

ZARIA FORMAN

Maldives #4, 2013
soft pastel on paper, 41 x 60 in



courtesy the artist

CHRISTINE HUFFARD

Octopus Lady Survival Patterns of the Octopoda

In December 2000, North Sulawesi, Indonesia was overwhelmed with floods. Bridges, villages, and mountainsides washed away. Koi overflowed from backyard ponds, careened down rivers, and gulped desperately in the bays, unable to process the brackish water. People carried them in bucketfuls home from the beaches and sautéed them with chiles over kerosene burners, a meal valued at more than a year's pay. At the harbor entrance, the runoff rushed out and erected a double-overhead standing wave. Lurching and bubbling erratically with brown foam, this upsurge shed a rogue wave over the bow of a small wooden boat just trying to make it home to the nearby island of Bunaken. The frightened passengers ran to the stern, tipping the boat on end, and most were washed overboard. Those who were still on board frantically unlashed jerry cans from stow and tossed the buoyant jugs over as life rings. That day, weeks before Christmas, Bunaken lost one of its elders, the month's supply of village generator fuel, and one of the island's only two phones connecting people to their distant relatives.

It is a unique quality of humans to attempt to understand someone else's priorities and struggles. And it might seem like an affront to evolution that we should spend energy on things that have no apparent connection to our own survival. On Bunaken my name is "ibu boboca"—"the octopus lady." Off and on for years, all day long, I floated face-down on snorkel, sometimes feet from the beach in inches of water. I had come all the way from America to write down notes on the second-by-second behavior of commercially unimportant pygmy octopuses, which most of my neighbors didn't even know existed. Although I did not speak the language when I first landed, the quizzical looks during introductions asked, "Could there possibly be a bigger waste of time and money for someone with so much opportunity?" People assured me that if they hadn't already known and revered my neighbor who studied mantis shrimps and coelacanths, they would have surely thought I was a spy—or at least not very bright. It was healthy for me to be given potent reminders early in my work that my discoveries could take light-years to make a difference to anyone else, if ever. Likewise, I learned to feel the weight of prior conversations wasted on weather, when I saw a baby lost to diarrhea for lack of understanding about dehydration, a pregnancy and marriage at the

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age of fourteen for not knowing what leads to what, and a friend's nearly succumbing to malaria for lack of pill-counting skills at the hospital. Nothing, least of all the chance to survive and learn, should be taken for granted.

Not all octopuses stay on the good side of survival, but those that do, thrive. Just about any marine carnivore will eat an octopus if it can find and catch one. And this happens often. Octopuses are major prey to fish, sharks, and marine mammals. But octopuses, both unprotected and unburdened by shells, are equipped with a lightning-fast reflex that transforms their skin into a replica of their surroundings and works as a formidable defense. Predators swim within inches of them and never seem to know they're there. Tiny muscles control fleshy bumps and little sacs of pigment sitting over a layer of mirror-like cells in the skin, changing the octopuses' skin color based on what the animals see. In the blink of an eye the octopus is cloaked as a rock, the reef, or even bare sand. Remarkably, they are color-blind, and cannot take credit for their picture-perfect color matching. They owe that skill to predators who, over thousands of generations, have eaten the most conspicuous individuals and left those with the most cryptic color combinations to survive and reproduce, typically in great quantity.

For all we know about octopuses in aquaria and on the dissecting tray, we know next to nothing about how they live their daily lives, avoid being eaten, and find a mate in the wild. Octopuses are generalized as being asocial. They live a hermit's life and rarely come across another

individual of their own kind. In theory, they don't compete for anything in nature because there's no one around with whom to compete. A dozen staged laboratory studies and a handful of field anecdotes back up different angles of this idea. A male deep-sea octopus was once photographed trying to mate with a female of an entirely different species. He might have remembered the geeky saying among biologists that "sperm are cheap" and figured it was worth the futile shot. Who knows when he'd get another chance? Yet fishermen all over the Pacific know that male and female Day-Reef octopuses form dens right next to each other. In the laboratory, some octopuses form size-based dominance hierarchies determining access to preferred dens. A researcher in Pennsylvania has shown that males of one type of pygmy octopus mate differently based on the recent mating history of a female. These findings were just off-kilter enough with the octopus's reclusive reputation to make me want to go sleuthing for answers in the South Pacific.

Floating above them on snorkel, as far back as visibility would allow, I tallied behaviors with no particular hypothesis in mind. Practically everything I had known about octopuses until then was based on dead specimens, whether from counting their suckers myself or reading explorers' accounts in 150-year-old species descriptions. I liked them, but I had not grown up obsessing about them since childhood, or entered science hell-bent on proving a point. I came to this study free of any expectations.

Some people look at an octopus and think it is looking back at them and sharing a curious moment. They want to touch its skin, which is so soft and fluid you can barely feel it. Underwater, divers want to rush toward one to see it change color or ink. People often describe octopuses as being intelligent, alien, and mysterious. They can learn and remember, and their relative the cuttlefish might even dream, a hypothesis based on rapid eye movements during rest observed in the laboratory. Octopuses can unscrew jars to get to the food inside, but instead of proving their cunning, this ability might just be an extension of their natural behavior of prying and twisting open clamshells to get at the meat. Scientists at the Seattle Aquarium discovered that Giant Pacific Octopuses can recognize individual humans, something that has long been known by home aquarists. Others have found evidence of personality,

with some individuals acting boldly and others being shy. When we found out that some species of octopus could walk bipedally, people quipped on YouTube that these animals were now ready to take over the world. Do octopuses' famed attributes hold value on the reef, or are they merely laboratory-conceived party tricks? My professor gave me the practical and invaluable advice: "Watch the animals and let them tell you what questions to ask."

