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NUMBER 3

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THE CUTTING EDGE:

New Approaches to the Archaeology of Human Origins

Editors

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Top: Homo habilis Utilizing Stone Tools. Painting by artist-naturalist Jay H. Matternes. Copyright 1995, Jay H. Matternes. Inspired by a prehistoric scenario by K. Schick and N. Toth in Making Silent Stones Speak: Human Origins and the Dawn of Technology (1993), Simon and Schuster, New York. Pp.147-149.

Lower right: Whole flake of trachyte lava from the 2.6 million-year-old site of Gona EG-10, Ethiopia. Reported by S. Semaw (2006), "The Oldest Stone Artifacts from Gona (2.6-2.5 Ma), Afar, Ethiopia: Implications for Understanding the Earliest Stages of Knapping" in The Oldowan: Case Studies into the Earliest Stone Age, eds. N. Toth and K. Schick. Stone Age Institute Press, Gosport, Indiana. Pp. 43-75. Photo courtesy of Tim White.

Lower left: Prehistoric cut-marks from a stone tool on Sterkfontein hominin partial cranium StW 53. Reported by T. Pickering, T. White, and N. Toth (2000) in "Cutmarks on a Plio-Pleistocene hominid from Sterkfontein, South Africa". American Journal of Physical Anthropology 111, 579-584. Scanning electron micrograph by N. Toth.

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CHAPTER 10

THE OLDOWAN IN NORTH AFRICA WITHIN A BIOCHRONOLOGICAL FRAMEWORK

MOHAMED SAHNOUNI AND JAN VAN DER MADE

ABSTRACT

Much of the Plio-Pleistocene data on the Oldowan is primarily from sites in East Africa. However, although North Africa is well underexplored compared to East Africa, there is a fairly good Oldowan record in this part of the African continent. There are a number of localities in sealed stratigraphic sequence with Oldowan artifacts that provide evidence of early human presence in North Africa. Yet, unlike East Africa, they lack a sound absolute chronological framework. Therefore, dating of the North African Oldowan depends on associated faunas with taxa of biostratigraphic significance. Using the well dated East African fossil records, faunas from North Africa and East Africa are compared to help dating the North African Plio-Pleistocene localities, especially those yielding Oldowan occurrences such as Ain Hanech and El-Kherba in Algeria. Dated minimum to 1.77 Ma, Ain Hanech and El-Kherba document clearly Oldowan artifacts associated with a savanna-like fauna, indicating that early hominins geographically ranged in wider areas outside East and South Africa.

INTRODUCTION

The primary information on early hominin behavior and adaptation derives chiefly from a number of Plio-Pleistocene sites in East Africa. Modern investigations undertaken at Olduvai in Tanzania (Leakey, 1971; 1975, Potts, 1988) and at Koobi Fora in Kenya (Bunn et al., 1980; Harris, 1978; Isaac, 1972; 1978) have allowed archaeologists to concentrate on the horizontal aspect of the accumulation of the archaeological materials, study its spatial distribution, and attempt to understand its behavioral significance. In fact, excavations of Oldowan sites in primary context have allowed archaeologists to address major questions regarding early hominin way of life, such as food acquisition, significance of concentrations of stone artifacts and fossil bones, the role of lithic technology in hominin adaptation and intelligence. These questions have generated heated scientific debates, such as the hunting/scavenging (Binford, 1981; Bunn, 1981, Bunn & Kroll, 1986), "home base" and "food sharing" hypothesis (Isaac, 1978), and site formation processes of paleolithic sites relative to hominin activities (Schick, 1986, 1987).

In contrast, North African Early Palaeolithic was regarded as providing scanty evidence and little information on a scarce early human presence in this part of the African continent. For example, Desmond Clark (1992: 33) wrote "the great majority are surface occurrences that cannot be tied to a stratigraphic sequence". Actually, this situation primarily was a consequence of lack of systematic investigations and less emphasis on understanding of past human behavior. Current studies have shown that there are a number of Early Palaeolithic sites in North Africa that are in sealed stratigraphic sequences providing ample possibilities for tackling early hominin behavior and adaptation in this region of the African continent. In fact, the sites of Ain Hanech and El-Kherba in Algeria, encased in fine-grained sediments, permit to address various aspects of hominin behavior, including manufacture, use and discard of artifacts; acquisition and processing of animal carcasses; and vertical and horizontal distribution patterns of archaeological remains.

Unlike East Africa, the North African Plio-Pleistocene paleontological and archaeological localities suffer from the lack of an accurate chronological framework due to the absence of radiometrically dateable materials. Absolute dating techniques are possible only for the Middle and Upper Pleistocene deposits. Consequently, the dating of the Plio-Pleistocene deposits depends primarily on associated faunas with taxa of biochronological significance. In contrast, the East African Plio-Pleistocene fossil records are derived from a radiometrically well dated lithostratigraphic background, offering a precise biochronological framework that can be used for dating other African fossil deposits that are devoid of radiometric dates but have yielded the same or close relative taxa found in East Africa. Using this approach, North African faunas are compared with their East African corresponding taxa to help dating the Plio-Pleistocene localities in North Africa, particularly those yielding Oldowan occurrences such as Ain Hanech and El-Kherba. Ain Hanech and El-Kherba yielded a number of large mammal taxa of biochronological significance that are well dated in East Africa, including *Equus*, *Anancus*, and particularly *Kolpochoerus*, as well as a less understood "*Dicerorhinus*". Indeed, Ain Hanech and El-Kherba *Kolpochoerus* is the same one that is found in the Koobi Fora KBS Mb, Shungura H, and Olduvai Bed I, which was after about 1.8 Ma a different species.

There are a number of localities with Oldowan artifacts that provide evidence of early human presence in North Africa. The localities are assigned traditionally to Pre-Acheulean (~Oldowan), which is divided into Ancient Pre-Acheulean and Evolved Pre-Acheulean. The entire Pre-Acheulean was correlated to Moulouyen and Saletian climatic cycles correlated to the Lower Pleistocene. This chapter examines the Oldowan record in North Africa in light of the new investigations carried out in the major archaeological areas of Casablanca in Atlantic Morocco and Ain Hanech in northeastern Algerian, and their implications on early hominin behavior and adaptation. In particular, the work at Ain Hanech has succeeded in establishing the timing and understanding of the characteristics of the earliest human occupation of this part of the African continent. Ain Hanech documents clearly Oldowan artifacts (*sensu* Leakey, 1971), indicating that early hominins geographically ranged in wider areas outside East and South Africa.

STRATIGRAPHIC BACKGROUND

The stratigraphic framework of prehistoric North Africa is based upon inferred correlations of sea-level sequences between the Atlantic costal sites and the Mediterranean deposits, especially the area between Rabat and Casablanca (Morocco), which provides continuous deposits rich in faunas and prehistoric lithic industries. Indeed, the Casablanca coastal area offers the most extensive Pleistocene stratigraphic sequence. Quarry exploitation opened for building materials have exposed a series of fluctuating high and low sea levels interbedded with terrestrial sediments reflecting changes in climate. The stratigraphic sequence has been studied by several geologists. Neuville and Rhulman (1941) studied the Sidi Abderrahman Quarry and established the stratigraphic chronology of Atlantic Morocco for dating the prehistoric industries known from the region. Choubert et al. (1956) proposed a general stratigraphic framework for the Moroccan continental Pleistocene deposits; and Biberson (1961a, 1971) redefined its major components. The stratigraphic framework in the Atlantic coast consists of a series of seven marine cycles, interbedded with six terrestrial episodes named after stratigraphic description of type-localities (Figure 1). The marine cycles include, from the oldest to the youngest, Moghrebian, Messaoudian, Maarifian, Anfatian, Harounian, Ouldjian, and Mellahian. The terrestrial cycles are Moulouyan, Saletian, Amirian, Tensiftian, Presoltanian, and Soltanian. The "Pebble-culture" or Pre-Acheulean industries are dated to Moulouyan and Saletian continental episodes (Biberson, 1971: 74). Although this stratigraphic system was defined for Atlantic Morocco, it became increasingly a classic scheme and a wide spread Quaternary relative chronological framework for the entire Maghreb.

A number of researchers questioned the validity and the relevance of this stratigraphic system to the Atlantic Coast. For instance, Beaudet (1969) criticized the validity of the Saletian stratotype. He argued that on one hand the type locality represents an older deposit, and on the other, in some localities two similar lithologies occur making it difficult to determine which of these corresponds to the Saletian. Based on a revised study of the Casablanca sequence, Texier et al. (1986) highlighted the weaknesses of the system, including: ambiguity of the pluvial-arid alternate principle, complexity of correlating the Moroccan climatic episodes with the European glaciations, and not taking into account the local Quaternary uplift and isostatic movements controlling the deposition of the successive episodes. To resolve these weaknesses, they recommended abandoning the entire old scheme and suggested an alternative lithostratigraphy for the Pleistocene sequence, incorporating four main formations (Texier et al., 1994). These formations include, from the oldest to the youngest, Oulad Hamida Formation (thereafter Fm), Anfa Fm, Kef el Haroun Fm, and Dar Bouaza Fm (Lefèvre & Raynal, 2002; Texier et al., 2002). The Lower Paleolithic sites, which consist basically of Acheulean occurrences, spanned from Oulad Hamida Fm to Kef el Haroun Fm (from ca. 1 Ma to 163 Ka [Rhodes et al., 2006]).

In the Sahara, the alternating erosion-sedimentation cycles in the absence of any other chronological and biostratigraphical criteria, such as dateable volcanic material and preserved fauna, served as a guide to build up a stratigraphic framework for the succession of the prehistoric industries of the Saoura in the Northwestern Saharan region (Alimen, 1978; Chavaillon, 1964). Six erosional and depositional cycles have been identified. The "pebble culture" is correlated with the Mazzerian episode (Early Pleistocene), and the Acheulean with the Taouritian and Ougartian episodes (Middle Pleistocene).

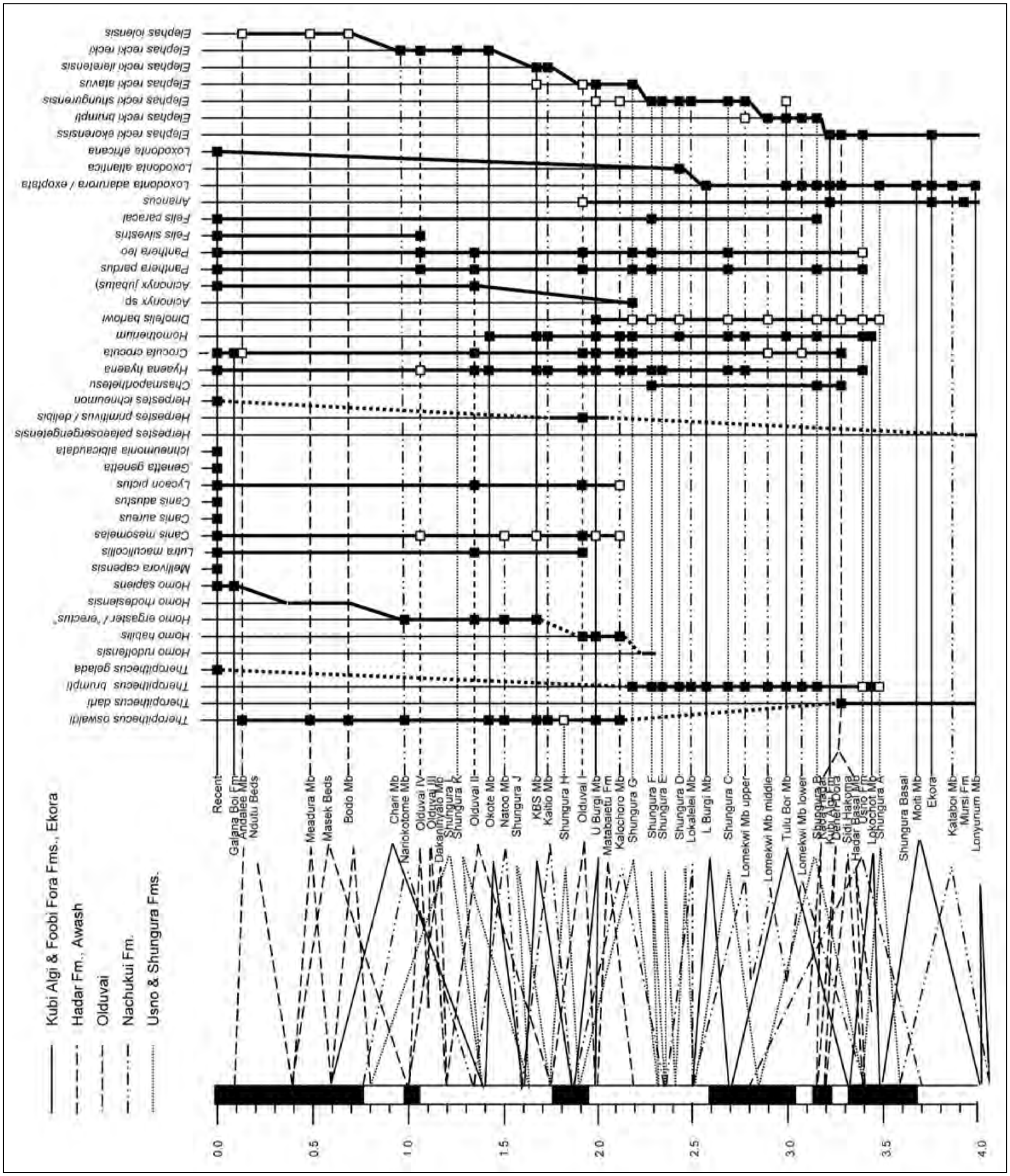
CYCLES MARINS		CYCLES CLIMATIQUES		INDUSTRIES PRÉHISTORIQUES				HOMMES FOSSILES DU MAROC
Europe	**Maroc Atlantique**		**Europe**	**Civilisations**	**Familles**	**Stades**	**Gisements-types**	
Versilien	Mellahien				Ibéromaurusien		Grotte de Taforalt	H. de Taforalt
		Soltanien	Würm final		Atérien		Dar-es-Soltan	H. de Tanger (?)
Néotyrrhénien	Ouljien				Moustérien		Jebel Irhoud	H. du Jebel Irhoud
		Présoltanien	Würm inférieur		Acheuléen évolué	St. VIII	Cap Chatelier (niv. D_1)	H. de Témara
Tyrrhénien	Harounien					St. VII	Sidi Abderrahman-Extension (niv. E)	H. de Rabat
		Tensiftien	Riss			St. VI	Grotte des Littorines (niv. D_0)	H. de Sidi Abderrahman
Paléotyrrhénien = Milazzien II	Anfatien			Civilisation du Biface	Acheuléen moyen	St. V	Grotte des Ours (niv. G_0)	
						St. IV	Sidi Abderrahman-Extension (niv. F)	
		Amirien	Mindel			St. III	Carrière de la STIC	
					Acheuléen ancien	St. II	Sidi Abderrahman-Anc. Exploit. (niv. M)	
						St. I	Sidi Abderrahman-Anc. Exploit. (niv. M)	
Milazzien I = Sicilien II	Maarifien				*Pebble-Culture* évoluée	St. IV	Sidi Abderrahman-Extension (niv. G)	
Sicilien I		Salétien	Günz	Civilisation du Galet aménagé		St. III	Souk-el-Arba du Rharb	
Emilien	Messaoudien					St. II	Carrière Déprez (Casa)	
Calabrien		Moulouyen	Donau		*Pebble-Culture* ancienne			
						St. I	Tardiguet-er-Rahla	
Précalabrien	Moghrébien	Villafranchien inférieur	Biber (?)					

Figure 1. Quaternary continental and marine cycles and associated lithic industries and hominins of Morocco after Biberson 1964.

Biochronology of the North African Plio-Pleistocene Localities

The North African Lower and Middle Pleistocene deposits suffer from the absence of a precise chronological framework due to lack of dateable tuffs. Uranium-series, optically stimulated luminescence (OSL), and electron spin resonance (ESR) dates are most applicable only for late Middle and Upper Pleistocene sites. As a result, the dating of the North African Pleistocene deposits relies primarily on biostratigraphic correlation. In contrast, the East African fossil record comes from a lithostratigraphic context well dated radiometrically and by palaeomagnetism, providing an excellent biochronological framework for comparison with other African regions devoid of sound dating context. Therefore, the Plio-Pleistocene faunas from North Africa and East Africa are compared here.

