# For threespine sticklebacks, you are what you Eda

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**A Neves**

A real stickleback swimming in parallel with a robotic school of model sticklebacks. this model school assay was used to show that the eda gene is important for the ability of sticklebacks to maintain a parallel body position while schooling.

*Image provided by Dr. Anna Greenwood.*

Ever since Dr. Seymour Benzer pioneered the field of behavioral genetics, scientists have known that genes control animal behavior. Importantly, genes that regulate behavior in model organisms are also present in humans, suggesting evolutionary conservation of function. For example, the first gene shown to control circadian rhythms, *period,* was identified using fruit flies, with subsequent work showing that mutations in the human homolog *PER2* cause familial advanced sleep phase syndrome. However, it is much more difficult to study behavior in vertebrates, particularly in wild populations. The Peichel Laboratory (Basic Sciences and Human Biology Divisions) uses the threespine stickleback fish as a model vertebrate to study complex behavioral traits. One such trait is schooling behavior, which varies considerably both within and between fish species due to the balance between advantages and drawbacks of social living in different habitats. For instance, marine sticklebacks from open-water habitats school extensively and maintain a parallel body position when schooling. In contrast, benthic sticklebacks from lake habitats spend much less time schooling and maintain an inefficient body position relative to their schooling group. Previous work from the Peichel Lab showed that these differences in schooling behavior can be recapitulated in the laboratory using a robotic model school, and used this technology to show that the ability to school mapped to a region on chromosome four (Wark et al., 2011, Greenwood et al., 2013). Intriguingly, this genomic region has also been linked to differences in bony plates as well as lateral line patterning, and both of these traits are known to be regulated by a gene on chromosome four called *Ectodysplasin* (*Eda*). A Fred Hutch follow-up study led by former staff scientist Dr. Anna Greenwood and published in *Genetics*, sought to determine if manipulation of this gene also contributes to differences in schooling behavior observed between marine and benthic sticklebacks.

The study began by leveraging a transgenic line of benthic sticklebacks wherein the marine allele of Eda was expressed under the control of a strong, ubiquitous promoter (human cytomegalovirus promoter; CMV). After generating six independent CMV:Eda transgenic lines, the authors compared both the ability and the tendency to school between the CMV:Eda fish and their non-transgenic benthic siblings. The CMV:Eda fish exhibited a more marine-like schooling ability but not tendency, consistent with their previous genetic mapping data. However, only 13% of the variance in behavior was explained by the *Eda* gene, compatible with the notion of schooling as a complex behavioral trait. Because Eda controls morphological differences in bony plates and lateral line patterning, the researchers asked whether either of these traits were correlated with schooling ability. Lateral line patterning, but not bony plates, was shown to associate with schooling ability in CMV:Eda benthic fish. However, neither physical nor chemical ablation of the lateral line affected schooling behavior. In summary, a combination of genetic and transgenic analyses showed that a single gene, *Eda*, sculpts evolutionary differences in behavior in wild populations of a vertebrate species. Said Dr. Peichel "We know that genes play an important role in behavior but we currently know very little about the specific genes that underlie behavior in any species. We know even less about the genes that underlie behavioral differences between species in the wild. This study is one of only a handful to identify a gene that contributes to behavioral variation between populations in nature, and one of the first to do so in a vertebrate system."

Greenwood AK,Mills MG,Wark AR,Archambeault SL,Peichel CL. 2016. Evolution of schooling behavior in threespine sticklebacks is shaped by the *Eda* gene. *Genetics* . DOI: 10.1534/genetics.116.188342. [Epub ahead of print.]

See also:

Greenwood AK, Wark AR, Yoshida K, Peichel CL. 2013. Genetic and neural modularity underlie the evolution of schooling behavior in threespine sticklebacks. *Curr Biol* 23(19):1884-8.

Wark AR, Greenwood AK, Taylor EM, Yoshida K, Peichel CL. 2011. Heritable differences in schooling behavior among threespine stickleback populations revealed by a novel assay. *PLoS one*. Mar 25;6(3):e18316

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