tinue" science funding for the space station.

Fettman, who also serves as chair of the NASA-funded National Space Biomedical Research Institute's external advisory panel, says the working group is prepared to quit in protest. The letter also warns that "the entire life sciences community would turn its support away" from a scaled-back station "and in fact become active campaigners against the station if the program continues to divert resources from science to solve construction problems." Members of the National Academy of Sciences' Space Studies Board raised similar concerns last week during a briefing by Administration and congressional aides on NASA's proposed budget for 2002. "It's the old fear of putting up a tin can that isn't capable of doing good science," says John McElroy, chair of the board and a former engineering dean at the University of Texas, Arlington.

Rothenberg says the list of cuts won't be finalized until June, and only after consultation with researchers. He adds that other partners, such as Europe, might contribute elements NASA can no longer afford. "We honestly believe the science community is our customer," says Rothenberg. That position is seconded by Steve Isakowitz of the Office of Management and Budget, who cautioned researchers "to wait for the agency to complete its review before taking any premature action." Speaking to the academy panel, he said that "whatever happens, we'll still have a station that's better [for research] than anything we've had before."

But Fettman and others are skeptical. Part of the problem, they say, is that scientists lack clout at Houston's Johnson Space Center, which until last month was in charge of the effort, and at headquarters, which now oversees the program. "Decisions are made by people who don't understand the science" or the equipment that it requires, Fettman complained in an interview. "The engineers don't seem to connect with what we want." For example, he says that it took much effort to convince industry contractors and NASA to abandon plans for an expensive lead-lined locker to hold film, at a time when "everyone is going digital." And NASA has just discovered a 60% cost overrun on the racks that will house nonhuman biological experiments, he adds: "This is no way to run a business." Fettman urges NASA to assign a scientist to a "critical management slot" before making any further cuts in the research program.

Rothenberg was still mulling a response to the challenge last week, but he makes a plea for patience. "Give us a chance," he says. "The community should be concerned, but it shouldn't panic."

–ANDREW LAWLER

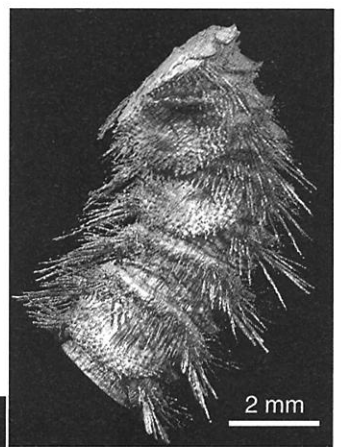
With reporting by Jeffrey Mervis.

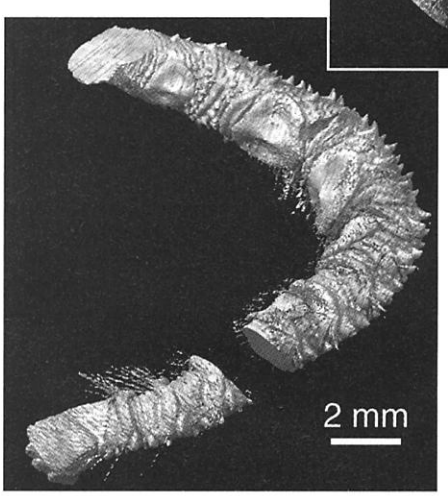
PALEONTOLOGY

New Fossil May Change Idea of First Mollusk

Some 425 million years ago, a heavily armored, wormlike mollusk died on the deep sea floor and was buried in volcanic ash. Now, using a novel technique, a team of paleontologists has created a virtual reconstruction of its perfectly preserved shape. The fossil has a strange mix of traits that, although not conclusive, supports a controversial idea about the identity of the earliest mollusks. "This is really a major discovery," says paleontologist Bruce Runnegar of the University of California, Los Angeles.

Mollusks include snails and bivalve clams and also several groups of more puzzling and obscure organisms. Tidepoolers known as the chitons, for example, have segmented shells and superficially resemble arthropods. Deep on the ocean bottom, feeding on foraminifera, live the aplacophorans—shell-less mollusks that look like odd worms. Because they lack some key traits, not just a shell but also sometimes the muscular foot, many malacologists think the aplacophorans resemble the first mollusks. Yet none had been found in the fossil record of mollusks, which stretches back more than 500 million years to the early Cambrian—until now.





Ancient armor. Shell plates like *Acaenoplax*'s may have girded the earliest mollusks.

