论文摘要

目 录

景观生态学与可持续性科学

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摘　要：世界城市人口已超过了农业人口，人类继续从“农业种”向“城市种”转变，全球生态系统中人为设计、规划和管理的成分日益增加。当今世界在生态、经济、社会及政治诸方面均可谓高度破碎化，从而导致了生物多样性减少，生态系统退化，经济发展不均衡，社会不稳定。这些问题是人类面临的前所未有的挑战 。 全球城市化使越来越多的自然生态系统被开发以容纳迅速增长的城市人口。 城市作为文化，经济，科学的中心对人类文明的进步起着重大作用，与此同时，城市也是许多环境问题的发源地。无疑，迅速增加的城市人口将加速资源消耗，以及人类生态足迹的扩张。为了实现可持续发展，人类活动就必须在局部、区域和全球尺度上进行合理规划景观，设计生态型城市。广而言之，整个地球可看作是一个景观，其空间配置与功能的协调是可持续发展的重要基础。景观生态学是研究和影响不同尺度上空间格局和生态过程关系的科学与艺术的整合。它对发展科学上合理，实践中可行的可持续性设计和规划原则起着重要作用。为什么呢？首先，人类所感知的景观（或区域）可被认为是研究可持续性的基本空间单元；第二，景观生态学提供了研究生物多样性与生态系统功能相互关系的一个多尺度，多学科交叉的生态学基础；第三，景观生态学已经发展了一系列整体论的、综合人文科学的方法以研究自然和社会耦合系统的结构和功能；第四，景观生态学可提供研究空间异质性对可持续性影响的一系列理论与方法；第五，景观生态学中的时空格局分析方法可用于将可持续性定量化的研究。第六，为了进一步发展各个尺度上的可持续设计和规划原则，景观生态学需要与景观建筑学，以及新兴的可持续科学相结合。可持续科学是一门新的跨学科科学，强调局部、区域、全球尺度上自然和社会的动态关系。可持续发展的核心是满足人类的基本需要，同时维持地球的生命支持系统，而发展可持续景观似为关键。

Landscape Ecology and Sustainability Science

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Abstract：As humans continue to transform themselves from a predominantly agrarian to an progressively more urban species, the world has become an increasingly planned and designed place. However, instead of improving the global environment, the increasingly designed and planned planet is met with an increasing number of problems. The world is highly fragmented ecologically, economically, and sociopolitically. This multifaceted fragmentation has resulted in accelerated biodiversity loss, ecosystem degradation, economic inequity, and social instability. These problems pose unprecedented challenges that humanity must deal with in order to sustain the biosphere and *Homo sapiens* itself. I see two important implications from the current trend with global urbanization. First, as more urban areas are developed to accommodate increasing urban populations, the world will become inevitably more "designed". Second, while cities have played an instrumental role in human civilization as centers of cultural, economic, and scientific endeavours, they also are a major source for myriad environmental problems. To achieve long-term sustainability, human activities must be constrained by sound planning and design principles at the local, regional, and even global scale. From this perspective, considering the world as a global "landscape" to emphasize the relationship between its spatial configuration and functionality is more fruitful.

Landscape ecology is the science and art of studying and influencing the relationship between spatial pattern and ecological processes on different scales. It is intuitive and logical that landscape ecology should play a critically important role in developing better design and planning principles for achieving sustainability on all scales. There are several reasons for this. First, the human landscape (or region) may be considered as *a* basic spatial unit for studying sustainability. Second, landscape ecology provides a hierarchical and integrative ecological basis for dealing with issues of biodiversity and ecosystem functioning. Third, landscape ecology has developed holistic and humanistic approaches to studying nature-society interactions. Fourth, landscape ecology offers theory and methods for studying the effects of spatial heterogeneity on sustainability. Fifth, to develop a rigorous science of sustainability, methods and metrics in landscape ecology can be used to quantify sustainability. Sixth, landscape ecology provides both methodological tools for dealing with scaling and uncertainty issues fundamental to most nature-society interactions. To help develop better design principles for sustainability on various scales, landscape ecology need to be integrated with landscape architecture and the emerging sustainability science which is a new transdisciplinary science that focuses on the dynamic relations between nature and society on local, regional, and global scales. The essence of sustainable development is to meet the fundamental human needs while conserving the life-support systems of the earth for future generations, and landscape ecology has much to offer to achieve this ultimate goal.

地理位置与海拔如何影响陆生脊椎动物的分布与丰度
——中国陆生脊椎动物多样性与气象因子的空间相关

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摘 要：中国东临太平洋，西邻干旱的亚洲腹地，高耸的青藏高原位于中国西南部。中国国土从南到北跨越49.52纬度(4.00-53.52 N)，从东到西，跨越61.42纬度(73.66- 135 08 E)。中国的海拔从最低点-154 米(吐鲁番盆地艾丁湖水平面)到最高点 8844.43 米(珠穆朗玛峰)，海拔跨度 8998.43 米。中国有丰富的气候类型、地貌和生物带。从南到北,主要植被类型有热带雨林、温带阔叶林、针叶林、草原。草甸主要发育在青藏高原。沼泽和水体则在上述植被类型中都有分布。干旱灌丛植被主要分布在西北地区。在动物地理区划中，中国横跨古北界和东洋界。中国具有丰富多样的动植物区系。一般地，陆生脊椎动物的多样性从海岸向内陆，从南到北递减，青藏高原的物种多样性低，在高原的腹地，没有两栖动物与爬行动物的分布。地理位置和海拔影响区域的气象因子如气压、气温、降水和太阳辐射。地理位置与海拔是如何影响陆生脊椎动物的分布与丰度的？我们分析了 686 座气象站从 1951 到 2005 年的气象资料（由于种种原因，有些气象站的记录时期短）。 我们还收集了 203 自然保护区的陆生脊椎动物的名录，包括两栖动物、爬行动物、鸟类和哺乳动物。自然保护区位于特定生物带，具有地带性的生态系统和代表性的动植物区系。自然保护区时自然保护的功能单元。利用 ArcView 的空间分析功能分析了陆生脊椎动物物种多样性与气象因子的空间相关。我们发现全国两栖动物与爬行动物物种数与一月平均最低气温、七月平均最高气温、全年日照小时数、年均相对湿度、年均降水和年均降水天数显著相关，而与年均气压无显著相关。爬行哺乳动物物种数与一月平均最低气温、全年日照小时数、年均降水、年均相对湿度和年均降水天数显著相关，而与七月平均最高气温和年均气压无显著相关。鸟类仅与年均相对湿度显著相关，与其它气象变量度无显著相关。中国分为季风区、高原区和干旱区。我们利用年均气压作为分类标准，将中国分为东部高气压区(绝大多地点的年均气压在 863-1027 hPa 范围内)、内陆中气压区(绝大多地点的年均气压在 783-907 hPa 范围内)和高原低气压区(年均气压在772-876 hPa范围内)。这三个气压带的边界与中国季风区、高原区和干旱区的边界大致重合。我们分别计算了这三个气压带陆生脊椎动物物种数与气象因子的空间相关，以检查这三个气压带陆生脊椎动物物种数与气象因子之间是否同样存在相似的空间相关关系。除了高原低气压区的两栖类以外，一月平均最低气温与两栖类与爬行类物种数目显著相关。一月平均最低气温与哺乳类物种数显著相关，但与鸟类物种数目无显著相关。一月平均最低气温仅仅与东部高气压区内两栖类与爬行类以及高原低气压区的哺乳类物种数目显著相关。除了东部高气压区的鸟类以外，三个气压带中两栖类、爬行类、鸟类和哺乳类物种数目都与年均日照时数显著相关。除了内陆中气压区的爬行类以外，三个气压带中两栖类、爬行类、鸟类和哺乳类物种数目都与年均湿度显著相关。此外，只有哺乳动物物种数目在东部高气压区和高原低气压区与年均气压显著相关。中国的地形深刻地影响了中国陆生脊椎动物，青藏高原的抬升导致了中国现代动物地理格局。在所有分析的气象因子中，一月平均最低气温、年均日照时数、年均湿度和年均气压式决定中国陆生脊椎动物分布的环境因子。相对而言，两栖类、爬行类更多地受到气候因子的作用，其次是陆生哺乳动物，而鸟类物种多样性受到气象环境的影响最小。因为在中国西部， 许多鸟类是季节性迁徙鸟类，尽管在沙漠或高原仍有零星分布的湿地为那些季节性迁徙鸟类提供了栖息地。

