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The archaeological context of the Iwo Eleru cranium from Nigeria and preliminary results of new morphometric studies

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Abstract

The Iwo Eleru skeleton was excavated from the rock shelter of this name in 1965 by Thurstan Shaw and his team. This contracted burial was found in a level with Late Stone Age (LSA) artefacts, and a radiocarbon determination on associated charcoal gave an (uncorrected) age of 11,200 ± 200 BP. The excavators went to considerable trouble to satisfy themselves that the specimen was in situ. There is no occupation prior to the LSA and only slight indications of a subsequent "iron age" occupation. Significant human burials have since been excavated elsewhere in West Africa (notably at Shum Laka and Gobero) but Iwo Eleru so far retains its status as the earliest known such burial in the region. The poorly preserved skeleton was of an adult and probably male individual, and the skull was reconstructed and studied by Brothwell. He linked the skull to recent West African populations, but he recognized that its lower vault and frontal profile were unusual. He also supplied cranial data for a Principal Components Analysis performed by Peter Andrews, and noted that this placed the specimen apart from recent African samples. Stringer included the Iwo Eleru cranium in univariate and multivariate (Canonical Variates, Generalised Distance) analyses for his doctoral thesis, completed in 1974. His results highlighted apparent archaic aspects in the specimen in its long and rather low cranial shape, and although modern overall, it also resembled fossils such as Omo Kibish 2 and Ngandong in certain respects. New studies using a primary replica of Brothwell's reconstruction have now been carried out by Harvati, employing geometric morphometrics to generate PCA, CVA, Procrustes Distance and Minimum Spanning Tree analyses of the specimen. The new morphometric studies establish the relatively archaic shape of the vault, and confirm that this Late Stone Age individual was markedly different from succeeding populations. The results highlight our present relative lack of knowledge concerning the identity of the manufacturers of LSA artefacts in West Africa and other parts of the continent.

Keywords: Iwo Eleru, Late Stone Age, human cranium, geometric morphometrics

The site and the excavations

Iwo Eleru is a rock shelter in south-western Nigeria, 24 km north-west of Akure, with coordinates 7°26'30" N and 5°7'40" E (Figure 1). It is 25 km south of the present northern limit of the forest zone. When Thurstan Shaw first visited the site, he observed that artefacts indicative of the Late Stone Age were eroding out of the talus slope in front of the platform, which clearly contained some depth of deposit. It was therefore chosen for excavation to test the conflicting hypotheses, *either* that the forest could not have been occupied before the introduction of iron tools, *or* that the occurrence of ground stone axes in presently forested areas implied that it had been so occupied. The excavations were carried out over a four month period in 1965. As Shaw commented, they succeeded in doing more than throwing light on those initial questions.

The plan of the site is shown at Figure 2. The rock shelter is formed by the overhang of a huge block of gneiss at the foot of an inselberg. A maximum area of about 7 x 15 metres is within the drip line (which is marked by a dotted line on the plan) and the maximum depth of deposit was about 1.5 metres. The area to the south of the inselberg was laid out in a one-metre grid system, designated by letters from west to east, and by numbers from south to north. Initially, two long trenches were laid out, F 1-26 running from south to north, and 16 D-HH running from west to east. Two south-north running trenches were later added, D 17-27 on the west and S 17-25 on the east. D 17-27 (which is particularly important for our purposes) was interrupted by an unexcavated square D 24 which contained a large fallen roof slab. The section along the east face of this trench is shown at Figure 3. The total number of excavated squares was 810, but for analytical purposes only trenches D and F were used. From the site as a whole >500,000 artefacts were recovered. The excavators were not able to distinguish distinct layers as the work proceeded, and the homogeneous deposits were therefore divided into arbitrary 15 cm levels. From trenches D and F, 141 stratigraphic units were therefore available for analysis, and it is upon this basis that the sequence of events at the site has been constructed. Two photographs of the excavations in progress (taken by Joel Vanderburg) are at Figures 4 and 5.

Stratigraphy and archaeology

In the absence of clearly differentiated natural stratigraphy observed in the field, the sequence of events at the site was determined to a large extent by the statistical analysis of the stone artefacts which made up the great bulk of the finds, according to their position within the defined stratigraphic units. A "time vector plane" accounting for 42.3% of the

Figure 1: Position of Iwo Eleru in South-western Nigeria.

variance was established for the site, and this was divided into 8 successive groups which are adequately robust and the time directionality of which corresponds with the radiocarbon dates and the superposition of the units within each column at the site (Shaw and Daniels, 1984, Fig. 67). At an early stage of the work, the excavators noticed that there was a tendency for the proportion of chalcedony versus quartz to decline with depth, hence the proportions were carefully noted as work proceeded, and the resultant "chalcedony index" was also useful as a stratigraphic check on their interpretation. Combining all the information together, the excavators produced an "outline of the Iwo Eleru succession" (Shaw and Daniels, 1984, Table 17) and this has provided the basis for all further characterisation of this site and its comparison to others. From our point of view, it is important to note that there was "little accumulation of deposit in the shelter" before it began to be used in the LSA (Shaw and Daniels, 1984: 6). It was used in the recent past by farmers lighting fires in it, hence its name in Yoruba ("Cave of Ashes"). Some of the pottery found near the surface may also be recent. The bulk of it is "iron age" in type and is likely simply to have become incorporated in the LSA deposits, since no distinctive iron age layer as such was observed. The only type of pottery definitely attributed to the LSA is comb stamped ware, as clearly found in situ in trench F 9 (Shaw and Daniels, 1984, Plate VIII).

Six samples of charcoal were selected for radiocarbon dating, all from trench D, since it was considered that this showed the least evidence of disturbance, and it also contained the burial which was located in square D 23. The dates as listed are as follows.

Lab. No.	provenance	depth below surface	date BP
Hv 1512	D 21-22	20-35 cm	3465±65
Hv 1510	D 19-20	50-65 cm	5570±60
Hv 1509	D 20	65-80 cm	7030±85
Hv 1511	D 18	95-110 cm	8685±120
I 1754	D 18	100-115 cm	9150±150
I 1753	D 23 around burial	70-100 cm	11200±200

Shaw commented that this is a "consistent block of dates on which considerable reliance can be placed" (Shaw

