No males needed: All-female salamanders regrow tails 36 percent faster

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Unisexual salamanders contain DNA of up to five species and reproduce primarily by cloning themselves. Credit: Kevin Fitzsimons, The Ohio State University

The lady salamander that shuns male companionship may reap important

benefits.

For instance, when a predator snaps off her tail.

New research from The Ohio State University compared an all-female population of mole salamanders to a related heterosexual species and found they grew their tails back 36 percent faster. The unisexual salamanders (part of the *Ambystoma* genus) contain DNA of up to five species and reproduce primarily by cloning themselves.

Salamanders' tails play a critical role in predator avoidance. As larvae, tails help them swim away. Once the animals are land-dwellers, the tails act as a distraction.

After accounting for weight and size differences - the all-female salamanders are larger and have more tail to grow back - the team concluded that the unisexual animals regenerated tail tissue at 1.5 times the rate of their heterosexual counterparts.

"I don't think we expected it to happen so fast," said Robert Denton, co-author of the study and a graduate student in Ohio State's Department of Evolution, Ecology and Organismal Biology.

The study appears in the *Journal of Zoology*.

Populations of unisexual mole salamanders have survived millions of years through cloning. Because they aren't mating with males (though they do mix things up by "borrowing" sperm left behind on leaves and twigs), their DNA stays relatively static.

And that might lead a salamander scientist to suspect the species would fizzle out. (Passing harmful genetic mutations to generation after generation could be bad.)

"I was wondering what makes them thrive, and there are some things that might point to them regenerating body parts at faster rates," said Monica Saccucci, who led the study as an undergraduate at Ohio State.

Unisexual salamanders are polyploids, meaning they have more than two sets of chromosomes. This is relatively common in plants and occurs in some other animals, including goldfish. But most animals have two sets, one from mom and one from dad.

Scientists who study everything from tomatoes to humans understand that genetic differences can play significantly into how fast cells divide and tissue grows. But little research has looked at closely related salamanders with different reproduction strategies.

The research team collected egg masses from wetlands in rural Ohio and reared 10 unisexual salamanders and 30 smallmouth salamanders for comparison. Then the researchers removed a portion of the salamanders' tails and monitored regrowth for four months.

Both groups regenerated at about the same rate up until three weeks after their tails were removed. (This was also the time most animals' diets were upgraded from brine shrimp to larger plankton, but it's unclear what role the nutrient shift might have played.)

Then the tails of the unisexual salamanders began to grow at a rate that outpaced their heterosexual counterparts. In about 10 weeks, the unisexuals had brand-new tails. It took the other salamanders another month or so.

The discovery illuminates how genetic differences can contribute to differences in regeneration rates that could amount to at least a partial explanation for the long-term survival of the hybrid unisexual salamanders, Saccucci said. And it shows a parallel between the small

vertebrates and polyploid snails, which also regenerate after injury more quickly.

Denton said it remains unclear whether the faster regeneration is due to the genomic differences alone.

"Is it because they have more genomes or because they reproduce differently? We don't know and it's difficult to disentangle with these animals," he said.

While the unisexual salamanders usually reproduce through cloning, they "borrow" salamander sperm from other species to stimulate egg production, a process called kleptogenesis.

"They can steal sperm from male salamanders and incorporate it into their genome. We don't know exactly how that works, but it's interesting," Saccucci said.

Maintaining a species without males is efficient if you can pull it off, because all the females are able to create more animals without the usual complications of mating, Denton said.

Saccucci, now a medical student at the University of Cincinnati, was particularly interested in regeneration because of its promise in human medicine.

"I had salamanders to work with, and they can regenerate all kinds of structures—tails, digits, part of their heart, part of their eye. That piqued my interest," she said.

In a salamander's life, regeneration ranks high in importance.

"They get injured a lot," Saccucci said. "If you can't regenerate, you're

dead."

More information: M. J. Saccucci, R. D. Denton, M. L. Holding, H. L. Gibbs. Polyploid unisexual salamanders have higher tissue regeneration rates than diploid sexual relatives. *Journal of Zoology*, 2016; DOI: 10.1111/jzo.12339 , onlinelibrary.wiley.com/doi/10.1111/jzo.12339/full

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