

Univ., Berkeley, private communication). The sandy clay unit can be further subdivided into sandy clay and silty clay subunits. To the north, along the shore, a hard, re-worked tuff, 10–12 cm thick, overlies the claystone. The occupational floor containing the skull rested on the silty clay subunit, and below it, resting on sand-free, green clay, were *in situ* lithic and faunal materials of what has been tentatively designated the second occupational floor.

The surface of the western margin flats are littered with lithic and faunal material but one problem concerns its provenance. Although the water level fluctuates at present it is not at all clear whether a similar situation obtained during the period when early man used either the lake or its vicinity as camping and hunting grounds. Did early man camp at the site seasonally during lacustrine recessions, or did he camp in the area when the lake was either non-existent or had dried up during such climatic oscillations as are known to have occurred elsewhere in the Pleistocene epoch? Or has the lithic and faunal material been brought into the area from elsewhere?

During the excavations it was found that there is a noticeable disconformity between the sand-free, green clay unit, and the overlying greenish, sandy-clay unit. Several small channels were cut into the green clay, in some cases to a depth of approximately 30 cm. Lithic and faunal materials were found at the bottom of the channels. It is, therefore, possible that early man camped or hunted at the lake shore when there was a minor climatic change which either resulted in the lake temporarily drying up or the level of the lake receding. This hypothesis is supported by the fact that it is only the sandy clay unit which is fossiliferous and contains implements. Although some of the artefacts are rolled it is nonetheless possible that both the lithic and faunal materials are archaeologically *in situ*; the rolling could be a consequence of the constant seasonal movements of lake currents.

During September and October 1973, an area of approximately 140 m² was excavated. The excavated deposits were situated in an area containing considerable amounts of surface lithic and faunal material. An area of approximately 80 m² included a high density of *in situ* lithic and faunal materials. It was in this area that the first and second occupational floors were exposed.

The *in situ* lithic materials are characterised by a very low percentage of finished tools. In the first floor, among the 270 plotted lithic and faunal materials only 20 are definitive tools (about 7.7%). Among the tools, spheroids and hammerstones predominate. There are six flakes in all, three of which are regular—two triangular and one rectangular. The remaining three are irregular. The cores are amorphous. Quartz and quartzite are the predominant raw material. The loose finds from within the sandy clay subunit overlying the first floor confirms this analysis. They include five cores, four regular flakes (one with retouched edges), three irregular flakes, one core scraper, two quartz pebbles probably used as hammerstones, and twenty-two waste flakes.

The tools represented in this collection are rather non-descript and of an indeterminate industry. Although hand axes and cleavers occur in the surface material, they are few, and even among the surface collections spheroids seem to be the predominant tool type, with cores also well represented. The absence of hand axes and cleavers among the *in situ* artefacts raises the question of the type of industry represented. The type of hominid represented by the skull is generally thought to be associated with the Acheulean industrial complex. The tentative date of the site as well as the mineralogical contents of the deposits also place the site within the chronological boundaries of the Acheulean industrial complex in the Olduvai Gorge and other sites in Tanzania and eastern Africa. Two possible hypotheses can be used to explain the absence of the tool types widely found

in the Acheulean industrial complex. Either the assemblage belongs to a different cultural and technological continuum and belongs to an industry post-dating, or contemporaneous with, later phases of the Acheulean industrial complex, or it belongs to the Acheulean, and the area excavated is only an indication of activity patterning. The latter hypothesis seems to be the most likely, and is supported by the fact that hand axes and cleavers, though few, are represented in the surface materials; moreover, excavation of a small trench on the site revealed an *in situ* hand axe (M. D. Leakey and R. Hay, private communication). The presence of a very high percentage of faunal materials in the collection—about 94 out of the 270 plotted *in situ* materials of the first floor are splinters and sizeable bone pieces including horns and antlers—seems to suggest that the area was probably a butchering site, though the presence of a hominid skull among the collection in such a context would be rather enigmatic.

The tuff overlying the claystone probably represents the Norkilili Member of the Masek Beds of Olduvai, though the possibility that it represents the lower unit of the Ndutu Beds cannot be ruled out (R. Hay, private communication). One preliminary chronometric date has been obtained from bone found in the first occupational floor, and preliminary racemisation measurements suggest a general age of ~500,000–600,000 yr (J. L. Bada, private communication). A sample of bone from the Masek Beds of Olduvai has given similar results.

