For fish, fear smells like sugar

February 23 2012

When one fish gets injured, the rest of the school takes off in fear, tipped off by a mysterious substance known as "Schreckstoff" (meaning "scary stuff" in German). Now, researchers reporting online on February 23 in the Cell Press journal *Current Biology* have figured out what that scary stuff is really made of.

Within that chemical brew is a special type of sugar found in abundance in fish skin. When a fish is wounded, fragments of the sugar known as chondroitin sulfate alarm other fish nearby.

"Our results provide a solution to a 70-year-old puzzle: the nature of this alarm signal," says Suresh Jesuthasan of A*Star's Neuroscience Research Partnership and the Duke/National University of Singapore Graduate Medical School in Singapore.

Chondroitin sulfate is a major component of fish skin, he said, and its breakdown—likely triggered by enzymes released upon injury—seems to be the key.

The new study shows that Schreckstoff and these sugar fragments register in a particular part of the zebrafish brain. That region in the scent-processing olfactory bulb includes an enigmatic class of sensory neurons known as crypt cells.

The researchers suggest that those neurons may be specialized to detect the sugary alarm cue. "This region of the olfactory bulb has unique projections to higher centers of the brain," Jesuthasan says, "so there

may be a special circuit mediating aspects of the innate fear response."

The findings identify a new class of odorants for fish. It also helps to explain how this "danger" signal might have evolved even though the signal offers no particular benefit to its sender. Those sugar fragments are naturally released upon injury, whether anyone can smell them or not. Fish able to pick up the scent and flee are more likely to survive and reproduce.

Puzzles remain, however. For instance, some fish species will sense alarm cues released from closely related species but respond less intensely to cues from more distant relatives. The trend suggests that chondroitin fragments may come in a variety of "flavors," and the researchers are now interested in testing whether the same fragments that breed fear in zebrafish will elicit responses in other species as well.

Ultimately, the discovery could lead to new insight into the nature of fear itself.

"These findings underscore the usefulness of the zebrafish as a system to investigate the neural basis of innate fear," Jesuthasan said. "Given the transparency of larval fish, it is possible to see at single-cell resolution what happens throughout the brain when the organism detects danger. This will allow us in the future to ask how neurons, as a group, regulate behavior and emotional responses."

More information: Mathuru et al.: “Chondroitin fragments are odorants that trigger fear behavior.” Current Biology - March 20, 2012 print issue, DOI:10.1016/j.cub.2012.01.061

Provided by Cell Press