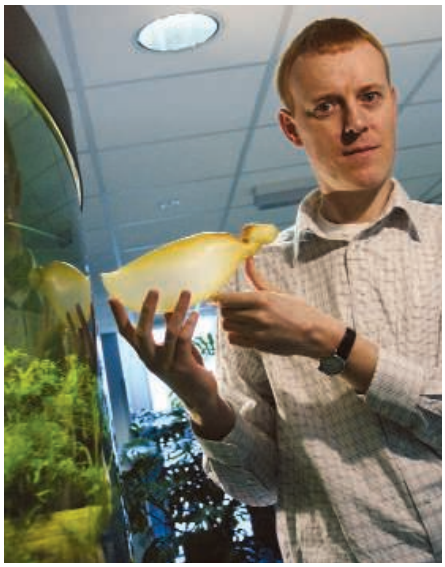
EVOLUTION

Special Hemoglobin Helped Swim Bladders Give Fish Diversity a Lift

Scuba divers wear air-filled dive vests to move up and down in the water column. Researchers have now used the fish family tree to piece together how the piscine equivalent, an internal air sac called a swim bladder, evolved a complex capillary network and special hemoglobin molecule to inflate it with oxygen. Moreover, according to the proposal presented on page 1752 by Michael Berenbrink of the University of Liverpool, United Kingdom, and his colleagues, these innovations helped fish expand their species diversity. "The scenario developed presents a fascinating picture of the evolution and radiation of fish," says Bernd Pelster, an animal physiologist at the University of Innsbruck, Austria.



CREDIT: ANDREW ROBERT COSSINS

Buoyancy compensator. Michael Berenbrink has reconstructed the evolution of swim bladders such as the one he holds.

Herring and other fish with primitive swim bladders must surface and gulp air to keep their bladders full and their bodies buoyant. The more sophisticated species use oxygen in the blood, an advance that freed them from their air tether and allowed for the expansion into the deep ocean. These species depend upon a network of blood vessels to concentrate oxygen in their swim bladder. However, high oxygen concentrations usually inhibit the release of oxygen from the blood. To get around this problem, these fish have a special Root-effect hemoglobin, a form of the protein that releases its oxygen cargo even when concentrations of the gas are high.

This new hemoglobin evolved before the swim bladder's capillary network, according to Berenbrink, a comparative animal physiologist. He and his Liverpool colleague Andrew Cossins reconstructed the history of the self-contained swim bladder by looking for its prerequisite components, such as the hemoglobin. The researchers studied species, ranging from sharks to dolphinfish, that represented the different stages of fish evolution.

According to the new study, the Root-effect hemoglobin evolved once in primitive fish. Although the molecules function at high oxygen concentrations in sharks, lungfishes, and even tetrapods, they are most efficient at releasing oxygen in those conditions in codfish and other modern fish. Next came a capillary network that supplied oxygen to fish eyes, allowing them to see better. This also evolved just once, about 250 million years ago, and depended upon the Root-effect hemoglobin. From that point, the hemoglobin was essential to fish.

About 100 million years later, a similar capillary network, this one supplying oxygen to the swim bladder, finally began showing up. This network arose four times in different fish groups, the researchers found.

"It's one of the few examples of our understanding of the evolution of a complex organ from simpler parts," says Albert Bennett, an evolutionary physiologist at the University of California, Irvine. "They have done an excellent job of teasing apart what happened when."

Over millions of years, the swim bladder's capillary network came and went in various species, adds Berenbrink. In those species in which the network disappeared, the Root-effect hemoglobins became less essential, he says.

The development of a self-contained swim bladder enabled fish to invade new waters and diversify, according to the researchers. As evidence, Berenbrink contrasts the 198 species of elephant fishes, all with the complex swim bladder, with a close relative that lacks this swim bladder and has just eight species.

Some remain skeptical, however. "To postulate that oxygen secretion is the reason for the diversity of fish … that might be an overstatement," says Axel Meyer, an evolutionary biologist at the University of Konstanz in Germany. The hypothesis rests on the questionable accuracy of the fish family tree, adds John H. Postlethwait of the University of Oregon, Eugene.

Still, he and others are impressed by the new study's breadth. "The paper nicely demonstrates the power of an integrated approach," says Pelster. "I am convinced this paper will stimulate scientists from other areas." –ELIZABETH PENNISI

ScienceScope

Tsunami Survivors Sue

PARIS—About 60 European survivors of the 26 December 2004 tsunami and relatives of victims have sued the U.S. and Thai governments for failing to issue appropriate warnings before the monster waves came ashore. A preliminary hearing is expected next month on the suit, which was filed 4 March in a New York district court and targets the Pacific Tsunami Warning Center in Hawaii.

Patricio Bernal, executive secretary of the U.N.'s Intergovernmental Oceanographic Commission, says the center "was not in a position to issue a tsunami warning" for the Indian Ocean because the region lacks a monitoring network.

–CHARLENE CRABB

Mammalian RNAi Library Set Up

A team of scientists and drug companies is creating a publicly accessible RNA-interference library for studies on 30,000 mouse and human genes.

The RNAi Consortium is a collaboration among six institutes and hospitals affiliated with the Massachusetts Institute of Technology and Harvard University, four companies, and a Taiwanese academic consortium. The Taiwan group and the companies—Bristol-Myers Squibb, Eli Lilly and Co., Novartis, and Sigma-Aldrich—are footing most of the $18 million bill.

The library, announced this week, will house tens of thousands of small RNA molecules embedded in lentiviral vectors that can infect cells. The RNA molecules, in turn, can shut down genes with a complementary sequence, allowing scientists to discern gene functions.

–JENNIFER COUZIN

EPA Issues Mercury Rule

The U.S. Environmental Protection Agency this week announced its first regulation of mercury emissions from coal-fired power plants, the largest source of mercury pollution in the United States. The controversial regulation would allow power companies to trade pollution credits, an approach that EPA claims will cut emissions by 70% by 2018.

Environmentalists say that faster, better progress could be made by mandating industry-wide reductions (*Science*, 11 February, p. 829). They also argue that the Clean Air Act prohibits trading of hazardous pollutants such as mercury. "There's a very strong prospect of litigation" within the 60-day time limit, says John Walke of the Natural Resources Defense Council in Washington, D.C.

–ERIK STOKSTAD

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