

Dynamic Population Breeding Improves Turquoise Killifish Husbandry

The short lifespan of the turquoise killifish (*Nothobranchius furzeri*) makes it an important model organism for aging research. However, its husbandry and breeding present research institutions with challenges: The fish have a short lifespan and must be continuously bred, while at the same time their genetic diversity must be preserved. Researchers at the Leibniz Institute on Aging – Fritz Lipmann Institute (FLI) have therefore developed the Dynamic Population Breeding (DPB) method. This new breeding concept improves the survival rate of offspring, reduces differences between breeding cohorts, and thus creates an important foundation for reproducible and sustainable research on biological aging.

Jena. Originally from southeastern Africa, the Turquoise Killifish (*Nothobranchius furzeri*) lives in seasonal bodies of waters that form during the rainy season and disappear again during the dry season. The fish is highly adapted to this seasonal cycle: it completes its entire life cycle—from hatching through reproduction to natural death—within a few months. Its short lifespan makes it a valuable model organism for aging research, as processes that often take years in other vertebrates can be studied in killifish within a few weeks.

To survive longer dry periods, killifish embryos can enter a natural resting phase, known as diapause, and resume their development only months later under suitable environmental conditions. Embryos can remain viable within the egg for several years. After hatching, however, the fish age extremely rapidly. This unique biology makes the killifish an important model organism for aging research. Several aspects of human aging—including changes in the immune system, the brain, and reproductive function—can thus be studied using this short-lived vertebrate.

Researchers at the Leibniz Institute on Aging—Fritz Lipmann Institute (FLI) in Jena have now developed a new breeding strategy to improve the long-term management and husbandry of these animals, while strengthening the scientific validity of future studies in aging research. “The killifish’s short lifespan opens up unique opportunities to investigate fundamental questions about aging,” explains Dr. Beate Hoppe, head of the Animal Facility Fish at the FLI. “At the same time, it challenges us to maintain stable and reproducible fish populations across many generations so that they can be used by researchers.”

New breeding strategy

As there are no commercial suppliers for the killifish strains used at the FLI, all fish are bred in-house. The short generation time creates considerable challenges: Within just a couple of weeks, the fish develop from juveniles into sexually mature adults. These rapid generational cycles increase the risk of inbreeding, genetic drift, and unintended selection.

To address these challenges, Dr. Beate Hoppe’s team developed the Dynamic Population Breeding (DPB) method. This dynamic breeding concept combines multiple hatching events with overlapping breeding-age cohorts from different generations. In addition, the embryos’ natural capacity to enter diapause is utilized, allowing hatching times to be precisely controlled. This reduces dependence on individual large-scale breeding events and enables more flexible management of the colony.

Quality control supports stable populations and robust offspring

The study showed that the animals' reproductive performance declines with age. However, through regular monitoring of clutches and the targeted selection of suitable breeders, these age-related changes could be mitigated: higher-performing breeders were identified, and less suitable animals were excluded from the breeding program at an early stage.

"We interpret modern colony management as more than just caring for our animals," emphasizes Dr. Hoppe. "It not only forms the basis for reproducible research results but also plays a crucial role in limiting the number of laboratory animals needed to a minimum."

Offspring survival depends on embryonic developmental stage

Another focus of the study was the investigation of embryonic development. The results showed that the survival probability of the offspring is influenced not only by the hatching rate but also by the timing of hatching. Juveniles that hatched shortly after reaching the hatch-ready stage exhibited a higher survival rate than those that hatched at later times.

After implementing the DPB strategy, early-life survival improved significantly. At the same time, the variability between individual breeding cohorts decreased. Overall, the populations became more robust and easier to manage.

"Our goal is to combine the best possible conditions for animal welfare and research," explains the head of the animal facility. "With the new DPB strategy, we can improve both the quality of our animal populations and the long-term sustainability of the colony."

The new breeding strategy offers a practical solution for the long-term maintenance of short-lived model organisms. In the future, complementary methods such as cryopreservation could help to further safeguard genetic diversity. The results thus not only make an important contribution to the management of killifish colonies but also lay the foundation for reproducible findings in aging research.

Publication

Dynamic Population Breeding: A Structured Colony Management Strategy to Improve Reproductive Performance and Early Survival in *Nothobranchius furzeri*. Uta Naumann, Julia Hammerer, Clemens Peters, Simone Gruner, Martin Neumann, and Beate Hoppe. *Zebrafish*. 2026 Jun 12:15458547261460388. doi: 10.1177/15458547261460388.

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Originally from southeastern Africa, the Turquoise Killifish (*Nothobranchius furzeri*) lives in seasonal bodies of water and has adapted extremely well to the constant alternation between the rainy and dry seasons. It completes its entire life cycle—from hatching through reproduction to natural death—within a few months. (Photo: FLI / Nadine Grimm)



The short lifespan of the turquoise killifish makes it a valuable model organism for aging research, as processes that often take years in other vertebrates can be studied in this species within just a few weeks.

(Photo: FLI / Nadine Grimm)

Background

The Leibniz Institute on Aging - Fritz Lipmann Institute (FLI) in Jena is a federal and state government-funded research institute and member of the Leibniz Association (Leibniz-Gemeinschaft). FLI conducts internationally recognized, high-impact research on the biology of aging at the molecular, cellular, and systems levels. Scientists from around 40 countries investigate the mechanisms of aging to uncover its root causes and pave the way for strategies that promote healthy aging. Further information: www.leibniz-fli.de.

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They are subject to an independent evaluation procedure that is unparalleled in its transparency. Due to the importance of the institutions for the country as a whole, they are funded jointly by the Federation and the Länder, employing some 21,400 individuals, including 12,170 researchers. The entire budget of all the institutes is approximately 2,3 billion Euros. For more information: www.leibniz-gemeinschaft.de/en/.