

The Lake Ndotu Cranium and Early *Homo Sapiens* in Africa

G. PHILIP RIGHTMIRE

*Department of Anthropology, State University of New York, Binghamton,
New York 13901*

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ABSTRACT The partial cranium from Lake Ndotu, near Olduvai Gorge in northern Tanzania, has generally been viewed as *Homo erectus*, although points of similarity to *H. sapiens* have also been recognized. Bones of the vault are in fact quite thick, and the cranium is small. Length and breadth dimensions are comparable to those of earlier *H. erectus* from Koobi Fora and Ileret, and the Ndotu individual is more similar in size to O.H. 12 than to O.H. 9. Unfortunately, the facial skeleton and frontal bone are very incomplete, and little useful information can be obtained from these parts of the existing reconstruction. The parietals are also damaged, but the left temporal is more satisfactorily preserved, and the occiput is nearly complete. Occipital morphology, mastoid shape, and characteristics of the glenoid cavity and tympanic plate probably provide the best available guide to affinities of the Ndotu hominid. In many of these features the cranium resembles Broken Hill, Elandsfontein, and other African fossils referred to archaic *H. sapiens*. There are some similarities to modern humans also, but no ties to the Neanderthals of Europe. Allocation of Ndotu to an African subspecies of *H. sapiens* seems most appropriate, even if the pattern of relationships between such archaic populations and recent humans is still unclear.

The origins of anatomically modern humans are still only poorly understood. Much of the debate bearing on this issue has been directed toward the hominid fossils from the Upper Pleistocene, often with Europe and the Near East as a primary focus. Whether the Neanderthal populations of this region evolved locally into people responsible for the cultural traditions of the Upper Paleolithic continues to be questioned. An alternate view, holding that modern *Homo sapiens* arose elsewhere and subsequently migrated into Europe to replace the Neanderthals, is actively supported. Even with the relatively large numbers of skeletons available, it is difficult to marshal evidence that decisively confirms one of these hypotheses or disproves the other. Given these problems, it is not surprising that still earlier developments in the history of our species have been outlined only in the broadest terms. Fossils from the earliest part of the Upper Pleistocene and later Middle Pleistocene are less numerous than Neanderthals, and the route(s) by which

H. sapiens evolved from more archaic ancestors (widely presumed to represent the species *H. erectus*) are also obscure. Here it is important to cast the net widely, as the relevant hominid discoveries come from Asia and Africa as well as Europe. In some regions, useful evidence is accumulating at an encouraging rate. New findings call for changes or adjustments in our interpretation of the fossil record, and in this report I discuss material from sub-Saharan Africa, with particular attention to the Ndotu cranium from Tanzania. Descriptive comments on the anatomy of the Ndotu hominid are provided, and some more general issues concerning the phylogeny of later *Homo* populations are then explored.

DATING AND STRATIGRAPHY OF THE NDUTU DEPOSITS

Lake Ndotu is a seasonal soda lake located at the western end of the Main Gorge at

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Olduvai, in northern Tanzania. Details of excavations conducted near the lake and of the 1973 discovery of the hominid remains have been published by Mturi (1976). The human cranium was uncovered in greenish sandy clay deposits, apparently laid down at or near the western shore of the Middle Pleistocene lake. Quantities of animal bones, mostly in rather poor condition, and a number of stone artifacts were also found in the excavated area. A few of the artifacts were in situ in the lake deposits, and these appear to represent an Acheulian industry, containing an unusually high proportion of spheroids and polyhedrons.

Dating of the Lake Ndutu deposits is problematical. The sandy clay in which the hominid and artifacts occur is overlaid by a hard, reworked tuff, several centimeters thick. It has been suggested that this layer may represent the Norkilili Member, as known from the upper part of the Masek Beds exposed at Olduvai. If this is the case, then the assemblage may approach 400,000 years in age. It is of interest here to note that J. Bada (unpublished) has obtained an isoleucine racemization ratio from Lake Ndutu bone which matches that reported for bone sampled from the Masek Beds.