关键词：两栖类、爬行类、鸟类、哺乳动物、物种多样性、物种多度、地理信息系统

How do geographic location and altitude affect the animal species distribution and abundance: Spatial correlations between territorial vertebrate diversity and meteorological parameters in China

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Abstract：Within its boundary, China stretches some 49.52 (4.00-53.52 N) latitudinal degrees from the south to north and 61.42 (73.66- 135.08 E) longitude degrees from the east to the west。China borders with the arid heartland of Eurasia continent on its west and the Pacific Ocean on the east, the highest and youngest plateau in the world -- Qinghai-Tibetan Plateau is located on its southwest part. Altitude of China varies from -154m below the sea level (water table level of the Aiding Lake in Tulupan Basin, Xinjiang) to 8844.43 m above the sea level (Mt. Himalaya)，with a range of 8998.43m; China is a country with arrays of different types of climates, landscapes and biomes: from the south to the north, tropical rain forests, temperate broadleaved forests, conifer forests，steppes are main vegetation zones; meadows is mainly distributed on the plateau whereas arid shrub lands in arid areas in northwest. Swaps and water-bodies scattered in all above vegetations. Zoogeographically, China is a country that transects the Oriental Realm and the Paleoarctic Realm; the fauna and flora of the country presents a diverse pattern. General species richness patterns of territorial vertebrates in the country decrease from the coast zone toward the inland and from the south toward the north; however, the Qinghai-Tibetan Plateau has lowest species richness in its heartland where amphibians and reptiles are absent. Geographic locations and altitudes influence local meteorological parameters such as air pressure, temperature, rainfall and solar radiation. How do geographic location and topography impact on the terrestrial animal species distribution and abundance? We analyzed the spatial correlations of territorial vertebrate species distribution and abundance in China in relation to meteorological parameters which are influenced by geographic positions and altitudes. We collected the metrological records of 686 weather stations overall China, which have weather records form 1951 to 2005, through some of those meteorological stations in remote areas may have shorter recorded periods. We also collected the territorial vertebrate checklists, including those of amphibians, reptiles, birds and mammals, of 203 nature reserves in China. Nature reserve is located in a biome and normally has a regional characterized ecosystem, representative sectors of the national flora and fauna; furthermore a nature reserve is a functional unit of conservation. By using the Spatial Analyses function of ArcView, we found that species abundance of amphibian and reptiles in the country are significantly closely correlated with the Mean Minimum Temperature in January (MMTJ ºC), Mean Highest Temperature in July (MHTJ ºC), Mean Total Annual Sunshine Hour (TASH), Mean Annual Relative Moisture (MARM %), Mean

Annual Total Precipitation (MATP), Mean Annual Total Rainy Days (ATRD), Mean Annual Average Air Pressure (AAAP Pa). Species abundance of mammals in the country is significantly correlated with the MMTJ, TASH, MATP, ATRD, and ATRD, but is not significantly correlated with AAAP and MHTJ. Species abundance of birds in the country is only significantly correlated with MARM, but it is not significantly correlated with MMTJ, TASH, ATP, ATRD, AAAP and MHTJ. China is divided into three physical geographic zones: the Manson Zone, the Plateau Zone and the Arid Zone. We used the average air pressures as dividing criteria and divided China into three zones: Eastern High Air Pressure Zone (most of the areas with average air pressures between 863-1027 hPa), Inland Median Air Pressure Zone (most of the areas with average air pressures between 783-907 hPa) and Plateau Low Air Pressure Zone (areas with average air pressures between 772-876 hPa), the outlines of those three air pressure zones generally matched with those of the Manson Zone, the Plateau Zone and the Arid Zone. We check whether above spatial correlations between terrestrial vertebrates and meteorological parameters still hold in each zone. We found, MMTJ is closely correlated with the species abundance of amphibians and reptiles across the three zones, except the amphibians in the Plateau Low Air Pressure Zone. MMTJ is also significantly correlated with mammal abundance but not the abundance of birds across the three zones. MHTJ only significantly affected amphibians and reptiles in Eastern High Air Pressure Zone and mammal on the Plateau Low Air Pressure Zone. TASH significantly affects amphibians, reptiles, birds and mammals in all three zones. MARM significantly correlated with amphibians, reptiles, birds and mammals in all three zones except birds in the Eastern High Air Pressure Zone. MATP significantly correlated with amphibians, reptiles, birds and mammals in all three zones except birds and mammals in the Eastern High Air Pressure Zone. ATRD significantly correlated with amphibians, reptiles, birds and mammals in all three zones except reptiles in the Inland Median Air Pressure Zone. Only mammal species richness significantly correlated with AAAP in the Eastern High Air Pressure Zone and the Plateau Low Air Pressure Zone. Topography of China has a deep impact on the terrestrial vertebrates; the elevation of Qinghai-Tibetan plateau shaped the modern zoographical pattern in China. MMTJ, MASH, AMRM, MATP and AAAP are important environmental parameters which determine the territorial vertebrate species abundance in China. he species richness of Amphibians and reptiles appear more rely on the meteorological conditions, followed by the species richness of mammals, the species richness of birds turns out to be the least rely on meteorological conditions. In western China, many birds are seasonal migrants and even in deserts or on the plateau, there are scattered wetlands which provide seasonal habitats for migrant birds.

Keywords: Amphibians, Reptiles, Birds, Mammals, Species diversity, Species Richness, GIS.

半干旱黄土高原可持续生态系统设计原理与实践

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摘　要：通过分析半干旱黄土高原区域生态系统的特点，指出：这里地带性植被极度退化，土壤质量严重恶化，治理难度大，可持续发展受到严重威胁。然后，进行生态系统退化关键驱动力的分析，认为，在不同时期，农民的利益驱动始终是土地利用格局和生态系统演化退化的关键驱动力。在寻求分析退化生态系统修复的突破口时，认为提高作物产量和经济效益，解决农民的需求是具有可操作性的途径。而实现这一途径必须提高单产，以减轻更广大土地面积上的生产力需求压力。通过集水、覆盖等措施改善农田水分条件，再配合地膜、化肥，在对农田进行合理管理的情况下，粮食单产可获得持续大幅度的提高。在此基础上，提出了实现区域可持续发展的途径——集水型生态农业及其景观配置模式。在这一模式中，经济作物、粮食作物、人工草地和天然草地在一个完整的景观单元内合理配置，形成完整的景观复合生态系统。对这一模式的深入研究和正确实施将推动半干旱黄土高原退化生态系统的修复，并为西部开发中经济建设和生态建设并举提供理论与实践指导。

Ecological Design Principles and Practices for sustainable ecosystem management in the semiarid Loess Plateau

