are 180 cm thick and silt is absent. At Mo6 and Mo7, these gravels are separated from Unit I by a layer of greyish brown (7, 5 YR 4/2) gravel which extends to Mo10 where it is 250 cm thick. It is comparable to the lower gravels in the Aïn Misteheyia section as well as those exposed in Wadi Hamaja to the west. These lower gravels are better stratified and sorted than the upper ones.

At six localities in Wadi Mohamed, dark brown (5 YR 2/1) lenses of reworked cultural materials were observed at the base of Unit II. These lenses vary in thickness from 10 to 20 cm and are between 30 and 150 cm in lateral extent. They contain concentrations of snail shell, fire-cracked rock, artifacts and bone fragments which do not appear to have subject to long distance transport.

Unit III consists of dull yellowish-brown sandy silt with an average thickness of 30 cm and a maximum thickness of 90 cm at Mo7. It includes scree gravel, scattered artifacts and other cultural material.

Unit IV consists of a pale brown (10 YR 6/3) sandy silt containing large numbers of rolled artifacts, snail shell and scree gravel. It is spotty in distribution and varies in thickness between 15 and 20 cm.

Microstratigraphy of the Aïn Misteheyia escargotière.

During the excavation of Aïn Misteheyia, one unit (Square J9) was dug as a stratigraphic control pit. The sediments exposed are beween 140 and 150 cm thick (fig. 13) and represent the maximum remaining depth of the site. These deposits overlie unconformably the orange calcareous deposits of Unit I, and we have divided them into six layers from bottom to top as follows :

1. Compact, light grey sandy clay loam with a high carbonate content, very few snail shells, and rare artifacts and bone fragments : 5 to 25 cm.

2. Soft brownish grey (7,5 YR 5/1) sandy clay loam containing angular gravels which are generally less than 10 cm diameter as well as smaller angular limestone clasts with abraded edges derived from Unit I deposits and abundant powdery specks of calcium carbonate : 20 to 35 cm.

3. Comprised of two levels (3a and 3b), this is a soft, friable, brownish grey (10 YR 4/1 to 5 YR 4/1) sandy clay loam with abundant crushed and whole snail shell, especially in 3a where there is a lens of whole shell visible in the section. Gravels of approximately 10 cm diameter are common at the base and top of this layer along with calcium carbonate specks : 55 to 70 cm.

4. A hard, consolidated brownish grey (7,5 YR 4/1) sandy clay loam in which cementation is patchy and gravels are rare : 15 cm.

5. A friable, brownish grey (10 YR 5/2) clay loam to sandy clay loam with some gravel and abundant shell : 10 to 15 cm.

6. A friable yellowish-brown to pale brown (7,5 YR 4/2 to 10 YR 6/3) sandy silt containing abundant rubble and roots : 10 cm.

Three radiacarbon dates are available for this sequence. All are based on samples of *Helix melanostoma* shell and calculated on the Libby half-life. Level 2 (125-135 cm) is dated at 9 280 ± 135 B.P. (I-7691) Level 3 (80-90 cm) at 8 835 ± 140 B.P. (I-8378), and Level 4 (40-45 cm) at 7 280 ± 115 B.P. (I-7690). These correspond to dates of 7 330 B.C., 6 885 B.C. and 5 330 B.C. respectively. We accept these dates on two grounds : (a) they fit the known chronology of the Capsian in this region, and (b) dates based on *Helix melanostoma* shell (I-7 692, 7 690 ± 120 B.P.) and charcoal (I-7 694, 7 340 ± 115 B.P.) from the same level of the escargotière exposed in the section at Wadi Redif are consistent and suggest that the shell is not contaminated by older carbonates (cf. Table 22).

The stratigraphic relationship of the cultural levels of the alluvial sediments (fig. 14) demonstrates that occupation of the Aïn Misteheyia escargotière was contemporaneous with the deposition of Unit II. The first occupants established their camp on a sculptured remmant of Unit I deposits bounded by a shallow humid depression watered by a perennial spring.

Climatic interpretation.

Unit I corresponds to the Upper Pleistocene pediment previously described by Ballais. The deposits at Aïn Misteheyia appear to represent a period of cold, moist climate with extensive frost weathering, colluviation and areal sheet deposition. The surface of Unit I has been subjected to extensive erosion of apparent long duration. As Unit II deposits were laid down unconformably on this surface at Aïn Misteheyia there may be an hiatus of unknown duration in the Upper Pleistocene sequence in the region.

Unit II deposits exposed in Wadis Hamaja and Mohamed generally indicate a torrential depositional regime with rapid runoff. The climate was semi-arid, with marked seasonal variability and, presumably, a reduced vegetation mat. The local palaeorelief of the Unit I erosional surface does not suggest deep stream incision. The deposits were laid down in shallow depressions ; well defined V-shaped or steep-sided channels are absent. Furthermore, lateral and vertical variation in these deposits demonstrates that runoff was diffuse and periodic. During the lower part of Unit II episodes of torrential sheet flood erosion occasionally transported large, almost intact, portions of escargotières.

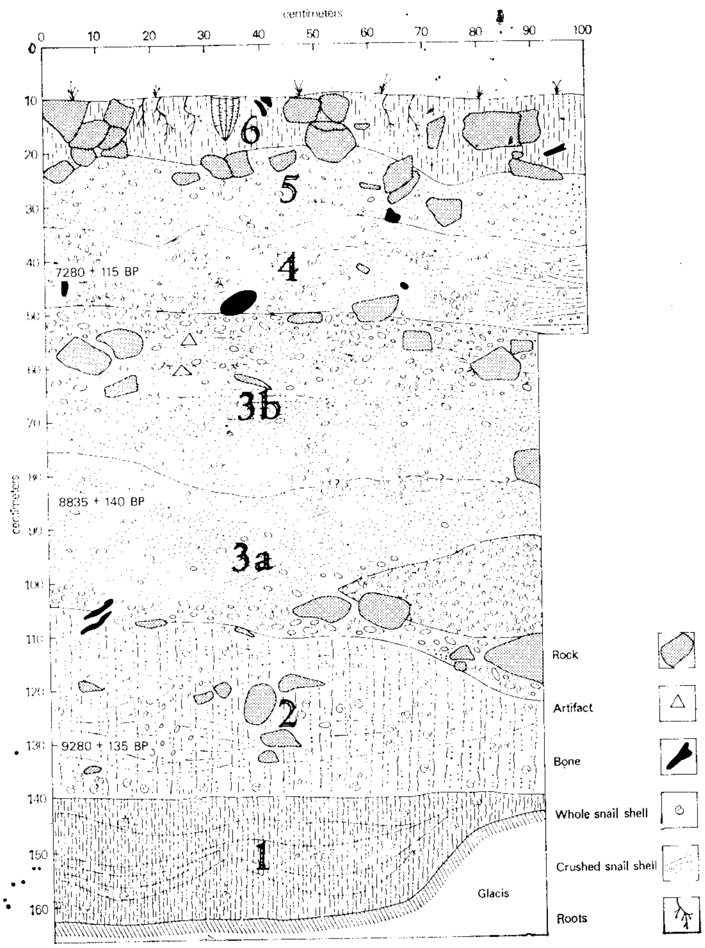

Fig. 13. — Profile of west face of Square J9 in Aïn Misteheyia escargotière.

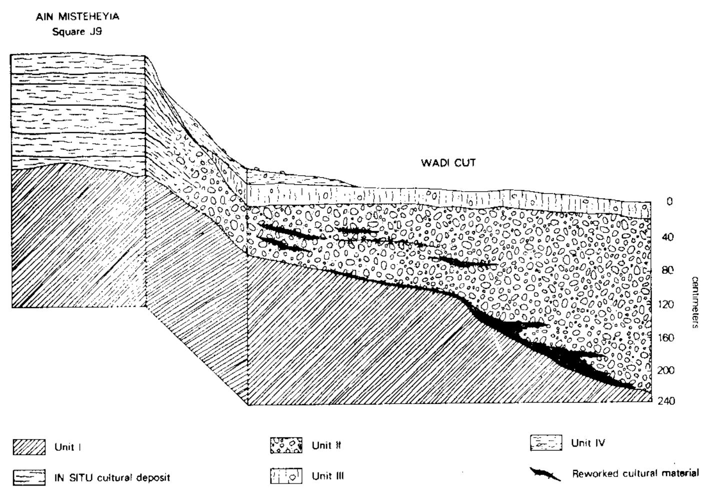

Fig. 14. — Schematic block diagram showing intercalation of Unit II sediments with cultural deposits of Aïn Misteheyia escargotière.

During the middle part of Unit II torrential activity appears to have decreased ; almost intact reworked escargotière deposits are absent, gravels are smaller, stratification is clearer, and a silty facies predominates in Wadi Hamaja. Periods of regular stream flow were more common than previously and strings of archaeological deposits intercalated with lenses of silty loam were redeposited downstream from the site (fig. 12). During the upper part of Unit II runoff increased again, depositing large rolled gravel in some localities.

Due to major differences in the geological setting of Aïn Misteheyia and the type locality of the Chéria formation in Wadi Chéria-Mezeraa, correlation of Unit II with the Chéria formation is difficult. Because Unit II deposits are intercalated with the Aïn Misteheyia escargotière, we estimate the major part of Unit II to date between ca. 9 000 and 7 000 B.P.

Member 1 of the Chéria formation is composed mostly of coarse clastics indicating torrential depositional conditions similar to those inferred for Unit II at Aïn Misteheyia. The fine clastics of member 2 are provisionally dated at ca. 6 000 B.P. (Table 22) and contain extensively reworked material from escargotières. Although no dates are available on samples taken directly from member 1 deposits, the available evidence suggests that member 1 and Unit II are at least partially contemporaneous. Therefore, it appears that the younger portion of the Chéria formation (members 2, 3 and 4) are not represented at the Aïn Misteheyia locality. The Roman alluviation observed elswehere in the regioı. also seems to be absent at Aïn Misteheyia. Instead, the eroded surface of the older fill (Unit II) is overlain by scree and redeposited archaeological materials (Unit III) on which an aridisol has developed which is presently being disturbed by grazing (Unit IV).

Pedology, Sedimentology and Geochemistry of the Aïn Misteheyia Escargotière.

As an additional aid to the reconstruction of the environmental conditions which prevailed during the occupation of the Aïn Misteheyia escargotière, we have applied an elaboration of the method pioneered by Cook and Treganza (1) for shell middens in California. This consists of sedimentological and geochemical analyses of a stratified series of samples to determine the depositional conditions of each observed level and relate these date to the cultural materials found within each level.

(1) Cook (S.F.) & Treganza (A. E.). *The quantitative investigation of aboriginal sites : comparative physical and chemical analysis of two California indian mounds.* American Antiquity, t. 13, 1947, pp. 135-141.

During the excavation of the stratigraphic control pit in square J9 we collected bulk samples of the deposit every five centimeters which were processed in the laboratory as follows :

1. - 350 grams of matrix was removed by quartering and air dried for 8 hours at 90°C and then weighed.

2. - The dried material was screened through a 1 mm mesh.

3. - The fraction over 1 mm (i.e. what remained on the mesh) was weighed and its percentage of the total sample calculated.

4. - This fraction was then hand sorted to segregate bone, shell, stone, gravel, artifacts and coarse sand fractions ; each of these was weighed.

5. - The material finer than 1 mm was split into two fractions ; one for sedimentological analysis of silt, sand and clay, and the second for determination of pH, phosphorus, nitrogen, organic carbon, iron and calcium.

The results of these analyses are summarized in figures 18, 19 and table 2. They are discussed below.

The section exposed in square J9 (fig. 13) consists of six levels as previously described. Due to pedogenesis, the original characteristics of the upper levels have been changed. On the basis of field observations plus geochemical and sedimentological data not fully reported here, the soil at the top of this section can be described as an orthic durorthid aridisol (1). It consists of an A horizon immediately overlying a C horizon. Such soils are commonly formed under semi-arid climatic conditions because, while organic material and biochemical activity are both abundant, chemical weathering of parent material is impeded by either insufficient moisture or low temperature (2).

(1) U.S. Department of Agriculture (Soil Staff). — *Soil classification : a comprehensive system, 7th approximation.* Washington, 1960.

(2) Butzer (K.W.). — *Op. l.*, 1971, p. 85.

The total thickness of the A horizon exposed here is 50 cm. It consists of an A_0 horizon of decomposed Artemisia litter underlain by an A_{11} horizon (Level 6). Beneath this an A_{12} horizon (Level 5) which is underlain in turn by an A_2/Ca horizon (Level 4). Below this, analysis of humus content revealed an A(B) horizon which forms the top 10 cm of Level 3. Levels 2 and 1 correspond to the C horizon.

The climatic reconstruction of Couvert (3) suggests temperature reductions of 2° to 3°C below present norms at ca. 6 000 B.P. as well as an increase in precipitation to about 400 mm above present values. This increased rainfall (following abandonnment of the site) seems to be partially responsible for the development of a marked A_2/Ca horizon at 25 to 40 cm below the present surface of the site which consists of discontinuous and very hard carbonate-cemented areas.

(3) Couvert (M.). — *l. l.*, 1972.

Sedimentology.

The majority of the samples consist of sandy clay loam with only a few falling within the range of clay loam sandy loam (fig. 15). The changes in sedimentological composition over the depth of the deposit are illustrated in figure 19. The decrease in clay in level 3a suggests a period of reduced precipitation compared with levels 1 through 2 and levels 4 through 6. Following the relationship between precipitation and clay content established by Chorley (4) we can interpret the proportion of clay as indicative of semi-arid climate with precipitation approximately double the present annual mean of 340 mm (5), in the upper and lower levels of the deposits which also contain abundant rounded pebble-sized reddish-orange limestone clasts derived from Unit I. These are more abundant in the lower levels where they may indicate increased gelifraction due to more marked diurnal or seasonal temperature fluctuations.

(4) Chorley (R.J.). — *The role of water in rock disintegration.* In, Chorley (R.J.), (ed.), *Introduction to fluvial processes,* London, 1969, pp. 53-73.

(5) Lebedev (A.N.). — *Op. l.*, 1970.

Geochemistry.

Geochemical data are presented in table 2 and summarized in figure 19, where it can be seen that calcium and phosphorus are positively correlated (both attaining maxima in level 3a) while iron is inverse to both of these. The pH values are positively correlated with iron but inverse to both calcium and phosphorus. In the lower part of the section (level 2) an average pH of 7,2 is correlated with 23 % to 25 % calcium, 0,2 to 0,5 % phosphorus, and 0,8 % to 0,9 % iron. In level 3a, pH is neutral at 7,0 with 26 % to 27 % calcium, 0,5 % to 0,6 % phosphorus and 0,5 % to 0,6 % iron. In level 3b, pH rises to a near consistent 7,6 while calcium decreases to between 23 % and 25 %, phosphorus drops to between 0,2 % and 0,3 % and iron rises slightly to between 0,6 % and 0,8 %. The anomalous increase in calcium in level 4 can be attributed to pedogenetic factors already discussed.

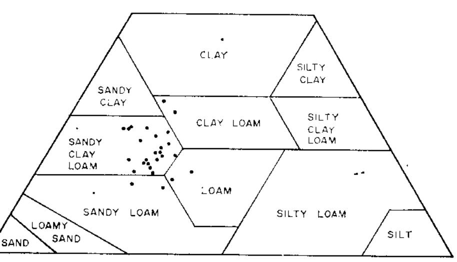

Fig. 15. — Granulometric Composition of Sediments from Aïn Misteheyia (J9).

The geochemical relationship between pH, calcium, phosphorus and iron diagrammatically illustrated in figure 20, is based on geochemical models published by Garrels and Christ (1), Garrels and MacKenzie (2), and Neuman and Neuman (3). The illustrated model explains the geochemical variability in these deposits as follows.

Increased dissolution of calcium will be associated with similar dissolution of phosphorus, the deposition of iron oxides and an alkaline pH. Presence of these three characteristics in the same deposit strongly suggests increased precipitation. Calcium carbonate from shells and inorganic detritus dissociates in the presence of H_2O to Ca^{++}, CO_3^{--}, HCO_3^{-} and H_2CO_3 with promotes further solution of $CaCO_3$, which will also be affected by the humic acids produced from decaying organic matter and by the $CO_{2\,aq}$ in the soil water which results from bacterial oxidation of organic matter. Furthermore, a reduction in CO_2 pressure because of seasonal climatic fluctuations might lead to redeposition of $CaCO_3$ (4). Exactly this situation is suggested by specks of powdery $CaCO_3$ in the lower deposits which contain a greater abundance of thermoclastic gravel.

The solution of phosphorus from bone remains associated which the dissolution of carbonates is facilitated by the presence of the acidic solutions formed by the initial effect of water on carbonates.

Dissolved CO_2 will attack ferrous containing minerals (Fe-silicate clay) to release ferrous oxide. As ferrous iron comes into contact with dissolved oxygen, the Fe^{++} is oxidized and precipitates as ferric oxide. Microscopic investigation revealed the presence of haematic coatings and very fine clots of powdery haematite in the archaeological deposit, which give the sediments an orange hue under the microscope and a brownish to, yellowish tint under natural light.

Nitrogen and carbon do not show a consistent pattern of variation. Both are low in level 1, however, and this may be related to lower initial intensity of occupation at the site, a conclusion also suggested by the frequency of faunal remains (fig. 17) and artifacts (fig. 22) in these levels. The higher level of nitrogen in level 4 may be related to pedogenetic factors. The very high carbon content (far too much for semi-arid climatic conditions) is a direct result of cultural practices by the Capsian occupants of Aïn Misteheyia.

(1) GARRELS (R.M.) et CHRIST (C.L.). *Solutions, minerals and equilibria,* New York, 1965.

(2) GARRELS (R.M.) & MACKENZIE (F.T.). — *Evolution of sedimentary rocks,* New York, 1971.

(3) NEUMAN (W.F.) & NEUMAN (N.W.) — *The chemical dynamics of bone mineral,* Chicago, 1958.

(4) BUNTING (B.T.). — *The geography of soil,* Chicago, 1965.

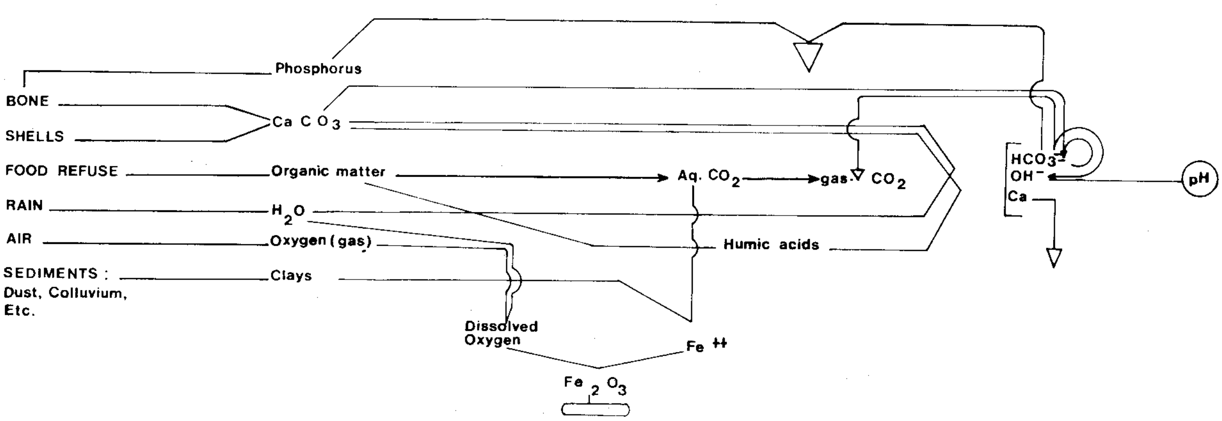

Fig. 16. — Geochemical Model used to explain variability in Aïn Misteheyia deposits.

SUMMARY

The combined results of the sedimentological and geochemical analyses suggest that the Aïn Misteheyia escargotière was occupied during a period of semi-arid climate considerably wetter than at present. An intermediate phase of somewhat drier conditions is also indicated.

The remarkable correlation of this sequence in the cultural deposits with the alluvial sequence exposed in Wadis Hamaja and Mohamed (and probably in Wadi Chéria-Mezeraa) is additional evidence for the general contemporaneity of the archaeological and alluvial deposits (ca. 9 500 to 7 000 B.P.). Furthermore, independent estimates of Holocene climate in Algeria by Couvert (1) based on analysis of charcoal from archaeological sites, indicates a similar sequence. Couvert suggests two periods of increased precipitation ; the first at ca. 8 500 B.P. (+ 200 mm above modern means) and the second at ca. 7 800 B.P. (+ 300 mm above modern means). These are separated by a drier interval at ca. 8 200 B.P. during which rainfall approached modern conditions. Between ca. 9 000 and 7 000 B.P. temperatures appear to have been between 2° and 4°C higher than today.

(1) COUVERT (M.). — [illegible], 1972.

PALYNOLOGY

D. Lubell

The partial (and very tentative) results of our palynological studies are presented in tables 3a and 3b. Because of high alkalinity, corrosion, and abrasion, pollen are neither abundant nor well preserved. We have counted an average of only 130 grains/150 gr of matrix. Furthermore, because we have been unable to obtain modern reference collections there are a large number of unknowns and this prevents us from arriving at substantive conclusions.

Nonetheless, certain patterns are of interest. Both *Acacia* (xeric) and *Cedrus* (mesic) are present in member 4 at Wadi Mezeraa but are absent from modern vegetation assemblages in the region. The presence of *Cheno-Ams* in the same deposit may indicate increasing abundance of disturbed xeric habitats. As member 4 is overlain bv Roman age denosits, it is possible that increasing agricultural activity is reflected by the slight variation in the frequencies of *Cheno-Ams*. In general, the pollen from member 4 agree with our earlier description of the climate during this depositional period as warm and relatively dry, although the presence of *Cedrus* and *Gramineae* suggest slightly greater availability of mesic habitats than is the case today.

The lower portion of the Wadi Redif section (200 to 300 cm) can be equated with at least part of member 2, during which we have previously suggested the climate was cooler and wetter than at present. The frequencies of *Salix* and *Malvaceae* in both sections, and *Liliaceae* in the deposits at Wadi Redif, imply a greater abundance of localized stream-bank habitats during the deposition of member 2.

The abundance of charcoal fragments and crushed land snail shells in member 2 deposits at Wadi Mezeraa is a result of the destruction of local Capsian sites by fluvial erosion during the deposition of member 2. This is not as evident at Wadi Redif (despite the presence of a destroyed escargotière in the section) owing to the coarser grain size of the matrix.

Overall, the palynological data suggests a heavier vegetation mat during the mid-Holocene than at present. The modern degraded aspect is the combined result of climatic and human influence.

