An Argument to Conduct More Research on the Common Octopus

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Octopuses are known not only for their intelligence, but for the cheeky stunts that take place because of it. YouTube is riddled with videos of them stealing GoPros from passing by tourists, twisting off lids, shooting rocks at plumbing, running away with their makeshift conch shell homes, and even predicting the world cup successfully. Stunts like these aren't common for most invertebrates, which makes the octopus pretty special. In fact, their genetic composition is so bizarre they're even known as being the closest thing we have to aliens (Courage, 2013).

The order *Octopoda* is characterized for being soft-bodied, eight-armed mollusks'**.** They have three hearts, blue blood, and no bones. The octopus is bilaterally symmetrical with two eyes and a beak at the center point of its arms. They also have a siphon that they use for breathing as well as expelling water out of to swim. The perks of having a soft body is that the octopus can fit into any shape bigger than its beak, enabling them to fit into small spaces to hide from predators. Due to the chromatophores in their skin, they can easily change not only the color of their skin, but the texture as well, making them the masters of disguise. Interestingly, not only do all eight of their arms act independently from each other, as if they each had their own brain, but they can also move each sucker separately, with each one being covered in taste receptors (Judson, n.d.). Octopuses have incredible eyesight and a complex nervous system, making them one of the most intelligent and behaviorally diverse of all invertebrates.

Currently, the octopus is one of our worlds mysteries. But, preliminary research on the octopus indicates that there are benefits to humanity that could derive from further research of the order *Octopoda's* chemistry and biology that could create tremendous advancements in science and medicine.

Because the octopus is so different from anything else we have on earth, it's hard to really uncomprehend what it is we're dealing with. Scientists have tried to study its intelligence, but their efforts have mostly failed. This is primarily due to the fact that traditional monitoring technology does not work on the octopus thanks to a combination of its dexterity and "smooshiness" (Courage, 2003). There are no hard structures on an octopus, which makes adhering monitoring devices to them quite difficult. Other methods have been tried, but octopuses are known for taking off external or implanted wires. Because of this, until new technology is invented to better monitor the octopus, it's going to be awhile before we get exact neural recordings of an octopus brain.

These challenges make it hard to fully understand the octopuses brain. Instead of monitoring how the octopuses brain works, we can try comparing their brain to other intelligent organisms. Unfortunately, this is a difficult process because measuring the size of one's brain does not exactly tell you how smart a creature is. One organism's brain can be organized completely differently from another organism's brain. Monkeys, dogs, birds, dolphins, the organisms we consider to be intelligent, all have vastly different brains. Different animals are good at different things and therefore their brains are organized differently. But, all these organisms we consider to be intelligent are all vertebrates. Meaning when you try to compare an octopuses' brain to a mammal's brain, things get even harder since octopuses' brains don't even come close to a mammal's brain (Godfrey-Smith, 2017). This is because the last common ancestor we shared with the octopus was about 750 million years ago and was a wormlike creature (Courage, 2003). Meaning that the octopuses' intelligence is derived from an almost entirely different genetic foundation than ours, they have evolved their intelligence entirely on their own.

Part of what makes octopuses so alien, is that the octopus's neurons aren't concentrated in its head. Most of their neurons, approximately two thirds of them, are distributed in its arms. The rest of their neurons are split between its central brain that is located in its esophagus, and the large optic lobes that are behind its eyes (Courage, 2013). This is a pretty big deal because no other organism organizes its nervous system in this manner. Therefore, we can assume that there's a possibility that the advanced behavior of the octopus could be associated with their development of their nervous system (Hochner, Shomrat, & Fiorito, 2006).

The way the octopus behaves, not only in its natural environment, but in captivity as well, gives us an idea that its intelligence is greater than our understanding of intelligence. What other animal out there decides it dislikes a member of the aquarium staff and spits water down the back of their neck every time they pass their tank. What other animal discovers how if they shoot water at a light bulb enough, the entire aquarium will lose power, forcing staff to release the octopus back into the wild. Twisting off lids is an easy task for the octopus, which is a common experiment to measure intelligence. But octopuses took it a step further and even taught themselves how to open childproof bottles, which some humans can't even do. There was even a story from a lab, that the octopuses disliked slightly stale fish, and when the staff came back to check on the octopus, they were pleasantly surprised that the octopus had eaten the fish anyways, only for the octopus to then throw it out of his tank.

These events aren't just random coincidences. Octopuses have real personalities and go above and beyond every intelligence task they have been given. They have displayed not only a clear way of communication with humans but also have displayed their abilities of cognition and mental capacity. And if we can understand how the octopus has evolved these amazing traits, we could come "closer to discovering some of the fundamental elements of thought- and to developing new ideas about how mental capacity evolved" (Courage, 2013).

But the octopuses' intelligence isn't the only curious thing about them. While understanding their brain could create many advancements in understanding what intelligence is, understanding the way their body works could create even more technological and biomedical advancements.

For example, Chen and Yang (2017) discuss how for decades we have been using gauzes to keep wounds clean and help them heal. But, when gauzes are removed they tend to damage the surrounding tissues and overall tend to cause more pain. Chen and Yang (2017) then go on to discuss how there are more favorable options for healing wounds that help promote natural healing without tearing or harming the surrounding tissues. But because they are so many regulations requirements from the U.S. Food and drug Administration, these other materials tend to be fairly expensive. Additionally, you cannot get these materials wet once applied and they are fairly difficult to remove.

