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JUST ASK A SCIENTIST!

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Question: ***I recently heard that the Amazon molly is a species without males. Is that true? How is that even possible?***

It turns out y'all have a lot of questions about how our fish reproduce. I figured this question would be a nice follow-up from the last installment of "Just Ask a Scientist!" that dealt with the possibility of sex change in livebearers. So, in the vein of weird reproductive practices, the Amazon molly (Poecilia formosa) does indeed exist, and it is an all-female species. Amazon mollies are actually named after the Amazons, the all-female warrior tribe of Greek mythology (not after the Amazon river as frequently assumed). Amazon mollies occur in coastal and freshwater habitats in Texas and Mexico, and their range along the coast of the Gulf of Mexico roughly stretches from Galveston, TX to Tampico, MX. The species has also been introduced in springs between San Marcos and New Braunfels in Central Texas, where some of you may have collected it during fieldtrips associated with past ALA meetings.

So, if Amazon mollies are all-female, how do they reproduce? The technical term for the Amazon molly's reproductive strategy is called gynogenesis, which is a form of asexual reproduction (also called parthenogenesis). Essentially, Amazon mollies clone themselves, producing all-female offspring that are genetically identical to the mother. Unlike truly asexual species, however, Amazons cannot clone themselves without the help of males; they need sperm to trigger the start of their offspring's development, even though the DNA contained within the sperm does not make it into egg. Somehow Amazons exclude the male DNA, only passing down the mother's genes.

At this point, you might be scratching your head, right? They are all-female, but they do need sperm donors… where do those males suddenly come from? Amazon mollies actually mate with males from other species to obtain sperm that enable their clonal reproduction. Mating partners include males of the Sailfin molly (P. latipinna), with which Amazons co-exist in the northern part of their

distribution, as well as the Atlantic molly (P. mexicana), with which they co-exist in the southern part. These two species are actually the evolutionary ancestors of Amazon mollies, because the original Amazon molly (the eve of Amazons) arose when an Atlantic molly female mated with a Sailfin molly male some 100,000 years ago. Thank genetic analyses for solving that mystery.

The non-traditional family life of Amazons and their dependence on males from other species opens up a bunch of intuiting questions. Accordingly, biologists from different fields have been scrutinizing the lives of these little fish…

Evolutionary biologists have used Amazon mollies to better understand how sexual reproduction – involving the mixing of genes between males and females – has originated. You see, asexual reproduction has some substantial benefits over sexual reproduction. Let's assume that a single female can produce only a certain number of offspring during her lifetime (maybe we pick 10 just as an example). If the female is asexual, all of her offspring will be female and also produce offspring, right? An asexual female should therefore have 100 grand-daughters and 1000 grand-grand-daughters (assuming every offspring actually survives). Compare this with a sexual female: they also produce 10 offspring per generation, but half of them will be males, and they don't actually contribute much to producing offspring beyond their sperm. So, a sexual female would be expected to have 5 daughters, 25 grand-daughters, and 125 grand-grand-daughters. You can see, reproducing asexually – producing only female offspring – essentially doubles the rate at which a population grows. If there was no difference between asexual and sexual females, other than the way they produce offspring, we would expect that asexual females should rapidly take over natural populations, causing sexual females to go extinct. For Amazons, that would prove to be fatal, because once they displace their sexual hosts, they would also go extinct (no sperm-donors, no babies). So, how does this work in nature? How do Amazon mollies and their related sexual species co-exist? In short, we don't exactly know, but asexual and sexual females clearly must differ in ways beyond they produce offspring. One idea is that sexual reproduction accelerates

evolution due to the constant reshuffling of genes, providing an advantage for sexual species when environmental conditions change over time.

Amazon mollies have also been scrutinized by animal behaviorists. For example, some researchers have studies why in the world a male molly would mate with an Amazon, when it does not actually improve its reproductive success. Mating with asexual females should be a waste of time and energy, so males would be expected to avoid such females and prefer to make with sexual females instead. Interestingly, one study has documented a potential benefit for males mating with asexual Amazons. It turns out, female mollies make their mating decisions in part by observing how successful a male is with other females. So, when males are seen mating with asexual Amazon mollies, it might actually increase their attractiveness to sexual females of their own species.

Finally, the fact that Amazon mollies produce genetically identical clones has also been leveraged by biomedical researchers. The clonality in this species allows researchers to perform experiments without the confounding effects of genetic variation, providing insights into how skin and thyroid cancers develop.

So, Amazon mollies may be a gray, unsuspecting species that is rarely kept by hobbyists. But at the same time, it has an absolutely fascinating biology.

"Just Ask a Scientist!" will hopefully be a regular component of Livebearers in the future. However, this requires your input. Have you ever wondered about the meaning of observations you made in your fish tank? Do you have questions about the behavior, reproduction, ecology, or evolution of livebearers? Submit your questions directly to Michi (tobler@ksu.edu). He will do his best to answer your question or find somebody that can.