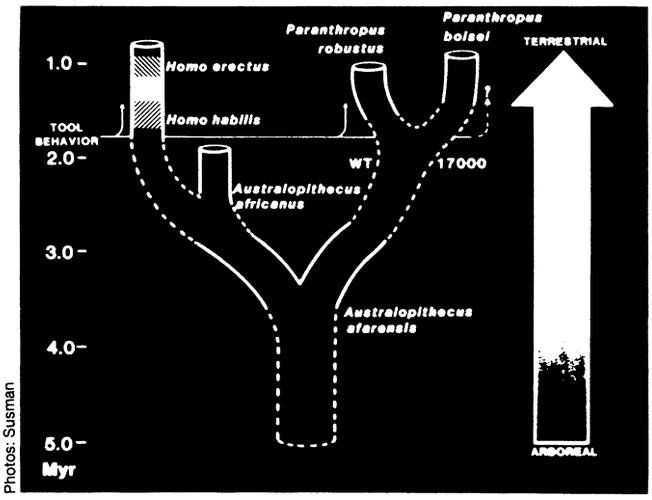
RETOOLED ANCESTORS

A group of small-brained creatures who disappeared 1 million years ago may have made and used tools before the direct ancestors of modern humans

By BRUCE BOWER



Photos: Susman

Susman's proposed hominid family tree. WT 17000 is a recently unearthed "robust" skull; its species is not firmly established.

Beginning 2 million years ago, an underground cave complex in South Africa known as Swartkrans became a catch basin for dead animals whose remains washed or fell into it. Antelopes, baboons, saber-toothed cats, leopards and early species of hominids, the evolutionary family that includes modern humans, became entombed there. In excavations conducted principally from 1979 to 1983, anthropologist C.K. Brain of the Transvaal Museum in Pretoria, South Africa, and his colleagues found the remains of roughly 130 hominids in a layer of Swartkrans soil that also contained 25 to 30 bone tools and several rudimentary stone tools.

That remarkable array of fossils, uncovered in sediment dated at approximately 1.8 million years old, includes the first well-preserved collection of hand and foot bones belonging to the robust australopithecines. This group of hominids evolved in Africa at the same time as the *Homo* lineage that led to modern humans, but became extinct around 1 million years ago. Delicate, easily crushed bones from the hands and feet rarely weather that stretch of time in shape for scientific study.

A new analysis of the Swartkrans bones indicates that members of this "dead-end" line of hominids possessed hands with a precision grasp and were, therefore, as capable of making and using tools as the earliest truly human species, *H. habilis,* which has long been considered the first stone-tool maker. Furthermore, the South African remains suggest the robusts were nearly as proficient at two-legged walking as are modern humans and spent much of their time on the ground.

The reasons for the demise of the robust lineage remain clouded, says anthropologist Randall L. Susman of the State University of New York at Stony Brook, but the Swartkrans remains undermine the traditional view that an inability to use tools paved the way to their extinction. Conversely, he adds, the new fossils suggest that "culture," at least as reflected by the manufacture and use of tools, was not the secret to evolutionary success for early human ancestors.

"The evidence suggests that tool behavior precedes hominid brain expansion [in the lineage leading to modern humans] and can no longer be viewed as the wedge that separated *Paranthropus* from early *Homo,*" Susman says. *Paranthropus* is the term he prefers for the robusts.

East African robusts are known as *Australopithecus boisei;* the South African variety is called *A. robustus.* Susman and some other investigators now place the robusts in the genus *Paranthropus,* or "near man," because there are indications that this line of creatures had distinct facial features and a unique pattern of dental development not observed in other australopithecines.

"The Swartkrans fossils provide clear signs that *Paranthropus* was as adept a tool-maker as *Homo habilis,*" says Susman. *Homo habilis,* or "handy man," entered the evolutionary scene around 1.9 million years ago, whereas the South African *P. robustus* and East African *P. boisei* appeared around 2 million and 2.2 million years ago, respectively. The oldest known stone tools in East Africa date to about 2.4 million years ago, closer to the time of *P. boisei* than *H. habilis.*

"*Homo habilis* may have been 'handy man,' but he had assistants," he says.