However, Lake Ndutu lies outside of the immediate Olduvai tectonic zone, and it is not possible without more field work to be very certain of this correlation with the well-established Olduvai sequence. I am informed by R. Hay (personal communication) that the mineral content of the Ndutu tuff is similar to that of the Norkilili Member and different from that of the tuffs of the Masek lower unit. This suggests that the hominid is no older than the top of the Masek Beds. At the same time, mineralogic analysis does not fully distinguish between the upper Masek tuffs, and tuffs of the overlying Ndutu Beds at Olduvai. It is therefore quite possible that the cranium is younger than Masek age, but the Ndutu lower unit covers a lengthy span of time, perhaps several hundred thousand years. Just where within this range the hominid may fall cannot be established, but a later Middle Pleistocene age can be assumed.

DESCRIPTION OF THE NDUTU HOMINID

When the cranium was found in 1973, some bones, including much of the frontal and the sphenoid, and parts of the facial skeleton, could not be recovered. The tables of the broken parietals were separated in places, and

the intervening spaces had become filled with sandy matrix. This damage has since been repaired by Clarke, who has also reconstructed the cranial vault and as much of the face as is available (Clarke, 1976). Unfortunately, the specimen is still quite incomplete (Figs. 1, 2). Only small pieces of the frontal squama survive, but a section of the supraorbital rim bears the anterior temporal line on the left side. There is no contact between this bone and the frontal processes of the maxillae. In addition to the maxillary parts outlining the nasal aperture, the face is represented only by nasal and lacrimal fragments and by some of the left maxillary alveolar process containing the roots of C to M¹. Although both temporal bones are damaged, the squama and mastoid portion are nearly intact on the left. The parietal is reasonably complete on the right, but only fragments are present on the left side. The occiput, which lacks its basilar part, is quite well preserved.

Cranial measurements and endocranial volume

A number of measurements can be taken (Table 1), and it is clear that the Ndutu cranium is rather small, despite the massive build of some of the individual vault bones. An estimate for glabella-opisthocranion length is comparable to that obtained for ER-3733, the most complete of the *H. erectus* crania recovered from the East Turkana localities. There is a good deal of postorbital constriction, and the piece of left frontal carries a rounded torus which is about 10 mm thick, near the frontomalar suture. The brow ridge could not have been much heavier over the center of the orbit. Unfortunately, bone has been lost from the superior surface of this frontal fragment, so the full extent of supraorbital development cannot be determined. Ndutu seems similar to several of the smaller African *H. erectus* specimens (e.g., ER-3733 or O.H. 12) but is certainly no match to individuals such as Broken Hill or Bodo, which have much thicker brows.

The Ndutu vault is broadest at the supramastoid crests and is comparable in this respect both to *H. erectus* and to various early African *H. sapiens* crania (for example, Broken Hill, Elandsfontein, Omo 2). Because of damage, biparietal breadth cannot be measured accurately but must be somewhat less than breadth at the auditory openings. The occipital bone is striking for its thickness (12 mm at asterion) and is strongly flexed. The

TABLE 1. Measurements of the Ndutu cranium (in mm)

| | | | |
|---------------------------------------|------------------|------------------------|-----------------|
| Cranial length | 183 ¹ | Occipital sagittal arc | 111 |
| Supraorbital torus thickness, lateral | 10.5 | Occipital subtense | 30 |
| Basion-nasion | 105 ¹ | Occipital angle | 35 |
| Max. cranial breadth | 144 | Lambdoid chord (rt.) | 83 |
| Biasterionic breadth | 113 | Lambdoid arc (rt.) | 91 |
| Max. frontal breadth | 112 (?) | Lambda-inion | 61 ³ |
| Biauricular breadth | 128 | Inion-opisthion | 45 ³ |
| Height, ext. auditory meatus | 8.5 | Inion-asterion | 65 ³ |
| Midorbital chord | 72 ² | Interorbital breadth | 23 |
| Width, nasofrontal contact | 12 | Nasal breadth | 27 (?) |
| Occipital sagittal chord | 87 | Mastoid length | 27 |

¹These measurements are taken from a cast and make use of reconstructed landmarks. Readings are subject to substantial error.

²Measurement obtained by doubling the distance from zygoorbitale (the intersection of the orbital margin and the zygomaxillary suture) to the midline of the face.

³Inion is here considered to lie at the center of the linear tubercle (the junction of the superior nuchal lines) rather than higher on the occipital torus.

