

城市绿地蝴蝶分类多样性和功能多样性的特征及其影响因素

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摘要:【目的】在城市化对全球生物多样性构成严重威胁的背景下, 城市绿地生物多样性及其影响因素已成为生物多样性保护的热门话题。然而, 大多数研究关注分类多样性, 而忽视了功能多样性。本文旨在洞悉城市绿地蝴蝶分类多样性变化的基础上, 结合功能多样性的分析, 进一步探究蝴蝶群落与城市绿地之间的关系。【方法】在安徽省合肥市的建成区选择了 80 个城市绿地, 进行了为期一年的蝴蝶采样和功能性状特征记录, 在洞悉蝴蝶多样性和功能性状特征差异的基础上, 通过广义线性回归模型、冗余分析和环境矩阵连接性状矩阵分析等方法, 探究了 9 个城市绿地的相关因素对蝴蝶分类多样性、功能多样性和功能特征的影响。【结果】为期一年的调查中, 共鉴定出隶属于 5 科 17 亚科 40 属 55 种, 共 4822 头蝴蝶。这些蝴蝶大多是中小体型、飞行时间长、多食性。公园绿地中蝴蝶的丰富度、Shannon、Simpson、功能丰富度和 Rao 的二次熵指数的平均值显著高于居住区绿地和街道绿地 ($P < 0.05$)。蜜源植物丰富度、绿地面积和与市中心的距离是影响蝴蝶分类多样性和功能多样性的重要因素。蝴蝶群落受到自发性蜜源植物和低强度管理的积极影响。绿地面积、蜜源植物丰富度、绿地内的水域面积、绿化率和形状指数与蝴蝶的功能特征密切相关。【结论】总的来说, 公园绿地中的蝴蝶分类多样性较高, 群落特征较丰富, 能为蝴蝶提供更加优良的栖息环境, 但部分居住区绿地和街头绿地展现出了对蝴蝶的保护潜力。与功能多样性指数相比, 分类多样性指数在不同绿地类型、区域和环路中表现出更显著的差异。然而, 功能多样性和物种性状所表现出的变化并不能完全从分类多样性中辨别出来。这意味着, 在探索城市绿地生物多样性的过程中, 对物种功能性状特征和功能多样性进行补充分析, 可以丰富仅从分类多样性获得的相对有限的结果。

关键词: 城市化; 城市绿地; 蝴蝶功能性状特征; 城市生物多样性; 影响因素

Characteristics of Taxonomic Diversity and Functional Diversity of Butterflies in Urban Green Spaces and Their Influencing Factors

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Abstract: 【Objective】 Under the background of urbanization posing a serious threat to global biodiversity, biodiversity of urban green space and its influencing factors have become a hot topic in biodiversity conservation. However, most studies focus on taxonomic diversity and neglect functional diversity. The purpose of this paper is to gain insight into the changes in the taxonomic diversity of butterflies in urban green spaces, and to further explore the relationship between butterfly communities and urban green spaces by combining the analysis of functional diversity. 【Methods】 Eighty urban green spaces in the built-up area of Hefei City, Anhui Province, China, were selected for butterfly sampling and recording of functional traits for one year. Based on the insight into the differences in butterfly diversity and functional tr

aits, the effects of nine factors related to urban green spaces on butterfly taxonomic diversity, functional diversity and functional traits were investigated by generalized linear regression models, redundancy analysis and environmental-matrix connected trait-matrix analysis. **【Results】** A total of 4,822 butterflies belonging to 5 families, 17 subfamilies, 40 genera and 55 species were identified during the one-year survey. Most were medium- and small-sized, with a long flying duration and were multivoltine. The mean values of butterfly abundance, Shannon, Simpson, functional richness and Rao's quadratic entropy index were significantly higher in the park green space than in the residential green space and street green space ($P < 0.05$). Nectar plant richness, plot area, and distance from the city center were significant factors influencing butterfly taxonomic and functional diversity. Butterfly communities were positively affected by spontaneous nectar production and low-intensity management. Area of plot, nectar plant richness, water area in sample plot, greening rate and shape index were strongly correlated with the functional characteristics of butterflies. **【Conclusion】** In general, park green spaces had higher taxonomic diversity and richer community characteristics, providing more excellent habitats for butterflies, but some residential green spaces and street green spaces showed potential for butterfly conservation. The taxonomic diversity index showed more significant differences across green space types, zones and rings than the functional diversity index. However, the functional diversity and the variation exhibited by species traits were not fully discernible from the taxonomic diversity. This implies that complementary analyses of species functional traits and functional diversity in exploring the biodiversity of urban green spaces could enrich the relatively limited results obtained from taxonomic diversity alone.

Keywords: urbanization; urban green spaces; butterfly functional traits; urban biodiversity; influencing factors