naturhistorisches museum Basel archive des lebens

Press release

Basel, 05 October 2023

Explosion of biodiversity thanks to the recycling of genetic material

African cichlids reveal new insights into the origin of the species

What usually takes aeons happened in a relative flash in Lake Victoria: Over 500 new species evolved from three stem species of cichlids in just 16,000 years. A study published in the renowned journal *Science*, to which David Marques from the Natural History Museum Basel contributed, provides an explanation: This explosion in biodiversity is the result of the existing genetic material being repeatedly reshuffled.

Why do some species in the animal kingdom tend to speciate quickly while others do not? This was the question investigated by a team led by Ole Seehausen and Joana Meier from the Swiss Federal Institute of Aquatic Science and Technology (eawag) and the University of Bern, together with the Natural History Museum Basel. Their work focused on the cichlids of Lake Victoria, which are known for having formed new species the fastest and most extensively. In a recent study published in the scientific journal *Science*, the research team provide answers to how this could have happened.

It all started with a disaster

Towards the end of the last ice age, around 20,000 years ago, Lake Victoria in East Africa dried up. Only a few isolated wetlands remained from what was once the largest lake in Africa, now a large savannah. When the former lake basin refilled with water 16,000 years ago, its survivors returned: three lineages of cichlids from the lake's inflows and outflows, as well as from the Great Lakes of the East African Rift. When they repopulated Lake Victoria 16,000 years ago, they interbred. This mixed their genetic material. Again, because their common ancestor was itself a mixture between cichlid species from the upper reaches of the Congo and Nile 350,000 years earlier.

Genetic analysis throws light on what happened

To reconstruct the evolutionary history of cichlids in Lake Victoria, Joana Meier analysed over 460 genomes of East African cichlids for the new *Science* study. 288 genomes came from 120 species, representing all but one known cichlid genera and ecological roles in Lake Victoria. Genomes of other cichlid species from the African Great Lakes region were also included.
The analysis revealed new findings: The vast diversity of species is the result of repeated recycling of genetic material. Lake Victoria's current biodiversity did not immigrate from other lakes. Instead, it

Yvonne Barmettler | Head of Mediation & Communication
+41 61 266 55 32 | yvonne.barmettler@bs.ch

dates back to the interbreeding of the survivors from the lake's early day inhabitants 16,000 years ago. As a result of this reshuffling of genetic material found in the three stem species, about 500 new species have formed in this short period of time.

Recombination instead of random mutation

Although all cichlid species in Lake Victoria are closely related, they have become specialists in a wide variety of feeding styles and habitats, and occupy various ecological niches. The repeat fusion and splitting of species played a key role in this process. The mixing of large predators with small plankton feeders, for example, gave rise to a new way of life, that of dwarf predators, which include many species today. "This repeat fusion of species and splitting of species helped them conquer ever new, more extreme ecological niches," says David Marques from the Natural History Museum Basel and co-author of the study.

Genomic mixing did away with the wait for random, new mutations when adapting to new niches. "So many new, specialist species emerged very quickly," Marques explains.

Genomic recycling makes it possible

The repeated fusion and splitting (350,000 years ago between the Congo and Nile, by survivors after the dry season 16,000 years ago, and within Lake Victoria since then) explains why this lineage of cichlids became a master of rapid speciation. Not only in Lake Victoria, but also in the nearby African Great Lakes, the majority of fish diversity originates from the genomic recycling among these cichlids.

Publications:

Meier, J. I.; McGee, M. D.; Marques, D. A.; Mwaiko, S.; Kishe, M.; Wandera, S.; Neumann, D.; Mrosso, H.; Chapman, L. J.; Chapman, C. A.; Kaufman, L.; Taabu-Munyaho, A.; Wagner, C. E.; Bruggmann, R.; Excoffier, L.; Seehausen, O. (2023) Cycles of fusion and fission enabled rapid parallel adaptive radiations in African cichlids, Science Vol. 381, Issue 6665

Paper: https://doi.org/10.1126/science.ade2833

More information

Press contact

Yvonne Barmettler, Head of Mediation & Communication
yvonne.barmettler@bs.ch
Tel +41 61 266 55 32

Dr. David Marques, Curator of Vertebrates
david.marques@bs.ch
Tel +41 61 266 55 31