Genetic conflict in fish led to evolution of new sex chromosomes

October 1 2009

The female cichlid fish in Lake Malawi are generally drab and brown (top), making them inconspicuous to predators. Drs. Kocher and Roberts believe that the orange blotch color pattern (bottom) emerged as a new mutation in females, and has a selective advantage in providing an alternative form of camouflage. Credit: Reade Roberts University of Maryland

University of Maryland biologists have genetically mapped the sex chromosomes of several species of cichlid (pronounced "sick-lid") fish from Lake Malawi, East Africa, and identified a mechanism by which new sex chromosomes may evolve.

In research published in the journal *Science* (October 1, 2009), Professor Thomas D. Kocher, Department of Biology, College of Chemical and Life Sciences; Reade Roberts, post-doctoral associate; and Jennifer Ser,

research associate, describe the genetic basis for two co-existing systems of sexual determination in cichlid fish from Lake Malawi.

In nearly all mammals, the gene that determines the sex of offspring is located on the Y chromosome, which is much smaller than the X chromosome. But in many other animal groups, the genetic mechanism of sex determination evolves quite rapidly, and the differences between sex chromosomes are harder to observe. Even sister species of fish may have entirely different sex determination systems. How and why the genetic mechanisms for such an ancient developmental distinction continue to evolve has remained a mystery. The thousands of closely related cichlid fishes in the lakes of East Africa turn out to be an excellent model system for understanding how the mechanisms of how sex determination evolve.

The East African cichlid fishes that inhabit Lakes Malawi, Tanganyika, and Victoria are known for their sexually distinct appearance - the males are generally conspicuous and brightly colored, making them more attractive to females, while the females are drab and brown, making them inconspicuous to predators. One exception to the uniformly brown pigmentation among female cichlids is the "orange blotch" pattern, which appears in some female cichlids that live in rocky areas of Lake Malawi. "We believe that the orange blotch color pattern emerged as a new mutation in females and has a selective advantage in providing an alternative form of camouflage," says Dr. Kocher, who has been leading research to identify the genetic basis for phenotypic differences in cichlids for the past 20 years, and who made the first crosses to map the gene responsible for this color pattern in 1993.

The blotched color pattern is not beneficial for males, who must appear brightly colored to attract the greatest number of female mates (photo above shows normal male coloration at top and a fish expressing the blotched color pattern below). Credit: Reade Roberts, University of Maryland

Depending on the surrounding natural background, this color pattern can help disguise female fish and help them avoid predation. However males who express this phenotype lack the species-specific color patterns used by females to select their mates. "This phenotype creates a sexual conflict because the allele is favored in females but not favored in males," explains Dr. Roberts, who fine mapped the gene. "In 'survival of the fittest,' the genes underlying a beneficial trait will increase in frequency, but this is an odd case where the trait is really good for females but really bad for males."

Using genomic techniques, Roberts identified the gene (pax7) that is responsible for this difference in color pattern. He found that the orange blotch (OB) allele that produces the variable pigmentation in females was dominant over the "brown barred" (BB) allele (that produces the more common brown pigmentation) and that it was located very near a

female sex determiner (W). The genetic conflict that started over color was resolved by a new mutation that took over the sex determining function, and ensured that nearly all orange blotch fish are female.

"This study marries two evolutionary mysteries: the incredible diversity of fish in the lakes of East Africa and the genetic basis of sex determination," says Sam Scheiner, program director in the National Science Foundation (NSF)'s Division of Environmental Biology, which funded the research. "This study shows how simple genetic changes can lead to enormous biological diversity."

Source: University of Maryland (news : web)

Citation: Genetic conflict in fish led to evolution of new sex chromosomes (2009, October 1) retrieved 16 April 2024 from https://phys.org/news/2009-10-genetic-conflict-fish-evolution-sex.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.