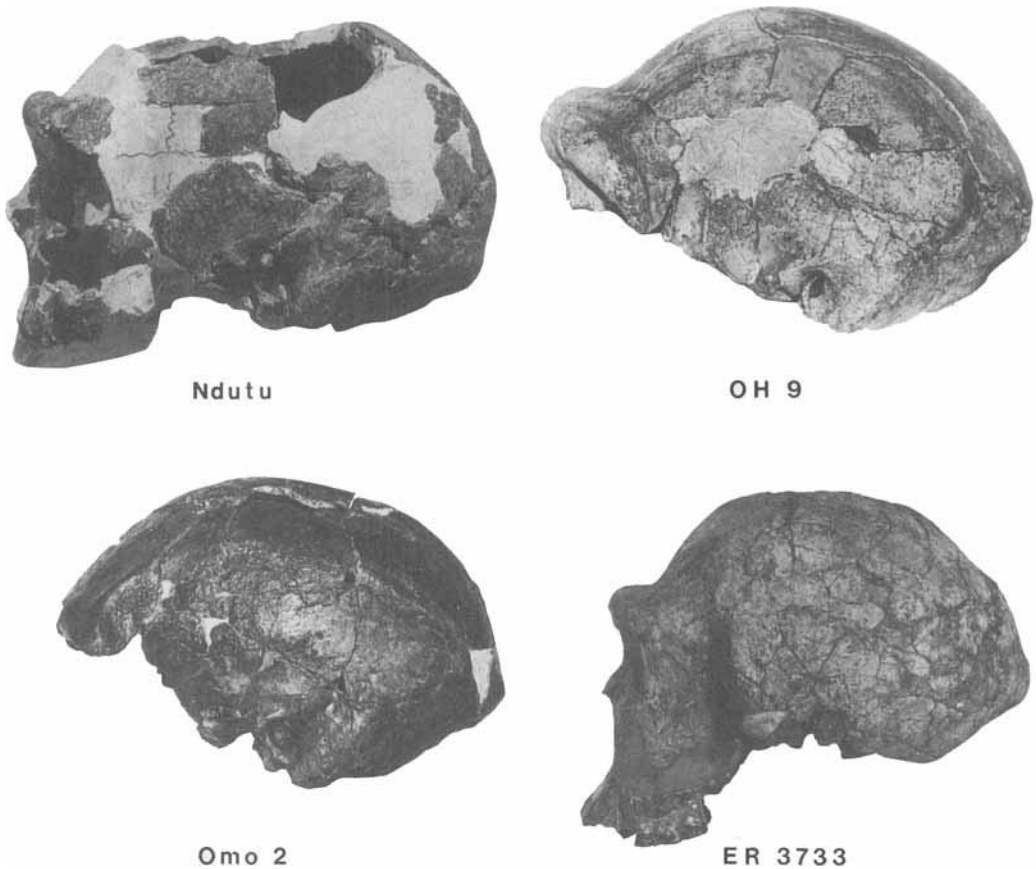


Fig. 1. Side view of the Ndutu cranium, for comparison with the more complete of the Omo (Kibish Formation) individuals, hominid 9 from upper Bed II at

Olduvai, and the best of the *H. erectus* crania from East Turkana. Specimens are shown only approximately to the same scale.

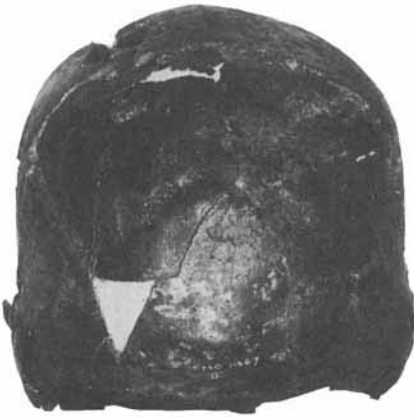
**Ndotu****OH 9****Omo 2****ER 3733**

Fig. 2. Occipital views of the Ndotu, Omo, Olduvai, and East Turkana hominids also illustrated in Figure 1.

