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PALEOANTHROPOLOGY

Small but Smart? Flores Hominid Shows Signs of Advanced Brain

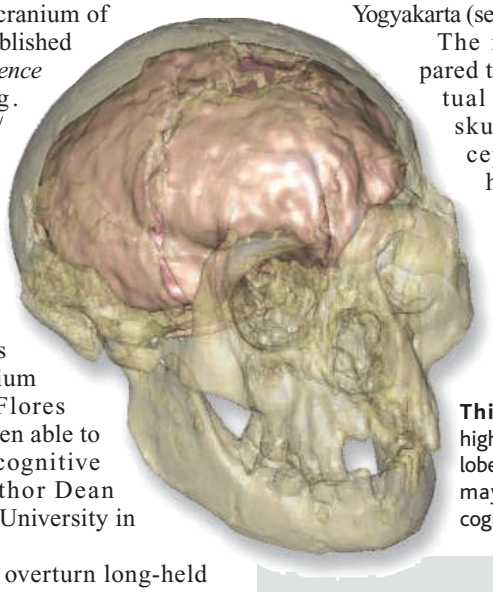
The startling announcement last October of an 18,000-year-old skeleton of a new species of human posed a paradox: Despite having a brain no larger than a chimp's, the diminutive hominid from the Indonesian island of Flores showed signs of advanced intelligence, including hunting with sophisticated stone tools. That paradox may now be solved. A detailed study of the cranium of *Homo floresiensis*, published online this week by *Science* (www.sciencemag.org/cgi/content/abstract/1109727), reveals that the hominid apparently managed to pack a number of features of more advanced brains into its very small skull. Brain features preserved in its cranium suggest that the Flores hominid may have been able to perform advanced cognitive tasks, says lead author Dean Falk of Florida State University in Tallahassee.

That finding may overturn long-held ideas about the evolution of the human brain and also raises some provocative notions about how the Flores people evolved in the first place. "If they are correct, this is really a stunner," says anthropologist Leslie Aiello of University College London (UCL). Evolutionary anatomist Fred Spoor, also of UCL, adds that the new study "upsets one of our main concepts of human evolution, that brain size has to increase for humans to become clever." The work also undercuts the notion proposed by some critics that the Flores bones are those of a microcephalic modern human rather than of a new species.

To study the hominid's brain, Falk and colleagues, including anthropologist Charles Hildebolt of the Mallinckrodt Institute of Radiology in St. Louis, Missouri, analyzed a cast of the inner surface of its skull, or endocast, which preserves the surface features of the brain. Because the skull was too fragile for the usual method of pouring liquid rubber inside it, the team made a virtual endocast from computerized tomography scans. The original discovery team, including co-authors Michael Morwood and Peter Brown of the University of New England in Armidale, Australia, had the skull scanned at a hospital in the Indonesian capital of Jakarta before the bones were temporarily moved last fall to Yogyakarta (see sidebar).

The researchers compared the endocast to virtual endocasts of the skulls of a microcephalic modern human, a modern woman, a *Homo erectus*, a pygmy, and a chimpanzee, as well as latex endocasts of other humans, primates, and extinct hominids. They found that, relative to its overall size, the brain of *Homo floresiensis* has very large temporal lobes, brain regions associated in living people with understanding speech and hearing. Even more dramatically, the hominid has highly folded and convoluted frontal lobes, areas of the brain just under the forehead that are implicated in higher cognition. "There are two huge convolutions," Falk says. "I haven't seen swellings like this before in any [extinct] hominid endocasts," including those of *Homo erectus*. The most convoluted region is in the most forward-projecting part of the frontal lobe, called the frontal pole. Falk identifies this region as Brodmann's area 10, which is expanded in modern humans and is involved in undertaking initiatives and planning future actions—key components of higher cognition.