The new fossil, described in this week's issue of *Nature*, comes from an ash bed of Silurian age in Herefordshire, United Kingdom, a deposit noted for preserving an extraordinary record of soft tissue in three dimensions. After creatures were entombed in ash, their bodies rotted away, and the cavities filled with calcite. This process also made the fossils frustratingly tough to study. The only way to reveal them was to laboriously pick away the surrounding rock. So the collection sat relatively unstudied until Mark Sutton, a postdoc at the University of Oxford, tried a better way—but one that is still a bit of a grind.

Sutton chose specimens that were numerous enough that a few could be destroyed. Then he ground down the rock 30 micrometers at a time. At each step, he polished the end of the rock and took a digital photograph. A computer outlined the fossil, which was darker than the rock matrix, on each picture. "We didn't have a clue what it was," Sutton says. But after the computer had stacked up several hundred slices into a 3D replica, "everything fell into place."

The fossil, named *Acaenoplax hayae*, has several aplacophoran traits, such as a posterior cavity with features that may have been gills and lack of a typical molluscan foot. With its rows of spiny ridges, however, *Acaenoplax* is more strongly serialized, or repetitively structured, than any known mollusk, Sutton says. That is consistent with the widely held idea that the common ancestor to all mollusks had a serial structure, even though most modern mollusks (chitons excepted) have at most faint serial patterns.

A more significant feature, in terms of molluscan evolution, is that *Acaenoplax* had dorsal shell plates. Chitons have always had this armor, but modern-day aplacophorans don't. This has led most malacologists to believe that the shell-less aplacophorans were the first to split from the early mollusk lineage, followed by chitons. *Acaenoplax* may support a more contentious view: that the ancestor of chitons and aplacophorans formed the first branch of the molluscan family tree. Sutton and his colleagues—Derek Briggs of the University of Bristol, David Siveter of the University of Leicester, and Derek Siveter of the University of Oxford—say that *Acaenoplax* suggests that shell plates were originally a common feature of both aplacophorans and chitons, and that the two form a natural group. It's not an exact match, because chitons have eight dorsal plates, whereas *Acaenoplax* has only seven. Nevertheless, "our creature seems to be the missing link" between chitons and aplacophorans, Sutton says.

Mollusk fans are happier than a clam. "This is a most amazing beast," says aplacophoran expert Amélie Scheltema of the

CREDIT: M. SUTTON *ET AL. NATURE* 410, 461 (2001)

Woods Hole Oceanographic Institution in Massachusetts. "It titillates the imagination." But she's not sure whether to call *Acaenoplax* an aplacophoran, because it is so different from modern ones. To Runnegar, that's part of the attraction. "It gives us a great deal of information about early molluscan evolution that cannot be retrieved from the living biota," he says. –ERIK STOKSTAD

DARK MATTER

Astronomers Glimpse Galaxy's Heavy Halo

Astronomers deal in light, so dark matter drives them a little crazy. For decades they have watched as the gravitational pull of an invisible hand twirls stars and gas around the fringes of galaxies like a ball on a string. And for decades they have failed to identify the source of the excess galactic gravity. With little to guide them, astronomers have fashioned dark matter candidates out of everything from underweight failed stars to massive subatomic particles that currently exist only in a theorist's imagination.

Now, they have something more to work with. In a paper published online today by *Science* (www.sciencexpress.org), an international team of astronomers claims to have directly spotted the source of at least 3% of all the dark matter in the galaxy: They have identified large numbers of fast-moving white dwarf stars that formed when the Milky Way first flickered to life several billion years ago. And that is just a cautious lower limit. "They could account for up to one-third of it," says team member Ben R. Oppenheimer, an astronomer at the University of California, Berkeley.

"The authors are to be congratulated," says astrophysicist Harvey Richer of the University of British Columbia in Vancouver. "This is a very nice piece of work."

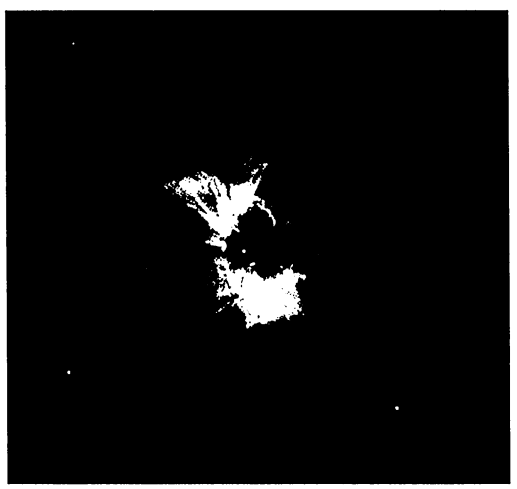
Most of the mass in a galaxy is invisible. The Milky Way's familiar sparkly pinwheel of relatively young stars sits amid an extended spherical halo of older stars and gas. Their combined gravity holds the galaxy together and keeps the stellar pinwheel spinning. Far enough from the center, the pull should eventually weaken and the stars slow down. But they don't. Stars and gas clouds as far as the telescope-aided eye can see continue to orbit at the same speed. The best explanation is that almost 90% of the total mass of the galaxy is an invisible substance spread throughout the halo called, for want of a better name, dark matter.