On the basis of foot bones unearthed at Swartkrans, Susman also places *Paranthropus* more firmly on the ground than have many anthropologists. "It appears that *Paranthropus* was as capable of walking on two legs as other contemporary hominids and probably spent most of its time on the ground, not in trees," he explains.

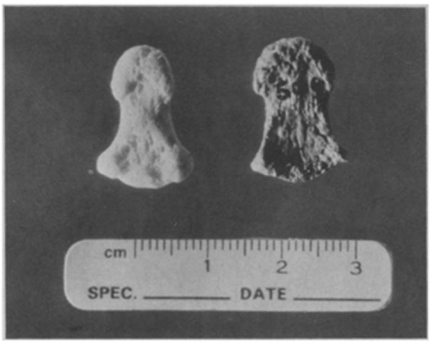
Susman, who was given access to the fossils by Brain, presented his findings at the recent annual meeting of the American Association of Physical Anthropologists in Kansas City, Mo. A report on the hand fossils is also in the May 6 SCIENCE. Researchers familiar with his study agree that *Paranthropus* had the precision grip needed for tool-making, but some question whether tools found at Swartkrans belong to *Paranthropus* or an early *Homo* species.

Susman's findings come at a time when some long-standing assumptions concerning the large-toothed, small-brained "robust" lineage are being retooled. With a more accurate portrayal of the robusts, scientists can better frame their investigations into why the direct ancestors of modern humans flourished while other hominids fell by the wayside.

At an international scientific conference at Stony Brook last year (SN: 4/11/88, p.229), two groups of scientists reported that there are no marked differences in body size between so-called robusts and other early hominids, including *H. habilis.* Another investigator took the first extensive measurements of robust australopithecine skulls and found that – in spite of the name – much of the skull above the jaw is relatively thin and fragile.

Distinguishing features of the robusts include massive teeth and jaws, as well as a skull structured to support enormous facial muscles. Anatomical anchors for the chewing muscles include a flared, bony crest running over the top of the head, a visor-like crest over the eyes and a triangular brain case.

From the Stony Brook conference, there emerged a new picture of the robusts as creatures who were not partic-



Corresponding thumb bones of Paranthropus *(right) and modern human.*

ularly robust in stature and had faces and teeth that differed significantly from other australopithecine species, such as the East African *A. afarensis* (the earliest known hominid, at about 3.5 million years old) and the South African *A. africanus* (dated at between 2.5 million and 3 million years old). Some anthropologists even discarded the term "robust australopithecine" and reclassified the line as *Paranthropus.* Debate over the justification for a separate *Paranthropus* lineage has waxed and waned since the 1930s, when Scottish paleontologist Robert Broom first assigned the genus to some South African hominid fossils he unearthed.

Despite classification clashes over *Paranthropus,* says Susman, its small brain and large, flat teeth apparently suited to a vegetarian diet led many anthropologists to assume that members of this lineage had neither the wits nor the need to make tools.

But they certainly had the hands for tool-making. At Swartkrans, Susman found that the species *P. robustus* possessed straight fingers and a broad thumb designed to support a large muscle found in the thumbs of modern humans, but not in the corresponding digits of apes or monkeys. The mobility and shape of the ancient hominid's wrist bones are also human-like.

Furthermore, bone tools found near the skeletal remains have worn points with a distinctive polish that Brain has duplicated by taking pieces of animal bone and digging out edible bulbs from the rocky soil near Swartkrans. The fossil and modern bones have similar patterns of wear marks when examined under a scanning electron microscope, reports Brain in *Ancestors: The Hard Evidence* (Eric Delson, Ed., Alan R. Liss, Inc., 1985).

No evidence exists, in the form of cut marks on animal bones found in the Swartkrans sediment, that meat-eating took place, he adds. But the stone artifacts from Swartkrans are now being examined for clues — possibly in the patterns of wear along their sharpened edges — as to whether they were used in vegetable or meat processing.

Anthropologist Eric Delson of the City University of New York agrees that *P. robustus* had the precision grip described by Susman, but remains uncertain they produced the Swartkrans tools. A small number of early *Homo* remains — probably representing *H. erectus* — are in the same deposits, he points out.

"Did the two species live side by side?" asks Delson. "Did [*P.*] *robustus* use leftovers of *Homo erectus* tool kits? There is no way to test these questions adequately."

