The Amazing Adaptations of Sticklebacks

By Kyla Younger

The Three-Spined Stickleback is a small fish native to BC, commonly found in creeks and rivers. These fish may seem ordinary, but they're species is capable of extensive adaptive radiation in very little time - so much so that they're species has become a focus for scientists studying adaptation and speciation. Through examining these sticklebacks, scientists are trying to pinpoint the common molecular changes responsible for adaptation, as well as evolution. So why sticklebacks?

Sticklebacks colonized the waters of BC between 10,000 and 20,000 years ago, beginning their accelerated evolution at the end of the last ice age. In the last 10,000 years or so, sticklebacks have undergone rapid adaptive radiation; exploring many new habitats and finding new ways to survive. Today, there are almost 50 subspecies of Three-Spined Sticklebacks living across the continent, with a great amount of phenotypic diversity (outward/physical diversity) in the shapes and sizes of those fish. These changes are so diverse that the fish were originally classified as separate species by the scientists who discovered them. These sticklebacks are now considered to be a single species, due to the fact that they interbreed so often and produce a myriad of healthy offspring.

This alone wouldn't have been enough to attract such a large portion of the scientific community; what really interested scientists is the fact that some subspecies *cannot* produce viable offspring through interbreeding. During the breeding season, freshwater sticklebacks migrate to the lower regions of their creeks or rivers to meet marine sticklebacks, who have likewise swam up those rivers from the ocean. These two variations of sticklebacks are referred to as ecotypes; a distinct animal species or variation occupying a particular habitat. The two ecotypes seldom interbreed, and although hybridization is possible, they seem to be too different to produce a large population of offspring. They prefer to form separate gene pools, and their offspring usually retain their genetic traits of shape and behavior. Although hybrids can be observed during breeding season, the two ecotypes definitely have distinct mating preferences.

According to the Theory of Evolution, the two ecotypes of stickleback should have merged into one new species; both their genes combining to make a stable hybrid. What makes these sticklebacks so interesting is that their breeding patterns contradict this theory; hybrid offspring *don't* seamlessly combine their parents' traits. Scientists believe that this is because hybrids are unable to survive without the correct adaptations for their environment. This means that even through interbreeding, the marine and freshwater ecotypes are preserved. This leads scientists to many different questions about evolution, such as what factors influence these consistencies.

Recently, the scientists at Tübingen have conducted a number of Whole Genome experiments on different stickleback populations. These experiments analyse 21 marine and freshwater genomes, or 10 pairs of interbreeding freshwater and marine fish. The results of the experiment: the majority of the freshwater sticklebacks were almost the same as those found in the ocean; consistent with the Evolutionary Theory. But genetic variations were found in the loci (genetic markers on chromosomes) of some of the more proximate ecotypes. In a way, this makes sense; it's Natural Selection at work, allowing the fish that are better adapted to survive to thrive and reproduce. But it also goes against the Theory of Evolution, as those loci should be the same as the other members of their species.

The experiments also found that about 35% of the differences between freshwater and marine ecotypes are primarily the result of parallel evolution (similar traits evolving independently of one another, starting with a common ancestor/condition). The same genetic mutations in freshwater ecotypes can be found in fish from BC and fish from Scotland; the same with marine sticklebacks. This means that these mutations had to have been carried by hybridization from population to population, possibly across the globe. Scientists also found that less than 2% of marine ecotypes carried freshwater-adaptive mutations. This shows that the stickleback populations have taken advantage of their neighbor’s adaptations; getting new, useful traits by interbreeding, instead of waiting for a mutation to occur genetically, which could take millions of years. In this way, stickleback communities can adapt to their environments in a fraction of the time it would take them to naturally.

Three-Spined sticklebacks have proven their seemingly unremarkable species to be one of many unexpected treasures. Their rapid adaptive radiation has given the scientific community a window into the molecular basis of speciation and adaptation. They provide accurate example of the lengths species will go to survive in new environments and continue to spread. Sticklebacks are such good models of these traits that scientists are developing a stickleback *genetic toolkit,* a collection of information meant to aid others in their research of these fish. Thanks to sticklebacks, scientists can see how a new adaptation directly affects the survival of an individual organism. The sticklebacks and their hybrid species have provided us with a new understanding of how evolution works.