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Gene for Sex Determination in Killifish Identified

“Phenofemales” Open New Perspectives for Research: Researchers at the Leibniz Institute on Aging – Fritz Lipmann Institute (FLI) in Jena, in collaboration with international partners, have made a significant breakthrough in killifish research. They identified a gene that determines the male sex in Nothobranchius furzeri. This gene, a Y-chromosomal version of gdf6 (gdf6Y), was described in the study “The master male sex determinant Gdf6Y of the turquoise killifish arose through allelic neofunctionalization”, recently published in the renowned journal Nature Communications. The study's first author is Dr. Annekatrin Richter.

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The African turquoise killifish, Nothobranchius furzeri, is an attractive model organism for aging research due to its short lifespan. Several years ago, the Jena researchers identified the region responsible for sex determination in this species. Now, they have conclusively demonstrated that the gdf6Y gene is expressed in specific cells of the developing testes and triggers male development—independently of germ cells. This discovery is particularly notable because it contrasts with the known mechanisms of sex determination in other fish species, such as zebrafish and medaka, where germ cells play a crucial role.

The Jena team also identified several genes as novel targets in the signaling pathways of the Gdf6 factor, expanding scientific understanding of the molecular basis of sex determination.

“Genetic sex determination by gdf6Y ensures an equal ratio of females to males in the population, regardless of environmental conditions,” explains Dr. Annekatrin Richter. This balance is vital for the species' survival since turquoise killifish can reproduce only during the rainy season in temporary ponds.

By deactivating the gene, researchers produced exclusively female animals, which were dubbed "phenofemales." These females are fully fertile and capable of reproduction. Conversely, when the gdf6Y gene was introduced into females, male-like individuals developed. “They look and behave like males but are not fertile,” explains Prof. Dr. Christoph Englert, research group leader. The incomplete sex reversal is likely due to experimental limitations, as gdf6Y was not active in all cells of the genetically modified animals.

This is not the first time Prof. Englert's research group has garnered attention by disabling a gene. Last year, Dr. Johannes Krug used CRISPR/Cas9 technology to create a transparent killifish named Klara. This innovation allows scientists working with this model organism to observe age-related processes in living organisms in real time.

Further Information:
The Leibniz Institute on Aging – Fritz Lipmann Institute (FLI) – upon its inauguration in 2004 – was the first German research organization dedicated to research on the process of aging. Around 350 employees from around 40 nations explore the molecular mechanisms underlying aging processes and age-associated diseases. For more information, please visit www.leibniz-fli.de.

