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MALE PREGNANCY IN SEAHORSES: ROLE REVERSAL MAY AFFECT FORMATION OF NEW SPECIES IN THIS FISH FAMILY

Male pregnancy in seahorses may do more than reverse traditional gender roles. It could also influence the way new species form from single populations of these ancient creatures.

Studies have shown that most new species arise from geographically, and therefore genetically, isolated populations. But some seahorses likely diversify in a process called sympatric speciation, in which new species arise from a single population that has no geographic barriers to inhibit gene flow, according to a paper published this week in the *Proceedings of the National Academy of Sciences* (PNAS).

"We think there's a fairly strong case that sympatric speciation may have occurred in seahorses," said Georgia Institute of Technology Assistant Professor of Biology Adam Jones, the lead author on the PNAS paper. "We're not arguing that all speciation in seahorses is sympatric. The majority of speciation is probably due to some geographic barrier to genetic migration. But in some instances it looks like sympatric speciation occurred."

Driving the sympatric speciation process in seahorses is the fish's size-similar mating practice imposed by male pregnancy, extended male parental care and monogamy, Jones said.

Shown above is a seahorse species found in the Red Sea. (Image courtesy of NOAA)

Seahorses choose similar-size mates to have the best chances for successful reproduction. The female inserts ripe eggs into the male's brood pouch, where the eggs are fertilized, embed and incubate for 10 days to six weeks, depending on the species.

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"Male reproductive rates, the size of the brood pouch and the number of eggs that a female produces all increase with the size of the seahorse," Jones explained. "So if you're a large seahorse, you want to mate with another large seahorse so you're not wasting your eggs or your brood pouch space. So this kind of mating is the real mechanism for sympatric speciation. A lot of forms of parental care might not cause that size-specific restraint in mating, but this one does."

In addition to size-specific mating, a process called disruptive selection is also necessary for sympatric speciation to occur, Jones said. Disruptive selection occurs when large-sized and small-sized individuals survive better than mid-sized animals.

To test their hypothesis, Jones and his co-authors developed a computer-based genetic model to determine if the rate of size-similar mating in their field study population was sufficient enough to produce disruptive selection and, in turn, sympatric speciation. The model allows simulated populations to evolve at the rate of size-similar mating that Jones and his colleagues observed in a seahorse species off the coast of Perth, Australia. Under these conditions, the model indicated sympatric speciation does occur with fairly modest levels of disruptive selection.

"So the remaining question is whether disruptive selection occurs at a sufficient strength in natural populations of seahorses," Jones noted. "The model shows it's plausible, but as in most cases of sympatric speciation, we have no definitive proof."

To determine that size-similar mating was occurring in the field study population, researchers conducted genetic analyses of parentage, much like the DNA "fingerprinting" technique used in humans. Researchers tagged males and females in the field, sampled the DNA of the males' progeny and then determined the mother of those offspring. Then, researchers compared the sizes of male and female partners to chart a statistical trend that indicated size-similar mating.

A third line of evidence for sympatric speciation came from the phylogeny, or family tree, of seahorses, which are found in coastal and ocean habitats throughout the world, except in extreme latitudes. Researchers gathered documentation of species pairs that are close relatives and live in the same place.

"If there had been sympatric speciation and it was based on assortative mating by size, then when speciation occurs, the result should be a large species and a small species that live in the same place," Jones explained. Indeed, researchers noted two examples of species that are close relatives that are sympatric over part or all of their range.

Further research on sympatric speciation could reveal patterns of genetic variation in species pairs that researchers suspect might have undergone sympatric speciation.

Ideally, Jones or other researchers who study the topic further would focus on seahorse populations in which sympatric speciation may have just begun. The populations described in the PNAS paper probably underwent sympatric speciation hundreds of thousands or millions of generations ago, Jones added.

"The genetic signature of sympatric speciation will erode over time," Jones explained. "So the evidence disappears. You can't rule out allopatric speciation (new species arising from geographically isolated populations) in these relatively old events. Maybe a geographic barrier disappeared. The case for sympatric speciation will be stronger if we can find recent events -- something that occurred in the past 50,000 years. The ideal case would be to find speciation that is occurring right now. But this is awfully hard, and that's why it is so hard to prove."

Jones' co-authors are Glenn Moore of the University of Western Australia, Charlotta Kvarnemo of Stockholm University, and DeEtte Walker and John Avise of the University of Georgia. The study was funded by the National Science Foundation, Pew Foundation, University of Georgia, Bergwell Foundation, Swedish Natural Science Research Council and the University of Western Australia.

More information on seahorses is available from a conservation group called Project

Seahorse found online at (www.seahorse.mcgill.ca/intro.htm). This group is concerned that seahorse populations are in danger of being wiped out from habitat destruction and overharvesting for use in the aquarium and non-traditional medicinal trades.

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