Navy grant to fund probe of squid and octopus camouflage

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Octopuses and squid are big brained species that use much of their mental powers to adjust their own appearances. This remarkable ability to camouflage on the fly has inspired the Office of Naval Research to award $7.5 million to Duke University and two collaborating institutions to learn more about how the animals do it.

Participating researchers plan to build an underwater version of the fictional "Star Trek" virtual reality "holodeck." They will also go out on expeditions both to collect animals for study and to document their surroundings in unprecedented detail. They will even take their investigations down to the molecular level where the skin can change its own optical properties.

"We need to know how the different animals we're going to look at actually see the world," said Sonke Johnsen, the Duke associate professor of biology who is principal investigator for this five-year Multidisciplinary University Research Initiative (MURI) study. "What is the nature of their vision? How sharp is it, how quick does it respond to changes, and can they see colors?

"Especially at the surface, where waves are moving and water quality is changing and the sun's positions are shifting, we need to measure how light fields around them change. We also want to see how they behave and change in different environments. That's where the holodeck will come in."

The cubical holodeck will be built by engineer and research oceanographer Jules Jaffe, one of two participating researchers at the University of California at San Diego's Scripps Institution of Oceanography. The aquarium-like chamber will be big enough to enclose the largest animals studied. Its walls will enable Duke and Scripps researchers to duplicate the changeable hues, lighting and optical conditions of the open ocean.

Cephalopods, the hundreds of different species classified as either octopuses or squids, are known to self-adjust skin colors and patterns in their effort to remain unnoticeable to predators or prey. Some can respond to the kinds of polarizing effects that humans need special sunglasses to discern. Some bioluminescent species even emit their own light, which they use to eliminate shadows that would give away their silhouettes.

"We will be able to change the colors, resolution, speed and everything else so that we can step inside their visual world under laboratory conditions," Johnsen said. "We will be able to show them natural scenes, but then also scenes that have been altered in different ways. The holodeck will be like a virtual reality machine for the ocean. In the world of marine biology we know of no other like it."

The other collaborator at Scripps will be Dariusz Stramski, a professor of oceanography who is a world expert on measuring rapidly changing light fields.

At the University of California at Santa Barbara, post-doctoral fellow Alison Sweeney, a former graduate student of Johnsen, will work with Daniel Morse, a professor of molecular genetics and biochemistry, to study proteins that can alter the animals' coloration. These pigments "can self-assemble and disassemble, more or less under the control of their nervous systems," Johnsen said. "And then those control how the animals

look."

Meanwhile, a separate MURI led by the University of Texas at Austin will work toward goals so similar that some participants will be going on each other's research trips. In the case of the Duke-led group, that involves expeditions to islands off California and work on the Pacific island of Palau. The Texas group will head to the Florida Keys and the Gulf of Mexico. Collectively, the two efforts will receive about $15 million, Johnsen added.

So why is the military interested? "Obviously, you can think that camouflage is a good thing to have," Johnsen said. "You would like to be able to hide. But the work we do is at a basic, fundamental level. We won't do it with a particular application in mind. The military for ages has funded fairly basic research."

A second MURI award announced May 8 also has a Duke scientist as its principal investigator. Electrical and computer engineering professor David R. Smith is leading a study on "transformation optical metamaterials" funded by the U.S, Army Research Office. Smith's group works on "metamaterials" that can bend light to make an object appear invisible.

Source: Duke University (news : web)