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New cranium of *Homo erectus* from Lake Ndutu, Tanzania

I DESCRIBE here the humanoid cranium recovered by Mturi¹ during excavations at Lake Ndutu in northern Tanzania. A fuller description will be published elsewhere.

The cranium is remarkable in that it seems to form an evolutionary link between *Homo erectus pekinensis* and *Homo sapiens*, having features in common with both. It cannot, however, be classified as *Homo sapiens*, and in spite of its strong resemblance to *H.e. pekinensis* its more advanced characteristics and its occurrence in Africa rather than Asia may eventually warrant the creation of a new subspecies of *H. erectus* to accommodate it. This will be determined following full comparative studies.

The specimen is similar to *H.e. pekinensis* in the following features:

- The form and contour of the occipital, which has a markedly thickened nuchal torus.
- The form of the mastoid region.
- The almost vertical forehead.
- The inferred supraorbital torus.
- The great thickness of the vault.
- The outline, as seen in norma verticalis.

The cranium differs from *H.e. pekinensis* and is similar to *H. sapiens* in the following features:

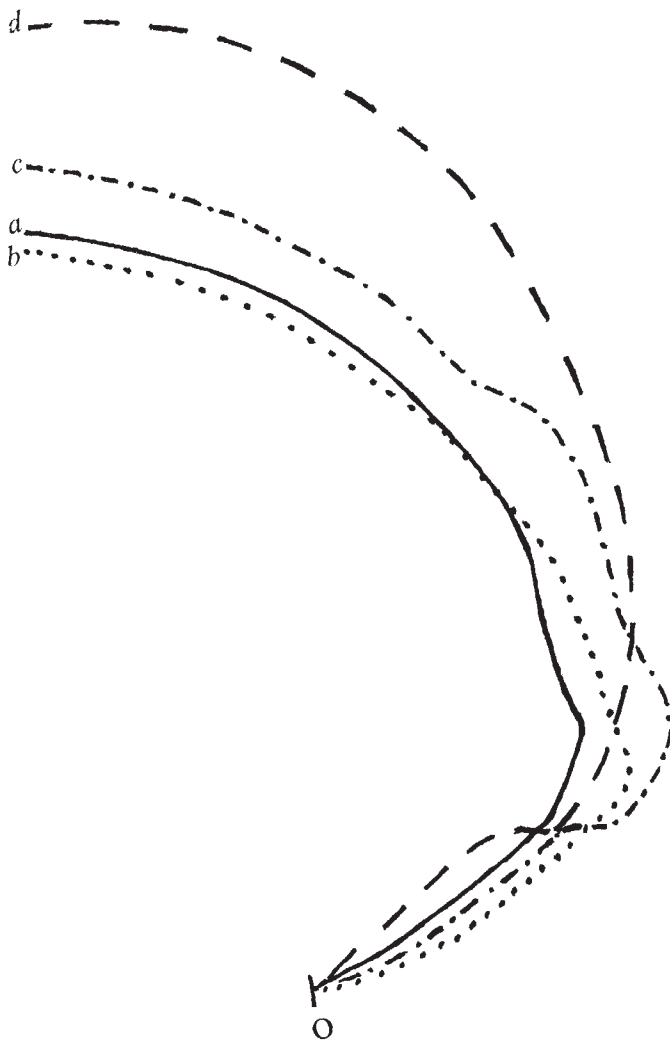


Fig. 1 Mid-sagittal craniograms of the occipital region: a, Ndotu cranium; b, *H.e. pekinensis* (Skull III from locus L); c, Ngandong (Solo), Skull V; d, Australian aborigine; O, opisthion. Adapted from Weidenreich².

- The presence in the adult of pronounced parietal bosses.
- The more vertical sides of the vault as viewed in norma occipitalis.
- The presence of an ossified styloid process.
- The apparent absence of a sagittal torus.
- The supramastoid crest does not extend over the external acoustic meatus.