PALAEONTOLOGY

A. Gautier

TERRESTRIAL MOLLUSCS

Modern Ecology.

The invertebrate fauna of the escargotières consists of pulmonate snails, the majority of which were consumed by Capsian populations. A few species are intrusive into the cultural deposits but these are infrequent. The four species of edible snails most frequently found in the escargotières around Tébessa and Chéria are *Helix melanostoma, Helicella setifensis, Leucochroa candidissima,* and *Otala* spp. Other species which occur less frequently are *Helix* (*Cryptomphalus*) *aspersa* and *Helicella* spp. Descriptions of most of these forms can be found in Baker (1) whose nomenclature, in a simplified form, we have adopted to avoid confusion. A thorough revision of the various species of Algerian land snails is much needed but is beyond the scope of this study. We shall confine the present work to a discussion of the palaeoecological significance of the various forms found in the escargotières.

(1) BAKER (F.C.). — *l. l.,* 1938.

Living and subrecent specimens of the edible snails found in the escargotières were collected at various localities during July 1972, and August to October 1973. This sample cannot be considered systematic. Furthermore, because present-day landscapes in Algeria have been seriously affected by prolonged over-exploitation by man, ecological information on these species is difficult to collect and one must consider the possibility of their adaptation to new man-made environments. In addition, the absence of reliable systematic studies of Algerian land snails makes interpretation difficult. Nonetheless, a combination of data gathered on identical or comparable species elsewhere in the Mediterranean basin with our own observations provides a tentative picture of the prefered habitats and life habits of the snails found in the escargotières. We have also benefited greatly from the observations of Morel (2).

(2) MOREL (J.). — *in litt.,* 1973.
ID. — *l. l.,* 1974.

Helix melanostoma.

This species is very often found in the upper soil layers during periods of inactivity. In winter a thick epiphragm is formed for hibernation in a long and continuous process. In the summer, individuals are often found with several thin, flat epiphragms, indicating that aestivation is interrupted by phases of activity. According to laboratory tests, formation of the epiphragm is a reaction to extreme temperature (3).

(3) BONAVITA (D.). — *Conditions écologiques de la formation de l'épiphragme chez quelques Hélicides de Provence.* Vie et Milieu, t. 15, 1964, pp. 721-755.

In France, the range of the species includes the calcareous regions of the Mediterranean departments. It is generally found on cultivated land, in vineyards and olive orchards, but it also occurs in the garrigue and the bottoms of small intermontane valleys. Apparently its distribution is generally controlled by the calcareous nature of the substrate, the possibility of burrowing in the soil, or the presence of natural cavities used for hiding during prolonged phases of inactivity, and the presence of half-open vegetation communities (bush, parkland).

Morel (4) has observed active *Helix* in the Tébessa region from February to June, especially following rainfall. From July to September they become rare, without doubt because these months are part of the aestivation period. Morel has no observations for the period from November to January.

(4) MOREL (J.). — *l. l.,* 1974.

The Logan Museum Expedition (1) collected more than 1 000 specimens of this species in the plain around its camp near Oum-el-Bouaghi (formerly Canrobert) after a heavy spring rainfall. We did not collect many specimens, as the field season covered June 1972 and mid-August to end-October 1973. Subrecent specimens were observed and collected in the plains around Tébessa, Chéria and Télidjène. A few subrecent specimens were also collected along the wadi flanks at Fedj Zerrhata and in Wadi Chéria-Mezeraa. On 28-08-73, after several days of rain, about thirty six living specimens, some of them copulating, were collected downslope from Aïn Misteheyia in a rather humid area where the animals were found on the soil and in *Artemisia* bushes.

(1) BAKER (F.C.). — *l. l.*, 1938.

Leucochroa candidissima.

In France, the species often hibernates buried in the upper soil layers. In summer, periods of inactivity (with epiphragm formation) alternate with nocturnal periods of activity (nycthemeral cycle), and the animals are found either on the soil or clinging to low bushes or rocks. The species is very polymorphous, and a relationship has been established between population densities, height/width ratio, and the degree of insolation. Dense populations with many high-individuals are most frequency found in areas with a thin vegetation cover (2). The species is considered very xerophilous and is most often found at higher elevations.

(2) ALTES (J.). — *Sur le polymorphisme du gastéropode* LEUCOCHROA CANDIDISSIMA *Drap.* C.R. Soc. Biol., Paris, t. 150, 1956, pp. 747-748.

In 1972, we collected living specimens on various djebel slopes southeast of Tébessa. Specimens were often found clinging to rockfaces exposed to the sun, a fact previously noted by Germain (3). Subrecent specimens were also found in great quantity in the Télidjène Depression near Relilaï and much less abundantly in the plains east of Tébessa, where, in our opinion, many of the specimens may have been washed downslope during heavy rains. Observations in 1973, confirm that the species is not a typical inhabitant of the plains, but is found more often on the lower djebel slopes (table 4, and fig. 18).

(3) GERMAIN (L.). — *Faune de France, T.* 21 *: mollusques terrestres et fluviatiles.* Paris, 1930.

Helicella setifensis.

In July 1972, we recorded this species live near Sétif, Tébessa, Aïn Télidjène, north of Batna, and along the road between Sidi Arissa and Algiers. Near Sétif, it was found in dense clusters clinging to low bushes. Elsewhere, dispersed specimens were seen clinging to the upper stems of high vegetation. Clustering of the species is effective in reducing dessication which is caused by higher temperatures near the ground. Specimens with epiphragms, clinging to the upper stems of higher vegetation, benefit from cooling by air currents. The species seems to belong to the group of helicellids which which do not bury themselves during periods of inactivity. In France, *Helicella arenosa* is found clinging to vegetation in summer and on the surface in winter (4). Observations on *Helicella* in winter are missing, but its behaviour may resemble that of *H. arenosa.*

(4) BONAVITA (A.). — *Conditions déterminant la production de l'épiphragme chez les gastéropodes Hélicellinés.* C.R. Hebd. Scéanc. Acad. Sci. Paris, t. 260, 1965, PP. 4093-4094.

During the period from July to mid-October 1971-1973, in the plains around Chéria and Aïn Télidjène, we found the species almost exclusively restricted to wadi bank habitats where high vegetation (rushes, *Juncus* sp.) existed. A few living specimens were also found at Fedj Zerrhata, clinging to low bushes growing out of rocky crevices. Apparently, its distribution is seriously limited by the absence of high vegetation which provides a refuge during summer periods of inactivity. Pond (5) records that the Logan Museum Expedition did not find the species. This may have been due to a lack of collecting along wadis and, as well, because the species was active and therefore far less conspicuous than when clinging in bunches to vegetation.

(5) POND (A.W.) *et al.* — *Op. l.*, 1938.

Otala spp.

Baker (1) described five *Otala* spp. from Djebel Sidi-Rgheiss near Oum el-Bouaghi (formerly Canrobert). These were either fossil or recent specimens, and several of the species may be invalid as they are based on minor differences in such variable characteristics as shape, bands, and coloration. Moreover, only one species (*O. punica*) is very freqent. The other species may therefore represent variations which, in the past when splitting was a normal procedure, were given specific names. As we are unable to distinguish the various *Otala* forms and have doubts as to their specific status, we have lumped then as *Otala* spp. Both ecologically and ethologically the different forms are certainly very comparable.

In July 1972, and August to October 1973, we found *Otala punica* and occasionally some other forms alive at various localities on the djebel slopes west of Tébessa. Generally, *Otala* seems to live at higher altitudes than *Leucochroa candidissima*. Specimens of the unidentified species were sent to the Reverend Biggs in England but no specific identifications have yet been received. The animals, most of them with an epiphragm, were found clinging to rocks either not exposed to the sun or protected by covering vegetation. Near Aïn Beida, specimens were collected from the center of very dense, large bushes. Morel (2) has observed *Otala* spp. from February to August around Tébessa. We do not know its behavior pattern during winter.

Thirty two samples of *Otala* spp. from the Aïn Misteheyia cultural deposits yielded the following distribution of forms : 78 % with five bands, 4 % with four bands, 18 % on which the pattern could not be identified due to masking of the shell by adhering matrix, poor preservation, or leaching. The last group probably includes some specimens with a reduced number of bands (none or one). The predominance of live-banded *Otala* in the Capsian was previously observed in 1972 and we have found a similar distribution at several sites investigated in 1973 in addition to Aïn Misteheyia. It is apparent that five-banded *Otala* were more common during the Capsian period than they are today. Samples of modern *Otala* spp. from various localities in the Tébessa-Chéria region, and especially in the Wadi Chéria-Mezeraa valley, are mainly composed of the four banded variety. The distribution of the various forms (based on data from the latter locality) is summarized in table 5.

Apparently the number of *Otala* spp., or the variability of one polymorphous species, decreases upslope. Only a tentative explanation for this differential distribution can be offered. It may be related to changes in vegetation, which decreases in density upslope, while *Artemisia* is replaced by *Stipa tenacissima*. Possibly predation pressure increases upslope as well, with more drastic elimination of the more conspicuous darker five-banded form or lighter palid form. The predominance of five-banded *Otala* in Capsian sites may therefore indicate the presence of denser vegetation cover on slopes as suggested by other evidence.

Seasonal availability of landsnails.

Landsnails are an easily available source of food in mav arid and non-arid regions, but unless cultivated they are only available seasonally (3). A search of available ethnographic literature has failed to provide definite evidence for the intensive use of land snails by modern hunter-gatherers. P. L. Shinnie (4) informs us that the Ashanti sometimes collect the giant African snail *Achatina* sp. seasonally. Pilsbry (5) records that the Mangbetu of Zaïre collect aestivating achatinids (e.g. *Achatina, Limicoloria, Burtoa*) from their hiding places at the

(1) Baker (F.C.). — *l. l.*, 1938.

(2) Morel (J.). — *l. l.*, 1974.

(3) Cadart (J.). — *The edible snail.* Scientific American, N° 197, 1955, pp. 113-118.

(4) Shinnie (P.L.). — Per. comm., 1972.

(5) Pilsbry (H.A.). — *A review of the mollusks of the Belgian Congo.* Bull. Amer. Mus. Nat. Hist., t. XL, Art. 1, 1928.

beginning of the dry season when their traces are still visible. In western Europe, *Helix pomatia* is generally collected in May, before the vegetation cover becomes too dense (1). In Algeria today, snail collecting for consumption (in the Tébessa region at any rate) is uncommon. Inhabitants of the Chéria area informed us they very occasionally use snails for medicinal purposes, especially to combat pulmonary infections. Analogous practices are recorded for Morocco by Westermarck (2). Gobert (3) mentions occasional collection of snails in the Tunisian Sahel « ... parmi certains groupes appauvris... ». G. Camps informs us he has seen snails eaten raw by local people in the region of Algiers, and J.-Ph. Rigaud (4) affirms that the same practice was current until just a few years ago in the Dordogne. Most informants in the Chéria region claimed snails could be collected either after the first autumn rains or in the spring.

In table 4, the modern habits of the major edible snails found in the escargotières are listed according to season and preferred habitat. Apparently, different species are available at different times of the year. In summer, *Helicella* can be collected without difficulty as they are conspicuously clustered on the vegetation bordering wadi courses. *Helix melanostoma* is extremely difficult to find in summer. *Otala* and, to a lesser extent *Leucochroa,* can be found if one looks in their normal hiding places. Winter is the only season in which all snails are difficult to collect.

Assuming that these habits have not changed drastically since the mid-Holocene, the foregoing leads to two hypotheses. If the different species were generally collected together, Capsian snail collecting would have been a spring and autumn activity. However, if each species was collected separately, Capsian snail collecting could have taken place in every season except winter. In all the escargotières we have observed, monospecific concentrations of land snails do occur, but the deposits contain all the species. These smaller (monospecific) concentrations such as the pocket of *Helix melanostoma* seen in the Aïn Misteheyia profile (fig. 13) appear to be the remains of a single collection ; i.e. one day's catch. We are inclined to accept the second hypothesis. We are sure that Capsian groups were not collecting snails during the winter in the Chéria region. However, it should be noted that Morel (5) argues that Capsian snail collecting took place in all seasons although the animals were most frequent in spring and summer. Our observations and analyses point to seasonal collecting and in slightly different seasons from those proposed by Morel.

(1) Dubois (L.). — *Un peu de malacologie et de malacophagie.* Naturaliste Belge, t. 48, 1967, PP. 198-211.

(2) Westermarck (E.A.). — *Ritual and belief in Morocco.* London, 1926, p. 358.

(3) Gobert (E.G.). — *l. l.,* 1937, p. 644.

(4) Camps (G.). — Per. comm., 1975 et Rigaud (J.-Ph). — per. comm., 1975.

(5) Morel (J.). — *l. l.,* 1974.

Modern population densities of edible land snails.

In order to obtain an estimate of land snail population densities and the availability of this food resource during Capsian times, we studied the quantitative

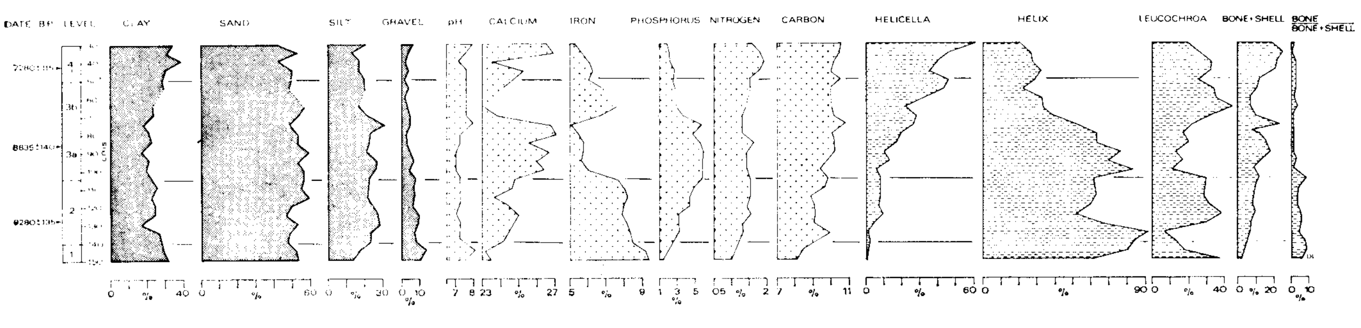

Fig. 17. — Sedimentological, Geochemical and Faunal Frequencies and characteristics of the cultural deposits in the Aïn Misteheyia escargotière.

distribution of snails in the Wadi Chéria-Mezeraa near the type section for the Chéria formation. The area was chosen as it was the only area in the region where all relevant species were present in sufficient abundance. Elsewhere, cultivation, overgrazing, deforestation and erosion have combined to destroy many of the natural habitats of snails and as a result, population densities are extremely low. Wadi Chéria-Mezeraa, being a perennial stream fed by springs, has a more humid microclimate and, therefore, higher population densities of land snails. In one area of the wadi, the high north-facing cliff upstream from the type section, we collected a number of examples of *Helix* (*Cryptomphalus*) *aspersa,* a species which prefers damp and cool habitats. The only other place we have observed this species is in the soil litter of the irrigated grove in the village of Chéria.

Densities per square meter are given in table 6 and illustrated in figure 11. The average density for all species combined is about 2 snails/m^2. We have designated five zones as follows : (I) channel banks, (II) high terrace, (III) hill foot-slope, (IV) hill mid-slope, (V) hill top-slope. In October 1973, we collected a series of 10 x 10 m areas in each of these zones.

The vegetation changes as one moves upslope. Channel banks are colonized by *Juncus, Salix* and *Cyperacea.* The high terrace and hill foot-slope are dominated by *Artemisia herba alba,* and the mid-slope and top-slope by *Stipa tenacissima* (fig. 18).

There is, as well, a trend in snail distribution both in terms of density and species frequencies as one moves upslope. Channel banks (zone I) are the exclusive habitat of *Helicella setifensis,* and the species averages 6,6 snails/m^2 with a maximum observed density of 41,8 snails/m^2. The high terrace (zone II) has almost equal frequencies of *Otala* spp., *Helicella* sp., and *Leucohroa* sp., and the average density falls to 1,2 snails/m^2. At the hill foot-slope *Helicella* almost disappears and the frequency of *Leucochroa* is slightly higher than *Otala* while the average density drops to 0,7 snails/m^2. At mid-slope this pattern starts to reverse, while at top-slope *Otala* becomes dominant and the density rises from 0,6 snails/m^2 at mid-slope to 1,1 snails/m^2 at top-slope.

These data suggest that Capsian escargotières located in different habitats (and especially at different altitudes) might be expected to contain different frequencies of the major species.

Conchometric data.

Measurements for the various species of land snails found in the escargotières are given in table 7. They indicate that (1) recent specimens of *Helix melanostoma* from Oum el-Bouaghi can attain a larger size than their analogues collected further south in the Tébessa region and that (2) specimens from escargotières in both regions are larger than their modern descendants. A deterioration of ecological conditions is probably responsible for the observed differences. The measurements for *Heliccella setifensis* also indicate a smaller size for the extant form, probably due to contraction of habitats with high vegetation, especially humid microenvironments along wadi courses or around springs. It should be noted that recent specimens from south of Tébessa are larger than their relatives from St Donat between Sétif and Constantine which were collected from one low bush and are probably a stunted cluster. In all probability, northern populations of *Helicella setifensis* should attain a larger size than their relatives found in drier areas to the south. As for *Leucochroa candidissima,* one would expect the extant form to be larger than its predecessor due to the thinner modern vegetation cover. However, the measurements do not show a clear trend, and the fossil samples from Oum el-Bouaghi contain some very large specimens.

Vertical changes in edible snail frequencies at Aïn Misteheyia.

The frequencies of *Helix, Leucochroa, Helicella,* and *Otala* spp. in the deposits of the Aïn Misteheyia escargotière were determined on the basis of bulk samples taken at 5 cm intervals throughout the stratigraphic column in Square J9. The vertical changes in species frequencies (table 8) are illustrated in (fig. 17). We have omitted *Otala* spp. since the species varies consistently between 0 and 5 % and was not, apparently, collected frequently.

The frequencies in the upper 10 cm of Level 4 are considered unreliable due to the possibility of preferential destruction of the more fragile *Helicella* and are therefore not included. Below 145 cm (in Level 1) the cultural deposits are mixed with the underlying stratum and the sample of snails is too small to be statistically reliable. Between these limits the sequence can be divided into three units which correspond closely to Levels 2, 3a, and 3b/4 as previously defined. From bottom to top three units can be described as follows :

1. 145 - 100 cm :

Helix melanostoma varies from a high of 93 % to a low of 52 %. *Leucochroa* is well represented, but *Helicella setifensis* is rare, never rising above 9 % ;

2. 100 - 70 cm :

Helix melanostoma declines gradually from almost 90 % to less than 40 % while. *Leucochroa* and *Helicella* both increase quite rapidly ;

3. 70 - 30 cm :

Helix melanostoma never surpasses 37 %, while *Helicella setifensis* shows a marked increase over earlier levels and *Leucochroa candidissima* declines gradually to about 25 %.

Throughout most of this sequence, *Helix melanostoma* and *Leucochroa candidissima* co-vary. This would seem to be normal since the two species were probably collected away from the site in the plain and on the lower djebel slopes. The variation in the frequencies of *Helix melanostoma* compared to *Helicella setifensis* are due to rather different factors which will be discussed below.

All other squares were excavated only to the base of Level 4. Vertical changes in land snail species frequencies in these units are comparable to the pattern observed for this level in J9 ; the three species are well represented and exhibit fluctuations of medium amplitude. While it is impossible to verify whether the marked frequency variation of *Helicella* observed in J9 occurs elsewhere in the site and does, therefore, represent a general event, some data suggest this as a possibility.

Originally, we interpreted the *Helicella* curve as evidence for a direct influence of climatic change on land snail population frequencies. We thought the increase in *Helicella* indicated increased availability of waterlogged deposits in the immediate vicinity of the site and, therefore, evidence for increased precipitation. However, if this were the case, one would expect to find two peaks in the *Helicella* curve corresponding to the two precipitation maxima already discussed. To explain this pattern one must have reference to the curves for bone and shell remains in figure 19. These represent the frequencies calculated from the bulk samples collected in J9. It is clear that the frequency of microscopic and macroscopic bone and shell remains increases steadily from Level 1 (less than 5 %) to Level 3a (more than 20 %), drops off sharply in Level 3b (less than 10 %) and then rapidly increases in Level 4.

Secondly, the ratio of bone/bone + shell drops off sharply at the interface between Level 2 and Level 3a. Taken together, these indicate a decrease in the intensity of occupation during Level 3b (which is also suggested by concommitant decreases in the amount of carbon and frequency of artifacts) and a shift in subsistence practices. The earlier pattern shows an emphasis on hunting of vertebrates with snail collecting limited primarily to the larger (and therefore more productive) *Helix melanostoma.* Above Level 2, this changes. Hunting appears to decrease while the emphasis in snail collecting shifts to the smaller *Helicella setifensis* which is one-quarter the size of *Helix melanostoma.* The reason for this shift may be due to a decrease in fainfall and a consequently reduced animal biomass.

Differential frequencies of edible snails in escargotières.

The quantitative composition of the edible snail assemblages from seventeen Capsian escargotières in the Tébessa region are given in table 9. Five of these were published by Baker (1) and the remainder constitute samples we have collected. Morel (2) has published two additional sites from the Tébessa region, Khanguet el-Mouhaâd and Dra-Mta-el-Ma-el-Abiod. We have not included these because Morel has split *Otala* spp. and *Helicella* spp. into numerous forms which we feel should be lumped into two species. Unfortunately he does not figure specimens and it is therefore impossible to correlate his identifications with ours. From his descriptions it appears that *Helix melanostoma* is the predominant form at Khanguet el-Mouhaâd while *Helicella* spp. is the most frequent at Dra-Mta-el-Ma-el-Abiod.

In 13 of the 17 sites in table 9, *Helix melanostoma* is the predominant form, although its frequency varies considerably. *Helicella* is the most frequent form at three sites and *Otala* at only one. It would appear that these variations are related to the nature of the catchment area surrounding each site as this effects the population of snail communities. The following examples will serve to illustrate our point (3).

(1) BACKER (F.C.). — *l. l.,* 1938.

(2) MOREL (J.). — *l. l.,* 1953 et 1974.

(3) Cf. VITA-FINZI (C.) & HIGGS (E.S.). — *Prehistoric economy in the Mount Carmel area of Palestine : site catchment analysis.* Proceedings of the Prehistoric Society, t. 36, 1970, pp. 1-37.

