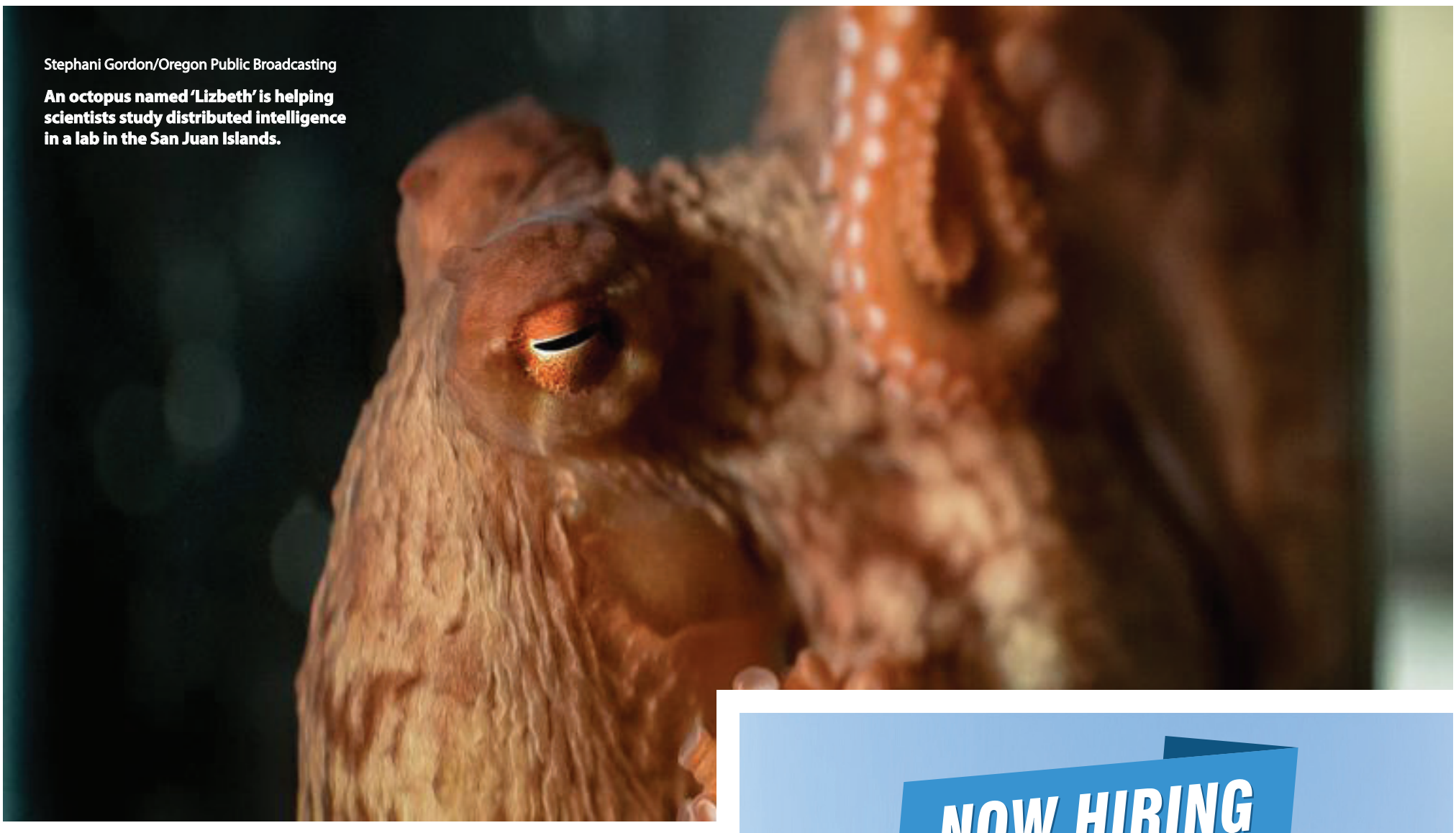

Stephani Gordon/Oregon Public Broadcasting

An octopus named 'Lizbeth' is helping scientists study distributed intelligence in a lab in the San Juan Islands.

Scientist looks to octopuses to understand life in space

By AARON SCOTT
Oregon Public Broadcasting

THE MAJORITY OF THE CEPHALOPOD'S NEURONS ARE NOT IN A CENTRAL BRAIN. THEY'RE SPREAD OUT BETWEEN THE ARMS AND SUCKERS, WHICH DO A LOT OF THINKING ON THEIR OWN. IT'S LIKE IF OUR ARMS AND FINGERS COULD PROCESS THE WORLD ON THEIR OWN.

