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NEWS





RESEARCH & IDEAS

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# UC Berkeley professor Robert Ritchie co-leads study on fish scales which may provide better armor

JEFFREY LEHMANN/COURTESY

BY MAXINE MOULY | STAFF

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A project led by Robert Ritchie, professor of mechanical engineering and materials science at UC Berkeley, and Marc Meyers, professor of nanoengineering at UC San Diego, provides inspiration for fish scales to be used in armor.

The scales of the Amazonian freshwater fish Arapaima gigas, or Arapaima, are tough and resistant to penetration to protect the species from piranha — the two fish species coexist in lakes, according to the research paper. Material scientists have studied the Arapaima and discovered that the mineralized outer surfaces of the scales serve as predator protection, while the inner layer of

collagen acts as a pressure absorber to localize damage. The findings of the study were published Oct. 16.

“Nature can take two materials which are pretty much mediocre in terms of their properties and make some amazingly tough and strong structures,” Ritchie said.

The scales of this species of fish are “one of the toughest flexible materials in nature,” according to the research paper. Therefore, these scales could be used to create stronger and lightweight synthetic armors by using engineering to mimic their design.

Bulletproof vests are made of ductile internal layers surrounded by hard plastic, bound together by an adhesive, according to a UCSD article. Fish scales are natural dermal armors, according to the research paper, which have layers that grow together — and some fish scales are joined on an atomic level by collagen, a structural protein.

Researchers hypothesize that the toughness of the Arapaima’s scales is related to its thick collagen layers, which are thicker than any other fish species.

“One of the biggest challenges in engineering is how we combine strength or hardness with toughness because they usually go in opposite directions,” said Kyriakos Komvopoulos, campus professor of mechanical engineering. “What we learned here is how nature can provide both in the materials.”

To test their hypothesis, researchers created cracks in Arapaima scales and soaked them in water for two days, according to the UCSD article. Next, they pulled the edges of the scales apart and discovered that as force increased, the tough outer layer expanded, cracked and eventually peeled off.

The collagen layer of the scales prevented the crack from spreading, and if this inner layer did crack, the scale was deformed rather than broken.

Meyers expressed his excitement for this discovery, calling himself a “guerilla fighter of science.”

“I want to be the first person to discover something, rather than the last person to write the last paper,” Meyers said.

The Bouligand structure, or spiral orientation, of the Arapaima scales is very difficult to simulate in a synthetic armor.

The researchers will have to wait until technology catches up to their research to see armor inspired by these fish scales.

“Nature-inspired materials have very effective combinations of properties,” Ritchie said. “The thing that is a bit (of a) roadblock in this point of time is our ability to make them, but I think with techniques like 3D printing, and as they develop and become more reliable, we’ll see a lot more structures and synthetic materials that are designed in the image of nature. … because nature does it in a very effective fashion.”

*Contact Maxine Mouly at mmouly@dailycal.org and follow her on Twitter at @moulymaxine.*

**Correction(s):**

*A previous version of this article misspelled Robert Ritchie’s name in the headline*


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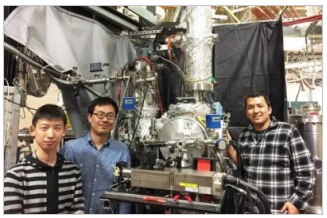
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3D printing, Kyriakos Komvopoulos, Marc Meyers, Robert Ritchie, UCSD

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