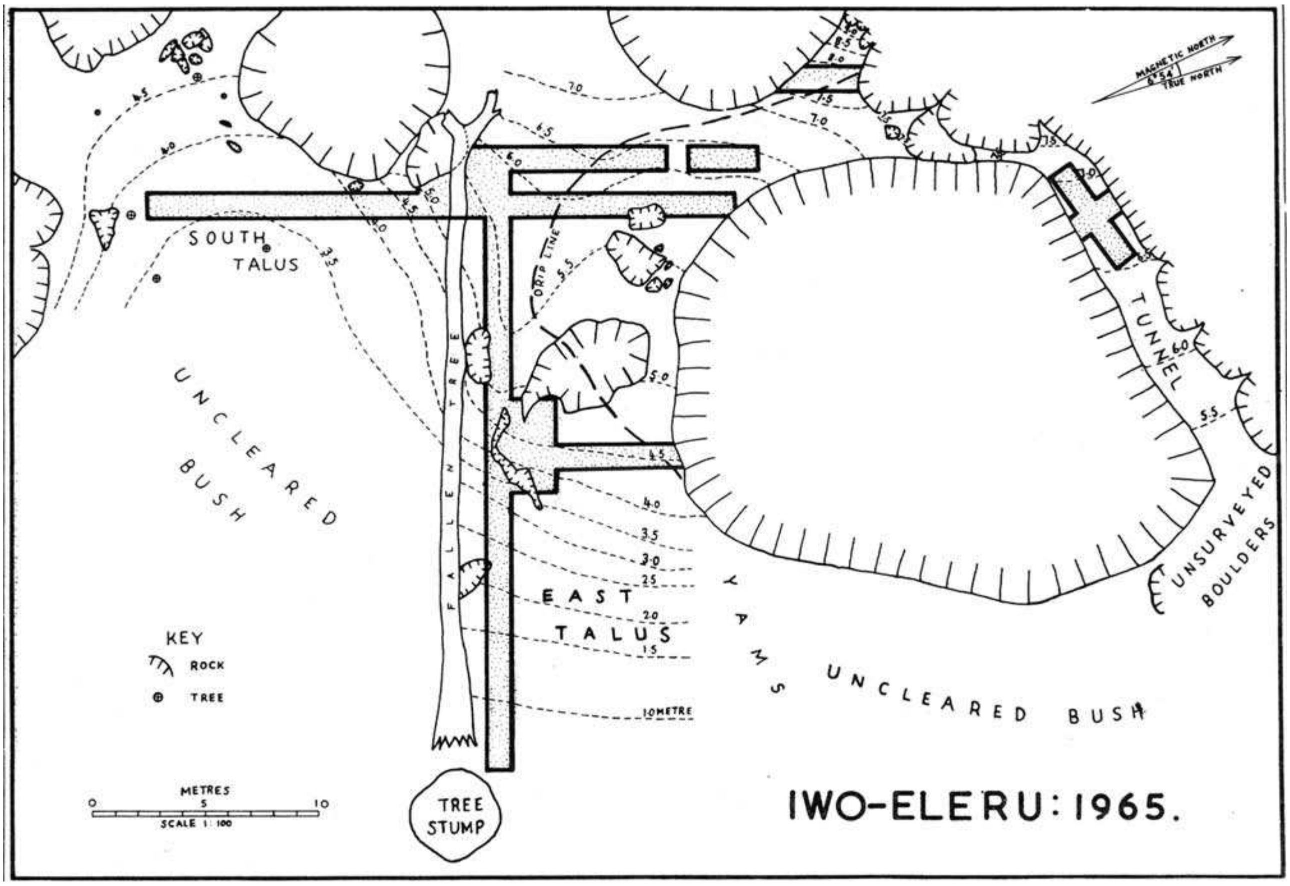


Figure 2: Iwo Eleru: plan of the site (after Shaw and Daniels 1984, Figure 2).

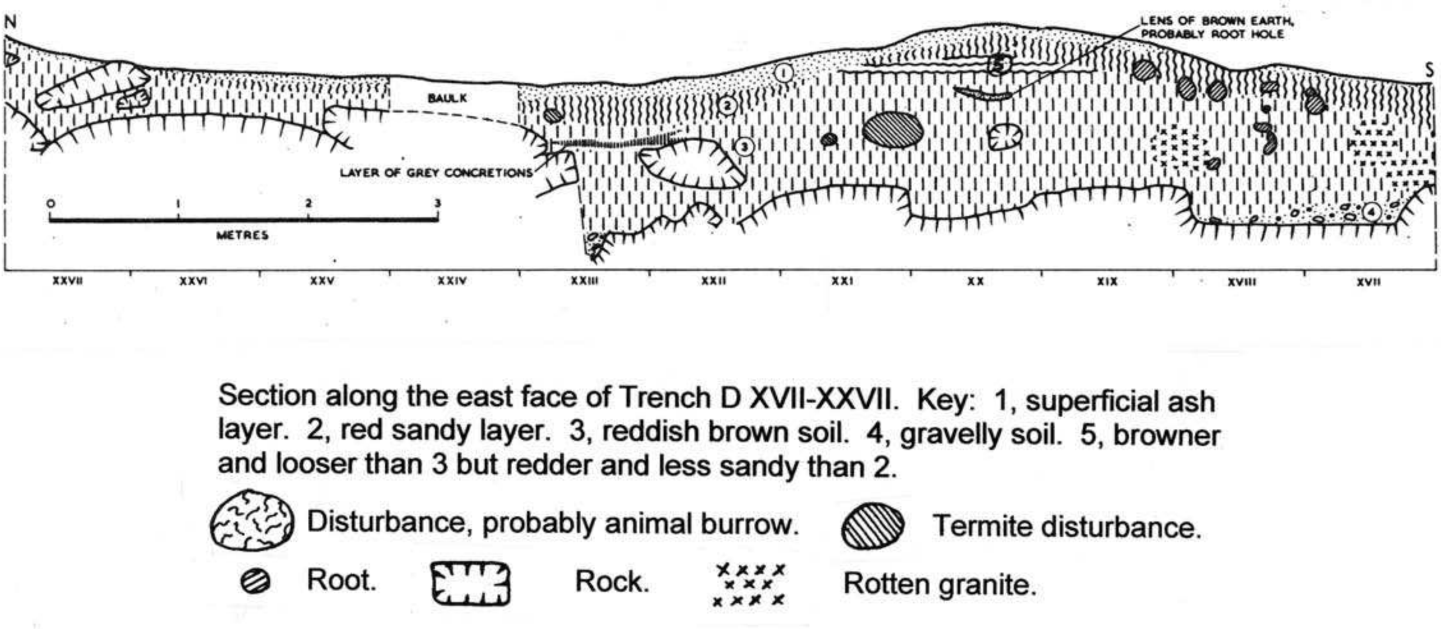


Figure 3: Section along east face of trench D XVII-XXVII (after Shaw and Daniels 1984, Figure 6).

Figure 4: Iwo Eleru: excavations in progress 1 (courtesy of Joel Vanderburg).

