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“Swimming Tongue” Catfish Sense Chemicals in Prey’s Breath


Posted by Mary Bates in Weird & Wild on June 5, 2014

Japanese sea catfish hunt at night, using an array of senses to peer through the dark water and find their prey.

Now scientists have discovered an additional way that the fish find food: Detecting slight chemical changes in the water produced by the breath of a sea worm.


Japanese sea catfish and adept at finding prey in the dark. Photograph courtesy of the Kagoshima Aquarium

The keen senses of smell, taste, hearing, and vibration detection of the sea catfish, *Plotosus japonicas*, are well known. But new research has revealed that the fish also detect tiny changes in the water's pH level—changes indicating that the surrounding seawater has become slightly more acidic. (See "Whales Have Sonar 'Beam' for Targeting Prey.")

John Caprio of Louisiana State University and colleagues at Kagoshima University in Japan identified this previously unrecognized sensory ability, which allows the fish to zero in on the breathing of prey hidden in the seafloor. The results of their study were published in the June 6 issue of the journal *Science*.

A Serendipitous Discovery

Caprio and his colleagues were studying the taste system of the catfish when they noticed something strange. Certain nerve fibers in the fish's barbels, or whiskers, were sensitive to changes in pH.

Caprio tested the responses of these fibers and found they were triggered by decreases in pH. What's more, the sensors could detect drops in pH as small as a tenth of a pH unit. "They're as good as a commercial pH meter," he says.

Caprio found pH sensors on the whiskers and lips of the catfish, but he believes such sensors could also be located all over the bodies of the fish. "Catfish don't have scales, but [they have] taste buds all over their bodies," he says. "They are literally swimming tongues." (See "Sawfish Snout Has Sixth Sense, Splits Prey in Half.")

The study suggests that the fish could also be swimming pH meters.

Every Breath You Take

The next question was why an animal that lives in seawater with a constant pH of about 8.2 would need to detect slight changes in pH.

Caprio thought that ability might help the catfish find one of their favorite foods, marine polychaete worms.

The worms hide in little tubes that they build in the mud of the sea floor. But their breath betrays them. As they exhale, they release carbon dioxide and hydrogen atoms, which slightly decrease the pH of the water in the immediate vicinity.

The researchers placed Japanese sea catfish and hidden worms together in aquariums and watched what the fish did. Even in complete darkness, the fish approached the mud tubes and sucked out the worms. (Also see "Pictures: New Suckermouth Armored Catfish Discovered.")

To confirm that the catfish were really sensing the change in pH and not finding the worms with their other senses, the team removed the worms and pumped seawater of differing pH levels into the aquariums. Whenever the catfish found pockets of lower pH values in the water, they changed their behavior immediately, becoming more active and searching for food.

Many animals can sense pH changes, even humans. Our ability to taste sourness is based on detecting acidity, for example, and sensors in our nervous system monitor levels of carbon dioxide and oxygen to help us breathe.

What makes the Japanese sea catfish special is its supersensitivity to pH changes and the way it uses this sense to find food.

"It may well be that other aquatic predators have such high sensitivity to pH changes, but they have yet to be demonstrated," says Charles Derby, a biologist at Georgia State University who was not involved in this study.

"I suspect that with the publication of this paper, other scientists will begin to look for them."

Uncertain Future

The catfish's sensitivity was highest in natural seawater with a pH of 8.2, but it decreased dramatically when the pH fell below 8.0.

This means ocean acidification—one of the consequences of climate change—could negatively affect the hunting ability of these fish.

"For millions of years, seawater has been 8.2. It's now dropping toward 8.1," says Caprio. "The predictions are that even before the end of this century it might drop below 8.0. And those are the pH levels at which the fish's sensitivity is affected."

"This study has a broader impact message that environmental conditions around us may interfere with animals in a lot of ways that aren't obvious to us," says Thomas Finger, a biologist at the University of Colorado School of Medicine, who was not involved in this research.

Scientists don't know if Japanese sea catfish will be able to adapt to oceans with a lower pH. "It would be interesting to know if these fish can compensate and reset the operational range of their sensors as ocean acidification continues, or if decreasing pH will disable this sensory system," says Finger.

Now that scientists know about the sea catfish's ability to sense pH changes, they might use it as a model to study the effects of ocean acidification. This catfish could be the equivalent of a canary in a coal mine.

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