Figures 2a and 2b display the stratigraphic ranges in East Africa of those large mammals, which also occur in North Africa or their close relatives. On the left, the stratigraphic units of main East African sequences and their assumed ages are shown. On the right, the presence of the large mammals in these stratigraphic units is indicated by solid squares, open squares in the case of uncertainty (cf., aff., indet., sp., ?), and their inferred time ranges by thick lines. The occurrences are taken from the literature. Occasionally, there are contradictions in the published literature, or one author cites certain taxa in a unit, but these are not mentioned at all by another author. In such cases, generally we follow the latest or more specialized literature. In other cases, there is controversy whether a series of species or subspecies represent anagenetic stages of a lineage (and thus are never coeval) or whether they are taxa with overlapping ranges (e.g. in *Elephas* and some Suidae). Figures 3a and 3b show the stratigraphic distribution of the North African large mammals (squares) compared to temporal ranges of the same or similar taxa from East Africa (thick lines). Presence of *Homo*, if inferred from lithic industry and


Elephas iolensis
Elephas recki recki
Elephas recki ileretensis
Elephas recki atavus
Elephas recki shungurensis
Elephas recki brumpti
Elephas recki ekorensis
Loxodonta africana
Loxodonta atlantica
Loxodonta adaurora / exoptata
Anancus
Felis caracal
Felis silvestris
Panthera leo
Panthera pardus
Acinonyx jubatus
Acinonyx sp
Dinofelis barlowi
Homotherium
Crocuta crocuta
Hyaena hyaena
Chasmaporthetes
Herpestes ichneumon
Herpestes primitivus / debilis
Herpestes palaeoserengetensis
Ichneumia albicauda
Genetta genetta
Lycaon pictus
Canis adustus
Canis aureus
Canis mesomelas
Lutra maculicollis
Mellivora capensis
Homo sapiens
Homo rhodesiensis
Homo ergaster / "erectus"
Homo habilis
Homo rudolfensis
Theropithecus gelada
Theropithecus brumpti
Theropithecus darti
Theropithecus oswaldi
Recent
Galana Boi Fm
Andalee Mb
Ndutu Beds
Meadura Mb
Masek Beds
Bodo Mb
Chari Mb
Nariokotome Mb
Olduvai IV
Olduvai III
Dakanihylo Mb
Shungura L
Shungura K
Olduvai II
Okote Mb
Natoo Mb
Shungura J
KBS Mb
Kaitio Mb
Shungura H
Olduvai I
U Burgi Mb
Matabaietu Fm
Kalochoro Mb
Shungura G
Shungura F
Shungura E
Shungura D
Lokalalei Mb
L Burgi Mb
Shungura C
Lomekwi Mb upper
Lomekwi Mb middle
Tulu Bor Mb
Lomekwi Mb lower
Shungura B
Kada Hadar
Kubi Algi Fm
Denen Dora
Sidi Hakoma
Hadar Basal Mb
Usno Fm
Lokochot Mb
Shungura A
Shungura Basal
Moiti Mb
Ekora
Kataboi Mb
Mursi Fm
Lonyumun Mb
Kubi Algi & Koobi Fora Fms., Ekora
Hadar Fm., Awash
Olduvai
Nachukui Fm.
Usno & Shungura Fms.
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

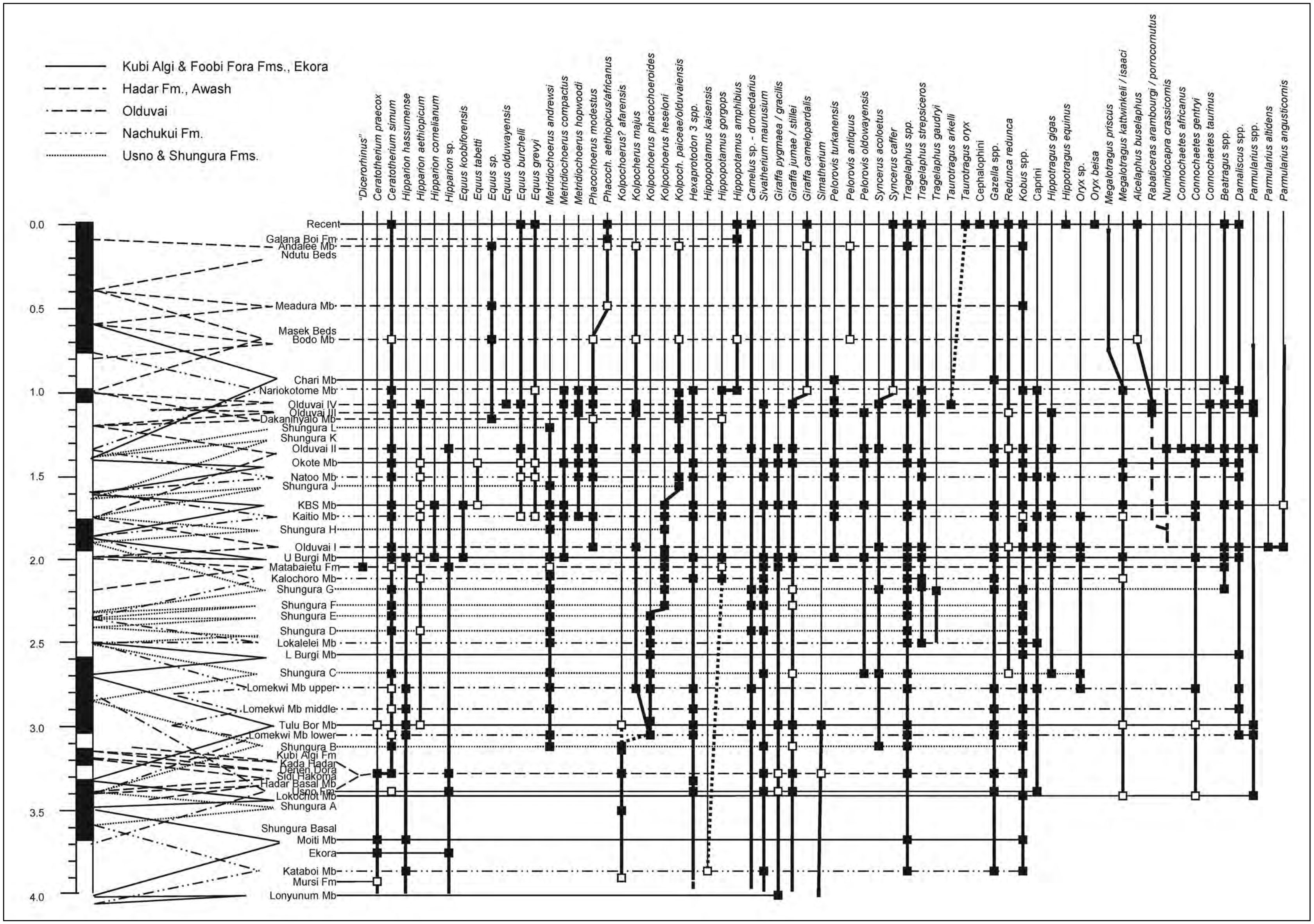


Figure 2a & 2b. The temporal distribution in the main East African sequences of the large mammals that occurred in North Africa based on Cooke (1985), Feibel, Harris & Brown (1991), Kalb et al. (1982), Rook (1994), Sahnouni et al. (2004), Turner et al. (1999), Vrba (1996; 1997). Solid squares indicate presence; open squares indicate possible (?) or imprecise (cf., aff.) presence. Thick lines indicate temporal ranges as inferred from presence and absence data in the figure and, occasionally, other information (e.g. Vrba 1996; 1997) and ancestor descendant relationships. Stippled thick lines indicate uncertainty.

cut marks, is indicated by open squares. The North African sites are arranged in such a way that a minimum of their taxa are situated outside the temporal ranges as established for East Africa.

Prior to correlating East African and North African faunas, it is constructive to stress some methodological considerations. A first comparison between figures 2 and 3 reveals that some taxa have very different ranges in North and East Africa. For instance, *Loxodonta* disappeared at the end of the Pliocene from the East African sequences (Figure 2b), but is again present in the recent faunas. The genus occurs in several Pleistocene sites in North and South Africa, from where it presumably recolonized East Africa. Similar patterns are observed in *Connochaetes* and *Oryx*. Obviously, the first and last appearances of these taxa cannot be used to correlate between East Africa and North Africa. This may also occur on a smaller temporal scale with other taxa. There is no way to know *a-priori* in which taxa this occurs, and the common way to detect this is when a correlation based on a particular taxon is in conflict with another means of correlation.

It is commonly read that two sites have to be of the same age because they share a particular species. However, there are also authors who claim that a mammal species may last 2.5 Ma (e.g. Van Dam et al., 2006). Obviously, the more we know about the evolutionary and biogeographical context of a taxon, the more precise the correlations that are based on that species. First appearance by dispersal and last appearance by (local) extinction of common taxa may provide very sharp datum planes. However, one needs to know the area in which these datum planes are applicable. For this method, rare taxa tend to be of little use (unless many of them disperse or go extinct at the same time, which to some extent tend to confirm the pattern). By contrast, even in a rare taxon, anagenetic evolution may provide important information, but the transition between one and another stage tends to be gradual. There is again the risk that diachronic evolution may occur, which should be detected by contradictory evidence. Some authors use the "grade of evolution" and compare samples of species that belong to different but related lineages. This is a questionable procedure, because it supposes that evolution proceeds in different lineages at a similar rate. However, in a well understood phylogenetic context, it can be stated that two samples from divergent lineages are younger than the last sample of a common ancestral form. Below are discussed, in chronological order, the Plio-Pleistocene localities with taxa of biostratigraphic interest:

Ahl al Oughlam, Lac Ichkeul, and Ain Brimba

Ahl al Oughlam (formerly Carrière Déprez) in Morocco, and Lac Ichkeul (near Bizerte) and Ain Brimba (near Chott Djerid) in Tunisia are landmark sites of the North African Upper Pliocene. The rich locality of Ahl al Ouglam has *Hipparion*, but no *Equus*. It does have a *Canis*, which appeared in Africa at the same time or slightly earlier than *Equus*. The alcelaphine bovid *Beatragus* from Ahl al Oughlam was interpreted as a little bit more primitive than the *Beatragus* from East Africa (Geraads & Amani, 1998), which ranges there from the Matebaietu Fm at 2.6 Ma till recent (Vrba, 1997). The absence of *Oreonagor* in Ahl al Oughlam is not indicative of an age, since the related taxa *Connochaetes* and *Megalotragus* as well as the ancestral "*Damalops denenedorai*" (see Vrba, 1997) are also absent. The suid *Kolpochoerus phacochoeroides* is well represented in Ahl al Oughlam (Geraads, 1993; 2004b) and has an evolutionary level that is comparable to that of *Kolpochoerus* from the Shungura Members (thereafter Mbs) C-F with ages comprised between roughly 2.8 and 2.3 Ma.

Early reports on the faunas from Lac Ichkeul and Ain Brimba were published by Arambourg and Arnould (1949), and Arambourg and Coke (1958), respectively. Arambourg (1970, 1979) described more in detail the material of both sites and concluded to an Early Villafranchian age. Like Ahl al Oughlam, these localities have *Hipparion*, but no *Equus*. The absence of *Equus* might indicate that they are older than the first appearance of that genus in Africa. *Machairodus* is close to but more primitive than *Homotherium*, which is present from about 3.5 Ma onwards. *Machairodus africanus* is thus a primitive element in the fauna from Ain Brimba. These faunas may be close in age to Ahl al Oughlam.

Ain Boucherit and Ain Jourdel

Ain Boucherit and Ain Jourdel are paleontological sites in northeastern Algeria. Pomel (1893-1897) described the first fossil remains collected at Ain Boucherit in the course of road works. Arambourg (1970, 1979) explored further the site and studied its fauna. Based on proboscideans and equids, he assigned the occurrences to the Lower Villafranchian, and correlated it with Shungura Mbs A, B, C, and D, and Kaiso deposits, implying an age between 3.7 and 2.5 Ma (p. 135). Other authors estimated Ain Boucherit age to 3.4-2.7 Ma (Coppens, 1972, Pl. 2), 2.7-2.5 Ma (Vrba, 1996, 1997), about 2.3 Ma (Sahnouni et al., 2002), and about 1.8 Ma (Geraads et al., 2004b).

Sahnouni et al. (2002) collected more fossils from the Ain Boucherit fossil-bearing stratum and studied its stratigraphy. The stratum is contained in Unit Q of the newly defined Ain Hanech Fm by Sahnouni and de Heinzelin (1998), 13 m below the Ain Hanech and El-Kherba Oldowan deposits (Unit T). The magnetostratigraphic study of the Ain Hanech Fm indicates a shift from reversed polarity in Unit P, Q and R to normal polarity in Unit S and T containing the Ain Hanech Oldowan deposit. Given the character of the fauna, the normal polarity most likely corresponds to the Olduvai (N) subchron dated between 1.95 and 1.77 Ma. The Ain Boucherit faunal assemblage comes from Unit Q, which being located lower in the formation and having a reversed polarity, is thus older than the Oldowan subchron.

The Ain Boucherit and Ain Jourdel taxa biochronologically relevant comprise *Hipparion, Anancus, Equus, Canis,* alcelaphines, and *Elephas*. The presence of the equid *Hipparion* and the proboscidean *Anancus* is confirmed by the recent collections. While *Hipparion* is less informative, *Anancus* indicates an approximate minimum age of about 2-1.8 Ma (as discussed under Ain Hanech below).

The horse *Equus* and *Canis* originated in North America and spread to the Old World. *Equus* arrived in Europe just before the end of the Gauss chron (2.581 Ma) (Alberdi et al., 1997; Lourens et al., 2004) and *Canis* around 2 Ma (Torre et al., 1992). The oldest well dated record of *Equus* in Africa is in Shungura Member (thereafter Mb) G (Churcher & Hooijer, 1980) around 2.3 Ma. However, there are old sites that are not well dated, and which might push down the first appearance in Africa to the European age. The first African record of *Canis* seems to be older than in Europe and might be in Ahl al Oughlam (Geraads, 1997) or some of the South African sites. The suggested age for Ain Boucherit by Sahnouni et al. (2002) is inspired by the fact that the fossil bearing stratum is located below the Olduvai subchron and the first known African record of *Equus*.

The alcelaphines include *Oreonagor tournoueri* and *Parmularius altidens*. While Geraads et al. (2004b) claimed that *Oreonagor* from Ain Boucherit is more advanced than that of Ain Jourdel, Vrba (1997), who carried out a detailed study of the phylogeny of the Alcelaphini, apparently believed this to be just the other way around estimating an age of 2.7-2.5 Ma for Ain Boucherit and 1.8 Ma for Ain Jourdel. In her cladogram and resulting tree, *Oreonagor tournoueri* originates after/from "*Damalops denendorai*" and before *Connochaetes gentryi*. The former species has its last occurrence in the Kada Hadar Mb and Shungura Mb B around 2.9 Ma. The latter species has its first appearance in the Upper Lomekwi Mb of the Nachukui Fm around 2.5 Ma. This probably induced Vrba (1996, 1997) to estimate Ain Boucherit age to between 2.7-2.5 Ma.

The presence of the alcelaphine bovid *Parmularius altidens* in Ain Boucherit and Olduvai Bed I suggested to Geraads et al. (2004b) that both localities would be contemporaneous, e.g. 1.8 Ma. However, the occurrence of one species in two sites does not necessarily indicate that these sites have exactly the same age. In Vrba's (1997) tree, *Parmularius altidens* is a descendant of *P. braini*, and *P. altidens* is an ancestor of *P. angusticornis* and *P. rugosus*. The last presence of *P. braini* is in Makapansgat Mb 3 with an estimated age of 2.8-2.6 Ma. The first occurrence of *P. angusticornis* is in Olduvai Bed I at about 1.8-1.75 Ma and that of *P. rugosus* at Olduvai Bed II, at 1.75-1.66 Ma. If the model is correct, the total range of *P. altidens* must be thus between some 2.8-2.6 and some 1.75 Ma, which indeed is more or less the case (from Shungura Mb C at 2.6 Ma till the Okote Mb at 1.6-1.39 Ma). As for *P. altidens* in Ain Boucherit, Vrba (1996, 1997) estimated its age to 2.7-2.5 Ma, which is not in contradiction with the other data on the Alcelaphini.

