Old Dates for Modern Behavior

Sophisticated tools made in Europe 40,000 years ago are, textbooks say, the first signs of truly modern human activity. Controversial African finds say Europeans were 50,000 years behind the times

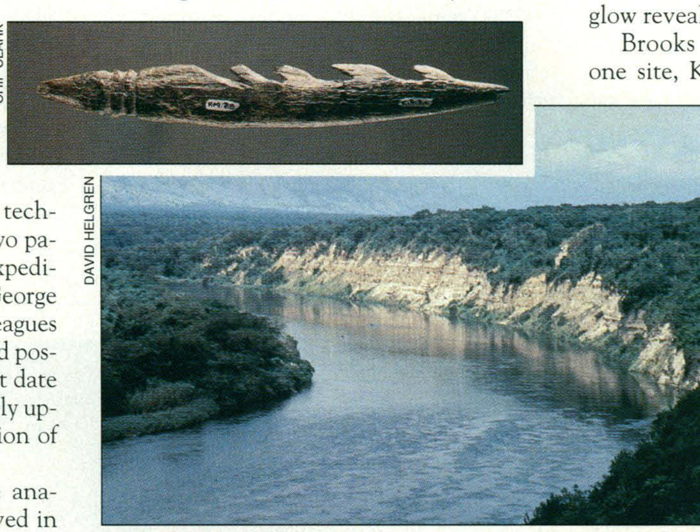
When archaeologist John Yellen and a colleague pulled a finely crafted barbed bone point from a cliff bank above the Semliki River in Zaire in 1988, Yellen felt dismay, not excitement. The carved bone reminded him of harpoon points made in Europe some 14,000 years ago, and Yellen had hoped the site in Zaire dated back to the Middle Stone Age (40,000 to about 200,000 years ago). "I wasn't happy about it," recalls Yellen, who works for the National Science Foundation in Washington, D.C.

His disappointment, however, was short-lived, because the site—according to a slew of new dating techniques—may be very old indeed. In two papers on pages 548 and 553, Yellen, expedition co-leader Alison Brooks of George Washington University, and their colleagues argue that the site is at least 75,000 and possibly 90,000 years old. Such an ancient date for modern-looking tools may ultimately upset received wisdom about the evolution of human behavior.

Most paleoanthropologists believe anatomically modern human beings evolved in Africa more than 100,000 years ago. But the textbook view is that the behavior of modern humans arose only 40,000 years ago in Europe, where humans were first able to make innovative tools, plan for the future, and express themselves symbolically. The work by Brooks and Yellen—if correct—could transform that view. "We're seeing clear evidence of sophisticated behavior in sub-Saharan Africa perhaps 90,000 years ago," says Brooks. The carefully made bone point is just one such sign. Michigan State University archaeologist Larry Robbins, who has found younger bone artifacts in Africa, agrees that "if the dates are correct, it would have profound implications."

But several scientists have a bone to pick with those dates. The period in question is beyond the reach of the most reliable method for dating archaeological sites: radiocarbon dating, which is useful only as far back as 40,000 years. So the Brooks and Yellen team dated their soil and bone samples with several experimental methods that work in a period from 1000 to several hundred thousand years ago.

While the methods all point to a similar antiquity for the site, retired University of Maryland physicist William Hornyak, a co-author of one of the papers who did some of the dating, admits that "all of these techniques have broad uncertainties associated with them." And those uncertainties, along with the tools' modern appearance, have produced some dubious reactions. "Oh dear," sighed University of California, Berkeley, archaeologist Desmond Clark, "they look to me like something from the early Holocene [6000 to 8000 years ago]."



CHIP CLARK

DAVID HELGREN

Tool for modern living. At a site along Zaire's Semliki River, archaeologists found a carved bone harpoon tip *(inset)* that may be the earliest sign of sophisticated human behavior.

The site of all this controversy is known as Katanda. There, beneath several meters of sand and gravel, three localities yielded bone tools. The local geology indicated that Katanda was substantially older than 25,000 years, but how much older was anyone's guess. The researchers could not date the bone toolkit directly, because there was not enough organic material left for radiocarbon dating. So they decided to use other techniques to date elements of the surroundings.