Chen and Yang (2017) then discuss how there are lots of natural solutions for these types of problems out in nature. One of these natural solutions could stem from the octopus and its suckers that allow the octopus to attach to objects, manipulate, investigate, grasp, and collect prey. The octopus suckers can attach to various different types of surfaces, from slippery to rough to irregular shaped. This adaptation could create a perfect new type of adhesion, which is exactly what Chen and Yang (2017) have developed. By mimicking the octopuses' sucker functionality, they have created Nano suckers that exhibit great adhesive capacities on both dry and wet surfaces. They're also extremely flexible and can be misshapen and adhered to micro rough surfaces. This new adhesive can be easily manufactured and can provide a variety of different type of medical applications from, hemostasis, wound care, and wound nursing.

The octopuses' cognition process has also been analyzed by scientists, such as Alfonso Iniguez (2017), as a model for creating artificial intelligence. Currently, computer processing units and the human brain processes operations similarly. But the problem with using the human brain as model for artificial intelligence is that once the complexity of tasks increases, the performance demand on the CPU proportionally increases. Because of this, Iniguez (2017) proposes using the octopus brain as the new model for artificial intelligence. The octopus is a prime candidate for this not because they are smarter than humans, but because "they are a model for efficient cognition given the limited number of available neurons in its brain- 500 million in the octopus as opposed to almost 100 billion in Homo sapiens" (Iniguiez, 2017. p. 440). The organization of their neurons means octopuses are able to move their arms without being entirely controlled by their brain. This means the octopus can perform one task with its arms, like opening a clam, while the octopus itself can focus on another task, such as searching for more food. The embedded cognition of its arms is why the octopus is the best subject to model artificial intelligence after.

This idea has been put into effect by many in regard to making new robotic arms. This is due to the fact that the octopuses arm has no hard structures, yet can perform multiple functions due to the composition of its muscle and nerves. A study done by Doi, Wakimoto, Suzumori, and Mori (2016) discusses the development of a new flexible robotic arm that mimic the muscle structure of an octopus arm. Doi et al. (2016) have created a new structure of thin fibers that are flexible like an octopus arm and could potentially change the world of robotics and artificial intelligence alike.

These are just a few examples of the many different types of innovations we could create from the octopus. Truly understanding the chemistry and biology of the octopus and how it has evolved such incredible intelligence entirely on its own, could provide countless solutions to problems our society is currently facing. This paper has identified just a few of these solutions ranging from healing wounds with new types of adhesions to advancements in artificial intelligence. We are just now starting to uncover the mysteries of the octopus and there is so much more we have to learn from them.

Naturally, this is why we should preserve the octopus the best we can. Unfortunately, because of limited research on the octopus and its ecology, there isn't enough data on how best to conserve the octopus. While preliminary research has been done on how rising water temperatures will affect the development, fertilization, physiology, and distribution of the octopus (hint: it's not good), it's hard to create a plan to save them, when we barely know how the species is living today.

Therefore, in order to benefit from the octopus, we should be funding research to uncover the mysteries of the octopus and its alien genetic composition. Those mysteries could create scientific advancements and innovations that would further our society in the biomedical and artificial intelligence world as well as help us understand the life and nature of the octopus. Not only will researching the octopus help us expand and grow an important knowledge base, but it could also help us save them, and perhaps, even save us.

References

Chen, Y. & Yan, H. (2017) Octopus-Inspired Assembly of Nanosucker Arrays for Dry/Wet Adhesion. *ACS Nano*. 11, 5332-5338. Retrieved from https://pubs.acs.org/doi/pdf/10.1021/acsnano.7b00809

Courage, K. H. (2013, October 1). How the Freaky Octopus Can Help Us Understand the Human Brain. *Wired*. Retrieved from https://www.wired.com/2013/10/how-the-freaky-octopus-can-help-us-understand-the-human-brain/

Doi, T., Wakimoto, S., Suzumori, K., & Mori, K. (2016, October). Proposal of flexible robotic arm with thing McKibben actuators mimicking octopus arm structure. *Intelligent Robots and Systems (IROS)*. Retrieved from http://ieeexplore.ieee.org/document/7759809/?reload=true

Godfrey-Smith, P. (2017, January 1). The Mind of an Octopus. *Scientific American.* Retrieved from https://www.scientificamerican.com/article/the-mind-of-an-octopus/

Hochner, B., Shomrat, T., & Fiorito, G., (2006, March 21). The Octopus: A Model for a

Comparative Analysis of the Evolution of Learning and Memory Mechanisms. *The Biological Bulletin*. 210(3), 308-317. Retrieved from http://www.journals.uchicago.edu/doi/full/10.2307/4134567

Iniguez, A. (2017, January). The Octopus as a Model for Artificial Intelligence. Retrieved from http://www.scitepress.org/Papers/2017/61254/61254.pdf

Judson, O. (n.d.). Why Do Octopuses Remind Us So Much of Ourselves? *National Geographic.* Retrieved from https://www.nationalgeographic.com/magazine/2016/11/octopus-anatomy-cephalopod-disguise-evolution/

National Geographic (n.d.). Common Octopus. *National Geographic.* Retrieved from https://www.nationalgeographic.com/animals/invertebrates/c/common-octopus/

Pierces, M. L., & Wood, J. B., (n.d.). Marine Invertebrates of Bermuda. Retrieved from http://www.thecephalopodpage.org/MarineInvertebrateZoology/Octopusvulgaris.html

Strugnell, J. & Roura, A. (2015, August 18). The genetic blueprint of an octopus reveals much about this amazing creature. *The Conversation*. Retrieved from https://theconversation.com/the-genetic-blueprint-of-an-octopus-reveals-much-about-this-amazing-creature-46088

Yong, E. (2017, April 6). Octopuses Do Something Really Strange to Their Genes. *The Atlantic*. Retrieved from https://www.theatlantic.com/science/archive/2017/04/octopuses-do-something-really-strange-to-their-genes/522024/