Hybrid fish raised in nature have fewer 'mismatched' genes than those in lab

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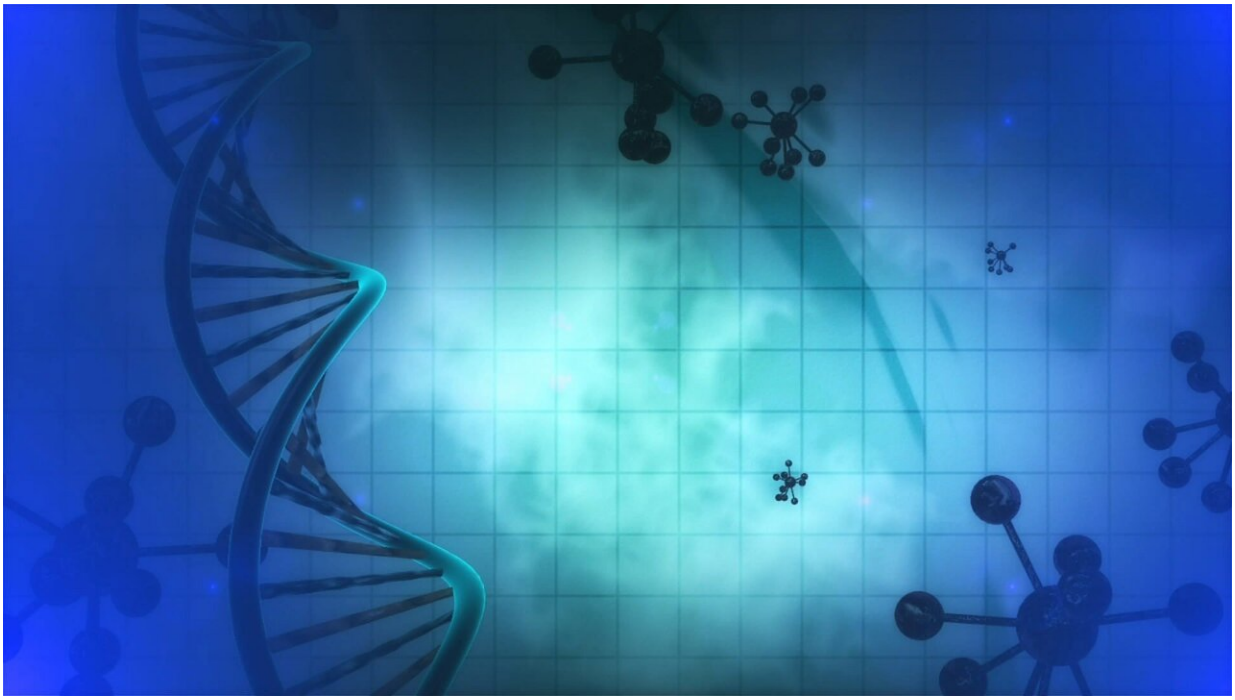

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You're likely familiar with the idea of the sterile mule: a hybrid animal born of a horse and a donkey that is unable to breed.

But what about a fertile mule whose teeth just aren't right for chewing the grass in its environment?

Hybrid animals are often infertile or inviable because their genes can be incompatible, a result of natural selection, where species adapt through evolution. These incompatibilities are a by-product of the genes that the parent populations used to adapt to their environments, and occur due to 'mismatched' genes that potentially affect things like cellular processes. These incompatibilities are an important mechanism in speciation, because instead of having different populations or species collapse into one larger population, they can instead remain distinct.

But research conducted at the University of British Columbia on hybrid threespine stickleback fish suggests that hybrid incompatibilities can be dependent on their environment, says lead author Dr. Ken Thompson, a doctoral student in the UBC department of zoology and Biodiversity Research Centre at the time of the study.

"Hybrid incompatibilities as a genetic mechanism, are almost always assumed to affect hybrid organisms in all of the habitats that they encounter," says Dr. Thompson, now a postdoctoral fellow at Stanford University's department of biology. "But some hybrids can be perfectly viable and fertile in the lab—it's only when subjected to ecological pressures, such as predators or foraging for food that they die off or don't mate as successfully as other fish."

Previous research has highlighted that there appears to be a 'mismatch' component to this ecological speciation, for example when some hybrid fish have mismatched jaw traits that reduce their ability to feed. What wasn't clear was whether the genetics of the 'ecological' mismatch were akin to the genetics of the 'intrinsic' mismatch that resulted in infertile or unviable individuals. "Although the genetics of 'intrinsic' incompatibilities have been relatively well-studied for decades, we knew almost nothing about the genetics of 'ecological' incompatibilities that only appear in particular environments. However, these ecological incompatibilities are likely to be quite common in nature" says co-author

Dr. Catherine Peichel, a professor at the Institute of Ecology and Evolution at the University of Bern.

Dr. Thompson and his colleagues compiled genetic data from experiments conducted at UBC between 2003 and 2013 of two types of hybrid threespine stickleback fish, where about 3,300 fish had been raised in large artificial ponds at UBC and 550 in a lab. The researchers found fish raised in the pond had a three percent higher heterozygosity, which indicates that they had a lower incidence of 'mismatched' genes. The researchers theorize that fish with 'mismatched' genes died off only in the ponds, leading to the surviving fish having greater average heterozygosity. In the lab, with no ecological pressures or influence, these 'mismatched' fish survived and heterozygosity did not differ from 50 percent, the expected amount under classical rules of genetics.

"This is the first paper to show that a genetic signature of hybrid incompatibilities—the death of individuals with more 'mismatched genes'—can be caused by ecology," says Dr. Thompson. "However, analyses of average 'ancestry heterozygosity' are very coarse, and further research is needed to identify exactly which genes and which traits are affected."

The research shows how theoretical predictions about selection on mismatched genes, for instance, ancestry heterozygosity, could be applied to real data from experiments, he says. "I think a lot of people will have this sort of genetic data available to them and perhaps they just never thought how they can use it to test predictions about hybrid incompatibilities."

"Analysis of ancestry heterozygosity suggests that hybrid incompatibilities in threespine stickleback are environment-dependent" is published in *PLOS Biology*.

More information: "Analysis of ancestry heterozygosity suggests that hybrid incompatibilities in threespine stickleback are environment-dependent" *PLOS Biology* (2022). journals.plos.org/plosbiology/ … journal.pbio.3001469

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