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Project Proposal

The question I will be delving into is attempting to identity the different types of convergent evolution through the use of case studies, and whether or not we could consider certain cases as convergent. Therefore, the project will be focused on identifying and illustrating the unique ways convergence can be explored in nature, given that convergence is not just as simple as looking like another organism.

The biggest help to identify what particular observable scenarios are convergent and which ones are not begins with understanding what convergent evolution is. Convergent evolution is the process in which organisms that are not closely related evolve similar traits independently in order to better adapt to their environment (Source 1). The simplest way for us to observe this phenomena, and the first way in which I want to distinguish convergent evolution patterns from one another, is in the case of mimicry.

Mimicry is when a species evolves to look similar to a different species due to the fact that the organisms they are copying are not palatable to predators (Source 1). Thus, the species doing the mimicry becomes safe because predators mistake them for a certain organism that they can not eat due to, in most cases, the “model” species being poisonous. There are, however, two types of this mimicry that add to the complexity of this type of convergence.

The first is Batesian Mimicry where, in the case of the eastern coral snake and the scarlet king snake, the scarlet king snake has adapted to look like the eastern coral snake because the eastern coral snake is venomous (Source 1). The false warning is what makes this type of mimicry beneficial for the scarlet king snake. The second type of mimicry is Müllerian. This is when two species that are distasteful to predators have evolved to look like one another. This is best exemplified in bees and wasps, who share the same coloration pattern. Since both organisms possess the ability to be harmful to predators, the fact that they share a similar coloration pattern teaches the predators, at a quicker rate, which organisms they should be avoiding (Source 4).

The interesting thing about both of these types of mimicry is the concept of how it occurs when both species are native to the same habitat. For mimicry to be successful, the predators in that habitat must be knowledgeable enough to know that the attributes of certain organisms are markers to indicate that that particular organism should be avoided, thus increasing the prey’s chances of survival (Source 1). But, simply sharing a habitat with an organism is not the only way for convergent evolution to take place.

A truly interesting phenomena is when we see convergent evolution take place between animals that do not share the same habitat. An excellent example of this is in the case of dolphins and bats. With both of these species it would appear that they evolved the same trait in order to overcome the same issue. Although both organisms travel in very different mediums, they both evolved convergently to overcome the issue of obscured vision, since sight is difficult in ocean water and the night sky. The dolphin and bat both evolved adaptations to their traits involved with hearing that resulted in a heightened auditory system that allows the bat and dolphin to echolocate. This adaptation is what increases their ability to survive in their environments, or in other words, raises their selective fitness (Source 2).

The conclusion is that convergent evolution doesn't need to occur between organisms living in the same habitat. Even with a creature moving through the ocean and a creature flying through the air, evolution was able to find the same solution to the same problem. This represents the second type of convergent evolution which demonstrates how the same traits used to overcome obstacles in the survival of a species can increase the fitness of organisms in a wide range of ecosystems.

Next, we see convergent evolution in cases where organisms not closely relates evolve to fill the same ecological niche. If we look throughout the world's continents, we will find that there are only so many different ecosystems that are present. Therefore, animals inhabiting these distant habitats, in order to have the best evolutionary fitness, will adapt to their environments in the same way. Across the continents, which are all thousands of miles away from one another, there are examples of small fishes with cylindrical bodies and reduced swim bladders that rest upon sand or gravel in streams where they feed on bacteria. The point is that there is an opportunity for these small bacteria to be eaten and it would most likely benefit the ecosystem as a whole if their populations were to be controlled. Therefore these fish have all evolved independently from one another with the same purpose of filling the ecological niche of resting on the bottom of their respective bodies of water to feed. This explains their similar body types and organs which all serve this function (Source 6). These small fish also supply food for larger fish, which fill a different niche.

