Poeciliid Research

Predation-driven evolution of locomotor performance in guppies: Experimental evidence and field-based convergence

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Abstract. Predation is widely regarded as a major selective force shaping phenotypic evolution, yet direct experimental evidence linking predator-induced mortality to heritable changes in locomotor performance remains limited. This essay synthesizes recent experimental findings by Yang et al (2025), who used artificial selection to test whether adult predation could causally drive evolutionary change in critical swimming speed ($U_{(crit)}$) in guppies (*Poecilia reticulata* Peters, 1859), and places these results in the context of earlier field observations from Lake Pețea. By selectively breeding guppies based on survival in simulated predation trials, Yang et al (2025) demonstrated that predation can produce rapid, heritable increases in $U_{(crit)}$ in females, accompanied by reduced trait variance, consistent with strong directional selection. The absence of a comparable response in males suggests sex-specific selective constraints, potentially arising from trade-offs with sexual ornamentation or alternative behavioural strategies. Although laboratory conditions necessarily simplified ecological complexity, the results provide robust experimental support for predation as a driver of locomotor evolution. When interpreted alongside field data documenting the rapid loss of ornamental traits in feral guppy populations, the study offers a mechanistic explanation for the reversion toward wild-type morphology under natural predation regimes. Together, experimental and observational evidence converge on the conclusion that predation can swiftly reshape both performance traits and morphology, overriding traits favoured under artificial or captive selection within only a few generations.

Key words: experimental evolution, natural selection, ornamental traits, *Poecilia reticulata*, predation, sexual dimorphism, swimming performance, Ucrit.

A study conducted by Mingfang Yang, Hannah De Waele, Alexander Kotrschal and Arjan P. Palstra, all affiliated with Wageningen University & Research in the Netherlands, explored whether predation on adult guppies could directly drive evolutionary change in a key locomotor trait: critical swimming speed $U_{(crit)}$. Their aim was to determine experimentally, rather than infer from correlative field comparisons, whether predator-induced mortality was sufficient to produce heritable shifts in performance traits. By relying on artificial selection over several generations, the authors placed themselves in a position to test causality rather than association.

To address this question, they established guppy lines in which survival during simulated adult predation trials determined which individuals reproduced. Parallel control lines were maintained without exposure to predation. After several generations, the researchers measured $U_{(}crit_{)}$ in a standardized swim-tunnel apparatus, evaluating males and females separately. Their working hypothesis was straightforward: if predation acted as a strong selective agent, then predation-selected lines would exhibit higher $U_{(}crit_{)}$ values and reduced variance relative to controls.

The results supported this expectation, though in a sex-specific manner. Females from predation-selected lines displayed significantly higher average $U_{(crit)}$ than females from control lines, and they also showed reduced trait variance. This pattern was

consistent with directional selection removing slower individuals from the population, leading to a more uniform and higher-performing phenotype. In contrast, males did not exhibit a comparable increase in $U_{(crit)}$ under predation selection. This discrepancy required cautious interpretation: it suggested that males might have been subject to more complex or conflicting selective pressures, such as trade-offs imposed by sexual ornamentation or behavioural tactics that were not aligned with high sustained swimming performance.

Although the findings provided compelling experimental evidence that predation could drive rapid evolutionary change in female locomotor performance, they also carried limitations. The predation assays used in the laboratory simplified ecological reality; real predator-prey interactions involve multiple predator types, habitat structures and behavioural escape strategies. Moreover, the experiment focused on a single performance axis, leaving open whether predation would have acted similarly on burst speed, maneuverability or non-locomotor traits. The three generations of selection demonstrated heritable variation, but they did not reveal longer-term evolutionary dynamics or potential trade-offs with traits such as fecundity, ornamentation or metabolic cost. These considerations meant that, while the study documented an evolutionary response, it could not yet generalize the full eco-evolutionary consequences of predation in natural settings.

The conclusions of Yang et al (2025) aligned closely with our own earlier field observations from Mag et al (2009), conducted in the natural population from Lake Peţea at Băile 1 Mai. That population had originated from aquarium strains of ornamental guppies released into the wild, and we had documented a rapid decline in ornamental characters over time. Large caudal fins, vivid colour patterns and other traits favoured in captivity became increasingly rare, eventually disappearing almost entirely. The population progressively reacquired the streamlined morphology and muted coloration typical of wild guppies. At the time, we inferred that such ornamental traits were likely costly in natural habitats, particularly under predation.

Seen through the lens of the later findings from Yang et al (2025), our 2009 observations gain clearer mechanistic context. If ornamental morphologies impaired swimming performance or increased detectability, predation would have eliminated them rapidly, exactly the pattern we had documented. The experimental evidence that predation could increase $U_{(crit)}$ in females and reduce performance variance supports the idea that natural selection in the wild acts swiftly against morphologies shaped by artificial sexual selection in captivity. While our field observations preceded the laboratory study, both pointed toward the same evolutionary principle: once guppies transitioned from controlled aquarium conditions to natural ecosystems, the dominant selective forces shifted abruptly. Traits that were advantageous or merely tolerated in captivity became maladaptive, and natural selection favoured a return to the wild-type form. See also a similar study on *Poecilia sphenops* Valenciennes 1846 in Petrescu-Mag et al (2008).

In sum, the experiment conducted by Yang et al (2025) demonstrated experimentally what long-term field observations such as ours had already suggested: predation acted as a powerful, directionally consistent selective force capable of reshaping both performance traits and morphology within only a few generations. Their work provided the mechanistic link that helped explain why ornamental guppies released into Lake Peţea lost their exaggerated forms so quickly and why wild-type phenotypes re-emerged so reliably under natural ecological pressures.

Figure 1. The agile wild type body morphology of guppy male (upper position), a long tailed ornamental guppy male (in middle position), and a guppy female (in the last picture).

Conflict of Interest. The authors declare that there is no conflict of interest.

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