change could bring in the future, says Karl.

The index gives the most weight to much-above-normal temperature—measured as daily minimums, because that's where climate models predict greenhouse influences will be strongest. But Karl and his colleagues also included yardsticks derived from the generally accepted assumption that a greenhouse climate will be more summery than the norm—not just warmer, but more prone to heavy rainstorms and droughts. The index's four other measures are much-above-normal precipitation in the cool months, extreme or severe drought in the warm months, a much greater than normal proportion of annual precipitation falling on days having more than 50.8 millimeters of precipitation, and reduced day-to-day temperature swings.

For each year since 1910, Karl and his colleagues determined the percentage of land area in the lower 48 states that experienced extremely abnormal climate of each of the five types. Taken together in the greenhouse index, these indicators reveal three episodes of greenhouselike climate: the Dust Bowl years of the 1930s, the drought years of the 1950s, and the 1980s and early '90s. The index values in the current episode are no higher than those of earlier episodes, but they have remained high for longer—since the late 1970s, the same time the tropical Pacific took a turn toward the warm side and global temperatures shot up (*Science*, 28 October 1994, p. 544). What's more, all five index components have contributed to the rise. As a result, Karl and his colleagues estimate a probability of only about 5% that the index's latest surge toward the greenhouse side is just another fluctuation of an otherwise stable climate.

Like Karl, climatologist David Robinson of Rutgers University says that number shouldn't be seen as proof of a greenhouse warming. The components in the greenhouse index "are the key players in recognizing global change," he says, "but they're not the be-all and end-all for identifying global change." But Robinson agrees that the high index is a sign of "some interesting things going on in U.S. climate."

To see whether the rest of the globe looks just as interesting, Karl would like to broaden the index beyond the 2% of the globe's area covered by the lower 48 states to include places like Russia, China, and Europe. If recent weather there looks as offbeat as it does in the United States, a greenhouse warming could be the only way to make sense of it.

–Richard A. Kerr

Additional Reading

T. R. Karl *et al.*, "Trends in U.S. climate during the twentieth century," *Consequences* **1**, 3 (1995). Published by Saginaw Valley State College, University Center, MI 48710, USA.

Anthropologists Overturn Old Ideas About New Developments

Some basic assumptions took tumbles between 28 March and 1 April, when the Paleoanthropology Society and the American Association of Physical Anthropologists (AAPA) held their annual meetings in Oakland, California. Surprises sprang from studies of Neandertal arms, island genetics, and primate birth, among other topics.

Arms and the Man

Fossil skeletons tell prehistorians that humans who looked fully modern first appeared in Europe around 40,000 years ago. But just when these people started *acting* like modern folks—planning their hunting strategies, for example—is another question entirely. "There's been a controversy over the emergence of modern subsistence behavior, like the shift from opportunistic scavenging to planned hunting," says anthropologist Steven Churchill of the University of New Mexico.

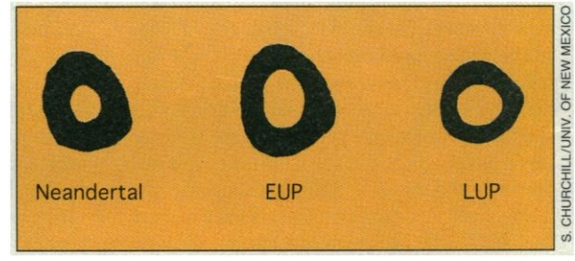
One problem is that behavior doesn't fossilize. But bones do, and some types of behavior leave their marks on bone shape and thickness. Based on an analysis of the shape of the upper arm bone, or humerus, in groups of ancient humans, Churchill told colleagues in Oakland that modern behavior seems to have appeared in stages. First, he says, there was a shift in strategy toward more planning, followed thousands of years later by a change in technology, when people developed spears that could be thrown instead of simply thrust. "It's valuable work," says anthropologist Christopher Ruff of Johns Hopkins University. "He's gone in and quantified bone variables related to mechanical loading and thus to behavior."