LI Fengmin

Abstract: The natural regional vegetation and soil quality in the semiarid Loess Plateau of China have been degraded extremely due to over-grazing and frequent reclamation of natural grassland. Functions of the ecosystems and regional sustainable development were seriously threatened. The analysis of the current ecological environmental situation suggests that transformation of natural vegetation to farm lands in the process of frequent reclamation of natural grassland results in water loss, soil erosion and land degradation. Repeated reclamation of wasteland due to the great pressure of food demand resulted from population grow this the key driving force to the degradation of these eco systems. To restore natural vegetation and soil quality, we have to find a way to meet the requirement of food for the local farmers in a small portion of the land to reduce the pressure of food product ion for the rest of the land of a region. In semiarid areas, many studies have shown that the key step for increasing grain yield per unit area is to imp rove field environmental conditions, including soil moisture supply, top soil temperature and soil nutrient level. This can be accomplished through the combination of water harvesting technology with plastic film mulching and fertilizer application, which can generally increase the unit grain yield twice o r mo re. Based on these technologies, we propose an app roach of water harvesting ecological agriculture (WHEA) and associated landscape configuration. Unit yield of cash and grain crops can be increased greatly through limited irrigation, and the irrigated crop land can be interspersed with improved pastures and restored natural vegetation in a continuous landscape (a typical hill) in WHEA. Further research and dissemination of WHEA can help supply local farmers with sufficient food and higher income. Various types of grasslands will replace cropland and cover a large proportion of the landscape; animal feeding will be mainly dependent upon pen feeding in order to decrease grazing pressure. These strategies closely follow the ecological patterns of natural vegetation and landscape, as well as the planning pat tern of regional industrial arrangement. The coexistence of multiple ecological and economic systems in a landscape helps to improve both biodiversity and industrial diversity, and enhance the flexibility and stability of these systems. Therefore, WHEA , an innovative approach for regional development, can lead to significantly improvement in both the restoration of degraded eco system s and regional sustainable development simultaneously in the semiarid Loess Plateau.

景观遗传学概论

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摘　要:景观遗传学是景观生态学和种群遗传学相结合而形成的一个新兴研究领域。其核心问题是，景观空间异质性如何影响种群的空间遗传结构以及种群的命运。景观遗传学从发现空间遗传格局入手，将这种格局与景观环境特征进行相关性分析，以达到理解两者之间相互关系的目的。由于繁殖体扩散的局限性而导致的种群遗传结构的距离隔离格局是分析空间遗传格局产生的时空过程的一个基本格局。很多研究表明，景观格局对遗传变异的空间分布具有重要作用。人类活动、自然干扰导致的景观格局改变，如生境破碎化，亦影响着空间遗传格局，对物种进化产生影响。本文将介绍景观遗传学的基本概念和研究方法，同时对一些常见的种群空间遗传格局和研究热点进行总结，旨在抛砖引玉，促进景观遗传学研究在中国的迅速发展。

An Introduction to Landscape Genetics

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Abstract: Landscape genetics is an emerging research field， resulting from the integration between landscape ecology and population genetics. Its key research question is how landscape heterogeneity affects the spatial genetic structures of populations. Landscape genetics starts with the identification of the spatial pattern of population genetic structure, and then relates it to relevant landscape structural attributes to understand the relationship between the patterns between landscape heterogeneity and population genetics. Genetic isolation by distance, due to limited dispersal, is a basic and important pattern landscape genetics, from which other more complicated spatial-temporal population genetic patterns can be analyzed. Numerous studies have shown that landscape structural attributes can significantly affect the spatial pattern of population genetics and thus the fate of populations in various landscapes. Landscape changes induced by human activities and natural disturbance, including habitat destruction and fragmentation, will undoubtedly lead to changes in the spatial genetic structure of native populations. To address such problems is critically important for better conserving biodiversity and managing ecosystems. This paper introduces the basic concepts, discusses major methods, and review some key research findings in landscape genetics. The primary purpose is, therefore, to stimulate the interests in landscape genetics among our colleagues, so as to promote its rapid development in China.

人类活动主导下陆地生态系统中氮素生物地球化学循环的改变

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摘　要：氮元素是所有生命有机体不可缺少的营养元素，又是生态系统中的经常性限制因子。人类活动造成年自然氮通量的倍增，从而大大增加了全球范围内有效氮素的含量。在任何地球生态系统中，氮素输入的增加会引发系统氮的积累，系统内氮循环机制的改变，以及液态氮与气态氮从系统的流失。氮循环的改变也会导致生态系统生产力与物质分解的改变，从而与碳循环互为影响。在城市生态系统中的研究表明，与已知自然生态系统不同，大量氮素可以生物可利用的无机氮形式存留于城市土壤中。在更多的情况下，大量的通过大气沉降的氮素输入会引发系统内氮循环的改变，包括硝化过程的增加，土壤硝态氮浓度的上升，氮淋溶及反硝化过程的增加。城市流域由于大量氮输入与氮存留能力下降的结合，往往造成河溪与地下水的氮污染。另一方面，如果氮素的增加能为植物有效地吸收，则人类引起的氮素输入可促进陆地生态系统中初级生产力的提高。目前研究表明土壤有机碳的组成与含量对于氮存留有很大作用，但碳-氮耦合机制仍有待深入研究。
恢复生态过程同时也是碳氮积累的过程。所以大力倡导森林与草原重建不仅有利于生物多样性的恢复以及经济效益的收获，也有助于生态系统碳氮的储存，土壤肥力的恢复，和当地水质的改善。

Alterations of nitrogen biogeochemical cycling in terrestrial ecosystems under the global dominance of human activities

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Abstract: Nitrogen (N) is an essential element for all biological organisms and is often a limiting factor in biological systems. Human activities have more than doubled the amount of reactive N annually entering the biosphere, and led to altered N biogeochemistry from local to global scales. In any earth ecosystem, elevated N input can increase N storage, alter N transformations and transfers within the system, and increase aqueous and gaseous N losses from the system. Altered N cycling can also interact with other biogeochemical changes such as altering C cycling by affecting both primary production and decomposition. Studies in urban ecosystems demonstrated that large quantity of inorganic N could be accumulated in soil, a phenomena rarely seen in any natural ecosystem. More often, increased N input through atmospheric deposition alters the process of N cycling, leads to increased nitrification, higher soil nitrate concentration, and higher leaching loss and denitrification. Urban watersheds which are receiving higher flux of N input but have reduced N retention capacity, often have higher N export in streams and groundwater recharges, polluting local and regional aquatic ecosystems. Higher N availability in terrestrial ecosystems can also lead to higher primary production, if excess N can be retained and is available to plants. Current researches suggested that organic C accumulation in soils could greatly affect N retention, yet the detailed mechanisms of C-N coupling remain unclear. Restoration process accompanies the accumulation of both C and N, consequently, would lead simultaneously to C sequestration, N retention, increase in soil fertility, improve in water quality, in addition to conserving biodiversity and bringing economic benefits to local community.

生态系统光合作用和呼吸作用：全球碳循环的关键过程

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摘　要：气候变化是近年来显现的全球环境问题, 危害着 21 世纪的自然生态系统和人类社会。气候变化主要源于人工排放的温室气体, 特别是燃烧化石能源所产生的 CO_2, 从而破坏生态系统和大气环境之间微妙的平衡关系。与人类排放的碳量相比(5-7 Pg C/y), 陆地生态系统和大气环境的碳交换(约 120 Pg C/y)要远大于人工排放。生态系统光合作用和呼吸作用是推动生态系统生产量和全球碳循环的关键过程。光合作用和呼吸作用的差值具有加剧或减缓气候变化的潜力。

植物光合作用固定太阳能并将 CO_2 和水份转换成碳水化合物, 从而为所有植物、动物和微生物提供能量。叶面水平的光合作用主要受光能和可利用的 CO_2 含量控制, 并受叶孔流通率调控。叶面水平的光合作用可以用远红外箱式系统来测量。 Farquhar 模型成功地模拟 C3 和 C4 植物的光合作用。生态系统毛初级生产量(GPP) 衡量生态系统中所有叶子光合作用的总合。目前还没有直接测量 GPP 的方法。

