

on how the *Sahelanthropus* position was assessed. Moreover, the anterior edge of the foramen is far from the back of the *Sahelanthropus* third molar, in contrast to hominids and similar to chimpanzees and female gorillas.

There are many other features that link the specimen with chimpanzees, gorillas or both, to the exclusion of hominids. Most significantly, the nuchal plane is long, flat and angled at about 55° to the Frankfurt horizontal: “relatively longer than in *Pan* [and] *Gorilla* ... and with crests as marked as those of *Gorilla*”¹. This describes the posterior cranial vault of a small quadrupedal ape with a powerful masticatory complex.

Because the face is orthognathic rather than prognathic and the anterior teeth are small, posture is the only credible explanation of this nuchal anatomy. It is evident that *Sahelanthropus* did not habitually hold its head in an upright position over the spine and was not an obligate biped. This contrast with all known hominids is itself sufficient to exclude *Sahelanthropus* from the hominid clade as we currently understand it.

We believe that *Sahelanthropus* was an ape living in an environment that was later inhabited by australopithecines and, like them, it adapted with a powerful masticatory complex. A penecontemporary primate with a perfect and well-developed postcranial adaptation to obligate bipedalism⁶ is more likely to have been an early hominid.

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1. Brunet, M. *et al.* *Nature* **418**, 145–151 (2002).
2. Contra Wood, B. *Nature* **418**, 133–135 (2002).
3. Pilbeam, D. R. *Am. J. Phys. Anthropol.* **25**, 1–6 (1966).
4. Endo, B. *Jpn. Facul. Sci., Univ. Tokyo, Sec. 5*, 3, 1–106 (1966).
5. Russell, M. D. *Curr. Anthropol.* **26**, 337–360 (1985).
6. Senut, B. *et al.* *C. R. Acad. Sci. Paris* **332**, 137–144 (2001).

Brunet *et al.* reply — In 1925, when Dart described *Australopithecus africanus*¹ as a hominid, critics interpreted it as a juvenile gorilla^{2–4}. Last year, Wolpoff's colleagues (B.S. and M.P.) claimed that their Kenyan fossil *Orrorin* was a direct ancestor of *Homo*⁵, and now Wolpoff *et al.* conclude that *Sahelanthropus* was an ape (specifically, a female gorilla ancestor⁶) — a belief that, to our knowledge, is not supported by published or unpublished data.

Overlooking their flippant taxonomic proposal (the genus name ‘*Sahelpithecus*’), which disregards the requirement for a new genus to have a type species and description⁷, we disagree with their (presumably more serious) opinions on the morphology and phylogeny of the Toumaï fossil.

Because the Toumaï fossil is the earliest known hominid ancestor⁸, it is not surprising that it bears primitive characters. Following modern systematic practice, we used newly evolved characters (rather than shared primitive characters) to establish phylogenetic relationships⁸. Those who ignore these derived characters and concentrate on primitive ones will reach the conclusion that early hominids, including *Orrorin*, are related to modern apes. This has not been in dispute since Huxley and Darwin. For Wolpoff *et al.* to revert to the use of primitive characters in an attempt to undermine a clear statement of affinity of Toumaï is curious.

Wolpoff *et al.* make several erroneous assertions about the cranial face and base. For example, they mischaracterize the configuration of the face in *S. tchadensis*, claiming that supraorbital size is directly related to postcanine tooth size and/or to masticatory forces. However, experimental and developmental investigations^{9,10} have shown that strains caused by mastication in the brow ridge of orthognathic and prognathic primates are always tiny, much too small to engender bone-growth responses to loading. Instead, large brow ridges grow because of facial projection relative to the cranial base¹¹.

Wolpoff *et al.* also obfuscate the facial similarities to *Homo*. We did not suggest that *Homo erectus* is 6–7 million years old — the point with *Homo* was comparative, rather than phylogenetic. Relying on measurements of our published photographs of the distorted original, Wolpoff *et al.* wrongly assert that the nuchal plane is angled at about 55° to the Frankfurt horizontal. Undistorted, the nuchal plane's angulation is outside the range of chimpanzees and within the range of fossil hominids¹². This configuration is nothing like that of any quadrupedal ape, with or without a powerful masticatory complex (which *Sahelanthropus* lacks, contrary to the assertions of Wolpoff *et al.*).

These authors not only misrepresent the specimen's morphology, but also fail to identify a single character to support their suggestion that Toumaï is a gorilla rather

than a hominid ancestor. They interpret our description of distal dentin exposure of the upper canine as evidence of honing wear (roughly equivalent to describing an African millet pestle as a Samurai sword). The Toumaï canine is not honing because it does not display the sharpened distal edge that is shared by all apes. Rather, this tooth is similar to those of later hominids in both size and proportion to the post-canine teeth.

In a modern example of how to miss the morphology between measuring points, Wolpoff *et al.* argue that the size of the Toumaï canine is ape-like. It is well known that early hominid and modern ape canine buccolingual diameters overlap in size. But, as Broom and Robinson¹³ noted in their assessment of Zuckerman's failed attempt to sideline *Australopithecus* 50 years ago: “If ... the affinities of an animal are to be determined by the size and indices of its teeth, and not by their structure, a horse may have to be put in the same group as a cow.” In its relative size, morphology and wear, the Toumaï canine is derived in the hominid direction relative to any ape.

This phylogenetic signal is significant. Ignoring it in favour of a belief based on *Orrorin* and primitive characters is unjustified, particularly as the phylogenetic position of the *Orrorin* fossils remains uncertain. Wolpoff *et al.* have described no derived ape feature of *S. tchadensis*, nor have they disproved any derived features that this species shares with later hominids⁸. Any alternative phylogenetic hypothesis should be based on explicit, supporting derived characters of Toumaï.

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1. Dart, R. A. *Nature* **115**, 195–199 (1925).
2. Keith, A. *Nature* **115**, 234 (1925).
3. Duckworth, W. L. H. *Nature* **115**, 236–237 (1925).
4. Keith, A. *Nature* **159**, 377 (1947).
5. Senut, B. *et al.* *C. R. Acad. Sci. Paris* **332**, 137–144 (2001).
6. Fléaux, R. *Sci. Avenir Paris* **666**, 12 (2002).
7. International Commission on Zoological Nomenclature *International Code of Zoological Nomenclature* 4th edn (Int. Trust Zool. Nomenclature, London, 1999).
8. Brunet, M. *et al.* *Nature* **418**, 145–151 (2002).
9. Hylander, W. L. & Johnson, K. R. in *The Biological Mechanisms of Tooth Movement* (ed. Davidovitch, Z.) 559–569 (Ohio State Univ. Coll. Dentistry, Columbus, 1992).
10. Ross, C. R. *Am. J. Phys. Anthropol.* **116**, 108–139 (2001).
11. Lieberman, D. E. in *Development, Growth and Evolution: Implications for the Study of the Hominid Skeleton* (eds O'Higgins, P. & Cohn, M.) 86–122 (Academic, London, 2000).
12. Kimbel, W. H., White, T. D. & Johanson, D. C. *Am. J. Phys. Anthropol.* **64**, 337–388 (1984).
13. Broom, R. & Robinson, J. T. *Mem. Transvaal Mus.* **6** (1952).

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