The nature of Taung dental maturation

SIR—In a recent letter to *Nature*[1], Conroy and Vannier describe the pattern of dental calcification and other age-related features in the immature fossil specimen from Taung (the type specimen of *Australopithecus africanus*). But their interpretation of the dental eruption and calcification sequence in the Taung child is incorrect.

The dentition of a modern human child (Fig. 1) shows a calcification sequence parallel to that of the Taung child. Most important, it possesses maxillary incisors and first molars in a state of relative development consistent with that described for the Taung specimen (Fig. 2). The minimal differences between the modern human specimen and Taung shown by Fig. 2 suggest the modern human's growth is more consistent with an ape pattern than that of the Taung specimen.

It was the relative state of development of the dentition that led Conroy and Vannier to identify Taung as ape-like, using observations on eruption patterns and on calcification stages. They observed that at eruption of the first molar (evident in both the Taung child and in the modern human shown here), no other permanent teeth are expected to have significant root development in apes. In humans, most of the anterior dentition has root forming, with about one half root calcification on the incisors (Fig. 2). Conroy and Vannier explain that these different patterns of calcification reflect the different patterns of eruption between apes and humans. According to this view, modern humans are 'unique' in that the eruption of incisors and first molars occurs together during one relatively brief time span, at about 6 years of age. This contrasts with the great-ape pattern, in which incisor eruption is "delayed for about two years after the first molar eruption"[1].

These assumptions on the relation between calcification and subsequent eruption must be questioned. The modern human (Fig. 1) has a calcification pattern and an erupted first-molar characteristic of the proposed ape pattern, like the Taung child. This pattern is not uncommon in samples of immature human dentition from the archaeological sites of Hasanlu and Tepe Hissar that are housed at the University Museum. In the 25 specimens assessed to date, none exhibits the proposed human pattern of M1/I1 calcification and eruption; in fact, most show a calcification pattern of the anterior dentition in the presence of erupted first molars similar to the Taung child. Based on the eruption status of the M1 together with the calcification of the M1 root, the crown and root calcification of M2 and the calcification status of the incisors, the incisors in these individuals would probably erupt from 2–3 years after the M1, precisely as proposed for the Taung specimen. Whether or not such a time lag would have occurred in these individuals, or in the Taung child, is unknown. It is merely suggested by a chart of the observable calcification and eruption stages (such as Fig. 2). Our sample, however, which parallels the dental development of the Taung specimen, is that of known modern humans and a conclusion that identifies them as apes is not reasonable.

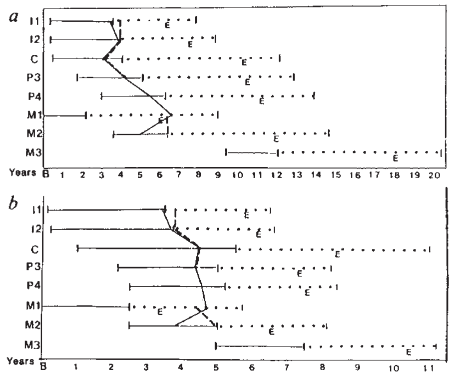

Fig. 2 Maxillary dentition of the Taung child (solid line) and a modern human child (dashed line) plotted against human[2] (*a*) and ape[3] (*b*) standards as outlined in refs 3 and 4. The maxillary dentition is characterized by a central incisor (I1) with minimal root initiation; lateral incisors (I2) are crown complete) canines (C) are 3/4 crown complete; P3, 3/4 crown complete; P4 are absent; M1 exhibits some wear with ~ 1/2–2/3 root completion (root length ~ 7.3 mm); M2, crown completely calcified; M3 without trace. The distinctions from the Taung specimen include minimal root on central incisors (equivalent to ~ 6 months growth beyond crown complete[2]) and a completed M2 crown; Taung is said to be without incisor roots and M2 to be only 1/2 crown complete. The lower dentition, as Conroy and Vannier note, shows a slightly greater degree of calcification.

The existence of known modern human children with dental calcification sequences and eruption patterns like that proposed for the Taung specimen leads to one of several conclusions: many modern humans grow in an ape-like pattern; or the patterns proposed and used here are incapable of distinguishing apes from humans and cannot be applied to characterize the nature of development in fossil hominid specimens.

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Fig. 1 Dentition of an immature modern human from Hasanlu, Iran (University Museum catalogue number 73-5-58), dated about 3,000 years before present.

Orbital forcing and the Vostok ice core

SIR—In their paper on the Vostok ice core Jouzel *et al.*[1] say that the 100-kyr oscillation that dominates the climatic record over the past million years is generally assumed to result from a nonlinear response of ice sheets to orbital forcing rather than directly from eccentricity changes. We take exception to this statement and, further, we wish to point out some recent theoretical modelling results that can account for many of the observational results presented in the important follow-on Vostok CO_2 papers[2,3].

Although there is certainly strong evidence that orbital forcing influences the course of ice growth and decay[4] (particularly with regard to the ~20 and 40-kyr variations), there is no general agreement that nonlinear responses of ice sheets to orbital forcing are the ultimate cause of the major 100-kyr ice age Pleistocene. On the contrary, it is also plausible to assume that we would still have the major ice ages even in the complete absence of orbital forcing. The most convincing, but by no means the only argument for this view was discussed recently in *Nature* by Mix[5], to the effect that the 'dominant' 100-kyr oscillation of the late Pleistocene came into being as a rapid transition from an