

# In stickleback fish, dads influence offspring behavior and gene expression

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The stickleback male is solely responsible for the care of his offspring. Credit: L. Brian Stauffer

Researchers report that some stickleback fish fathers can have long-term effects on the behavior of their offspring: The most attentive fish dads cause their offspring to behave in a way that makes them less susceptible to predators. These behavioral changes are accompanied by changes in gene expression, the researchers report.

The findings appear in the *Proceedings of the Royal Society B: Biological Sciences*.

"There is lots of evidence that moms are very important for their offspring," said University of Illinois animal biology professor Alison Bell, who led the study with researcher Katie McGhee. "But we know much less about fathers."

Studies in mice, monkeys and voles, for example, show that maternal care and attentiveness to newborns can influence the future [behavior](#) of the young – even when these moms care for young that are not genetically related to them, Bell said. The [behavioral changes](#) are often linked to changes in [gene expression](#) via "methylation," a chemical process that reduces the rate at which specific genes are translated into proteins, she said.

The three-spined stickleback (*Gasterosteus aculeatus*) is a small fish species – it is up to the father, alone, to care for its offspring, making sticklebacks ideal organisms for the study of fatherly influence, Bell said.

The stickleback dad's job is a challenge, she said.

"Everybody loves to eat fish eggs; caviar is totally delicious, so you can imagine how in the wild everybody and their mother is trying to eat the stickleback's clutch of eggs," she said. "So males are very aggressive towards intruders, and they spend a lot of time just hanging out at their nest and defending it."

Fathers differ, however, in the kinds of care they provide to the young, Bell said. Some dads more aggressively chase away intruders and barely interact with their offspring, while others hover above the nest, fanning it with their fins to boost oxygen and retrieving youngsters (called fry)

that wander off.

"The dad is actually handling the fry in his mouth," she said. "He'll chase them down, suck them up into his mouth and then spit them back into his nest. Early studies in sticklebacks suggested that fry are learning about predators by having their dad chase after them."

In the new study, Bell and McGhee evaluated fatherly influence on fry behavior by separating half of the fry from their dads before they hatched.

"This allowed us to compare these offspring that were orphans with their siblings, who were raised by their father," Bell said.

McGhee tracked the sticklebacks' behavior in and around the nest and in the presence of a predator. She found that the orphaned offspring of very attentive fathers had a tendency to be much more active, particularly in the presence of a predator. When a predator fish (in this case a pike) was near, the young sticklebacks swam around, pecking at the sides of the tank as if trying to escape, a behavior that makes them more susceptible to being spotted and eaten by a hungry pike.

Having been reared by attentive fathers, however, reduced this frantic fry behavior. The father-reared offspring were much less active than their siblings that had been orphaned, the team reports.

The less-attentive fathers had no discernible influence on their offspring, however. The orphaned fry and the father-reared fry of these dads behaved similarly in the presence of a predator, Bell said.

These findings suggest that fish families differ in their responses to stress, and that fathers can help to compensate for inherent vulnerabilities by changing their behavior in ways that affect offspring

behavior, Bell said.

The team also looked at gene expression in their study fish, and found that the variation in parental care was associated with changes in an enzyme that promotes DNA methylation in the young.

"Our study is important because, one, we show that dads can be like moms in that their care can influence their [offspring](#); two, we show that dads can be like moms in that it looks like it could be mediated by [gene expression changes](#) due to differences in methylation; and three, we find this funky thing where the amount of methylation and the amount of care seems to vary among families," Bell said.

**More information:** "Parental care in a fish: epigenetics and fitness-enhancing effects on offspring anxiety," [rsos.royalsocietypublishing.org/.../1/1794/20141146.full](https://rsos.royalsocietypublishing.org/doi/10.1098/rsos.1794)

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