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Jean-Jacques Hublin

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JEAN-JACQUES HUBLIN

Department of Anthropology, University of California, Berkeley, California 94720, U.S.A. and CNRS, Chaire de Paléoanthropologie du Collège de France, Museum National d'Histoire Naturelle, Paris, France

SUMMARY

The first modern humans in the Maghreb are said to be associated with the Aterian industries which appeared at least 40 ka BP in the northwest. Their predecessors are mainly represented by the Jebel Irhoud (Morocco) specimens. Palaeontological evidence, as well as electron spin resonance (ESR) dating, suggests that this series is older than previously published, and should belong to oxygen isotope stage 5 or even 6. There is no evidence of any Neanderthal apomorphy in this group which can no longer be considered as 'African Nanderthals'. Clear synapomorphies with modern man combined with some plesiomorphic retentions indicate a slightly more primitive (and older?) grade than the Qafzeh–Skhul sample in southwestern Asia. The Northwestern evidence demonstrates that the mediterranean sea was a major biological barrier during the upper Middle and lower Upper Pleistocene and that the rise of anatomically modern features cannot be restricted to a sub-Saharan of eastern African area.

Fossil hominids associated with the Aterian industries in Morocco are usually considered the oldest anatomically modern humans in the Maghreb. The first discovery of human remains related to this industry was made by C. S. Coon in 1939 at Mugharet el Aliya (Tangier). It consists of an isolated and heavily worn left upper second molar and a fragment of a juvenile left maxilla bearing two unerupted premolars and the unerupted canine. These very fragmentary remains were compared with Neanderthals and the juvenile maxilla was said to lack a canine fossa (Senyurek 1940), although a clear *incurvatio inframalaris frontalis* is observed on the specimen. Two other teeth discovered in 1947 remain undescribed. Later the Temara mandible, a more complete specimen, was discovered by J. Roche in 1959 near Rabat and initially attributed to the Acheulean. However, its taxonomic attribution remained unclear and it was described by Vallois & Roche (1958) as bearing 'un ensemble de caractères dont certains rappellent les Néanderthaliens, quelques' uns sont plus avancés, un plus grand nombre est nettement plus primitif'. New excavations at the site have recently demonstrated that the Temara mandible belonged to the Upper Aterian levels of the site (Roche & Texier 1976). In 1975 an Upper Aterian level at the same site yielded a rear skull (*squama occipitalis* with part of the parietals) and a piece of the left supraorbital part of the frontal from the same individual. The same year more complete remains were discovered in the Dar-es-Soltane II cave. They were unearthed on top of a marine sand layer below a fallen sand stone block overlaid by Aterian levels. At least three individuals are represented by a partial skull including part of the upper face and an associated hemimandible (Dar-es-Soltane 5), an adolescent mandible lacking its ramus and a juvenile calvaria (Debenath 1975; Ferembach 1976*b*; Debenath *et al.* 1982, 1986). Finally the Zouhra cave (El Harhoura) yielded a mandible in 1977 and a canine in 1978, associated in an 'Aterian with Moroccan points' level (Debenath *et al.* 1982).

The Temara and Dar-es-Soltane II cranial remains were briefly described by Ferembach (1976*a*,*b*) who emphasized the modern status of the Aterian people. Debenath (1991) also provides an illustration of Dar-es-Soltane 5. In Temara the morphology, and the metrical features of the occipital do not show any significant difference from modern series such as those from Afalou or Taforalt. The frontal fragment does not display a supraorbital torus but a flattened *trigonum supraorbitale* (pattern B of Cunningham (1908)). Dar-es-Soltane 5 is a very robust specimen assigned to a mature male individual. The dimensions are large, especially the tranversal ones. Facially the bizygomatic, bijugal, interorbital, orbital and nasal breadths are very large, whereas upper facial height remains moderate, and the orbits and nasal cavities are low. The vault is high (bregma above the biporion axis) but still has wide proportions. One of the most distinctive features of the specimen is the development of the supraorbital relief. The glabella projects, overhanging a deep infraglabellar depression. The *arcus superciliaris* is protuding but well differentiated from the glabella and from the lateral part of the supraorbital area, which is less voluminous and forms a thick *tigonum supraorbitale*. The orbits are voluminous, deep and rectangular. Their axes slightly slope laterally. The nasal opening is pyriform with a sharp inferior border. The face is flattened with the lateral part of the maxilla in a coronal orientation forming a clear angulation with the zygomatic. In *norma lateralis* it is orthognatic with a moderate alveolar prognathism.