The early dates that are the cornerstone of their papers are largely the product of two methods—thermoluminescence (TL) and electron spin resonance (ESR). TL provides an age for quartz grains in the soil by indirectly counting the number of electrons that get trapped in physical defects within the quartz crsytals. Trapping occurs at a regular rate, as electrons are hit with radiation from radioactive isotopes in the soil, and it forms the basis for a clock. Many electrons can be released by energy from the sun, resetting the clock to zero. If the grains are subsequently buried, electrons start falling into traps and the clock starts ticking. Millennia later, scientists can release the trapped electrons by heating the quartz or shining a bright light on it. The freed electrons release photons, producing a brief glow proportional to the number of electrons set free. Measuring the glow reveals the elapsed ticks of the clock.

Brooks sent a sample of the sands of one site, Katanda-9, to Hornyak at Maryland's Archaeometry Laboratory. Hornyak used several lab techniques to measure the released photons, and all gave dates between 75,000 and 180,000 years old.

But James Feathers of the University of Washington, who as a postdoc at Maryland did a lot of the dating work, has reservations about these dates. There are two types of electron traps within quartz, he explains. One type, which responds rapidly to light, is generally viewed as the most reliable age gauge. But in the Katanda samples, the light released by these traps produced anomalous signatures which, Feathers says, indicates their chronology is not to be trusted completely.

That means TL dating of Katanda rests on the second type of trap, which responds more slowly to light and may not be zeroed completely by sunlight exposure. Despite this, Hornyak says he is "very confident" of the dates, because repeated tests have yielded consistent ages; moreover, the dates agree with those produced by other methods.

One of those methods is ESR. Like TL, this technique also counts the number of electrons caught in traps, in this case within the enamel of hippo teeth from Katanda-9. Trapped electrons can be induced to "flip"—change their magnetic orientation—and when they do so in a lab they absorb a measurable amount of radiation from a surrounding microwave field. That produces a count of the trapped electrons and a date. When McMaster University geologist Henry Schwarcz used ESR on three hippo teeth from Katanda-9, he came up with a date between 89,000 and 160,000 years ago. To check that finding, he ran another dating test—called a uranium series—where he measured the amount of daughter elements produced by the decay of uranium in the teeth. The result was a date between 139,000 and 173,000 years ago.

But Schwarcz adds a caveat: These dates are for the hippo teeth, not the bone artifacts or the soil surrounding the artifacts. It is possible that the teeth were washed into the soils at a different time from the bone, although Schwarcz doubts this occurred. "There are risks involved with any kind of dating," says Schwarcz. "But I feel reasonably confident about the window in which we've placed these dates."

If that window through time hasn't distorted the view, the Katanda bone tools are in a class by themselves. Not only are these the oldest such tools, but they also come in a variety of shapes and sizes, including points with both rounded and flattened shafts, some with barbs, and a flat dagger. "The people who made them really had a sense of bone as a plastic medium that could be used for very different things," says Yellen. This indicates that the toolmakers were engaging in sophisticated behavior: planning ahead for activities like fishing—hence the barbs—or possibly hunting with some of the other tools.

Other aspects of the site also suggest the ability to plan. People appeared to be camping at Katanda to fish during the catfish spawning season, says Brooks. They were also using ocher pigments and grindstones made of materials that were not local and must have been deliberately carried to the site from another place. "I think we're seeing the capacity to plan ahead and to conceptualize complicated technologies," says Brooks. "We're seeing a level of sophistication in several domains of behavior—the social aspect, the aesthetic aspect, the technological and economical aspect."

Still, this is nothing compared with the sophistication seen in Europe at 35,000 to 40,000 years ago, says Robbins. At that time, modern humans were artistic—making blades, ornaments, and necklaces, and decorating the dead with ocher. "What you have at Katanda is one part of that suite of things that indicates modern human behavior—not necessarily the whole package," says Robbins.

That in itself may not be so odd—a lot can happen in 50,000 years, after all—but another aspect of the discovery troubles Stanford University paleoanthropologist Richard Klein, who is a co-author on one of the papers. "Why don't we have the same early evidence for modern human behavior at other sites in Africa?" he asks. "Why does this site stand out like a big, sore thumb?"

Yellen thinks one reason is that "people are acting in very localized ways, without vast open networks where their ideas are spread around." Brooks adds that archaeologists may have missed the earliest signs because they have been looking in the wrong places—at rock shelters, which apparently were living sites, rather than hunting venues that would contain weapons.

