Offspring from fat fish on deep reefs help keep shallower populations afloat

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Bicolor damselfish population density decreases as reef depth increases. Credit: Esther D. Goldstein

Populations of coral reef fish in shallower, more vulnerable habitats likely owe at least some of their sustainability to the prodigious reproductive abilities of large, old counterparts that dwell at greater depths, a recent study suggests.

Researchers found that fish in the mesophotic zone - 30 to 150 meters underwater, the depth limit for reefs that depend on photosynthesis - are

present in lower densities than at other depths, but consisted of larger, older fish with better than average reproductive capabilities.

That mesophotic population, research suggests, is heavy on what are known as BOFFFFs: big, old, fat, fecund, female fish.

Results of the study were recently published at nature.com. Primary funding for the research came from the National Oceanic and Atmospheric Administration Center for Sponsored Coastal Ocean Research.

Su Sponaugle, a professor of integrative biology at Oregon State University's Hatfield Marine Science Center, teamed up with two other researchers, lead author Esther D. Goldstein and Evan K. D'Alessandro, both of the University of Miami, to study the demographics of bicolor damselfish populations across three reef depths off the Florida coast.

The team studied bicolor damselfish at shallow (less than 10 meters); deep shelf (20 to 30 meters); and mesophotic reef locations, looking at population density and individuals' structure, growth, size and reproductive output. The damselfish is a small, short-lived plankton feeder that's closely associated with reef habitat. At mesophotic depths, however, the fish can live more than a dozen years.

The researchers sought to assess the potential of mesophotic reefs to support robust fish populations. Because of their greater depth, those reefs are less susceptible to both human-caused and natural habitat disturbances such as temperature increases.

The scientists found that as water depth increased, the bicolor damsel fish population density decreased and age distributions shifted toward older, and larger, individuals. Among those individuals are the BOFFFFs that produce lots of large eggs that likely hatch high-condition larvae.

The larval stage for the bicolor damselfish lasts 30 days, during which time the larvae are carried by water currents to eventually settle to a reef. At whatever depth they settle to, within 24 hours, larvae will metamorphosize into juveniles and then remain in close proximity to the reef for the duration of their lives.

"They're very site attached," Sponaugle said. "Once they settle somewhere, that's where they live, grow and reproduce - that is, until they're eaten."

Across all depths, the fish are genetically similar, meaning it's probable that shallow water and mesophotic reefs exchange young.

"Mesophotic reefs are sort of a warehouse for future fish in the shallower reefs," Goldstein said. "The fish are older and larger on average, and they invest a lot into reproduction, which is good.

"So even though there are not as many of them on these deep reefs, their offspring hatch from larger eggs and likely experience higher survivorship, so it would seem they have the capacity to contribute more than their fair share to the shallow-water environments."

More information: Esther D. Goldstein et al, Demographic and reproductive plasticity across the depth distribution of a coral reef fish, *Scientific Reports* (2016). DOI: 10.1038/srep34077

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