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The temporal squama is rather small and elongated. In *norma basiliaris*, the axes of the tympanic and the petrosal parts of the temporal have the same orientation. The mastoid process is robust and projecting with a marked mastoid crest. The mandible is also very robust. The corpus is thick with great depth anteriorly which decreases markedly posteriorly. The mental foramen is located at mid-height of the corpus, below P4. The ramus is wide and high. None of the mandibular or cranial features observed in Dar-es-Soltane 5 exclude it from modern variation. The Aterian people always display a very robust masticatory apparatus and a pronounced megadonty. These features could explain why the first discoveries (Tangier and Temara), which were represented by mandibular material, were considered as more primitive than they actually are.

The dating of the Aterian in Morocco was reviewed in 1986 by Debenath *et al*. The oldest dated levels seem, unfortunately, beyond the reach of the ^{14}C method. In Temara three dates greater than 40 ka BP, from levels 23 to 19 (Gif 2279, Gif 2588 and Gif 2589), are not considered by Debenath *et al.* (1986), who retain Gif 2277 > $34\,550 \pm ^{3200}_{2280}$ years BP in level 19 as the *terminus ante quem* of the Moroccan Aterian. Nevertheless, a thermoluminescence (TL) dating BOR56: 41 160 + 3500 years was obtained in the Aterian Level 1 of El Haroura, whereas in this site as well as in Dar-es-Soltane only the upper Aterian seems represented (Debenath *et al.* 1986). These authors, as well as Texier *et al.* (1988), place the chronology of the Aterian industries in northwestern Africa between 40 and 20 ka BP, with a late development toward the South, in North Chad and Niger (Tillet 1983), while the occurence of a hiatus between the Aterian and Iberomaurusian has been argued (Roche 1976).

The question of dating the very first Aterian in North Africa is closely connected with the problem of defining the relationship between this industry and the Mousterian. In Morocco the two 'cultures' seem to evolve one from the other without any discontinuity. The superposition of the two industries was described in the Grotte des Pigeons at Taforalt (Roche 1952). It occurs also at Temara (Debenath *et al.* 1986) and at Rhafas (near Oujda) (Wengler 1986). In both sites a typological transition is observed. At Rhafas, the first genuine Aterian level, with a high percentage of tanged artifacts, still belongs to the 'Lower Soltanian' which is imprecisely identified with the 'Lower Wurm' in the local chronostratigraphy. It overlays a 'proto-Aterian' and a 'final Mousterian'. All the series show a regular technological evolution with an expansion of tanged artifacts and end-scrapers, while side-scrapers decrease. In eastern Morocco, Wengler (1990) observed the same strategy in raw materials exploitation and debitage techniques in both Mousterian and Aterian and subscribed to their 'cultural likeness'.

To the East the situation is more confused. Wendorf *et al.* (1990) assert the Aterian is significantly older than usually accepted, claiming that the only acceptable ^{14}C dates for the Aterian are the infinite or the oldest ones, such as the age near 47 ka BP obtained for one level in Haua Fteah (McBurney 1967), although the Aterian nature of this level might be contested (Debenath *et al.* 1986). Furthermore, according to Wendorf *et al.* (1990), the Mousterian and Aterian may not even be chonologically separated. The antiquity of the Aterian in Algeria may be supported by its occurrence in beach deposits of the last interglacial (Roubet 1969). In El Guettar (Tunisia), a 'typical Aterian tanged point' was discovered in the lowest part of the Mousterian sequence, within an artificial cairn (Gruet 1954). In Egypt, the dating provided for the Bir Tarfawi depression deposits stretches from 160 to 70 ka ago (Wendorf *et al.* 1990). These authors initially assigned most of the excavated sites of this area to a 'Denticulate Aterian' while none of them yielded any tanged pieces in a stratigraphic context. But finally, except for the oldest ones which are considered as 'Mousterian', they assigned the Bir Tarfawi sites to a 'Middle Palaeolithic with denticulates and bifacial foliate points'. However, while in northwestern Africa the later Aterian/Iberomaurusian succession appears to be a clear cut replacement (Roche 1976), perhaps related to a major environmental deterioration (Texier *et al.* 1988), the Mousterian and Aterian succession should, in contrast, be considered as an evolutionary process.