Specimens are shown only approximately to the same scale.

upper scale is vertical, and the lambda-inion chord (61 mm) is longer than the inion-opisthion distance (45 mm), where inion is taken as the center of the linear tubercle. A relatively expanded upper scale is usually said to be characteristic of *H. sapiens* rather than *H. erectus*. However, this is not invariably the case, and Table 2 shows that Omo 2, for example, has a short lambda-inion distance

coupled with an extensive nuchal plane. Unfortunately, measurements of the Ndotu cranial base forward of the foramen magnum cannot be taken.

Cranial capacity for the Ndotu hominid has not been determined directly, although at least a partial endocast can probably be obtained from the reconstruction. Using instead my estimate for internal biasterionic

TABLE 2. Measurements taken on the Ndotu cranium and on other African individuals representing both *H. erectus* and early *H. sapiens*

| Measurement (mm) | Ndotu | ER-3733 | O.H. 9 | Salé | Broken Hill | Omo 2 |
|------------------------------|------------------|---------|------------------|--------|-------------|-------|
| Cranial length | 183 ² | 182 | 206 | — | 205 | — |
| Torus thickness ¹ | | | | | | |
| Central | — | 8 | 19 | — | 23 | — |
| Lateral | 10.5 | 9 | 14 | — | 16 | — |
| Basion-nasion | 105 ² | 107 | 119 ² | — | 108 | — |
| Max. cranial breadth | 144 | 142 | 150 | 137 | 145 | 147 |
| Biauricular breadth | 128 | 132 | 135 | 124 | 140 (?) | 132 |
| Max. frontal breadth | 112 (?) | 110 | — | 98 | 118 | 121 |
| Biasterionic breadth | 113 | 119 | 123 | 116 | — | — |
| Occipital chord | 87 | 88 | 80 ² | 77 | 87 | 106 |
| Occipital angle | 35 | 37 | — | 32 | — | 34 |
| Lambda-inion ³ | 61 | 57 | 54 ² | 58 (?) | — | 59 |
| Inion-opisthion ³ | 45 | 53 | 51 ² | 32 (?) | — | 74 |
| Mastoid length | 27 | — | — | 28 | 27 | 30 |

¹Supraorbital torus development is difficult to quantify in any standard fashion. One reading is taken in the center of the orbital margin, though this need not be the point of maximum thickness. The second measurement is taken close to the frontozygomatic suture, to gauge the extent of lateral attenuation of the torus.

²These measurements make use of reconstructed landmarks.

³Note that these measurements are influenced by the way in which inion is defined. If this landmark is considered to be on the linear tubercle (at the junction of the superior nuchal lines), then length of the occipital upper scale will generally be greater than when inion is located at the center of the transverse torus. Length of the nuchal plane will be reduced (or increased) accordingly. In the case of the Ndotu hominid, these measurement differences amount to as much as 5 mm. The figures given here are obtained by measuring to inion at the linear tubercle.

breadth, R. Holloway has come up with several predicted values for brain volume, and I am indebted to him for this help. Holloway's figures, based on regression and using both hominids and pongids as a guide, range from about 1,070 ml to 1,120 ml. An average is very close to 1,100 ml, and I have plotted this in Figure 3, which also gives the distribution of endocranial volume for *H. erectus*. This *H. erectus* distribution is based on 24 African and Asian specimens, including material from Olduvai, Turkana, Sangiran and other Indonesian localities, Gongwangling, and Choukoutien. The mean of these values is 994 ml, and Ndotu lies less than one standard deviation from this figure. The skull is small by modern human standards, and falls within the range of variation expected for *H. erectus*. At the same time, Ndotu cannot be excluded on grounds of cranial capacity from any reasonable distribution constructed for archaic (or even recent) *H. sapiens*.

Anatomy of the cranial vault and base

Attention to other aspects of anatomy, more difficult to quantify through measurement, suggests that Ndotu does share with *H. sapiens* some traits not considered characteristic of *H. erectus*. Although the Ndotu frontal is represented only by fragments, some of the squama has been reconstructed. The presence of a supratotal sulcus cannot be confirmed, but the frontal profile is steep behind

