Antidepressant pollution is rewiring fish behavior and reproduction, biologists reveal

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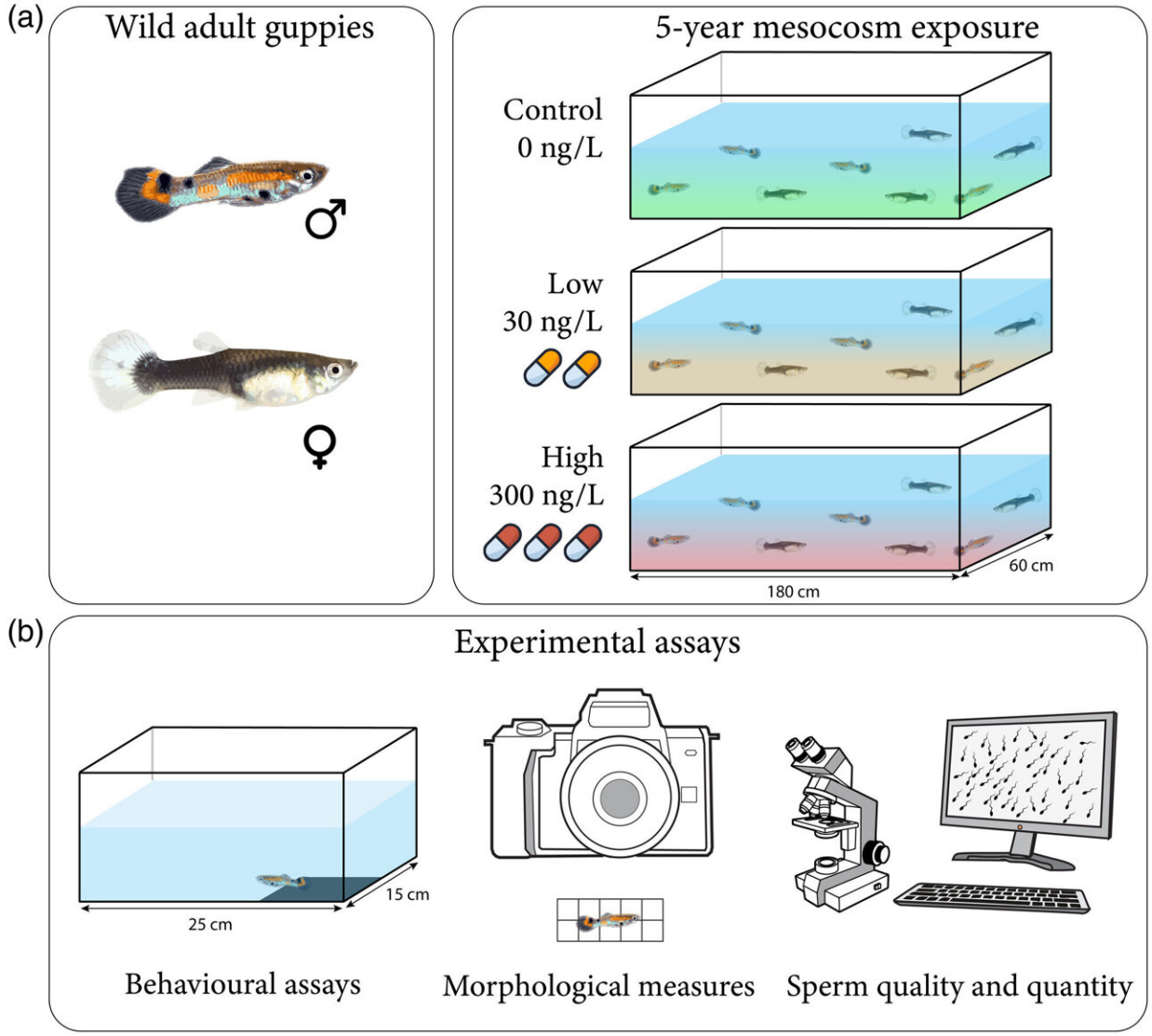

Schematic of the exposure protocol and experimental design. Credit: *Journal of Animal Ecology* (2024). DOI: 10.1111/1365-2656.14152

An international study led by biologists from Monash University and the University of Tuscia has revealed how long-term exposure to pharmaceutical pollutants is dramatically altering fish behavior, life history, and reproductive traits.

The five-year investigation, focusing on wild-caught guppies exposed to the widely prescribed antidepressant fluoxetine (Prozac), highlights the profound and interconnected effects of this pollutant on aquatic ecosystems.

The study, led by Dr. Upama Aich from the Monash University School of Biological Sciences and Assistant Professor Giovanni Polverino from the University of Tuscia, is published in the *Journal of Animal Ecology*.

Pharmaceutical pollutants, especially antidepressants like fluoxetine, have become a pervasive issue in water bodies worldwide. These pollutants, often introduced through wastewater discharge, persist at low levels in rivers, lakes, and oceans.

Despite their widespread presence, the full impact of these chemicals on aquatic wildlife, particularly on behavior and reproductive success, has remained unclear.

"Even at low concentrations, fluoxetine altered the guppies' body condition and increased the size of their gonopodium, while simultaneously reducing sperm velocity—an essential factor for reproductive success," said Dr. Aich, from the Monash University School of Biological Sciences.

"Fluoxetine exposure also significantly reduced the behavioral plasticity of guppies, leading to a lower capacity of the individuals to adjust their

own activity and risk-taking behaviors across contexts," said Assistant Professor Giovanni Polverino, from the University of Tuscia.

To explore the effects of antidepressant pollution, the research team exposed guppies to three environmentally relevant concentrations of fluoxetine over multiple generations. The team then meticulously tested fish behavior, physical condition, and reproductive health after five years of pollutant exposure.

Male guppies were the focus due to their heightened sensitivity to environmental shifts, particularly in traits tied to behavior, body condition, and reproduction. Researchers measured key life-history traits such as body condition, coloration, and gonopodium size (a modified anal fin used as a reproductive organ in males), along with critical sperm traits including vitality, number, and velocity.

Fluoxetine exposure disrupted the natural correlations between key traits. For instance, the expected link between activity levels and body condition, and between gonopodium size and sperm vitality, was altered. This disruption indicates that the pollutant is interfering with the natural trade-offs fish make between survival and reproduction.

The study reveals the extensive and nuanced impacts of pharmaceutical pollutants on aquatic life.

"The disruption of behavioral plasticity and the altered correlations between critical traits could undermine fish populations' ability to adapt to environmental challenges, threatening their long-term survival," said Professor Bob Wong, from the School of Biological Sciences and senior author of the study.

These findings emphasize the need for a more comprehensive approach to evaluating the ecological and evolutionary consequences of

pharmaceutical pollution. As human activities continue to introduce new pollutants into the environment, understanding their effects on wildlife is crucial for preserving biodiversity and ensuring the health of ecosystems.

This research offers vital insights into how chronic exposure to common pharmaceutical pollutants like fluoxetine can fundamentally alter the traits that fish rely on for survival and reproduction.

The findings highlight the need to address pharmaceutical pollution and implement stricter regulations to protect aquatic life from this threat.

More information: Upama Aich et al, Long-term effects of widespread pharmaceutical pollution on trade-offs between behavioural, life-history and reproductive traits in fish, *Journal of Animal Ecology* (2024). DOI: 10.1111/1365-2656.14152

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