Lastly are cases in which convergent evolution does not take place on the molecular level. If we look at bats and dolphins again, scientists have found that genes involved in hearing were more likely to have evolved similarly across species than those involved in other biological traits. This means that echolocation evolved similarly across the different species' genomes (Source 2). However, this does not always have to be the case in order to observe convergence, and this type of convergent evolution is known as behavioral convergence. This can be seen in the case of the aye-aye, which are nocturnal lemurs with a specialized auditory processing system for getting food. The aye-aye taps on tree branches in order to find out what lies within, and this acts as a way of echolocation. But, this not an example of convergent evolution in the same sense as the bat and the dolphin because it did not evolve similarly on the molecular level.

When looking at the aye-aye's genome in comparison to bats and dolphins, there was no significant signals that would suggest that the aye-aye genome was similar to the bats and dolphins in terms of echolocation development. This suggests that the aye-aye's tap-foraging auditory adaptation represent a distinct evolutionary innovation that represents a trait brought upon by behavior (Source 3). Although this trait is not molecular synonymous with that of other echolocating organisms, this still represent a case of convergent evolution because an adaptive tool, used by other species, is being used to overcome an ecological problem.

I also want to address situations in which two organisms appear to have evolved convergently, but have actually not. There are two distinctive situations that could be mistaken for convergent evolution. The first is in parallel evolution.

Parallel evolution is the instance in which two organisms that are distantly related by a common ancestor, but have evolved separately, develop similar traits (Source 5). An excellent example of where this would be confused with convergent evolution is in the example of praying mantises and mantispids.

Both organisms look to resemble one another in terms of color and overall body shape. So, it is understandable how someone could easily mistake this as an example of mimicry. However, the mantispid and praying mantis find no benefit from looking like one another. In addition, neither organism appears to have evolved in completely separate environments in order to fill an ecological niche. This leads to the fact that both of these animals split off from a common ancestor and share that ancestor's traits, which allowed them to evolve in a similar fashion (Source 5). Convergence may seem to be apparent, but the organisms are not distantly related enough to show that their similar traits were caused by the same mutations to genes that are vastly different from one another like in the case of the bat and dolphin, who, although both being mammals, share a common ancestor too far back in history to influence their echolocation similarities.

Lastly, it is important to distinguish what is convergent evolution and what is coevolution. Coevolution occurs when two or more species reciprocally affect each other's evolution (Source 7). So, in the case of the snakes, it is easy to say how the evolution of the venomous eastern coral snake has affected the evolution of the scarlet king snake. Although this is true, the main reason that this is not considered coevolution is due to the fact that the scarlet king snake offers nothing in return for having evolved in this manner and only parasites the look of the venomous snake (Source 1). Predators already knew that the eastern coral snake was venomous and their color pattern solidifies their recognizability, so there is no benefit given back to the venomous snake by having its colors replicated by a prey species. Even in Müllerian mimicry, if we look at the case of bees and wasps, neither species evolved those similar color patterns in order to benefit their interaction with each other, but instead mutually mimic each other to ward off predators. It is this self-interest and lack of symbiotic interaction that distinguished convergent and coevolution (Source 4).

In my creative work I am going to incorporate the ideas of mimicry, niche filling, ecological hindrance overcoming, and behavioral convergence in order to demonstrate the ways we can observe this phenomena. Another important idea I want to utilize in my creative work is idea that an organism does not evolve convergently with another in order to form a symbiotic relationship. Convergence is a selfish tool that never evolves to benefit any other organism or a species' relationship with another organism. This is how we can tell convergent evolution from coevolution. These distinct adaptations also have to be purposeful, which is how I am going to incorporate the idea of how convergent evolution and parallel evolution differ, since parallel evolution only occurs because of similar and recent ancestry between species. Finally, I am thinking of creating a zine or poetry pamphlet in which these ideas are expressed in the form of accounts or poems told from the point of view of these organisms examine species that are similar in appearance or functionality to each other. I imagine this to be humorous and a fun way to express these ideas to an audience curious about convergence.