The only North African site which has yielded a rather complete set of Mousterian human remains is the Jebel Irhoud cave, 55 km southeast of Safi (Morocco). The site belongs to the upper part of a karstic network filled with Pliocene and Pleistocene deposits. It was opened in 1960 during the exploitation of a barytine mine. The incidental discovery of a cranium (Irhoud 1) occurred in 1961. Then, an excavation undertaken by E. Ennouchi yielded an adult calvaria (Irhoud 2) at the bottom of the sequence ('ashy level C' of Ennouchi (1963)). In 1968 a juvenile mandible (Irhoud 3) was unearthed 0.6 m lower than Irhoud 2 (Ennouchi 1969). During an excavation by J. Tixier and de Bayles des Hermens in 1969, a juvenile humeral diaphysis (Irhoud 4) was discovered in the lowermost part of the archaeological depositis in level 18 (Hublin *et al.* 1987). The industry studied by Tixier (Hublin *et al.* 1987) is mainly made with flint (54%) or local quartzite (36%). It is characterized by the use of the Levallois technique ('lineal' or 'reccurent') for a quarter of the tools and by 'facettage'. The artifacts are made on flakes without evidence of Quina retouch and very little bifacial rework. Side scrapers are predominant. Unretouched Lavallois tools, notches and denticulates are numerous. The absence of end-scrapers and tanged artifacts is notable.

Biberson (1964) set the Irhoud cave filling near the Presoltanian/Soltanian boundary, i.e. close to oxygen isotope stage 5e. In this view Irhoud would be older than the 'classical' Neanderthals of western Europe. Nevertheless, the contemporaneity of the two groups has been accepted by most palaeoanthropologists (see, for example, Wolpoff (1980); Debenath *et al.* (1982); Bräuer (1984)). This opinion was partly based on the supposed age of all the Mousterian industries and on a ^{14}C dating (greater than 30 ka BP) published by Ennouchi (1966). Actually the date was beyond the reach of the method. To obtain a more accurate age

Table 1. *Some measurements of Irhoud 1 and 2 discussed in the text, compared with the means and standard deviations observed in European Neanderthals and in the Skhul–Qafzeh group*

(The abbreviations of the measurements are after Martin (1928) or Howells (1973). When the number of individuals measured is below 4, only the range of variation is given).

measurements		Irhoud 1	Irhoud 2	Skhul–Qafzeh	European Neanderthals
maximum length (g-op)	M 1	196.5	194.0 ?	201.0 ± 8.4	203.5 ± 4.4
maximum breadth	M 8	149.5	161.0 ?	144.4 ± 2.7	149.7 ± 6.5
minimum frontal breadth	M 9	105.8	117.0	102.4 ± 4.9	106.8 ± 2.9
maximum frontal breadth	M 10	120.0	131.0 ?	119.4 ± 4.2	120.3 ± 6.8
frontal angle of Schwalbe	M 32a	78.0	84.5	81.6 ± 6.2	65.6 ± 4.4
bregma-glabella-inion angle	M 32(2)	54.3	55.0	56.0 ± 3.4	47.9 ± 2.2
frontal convexity angle	FRA	133.0	131.0	130.5–135	140.9 ± 4.1
parietal sagittal arc (b-l)	M 27	122.0	121.0 ?	132.5 ± 10.3	115.6 ± 5.9
parietal convexity angle	PAA	150.0	145.5	136.6 ± 1.7	139.3 ± 6.2
upper facial height	M 48	76.0	—	72–79	86–92
zygomaticomaxillary angle	SSA	125.0	—	124–133	110.6 ± 4.3
AVR-ZMR		16.5	—	3.0–21	22.1 ± 3.0
nasal height	M 55	52.5	—	53.8 ± 1.3	61–66

