First Known Dinosaur Brain Fossil Discovered

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The 133-million-year-old specimen is a stunningly well-preserved sample of mineralized tissue from inside a Cretaceous dinosaur’s skull.

SALT LAKE CITY, UTAHAn unassuming lump found on a Sussex beach in 2004 contains the first known fossilized brain tissue from a dinosaur.

The 133-million-year-old fossil belongs to a relative of *Iguanodon*, an iconic herbivorous dinosaur that lived during the early Cretaceous. The fossil mostly consists of an endocast—a sediment cast of the skull cavity where the dinosaur’s brain resided.

Typically, endocasts give vital but indirect information about the brains of fossilized animals, as these sensitive organs are often the first to decay. But this endocast’s top surface contains microscopic features that appear to be directly mineralized bits of brain tissue.

Fossilized Dinosaur Brain Discovered in England
A piece of a dinosaur's brain has been found in Sussex, England. The fossilized brain tissue is thought to be from a species similar to *Iguanodon*, large herbivores that lived about 133 million years ago.

Fibrous textures across the endocast surface probably started as pieces of the meninges, the tough, protective membranes that envelop and nurture the brain. Mineralized networks of blood vessels—some smaller in width than a human hair—crisscross the surface. And tantalizingly, ripples in the preserved meninges might trace some of the folds in the cortex, the wrinkled outer layer of the brain.

“That is the nearest I suspect we’re ever going to get to the whole [brain],” says paleontologist David Norman of the University of Cambridge, one of the researchers who worked on the fossil. The remarkable find was announced on October 27 at the Society of Vertebrate Paleontology’s annual meeting in Utah.

High-resolution scans of the fossil revealed signs that the dinosaur’s meninges and overall brain structure resembled those of living birds and crocodilians. Although it’s tricky to extrapolate the dinosaur’s intelligence from the fossil, Norman and his colleagues say that based on it and other endocasts, the animal was at least as smart as modern crocodilians.

Pickled Brains

Soft tissue preservation in fossils is extremely rare, in part because it requires exacting chemical conditions to occur. Previously described dinosaur fossils have captured skin, organs, and even red blood cells. (Read about a fossil fish with an exquisitely preserved heart of stone.)

Based on the brain fossil’s minerals and orientation, Norman and his colleagues believe that the dinosaur sank into a stagnant pond after it died, flipping belly up as it descended to leave its head upside down and partially buried in the lake bed sediments.

The animal’s braincase served as a natural bowl, cradling the collapsed brain as the pond’s acidic, low-oxygen waters essentially pickled its membranes. As the waters ate away at the dinosaur’s blood and bone, the corrosion freed charged atoms that replaced the pickled tissues with minerals—preserving their impressions 133 million years later, down to the microscopic level.

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“It looks like a very exceptional specimen, for sure,” says Ohio University paleontologist Lawrence Witmer, an expert on dinosaur brain evolution who wasn’t involved with the study. “Soft tissue preservation of any kind gets us excited, and for those of us looking at the brain, potentially getting a glimpse into what the brain is like blows us away.”

The ancient brain first came to light in late 2004, when fossil hunter Jamie Hiscocks combed the beaches of Bexhill, some 50 miles southeast of London, after a winter storm. As he prowled the fossil-rich shore by torchlight, an unusually shaped object jumped out at him among the piles of rock debris.

In short order, Hiscocks and his brother concluded that the fossil was an endocast—but he remained struck by its unusual preservation, eventually leading him to ask Oxford paleobiologist Martin Brasier for his opinion.

“Martin knew immediately we had something special here, so I agreed to loan the specimen to him,” Hiscocks writes in an email. “In his initial email to me, he asked if I’d ever heard of dinosaur brain cells being preserved in the fossil record. I knew exactly what he was getting at. I was amazed to hear this coming from a world-renowned expert like him.

“Not in my wildest dreams did I ever think I would find anything like this,” continues Hiscocks. And he’s no

stranger to significant discoveries: Hiscocks also found the world's oldest spiderweb fossil, which was described in 2008.

In 2011, Brasier brought the brain fossil to the attention of Norman, his longtime friend and colleague. Norman's first read: The endocast was mostly made of sediments encrusted with a thin layer of mineralized soft tissue. Brasier, on the other hand, was more bullish about the endocast, holding on to the hope that the fossil was an entire dinosaur brain.

"We then went into this prolonged argumentative debate between friends—the sort of stuff you argue about over a beer," says Norman. But the two could never agree, leading Norman in 2013 to write down his interpretation of the fossil for Brasier's reference.

But Brasier never replied to Norman in life: In December 2014, he died suddenly in a car crash, shocking the paleontological community.

A few months later, Brasier's former Ph.D. student Alex Liu was sorting through Brasier's papers when he came across Norman's letter.

"Martin had gone through it in detail, and after each paragraph, [he had written] 'agreed,'" says Norman. "He had completely turned around to my way of thinking," he adds, even embracing Norman's flip-and-pickle explanation for how the tissues mineralized.

Norman and Liu then resumed work on the fossil, conducting additional scans that revealed the extra details. Their paper will be included in a special publication of Earth System Evolution and Early Life from the Geological Society of London honoring Brasier's life.

Smart Search

Future studies may reveal even more about the potential link between this ancient brain and the noggins of modern animals, including 3-D scans that directly compare the dinosaur's brain structure to that of bird and crocodilian brains.

Amy Balanoff, a research scientist with Johns Hopkins University's Center for Functional Anatomy and Evolution, says she isn't yet fully convinced of the brain tissues, but she looks forward to seeing more detailed information about the fossil.

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"Confirmation in science is a long process, and this publication is the first step toward that end," she writes in an email. "I have a feeling that because this is such a sensational find, it will be thoroughly examined by the scientific community."

To that end, Hiscocks and Norman are working to place the fossil, currently in Hiscock's possession, in a publicly accessible museum collection.

Beyond its anatomical value, Norman and Witmer say that the Bexhill fossil's real significance comes from how it expands the realm of possible tissues that can be preserved in the fossil record.

"These are the kinds of things we don't expect to see, and what makes this [fossil] so important is that now we can look," says Witmer. "Things that change our search image wind up being the most important finds."

Although Norman doesn't think that fossils like the Bexhill specimen will spark their own research program—he calls it "an interesting one-off"—he says he will double back to endocasts he has examined previously, to be sure he didn't miss similarly revealing surface features.

"It never really occurred to me that there could be mineralization of the tissues in that area, because the brain is so fragile," he says. "It's putting a flag up the pole."