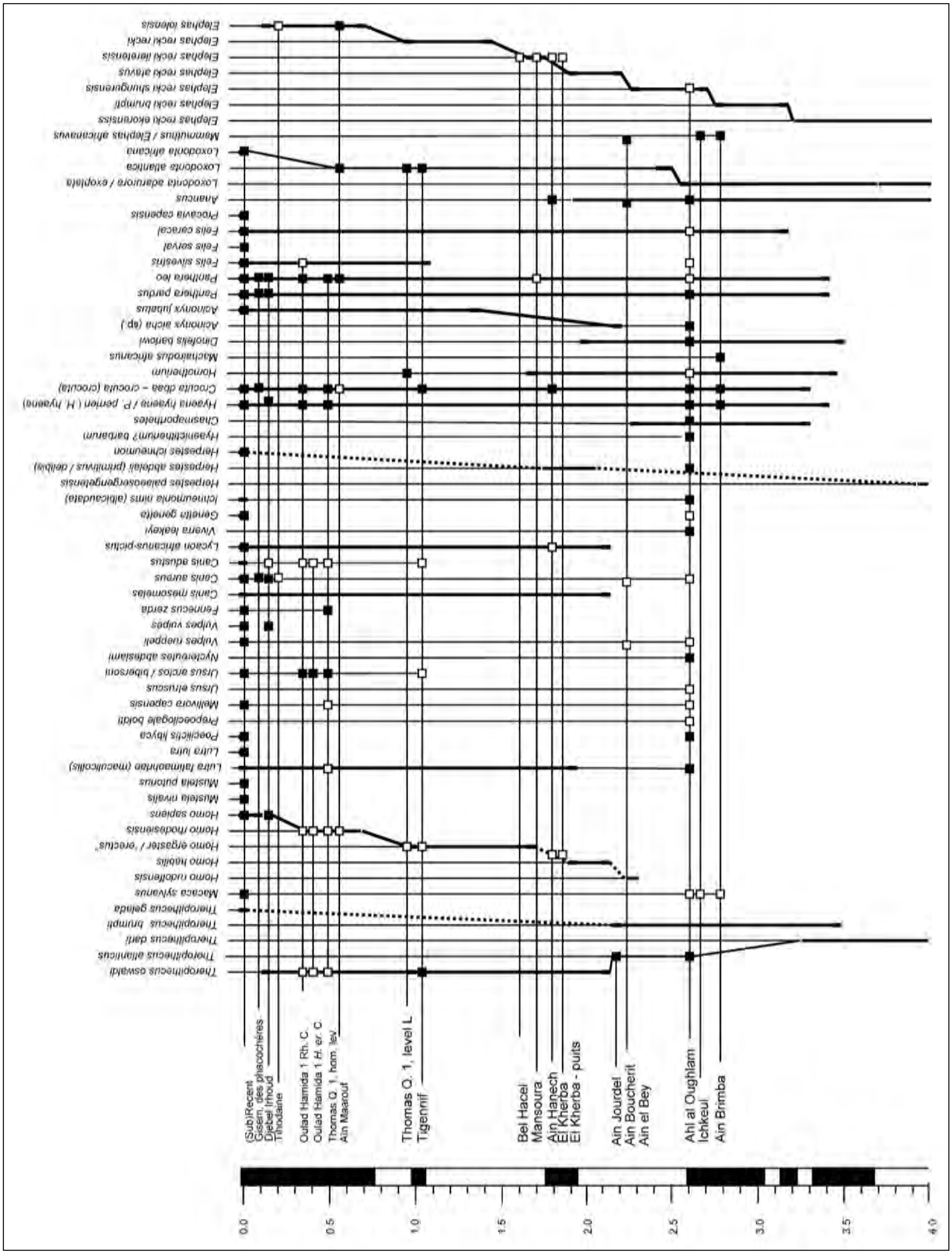
Arambourg assigned some specimens from Ain Boucherit to *Elephas africanavus* and considered this species anterior to *Elephas moghrebiensis*, which he defined on material from Ain Hanech. It has been suggested, however, that it belongs to the genus *Mammuthus* and that it gave rise to the Eurasian *Mammuthus meridionalis* (e.g. Coppens et al., 1978). Geraads & Metz-Muller (1999) seem to be more inclined to maintain the species in *Elephas*, but are of the opinion that the material from Ain Boucherit is too poor for a reliable determination.

Biochronology points to an age between 1.8-2 Ma and 2.3-2.6 Ma for Ain Boucherit. Its position in sediments with reversed polarity below Ain Hanech in sediments with normal polarity correlated to the Olduvai subchron, narrows this down to between 1.95 and 2.58 Ma. Ain Jourdel does not have a particularly rich fauna (Figures 3a & 3b), but, like Ain Boucherit, it has *Hipparion* and *Equus* and thus is younger than the appearance of the latter genus in Africa. Besides, it has several bovids that are present also in that locality. An age close to that of Ain Boucherit seems likely.

Ain Hanech, El Kherba, and El Kherba-Puits

The sites of Ain Hanech and El-Kherba are key Plio-Pleistocene fossil localities in north-eastern Algeria (see further information provided in the Oldowan section below). Arambourg (1957) analyzed the fauna he excavated from Ain Hanech. Renewed investigations at Ain Hanech by Sahnouni et al (1996, 2002) yielded more faunal material and led to the discovery of the rich locality of El-Kherba. El-Kherba-Puits is a locus within a short distance (110 m) south of El-Kherba. The faunal list is provided in figures 3a and 3b.

Arambourg (1957, 1970, 1979) believed that Ain Hanech; Olduvai Bed I; and the Shungura Mbs H, I and J follow an important faunal break between 2.5 and 1.8 Ma marking the onset of the Upper Villafranchian (Arambourg, 1969). Other sites, that were believed to be of similar age, are Laetolil (Tanzania), Makapansgat, Taung and Sterkfontein (South Africa). Coppens (1972) placed Ain Hanech in his biozone VI dated between 2.7 and 1.4 Ma, and Vrba (1996, 1997) estimated its age to 1.8 Ma. Sahnouni et al. (2002) showed that Ain Hanech is dated between 1.95 and 1.77 Ma based on paleomagnetic and biochronological evidence. Geraads et al. (2004b) cast doubt on the suggested age by Sahnouni et al. (2002), arguing that it might be only 1.2 Ma. Sahnouni et al. (2004) reiterated the age of 1.8 Ma for Ain Hanech, but again Chaid-Saoudi et al. (2006) consider that it is close chronologically to Ubeidiya, which is widely assumed to date to ca 1.4 Ma. Thus, there are two hypotheses on the age of Ain Hanech: 1.4-1.2 Ma and 1.9-1.8 Ma. Below we go over the discussion of Ain Hanech and El-Kherba age and add new biostratigraphic elements.


Elephas iolensis
Elephas recki recki
Elephas recki ileretensis
Elephas recki atavus
Elephas recki shungurensis
Elephas recki brumpti
Elephas recki ekorensis
Mammuthus / Elephas africanavus
Loxodonta africana
Loxodonta atlantica
Loxodonta adaurora / exoptata
Anancus
Procavia capensis
Felis caracal
Felis serval
Felis silvestris
Panthera leo
Panthera pardus
Acinonyx jubatus
Acinonyx aicha (sp.)
Dinofelis barlowi
Machairodus africanus
Homotherium
Crocuta dbaa – crocuta (crocuta)
Hyaena hyaena / P. perrieri (H. hyaena)
Chasmaporthetes
Hyaenictitherium? barbarum
Herpestes ichneumon
Herpestes abdelali (primitivus / delibis)
Herpestes palaeoserengetensis
Ichneumonia nims (albicaudata)
Genetta genetta
Viverra leakeyi
Lycaon africanus-pictus
Canis adustus
Canis aureus
Canis mesomelas
Fennecus zerda
Vulpes vulpes
Vulpes rueppeli
Nyctereutes abdesiami
Ursus arctos / bibersoni
Ursus etruscus
Mellivora capensis
Prepoecilogale bolti
Poecilictis libyca
Lutra lutra
Lutra faimaohrae (maculicollis)
Mustela putorius
Mustela nivalis
Homo sapiens
Homo rhodesiensis
Homo ergaster / "erectus"
Homo habilis
Homo rudolfensis
Macaca sylvanus
Theropithecus gelada
Theropithecus brumpti
Theropithecus darti
Theropithecus atlanticus
Theropithecus oswaldi
(Sub)Recent
Gisem. des phacochères
Djebel Irhoud
Tihodaine
Oulad Hamida 1 Rh. C.
Oulad Hamida 1 H. er. C
Thomas Q. 1, hom. lev
Ain Maarouf
Thomas Q. 1, level L
Tigennif
Bel Hacel
Mansoura
Ain Hanech
El Kherba
El Kherba - puits
Ain Jourdel
Ain Boucherit
Ain el Bey
Ahl al Oughlam
Ichkeul
Ain Brimba
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

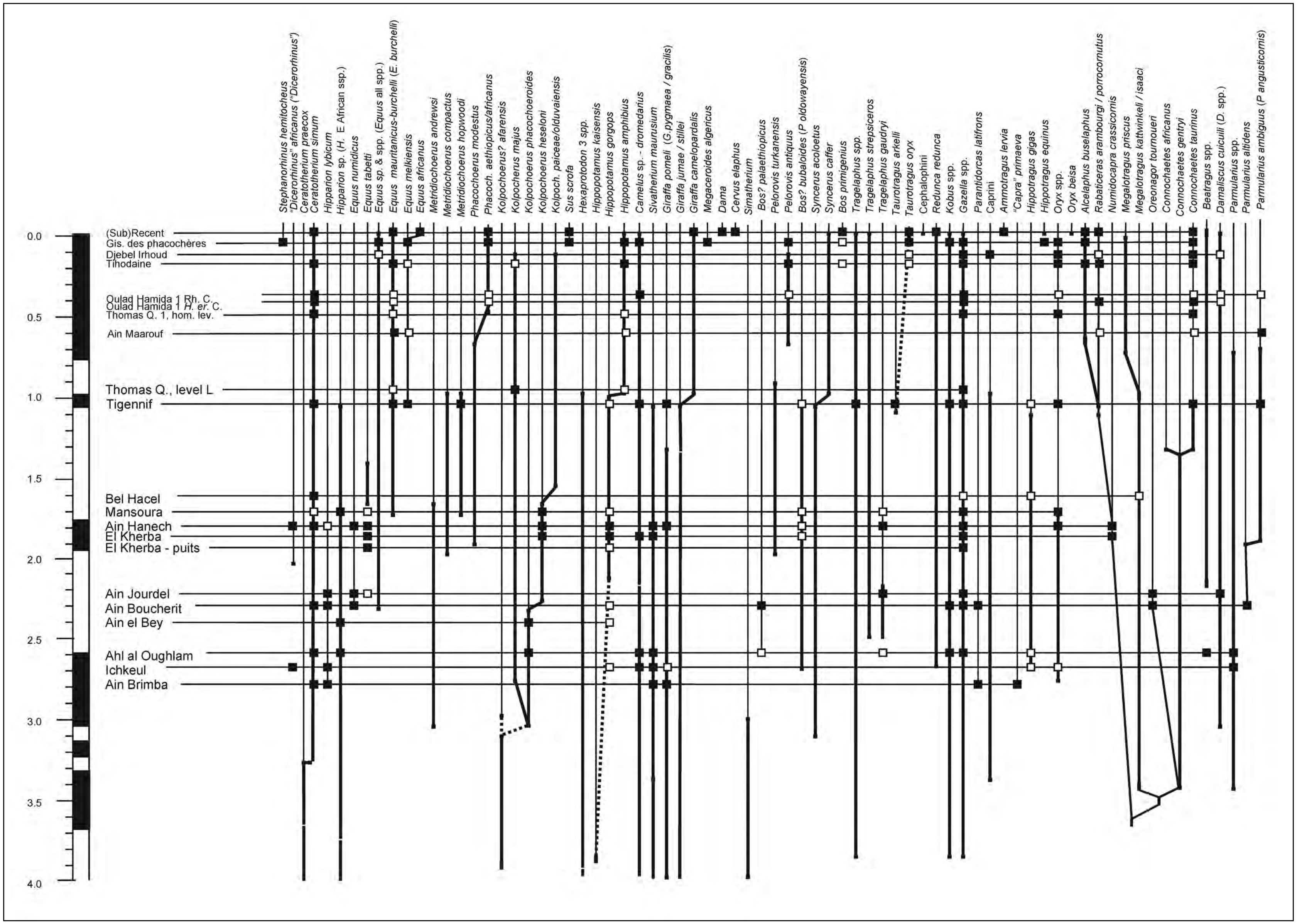


Figure 3a & 3b. The temporal distribution of the large North African mammals compared to that of the same or similar species in the main East African sequences based on data from Amani & Geraads (1998), Arambourg (1979), Chaid-Saoudi et al. (2006), Eisenmann (2006), Geraads (1981, 2002), Geraads et al. (1998), Hadjouis (1985), Kowalski & Rzebek-Kowalska (1991), Sahnouni et al. (2004), Thomas (1977), Vrba (1996, 1997), and personal observations and interpretations of the literature. Solid squares indicate presence; open squares indicate possible (?) or imprecise (cf., aff.) presence. Thick lines indicate temporal ranges in East Africa (from Figures 2a & 2b) of the same species or of closely related or similar species (indicated between brackets). Lines of intermediate thickness are based on the North African material.

Arambourg (1957) included the mastodon *Anancus* in the Ain Hanech faunal list. Yet, later (1970, 1979) he considered it dubious listing it as a surface find, due likely to the chronological implications of its presence in this site. Geraads et al. (2004b) used its presumed absence as an argument for a young age of Ain Hanech. Nonetheless, the recent excavations confirmed the presence of *Anancus* at Ain Hanech with an *in situ* tooth. The proboscidean *Anancus* was wide spread in the Old World, going extinct in Europe around 1.8-2 Ma with a last occurrence at Le Coupet (France) (Arambourg, 1969; Geraads & Metz-Muller, 1999). Its last record in East Africa seems to be at Olduvai Bed I (Coppens et al., 1978) or even in Bed II (Arambourg, 1979). However, the occurrences at Olduvai are not mentioned by Turner et al. (1999) and otherwise the latest East African records are from the Nachukui Apak Mb (Tassy, 2003), Kanapoi, Ekora, Laetolil, the Mursi Fm, and Kubi Algi Fm (Coppens et al., 1978). It is also present at Makapansgat (Cooke, 1993), and from the Vaal river gravels at Waldecks Plant near Barley West (Windsorton, South Africa) from a terrace that is younger than a terrace with *Equus* (Fraas, 1907). There are several North African Late Pliocene sites such as Lac Ichkeul, Fouarat, Ahl al Oughlam and Ain Boucherit (Arambourg, 1970, 1979; Geraads & Metz-Muller, 1999), suggesting that *Anancus* did not survive longer in Africa than in Europe.

Arambourg (1970) defined the species *Elephas moghrebiensis* on material from Ain Hanech. Coppens et al. (1979) included the species in *Mammuthus meridionalis*. Yet Geraads and Metz-Muller (1999) considered it a North African form of *Elephas recki* that corresponds to the East African *E. recki ileretensis*, and Geraads et al. (2004b) used its temporal range for discussing North African biostratigraphy. Whether the different subspecies of *Elephas* are really distinct in morphology and whether or not these have different time ranges and really form an anagenetic lineage (e.g. Maglio, 1972; Cooke, 1993) is a matter of debate (e.g. Todd, 2001). However, according to Feibel et al., (1991), *E. r. ileretensis* occurs in the KBS Mb of the Koobi Fora Fm and in the Kaitio Mb of the Nachukui Fm, both of which are of earliest Pleistocene age.

Arambourg (1957) included the three toed horse *"Stylohipparion" libycum* without reservation in the Ain Hanech faunal list. Yet, in a later publication, he listed this taxon as very rare, arguing that the teeth (an upper and a lower M2) might have been reworked from the underlying deposit (Arambourg, 1970: 85). He probably believed that *Hipparion* is too old for Ain Hanech. Geraads et al (2004b: 753) used the alleged absence of *Hipparion* from Ain Hanech as an evidence for a younger age. Nonetheless, the upper cheek tooth is especially very indicative of the presence of *Hipparion*, and in view of the flat lying sediments, reworking from a considerably older deposit seems unlikely. In Europe, *Equus* replaced *Hipparion* around 2.6 Ma, but in East Asia and Africa both genera overlapped for a considerable time. While the first appearance of *Equus* in Africa is in Shungura Mb G (ca. 2.3 Ma) (Churcher & Hooijer, 1980), *Hipparion* is still present in the Kaitio, Okote and Natoo Mbs and in Olduvai Beds I to IV (Arambourg, 1979; Feibel, et al., 1991) for more than 1 Ma after the appearance of *Equus*. In addition, in South Africa *Hipparion* survived well into the Pleistocene. Therefore, the presence or absence of the genus *Hipparion* at Ain Hanech is irrelevant for discussing the age of the site.