植物和微生物的呼吸作用分解碳水化合物并提供生长和维持所必需的能量。 植物呼吸作用(含叶子、树干和根系呼吸)主要受温度控制, 但是最新研究表明, 除环境要素的控制之外, 光合作用也能调控呼吸作用。土壤呼吸(含根系和微生物呼吸)主要受温度调控, 但在很多生态系统中土壤呼吸更多地受土壤湿度控制。植物呼吸和土壤呼吸可用箱式法来测量。生态系统呼吸量(R_{eco})是自养呼吸和异养呼吸之和。 呼吸作用的 Q_{10} 模型是一种经验模型。当前还没有基于过程的呼吸模型。

生态系统净生产量(NEP)是 GPP 和 R_{eco} 之差, 它能直接由新近开发的涡旋相关法来测量。NEP 是生态系统碳汇或碳源的衡量指标。全球分布的涡旋相关法测量站(Fluxnet)能够研究全球范围的 NEP、GPP 和 R_{eco} 的时间和空间的变化, 并支持和标定全球及区域的生态系统碳模型。

在全球尺度上, GPP 和 R_{eco} 随生态系统类型、年龄和环境因素变化而变化。但是我们对此的认识还很有限。为了深入理解陆地生态系统吸收碳的能力和未来趋势及气候变化对生态系统的影响, 我们应综合利用涡旋相关法、箱式法、生物量测量法和遥感测量法, 提高对光合作用和呼吸作用的认识, 并开发基于过程的生态系统动态模型。

Ecosystem photosynthesis and respiration: Key processes in global carbon cycling

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Abstract: Climate change is an emerging global environmental problem deteriorating both natural ecosystems and human society in the 21st century. Climate change is mainly induced by anthropogenic emissions of greenhouse gases, particularly CO_2 through combustion of fossil fuels, which destroys the delicate balance of carbon cycling between ecosystems and the atmosphere. Compared with human emissions of carbon (5-7 Pg C/year), the carbon exchange between terrestrial ecosystems and the atmosphere is much greater (approximately 120 Pg C/year). Ecosystem photosynthesis and respiration are key processes driving ecosystem production and global carbon cycling. The net difference of photosynthesis and respiration has a potential to either accelerate climate change or mitigate climate change.

Plant photosynthesis fixes sunlight and converts CO_2 and water into carbohydrate, and thus provides all the energy available to plants, animals, and microbes. Leaf-level photosynthesis is primarily limited by light and CO_2 availability, and regulated by stomatal conductance. Leaf-level photosynthesis can be measured by chamber-based infra-red gas analyzers. The Farquhar model successfully simulates leaf-level photosynthesis for both C3 and C4 plants. Gross primary production (GPP) integrates the sum of photosynthesis by all leaves in an ecosystem. Direct measurement of GPP is currently difficult.

Plant and microbial respiration decomposes carbohydrate and provides energy essential for growth and maintenance. Plant respiration (leaf, wood, and root respiration) is mainly controlled by temperature, but recent studies have shown photosynthesis regulates respiration in addition to environmental controls. Soil respiration (root and microbial respiration) is mainly controlled by soil temperature, but in many ecosystems soil respiration is controlled more by soil moisture than temperature. Plant respiration and soil respiration can be measured by chamber-based methods. Ecosystem respiration (R_{eco}) is the sum of autotrophic respiration and heterotrophic respiration. Q_{10}-type respiration models are empirical models to simulate respiration. Currently, there are no process-based respiration models.

Net ecosystem production (NEP), the difference between GPP and R_{eco}, can be directly measured by recently developed eddy covariance techniques. NEP is an indicator of carbon sink or source in an ecosystem. We can derive GPP and R_{eco} by interpreting eddy covariance flux measurement. The global deployment of eddy covariance flux measurement sites (Fluxnet) is to examine global variations of NEP, GPP, and R_{eco} among ecosystems and across time, and to support and validate global and regional ecosystem carbon models.

On the global scale, both GPP and R_{eco} vary among ecosystem type, age, and environmental conditions. But our knowledge in GPP and R_{eco} is still limited. To understand the capacity and future changes of terrestrial ecosystems to absorb carbon, and the impacts of climate change on ecosystems, we should combine the eddy covariance, chamber-based, biometric, and remote sensing methods, advance understanding of photosynthesis and respiration, and develop process-based ecosystem dynamic models.

当今景观生态学发展之纲要

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摘　要：景观生态学是生态学领域中，近二十年来引人注目的一门年轻学科，但还缺乏成熟、能广为接受的基本理论。我首先由逻辑角度，引入景观生态学中应当包含的主要内容，然后提出四点推动生态学完善的要点，和大家共商如何开创以检验科学假设的实验，为什么要强调多学科合作以及高新技术的应运。最后希望我们能携手合作，一同探索未来景观生态学的理论、原理及其在经营管理中的应运。

Landscape Ecology: Challenges

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Abstract: With a brief overview of landscape ecology in context of broader ecological science, I will highlight the process and major component of modern landscape ecology. More importantly, I provide my view of four major challenges facing ecologists aiming at advancing this young scientific discipline. They are: 1) developing innovative field and lab experiments for testing sound hypotheses; 2) engaging diverse scientific community and decision makers; 3) incorporating high technology into landscape ecology; and 4) advancing landscape ecology by developing sound theories, principles, and applications.

景观结构与生态过程

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摘　要：景观结构是景观中生态系统或土地利用类型的组成、数量、比例和空间配置；生态过程是景观中生态系统内部和不同生态系统之间物质、能量、信息的流动和迁移转化过程的总称，具体表现为特定景观中物理、化学和生物过程以及人类活动对这些过程的影响和响应。景观结构与生态过程之间的关系和作为地表综合体意义上的景观一样具有相当的复杂性，成为景观生态学研究的核心领域和主要方向。一般认为，景观结构是生态过程发生发展的环境背景，对生态过程具有影响和调控作用；另一方面，生态过程的持续作用能够推动景观结构的发展演变。然而，要明确景观结构和生态过程关系的性质，就必须首先确定具体的生态过程及其特征，并且景观结构与生态过程的关系随尺度的不同而变化，即具有尺度依赖性，所以尺度效应和尺度转换成为研究中的难点。从景观结构与土壤水分、景观结构与土壤养分、景观结构与土壤侵蚀、景观结构与流域可持续土地利用及生态恢复等方面系统讨论了景观结构与生态过程研究的现状和特征，指出：1)景观结构对土壤水分的影响涉及生态系统、坡面、小流域和区域等系列尺度，景观单元的数量比例和空间配置影响土壤水分的时空变异；2)景观对土壤养分的影响表现在景观的镶嵌格局影响土壤养分的分布和迁移，这种格局的变化可以引起土壤养分的变化；3)景观与土壤侵蚀关系密切，景观结构的改变能够减少或增加水土流失；4）在生态恢复过程中，景观结构及其生态系统特征会发生一系列变化，有助于景观生态水文功能的改善；5）尺度不同，景观结构与土壤侵蚀的作用机制不尽相同，多尺度土壤侵蚀评价指数的提出，将景观结构和其他相关因子置于统一的框架下，通过一定的尺度转换，形成对于解决不同尺度土壤侵蚀的评价、高风险区定位、系统诊断和基于景观结构调整的控制对策等问题都具有良好应用前景的方法。除了要强调深入研究具体生态过程与景观结构关系及其尺度变异性以外，还需要进一步注重大尺度和多尺度上的综合研究。

Landscape structure and ecological processes

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Abstract: Landscape structure refers to the composition and spatial configuration of the ecosystem or land use/cover types nested in a landscape. Ecological processes represent the flows and transformations of material, energy, information within and among the ecosystems or land use/cover types in a landscape. Thus, the physical, chemical and biological processes and the human impacts on and response to these processes are all relevant to the analysis of ecological processes in a broad perspective. The relationships between landscape structure and ecological process are at least as complex as the landscape itself as an integrative earth surface entity. Consequently, the researches on these relationships become one of the core fields and the main direction of landscape ecology. Generally, landscape structure influences and regulates ecological processes; on the other hand the landscape structure will change under the persistent functioning of ecological processes. To characterize these relationships, however, the ecological process and the pertinent spatiotemporal scale need to be defined at first because of the scale dependency of these relationships. Scale effects and scaling of these relationships are still big challenges in landscape ecological studies.