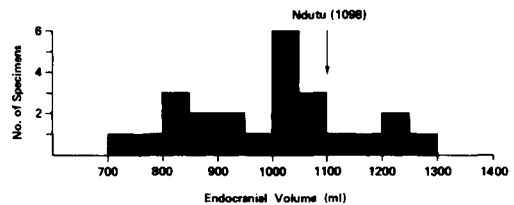


Fig. 3. The distribution of endocranial volume for 24 African and Asian *H. erectus* specimens (plotted using 50-ml intervals). Skulls are from East Turkana (2), Olduvai Gorge (2), Sangiran (6), Sambungmachan (1), Trinil (1), Ngandong (5), Choukoutien (6), and Gongwangling (1). For this sample, the mean is 993.7, the standard deviation is 148.3, and the observed range is 727–1,251. The capacity obtained by regression for the Ndotu hominid is also plotted.

the brows. However, a liberal amount of plaster has been incorporated into the supratotal region, and it is likely that frontal fullness has been exaggerated in the preliminary reconstruction. The central part of the squama, along with bregma and most of the coronal suture, is missing, so whether there was keeling in the midline cannot be ascertained.

There is no trace of any keeling or heaping up of bone on the parietal vault, although the sagittal suture is preserved along a length of some 65 mm. Both of the parietals are severely damaged. Even on the right, where more of the bone is intact, many fine cracks have had to be sealed, and plaster has

been used to fill out the original contour of the vault. Parietal bossing is emphasized in Clarke's reconstruction, and this gives the cranium almost a spherical form in superior view. This must be approximately correct, but in fact the actual extent of bossing is hard to assess. The parietals could probably be flattened, to give the walls a more sloping appearance. These adjustments would have to be minor, however, and I think that Clarke's (1976) claim that the Ndutu vault has walls that are more nearly vertical than would be expected in *H. erectus* is accurate.

On the right, the superior temporal line is faintly marked anteriorly, but is slightly raised as it passes from the parietal downward toward the mastoid region. There is no strong angular torus. The mastoid crest itself is well defined and extends along the full length of the short, pyramidal mastoid process. This crest forms the lower margin of a shallow supramastoid sulcus, which contains no sign of an anterior mastoid tubercle. Such a tubercle is said to be common among European Neanderthals (Hublin, 1978; Santa Luca, 1978). The sulcus is quite wide (approx. 18 mm) and is bounded above by a moderate supramastoid crest. The latter crest seems to extend posteriorly onto the parietal, as is the case with Broken Hill. Anteriorly, this crest joins the root of the zygomatic process. Where the morphology of this region is clearer on the left side, the posterior root of the zygoma does not appreciably overhang the external auditory meatus. The porus, broken above, appears to be elliptical in form, and its long axis is oriented nearly vertically.

The upper scale of the occipital is approximately vertical; the extensive, flattened nuchal area does not rise quite to the level of the horizontal plane. There is a well-developed transverse torus. This is prominent centrally and is still slightly raised at a distance of about 10 mm from the occipital margin. The superior border of the torus is clearly marked near the midline, where there is a roughened external occipital protuberance. Above this protuberance, there is an oval depression or supratoral sulcus. Here there is no uplifting of the surrounding bone to produce a triangular plateau of the sort usually associated with a suprainiac fossa, as described for Neanderthal crania by Santa Luca (1978). The morphology of this supratoral sulcus and the presence of a "true" external protuberance combine to give the Ndutu occiput an appearance unlike that of European Upper Pleistocene fossils. The to-

rus itself has a flattened surface, similar to that of Omo 2. Its lower margin is sculpted by the superior nuchal lines, which meet at a linear tubercle of low relief. The distance separating this tubercle from the protuberance above is 16 mm. Laterally, the superior lines can be traced toward the mastoid crests, and there are no retromastoid protrusions. Since the occiput has been damaged slightly near the midline, signs of an external crest are mostly lacking. Adjacent areas of the nuchal surface, including the posterolateral faces of the mastoid processes, are flattened or gently convex. Near the junction of the occiput with the mastoid portion of the temporal bone, there is a short, deep digastric incisure. The medial wall of this groove contributes to what has been called by recent workers either a juxtamastoid eminence (Hublin, 1978) or an occipitomastoid crest (Santa Luca, 1978; Olson, 1981). The latter term was employed by Weidenreich (1943), who noted that in the Choukoutien *H. erectus* material there is a distinctive ridge following the occipitomastoid suture. In the case of Ndutu, there is little involvement of the eminence posteriorly with the line marking insertion of the superior oblique muscle, and the morphology does not correspond to that described by Weidenreich for the Chinese fossils. Nor is this structure as exaggerated in size as in some (European) Neanderthal individuals.

