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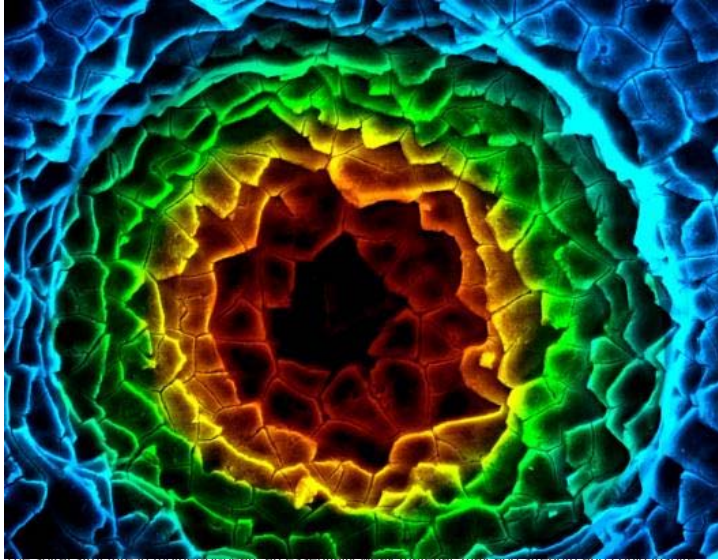
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Armor tips from a scaly era

MIT team is mining secrets of Cretaceous

The Boston Globe



The spiral structure in mother-of-pearl, an essentially weak material, may add strength and could inspire designs for a more lightweight body armor. (benjamin bruet)

By Carolyn Y. Johnson
Globe Staff / July 28, 2008

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The next advance in body armor may come from the scales of a 96-million-year-old fish.

The grasping jaws and piercing claws of hungry predators may seem a far cry from bullets and shrapnel, but MIT researchers funded by the US Army reported yesterday that the rigid, interlocking scales of a primitive fish sometimes called the "dinosaur eel" could provide insights for protecting soldiers in the future.

The researchers aren't thinking of literally making body armor out of fish scales. Instead, they are studying everything from ancient fish to mother-of-pearl, plumbing millions of years of evolution for hints on how to construct tougher, lighter, more versatile materials.

"Materials scientists are looking at nature as a source of inspiration mainly because some natural materials exhibit structures and properties that our modern technologies have not yet been able to create," said Andre Studart, a materials scientist at Harvard University who was not involved in the research. Natural "materials have evolved over millions of years, whereas even our most ancient technologies are hardly older than a thousand years."

Biology has long provided inspiration for new technologies. Burrs that snagged on a dog's fur and its owner's pants provided the inspiration for Velcro. The field of aviation took many of its cues from bird flight. But modern-day technologies that allow scientists to probe and imitate organisms at the nano-

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Howard Johnson

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scale - billionths of a meter - are pushing such imitation further.

"Over the last five to 10 years, it's just kind of exploding - it goes way beyond materials design," said Christine Ortiz, an associate professor of materials science and engineering at the Massachusetts Institute of Technology and coauthor of the paper published online in the journal Nature Materials.

"Because of advances in tools and technology, we can see the structure of different things."

Often, the scientists find that nature has developed a clever and elegant solution to problems. For example, researchers have mimicked the tiny hairs on gecko toes that help the creatures scale smooth walls to create a prototype of a new kind of tape. Researchers at the University of California at Santa Barbara examined squid beaks and discovered that a marvelous design allows the animals to exist with sharp beaks on a soft body without tearing themselves apart.

The MIT work reveals how organisms can turn simple ingredients into something much stronger.

"Seashells and armored fish are made of very weak materials - basically they're made of chalk," Ortiz said. "But they put them together with a design in such a way you get an increase in the toughness and strength by orders of magnitude."

Ortiz and her colleagues studied fish scales removed from the dinosaur eel, a fish that first appeared in the Cretaceous period and is still found swimming around African estuaries. The team discovered that the armored fish scales were lightweight and flexible, composed of four layers of different materials, and probably evolved to protect the fish's ancestors from territorial fights and a slate of prehistoric predators - including a scorpionlike creature with spines, claws, and grasping jaws.

That could hold clues for improving human body armor. Today's state-of-the-art system for the military weighs about 30 pounds. While the armor is vastly better than the rigid, heavy sheathing of the past, there is still a constant search for improvement, according to Michael Foreman, senior vice president of sales at Point Blank Solutions Inc., which supplies body armor to the military. "Its primary purpose is as a life-saving tool - the first thing we look at is ballistic performance, but ultimately what we're trying to do is lower that weight," Foreman said.

The researchers discovered several intriguing natural properties that could be useful for human body armor. When the researchers mimicked an attack on the fish scale, for example, they found that the cracks spread in a circle around the impact, leaving the scale intact. That meant the scales could take multiple blows - a fundamental property that could be useful on the battlefield, too.

The next step will come as scientists experiment with mimicking the structure of the fish scales using sophisticated materials.

Stuart, who is working on creating a new material by following some of the design principles from mother-of-pearl, said that because of heavy interest in this area, it will probably take only a few years for a prototype to appear.

For decades, he said, materials scientists were interested in developing new synthetic materials, and left seashells and fish to the biologists. Now, they are increasingly realizing that many of the problems they face in the lab have already been solved by evolution.

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