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Sample Research Paper

Definiens Conscientia

Within the book *The Soul of an Octopus*, author, Sy Montgomery, often recounts and reflects upon the relationships that she established with multiple octopuses in the New England Aquarium. Each octopus described has his or her own name, given not only because of the aquarium handlers' affection towards them, but also because each one seemingly has its own unique personality. Montgomery, who has spent years interacting with some of these octopuses, often marvels at how clever and eclectic each octopus that she connects with is; while at one point, when meeting one of the newest and youngest "residents" in the aquarium, all she could do was "Stare into the water and ask: *Who are you?*" (186). One of the reasons that Montgomery began to ask herself this question, is because of her previous interactions with an octopus named Octavia. One day behind the display tanks of the aquarium, away from the public, Montgomery and five other people were feeding Octavia fish from a bucket and allowing her to touch them. Without anyone noticing, Octavia swiped the bucket of fish and began to explore it and its contents. When Montgomery noticed this, she came to the conclusion that "Six of us were not sufficiently interesting [enough]," and "unlike the guest who texts and checks his e-mail while eating and carrying on a conversation…Octavia did not seem distracted as she multitasked" (48).

While Montgomery's personal encounters are both enlightening and amusing, they also raise many important questions about octopuses' and their behavior. Why do these surreal and alien-like creatures not only appear to possess some level of intelligence, but are also capable of

connecting with human beings? Octopuses are cephalopods and are more closely related to brainless clams and mollusks, while humans are mammals and are considered the most intelligent life-form on planet earth. How can these two very distant species form any type of relationship? Octopuses—like humans—have seemingly evolved as a result of a combination of physical, environmental, and behaviorally factors, with the end result of each achieving differing levels of consciousness. Or more simply put, consciousness is an adaptive trait that develops in certain species and allows them both to survive and thrive.

While octopuses have eight flexible suction-cup covered tentacles, it is the two arms and hands of humans that have been more impressive and instrumental in their own survival. Over 4 million years ago, a hominid ancestor of human beings called *Australopithecus africanus* moved from place to place employing the use of bipedalism—or walking around on only two legs. This style of walking freed the *australopithecine* to use their hands in new and more complex manners; which also allowed for more strength and dexterity to develop within them. While according to one scientific report, this "Show[s] that *A. africanus* was capable of habitual and forceful human-like opposition of the thumb and fingers during precision and power (squeeze) grips that are used during tool-related behaviors" (Skinner et al. 399). This is the first evidence of the earliest use of tools by any of humanity's ancestors, while, also signaling an important time frame of physical change and the development of a primary consciousness within them. If not for the capability and development of these tools and weapons, these early hominids—because of their lack of natural defenses such as claws or fangs—would be very vulnerable in protecting themselves from the attacks of apex predators.

In the same way that human beings had a definitive physical adaptation that changed their behavior exceedingly, octopuses also had a similar development through and because of their

ancestors. During the Cambrian period, or almost two million years ago, cephalopods evolved from a shelled mollusk into a floating chambered nautilus. This ancient creature was mobile due to its ability to physically propel water out of a cavity, while also developing an ink sac that it could use to disorient any predator while being attacked. Both of these physical attributes are still maintained and used by modern octopuses, although, the jet propulsion system now has many uses. Yet, according to one study, the most important evolutionary change to these creatures is when they "Exhibit[ed] several degrees of shell reduction, including the complete loss of supporting hard parts," which led to "an increased ability to engage in more active modes of life" (Kroger et al. 609). This is the first evidence of cephalopods fully "internalizing" and sacrificing the protection of their cumbersome shells. As a result, octopuses were much more mobile and could travel at greater speeds, but similar to humans, were now more vulnerable to the attacks of apex predators. This development led to octopuses having to begin to outlearn and outmaneuver the various threats within their environment, which is believed to have led to their present day intelligence.