The glenoid cavity is reasonably well preserved on the left side. It is deep and also comparatively short in anteroposterior extent. The lateral part of the articular tubercle and the ectoglenoid process are broken away, but enough of the articular surface remains to show that the forward wall of the cavity is gently convex. The tubercle itself is slightly raised and more prominent than is usually the case for *H. erectus*, where the front of the cavity grades smoothly onto the preglenoid planum. The floor of the fossa is straight from side to side and channel-like, and its width (ectoglenoid to entoglenoid) can be estimated as 25–30 mm. The medial wall of the cavity is damaged, and part of the entoglenoid process is missing. The sphenotemporal suture seems to bisect this process, but whether a sphenoid spine of the sort found in modern *H. sapiens* was developed from this region can no longer be determined. A prominent postglenoid process is present.

The tympanic bone is more complete, and the lateral aspect of the plate, surrounding

the auditory porus, is clearly thickened. Its inferior border is much thinner, as in more modern humans. From this border, there is no projection of what Weidenreich (1943) termed a "spine of the crista petrosa." But a styloid sheath is preserved, and on one side the root of the styloid process is still in place.

DISCUSSION

At the start of any discussion of the affinities of the Ndutu hominid, it should be recognized that neither the incomplete, heavily reconstructed facial skeleton nor the damaged frontal bone can provide much evidence relevant to identification of this individual. The parietals are in somewhat better condition, but here also there has been extensive application of plaster. Parietal bossing has probably been exaggerated in the reconstruction. In any case, neither here nor in the supraorbital region are there any compelling links to *H. erectus*. The Ndutu cranium is small, with relatively well developed brows and thick vault bones, but these are features found in some early *H. sapiens* as well as *H. erectus*. The well-preserved occiput and temporal bone exhibit characteristics that point more certainly in the direction of *H. sapiens*.

Resemblances to early African Homo sapiens

In his preliminary report, Clarke (1976) provides only limited comparative information, although he does note that Ndutu is unlike the Omo 2 and Broken Hill crania in several features. Ndutu is said to have a higher frontal contour than either of these archaic *H. sapiens* skulls and to differ from them also in mastoid form and other aspects of temporal anatomy. However, if supraorbital structures and morphology of the frontal squama are regarded as largely undeterminable, then differences are far less marked. In superior view, the Ndutu vault is somewhat more rounded than that of Broken Hill but is comparable to the cranium from Elandsfontein. A general resemblance of Ndutu to the Elandsfontein specimen is again apparent when the two fossils are viewed from the rear. Both skulls have walls that rise steeply from the supramastoid region and appear better filled than those of Broken Hill, although Ndutu may exhibit little if any of the parietal keeling which is a prominent feature of the Elandsfontein vault. Occipital morphology is also broadly similar in all of these African hominids. The upper scale varies in orientation but is approximately vertical, rather than forward-sloping as in many

H. erectus skulls. The occiput is strongly flexed, and a transverse torus is prominent. The Ndutu torus, which is moundlike and presents a flattened surface, is like that of Omo 2 rather than similar to the more sharply defined tori of Broken Hill and the Elandsfontein cranium.

In other aspects of occipital anatomy and in details of mastoid architecture, Ndutu is especially close to Broken Hill. In both individuals, the extensive nuchal area is flattened or slightly convex, with some relief resulting from muscle insertions. The superior nuchal line can be followed onto the mastoid process, where it merges with the mastoid crest. This crest is strongly developed superiorly and is continued toward the tip of the process; it does not give rise to a distinct protuberance or tubercle behind the external auditory meatus. The posterolateral surface of the mastoid itself is flattened rather than convex. A deep digastric incisure is present, and there is some heaping up of bone on its medial side to form an eminence. In Broken Hill, this is accentuated by hollowing of the adjacent attachment for Rectus capitis posterior major, but an occipitomastoid crest in the sense of Weidenreich (1943) is not produced. In both skulls, the eminence carries a narrow channel, probably for the occipital artery. No clear occipital groove is otherwise apparent. Protrusion of this entire juxtamastoid complex is not nearly as extreme as in Neanderthals, and rather resembles the condition seen in many modern human crania.