The Ndotu cranium is housed at the National Museum of Tanzania in Dar es Salaam. The specimen includes the virtually complete occipital and left temporal; the right temporal lacks the glenoid fossa, parts of both parietals and part of the right side of the frontal, parts of the sphenoid, and the fragmentary central region of the face which is attached to a fragment of the left maxilla. In addition, there are isolated right tympanic plates and both isolated petrous temporals.

Before reconstruction the parts of the cranium were very much broken and separated, but were retained in their approximate anatomical position by a matrix of sand and clay which was impregnated with a hardener (Bedacryl) before the cranium was removed from the site. Much of the parietals had suffered badly from cracking and fragmentation, and also from a displacement of inner and outer tables. In parts the inner table only was present and in others only the outer table in the form of a thin shell with the diploë missing. In other places the inner and outer tables had been pushed apart from the diploë, and the spaces between were filled by the sandy matrix, thus giving an artificial, exaggerated thickness to the vault.

The occipital is nearly complete, lacking only the left occipital condyle and some small areas near the foramen magnum. The foramen magnum measures 37.5 mm in anteroposterior length and 28.7 mm in breadth. The apex of the occipital is represented by a sutural bone. There is also a sutural bone to the right of this along the lambdoid suture. On each side there are two small sutural bones at asterion, but one of those on the right had fallen out and was not recovered during the excavation.

There is a well developed nuchal torus as in *H.e. pekinensis*, giving the bone a markedly angulated lateral contour (Fig. 1). The bone is fairly thick, particularly at asterion.

The left of the temporals is the more complete. Its mastoid process is small and of a triangular horizontal cross section. The posterior part of the mastoid is flattened and lies in the nuchal plane. The mastoid is thus similar to that of *H.e. pekinensis*, and is particularly similar to that of Olduvai hominids 9 and 12. There is a well defined mastoid notch which is divided along its length by a central ridge.

An ossified styloid process is present and can be seen particularly well under cover of the isolated right tympanic plate.

The lower margin of the external acoustic meatus preserved on the left is thick and elongated in a downward direction.

A supramastoid crest can be seen, but it does not extend over the external acoustic meatus as in *H.e. pekinensis*.

The left glenoid fossa is deep, relatively small and short anteroposteriorly. The articular tubercle lacks its lateral margin.

The bone at asterion is very thick as is the case in *H. erectus pekinensis*.

The right parietal is missing large areas around its centre and anteromedially, but it has contact laterally at the coronal suture with a frontal fragment. The conformation of the bone around the centre of the parietal indicates that it had a pronounced parietal boss. The parietal thickness at a point anterior to the boss is 11.5 mm. This is well within the upper range of parietal thickness given by Weidenreich² for *H.e. pekinensis*, and much thicker than the range he quotes for *H. sapiens*.

The left parietal is represented mainly by the posteromedial portion externally and the posterolateral portion internally. The anterior part is missing but an anterolateral fragment adjoins the squamous part of the temporal. The left parietal is in articulation with the occipital and left temporal at asterion.

The temporal line is seen only very faintly on the right parietal and, from the contour of the surface of the parietals near the sagittal suture, there was apparently no sagittal torus, such as occurs in *H.e. pekinensis*.

The preserved right frontal fragment is 8.6 mm thick and thus well within the range of 7.0–13 mm given by Weidenreich² for *H.e. pekinensis*, and is at the same time greater than the maximum of 6.3 mm he quotes for *H. sapiens*.

The anterolateral corner of this frontal fragment curves forward and outward, indicating that there must have been a supra orbital torus in order for that fragment to meet with the glabellar fragment attached to the face. The glabella together with the face, could not be placed further back because it is restricted by other anatomical features such as the cribriform plate of the ethmoid bone, and by the necessity for room for the anterior fibres of the temporalis muscle. In reconstruction, allowance was made for only the smallest supraorbital torus permitted by the preserved anatomy, but it is possible that a larger torus could have been present.

The frontal bone rises in a high curve of the forehead as in *H.e. pekinensis* but unlike the frontals of *H. erectus erectus*, the Ngandong crania or the Broken Hill cranium.

The middle portion of the face is preserved, including much of the nasal aperture, the upper part of the left nasal bone, the lower medial parts of the orbital rims together with the lacrimal grooves, and much of the superior part of the right orbital plate. The crista galli is present and is attached to the cribriform plate behind the nasal bones.