for this site, I provided R. Grün (then at McMaster University in Canada) with three horse teeth and a block of matrix from the Tixier excavation. Five electron spin resonance (ESR) dates were obtained and recently published by Grün & Stringer (1991). EU age estimates range between 90 and 125 ka and LU estimates between 105 and 190 ka. These authors conclude that the site had a long depositional history covering at least oxygen isotope stages 5 and 6 and favour an age within stage 6 (130–190 ka) for the hominids, assuming that they were low in the stratigraphic sequence. Nevertheless, the sediment sample from which the external dose rate was derived does not seem to be representative of the environment of the three teeth, and the close stratigraphic origin of these samples, in the bottom of the stratigraphic sequence, seems inconsistent with the very wide range of ages determined. The fauna yielded by the Tixier excavation was studied by Thomas (1981), and more recently Amani (1991) studied the collections kept in the Faculté des Sciences in Rabat. The faunal association evokes a landscape varying from steppe to desert. The lack of some immigrant species (*Sus*, Cervids) indicates that the deposits predate the major faunal changes affecting the Soltanian, but the accurate age of these changes remains uncertain. According to Jaeger (personal communication) the microfauna is more likely to be 'Ouljian' (i.e. belonging to stage 5 according to this author). Interestingly in the faunal list established by Amani (1991) one finds *Gerbillus grandis*, a species which was described in the Thomas Quarry (Tong 1989) and an Alcelaphinae bearing a primitive dentition (*Rabaticeras*?). These two elements give the fauna a more archaic character than the fauna of Soltanian sites such as Doukala (Morocco). The palaeontological evidence would then support the ESR ages predating stage 4 obtained by Grün.

The Irhoud specimens have been repeatedly allocated to the Neanderthals or designated as bearing Neanderthal features (e.g. Ennouchi 1963, 1969; Howell, 1978; Brauer 1984). This interpretation has been contested by Ferembach (1972), Howells (1974, 1975), Stringer (1974, 1978); Hublin (1978*a*, 1991), Santa-Luca (1978), Hublin & Tillier (1981) and Hublin *et al.* (1987). Detailed descriptions of Irhoud 3 and 4 were published (Hublin & Tillier 1981; Hublin *et al.* 1987) while the most complete specimens, Irhoud 1 and 2, have been only recently described in detail (Hublin 1991). The main measurements of the Irhoud skull are displayed in table 1.

The Irhoud 3 mandible belonged to an individual about 8-years-old. It is more robust than a present day mandible of an individual of the same age, with some primitive aspects on the posterior side of the symphysis which bears a *planum alveolare* and a *fossa genioglossa*. However, it does not display any clear Neanderthal apomorphy. The anterior teeth are not in alignment. The condyle is not expanded laterally. It can be extrapolated that the retromolar space would have been reduced in the adult. In contrast, modern traits such as the small size of the condyle, the decreasing depth of the corpus posteriorly, the orientation of the digastric fossae, and the association of the four components of a bony chin (*tuber symphyseos*, *tuber lateralia*, *fossae mentales* and *incurvatio mandibulae*) are observed. One of the most striking features is the size of the teeth, especially the cheek teeth (Hublin & Tillier 1981). This macrodonty associated with a modern-like chin area and with the persistence of some archaic features on the posterior side of the symphysis evokes the conditions observed in the Skhul–Qafzeh series from the Middle East.

The Irhoud 4 humeral diaphysis is flattened mediolaterally. The lateral supracondylar crest is projecting and the distal epiphysis would have been wide. The deltoid tuberosity is positioned high on the humerus and is frontally oriented. The cresting in the deltoid area forms a very narrow V. The *facies anterior medialis* is flattened and the lateral side of the shaft does not display a *sulcus nervi radialis* but a faint convexity. The cortical part of the bone is thickened relative to the