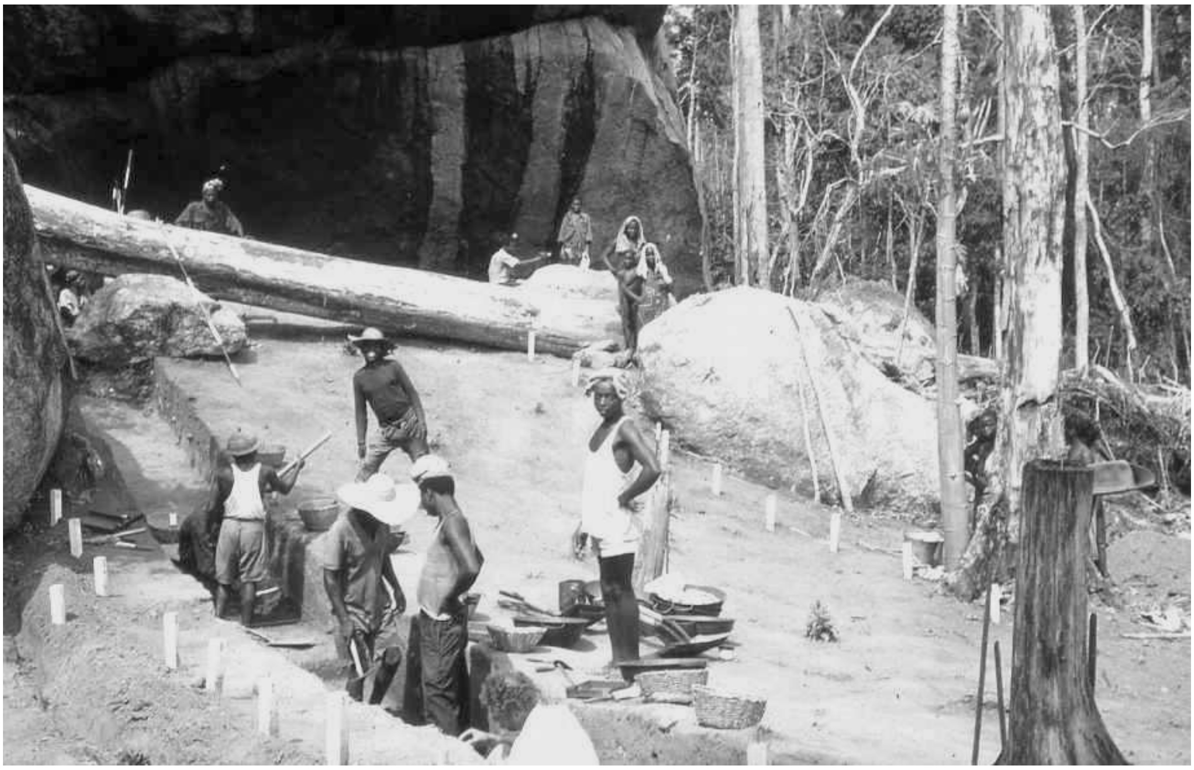


Figure 5: Iwo Eleru: excavations in progress 2 (courtesy of Joel Vanderburg).

and Daniels, 1984: 7). In their outline of the Iwo Eleru succession, the excavators suggested that there were two basic periods or phases into which the sequence could be divided, A and B, respectively aceramic and ceramic, each of which could be further divided into two sub-periods. The four successive divisions could each be associated with certain of the "time vector plane" groups and the radiocarbon dates, as follows.

period	sub-period	TVP group	radiocarbon date BP
B	B2	VI-VII-VIII	3465±65
	B1	V	5570±60 and 7030±85
A	A2	III-IV	9150±150
	A1	I-II	8685±120 and 11200±200

Broadly speaking, it was suggested that the chronological boundaries for the periods and sub-periods were approximately as follows: A1 12,000-9000 BP; A2 9000-7000 BP; B1 7000-4500 BP; B2 4500-2000 BP.

As stated, a basic criterion for the distinction between periods A and B is the appearance of pottery in B, certainly in B2 and probably in B1. Also characteristic of B is the presence of ground stone axes and other ground stone artefacts, commonly made of very durable materials such as sillimanite, dolerite, and charnockite. Chalcedony and quartz was used for the chipped stone tool component, which alone characterised period A. One set of tools that appears in B2 are trapezoids, many with a pronounced gloss along the sharp edge, the position of which suggests slightly oblique hafting, possibly for the cutting of grasses or cereals such as sorghum (Shaw and Daniels, 1984, Fig. 38 a and b). Generally however it is noticeable that microliths (defined quite tightly as small tools with at least one edge trimmed by steep backing or blunting) decline in number from the base of the sequence upwards. Their decline is balanced by an increase in the number of core tools and other heavy-duty pieces. This was tentatively interpreted in environmental terms.

Environmental evidence

Direct environmental evidence at the site is slight. Only a few small badly preserved fragments of animal bone were recovered and no information is available as to what species may have been represented (Shaw and Daniels, 1984: 30). Fish otoliths were identified in trench F 21 level 9. 12 species of molluscs were recognised by Nora McMillan (in Shaw and Daniels, 1984: 142-144). Most frequent was *Archachatina marginata*, a land snail still commonly used for food at the present time. All the other land snails could have occurred naturally in the surroundings of the site. *Potadoma morchii* is a freshwater species, and its appearance in trench S, where a red clay layer abuts the gneissic block at the back of the site, supports the excavators' conclusion that storm water did accumulate here from time to time. 4 cowries (*Cypraea moneta*) occurred near the surface. No macrobotanical remains nor traces of pollen were preserved.

The environmental history of the site was therefore interpreted in terms of its geographical situation and in the light of what was then known about the climatic and vegetational history of West Africa in general. Relying on the evidence from Lake Chad and Lake Bosumtwi, among other places, Shaw assumed that West Africa was generally dry in the late Pleistocene from about 18,000 to 10,000 bc; the beginning of the Holocene from 10,000 to about 5000 bc represented a climatic optimum; and thereafter there were fluctuations, before the present climatic regime (involving desiccation of the Sahara) set in at about 2500 bc. On this assumption, the area around Iwo Eleru at the beginning of its occupation will have been generally dry savanna country. It was assumed that during the late Pleistocene the forest will have retreated to small relict areas along the coast, including the Niger delta. So the question was, when did the forest recover in the early Holocene, so that it embraced the Iwo Eleru area, and what happened after 5000 bc? Weighing all the odds, Shaw suggested that the forest may have advanced quite rapidly, moving northwards some 200 or 350 km in a few hundred years. He concluded that the forest will have covered Iwo Eleru by 5000 bc and that thereafter "it remained in forest until the end of the stone age occupation" (Shaw and Daniels, 1984: 52).

Some elements of the archaeological succession were interpreted in that light. It was assumed that microliths equated with the use of a bow and arrow in open country, so their decline and replacement by heavy-duty equipment (as known from sites in other forested areas such as Blandè and Yengema: Shaw, 1978/79, Figs. 4 and 5) would be quite comprehensible. Shaw inclined to the view that the advent of pottery was due to diffusion from the north, even perhaps with the "actual movements of people southwards", since this was the time when desiccation commenced in the Sahara (Shaw, 1978/79: 60).

The burial

A human burial was found in square D 23, the various parts of which were at depths between 82 and 100 cm from the surface. A photograph of the skull as first located is at Figure 6, and a plan of the skeletal remains is at Figure 7. As already mentioned, there is a radiocarbon date of 11,200±200 BP obtained on charcoal found in the immediate vicinity of the burial. The skeletal remains were found in a space between and below two rocks, and a layer of calcareous concretions was observed in the same space, at a higher level, between the upper surfaces of the two rocks. According to Shaw's description, the corpse of this person "had been placed not far from bedrock … and covered with a shallow depth of soil early on in the shelter's use" (Shaw and Daniels, 1984: 4-5). The excavators believed that the body had probably been buried in a tightly contracted position. At the time, they carefully considered the possibility that the burial may have been intrusive, and they rejected this notion on the grounds that there was no evidence of disturbance or of a burial pit. The "chalcedony index" did not indicate any anomaly

