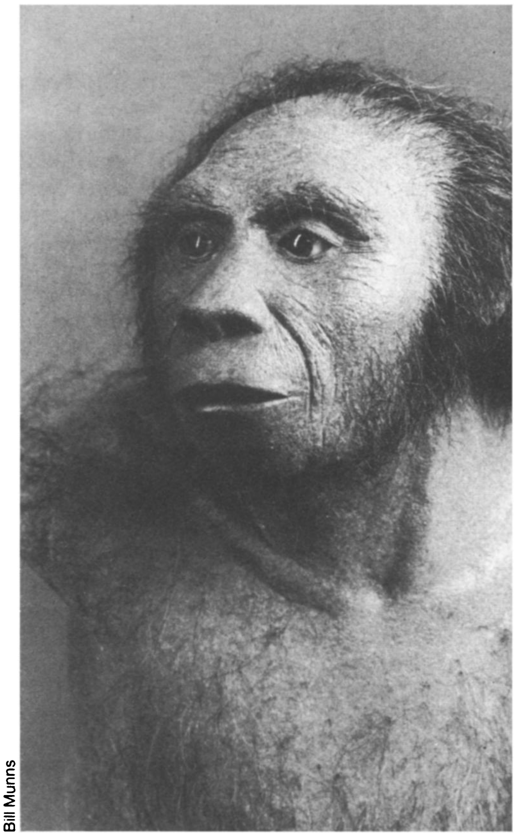
Erectus Unhinged


Bill Munns

Debate over a human ancestor reflects deeper splits concerning the nature of fossil species

By BRUCE BOWER

For more than 40 years, anthropologists have generally agreed that *Homo erectus* served as an evolutionary link between our earliest direct ancestor, *Homo habilis*, and modern *Homo sapiens*. This view holds that a hardy breed of *H. erectus* spread from Africa to Asia and Europe and lived from approximately 1.8 million to 400,000 years ago.

But in the last few years, *H. erectus* has suffered an identity crisis. Leading investigators now propose three contrasting theories of human evolution that would give any ancient ancestor cause for concern. One proposal advocates sticking with a single, widespread *H. erectus*; another calls for splitting *H. erectus* into at least two species, only one of which evolved into modern humans; and a third seeks to abolish *H. erectus* altogether, placing its fossil remains within an anatomically diverse group of *H. sapiens* that split off from *H. habilis* about 2 million years ago.

Disagreements of this sort stem from a fundamental parting of the ways about how to discern a species in the fossil record. Most anthropologists accept the species as the basic unit of evolution, while acknowledging that defining a species, even among living animals, often presents problems. Thus, different theories about how best to sort out extinct species based on the features preserved in ancient bones fuel the dispute over *H. erectus* and other members of the human evolutionary family, known as hominids.

However, some researchers stand outside the fray, viewing any attempt to nail down fossil species as an unscientific, arbitrary exercise in cataloguing the ambiguous bits of anatomy surviving in fossil bones.

"There's a growing diversity as to how species are perceived in modern and ancient populations," asserts Erik Trinkaus of the University of New Mexico in Albuquerque. "[Researchers] often end up talking past each other."

In April, Trinkaus and others debated various approaches to understanding *H. erectus* and fellow hominid species at the annual meeting of the American Association of Physical Anthropologists in Las Vegas and in interviews with SCIENCE NEWS.

The roots of this sometimes confusing clash extend back 100 years, when the first *H. erectus* fragments turned up in Java. Initially classified as Pithecanthropus, or ape-man, these Asian specimens and most ensuing hominid finds received a unique species designation from their discoverers. In the early 1950s, anthropologists realized that human evolution made no sense if virtually all fossil discoveries represented different species. Taking the view that an ancestral species with a wide array of skeletal features gradually transforms into a descendant species, researchers proceeded to group fossils into a much smaller number of species.

So-called "lumping" of specimens led to a picture of human evolution as a series of three progressive steps, with *H. habilis* begetting *H. erectus* begetting *H. sapiens*.

But by the early 1980s, these ancestral lumps had begun to stick in the throats of some anthropologists. At the same time, concern grew that the definition of a species used by biologists and often borrowed by anthropologists — namely, characterizing a species as a group of organisms that reproduce only among themselves — offered no help in evaluating fossils.

Another approach — called cladistic, or phylogenetic, analysis — rapidly gained popularity. This view holds that new species evolve relatively quickly rather than in a series of gradual adjustments within ancestral species. Specifically, cladistics assumes that although most members of a population of related organisms display the "primitive" skeletal features that arose early in their evolutionary history, some members of the population sport "derived," or advanced, anatomical features that appeared later. A consistent pattern of unique derived features on a group of fossils serves as a species marker.