The unforgiving and ever-changing landscape of the ocean is a difficult place for any type of creature to live in—especially one that is soft and without scales or a protective shell. Yet, octopuses have not only physically adapted to, but have also learned how to survive and thrive within this inhospitable environment. When avoiding predators, octopuses have an array of different tactics that have proven to be successful, including: hiding under rocks and in crevices, taking brief hunting trips, and using their camouflaging ability to blend in to any surrounding area. But, the most impressive aspect of octopuses' evasion skills is that they recognize how different predators pose different threats in each environment. For example, researchers found that when in the presence of a moral eel, which "Hunted by snaking through

rocks and rubble…sheltering would not avoid this predator," so instead "octopuses avoided this potential predator by spending more time out of [the] shelter, suggesting a sophisticated avoidance based on the hunting style of the specific predator" (Mather et al. 139). While this instance may seem as if the octopuses' instincts of "flight" may just be taking over for them, it actually shows that they are actively aware of how to avoid this and other specialized predators.

In the same way that octopuses recognize familiar threats within their natural habitats, they also seem to discern between new and strange threats in an unnatural environment or laboratory setting. Many different aquarium employees and handlers have experienced firsthand if an octopus perceives them as a threat. One researcher, named Dews claimed that "One [octopus] continually jetted water at [a] researcher rather than performing a lever-pressing response," while another researcher named Anderson described "An octopus who jetted water only at a particular night guard" (qtd. in Anderson et al. 263). To test if octopuses could differentiate between specific human beings, researchers at the Seattle Aquarium created an experiment where two different men dressed identically, and over a two week period, one would irritate captive octopuses with a bristly brush while the other would only feed them. After the two week trial period, researchers found that "Octopuses aimed their funnels and water jets mostly away from feeders (aiming toward feeders in only 1 of 8 trials) and usually [sprayed] irritators (6 of 8 trials)" (267). The captive octopuses overwhelmingly displayed that they could discern between which man was a threat based on his actions, but more importantly, they continued to see him as a threat after the experiment had ended. This seems to show that octopuses can recognize individual humans; while also providing further evidence that they deal with each predator in a specialized or different manner.

While octopuses have been rigorously studied in laboratory settings for the past 100 years or so, some of the most useful and surprising aspects of how they interact with their environment have only recently been discovered. One behavior that was thought to be unthinkable for all invertebrates—octopuses included—was playing. Only vertebrates—mainly mammals—had ever really shown an outward predisposition to play, which was also believed to provide some evidence of consciousness as well. Yet, studying play in any animal can be difficult, as researchers Pellis and Burghardt claim, "Even closely related mammals such as rodents, carnivores and primates…show different types and amounts of play" (qtd. in Kuba et al. 66). What is especially unique when attempting to study play specifically in octopuses is the many challenges presented to researchers, such as this animal being both solitary and residing in the vastness of the ocean. However, cephalopod specialists Kuba, Gutnick, and Burghardt defined specific parameters after observing captive octopuses for years, which included the exploration of their environment—through both food and non-food objects, and whether the play was locomotor-rotational (typically solitary), social, or object-oriented (59).

The octopuses were given both food and different items to explore and play with when they were both hungry and when they were not. When hungry, the octopuses would first eat the food items and rest for differing periods of time. After their hunger had been satisfied, the octopuses would next explore the non-food items, through object-oriented play such as pushing and pulling, passing the objects between their arms, or holding the objects close to their mouths. When the octopuses were not hungry, they would still be presented with either food or a non-food item and "[The] animals specifically chose to approach and manipulate the non-food item" (59). What the researchers found when applying these parameters and observing the captive octopuses, was that not only do they play, but that it "Might also be a way to keep a brain 'busy'

in times of stimulus deprivation" (67). The exploratory behavior of the octopuses and how they interacted with the different objects and elements within their environment seems to suggest this behavior as their version of playing—and as a result, a possible underlying consciousness at once thought impossible in invertebrates.

