Fossil enigma bares teeth, tells its tale

Once regarded as the greatest unsolved puzzle in paleontology, tiny fossils known as conodonts are finally revealing their true identity as some of our most ancient relatives, according to two new studies reported this week. The new evidence threatens to overturn theories of the evolution of early vertebrates more than half a billion years ago.

Extremely common in rocks from 520 to 205 million years old, the pointy, millimeter-sized conodont fossils have mystified paleontologists for 150 years. Whereas some thought the comblike pieces belonged to ancient mollusks, others saw them as fossilized algae or plants, and many more suggested that conodonts represent teeth from some type of unknown, extinct animal.

In the early 1980s, paleontologists discovered conodonts arranged near the front of an eel-like body, proving that they were parts of a larger creature — perhaps the earliest vertebrate. But critics contended that the animal lacked many typical vertebrate features.

"For many years, we as vertebrate paleontologists did not want anything to do with conodonts," says Peter Forey of the Natural History Museum in London.

Now, studies of a giant conodont from South Africa reveal that these animals had distinctive eye muscles seen only in other vertebrates, report Sarah E. Gabbott and her colleagues from Leicester University in England. The muscles sit outside the actual eye, permitting the animal to shift its gaze up and down and from side to side. In the April 27 NATURE, Gabbott and her coauthors argue that this discovery places conodonts securely within the vertebrate line.

The new evidence has swayed at least one prominent skeptic. In an accompanying comment, paleontologist Philippe Janvier of the Centre National de la Recherche Scientifique in Paris admits his conversion. "Considering this and other evidence for the vertebrate affinity of the conodonts that has accumulated over the past 10 years, I think it is time for me to stop playing Devil's advocate against this theory," he says.

Purnell/NATURE

Micrograph shows single tooth with close-up of ridges worn down by chewing.

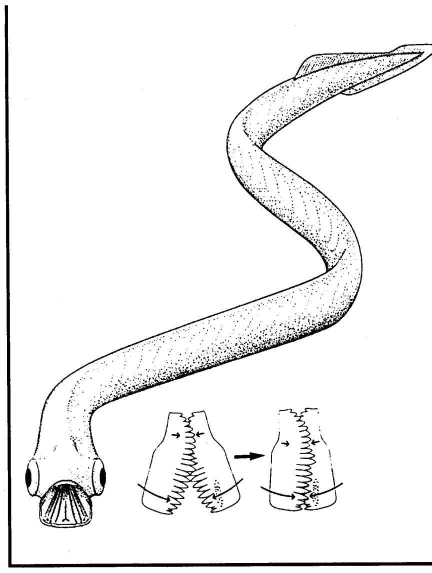
In the same issue of NATURE, Mark A. Purnell of Leicester University puts to rest arguments about the function of the conodont elements. Although the fossils look like teeth, some paleontologists discounted the resemblance because they could find no signs of wear. Instead, researchers argued that the comblike structures served as sieves for filtering out fine plants and animals from seawater. This picture fits with standard images of the earliest vertebrates as slow, filter-feeding fish that lived on the ocean floor.

Purnell, however, finds evidence of microscopic scratches and pits etched into the conodont fossils. "They must have been used to crush and shear food," he says.

Together with the evidence of large, movable eyes, Purnell's findings suggest that conodonts were predatory animals that devoured fairly large prey. If so, this challenges the textbook picture of vertebrates starting out as lethargic filter-feeders.

The emerging portrait suggests that the earliest vertebrates may have distinguished themselves by an active, predatory mode of life, says Purnell.

— *R. Monastersky*



Purnell/NATURE

Diagram illustrates chewing motion of two teeth belonging to an eel-like conodont, pictured here swimming with its mouth open.

Halo of the Milky Way: Not so MACHO?

The halo of our galaxy just got stranger.

Evidence has mounted since the 1970s that the halo — the envelope of material that extends to the outskirts of the Milky Way — contains lots of dark matter. This invisible material must provide the gravitational glue that holds the rapidly rotating outer regions of the galaxy together. Its visible stars and glowing gas simply don't have enough mass to keep the Milky Way intact.

Now, using a technique that takes advantage of one of the odder properties of gravity, scientists report that no more than 20 percent of that dark matter consists of objects ranging from small black holes to dim, planetlike bodies similar in mass to Jupiter.

Collectively known as MACHOs (massive compact halo objects), these dark matter objects are thought to be composed of baryons — neutrons, protons, and other building blocks of ordinary matter. The new study suggests, however, that the halo consists mostly of exotic material totally unlike ordinary atoms.

Kem H. Cook of Lawrence Livermore (Calif.) National Laboratory and his colleagues presented these and other findings last week at a meeting of the American Physical Society in Washington, D.C., and in the April 10 PHYSICAL REVIEW LETTERS.

"Combining our results for the dark halo and the galactic center is forcing us to reevaluate the standard model of our galaxy's structure, as well as its dark halo," Cook says. To search for dark matter, the team relies on gravitational lensing. In this phenomenon, a massive object, whether visible or not, betrays its presence by bending and brightening the light emitted by a body behind it.

Using a telescope at Mount Stromlo Observatory near Canberra, Australia, the team scans millions of stars in the central bulge of our galaxy and in its neighbor, the Large Magellanic Cloud (LMC).

Viewing the center of our galaxy, the Mount Stromlo team and another group found many more lensing events than expected. Because dark matter doesn't concentrate at galactic centers, scientists suggest that visible stars cause the lensing. Cook says the finding confirms that our galaxy's bulge has a bar-shaped concentration of stars.

To view the LMC, the telescope's line of sight must pass through the Milky Way's halo. So far, the Mount Strombo team has found the fingerprints of four MACHOs. That represents only about one-fifth the mass needed to account for all the dark matter they expected to find in that area of the halo, Cook notes.

MACHOs might contribute even less if researchers have misidentified a true increase in the brightness of an LMC star as a lensing event, says collaborator Kim Griest of the University of California, San Diego.

If the halo's dark matter isn't mostly MACHO, what then? David N. Spergel of Princeton University suggests that, like the rest of the cosmos, the Milky Way's outskirts may contain a mélange of exotic dark matter particles with a sprinkling of "ordinary" dark matter.

— *R. Cowen*