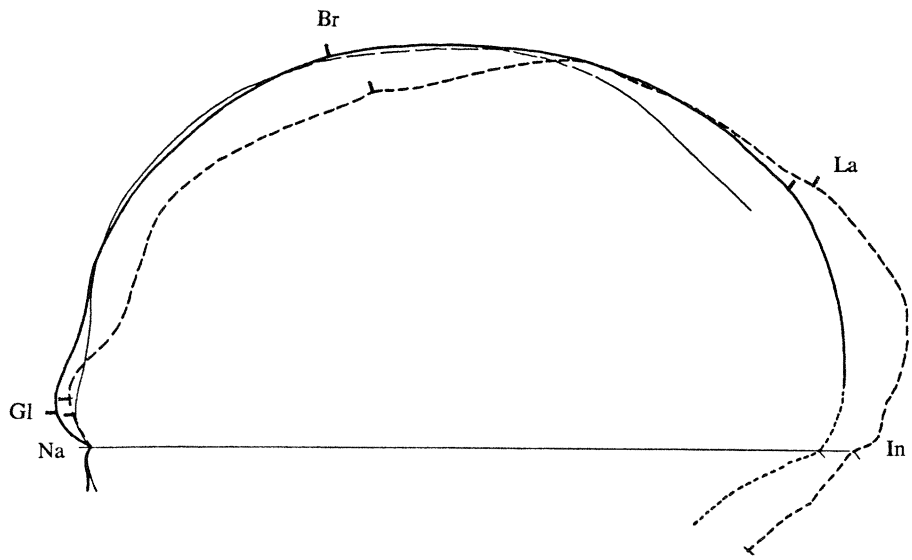

Figure 1. Median outlines of Irhoud 1 (bold continuous line), Irhoud 2 (fine continuous line) and La Chapelle-aux-Saints (discontinuous line). Magn. ×0.53.

medullary cavity. None of these features, however, need be considered as exclusively Neanderthal but express a great robusticity. The high position of the deltoid tuberosity, the flattening of the diaphysis and the reduction of the medullary cavity are more likely to be plesiomorphic conditions which were common in archaic *Homo sapiens*.

Irhoud 1 (table 1; figures 1 and 2) is a large skull, long and wide but already with an anteriorly positioned maximum width. The vault is low, in the common range of variation of the Neanderthals and the first modern humans. The sagittal profile is elevated in its anterior part but after the bregma it forms a long and moderately convex arc. Thus, the bregmatic index (height of bregma above the glabellainion line/glabella-inion length) is 51.35, well above the range of variation of the European Neanderthals (36.5–43.1) and near the values of Skhul V (47.8) or Qafzeh 9 (50.2). In posterior view it displays a pentagonal profile flattened at the top; the lateral sides are nearly parallel. The *tuber parietale* are well defined and superiorly positioned. The frontal bone is

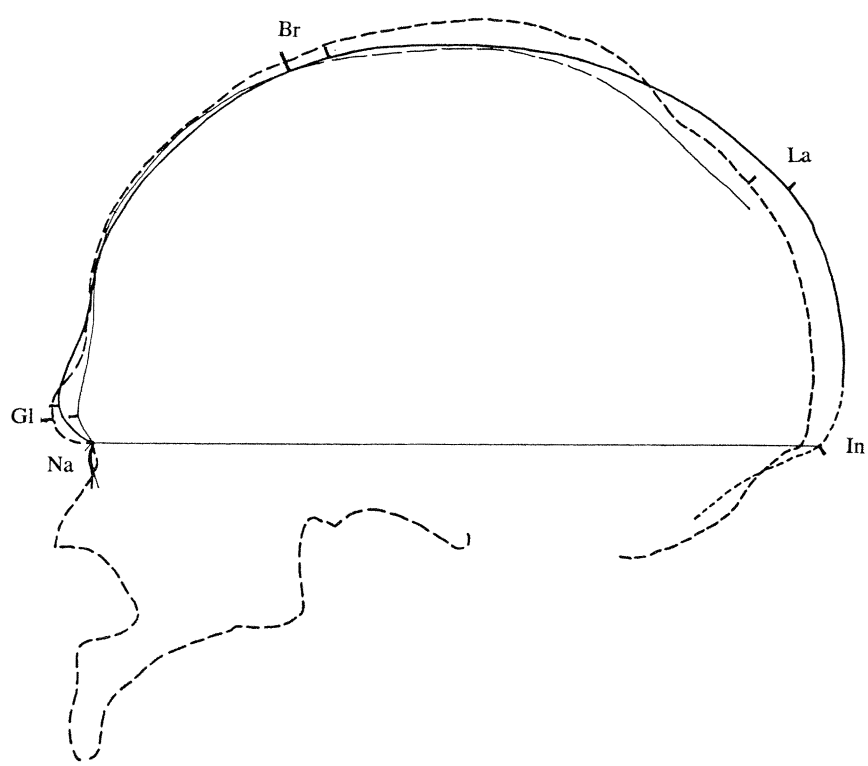

Figure 2. Median outlines of Irhoud 1 (bold continuous line), Irhoud 2 (fine continuous line) and Skhul V (discontinuous line). Magn ×0.53.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