This enlarged area suggests that the little Flores people may well have been capable of creating the stone tools that were found near them, which are more typical of those made by prehistoric modern humans than earlier hominids including *Homo erectus*. "The real take-home message here is that advanced behaviors, like making sophisticated stone tools, do not necessarily require a large, modern, humanlike brain," says Spoor. "It can be done by reorganizing a small brain, with convolutions and rewiring, and this goes to the heart of our understanding of human evolution." ▶



Thinking ahead? The highly convoluted frontal lobes of *Homo floresiensis* may indicate advanced cognition.

CREDIT: D. FALK *ET AL.*, *SCIENCE*

"Hobbit" Bones Go Home to Jakarta

While scientists debate the evolutionary lessons to be drawn from the discovery of *Homo floresiensis* (see main text), a bitter custody battle over the tiny hominid's remains (*Science*, 25 February, p. 1179) may be almost over. Late last week, Indonesian paleoanthropologist Teuku Jacob gave most of the remains of up to eight individuals of the claimed new human species to members of the Center for Archaeology in Jakarta, the bones' official repository. Jacob had been studying the bones since November, when a center researcher helped him pack them into a leather bag and take them to his laboratory at Gadjah Mada University in the Indonesian city of Yogyakarta.

Some members of the original Australian-Indonesian team that discovered the hominid on the island of Flores protested loudly that the hominid had been in effect kidnapped, in violation of a memorandum of understanding between the Australian and Indonesian institutions involved. Jacob insisted that he had full permission from the archaeological center and in turn charged the Australians with interfering with long-standing arrangements among Indonesian laboratories.

According to center director Tony Djubiantono, Jacob has now returned all the hominid remains except two leg bones—a tibia and a femur—to Jakarta. Djubiantono says he is not sure when the rest of the bones will be reunited at their Jakarta home, but says that he will call Jacob "next week and every week" until they are returned.

–M.B.

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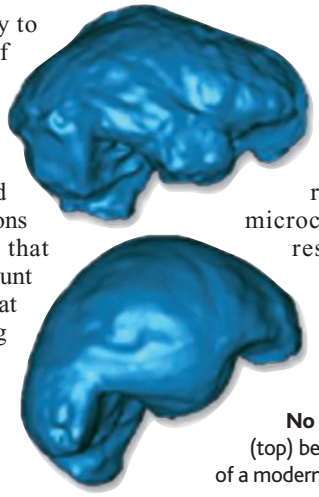
Not everyone is ready to discard the importance of brain size, however. Anthropologist Katerina Semendeferi of the University of California, San Diego, who has studied area 10 extensively, cautions that "many would argue that absolute size is of paramount importance"; she adds that stronger evidence linking the stone tools with the small Flores people would strengthen the case for their cognitive abilities.



Whatever the hominid's capabilities, the endocast results argue against the notion that it was a pathological case of microcephaly, the authors say. In overall brain shape, the Flores hominid least resembles the microcephalic, and it also bears little resemblance to the pygmy. "The skull is totally the wrong shape" to be a microcephalic, Falk says.

But anthropologist Alan Thorne of the Australian National University in Canberra counters that the single European microcephalic analyzed "tells us virtually nothing about the global range of microcephalic virtual endocasts." Others agree that the paper alone does not completely rule out microcephaly. "The case [against microcephaly] is increasingly less likely but not entirely closed," says Aiello. Spoor notes, however, that few researchers are convinced by the microcephaly argument at this point. "Colleagues advocating that [the Flores hominid] is a modern human microcephalic should start publishing hard evidence in peer-reviewed journals to underpin their claims," he says.

Assuming that *Homo floresiensis* is a ▶

No match. The brain of *Homo floresiensis* (top) bears little resemblance in shape to that of a modern human microcephalic.

