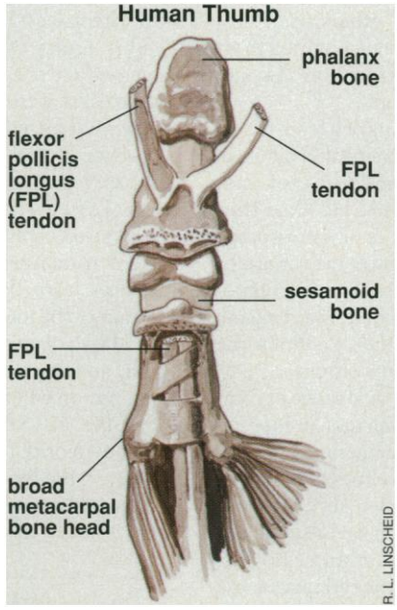
PALEOANTHROPOLOGY

Tracing the Identity of the First Toolmakers

At dozens of archaeological sites in Africa, razor-sharp stone flakes and round hammerstones mark the handiwork of anonymous craftspeople who forged tools as early as 2.6 million years ago. But researchers have been hard pressed to determine which of the half-dozen hominid species then roaming Africa made these artifacts. Were the first toolmakers one of our ancestors, or some more distant, dead-end branch of our family tree? Three years ago, State University of New York, Stony Brook, anatomist Randall Susman proposed a rule of thumb to solve this mystery—an easy test based on the width of a bone in the thumb. He argued that this measure identified whose hands could grip objects with the precision needed for toolmaking (*Science*, 9 September 1994, p. 1570). His influential paper concluded that by 2 million years ago, most hominids could make tools; it also prompted speculation that the oldest such tools were made not by our relatively big-brained ancestors but by their small-brained vegetarian cousins. But new data suggest that Susman's test, like all rules of thumb, may have a wide margin of error that could lead to erroneous conclusions.



Thumbs down? Traits in the thumb may not be enough to identify toolmakers.

In new work presented this week at the annual meeting of the American Association of Physical Anthropologists in St. Louis, two teams of scientists described a more complex test—developed by watching humans actually make tools—that may upset previous ideas about the identity of the ancient toolmakers. After applying her new test to some ancient hands, Arizona State University physical anthropologist Mary Marzke concludes—in contrast to Susman's work—that even 3.3 million years ago, the famous human ancestor nicknamed "Lucy" was beginning to acquire the needed hand structure for toolmaking. She adds that the acquisition of this skill involved many parts of the hand and not just the thumb, and that "the capability for toolmaking arose gradually."

Susman set out to determine which of the known species of australopithecines and early *Homo* might have made the Oldowan tools, which first appear in Ethiopia about 2.6 million years ago; similar tools are found until about 1 million years ago. He noted that humans, but not most apes, have a bone at the base of the thumb, the metacarpal, that has a broad head in relation to its length. He also found that the human thumb has three muscles not seen in apes, including a thick tendon called the flexor pollicis longus (FPL) that is linked with a broad metacarpal head and is vital for pinching objects between the pad of the thumb and another finger—a grip essential for toolmaking.

Assuming that the wide metacarpal head indicated toolmaking ability, Susman measured bones from four extinct hominid species. He got a surprise: All human species from about 2 million years ago, including a small-brained vegetarian called *Paranthropus robustus*, had wide metacarpal heads. But Lucy's narrow bone head failed the test, suggesting that her species, *Australopithecus afarensis*, was not a toolmaker.

Susman's simple method appealed to many. Biological anthropologist Leslie Aiello at University College, London, wrote at the time that the method offered "an apparently foolproof way of determining which of our early ancestors would have had hands that functioned in a way similar to our own." But some were skeptical; at Northwestern University, for example, paleoanthropologists Mark Hamrick and Sandra Inouye showed that the wide metacarpal heads of mountain gorillas also passed Susman's test—although these apes clearly were not toolmakers.

Hamrick, now at Duke University, and Marzke have both been tackling the problem in a more empirical manner. Marzke got Indiana University archaeologist and tool expert Nicholas Toth and two anthropologists to make stone tools at the Mayo Clinic; she wired their hands with electromyography sensors to measure which muscles were most stressed and videotaped the toolmaking process. She found that a complex group of muscles in the pinkie, thumb, and palm was used in toolmaking—but that the thumb muscle and precision grip highlighted by Susman were not heavily used. Hamrick, whose team at Duke did similar studies on nine people, corroborated that the precision grip wasn't a major factor.

Working with Mayo Clinic hand surgeon Ronald Linscheid, Marzke also dissected human and ape hands and found that the muscles used in toolmaking leave an elaborate signature on the skeleton. For example, in humans the shape of the thumb joints reflects the fact that the small muscles of the thumb are more efficient. And the bones at the tips of the fingers have spines marking where ligaments hold the fingers steady during firm pinches.

Using these data, Marzke has developed eight criteria, described in a recent article in the *American Journal of Physical Anthropology*, for identifying toolmaking capability. Although they incorporate Susman's criteria, including a well-developed FPL muscle, she says "no single skeletal feature can be relied upon as a safe indicator of toolmaking," because any one feature could have evolved for other behaviors. Thus, she says, Susman's conclusions are suspect. Aiello, among others, applauds these refinements, and now agrees that a strong thumb "is not the only thing that is important."

So far, Marzke has analyzed a small collection of fossils and has found that *A. afarensis* met three of the eight criteria. That means, she says, that this species wasn't actually a toolmaker but that other behaviors, such as throwing stones, were changing their hands in ways that would later be used for toolmaking. Of the 2-million-year-old species studied by Susman, she found only one—*H. habilis*—that met all her criteria; fossils of the other species were too fragmentary for her to accept or reject them as toolmakers.

And that's just the problem with her approach, says Susman: It is highly unlikely that researchers will ever find all the bones needed to test a species on all eight criteria. "What's the value of her criteria if they're inapplicable to fossils?" he asks. He also points out that Toth and other human volunteers may not make tools the same way early humans did: "Nick Toth isn't an australopithecine."

But Marzke and others already have permission to study the hand bones of *P. robustus* in South Africa, as well as more recent fossils of *Homo* species from China. Says Hamrick, who is planning follow-up work on one of Marzke's criteria: "Her work sets a stage where future researchers can look for those traits and test them." So, the mystery of who made the first stone tools may soon be resolved by a show of hands—from the fossil record.

–Ann Gibbons