More specifically, the relationships between landscape structure and ecological processes were discussed from the perspectives of soil moisture, soil nutrient, soil erosion, sustainable land use and ecological rehabilitation. The spatiotemporal variation of soil moisture is influenced by landscape structure at a series of spatial scales including individual patch/ecosystem, hill slope, watershed, and region. The landscape mosaic influence the distribution and movement of soil nutrient, hence, soil nutrient changes with the change of landscape structure. Furthermore, the change of landscape structure can intensify or mitigate soil erosion. The landscape structure change and ecological succession during ecological rehabilitation can improve landscape hydro-ecological functions. The interaction mechanisms between landscape structure and soil erosion may vary with spatiotemporal scales. The multi-scale soil loss evaluation indices integrated landscape structure and other important factors and their scaling under the same theoretic framework. These indices are potentially useful for soil erosion diagnosis, risk assessment, and decision making on erosion control from hill slope to regional scales. Besides in-depth studies on the relationship between landscape structure and certain ecological process and its scaling effects, the integrative researches at large scale and across multiple scales need also be attached much importance.

全球沙尘暴气候与沙尘暴模拟

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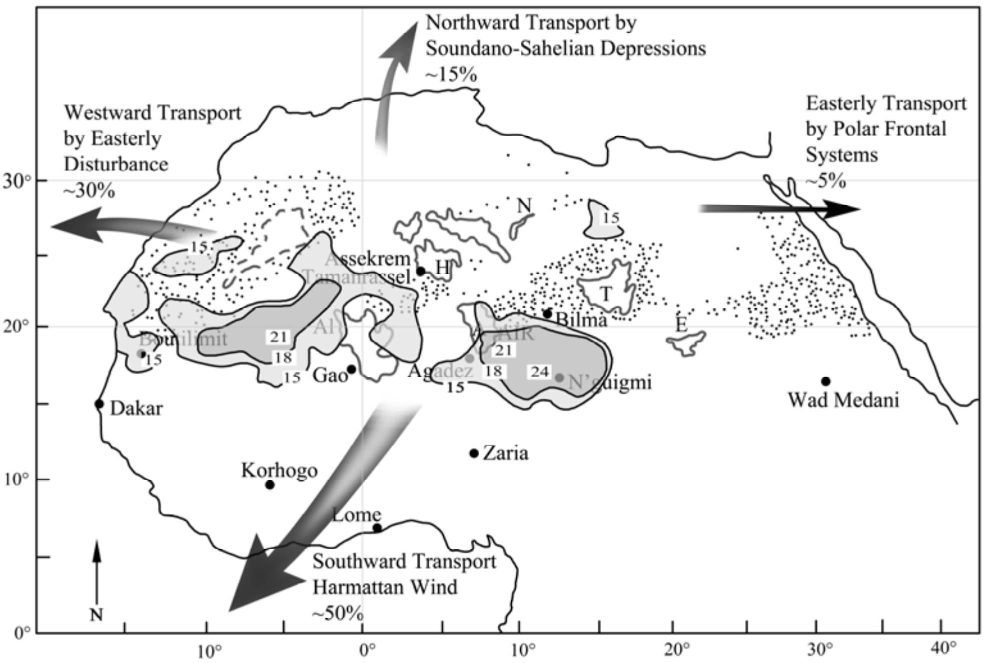
摘　要：北非，东北亚，南亚，中东和澳大利亚是全球主要的沙尘源地。在这些地区，沙尘暴频频发生，将大量沙尘卷入大气之中并将沙尘输送到很远的地方。沙尘暴的发生首先是一个地质与大气现象，但在一定程度上受到人类活动的影响，为了更好地理解中国的沙尘暴的实质，我们有必要在全球的沙尘暴气候背景之下来探讨他们。本文将首先概述全球沙尘暴的气候等征。1980 年之来，沙尘暴模拟有很大的发展。沙尘暴模拟的难点在于对起沙与沉降过程的参数化。这些物理机制复杂的过程涉及堵多环境因子，如土地类型与植背复盖。要克服这些困难，我们需要集成包括大气科学与生态科学在内的多学科的知识。本文将回顾与展望沙尘暴模拟的发展进程，并展视沙尘暴模拟的研究个例。



Global Dust Storm Climate and Dust Strom Modelling

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Abstract: North Africa, Northeast Asia, Southeast Asia, the Middle East and Australia are the most important dust sources to the global atmosphere. Severe dust storms often develop in these regions, which lift large quantities of dust particles into the atmosphere and transport them over thousands of kilometres. Dust storms are in the first instance a geological and climatologic phenomenon, but are influenced to some degree by human activities. To better understand the nature of dust storms in China, it is important to examine them in the context of global dust climatology and to compare the atmospheric and ecological conditions for dust storms in the various regions. In this talk, an overview of global dust climatology will be presented. Dust storm models have been under development since the 1980s. The most challenging problems for dust modelling lie in the parameterizations for dust emission and the deposition. These processes are complex and are influenced by a number of environmental factors, e.g., soil type and vegetation cover. To overcome these difficulties, it is necessary to integrate the knowledge from a wide range of disciplines, including atmospheric science and ecology. In this talk, a review on dust storm modelling and an outline of the challenges will be given. Examples of dust storm modelling will be shown.

湿地退化与恢复的科学前沿

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摘 要：湿地是介于陆地与开敞水域的生态系统和生态交错带。其基本特征是：（1）湿地以水的存在为基础，无论在地表，还是在植物的根区；并具有特殊的生物地球化学循环过程。（2）湿地的土壤条件不同于邻近的陆地和开敞水域，存在周期性的氧化与还原过程的交替变化。（3）湿地植被以适合于湿润环境的植物组成，但缺乏耐受洪水胁迫的植物。尽管湿地只占全球表面的 4－6%，但它在所有生态系统类型中具有最强大的生态、经济和社会服务功能。这些功能通过水资源保护、吸纳与净化污染物、提供天然产品和为珍稀濒危生物提供栖息生境等方面得以体现与表达。由于湿地是人类文明起源和延续的重要支持系统与环境基础，湿地的退化、保护与恢复是人类社会永恒的主题；尤其工业革命之后，湿地的保护与恢复成为我们面临的主要挑战之一。该文简要介绍了被长期忽略的湿地的基本特征，总结了湿地的退化与损失的现状及其肇因；重点剖析了 2004 年举办的第七届国际湿地会议、第 25 次湿地科学家学会会议和美国生态学会年会有关湿地的主题与论文分布；同时对近 5 年来发表在 Science、Nature 和 TREE 有关湿地的论文进行了解译。在此基础上，概括了湿地研究，尤其是退化与恢复研究的科学前沿，并提出我国湿地领域应该优先研究的主要方向。作为全球湿地系统中的重要国家之一，我国需要优先开展：（1）多因子协同作用下湿地退化机制及其复杂性，（2）生物入侵导致湿地退化的过程与机制，（3）食物网及功能群在湿地恢复中的重要性，（4）湿地生物地球化学循环，（5）全球变化与湿地变迁及其温室效应反馈以及（6）湿地恢复与重建的理论、技术与途径等研究工作。并且，在追踪世界科学前沿的同时，需要提高解决实际问题的能力，特别是：（1）湿地的退化机制，并考虑如何通过实验手段，区分人为干扰的直接作用和全球气候变化对湿地生态系统产生的影响；（2）破碎化后湿地斑块的管理与恢复；（3）构造湿地的物质循环和净污能力及其对全球变化的响应；（4）湿地恢复中功能群和大型水生植物作用的界定；（5） 湿地退化诊断与评价和（6）针对不同湿地的修复技术及其技术原理等领域的实际问题。

