Three cheers for the three-spined stickleback

Kathleen Heng, Abbey Thompson, David Chu & David M. Kingsley

SCIENTIFIC NAME
Gasterosteus aculeatus

TAXONOMY
PHYLUM: Chordata
CLASS: Actinopterygii
ORDER: Gasterosteiformes
FAMILY: Gasterosteidae

General description

Three-spined sticklebacks are small bony fish that have prominent spines for protection against predators. The fish occupies widespread habitats and can be found in both marine and freshwater parts of the Northern hemisphere[1]. Since the end of the last Ice Age, marine sticklebacks have colonized many new freshwater lakes and streams in formerly glaciated regions. This recent adaptation in response to dramatic ecological change has recurred in many locations within 10-20,000,000 years. Because the stickleback has undergone repeated adaptation to divergent marine-freshwater environments, the species exhibits multiple examples of parallel evolution[1].

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Husbandry

Sticklebacks are normally found in cool northern environments covering a range of pH and salinities. Wild fish use a paternal care system, with males building nests, recruiting females, fertilizing external clutches of a few dozen to several hundred eggs, and fanning eggs during the week or so before hatching. In the laboratory, both marine and freshwater fish can be raised from eggs to fertile adults in 6 to 12 months at temperatures of 16–18 °C, a salinity of 3.5 parts per thousand (55,00-60,000 μS), and pH between 6.5 and 7.5. Since wild fish occupy a wide range of environments, many populations can likely tolerate parameters outside of these ranges. In laboratory settings, *in vitro* fertilization can be used to replace natural matings and overcome reproductive barriers between populations. Housing density is partly dependent upon the system's filtration efficiency, but a useful rule of thumb is 2 cm of fish per liter of water. Possible laboratory diets include *Daphnia*, brine shrimp, mysis shrimp, and bloodworms. Detailed descriptions of common husbandry procedures for sticklebacks are available (https://www.researchgate.net/profile/Jeffrey_Divino/publication/280076726_Juvenile_Threespine_Stickleback_Husbandry_Standard_Operating_Procedures_of_the_Schultz_Lab/links/55a67ea508ae410caa74d8f0.pdf).

Research résumé

Scientists have selected three-spined stickleback as a model for ecological and genetics research in part because the species has undergone one of the most recent and dramatic evolutionary radiations on earth. Different forms show striking changes in size, body armor, teeth, craniofacial structures, dorsal spines, pelvic development, pigmentation, salt handling, parasite resistance, social and reproductive behavior, and many life history traits[1]. Despite these major morphological and physiological differences, many recently evolved populations can still be crossed, making it possible to map particular chromosome regions that control interesting phenotypic differences[2]. The three-spined stickleback genome has been sequenced, facilitating the study of chromosome regions and genes that contribute to phenotypic differences[3]. Researchers have also developed methods for adding and removing genes in sticklebacks, making it possible to transfer traits and confirm the effects of particular genes and mutations[2].

The diversity of fossil and living stickleback populations adds to the value of these fish as an evolutionary, ecological, and environmental model[4]. Interactions between fish and other organisms can be studied in a range of environments, ranging from laboratory aquaria, artificial ponds, common garden experiments, or natural lakes and streams followed over time[5]. Host-parasite interactions have been studied in sticklebacks since they possess a well-documented parasite fauna, and different populations show marked variation in parasite susceptibility[6]. The stickleback is also an emerging model for environmental biomonitoring, with wide distribution as a native species, simple DNA markers for molecular sex determination, clear biomarkers for exposure to androgens and endocrine-disrupting chemicals, and reports of intersex fish[7].

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3. Jones, F.C. *et al.* The genomic basis of adaptive evolution in threespine sticklebacks. *Nature* **484**, 55–61 (2012).
4. Gibson, G. The synthesis and evolution of a supermodel. *Science* **307**, 1890–1891 (2005).
5. Arnegard, M.E. *et al.* Genetics of ecological divergence during speciation. *Nature* **511**, 307–311 (2014).
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