

Environmental unpredictability and offspring size: conservative versus diversified bet-hedging

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ABSTRACT

Classic life-history theory and extensions thereof can readily explain variation in egg size among populations and individuals. However, most such models assume that there is some degree of predictability in offspring environment. Offspring provisioning when environments vary unpredictably is more problematic and may lead to bet-hedging (i.e. reducing variance in fitness). Bet-hedging may involve the production of fewer and larger offspring (conservative) or of variable-sized offspring (diversified). The use of diversified bet-hedging theory to explain within-clutch variation is common but controversial, and simulation models have shown that the fitness benefits of such variability depend critically on the shape of the egg size–offspring fitness curve. Here, we use one of the few empirically derived egg size–offspring fitness functions (from Atlantic salmon) in conjunction with simulations to examine the plausibility for the evolution of such bet-hedging strategies. We show that conservative bet-hedging can be a viable strategy for dealing with unpredictable environments, while diversified bet-hedging is rarely selectively advantageous (i.e. only under extremely variable environments), and then only for purely annual organisms. This is supported by empirical evidence from iteroparous Atlantic ($n = 37$ populations) and semelparous Pacific ($n = 26$ populations) salmon where less than 3% of the variation in egg size among wild fish is due to within-clutch variability. Only under novel (rare) rearing conditions, such as captive rearing to maturity in freshwater, was a significant increase in within-clutch variation observed. These patterns in conjunction with the modelling results indicate that within-clutch variation, at least in salmon, is more likely a reflection of the direct influences of the rearing environment on a female's ability to allocate resources evenly than of evolutionary adaptation. Future work in the area of egg size evolution in unpredictable environments may benefit from a stronger focus on conservative rather than diversified bet-hedging.

Keywords: environmental variation, life-history evolution, *Oncorhynchus*, physiological constraints, *Salmo salar*.

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