Basketball-sized eyes help squids play defense

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Two men inspect a nearly intact 9.2 meter giant squid. Credit: Photo: NTNU Museum of Natural History and Archeaology, via Wikimedia Commons

Giant and colossal squids have eyes as big as basketballs, and a Duke scientist thinks he knows why.

"They're most likely using their huge eyes to spot and escape their predators, sperm whales," said Duke biologist Sönke Johnsen.

Johnsen collaborated with a group of biologists to model, both physically

and biologically, how and why a squid uses such a big eye. The team found that the design and size of the eye give squids the ability to see approaching sperm whales as they disturb bioluminescent organisms. The study appears in the March 15 *Current Biology*.

Big squids come in two types -- giant and colossal. They can grow to weights of five adult men put together, which is comparable to a large swordfish. But swordfish eyes are about the size of softballs, about 3 inches in diameter.

"It doesn't make sense a giant squid and swordfish are similar in size but the squid's eyes are proportionally much larger, three times the diameter and 27 times the volume," Johnsen said. "The question is why. Why do giant squid need such large eyes?"

To explain the squids' eye size, Johnsen and his collaborators first measured giant and colossal squid eyes using photos and captured animals. They also found data on the water clarity and amount of light at the ocean depths where the squid live -- typically 300 to 1000 meters. Using this information, the scientists began to mathematically model how the creatures' eyes would work and what they could see.

The team found that the squids' large eyes collect more light compared to animals of similar size but with smaller eyes. The extra light intake improves the squid's ability to detect small contrast differences under the dim conditions of the deep ocean, they argue. Johnsen said this ability doesn't matter much to the majority of deep-sea animals, which are looking at small objects that become too small to see before they fade away.

But the boost in being able to sense contrast, which large eyes provide, is critical for detecting the low light differences of large, distant objects, the most important one being the bioluminescence stimulated by large

animals such as approaching sperm whales, Johnsen said.

The team realized that sperm whales dive and swim continuously while emitting sonar to ping the squid. The cephalopods are deaf to the sonar, but the whale's wake triggers small organisms like plankton to produce light. Based on the design of the squid's eye, the animal could see this light, though contrast is low, over "freakishly long distances," about 120 meters -- the length of an American football field, Johnson said.

It's no surprise that giant and colossal squid are big, but it's their eyes that are the real standouts when it comes to size, with diameters measuring two or three times that of any other animal. Now, researchers reporting online on March 15 in *Current Biology*, a Cell Press publication, have used complex computations to explain those massive peepers. Giant squids' 10-inch eyes allow them to see very large and hungry sperm whales from a distance in the pitch darkness of their deep-sea home. According to the researchers' calculations, animals living underwater would have no use for such large eyes if the goal were to see an average object, such as prey smaller than themselves. That's why even the eyes of large whales aren't much more than 3.5 inches across. Credit: Nilsson et al.: "A unique advantage for giant eyes in giant squid." *Current Biology*

The contrast is low because water absorbs and scatters the light as it travels from the glowing plankton to the squid's eye. Bigger eyes mean seeing more of the faint light and predicting a predator's approach. But Johnson said a sperm whale's sonar would probably still detect the squid before it sees the light. As a result, the squid's basketball-sized eye, and the body to carry it, isn't necessarily for moving out of the whale's detection range, but for planning a well-timed escape.

"It's the predation by large, toothed whales that has driven the evolution of gigantism in the eyes of these squid," Johnsen said.

"I like the idea. The paper is speculative, however," said Michael Land, a University of Sussex zoologist who was not involved in the study. "Big eyes are always better, and the laws of growth that tend to make large vertebrates have relatively smaller eyes may not apply to cephalopods. Maybe they just grow that big," he said.

The scientists do extend their theory beyond squid to explain how ichthyosaurs, a type of swimming dinosaur, also may have used oversized eyes for detecting large targets, such as other marine dinosaurs, in the dim light of the deep ocean.

In spite of Land's reservations, the team's theory "may well be right," he said. "It is an idea that will be pretty hard to falsify, but a good one to have there in the melting pot."

The research is "really just a cool example" the team used to develop a more detailed model of how eyes in general work in the deep sea, at depths inaccessible to humans, Johnsen said. The team plans to publish its complete theory on underwater vision later this year.

More information: "A Unique Advantage for Giant Eyes in Giant Squid." Nilsson et al. *Current Biology*, March 15, 2012. doi:10.1016/j.cub.2012.02.031

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