Tiny clumps of dark matter occasionally pass between Earth and distant stars. The gravitational field of the clump bends light from the star, causing a sudden brightening called microlensing. After spending the last 6 years counting these rare microlensing events, the Massive Compact Halo Object survey has concluded that between 8% and 50% of galactic dark matter is in clumps weighing about half the mass of the sun. But they never actually caught the culprit in the act.

White dwarfs in the halo have long been the leading suspects, says Richer. They are of the right mass, they move fast enough, and they should be quite common. Any star born weighing between one and eight times the mass of our sun sheds most of its mass as it evolves, eventually ending up as a dimly glowing, cold, half-solar-mass white dwarf. But are they common enough? The answer seemed to be no. When the number of nearby white dwarfs in the galactic disk—they can be seen directly because they are closer—was extrapolated to the halo, the total density came up short. Although isolated halo dwarfs had been spotted before, attempts to directly identify a large enough population to explain the microlensing had failed. Part of the reason, it turns out, is that astronomers were looking for the wrong color star.

Contrary to the popular images of red-hot peppers and cool blue ice, hot stars are blue and cold stars are red. So searches for white dwarfs in the halo targeted faint red stars. It was a mistake. The light radiated by a hot white dwarf starts off blue and turns red as the dwarf cools, as expected. But when the dwarf's temperature drops below 4500 kelvin, recent theoretical models by astrophysicist Brad Hansen of Princeton University and others show that molecular hydrogen in the dense, cold atmosphere absorbs the red light and reemits it at higher, bluer frequencies.

The realization led the team to change strategies. First, team member Nigel Hambly of the University of Edinburgh scanned almost 200 digital



CREDITS: (LEFT TO RIGHT) H. BOND/STSCI, R. CIARDULLO/PSU, NASA; M. BALTER

Dim prospects. Invisible dark matter may have started out as hot white dwarfs like this one in the middle of planetary nebula NGC 2440.

ScienceScope

Bright Idea The French government may be rethinking plans to privatize a new materials research center after protests shut down two related devices for nearly a week. The scientists are unhappy with plans to operate as a private nonprofit the $172 million SOLEIL synchrotron (*Science*, 15 September 2000, p. 1859), which was also the subject of protests last year (right). The structure makes it easier for other nations to participate, but French scientists worry that it will make it harder for them to win jobs at government research centers. To make their point, nearly 100 scientists last week pulled the plugs on two machines, known as SUPER-ACCO and DCI. They also petitioned CNRS, France's basic research agency, to make SOLEIL a "mixed research unit" that can employ public-sector scientists.

The CNRS appears to be warming to the idea, says protester Pierre Lebasque of LURE, an x-ray lab in Saclay. One compromise would create a public research unit alongside a private management group, he says. Officials have time to mull: SOLEIL won't open until 2005.

No Comment In a rare public dispute, the National Science Board last week thwarted an attempt by its chair, Eamon Kelly, to chide the Bush Administration for neglecting the physical sciences in its 2002 budget proposal (*Science*, 9 March, p. 1882).

It wasn't the content that bothered the board, a presidentially appointed body that oversees the National Science Foundation (NSF). "It's a good statement, and inoffensive," said M.R.C. Greenwood, chancellor of the University of California, Santa Cruz, about a position paper that many board members saw for the first time at the meeting. But Greenwood and others argued that it would be better to wait at least until details of Bush's budget are released in early April. And some thought the less said, the better. "How often do we want to make such statements?" wondered Cornell University administrator Robert Richardson.

Kelly implored the board "to add one more voice to the chorus" calling for larger budgets for NSF and other agencies (see p. 2291). But Greenwood counseled that "voices raised on our behalf are more effective." In the end, the board deferred action until its May meeting.

Contributors: David Malakoff, Jeffrey Mervis, Alexander Hellemans