

100 INFLUENTIAL PAPERS – LONGER COMMENTARY

73 Stearns, S. C. (1989)

Trade-offs in life-history evolution. *Functional Ecology*, **3**, 259–268.

In this paper Stephen Stearns conceptualized the idea of correlated variation among traits, specifically when a beneficial change in one trait is linked to a detrimental change in another in relation to fitness gain. The idea of trade-offs is so powerful because in their absence, most traits would be bounded just by design or shared history. Thus, trade-offs open new opportunities for the evolution of phenotypic integration in complex anatomical structures or life-history variables.

Stearns advocated an integrative analysis of trade-offs, with measurement at the levels of both genotype and phenotype, and from individual (intra-individual) to population level (i.e., inter-generational trade-offs). A persistent challenge in the analysis of trade-offs is the distinction between immediate effects, i.e., those emerging from the genetic variance-covariance matrix, and past constraints, i.e., evolutionary trade-offs emerging from negative evolutionary covariance among traits within a specific radiation. Stearns proposed a theoretical framework to address these multiple levels of understanding. He provided an insightful analysis of the genotypic/phenotypic interface for trade-offs like age vs. size at maturity and reproductive investment vs survival, and then discussed specific methods for measurement and quantification. Given the pervasive influence of genotype x environment interactions it is surprising that we often still discuss trade-offs as invariant properties. In particular, extreme variation in the form and amount of trade-offs is expected along current environmental gradients, when individual trade-offs scale to population-level effects.

Population-level trade-offs, Stearns argued, differ qualitatively from trade-offs among functions within individuals. By dissecting the different levels at which trade-offs operate, Stearns offered insightful guidelines for future research. This important paper combines powerful insight for conceptual advances with methodological suggestions which have been extremely important in subsequent research on life-history evolution. We can

identify in the paper the germ for ideas that flourished in his book *The Evolution of Life Histories* (Oxford University Press, 1992).

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