

A Tale of Three Species

Highlight the key points from the reading as you go, answer the questions at the end, and then discuss the story with your group in order to prepare for sharing with the class.

The Purple Urchin, The Red Urchin, and The Green Urchin

The ocean is full of often foreign-looking unusual forms of life. Sea urchins, cousins to the sea stars, are no exception. These spiky balls are actually animals— and they're generally herbivores that eat kelp and other seaweeds.

Three species of urchin coexist in the eastern Pacific Ocean along the shores of the west coast of the United States and Canada. The purple urchin, red urchin and green urchin are closely related and belong to the genus *Strongylocentrotus*.

What's amazing about urchins in general is how they reproduce. Instead of mating through direct contact, these urchins do what many sea creatures have been doing for hundreds of millions of years: they spawn. Spawning involves the release of gametes from the body. Both male and female urchins do this, releasing their eggs and sperm into the water. For successful fertilization, eggs and sperm must somehow meet out in the vast ocean. To increase the probability of this happening, urchins will aggregate near one another and simultaneously stream their gametes into the water above.

What's amazing about these three urchins in particular is that they can be found in similar habitats, they eat similar foods, and they also likely respond to some of the same seasonal cues for spawning. So, how do they remain separate species if they are in close proximity and releasing their eggs and sperm into the water column, potentially at the same time?

Marine evolutionary biologists wanted to understand exactly this: what keeps these three species of urchin from hybridizing so much they come back together to become one again? In the lab, researchers set up some experiments where they exposed eggs of one species to different concentrations of sperm from each of the three species. Then they scored how many of the eggs were successfully fertilized. In looking across all three species, a general pattern emerged: sperm were best at fertilizing eggs from their same species.

There was one exception, however. It seemed as though any sperm could fertilize the eggs of green urchins, with the purple urchin's sperm performing nearly as well as the green urchin's. But the experimental biologists running the study watched closely in the coming days as the newly-formed urchin embryos began to grow. Sure enough, most hybrids that were created from green urchin eggs fertilized by purple or red urchin sperm, actually died in the coming days. The only ones to survive in significant numbers were those embryos created by a green urchin egg and green urchin sperm.

The exact mechanism that prevents fertilization in most of these combinations likely comes back to special proteins on the surface of the eggs and sperm that allow them to recognize conspecifics (same species) in a lock-and-key kind of mechanism. Developmental biologists think this is a common mechanism for ensuring within-species fertilization in many animals. Research on prevention of heterospecific (other species) fertilization continues to this day in lots of different animals.

Name: _____ Period: _____ Date: _____

After you have highlighted some key points from the reading above, paraphrase three of them.

1.

2.

3.

Title: [What organisms are you looking at?]

Summary: [1-2 sentences summarizing what is happening in the system]

Focus trait: [what trait is keeping the species separate?]

Web Resources:

Wikipedia Article, "Reproductive Isolation" (https://en.wikipedia.org/wiki/Reproductive_isolation)

Scientific Articles:

Kosman, E. T., and D. R. Levitan. "Sperm competition and the evolution of gametic compatibility in externally fertilizing taxa." *Molecular human reproduction* 20.12 (2014): 1190-1197.

Levitan, Don R. "The relationship between conspecific fertilization success and reproductive isolation among three congeneric sea urchins." *Evolution* 56.8 (2002): 1599-1609.