Figure 1 Relation between the relative dispersion of cloud droplet size distribution, \( e \), and the number concentration of cloud droplets, \( N \). Symbols indicate programs and/or references from which the data points were derived. Connected points represent cases previously identified as evidence for an indirect aerosol effect. The parameter \( \beta \) is defined by equation (2). Green symbols (from ref. 8): triangle, FIRE; northeastern Pacific; crossed circles, SOCEX, Southern Ocean; filled circle, ACE2, Southern Ocean. Blue symbols: filled circles, ASTEX, northeastern Atlantic; diamonds, SCMS, Florida coast; filled triangles, Scud 4, ASTEX; filled squares, horizontal9, ASTEX; open inverted triangles, level 1; open upright triangles, level 2; open circles, level 3 — all from southwest of San Diego10; open diamonds, SCMS11; stars, vertical, ASTEX12; plus signs, horizontal, ASTEX13; multiplication signs, ASTEX14; squares, INDOEX, Indian Ocean (G. M. McFarquhar, personal communication). Red circles, MAST6,14,15, California coast.

polluted cloud compete for water vapour and broaden the droplet size distribution compared with clean clouds that have fewer droplets and less competition.
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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”. 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 post-craniad adaptation to obligate bipedalisim is more likely to have been an early hominid.

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

Because the Toumai fossil is the earliest known hominid ancestor, 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 relationships. 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 Toumai 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 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 base.

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 orientation is the range of chimpanzees and within the range of fossil hominids. 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 Toumai 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 Toumai 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 Toumai canine is ape-like. It is well known that early hominid and modern ape canine buccolingual diameters overlap in size. But, as Broom and Robinson 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 Toumai 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 disproven any derived features that this species shares with later hominids. Any alternative phylogenetic hypothesis should be based on explicit, supporting derived characters of Toumai.

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