The glenoid cavity of Broken Hill is shallower than that of Ndutu, and the articular tubercle is slightly hollowed near the zygomatic root. Here as in Ndutu, however, the tubercle is prominent enough to stand out in some relief against the preglenoid surface of the temporal. The small entoglenoid process is primarily of temporal origin, but the sphenotemporal suture passes just to its medial side and there is a definite sphenoid spine. This spine is not particularly projecting but is oriented in about the same way as in modern *H. sapiens*. Its medial border is flattened and appears to form with the adjacent tympanic bone a narrow groove for the cartilaginous part of the auditory tube. Unfortunately, the lateral portion of the Broken Hill tympanic plate is damaged, although a heavy sheath for the styloid is still preserved. A circular opening marks the position of the styloid process. More medially, there is some irregular thickening of the

plate, but in most respects the tympanic anatomy of both Broken Hill and Ndotu is similar to that of recent humans.

All of this suggests that the Ndotu hominid is not too different from other eastern and southern African representatives of archaic *H. sapiens*. The small size and relatively low cranial capacity estimated for Ndotu may also indicate that this individual is female, as noted recently by Wolpoff (1980). Wolpoff's study is directed principally toward European specimens of the later Middle Pleistocene, with emphasis on Petralona, Steinheim, and other fossils for which facial parts are preserved. As a result, many of the features he lists as (probably) sex-related cannot be measured or assessed very accurately in the Ndotu case, where the facial skeleton is fragmentary. Neither orbital proportions, shape of the maxillary zygomatic processes, glabellar prominence, nor much of the original outline of the supraorbital torus or of the supratatorial surface can be reconstructed. Other features of the occipital, along with absence of very strong muscle markings and small size, certainly do not contradict the identification of Ndotu as a female. But where cranial material is incomplete, and diagnostic postcranial remains are lacking, determination of sex must always be difficult.

Problems in the recognition of fossil species

Questions of sorting or identification of Ndotu are important, as the distinction between *H. erectus* and *H. sapiens* need not be as arbitrary as is commonly argued, particularly by paleontologists who favor a gradualistic interpretation of the hominid record. Other workers who are inclined to accept a punctuational view of human evolution see species as more stable entities, separated by morphological gaps representing brief episodes of rapid change. Whether *H. sapiens* evolved from populations of *H. erectus* gradually, or rapidly during a short pulse of evolution late in the Middle Pleistocene, has not been settled, although a good deal of attention has been focused on this problem. Models of punctuational change (Gould and Eldredge, 1977; Stanley, 1979) or arguments for stasis in mid-Pleistocene human populations (Rightmire, 1981a), which contrast with recent expressions of support for phyletic gradualism (Cronin et al., 1981), are all defended by reference to the fossil evidence. So far, there is no agreement even whether the hom-

inid record itself is reasonably complete, rather than quite inadequate owing to accidents of sampling and poor preservation.

One point seems clear: There are real and intractable difficulties with dating many of the available human fossils, including the Ndotu hominid. Ages often cited for some of the more important assemblages may be in error by thousands or hundreds of thousands of years. This is a serious problem, if one is trying to detect (speciational) events that may have occurred relatively rapidly, over intervals of 50,000–100,000 years or less. Other issues will also have to be resolved, if we are to apply the fossil evidence toward satisfactory settlement of controversies surrounding the tempo and mode of evolution in the *Homo* lineage. There is uncertainty as to how much change, accumulating among known *H. erectus* assemblages for example, can be attributed to normal variation within a stable taxon—i.e., one undergoing evolutionary stasis throughout most of its history. What criteria should be used to distinguish situations of “no change” from cases in which trends are present? Should all characters be treated equally in this assessment, or are changes in certain key “species-specific” characters to be weighted differently from variation in features shared with other taxa? Also, what sorts of morphological gaps, if any, may be expected to separate “good” species as recognized from fossil material? Presumably, if one of several possible rapid modes of speciation is operating, and if it is assumed that major morphological changes resulting from genetic reorganization are associated with discrete speciation events, there should be little difficulty in sorting members of one taxon from others representing a descendant group. Individuals sampled from small, regionally restricted, transitional populations should be rare or non-existent in the record. But just how large or obvious these gaps should be is unclear, as far as later *Homo* species are concerned. As with other organisms, there is some danger of confounding the attempt to document patterns of change in lineages with the process of species identification (Levinton and Simon, 1980). At present, it is not easy to decide whether specimens exhibiting intermediate morphology should be viewed as falling within the expected limits of one taxon or rather as representative of populations that are transitional in an actual phylogenetic sense. Recognition of populations of