On the right, the medial part of the face is preserved as far down as the infraorbital foramen, and on the left there is continuous bone contact from the nasal bone to the palate. The



Fig. 2 *a*, Right norma lateralis of the Ndutu cranium; *b*, left norma lateralis of the Ndutu cranium.

conformation of the bone around the nasal aperture, and the angle between the nasal bones indicate that the nose was very prominent.

The left portion of the palate contains fragments of the roots of the canine, P³, P⁴ and M¹ and the mesiobuccal socket of M². This palatal fragment reaches almost to the midline of the cranium.

Areas of the cranium were reconstructed with plaster of paris both to strengthen the parietal region, where either inner or outer tables only were preserved, and to attach the face to the rest of the cranium. This reconstruction was minimal and preliminary. The reconstruction suggests that slight adjustments can be made to the position of the face, but this will not affect the conclusion that a supraorbital torus must have been present originally. The size and shape of the maxilla remain unknown as it is extremely fragmentary. The top of the cranium has been left open in order that the internal anatomy can be seen.

The cranium (Fig. 2) has some similarities to Olduvai hominid 12 in the thickness of the vault and the shape of the mastoid, but it is much larger. It differs from the Ngandong and Omo II crania in its outline as seen in norma verticalis. The former have a more rectangular outline whereas the Ndutu cranium and *H.e. pekinensis* have a pear-shaped outline. It differs from Ngandong and Omo II also in possessing a more vertical forehead, though it is similar to Ngandong in the morphology of the temporal. The mastoid of the Ndutu cranium differs from that of Omo II. It differs from the Broken Hill cranium in its temporal and frontal and in being much smaller. It differs from Swanscombe and Steinheim in its occipital curvature and in that the mastoid of Steinheim is sapient in form. It differs also from Skhul V in its occipital and mastoid. It bears little comparison with *H.e. erectus* except in vault thickness and in its

outline seen in norma verticalis. The mastoid region is similar to that of Olduvai hominid 9, but otherwise, apart from thickness of the vault, there is little resemblance.

It would have been of interest to compare the Ndutu cranium with that of the Eyassi I cranium³ but unfortunately the original disappeared in Berlin in 1945 according to Weinert³, and available casts are too poor to allow comparison. Published descriptions and photographs are also not of any great help because the cranium was reconstructed from fragments, and it is difficult to ascertain what is reliable. In spite of all of these deficiencies, the Eyassi cranium does seem to have been rather similar to the Ndutu cranium. It was found not far away from Lake Ndutu in a similar deposit on the shore of the saline Lake Eyassi. It had also undergone separation of inner and outer tables of the vault bones, probably as a result of alternating crystallisation and solution of the salt within the diploë. A few broken handaxes and an early water-rolled fauna also occurred at the site, but Leakey^{4,5} considered the cranium to be contemporary with an unrolled modern type of fauna, and with levalloisian artefacts that were also to be found on the surface. The possibility should not, however, be dismissed that the Eyassi cranium could have been contemporary with the hand axes and the rolled fauna. This is supported by the fact that, although Leakey⁴ has described the skull as unrolled, Weinert³ has claimed that the edges broken in antiquity were rounded and rarely fitted together.

The Eyassi II occipital fragment, which is preserved in the National Museum in Dar es Salaam has some similarity to that of the Ndutu cranium.

Finally, it is of interest to note that Dr Peter Andrews subjected the Ndutu cranium to a form of multivariate analysis described by Andrews and Williams⁶. He found that the cranium grouped with *H.e. pekinensis*, thus confirming by measurement the conclusion reached through observation.

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Antennal receptor response to sex pheromone mimics in the American cockroach

THE essential oils D-bornyl acetate, α - and β -santalol and several plant sesquiterpene hydrocarbons have been shown to induce sexual excitement in male American cockroaches¹, and thus seem to mimic the cockroach sex pheromone. Tahara *et al.*² have identified one of the active sesquiterpene hydrocarbon species obtained from Compositae plants as germacrene D. The contrast in structures of these various active compounds poses a serious problem as to the specificity of the sex pheromone receptor. To resolve this we have undertaken an electrophysiological study of the antennal receptors of both male and female cockroaches. The electroantennogram (EAG) responses of both sexes were examined during exposure to the compounds in question. Theoretically the sex specific receptors of the male