# Researchers discover how new corals species form in the ocean

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Credit: Twilight Zone Expedition Team 2007, NOAA-OE

Since the observations made by English naturalist Charles Darwin on the Galapagos Islands, researchers have been interested in how physical barriers, such as isolation on a particular island, can lead to the formation of new species through the process of natural selection. Natural selection is a process whereby heritable traits that enhance

survival become more common in successive generations, while unfavorable heritable traits become less common. Over time, animals and plants that have morphologies or other attributes that enhance their suitability to a particular environment become more common and more adapted to that specific environment.

Researchers today are intimately familiar with how physical barriers and reproduction isolation can lead to the formation of new species on land, especially among plants and animals with short generation times such as insects and annual plants. Michael E. Hellberg, associate professor in the Department of Biological Sciences at LSU, however, is interested in a more obscure form of speciation: the speciation of animals in the ocean.

"Marine plants and animals can drift around in the ocean extremely long distances," Hellberg said. "So how do they specialize?"

In a recent publication in the Proceedings of the National Academy of Sciences, or *PNAS*, Hellberg and his graduate student Carlos Prada investigate how corals specialize to particular environments in the ocean. Corals, animals that form coral reefs and some of the most diverse ecosystems in the world, start their lifecycle with a free floating larval stage. Coral larvae can disperse vast distances in open water. Different coral species share similar geographical locations, with different species often existing only yards apart. As Prada and Hellberg propose in their recent publication, the large dispersal potential of coral larvae in open water and the proximity of different species on the ocean floor creates a mystery for researchers who study speciation. Hellberg and Prada ask, "How can new marine species emerge without obvious geographic isolation?"

When it comes to corals within the relatively small confines of the Caribbean, which spans approximately 3 million square kilometers, the key to the puzzle appears to be habitat depth in the ocean. In others

words, natural selection has led to the formation of different coral species according to how deep in the ocean these different corals grow.

Prada and Hellberg study candelabrum corals of the genus *Eunicea*, generally known as "sea fans," for which sister species have been shown to be segregated by ocean depth. One sister species survives better in shallow waters, while the other is better adapted to deep waters. These corals, like other corals, are very slow-growing animals. In fact, sea fan corals don't reach reproduction age until they are 15-30 years old, and can continue reproducing until they are 60 or more years old. So while candelabrum coral larvae can disperse large distances from their parents, landing and beginning to grow in either shallow or deep water habitats, small differences in survival rates at different depths between the two species and long generation times can combine to produce segregation.

"When these coral larvae first settle out after dispersal, they are all mixed up," Hellberg said. "But long larvae-to-reproduction times can compound small differences in survival at different depths. By the time these corals get to reproduction age, a lot has changed."

The shallow water sea fan coral even has a different morphology than its deep water sister. The shallow water coral fans out into a wide network of branches, while the deep water coral grows tall and spindly. According to Hellberg, these differences in morphology might well be genetic, with the different corals having different protein structures and levels of expression that are better adapted to their specific water depth environment. Hellberg hopes in future research to investigate the genetic basis of these different morphologies.

In other interesting results, Prada explained how transplanting the shallow coral species to deep water environments, and vice versa, can cause the coral to take on a morphology more like that of its sister species.

"Their morphologies are not super fixed," Prada said. "But they can't change all the way to a different morphology."

Prada observed that while shallow water sea fans can become taller and more spindly when transplanted in deep water environments, they don't seem to be able to make a complete transition to the morphology of the deep water sea fan. This suggests that the two corals, while they likely had a common ancestor, have adapted genetically and biochemically to their respective water depths.

Prada did ocean dives in the Bahamas, Panama, Puerto Rico and Curaçao to sample candelabrum coral colonies. Back in the lab, he performed tests on the coral samples' genes to determine how shallow and deep corals become genetically different.

"Normally, organisms are differentiated by geography," Prada said. "But these corals are differentiated by depth."

Prada and Hellberg's research provides new insights into how new species form in the ocean, a topic of relatively limited research as opposed to speciation of terrestrial organisms.

**More information:**
www.pnas.org/content/early/2013/01/22/1208931110

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