Phylogenetic studies indicate that *H. erectus* fossils actually encompass two species, one in Asia that became extinct and another in Africa that evolved into modern humans. Peter Andrews of the Natural History Museum in London reported in 1984 that most skeletal features commonly accepted as unique derived traits of *H. erectus* are actually primitive retentions shared by earlier *Homo* species. Moreover, the seven derived characteristics exclusive to *H. erectus* appear predominantly among Asian fossils. These include an angling of the cranium that produced a bony ridge at the top of the head, thick cranial bones, a cleft in the bone just behind the ear and a plateau-like bony swelling at the back of the head.

Since these features appear in only one geographically restricted set of fossils and do not turn up later in modern humans, Andrews suggests that Asian *H. erectus* met extinction on a side branch of human evolution. A separate species of African hominids living at the same time evolved into *H. sapiens*, he posits. Andrews' analysis dovetails with the theory that modern humans originated in Africa around 200,000 years ago and then spread throughout the world.

Bernard Wood of the University of Liverpool, England, has elaborated on

Andrews' phylogenetic thesis. In the Feb. 27 NATURE, Wood presents a cladogram — a tree diagram organizing hominid species according to the number of derived features shared by groups of fossils — based on analysis of 90 cranial, jaw and tooth measurements. Wood concludes that, sometime before 2 million years ago, at least three *Homo* species emerged in Africa: the relatively small-brained *H. habilis*; a group with larger brains and teeth, which he calls *H. rudolfensis*; and *H. ergaster*, represented by the fossils that Andrews separated from Asian *H. erectus*.

The three species apparently shared an unidentified common ancestor, with *H. ergaster* serving as the precursor of *H. sapiens*, Wood argues.

Wood splits up early *Homo* species in a reasonable way, notes Ian Tattersall of the American Museum of Natural History in New York City. But neither phylogenetic theory nor any other approach offers practical help to fossil species hunters, Tattersall maintains. Closely related living primate species often differ in only one or a few subtle anatomical features, which may not show up in a set of bones, he points out (SN: 4/13/91, p.230). Thus, cladistic analysis tends to lump together some hominid species that share derived anatomical characteristics, he holds.

In an article accepted for publication in the JOURNAL OF HUMAN EVOLUTION later this year, Tattersall advises investigators to use the phylogenetic approach to identify groups of fossils with derived features that signal either a distinct species or possibly a clutch of related species. Lumping inevitably occurs, but the general pattern of human evolution remains unobscured, he argues.

H. sapiens also requires splitting when viewed under this modified phylogenetic lens, Tattersall contends. He places several partial skulls found at European sites and usually assigned to early, or "archaic," *H. sapiens* (mostly dating to around 200,000 to 400,000 years ago) in a new species, *H. heidelbergensis*.

"It's a virtual certainty that speciations have been much more common in hominid biological history than many paleoanthropologists have been willing to admit," he asserts.

Tattersall has it exactly backwards, according to adherents of the theory of "multiregional evolution." The phylogenetic approach fails to appreciate the anatomical diversity that arises within different populations belonging to the same species, argues Milford H. Wolpoff of the University of Michigan in Ann Arbor. Wolpoff and his colleagues champion an evolutionary perspective in which each hominid species encompasses one or more populations that share the same common ancestor, follow the same evolutionary patterns over time and yield anatomical evidence of a historical beginning and end.

H. erectus clearly splits off from *H. habilis*, but it gives no sign of an evolutionary demise, according to a study conducted by Wolpoff and Alan G. Thorne of Australian National University in Canberra. Instead, *H. erectus* gradually merges into the range of skeletal characteristics observed in regional populations of early *H. sapiens*, Wolpoff and Thorne argue. Of the 23 derived anatomical traits that distinguish *H. erectus* from *H. habilis*, 17 consistently turn up on *H. sapiens* fossils, they assert.

In other words, *H. erectus* never existed and *H. sapiens* has evolved in several parts of the world for approximately 2 million years, Wolpoff and Thorne maintain.

Evolutionary patterns observed in four different regions — Africa, Europe, China and Australia-Indonesia — show continuous, gradual change from about 2 million years ago to the most recent human populations, with no evidence of Africans replacing the other groups, Wolpoff and Thorne contend. They also hold that *H. sapiens* encompasses most, perhaps all, specimens now classified as Neandertal (SN: 6/8/91, p.360).