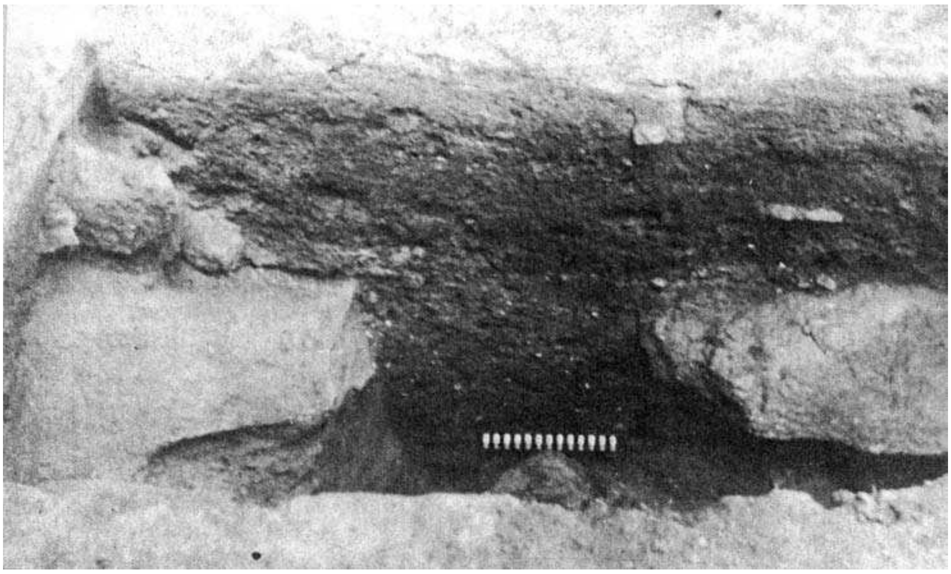


Figure 6: Iwo Eleru, 1965, east face of trench D XXII-XXIII. Centimetre scale rests on skull of skeleton. Layer of calcareous concretions can be seen extending between the upper surfaces of the two rocks. (after Shaw and Daniels 1984, Plate IX).

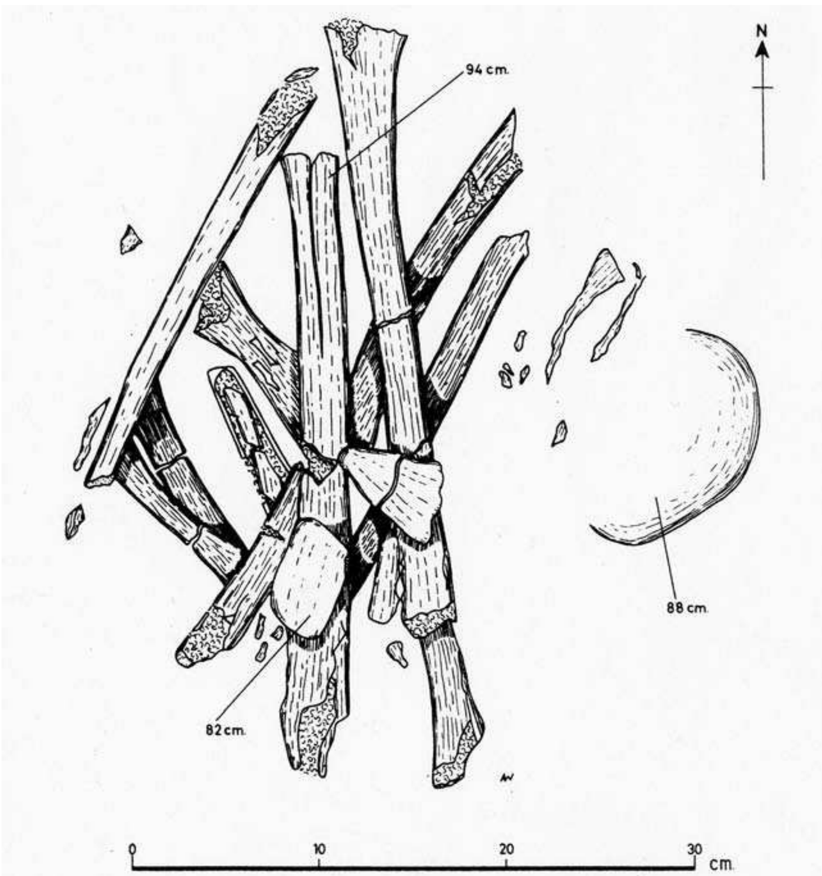
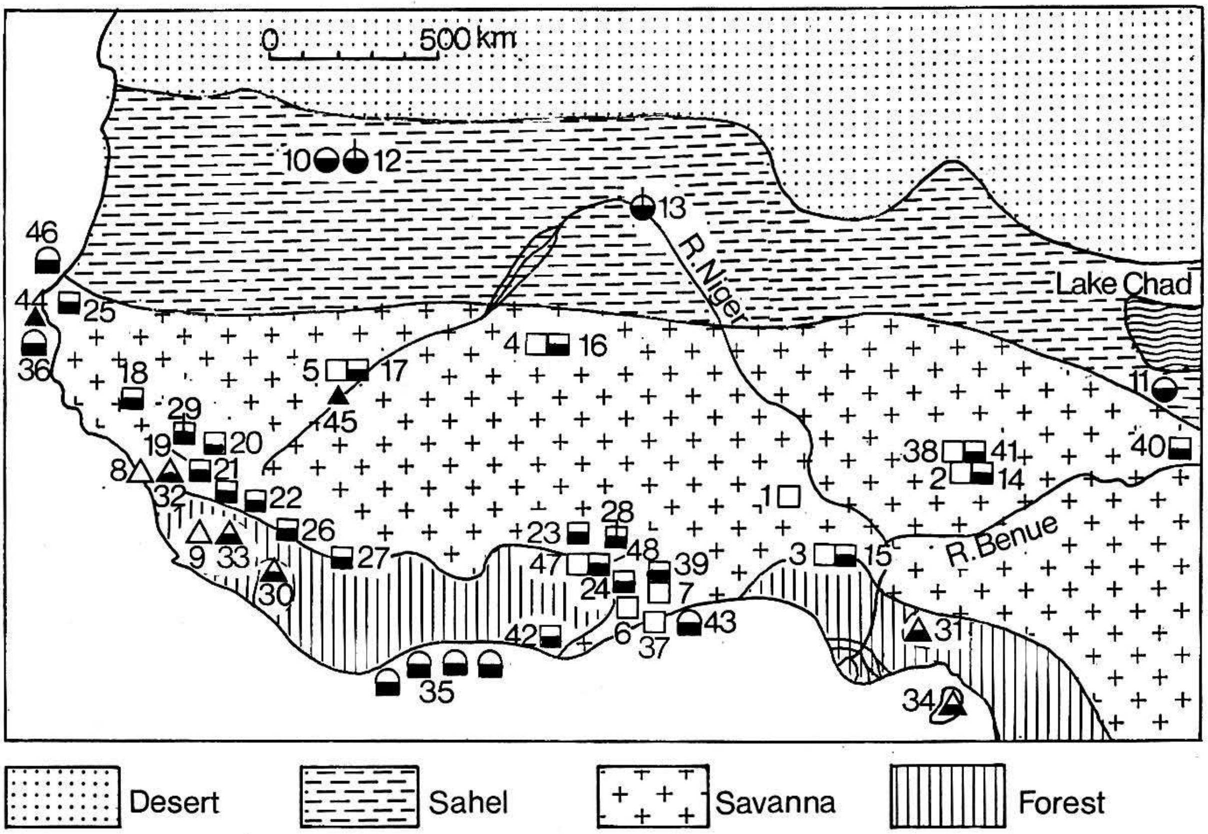


Figure 7: Iwo Eleru: plan of human bones in trench D XXIII. Depths indicated are measured from the surface after the removal of the superficial layer of modern ash. (after Shaw and Daniels 1984, Figure 64).



