Fossil primates emit elusive species clues

Paleoanthropologists who attempt to decipher the evolutionary history of humans and other primates, express increasing skepticism concerning their ability to identify long-extinct species from fossil evidence alone. New glimpses of the pitfalls of trying to squeeze primate species out of bone emerged last week at the American Association of Physical Anthropologists' annual meeting in Milwaukee.

Even the concept of "species" provokes dispute among investigators. Many assume a species consists of organisms that look alike and can mate to produce fertile offspring. But skeletal anatomy often changes rapidly in response to environmental influences, making a simple list of skeletal traits unreliable as a guidepost to species recognition, asserts William H. Kimbel of the Institute of Human Origins in Berkeley, Calif.

Moreover, the primate fossil record — largely made up of partial skulls and teeth — often yields underestimates of the number of related species represented in a collection of bones, says Ian Tattersall of the American Museum of Natural History in New York City.

Tattersall and Jeffrey Schwartz of the University of Pittsburgh examined 77 skulls from the seven modern lemur species making up the genus *Lemur*. Each species has distinctive external features, Tattersall notes. But identifying the species on the basis of skulls and teeth alone proved extremely difficult, he reports. In fact, Tattersall contends that most investigators would classify no more than three species in this skeletal sample. The major problem: Different lemur species share numerous anatomical features of the head and teeth that apparently evolved independently, thus shrouding the boundaries between species.

"The genus is the [meaningful] category with regards to teeth and crania, Tattersall says.

He argues that cranial and dental analyses may have led to an inappropriate lumping together of separate species of hominids, the evolutionary family that includes modern humans. For instance, he holds that fossils classed as *Homo erectus* — a hominid species that lived in Africa and Asia from about 1.6 million to 300,000 years ago — actually encompass several species, only one of which represents a direct human ancestor (SN: 4/25/87, p.264).

Terry Harrison of New York University concurs with Tattersall's cautions about deriving species from bones, but he sees no reason to split up *H. erectus*. The widespread reliance on primitive and advanced skeletal features to establish evolutionary connections between groups — an approach known as cladistics — best identifies broad evolutionary levels, such as the family of hominids, Harrison says. But cladistics often cannot resolve controversies about genera or species within an evolutionary family, he maintains. The limited fossil record and the parallel evolution of similar features in related species — as documented among lemurs by Tattersall and Schwartz — often confuse evolutionary reconstructions, Harrison says.

To date, the far-flung fossil remains of *H. erectus* have shown no more anatomical variation than modern human populations, supporting the traditional view of *H. erectus* as a single species, he adds.

Body-size differences between the sexes also impede the identification of fossils from ancestral primate species, points out Jay Kelley of Brown University in Providence, R.I. Proposed sex differences in size have long stoked controversy over the earliest known hominid species, *Australopithecus afarensis*. Many anthropologists classify *A. afarensis* as one species, with males considerably larger than females. Others claim the size differences reflect separate species (SN: 3/23/91, p.182).

Similar arguments plague assessments of fossil apes dated at between 5.5 million and 23 million years old, Kelley notes. In his analysis of the only good population sample of a fossil ape from that time period, Kelley concludes that marked size differences between the sexes "probably characterized many early primate species to a much greater extent than modern primates."

He compared several hundred teeth belonging to *Lufengpithecus*, which lived about 7 million years ago in China, with the teeth of modern orangutans, which display large sex differences in body and tooth size. The fossil ape's cheek teeth fell into two groups with more striking size differences than those observed among orangutans, Kelley reports. Noting that sex contrasts in tooth size closely correspond to sex differences in body size among all living primates, he argues that *Lufengpithecus* represented a single species in which these gender disparities exceeded the modern limit. *— B. Bower*

Plasma guns take aim at larger surfaces

New technologies for tailoring the surfaces of materials for specific purposes are making engineers' dreams come true. Ion implantation, for instance, allows manufacturers to embed atoms of another material into silicon semiconductors and to produce tougher ball bearings by adding a stronger metal to their surfaces. For the most part, however, this exciting technique has proved too expensive and cumbersome for items much bigger than a computer chip or a ball bearing.

Now, three researchers have developed a way to implant metal ions (charged atoms) or to lay down a thin metallic film with less fuss. In the April 1 Applied Physics Letters, plasma physicist Ian G. Brown and his colleagues at the Lawrence Berkeley (Calif.) Laboratory report using a vacuum-arc plasma gun to generate a dense fog of metal ions in a vacuum chamber. The researchers then create a high voltage, or electric-potential difference, in the vacuum. This drives the metal into the surface of the material they wish to modify.

"This technique is scalable up to a very, very large throughput," Brown told Science News.

Though researchers can generate plasmas in many ways, Brown says the pulsed vacuum-arc process he uses is more straightforward. This longstanding technique, which Brown considers underused, vaporizes atoms directly into ions by applying pulses of intense electric current to a metal plate. "Plasma guns are simple, cheap and efficient," Brown adds.

Some surface-modifying technologies, such as physical vapor deposition, also lay down wear-resistant films, but in much thicker layers. Techniques such as sputtering lay down thinner layers, but are "very expensive and limited to not very large components," notes John Stringer, a technical director at the Electric Power Research Institute in Palo Alto, Calif.

Brown can not only vary the thickness of the film he lays down, but also implant several metals simultaneously. By raising or lowering the voltage of the bursts that pull the ions toward the surface, he can control whether the metal plasma forms a thin film or instead penetrates to a certain depth. And by shooting plasma guns that generate different metal fogs, he can mix and match the materials being implanted.

In the new experiments, the researchers first added yttrium to silicon, shoving 65 quadrillion atoms onto every square inch of silicon. Then they used two plasma guns, one loaded with yttrium and the other with titanium, to build up alternating layers of the two materials. Next they plan to scale up the technology, using an array of six or more plasma guns to modify a 4-inch long, 4-inch-diameter pipe.

"There's nothing technically holding it back from becoming viable," engineer Bruce C. Haywood of Spire Corp. in Bedford, Mass., told Science News. "But it takes money and time to commercialize it." About half of his company's business involves ion implantation, primarily of ball bearings and biomedical devices. *— E. Pennisi*