We Now Know The Mechanism Behind The Mantis Shrimp's Powerful Punch

3.7K SHARES

The mantis shrimp (Hemisus maber) is the Muhammad Ali of the animal kingdom and now we know the secret behind its powerful punch. According to research published in the journal *Science*, it all comes down to a saddle-shaped structure in its fighting limits.

The mantis shrimp is a colorful but aggressive little crustacean that attacks its prey with a clobbering, using its club-like appendages (dactyl clubs) to beat them to death. Charming.

Like Ali, the stomatopod relies on incredible speed, striking victims at velocities as high as 23 meters (75 feet) per second. Unlike Ali, it doesn’t have particularly strong muscles – an earlier research has shown. Its dactyl clubs are not in themselves enough to deliver such a powerful blow.

Instead, mantis shrimps’ success hinges on ingenious evolutionary design, which has blessed them with naturally spring-loaded limits. These stores and then release electric energy, enabling the critters to deal the fatal punch.

“Nature has evolved a very clever design in this sledge,” Ali Miserez, a materials scientist at Nanyang Technological University in Singapore and senior author of the paper, said in a statement.

“If it was made of one homogeneous material, it would be very brittle. It would for sure break.”

Miserez and colleagues examined the composition of the saddle-like structure. Using a technique called nanoindentation, they probed and probed the materials that make up the structure to determine their hardness.

They discovered that it was actually made up of two materials. One, a relatively brittle bioceramic, formed the top layer. The second, found on the underside, was stretchy and contained a higher concentration of biopolymers. This, they describe as fibrous – like a rope – and very strong when pulled on.

When the mantis shrimp prepares for a hit, the top layer compresses, enabling it to store a high-energy load. At the same time, the bottom layer stretches, holding it all in place.

“If you asked a mechanical engineer to make a spring that can store a lot of elastic energy, they would design of using a ceramic. Ceramics can store energy if you can deform them, but they’re so brittle that it wouldn’t be intuitive,” Miserez explained. (Think of bone or the ceramic used in pottery.)

“But if you compress them, they’re quite strong. And they’re stiffer than metal or any polymer, so you can actually store a higher amount of energy than you could with those materials.”

Next, the researchers used a laser to cut tiny strips of the saddle structure from actual mantis shrimps so that they could compare the way forces were distributed when the strip was pushed one way versus the other.

They found that when they reverse-bent the strips to the bioceramic layer was, on the underside, the biopolymer layer compressed while the bioceramic layer stretched, and the structure was not able to withstand the energy load it did previously. This, they say, is probably due to small fractures in the bioceramic layer.

As well as continuing the study of this unique mechanism, the team is developing 3D-printed springs inspired by the mantis shrimp’s saddle-shaped structure that could one day be used in robotics. Let’s just hope Elon Musk doesn’t get any ideas for his space-based robot.