If you wanted to study how aliens might think, but you didn't have the ability to travel light-years into space to find them, where would you look?

For scientist Dominic Sivitilli, a doctoral candidate in astrobiology and psychology at the University of Washington, the answer is under the sea.

"The octopuses' long, separate evolution toward cognitive complexity makes them a very appropriate model for what intelligence might look like if it evolves on a completely different planet," he said.

What makes the octopuses' mind so foreign to ours is not just that they evolved intelligence in a cold, dark, underwater setting, nor that our last common ancestor was a worm some 350 million years ago — although those things certainly help. The key difference is that the majority of the cephalopod's neurons are not in a central brain. They're spread out between the arms and suckers, which do a lot of thinking on their own. It's like if our arms and fingers could process the world on their own.

Sivitilli calls it distributed intelligence, and it's the focus of his research at Friday Harbor Laboratories in the San Juan Islands.

"This is 'Lizbeth,'" said Sivitilli, taking the lid off one of the plastic tubs that fill his small research room.

As he lowered his fingers to the surface of the water, a small octopus came up to meet them.

"She's our giant Pacific octopus," he said. "She can grow to being well over 20 feet long if she spread her arms out."

Right then, her arms spread only a foot or so, as they explored Sivitilli's fingers. But while his fingers can feel the texture and temperature of Lizbeth's arms and the pull of the suckers as they attach, Lizbeth's suckers can feel far more.

"Our fingertip might have 400 mechanical receptors," he said. "A given sucker might have tens of thousands of mechanical and chemical receptors on it. So each sucker is many times more mechanically sensitive than one of our fingertips is, and it also has the benefit of being able to taste and smell the world around it. And it is able to do this because each sucker has a local computation center, where most of this information is being processed."

In other words, the suckers not only feel, taste and smell: Each sucker basically has a mini mind of its own.

"It's really hard to imagine how these animals are experiencing the world," Sivitilli said. "Their nervous system and their perceptions and sensory systems are built entirely differently from ours. While most of our neurons are in our brain, most of their neurons exist beyond their central brain in their arms and suckers."

Of the roughly 500 million neurons in the octopus, fewer than 150 million are in the central brain and optic lobes. The rest are in the arms and suckers.

And yet, octopuses are notoriously intelligent creatures, able to solve complex puzzles and escape many a lab setting.

To try to figure out how this distributed intelligence works, Sivitilli created a plastic puzzle box that contains holes giving the octopus' arms access to changeable rows of crevices similar to what it would find in a rock wall or reef. Sivitilli hides a piece of shrimp in one of the crevices and attaches the box to the side of the tank, where he can film the arms as they explore the box with their suckers and then analyze their process.

"There seems to be a strategy that the suckers use to coordinate," said Sivitilli. "And this strategy seems to rely on a recruitment mechanism. So if one sucker finds something of interest, so if it's like a clam or mussel or some kind of prey — a sucker will find that prey, and then it will tell the next sucker over, 'Hey, I found something of interest.' And that sucker will turn toward that prey."

It's a bit like a sucker chain reaction, and the more suckers that get involved, the higher a signal they send to the brain. Sivitilli compared the arms and suckers to our smartphones: They process a lot of code in the background and only show the brain the stuff it wants to see.

Spreading its brain out amongst its arms serves an evolutionary purpose. Unlike humans and other simple vertebrates, which can only move our arms and legs in a couple of directions, an octopus can bend its eight arms with seemingly infinite freedom. Add the fact that they mostly hunt at night when they can't see, and that's a lot of information for the brain to process all at once.

"What the brain will do is send out a very generalized command to multiple arms at once and let the arms kind of figure it out from there," Sivitilli said. "At that point, the suckers seem to be guiding a lot of the behavior. And the suckers — with all their chemoreceptors, all their mechanical receptors — are very well equipped to then find interesting objects out there in the world."

And in the lab, Sivitilli is one of the most interesting things for them to find.

"If they sense me around the lab, or if they see someone around the lab, they will approach, go to the edge of their tank and just watch the interesting things that are happening," he said. "It's a very uncanny feeling, being constantly watched and being constantly observed. You never really feel like you're alone in that lab."

Their curiosity is one of the first things that fascinated Sivitilli. It's almost as if, as he studies them, they study him back in their own way.

"In my time studying the octopus, I've really learned to appreciate that there are many varieties of intelligence out in the world and possibly the universe. The human mind is just one of many different varieties," Sivitilli said. "It's not about how intelligent they are. It's about how they are intelligent."