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研究综述与进展

WBE 模型及其在生态学中的应用：研究概述

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摘要 介绍了WBE模型，综述了该模型在生态学中的应用进展。WBE模型，以及以该模型为基础的MTE模型，假设生物体为自相似分形网络结构，提出代谢速率和个体大小之间存在3/4指数关系，分别预测了从个体到生物圈多个尺度上的生物属性之间的异速生长关系，而且部分得到了验证。WBE模型的应用涵盖了个体组织生物量、年生长率，种群密度和生态系统单位面积产量、能量流动率等多个方面；即使在生物圈大尺度上，WBE模型也可用来预测试验中无法直接测量的特征变量的属性，如全球碳储量的估算等。至今，关于WBE和MTE模型仍然存在各种褒贬争论，讨论焦点主要集中于模型建立的前提假设以及权度指数的预测。今后的研究工作应规范试验技术和方法，考虑物种多样性和环境等因素的影响，提出符合各类生物的模型结构体系，使其具有更广泛的应用性和预测性。

关键词 异速生长 _ WBE模型 _ 生态代谢理论 _ 权度指数 _ 个体大小

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Application of WBE model to ecology: a review

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Abstract This paper introduces the WBE model and reviews applications of the model to ecology. Provided that organisms are of a self-similar fractal-like network and their metabolic process follows laws of mass and energy conservation, and that energy distributes within organisms with least cost, West, Brown and Enquist（1997）proposed a 3/4 scaling relationship between metabolic rate and body size, i.e. the so called WBE model. Thereafter, based on WBE, Brown et al. developed the metabolic theory of ecology (MTE), which incorporated temperature effect on metabolism rate. The WBE and MTE models have been applied to hierarchic ecological systems from individual to biosphere level, and many scaling relationships based on the models have been predicted and confirmed. At individual level, WBE model predicts that the biomass fixed by leaves has a 3/4 scaling relationship with that fixed by root or stem. The annual growth rate of plant vegetative organs (leaf, stem and root) scales isometrically with respect to each other. Annual reproductive biomass of seed plants has a nonlinear logarithmic relationship with the biomass of leaf, root and stem. Growth rate and mortality rate scales as the -1/4-power of body size. At community level, there is a -1/3 scaling relationship between total standing biomass and population density, while annual community growth rate is irrelevant to population density. At ecosystem level, yield per unit area and energy flow rate have no relationship with individual biomass and increases with environmental temperature rising, namely the energetic equivalence rule (EER). Generally speaking, WBE model has been widely applied in physiological ecology, population ecology, community ecology and ecosystem ecology. Even for global change research, WBE model can be used to determine the parameters that can not be measured directly, for example, the estimation of global belowground carbon storage based on the scaling relationship between plant roots and aboveground parts. Up to now, there are still a lot of debate on the WBE and MTE model, generally focusing on the presumptions of the model and the predicted scaling exponents. This paper tries to show the val

ue of the model and also advances several suggestions for future work.

Key words allometric scaling _ WBE model _ metabolic theory of ecology _ scaling exponent _ body size

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