Surprise Findings in the Taung Child's Face

Some of the most important recent developments in paleoanthropology focus on diagnositic features in the face, which, in Taung, raises questions

When, 60 years ago in February, Raymond Dart claimed he had found the first fossil of an early human ancestor in southern Africa, he faced a mixed reaction of indifference and scornful rejection from the anthropological establishment. British authorities, at the time in the thrall of the fraudulent Piltdown man, dismissed Dart's fossil infant cranium—known as the Taung child—as nothing more than that of an extinct ape akin to a chimpanzee (*1*). More than 20 years were to pass before Dart's claim was to be widely accepted. The recent international symposium* held to mark the Taung child's diamond jubilee highlighted the fossil's troubled past and its still somewhat uncertain present.

For instance, although virtually all authorities would place the Taung fossil—and the species it represents, *Australopithecus africanus*—within the human family, the Hominidae, there is still disagreement over its position on the tree. Specifically, is *A. africanus* part of the main trunk leading to our own genus, *Homo*? Or is it on a specialized sidebranch, leading to extinction?

The Taung child's age was also called into question, both in geological (see box) and individual terms. Although many experts have estimated that he (the fossil does appear to be male) lived some 2 million years ago, there was one suggestion that it might be nearer to 1 million and another that perhaps it was more like 3 million. And while the child himself has usually been considered to have died at the age of 6 years, new evidence indicates he was only three.

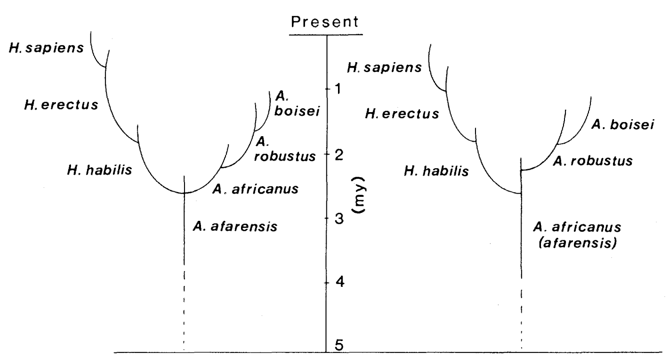
One of the most striking features of the recent gathering, however, was that paleoanthropology appears to be on the brink of something of a new era, an era in which the application of powerful techniques, including computerized tomography, will read in the fossils details of anatomy unimagined just a few years ago. A glimpse of the semicircular canals of the inner ear, entombed in a 2-million-year-old, rock-hard fossil cranium, caused quite a stir, for instance.

The gathering, properly held in South Africa, where the first australopithecines were unearthed, inevitably suffered some political attention, most prominent of which was the absence of Mary Leakey, who sent regrets that she could not visit from Kenya. A pity, because the symposium's organizer, Phillip Tobias, and the host institution, the University of the Witwatersrand, are openly and staunchly fighting the system to which outsiders rightly object. And the subject of the meeting—the evolution of humans from "lower" forms—can have had few supporters within the government, which is in effect the Dutch Reformed Church in power and no advocate of the theory of evolution.

First, Taung—*A. africanus*—should be put in the context of discoveries that followed it. South Africa, and subsequently East Africa, yielded more australopithecines of the same type as Taung and a second, more robust form, named *A. robustus* in the south and *A. boisei* further north. Representatives of our own genus also turned up, to wit, the relatively primitive *Homo habilis* and the more advanced *H. erectus*. One very reasonable, but by no means universally accepted, family tree put *A. africanus* as the common ancestor of the robust australopithecines on the one hand and *Homo* on the other.

Alternate trees

The tree on the right maintains Taung's position as a direct human ancestor. On the left it is relegated to a sidebranch.



This neat tree has been shaken in recent years with the introduction of a new member of the family, *A. afarensis*, which has been found in Ethiopia and Tanzania. If *afarensis* is indeed a valid species, over which point there is some dispute, the question of its position in the tree remains to be solved. Is it simply a forerunner of *africanus*, which would leave Taung as a representative of the common ancestor of the robust australopithecines and ourselves? Or is *afarensis* the common ancestor, with *africanus* already on the sidebranch leading to its robust relatives?

