New fossil may revise the timeline for hominid evolution

Walter Gilberti
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A new fossil discovery has thrown the widely accepted time and place for the divergence of the evolutionary lines of humans and chimpanzees into somewhat of a turmoil. Working in southern Chad in central Africa, a team of researchers led by French paleontologist Michel Brunet has uncovered the nearly complete cranium and lower facial fragments of a creature that appears to reside almost at the point of transition between apes and hominids. Hominids are primates that exhibit erect posture and bipedal locomotion, a category that includes humans and their evolutionary forebears.

The fossil—nicknamed Toumai or "hope of life" in the Goran language of southern Chad—has been given the scientific (Genus, species) name Sahelanthropus tchadensis, since it was discovered in the sahel, a semiarid region of central and west Africa that separates the Sahara from the more southerly tropical forests. A preliminary analysis of the fossil appeared in the July issue of the journal *Nature*.*

What is particularly striking about this discovery is not that it exhibits some hominid characteristics, but that it is 7 million years old. Some experts in the field are hailing the find as having the most far-reaching implications for the theory of human evolution since the discovery of the "Taungs child" by South African anthropologist Raymond Dart in 1924. Dart, who along with Charles Darwin before him suspected that Africa, not Asia, was the cradle of humankind, named the fossil Australopithecus, or "southern ape. Subsequent discoveries throughout the Great Rift Valley region of eastern and southern Africa have transformed that supposition into a fact.

The validity of the Brunet team's claim that the discovery is in fact a hominid remains to be determined. One anthropologist at the Natural History Museum in Paris described the fossil as belonging to a proto-gorilla. However, there is ample reason to conclude that the Chad fossil has a unique significance. The remains exhibit a curious ensemble of primitive ape and more advanced hominid characteristics. For example, while the specimen seems to have a sagittal crest—a ridge of bone at the top of the skull that serves to anchor the massive chewing muscles found in the great apes—this feature seems to be combined with more advanced dental characteristics, in particular, the absence of a diastema—a space between the canines and the incisors and premolars that allow for the meshing of the large canine teeth found in apes.

Sahelanthropus reveals a cranial capacity (brain size) within the chimpanzee range (320 -380 cc), and yet its face is not nearly as prognathic as that of a chimp, and is less so than even more recent austalopithecine discoveries, such as the 3.5 million-year old "Lucy," discovered by Donald Johanson in Ethiopia more than 25 years ago.

Prognathism, or the appearance of a "muzzle" denoting a sharp outward facial angle common among four-legged animals, began to recede in higher primates, whose diurnal behavior and arboreal lifestyle led to the emergence of acute color vision, and a consequent reduction in the importance of the olfactory sense. This tendency became less pronounced as hominids evolved, and has all but disappeared in modern humans. To find a fossil this ancient exhibiting a characteristic this seemingly advanced is indeed remarkable, and raises important questions about the evolutionary process, as well as the current perception of how the hominid line evolved.

Then there is the question of the location of Sahelanthropus. To many paleoanthropologists, Chad is somewhat off the beaten path for hominid evolution, when compared with the famous fossil troves of southern and eastern Africa. In a recent op-ed piece in the *New York Times*, Harvard anthropologist Daniel Lieberman offered an amusing analogy; "Like the drunk in the old joke, searching for his keys under a lamppost because the light is better there, we've focused on these two regions because fossils preserve best there. Yet Africa was a huge and complex place, full of diverse habitats that might have been wonderful places to be a human ancestor—but where the bones don't fossilize well."

According to Brunet, the Chad location "suggests that an exclusively East African origin of the hominid clade [a clade

is an evolutionary lineage distinguished by certain derived characteristics—WG] is unlikely to be correct. It will never be possible to know precisely where or when the first hominid species originated, but we do know that hominids had dispersed throughout the Sahel and East Africa (Brunet, et al, 2002)."

It is the antiquity of Sahelanthropus, however, that calls into question some basic assumptions about the chimp/hominid timeline. While the Brunet team has been unable to use the standard potassium-argon radio-isotope dating technique for establishing the approximate age of the specimen due to the lack of volcanic ash at the site, a comparative examination of the remains of other animals from the same strata with positively dated specimens from Kenya place the Brunet team's discovery as having lived between 6 and 7 million years ago. This is nearly 2 million years earlier than the currently accepted point of separation for the human and chimp lines, and a million years earlier than the next oldest fossil, Orrorin tugenensis, which was discovered in Kenya and whose hominid credentials are currently under dispute.

A 7 million-year old "hominid" would place it as having existed during the late Miocene, a 15 million year chunk of the Tertiary period ("Age of Mammals") that witnessed the growth of vast tropical rainforests. The Miocene could be considered a "golden age" for the evolution of higher primates, particularly monkeys. But ape evolution was also undergoing rapid change, with the ancestors of the modern "great apes," chimps, bonobos, gorillas and orangutans, beginning to diverge. There has also been a small amount of fossil evidence that suggests that hominid evolution had been well under way during the Miocene, with the remains of a possible proto-hominid, Ramapithecus, existing 14 million years ago and having a distribution as distant as the Indian subcontinent.

How does one account for the existence of a fossil primate that exhibits hominid characteristics, but is considerably older than the widely accepted boundary between upright walking hominids and chimpanzees? Humans share more than 98 percent of their DNA with chimpanzees, making the ape the closest living relative to Homo sapiens. Recent developments outside the field of paleontology, specifically in molecular biology, have determined the point of divergence to be approximately 5 million years ago, a date that is based on what some researchers call the "molecular clock."

Genes are segments of the DNA molecule. Each gene, or a combination of genes, codes for the assembly of amino acids that combine in long chains forming proteins. However, there are segments of the DNA molecule where mutations accumulate but have no effect on the makeup of the organism. Since deleterious mutations would be absent because those individual organisms would have been selected against by nature, the molecular clock is based on the notion that if one establishes the number of these neutral alterations that are present in a segment of a human DNA molecule, but absent in the chimp's DNA, and assuming that these mutations occur at a constant rate, one can then extrapolate backward in time to the point of divergence.

While this method has gained a certain acceptance—and has also served as the basis for the "mitochondrial Eve" hypothesis that purports to establish the date that modern humans evolved and began their migration out of Africa—the Sahelanthropus discovery, along with the recent hominid skull uncovered at the Dmanisi site in the Georgian Republic, indicates that the fossil record still has much to say on these questions.

Another important issue that Sahelanthropus raises pertains to the process of human evolution: whether humans evolved by way of a linear progression of intermediate types, or was more complicated, a tangle of evolutionary branches out of which the human line emerged. In his article in *Nature*, Brunet comments: "Sahelanthropus is the oldest and most primitive known member of the hominid clade, close to the divergence of hominids and chimpanzees. Further analysis will be necessary to make reliable inferences about the phylogenetic position of Sahelanthropus relative to known hominids."

Whether Sahelanthropus is a direct human ancestor is certainly an open question. In fact it is likely that at the base of hominid evolution, within the vast expanse of tropical rainforests that girdled the earth during the Miocene, and among the flourishing and evolving ape populations, from which today's few descendants are mere relicts, there was such a diversity that the tendencies in the direction of hominid evolution were recurrent and fairly common. Sahelanthropus could be a direct human ancestor, or an extinct Miocene ape that has left no descendants.

The fossil's importance as a major contributor to the study of human origins is best summed up by UC Berkeley paleoanthropologist Tim White, who commented: "This is a great extension onto the fossil record. But that's the real story here—it's an opening window."

* Brunet, Michel. et al. (2002). A new hominid from the upper Miocene of Chad, Central Africa. *Nature*. (418).145-151.