CREDITS (TOP TO BOTTOM): D. FALK *ET AL.*, *SCIENCE*; JPL/NASA

PLANETARY SCIENCE

A Strange Little Saturnian Ice Ball Gets Stranger Still

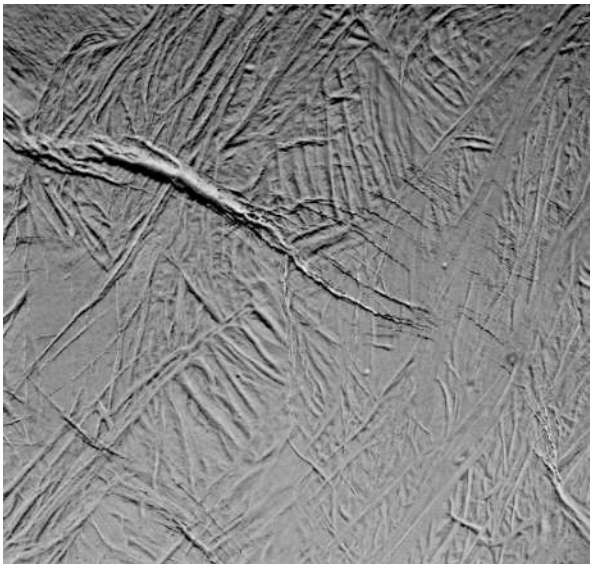
When the Cassini spacecraft approached Saturn's icy-bright satellite Enceladus (en-SELL-uh-duss) last month, "we knew it was going to be weird," says camera team member Torrence Johnson. "We just didn't know how weird." The misfit satellite turned out to be even stranger than scientists thought in 1981, when Voyager 1 first visited. Voyager images showed the supposedly long-dead primordial ball of ice to have been geologically refreshed in recent times. Some unidentified geologic process had smoothed its battered surface in places. Now, says Johnson, it appears "some areas on Enceladus have to be very young, possibly younger than on Europa," the ice-covered ocean moon of Jupiter.

The Cassini camera, which returned 20 times the fine detail of Voyager images, imaged three sorts of terrain as it swept within 1180 kilometers of Enceladus, says Johnson, who works at the Jet Propulsion Laboratory in Pasadena, California. As seen in Voyager images, large parts of the 500-kilometer-diameter moon are cratered by comet impacts, although the craters appear "softened." Presumably, this geologically older surface ice has been warm enough to flow and "relax." A second sort of terrain that in Voyager images looked completely blank now appears to be fractured by repeated squeezing and stretching of a brittle crust.

A third terrain looks "scallopy, twisted, taffylike," says Johnson. Absent are the smooth plains formed by once-fluid water that were assumed to have spewed onto the surface in "cryovolcanic" eruptions. "You don't see the flat, flooded picture of cryovolcanism" discussed after Voyager, says Johnson. "Something flowed there, but it was very viscous." All in all, large parts of Enceladus have suffered "fairly energetic events fairly recently," perhaps less than 100 million years ago.

The missing piece of the puzzle is an energy source that could have warmed and melted ice as well as fueled tectonic forces on Enceladus. Cassini may have found one. As the spacecraft flew by, its radio signal's frequency shifted more than expected. That means the moon was gravitationally tugging on Cassini harder than a ball of pure ice would, says camera team member Joseph Veverka of Cornell University. "It's definitely got some rock in there," he says. And rock would carry radioactive elements such as potassium-40 whose decay would have heated the interior, perhaps melted ice with the help of some naturally occurring ammonia antifreeze, and churned the interior to deform the surface.

Rock would help, notes planetary physicist David Stevenson of the California Institute of Technology in Pasadena, but, he adds, "I don't understand why Enceladus is doing something different from other moons." Neighboring Tethys, for example, is twice the diameter of Enceladus and has perhaps six times the mass, yet it is covered by ancient cratered terrain. Unlike watery Europa, Enceladus does not presently orbit in step with other moons, which could pump tidal energy to it from Saturn, although it might have done so in the past (*Science*, 29 July 1983, p. 449). More clues to Enceladus's energetic lifestyle could come next week (9 March), when Cassini makes an even closer pass. **–RICHARD A. KERR**



Wrinkled youth. Something has more than once crumpled this part of icy Enceladus. Judging by the dearth of impact craters, it happened in the geologically recent past.

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