The authors of *afarensis*, Don Johanson of the Institute of Human Origins, Berkeley, and Tim White of the University of California, Berkeley, prefer the latter interpretation (*2*), and are supported in this view by many workers. Tobias, who is Dart's successor at the University of Witwatersrand, Johannesburg, inclines to the former, but considers *afarensis* simply to be a geographic variant of *africanus*, which restores the status quo for Taung (*3*). Still others argue that the true picture is rather more complicated than this simple Y-shaped tree, involving yet-to-be-recognized species. The presentations at the recent gathering variously supported these different positions, of which more later.

One of the early presentations told a story of the striking combination of techniques both new and old, which yielded some truly exciting insights into the evolutionary origin of the australopithecine face and cranium. The work, by Tim Bromage of University College, London, involved the comparison of the growth dynamics of the face of the Taung child, chimpanzees, and modern humans.

It is clear from the gross anatomy that chimpanzee's face protrudes in characteristic apelike fashion, a human face is pretty much flat, while the adult australopithecine face is somewhat intermediate. Chimpanzees have characteristic browridges, even in infancy, which humans and the gracile australopithecines more or less lack, especially in infancy. The question Bromage asked was, how are these different results achieved through infant growth patterns?

The overall size and shape of an infant's face and cranium changes as it matures. The process is achieved by

*Taung Diamond Jubilee International Symposium, 27 January to 4 February, University of the Witwatersrand, Johannesburg, and University of Bophuthatswana, Mmabatho.

patterns of bone deposition and resorption that are characteristic to the species. For instance, relatively speaking, there is a great deal more deposition in the mid-facial region of a chimpanzee than in humans, which produces the characteristic prognathism. In humans, the lower jaw is "pulled back" underneath the face during maturation, which is achieved by a complex, characteristic pattern of bone deposition and resorption.

Bromage realized that information of this sort about the australopithecine would at the very least be extremely interesting and probably very informative. The cells responsible for bone deposition and resorption have a characteristic surface appearance, which can readily be seen in modern material under the scanning electron microscope. It turns out that, against all odds and most predictions, these details are sometimes preserved in fossils.

Remodeling fields—that is, the areas of resorption and deposition—have three primary attributes: size, shape, and rate of activity. Humans and chimpanzees have significant differences in most of these attributes. By contrast, the overall patterns of remodeling in chimpanzees and *A. africanus* are very similar to each other. There is a difference, however, in the rate of activity of some of these fields. For instance, a lower deposition activity in the mid-facial region of the australopithecine compared with the chimpanzee produces decreased prognathism in the adult.

Bromage made the important point that, because some parts of the australopithecine face are distinctly different from that of an ape while others are not, the notion that neoteny—evolutionary advance through the slowing down of development—can no longer be adduced by itself to explain the origin of the human face.

The conclusion about differences in rate of activity of remodeling fields depended critically on an accurate assessment of the age at death of the Taung child, so that the patterns could be matched with those of a chimpanzee of the same age. Bromage, in collaboration with Christopher Dean, was able to obtain this by counting growth lines in the teeth of another australopithecine fossil of the same developmental stage as Taung. The answer was that he had died between 2.7 and 3.7 years of age.

Yoel Rak of the University of Tel Aviv has also been studying the australopithecine face, and during the past couple of years has wrought a minirevolution of his own. Comparatively neglected by paleoanthropologists through the years, Rak has seen in the facial architecture of adults a story that some think is conclusive support for the Johanson/White phylogeny.

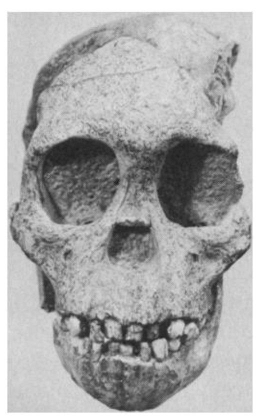
The robust australopithecines had clearly become dietarily specialized, as virtual grinding machines. Their huge molars—some five times the surface area of modern human cheek teeth in an animal of shorter stature—were set in powerful jaws. This specialization demanded a restructuring of the facial architecture so as to cope with the necessary distribution of forces. This involved the tucking under the face of the lower jaw, the buttressing of the face with "pillars" on either side of the nasal aperture and the strengthening of the nasal bridge and frontal bones. In addition, the zygomatic arches—the cheekbones—become more flared and rounded. This pattern, which is fully apparent in *A. robustus*, is developed to extreme in *A. boisei*.

