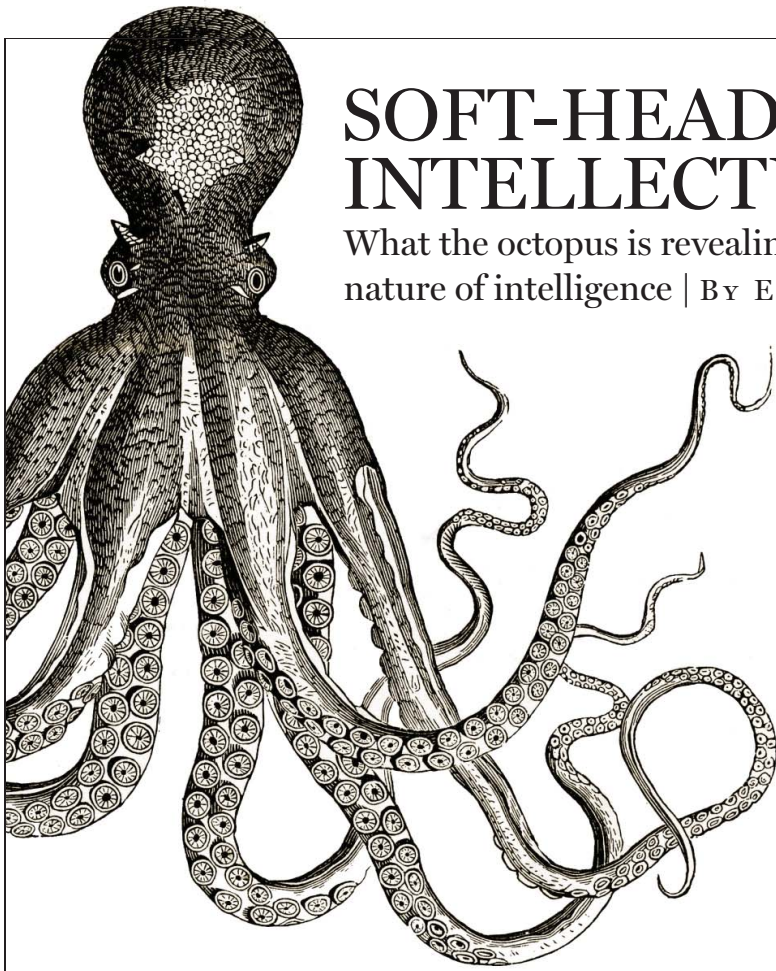


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Ideas

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SOFT-HEADED INTELLECTUALS

What the octopus is revealing about the nature of intelligence | BY EMILY ANTHES

PERHAPS THE MOST unlikely hero to emerge from this summer's World Cup was Paul the octopus, a lightly spotted invertebrate living in an aquatic center in Germany. Paul earned worldwide fame for successfully "predicting" the winner of eight out of eight soccer games, including the final match. Before each game, Paul's keepers would place two food-filled boxes, each of which was decorated with one team's national flag, in the creature's tank. Whichever box Paul ate from first was considered to be his pick. The octopus nailed it all eight times.

Though Paul's success seems mainly to have been luck—evidence for psychic sports forecasting ability in octopuses is, well, somewhat lacking—if you were looking to consult a brainy animal, you could do worse than an octopus. Research is increasingly revealing that there's something sophisticated going on inside the octopus's soft and squishy head. The critters, it seems, are surprisingly smart.

Octopuses "make decisions all the time, complicated decisions," says Roger Hanlon, a senior scientist at the Marine Biological Laboratory in Woods Hole. "People don't expect that from a creature related to an oyster."

What scientists are discovering about the octopus calls into question many of our assumptions about intelligence. Partly this is because the creatures are so different from the kinds of animals—social vertebrates, especially mammals—that have long been seen as having a monopoly on **OCTOPUS, Page C12**

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smarts. Octopuses are members of a class of creatures known as cephalopods, which appeared on the planet even before the first fish, and they are almost as far removed from us primates as another animal can get. And although it has long been theo-

ricized that intelligence evolved in social creatures as a way for species that live in groups to navigate the complex social world, the octopus leads a solitary life.

That suggests that perhaps the octopus's smarts evolved for a different reason. The soft creatures are a favored prey for many marine species, and unlike, say, clams, they lack protective shells. Many of the

octopus's cleverest tricks, then, have nothing to do with navigating the social world and everything to do with avoiding becoming dinner. It's an entirely different kind of intelligence than what's required in the human world. And that's what makes the creatures so fascinating.

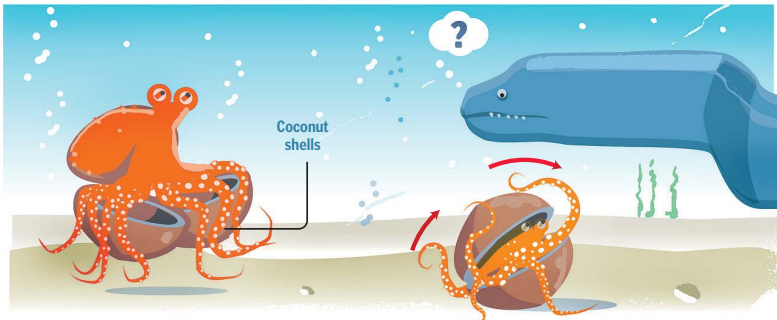
"We're smart and the octopus is smart, but octopus intelligence just can't be related to our intel-

ligence," said Jennifer Mather, a psychologist at Canada's University of Lethbridge and expert on cephalopod behavior. The cephalopod's mental skills, she said, suggests that perhaps we have defined intelligence too narrowly.

