Phenotypic integration of morphology and energetic performance under routine capacities: a study in the leaf-eared mouse phyllotis darwini

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Abstract

A major goal of evolutionary physiology is to understand the intrinsic and the extrinsic factors that impose limitations on an animal's energy budget. Although natural selection acts upon organismal traits such as performance (e.g., burst, sustained metabolic rates), from a mechanistic perspective, organismal performance results from the integrated functioning of different levels of biological organization. Hence, a better understanding of whole-animal performance must necessarily incorporate an explicit analysis of the integration between those different levels. Although this topic has been under intense scrutiny, overall there have been very few consistent patterns. Here, we explore the phenotypic integration between organ masses and the overall energy budget under routine capacities by statistically decomposing the covariance matrix (using path analysis and canonical correlation analysis) between organ masses and thermoregulatory burst and sustained metabolisms in cold acclimated individuals of Phyllotis darwini. Our results suggest that (a) central organs associated with the processing of food (cecum and liver), residuals (kidneys) and pumping of O2 (heart) are tightly integrated to sustained expenditure and between themselves; (b) with the exception of the heart, central energy supplying organs are weakly related to burst expenditures; (c) sustained and burst metabolisms refer to complete different strategies and (d) basal metabolic rate is not related to any of the physiological or morphological traits considered in this study. Overall, our results support the hypothesis of an economic phenotype: animals maintain their excess capacities to face those critical extreme events, but their physiology and internal morphology are tightly integrated to function under routine needs.

Keywords

Sustained metabolic rate, Basal metabolic rate, Maximum metabolic rate, Organ masses, Path analysis, Canonical correlation.