
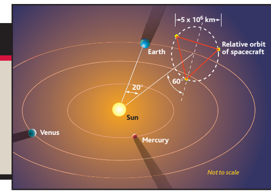

preserved in the 1.7-billion-year-old sediments, the two ancient ocean basins "simply look like the deep Black Sea," says Knoll. But these might have been restricted ocean basins such as the Baltic, not the open ocean, so Anbar is working on a molybdenum-isotope analysis that could gauge the oxidation state of the world ocean from a few samples. Even then, many geophysiological links would remain to be proven between ancient ocean chemistry and the rise of well-fed eukaryotes. –RICHARD A. KERR

LANGUAGE EVOLUTION

'Speech Gene' Tied to Modern Humans

The ability to communicate through spoken language is the trait that best sets humans apart from other animals, most human origins researchers say. Last year the community was abuzz over the identification of the first gene implicated in the ability to speak. This week, a research group shows that the human version of this so-called speech gene appears to date back no more than 200,000 years—about the time that anatomically modern humans emerged. The authors argue that their findings are consistent with previous speculations that the worldwide expansion of modern humans was driven by the emergence of full-blown language abilities.

"This is the best candidate yet for a gene that enabled us to become human," says geneticist Mary-Claire King of the University of Washington, Seattle. But other researchers caution that uncertainties underlying the team's mathematical analysis, as well as debate about the gene's function, make dramatic conclusions premature. The case that the gene is closely linked with language ability "can only be said to be circumstantial," comments geneticist David Goldstein of University College London.

The gene, called *FOXP2*, was identified last fall by geneticist Anthony Monaco's group at Oxford University, in collaboration with cognitive neuroscientist Faraneh Vargha-Khadem and colleagues at the Institute of Child Health in London (*Science*, 5 October 2001, p. 32). They showed that *FOXP2* mutations cause a wide range of speech and language disabilities. Geneticist Svante Pääbo's group at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, in collaboration with Monaco's team, then set about tracing the gene's evolutionary history.

The Leipzig team, with graduate student Wolfgang Enard taking the lead, sequenced the *FOXP2* genes of several primates—chimpanzee, gorilla, orangutan, and rhesus macaque—as well as that of the mouse and compared them with the human sequence. The gene encodes a protein with 715 amino acids; it resembles other members of a family of regulatory genes implicated in embryonic development. Since the last common ancestor of humans and mice, which lived some 70 million years ago, there have been only three changes in the protein's amino acid sequence, the team reported online in *Nature* on 14 August. And two of these changes have occurred in the human lineage since it split with that of chimps roughly 6 million years ago.

These amino acid changes might have given some evolutionary advantage to the hominids who harbored them, the researchers surmised. This hypothesis gained support from calculation of a parameter known as Tajima's D statistic, an estimate of how much selection pressure has been exerted on a particular gene over the course of evolution. In general, the more negative this D value, the more selection has occurred. *FOXP2* had a highly negative D value—in fact, out of 313 well-characterized human genes recently analyzed, only one outscored *FOXP2* (*Science*, 20 July 2001, p. 489).

Evolutionary leap. One of these primates is able to talk about what he's seeing; the other isn't.

CREDIT: KAREN HUNTT MASON/CORBIS

The team estimated how recently the human version of *FOXP2* became "fixed" in human populations—that is, when all humans harbored the last amino acid substitution. Although the date cannot be pinpointed, the team concluded that the fixation was 95% likely to have occurred no more than 120,000 years ago and was virtually certain to have occurred no earlier than 200,000 years ago.

Most of the researchers who spoke with *Science* agree that the authors make a strong argument that the human version of *FOXP2* has been favored by natural selection. "Overall, [that] case has been made," says Goldstein. But he and others were less eager to accept the dating of the gene: "Dating analyses [such as these] are fraught with uncertainty."

Now that the human version of *FOXP2* has been found to be advantageous to human evolution, the debate over the gene's role in language has become even more relevant. Some scientists caution against overstating the importance of *FOXP2* in the evolution of language ability. "It would be foolish to talk about *FOXP2* as the gene that evolved to permit the emergence of speech and language," says Elizabeth Bates, a neuroscientist at the University of California, San Diego, although it is clearly "one of the genes" that did so. Indeed, Pääbo suggests that this gene, which may be implicated in the ability to make the mouth and facial movements essential to speech, might have been selected for precisely because it improved vocal communication once language had already evolved.

–MICHAEL BALTER

NUMBER THEORY

Simple Recipe Creates Acid Test for Primes

Quick, now: Is 341 a prime number? That one's pretty easy to answer. How about 4,294,967,297? That's still a snap if you use a computer. But what if the number you're interested in has thousands of digits? Then things get murky, because the obvious way to settle the issue—systematically checking whether smaller numbers divide it—takes far too long. In recent decades, theorists have devised clever algorithms for telling whether a large number is prime, but none that could be proven to work quickly.

Until now.

Three computer scientists at the Indian Institute of Technology in Kanpur have found what researchers have long sought: a provably efficient algorithm for testing primes