Because outer layers of bone thicken where stresses generated by muscles are the greatest, the amount and distribution of that extra material can reveal overall workloads and particular activity patterns. "It's a fine-grained record of what an individual was doing habitually," Churchill says.

Churchill compared that record in the humeri of three groups of fossil humans, focusing on males because they are almost always the hunters. His sample included seven Neandertals, who lived in Europe until about 35,000 years ago and are not considered anatomically modern; 11 modern-looking humans from the Early Upper Paleolithic (EUP), 35,000 to 20,000 years ago; and 17 humans from the Late Upper Paleolithic (LUP), beginning about 20,000 years ago.

After scaling the bones to account for differences in body size, Churchill found there was a big drop-off in overall humerus thickness from the Neandertals to EUP humans. Apparently, the more recent humans had found ways of easing their workload. "My interpretation is there's been some kind of subsistence shift, a reduction in opportunistic scavenging," he says. "If you are opportunistic, you have to put more effort out than, say, if you are hunting one or two times a week. In the EUP they were doing better—maybe they had better prey intercept strategies. They knew where deer migrated and moved there to catch them."

But the shape of the humerus didn't change until the LUP, around 20,000 years ago. In both Neandertals and EUP human males, its cross section was oval, elongated from back to front. That shape, says Churchill, is a sign that the arm was used heavily for thrusting, an action in which muscles tug on the front and back surfaces of the bone. But in the LUP, the bone's cross section suddenly became rounder. And a round humerus, Churchill argues, is a response to frequent throwing. Throwing an object like a spear generates twisting forces on the upper arm; to cope with these stresses, he says, the body distributes extra layers of bone evenly around the humerus.



Behavior shift. Upper arm-bone cross sections from Neandertals and Early Upper Paleolithic (EUP) humans are oval, a result of muscles tugging at the front and back. This happens when thrusting a spear. The rounder shape in Late Upper Paleolithic (LUP) humans can be produced by a throwing motion.

That's consistent with archaeological evi-

dence, says John Shea of the State University of New York, Stony Brook, who notes that 20,000 years ago is just when very streamlined spear points—possibly designed for throwing—first appear. Shea does have some cautions, noting that activities other than hunting, such as carrying loads, can also affect humerus shape. And archaeologist Mary Stiner of the University of Arizona points out that the sample size is very small. Still, Churchill notes, it's starting to look as if "the modern package didn't arise full-blown. It came in pieces."

–Joshua Fischman

The First Pacific Islanders?

The striking physical differences among Solomon Islanders amazed anthropologist Jonathan Friedlaender in 1967 when he first visited the islands, which lie in a part of the southwestern Pacific called Melanesia. The prevailing wisdom was that all Melanesians came from one or two migrations out of Asia within the last 10,000 years. Yet the people of the island of Malaita had blond Afros, while the highland people of nearby Bougainville had wiry hair and jet-black skin like West Africans—hardly what one would expect from recent, homogeneous migrations.

The movements may, in fact, have been ancient and diverse, according to new genetic evidence. In a presentation at the AAPA meeting, Friedlaender, who works for the National Science Foundation in Washington, D.C., showed that some Solomon Islanders don't have genetic markers that tie them to a recent Asian migration, but do have a surprising amount of diversity in their DNA. Diversity equals antiquity in population genetics, and he and his colleagues think this diversity is such that it pushes the original settlement dates in the Solomon Islands back before 30,000 years ago. The work is part of a growing body of evidence suggesting these islands could be one of the first, not last, parts of the world to be settled by modern humans. "The whole bottom has dropped out of the picture we had for when the first people lived in the region," says anthropologist John Terrell of Chicago's Field Museum.

