Rainbow trout genome sequenced

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Rainbow Trout (Oncorhynchus mykiss). Image: Knepp, Timothy - U.S. Fish and Wildlife Service

Using fish bred at Washington State University, an international team of researchers has mapped the genetic profile of the rainbow trout, a versatile salmonid whose relatively recent genetic history opens a window into how vertebrates evolve.

The 30-person team, led by Yann Guiguen of the French National Institute for Agricultural Research, reports its findings this week in *Nature Communications*.

The investigators focused on the rate at which genes have evolved since a rare genome doubling event occurred in the rainbow trout approximately 100 million years ago. Unlike most evolutionary processes involving mutations and the selection of advantageous traits, a doubling event acts like the copied draft of a piece of writing that can be edited and recast without the risk of destroying the earlier version.

Ordinarily, the consequences of such doubling events are lost to science as they get cast out as a result of genetic changes in subsequent generations. But because 100 million years is a relatively short time for doubling events, the trout researchers could in effect glimpse the fish's evolutionary editing process.

"In humans and most vertebrates the duplication events were older so there are fewer duplicated genes still present," said Gary Thorgaard, a co-author and WSU biologist with four decades of experience peering into the trout's genes. "Most of the duplicated genes get lost or modified so much that they are no longer recognizable as duplicates over time. In the trout and salmon we can see an earlier stage in the process and many duplicated genes are still present. "

The rainbow trout, Oncorhynchus mykiss, is one of life's great success stories. It has straddled the worlds of nature and nurture, naturally thriving in a range of temperatures and water quality while responding to domestication so well that it has been spread by human hand from the Pacific Rim to thrive in waters on six continents.

In Washington alone, state hatchery crews have stocked more than 16 million fish in lakes. The lowland-lake trout-fishing season opener, which takes place this year on April 26, draws some 300,000 people, making it the state's most popular outdoor sporting event.

Thorgaard, the only American on the largely French research team, provided genetic material from the Swanson line of rainbow trout. Originally from Alaska's Kenai Peninsula, the fish has been cloned at WSU, ensuring that researchers are looking at the same fish in successive studies and simplifying interpretation of its sequenced genes.

"Several studies had previously been done on the Swanson clonal line," said Thorgaard, "which helped in producing and interpreting the genome sequence in this study."

WSU research associate Joe Brunelli extracted DNA from fin tissue, using fish managed with several other lines by Paul Wheeler in the Pullman campus's indoor fish hatchery.

Guiguen and his colleagues used both the genome sequence and gene expression data from the

rainbow trout to show that roughly half of all protein coding genes have been deleted since its genetic doubling event. It has retained almost all its microRNA genes, which help regulate gene expression.

The researchers also found the fish retained original or nearly original genes involved in embryonic development and development of connections between nerve cells. The timing associated with these changes suggests gene evolution after an event such as this is a much slower process than previously thought.

"It seems that the rate of evolution can vary in different situations," said Thorgaard. "Some animals, like the lungfish and coelacanth, are 'living fossils' that have been around for hundreds of millions of years without changing very much. Others, like the polar bear, seem to have evolved quite recently. After the trout gene duplication, the process happened more slowly than it has in most other vertebrate animals, and we can still watch it going on."

More information: The rainbow trout genome provides novel insights into evolution after whole-genome duplication in vertebrates, *Nature Communications*, dx.doi.org/10.1038/ncomms4657

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