In the second branch of the hominid tree, the *Homo* lineage, there is no indication of this kind of buttressing. Now, the putative common ancestor to the *Homo* lineage on the one hand and the robust australopithecine lineage on the other must be sufficiently generalized to

How Old Is the Taung Child?

The Buxton Lime works in Bophuthatswana, from which the Taung fossil was removed in November 1924, is now just a very big hole in the ground. No records were kept of exactly where the cranium came from nor with what it was associated. The problems of accurately putting the fossil in context are therefore immense. Added to which are the difficulties in dating the calcite material that overlies the site. The geological age of the Taung child is therefore still in debate.

Two million years has for some time been accepted as a reasonable age estimate for Taung, which would make it a relatively late representative of *Australopithecus africanus*. In recent times three separate suggestions have been offered for a more accurate assessment: each suggests widely different numbers.



For instance, Eric Delson of the American Museum of Natural History considers that the other primate remains that come from the site indicate an age of some 2.3 million years. Yoel Rak of the University of Tel Aviv would make the fossil even older, perhaps close to 3 million years, on the basis of comparisons with other South African australopithecines. The Taung face is relatively robust, which fact has in the past encouraged some to speculate that the child is in fact a member of *A. robustus* rather than *A. africanus*. Rak, however, says that Taung is almost certainly a member of the gracile species, and the material it most resembles is that from the Makapansgaat cave, which has been dated at about 3 million years.

Meanwhile, John Vogel of CSIR in Pretoria has put a date of 1 million years on the overlying calcite, using uranium series dating, which means that the Taung child can be no older than this. If true, there are two immediate possible interpretations, based on the fact that this species is generally considered to have become extinct about 2 million years ago.

First, the fossil represents the youngest by far of any *A. africanus* species and may have been part of a relict population in an ecological "refuge." The second interpretation is that the Taung child is actually an *A. robustus* because this species is known to have survived until about this date. Phillip Tobias, Dart's successor at the University of the Witwatersrand, once proffered this suggestion but no longer defends it.

Most likely, however, the Taung child will remain suspended in a temporal void, the enigmatic infant who started the modern age of paleoanthropology.—R.L.

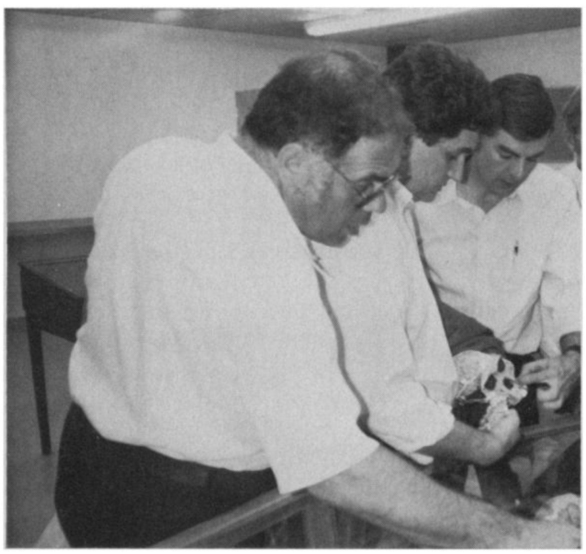
allow the evolutionary development of both patterns, argues Rak. How do the candidates—*A. afarensis* and *A. africanus*—measure up to this? Rak's assessment is that *A. afarensis* is sufficiently generalized to give rise to the *Homo* and robust patterns, whereas *A. africanus* already shows indications of buttressing. It is, in effect, already part of the robust lineage, he says.

The face is, of course, just one part of the story. Bernard Wood of The Middlesex Hospital Medical School, London, described an analysis of several characters each of the cranial vault and base, the face, the palate, and the lower jaw among the various australopithecine and *Homo* species. In company with a growing number of paleoanthropologists, Wood uses a cladistic approach, which seeks to reveal taxonomic grouping on the basis of specialized, as opposed to primitive, characters. The analysis produces a series of possibilities, one intriguing aspect of which is the grouping of *A. afarensis* with the robust australopithecines and *Homo*. This apparent affinity of *Homo* with the robust australopithecines has been cropping up repeatedly in recent times and is a puzzle.