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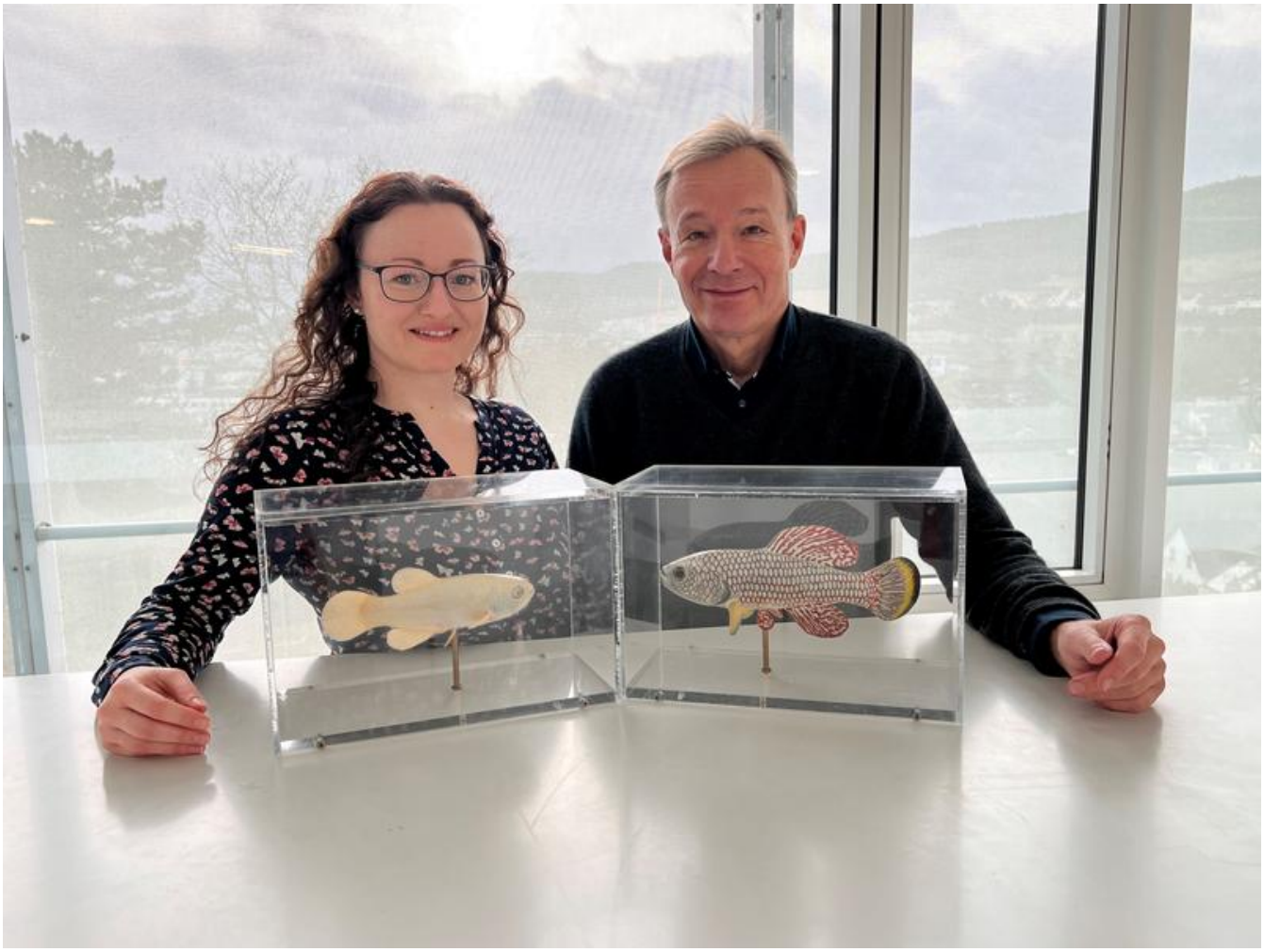
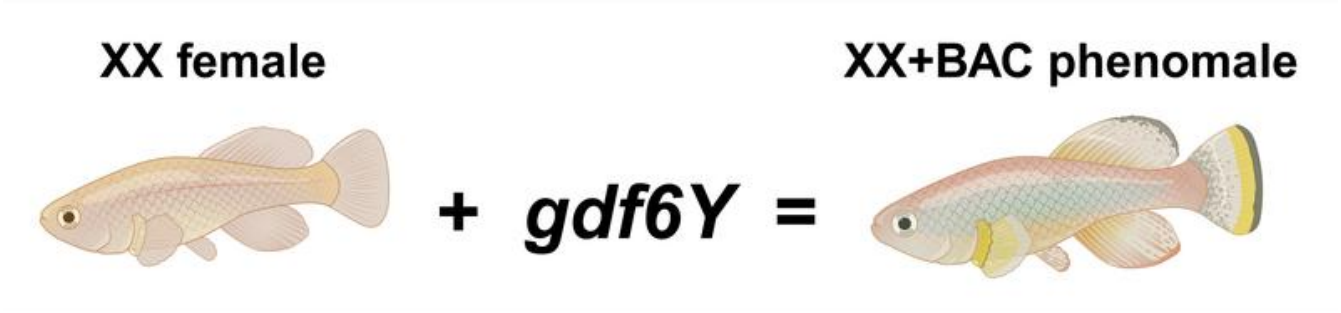
The master male sex determinant Gdf6Y of the turquoise killifish arose through allelic neofunctionalization. Richter, A., Mörl, H., Thielemann, M. et al. The master male sex determinant Gdf6Y of the turquoise killifish arose through allelic neofunctionalization. Nat Commun 16, 540 (2025). https://doi.org/10.1038/s41467-025-55899-7



Dr. Annekatrin Richter and Prof. Christoph Englert identified a gene that determines the male sex in Nothobranchius furzeri. (Photo: FLI)



Female killifish with XX sex chromosomes become phenotypic males (phenomales) in the presence of the sex-determining gene gdf6Y - here introduced with BAC. (Created with BioRender.com)