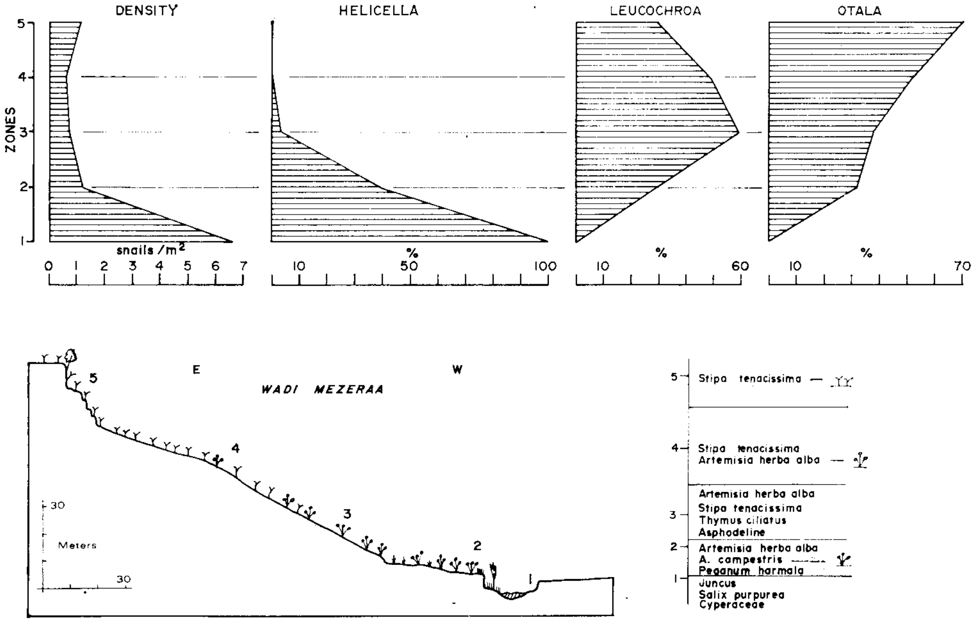

Fig. 18. — Modern distribution and density of land snails in Wadi Chéria-Mezeraa.

The Relilaï rockshelter is situated about 50 m above the Télidjène plain at the foot of an escarpment. The Capsian occupants would have been able to exploit the slopes (*Leucochroa candidissima*), the plain (*Helix melanostoma*), and the banks of Wadi Télidjène or, perhaps, Wadi Chéria-Mezeraa (*Helicella setifensis*). As a result, the frequency of *Helix melanostoma* is slightly attenuated.

Sites 25 and 26 of the Logan Museum Expedition are located within four kilometers of each other on the south slope of Djebel el Tarf south of Oum el-Bouaghi, yet the composition of the snail assemblages is completely distinct. Site 26 is located on the lowest escarpment overlooking the Garaet el Tarf (an evaporative basin) while Site 25 is located below the escarpment on the edge of the pan. The high frequencies of *Otala* and *Leucochroa* (both species prefering higher elevations) in Site 26 is directly related to the location of this site.

The very high frequency of *Helicella setifensis* at site G-12 in the plain of Wadi Ebtine can be explained as due to the proximity of marshy conditions along the wadi banks at the time the site was occupied. Site G-41 at Fedj Krima just east of Aïn Misteheyia and site G-45 at Aïn Djemel about 25 kilometers to the northeast are situated in the uplands but near wadis. At the time represented by our samples (the upper part of the sites) these wadis may have been perennial and therefore heavily colonized by *Helicella setifensis* which predominates in both assemblages. Site G-203, a rockshelter at the base of the escarpment of Arhour el-Kifene about three kilometers southwest of Relilaï, is so situated that snails could only be collected downslope from the site and in the plain. The slope was probably forested and therefore not colonized by *Leucochroa candidissima.* Therefore, most of the snails were collected in the plain which accounts for the very high frequency of *Helix melanostoma* in our sample.

While these observations do tend to suggest a correlation between site location and composition of the snail assemblage, we must emphasize that our information is both selective and limited. As the sequence at Aïn Misteheyia demonstrates, initial appearances may be deceiving. The demonstration of this correlation must remain hypothetical until systematic stratified samples from a large number of sites can be obtained and analyzed.

Non-edible snail species found in escargotières.

In addition to the four major species discussed above, we have also found occasional specimens of *Rumina decollata, Helicella pyramidata, Ferussacia carnea* and *Mastus* sp. in archaeological deposits (1). With the possible exception of *Rumina docollata* these species were not consumed by Capsian populations because they are very small. We observed *Helicella pyramidata* clinging to plants in various habitats in 1972 and 1973. The lanceolate forms (*Ferussacia* and *Mastus*), while present today, are rare. This may, however, be due to their small size and burrowing habits which make them difficult to observe.

The presence of *Rumina decollata* in the escargotières poses a problem. It is usually rare suggesting either very infrequent collection or perhaps that the species colonized escargotières (2). In addition, the species provides only a very small amount of edible flesh which is, furthermore, quite difficult to extract from the shell as we found through experimentation. However, in three of the sites studied by the Logan Museum Expedition the species is fairly abundant. It represents 5,3 % at Site 12, 9,4 % at Site 10, and 14, 3 % at Site 26 (3). These frequencies do not necessarily mean the species was consumed. *Rumina decollata*

(1) PAIN (T.). — *in litt.*, 1973.

(2) MATTESON (M.R.). — *Snails in archaeological sites.* American Anthropologist, t. 61, 1961, pp. 1094-1096.

(3) BAKER (F.C.). — *l. l.*, 1938.

prefers habitats with loose soils of high organic content in which the animal can bury itself during short or prolonged periods of inactivity (1). Furthermore, although we lack supporting evidence for this suggestion, Solem (2) mentions that many carnivorous and/or omnivorous land snails have elongated shells such as the shell of *Rumina decollata,* and it might be that this species colonized escargotières to feed in the decaying plant and animal matter.

(1) BATTS (J.H.). — *Anatomy and life cycle of the snail* RUMINA DECOLLATA (*Pulmonata : Achatinide*). South western Naturalist, t. 2, 1957, pp. 74-82.

(2) SOLEM (G.A.). — *The shell makers.* New York, 1974, pp. 207-209.

VERTEBRATE REMAINS AT AIN MISTEHEYIA

The vertebrate remains recovered during the excavation of Aïn Misteheyia consist of some 3 700 fragments which vary in size between 0,5 and 200 mm. Only 4 % of these are identifiable, the remainder consists primarily of long bone fragments of medium-sized animals. Recognizable fragments of vertebrate, ribs and skulls are rare. The predominance of medium-sized animals is also reflected in the frequency distribution of identifiable fragments per species (table 10) which shows that most of the identifiable fragments are derived from *Alcelaphus buselaphus, Ammotragus lervia* and *Equus mauritanicus.*

Systematic descriptions.

Golden jackal (*Canis aureus*) :

A single fragmentary scapula certainly represents a medium-sized canid. The greatest dimension of the articular end is c. 31 mm and the diameter of the glenoid cavity is approximately 23 x 27 mm. The systematics of North African jackals are a bit confused ; many authors distinguish between *C. aureus* and *C. lupaster* while others include all forms under the single species *Canis aureus* which is the alternative we have adopted.

Equid (*Equus mauritanicus*) :

Some fragmentary postcranial remains, including three incomplete phalanges and numerous teeth fragments, can be ascribed to a slender equid. One very worn P_2 measures 29,2 mm. The same tooth in Morocan material described as *E. mauritanicus* by Arambourg (3) measures 32 mm and has a very similar enamel pattern. *Equus mauritanicus* is the typical equid of the Maghreb Quaternary and is generally accepted to be a relative of the zebras (4).

(3) ARAMBOURG (C.). — *Mammifères fossiles du Maroc.* Mém. Soc. Sci. Nat. Maroc., Rabat, 1938.

(4) VAUFREY (R.). — *Op. l.,* 1955.

Large bovid, probably aurochs (*Bos primigenius* ?) :

A large bovid is represented by some small postcranial fragments, one fragmentary upper molar, and an M_3. The lengths of the latter two are 35 mm and 45,8 mm respectively. Both wild cattle (*B. primigenius*) and the extinct buffalo *Homoioceras antiquus* are known from the Quaternary in the Maghreb. However, during the Capsian the buffalo appears to have been quite rare, and Vaufrey (5) records the species with certainty only at Relilaï. The species was more frequent during Neolithic times, which Vaufrey suggests (6) might reflect climatic changes and a shift from dry steppic to more lush vegetation. We question whether sufficient information on the ecological requirements of *Homoioceras antiquus* is available to support this interpretation, although independent estimates of climatic variability suggest such changes may have occured locally. In any event, our material is too fragmentaty to distinguish unequivocally between aurochs and giant buffalo and is only tentatively assigned to the former.

(5) *Ibid.*

(6) *Ibid.,* p. 391.

Hartebeest (*Alcelaphus buselaphus*) :

An alcelaphine is represented by several well preserved teeth and postcranial bones. Measurements for this material are provided in table 11. These indicate that the Algerian alcelaphine is probably smaller than the *Alcelaphus buselaphus* of the late Quaternary in the Sudan (1). Vaufrey (2) has recorded two alcelaphines, hartebeest and gnu (*Conochaetes* cf. *taurinus*) from the Capsian. In two cases, the gnu material consists respectively of a magnum, three cannon bones, and a distal radius moiety. The third is a horncore fragment. We find it extremely difficult to distinguish between the postcranial remains of gnu and hartebeest and therefore question these records. Lacking an illustration of the horn core we cannot assess its validity. In any event, gnu is not a common alcelaphine in the Capsian, while hartebeest is frequent and well documented. We have, therefore, referred the Aïn Misteheyia material to hartebeest (3).

(1) GAUTIER (A.). — *Mammalian remains of the northern Sudan and southern Egypt.* In, WENDORF (F.), (ed.), *The prehistory of Nubia.* Dallas, 1968, pp. 80-99.

(2) VAUFREY (R.). — *Op. l.,* 1955.

(3) ROMER (A.). — *l. l.,* 1938

Barbary sheep (*Ammotragus lervia*) :

A number of postcranial bovid remains in our collection are intermediate in size between hartebeest and gazelle (table 11). The most frequently cited species for the late Quaternary in Algeria which fits this size range is the Barbary sheep, *Ammotragus lervia.* According to Vaufrey (4) this species is characterized by marked variation in size ; individuals of the High Constantine Plains are less robust than their relatives in the Kabylie Mountains to the north. Many Iberomaurusian, Capsian and Neolithic sites have yielded remains of an ovid, recorded as *Ovis* sp., which is still smaller than the fossil specimens of *Ammotragus lervia* recorded by Vaufrey (5) and may, therefore, represent small female Barbary sheep.

The Aïn Misteheyia material belongs to a form which is smaller than specimens from both Beni Ségoual and Haua Fteah (6). It is probably comparable in size to *Ovis* sp. of Vaufrey which can, in our opinion, be included in *Ammotragus lervia.*

(4) VAUFREY (R.). — *Op. l.,* 1955.

(5) *Ibid.*

(6) HIGGS (E.S.). — *Environment and chronology : the evidence from mammalian remains.* In, MCBURNEY (C. B.M.), *The Haua Fteah (Cyrenaica) and the stone age of the southeast mediterranean,* London, 1967, pp. 16-44.

Gazelle (*Gazella* sp.) :

An incomplete scapula and a humerus fragment both agree in size and morphology with those of late Quaternary *Gazella dorcas* from southern Egypt and northern Sudan (7) *Gazella dorcas* and *G. cuvieri* have both recorded from the Capsian. The species exhibit minor differences in horncores and size (8) and in the absence of diagnostic cranial material we cannot determine which (or both ?) of the species is represented in our collection.

(7) GAUTIER (A.). — *l. l.,* 1968.

(8) VAUFREY (R.). — *Op l.,* 1955.

Rodent :

The distal moiety of a humerus, an incomplete femur, and a fragment of an innominate bone seem to represent one or two individuals of a rodent species which is about one-third the size of the common European rat (*Rattus rattus*). We have been unable to identify this material which almost certainly is intrusive into the cultural deposits.

Lagomorphs, (probably *Lepus capensis* and *Oryctolagus cuniculus*) :

Lagomorph remains consist of a small incomplete ulna, a large complete calcaneum, and two metapodial fragments. The ulna is comparable in size to the small European wild rabbit. The calcaneum (length 28,1 mm) is larger than those in the sample of European rabbits but comparable in size with calcanea of upper Quaternary *Lepus capensis* in southern Egypt and northern Sudan (1) *Lepus capensis* (2) occurs as early as the Middle Palaeolithic in the Maghreb. *Oryctolagus cuniculus* is known from the Neolithic. Material from Iberomaurusian and Capsian sites has been ascribed to both species as a distinction between the two is not always possible. Both species could have been hunted by the occupants of Aïn Misteheyia as was the case at Haua Fteah where *Oryctolagus cuniculus* is recorded from Libyco-Capsian levels and *Lepus* sp. from both the Libyco-Capsian and the preceeding Oranian (3).

(1) GAUTIER (A.). — *l. l.*, 1968.

(2) Cited as *L. kabylicus* by VAUFREY (R.). — *Op. l.*, 1955.

(3) HIGGS (E.S.). — *l. l.*, 1967.

Paleoecological interpretation of the vertebrate fauna.

In table 9 the frequencies of the different vertebrates present at Aïn Misteheyia are given by number of identifiable fragments and as a function of their relative weights per individual animal. Comparison with the presence/absence of these species in the twenty three sites listed by Vaufrey (4) demonstrates that this sample contains all of the common as well as some of the more incidental forms found in other Capsian sites. Unfortunately, more substantive comparisons are not possible because faunal lists are unavailable for most of these sites. In addition, the published lists are frequently innapropriate for accurate comparisons. For example, in his study of the vertebrate from the escargotières excavated by the Logan Museum Expedition, Romer (5) gives species frequencies based only on teeth and jaws. Morel's (6) study of the vertebrate remains from Dra-Mta-el-Ma-el-Abiod is far more useful despite a few terminological problems. Multiplying the estimated weight per individual of each species times the estimate number of individuals of each species present at this site we find a very tentative similarity between the Aïn Misteheyia and Dra-Mta-el-Ma-el-Abiod assemblages. However, the difference in sample sizes is extreme and there are many more species represented at the latter site. It should be noted that there are great differences in the vertebrate assemblages from different Capsian sites which may mitigate against simplistic comparisons.

(4) VAUFREY (R.). — *Op. l.*, 1955, table IX.

(5) ROMER (A.). — *l. l.*, 1938, p. 184.

(6) MOREL (J.). — *l. l.*, 1974.

In the assemblage from Aïn Misteheyia, *Alcelaphus buselaphus* predominates, followed by equal frequencies of *Ammotragus lervia* and *Equus mauritanicus*. Wild cattle (*Bos primigenius*) are rare despite the fact that its heavy bones usually preserve well. This may be due to differential preservation, for the species is more abundant at some sites than others. Gazelle and lagomorphs are also rare.

If we recalculate these frequencies in terms of the amount of meat these remains would provide, there is a notable shift. Aurochs moves to second place, followed by equid and Barbary sheep while hartebeest remains the most frequent and therefore the most important source of meat for the Capsian occupants of Aïn Misteheyia. If Morel's estimates for the number of individuals present at Dra-Mta-el-Ma-el-Abiod are correct, the shift there is even more pronounced, with aurochs superseeding hartebeest as the most important source of vertebrate.

The Aïn Misteheyia sample is suggestive of open steppic plains inhabited by *A. buselaphus* and *E. mauritanicus* with occasional accidented open biotopes (mountain slopes) prefered by *Ammotragus lervia*. This model excludes the factors of biased preservation and selective hunting. Gazelle, which is not typical of such regions, may have wandered in from the south during dry seasons. The rarity of aurochs may be due to its preference for lusher vegetation. The species is far more common in the fauna of Mechta-el-Arbi (7) and Dra-Mta-el-Ma--el-Abiod (8), both of which may have been located in areas more suitable to this species.

(7) ROMER (A.). — *Pleistocene mammals of Algeria : fauna of the palaeolithic station of Mechta-el-Arbi.* Logan Museum Bulletin n° 2, 1928, pp 79-137.

(8) MOREL (J.). — *l. l.*, 1974.

ARCHAEOLOGY

D. Lubell

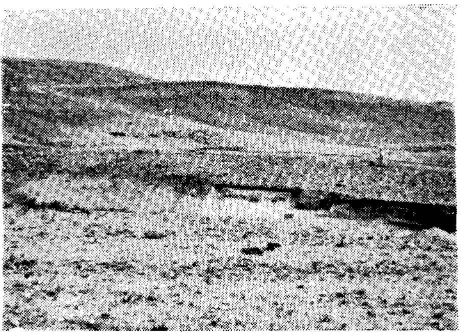

Fig. 19. — The Aïn Misteheyia escargotière showing stratigraphic trenches along Wadi Hamaja (in foreground).

The Aïn Misteheyia escargotière is Site 36 in Grébénart's (1) gazeteer for the Tébessa region, and draws its name from the local perennial spring which is incorrectly identified as Aïn Messaïa on the topographie maps used by Grébénart (2).

The southern edge of the escargotière has been truncated by Wadi Hamaja. The profile thus exposed (fig. 12 and 19) suggested the presence of two distinct occupations to Grébénart (3). Our investigations indicate that while the escargotière is the result of multiple occupations over a span of at least 2 000 years, the apparently distinct horizons exposed in Wadi Hamaja are actually deposits from the escargotière which have been reworked into the alluvium of Unit II during the two periods of increased stream flow and precipitation discussed earlier in this report. The intercalation of escargotière deposits with Unit II alluvium is diagrammatically illustrated in figure 14.

The area of excavation comprised a 2 m x 4 m trench located at the summit of the site (fig. 19) and gridded into one-meter squares (fig. 20). A datum stake was positioned at the southwest corner of square J8, and the datum level taken from the top of this stake set at 10 cm above present surface. Whenever possible during the excavation of levels 6, 5 and 4, we followed the « natural » stratigraphy of the deposits. When this was not possible (as is frequently the case in escargotières), we excavated in levels of 5 cm. The stratigraphic test pit in square J9 which plumbs levels 3b, 3a, 2 and 1 was excavated entirely by 5 cm levels. All excavated material was screened through 0,3 cm mesh with the exception of twenty-five bulk samples of approximately 2 kg each used for sedimentological and geochemical analyses and several larger samples which were processed by flotation in the field.

The excavated assemblage consists of 22 682 lithic artifacts, 2 bone needles, 6 ostrich egg shell beads, 1 fragment of decorated ostrich egg shell and 42 undecorated fragments, 10 pieces of ochre (9 red and 1 yellow), and several sherds of badly fired, shell-tempered pottery. In addition, there are two intact circular arrangements of stones on an occupation surface and the usual component of land snail shells, fire-cracked rocks, and fragmentary vertebrate remains.

Lithic artifacts.

The lithic assemblage consists of eight major artifact classes which are summarized in table 12 and figure 24-a. The manufacturing technique employed to produce them is the « débitage de type capsien supérieur » (4). The raw material utilized for manufacture is the fine-textured dark grey or tan flint found locally in nodular form in the Eocene limestone. Capsian flint knappers could have obtained their supply from talus deposits, wadi gravels, or by mining the nodules.

Cores.

There are 80 complete cores and 59 core fragments included in the assemblage. The latter have been analyzed using a taxonomy developed for Nilotic epipalaeolithic industries (5) and are summarized in table 13. The small size of the sample precludes either refined statistical analysis or stratigraphic presentation. Single platform cores are the most frequent typological class and blade cores outnumber flake cores (cf. fig. 23).

The morphology of these cores suggests the predominant use of indirect percussion (or punch technique) although use of pressure flaking cannot be ruled

(1) GREBENART (D.). — *Op. l.*, 1975.

(2) GREBENART (D.), *in litt.*, 1976 argues that the name Messaïa has nomenclatural precedence over Mistevia because the former is used on currently available topographic maps of the region. We discussed the question of locality name extensively in both 1973 and 1976 with local indigenous inhabitants who *all* insisted that Misteheyia, not Messaïa was the correct name. While we are sympathetic to the principle of M. GREBENART'S argument, we prefer to correct what seems to have been a mistake made by cartographers earlier in this century.

(3) GREBENART (D.). — *Op. l.*, 1975.

(4) TIXIER (J.). — *Procédés d'analyse et questions de terminologie concernant l'étude des ensembles industriels du paléolhitique récent et de l'épipaléolithique dans l'Afrique du Nord-Ouest.* In, CLARK (J.D.) et BISHOP (W.W.), (eds.), *Background to evolution in Africa,* Chicago, 1967, p. 798.

(5) LUBELL (D.). — *The Fakhurian : a late palaeolithic industry from upper Egypt.* Geol. Survey of Egypt, Paper n° 58, Cairo, 1974, pp. 44 ff.

out. It is present in other Capsian assemblages of equivalent date (1). Either technique would account for the lack of differentiation between the striking platform angles of blade vs flake cores (table XIV). This characteristic seems to be important in other North African epipalaeolithic industries. Careful pre-adjustment of the striking platform angle (acute for blade cores and approaching 90° for flake cores) reduces the tendency for a small core supported on an anvil to slide to the side when struck. In other words, the knapper has greater control. Moreover, an acute angle reduces the tendency of the blade to curve inwards at the distal end. The higher frequency of faceted platforms on blade cores (table XIV) suggests micro-adjustments to the striking platform for increased purchase of a punch (2).

Flakes and blades/bladelets.

The frequencies of unretouched flakes and blades or bladelets are given in table 12 and illustrated in figure 21-a. From these data it can be seen that flakes are slightly more abundant in levels 2 and 3a (the level 1 sample is too small to be statistically significant) but blades are always more frequent than flakes in the upper levels. Blades are most abundant in level 4 where they constitute almost 30 % of the assemblage.

The metrical attributes of the unbroken and unretouched flakes and blades or bladelets (i.e. those with both the striking platform and the distal tip present) are summarized in table 15. There is no clear evidence for temporal change in these characteristics although blades may become wider in the upper levels. In general, flakes tend towards a square shape with a length/width ratio approaching 1 : 1 and blades or bladelets always fall within the « wide blade » category of Hassan (3). With the exception of the sample of blades or bladelets from level 5, the mean length of most unretouched pieces in this category is at or below the 30 mm boundary for microlithic artifacts.

Microburins.

Following the current practice of J. Tixier (4) we have removed microburins from the typological list and included them as a technological class. Present within this group are 4 examples of type 101, 186 examples of type 102, and 24 examples of type 103.

Evidence for burned artifacts.

There are numerous artifacts in this assemblage which are fire-cracked and were presumably either intentionally or accidentally exposed to heat. The final tabulation shows that very few retouched tools or cores are fire-cracked. Rather the phenomenon is almost entirely restricted to unretouched flakes, blades or bladelets, and débitage. The data presented in table 16 does not indicate any clear vertical distribution (the higher frequencies in level 2 can be ascribed to sampling problems of a small assemblage) and there is no observable horizontal distribution as well.

