Digest

Digest: More than just a pretty fin: the evolution of sexual ornaments in killifish

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Footnote: This article corresponds to SOWERSBY, W., ECKERSTROM-LIEDHOLM, S., ROWINSKI, P. K., BALOGH, J., EILER, S., UPSTONE, J., GONZALEZ-VOYER, A. & ROGELL, B. 2021. The relative effects of pace of life-history and habitat characteristics on the evolution of sexual ornaments: A comparative assessment. *Evolution*. https://doi.org/10.1111/evo.14358

Abstract: What conditions favor the evolution of elaborate sexual ornaments? In freshwater killifishes, Sowersby et al. (2021) found that larger sexual ornaments were negatively associated with locomotive performance. While selection clearly favored large ornamental fins in environments with fewer predators, there was no clear association between large ornamental fins and differences in life-history strategy. This finding illustrates that habitat differences in predation risk have the potential to influence the evolution of secondary sexual traits such as ornaments through natural selection.

Main text: Sexual ornaments are known to come in many different shapes and sizes, but the reasons for these differences in morphology are less well understood (McCullough et al., 2016). Mating success (Andersson, 1982) and predation risk (Gadgil and Bossert, 1970) have been put forward as two of the primary evolutionary drivers of sexual ornaments in animals. In animals with sexual ornaments or conspicuous displays of courtship, mate choice (Suk, 2002) and competition for access to mates (Goldberg et al., 2019) appear to have strongly influenced the evolutionary divergence of sexual ornaments across species and taxa. Male killifish with larger ornamental fins are expected to have higher mating success, trading off with impaired locomotion and potentially a greater risk of predation. The potential for predation risk and differences in life-history strategy to drive evolution of sexual ornaments remains an underexplored topic. To that end, the killifishes (Suborder: Aplocheiloidei),

which exhibit significant differences in the pace of life-history (investment in current versus future reproduction) and habitat type (difference in predation risk), present an ideal model system to further explore this topic.

Competition for access to mates is widely known to influence the evolution of secondary sexual ornaments, increasing chances for mating success, at a potential cost to survival (Andersson, 1982). Secondary sexual traits therefore constitute an important investment into reproduction, with many either targets of inter- and/or intrasexual selection. In this study, Sowersby et al. (2021) predicted that predation risk and the pace of life-history will influence the evolution of secondary sexual traits in killifishes. Killifish species in ephemeral and low-predation risk environments with faster life histories should have larger male ornamental fins. To test these predictions, the authors assessed habitat type as a proxy for predation risk and the pace of life history across both sexes and several species of killifish. Using a macroevolutionary comparative framework, they measured swimming performance in 19 species (N = 259) and fin and body area in 28 species (N = 227) under a standardized common garden setting.

As predicted, they found negative associations for swimming performance (Fig. 1A) and risk of predation (Fig. 1B) with residual total fin area in killifishes. In addition, the authors found that the position of different fins on the body has a significant impact on swimming performance in killifish. This often-overlooked fact can explain the mixed or even contradictory findings of previous studies investigating the costs of secondary sexual traits. The authors also found that sexual dimorphism was greater in ephemeral habitats, where predation risk is lower, compared to both generalists and permanent habitats (Fig. 1C). In contrast, they found no clear evidence for the influence of different life history strategies (fast or slow) on ornamental fin size (Fig. 1D). However, and in accordance with prior studies, the authors note that this could be influenced by the subtle and often difficult-to-detect costs of bearing and maintaining sexual ornaments, rather than an effect of pace of life-history (Clark and Dudley, 2009, Narayan, 2021, Narayan and Wang, 2021).

The authors demonstrate that in killifish, the evolution of sexual dimorphism in ornament size is favored in ephemeral habitats , even at the cost of impaired locomotion, but not in permanent habitats, likely due to the higher risk of predation in these environments. They did not, however, find evidence for the co-evolution of male ornaments with pace of life-history. Possible limitations to this study include habitat as a proxy for predation risk, and

fluctuations in abiotic factors across different types of habitats, which may also influence ornamental fin evolution. Overall, this study by Sowersby et al. (2021) demonstrates that in killifish, predation risk more than the pace of life history influences the evolution of large sexual ornaments.

References

ANDERSSON, M. 1982. Sexual selection, natural selection and quality advertisement. *Biological Journal of the Linnean Society,* 17**,** 375-393.

CLARK, C. J. & DUDLEY, R. 2009. Flight costs of long, sexually selected tails in hummingbirds. *Proc Biol Sci,* 276**,** 2109-15.

GADGIL, M. & BOSSERT, W. H. 1970. Life Historical Consequences of Natural Selection. *The American Naturalist,* 104**,** 1-24.

GOLDBERG, D. L., LANDY, J. A., TRAVIS, J., SPRINGER, M. S. & REZNICK, D. N. 2019. In love and war: The morphometric and phylogenetic basis of ornamentation, and the evolution of male display behavior, in the livebearer genus Poecilia. *Evolution,* 73**,** 360-377.

MCCULLOUGH, E. L., MILLER, C. W. & EMLEN, D. J. 2016. Why Sexually Selected Weapons Are Not Ornaments. *Trends Ecol Evol,* 31**,** 742-751.

NARAYAN, V. P. 2021. Digest: Sexually selected weapons: Winning the fight, but losing the war for reproduction on a changing battlefield. *Evolution,* 75**,** 559-560.

NARAYAN, V. P. & WANG, Y. 2021. Digest: Does size matter? Condition-dependent sexual selection in *Drosophila melanogaster*. *Evolution,* 75**,** 2135-2136.

SOWERSBY, W., ECKERSTROM-LIEDHOLM, S., ROWINSKI, P. K., BALOGH, J., EILER, S., UPSTONE, J., GONZALEZ-VOYER, A. & ROGELL, B. 2021. The relative effects of pace of life-history and habitat characteristics on the evolution of sexual ornaments: A comparative assessment. *Evolution*. https://doi.org/10.1111/evo.14358

SUK, H. 2002. Females prefer males with larger first dorsal fins in the common freshwater goby. *Journal of Fish Biology,* 61**,** 899-914.