wide as in the Neanderthals, but also as in the Skhul–Qafzeh group or in Omo 2 or Eliye Springs, but less than in the extremely wide Florisbad frontal. The convexity of the frontal is close to the modern condition. A moderately pneumatized supraorbital torus is present which thins laterally. The parietal arc is long absolutely and relatively to the temporal border of the parietal, but the sagittal convexity remains weak. The squamosal has a rounded and absolutely high outline but it is elongated antero-posteriorly. The root of the zygomatic process is set above the external acoustic meatus. The glenoid fossa is deep and well delimited, with a raised *tuberculum articulare*. The mastoid process is rather small but well defined and projecting downward below the juxtamastoid eminence. The occipital displays low proportions and a flat *planum occipitale* without protruding occipital torus. The endocranial capacity has been estimated to be 1480 cm^3 by Anthony (1966) and 1305 cm^3 by Holloway (1981). The face is wide and low. The prognathism does not exceed the modern condition. The alveolar prognathism is strong but there is no indication of mid-facial prognathism. The orbits are voluminous, rectangular, with axes oriented slightly downward laterally. The nasal cavity is wide in its lower part, but narrow upward, and it is very short. The medial part of the zygomatic bone as well as its *facies lateralis* are oriented frontally. The maxilla is of the 'inflexion' type, with an obliquely oriented and moderately wide frontal process. The alveolar arcade is very robust.

Irhoud 2 (table 1; figures 1 and 2) is very similar to Irhoud 1, but the former is metopic, which might explain some difference between the two specimens, including its wider proportions and its more convex frontal bone. This more modern aspect of the frontal is associated with a higher differentiation of the supraorbital elements. Nevertheless, the specimen has no genuine *trigonum supraorbitale*. The cranial bones are thinner than in Irhoud 1 and not far from the modern values. Some other aspects including the higher proportions of the temporal, a more convex parietal arc and the occurrence of an infratemporal crest are more advanced than in Irhoud 1. But in contrast, some other features are more primitive (length of the temporal edge of the parietal, lower proportion of the occipital). This variation seems compatible with the one observed in series such as Qafzeh, Skhul or Shanidar (McCown & Keith 1935; Vandermeersch 1981; Trinkaus 1983). Despite the stratigraphical uncertainties, Irhoud 1 and 2 likely belonged to the same population.

The features observed on Irhoud 1 and 2 are consistent with those already described on Irhoud 3 and 4. No Neanderthalian apomorphies are observed. The skull especially lacks: (i) a round profile ('en bombe') in *norma occipitalis*; (ii) a flattening of the mastoid process on the petrous part of the temporal; (iii) a *tuberculum mastoideum anterius* (Hublin 1978*b*); (iv) a projecting juxtamastoid eminence; (v) the bilateral protusion of the occipital torus associated with a developed suprainiac fossa; (vi) a strong convexity of the *planum occipitale* (figure 2); (vii) high and rounded orbits; (viii) mid-facial prognathism and related features: flattening of the antero-lateral part of the maxilla, with no frontal, sagittal or horizontal concavity; a broad and sagitally oriented frontal process of the maxilla; a receding zygomatic; a low subspinale angle (SSA of Howells 1973); and a large difference between M1 alveolus and zygomaxillare radii (AVR and ZMR of Howells 1973).

The only features shared with the Neanderthals are primitive retentions: (i) general robusticity of the skull and of the mandible; and (ii) platycephaly (already reduced), and related features: weak convexity of the parietal; low proportions of the occipital squama; and elongated temporal.

The Irhoud hominids are, therefore, clearly to be excluded from the neanderthal clade. Moreover, they display clear affinities to the first modern humans of the Skhul–Qafzeh group, combining modern apomorphies (especially the development of a bony chin on the mandible, the convexity and orientation of the frontal squama, the dissociation of the supraorbital elements in Irhoud 2) and some plesiomorphies (general robusticity, macrodonty, strong supraorbital relief, a wide, low and flattened face (?)) which allow an ancestor–descendant relationship with late Upper Pleistocene modern humans.