The distribution of fire-cracking on artifacts suggests that some of the unwanted debris from tool manufacture was systematically collected and discarded in burning hearths or smoldering heaps of ashes. At least one similar practice has been ethnographically documented for a stone tool using group in Ethiopia (5). It is interesting to note that the two squares at the base of level 4 which contain the two stone circles also contain the highest frequencies of burned artifacts in that level (see discussion below).

(1) CAMPS (G.). — Le *Capsien supérieur : état de la question.* La Préhistoire : problèmes et tendances, Paris, 1968, pp. 87-102.

(2) CRABTREE (D.E.). — *Mesoamerican polyhedral cores and prismatic blades.* American Antiquity, t. 33, 1968, pp. 446-478.

(3) HASSAN (F.A.). — *Toward a définition of « lames », « lamelles » and « microlamelles ».* Libyca, t. 20, 1972, pp. 163-167.

(4) TIXIER (J.). — Per. comm., 1975.

(5) GALLAGHER (J.P.). — Communication presented to the 7 th Panafrican Congress on Prehistory, Addis Ababa, December, 1971.

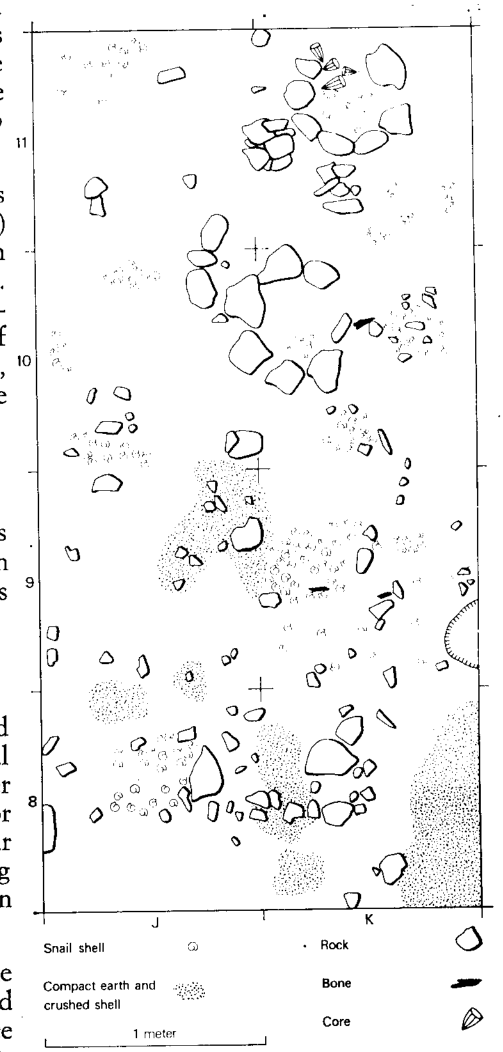

Fig. 20. — Plan of excavations at Aïn Misteheyia (50 cms below datum) showing occupation surface with at least tree circular arrangements of flat stones

Retouched tools.

The technological characteristics of the retouched tools are given in table XVII. The data show that (a) the majority of tools are made on blades or bladelets, (b) approximately one-half of all tools are microlithic, (c) the mean length of blade tools is approximately the same as the mean length of unretouched blade débitage (cf table XV), (d) the mean length of flake tools is consistenly greater than the mean length of unretouched flakes (cf. table XV), (e) the upper levels of the site contain a greater number of broken tools than the lower levels. The last point may be a reflection of the larger sample size available from levels 6, 5 and 4 (excavated volume of 4 m^3) than from levels 3b, 3a, 2 and 1 (excavated volume of 1 m^3).

The type list (table XIX) is largely self explanatory. It is clear from this list, the cumulative graph (fig. 22) and the typological indices (table XVIII) that the Aïn Misteheyia assemblage falls within the established parameters of the Capsien supérieur (1), despite the temporal changes illustrated in figure 24 and discussed below. We should point out that, following procedures established for the analysis of Nilotic epipalaeolithic assemblages (2), we classify as « continuously retouched » any flake, blade or fragment of either on which at least one-quarter of an edge is retouched. We do not include backing or Ouchtata retouch in this category.

(1) TIXIER (J.). — *Typologie de l'épipaléolithique du Maghreb*. Mém. C.R.A.P.E., n° II, Alger, 1963. — ID., *l. l.*, 1967.

(2) Cf. LUBELL (D.). — *Op. l.*, 1974. PHILLIPS (J.L.). — *Two final palaeolithic sites in the Nile Valley and their external relations*. Geol. Survey of Egypt, Paper n° 57, Cairo, 1973. SCHILD (R.). & *al.* — *The Arkinian and Shamarkian industries*. In, WENDORF (F.), (ed.), *The prehistory of Nubia*, Dallas, 1968, pp. 651-767.

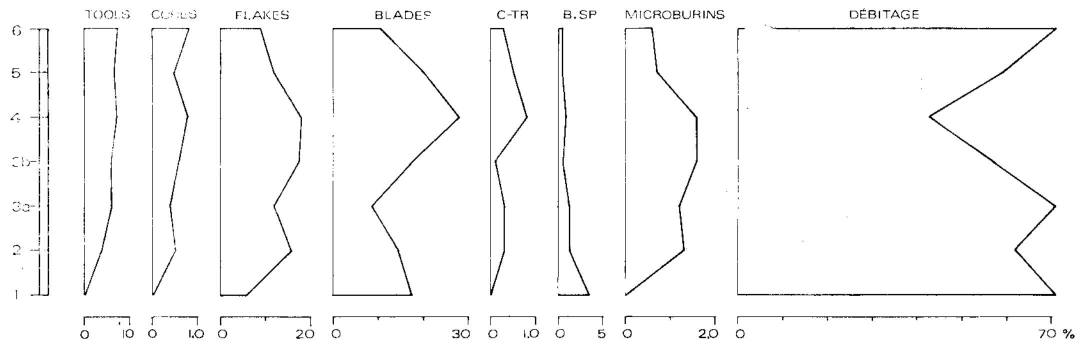

Fig. 21-a. — Vertical Changes in Frequencies of Major Artifact Classes in the Aïn Misteheyia Escargotière.

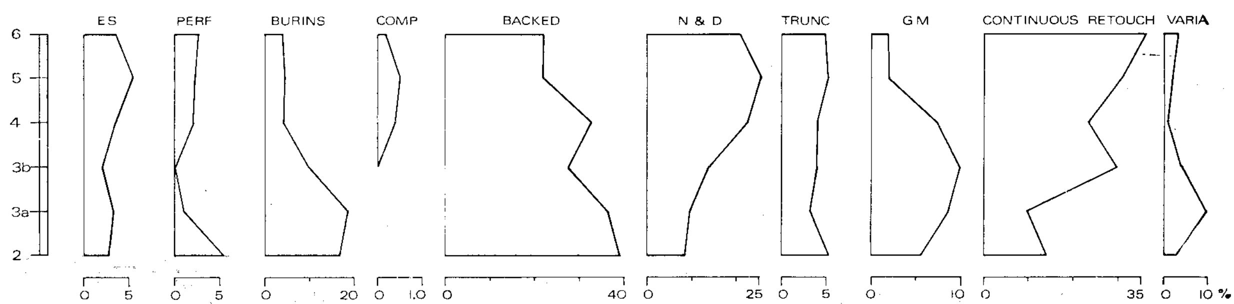

Fig. 21-b. — Vertical Changes in Frequencies of Retouched Tool Classes in the Aïn Misteheyia Escargotière.

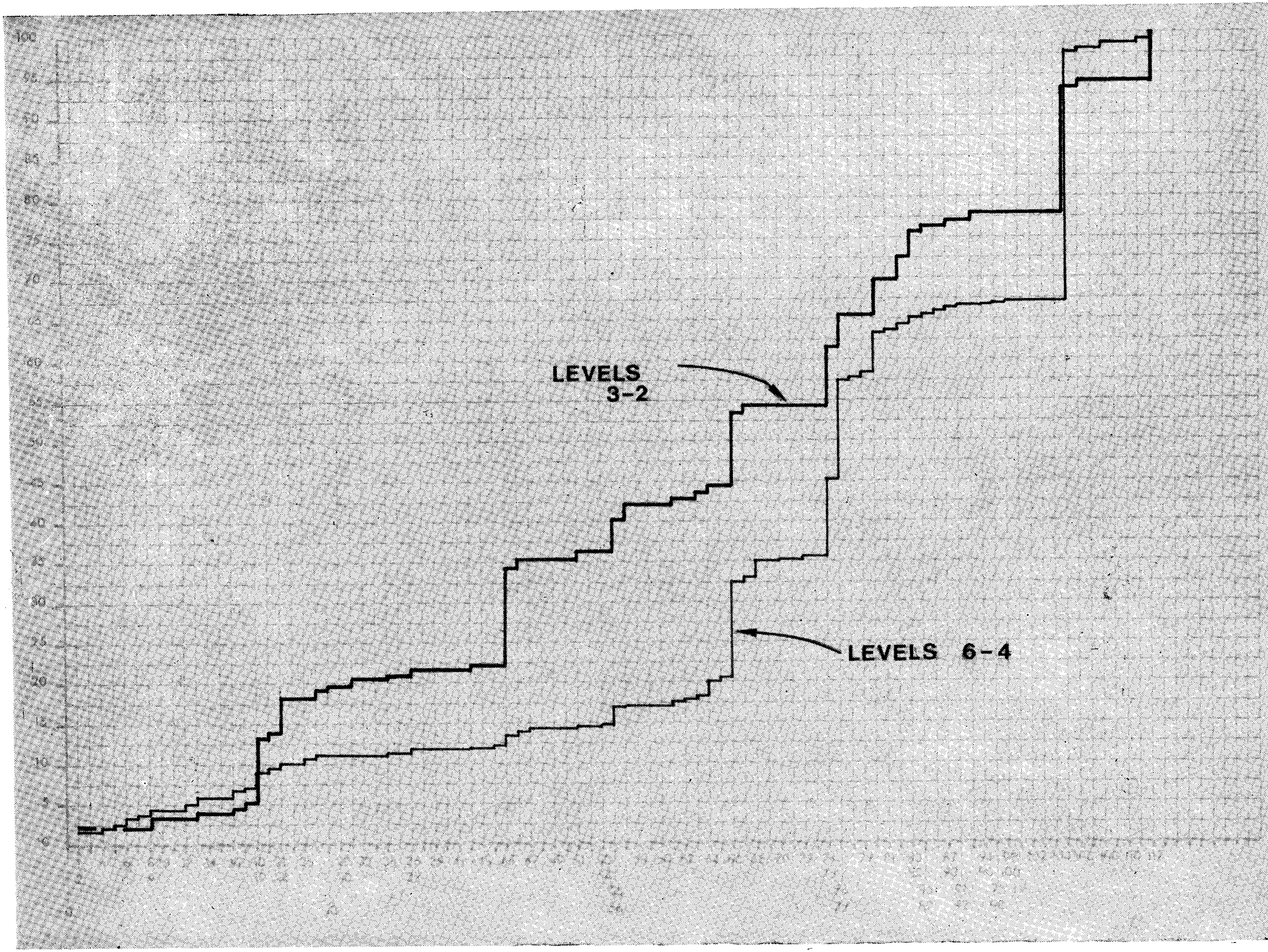

Fig. 22. — Cumulative Graph for Levels 1-3 and Levels 4-6 at Aïn Misteheyia.

Temporal change in the artifact assemblage.

There are few, if any, indications of technological change over the 2 000 radiocarbon years represented in the Aïn Misteheyia deposits. However, there are clear typological changes which are shown in figure 21-b. Two distinct assemblages seem to be present. In levels 2, 3a and 3b, burins, blacked blades and bladelets, and geometric microliths predominate. In levels 4, 5 and 6, the most frequent tool classes are endscrapers, notched and denticulated pieces, truncations, and continuously retouched pieces. We have graphed these two assemblages seperately in figure 22.

On the basis of the cumulative graph and the typological indices we can tentatively place these two assemblages in Phase II of the Tébessa facies of the Capsien supérieur as defined by Camps (1). However, the radiocarbon dates for levels 3b, 3a and 2 are older than the limits established by Camps for this phase. Furthermore, the curve for these levels is not consistent with the curve for a Phase I assemblage from Bou Nouara published by Camps and Camps-Fabrer (2). Small sample size is not the problem here, for exactly the same pattern emerges when only the J9 sample is used to plot the curves and calculate the indices.

(1) CAMPS (G.). — *l. l.*, 1968.

(2) CAMPS (G.). et CAMPS-FABRER (H.). — *L'épipaléolithique récent et le passage au Néolithique dans le Nord de l'Afrique*. In, LUNING (J.), (ed.), *Die anfänge des Neolithikums vom Orient bis Nord-Europa*. VII, Köln, 1972, pp. 19-59.

The absence of major technological changes suggests to us that the observed typological changes are related to activity specific tool kits rather than an evolutionary progression. A similar interpretation may eventually be possible for the phases and facies of the Camps scheme. Further evidence for our interpretation of the Aïn Misteheyia assemblage will be presented in the concluding section of this report.

Non-lithic artifacts.

The inventory of non-lithic artifacts includes two bone needles. One is a distal fragment 27 mm long and 3 mm in diameter at the proximal end. It was found at the base of level 4 (45-50 cm below datum) in square J8. The other, which is missing the basal portion, is 78 mm long and has a sinuous groove at the broken proximal end where the diameter is 5 mm. It was found slightly above the base of level 4 (40-45 cm below datum) in square J 11 (fig. 24, n^{os} 1 à 3).

Several potsherds were recovered during the excavation of level 4. Most important is a group of fragments from what appears to be a single sherd which were recovered *in situ* within the hearth in square K10 (figure 22) but slightly above the base of level 4 (35-40 cm below datum).

The six fragments surveyed are all very thin, of irregular thickness, ranging from 2 to 4 even 5 mm. The two biggest reaching about 40/25 mm, the three smallest measuring about 10/5 mm. They are slightly curved ; the biggest seems to have a inflection point, but it might be due to an irregularity of fabrication. Although it remains difficult to determine because of the dimension of the fragment. The past is very hard.

The fragments are not split longitudinally, contrary to the impression one gets from a simple examination with the naked eye. The outer surface has been carefully smoothed by plants, probably Graminaceae, whose impressions can be seen here and there. It is covered by an important pattern of small cracks. The inner surface is irregular. Under side-light it shows the attenuated imprints of a brainding whose the fibres are about 1 mm large. Consequently the paste has been applied to a sort of winnowing, before the firing. The disposition of the non-plastics materials confirms this technique. There are several who extend beyoud the surface, either perpendicularly or obliquely. It is really what one could call a *poterie poussée.* The hypothesis attributing it to a vessel, may be confirmed by the existence of a rim sherd. The rim profil is simple, with an ogival lip. Only the outer part of the rim has been smoothed, the interior part has kept the marks of the braiding.

The study of the paste reveals a bulky texture, which here and there is interrupted by foliated stains. These stains are subparallel or oblique to the surface, and correspond to zones which a higher density of non-plastics. These non-plastics, abondantly used (more than 1/3) are made of crushed mollusc shells (probably Lamellibranches). The colour of the paste is uniformly brick-red (2,5 Y R 5/8), wich proves an oxidizing firing atmosphere.

Whatever object has been manufactured or repared, we have here a method that has not been previously identified either in North Africa and in the Sahara. To our knowledge this is the earliest dated pottery in the region. It occurs in a level dated at 5 330 B. C.

The collection from Aïn Misteheyia includes few of the decorative artifacts frequently found with Capsian assemblages. Our total collection includes one decorated fragment of ostrich egg shell and six ostrich egg shell beads which correspond to examples illustrated by Camps-Fabrer (1).

(1) CAMPS-FABRER (H.). — *Matière et art mobilier dans la Préhistoire nord-africaine et saharienne.* Mém. C.R.A. P.E., n° 5, Alger, 1968, p. 329, fig. 107, n^os^ 27 et 28.

Habitation surface.

At the base of level 4 we recovered the partial remains of an occupied surface (fig. 20) on which at least two stone circles are visible. In both cases, the flat upper surfaces of the stones dip in towards the center, forming a bowl-shaped depression. In the K10 circle we recovered the previously mentioned potsherds, and in the K11 circle the four cores illustrated in figure 20.

Square K 11 has the lowest artifact density in this level ; only 88 artifacts. Square K 10 is richer, containing 242 artfiacts which is close to the average of 251 artifacts/m^2 for this level. On present evidence, therefore, we cannot assign a specific activity function to these areas. The stone circles may well have been used as hearths, as is suggested by the higher frequencies of fire-cracked artifacts in these squares. However, we observed neither abnormally high amounts of ash and charcoal nor evidence for fire-hardened earth in either square. Most of the stones forming the circles had been exposed to fire, and were either reddened or fire cracked or both.

Summary

The Aïn Misteheyia escargotière contains a record of over 2 000 years of Capsian occupation. The lithic artifacts show evidence for change during this time which is best explained as change related to differential activities. In toto, the assemblage can be ascribed to Phase II of the Tébessa facies of the Capsien supérieur despite problems of chronology. The occupational surface at the base of level 4 suggests that occupation of the site may have been discontinuous. as there is a rather marked difference in the assemblage below this level and that above it.

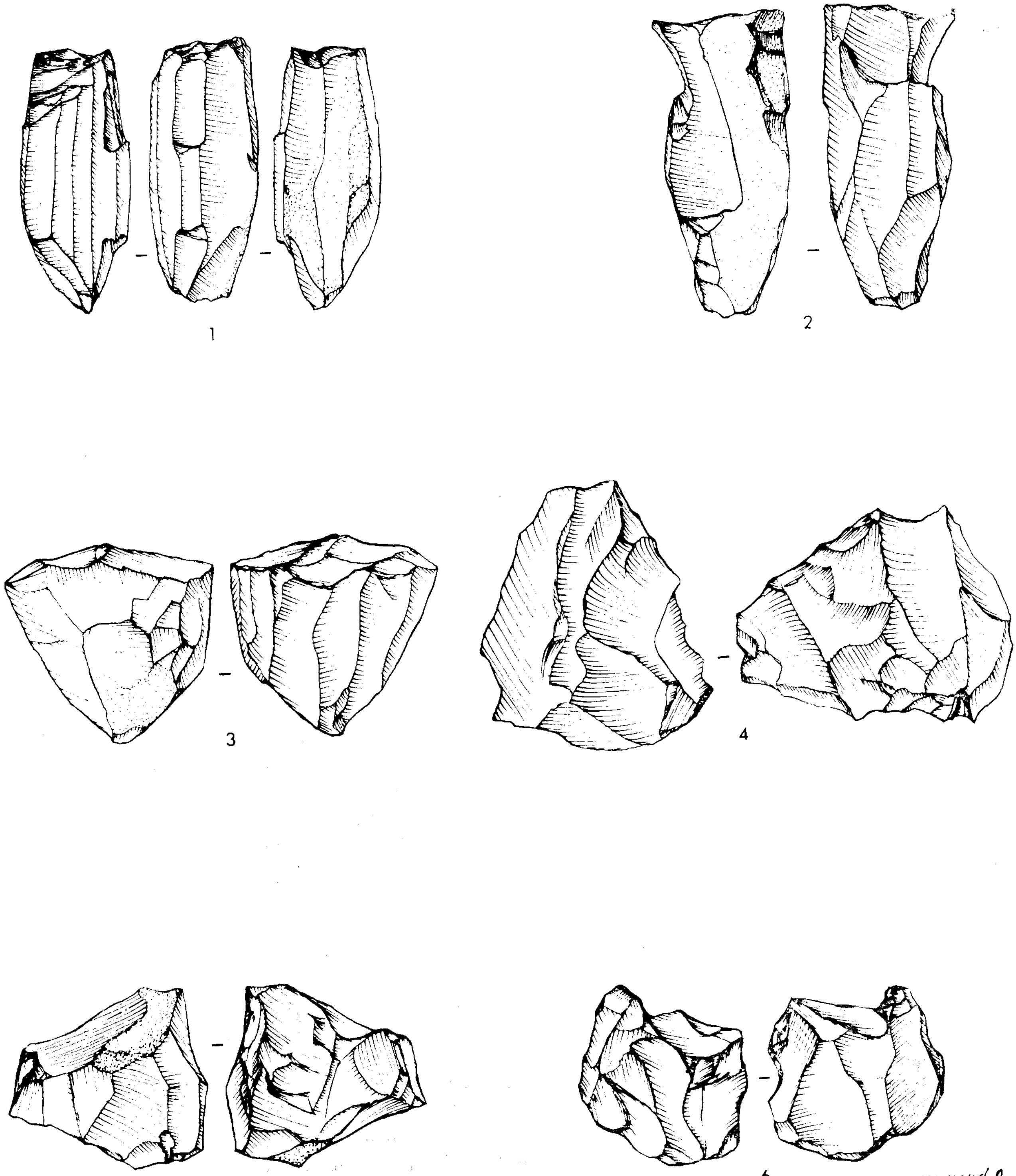

Fig. 23. — Cores : 1) Opposed Platform Blade Core ; 2) Single Platform Blade Core ; 3) Single Platform Blade Core ; 4) Ninety Degree Flake Core ; 5) Multiple Platform Flake Core ; 6) Globular Flake Core.

