Getting a grip on prehistoric tool makers

A small, unassuming bone runs halfway up the thumb from its base. That same bone offers scientists a surefire way to tell which ancient members of the human evolutionary family, known as hominids, possessed hands capable of making stone tools, according to a report in the Sept. 9 Science.

Moreover, an analysis of thumb fossils indicates that an extinct line of small-brained hominids called *Paranthropus* (or robust australopithecines) proved as anatomically prepared to fashion such implements as *Homo erectus,* a direct human ancestor, asserts Randall L. Susman, an anthropologist at the State University of New York at Stony Brook.

"I'm offering a new way to diagnose tool behavior," Susman says. "So far, it looks like no hominids were capable of tool making before 2.5 million years ago, and after that time all hominids were capable of tool making."

The new study supports Susman's prior elevation of *Paranthropus* to the status of tool maker, an assessment that challenged the widespread view that the *Homo* lineage held a monopoly on chipping useful devices out of stone (SN: 5/28/88, p.344).

The Stony Brook scientist examined lower-thumb bones of 12 pygmy chimpanzees, 49 common chimpanzees, and 41 modern humans, as well as single thumb fossils from *Australopithecus afarensis* (dating to about 3 million years ago), *Paranthropus* robustus (found at a 1.8-million-year-old South African cave), *H. erectus* (from the same cave), and a Neandertal dating to around 50,000 years ago.

Modern human specimens display a broad thumb head (where the joint forms) in relation to thumb length. Chimps' thumb bones show much narrower heads relative to their length.

The wider portion of the human bone allows for the insertion of three additional muscles that add strength and refined motor control to thumb movements, Susman argues. As a result, human hands can generate the force needed to manufacture and wield stone tools, he contends.

A chimplike thumb occurs in *A. afarensis,* but human thumb proportions characterize the remaining hominids, Susman holds.

"Susman has given us an apparently foolproof way of determining which of our early ancestors had hands that functioned in a way similar to our own," writes Leslie C. Aiello, an anthropologist at University College London, in an accompanying comment. But the thumb bone Susman identifies as *P. robustus* shows enough similarity to the corresponding *H. erectus* bone to raise the possibility that both fossils belong to the latter species, Aiello argues.

Susman

Lower-thumb bones of Paranthropus, *left, and* Homo, *right.*

"We simply can't tell whether these bones belonged to *Paranthropus* or *Homo,*" holds Erik Trinkaus, an anthropologist at the University of New Mexico in Albuquerque.

But in an unpublished comparison to modern primate thumbs, the two South African fossils show contrasts in size and shape that place them in different species, Susman responds.

He emphasizes that the first tool makers needed powerful hands, not large brains. Still, reorganization of motor and spatial regions in the brain must have made this behavior possible, Trinkaus argues. *— B. Bower*

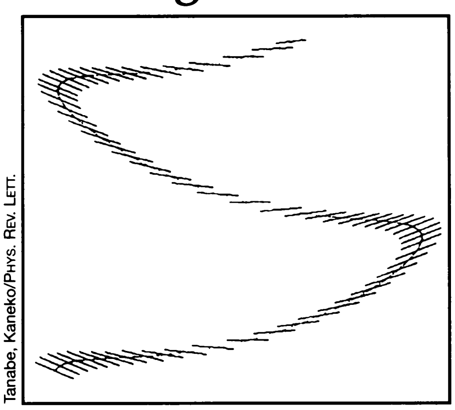
Catching the flutter of a falling leaf

With the approach of autumn in the Northern Hemisphere, falling leaves are in the air — and in the scientific literature.

The falling motions of a leaf or sheet of paper are very complex, say Yoshihiro Tanabe and Kunihiko Kaneko of the University of Tokyo. Sometimes, the leaf or paper may drift randomly to the left or right as it falls. At other times, it may tumble erratically while maintaining a downward course. Its motion can also be quite regular.

To investigate whether paper's irregular motions can be attributed to chaos, Tanabe and Kaneko developed a simplified mathematical model of a sheet of paper falling through the air. Their analysis of the model demonstrates that tiny changes in the amount of friction acting on falling paper can induce unpredictable, erratic behavior, suggesting that its motion is chaotic.

The most direct way to take into account the complicated interactions between air and a sheet of paper is to use the Navier-Stokes equations, which describe the motions of a fluid. But such an approach, even with approximations, would require huge expenditures of computer time.


Tanabe, Kaneko/Phys. Rev. Lett.

An example of periodic fluttering in the motion of a falling sheet of paper.

Instead, Tanabe and Kaneko focused on a simple model with only a few variables to capture the motion's essential features. They simplified the motion so that it takes place in two dimensions and assumed the paper has a length and mass but no width or thickness.

In addition, only three forces act on the paper: lift, friction, and gravity. The friction is divided into two components, one acting parallel and the other perpendicular to the direction of fall. The researchers set the perpendicular component to be always larger than the parallel component.

They used this crude approximation to study the effect on the falling paper's motion of increasing the amount of friction in the perpendicular direction. They clearly distinguished five falling patterns.

When the friction force is weak, the paper drifts to one side, steadily rotating or flipping over as it falls. For slightly higher values, this rotation turns into erratic tumbling.

As the friction increases, the paper begins to flutter, swaying chaotically from side to side during its downward course. At still higher values, the swaying motion becomes regular (see illustration).

Finally, the paper's sideways movements decrease to zero, and it falls straight down. It's like the fall of a needle in honey, the researchers note.

"We have succeeded in constructing a simple model reproducing a variety of falling patterns observed in daily life," Tanabe and Kaneko conclude in the Sept. 5 Physical Review Letters.

It may be possible to test this model experimentally — perhaps by dropping a thin, flat object in fluids of different densities — to confirm the chaos of fluttering fall. *— I. Peterson*