

# Genetic and plastic contributions to trait divergence between parapatric habitats: female life-history traits in threespine stickleback within the Misty Lake system

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## ABSTRACT

**Question:** How do genetic and plastic effects on maternal investment influence divergence between parapatric populations that do or do not show high gene flow? How might these patterns influence adaptation and progress towards ecological speciation?

**Organisms:** Wild-caught and laboratory-reared lake, inlet stream, and outlet stream three-spine stickleback (*Gasterosteus aculeatus*) from the Misty Lake system, northern Vancouver Island, British Columbia, Canada. In nature, the inlet–lake pair shows low gene flow, whereas the outlet–lake pair shows high gene flow.

**Methods:** Analysis of covariance was used to compare egg size (dry mass), clutch size (number of eggs = fecundity), and clutch mass (dry mass = reproductive effort) among habitats (lake, inlet, outlet) and between rearing environments (wild, laboratory). Body size was used as a covariate to consider life-history variation relative to body size.

**Results:** In the wild, inlet females had greater reproductive effort and higher fecundity than did lake females, both before and after correction for body size. Outlet females were intermediate but closer to lake females, and showed clines in life-history traits with distance from the lake. In the laboratory, differences in these traits were in a similar direction but smaller. Differences between habitats in reproductive effort and clutch size are thus shaped by complementary (co-gradient) contributions from genetic differences and plasticity. Egg size did not vary between the habitats and was not plastic.

**Conclusions:** Outlet females were estimated to have a 32–71% decline in reproductive output in the wild – but this maladaptation would have been greater in the absence of plasticity. These modifying effects of plasticity on maladaptation will influence gene flow and progress towards ecological speciation.

**Keywords:** ecological speciation, gene flow, parapatry, plasticity, stickleback.

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