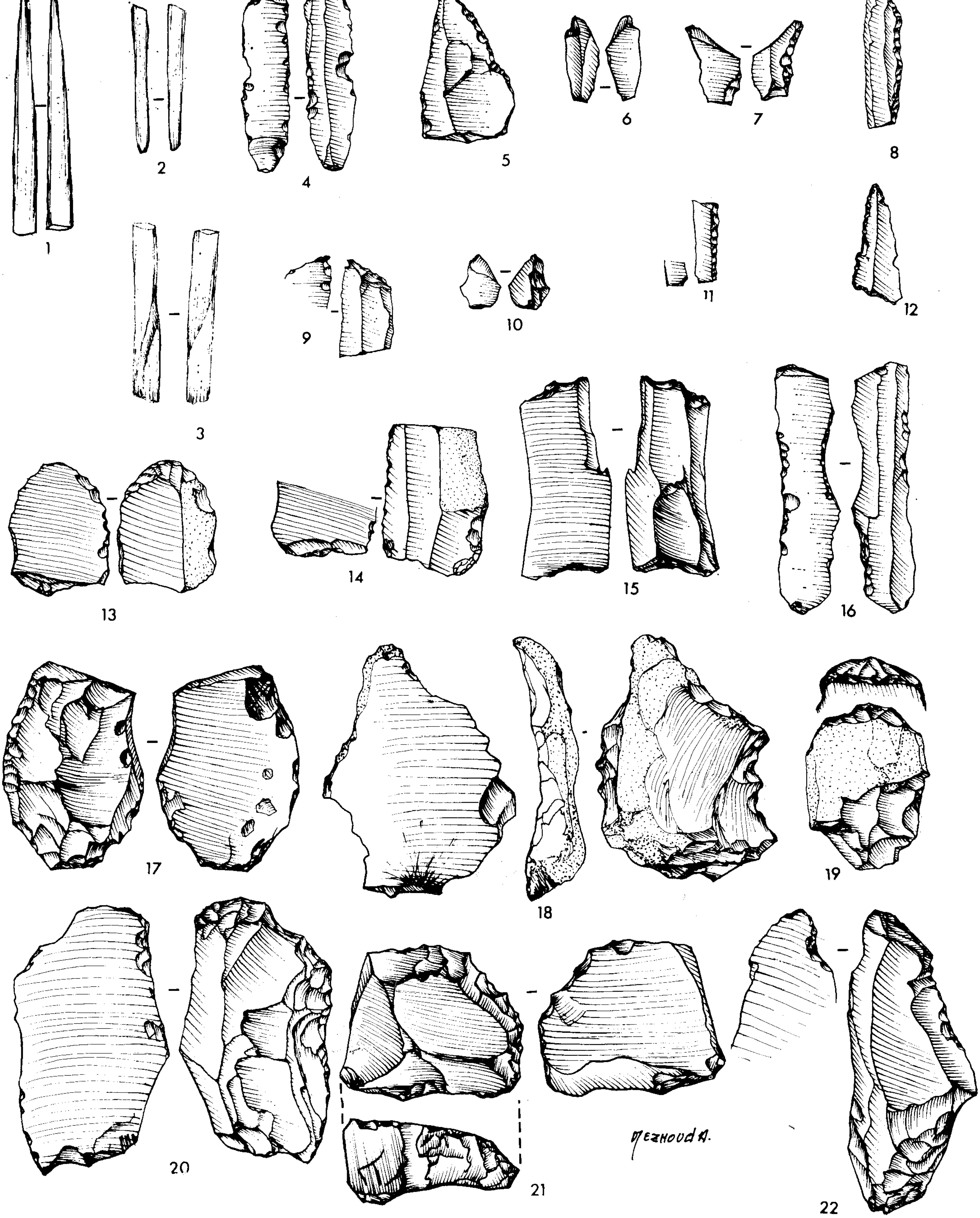

Fig. 24. — Retouched Tools - Level 4 : 1) Bone awl ; 2) Bone awl ; 3) Bone awl ; 4) Notched bladelet with continuous retouched (T. 79) ; 5) Continuously retouched flake (T. 105) ; 6) Microburin (T. 102) ; 7) Krukowski microburin (T. 103) ; 8) Blacked bladelet (T. 56) ; 9) Truncated bladelet (T. 80) ; 10) Microburin (T. 102) ; 11) Fragment of a bladelet (T. 66) ; 12) Scalene triangle (T. 90) ; 13) Simple endscraper on a blade (T. 8) ; 14) Truncated blade (T. 80) ; 15) Endscraper (T. 1) ; 16) Continuously retouched bladelet (T. 105) ; 17) Backed flake (T. 34) ; 18) Denticulated flake (T. 75) ; 19) Simple endscraper on a flake (T. 1) ; 20) Shouldered endscraper (T. 6) ; 21) Varia (T. 112) ; 22) Notched blade (T. 76).

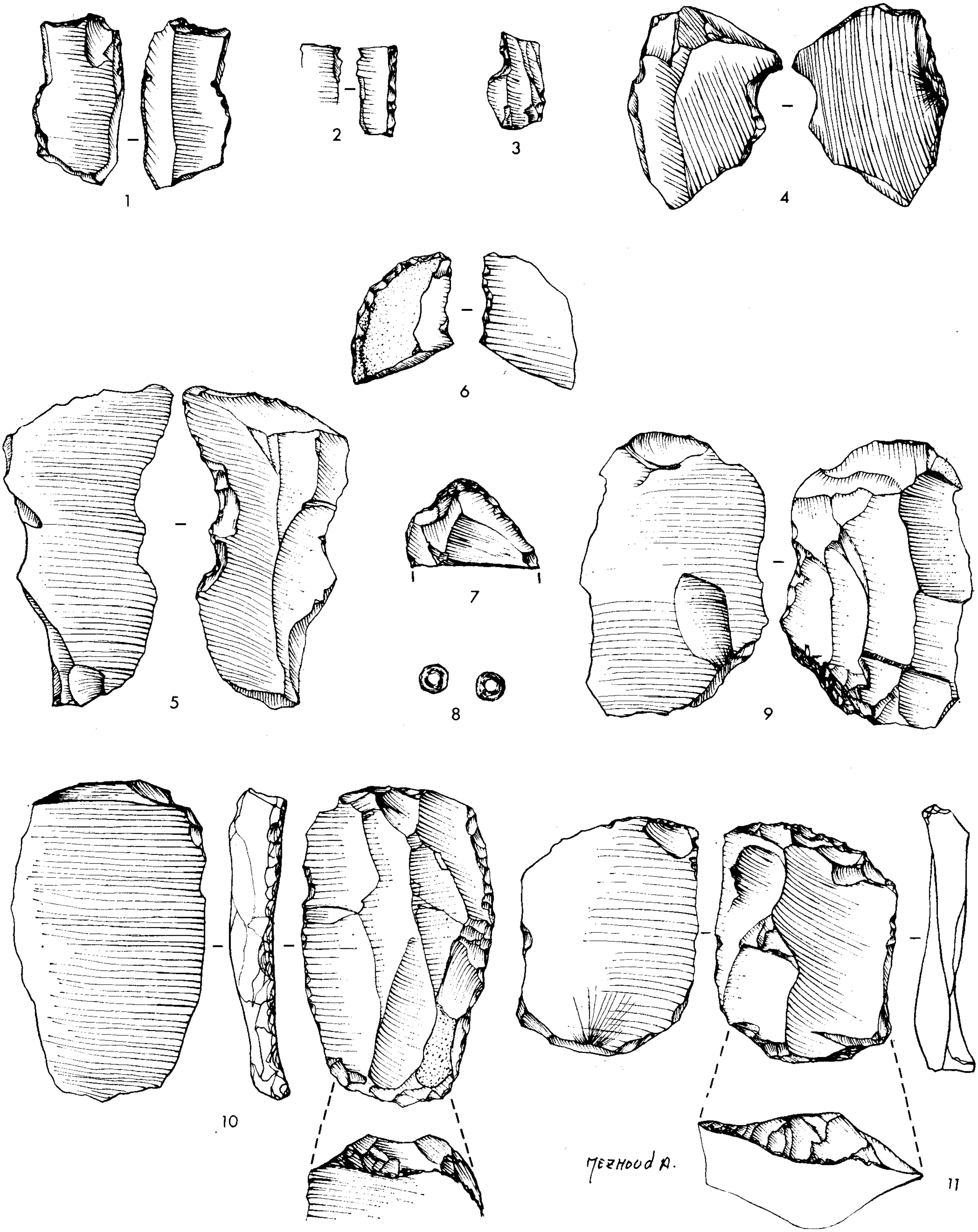

Fig. 25. — Retouched Tools - Level 6 : 1) Angle buring on a concave truncation (Type 23) ; 2) Fragment of a backed bladelet (Type 66) ; 3) Notched bladelet (Type 76) ; 4) Notched flake (Type 74) ; 5) Denticulated blade (Type 77) ; 6) Fragment of an arch-tipped bladelet (Type 55) ; 7) Fragment of a shouldered endscraper (Type 6) ; 8) Ostrich egg shell bead ; 9) Notched flake (Type 74) ; 10) Endscraper on a retouched flake (Type 2) ; 11) Simple endscraper on a flake (Type 1).

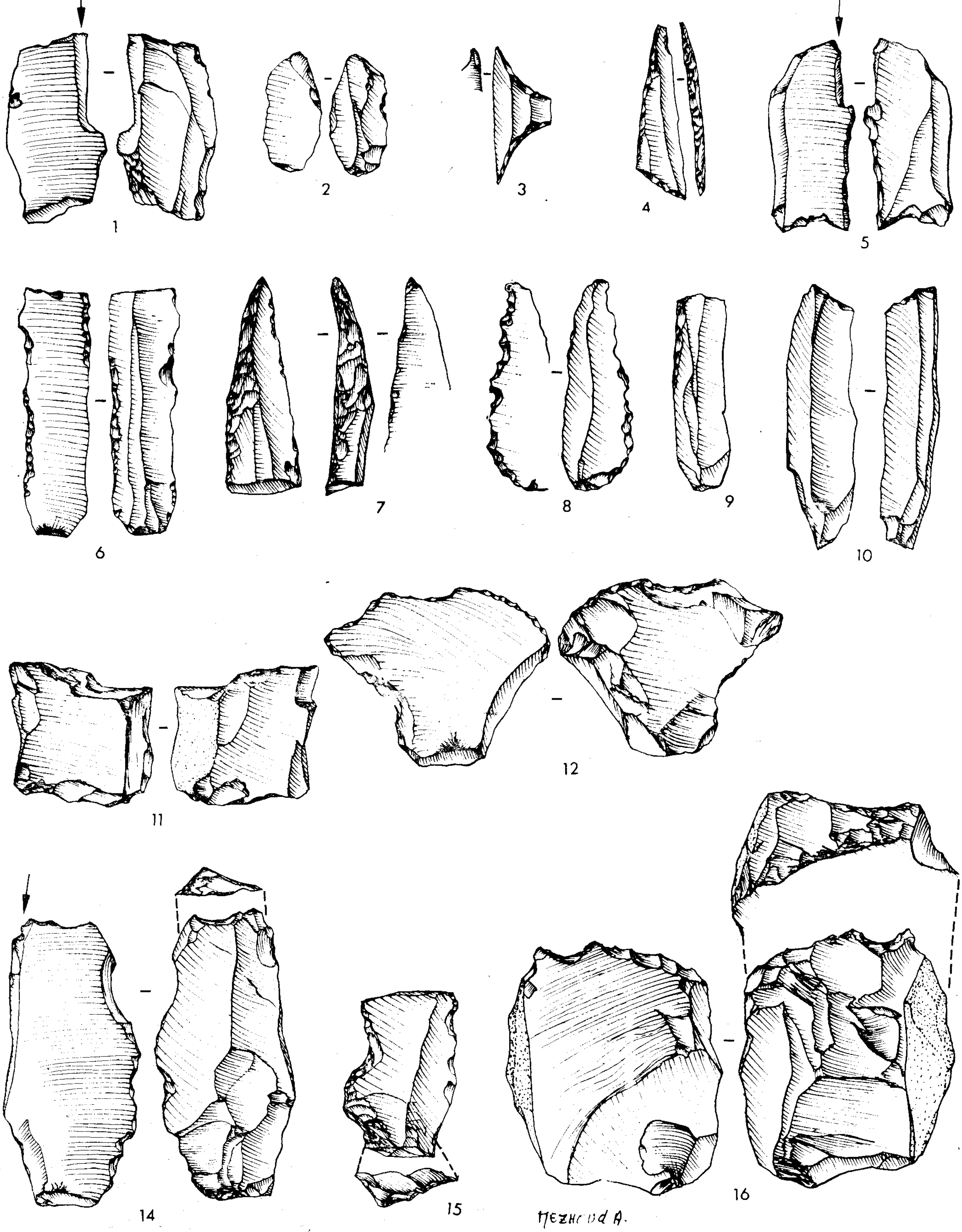

Fig. 26. — Retouched Tools - Level 5 : 1) Angle burin on a break (Type 19) ; 2) Microburin (Type 102) ; 3) Double concave trapeze (Type 87) ; 4) Elongated scalene triangle with a small short side (Type 95) ; 5) Multiple burin on truncation (Type 26) ; 6) Continuously retouched bladelet (Type 105) ; 7) Fragment of a backed blade (Type 42) ; 8) Denticulated bladelet (Type 77) ; 9) Partially backed bladelet (Type 63) ; 10) Multiple mixed burin (Type 27) ; 11) Multiple burin on Truncation (Type 26) ; 12) Notched flake (Type 74) ; 13) Straight backed and pointed bladelet (Type 45) ; 14) Angle burin on a break (Type 23) ; 15) Notched bladelet (Type 76) ; 16) Denticulated endscraper (Type 5).

PREHISTORIC CULTURAL ECOLOGY

F. A. Hassan & D. Lubell

Introduction.

In the introduction to this report we emphasized the conflicting interpretations of Capsian subsistance found in the literature and the tendency of prehistorians to view the Capsian as a unique occurence in the archaeological record. There is an abundant literature which suggests the latter point is falacious, and that the Capsian subsistence adaptation may be only one example of a generalized Holocene pattern in the circum-Mediterranean region. Land snails are reported as common in Holocene sites with epipalaeolithic or mesolithic assemblages from Portugal (1), Spain (2), southern France (3), Italy (4), the Zagros (5), the Levant (6) and elsewhere. Unfortunately, the land snails mentioned in these reports are usually treated as a side-light ; species lists are sometimes given but generally without frequencies. As a consequence, few attempts can be, or have been, made vis-à-vis palaeocological reconstruction of the subsistence importance of land snails (7). The intent of the present section is to provide such a reconstruction of the Capsian in the Tébessa region and present a model which other researchers can use and/or criticize for analogous patterns in other areas.

The dietary importance of land snails vs. vertebrates.

Were land snails the most important source of animal protein in the Capsian diet ? The question was first posed by Gobert (8) and answered in the negative. Little subsequent investigation was directed to this question. Both Baker (9) and Romer (10) implied that Capsian subsistence patterns might have changed seasonally but again, subsequent investigators ignored the evidence necessary to deal with the problem.

To do so we designed a field methodology incorporating the investigation of all evidence we thought would bear on the problem. This evidence has been presented in previous sections. We also designed a series of laboratory analyses to supplement our other investigations and the data from these constitute the information base of the present discussion.

We required an estimate of the proportional contribution of land snails in the Capsian diet. Snails are a rich source of protein but contain few calories or fats compared to vertebrate meat (table XX). In order to determine the nutritional value of the land snail species found in the escargotières we collected live specimens, boiled them, and removed the meat from the shell. We recorded the live weight of the total animal, the shell weight, and the weight of the cooked flesh. The data in (table XXI) clearly indicates that the refuse of land snails will be less voluminous than marine shell refuse (since the latter are more heavily constructed), but that land snail shell will be a more important refuse item in an archaeological deposit than mammal bone. The data also show that different species of land snails will vary in their productivity vis-à-vis the requirements of a hunting-gathering subsistence regime. As well, the data on modern land snail ethology and ecology (table IV) suggest that seasonal availability of land snails

(1) Roche (J.). — *Les amas coquilliers* (conchieros) *mésolithiques de Muge (Portugal).* In, Luning (J.) (ed.), *Die anfänge des Neolithikums vom Oirent bis Nord-Europa.* VII, Köln, 1972, pp. 72-107.

(2) Clark (G.A.). — *The Asturian of Cantabria : subsistence base and the evidence for post-Pleistocene climatic shifts.* American Anthropologist, t. 73, 1971, pp. 1245-1257.
Vilaseca (S.). — *Les industries de silex en Catalogne méridionale.* Actes du 86e Congr. Nat. Soc. Savantes, Montpellier, 1961, section archéologique, 1962, pp. 55-60.

(3) Cauvin (M.-C.). — *Les industries post-glaciaires du Périgord.* Pub. du Centre de Recherches Ecologiques et de Préhistoire, nº 2, St André-des-Cruzières, 1971.
Laplace-Jauretche (G.). — *Les couches à escargots des cavernes pyrénéennes et le problème de l'arisien de Piette.* Bull. Soc. Préhist. Franç., t. 50, 1953, pp. 199-211.
Sacchi (D.). — *Recherches sur les Paléolithiques en Languedoc occidental.* Cahiers de Préhistoire et d'Archéologie, t. 20, 1971, pp. 157-168.

(4) Durante (S.) & Settipasi (F.). — *I molluschi del giacimento quaternario della Grotta della Madonna a Praia a Mare (Calabria).* Quaternaria, t. 16, 1972, pp. 255-270.

(5) Reed (C.A.) & Braidwood (R.W.). — *The fauna from the terminal Pleistocene of Palegawra Cave, a Zarzian occupation site in northeastern Iraq.* Fieldiana Anthropology, t. 63, 1974, pp. 81-146.

(6) Altena (O.V.R.). — *Molluscs and echinoderms from Palaeolithic deposits in the rock shelter of Ksar 'Akil Lebanon.* Zoologische Mededelingen, t. 38, 1962, p. 5.
Avnimelech (M.). — *Sur les mollusques trouvés dans les couches préhistoriques de Palestine.* Jr. Pales. Orientl. Soc., t. 17, 1937, pp. 81-92.

(7) But cf. Morel (J.). — *l. l.*, 1974.

(8) Gobert (E.G.). — *l. l.*, 1937.

(9) Baker (F.C.). — *l. l.*, 1938.

(10) Romer (A.). — *l. l.*, 1938.

probably played an important role in the scheduling of Capsian subsistence strategies.

Knowing this, we then attempted to estimate the percentage of land snail in the Aïn Misteheyia deposit. This required some educated guesswork, as the deposit includes both whole and crushed shell and additional shell may have been leached out. We determined the volume of the site as 944 m^3 using the formula $1/6\,\pi\, h(3r^2 + h^2)$ where r is the radius (ca. 20 m) and h is the depth (1,5 m). Using a value of 1,3 for the specific gravity (1) we estimate the mass of the deposit at 1 227 metric tons.

Each cubic meter of deposit contains approximately 25 000 whole land snail shells and the average dry shell weight of each of the three major species in the site is 1,7 gr (table 21). Each cubic meter therefore contains at least 42,5 kg of whole shell and the entire site about 40 120 kg. This total constitutes 3,3 % of the deposit by weight. Since at least 7 % of the material passed through a 1 mm mesh consists of finely powdered shell (and fragments of crushed shell occur throughout the deposit), we estimate the total weight of shell in the site to be 10 % or ca. 125 000 kg. The edible portion of the predominant species in the site averages ca. 80 % of the dry shell weight, and on this basis we can estimate the total amount of snail flesh originally available at 100 000 kg.

During excavation we recovered 3,5 kg of vertebrate bone from 5 m^3 of deposit. This gives an estimate of only 0,7 kg/m^3 or 660 kg of bone in the site. However, the average percentage of bone fragments recovered during laboratory analysis of the bulk samples is 0,44 % by weight. Projected over the entire deposit this adds 5 400 kg of bone bringing the total to an estimated 6 000 kg.

The dry weight of bone remains represents between 5 and 7 per cent of the original animal live weight (2), and Cook and Treganza estimate that ca. 25 % of this will be lost through bacterial action and chemical weathering thus reducing the relative dry weight to ca. 4 % of the original live weight. Hunting patterns, butchering practices and destruction or removal by scavengers will further reduce this figure. Therefore, at least 50 % of the bone will not be preserved and the total actually preserved is probably closer to 10 % (3). The weight of preserved bone will therefore be equivalent to between 2,0 and 0,4 percent of the original live weight. Thus, the total live weight mass represented in the Aïn Misteheyia deposits can be estimated between ca. 300 000 kg and ca. 1,5 million kg. If 60 % of this represented edible meat (4) the total amount of flesh available can be estimated between ca. 180 000 kg and 900 000 kg. If we take the midpoint, or ca. 500 000 kg, we can estimate the contribution of land snails to the Capsian diet as about one-sixth of the animal flesh consumed.

This seems a very reasonable estimate given the very different nutritional value of land snails as opposed to vertebrate meat. Despite the demonstrated value of land snails as a survival food (5), it is unlikely they ever formed a major source of protein in the Capsian diet.

Vertebrate meat is a more important source of high quality protein (i.e. protein with a balanced composition of amino acids). Individual requirements are about one gram/kilogram of body weight or ca. 50 gr/person/day (6) in a mixed group of adults, juveniles and children. Meat has a higher protein value than plants (16 % vs 5 %) and therefore will contribute 1,8 times the protein of plant

(1) COOK (S.F.). et TREGANZA (A.E.). *l.l,* 1947.

(2) *Ibid.*
KUBASIEWICZ (M.). — *Uber die methodik de forschungen bei tierausgrabungsknochen.* Materialnie Zachodnio-Pomerskie, t. , 1956, pp. 235-244.
MEIGHAM (C.E.). — *Molluscs as food remains in archaeological sites.* In, BROTWELL (D.) et H(44° (E.S.), (eds.), *Science in Archaeology,* London, 1969, pp. 415-422.

(3) ISAAC (G.Ll.). — *Towards the interpretation of occupation debris : some experiments and observations.* Kroeber Anthropology Society Papers, Berkeley, t. 37, pp. 31-57.

(4) WHITE (T.E.). — *A method for calculating the dietary percentage of various food animals utilized by aboriginal peoples.* American Antiquity, t. 18, 1953, PP. 396-398.

(5) BILLINGHAM (J.). — *Snail haemolymph : an aid to survival in the desert.* The Lancet, 1961, PP. 903-906.

(6) DUBOS (R.). — *Man Adapting,* New Haven, 1971.

food or two-thirds of the protein in the diet. Therefore, if meat constitutes 35 % of the diet (1) it will contribute 32,5 kg of the required 50 gr/day.

(1) LEE (R.B.). — *What hunters do for a living, or, how to make out on scarce resources.* In, LEE (R.B.) et DEVORE (I.), (eds.), *Man the Hunter,* Chicago, 1968, PP. 30-48.

If we assume the average Capsian group size to have approximated modern hunter-gatherers in semi-arid environments, and Aïn Misteheyia to have been no exception to this, we can estimate the population of the site at ca. 20 individuals at any one time (2). We can therefore estimate the total daily animal protein requirement at 650 gr (20 x 32,5). The total protein available in the site is ca. 96 000 kg (600 000 kg of snail and vertebrate flesh containing 16 % protein). This represents a total of 147 000 man-days of protein support (96 000/0,65) which equals 400 years or 4 800 months. Calculation on the basis of available calorie support from meat gives a slightly lower estimate which we think is less reliable ; as with modern hunter-gatherers in semi-arid environments, plants constitute the bulk of the calorie-rich foods in the diet (3), so did they probably among Capsian groups.

(2) HASSAN (F.A.) — *On mechanisms of population growth during the Neolithic.* Current Anthropology, t. 14, 1973, PP. 535-540.
LEE (R.B.). — *l.l.*, 1968.
WOBST (H.M.). — *Boundary conditions for Palaeolithic social systems : a simulation approach.* American Antiquity, t. 18, 1974, PP. 147-178.

(3) LEE (R.B.). — *l.l.*, 1968.

Seasonality ?