The few anatomical idiosyncrasies separating *H. sapiens* from fossil remains widely attributed to *H. erectus* — such as greater cranial volume, smaller teeth and lighter limb bones — reflect evolutionary trends in the former species toward larger brains and a greater reliance on tools and other technologies spawned by increasing cultural complexity, Wolpoff argues.

In Wolpoff's view, the merging of *H. erectus* into *H. sapiens* (first proposed in the 1940s by German anatomist Franz Weidenreich, who continues to inspire the multiregional approach) forces scientists to take a closer look at anatomical changes that have occurred over time within our species. It also exposes the need for a workable definition of "anatomically modern humans," he says.

Milford Wolpoff

An artist's conception of Homo erectus *(top left), based on fossil evidence, and a female* H. erectus *skull (left) found in China that dates to approximately 400,000 years ago.*

Between those vying to split or to sink *H. erectus* stand some stalwart defenders of its status as a unified species. "I see *Homo erectus* as a single species that spread across the Old World," says G. Philip Rightmire of the State University of New York at Binghamton. *H. erectus* probably gave rise to modern humans in a restricted geographic area, for example Europe, where temperatures cooled dramatically around 400,000 years ago, or possibly in Africa, Rightmire suggests. *H. erectus* populations apparently survived for a while in Asia, whereas *H. sapiens* thrived elsewhere, he says.

To buttress his theory, Rightmire offers a reassessment of a group of fossil skulls and skull fragments found at the Ngandong site in central Java. Multiregional theorists such as Wolpoff view the anatomy of these skulls as intermediate between *H. erectus* and *H. sapiens*, indicating a long, gradual evolution toward modern humans in that part of the world.

However, the Ngandong fossils — poorly dated, but generally placed between 100,000 and 250,000 years old — clearly fall within the range of anatomy observed in older *H. erectus* skulls from Java and elsewhere, Rightmire contends. This holds for the size and shape of Ngandong braincases, the thickness of the cranial bones and other features, he points out.

In contrast, the earliest *H. sapiens* specimens display marked increases in brain size, changes in cranial bones that signify shifts in brain organization, and a more flexed cranial base, indicating a vocal tract capable of producing a greater variety of speech sounds — all signs of substantial genetic changes that produced a new species in a relatively short time, Rightmire holds.

Another study, conducted by Steven R. Leigh of Northwestern University in Evanston, Ill., lends some support to

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drogen clouds (SN: 5/25/91, p.326).

No one knows the dimensions of any of these mysterious clouds, which could represent material that somehow failed to coalesce into galaxies. But the lensing properties of BR0952-01 may allow astronomers to gauge their size.

McMahon suggests that Hubble, and perhaps some ground-based telescopes, could analyze the spectrum of light from each quasar image. Light from each image stems from a different part of the quasar and takes a slightly different path to Earth. So, if light from both images carried the same fingerprint – the same absorption line – this would indicate that the hydrogen cloud was wide enough for both beams to pass through it. Similarly, if light from only one image contained a particular absorption line, it would mean that the cloud was smaller than the separation between the images. While arduous, such measurements promise to shed new light on the structure of these intriguing clouds, McMahon says.

In the meantime, he and his co-workers plan to extend the lensing survey to include their entire list of distant quasars. They expect to find that only a few additional quasars undergo lensing.

For McMahon, the cosmological implications of the study remain paramount. "We're detecting a universe that was much more lumpy [early on] than people had hypothesized," he says. □

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quence of evolution since the Big Bang. If we do not believe that events one hour hence are unalterably occurring "somewhere," why should we believe that the events of one hour ago are still "out there," controlling the future for the folks *two* hours ago? Each time span since the beginning has its own history – its own totally different universe.

It may be disheartening to accept that there is no place "over the rainbow" we might get back to where JFK is still alive or the Titanic sails the seas, and it is perhaps a little frightening to realize that, were we to slip a microsecond in time, there would be no United States, no Earth and no Milky Way (I think), but it sure solves a lot of time travel paradoxes. I will defer to larger brains to explain how time dilation fits into this model, and whether or not it works at all in non-Big Bang universes.

Charles D. Feldman
Lindenhurst, N.Y.

The laws of physics are descriptive, not prescriptive. They do not "allow" anything. Time travel to the past is not possible because time's arrow runs forward only. Because chemical and nuclear reactions can be reversed or because equations can be solved in either direction does not mean time goes in both directions. Just because with language (math or words) we *can* express truths does not mean language *must* express truths.

A solution to an equation is sensible only if it describes what actually is. We sometimes tend to forget this fact about "laws" of nature.