Ain Hanech is the type locality of *Equus tabeti*. *Equus* cf. *tabeti* was found in the KBS and Okote Mbs (Eisenmann, 1983), with ages ranging from 1.4 to over 1.8 Ma. Feibel et al (1991) cited *E.* cf. *tabeti* in the same members, while Geraads et al., (2004b) mentioned *Equus numidicus* and/or *E. tabeti* from Shungura Mbs G and H lower (2.12-2.04 to 1.88±0.02 Ma [Howell et al, 1987: 667]). In any case, forms similar to *E. tabeti* appeared in East Africa roughly between 2.3-1.9, and 1.4 Ma.

There is also a larger *Equus* species at Ain Hanech attributed by Sahnouni et al. (2002, 2004) to *E. numidicus* based on its morphological and metrical resemblances with the specimens from the older deposit of Ain Boucherit. In contrast, Geraads et al. (2004b) viewed it as a "zebra-like" form and assigned it to *Equus* cf. *mauritanicus*. *Equus mauritanicus* is present in Tighenif (formerly Ternifine) and the North African Middle Pleistocene, and its alleged presence at Ain Hanech was used by Geraads et al. (2004) to date this site to the early Middle Pleistocene. *E. mauritanicus* from Tighenif is believed to be close (Eisenmann, 2006) or identical to the plains zebra *Equus burchelli* (Churcher & Richardson, 1978). *Equus* cf. *burchelli* is present in the Kaitio, Natoo, and Okote Mbs respectively of the Nachukui Fm and Koobi Fora Fm (Feibel et al., 1991; Eisenmann, 1983), with ages spanning from 1.8 to 1.4 Ma. Though Eisenmann (2006) discussed the first appearances of the different types of equids, she did not mention the older presence of a plains zebra. Whatever the affinities of the larger equid from Ain Hanech, an age close to the Plio-Pleistocene transition cannot be excluded.

Arambourg (1970) named the rhinoceros *Dicerorhinus africanus* on the basis of an M^3 and a mandible with $M_{2\text{-}3}$ from Lac Ichkeul in Tunisia. This was at a time when European species, attributed now to *Stephanorhinus*, were assigned to *Dicerorhinus*. The material from Lac Ichkeul was said to be more brachyodont than *Stephanorhinus etruscus*, but evidently it is poor for assessing its affinities. A fragment of a very low crowned lower molar from Ain Hanech suggests the presence of a similar rhino. Kalb et al. (1982) reported a "*Dicerorhinus*" from the Matabaietu Fm. The records of a rhino with resemblances to "*Dicerorhinus*" suggest a Late Pliocene age for Ain Hanech.

The pigs or Suidae are considered to be of great biostratigraphic interest and have been intensively studied in East Africa (Maglio, 1972; Cooke, 1976, 1978a-c, 1979, 1985, 1997, 2007; White & Harris, 1977; Harris & White, 1979; and Harris, 1983). Despite nomenclatorial changes, the evolution of *Kolpochoerus* in East Africa seems to be essentially clear. There are, however, different opinions on whether the same species are found in North Africa (Sahnouni et al., 2002, 2004), or whether there are endemic species (Geraads, 1993, 2004b). Even though Geraads et al. (2004b) recognised different species in North Africa and believed that the evolution of *Kolpochoerus* in this region of Africa is imperfectly understood, Geraads (1993) and Chaid-Saoudi et al. (2006) used the enlargement trend in the East African third molar to estimate the ages of North African sites. In spite that the M_3 of *Kolpochoerus* from Mansourah is of simple morphology, Chaid-Saoudi et al. (2006) claim that it is geologically young, and compared it with those from Konso (southern Ethiopia) to argue that the North African *Kolpochoerus* represents a different lineage. Suwa et al. (2003) considered the Konso *Kolpochoerus* as endemic, because they believed it is morphologically primitive or simple compared to specimens from Shungura and Koobi Fora Fms. However, the variations in the presence or absence of a terminal cusp in the last lobe of the M_3, or the variation in its size, if such a cusp is present, are similar to those observed in the sample of recent *Sus scrofa vittatus*, that was studied by Van der Made (1991) for sexual bimodality, or in the Spanish *Microstonyx* (Van der Made et al., 1992). We believe that endemism in North African *Kolpochoerus* is not demonstrated, and that, if variation, that is to be expected in a representative sample, is taken into account, the specimens from North Africa and Konso fit well in the East African evolutionary trends (Figure 4). Thus the most parsimonious model is that the same species were present in both East Africa and North Africa.

Kolpochoerus is represented in Ain Hanech and El Kherba by teeth with low crowns, and short M_3 and M^3 that do not have many distal lobes. These specimens were assigned to the species *K. heseloni*, and suggest that these localities are comparable in age to Olduvai Bed I and Shungura Mb H and are older than Olduvai Bed II and Shungura Mb J (Sahnouni et al., 2002, 2004; Van der Made, 2005). The transitions of Olduvai Bed I to II and Shungura H to J are around 1.7 Ma.

The antelopes *Parantidorcas* and *Oreonagor* are present at Ain Boucherit, but their absence at Ain Hanech was given much importance as an argument for a much younger age for the latter site (Geraads et al., 2004b). However, these species are very rare and are nearly only known from the former site (Vrba, 1996, 1997). In our opinion, presence/absence of extremely rare species should not be used in stratigraphy.

The giraffe *Sivatherium* was discussed by Geraads et al. (2004b) in Ain Hanech biochronology. Nevertheless, it is really irrelevant here since it appeared well before the end of the Pliocene and lived on till after 1 Ma ago.

Arambourg (1979) named the species "*Oryx el eulmensis*" based on material from Ain Hanech. This should be emended as *Oryx eleulmensis* (ICZN, 1999, article 11.9.5). In contrast, Geraads et al (2004b) regarded it as the living species *Oryx gazella*, which differs from older forms in the degree of compression of the horn cores. In this character, the Ain Hanech specimen plots between, on the one hand, material from the KBS and Upper Burgi Mbs, and, on the other hand, Tighenif and the living species; so that it could cluster either way. The variation of all the material from the Koobi Fora Fm, Ain Hanech, and Tighenif fits in the variation range of a single bovid species from one locality (Sahnouni et al., 2004: 765), precluding biostratigraphic use.

Arambourg (1979) described some Ain Hanech material as *Crocuta crocuta*. Some authors assigned African fossils of well over 2.5 Ma and up to nearly 4 Ma to *Crocuta crocuta* (Turner & Antón, 1998; Turner et al., 1999; Feibel et al., 1991), while others recognize various Late Pliocene species (e.g. Geraads, 1997). A principal component analysis by Geraads et al. (2004b) shows that there is a wide range of variation in the larger Middle-Late Pleistocene and recent samples of *Crocuta*, while the much smaller Early Pleistocene and Pliocene samples have a lesser range of variation. This suggests that these forms are not well enough known in this respect to draw far reaching conclusions.

Arambourg (1979) named the species *Bos bubaloides* and *Bos praeafricanus* from Ain Hanech. Geraads and Amani (1998) assigned material from Ahl al Oughlam to *Pelorovis? praeafricanus*, transferring thus the species tentatively to the genus *Pelorovis*. Hadjouis and Sahnouni (2006) named *Pelorovis howelli* from El Kherba based on a skull with complete horn cores. Geraads et al. (2004b) assigned a skull from the earliest Middle Pleistocene of Asbole (Ethiopia) to *Bos* after comparing it with *Bos* and *Pelorovis*. Martínez-Navarro et al. (2007) proposed that *Bos* (as in Asbole and Europe) evolved from *Pelorovis* and suggested that *P. howelli* and *B. bubaloides* are close to or identical to *Pelorovis oldowayensis*. This latter observation finds some support in the metacarpal, which was chosen by Arambourg (1979) as the syntype of *B. bubaloides*. This metacarpal has a robusticity similar to that of *P. oldowayensis* from Olduvai (Figure 5). It is also larger, but not too large to preclude a synonymy. The latter species has a temporal distribution from about 2.5 to 1.3 Ma (Vrba, 1996), while the earliest record of what certainly is *Bos* is dated close to 1 Ma (e.g. Trinil, Java; Van den Bergh et al., 2001).

Arambourg (1949) described the genus and species *Numidocapra crassicornis* from Ain Hanech. Vrba (1997) considered that this species is an alcelaphine, which is also present in Olduvai Bed II, Anabo Koma and Bouri, and proposed an evolution from *Numidocapra* to *Rabaticeras* and *Alcelaphus*. Though *N. crassicornis* persisted alongside *Rabaticeras*, this scenario implies that *Numidocapra* appeared before the first *Rabaticeras* (dated roughly to 1.8 Ma at Swartkrans).

In summary, of the taxa discussed above, *Anancus*, the *Dicerorhinus*-like rhino, and *Kolpochoerus* are the most relevant biostratigraphically. They falsify the 1.2-

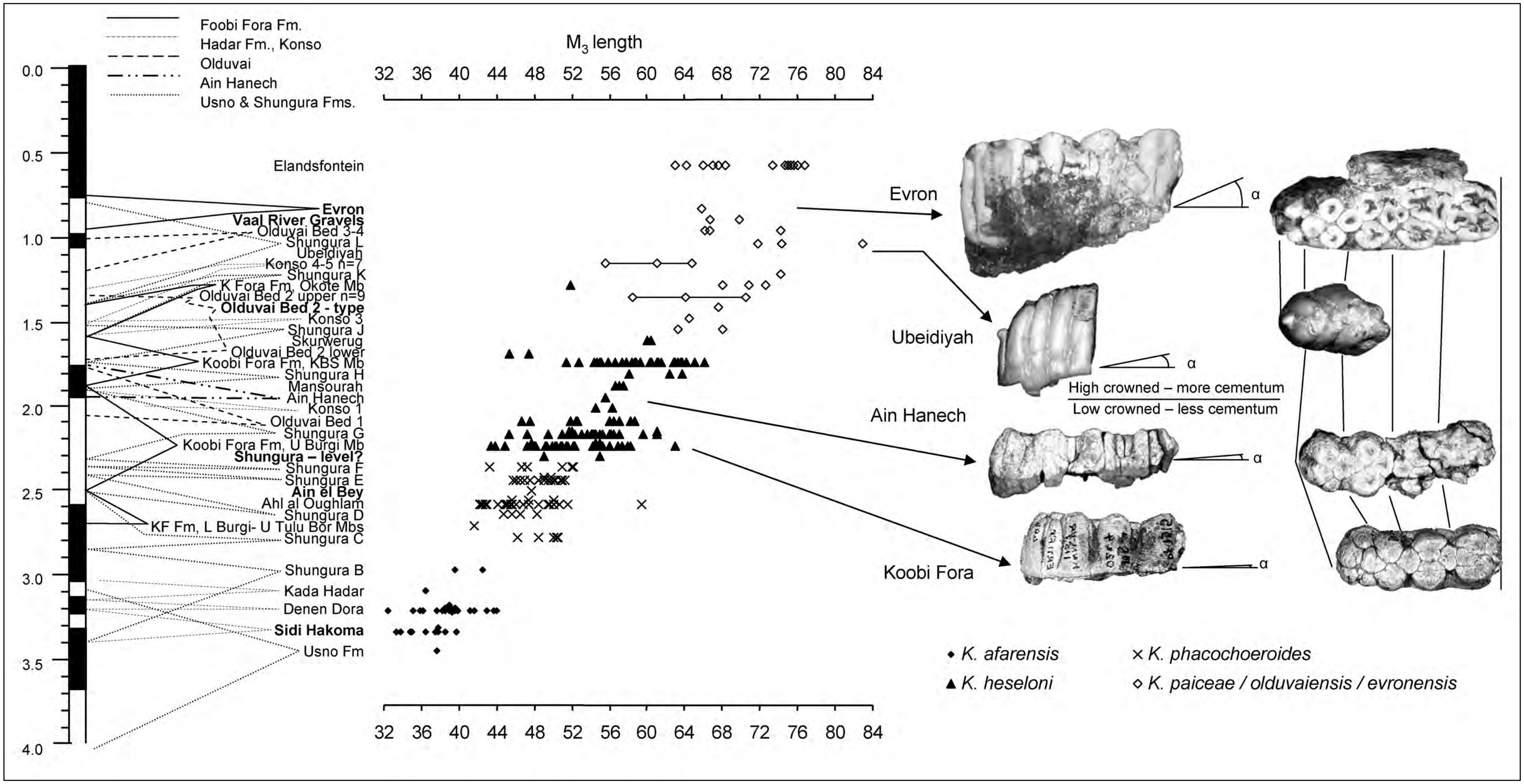


Figure 4. The evolutionary changes in morphology and length in the third lower molar of Kolpochoerus. *On the left are the age in Ma, palaeomagnetism and samples (localities, formation, member, biozone). Data from Koobi Fora Fm, Harris (1983): (*M. compactus *zone corresponds to the Okote Mb;* M. andrewsi *zone corresponds to KBS Mb;* N. scotti *zone corresponds to Upper Burgi Mb; zone C corresponds to the Lower Burgi Mb and the top of the Tulu Bor Mb); Usno Fm & Shungura Fm, Cooke (1976); Ahl al Oughlam & Ain el Bey, Geraads (1993, 2004); Ain Hanech, Sahnouni et al. (2002); Skurwerug, Olduvai Bed 1, Vaal River Gravels & Elandsfontein, Hendey & Cooke (1985); Olduvai Bed 2, Leakey (1943); Evron, Hebrew University of Jerusalem (HUJ). On the right are four specimens:* Kolpochoerus heseloni *from the* N. scotti *zone or Upper Burgi Mb at Koobi Fora (Kenya National Museums, KNM ER1153) and from Ain Hanech (collection),* Kolpochoerus paiceae/olduvaiensis/evronensis *from Ubeidiyah (HUJ K25) and holotype from Evron (HUJ). The morphological changes include increase in crown height and deposition of cementum, the increase of the angle between the crown base and the occlusal surface, and the addition of distal lobes and cusps.*

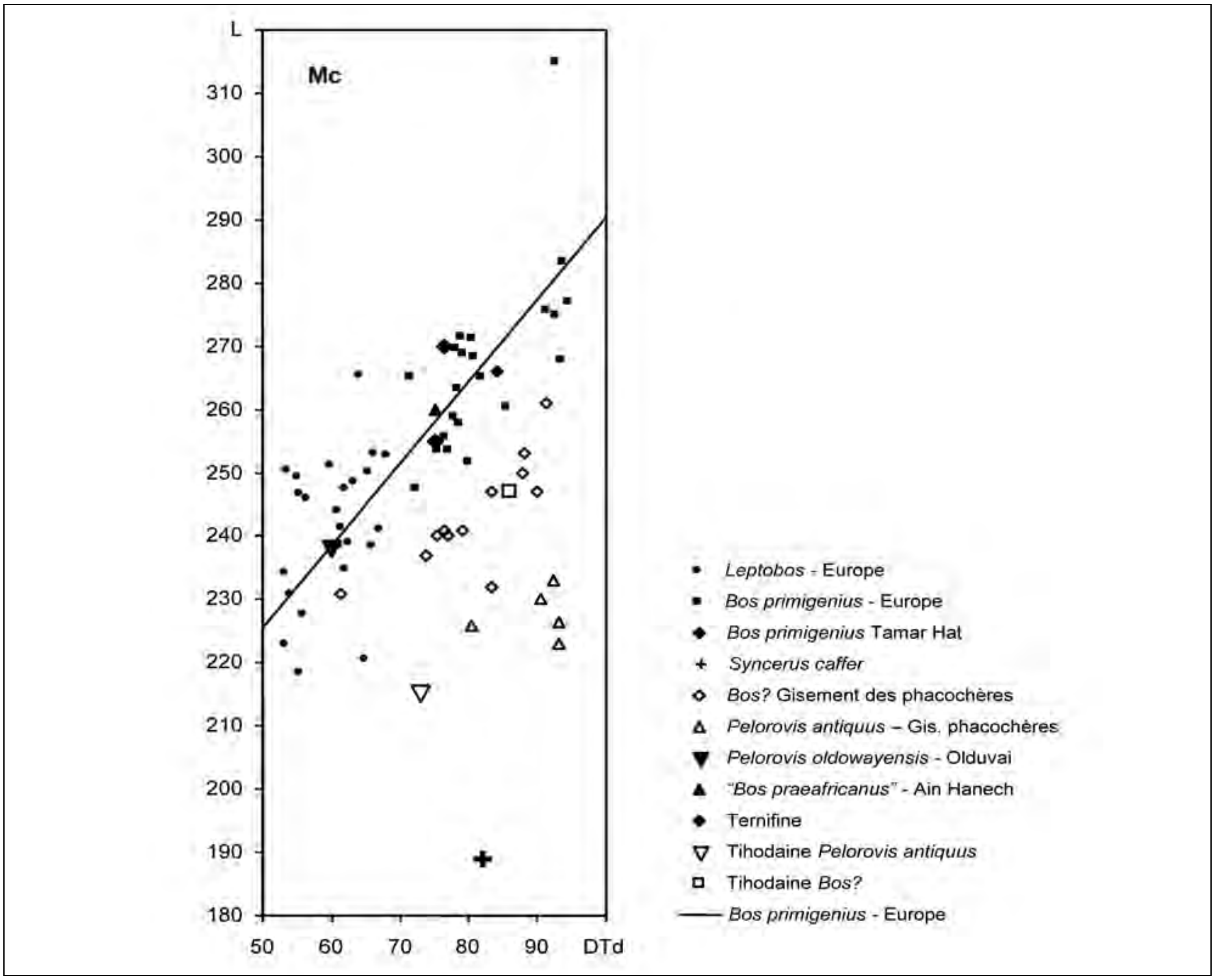


Figure 5. Bivariate plot of the metacarpals of selected Bovidae *using distal width (DTd) versus length (L).* Leptobos *de Villaroya (IPS), Montopoli (IGF), Senèze (MNHN), Olivola (IGF), Valdarno (Bologna);* Bos primigenius *from Miesenheim (Monrepos), Ariendorf (Monrepos), Plaidter Hummerich (Monrepos), Neumark Nord (Halle), Taubach (IQW), Lehringen (HMV), Pinilla del Valle (UCM), Villa Seckenberg (SMNS) and Can Rubau (Gerona);* Bos primigenius *from Tamar Hat (Geraads, 1981);* Pelorovis oldowayensis *from Oduvai Bed I (Gentry, 1967);* Pelorovis antiquus *(or* Syncerus antiquus*) from the Gisement des phacochères (Hadjouis, 1985, 2002); recent* Syncerus caffer *(NNML);* "Bos? bubaloides" *from Tighenif (Geraads, 1981);* "Bos praeafricanus" *from Ain Hanech (Arambourg, 1979).*

1.4 Ma hypothesis, but do not contradict the 1.8-1.9 Ma hypothesis, corroborating the Olduvai subchron polarity evidenced at Ain Hanech.