When scientists say an octopus is smart, then, what do they mean? Here, a guide to some of the capabilities that scientists are investigating.

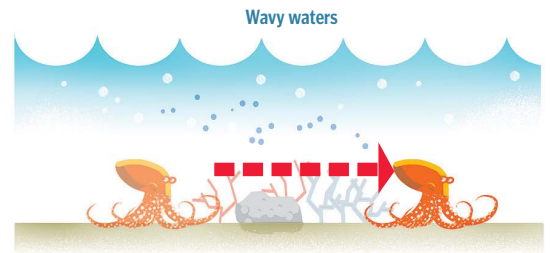
TOOL USE

Octopuses will carry around two halves of an empty coconut shell and then hide inside them to avoid predators, a team of Australian researchers reported in late 2009. (Videos of this trick are easy to find on YouTube.) Tool use is considered a mark of cognitive sophistication; aside from humans, only a few creatures—including some primates, certain birds, and dolphins—have been shown to make and use tools. So far, the octopus is the only invertebrate known to manipulate tools.



STEALTH MOTION CAMOUFLAGE

Hanlon calls it "the moving rock trick": When an octopus has to move across the open sea, it will take on the appearance of a rock and slowly creep along the ocean floor. "What's really sophisticated," Hanlon said, "is that they will adjust their speed based upon the amount of apparent motion in the water." More motion to distract from the octopus, and the creature will move more quickly. If the sea is calm and still, the cephalopod tiptoes more slowly. "It takes a big brain, excellent eyes, and magnificent coordination to pull off this cunning trick," Hanlon said.



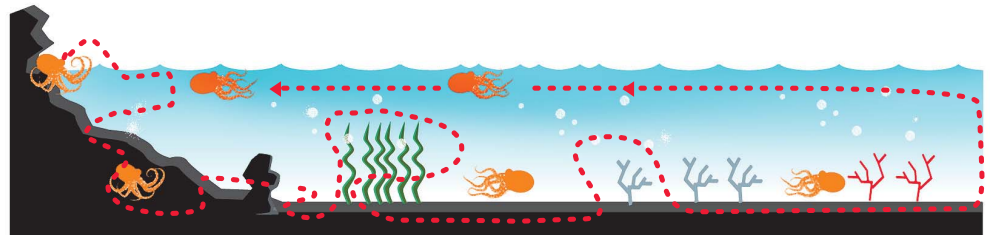
PROBLEM SOLVING

It requires a certain kind of smarts for a creature to recognize that its efforts to solve a problem aren't working, and then to switch to a new strategy. The octopus seems capable of just that. Clams, which make up a major portion of the octopus diet, are difficult to open: Some have shells weak enough to just yank open, while others require the octopus to drill into the shell or chip around the edges. Mather and her colleague Roland Anderson, a biologist formerly at the Seattle Aquarium, decided to surprise octopuses by wiring shut clams that are usually easy to open. After trying in vain to yank the shells open, the animals quickly changed their approach, drilling into the clams instead. "The octopus is very good at trying different strategies," Mather said.



SPATIAL MAPPING

In the wild, an octopus may go out foraging for hours, winding through numerous different types of habitats. And then, "suddenly," Hanlon said, "they'll leap up in the water column and make a beeline back home." In laboratory experiments, Hanlon and others have shown that the cephalopods can recognize environmental landmarks and use them to navigate. It sounds simple, but it requires some serious smarts—the creatures are essentially creating abstract mental maps of their environments and then storing and retrieving them from their long-term memories.

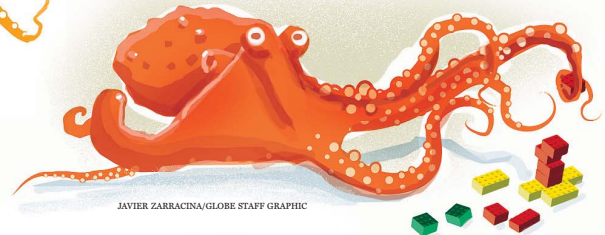


PLAYING

Play, a behavior restricted to the most intelligent species, is a sign of an active mind at work, and there are some indications that an octopus can play. When Mather and Anderson placed an empty pill bottle in an octopus tank, they observed that several of the creatures would blow a jet of water at the bottle, pushing the container into the tank's water current, then wait for the current to bring the bottle back, and blow it away again. "It's the water equivalent of bouncing a ball," Mather said.



Subsequent studies, published in 2003 and 2006, documented play-like behavior with Legos. Whether this truly counts as "play" remains controversial: It can be tough to determine whether the octopus is playing with a new object or merely investigating it.



JAVIER ZARRACINA/GLOBE STAFF GRAPHIC