Human Evolution

New Fossil Raises More Questions Than Answers

Anthropologists have found a new fossil skeleton of *Homo habilis*, the oldest direct ancestor of humankind. The new fossil is dated at 1.8 million years old, and represents the first time scientists have uncovered both skull and skeletal material from the same *H. habilis* individual. Presumed female because it is so small, the skeleton is that of a creature about 30 years old who stood little more than three feet tall and had a definite chimplike build.

The fossil was found on a late afternoon in July 1986 by anthropologist Tim White of the University of California, Berkeley. White was making his way out of the lower depths of Tanzania's Olduvai Gorge when he rounded a stand of spikey sisal plants and suddenly spotted a telltale fragment of fossilized human bone. "Whoa! This is a hominid!" White called out to his colleague, Donald Johanson, director of the Berkeley-based Institute of Human Origins. Within seconds, Johanson's eyes lit on the creature's arm bone; while Berhane Asfaw, an Ethiopian student at Berkeley, discovered its upper jaw. Subsequent excavations uncovered all of the limb bones of one arm, two leg bones, and numerous skull fragments.

Both the skeleton's size, proportions, and primitive appearance have surprised scientists. "It is much smaller and more apelike in build than we anticipated," said Johanson. "Only 200,000 years later, our next ancestor, *Homo erectus*, is between five and six feet tall, and has a recognizably human build."

The skeleton's apelike shape is clearly shown by the length of its upper arm bone—95 percent longer than the length of its upper leg bone. That means the arms would have extended to the mid-knee, as do a chimpanzee's. This suggests that the species spent a lot of time in trees, possibly, Johanson says, "because there were certain advantages to climbing trees—going after food, escaping from predators, or looking for a sleeping spot." Scientists did not expect such a primitive build in our ancestors at the 1.8 million year mark, largely because the faces and skulls of *H. habilis* look more advanced.

Anthropologists have known about *Homo habilis* since 1960, when Jonathan Leakey discovered the species' first skull. It was named *H. habilis*, "Man the toolmaker," because of its association with Olduvai's earliest stone tools. Since then, fossil hunters have recovered skulls, jaws, and teeth of *Homo habilis* from badlands throughout East Africa. But they also found the skulls of a heavy-jawed, manlike creature known as *Australopithecus robustus* a, who lived alongside our *habilis* ancestors. Occasionally, paleontologists also turned up fossilized limb bones. But because both *H. habilis* and *A. robustus* were upright creatures, scientists could only make educated guesses about which limb bones went with which animal.

"We used to base our guesses on how much the limb bones looked like those of modern humans," explained Henry McHenry, an anthropologist at the University of California, Davis, who has worked extensively on these fossils. "We assumed that larger forelimbs meant a more primitive creatures, and we assigned those to *A. robustus*. So I just laughed when I saw the new skeleton. It turned everything upside down; it was exactly the opposite of what we'd expected."

McHenry also notes that anthropologists may have to revise their thinking about tooth size as a measure of primitiveness. In the past, large cheek teeth were generally associated with *A. robustus*. Scientists believed that smaller cheek teeth belonged to ancestors in the human lineage. But these same teeth in the new skeleton are large.

The new find suggests an interesting sequence in the evolution of humankind. First our ancestors learned to walk on two legs: Johanson's previous discovery—*A. afarensis*, popularized as Lucy—showed that they were bipedal more than 3 million years ago. Their brains, however, remained the size of a chimpanzee's. Next their brains began to increase in size, as in this *Homo habilis* specimen; but their bodies continued to look very much like Lucy. And then over the next 200,000 years, the body changed drastically—as Johanson puts it, "making a leap toward our modern build."

But the overwhelming question is how such a tiny and primitive species as *Homo habilis* could have evolved to *Homo erectus* in a mere 200,000 years. What forces could have caused so abrupt a change? "It's a mystery, an enigma right now," says Johanson. "Perhaps it was diet; perhaps *Homo erectus* was becoming more of a hunter and needed the greater size and musculature. What that behavioral change was is still to be found in the sediments."

The Magellanic Supernova

Mighty Blast Begins New Era of Astronomy

"What an exciting time to be alive," exclaimed physicist John Bahcall when he heard the news. Astronomers had been waiting for nearly four centuries. As February 23rd turned into the 24th, observers in Chile sighted an exploding star in the southern sky. The Large Magellanic Cloud, a small companion to our Milky Way galaxy and normally viewed from Earth as a mistlike haze, harbored a faint yet distinct pinpoint of light. The last supernova to be observed in our galactic neighborhood took place in 1604 before the invention of the telescope.