Mansoura

During the second half of the 19th century and the beginning of the 20th century faunal remains were collected in the Mansourah area in the vicinity of Constantine though not much attention was given to local stratigraphy (Bayle, 1854; Thomas, 1884; Joleaud, 1918). Half a century ago, stone artefacts were collected at Mansourah and a sketchy stratigraphy was reported (Laplace-Jaurechte, 1956). Chaid-Saoudi et al. (2006) studied fauna from the earlier collections housed in Algiers, Constantine and Rabat, but artifacts from the Laplace collections, housed in Les Eyzies (France). There is thus no guarantee that conclusions on the age, drawn from that fauna, apply to the lithic industry, nor that the fauna comes from a single site or level.

Chaid-Saoudi et al. (2006) concluded that the fauna from Mansourah is Early Pleistocene in age and slightly older than that of Ain Hanech, arguing that the latter fauna lacks the Tragelaphini and Reduncini, which for Mansourah indicate an earlier age. The form belonging to the Reduncini was described as *Kobus* aff. *kob*, an extinct subspecies of *Kobus kob* or a new species. *K. kob* is a living species, and it is hard to see, how fossils of insecure taxonomy, but close to a living species can be an argument for an old age. They assigned the tragelaphine from Mansourah to *Tragelaphus* cf. *gaudryi*, while they assume that *T. gaudryi* (present in Ain Boucherit and Ain Hanech) gave rise in North Africa to *T. algericus*, present in Tighenif. So, *Tragelaphus* is assumed to have been present all the time, though there is no precise documentation of the transition from one species to the other. How can the presence or absence of a form of this lineage, but of imprecise specific affinities, be used in precise biostratigraphy?

We agree with Chaid-Saoudi et al. (2006), that the Mansourah faunal list as presented shares several taxa with Ain Hanech (Figures 3a & 3b), in particular the suid, which we believe to be *Kolpochoerus heseloni* (Figure 4); and that the age of the Mansourah fauna (if indeed homogenous) may be close to that of Ain Hanech, which in our opinion is around 1.8-1.9 Ma old.

Tighenif and Thomas Quarry level L

Tighenif and Thomas Quarry Level L are important North African Late/Middle Pleistocene localities. The locality of Tighenif (formerly Ternifine, formerly Palikao) in northwestern Algeria was discovered in 1870 in the course of sand quarry exploitation where vertebrate fossil bones and lithic artifacts were collected. Subsequently, Pomel (1878, 1893-1897) described the first mammalian fossils. Initially, Arambourg (1951) correlated the site to the Riss, but later gave a faunal list and indicated an older age between 1.23 and 0.23 Ma. In 1954-1956 Arambourg carried out large scale excavations that led to the discovery of the oldest North African *Homo erectus* remains associated with a rich fauna and Acheulean assemblage (Arambourg & Hoffstetter, 1963). He dated the fauna to the base of the Middle Pleistocene and correlated the site to Olduvai Upper Bed II (Arambourg, 1979). Geraads (1981, 2002) re-analyzed the Bovidae and published a revised faunal list. Further investigations on the site were carried out including the results of a plaeomagnetic study with normal polarity of the lower deposits, indicating either the Brunhes Epoch or the Jaramillo Event (Geraads et al., 1986). Vrba (1997) assumed an age of about 0.7 Ma, but this is not based on her phylogenetic tree of the Alcelaphini, which would allow an age of 1.5 Ma for Tighenif as well. Taxa from Tighenif are shown in figures 3a and 3b and those that may have stratigraphic interest are discussed below:

Metridiochoerus is closely related to the living a wart dog. Different views on the evolution of this suid have been published (Cooke, 1976, 1978a, 1978c, 1985; White & Harris, 1977; Harris & White, 1979; Harris, 1983). *Metridiochoerus hopwoodi* (*M. nyanzae* for Cooke) occurs last in East Africa in the Nariokotome Mb of the Koobi Fora Fm and in Olduvai Bed IV (Harris, 1983; Turner et al., 1999). Its occurrence in Tighenif suggests thus an age of not less than about 1.0-0.8 Ma.

The Giant sable antelope (*Hippotragus* cf. *gigas*) is cited last in East Africa in Olduvai Bed III and in the Natoo Mb of the Nachukui Fm (Harris, 1983; Turner et al., 1999), with ages of just over 1 Ma.

A large bovid, represented only by some foot bones including metacarpals, was assigned to *Bos?* cf. *bubaloides*, a species present in Ain Hanech (Geraads, 1981). As discussed above, this form might be identical to *Pelorovis oldowayensis*. The metacarpals from Tighenif are similar in proportions and size to those from Ain Hanech, but also similar to those of European *Bos primigenius*. On one hand, in Europe, the earliest *Bos* appeared around 0.5 Ma, maybe 0.6 Ma (Petronio & Sardella, 1998). *Bos primigenius* is present in Gesher Benot Yakov, which may be earlier than in Europe, and a *Bos* was reported from Asbole (Geraads et al., 2004b). On the other hand, the last record of *Pelorovis oldowayensis* in East Africa is in Olduvai Bed III at about 1.3 Ma (Vrba, 1996).

Despite the common practice to place Tighenif in the Middle Pleistocene, there is no well documented species that indicates such an age. In fact, several species suggest rather a late Early Pleistocene age. In combination with the normal palaeomagnetic polarity detected in the sediments of this locality, the biostratigraphic data suggest a correlation with the Jaramillo event rather than to the basal Middle Pleistocene.

Level L at Thomas Quarry 1 constitutes the oldest archaeological deposit of the long Acheulean sequence of Atlantic Morocco. It yielded an Acheulean industry associated with a small faunal assemblage. The sediments signal probably a reversed polarity, while OSL dating points out a maximum age of 989±208 Ka for Unit L (Rhodes et al., 2006). Although the fauna is not very informative in terms of biostratigraphy (Figures 3a & 3b), it suggested an Early Pleistocene age to Geraads (2002), either after (p. 47, fig. 2) or before the Jaramillo Event (p. 49), and even up to 1.5 Ma (Geraads et al., 2004b). The following taxa were discussed by that author in relation to the age of level L:

The gerbilid *Ellobius* and *Gazella atlantica* are present in Tighenif (early Middle Pleistocene for Geraads) and Middle Pleistocene sites. The presence of similar gazellas in both Level L and Tighenif is not taken as an indication of similar age while the absence of gerbilid in Level L is interpreted as an indication that Level L is older than Tighenif. The absence of evidence is thus valued more than the presence of evidence.

An upper third molar of *Kolpochoerus* is similar to that of the type of *K. maroccanus* (of unknown age [Geraads, 2002]) and *Kolpochoerus majus*. *K. majus* is known to have survived well into the Middle Pleistocene (Cooke, 1976, 1978a, 1978c, 1985; White & Harris, 1977; Harris & White, 1979); nevertheless Geraads (2002) argued that the genus is not known from the Middle Pleistocene of North Africa and that its presence in level L points to an Early Pleistocene age.

Several species of small mammals are represented by poor material. While this material is different from that of other sites in the quarry, its biochronological value is limited, since the material does not allow for a precise taxonomic assignment.

None of these are really good biostratigraphic criteria for dating Level L, but we are willing to accept a late Early Pleistocene age for that level, mainly because of the reversed paleomagnetics and the OSL dates.

In conclusion to the biostratigraphical study of the North African Plio-Pleistocene localities, the faunas can be clustered into the following chronologies:

1. Ahl al Oughlam, Lac Ichkeul, and Ain Brimba are Late Pliocene about 2.5 Ma or older;
2. Ain Boucherit, Ain Jourdel, and Ain el Bey are Late Pliocene between about 2.58 and 1.95 Ma;
3. Ain Hanech, El-Kherba, El-Kherba Puits, and Mansourah are latest Pliocene-earliest Pleistocene between about 1.95 and 1.6 Ma; the first two localities belonging to the Olduvai subchron; and
4. Tighenif and Thomas Quarry Level L are late Early Pleistocene in age, the former site being correlated to the Jaramillo subchron (0.99-1.07 Ma); while the latter with reversed paleomagnetism and a date of 989±208 Ka might most probably be a little younger.

PRE-ACHEULEAN OR OLDOWAN

A terminological issue that is essential to be addressed in this chapter is whether or not the North African lithic assemblages preceding the Acheulean tradition should be designated as Pre-Acheulean or Oldowan. Because of the inadequacy of then used terminology, the Pan-African Congress held in Tenerife (Spain) in 1963 adopted the resolution “to reexamine entirely all terms relating to technique, typology and cultures in Africa and to make precise recommendations for a standardized African nomenclature” (Cuscoy, 1965: 91). “Pebble culture” was among the terms that the congress recommended to be replaced. Subsequently, it has been decided at the Wenner-Gren conference at Burg Wartenstein, (Austria) that the term “Pebble-Culture” to be replaced by Oldowan to refer to industries that precede the pre-bifacial technology. However, instead of the Oldowan, the term Pre-Acheulean was proposed by North Africanist prehistorians for North Africa, arguing that the term Oldowan is impossible to apply to Moroccan “Pebble Culture” levels and because North African assemblages are not found in a sealed context, e.g. “living floor” (Bishop & Clark, 1967: 866-867).

Yet, the term Pre-Acheulean has a chronological connotation, and the arguments advanced against the use of the term Oldowan in North Africa are no longer valid. In fact, recent studies showed that the presence of Pre-Acheulean industries in Atlantic Morocco is not authentic (Raynal & Texier, 1989), and the Oldowan industry truly occurs both chronologically and typologically in North Africa, e.g. Ain Hanech and El-Kherba (Algeria). At these two sites the Oldowan industry is found in a sealed context and detailed study has clearly shown that the North African Lower Palaeolithic assemblages from Ain Hanech are very similar to the Oldowan stone tools recovered from Upper Bed I and Lower Bed II at Olduvai in Tanzania (Sahnouni, 1998). Therefore, in accordance with the recommendations of the Burg Wartenstein conference, we propose here that the term Oldowan should replace the Pre-Acheulean for North African assemblages predating the Acheulean.

OLDOWAN IN NORTH AFRICA

The earliest lithic artifacts attributed to Mode I are presently known in Eastern Africa, and are dated to roughly between 2.6-1.5 Ma. Major sites include: East Gona 10 (EG10), East Gona 12 (EG12), and Ounda Gona South 7 (OGS7) (Gona, Ethiopia) (Semaw et al., 1997, 2003), Lokalalei (West Turkana, Kenya) (Roche et al., 2003), Koobi Fora, East Turkana) (Isaac, 1997), Olduvai Gorge, Tanzania (Leakey, 1971, 1975) Melka Kunture, Ethiopia (Chavaillon & Piperno, 2004). South African sites that yielded Mode I artifacts include Sterkfontein (Kuman et al., 2005) and Swartkrans (Clark, 1993). These artifacts are generally assigned to the Oldowan Industrial Complex, named for Olduvai Gorge in northern Tanzania. The Oldowan technology is simple but required mastering by early hominins of some fundamental stone flaking techniques. The Oldowan assemblages incorporate cores and core-tools (choppers, polyhedrons, subspheroids, spheroids), debitage, and less-frequent retouched pieces as well. Similar assemblages are known from the earliest archaeological sites in the Maghreb, including Ain Hanech. These assemblages were generally referred to as “Pebble Culture” and sometimes as Pre-Acheulean. Most of the sites are located in Morocco and in Algeria (Figure 6). Outside of Algeria and Morocco, rare and/or doubtful finds have been reported in Tunisia and Egypt. In Tunisia only a single bifacially flaked core/chopper, encountered within a sandy-clay deposit has been reported (Gragueb & Ouslati, 1990). In the Egyptian Nile Valley there are reports of Pre-Acheulean stone tools in the Early Pleistocene (Biberson et al., 1977), but they seem of doubtful authenticity (Vermeersch, 2001, 2006). These so called “Pre Acheulean” sites are environmentally located in three distinct areas, namely High Plateaus of Algeria, the Sahara, and possibly Atlantic coast of Morocco (Figure 6).

Ain Hanech and El-Kherba

The major Oldowan sites are formed within basin deposits of the Algerian High Plateaus. These include Ain Hanech and El-Kherba, Mansourah, and Monts Tessala. Ain Hanech and El-Kherba are located on the edge of the eastern Algerian Plateau. Ain Hanech was discovered by Arambourg (1970, 1979), and yielded a Plio-Pleistocene fauna associated with Oldowan artifacts. Beginning in 1992-93 Sahnouni and colleagues have re-investigated this major site. These new studies have involved investigations bearing on stratigraphy, dating, nature of the association of broken up bones and stone artifacts, lithic assemblages, and overall behavioral implications of the archaeological occurrences. The preliminary results are accessible in a number of publications (Sahnouni, 1998; Sahnouni & de Heinzelin, 1998; Sahnouni et al., 2002,

Figure 6. Map showing major Oldowan and Plio-Pleistocene sites in Northwest Africa. Note that the only Oldowan sites with clearly associated Plio-Pleistocene large mammal fossils are Ain Hanech and El-Kherba in Algeria.

2004), and only a summary is provided here. Ain Hanech is not a single site but rather a Plio-Pleistocene site complex stretching over an area of approximately one Km^2. The localities include Ain Boucherit, Ain Hanech, El-Kherba, and El-Beidha. Ain Boucherit is a Late Pliocene paleontological locality and the oldest in the region (see section above) (Arambourg, 1970, 1979, Sahnouni et al., 2002). Ain Hanech is located near a small local cemetery in a sedimentary outcrop cut by the deep ravine of the intermittent stream of Ain Boucherit. El-Kherba and El-Beidha are newly discovered archaeological localities, and are situated in the immediate vicinity south of the site of Ain Hanech. While the investigations are well underway at Ain Hanech and El-Kherba, the locality of El-Beidha has yet to be fully explored. The Acheulean occurrences are entirely independent of the Oldowan, and belong to the calcrete deposits located 6m higher sealing the entire formation.

Three distinct archaeological levels have been identified at Ain Hanech. They yielded Oldowan assemblages associated with Plio-Pleistocene faunas (Sahnouni et al., 2002). They are from the youngest to the oldest A, B, and C. Levels A and B comprise a gravel layer at the bottom, abruptly overlain by a silty stratum. These deposits suggest an alluvial floodplain cut by a meandering river channel. Level C is easily discernable as it is separated from level B by 0.50 m of sterile deposits. It is 50 cm thick and consists of dark sandy clay with pebbles and cobbles, and black flint fragments. A test excavation yielded a few fossil bones and 15 lithic artifacts.