P.M. deLaubenfels
Corvallis, Ore.

Arsenic on tap

A recent assessment by the California Environmental Protection Agency ("Arsenic in water: Bigger cancer threat," SN: 4/18/92, p.253) revealed that the current federal guideline of 50 parts per billion of arsenic allowed in drinking water has a 1 in 100 chance of causing cancer. The study also indicated that this environmental hazard is just as serious as being exposed to radon gas or secondary cigarette smoke. The researchers believe that the current standard should be lowered. I most definitely agree.

The current U.S. EPA standard, established in 1976, is apparently outdated because it claims that the risk of developing skin cancer from our drinking water is 2.5 in 1,000. I hope the U.S. EPA will enact new guidelines immediately. If they do not respond soon, our population will continue to be exposed to harmful substances such as arsenic. The most obvious outcome is a major rise in the cancer rate.

Sheila A. Edwards
Sacramento, Calif.

Michael N. Bates and his co-workers at the University of California, Berkeley, have completed a new risk assessment for the ingestion of arsenic-contaminated water. Primarily on the basis of studies of people living on the southwest coast of Taiwan, they conclude in the March 1 AMERICAN JOURNAL OF EPIDEMIOLOGY: "... daily consumption of 1 liter of water containing arsenic at the current U.S. maximum contaminant level [50 ppb] might be associated with an increased lifetime cancer mortality risk of up to 1 in 100." – J. Raloff

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Rightmire's contention that a measurable split occurs between *H. erectus* and *H. sapiens*. Leigh examined 20 *H. erectus* skulls from Africa, China and Indonesia that span a broad time range, as well as 10 early *H. sapiens* skulls. Significant expansion of brain size from the oldest to the most recent specimens occurs in the latter group, whereas the three regional samples of *H. erectus* show no such increases, Leigh reports in the January AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY.

However, analysis of the Chinese and Indonesian skulls reveals substantial brain-size increases that do not necessarily coincide with Rightmire's view of an anatomically stable *H. erectus* inhabiting the entire Old World, Leigh points out.

The single-species view gets further ammunition from another study of 70 hominid craniums, mainly *H. erectus* and *H. sapiens* specimens. The seven derived features considered unique to Asian *H. erectus* by Peter Andrews also appear on many African fossils attributed to *H. erectus*, as well as on a significant number of *H. habilis* and early *H. sapiens* specimens, according to Gunter Brauer of the University of Hamburg, Germany, and Emma Mbua of the National Museums of Kenya in Nairobi.

Although additional anatomical features need study, cladistic procedures mistakenly assume that unique derived traits are either present or absent in all members of a species, Brauer and Mbua contend in the February JOURNAL OF HUMAN EVOLUTION. They emphasize Tattersall's point that the same derived features may occur to a greater or lesser extent in different hominid species. Investigators need better data on variations in the skeletal anatomy of living primates and fossil hominids, they conclude.

Some anthropologists take a dim view of the entire controversy surrounding hominid species. "These fights over species classification are somewhat of a waste of time," says Alan Mann of the University of Pennsylvania in Philadelphia. "Most researchers see *Homo erectus* as a single species that evolved into *Homo sapiens*."

Others argue that fossil bones provide too little evidence for teasing out hominid species.

"Fossil species are mental constructs," contends Glenn C. Conroy of Washington University in St. Louis, who directed an expedition that recently found an approximately 13-million-year-old primate jaw in southern Africa (SN: 6/29/91, p.405). "Cladistic approaches try to separate species out of a vast array of biological variability over a vast time range, and I don't think they're capable of doing that."

Conroy prefers to group hominid fossils into "grades," or related groups tied together by general signs of anatomical unity with no evidence of sharp breaks between species. Thus, an *Australopithecus* grade (which includes the more than 3-million-year-old "Lucy" and her kin) merges into a grade composed of *H. erectus* fossils and then shades into a *H. sapiens* grade, in Conroy's view.

"I'd put our limited funding into looking for new fossil primates or studying living primates, rather than pushing cladograms or arguing about the number of *Homo* species," he asserts.

But anthropologists wrangling over *H. erectus* and other hominid species find room for optimism amid their discord.

"The really interesting question isn't whether *H. erectus* existed," remarks William H. Kimbel of the Institute of Human Origins in Berkeley, Calif., a proponent of phylogenetic analysis. "For the first time in years, we're taking a step back and asking about the theories that underlie our work and the units we use to establish evolutionary relationships. It's a healthy sign that we're debating these questions vigorously." □