Despite the contention being made about octopuses possessing some level of intelligence, it is human beings that are the absolute pinnacle of how consciousness is currently defined. Simply put, human beings possess abilities that are wholly unique to their current species. Jennifer Mather, a psychologist who argues on the behalf of cephalopod consciousness, recognizes that only humans are in possession of "Language, the capacity for metacognition and the ability to make first-person reports of the contents of one's thought" (37). These are more abstract concepts that are harder to measure within an experiment or laboratory, but all of these abilities do exist, and are still not evenly distributed across the entire human race. Just as there are humans that may struggle to complete a task like opening a pill bottle, there are some octopuses that not only can achieve this, but sometimes it takes them mere seconds. But this point is moot, as David Premack, another psychologist argues that not only are humans more intelligent than animals, but, that 5% or less of humanity's population has contributed to inventions and materials such as fire, the wheel, gunpowder, domesticated plants and animals, cars, and electronics (31). This is both a compelling instance and further confirmation of there being differing levels of consciousness in this world—sometimes even within a single species such as human beings.

Another area where it is believed human beings are oftentimes superior to any of the animals on earth is their abilities are domain-general and can serve many different goals. Premack argues that "Humans command all cognitive abilities…whereas animals, by contrast,

command very few abilities, and all of them are adaptations restricted to a single goal" (30). For instance, when a human being teaches its child a skill such as how to tie their own shoe, then the child should be able to apply this new ability towards other activities like tying a hook on to line for fishing. Animals, on the other hand, do not possess this skill; for example, when a cat teaches its kitten how to stalk, the kitten can only ever use this skill for the single purpose of capturing prey. But, unlike most other animals, octopuses seem to be able to use their abilities to serve the completion of more than one goal. Mather explains that octopuses were able to pull clams with weak shells apart, while if clams had stronger shells, they drilled a hole or chipped at its margins, next injecting a paralytic toxin to weaken the muscle holding the shell shut, and if researchers tied the clams shut with wire, the octopuses attempted to drill around or pull the wire off (42). This shows that octopuses not only are capable using multiple skills to attempt to complete a goal, but—due to their solitary nature—must learn all of this on their own or by observing others.

In 2008, Andrea Seabrook, host of the radio program, "All Things Considered" interviewed Elfriede Kummer, the director of the Sea Star Aquarium in Germany, about some mysterious circumstances that were happening there. Kummer spoke of how one morning, when arriving to work, she was told the entire electrical system of the aquarium had either failed or shorted out the night before. It was immediately fixed that morning, but the next day the same thing happened, and the next day after that. Flummoxed, Kummer had some employees spend the night to see if they would be able to figure out what was happening. The staff took turns sleeping and watching, but still could not figure out what had shorted the power supply. In the morning, when Kummer had the power turned on again, she saw the aquarium's octopus Otto immediately start to squirt water at the lights over his tank.

Otto had been trained by the staff to squirt water at visitors of the aquarium. According to Kummer, "[Otto] had climbed up the side of his tank and was squirting water at the 2,000-watt spotlight overhead," and "Otto himself had made the connection between turning out the lights and causing a commotion" (par 5). Apparently, Otto either did not like how bright the lights were in his tank, or he was just exploring and testing out everything within his environment. After the incident with the power shortages at the aquarium, Kummer had the employees bring Otto different types of objects to play with, including a chess board. When the board is placed in Otto's tank, apparently he jumps from the black spaces to the white spaces and this keeps him entertained for a time. When finally tired of playing with the chess board, Kummer explains that "[Otto] just threw it out of [his] aquarium" (par 7). Not only does Otto seem to have his own distinct personality, it appears that he can learn to manipulate his environment, remember how to do it, and is in constant need of challenging himself.

Otto—like Octavia before him—raises and emphasizes the same questions dealing with what the definition of consciousness truly is. Octopuses and human beings are as distant in a phylogenetic sense as two creatures of earth can be. Yet, both octopuses and humans share a point in their respective evolutionary histories where a major physical development changed how they survived their environments. While as their surroundings and habitats have changed and expanded, both humans and octopuses have adapted to explore and exploit all of the available resources within them. Seemingly, though the development and evolution of consciousness, these strikingly different creatures are unknowingly taking steps up two very different paths towards the same goal: survival. Although it seems that human beings are at the current peak of consciousness on planet earth, it would not be surprising within the next few million years to see an eight-tentacle creature nearing the summit itself.

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