Like some Dickensian tale, astronomers have experienced both the best and worst of times in their examination of the supernova, whose light traveled some 160,000 years before arriving at Earth. Underground detectors recorded an onslaught of ghostly subatomic particles called neutrinos emanating from the blast, spawning a new field of astronomy. With this historic burst, researchers may have witnessed the formation of one of the universe's most compact objects: a dozen-mile-wide neutron star. What was once a theoretical game, played out on computers, has finally turned into real science.

A Bewildering Brilliance

Yet, through March and into April, observers were bewildered by the unprecedented behavior of the visible explosion, which burned with the intensity of billions of suns. From the start, an arsenal of equipment was aimed toward the brightening spot: radio dishes in South Africa and Australia; X-ray and gamma-ray detectors aboard space satellites; optical telescopes throughout the southern hemisphere; and, later, airborne infrared instruments.

Over the first few days of the explosion, much swifter than expected, the supernova's brightness increased a thousandfold. But then its luminosity leveled off for several weeks at a magnitude ten times dimmer than predicted. (From that distance it appeared about 200 times fainter than the bright star Sirius.) And while very hot and blue at first, the supernova turned red astonishingly quickly, a change that occurred as the shell of debris raced outward at 50,000,000 miles per hour and cooled.

Astronomers were initially led astray in identifying the progenitor star. They knew that for a star to blow up, its mass must be at least eight times greater than our Sun's. Studying pre-blast photos, they chose a giant blue star known as Sanduleak-69 as the most likely candidate until Harvard astronomer Robert Kirshner, utilizing the International Ultraviolet Explorer space telescope, assured everyone that Sanduleak-69 was still shining serenely.

But at the American Physical Society's spring meeting held near Washington, D.C., at the end of April, Kirshner contritely announced that he and his colleagues had been misled by two other blue stars in the immediate area. "Let's not pussyfoot around," Kirshner told the conferees, "Sanduleak-69 was it." Upon hearing his reversal, someone sent Kirshner a can of red herring. "And theorists issued a collective sigh of relief," says Stirling Colgate of the Los Alamos National Laboratory.

With the host star pinned down, the pieces of the celestial puzzle at last began to fit. Most textbooks describe a red supergiant star, bloated and shedding its outer hydrogen envelope, as ripe to go supernova. But the death of a smaller, though still massive blue giant does not surprise theorists—in fact it helps explain much of the Magellanic supernova's quirky conduct. A shorter supply of material both dampens and hastens the visual fireworks.

Colgate speculates that up to half the giant stars that eventually blow up may be like Sanduleak-69. These less spectacular supernovae may have been overlooked in the past because they are dimmer and more difficult to observe in other galaxies.

A computer simulation by Stan Woosley of the University of California at Santa Cruz suggests this route to the stellar demise: Born with the mass of 20 Suns about 10 million years ago, Sanduleak-69 was 40 times the size of our Sun, 100,000 times more luminous, and aged 1,000 times faster. For millennia its nuclear furnace, deep in its center, fused matter into ever-heavier elements, until iron was formed. Thereafter the core of the star generated no more energy.

Incredible Energy Release

No longer able to support itself, the entire core, which encompassed a volume about the size of the Earth, collapsed in less than a second to a mass perhaps 10 miles in diameter. Protons and electrons merged to become neutrons, instantly creating a flood of 10^{58} neutrinos that sped outward at or near the speed of light. Ninety-nine percent of the supernova's energy—generated by the conversion of roughly one-tenth of the star's mass to energy—was carried off by these neutrinos. Over that split second, Sanduleak-69 released more energy than all the other stars in the universe combined. The light given off by the supernova later—bright as it is—is surprisingly incidental.

Like a coiled spring, the newly created neutron core bounced, creating a shock wave that spent an hour working its way through the rest of the star and fusing light elements into heavier ones until the star's outer envelope was completely blown off, scattering the stuff of future planets—from carbon to uranium—into space.

The very moment of the neutron star's formation was unwittingly recorded nearly a day before the supernova was first glimpsed from the Chilean Andes. As soon as they heard of the explosion, Bahcall and other theorists immediately sat down to calculate the number of supernova-generated neutrinos that could have been captured on Earth with special instruments—huge tanks of water set in underground mines far from disruptive cosmic rays.