Major excavations were undertaken mainly at Ain Hanech and El-Kherba. The excavated areas total 118 m^2 x 1.50 m depth at Ain Hanech and 80 m^2 x 1.40 m depth at El-Kherba. At both localities a rich assemblage was recovered. A total of 2475 archaeological remains was recovered at Ain Hanech, including 1242 fossil bones and 1232 stone artifacts >2 cm. At El-Kherba the excavations yielded a total of 631 specimens, including 361 fossil bones and 270 stone artifacts. The materials are contained in all three levels sealed in a fine sedimentary matrix.

Made primarily of limestone and flint, the lithic assemblages incorporate a full range of Oldowan artifact categories, including core-forms (Figure 7), unifacial and bifacial choppers, polyhedrons, subspheroids, spheroids, whole flakes, and retouched pieces (chiefly scrappers and denticulates) (Figure 8). Several simple flakes and retouched pieces were utilized in cutting meat as ev-

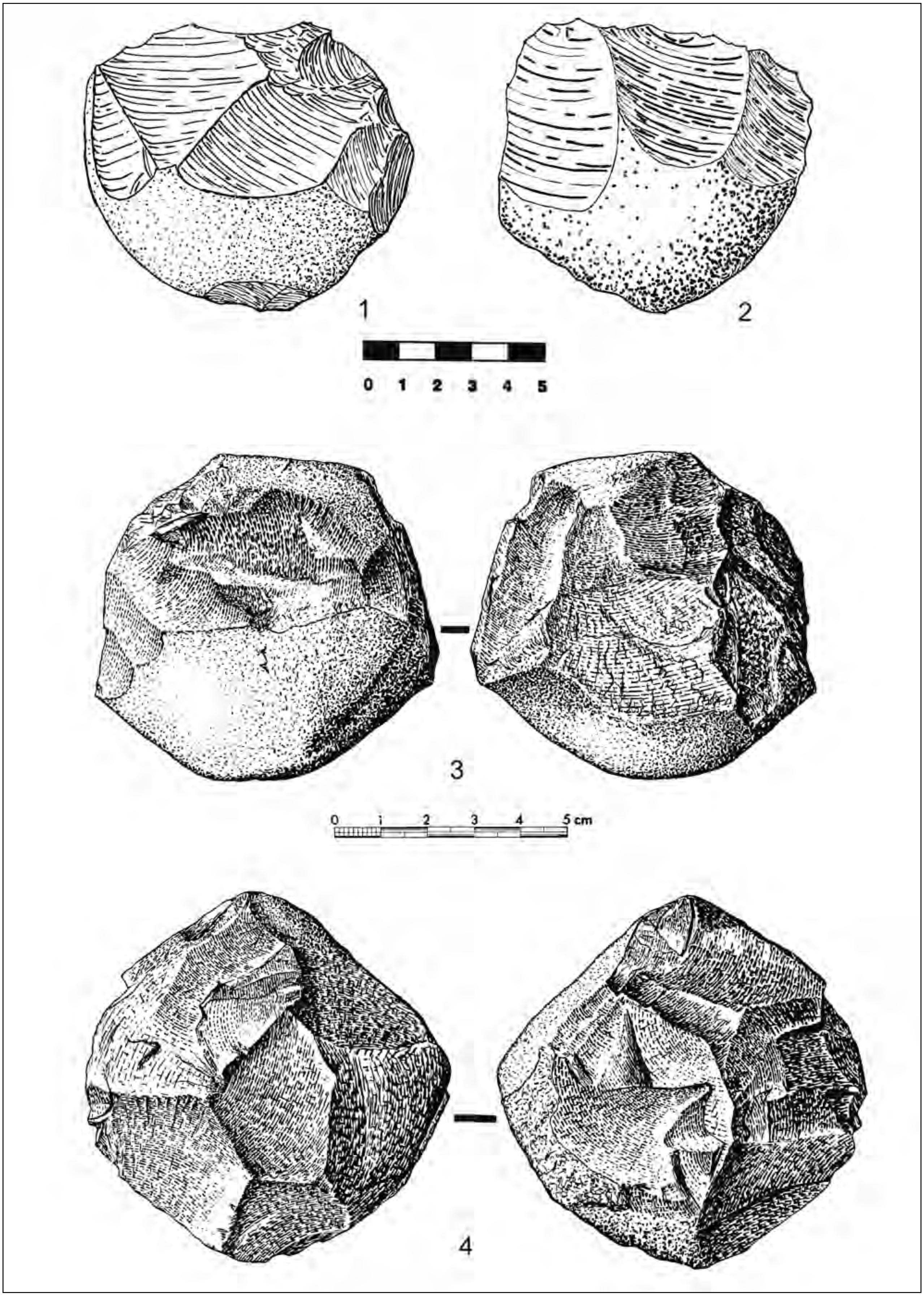


Figure 7. Examples of core-forms from Ain Hanech (3, 4) and El-Kherba (1, 2) sites in northeastern Algeria (1 and 2 drawn by de Heinzelin, 3 and 4 modified after Biberson [1967])

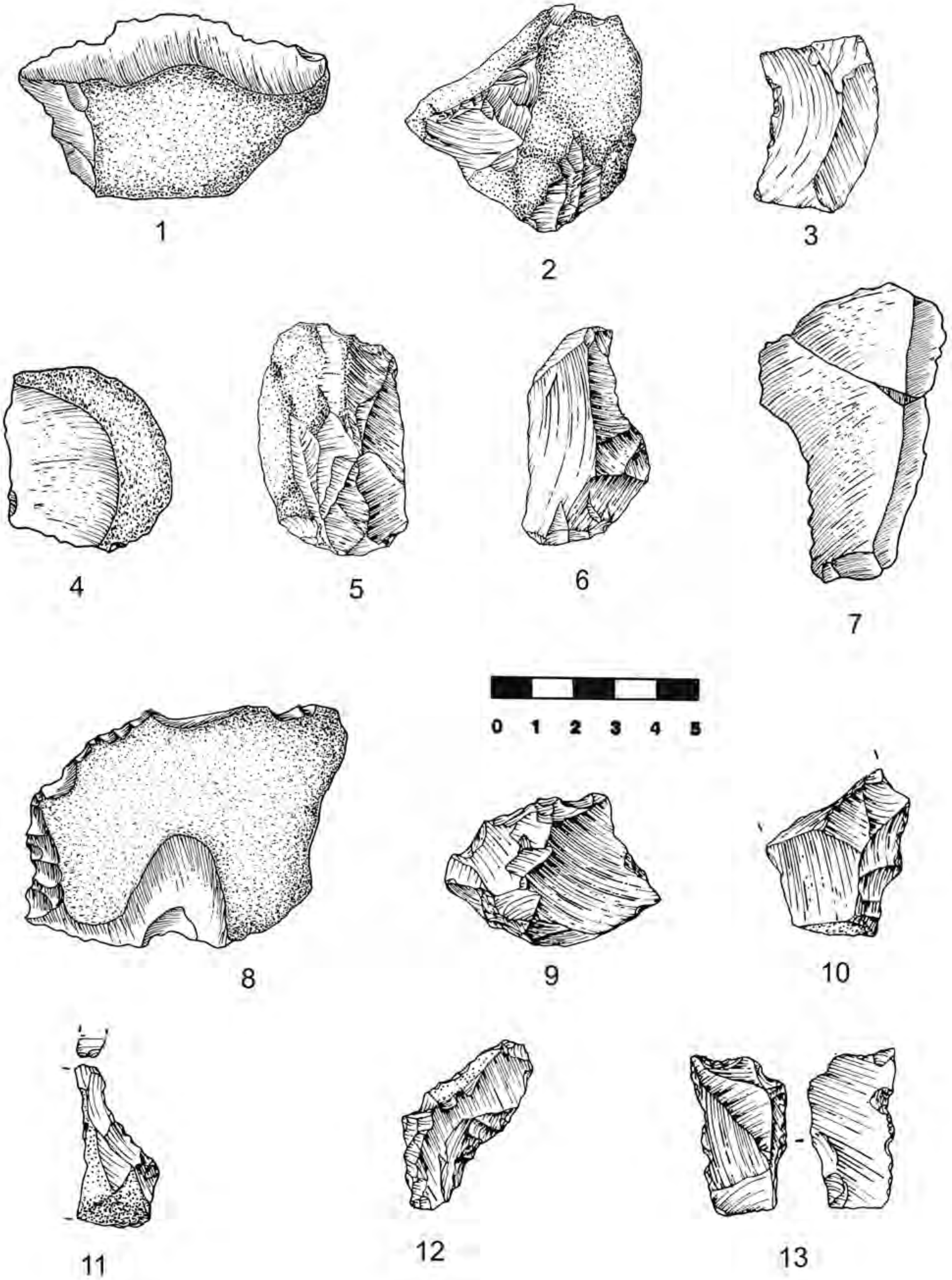


Figure 8. Whole flakes and retouched from Ain Hanech (1 to 5 and 7 to 10) and El-Kherba (6 and 11 to 13) sites (from Sahnouni's excavations).

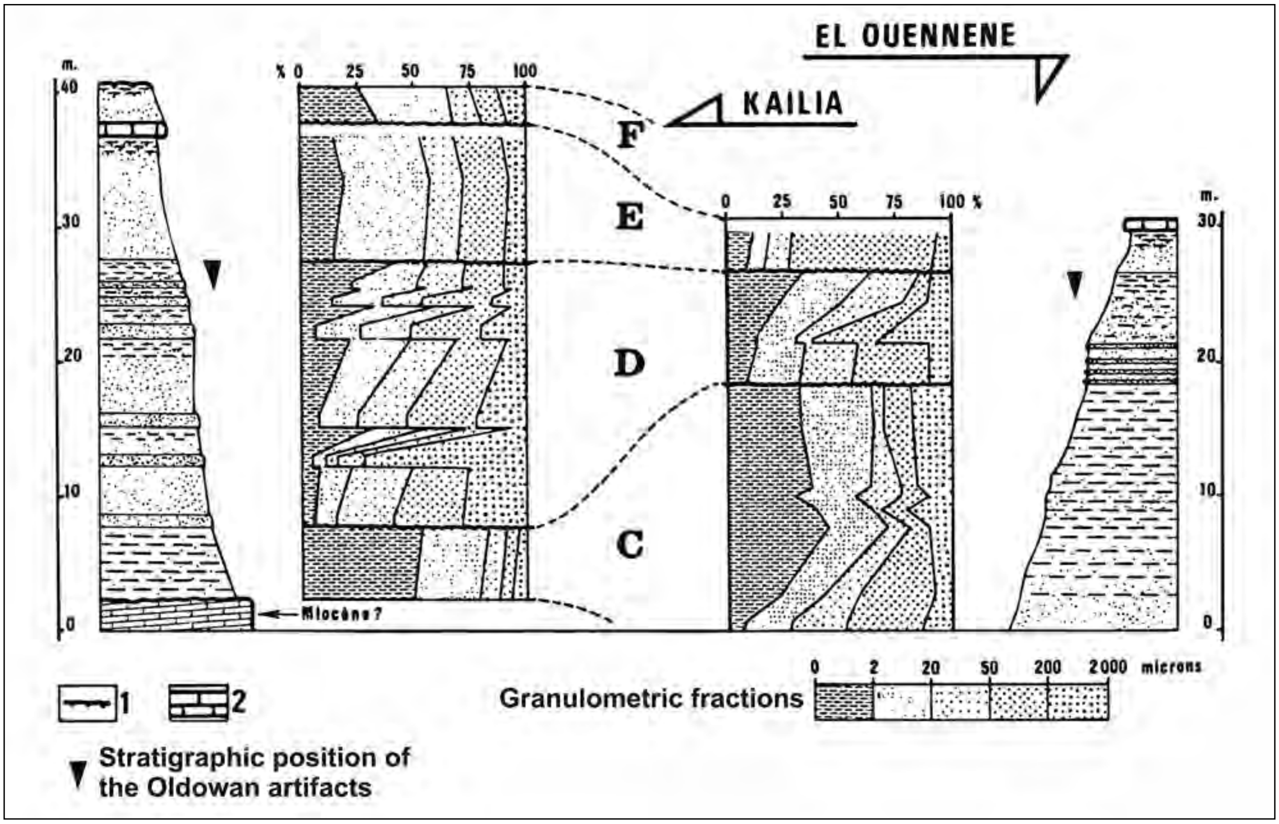


Figure 9. Stratigraphic section showing the in situ position of the Oldowan assemblages in Formation D found at Monts Tessala (western Algeria) modified after Thomas (1973).

idenced by the presence of meat polishes on their edges. The lithic artifacts from Ain Hanech and El-Kherba are very similar to those known from Olduvai upper Bed I and lower Bed II, especially in terms of flaking patterns and resultant artifacts forms.

Mansourah

Mansourah in the vicinity of Contantine yielded approximately 500 lithic artifacts most of which were collected *in situ* from three different stratigraphic layers; from top to bottom, red silts, silty sands with cobbles, and travertines (Laplace-Jauretche, 1956). The travertine deposit yielded Oldowan-like artifacts, consisting of fresh polyhedrons-cores made of quartzite and flakes made of quartzite and flint. A collection of 11 pieces made by R. P. Poyto and published by Camps (1964), also included bifacial choppers, polyhedrons, spheroids, bifaces, and tools on large flakes. However, Camps did not precise their stratigraphic provenience. Jolaud (cited in Laplace-Jauretche, 1956) and Arambourg (1970: 18) assigned the travertine deposits to the Upper Villafranchian (=Early Pleistocene). Nevertheless, Laplace-Jauretche (1956) did not report unambiguously the finding of large fauna associated with the Oldowan artifacts. Therefore, the remote antiquity of the Mansourah industry as proposed by Chaid et al. (2006) is doubtful. The silty sand deposit overlaying the travertines strata yielded typical Acheulean materials made primarily of quartzite and flint, including bifaces, trihedrons, polyhedrons, and large flakes.

Monts Tessala

The two archaeological localities of Douar Kailia and Douar El Ouennene in the Monts Tessala area of northwestern Algeria have yielded *in situ* Oldowan artifacts (Thomas, 1973). The localities are situated at the limits of the sub-coastal valleys and the southern Tell (Tessala and Oulad Ali Mounts) of the Oran region. Douar Kailia is located between the villages of Oued Tlelat and Taferaoui, and Douar El Ouennene is located to the North West of the town of Sig.

Stratigraphically, the artifacts were contained in a detritic deposit comprising sometimes heterometric gravels wrapped in a clear sandy or silty matrix (Formation D) (Figure 9). The deposit is sealed by a paleosol. Thomas (1973) correlated the deposit with the Moroccan Saletian stage, which is a pluvial cycle dated to the Lower Pleistocene.

The lithic assemblage (Figure 10) totaling 237 pieces include 48 artifacts recovered from Kailia and 187 from El Ouennene. The artifacts were fresh and made primarily of limestone (97%) and Jurassic or Cretaceous sandstone. The assemblages comprise unifacial and bifacial choppers (8.51%); polyhedrons and/or cores (14.04%); whole flakes (69.78%); retouched flakes (2.55%); and percussors and split cobbles (5.1%). Following Biberson's classification system, Thomas assigned the industry to the "Pebble Culture" stage III or IV.