1. Pianka, Eric R. Convergent Evolution. www.zo.utexas.edu/courses/thoc/convergence.html. Accessed 29 Sept. 2017.

This source contributed the initial definition of convergence, which provided the launching point for my further research of particular case studies. In addition, this source provided the definition of Müllerian and Batesian mimicry, which gave me sufficient information to consider mimicry an important category of convergent evolution not only to use as an example of the phenomena, but also a counterexample in terms of instances that can be mistaken for co evolution.

2. Hayden, Erica Check. "Convergent evolution seen in hundreds of genes." Nature: National Weekly Journal of Science, 4 Sept. 2013, www.nature.com/news/convergent-evolution-seen-in-hundreds-of-genes-1.13679. Accessed 29 Sept. 2017.

This source provided the example of the evolution in echolocation of bats and dolphins and exemplifies how convergence in a multitude of the organisms' genes is what caused the adaptation that made them better suited for their environment. I am staying out of the technicalities of the genes exactly that lead to this, but the biggest takeaway for my project is using this case an an example of how distantly related organism can evolve the same coding sequences in their amino acids when adapting to their environment, which leads to the same trait in very different species.

3. Bankoff, Richard J, et al. "Testing Convergent Evolution in Auditory Processing Genes between Echolocating Mammals and the Aye-Aye, a Percussive-Foraging Primate." GBE: Genome Biology and Evolution, 26 July 2017, academic.oup.com/gbe/article/doi/10.1093/gbe/evx140/4037174/Testing-convergent-evolution-inauditory. Accessed 29 Sept. 2017.
This source provided the entire basis for my behavioral convergence argument. Coupled with source number two, and staying focused on the attention to the amino acids that are changed in order for mutations and adaptations to occur, I am able to show how similar tendencies can be convergent without molecular similarities. In this instance the aye-aye is shown to use a form of echolocation that is only similar behaviorally, but not molecularly, to bats and dolphins.

4. "Batesian Mimicry Vs. Mullerian Mimicry." Biology Wise, 2017, biologywise.com/batesian-mimicry-vs-mullerian-mimicry. Accessed 29 Sept. 2017.
This source aided in my understanding of the two types of mimicry and also headed light on how cases of mimicry can prove to be harmful to one species by diluting the affect of their mimicry if the model population sinks below the population of the mimics. This is why I find it necessary to differentiate between coevolution and convergent evolution, because convergence does not yield beneficial results like coevolution.

5. “Parallel and Convergent Evolution Similar Terms That Are Difficult To Distinguish.” Wayne's World, 2005, www2.palomar.edu/users/warmstrong/convevol.htm. Accessed 29 Sept. 2017.

This article provides evidence that showed to me that parallel and convergent evolution can be easily mistaken if we are looking at the physical structure of an organism alone. In the case of praying mantises and mantispeds, two organisms that look alike, it is important to realize that their similarities are not driven by mimicry or necessity to fill a niche, but for another reason. The conclusion is that they must have split off from a common ancestor and continued to evolve in a similar manner which, although they are mostly similar, does not provide an example of convergence.

6. Winemiller, Kirk O, et al. “Functional traits, convergent evolution, and periodic tables of niches.” Wiley Online Library, 21 June 2015, onlinelibrary.wiley.com/doi/10.1111/ele.12462/full.

This article provided the examples of ecological niches. For example, it presents how certain organisms are best equipped for specific ecosystems that are apparent throughout the world. This desire to fill a niche is what causes convergence because if the niche is not filled, the ecosystem would be thrown out of proportion. More so, it treats convergence in some species as a way to take advantage of an opportunity in an ecosystem, which is a completely reasonable explanation for survival.

7. Zimmer, Carl . Evolution: The Triumph of an Idea. 1st ed., New York, NY, HarperCollins Punlisher Inc.

This book delves into what is considered coevolution and defines it as a symbiotic relationship between two or more species. I relate this to my argument because there are instances, like in mimicry, where the evolution appears to be symbiotic when it could actually be harmful. Convergence does not take another species into account, but instead only focuses on the survival of a singular species, which is the key distinguishing factor.