Geneticists Andrew Merriwether and Ilyas Kamboh of the University of Pittsburgh sequenced segments of DNA from both the nucleus and the mitochondria (a cellular organelle whose genes are maternally inherited and thus unscrambled by sexual recombination) from various Melanesians. Their first finding was that the jet-black highlanders of Bougainville, the Aita, lacked a 9–base pair deletion in a noncoding segment of their mitochondrial DNA. This deletion ties many Oceanic people to Southeast Asians, who also have it, and archaeological evidence dates this settlement wave to within 3700 years. The deletion's absence in the Bougainville highlanders separates them from this recent migration. A distinctive 12–base pair deletion found in the *APO A4* gene of almost 30% of the Bougainville highlanders—a pattern which has never been seen outside the Solomons (except in the odd case of one African American)—adds to this impression of isolation.

But the Bougainvilleans, along with other Solomons inhabitants, also had a great diversity of short, noncoding DNA sequences called microsatellites. It takes time for such divergence to occur from a single genotype—at least 30,000 to 40,000 years or so, according to Friedlaender. This genetic evidence, combined with the fact that the earliest signs of human activity in the region are stone tools dated to about 60,000 years ago in Australia (*Science*, 31 March, p. 1908), suggests to Friedlaender that there may have been very early migrations from Asia to Australia and the smaller islands.

If the new findings from genetics prove right—and Terrell says he would like to see more nuclear DNA data—modern humans were fanning out in the islands of Melanesia and in Australia even before they reached Europe 40,000 years ago. That may not drop the bottom out of the picture of the world, but it certainly gives the region down under new prominence.

–Ann Gibbons

Birth Tale Gets a New Twist

Human birth, anthropologists have long assumed, is unique among primates. Long and painful labor, accompanied by a distinctive rotation of the infant in the birth canal, have been linked to the unique combination of big brains and a two-legged stance, for our babies have to spin and squeeze through a pelvis narrowed for better bipedality.

But graduate student Melissa Stoller of the University of Chicago undercut the assumption that bipedality is a prerequisite for rotational birth with a dramatic series of x-rays presented at the Oakland meeting. Stoller captured baboon and squirrel monkey babies revolving down the birth canal, through pelves never associated with walking. Robert Tague of Louisiana State University, who has analyzed the mechanics of birth in human ancestors, concludes that "the notion of fetal rotation as solely a consequence or correlate of bipedality is no longer a justifiable interpretation."

Anthropologists had observed primate birth before, but only from the outside. They assumed from the consistent oval shape of the nonhuman pelvis and the apparent ease of the baby's exit that primate babies simply slid straight out, without rotating. Stoller is the first to use medical imaging to get an inside look. In primate labs at the University of Illinois and the University of South Alabama, she waited and watched pregnant mothers. When labor finally began, she snapped radiographs of the unrestrained animals whenever they seemed to alight in a consistent orientation.

The results from seven squirrel monkeys and four baboons clearly show that infants of both species rotate. In one series of radiographs of a baboon in labor, for example, one image shows an infant facing the back of the mother's body; in a later radiograph, it has rotated 180 degrees to face front.

MELISSA STOLLER / UNIV. OF CHICAGO

Spinning quadruped. About to enter the birth canal, this baby baboon faces the mother's back. But minutes later it will do an about-face—evidence that human infants aren't the only ones to rotate during labor.

Other anthropologists do note that the rotation seen in the monkeys is different from that in humans. In humans, the infants' twists match the constrictions of the bony pelvis, points out Christopher Ruff of Johns Hopkins University. And the nonhuman primates exit facing forward, while humans face away from the mother, adding a considerable burden to immediate postnatal care (*Science*, 20 May 1994, p. 1082).

Still, rotation in both these species, which diverged from a common ancestor before human ancestors split off from other primates, raises the possibility that some kind of rotation did exist very early on in our history. "We assume that our ancestors evolved from an apelike condition, and we thought we knew what that was—a straightforward, simple birth, with no rotation. This shows that some monkeys have rotation, so if our ancestors were small-bodied apes giving birth in a monkeylike way, they could have had rotation as well," says University of Delaware anthropologist Karen Rosenberg. It's possible, then, that our ancestors learned to twist before they could walk.

–Elizabeth Culotta