General enzyme-driven rule of metabolic scaling with body mass and evolution in organisms

Liyan Li[1] and Gen-Xuan Wang[2]

[1]Zhejiang University College of Agriculture and Biotechnology
[2]Zhejiang University

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Abstract

The origin and dynamics of the metabolic scaling is a fundamental problem in ecology. The famous power law was queried by the notable variations of the power exponent and the non-log-linear curvature of metabolic scaling. Here, we proposed a novel enzyme-driven model of metabolic scaling based on the hypothesis that the key enzyme constrained the relative rate of both metabolism and growth based on the basic biochemical evidences. The predictions were tested by the broad range of compiled database from prokaryotes to higher animals. The results showed that: (1) both metabolism (Q) and body mass (m) were increased with the rate-limiting enzyme activity exponentially, (2) both natural logarithmic metabolism (lnQ) and body mass (lnm) were limiting resource dependent, and (3) lnQ was lnm dependent, that is the non-log-linear scaling, when Q and m had the different half-saturation constant of substrate response (KQ [?] Km) and log-linear scaling when KQ = Km, which showed how and why the variation of scaling dynamics and the exponent. The results mean that the dynamics of metabolic scaling may be mainly originated from the enzymatic dynamics and the lnQ and lnm dependent model may be more general than the power law of metabolic scaling.

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