Moira Kelly

Final Project Summary & Annotated Bibliography

Key Scientific Concepts

STARFISH REGENERATION/CLONING

Fragmentation: some animals, such as starfish, can reproduce asexually through fragmentation. In this process, a single individual can split into two or more pieces, each of which can develop into genetically identical offspring.

1.) How do starfish adapt cloning behavior?

Starfish adapted to this fragmentation behavior because they have the ability to **regenerate** their own limbs, also known as epimorphic regeneration. By breaking apart and regenerating into new individuals, starfish can quickly replace lost body parts and increase their numbers.

2.) How do starfish maintain genetic diversity despite cloning?

Despite the ability of starfish to reproduce asexually through cloning, which may seem to limit their genetic diversity, some scientific studies have suggested that mechanisms such as somatic mutation and gene conversion may still contribute to genetic diversity in asexual populations, including in starfish.

3.) Why do starfish clone themselves/why is it beneficial?

Fragmentation and fission are beneficial to starfish because the starfish can ensure that they are able to pass on their genes and continue their species, this can be useful in environments where suitable mates are scarce or reproductive opportunities are limited.

Final Project Summary

Starfish, also known as sea stars, are fascinating marine animals that possess the unique ability to regenerate lost limbs and even entire bodies (Cary et al., 2019). One of the most remarkable ways in which some species of starfish reproduce is through a process called fragmentation (Biology Online Dictionary, 2022). This biological phenomenon occurs when a single starfish splits into two or more pieces, each of which can then grow into a new individual (OpenEd CUNY, 2022). Starfish can fragment for various reasons, such as predator attack or physical damage.

Fragmentation as a form of asexual reproduction benefits starfishes by allowing them to reproduce guickly and efficiently as organisms that are relatively immobile and have a limited ability to disperse. It allows them to produce new individuals without the need for a mate or the risk of dispersing offspring into unsuitable habitats. (Biology Online Dictionary, 2022). Fragmentation can also allow starfishes to regenerate lost or damaged body parts, which can help them to recover from injuries or other stressors. Additionally, starfish fragmentation can help to maintain genetic diversity in asexually reproducing populations, as somatic mutations can occur during the regeneration process, resulting in differences in the genetic makeup of the new individuals. (Emlet et al. 1991) Somatic mutations can occur in a fragment of a starfish when the DNA within that fragment is altered through various mechanisms, such as errors during DNA replication or exposure to mutagenic agents. These mutations can then potentially be passed on to future cells that arise from that fragment, potentially leading to genetic diversity even in a clonal population. (Emlet et al. 1991) Species of starfish such as the Allostichaster polyplax (aka Four and Four Starfish), the Allostichaster insignis (aka Three and Three Starfish), and the Coscinasterias muricata (aka Spiny Starfish) all reproduce asexually via fragmentation (Zilioli, 2015).

I created an acrylic, oil and collage on canvas painting that conceptually describes the asexual reproduction of starfish known as fragmentation. This painting is a diptic. The top half consists of ten silhouette cut outs (unprimed canvas) resembling the shapes of starfish that are adhered to the surface of the stretched and primed canvas. The ten silhouettes are overlapping each other slightly, creating a circular shape and symbolizing the cyclical nature of a starfish's

ability to clone themselves and pass on their genetic information to their offspring. You'll notice that the hue of these shapes shift slightly in a scale from a warmer color to a cooler color as you move your eyes around each of them. This shift in hue represents the genetic diversity that can occur during the process of fragmentation such as somatic , despite the misconception that starfish are only able to pass on their identical genetic information. Behind these cutouts is empty space, defined by a receding blue. I left this space open in order to symbolize an environment where suitable mates are scarce and where reproductive opportunities are limited, a leading cause in the evolution of a starfish's ability to fragment and clone. In the bottom portion of the diptic, three shapes were adhered to the surface and I used fiber paste to build upwards, creating a sculpted, three-dimensional surface that represents the bodies of starfish. These shapes represent the cycle of a starish's fragmentation process, the first, beginning as a small segment and the last, a fully formed starfish.

This painting might appeal to those who are interested in animals and marine biology, but hopefully those who appreciate conceptual fine art as well. Despite the shift from my usual subject matter, I used techniques that I typically incorporate into my primary painting process, specifically collage using pieces of unprimed canvas, glazing, sanding, and the use of complimentary colors. I wanted to treat this work with the same seriousness as I would with any of my other paintings.

Annotated Bibliography

"Biology 2e, Animal Structure and Function, Animal Reproduction and ..." *OpenEd CUNY*, https://opened.cuny.edu/courseware/lesson/829/student/?section=8.

I plan to use this article to help describe asexual reproduction in general and also more specifically about the way seastars can use the process called, "fragmentation" to reproduce asexually. For example, if the arm of a seastar becomes detached somehow, it can begin to grow into a new individual, which would be a clone of the original seastar.

Cary, Gregory A., et al. "Analysis of Sea Star Larval Regeneration Reveals Conserved Processes of Whole-Body Regeneration across the Metazoa - BMC Biology." *BioMed Central*, BioMed Central, 22 Feb. 2019,

https://bmcbiol.biomedcentral.com/articles/10.1186/s12915-019-0633-9.

The study examines the cellular and molecular mechanisms involved in the regeneration of sea star larvae, which have the ability to regenerate their entire bodies after being dissociated into individual cells.

Emlet, R.B., Hoekstra, L.A., Girard, M.L. and Strathmann, R.R., 1991. Development, heterochrony, and the evolution of larval forms. Evolution, pp. 386-399.

I am using this source to gether information about how somatic mutations can occur in the cells of the fragments during the regeneration process, resulting in differences in the genetic makeup of the new individuals. This process can contribute to genetic diversity in asexually reproducing populations, including in starfish.

"Fragmentation - Definition and Examples - Biology-Online Dictionary." *Biology Articles, Tutorials* & *Dictionary Online*, 16 June 2022, https://www.biologyonline.com/dictionary/fragmentation.

The website discusses the advantages and disadvantages of fragmentation as a reproductive strategy. One advantage is that fragmentation allows organisms to reproduce rapidly and without the need for a mate. This is beneficial to starfish because it allows the parent organism to produce genetically identical offspring, known as clones, through the separation and regeneration of body parts. This process can occur quickly

and efficiently, with each fragment developing into a new individual. In the case of starfish, this allows them to increase their population size rapidly, which can be advantageous in unstable or unpredictable environments.

Zilioli, Marco, director. *The Dividing Starfish. YouTube*, YouTube, 19 Apr. 2015, https://www.youtube.com/watch?v=AaN6uRvfPLY. Accessed 29 Mar. 2023.

I will use this YouTube video to help explain the benefits to asexual reproduction amongst seastars and if need be, how many species of seastars possess the ability to reproduce via fragmentation, Three species are listed in this video that takes place in New Zealand.