湿地的破坏、消失与复育

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摘　要：在一般大众的概念中，湿地指的是坐落于坡地与湖泊、河川之间的低洼地，每每是终年潮湿的，或是在地面上有浅浅的积水。然而现今在国际上对湿地的定义是更广泛的，湿地包含天然的或是人造的地区，只要平均至少每二年有一段时间其土地是潮湿的，并因而限制了能够在该处衍生的动植物物种，造成过半数的植物是湿地特有的物种，该处便可称为湿地。湿地也包括了浅水地区，只要是水深不超过二米，并有湿地特有的植物物种在该处生长，皆可称为湿地。现今全球估计约有一千二百八十万至五百三十万平方公里的地区为湿地。虽然在国际间，或各国国内，有许多协定和法令在保护着湿地，但是仍有超过半数的湿地已遭破坏，甚至是已经消失了，而仅剩的湿地仍面临着种种威胁。人类对湿地的破坏，最常见的是将湿地填平或将其水流乾，进而将其改成其他用途，像是改成为住宅区、农渔业用地、工厂、或是道路。特别是沿海地区，由于人口稠密，土地的需求量增加，许多沿海湿地都已被填平做为其他用途。湿地破坏的其他原因，更包括了水污染、海水倒灌、滥挖土石、外来物种的入侵、和全球气候的变迁。

随着人类对湿地的了解日益增加，人类已日益了解湿地对整体地球生态环境的重要性。每年湿地对整体地球生态环境的贡献，其价值估计高达一百三十亿美元以上。其功能包括湿地是许多湿地特有物种的衍生处，保存湿地便是延续生物多样性。湿地的消失会直接造成许多物种的灭绝。湿地另一个重要功能，是其能净化空气和水质，减低空气污染和水污染对生态环境所造成的损害。沿海湿地更加可减低像台风等天灾所引起的狂风巨浪所带来的灾害。

湿地的许多功能是无法取代的，而这些功能随同湿地也正在消失中，因此近年来湿地的复育成了一个新的热门课题。在全球各地积极的进行着，借湿地的复育计划重整受损的湿地，增加湿地面积，维护湿地的功能。

湿地复育需循序渐进，首先要确立明确的复育目标。接着必须仔细执行环境调查，详细了解该地的水文、水质、土质、地形、和动植物族群，根据这些资料来选择复育的方式和步骤。一份完善的方案和计划，必须送交有关单位审查。湿地复育计划一般来说都需经有关单位审核通过才可进行。有关单位常常会更进一步要求在计划完成后继续进行环境调查，借此了解复育计划的成效。

Wetland Destruction, Loss, and Restoration

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Abstract: Wetlands include both natural and human-made lands transitional between terrestrial and aquatic systems. Shallow and sometimes temporary or intermittent water is the primary factor controlling the environment and the associated plant and animal life. Wetlands are commonly referred to as swamps, marshes, bogs, fens, mangrove, meadow, etc. and can be found on every continent except Antarctica. The extent of the world's wetlands is generally thought to be from 5.3 to 12.8 million km^2, or about 3.6 to 8.6% of the land surface of the Earth. Although wetlands are considered a valued resource because they supply useful products and perform important functions, about 50% of the global wetland area has been lost mainly due to human activities. Despite the many laws and international agreements that have been initiated to protect wetlands, they are still being lost at an alarming rate and much of the remaining area suffers from degradation.

Common threats to wetlands include hydrological alteration, filling, peat mining, mineral and water extraction, plant and animal harvesting, water pollution, salinization, exotic species invasion, and climate change. As wetland area is lost or is degraded, functions provided by wetlands are also lost. Wetland ecosystems function to: 1.) support biodiversity, 2.) maintain air and water quality, 3.) recharge aquifers, and 4.) reduce flood/storm damage. These functions have been estimated to contribute up to 40% of global annual renewable ecosystem services with a value of $13 trillion per year. To reduce wetland degradation, and to recover lost wetland area and ecosystem services, wetland restoration-activities assisting wetland recovery from degradation, damage or destruction-has been implemented worldwide.

Wetland restoration projects are similar to phased experiments. First, it is crucial to identify restoration goal(s). Second, it is important to obtain a thorough understanding of the study site by conducting a detailed site survey. A wetland site survey typically includes sampling wetland hydrology, water chemistry, plant and animal communities, site topography, and soil profiles. Following a site survey, restoration strategies will be identified and planned in detail. In most cases, special permits are required to conduct a wetland restoration project. Pre-restoration communication with regulatory agencies is strongly recommended. Upon completion of restoration activities, post-restoration monitoring might be required by regulatory agencies for up to 5 years to assess results of restoration efforts. Although restoration might be able to reverse some wetland degradation, many damages, particularly to ecosystem functions, might not be reversible. Preventing wetlands from further destruction and degradation is essential to protecting wetland ecosystems and the critical functions and services that they provide.

南佛罗里达大沼地的生态复杂性：过程、机制与表形

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摘 要：生态学世界具有无限复杂性，而人们对于生态学问题和环境问题孜孜以求的恰是简单的描述和解答。如何简化复杂性，换言之，什么是简单与复杂的关系，是有趣亦有用的课题。在生态学研究中，什么样的过程决定和产生什么样的时空动态形式长期以来是一个主要关注重点。本文以南佛罗里达大沼地的研究为例，描述简单与复杂同过程与形式之间的关系、在这些研究中面临的挑战、和新的方法手段。首先，简单的过程可以产生简单的现象。在估量这种简单机制的时候，应该注意和消除隐含的复杂性所带来的误差。我们使用分位点回归方法估测了水深度对萨博角海边雀的影响。第二，简单的过程可以产生复杂的时空动态形式，例如多稳态、非连续性、和非可逆现象。我们使用了基于模型的统计学方法和多模型比较的方法来检验、发展、和选择关于附生藻同水磷含量的相互作用的假说。第三，简单的现象可以由复杂的过程和机制产生和维持。我们用模型结合野外实验发现强大的碎屑食物链可以提升植食食物链上的营养叠落效应。最后，复杂的过程可以产生复杂的现象。我用模型研究发现，环境因子和物候季节性波动通过影响营养相互关系，可以非线性地在不同营养层次中扩散和展现，产生波动幅度的抵消或者迭加和位相的错移，既有稳定又有激荡的作用。通过这些研究例子，本文说明为了发展预测性的生态学，我们需要新的多元模型和理论来准确地简化和描述复杂系统及其不确定性。

