Geneticists discover hidden 'whole genome duplication' that may explain why some species survived mass extinctions

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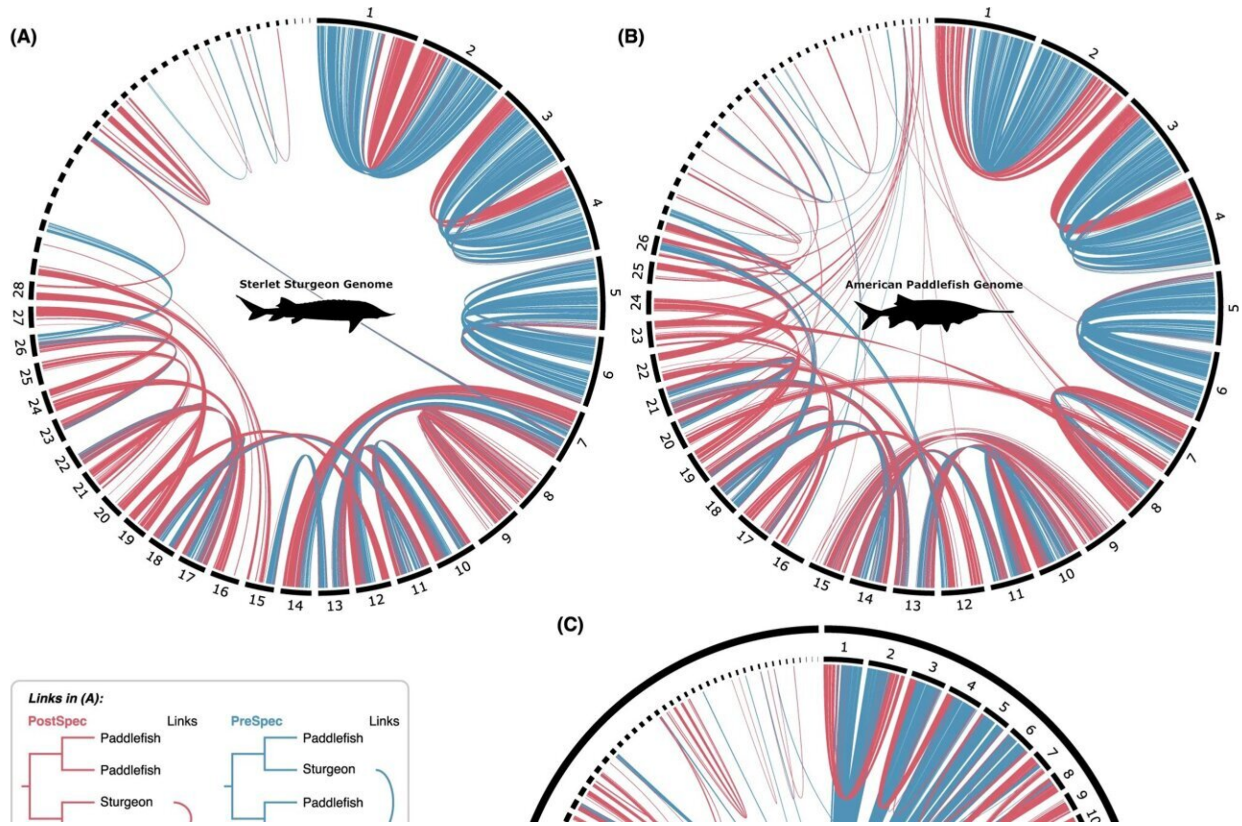

Synteny patterns of 'PreSpec' and 'PostSpec' ohnolog pairs in the paddlefish and sturgeon genomes. Circos plots of the sterlet sturgeon genome (**A**) and the American paddlefish genome (**B**) showing the chromosomal locations of ohnolog pairs, with links colored according to the PreSpec (blue) or PostSpec (red) tree topology. Microchromosomes 40 Mb from each species are labeled. Credit: *Nature Communications* (2023). DOI: 10.1038/s41467-023-38714-z

Geneticists have unearthed a major event in the ancient history of sturgeons and paddlefish that has significant implications for the way we understand evolution. They have pinpointed a previously hidden "whole genome duplication" (WGD) in the common ancestor of these species, which seemingly opened the door to genetic variations that may have conferred an advantage around the time of a major mass extinction some 200 million years ago.

The big-picture finding suggests that there may be many more overlooked, shared WGDs in other species before periods of extreme environmental upheaval throughout Earth's tumultuous history.

The research, led by Professor Aoife McLysaght and Dr. Anthony Redmond from Trinity College Dublin's School of Genetics and Microbiology, has just been published in *Nature Communications.*

Professor Aoife McLysaght said, "Whole genome duplication is exactly as it sounds—it's a fascinating evolutionary event where an entire genome is copied and pasted so that a species suddenly has twice the genetic material as it did before."

"Whereas most species, like us, are 'diploid'—having pairs of chromosomes, one from each parent—after whole genome duplication everything is in four copies. This effectively provides a lot of raw material for mutations—and evolution—to occur. Eventually, a species genome will revert to the typical pairs through a process called rediploidization."

"We've know about whole genome duplication and rediploidization for a long time but what is new, and exciting, is that we have shown that the time it takes for the second part of the process to complete is very important. In this case, it took a long, long time—so long that some gene duplications appear to be species-specific, occurring after the two species went their separate ways on the tree of life."

"As a result, the ancient original whole genome duplication that happened before the species had separated had been missed until now. We believe the same thing might have happened in many other species lineages and that is important given the possibility that it generated genomic conditions that helped the species survive mass extinctions."

Genetically, sturgeons and paddlefish show evidence of shared and non-shared gene duplications that were themselves derived from the ancient WGD, which, when timestamped to just over 250 million years ago places it just before the Permian-Triassic mass extinction that wiped out over half of the families of all living things.

This would seem to add more weight to the theory that WGD events provide species with more of an evolutionary canvas to work with; more genetic material means more capacity for variations over a given time, and that in turn increases the chance of some conferring an advantage to cope with difficult or changing environmental conditions. These would certainly have been in evidence during the period of rediploidization that overlapped with the Triassic-Jurassic mass extinction around 200 million years ago.

Dr. Anthony Redmond said, "Multiple whole genome duplication events famously occurred in our ancient early vertebrate ancestors and these have shaped the landscape of our modern human genome."

"Our findings are exciting because as well as shining a light on sturgeon and paddlefish genome evolution, they provide a comparative snapshot of how our early vertebrate ancestors genome and duplicated genes evolved after these doubling events."

More information: Anthony K. Redmond et al, Independent rediploidization masks shared whole genome duplication in the sturgeon-paddlefish ancestor, *Nature Communications* (2023). DOI: 10.1038/s41467-023-38714-z

Provided by Trinity College Dublin

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