Certain female fish have special mating preference

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Ladies' choice

A biologist at Washington University in St. Louis has shown that for some fish species, females prefer males with larger sexual organs, and actually choose them for mating. That does not exclude males with an average-sized sex organ, called a gonopodium. These fish out-compete the larger-endowed males in a predator-laden environment because they have a faster burst speed than the males with larger genitalia, who lose out because the size of their organ slows them down, making them ripe for capture by larger fish.

Image: Male Bahamas mosquitofish (left) chasing a female (right) in a blue hole on Andros Island, The Bahamas.

Brian Langerhans, Washington University biology graduate student in Arts & Sciences, has performed studies on mosquitofish (guppy-like fish, about an inch long) and found that female mosquitofish spend 80 percent more time with males who have a large gonopodium.

"A male with a larger gonopodium has a higher chance of mating, but in a predator environment he has a higher probability of dying," Langerhans said. "That's the cost, the tradeoff. On the other hand, we found that in predator-free environments gonopodia size was larger, as there is minimal cost for large genitalia in that environment. Bigger is better for mating, but smaller is better for avoiding predation."

Langerhans and colleagues reported their findings in the May 9 on-line issue of Proceedings of the National Academy of Sciences.

Langerhans specializes in the study of ecological factors that shape the evolution of body forms. Male genitalia are more variable than just about any other body form studied, and there is a significant cadre of evolutionary biologists studying this field because genital shape - morphology - is one of the chief characters that taxonomists use to distinguish between closely related species.

Striking diversity

Researchers have thought for about 20 years that the striking diversity of genital form results from post-mating sexual selection, such as sperm competition or cryptic female choice. That is, most evolutionists have believed that for animals with internal fertilization — like the livebearing fish Langerhans studies which don't lay eggs — selection acting within the female's body that biases fertilization toward males with a particular genital morphology has been largely responsible for the generation of genital diversity. Langerhans's finding, however, contradicts that theory: he has shown that female mosquitofish make

their choice before mating, and overwhelmingly that choice is made with size being the prize.

Langerhans and colleagues collected about 350 males of Gambusia affinis in Texas and the same number of Gambusia hubbsi in the Bahamas, taking them from both predator and non-predator environments. He found that mosquitofish in predator-free environments had gonopodia 15 percent larger than those in predator-laden environments. That's a heritable trait over generations made easier by the lack of predators. He also observed that the mosquitofish with larger genitalia had slower burst speeds compared with those of smaller genitalia types.

In the laboratory Langerhans took offspring of Texas mosquitofish from both environments and ran a common-garden experiment - in which all environmental factors are the same for all individuals - in laboratory aquaria. He found that gonopodia size was larger in the lab for the offspring of parents collected in predator-free environments - just as in the field - proving heritability.

Sex, lies and videotape

He even got female selection on film. He examined the mating preference of about 50 mosquitofish females, where each female was placed in an aquarium having two videos playing side-by-side at one end of the aquarium. One video was of a male mosquitofish with an average gonopodium; the other was of a male with a 15 percent larger one. This forced a female to make a pre-mating sexual selection. After testing each individual and devoting over 1,000 minutes of observation, Langerhans found that it wasn't even close.

"They chose the larger one over and over," Langerhans said. "All females had the same preference."

A tenet of Langerhans's study was his belief that the gonopodium could be viewed as a secondary sexual trait - similar to a peacock's tail, meant to enhance reproductive opportunity and selected by the female - rather than a primary sexual trait, which is the actual reproductive organ itself, simply meant to transfer sperm. Historically, genitalia were not believed to be subject to such sexual selection.

"Male genitalia can be seen as just another morphological character, and if you think of them that way, females might be choosing just as they would for any morphological trait," he said. "This at least partially explains the variability in male genital morphology."

Using this study as a springboard, Langerhans is exploring the role of genital divergence in the process of speciation. Divergence in a copulatory organ might be especially important in speciation — owing to its obvious link to reproduction, which largely defines species boundaries. Evolutionary changes in male genital morphology between populations may result in reproductive incompatibility when populations merge again in the future, resulting in the generation of new species.

"Since gonopodium size is highly variable among livebearing fish species — ranging from less than 20 percent of the body length to more than 70% — I am extending the results reported in the PNAS paper — divergence of genital size within species — to an investigation of diversification in genital size between species, inferring possible modes of speciation. Since variation in predator regime exists between as well as within species, we can test specific theoretical predictions regarding genital evolution to evaluate what processes might have caused the patterns."

Langerhans also plans to examine whether other species of livebearing fish also exhibit female mating preference for males with large genitalia. If true, he said, the evolution of this mating preference might help

explain the evolution of swords in male swordtail fishes. Swords are conspicuous, elongate projections of the tail fin and are known to be subject to female mate choice.

"Swords resemble gonopodia in overall shape, and thus might effectively represent gonopodium mimics that evolutionarily exploit a pre-existing sensory bias in females," he said. "That is, male ornamentation of the tail fin may have evolved largely due to the pre-existing preference for an elongate structure of a similar shape — the gonopodium."

Source: Washington University in St. Louis