□ *Aceramic sites, savanna*

1. Mejiro Cave, Old Oyo
2. Lower level of Rop
3. Lower level of Iwo Eleru
4. Rim I
5. Lower level of Kourounkorokale
6. Adwuku
7. New Todzi ('Mesoneolithic')
37. Achimoto Cricket Pitch
38. Lower level of Dutsen Kongba
47. Lower level of Voltaian Scarp Shelters

△ *Aceramic sites, forest*

8. Lower level of Grotte de Kakimbon
9. Middle level of Yengema

Ceramic sites, sahel

10. Tichitt, Akrejit phase
11. Lower levels of Daima

Ditto with 'Sahara Neolithic' affinities

12. Tichitt, Khimiya and subsequent phases
13. Karkarichinkat

Ceramic sites, savanna

14. Upper level of Rop
15. Upper level of Iwo Eleru
16. Rim II and III
17. Upper level of Kourounkorokale
18. Nhampasseré
19. Kindia group **20. Pita**
21. Yagala
22. Kamabai
23. Kintampo
24. Abetifi
25. Rufisque
26. Kokosu
27. Sopie
39. New Todzi ('Neolithic')
40. Sumpa
41. Upper level of Dutsen Kongba
42. Nsuta
48. Upper levels of Voltaian Scarp shelters

Ditto with 'Sahara Neolithic' affinities

28. Ntereso
29. Oualia

▲ *Ceramic sites, forest*

30. Blandé
31. Afikpo
32. Upper level of Grotte de Kakimbon
33. Upper level of Yengema
34. Fernando Po

Ceramic sites, coastal

35. Ivory Coast sites
36. Joal and other Senegal coast sites
43. Tema
46. Khant

▲ *Factory sites*

44. Cap Manuel
45. Bamako

Figure 8: Late Stone Age sites in West Africa in relation to vegetation zones. (revised after Shaw 1978-79, Figure 6).

at this point, and the layer of calcareous concretions above the skeleton did not show any signs of disturbance either. The excavators believed that the human remains "probably owe their preservation to a microenvironment which was exceptionally dry" (Shaw and Daniels, 1984: 29). The calcareous nodules were examined by K. Burke and S.J. Freeth (in Shaw and Daniels, 1984: 136) and the conclusion was that they were probably formed as a result of the seasonal movement of groundwater in this particular microenvironment. The post-cranial remains were found to be in a state beyond useful reconstruction, but this did not apply to the skull, teeth, and mandible (Brothwell and Shaw, 1971).

Comparisons to other West African sites

Thurstan Shaw addressed this question in the monograph devoted to the site, and also in two general accounts of the Late Stone Age in West Africa (Shaw and Daniels, 1984; Shaw, 1978/79, 1985). The most detailed map was that published in "Early Man News", which is reproduced here (slightly revised) at Figure 8. In the general scheme put forward, Shaw divided the LSA into two successive phases, aceramic and ceramic, each of which was characterised by a number of facies. In the aceramic phase, there were essentially two facies only, microlithic and non-microlithic (represented on the map by open □s and Δs) and these were equated with savanna and forested environments respectively. In the succeeding phase, the same distinction was observed between savanna and forest (the sites being represented on the map by filled squares and triangles). In both, pottery and ground stone axes made their appearance, but in the savanna these elements were added to the microlithic base whereas in the forest there were still few or no microliths. In the former case, as Shaw put it, pottery and ground stone axes appeared to be "grafted onto the microlithic tradition rather than to replace it" (Shaw, 1978/79: 61). Both phases were represented in superposition at some sites in both environments. In the forested south-western part of the region, mention has already been made of Yengema, and this is shown on the map as a numbered pair (9:33), as is Kakimbon (8:32), whereas Blandè (30) is represented by the ceramic phase only. The succession at Iwo Eleru (3:15) is paralleled among other places by that at Dutsen Kongba (38:41), Rop (2:14), Bosumpra (Abetifi), and other shelters along the Voltaian scarp (47:48 and 24). Bosumpra was excavated by Shaw in the 1940s and originally published as a ceramic phase site only, but a pre-ceramic phase was later detected at this location (Smith 1975). Radiocarbon dates for the transition from aceramic to ceramic at Dutsen Kongba and Bosumpra were not inconsistent with those from Iwo Eleru. Apart from the two major ceramic variants, a number of sites in the Sahel with few or no microliths were distinguished as a separate facies, as well as some coastal shell middens and factory sites (Shaw, 1978/79: 67 Table). Shaw was cautious in not claiming too much for his scheme, since as he said, it was no more than a "convenient classification of artefact groups with some reference to ecology", whereas "its interpretation in cultural, ethnic and linguistic terms" would require more research before it could be said to have much reliability (Shaw, 1978/79: 65). Nonetheless, the scheme did provide and still provides a useful framework within which to consider the wider significance of Iwo Eleru.

Human skeletal material was mentioned from Karkarichinkat, Kourounkorokale, Tichitt, Daima, Kintampo, and Rop (Shaw, 1978/79: 76) but at the time none of this material was dated and was certainly not considered older than Iwo Eleru.

Recent developments

Since the original report on Iwo Eleru was published, at least two hitherto unknown sites with skeletal remains have been located in the region, new information has been obtained about the chronology of the MSA and the LSA in general, and considerable attention has also been devoted to the study of the environment during the period in question. These developments will briefly be summarised insofar as they are relevant to Iwo Eleru.

Shum Laka and Gobero

These are key sites, neither of which was known when Shaw published his work on Iwo Eleru.

Shum Laka is a rock shelter 15 km south-west of Bamenda in western Cameroun (5°51'37" N, 10°04'44" E). At an altitude of 1650 metres above sea level, it is situated in the mountainous region known as the Grasslands. Following initial investigations, an extensive excavation was undertaken over a six month period in 1991-1994, and this has provided the essential information about the site (Lavachery et al., 1996; Moeyersons, 1997; Lavachery, 2001; Cornelissen, 2003). It has been demonstrated, for the first time in West Africa, that the LSA extends back into the Pleistocene. Five radiocarbon dates (from layer S) span the period from 31,700±750 to 12,800±110 BP. As at Iwo Eleru, the sequence continues into the early Holocene and beyond (layer A, divided into a lower ochre and an upper grey coloured unit), extending without much sign of interruption into the early iron age. The microlithic industry, made principally in quartz, is very similar to that from Iwo Eleru, although macrolithic elements which appear in the upper part of the sequence are distinctive. Cornelissen and Lavachery question whether (as in Shaw's scheme) microliths should necessarily be considered an adaptation to savanna conditions, and the macrolithic "culture" characterised by "waisted axes" which appears later seems to be bounded by frontiers which do not reflect ecological conditions. As at Iwo Eleru however an aceramic phase is succeeded by a ceramic phase, with the earliest pottery in the ochre layer A dated to 7140±50 BP. As a result of these discoveries, it has been suggested by MacDonald (1997: 161, 192) that we should think in terms of "a new model for the peopling of West Africa based upon a long-term autochthonous presence south of the Sahara", which found its material expression in "an indigenous terminal Pleistocene West African microlithic techno-complex".