Brooks and Yellen are planning to look hard in what they consider to be the right places. For until archaeologists see signs of this sophisticated activity at other sites in the same time period, doubts will abound. Says Clark: "With something this controversial, one would have to find another site to substantiate this." If researchers pull another finely crafted bone point from such ancient ground, this time the reaction would be celebration.

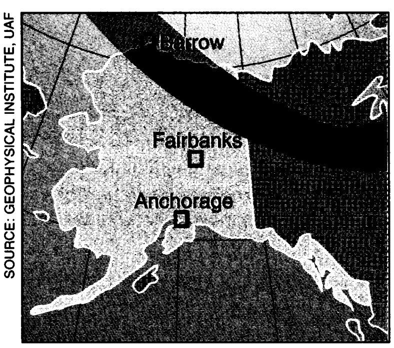
–Ann Gibbons

SPACE PHYSICS

Forecasting the Northern Lights

When the aurora borealis flickered overhead, the Norse once recognized the warlike Valkyries, and medieval Europeans to the south saw ominous portents. The gods and omens faded when the aurora turned out to be the handiwork of high-energy particles bombarding the upper atmosphere, and now the northern lights may lose a little more of their mystique: Since late March, newspapers and television stations in Alaska have been presenting forecasts of the aurora along with the weather outlook, describing it in the same breath as sleet and ground fog.

SOURCE: GEOPHYSICAL INSTITUTE, UAF



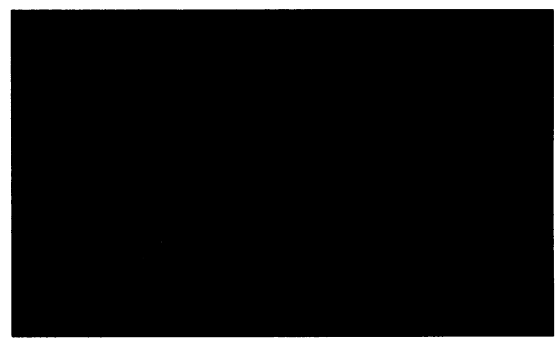


PHOTO RESEARCHERS

One week's forecast. A map showing the auroral zone for late April *(left)* was posted on the World Wide Web.

But the fascination of these celestial displays is as great as ever, which is why everyone from scientists to ordinary gawkers is welcoming the forecasts, posted twice a week on the Internet's World Wide Web (http://www.gi.alaska.edu) by the Geophysical Institute of the University of Alaska, Fairbanks (UAF). For researchers who probe the notoriously erratic discharges with rockets, the forecasts of aurora location and intensity improve the chance of choosing the best launch "window." They have also been a hit with tourists and local residents who just want to know if they can catch an aurora over the weekend. "They've been right on," says Walter Munly, a television weatherman at KATN in Fairbanks who has incorporated the forecasts into his show.

UAF geophysicists Syun Akasofu and Charles Deehr produce the forecasts by combining observations of solar activity with worldwide data on Earth's magnetic field. They are more than just handy predictions. The aurora is a visible sign of turmoil in the far-flung system of charged particles and magnetic fields that emanates from the sun—turmoil that can also disrupt communications and menace satellites. By predicting aurorae, geophysicists hope to test their understanding of these particles and fields. "If you're successful time after time in making these predictions, it says you're pretty much on the right track," explains space physicist Daniel Baker of the University of Colorado, Boulder, who has his own approach to aurora prediction.

Just how the sun drives the aurora is "extremely controversial," says Roger Arnoldy, director of the Space Science Center at the University of New Hampshire in Durham, but researchers do agree on the outlines of the process. Arnoldy explains that during the quiet minima of the sun's 11-year sunspot cycle, such as the present, most auroral activity can be traced to long-lived solar features called coronal holes, areas that appear dark in soft x-ray pictures of the corona. Elsewhere on the sun, the magnetic field loops back to the surface, trapping most charged particles, but at the holes, the field lines wander into space. As a result, the holes spout streams of charged particles that spin like lawn sprinklers with the sun's 27-day rotation.

As the particles fly outward, they sweep up and intensify fluctuations in the magnetic field that travels with the slower "wind" of particles blowing steadily from the sun. When one of these bundles of intensified field runs into Earth's magnetosphere—a region of calm in the solar wind, carved out by Earth's own magnetic field—they can cause mayhem if the bundle's lines point southward, in the opposite direction from Earth's. The two