The figure of 400 years possible occupancy at Aïn Misteheyia appears at first glance to be in conflict with the radiocarbon dates (table XXII) which indicate a time span of over 2 000 years. This is a false impression, for there is no need to assume the site was occupied continuously. In fact, the stratigraphy discussed previously suggests there is at least one break in the sequence (at the base of level 4) which appears to be corroborated by the radiocarbon dates. What the figure 400 years (or 4 800 months) *does* suggest, however, is that the site was occupied either annually (for ca. 6 weeks/year) or more probably on a sporadic basis with long intervening periods of vacancy. Depending on the duration of each occupation, the site could have been vacant for two to six years for each year of occupancy as suggested in the following table.

Duration of annual occupation	Total years of occupation	Ratio of years of vacancy to years of occupation
3 months	1 600	1,88 : 1 or ca. 2 : 1
6 months	800	3,75 : 1 or ca. 4 : 1
9 months	533	5,63 : 1 or ca. 6 : 1.

Six months of occupation every four years equals 4 500 months of occupation which is remarkably close to our estimate of 4 800 months of available protein support for a group of 20 people.

Was this pattern seasonal ? Our data on modern land snail ethology and ecology strongly implies that edible snails would not have been available to Capsian groups during the winter. The vertebrate remains from Aïn Misteheyia are too limited and fragmentary to permit an age curve being constructed and so we are unable to further test this idea with independent evidence. Similar attempts have not been made for those escargotières with more complete faunal assemblages. However, our data from geomorphology, sedimentology and geochemistry all suggest that the period of Capsian occupation at Aïn Misteheyia was one of great seasonal variation (perhaps greater than at present) which could mean that Capsian groups went elsewhere during the winter as land snails may have been even more of a seasonally available resource than they are today.

Furthermore, despite the documented presence of charcoal from oak and pistachio trees in Capsian deposits (1), there is no published report of seeds or nuts from these trees. One would certainly expect to find some evidence for this food source after half a century of research if it existed. It is, of course, possible the seeds and nuts were ground to a powder in much the same way that pine nuts were processed by the Washo in the Great Basin of North America (2), and grinding stones are sometimes found in Capsian sites. Even if this were the case, however, some evidence should remain. We processed approximately 100 kg of matrix from Aïn Misteheyia by flotation without finding any macrofloral remains other than charcoal. Since seeds and especially nuts or acorns would be a resource available only in the autumn, their absence from archaeological sites suggest sites were not occupied during this season. Since spring and summer appear to be the best times for snail collecting, these seasons would seem to be the most logical time for Capsian occupation in the region given present evidence. In this context, the possibility of transhumance between the High Constantine Plains and the *chotts* to the south provides new avenues of exploration for further investigations.

(1) COUVERT (M.). — *l.l.*, 1972.

(2) DOWNS (J.). — *The two worlds of the Washo.* New York, 1966.

Subsistence efficiency and ecological equilibrium.

We have shown that the environment of the Chéria region has been seriously degraded since the Holocene. Were Capsian groups in any way responsible ? Did they over-reach the carrying capacity of the environment as has been suggested for other Holocene hunter-gatherers in the Near East (3) and thereby precipitate a situation later exacerbated by the introduction of herding and agriculture ? What, if any, was the predation pressure of Capsian groups on available animal resources and on the environment in general ?

(3) BINFORD (L.R.). — *Post-Pleistocene adaptations.* In, BINFORD (S.R.) et BINFORD (L.R.), (eds.), *New Perspectives in Archaeology,* Chicago, 1968, pp. 313-341.

The average modern density of land snails in the Chéria region is 2,1 snails/m^2, and only 10 % of any area could be effectively occupied by land snails. If we assume similar conditions during the Holocene, a site catchment area of 5 km radius (4) would encompass 78,5 km^2 and contain a population of 16,5 million land snails most of which would be edible. Dividing the total weight of snail meat estimated for Aïn Misteheyia (100 000 kg) by the maximum number of years estimated for occupation (400) and multiplying this by a factor of 2,31 (the proportion of live weight to edible portion of *Helix melanostoma*), we arrive at an estimated annual consumption of 722 kg (liveweight) of snails each year. At an average weight of 3,47 gr (liveweight) snail, this represents a total of 208 000 snails/year which is a predation rate of 1,24 % which was certainly not a danger to the population viability of land snails. Furthermore, the relatively constant minimum size of shells in the deposit (20 cm diameter) indicates that there was no pressure to collect younger snails which would have been necessary if they were in short supply due to predation pressure.

(4) VITA-FINZI (C.) et HIGGS (E.S.). — *l.l.*, 1970.

Predation pressures on vertebrates appear to have been of a similar order of magnitude. We have previously stressed that the predominance of *Alcelaphus buselaphus* and *Equus mauritanicus* at Aïn Misteheyia (and other Capsian sites) indicates a biome of open steppic plains with forested slopes. The latter are suggested by both the frequency of five-banded *Otala* spp. in Capsian deposits and study of charcoal from these deposits. Bourlière (5) estimates that such a biome can support about 10 000 kg of animal biomass per square kilometer. Therefore, a catchment area of 78,5 km^2 in which 25 % of the area was effectively occupied by game, would provide ca. 196 250 kg of available live weight. If

(5) BOURLIERE (F.). — *Observations on the ecology of some large African mammals.* In, HOWELL (F.C.) et BOURLIERE (F.), (eds.), *African Ecology and Human Evolution,* London, 1964, pp. 43-54.

Capsian hunters utilized only 60 % they would have had ca. 117 750 kg of meat available.

We have already conservatively estimated that ca. 500 000 kg of vertebrate meat was consumed over a period of 400 years at Aïn Misteheyia. We therefore estimate per annum consumption of meat at ca. 1 250 kg on average, or ca. 2 000 kg liveweight. This means a culling rate of only 1,7 % of the maximum biomass if only one Capsian group was active within the catchment area. If there were two active groups a figure of about 4 % can be inferred. If we double our estimate of the amount of meat consumed the culling (or predation) rate would increase to 8 % which is still well below the accepted rate of 10 %. This lower rate would have been rewarding in the long run as it makes allowance for other predators and seasonal or periodic fluctuations in the abundance of game animals. Capsian groups would, therefore, have utilized between 20 and 40 percent of the maximum available yield. This figure is in accord with estimates of Birdsell (1) and others on the practice among hunter-gatherers of allowing for a wide margin between what is potentially available and what is actually consumed. In sum, then, it is highly unlikely that Capsian groups (successful as they were) could have been a disruptive factor in their chosen habitat. We suspect the same can be said for other late Pleistocene and Holocene groups. This adaptive success is in accord with the long survival of the Capsian subsistence pattern and the abundance of Capsian sites. It is also notworthy that snail collecting was apparently not a « last resort » activity forced on Capsian groups by stress.

(1) BIRDSELL (J.B.). — *Some predictions for the Pleistocene based on equilibrium systems among recent hunter-gatherers.* In, LEE (R.B.) et DEVORE (I.), (eds.), *Man the Hunter,* Chicago, 1968, pp. 229-240.

Temporal changes in the subsistence regime.

Despite its longevity, the Capsian subsistence adaptation did not continue unchanged during the 2 000 or more years during which the Aïn Misteheyia escargotière was intermittently occupied. Given the changes in environment we have already discussed one would not, in fact, expect it to remain unchanged. The nature, and to some extent the degree of this change in subsistence is indicated in figure 19, which is based on data presented in table 2. The last column in figure 19 (bone/bone + shell) shows a sharp decrease in the amount of bone at the interface between levels 2 and 3a. Below this interface the average frequency of bone is 0,62 % and above it 0,33 %. At the same time the frequency of snail shell increases from an average of 3,5 % in levels 1 and 2 to an average of 6,7 % in levels 3 and 4. These figures suggest a substantive change in subsistence practices from an earlier pattern in which vertebrates like hartebeest and aurochs were frequent to a later one in which game animals declined in importance and land snails increased.

We have previously shown that the increased frequency of *Helicella setifensis* (fig. 19) cannot be interpreted as a direct response by this species to environmental change. Rather, it appears to be a result of changing adaptive practices by the inhabitants of Aïn Misteheyia due to a decreased animal biomass. The postulated change in subsistence coïncides with a period of reduced precipitation. This change in precipitation regime may have approached the threshold between two habitats of markedly different carrying capacity : grassland savana and desert shrub. The former would likely be associated with an increase in Mediterranean-type forest cover at higher elevations. This is the most likely combination of habitats in which to find hartebeest and aurochs which are the predominant vertebrates in most Capsian sites. Neither can exist effectively in a desert shrub habitat.

A change from savana-grassland-parkland to an environment approaching desert shrub would result in a decreased animal biomass. The decrease in the amount of bone in the Aïn Misteheyia deposits may reflect such conditions. The response of the inhabitants of Aïn Misteheyia appears to have been one of diversification and adjustment by increasing their exploitation of *Helicella setifensis* which had previously been neglected. The same change in environmental conditions might also have had a deleterious effect on the abundance of *Helix melanostoma* which may explain the decreasing frequency of this species in the deposits.

The effects of this suggested environmental change appear to have been irreversible despite a subsequent increase in precipitation. Perhaps the decreased vegetation mat resulted in increased slope erosion as is indicated by our geomorphological studies in the region.

This interpretation is also in agreement with changes in the artifact assemblage and apparent decrease in the intensity of occupation at the site during level 3b. The latter is clearly indicated by the frequencies for bone + shell shown in figure 19. These data suggest that the success and longevity of the Capsian subsistence adaptation were due to two complimentary factors : the varietal richness of the environment and the ability of Capsian groups to adjust their subsistence practices to changing conditions. It is clear, therefore, that one should not expect to find the same subsistence pattern (or the same archaeological assemblage) in every Capsian escargotière throughout the span of time represented in each site. Rather, differentiation over both time and space is to be expected. In other words, the regional and temporal variation documented by Camps and Camps-Fabrer (1) is probably best explained as the result of different groups belonging to the same cultural tradition making different tool kits at different times in different places in response to changing needs.

(1) CAMPS (G.) et CAMPS-FABRER (H.). — *l. l.*, 1972.

Capsian cuisine.

During microscopic examination of soil samples collected from various escargotières in 1972, we observed abundant fragments of both comminuted periosteal bone and degraded cancellous bone. Initially the latter were interpreted as microfaunal remains, but Dr C.S. Churcher of the University of Toronto (2) identified the material as degraded cancellous bone. Subsequently, T.C. Losey (3) of the University of Alberta examined the samples and remarked that the pattern of bone fragmentation was remarkably similar to samples taken from bone boiling pits as a bison butchering site in Central Alberta (4). The practice of crushing and boiling bone to extract the maximum amount of fat is widespread in North America and especially in the Arctic. It has also been inferred for other regions of the world during Palaeolithic times. In as much as land snails have a very low fat content (table 20), it seems likely that Capsian cooks followed similar practices in order to supplement the fat content of their diet. The generally deplorable state of preservation of vertebrate bone in escargotières seems to confirm this hypothesis.

(2) CHURCHER (C.S.) — *in litt.*, 1973.

(3) Personnal communication, 1973.

(4) LOSEY (T.C.). — *Archaeology of the Cormie Site : an interim report.* Archaeological Society of Alberta Newsletter, n° 28, Edmonton, 1971.

We have experimented with various means of extracting a snail from its shell. We have had not success unless the snail is first exposed to high temperatures in order to loosen the muscles. Either boiling or roasting will achieve this but we found boiling to be the most efficient. Living specimens of *Helix aspersa, Helix melanostoma, Helicella setifensis, Leucochroa candidissima* and *Otala* spp. were dropped into water which was either heating or already boiling. After boiling for several minutes the animals were easily extracted with a dental pick. A thorn, pine needle, bone awl, or pointed backed bladelet would do as well. We are under the impression that snails dropped directly into already boiling water were more easily extracted than those placed in water which was heating.

We conclude that Capsian cooks boiled their snails (1), probably by placing heated rocks (pot-boilers) in skin containers. We have observed almost no land snail shells which were exposed to direct heat, an observation also made by Morel (2) for the assemblage from Dra-Mta-el-Ma-el-Abiod.

(1) Cf GOBERT (E.G.). — *l. l.*, 1937.

(2) MOREL (J.). — *l. l.*, 1974.

The effects of fire (i.e. roasting) on land snail shell are quite characteristic and if present in archaeological deposits would be easy to identity (3). We observed these effects in a recently burned field in Wadi Chéria-Mezeraa during September 1973. Prior to being burned by the local farmer, the field was heavily colonized by *Helicella setifensis* clinging in bunches to the vegetation. We observed the following degrees of burning :

(3) For an example see FALKNER (G.). — *Die bearbeitung ur-and frügeschichtlicher molluskenfunde in archäologie und biologie.* In, BOESSNECK (J.). (ed.), *Deutsche Forschungsgemeinschaft, t.* 15, 1969, pp. 112-140.

1) brown coloration resulting from incomplete combustion of organic material ;

2) more complete combustion with formation of blackish and blueish-grey zones ;

3) complete oxydation of organic material and formation of calcium oxide (white and powdery) ;

4) distortion, fissuration and desquamation of the shell ;

We have never observed these phenomena in a Capsian escargotière, and we conclude that Capsian cooks rarely (if ever) roasted snails.

Our impression is that the Capsian diet consisted primarily of a stew composed of meat, bones, snails and presumably plants. Exactly which plants were collected by Capsian groups (and what proportion of the diet they constituted) remains unknown. One clue to this may be the few charred bulbs we discovered in the Logan Museum Collections at the University of Minnesota which have been identified as *Allium* (possibly *A. ascalonicum* the shallot) (4).

(4) STEWART (W.). — *in litt.*, 1975.

SUMMARY AND CONCLUSIONS

The Holocene geological and archaeological history of the Chéria and Télidjène depressions has been summarized in table 1. Our data and observations demonstrate that :

1. - Capsian occupation in the Chéria and Télidjène depressions (ca. 9 500 to at least ca. 6 500 B.P.) coincides with a phase of alluviation represented by Unit II at Aïn Misteheyia which is probably contemporaneous with member 1 and part of member 2 of the Chéria formation. These deposits indicate semi-arid climatic conditions which were cooler and more humid than those prevailing today.

2. - At ca. 8 800 B.P. these conditions were briefly interrupted by an interval of warmer and drier climate which has been identified in both member 1 and Unit II as well as by independent studies of Couvert in numerous escargotières.

3. - The faunal remains from Aïn Misteheyia and other excavated escargotières consist of edible land snails and vertebrates typical of the grassland-steppe habitats which would be present under the semi-arid climatic regime described above. The distribution of available habitats under these conditions appears to be reflected by inter-site differences in the frequencies of land snails and vertebrates. Part of the Capsian fauna is still extant, and the absence of certain species from modern assemblages is largely the result of post-Capsian human interference with the environment.

4. - The climatic changes discussed above are reflected in the faunal sequence from Aïn Misteheyia. A higher frequency of vertebrate remains is associated with the first period of increased precipitation in level 1 and 2. The increased frequency of land snails and decreased frequency of vertebrate remains in levels 3 and 4 is contemporaneous with the short warmer and drier interval. Therefore, these changes can be interpreted as a response by the occupants of Aïn Misteheyia to deteriorating ecological conditions under which the quantity of available vertebrate game was reduced.

5. - Contemporaneous changes have been recorded in the artifact assemblage at Aïn Misteheyia. In levels 2 and 3 the most frequent tools are burins, backed blades and bladelets, and geometric microliths. In levels 4, 5, and 6, the most frequent tools are endscrapers, notches and denticulates, truncations, and continuously retouched pieces. Therefore, we interpret these changes as being related to the observed change in subsistence practices.

6. - An occupation surface was recovered at the base of level 4, which consists of two several lithic artifacts, three unidentifiable fragments of vertebrate bone, clusters of land snail shells, and fire-cracked rocks. One circle contains several fragments of ceramics which are *in situ.*

7. - We conclude that land snails formed an important, but not the most important, source of animal protein in the Capsian diet ; primarily because they were only available seasonally. Nonetheless, their adaptive value is clearly indicated by the change in subsistence practices documented at Aïn Misteheyia. Furthermore, our calculations suggest that Capsian escargotières were occupied intermittently (perhaps on a seasonal basis) rather than on a year-round permanent basis ; that Capsian population densities were lower than might be inferred from the number of sites ; and that the Capsian subsistence adaptation was both innovative and conservationist and therefore highly successful. We suspect that this success is a major reason for the rather late adoption of a Neolithic economy in the Maghreb.

RESUME

Le tableau 1 donne un résumé provisoire de l'histoire géologique et archéologique de l'Holocène dans la dépression de Chéria et celle de Télidjène. Nos données et observations démontrent que :

1) L'occupation de la dépression de Chéria et de Télidjène (ca. 9 500 à au moins ca. 6 500 B.P.) par les Capsiens coïncide avec une phase d'alluviation représentée par Unit II (Unité II) à Aïn Misteheyia, laquelle est probablement contemporaine du membre 1 et d'une partie du membre 2 de la formation de Chéria. Ces dépôts indiquent des conditions de climat semi-arides, toutefois plus fraîches et plus humides qu'aujourd'hui.

2) Ces conditions climatiques ont été brièvement interrompues par un intervalle à climat plus chaud et plus aride vers 8 800 B.P. Cet intervalle fût identifié respectivement dans le membre 1 et Unit II, aussi bien qu'indépendamment par Couvert dans de nombreuses escargotières.

3) Les restes fauniques d'Aïn Misteheyia et autres escargotières fouillées consistent en gastéropodes terrestres comestibles et vertébrés, tous typiques pour des habitats de prairies steppiques tels qu'on les trouve sous un climat semi-aride. La distribution des habitats disponibles sous ces conditions semble être reflétée dans les différences des fréquences de mollusques et de vertébrés dans les différents gisements échantillonnés. Une partie de la faune capsienne est encore présente dans la région ; l'absence de certaines espèces dans les assemblages d'aujourd'hui résulte surtout de l'influence de l'homme post-capsien sur l'environnement.

4) Les changements climatiques rapportés sont reflétés dans la séquence faunistique d'Aïn Misteheyia. La première période de précipitation plus marquée (niveaux 1 et 2) est caractérisée par une haute fréquence de vertébrés. L'augmentation de fréquence des coquilles terrestres et une diminution dans le nombre des restes de vertébrés constatés dans les niveaux 3 et 4 sont contemporaines de l'intervalle plus chaud et plus aride. Par conséquent, ces changements peuvent être interprétés comme une adaptation des habitats d'Aïn Misteheyia aux conditions écologiques détériorées sous lesquelles la quantité de faune de chasse disponible se réduisait.

5) Des changements concordants dans les assemblages lithiques on été observés à Aïn Misteheyia. Dans les niveaux 2 et 3 burins, lames et lamelles à dos et microlithes géométriques sont les outils les plus fréquents. Dans les niveaux 4, 5 et 6, ce sont grattoirs, coches et denticulés, troncatures et pièces à retouche continue. Nous interprétons ces changements comme étant liés au changement du mode de vie observé.

6) Une surface d'occupation fût découverte à la base du niveau 4, consistant en deux foyers, plusieurs silex taillés, trois fragments d'os de vertébrés, des concentrations de coquilles entières, et des pierres brûlées. Un des foyers contenait plusieurs fragments de terre cuite *in situ,* mais légèrement au-dessus de la surface d'occupation.

7) Nous concluons que les mollusques terrestres formaient une source importante, bien que non la plus importante, de protéines animalières dans la diététique capsienne, surtout parce qu'ils n'étaient disponibles que saisonnièrement. Néanmoins leur importance nutritive est clairement indiquée par les changements dans le mode de vie dont témoigne Aïn Misteheyia. En outre, nos calculs suggèrent que les escargotières étaient occupées de façon intermittente (peut-être saisonnièrement) plutôt que durant toute l'année, que les densités de populations pendant le Capsien étaient plus basses qu'on pourrait le déduire du nombre de sites, et que dans leur mode de vie les Capsiens étaient innovateurs aussi bien que conservateurs et pour cette raison très prospères. Nous croyons que leur succès est une raison majeure pour l'adoption retardée dans le Maghreb du mode de vie Néolithique.

ملخـــص

يتضمن هذا البحث دراسة لآثار ما قبل التاريخ بمنطقة الشريعة وتشمل خلاصة نتائج البحث ما يلي :

1 ـ توجد بمنطقة الشريعة آثار ترجع الى مرحلة الصناعة القفصية (9500 ـ 6500 ما قبل الوقت الحاضر) وقد تراهنت هذه الصناعة مع فترة ترسيب نهري كما تدل الرواسب فى منطقة عين المستحية على مناخ شبه صحراوي أكثر امطارا وبرودة من المناخ الحالي .

2 ـ تحول المناخ حوالي 8800 عام قبل الوقت الحاضر الى مناخ أكثر جنافا .

3 ـ يحتوي موقع عين المستحية على بقايا حيوانات وقواقع برية تدل على بيئة براري تسودها الحشائش .

4 ـ تتزامن الفترة المناخية الجافة (8800 قبل الوقت الحاضر) مع نقص فى بقايا الحيوانات مما يدل على تأثير المناخ الجاف على لحيوانات .

5 ـ توجد أدلة على تغيرات فى الأدوات الحجرية خلال الزمن فتحتوي الطبقات السفلى (2 و 3) على أزاميل ونصال مجتتة وأدوات صغيرة هندسية الشكل بينما تحتوي الطبقات العليا (4 ـ 6) على مكاشط وأدوات مسننة ونصال مشذبة .

6 ـ كشفت الحفائر عن وجود سطح معيشي (طبقة 4) يحتوي البقايا الكاملة لموقدين وتحتوي احدى المواقد على شقف فخار .

7 ـ دلت الأبحاث على أن القواقع كانت مصدر غذائي مكمل ولكنها لم تكن المصدر الأساسي .

كما دلت الأبحاث على أن المو قع السكنية لم تكن مأهولة طيلة العام كما اتبع السكان نظام دوري فى سكن المواقع ونستنتج من هذا أن نظام المعيشة المرتبط بالصناعة القفصية كان نظاما ناجحا مما يفسر تأخر دخول الاقتصاد النيوليثي لمنطقة المغرب بشمال افريقيا .

Table I. — Holocene Stratigraphy and Events in the Chéria and Télidjène Depressions.