In any case, Wood's one firm conclusion is that neither *A. afarensis* nor *A. africanus* is a good candidate as an ancestor for *Homo*. Just to show that there are different ways of looking at things, Henry McHenry, of the University of California, Davis, concluded from a study of cranial and dental characters that, of the species known so far, *A. africanus* is the best bet as ancestor. He acknowledges that in a significant number of traits, *A. africanus* is specialized in the direction of the robust australopithecines, but overall this species, rather than *A. afarensis*, has sufficient scope for leading to the *Homo* and robust lineages. He does emphasize, however, that there may be yet unrecognized species that would be more suitable.

Johanson's presentation concluded, not surprisingly, that *A. africanus* is already too specialized in cranial and dental characters to be a potential ancestor, which position is correctly occupied by *A. afarensis*. As chief spokesman for *A. afarensis*, and therefore against *A. africanus*, Johanson earned himself the description of "heretic" in the local press because the Taung fossil, local boy that he is, is thus relegated to the sidelines.

The one clear conclusion from all this is that the morphology as presently analyzed cannot provide an unequivocal answer. Part of the problem, as always, is the relatively small samples of material under scrutiny. A second part, again as always, is that the phylogenetic significance of any single character or suite of characters remains open to interpretation: there is no identified morphological feature that clearly flags the genetic relationship of these creatures. This is a fundamental problem of biology.



Facial focus

Yoel Rak, center, discusses facial architecture in an australopithecine fossil with Donald Johanson, right, and Milford Wolpoff, left.

Something that can be done with single fossils, and with startling results, is the application of techniques that until just recently have been the sole province of other worlds. For instance, Glen Conroy, in company with M. W. Vannier, of Washington University Medical Center, has been turning the power of computerized tomography on fossils, with extremely encouraging results. The technique is capable of generating a three-dimensional image of a fossil, even if it is completely embedded in rock-hard matrix. Resolution is thought by some to be somewhat crude at the moment, but Conroy expects this to be improved in the near future to within the limits currently demanded for metrical study.

One obvious application of the technique is to "look inside" fossil craniums that are filled with matrix and cannot be cleaned. The intact, but matrix-filled, robust australopithecine cranium, numbered KNMER 406, from East Turkana in Kenya, is a star candidate. Another potential application would really bring paleoanthropology into the age of high technology: once a detailed three-dimensional image of a fossil is encoded in the computer, this, rather than the fossil itself, could, for many purposes at least, be used for study. The ability to "climb inside" and manipulate in all kinds of ways such a computerized fossil boggles the mind. The existence of fossils on floppy discs would introduce a new dimension into the sometimes tricky problem of access to fossil data.

Computerized tomography in the hands of two Dutch researchers, Frans Zonnenveld and Jan Wind, gave participants the first-ever glimpse of the middle ear bones and inner-ear semicircular canals of "Mrs Ples," a remarkably complete *A. africanus* cranium from the Sterkfontein cave. Zonnenveld and Wind put Mrs Ples under the CT scan in the Johannesburg hospital just the weekend before the symposium opened and were richly rewarded with what they saw.

At least one interest in the semicircular canals is the indication they give of the carriage of the head: the horizontal canal has a particular relationship with the angle of the head in humans, whom we know to walk perfectly upright. Judging from the angle of the semicircular canal in Mrs Ples, she walked with her head carried at a greater forward-sloping angle than in modern humans. A preliminary glimpse in a robust australopithecine indicated a similar, though not exactly the same, position as in the gracile species. Such insight, if confirmed, will certainly fuel the debate over the locomotor style of the australopithecines: did they walk like modern humans; like the caricature of stooping, shambling apemen; or like something else?

Sixty years after Taung, the fields of paleoanthropology are clearly in vigorous health but with many questions still unanswered. As one participant said: "There are the hard sciences, like physics and chemistry. And then there are the very difficult sciences, like paleoanthropology."—**Roger Lewin**

References

1. R. Lewin, *Science* **227**, 1188 (1985).
2. D. C. Johanson and T. D. White, *ibid.* **203**, 321 (1979).
3. P. V. Tobias, *Palaeontol. Afr.* **23**, 1 (1980).