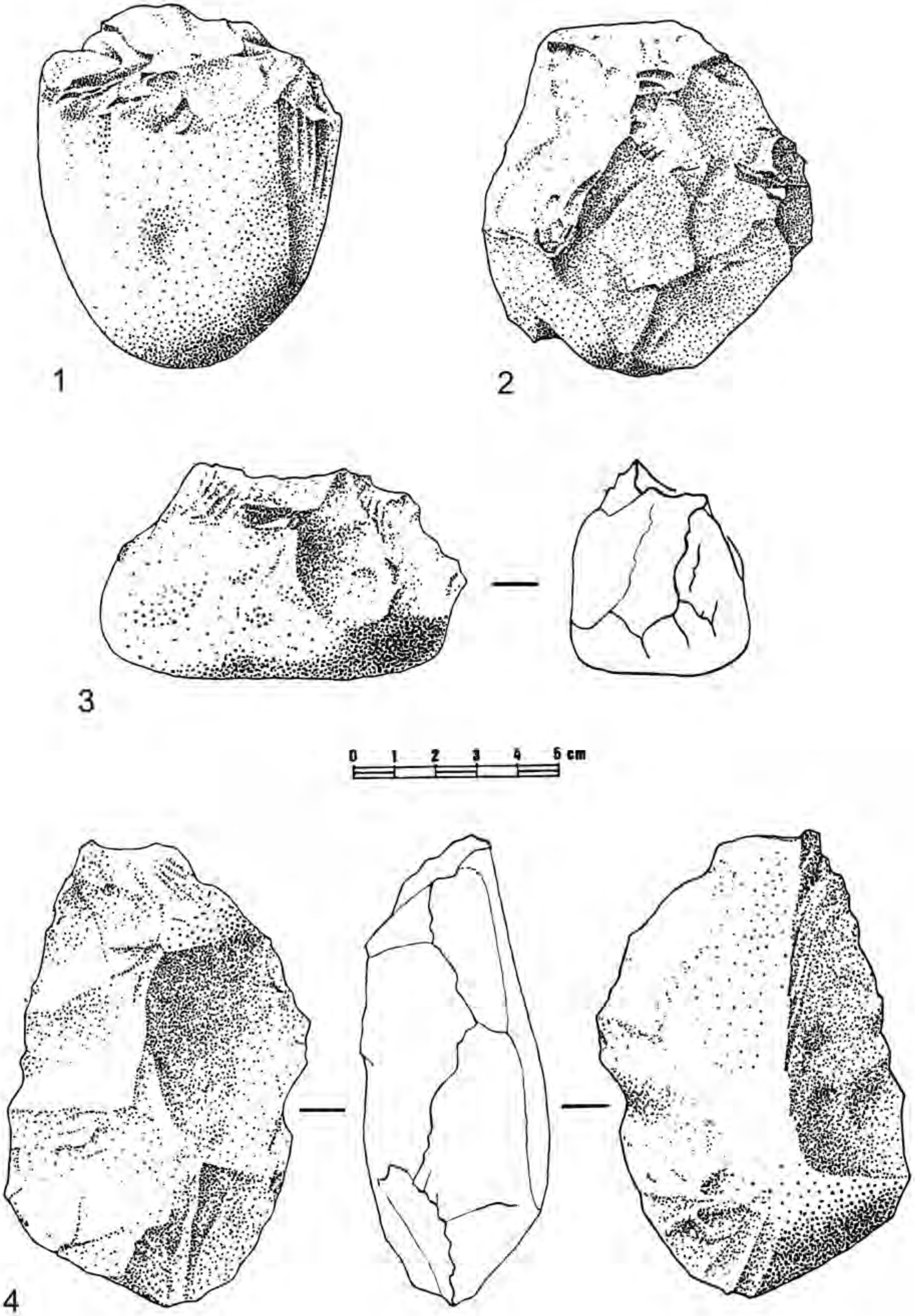


Figure 10. Examples of Oldowan artifacts from Monts Tessala (western Algeria) modified after Thomas (1973), including 1 and 3: bifacial choppers, 2: polyhedron, and 4 a proto-biface. Note that Monts Tessala assemblages might depict a transitional phase between the Oldowan and Acheulean in North Africa.

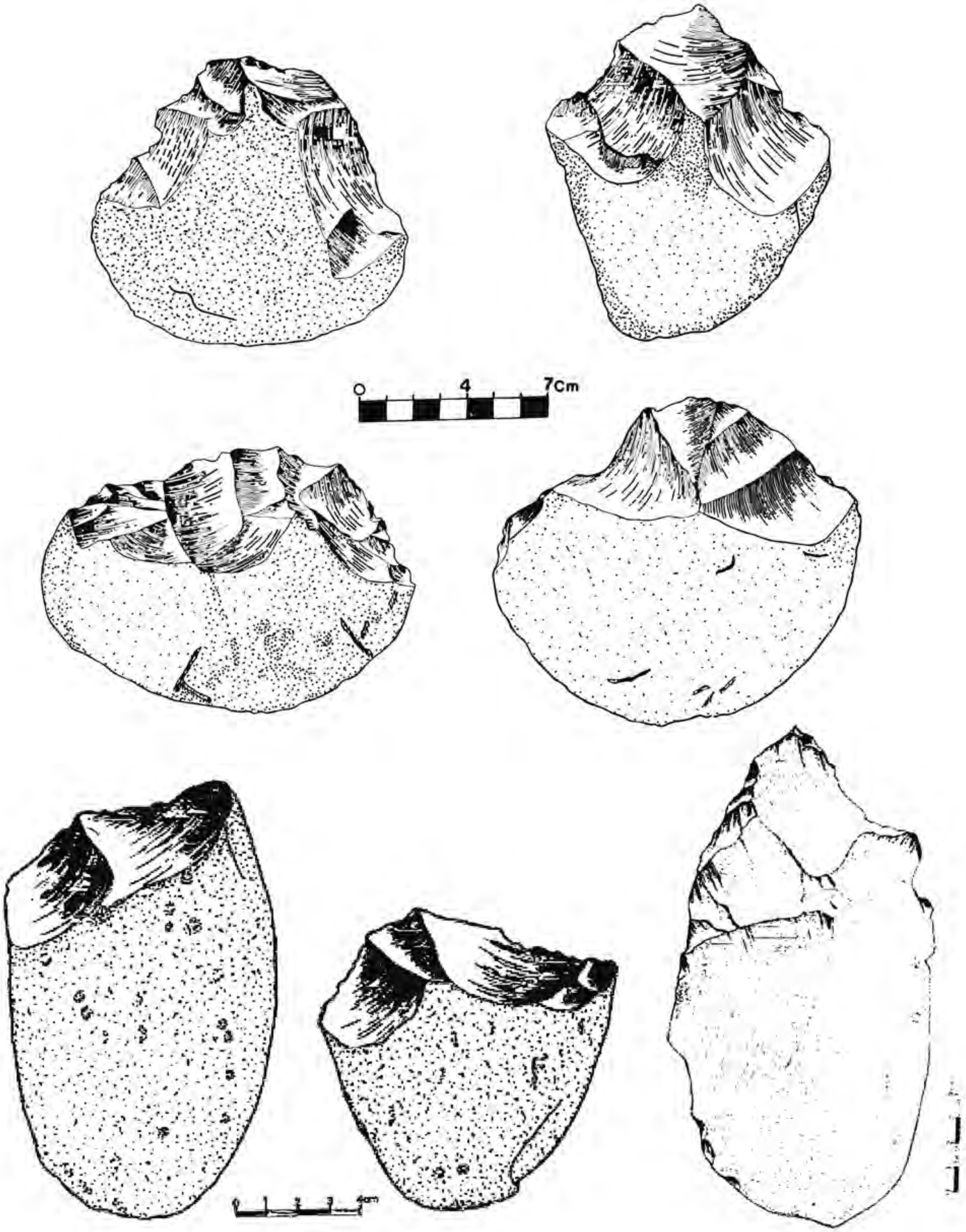


Figure 11. Example of Oldowan artifacts from the site of Bordj Tan Kena in northeastern Algerian Sahara modified after Heddouche (1980, 1981). Note that the assemblage might represent a transitional phase between Oldowan and Acheulean in the Sahara.

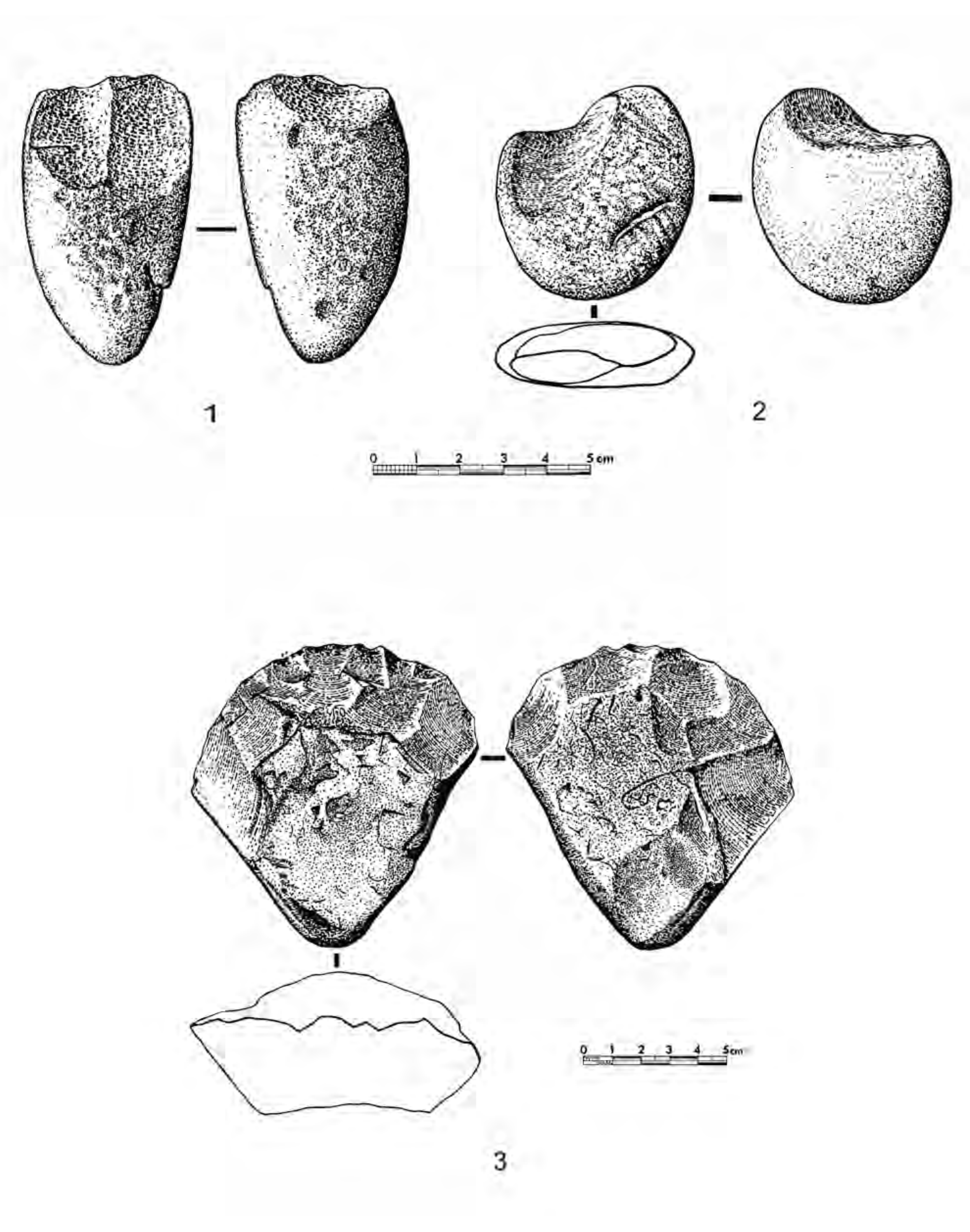


Figure 12. Example of Oldowan artifacts from the Sahara modified after Biberson (1967), including 1 and 2 choppers from Aoulef in the Algerian Central Sahara, and 3 a bifacial chopper from Mazzer in Algerian Northwestern Sahara.

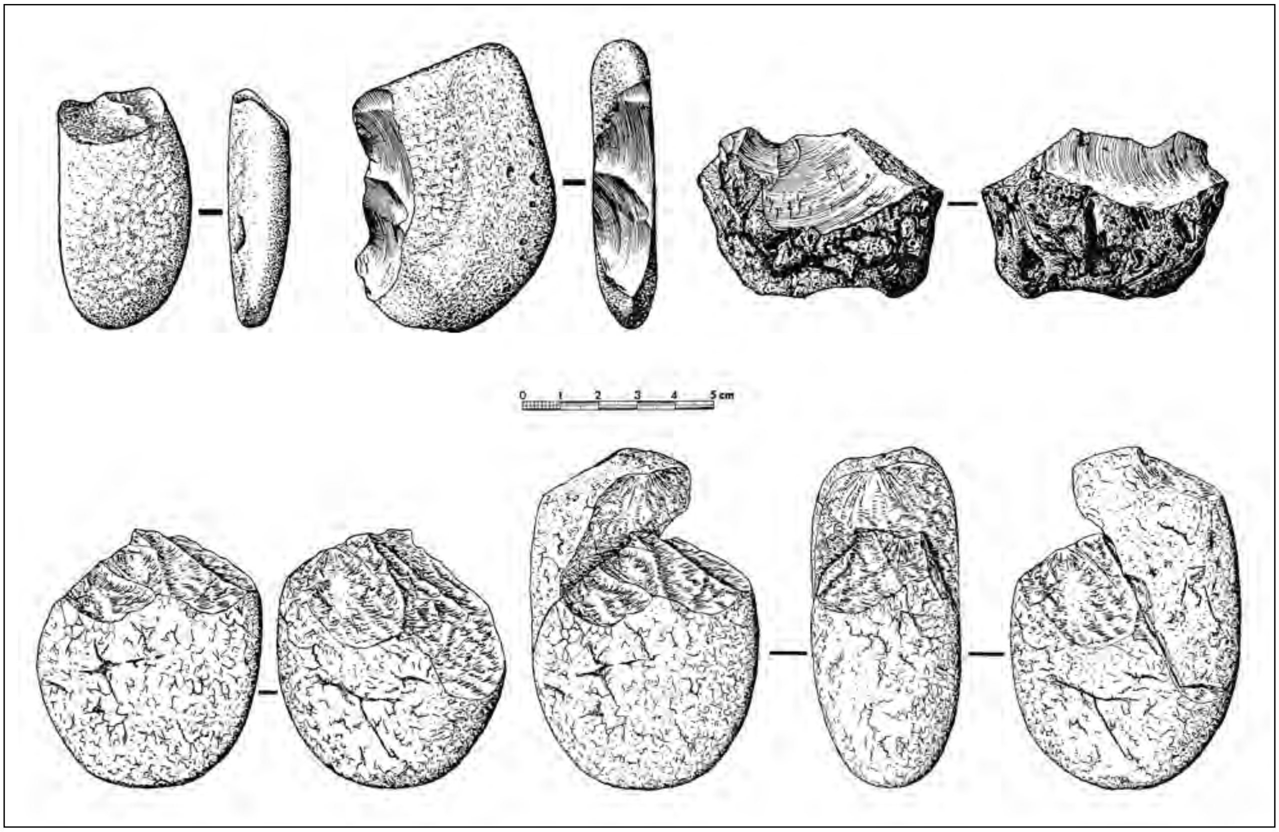


Figure 13. Unifacial and bifacial choppers from the site of Reggan in the Algerian Central Sahara modified after Ramendo (1963, 1964) and Biberson (1967). Note the nicely refitted flake with the chopper.

The Sahara

Oldowan-like artifacts have also been found in at least four localities in the vast Algerian Saharan landmass. These include Aoulef (Hugot, 1955) and Reggan (Ramendo, 1963) in the Central Sahara; Saoura (Alimen & Chavaillon, 1962) in the Northwestern Sahara; and Bordj Tan Kena (Heddouche, 1980, 1981) in the Northeastern Sahara. While the specimens from Aoulef and Reggan are surface collections, those from the Saoura region and Bordj Tan Kena were excavated *in situ.* At this latter site (9° 20 E, 26° 32 N) Heddouche (1980, 1981) has excavated 154 "pebbles tools" (Figure 11) from a Glacis type deposit (Glacis 4). However, not a single flake was reported associated with the flaked cobbles, which raises the issue of site integrity. The assemblage incorporates unifacial and bifacial choppers, discoids, bifaces, and a trihedral pick made of quartzite. Because of the abundance of bifacial choppers, Heddouche assigned the industry to the later stages of the Evolved Pre-Acheulean of Biberson's classification system.

The Aoulef and Reggan collections comprise 90 and 321 specimens, respectively. The artifacts include a range of types: unifacially, bifacially, multifacially flaked pebbles, discoids, and whole flakes made of variable raw materials (quartz, quartzite, sandstone, flint, fossil wood, and eruptive rocks) (Figure 12). Interestingly, the surface collection from Reggan includes a flake that refits nicely with a bifacially-flaked chopper made of quartz (Ramendo, 1964) (Figure 13). If the flake was not removed as a result of post depositional processes, these conjoined pieces suggest that the assemblage may have not been heavily disturbed by natural agencies.

In the Saoura region, Alimen and Chavaillon (1962) collected 110 "pebble tools" *in situ* from several localities contained in alluvial and lacustrine deposits correlated to the Mazzerian depositional cycle (=Early Pleistocene). Made primarily of quartzite and quartz; the "pebble tools" included split pebbles, and unifacial and bifacial choppers with an alternate flaking reduction (Figure 12 [3]). Sediment and pollen analyses indicate that the climate was fairly humid during the Mazzerian episode (Alimen, 1981).