<table>
<tr><th>DATE</th><th colspan="2">LITHOSTRATIGRAPHY</th><th colspan="2">MAJOR EVENTS</th></tr>
<tr><td rowspan="2">Post-Roman</td><td colspan="2"></td><td colspan="2">Downcutting</td></tr>
<tr><td colspan="2">Recent terraces</td><td colspan="2">Minor alluviation</td></tr>
<tr><td>Roman</td><td colspan="2">Roman deposit</td><td colspan="2">Deforestation, slope erosion, downcutting</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2">Soil formation ?</td></tr>
<tr><td rowspan="3"></td><td rowspan="5">Chéria Formation</td><td>Member 4</td><td colspan="2">Fine alluvium and reduced gelifraction</td></tr>
<tr><td>Member 3</td><td colspan="2">Coarse alluvium and increased gelifraction with formation of alluvial fans and destruction of Capsian sites by rock shelter collapse</td></tr>
<tr><td></td><td colspan="2">Downcutting</td></tr>
<tr><td>ca. 5800 B.P.
ca. 6500 B.P.</td><td>Member 2</td><td rowspan="2">Capsian occupation</td><td>Fine alluvium and reduced gelifraction with destruction of Capsian sites by fluvial erosion</td></tr>
<tr><td>ca. 7000 B.P.
ca. 8800 B.P.
ca. 9500 B.P.</td><td>Member 1</td><td>Two periods with coarse alluvium and intensive gelifraction, interrupted by a warmer and drier interval</td></tr>
<tr><td></td><td colspan="2">?</td><td colspan="2">?
Downcutting
?</td></tr>
<tr><td>Late Pleistocene</td><td colspan="2">"Soltanian"</td><td colspan="2">Colluviation</td></tr>
</table>

Table II. — Sedimentology and Geochemistry of the Aïn Misteheyia Escargotière.

Depth from datum	Clay	Sand	Silt	Gravel	pH	Calcium	Iron	Phosphorus	Nitrogen	Carbon	Bone	Shell	
cm.	%	%	%	%		%	%	%	%	%	%	%	
30-35	36.0	42.0	22.0	6.8	8.0	26.7	0.54	0.20	0.16	10.6	0.26	9.0	Level 5
35-40	32.0	54.0	14.0	4.3	7.6	26.9	0.57	0.20	0.18	10.5	0.10	12.7	Level 4
40-45	39.0	43.0	18.0	1.9	7.2	23.5	0.61	0.20	0.19	10.2	0.35	10.7	
45-50	31.5	50.5	14.0	4.3	7.6	25.3	0.63	0.25	0.18	10.1	0.76	10.4	
50-55	29.0	50.0	21.0	2.1	7.6	24.8	0.62	0.25	0.15	10.6	0.32	4.6	Level 3b
55-60	30.0	49.0	21.0	3.6	7.6	24.2	0.68	0.26	0.15	10.1	0.49	5.0	
60-65	-	-	-	2.7	7.6	-	-	-	-	-	0.23	4.3	
65-70	24.0	58.0	18.0	4.4	7.6	23.5	0.76	0.29	0.14	10.1	0.55	3.5	
70-75	24.0	54.0	22.0	4.5	7.6	23.9	0.67	0.37	0.13	10.2	0.26	4.9	
75-80	19.0	49.0	32.0	5.3	8.0	26.8	0.51	0.60	0.13	10.9	0.26	11.4	
80-85	22.0	54.0	24.0	3.2	7.2	27.1	0.55	0.47	0.13	10.2	0.21	5.9	Level 3a
85-90	23.0	54.0	23.0	3.4	7.2	25.5	0.58	0.55	0.16	10.3	0.29	7.5	
90-95	18.0	60.0	22.0	5.4	7.0	26.8	0.58	0.58	0.14	10.3	0.31	8.8	
95-100	22.0	54.0	28.0	6.9	7.0	26.0	0.57	0.59	0.14	9.8	0.32	6.5	
100-105	21.0	52.0	27.0	5.0	7.3	26.1	0.64	0.56	0.14	9.4	0.18	4.3	
105-110	24.0	52.0	24.0	7.6	7.2	24.8	0.77	0.59	0.15	9.9	1.40	4.7	
110-115	26.0	51.0	23.0	7.2	7.2	24.6	0.81	0.49	0.15	9.7	0.70	4.5	Level 2
115-120	23.0	55.0	22.0	7.2	7.2	23.7	0.82	0.44	0.15	8.9	0.51	4.3	
120-125	25.0	50.0	25.0	6.5	7.2	24.4	0.80	0.44	0.14	9.1	0.52	4.1	
125-130	25.0	47.0	28.0	9.8	7.0	25.0	0.79	0.33	0.15	9.2	0.76	4.4	
130-135	17.0	54.0	29.0	8.7	7.2	24.7	0.82	0.32	0.13	9.1	0.17	3.8	
135-140	27.0	49.0	24.0	8.7	7.2	24.4	0.84	0.27	0.13	9.9	0.55	3.3	
140-145	28.0	48.0	24.0	7.6	7.2	24.1	0.85	0.22	0.12	9.3	0.49	2.8	
145-150	29.0	53.0	18.0	14.3	8.0	23.1	0.93	0.21	0.11	8.5	0.63	2.0	Level 1
150-155	32.0	54.0	14.0	11.1	7.6	23.4	0.94	0.16	0.10	8.1	0.42	1.5	

Table III-a. — Percentage Frequencies of Pollen in Wadi Mezeraa Deposits.

Stratigraphy	Samples	Sedimentology	pH	Total grains counted	Compositae, liguliflora	Compositae, tubiflora including artemisia	Malvaceae	Gramineae	Pistacia	Quercus	Cheno-am	Acacia	Pinus	Liliaceae	Caryophyllaceae	Salix	Cedrus	Cyperaceae	Unknown	Indeterminate	Ratio of charcoal fragments to identifiable pollen grains
Member 4	3a	clay	7.2	43	7.0	4.6	11.6			4.6	4.6	2.3					9.3		32.4	39.0	2.14:1
	3b	clay	7.0	59		10.2	13.6	3.4	6.8	1.7	3.4	1.7	3.4				6.8		40.7	34.0	2.17:1
	3c	clay	7.2	69		7.2	17.5	15.0		4.3	2.9						2.9	4.3	10.1	29.0	2.29:1
Mbr 3					NOT SAMPLED																
Member 2	IV	sandy loam with abundant shell greasy texture	7.6	149	5.4	27.5	21.0				4.7					8.1	3.4		14.4	58.1	1.59:1
	III	silt with abundant shell	7.0 7.2	6	STERILE																3.80:1
	II	silty clay with some shell	7.2 7.6	120				4.2				9.2	16.7						40.8	24.2	1.19:1
Member 1	I	clay	7.6 8.0	27			7.4	3.7											66.6	30.0	2.74:1

Table III-b. — Percentage Frequencies of Pollen in Wadi Redif Deposits.

Depth in cm from surface	sample number	Sedimentology	pH	total grains counted	Compositae, liguliflora	Compositae, tubiflora including artemisia	Malvaceae	Gramineae	Pistacia	Quercus	Cheno-am	Acacia	Pinus	Liliaceae	Caryophyllaceae	Salix	Cedrus	Cyperaceae	Unknown	Indeterminate	Ratio of charcoal fragments to identifiable pollen grains
105-115	9	silty clay	8.0																		
125-135	8	silty sand	7.6	PROCESSED BUT NOT COUNTED																	
147-157	7	silty sand	6.8																		
175-185	6	clayey silt with angular gravel	7.2																		
200-210	5	clayey silt	7.0	128	6.2	2.3	2.3	3.8	15.7										62.3	91.5	.13:1
225-232	4	silty sand with a little clay	6.8	146	3.4	6.2	19.8	3.4	13.7					0.8	6.9	1.6			24.0	67.0	.44:1
245-253	3	silty sand with bentonitic clay	7.0	244		25.0	13.9	2.9	12.3	1.2			0.4	2.5	1.6				20.9	60.0	.18:1
263-270	2	silty sand with bentonitic clay	7.2	221	4.1	35.3	15.8	0.5		0.9		0.5		0.9					20.8	37.0	.13:1
290-300	1	sandy silt	7.0	237		21.9	10.5	4.6	2.1	2.9	2.5	0.8	0.4	0.8					35.6	60.0	.33:1

Table IV. — Modern Ethological and Ecological Parameters of Edible Land Snails.

Species	Ecology	Seasonal Ethology			
		Winter	Spring	Summer	Autumn
Helix Melanostoma	Open Parkland, Garrigue and Valley Bottoms	Buried	Active	Buried	Active
Helicella Setifensis	Humid Environment with High Vegetation	Hiding Near Soil?	Active	Estivating in Visible Position	Active
Leucochroa Candissima	Very Xerophilous Higher Elevations	Buried	Active	Estivating but not always visible	Active
Otala Spp.	High Elevations Low Scrub Vegetation	Hiding or Buried?	Active	Estivating and Hiding	Active

Table V. — Distribution of *Otala* spp.

Site of collection	Total	4 bands		5 bands		0-1 band	
		No.	%	No.	%	No.	%
Zone I (channel banks)	64	58	90.6	5	7.8	1	1.6
Zone II (high terrace)	99	72	72.7	19	19.2	8	8.1
Zone III (foot slope)	112	95	84.8	11	9.8	6	5.4
Zone IV (mid slope)	102	102	100.0	-	-	-	-
Zone V (top slope)	103	103	100.0	-	-	-	-

Table VI. — Density of Land Snails in Wadi Chéria-Mezeraa.

	No.	Diameter (mm.)
Helix melanostoma		
Recent: Oum el-Bouaghi	8	24.5 - 35.0
Fossil: Oum el-Bouaghi	14	22.0 - 37.5
Recent: S. of Tébessa	19	24.5 - 29.5 (30.6)(2)
Fossil: S. of Tébessa	50	25.5 - 32.7
Leucochroa candissima		
Recent: Oum el-Bouaghi	8	19.0 - 23.5
Fossil: Oum el-Bouaghi	24	17.0 - 26.0
Recent: S. of Tébessa	+100	17.5 - 25.5
Fossil: S. of Tébessa	+200	18.4 - 24.0
Fossil: Biskra	6	19.5 - 25.1
Helicella setifensis		
Recent: St. Donat	+25	15.5 - 20.6
Fossil: Oum el-Bouaghi	16	20.5 - 27.0
Recent: S. of Tébessa	+100	17.0 - 23.9
Fossil: S. of Tébessa	+100	17.3 - 25.3
Recent: Batna	+25	19.9 - 24.5

(1) Based mainly on data collected in 1972.

(2) Between brackets, teratological specimen.

Table VII. — Conchometry of Modern and Fossil Land Snails.

Species	I		II		III		IV		V	
Zone / Plot area	230 m^2		250 m^2		300 m^2		300 m^2		300 m^3	
	No.	%	No.	%	No.	%	No.	%	No.	%
Helix melanostoma (2)	-	-	1	0.3	-	-	-	-	-	-
Otala spp.	1	0.1	101	31.9	102	38.1	102	52.3	202	68.0
Leucochroa candissima	-	-	90	28.4	159	59.3	93	47.7	92	30.9
Helicella setifensis	1521	99.9	125	39.4	7	2.6	-	-	-	-
Rumina decollata	-	-	-	-	-	-	-	-	3	1.0
	1522	100.0	317	100.0	268	100.0	195	100.0	297	99.9
Density (snails/m^2)	6.6		1.3		0.9		0.7		1.0	

(1) As observed in October 1973.

(2) Dead and empty shells of this species were observed in Zones II and III, but no living animals.

Table VIII. — Vertical Changes in Land Snail Frequencies at Aïn Misteheyia.

Depth below datum cm	Helix No.	Helix %	Leucochroa No.	Leucochroa %	Helicelia No.	Helicelia %	Total No.
30-35	344	26.5	359	27.7	594	45.8	1297 (1)
35-40	125	28.1	145	32.6	175	39.3	445
40-45	103	33.2	99	31.9	108	34.8	310
45-50	140	29.1	120	24.9	221	45.9	481
50-55	108	22.2	169	34.7	210	43.1	487
55-60	116	32.8	123	34.7	115	32.5	354
60-65	176	33.8	235	45.1	110	21.1	521
65-70	118	40.7	92	31.7	80	27.6	290
70-75	178	53.1	73	21.8	84	25.1	335
75-80	187	64.0	51	17.5	54	18.5	292
80-85	203	63.6	65	20.4	51	16.0	319
85-90	248	76.5	41	12.7	35	10.8	324
90-95	179	70.6	42	16.6	32	12.6	253
95-100	156	84.8	21	11.4	7	3.8	184
100-105	77	62.1	37	29.8	10	8.1	124
105-110	153	61.9	75	30.4	19	7.7	247
110-115	108	62.8	50	29.1	14	8.1	172
115-120	150	60.5	81	32.7	17	6.9	248
120-125	99	51.8	74	38.7	18	9.4	191
125-130	105	67.3	46	29.5	5	3.2	156
130-135	349	93.3	21	5.6	4	1.1	374
135-140	265	85.2	41	13.2	5	1.6	311
140-145	218	81.0	49	18.2	2	0.7	269

(1) Based on four samples rather than one as in all other levels.

Table. IX. — Percentage Frequency of Land Snail Species in Various Escargotières.

	Logan Museum Sites						Sites Investigated in Chéria Region										
	10	12	14	25	26	51	G49	G33	G25	G108	G41	G45	G12	G203	AL	RED	G17
Helix melanostoma	39.5	82.1	78.5	62.5	24.2	59.2	86.8	87.6	79.7	48.8	23.5	22.3	24.1	89.9	45.6	73.5	70.2
Otala spp.	4.2	1.0	0.7	14.8	55.3	0.4	1.3	1.0	13.5	4.4	1.2	10.3	2.3	6.4	1.9	6.2	6.8
Leucochroa candissima	30.1	5.1	17.8	21.9	20.5	39.3	10.3	8.2	3.4	25.4	28.9	15.9	8.7	1.7	41.7	5.9	16.2
Helicella setifensis	26.3	11.7	3.0	0.7	-	1.1	1.5	3.0	3.4	21.4	46.6	51.5	64.9	1.7	11.0	14.4	6.8

(1) Data for Logan Museum Sites from Baker in Pond et. al. (1938). The prefix G indicates a site listed in Grébénart (1975). AL indicates the site of Djebel el-Allouchèt and RED the destroyed escargotière in the section at Wadi Redif both discovered and investigated by our team.

Table X. — Frequencies of Mammals in Various Escargotières.

	average (1) weight in kilograms	number of identified bones at Aïn Misteheyia		percentage by weight at Aïn Misteheyia	percentage (2) by weight at Dra-Mta el-Ma-el Abiod	frequency (3) in Capsian sites
		No.	%			
Alcelaphus buselaphus	175	75	47.4	42.0	40.9	19/23
Ammotragus lervia	80	30	19.0	7.7	4.3	10/23
Equus mauritanicus	175	30	19.0	16.8	9.4	15/23
Bos primigenius (incl. B. ibericus)	800	13	8.2	33.3	42.8	18/23
Gazella sp. (G. dorcas & G. cuvieri)	17	4	2.5	0.2	1.9	5 1?/23
Lepus capensis & Oryctolagus cuniculus	2	5	3.2	+	0.5	8/23
Canis aureus &/or Canis spp.	8	1	0.7	+	0.2	4/23
		158	100.0	100.0	100.0	

(1) Deduced from weights given by Malbrant (1952).

(2) Computed from data in Morel (1974).

(3) Indicates frequency of presence in the twenty-three sites reviewed by Vaufrey (1955, Table IX).

Table XI. — Measurements for *Alcelaphus buselaphus* and *Ammotragus lervia*.

		Alcelaphus buselaphus	Ammotragus lervia
Upper jaw			
	P4, L.	13.3	
	M1/2, L.	18.0 - 20.8	
Lower jaw			
	P2, L.	9.5	
	P3, L.	±11.6 - ±12	
	P4, L.	13.5	
	M3, L.	28.8	
Scapula			
	Max. D. articular end	54.0	
	Glenoid cavity, D.	36.2 x 42.8	
Humerus			
	TR. D. dist.	52.0	36.9
Astragalus			
	L.	46.6	34.0
	TR.D.	29.9	22.4
Mc, TR.D. prox.		±42	
Mc/mt, TR.D. dist.		39.6	
Mt, TR.D. dist.		±32	
Ph I, TR.D. dist.		17.7-18.2	11.0
Ph II			
	Max. L.	35.0	25.0-25.9 (25.2)(1)
	TR.D. prox	18.2 (18.5)(1)	13.2-15.0 (11.0)(1)
	TR.D. dist.	16.5	10.4-11.7 (9.5)(1)
Ph III			
	Max. L.	43.9	
	TR.D.	15.0	

(1) Ph II listed separately because of slender form.

Table XII. — Major Artifact Classes.

Level	Tools		Cores		Flakes		Blades		Core-trimming Pieces		Burin Spalls		Micro-burins		Debitage		Total
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
6	451	7,4	48	0,8	556	9,1	636	10,4	18	0,3	32	0,5	39	0,6	4328	70,8	6108
5	624	6,7	45	0,5	1105	11,9	1860	20,1	43	0,5	42	0,5	69	0,7	5469	59,1	9257
4	285	7,1	30	0,8	725	18,1	1128	28,2	31	0,8	36	0,9	63	1,6	1698	42,5	3996
3b	51	6,1	5	0,6	139	17,3	147	17,6	1	0,1	5	0,6	13	1,6	474	56,8	835
3a	92	6,2	6	0,4	179	12,0	124	8,3	4	0,3	20	1,3	18	1,2	1049	70,3	1492
2	36	3,8	5	0,5	150	15,8	137	14,5	3	0,3	13	1,4	12	1,3	587	61,9	943
1	–	–	–	–	3	5,9	9	17,6	–	–	2	3,9	–	–	37	72,5	51
	1539		139		2857		4041		100		150		214		13 642		22 682

Table XIII. — Core Typology.

Level	Single Platform			Opposed Platform			Multiple Platform			90° Platform			Total
	Flake	Blade	Both	Flake	Blade	Both	Flake	Blade	Both	Flake	Blade	Both	
6	2	4	–	2	4	–	4	–	–	–	1	1	18
5	4	11	–	4	3	2	1	–	2	–	–	3	30
4	2	5	–	1	4	1	1	–	1	2	2	–	19
3b	–	2	1	1	–	–	–	–	–	–	–	–	4
3a	–	–	–	–	1	–	–	1	–	2	–	1	5
2	1	–	–	–	1	–	–	–	–	1	1	–	4
	9	22	1	8	13	3	6	1	3	5	4	5	80

Table XIV. — Core Technology.

	$\bar{X}$ Length mm	$\bar{X}$ Width mm	$\bar{X}$ Angle degrees	Unfaceted %	Faceted %
Flake cores	33,7	30,7	76,1	66,7	33,3
Blade cores	40,7	29,1	75,8	50,0	50,0

Table XV. — Unretouched Flake and Blake Technology.

Level	FLAKES					BLADES				
	N[1]	$\bar{X}$ Length mm	$\bar{X}$ Width mm	$\bar{X}$ Thickness mm	$\bar{X}$ L/W	N[1]	$\bar{X}$ Length mm	$\bar{X}$ Width mm	$\bar{X}$ Thickness mm	$\bar{X}$ L/W
6	243	26,1	21,3	6,1	1,23:1	66	28,7	11,9	6,1	2,41:1
5	329	22,8	20,0	4,6	1,14:1	153	34,1	13,4	4,8	2,54:1
4	290	24,6	20,1	4,6	1,22:1	157	30,6	11,4	3,2	2,68:1
3b	70	22,1	19,1	4,1	1,16:1	34	31,0	10,6	2,8	2,93:1
3a	62	23,7	22,6	5,0	1,05:1	30	30,0	11,0	3,5	2,73:1
2	37	22,8	18,6	4,6	1,23:1	27	27,4	10,5	3,6	2,61:1

(1) number of unbroken flakes or blades in the assemblage from the level.

Table XVI. — Frequency of Fire-Cracked Artifacts.

Level	Flakes %	Blades %	Débitage %
6	12,2	8,3	38,3
5	16,4	15,4	40,6
4	16,5	14,3	42,6
3b	15,8	17,7	38,0
3a	14,5	13,7	40,9
2	41,3	44,5	65,2

Table XVII. — Retouched Tool Technology.

Level	Flake Tools	Blade Tools		Microlithic Flake Tools	Microlithic Blade Tools	Mean Length Flake Tools	Mean Length Blade Tools	Broken Flake Tools	Broken Blade Tools
	N	N	%	%	%	mm	mm	%	%
6	144	283	66,3	52,5	58,5	28,6	31,0	63,2	79,2
5	152	388	71,9	40,3	40,7	35,4	34,1	61,2	81,4
4	63	222	77,9	52,9	50,0	31,6	31,2	39,7	69,4
3b	15	35	70,0	50,0	50,0	32,6	31,5	33,3	54,3
3a	22	67	75,3	46,7	31,3	32,0	34,2	27,3	55,2
2	4	28	87,5	50,0	id (1)	35,5	id	id	64,3

(1) insufficient data

Table XVIII. — Typologycal Indices.

Level	I.l.b.ab.	I.B.	I.G.	I.C.D.	I.M.G.	I. lamel. (restricted)(1)	I. lam. (restricted)(2)
6	21,06	3,99	3,55	21,29	1,77	27,68	25,00
5	21,31	4,49	5,29	25,48	1,92	22,14	32,06
4	31,23	4,21	3,16	22,81	7,37	33,96	30,19
3b	27,45	9,80	1,96	13,73	7,84	30,77	34,62
3a	33,69	18,48	3,26	17,65	8,70	30,43	34,78
2	36,10	16,67	2,78	8,33	5,56	23,81	23,81

(1) only pieces with both striking platform and distal end used for computation.

Table XIX. — Retouched Tools.