Susman contends that *P. robustus* is the more likely tool manufacturer, since analysis of skull fragments and teeth in the Swartkrans deposit indicate that *P. robustus* individuals outnumber early *Homo* 125 to 5.

Shifting the focus from grip to gait, Susman says foot and toe bones at the site resemble, for the most part, those of modern humans. He concludes that *P. robustus* walked fairly flat on its feet and was a terrestrial creature. But the narrow end of a complete big-toe bone indicates that a critical toe joint was not strong enough for *Paranthropus* to push off its big toe into the full stride employed by modern humans.

"That was the last change in the evolution of walking," says Susman. *H. habilis* remains in East Africa are too fragmentary for researchers to judge whether it walked like *P. robustus* or was capable of a full stride.

P. robustus, Susman maintains, clearly spent more time on the ground than *A. afarensis,* the earliest known hominid whose remains, including those of "Lucy," were found in East Africa by Donald Johanson of the Institute of Human Origins in Berkeley, Calif., and his colleagues. The curved toe bones of Lucy and her kin indicate they spent a good deal of the time in trees, says Susman.

Interpretations of the *A. afarensis* lifestyle remain controversial (SN: 7/2/83, p.8). "I don't rule out that smaller individuals, such as Lucy, didn't at times climb in trees for food or for shelter at night," says Johanson. "But the *afarensis* knee, ankle and hip bones were modified primarily for bipedal [two-legged] locomotion."

While Susman's work suggests that *P. robustus,* and by inference *P. boisei,* had human-like hands and feet, Stony Brook anthropologists Frederick E. Grine and Lawrence B. Martin say tooth enamel distinguished the *Paranthropus* line sharply from other hominids, and from ancient and modern apes as well.

The deciduous and permanent teeth of *Paranthropus* grew so fast that they "blew out like a balloon" in comparison to the dental development of modern humans, apes, early *Homo* and *A. africanus,* says Martin.

The researchers, who also presented their data at the physical anthropology meeting, cut sections of enamel out of six early hominid molar teeth representing *A. africanus, P. boisei, P. robustus* and *P. crassidens,* a separate *Paranthropus* species to which they attribute the Swartkrans remains.

Enamel thickness relative to tooth size in *A. africanus* is comparable to that previously measured in modern humans and in *Sivapithecus,* an 8-million-year-old ancestor of modern orangutans. The *Paranthropus* specimens share a much thicker coat of molar enamel, says Grine.

He and Martin viewed the teeth under a polarizing light microscope to zero in on growth lines in the enamel known as striae of Retzius. Striae, explains Martin, are traces of the enamel surface at various stages of tooth formation. These lines are separated by cross striations, which many researchers accept as daily increments of growth, although this estimate is strongly challenged by others (SN: 12/19&26/87, p.408).

Striae in the *Paranthropus* molars run nearly parallel to the junction of the enamel with the underlying dentin, says Martin. A smaller, more parallel angle of slope of striae as they rise from the enamel-dentin junction indicates that teeth grew rapidly and contained large numbers of enamel-secreting cells. Striae in modern human teeth are at a larger angle to the enamel-dentin junction, corresponding to a longer period of enamel formation.

Another study of striae in naturally fractured hominid teeth, reported by British scientists in NATURE last year, reached a similar conclusion. Dental anatomist David Beynon of the University of Newcastle and anthropologist Bernard A. Wood of the University of Liverpool found that *P. boisei* permanent molars are much larger and have considerably thicker enamel than modern human, ape and early *Homo* molars, even though the *Paranthropus* teeth erupted and completed enamel formation more quickly.

The pattern of accelerated enamel formation in *Paranthropus* permanent molars resembles that observed in human deciduous teeth that are shed during childhood, says Martin. Jaw growth would have to be rapid, he adds, to allow the early eruption and rapid expansion of large permanent molars.

"Modern *Homo sapiens* apparently retain a primitive enamel condition from a common ancestor of apes and humans," says Martin.

As important as the enamel data and Susman's Swartkrans study are, the true nature of *Paranthropus* — which Delson still places under the australopithecine umbrella — remains rather mysterious, he says.

"It's difficult to define a genus using only dental characteristics," remarks Delson. "And it's not known what the hands of *A. africanus* or [*P.*] *boisei* looked like. We're comparing some really interesting findings to a gap in the fossil record." □