Atlantic Moroccan sites

Large quarries on the Moroccan Atlantic coast, exploited for building materials, have exposed a series of marine deposits interbedded with terrestrial sediments. A series of sites located in the vicinity of the town of Casablanca have been investigated by Biberson (1961a). These sites include Arbaoua, Oued Mda, Douar Doum, Terguiet el-Rahla, Carriere Deprez, Sheneider Quarry (lower and upper), Chellah, Souk Arba-Rhab, and Sidi Abderrahman (niveau G).

Mode I assemblages recovered from these localities allowed Biberson (1961b) to construct a typological chronological sequence showing the evolution of the Pre-Acheulean industry through time. He divided the

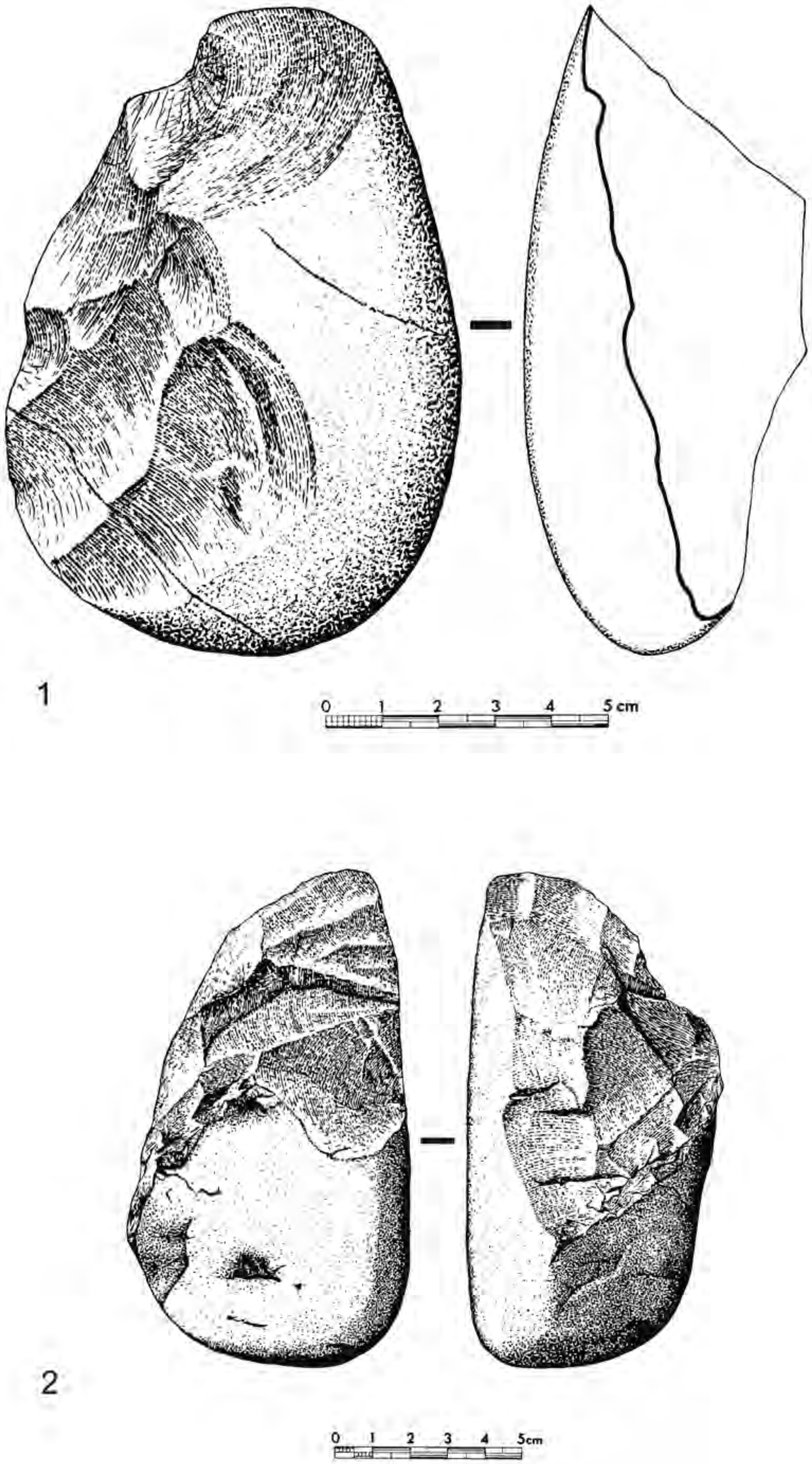


Figure 14. Oldowan artifacts from the site of Targuiet el-Rahla in Morocco modified after Biberson (1967).

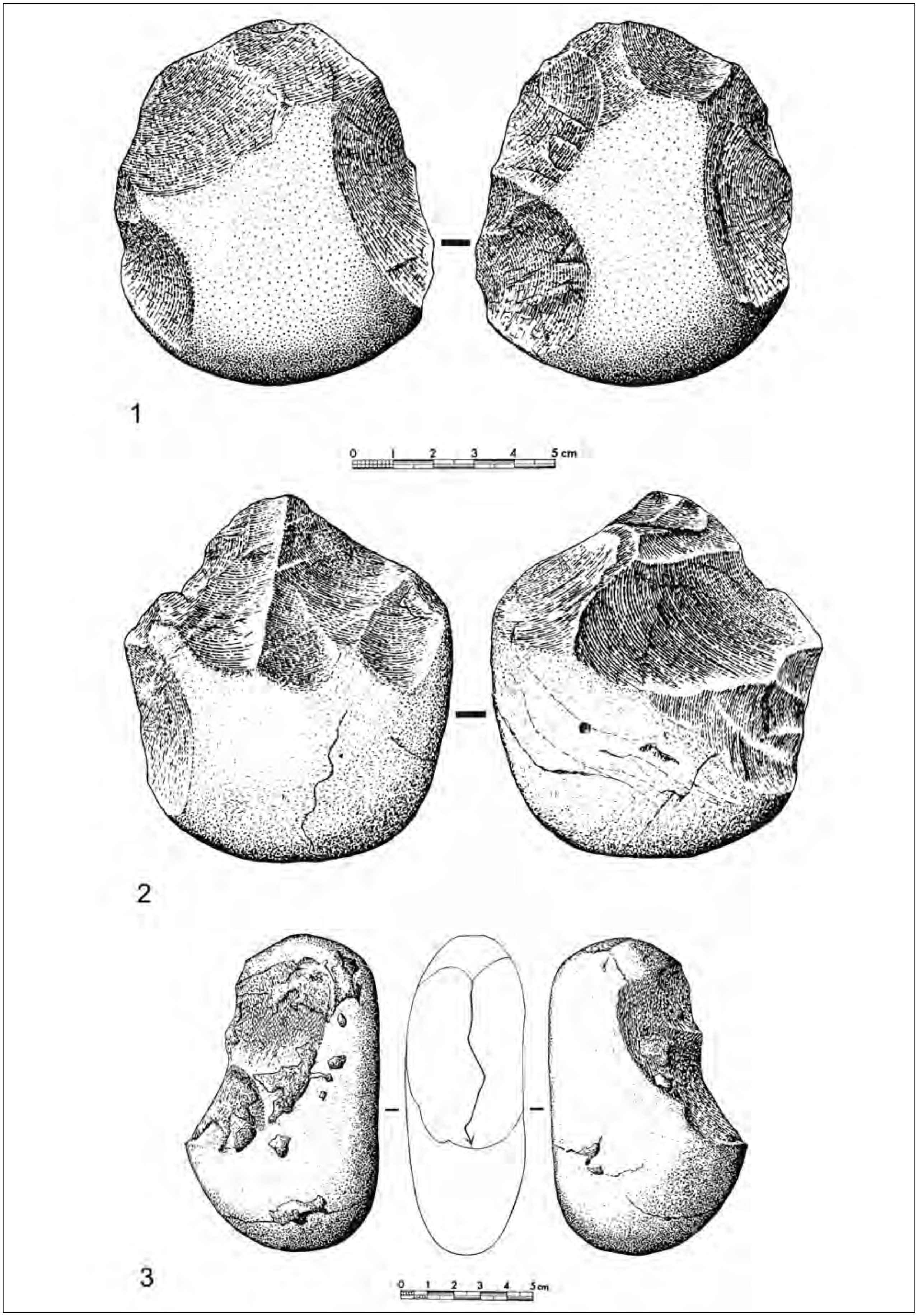


Figure 15. Bifacial choppers from the site of Souk Arba-Rhab modified after Biberson 1967.

Pre-Acheulean (previously labeled as “Pebble-Culture”) into four successive stages. Stage I includes the oldest artifacts from simple technological gestures (unidirectional). This stage is illustrated by the site of Targuiet-el-Rahla (Figure 14). Stage II incorporates “pebble tools” characterized by bi-directional flaking. The site of Carriere Deprez in Casablanca (presently Ahl Al Oughlam) represents this stage. In stage III the multidirectional technique appeared where the artifacts are considered to be more evolved. This stage is represented by the site of Souk-el-Arba du Rhab (Figure 15). The last stage (IV) is represented by level G of the Sidi Abderrahman sequence, and is characterized by the emergence of the first Acheulean elements. Stages I and II constitute the Ancient Pre-Acheulean while stages III and IV Evolved Pre-Acheulean forms (Biberson, 1976).

Recently, researchers revised Biberson’s stratigraphic sequence casting doubts on the antiquity of his “Pebble Culture” (Raynal & Texier, 1989; Raynal et al., 2004). The researchers claim that assemblages of “Pebble Culture” Stage I are either surface finds or reworked materials. Artifacts assigned to the “Pebble Culture” stage II were recovered from high energy deposits. Materials of the “Pebble Culture” Stage III are from polycyclic colluviums. “Pebble Culture” Stage IV is reclassified as Acheulean by these researchers instead of the “Pebble Culture” tradition as defined by Biberson. In addition, new investigations at the site of Ahl Al Oughlam in Casablanca (Morocco) indicate that the assemblages assigned to “Pebble Culture” Stage II by Biberson appear to be pseudo-artifacts generated by high energy deposits (Raynal et al., 1990). The authors concluded that the earliest human occupation in Morocco is estimated to a maximum of 1 Ma (Raynal et al., 1989, 2002a-b).

CONCLUSIONS

This article examined the Oldowan in North Africa within a biochronological framework. Despite the fact that North Africa is well underexplored relative to East Africa, there is a fairly good record of Oldowan in this region. The record consists mainly of stone assemblages found in stratigraphic contexts but it usually lacks associated fauna except for the sites of Ain Hanech and El-Kherba in Algeria. The fauna is crucial for dating North Africa earliest archaeological sites in the absence of suitable dateable materials where, unlike East Africa, there are no volcanic rocks to provide sound radiometric ages. Uranium-series and OSL dating are applicable only to the sequence around the end of the Lower Paleolithic. As it was applied to the dating of the South African cave sites, East African well dated fossil records can help dating the North African Plio-Pleistocene localities with similar taxa or their close relatives but devoid of radiometric ages. Indeed, the comparative biostratigraphical study of large fossil mammals permitted to date the North African Plio-Pleistocene faunas. The faunas range successively from approximately 2.5 Ma or older to 1.0 Ma. Ain Boucherit, situated stratigraphically below Ain Hanech, has a fauna that dates to between 2.3 Ma and 1.95 Ma. Ain Hanech and El-Kherba faunas, the only ones clearly associated with Oldowan stone artifacts, date to 1.9-1.8 Ma. This age is corroborated by the presence of three taxa biostratigraphically pertinent, including the proboscidean *Anancus*, the suid *Kolpochoerus*, and the “*Dicerorhinus*” like rhino, and by the paleomagnetic normal polarity dated to the Olduvai subchron. Tighenif and Thomas Quarry Level L, with Acheulean assemblages, are contemporaneous dating to around 1.0 Ma.

So far, the most secure data on the earliest hominin occupation in North Africa are provided by the sites of Ain Hanech and El-Kherba. The Ain Hanech and El-Kherba archaeological evidence shows that the human presence in this part of the African continent dates back to 1.8 Ma, and the earliest artifact tradition was the Oldowan, (Sahnouni, 2005; Sahnouni & de Heinzelin, 1998; Sahnouni et al., 2002, 2004) *sensu stricto* East African Oldowan (e.g., Leakey, 1971, Semaw et al., 1997). This long chronology model for an early human occupation in North Africa fits relatively well in the generally accepted scenario regarding hominin dispersal into the northern hemisphere. The current evidence indicates that early hominins colonized the Eurasian landmass by 1.8 Ma. Indeed, the oldest presence of hominins out of Africa is documented in the Caucasus at the site of Dmanisi in the Republic of Georgia. Dmanisi is dated to 1.8 Ma, and has yielded several hominin fossils associated with an Early Pleistocene fauna and Oldowan-like artifacts (Gabunia & Vekua, 1995; Gabunia et al., 2000, 2001; Lumley et al., 2005). Mode I artifacts from Majuangou (Nihewan basin, China) are dated to 1.6 Ma (Zhu et al., 2004). Earliest hominins in Indonesia are dated to 1.81 Ma (Swisher et al., 1994), although their chronological placement is still being debated (Klein, 1999: 272). There is now evidence showing that Oldowan-like artifacts older than 1 Ma have been found in southern Europe, and this new evidence is pushing back the dates for human presence a bit earlier than previously known. The new European archaeological sites with earlier dates include: 1) Pirro Nord site in Italy (with an assumed age of 1.3 Ma) (Arzarello et al., 2007), 2) Barranco Leon (1.3 Ma) (Toro-Moyano et al., 2003) and Fuenta Nueva 3 (1.2 Ma) (Turq et al., 1996) at Orce (Guadiz-Baza basin, Southern Spain), 3) Le Valonnet cave near Nice (Southern France) dated to Jaramillo Normal subchron (0.99-1.07 Ma) (Lumley et al., 1988), 4) Ca’Belvedere di Monte Poggiolo in Italy dated to 0.9 Ma (Peretto et al., 1999), and 5) Atapuerca near Burgos in Spain, with archaeological materials dated to 0.8 Ma (Carbonell et al., 1995).

The other major problem is the lack of contextual information, making the occurrences unsuitable for inferring Oldowan hominin behavior. In fact, most of the Oldowan sites have been discovered and studied without systematic archaeological survey and excavations. The sites have been located either casually or coincidentally in the course of urban development. A few of the sites, encountered following geological or paleontological expeditions, have been investigated without a real archaeological perspective or appreciation. As a result, most of the materials have been casually collected, with mostly the "pebbles tools" being systematically selected and examined. These selected artifacts constituted the basis for a proliferation of typological and classificatory systems, where mostly each lithic assemblage has its specific type-list (Alimen & Chavaillon, 1962; Biberson, 1967; Heddouche, 1981; Hugot, 1955; Ramendo, 1963). In addition, the lithic artifacts encountered are abraded to varying degrees, making them of doubtful authenticity. They were often collected from the surface or from high energy deposits as shown by Raynal and Texier (1989) in the case of Atlantic Morocco.

For a long period of time the earliest North African sites were viewed to be in secondary context, which largely eliminates the possibility to identify early hominin behavioral patterns (Clark, 1992). Recent research indicates that this major difficulty was not due to the absence of sites in primary context, but rather it was primarily because much of the emphasis by Palaeolithic researchers until the 1960s was on culture-history and to little systematic investigations have been undertaken to shed light on behavioral patterns. However, this is changing gradually with modern investigations on key localities being more systematic since the late 1980s-1990s. Where major systematic investigations took place in North Africa includes our investigations of the Oldowan site of Ain Hanech. These sites were investigated in primary context with fresh artifacts and well-preserved fauna, and have yielded relevant behavioral information for a better understanding of early hominin adaptation in northern Africa. For example, the Oldowan site of Ain Hanech can be viewed as a spot for short-term occupations by early hominins near a shallow river embankment, where raw materials were accessible from nearby river beds, and plenty of game for acquiring meat. The technology used by Ain Hanech hominins is simple (Mode I Technology), expedient, and characterized by a low degree of standardization. There is no evidence for long distance raw material transport. The industry is primarily composed of core-tools/choppers, flakes, fragments, and occasional retouched pieces that are the main characteristics of early stone artifact assemblages assigned to the Oldowan. Bones belonging to different animal taxa such as equids, large and small bovids, hippo, and elephant were recovered in association with the lithic artifacts. One taxon, i.e. Equidae, appears to dominate the faunal assemblages. Whole flakes and retouched pieces were used to process soft animal tissue, suggesting that meat was a major component of early hominin diet in North Africa. An in depth study is underway for documenting subsistence patterns, the strategy employed for meat acquisition, and breaking bones for marrow.

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