18 skeletons have been found in the Holocene deposits at the site, in 9 burial complexes, which are attributed to two different chronological phases (Orban et al., 1996; Ribot et al., 2001). 3 burials with 4 individuals are attributed to the ochre layer A, with dates in the range from 7150±70 to 6870±80 BP. This layer corresponds archaeologically and chronologically to period B1 at Iwo Eleru, and the burials are clearly more recent than the one at Iwo Eleru. Orban and Ribot and their colleagues compared these skeletons to Iwo Eleru principally on the basis of postcranial features, particularly estimated stature (Ribot et al., 2001: table 35), though similarities were also detected in terms of a broad mandibular ramus and very worn teeth (Ribot et al., 2001: 193). Two adult male burials at Shum Laka have an estimated stature in the range 161-166 cm, compared with a figure for Iwo Eleru of 158-166 cm. 6 burials are known from the grey layer A, which has dates between 3300±90 and 2940±60 BP. Of the individuals identified 9 are children and 5 are adults. Chronologically the finds correspond to period B2 at Iwo Eleru. There are marked

distinctions between this population and the preceding one, so much so that they are considered to be "biologically different" (Ribot et al., 2001: 192). Two adult female individuals at Shum Laka, SE III and SE IV, have an estimated stature of 153-155 and 143-148 cm respectively; this, it is considered, suggests "an affinity with Pygmy populations", although there is no supporting evidence to confirm this hypothesis (Ribot et al., 2001: 176).

Gobero is a site complex in central Niger, which was discovered in 2000 and excavated in 2005-2006; not surprisingly, it has attracted a good deal of attention (Sereno et al., 2008; Gwin, 2008). It is located on the north-western rim of the Chad basin, about 150 km south-east of the Aïr massif. At the beginning of the Holocene a shallow freshwater lake formed here, pooled against a low east-west fault scarp, and, with an interruption, this lake continued in existence for some 5000 years. Both lake episodes were associated with human occupation, traces of which are now preserved in three main palaeodune deposits (Sereno et al., 2008, Fig. 1). A minimum of 182 human burials have been noted, of which 67 have been excavated. 78 radiocarbon dates have been obtained and 9 OSL dates on palaeodune sand. On this basis, the excavators have divided the sequence into four principal phases (Sereno et al., 2008, Fig. 3). Phase 2 represents the early Holocene occupation, which has been dated in the range from 8640±40 to 7390±40 BP. The artefacts (including bone harpoons and ceramics) are characteristic of the Kiffian techno-complex. The analysis conducted by Sereno and his colleagues suggests that the population represented here is similar to the "Mechtoids" described from North Africa and the Sahara. Phase 3 is assigned to the mid-Holocene and has dates in the range from 5940±40 to 4090±40 BP. The artefacts (including hollow-based projectile points and pottery) belong to the Tenerean techno-complex. No particular affinities have been suggested for this "morphologically isolated" human group (Sereno et al., 2008, Fig. 6), but it is considered unlikely that they evolved in situ from the preceding population.

These studies clearly show that the population of this area in the early and mid Holocene was not homogeneous. But so far, Iwo Eleru retains its status as the earliest known excavated burial in the region.

The wider context

So far, there is no other Pleistocene LSA succession in West Africa comparable to Shum Laka. As already remarked, pottery came into use at that site at about the same time as at Iwo Eleru. At Ounjougou, in Mali, there is a radiocarbon date of 8700±75 BP directly associated with pottery at Ravin du Hibou (Huysecom et al., 2004a, 2004b; Raeli and Huysecom, 2004). The assemblage here is described as Kiffian, and in terms of dating this obviously is consonant with the evidence from Gobero. In 2007 a few more sherds were found in a stratigraphically lower horizon at Ravin de la Mouche, so the advent of pottery at this site may be even earlier (Huysecom et al., 2009, Fig. 1 and Table 1). As a whole therefore the evidence still seems to support Shaw's view that the advent of pottery in West Africa was due to diffusion from the north. Ounjougou is important for an entirely different reason, since, as reported at this conference by Sylvain Soriano (see also Rasse et al., 2004), it has produced for the first time a reliably dated West African Pleistocene sequence for the MSA, dated by OSL to a period from about 160 to 19 kyrs BP. There are also two OSL dates of 40.8±11.4 and 23.6±9 kyrs BP from Birimi in northern Ghana for a "flake industry with a strong Levallois component" (Casey, 2003; Quickert et al., 2003). There are still no hominid associations with the MSA in West Africa, but if the younger of the dates at these two sites are correct then the makers of these industries (whoever they were) will have lived (presumably) side by side with the makers of the LSA.

The main characteristics and the chronology of the late Pleistocene and the early Holocene in West Africa and the Sahara have been clearly delineated in recent studies, which broadly speaking do confirm the model which Shaw employed at the time the Iwo Eleru report was written. DeMenocal and his colleagues have established a framework for the nature and longevity of the African Humid Period, which followed the end of the Pleistocene, on the basis of the marine core at ODP site 658C off Cap Blanc, Mauritania (DeMenocal et al., 2000, Figs. 2, 3, and 4). Humid conditions initially commenced at about 14.8 cal kyrs BP, with the main episode of the AHP occurring between about 9 and 5.5 cal kyrs BP. It is likely that during the Late Glacial Maximum the southern boundary of the Sahara may have been situated at about 14°N, whereas in the early Holocene the northern boundary of the forest may have reached as far as 10-12°N (Dupont et al., 2000). Lézine and Cazet (2005, Fig. 5) have proposed a step-wise model for the northward expansion of the forest in West Africa during the AHP, extending from about 11.6 to 9.3 cal kyrs BP. There was a similarly uneven retreat at the end of the period. There is some disagreement about the extent to which the forest was reduced to fragments along the coast during the LGM, but the principle of its expansion is not in doubt. Any discrepancy between these authors is unlikely to upset Thurstan Shaw's idea that the occupation of Iwo Eleru began in savanna conditions and persisted in a forested environment. The advance of the forest in the AHP was mirrored by a rise in lake levels, most notably Lake Chad (Leblanc et al., 2006). The lake may have begun to fill as far back as 10,160±160 BP and may not finally have begun to retreat until 3000±110 BP. It is estimated that it will have been at its maximum extent between about 7700 and 5500 BP, corresponding to about 8.5 to 6.3 cal kyrs BP. Lake Mega Chad therefore constitutes one of the most dramatic evidences for an early Holocene climatic optimum and its eventual decline to conditions more resembling those of the present.

Studies of the Iwo Eleru cranium

The poorly preserved skeleton was of an adult and probably male individual, and the skull was reconstructed and studied by Brothwell (Brothwell and Shaw, 1971). He

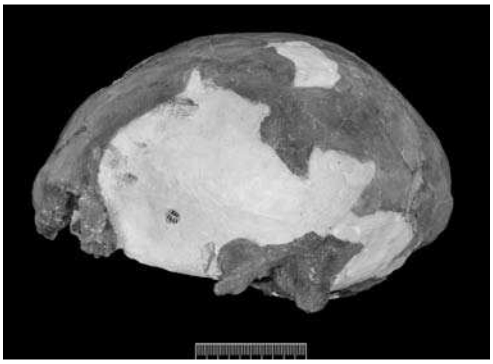


Figure 9; Iwo Eleru cranium: left lateral view.

