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综述与进展

森林生态系统发展和植物种群变化的热力学过程

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摘要 随着生态学的发展，人们对自然生态系统的认识逐渐从对自然现象的记录、描述，发展为对机制的系统认识。热力学定律为人们提供了认识系统发展规律的理论基础，但在生态系统中的应用还处于起步阶段。基于前人关于生态系统可用能的研究，探讨了森林生态系统和植物种群变化的热力学过程。在生态系统水平上，把可用能耗散分为了植物耗散和环境耗散两个部分，并探讨了这两个过程之间的关系。第一次明确地提出蒸散是植物耗散的主要部分。在植物种群水平上，“可用能储存”与“可用能耗散”是决定植物竞争力的关键因子，在同一区域相同条件下，拥有更大可用能耗散能力的物种应当被优先选择。因此，群落中的优势物种应当比同层次的伴生种具有相对高的生长速度和更强的蒸腾能力。研究试图在热力学理论体系与实际生态系统的生理生态过程之间建立了纽带和桥梁，为开展森林生态系统的健康评估、深刻认识植物与环境的关系、以及评价物种竞争能力提供新的理论视野。

关键词 能量耗散；可用能；热力学过程；生态系统

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Thermodynamic processes in the development of forest ecosystems and plant populations

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Abstract Thermodynamic theories lay out the foundations for system development, but have rarely been applied to studies of forest ecosystems. This article discussed the thermodynamic processes in the development of forest ecosystems and plant populations based on the exergy theories of ecosystems. We linked the exergy dissipation with the corresponding eco-physiological processes in the forest ecosystems. At the ecosystems level, we divided exergy dissipation into plant dissipation and environment dissipation, and analyzed the relationship between the two processes. We firstly elucidated that transpiration is the fraction of plant exergy dissipation and discussed how to use it to evaluate ecosystem development and plant competitive capacity. At the level of individual plants, we proposed that “exergy storage” and “exergy dissipation” are two important factors determining the outcomes of plant competition. Under the same physical conditions, species with high levels of dissipate energy have competitive advantages. Therefore, dominant species should have faster growth and transpiration rates than the non-dominant species occupying the same physical space. The thermodynamic theory provides a new means for the understanding of forest ecosystem development, assessment of ecosystem health, relationship between plant and environment, and outcomes of species competition.

Key words energy dissipation _ exergy _ thermodynamic process _ ecosystem

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