Ecological Complexity of the Everglades Wetlands: Processes and Patterns

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Abstract: Simple minds of humans necessitate simplification in ecological studies. Nevertheless, simplification is challenging, particularly in the studies of the mechanistic links of processes and patterns. This presentation uses the studies in the Everglades to show how simple or complex processes determine the simplicity and complexity in patterns, the challenges, and new approaches. First, simple processes can generate simple patterns. For example, abiotic environmental factors can set constraints on the abundance and distribution of populations. In the studies of these constraints, biological complexity is often hidden and unmeasured, nevertheless, can cause biases in quantification of these constraints. We used quantile regression to quantify hydrological constraints on the Cape Sable Seaside Sparrow, Ammodramus maritimus mirabilis, in order to avoid the biases that traditional statistical methods would bring about. Second, simple processes can generate complex patterns. For example, simple nonlinear processes can generate multiple steady states, threshold effects, and hysteresis. This occurs in the periphyton dominated freshwater slough ecosystem, because of a simple Grinnellian niche response to phosphorus and the phosphorus removal effect of periphyton. We used multiple model selection methods to evaluate the multiple steady states hypothesis. Often, relatively simple ecosystems show instable, unpredictable, and thus complex behaviors. Third, simple patterns may require complex mechanisms to generate and maintain, such as trophic cascades. We found an escalated trophic cascades exist in the grazer chain in a detritus-based food web, due to the hidden detrital energy shunt. Fourth, complex processes also can generate complex patterns. I proposed the nonlinear pulse transmission hypothesis: a trajectory trophic cascade may operate to influence the pulse transmission across trophic links in the marsh aquatic food web. The hydrological pulses and particularly dry-outs produce and maintain oscillations in producers and consumers, a significant detrital support to predators allows an escalated top-down control on herbivores, and the weak herbivory link disengaged primary producers from trickle-down of consumer oscillations. As a result, the hydrological pulses transmitted through the trajectories of primary producers, then offset, resonated, or intruded by trophic oscillations, to produce complicated patterns in primary consumers and predators. These case studies suggested that we need a meta-frame modeling approach with hierarchical and modular design and model-based statistics to simplify our conceptual framework, to characterize complexity, and to generate alternative models and hypotheses, to characterize uncertainty, and to develop predictive ecology.

稳定同位素分析在食物网生态学中的应用

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摘　要：食物网生态学是一门研究生态系统复杂的营养关系的学科，是进一步研究生态系统功能的基础。长期以来，我们有关食物网方面的知识都是通过食性分析，野外或实验室对动物摄食的直接观察而获得的。这些方法有时很难揭示食物网的能量来源和消费者之间的营养关系。 这是因为许多的营养关系是不可见的。 同时，食性分析不能确定究竟何种食物最终被动物利用和利用程度。 近年来，稳定同位素分析技术(d^{13}C和d^{15}N)已成为食物网生态学研究一种强有力的工具。 这项技术是建立在如下的假设上：(1) 来源不同的物质的稳定同位素天然丰度有明确区别；(2) 动物对食物的摄食和吸收不会造成显著的碳同位素分馏（0.5‰）；（3）动物的氮同位素值（d^{15}N）比其食物的氮同位素值平均高出 3.4‰。 因此，d^{13}C比率常被用于研究生态系统的能量来源，而d^{15}N则被用作食物链层次的示踪物。相对于食性分析而言，稳定同位素分析有如下几个优点：稳定同位素记录了动物吸收的物质，而不是仅仅是动物所吃的食物。稳定同位素同时记录了动物摄食的时空变化， 反映了动物的摄食历史。稳定同位素在食物网生态学中的应用包括追踪支持食物网的能源，食物网结构，食物链长度，营养位和同位素营养幅等。我将用研究实例来说明稳定同位素分析在食物网生态学研究中的应用。

Application of Stable Isotope Analysis in Food Web Ecology

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Abstract: Food web ecology depicts the complex trophic connections among producers and consumers in ecosystems and is the basis for the study of ecosystem function. Traditionally, our knowledge of food webs comes from dietary analysis, field and laboratory observations of animal feeding. These approaches may provide a poor understanding of the sources of energy and the trophic links among consumers because many trophic relationships are not visible. Furthermore, these methods only provide information on the food ingested by animals, the various sources of which are not necessarily assimilated or assimilated equally. Stable isotope analysis (SIA) of carbon ($d^{13}C$) and nitrogen ($d^{15}N$) has become a powerful tool for the studies of food web ecology in recent years. Food web research using SIA is based on three assumptions: (1) the organic carbon having different origins possesses a distinct stable carbon isotope signal; (2) there is little or no isotope fractionation of carbon (~0.5‰) during animal feeding, digestion and assimilation and (3) the stable nitrogen isotope ratio of the tissue of a consumer is enriched by 3.4‰, on average, relative to its diet. Therefore, the $d^{13}C$ is used to indicate carbon flow while the $d^{15}N$ is used to indicate the trophic position of consumers. There are several advantages of SIA over conventional analyses. First, stable isotopes provide a record of the food assimilated by consumers, rather than the food ingested. Second, stable isotopes integrate animal feeding over time and space, thereby providing insights into the trophic history of a consumer. Stable isotope analysis in food web ecology includes tracing the energy sources supporting the food webs, food web structure, food chain length，trophic position and isotopic niche width. I will use examples from my work and the literature to illustrate the applications of SIA to food web research.

稳定性氮同位素技术在研究生态系统过程中的应用

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摘　要：随着稳定性氮同位素技术的发展，测定微量样品或含氮量低的样品中氮同位素组成成为可能，因此以稳定性氮同位素自然丰度为基础的研究手段已广泛地应用于氮循环机理研究的各个领域。比如利用^{15}N丰度作为生物食谱的生物标记物，或在考古学中用来研究古代人类的食谱，检测绿色食品生产过程中工业氮肥的施用，到判定管理措施或干扰(比如施肥，耕作措施，大气污染)对不同生态系统内氮循环的影响。环境中^{15}N的丰度通常用$\delta^{15}N$ [$\delta^{15}N$=(样品^{15}N丰度 - 标准样^{15}N丰度)/标准样^{15}N丰度 x 1000]来表示。世界上通用的N的标准样为大气中的氮气，其原子^{15}N自然丰度是0.3663%。依据上述定义，大气的$\delta^{15}N$为零。^{15}N自然丰度在上述例子中的应用基于已广泛观察到的下列现象：^{15}N在食物链中的富集，^{15}N丰度在氮循环过程中的继承性，以及同位素的分馏作用。氮同位素分馏作用的产生是因为由轻同位素(^{14}N)组成的分子的化学反应速率比由重同位素(^{15}N)组成的分子的反应速率快，导致反应生成的产物中^{15}N的丰度比反应前的基质中低。同位素分馏的程度可以用分馏系数(α)来衡量。分馏系数是由^{14}N组成的分子的反应速率和由^{15}N组成的分子的反应速率相除得来。所以α值总是大于或等于1。在陆地生态系统中，硝化作用(α值1.015 - 1.035), 反硝化作用(α值1.020 - 1.033), 和氮的挥发(α值1.020 – 1.029)反应中氮同位素的分馏效应较大，而生物固氮，土壤有机氮矿化和植物对氮的吸收过程中氮同位素不产生或产生微小的分馏效应。在我们研究组里，我们成功地运用了^{15}N自然丰度技术检验关于生态系统中氮循环的多种假设。这些工作包括研究大气污染，土壤压实，灌溉，化肥氮和有机肥的施用，以及湿地排水对土壤和植物$\delta^{15}N$的变化。但是，正由于氮同位素的分馏作用可以造成土壤和植物体里$\delta^{15}N$朝相同或相反方向变化，$\delta^{15}N$技术目前还不能常规地用来定量氮素在生态系统中的循环过程。

The application of the nitrogen stable isotope technique in studying ecosystem processes