Figure 10: Iwo Eleru mandible: left lateral view.

linked the skull to recent West African populations, but he recognized that its lower vault and frontal profile were unusual, and the mandible was robust (Figures 9 and 10). He also supplied cranial data for a Principal Components Analysis performed by Peter Andrews, and noted that this placed the specimen apart from recent African samples.

Stringer included measurements of the original Iwo Eleru cranium in univariate and multivariate (Canonical Variates, Generalised Distance) analyses for his doctoral thesis, completed in 1974 (Stringer 1974a). Coefficients of separate determination in a cranial analysis using 17 of Howells' measures showed that the main discriminators from the Upper Palaeolithics were low frontal subtense, low vertex radius, high cranial breadth, high bifrontal breadth, high cranial length and low parietal subtense, against Neanderthals they were primarily low supraorbital projection, low frontal fraction, high parietal chord, high frontal chord, low frontal subtense and low vertex radius, while against Zhoukoudian *Homo erectus* they were low supraorbital projection, high parietal chord, high bifrontal breadth, high vertex radius, high frontal chord and low frontal subtense.

Overall it appeared that the cranium was "modern" in its low supraorbital projection, and long frontal and parietal chords, but "archaic" in its high cranial length, low vertex radius, and low frontal and parietal subtenses. Stringer's results highlighted apparent archaic aspects in the specimen in its long and rather low cranial shape, and although modern overall, it also resembled fossils such as Omo Kibish 2 and Ngandong in several respects, falling closer to them than to Upper Palaeolithic and recent samples in some analyses (Figure11: after summary diagram in Stringer 1974b).

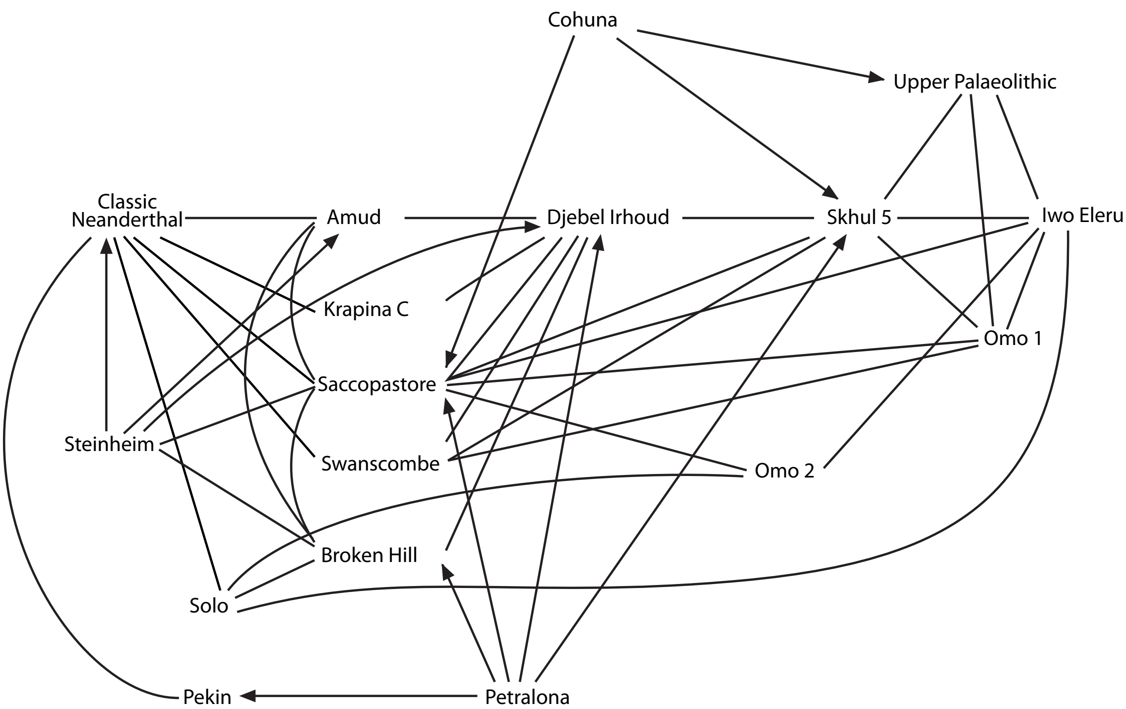


Figure 11: Comparative analysis of Iwo Eleru cranium (after Stringer 1974b).

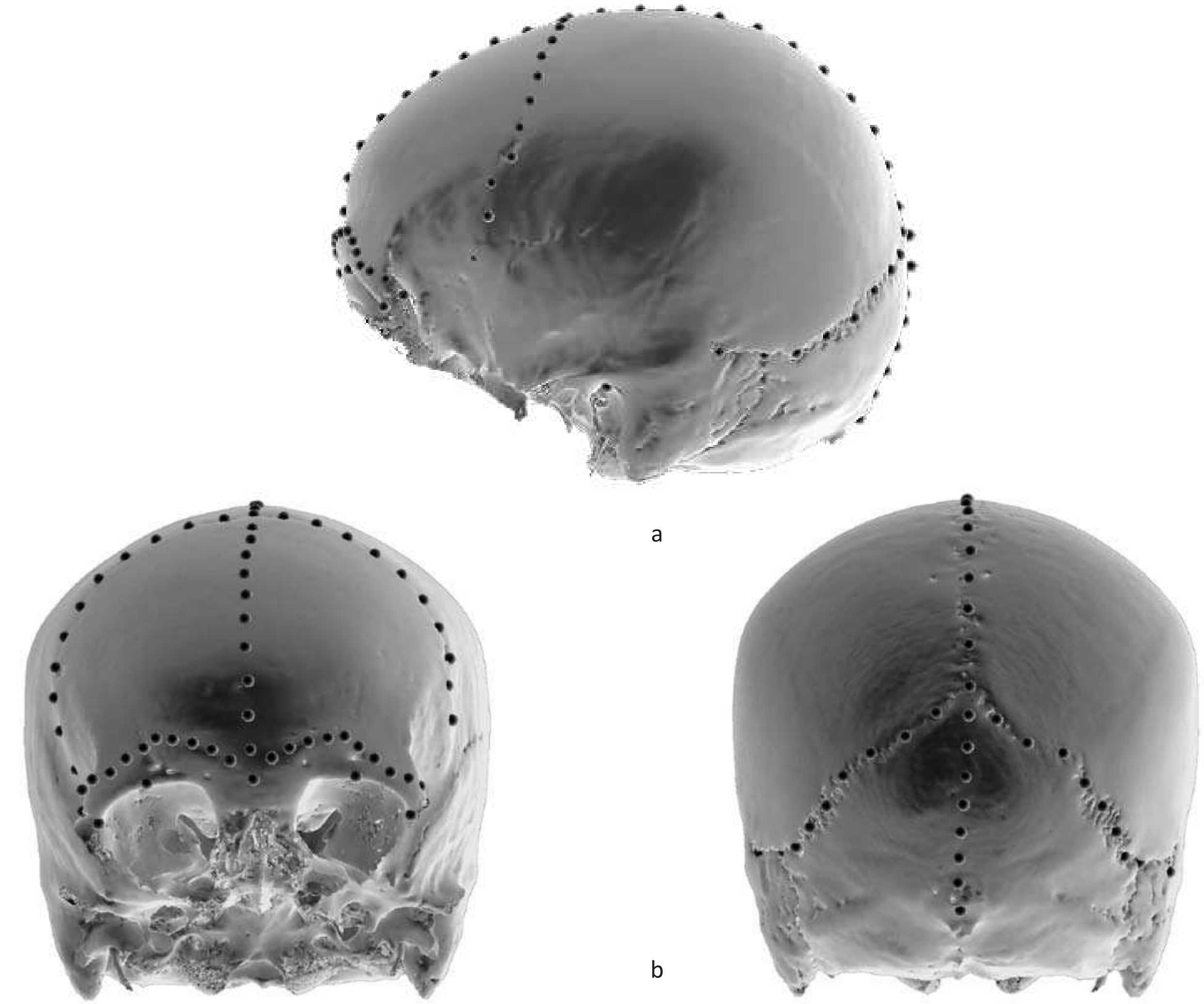


Figure 12 a and b. Coordinates of neurocranial osteometric landmarks.

