The genetic basis for spine-length differences in sticklebacks

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Video Abstract

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Abstract

Understanding the genetic basis of physical traits has long been of interest to biologists. But uncovering the precise DNA changes that underlie changes in morphology is a difficult task. Now, a team of researchers has done just that in stickleback fish, shedding light on the evolution of morphological diversity found in naturally occurring species. Three-spine sticklebacks in marine environments typically have long dorsal spines that form part of their skeletal armor. Populations found in freshwater, however, often have much shorter spines or, in some cases, have lost these spines all-together. So what is the cause of this drastic morphological difference? To find out, a team of researchers in the US carried out a number of crosses and an in-depth genetic study of both freshwater and marine populations. By using fine-scale genetic mapping, the team was able to identify not only the chromosome regions with the biggest effects on spine length differences, but also one of the specific genes controlling dorsal spine reduction. They found that differences in spine length between marine and freshwater sticklebacks are likely the result of a single nucleotide change in this key developmental-control gene. Though it may not sound like much, this seemingly small change results in a new regulatory element which limits the function of the gene in freshwater populations and, in turn, reduces the spine length of these fish. Interestingly, the evolution of this trait appears not to have occurred through a change in amino acid sequence or gene expression levels but through a change in the ratio of normal and truncated proteins produced by alternative splicing. By unraveling the genetic basis of spine-length differences in sticklebacks, this study adds to a body of knowledge about how the evolution of physical traits occurs in nature. Evolution makes use of powerful developmental control genes to produce new traits in wild species. Even when these genes are essential for normal development, small adjustments can cause interesting changes in skeletal structures while preserving the overall development of the animal.