the latter sort, spread over a substantial geographic range, would provide support for gradualism. Such questions cannot be answered easily, but the extent to which the Ndotu hominid displays characters common to two *Homo* taxa certainly merits close consideration. Clarke (1976) has suggested that this fossil forms a "link" between *H. erectus* and *H. sapiens*. My own view is that occipital characteristics, morphology of the glenoid cavity, and anatomy of the tympanic plate of the Ndotu cranium are all consistent with identification as *H. sapiens*.

Subspecies versus evolutionary grades

If Ndotu is accepted as *H. sapiens*, then another issue is whether the fossil should be allocated to one of several named subspecies, recognized on geographic or chronological grounds. The Tanzanian material might reasonably be referred to *H. sapiens rhodesiensis*, for example, along with such other skeletons as Broken Hill, Elandsfontein, and probably the Bodo find. This use of subspecific designations is one that I have advocated before (Rightmire, 1976, 1981b), although Howells (1980) has noted that it may be problematical. Such a scheme implies that a mid-Pleistocene African subspecies must be broadly ancestral to all later *H. sapiens* and/or that subspecies of sub-Saharan Africa and Europe (the Neanderthals and their antecedents) must share a common stem from *H. erectus*. Although archaic *H. sapiens* appears to be present at an early date in Africa, both of these assumptions can be questioned. The fossils are scattered, poorly preserved, and not adequate to permit testing with confidence of phylogenetic hypotheses. The position of the Omo (Kibish Formation) crania in regard to *H. sapiens rhodesiensis* is still debated. Omo 2 does share some characters with Broken Hill and Elandsfontein, but this individual differs from Broken Hill in the greater breadth and flatness of its frontal, and the supraorbital torus is not so thickened. The Omo 1 vault is higher, with a more rounded parietal profile. Another cranium, ER-3884 from the Guomde Formation of East Turkana, is similar in many respects to Omo 2, although fragments of frontal suggest that the brow is heavier laterally. At the same time, the occiput is rounded and recalls the morphology of Omo 1. So, there may now be less reason to emphasize the differences between the two Omo skulls, and there are firmer indications that

populations differing from Broken Hill in occipital as well as frontal features were established in eastern Africa. Here the lack of good dates is especially bothersome. Without more information, it is difficult to assess ties of the Omo and Turkana fossils with either *H. sapiens rhodesiensis*, other archaic *H. sapiens*, or modern humans.

An alternate course is to assign the fossils to broad evolutionary grades, identified by numbers rather than by formal names. In a framework devised recently by Stringer et al. (1979), African individuals including Broken Hill and Bodo and European hominids from Petralona and Bilzingsleben may be placed in *H. sapiens* grade 1. Some of the earlier European Neanderthals are allocated to grade 2, perhaps along with Steinheim and Swanscombe. If this is accepted, then the Ndotu cranium can presumably be lumped with the grade 1 specimens. There are no clear links with the later Neanderthals or Neanderthal-like Europeans of grades 2 and 3. However, this does not tell us a great deal. In the grade system, groups are not constructed to correspond to biological units such as subspecies, and the members of one grade cannot be regarded as necessarily ancestral to those of a succeeding level. A concern for ancestors may be taken too far, but it would appear to make sense to sort the fossils into groups that do have meaning as biological entities, even if we do not wish to name these as taxa. It is in fact the pattern of relationships between such groups that is interesting from a phylogenetic perspective. By this reasoning, the Ndotu hominid is better left in a sub-Saharan African subspecies of *H. sapiens*, even if we are not sure of the ties between this subspecies and other humans. This makes more explicit an hypothesis about relationships, which can be explored as additional information comes to light.

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