Middlebury

Lessons from an octopus: student studies invertebrate learning [video]

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The surprisingly wily creatures offer insight into how learning takes place.

By Thomas Brant '10

As senior Alexa Warburton opens the door to the cephalopod lab, a pungent smell escapes into the third-floor hallway of Middlebury College's McCardell Bicentennial Hall. "It smells like the ocean," she comments. And it should. Warburton, a senior biology major from Hopkinton, N.H., is spending her summer studying a member of the cephalopod family, *Octopus bimaculoides* . Her goal is to study the way these saltwater creatures learn, thereby furthering the already-extensive body of research on invertebrate intelligence.

Alexa Warburton '10 in the cephalopod lab at McCardell Bicentennial Hall.

"We know that vertebrates can show intelligence; we've seen it in primates, we've seen it in dolphins, parrots, you name it," Warburton explains. There's some limited understanding of learning in the invertebrate field as well, she says, including some studies on hermit crabs. She hopes her research this summer will help biologists better understand invertebrate intelligence by exploring its similarity to vertebrate intelligence.

VIDEO: Student researcher Alexa Warburton describes octopus experiment (1:34)

Warburton spends much of her time running back and forth between the cephalopod lab — a cramped room filled with aquarium tanks where the octopuses are stored — and a bigger room one floor below where she built a large white aquatic maze in the shape of a T. The maze is at the heart of her experiment, and she often spends nearly 10 hours a day watching the octopuses swim through it, trying to make sense of the paths they choose.

At the beginning of the experiment, the animal is placed in the center part of the T, a holding chamber not much bigger than a casserole dish. After a short acclimation period, Warburton opens a door to the rest of the maze, and the octopus swims out of the holding chamber, its tentacles streaming behind it like the tails of a comet. It soon finds itself in a long, narrow chamber, and it is faced with the choice of swimming right or left. At one end of the chamber is an inviting compartment shielded from the bright, glaring lights that illuminate the rest of the maze. The compartment is lined with rocks that resemble the octopuses' natural habitat. At the other end of the chamber is a compartment nearly identical to the one in which the octopus began the experiment. This one is less enjoyable for the octopus because it's exposed to the bright lights, but it doesn't cause them any discomfort. Warburton's goal is to get the octopuses to swim into the dark chamber 80 percent of the time. When they do, they get a 10-minute break to enjoy the cool dark water before starting the next trial.

Sometimes, however, the animals don't cooperate, even after they've been through the maze several times. One mistake is simply remaining in the long chamber and avoiding swimming into either compartment. The animals are only allowed 15 seconds to choose. If they don't make up their minds, Warburton gives them a gentle prodding. So far, the octopuses have largely met Warburton's goal, choosing the right compartment about 80 percent of the time.

Watching the octopuses swim through the maze isn't like a day at the aquarium. For Warburton, it's a full time job. Anywhere from one to six octopuses swim through the maze every day, and each one can do up to five trials. Even getting the octopuses from their storage tanks on the third floor to the lab down below is sometimes a challenge. "Some of them will come right over to me, allow me to touch them, actually get into the net for me so I don't have to wrestle them," Warburton says. "Others will squirt ink at me, or they'll siphon water, come up to the top, look at me and squirt water on purpose."

The health and comfort of the animals is always paramount, and one of Warburton's first responsibilities in the lab was to learn all she could about octopus care.

She became interested in the tentacled creatures after taking a class on invertebrates. "We watched all these videos of octopuses going through mazes and opening jars, escaping, causing whole aquariums to be ruined because they get into the

filtration system and just tear them apart," she says. "They really inspired me to use their bad behaviors as a way to prove that they really are intelligent and that they're not just doing all this haphazardly."

Studies on cephalopod intelligence have been published in the past. Similar maze experiments conducted at the University of Texas with the same species of octopus revealed their ability to remember the correct chamber. Other studies have demonstrated that octopuses can distinguish between shapes and patterns, use landmark navigation while foraging for food, use tools, show play behavior, and even have individual personalities. But no published study so far has focused specifically on octopuses' ability to make a decision when presented with a range of possible choices, as in Warburton's maze. She plans to incorporate the results of her research into her senior thesis this fall, as well as submit an article to the journal Animal Behavior.

Biology professor Tom Root, Warburton's research advisor, says that the unusual initiative that Warburton and her fellow summer researchers have taken in their work is the reason for their success. "This is the extreme of student independence," Root says. "When they started this project, I knew nothing other than what I taught from a textbook about octopuses. They're the ones who started it — they started the facility, made the mistakes, found the experts in the field, and found the suppliers who can provide octopuses." It's good to note, says Root, the opportunity for students to do their own research that is quite different from something a faculty member is working on.

As for the octopuses, "You know there's intelligence there," Warburton says. "We just have to put ourselves in the octopuses' tentacles and try to understand it."