The little octopuses I studied in the wild, *Abdopus aculeatus*, quietly unraveled some ideas formed in the lab, and supported others. Males regularly competed for the chance to mate, and as in the lab, size determined who won fights. Instead of opportunistically bumping into the occasional female and mating at any chance, males chose to hold out and invest their energy trying to mate with very large females, who would produce more eggs and were less aggressive than the smaller females. The largest males tended to set up a den within arms' reach of the largest females, so they could mate with them (and guard them from smaller males) for more than a week—incidentally about the same duration of octopus long-term memory shown in laboratory studies. Forgetting they were supposed to be asocial, they appeared to learn from their interactions with others and alter their behavior according to their environment.

Although the context is different, this discovery backed up work by scientists at Millersville University who showed that some octopuses can learn to make "if-then" decisions. For example, males only started mate-guarding females when they were big enough to win a majority of the fights with the other males nearby, perhaps because they had learned their relative competitive rank through repeated fights. Smaller males spent more time mating when there were more competitors around, another possible indicator of learning on the reef. The efforts males went through to monopolize access to the females were made for good reason. Females eventually accepted the advances of any male who could make it through a well-guarded gauntlet, showing no discrimination between the fathers of their thousands of young. So much for females being the choosy sex.

Learning, memory, and decision-making are traits we can relate to, yet octopuses are obviously different from us and other animals, both more and less complex depending

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on how you look at it. Recently, scientists have discovered the underpinnings of pain in octopuses, which are now, along with other cephalopods, protected from unethical research by law in the European Union—a status no different from that of vertebrates. Yet by many behavioral measures, they are no more complex than insects or spiders. Their eyes seem like pinhole cameras compared to those of the mantis shrimp. Communication doesn't appear to extend much beyond "mate with me" or "I'm male and will fight you." I have seen no demonstrations of play, or any behavior that could be called emotion, though it's hard to imagine decoupling fear from attempts to escape. But what I wouldn't give to have skin that could change like that, three hearts, and a home in the sea.

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Aside from the occasional rooster call, most of the sounds to be heard this time of day are underwater. The gray clouds are just barely starting to blush, and I throw down a quick breakfast of shortbread cookies, overly sweet peanut butter, and smoky water. A week ago, the water was high enough to smack arhythmically against the karst caves under my hut and spray the Indian Almond branches over my porch, and it will be that high again a week from now. But with today's quieter neap tide, the squeaks, snaps, and zip of my still-damp wetsuit seem especially intrusive. Down at the boat dock I toss my gear onto the steps and spit into my mask. I take quick stock of everything I'll need for the next six hours: fins, a dark green butterfly net, an

aluminum slate with underwater paper held fast by rubber tubing, and fresh tips in the plastic pencil secured to the corner of the slate with a shoestring and frayed brown athletic tape. My trusty watch face fixed to the slate is still ticking after four rugged years. As I slip under the shallow water, my ears fill with the crackling of shrimp and the low rumble of shifting sand. A frog kick pushes me quietly through the water while I peek up at the sunrise on my way to the octopuses’ dens.

Eventually the female pushes up from underneath the pebbles at her den’s entrance and bobs her pea-sized eyes up and down. When a little wave rolls by, tossing glare and shadows all over the place, she changes from dark brown to washed-out ochre and spills out over the rocks with the surge. Like a predator would, I almost lose sight of her, but her movements against the grain of the swaying algae give her away. I note the time. An hour later she’s still looking for food. Her sucker-lined web blankets over rocks, and a flush of white spreads across her eyes and arms. Now and then she twitches, probably snaring little crabs. The male had been up at his den’s entrance for an hour before the female emerged from hers, and had pushed a few armfuls of sand from inside his burrow. As soon as she’d crawled out and started to forage, he’d gotten out too. At best he has spent some of the past hour being dragged behind her by his specialized mating arm, and he’s fought off a few rival males. But mostly he’s just crawled through the seagrass keeping her in sight.

Breaking briefly from his watch, he ducks into a little hole in the sandstone, but instead of finding much-needed prey inside, it’s his bad luck that he’s chosen the home of a damselfish. Unable to make a quick retreat and catch up with his mate, he is held hostage in the hole, and is pecked relentlessly by the puny fish, which doesn’t understand that letting him go would be a win for all. One minute. Five minutes. Ten minutes, and the stalemate continues. To my shock, a tuft of algae I glimpse out of the corner of my eye reveals itself to be the female, who had waited there instead of continuing to forage. She crawls over to the damsel, flares her arms and web, and grabs the male, pulling him past the stunned damsel to safety. Off they crawl, around the seagrass bed and back to their dens, where they sit in silence and watch the fishes go by until sunset.

Christine Huffard is a Senior Research Technician at Monterey Bay Aquarium Research Institute. She performed a Postdoctoral Fellowship at MBARI with Bruce Robison from 2007-2008. Since that time, she worked several years in marine conservation with Conservation International Indonesia, as a consultant with the World Wildlife Fund in Washington, D.C. and as a Research Associate with the California Academy of Sciences. She received her PhD in Integrative Biology from the University of California, Berkeley.

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