Long live Nemo! New animal model in aging research?

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Clownfish are the best-known representatives of the anemone fish genus (Amphiprion) and live in coral reefs in close symbiosis with sea anemones, which protect them from predators. Credit: K. Wagner / FLI

The colorful Clownfish lives longer than 20 years in the aquarium. Researchers of the Scuola Normale Superiore in Pisa, Italy, in collaboration with the Leibniz Institute on Aging (FLI) in Jena, Germany, have investigated the genetics behind the longevity of

clownfish. By sequencing the genome and comparing the sequences with other species, they were able to show, that the secret of this longevity lies in the mitochondria and lysosomes of the clownfish. Because it is uncomplicated to keep and breed clownfish, they represent an interesting new animal model for research on longevity. The results are now published in the journal *BMC Evolutionary Biology*.

Clownfish, famous because of the Disney movie "Finding Nemo," are a bright orange-white-black colored fish with three vertical stripes, which occur in the western Pacific and Indian Oceans. Clownfish live in symbiotic relationship with sea anemone. They are reliant on sea anemone for shelter in their natural habitat, which offer protection for the fish with its tentacles. The Clownfish's mucus protection prevents it from being stung by the tentacles of the sea anemone. Thanks to this survival strategy, clownfish have a lower mortality rate than other fishes and can grow quite old. Until now there was not much known about the lifespan of this interesting sea dweller.

Lifespan of Clownfish

Researchers of the Scuola Normale Superiore in Pisa, Italy in collaboration with colleagues of the Leibniz Institute on Aging (FLI) in Jena, Germany, conducted a survey to reveal the secrets behind the clownfish's longevity. "So far, it was not known how old clownfish can get. Therefore we surveyed public aquariums in Europe about the age of their oldest-living clownfish," says Prof. Alessandro Cellerino form the Scuola Normale Superiore in Pisa, Italy, and associated group leader at FLI in Jena, Germany. The results of this survey showed that the oldest clownfish (Amphiprion ocellaris) were more than 20 years old. Despite this old age, they were still able to regularly reproduce, suggesting that they were not approaching the end of their natural lifespan. But what is the secret behind this old age?

Evolution of Longevity

Lifespan of vertebrates can vary greatly, from a few months for the turquoise killifish Nothobranchius furzeri, to several centuries for the Greenland shark. Understanding of the "genetic architecture"—the way species differ genetically—can lead to new insights into the evolutionary mechanisms of lifespan and longevity. State-of-the-art sequencing methods have already provided genome sequences for a large number of species. The analysis of positive selection is particularly suitable for identifying the genetic architecture of specific characteristics, such as longevity, since all organisms are perfectly adapted to their habitat and these adaptations have arisen in the course of evolution. A frequently used method for detecting positive selection relies on the comparison of the sequence of protein-coding genes in related species.

To study the longevity of clownfish, the researchers conducted a sequence of analyses of the genome of clownfish (A. occelaris, A. percula und A. clarkii) in comparison to Chromis, the damselfish. The two species are very similar, but only clownfish have a symbiotic relationship with the sea anemone.

Modified Proteins – Indicator of Longevity

By comparing the sequenced genome of the two species, the research team found interesting differences in the proteins of mitochondria (widely known as the "powerhouse of cells") that generates energy for the cell, and the lysosomes, which degrade macromolecules inside the cell. "These proteins have significantly changed during the evolutionary history of the clownfish," explains Prof. Cellerino. The results have now been published in the Journal *BMC Evolutionary Biology*.

Previous studies already demonstrated differences in the composition of

mitochondria in short- and long-lived model organisms. These changes indicate that in the course of evolution specific pathways develop that lead to an exceptionally long or shortened life span. According to the results of this study, these differences arose in correspondence to the evolution of longevity in the Clownfish.

With a maximum life span of about 120 years, humans are extremely long-lived, but basic research on aging mostly relies on shorter-lived animal models. The present study shows that the relatively small Clownfish are a suitable animal model for research on longevity. They are among the easiest marine fish to keep in an aquarium and can be easily bred, hence they may represent an interesting animal model for research on aging and longevity.

More information: Arne Sahm et al. Analysis of the coding sequences of clownfish reveals molecular convergence in the evolution of lifespan, *BMC Evolutionary Biology* (2019). DOI: 10.1186/s12862-019-1409-0

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