A new geometric morphometric study of the cranial vault

Recently a primary replica of the cranial vault of the Iwo Eleru specimen, produced before its return to Nigeria, was digitized by Harvati and included in a 3-D geometric morphometric multivariate statistical analysis. Comparisons of Stringer's measurements on the original and the replica show a maximum discrepancy of 1 mm, suggesting that the replica accurately reflects the original shape of the cranium. The goal of this study was to evaluate the cranial shape and size of this specimen in the context of Middle and Late Pleistocene and Holocene human morphological variation in order to further assess its affinities and phylogenetic/population relationships.

Geometric morphometric approaches are complementary to and expand on traditional multivariate analyses based on linear and angular measurements, such as those conducted by Stringer. These coordinate-based methods better preserve the geometry of the objects studied and allow intuitive visualization of shape differences between either individual specimens or group mean shape configurations in specimen space (Rohlf and Marcus, 1993; O'Higgins, 2000; Harvati, 2003a,b; Harvati et al., 2007). Geometric morphometrics also readily account for size correction and provide a way of quantifying shape variability of traits which are difficult to measure with conventional measurements and are therefore usually described qualitatively (Harvati, 2003a; Nicholson and Harvati, 2006, Gunz and Harvati, 2007). The geometric morphometric study of the Iwo Eleru specimen included curve (semilandmark) as well as landmark data. Thus the analysis quantifies not only overall cranial shape, which is also reflected by traditional measurements, but also the detailed shape of particular anatomical regions, such as the supraorbital morphology.

Data were collected in the form of three-dimensional coordinates of neurocranial osteometric landmarks, defined as homologous points that can be reliably and repeatedly located, using a Microscribe (Immersion Corp., 1998) portable digitizer. Landmarks along the midsagittal profile from glabella to inion, along the coronal and lambdoid sutures, and along the upper margin of the supraorbital torus were also registered (Figure 12). The points along

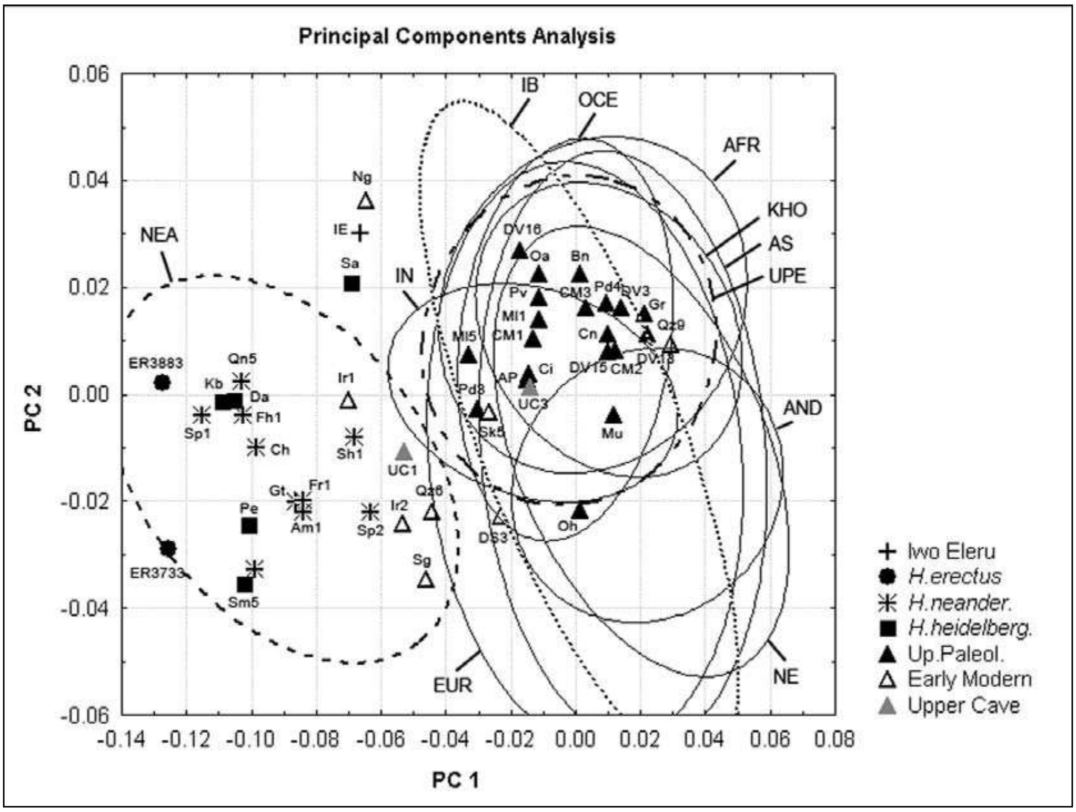


Figure 13: Position of Iwo Eleru cranium as determined by Harvati (present study).

these outlines were automatically resampled to yield the same semilandmark count on every specimen (Bookstein, 1997; see also Gunz and Harvati, 2007). These points were chosen so as to reflect the neurocranial morphology of the Iwo Eleru specimen as fully as possible. Semilandmarks were 'slid' in Mathematica (Wolfram Research, Inc., 2007) using routines developed by Philipp Gunz and Philipp Mitteroecker (see also Gunz and Harvati, 2007; Harvati et al., 2007). Finally, landmarks and slid semilandmarks were superimposed with Generalized Procrustes Analysis (GPA) using the Morpheus software package (Slice, 1998). The superimposed coordinates were then analyzed statistically using principal components analysis (PCA), canonical variates analysis, Procrustes distances, and Mahalanobis squared distances. These statistics were calculated with the software packages SAS (SAS Institute, 1999-2001), NTSys (Applied Biostatistics Inc., 1986-2000), and TPSsmall (version 1.20; Rohlf, 2003).

The comparative sample for this analysis comprised forty-seven Pleistocene adult human fossils from Africa and Eurasia, including specimens attributed to *Homo heidelbergensis*, Neanderthals, early anatomically modern humans and Upper Paleolithic modern humans. It also included two hundred and forty two recent human crania representing nine broad geographic groups, including Africans.

The preliminary results of this reanalysis (Figure 13) largely concur with the findings of Stringer (1974a). Iwo Eleru, while overall modern, appears to retain important archaic elements in its morphology that align it with specimens of early modern and late archaic humans. These retentions are evident both in the results of the statistical analysis as well as in the visualization of Iwo Eleru's cranial shape in comparison with the mean shapes of the various groups included in the analysis. A complete description of the 3-D analysis and its findings is currently being prepared for publication.

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