When compared with the Skhul–Qafzeh group, the Irhoud specimens are only slightly more primitive. The cranial vaults of Irhoud 1 and 2 are lower than Skhul 5 (figure 2), mainly in their posterior parts. The rotation of the occipital is less advanced, with a series of consequences such as m derate sagittal convexity of the parietal, a still rather longated temporal, and the low proportions of the occipital squama. In some morphological aspects, as for example the supraorbital morphology, Irhoud 1 and 2 are similar to the most primitive specimens from Skhul and Qafzeh. When comparing Irhoud with the Aterian specimens, the latter display a more advanced morphology. Nevertheless, no anatomical argument would demonstrate any evolutionary discontinuity between the two groups, a statement already emphasized by Ferembach (1976*b*) and which is consistant with the archaeological record. Furthermore, as with Irhoud, the Aterian hominids display a comparable combination of modern features in association with the same primitive retentions, i.e. the supraorbital relief, the broad braincase and megadonty (Ferembach 1976*b*; Hublin & Tillier 1981; Hublin 1991).

CONCLUSIONS

Anatomically it seems difficult to advocate the 'Neanderthal' or 'Neanderthaloid' nature of the Irhoud material. More likely the few primitive retentions that the Irhoud specimens share with the Neanderthals are explained by their age which probably antedates oxygen isotope stage 4. Furthermore, some of these primitive retentions are still present in the first modern humans from the Middle East. The Mediterranean Sea appears, therefore, as a major biological barrier during at least the second half of the Middle Pleistocene. Although we see in Europe a steady accretion of Neanderthal features from around 300 ka at least, the northwestern African series differs considerably (Hublin 1991). As a result, by the beginning of the Upper Pleistocene two very different populations are separated by the Straits of Gibraltar. This statement is not consistent with substantial exchanges between North Africa and Spain during low sea level periods, an hypothesis regularly proposed mainly on the basis of cultural evidence (Alimen 1975). Tixier (Hublin *et al.* 1987), in describing the Irhoud industries, noted some typological similarities with the Cova Negra industry, and without endorsing a crossing via the Gibraltar straits, stated that the Irhoud Mousterian would not come as a surprise in western Europe. However, some cultural exchanges could have occured without massive human displacement. If the similarities tentatively demonstrated in the Palaeolithic industries North and South of the Gibraltar Straits did not result from simple technical convergence, then whatever population exchanges took place were not substantial enough to allow significant biological change.

Another important aspect of this evolutionary process is that the Irhoud hominids should be considered as a grade immediately preceding the first modern humans of the Middle East and probably predating this group (Valladas *et al.* 1988; Schwarcz *et al.* 1988; Stringer *et al.* 1989). In this view, no anatomical or chronological argument would exclude them from possible ancestry of this group or later still modern Europeans. If an African origin for modern humans is assumed, the 'cradle' is rather large and should be extended from the Atlantic coast of Morocco to South Africa, and should probably include also the Middle East. This scheme rather contradicts the initial 'Out of Africa' genetic model which emphasized the role of the sub-Saharan area (Cann *et al.* 1987; Cavalli Sforza *et al.* 1988; Vigilant *et al.* 1989) nor does it strictly fit the 'Afro-European hypothesis' (Bräuer 1984) which also allocated the origin of modern European to a southeastern part of Africa.

Finally the Irhoud hominids highlight the vexing question of subspecific taxonomy within *Homo sapiens*. The fossil evidence would support the regular, even if accelerated, incrementation of modern features in the late Middle Pleistocene and early Upper Pleistocene in Africa rather that a quick and clear cut emergence of an Adamic 'anatomically modern man'. The attempts to define grades within our species, as for example those by Stringer *et al.* (1979) or Bräuer (1984, 1989) seem unable to resolve this problem. To remain with the North African record, how can we classify together as 'archaic *Homo sapiens*', such a primitive specimen as Salé (which indeed already displays some '*sapiens*' derived features) together with the very different Irhoud specimens, which are already phenetically very near to the middle-eastern forerunners of modern Europeans?

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