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By Michael Bear
Part I

Octopuses, with their amazing intelligence, incredible flexibility and ability to fit through openings many times smaller than their body as well as their ability to artfully camouflage themselves against varied backgrounds have fascinated humans for centuries. Divers report encounters with these crafty creatures and come away amazed, with stories of being probed by their arms and, even in some cases, having expensive cameras stolen from them.

There seems to be a general agreement among scientists that octopuses are the most intelligent members of phylum Mollusca which includes animals like snails, clams, slugs, squid and more.

An octopus in the Flower Garden Banks National Marine Sanctuary. Photo credit NURC/UNCW/NOAA.

To help answer some basic questions about octopuses (more on the proper plural use later), we thought it would be interesting to interview a scientist who studies them.

Chelsea Bennice is a PhD Candidate at Florida Atlantic University whose research focus is on the behavioral and ecological dynamics of multiple species and how these dynamics are responsible for the way in which organisms adapt to their surrounding environment. The current focus of her research is to study how two species of octopus coexist in a South Florida habitat.

Q: Can you tell us a little about your background and how are you came to

become an octopus researcher?

A: Growing up in Ohio my exposure to the ocean was on Christmas vacations to Florida. However, Lake Erie was my backyard and I quickly became fascinated with aquatic life. My first introduction to marine biology was in high school. We were learning how to ID different reef fishes and about relationships between organisms (symbiotic relationships). I did a project on the relationship between the sea anemone and clownfish. I was fascinated with animal behavior and how animals interact with each other. From that point on, I was hooked.Before graduate school, I gained experience in the marine science field by completing two internships and a research assistantship. I was a marine science instructor for Seacamp on Big Pine Key, FL. I led snorkel trips and educated school groups on the local marine plants and animals. After this, I made the move to Woods Hole, MA and completed an internship and a research assistantship at the Marine Biological Laboratory under the direction of Dr. Roger Hanlon focusing on cuttlefish and squid behavior. After a year of internships and a research assistantship, I made my way back down to Florida for my MS and

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Lake Worth Lagoon, a section of the intracoastal waterway, in Riviera Beach, FL is home to different species of octopus. My research question is: How are these two octopus species (*Octopus vulgaris* and *Macrotritopus defilippi*) coexisting and not competing for resources? This is my research focus for my Ph.D. – to determine the resources used by each octopus species. I am asking specific questions such as: What does each species eat? What time of day does each species feed? Where are their homes located? Answering these questions will aid in the understanding of what resources both species use and what recourses they are partitioning to facilitate coexistence.

Q: How do octopuses manage to camouflage themselves so perfectly against their backgrounds?

A: Most of us only think of the color changing organs (chromatophores) or tiny color-filled sacs as being responsible for the octopus's extraordinary color changing ability. However, these chromatophores act with other structures to produce a final appearance known as a body pattern. First, Chromatophore patterns are controlled by the octopus's eyes. Next, this visual input travels to the brain, the brain selects a body pattern, and then this information is sent to muscles in the skin that are connected to these tiny color-filled sacs. Sac muscles will either expand (display color) or retract (minimize color) the chromatophores. Chromatophores are either red, orange, yellow, brown, or black. To produce other colors, octopuses use reflecting cells known as iridophores, reflector cells, and leucophores that reflect blues, greens, silvers, pinks, and white. By working under neuromuscular control, an

octopus can change its body pattern in under a second!

Q: Is it true that octopuses have three hearts and bluish blood? Why do they need three hearts?

A: True! Octopuses do have 3 hearts! Two of the hearts pump blood to the gills and a 3rd heart pumps blood from the gills through the rest of the body. Their blood is blue because it contains the copper-rich protein hemocyanin instead of the iron-rich protein hemoglobin. Hemocyanin is more efficient than hemoglobin for oxygen transport in low temperature and low oxygen environments.

Q: Octopuses have been known to engage in what we would call playful behavior, such as releasing bottles or objects into a circular current in an aquarium and catching them again, as well as using tools to accomplish certain tasks. Are these signs of their relatively high intelligence?

A: One must be careful when using terms such as playful to describe animal behavior besides our own. Anthropomorphism is the attribution of human traits, emotions, and intentions to non-human entities. We may perceive the octopus as playful, but the octopus may be trying to figure out what to do with this bottle or object or how it can use it as a home/ protection (I bet you've seen the videos of octopuses living in shells or coconuts). This doesn't mean that animals besides humans do not engage in playful behavior, but we need to closely observe what the animal is doing and why. Are we relating the cognitive behavior of the animal to the requirements of its environment or simply relating its behavior to a human-like behavior?

Octopuses may gather rocks or rubble to modify the opening of their home. This is to make the opening smaller so predators cannot attack. Octopuses potentially use different feeding behaviors on different types of substrates (rock, rubble, sand) that are more advantageous than others (better chance of catching prey). They may use mimicry or masquerade behaviors to avoid predation. These may all be signs of higher intelligence, but they also relate to the animals survival in the environment in which it lives.

Q: Certain species of octopuses specialize in mimicry of other sea creatures. How is an octopus able to mimic an algae covered rock, for instance?

A: Not only can octopuses change their skin pattern to match their background, but they can also change their skin texture. Skin texture is controlled by muscles in the skin that can change the skin from smooth to bumpy. Skin texture and the appearance of the octopus's arms, head, eyes, mantle, or arm webbing, as well as how the octopus moves, all contribute to the animal's body pattern. Essentially, body patterns are used either for camouflage or for communication. For example, the cryptic pattern may be uniform if the octopus is on sand, mottled if the octopus is on contrasting light and dark rubble, or a disruptive pattern that breaks up the outline of the body so the shape of the octopus is obscured. But camouflage doesn't stop there! Octopuses can mimic other animals. One of the species I study, the Atlantic longarm octopus, mimics a species of flounder when the octopus is searching for food. This flounder swimming or flounder mimicry helps the octopus not be detected by potential predators. A behavior known as masquerade is used to deceive either predators or prey. The octopus can resemble plants, algae, or use

their “moving rock” trick.

Q: The main method of locomotion for octopuses is jet propulsion and swimming. There was a remarkable video circulating recently on YouTube showing one gliding for short distances *out of the water* in a shallow tide pool….is that common?

A: The main method of locomotion may vary between octopus species depending on where the octopus lives. Open ocean species may tend to use jet propulsion or swimming as their main method of locomotion. However, I usually see bottom-dwelling species using methods of crawling or walking behavior. They may use methods of swimming when hunting or trying to attack prey. Forward swimming is when the octopus swims with eyes and head forward, the arms usually divided four to a side and trailing along with the mantle. This can be followed by a pounce to attack prey. Fast backward swimming (streamlined swimming in water column with the mantle first and head arms trailing) is typically used when the octopus wants to retreat to its den quickly or escape a predator. An octopus that uses swimming while foraging is the Atlantic longarm octopus. *Macrotritiopus defilippi* (Atlantic longarm octopus) uses flounder-like swimming (forward swimming in which the octopus positions its arms to attain a flounder-like appearance; sometimes with undulations of the body that are similar to flounder body movements) when searching for prey.

Octopus Changing Colors (Video by Michael Bear)

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