Type	Level 6 N	Level 6 %	Level 5 N	Level 5 %	Level 4 N	Level 4 %	Level 3b N	Level 3b %	Level 3a N	Level 3a %	Level 2 N	Level 2 %	Total N
Endscrapers													
1-2	5	1,1	15	2,4	6	2,1	1	2,0	2	2,2	1	2,8	30
4	1	0,2	1	0,2									2
5	4	0,9	2	0,3	1	0,4							7
6	1	0,2	4	0,6	1	0,4							6
7	2	0,4	7	1,1									9
8-9	3	0,7	4	0,6	1	0,4			1	1,1			9
	16		33		9		1		3		1		63
Perforators													
12	6	1,3	4	0,6	2	0,7							12
13	2	0,4	6	1,0	2	0,7					1	2,8	11
16	4	0,9	4	0,6	2	0,7			1	1,1	1	2,8	12
	12		14		6				1		2		35
Burins													
17	3	0,7			1	0,4					1	2,8	5
18-19	8	1,8	13	2,1	6	2,1	3	5,9	9	9,8	2	5,6	41
20	1	0,2	3	0,5	3	1,1			1	1,1			8
21-24	5	1,1	7	1,1	2	0,7	2	4,0	5	5,4	1	2,8	22
26	1	0,2	3	0,5									4
27			2	0,3					1	1,1	1	2,8	4
28											1	2,8	1
31									1	1,1			1
	18		28		12		5		17		6		86
Backed Blades													
34	2	0,4	1	0,2					1	1,1			4
36-37	1	0,2			1	0,4					1	2,8	3
42	1	0,2	2	0,3	2	0,7			1	1,1			6
	4		3		3				2		1		13
Composite Tools													
44	1	0,2	3	0,5	1	0,4							5
													5
Backed Bladelets													
45	4	0,4	14	2,2	6	2,1	10	19,6	9	9,8	3	8,3	46
46			4	0,6	1	0,4	1	2,0	1	1,1			7
47	1	0,2											1

51			1	0,2			1	2,0	1	1,1			3
53-54			1	0,2	3	1,1							4
55-56	8	1,8	19	3,0	11	3,9	2	4,0	3	3,3	2	5,6	45
57					1	0,4			3	3,3			4
60									1	1,1			1
61	1	0,2	1	0,2	1	0,4							3
62					1	0,4							1
63	3	0,7	5	0,8	7	2,5					1	2,8	16
64	4	0,9	6	1,0	8	2,8					1	2,8	19
65			1	0,2	1	0,4							2
66	68	15,1	68	10,9	33	11,6			11	11,9	6	16,7	186
67	1	0,2	2	0,3	3	1,1			2	2,2			8
68	5	1,1	10	1,6	12	4,2							27
70					1	0,4							1
72			1	0,2									1
	95		133		89		14		31		13		375
Notches & Denticulates													
74-75	59	13,1	55	8,8	24	8,4	7	12,8	4	4,3	2	5,6	151
76-77	35	7,8	93	14,9	35	12,3			5	5,4	1	2,8	169
78					1	0,4							1
79	2	0,4	11	1,8	5	1,8							18
	96		159		65		7		9		3		339
Truncations													
80	23	5,1	35	5,6	10	3,5	2	4,0	3	3,3	2	5,6	75
81					1	0,4							1
	23		35		11		2		3		2		76
Geometric Microliths													
82	2	0,4	1	0,2					6	6,5			9
83-85	5	1,1	4	0,6	6	2,1	3	5,9	2	2,2			20
86-87			1	0,2	5	1,8	1	2,0					7
88	1	0,2	1	0,2	2	0,7							4
89-90			1	0,2	2	0,7	1	2,0			1	2,8	5
91-92			2	0,3									2
93											1	2,8	1
95			2	0,3									2
96					1	0,4							1
97-98					1	0,4							1
99-100					4	1,4							4
	8		12		21		5		8		2		56
Varia													
105	164	36,4	192	30,8	66	23,2	14	27,5	8	8,7	5	13,9	449
106	4	0,9	3	0,5	1	0,4	1	2,0	1	1,1			10
108			1	0,2									1
111	1	0,2											1
112	9	2,0	8	1,3	1	0,4	2	4,0	9	9,8	1	2,8	30
	451		624		285		51		92		36		1539

Table XX. — Edible Flesh/Refuse Ratio and Edible Flesh Weights.

PER 100 GRAMS OF EDIBLE PORTION

	Water	Food energy	Protein	Fat	Carbo- hydrate	Calcium	Phos- phorus	Iron	Sodium	Vita- min A	Thia- mine	Ribo- flavin	Nia- cin
	%	cal.	gm.	gm.	gm.	ug (2)	ug	ug	ug	IU (3)	ug	ug	ug
Snail (raw)	79.2	90	16.1	1.4	2.0	-	-	3.5	-	-	-	-	-
Beef (total edible raw)	52.4	347	15.8	31.0	-	8	124	2.0	-	80	.06	.12	3.3

(1) Data from U.S. Department of Agriculture, Agriculture Handbook No. 8, Composition of Foods, 1963.
(2) milligrams
(3) International Units

Table XXI. — Nutritional Composition of Land Snails and Beef.

Species	edible flesh / refuse	total sample	$\bar{X}$ weight one individual	$\bar{X}$ weight one animal	$\bar{X}$ weight of shell
			gr.	gr.	gr.
Helix aspersa (1)	1 : 0.7	30	16.7	9.4	7.3
Helix melanostoma (2)	1 : 1.0	36	5.4	2.6	2.8
Helicella setifensis (1)	1 : 1.2	152	1.6	0.7	0.9
Otala spp. (1)	1 : 1.0	64	7.2	3.4	3.8
Leucochroa candissima (1)	1 : 1.6	65	3.4	1.3	2.1
Mussels, clams, Haliotis (3)	1 : 2.35-5				
Mammals and birds (3)	1 : 0.04				
Mammals (4)	1 : 0.07				

(1) Collected in Wadi Chéria-Mezeraa
(2) Collected in Télidjène Depression, most individuals not well developed.
(3) Data from Meighan (1969).
(4) Data from Kubasiewicz (1956).

Table XXII — Radiocarbon Dates.

Sample No.	Provenience	Sample Composition	Date[1]	
I-7690	Aïn Misteheyia, Square J9 Level 4 (40-45 cm below datum)	<u>Helix melanostoma</u> shell	7280±115 B.P.	5330 B.C.
I-8378	Aïn Misteheyia, Square J9 Level 3 (80-90 cm below datum)	<u>Helix melanostoma</u> shell	8835±140 B.P.	6885 B.C.
I-7691	Aïn Misteheyia, Square J9 Level 2 (125-135 cm below datum)	<u>Helix melanostoma</u> shell	9280±135 B.P.	7330 B.C.
I-7692	Wadi Redif: from escargotière exposed in profile	<u>Helix melanostoma</u> shell	7690±120 B.P.	5740 B.C.
I-7694	Wadi Redif: from escargotière exposed in profile	Charcoal	7340±115 B.P.	5390 B.C.
I-7693	Wadi Chéria-Mezeraa: from member 2 deposits	Small spiriform shell of unidentified snail species	5830±95 B.P.	3880 B.C.

(1) All dates are calculated on the Libby half-life and are uncorrected.

BIBLIOGRAPHIE

ALTENA (O.V.R.) 1962. — Molluscs and echinoderms from Palaeolithic deposits in the rock shelter of Ksar 'Akil Lebanon. *Zoologische Mededelingen,* t. 38, p. 5.

ALTES (J.) 1956. — Sur le polymorphisme du gastéropode *Leucochroa candidissima Drap. C.R. Soc. Biol. Paris,* t. 150, pp. 747-748.

ARAMBOURG (C.) 1938. — *Mammifères Fossiles du Maroc.* Mém. Soc. Sci. Nat. Maroc, Rabat.

AVNIMELECH (M.) 1937. — Sur les mollusques trouvés dans les couches préhistoriques de Palestine. *Jr. Pales. Orient. Soc.,* t. 17, pp. 81-92.

BAKER (F.C.) 1938. — The mollusca of the shell heaps or escargotières of northern Algeria including comparisons with the recent fauna of Algeria. *In,* A.W. Pond et al., pp. 185-226.

BALLAIS (J.-L.) 1972. — *La Dépression de la Sebkhet en Noual.* Thèse 3e cycle, Paris.

1974. — Etude comparative des glacis des piémonts nord et sud des Aurès. *Colloque sur les Glacis d'Ablation,* Tours.

BALLAIS (J.-L.) and GUIRAUD (R.) 1973. — *Carte géologique d'El Kantara au* 1/50 000. Service de la Carte Géologique d'Algérie. Alger.

BALOUT (L.) 1955. — *Préhistoire de l'Afrique du Nord.* Paris.

BATTS (J.H.) 1957. — Anatomy and life cycle of the snail *Rumina decollata* (Pulmonata : Achatinidae). *Southwestern Naturalist,* t. 2, pp. 74-82.

BEAUDET (G.) & *al* 1967. — Le quaternaire marocain. *Revue Géog. Phys. et Géol Dyn.,* t. 9 (fasc. 4), pp. 269-309.

BILLINGHAM (J.) 1961. — Snail haemolymph : an aid to survival in the desert. The Lancet, pp. 903-906.

BINFORD (L.R.) 1968. — Post-Pleistocene adaptations. *In,* S.R. Binford and L.R. Binford (eds.), *New Perspectives in Archeology,* Chicago, pp. 313-341.

BIRDSELL (J.B.) 1968. — Some predictions for the Pleistocene based on equilibrium systems among recent hunter-gatherers. *In,* R.B. Lee and I. Devore (eds.), *Man the Hunter,* Chicago, pp. 229-240.

BONAVITA (A.) 1965. — Conditions déterminant la production de l'épiphragme chez les Gastéropodes Hélicellinés. *C.R. hebd. Séanc. Acad. Sci.* Paris, t. 260, pp. 4093-4094.

BONAVITA (D.) 1964. — Conditions écologiques de la formation de l'épiphragme chez quelques Hélicides de Provence. *Vie et Milieu,* t. 15, pp. 721-755.

BOURLIERE (F.) 1964. — Observations on the ecology of some large African mammals. *In,* F.C. Howell and F. Bourlière (eds.), *African Ecology and Human Evolution,* London, pp. 43-54.

BUNTING (B.T.) 1965. — *The Geography of Soil.* Chicago.

BUTZER (K.V.) 1971. — *Environment and Archaeology.* Chicago.

CADART (J.) 1955. — The edible snail. *Scientific American,* n° 197, pp. 113-118.

CAILLEUX (A.) 1945. — Distinction des galets marins et fluviatiles. *Bull. Soc. Géol. France,* 5e série, t. 15, pp. 374-404.

CAMPS (G.) 1968. — Le Capsien supérieur : état de la question. *La Préhistoire : problèmes et tendances.* Paris, pp. 87-102.

CAMPS (G.) and CAMPS-FABRER 1972. — L'Epipaléolithique récent et le passage au néolithique dans le Nord de l'Afrique. *In,* J. Lüning (ed.), *Die Anfänge des Neolithikums vom Orient bis Nordeuropa.* VII, pp. 19-59.

CAMPS (G.), DELIBRIAS (G.) and THOMMERET (J.) 1973. — Chronologie des civilisations préhistoriques du Nord de l'Afrique d'après le radiocarbone. *Libyca,* t. 21, pp. 65-89.

CAMPS-FABRER (H.) 1968. — *Matière et Art Mobilier dans la Préhistoire Nord-Africaine et Saharienne.* Mém. du C.R.A.P.E., n° V, Alger.

CAUVIN (M.-C.) 1971. — *Les Industries Post-Glaciaires du Périgord.* Pub. du Centre de Recherches d'Ecologie et de Préhistoire. II. Saint André de Cruzière.

CHORLEY (R.J.) 1969. — The role of water in rock disintegration. *In,* R.J. Chorley (ed.), *Introduction to Fluvial Processes,* London, pp. 53-73.

CHOUBERT (G.) & *al* 1956. — Essai de classification du Quaternaire continental du Maroc. *C.R. Ac. Sc. Paris,* t. CCXLIII, pp. 504-506.

CLARK (G.A.) 1971. — The Asturian of Cantabria : subsistence base and the evidence for post-Pleistocene climatic shifts. *American Anthropologist,* t. 73, pp. 1245-1257.

COOK (S.F.) and TREGANZA (A.E). 1947. — The quantitative investigation of aboriginal sites : comparative physical and chemical analysis of two California Indian mounds. *American Antiquity,* t. 13, pp. 135-141.

COQUE (R.) 1972. — *La Tunisie Présaharienne.* Thèse Lettres, Paris.

COUVERT (M.) 1972. — Variations paléoclimatiques en Algérie : traduction climatique des informations paléobotaniques fournies par les charbons des gisements préhistoriques. Note Préliminaire. *Libyca*, t. 20, pp. 45-48.

CRABTREE (D.E.) 1968. — Mesoamerican polyhedral cores and prismatic blades. *American Antiquity,* t. 33, pp. 446-478.

DOWNS (J.) 1966. — *The Two Worlds of the Washo.* New York.

DRAKE (R.J.) 1960-1962. — *Molluscs in Archeology and the Recent.* 7 vols. mimeographed.

DUBOIS (L.) 1967. — Un peu de malacologie et de malacophagie. *Naturaliste Belge,* t. 48, pp. 198-211.

DUBOS (R.) 1971. — *Man Adapting.* New Haven.

DURANTE (S.) and SETTIPASI (F.) 1972. — I molluschi del giacimento quaternario della grotta della Madonna a Praia a Mare (Calabria). *Quaternaria,* t. 16, pp. 255-270.

FALKNER (G.). 1969. — Die Bearbeitung ur-uand frügeschichtlicher Molluskenfunde in Archäologie und Biologie. *In,* J. Boessneck (ed.) *Deutsche Forschungsgemeinschaft,* t. 15, 112-140.

FLANNERY (K.V.) 1969. — Origins and effects of early domestication in Iran and the Near-East. *In,* P.J. Ucko and G.W. Dimbleby (eds.), *The Domestication and Exploitation of Plants and Animals,* pp. 73-100.

GALLAGHER (J.P.) 1971. — Communication presented to the 7 th Panafrican Congress on Prehistory and the Study of the Quaternary. Addis-Abéba.

GARRELS (R.M.) and CHRIST (C.L.) 1965. — *Solutions, Minerals and Equilibria.* New-York.

GARRELS (R.M.) and MACKENZIE (F.T.) 1971. — *Evolution of Sedimentary Rocks.* New-York.

GAUTIER (A.) 1968. — Mammalian remains of the northern Sudan and southern Egypt. *In,* F. Wendorf (ed.), *The Prehistory of Nubia,* pp. 80-99, Dallas, South. Meth. Univ.

GERMAIN (L.) 1930. — *Faune de France,* T. 21 : Mollusques Terrestres et Fluviatiles. Paris.

GOBERT (E.G.) 1937. — Les escargotières : le mot et la chose. *Revue Africaine,* t. 81, pp. 639-645.

GREBENART (D.) 1971-a. — Le gisement capsien de Rabat près d'Ouled Djellal. *Libyca,* t. 19, pp. 165-169.

1971-b. — Vues générales sur le peuplement capsien au Nord des Némencha : secteurs de Chéria, Télidjène et Rass el-Euch. *Libyca,* t. 19, pp. 171-178.

1975. — *Le Capsien des Régions de Tébessa et d'Ouled Djellal, Algérie.* Aix-en-Provence.

GUIRAUD (R.) 1973. — *Evolution post-Triasique de l'Avant-Pays de la Chaîne Alpine en Algérie d'après l'étude du Bassin du Hodna et des Régions Voisines.* Thèse Sciences, Nice.

HASSAN (F.A.) 1972. — Toward a definition of « lames », « lamelles », and « microlamelles ». *Libyca,* t. 20, pp. 163-167.

1973. — On mechanisms of population growth during the Neolithic. *Current Anthropology,* t. 14, pp. 535-540.

1975. — Determinants of the size, density, and growth rates of hunting-gathering populations. *In,* S. Polgar (ed.), *Population, Ecology and Social Evolution.* The Hague : Mouton.

HIGGS (E.) 1967. — Environment and chronology : theevidence from mammalian remains. *In,* C. B. M. MCBURNEY, *The Haua Fteah (Cyrenaica) and the Stone Age of the Southeast Mediterranean,* pp. 16-44. London.

LE HOUEROU (H.N.) 1970. — North Africa : past, present, future. *In,* H.E. Dregne (ed.), *Arid Lands in Transition,* pp. 227-278. Washington.

ISAAC (Gl. Ll) 1967. — Towards the interpretation of occupation debris : some experiments and observations. *Kroeber Anthropological Society Papers,* t. 37, pp. 31-57.

KUBASIEWICZ (M.) 1956. — Uber die Methodik de Forschungen bei Tierausgrabungsknochen. *Materialnie Zachodnio-Pomerskie,* t. 235-244.

LAFITTE (R.) 1939. — Les plissements post-nummulithiques dans l'Atlas Saharien. *Bull. Soc. Géol. France.* 5ᵉ série, t. 9, pp. 135-159.

LANGBEIN (W.B.) and SCHUMM (S.A.) 1958. — Yield of sediment in relation to mean annual precipitations. *Amer. Geophys. Union Transactions,* t. 39, pp. 1076-1084.

LAPLACE-JAURETCHE (G.) 1953. — Les couches à escargots des cavernes pyrénéennes et le problème de l'Arisien de Piette. *Bull. Soc. Préhist. Franç.,* t. 50, pp. 199-211.

LEBEDEV (A.N.) 1970. — *The Climate of Africa,* Part I : Air Temperature, Precipitation. Jerusalem.

LEE (R.B.) 1968. — What hunters do for a living, or, how to make out on scarce resources. *In,* R.B. Lee and I. DeVore (eds.), *Man the Hunter,* pp. 30-48.

LEE (R.B.) and DEVORE (I.) (eds.), 1968. — *Man the Hunter.* Chicago.

LOSEY (T.C.) 1971. — Archaeology of the Cormie Ranch Site : an interim report. *Archaeological Soc. of Alberta Newsletter* N°. 28, Edmonton.

LUBELL (D.) 1974. — *The Fakhurian : a Late Palaeolithic Industry from Upper Egypt.* The Geological Survey of Egypt, Paper, n° 58, Cairo.

MALBRANT (R.) 1952. — Faune du Centre Africaine Français. *Encyclopédie Biol.,* XV, Paris.

MATTESON (M.R). 1961. — Snails in archeological sites. *American Anthropologist,* t. 61, pp. 1094-1096.

MEAD (A.R.) 1961). — *The Giant African Snail : a problem in economic malacology.* Chicago.

MEIGHAM (C.E.) 1969). — Molluscs as food remains in archaeological sites. *In,* D. Brothwell and E.S. Higgs (eds.), *Science in Archaeology,* London, pp. 415-422.

MOREL (J.) 1953. — Le capsien de Khanguet-el-Mouhaâd. *Libyca,* t. 1, pp. 103-119.

1974. — La faune de l'escargotière de Dra-Mta-El-Ma-El-Abiod (Sud-Algérien). *L'Anthropologie,* t. 78, pp. 299-320.

NAVEH (Z.) and DAN (J.) 1973. — The human degradation of Mediterranean landscapes in Israel. *In,* F. di Castri and H.A. Mooney (eds.), *Mediterranean Type Ecosystems. Ecological Studies,* 7, pp. 373-390. New York.

NEUMAN (W.F.) and NEUMAN (M.W.) 1958). — *The Chemical Dynamics of Bone Mineral.* Chicago.

PASKOFF (R.P.) 1973. — Geomorphological processes and characteristic landforms in the Mediterranean regions of the world. *In,* F. di Castri and H.A. Mooney (eds.), *Mediterranean Type Ecosystems. Ecological Studies,* 7, pp. 53-60. New York.

PHILLIPS (J.L.) 1973. — *Two Final Paleolithic sites in the Nile Valley and their External Relations.* Geological Survey of Egypt, Paper, n° 57, Cairo.

PILSBRY (H.A.) 1928. — *A review of the mollusks of the Belgian Congo.* Bull. Amer Mus Nat. Hist. XL, Art. 1.

POND (A.W.) & *al* 1938. — *Prehistoric Habitation Sites in the Sahara and North Africa.* Logan Museum Bulletin V. Beloit.

QUEZEL (P.) and SANTA (S.) 1962. — *Nouvelle Flore d'Algérie et des Régions Désertiques Méridionales.* Paris.

REED (C.A.) 1962. — Snails on a Persian Hillside. *Postilla,* n° 66, pp. 1-20.

REED (C.A.) and BRAIDWOOD (R.W.) 1960. — Toward the reconstruction of the environmental sequence in northern Iraq. *Studies in Ancient Oriental Civilisation,* n° 31, pp. 169-174. Chicago.

ROCHE (Abbé J.) 1972. — Les amas coquilliers (*conchieros*) mésolithiques de Muge (Portugal). *In,* J. Lüning (ed.), *Die Anfänge des Neolithikums vom Orient bis Nordeuropa,* t. VII, pp. 72-107.

ROMER (A.) 1928. — Pleistocene mammals of Algeria : fauna of the paleolithic station of Mechta-el-Arbi. *Logan Museum Bulletin,* t. 2, pp. 79-137.

1938. — Mammalian remains from some Palaeolithic stations in Algeria. *In,* A.W. Pond & al. (loc. supra.).

SACCHI (D.) 1971. — Recherches sur le paléolithique en Languedoc occidental. *Cahiers Ligures de Préhistoire et d'Archéologie,* t. 20, pp. 157-168.

SCHILD (R.) et al. 1968). — The Arkinian and Shamarkian Industries. *In,* F. Wendorf (ed.), *The Prehistory of Nubia,* Vol. 2, pp. 651-767. Dallas

SOLEM (G.A.) 1974. — *The Shell Makers.* New-York.

TIXIER (J.) 1963. — *Typologie de l'Epipaléolithique du Maghreb.* Mém. du CRAPE, n° II, Alger.

1967. — Procédés d'analyse et questions de terminologie concernant l'étude des ensembles industriels du paléolithique récent et de l'épipaléolithique dans l'Afrique du Nord-Ouest. *In,* W.W. Bishop and J.D. Clark (eds.), *Background to Evolution in Africa,* pp. 771-820. Chicago.

TURNBULL (P.F.) and REED (C.A.) 1974. — The fauna from the terminal Pleistocene of Palegawra Cave, a Zarzian occupation site in northeastern Iraq. *Fieldiana Anthropology,* t. 63, pp. 81-146.

U.S. Department of Agriculture, Soil Staff, 1960. — *Soil Classification : a Comprehensive system. 7 th Approximation.* Washington.

VAUFREY (R.) 1933. — Notes sur le Capsien. *L'Anthropologie,* t. XLIII, pp. 456-483.

1932. — Les plissements acheuléo-moustériens des alluvions de Gafsa. *Rev. de Géog. Phys. et de Géol. Dynamique,* t. V, pp. 299-321.

1955. — *Préhistoire de l'Afrique, T. I : Le Maghreb.* Paris.

VILASECA (S.) 1962. — Les industries de silex en Catalogne méridionale. *Actes du 86e Congrès National des Sociétés Savantes,* Montpellier, 1961. Section d'Archéologie, pp. 55-60.

VITA-FINZI (C.) and HIGGS (E.S.) 1970. — Prehistoric economy in the Mount Carmel area of Palestine : site catchment analysis. *Proceedings of the Prehistoric Society,* t. 36, pp. 1-37.

WESTERMARCK (E.A.) 1926. — *Ritual and Belief in Morocco.* London.

WHITE (T.E.) 1953. — A method for calculating the dietary percentage of various food animals utilized by aboriginal peoples. *American Antiquity,* t. 18, pp. 396-398.

WOBST (H.M.) 1974. — Boundary conditions for Palaeolithic social systems : a simulation approach. *American Antiquity,* t. 39, pp. 147-178.

YORK (J.C.) and DICK-PEDDIE (W.A.) 1969. — Vegetation changes in southern New Mexico during the past hundred years. *In,* W.G. McGinnies and B.J. Goldman (eds.), *Arid Lands in Perspective,* pp. 155-166. Tucson.