Elusive prey

July 28 2011

Escape responses are some of the most studied behaviors by neurobiologists who want to understand how the brain processes sensory information. The ability to evade predators plays a vital role in the process of natural selection. Animals explore their environment to find food, find mates and locate new habitats, and have developed distinct escape responses to avoid predators, thereby increasing their chances for survival. Yet there are few examples that illustrate a complete understanding of the basic biological mechanisms of behavior with its ecological relevance.

New research by scientists at the University of Massachusetts Medical School (UMMS) published this week in Current Biology offers evidence that for the first time illuminates a biological and ecological path that links genes to molecule to neural circuit to behavior to environment. "We're studying how the nervous system generates behavior and translates sensory information into a coordinated motor output," said Mark Alkema, PhD, assistant professor of neurobiology at UMMS and lead author of the study. "For example, when you try to swat a fly, it has to coordinate its leg lift and wing flapping in order to escape being crushed. We believe that the small roundworm C. elegans does something similar in its own escape-response."

A gentle touch to the head of the C. elegans causes the microscopic nematode to cease normal exploratory head movements and quickly reverse direction. This response is one of the rare examples where the complete path from sensory neuron to coordinated motor output is understood by scientists. What wasn't known, however, is why C. elegans would suppress exploratory head movements when touched on the head but not when touched on the nose or tail. While the C. elegans is commonly grown in petri dishes in laboratories, its normal habitat is in the soil. Dr. Alkema and his colleagues at UMMS hypothesized that the nematode adapted this singular behavior in response to predacious fungi found in its natural environment that use constricting rings to trap its prey.

"Predacious fungi and soil nematodes have a long predator-prey relationship that goes back more than 100 million years," said Alkema. "Predacious fungi have developed very sophisticated strategies to catch and devour nematodes. The most ingenious of these fungi use constricting rings that ensnare the nematode when it passes through the ring. But in the evolutionary arms race between the two organisms, the nematodes have found a way to escape these fungal nooses."

Though the fungi's ensnaring rings react quickly once the trap is triggered, there is a small delay that occurs during which the worm can carefully backup and escape the trap. Alkema suspected the suppression of head movements in response to touch would increase the microscopic worm's chances to escape from the deadly fungal noose.

To test the contribution of the head suppression gene in this predator-prey interaction, Sean Maguire, a research assistant, and Chris Clark, a PhD student, in Alkema's lab, performed competition experiments between mutant and normal nematodes. "What we found was that worms that couldn't suppress their head movements were caught much more efficiently than worms that could," said Clark. "This indicates that suppression of head movements provide a selective advantage to surviving fungal encounters in the natural environment for nematodes."

"This study raises the intriguing possibility that maybe this behavior has evolved as a result of selective pressures imposed by predacious fungi as part of an evolutionary arms race," said Alkema. "There is wide variety of nematodes with different escape behaviors. Since we know the neurotransmitters and receptors that control this behavior in C. elegans, we can start to understand how the environment has shaped the evolution of their behavior."

Provided by University of Massachusetts Medical School