Body size scaling relations: are reserves responsible?

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The relationship between physiological rates and body size has challenged biologists for decades. Much debate has focused on the theory that universal, allometric (power law), inter-specific scaling relations are the consequence of minimizing transport costs in energy supply networks (e.g. West et al. 1997; Banavar et al. 2002). A recent theory of ontogenetic growth assumes that the same allometric scaling of physiological rates applies intra-specfically (West et al. 2001). Here, we contrast these ideas with a previous body of theory that also offers a unified representation of ontogenetic growth and inter-specific scaling relations (Kooijman 2000). That theory is based on a dynamic energy budget (DEB) model that describes assimilation, storage and utilization of energy by individual organisms. Inter-specific variation in growth and respiration rates is a consequence of reserve dynamics (not of any optimization requirement), and respiration rate is the sum of explicitly defined components. We show that interspecific variation in parameters describing individual growth and respiration rates from a wide range of species are equally well fitted by both theories. However, network optimization and DEB theory differ fundamentally in the role they assign to physiology versus evolution in determining body size scaling relations.

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