After sifting through their data banks, two separate groups reported seeing a burst of neutrinos, whose intensity and duration closely matched the predictions. Furthermore, the two detections occurred at the very same moment, three hours before the supernova started brightening and around 20 hours before it was first noticed.

Conclusive Neutrino Signals

Of the ten thousand trillion trillion neutrinos passing through the Earth from the supernova, a detector in Japan snared 12 over a 13-second span; a similar instrument in an Ohio salt mine saw eight events. The coincidence of these two neutrino signals with the sighting of the supernova is, to scientists, conclusive. Decades of theoretical work on supernovae were confirmed in seconds. "It's mind-blowing," exclaimed Colgate. With the death of a star came the birth of a new science, boosting plans for the construction of even larger neutrino "telescopes."

Intriguingly, the neutrino signal provided valuable insights for physicists studying the particle itself, a mote so elusive it can travel through light-years of matter and not collide with a single atom. In recent years, scientists have been trying to answer the question of whether neutrinos have mass or not, an issue with cosmic consequences; neutrinos are so prolific that their combined weight, if they have any, could cause the universe to collapse in a "Big Crunch" innumerable eons from now. But Bahcall of the Institute for Advanced Study and Harvard's Sheldon Glashow, among others, now believe that the duration of the supernova neutrino pulse set an upper bound on the particle's mass that is too small to affect the universe's evolution. It is "well below the mass needed to close the universe back up," concludes Bahcall.

At the end of March, the supernova moved off its plateau and began to brighten once again. "As the supernova expands," explains Kirshner, "it becomes more and more transparent, enabling us to view its inner layers." Many suspect this second rise in luminosity is powered by radioactive cobalt, forged in the blast, decaying into iron. By June, the supernova is expected to have peaked and start a slow fade into oblivion.

"Though a supernova catches the public's imagination while it is brightest," says Woosley, "it's actually more interesting as it fades." By fall or winter, gamma rays emitted by a host of radioactive elements will at last be able to pierce the supernova's thinning envelope, enabling astronomers to conduct an autopsy of the star's former innards. NASA has plans to loft a series of X-ray and gamma-ray detectors aboard balloons and rockets over the next eighteen months.

If the orientation is favorable, radio telescopes may also detect a periodic *beep* as the neutron star, or "pulsar," whirls around like a celestial lighthouse, causing beams of radio waves to regularly sweep across Earth.

The Magellanic supernova won't rewrite the textbooks, but it will amend and lengthen them appreciably. "There's a marvelous spirit of cooperation," says Woosley. "It's science at its best."

NEXT ISSUE

Cancer from our Food

Chaos

A Laser Like No Other

Ozone Worries

Science Notes:

■ If the economic buzzword of 1987 is "competitiveness," the latest figures from the U.S. Patent and Trademark Office give reason for pause. According to the Patent Office, nearly half the patents issued in 1986—45 percent—were issued to foreigners. That percentage, the highest ever, has been steadily rising since the 1960s, when the foreign patents were only about 17 percent of the total. The largest number of U.S. patents awarded a single company went to the Japanese firm Hitachi.

■ Researchers at Johns Hopkins University are beginning human tests of a new drug that blocks one of the body's most powerful pain messengers. The drug blocks the action of a substance called bradykinin, which is released by damaged body tissues and binds to nerves, causing them to send pain signals. The researchers say the new drug might be useful against headaches, arthritis, and backaches.

■ Ever wonder why the Brazil nuts always seem to be on top when you open a can of mixed nuts? Or why the first few bowls of cornflakes are filled with big flakes and the last few bowls filled with crumbs? A team of physicists and engineers have demonstrated why big things rise to the top. The reason, it appears, has to do with the random movement of the particles that occurs when a mixture of large and small objects—such as a can of mixed nuts—is shaken. As the particles jostle about, spaces open up underneath them. Since it is more likely that a small space will open up rather than a large space, the smaller particles are more likely to move downwards into the space. As the small particles move downwards, the big particles, by default, move up. While the findings will provide little solace for New England farmers who must suffer large boulders that continue to rise up into their fields, the findings do have practical implications for pharmaceutical manufacturers and other companies that use mixtures of different-sized powders.