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Abstract: With the advancement of techniques for measuring stable N isotope compositions with small sample size and low N concentrations, the natural abundance N stable isotope technique has now been extensively used to understand the mechanisms for N cycling. Such applications range from using N stable isotope ratios [$\delta^{15}N$, calculated as (^{15}N atom% of sample – ^{15}N atom% of standard)/^{15}N atom% of standard × 1000, the standard for N is atmospheric N_2, which has an atom% of 0.3663% and by definition its $\delta^{15}N$ is 0‰] as a diet pattern biomarker of living organisms to archaeological studies of human diet, and from potentially detecting the use of inorganic fertilizers in an organic farming system to inferring N cycling processes under various management or disturbance regimes (such as fertilization, cultivation, air pollution) in different ecosystems. Those applications are based on widely observed enrichment of $\delta^{15}N$ up the food chain, the preservation of the stable isotope signature in the N cycling process, and the widely reported discrimination (or fractionation) of the isotope during some of the N cycling processes. Discrimination occurs because the rate of reaction of molecules bearing the lighter isotope is faster than those bearing the heavier isotope and as a result, the product of a reaction is depleted in the heavier N isotope (^{15}N). The degree of isotopic discrimination is measured by the isotope discrimination factor α ($\alpha=k_{14}/k_{15}$=the rate constant of molecules bearing ^{14}N/the rate constant of molecules bearing ^{15}N, $\alpha\geq1$). In terrestrial ecosystems, nitrification (α between 1.015 and 1.035, same below), denitrification (1.020~1.033) and ammonia volatilization (1.020~1.029) are known to cause large N isotope discriminations, while biological N fixation, ammonification, and plant N uptake cause little or no N discrimination. In our labs, we have successfully used the natural abundance ^{15}N technique to test hypotheses about N cycling in ecosystems, including investigations of air pollution, soil compaction, irrigation and inorganic N fertilization, manure application, and peatland drainage effects on $\delta^{15}N$ in plant and soil samples. We, however, cannot as yet to conveniently use this technique to quantitatively study the processes of N cycling, due exactly to the discriminations of the N isotopes that can have counteractive effects on the $\delta^{15}N$ signature in plant and soil samples.

内蒙古典型草原生态系统受损与恢复演替机理研究的进展

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摘 要：基于长达 20 余年对内蒙古典型草原受损生态系统恢复演替过程的监测所揭示的演替机理表明植物个体大小的变化在演替过程中起着重要作用——成为机理的重要环节。探讨草原生态系统演替过程上植物个体大小变化的机理则成为本项研究试图解决的问题之一。为此，本项研究通过分解放牧作用的实验确定家畜放牧中的践踏作用对导致植物个体小型化的作用显著。践踏导致的土壤形成紧实层，这个土壤层次已通过土壤剖面上的微形态分析所确定。土壤紧实层的存在势必导致群落生境与资源分配格局的变化。为此，就水资源的分配与可利用性诸方面追踪这一线索：研究了露水的量及其在典型草原中的作用，证明露水降水量很小，但对补充草原中夜间潜热释放导致的土壤水分丧失具有重要作用；降雨是草原获得水资源的最主要途径，群落受损后地表径流量相应增大，证明草原群落中的降雨首先被保存在地表大大小小的微地形小坑中，这些小坑能保证在中等强度的降水条件下不会形成地表径流；群落蒸散是草原中水分丧失的最重要途径，通过对群落蒸散的测定，确定已恢复群落中绝大多数的水分通过蒸腾逸入大气，而严重受损的群落更多地通过地表蒸发使水分离开群落。生境与资源的变化对植物个体大小变化而言只提供了条件，这种条件必然通过植物自身的响应才能体现出来，就这要求我们必须对植物进行研究，探讨植物如何改变自身的大小。于是，通过解剖植物的营养器官，分析植物组织中各类细胞的大小与多少来确定植物个体大小的变化导因于细胞大小的变化，抑或细胞多少的变化。初步的结果表明导致植物个体小型化的解剖学结果通常是细胞变小，但有时会出现细胞数量增加的现象。依据现有的生物学知识，内源激素通常是决定植物个体大小变化的调控者。本项研究证明：植物体内的细胞激动素和脱落酸对调控植物个体大小具有突出的作用。此外，还研究了植物根系在土壤中的分布及其与土壤紧实的关系，确定土壤紧实层的作用是导致植物根系分布变浅。

草原生态系统的演替过程实质上是植物群落在特定的作用下做出响应以实现自我维持的过程，其机理是通过诸多负反馈作用实现的负反馈调节。典型草原通过增加豆科植物和地木耳等固氮植物弥补过度放牧损失的氮素，通过强烈的灌丛化保藏草本植物的生殖个体，并缓解风力作用下的地表蚀积过程；而植物个体的小型化、硬化则是对过度放牧的最有效负反馈。

草原生态系统的恢复演替过程不可避免地出现植物种间相互作用现象，竞争对推动群落进一步演替具有重要作用。群落中各植物种群的空间分布格局可以确定各个演替阶段上种间竞争的效应。

Advance Research On Mechanism Of Succession In The Damaged Ecosystem Restoration In Typical Steppe, Inner Mongolia

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Abstract: The mechanism of succession in the damaged ecosystem restoration indicates that the change of plant individual size plays a important role and is the key points in the process of succession based on the monitoring the succession of the damaged ecosystem restoration more than 20 years in typical steppe. The research tries to answer the mechanism of change of plant individual size in the process of ecosystem succession in steppe. The trample by grazing livestock has remarkable effect on “miniaturization” of plant individual size through decompounding the graze experiment. Trampling on the soil leads to form the tight layer. This layer has been confirmed with analyzing the micro-configuration of the soil profile. The tight soil layer must cause the diversification of environment in community and partitioning pattern of resources. So, following the trail of this clue on the different factors effect on water resource portioning and bioavailability, we studied the quantity of the dew and its role in typical steppe firstly. Though the quantity of dew is very small, it has important function that can be supply the loses of soil water caused by the latent heat releases at night. Secondly, the rainfall is the main way that the steppe obtains the water resource. The surface runoff increase correspondingly after community damaged. We proved that the rainfall in community would be conserved firstly in the small holes of micro-topography on the soil surface. Those small holes can guarantee that will not form the surface runoff under the condition of the medium-sized intensity of precipitation. Finally, the community evapotranspiration is the most important way for losing water in steppe. Through analyzing the community evapotranspiration, we confirmed that the community lost most of water through transpiration in the restored community, while through evaporation from soil in the seriously damaged community.

The diversification in environment and resources provide the good conditions for the change of plant individual size. Those conditions could be embodied through the response of plant oneself. Then, analyzing the size and number of all kinds of cells in the plant tissues through anatomizing the nutrition organs of the plants, it confirmed the change of plant individual size caused by the change of cells size or number. The conclusion showed the anatomy results leading to “miniaturization” of plant individual size are cells smaller, but cells increasing sometimes. According to the existing biological knowledge, the endogenous hormone is usually the controlling the change of plant individual size. We have proved that the cell kinetin and abscisic acid in plants have the remarkable role on controlling the change of plant individual size. Furthermore, we have also studied the distribution of roots in soil and its relationship with the tightness of soil. The role of the tight layer of soil lead to the distribution of plant roots more shallow.

The succession in steppe ecosystem essentially is the response of plant community under special effects in order to carry out the maintenance by itself. Its mechanism is adjusting the negative feedbacks maintained by a good many effects of negative feedback. In typical steppe, it can be supply the loses of nitrogen caused by over graze through increasing the plants of nitrogen fixation, such as leguminous plants and *Nostoc commue*, and save the procreated herb plants and delay the soil erosion by wind through intense thicketization, and also the “miniaturization” of plant individual size and rigidification are the most effective negative feedback to over graze.

It can’ t be avoided that appear the interaction among kinds of the plants in the process of restoration succession in steppe ecosystem. Competition promotes the community success further. The space distribution pattern each plant population in community can be used to confirm the effect of the interspecific competition among every phase of succession.

中国北方草原与农牧交错带的可持续发展问题浅谈

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摘　要：中国北方草原的主体位于内蒙古自治区，它的北面与蒙古国的草原相连接，东面是中国黑龙江省和吉林省西部的松嫩平原草原，南面与冀北、晋北、陕北、宁夏和甘肃东部的草原相连，西边以贺兰山为界。草原区的北部是蒙古族为主的草原牧区，东部和南部是多民族聚居的农牧交错区。20 世纪 50 年代以来，由于牧区人口逐年增加、草场载畜量迅速加大，再加上草地资源的不合理利用，北方草原发生了大面积的退化，环境质量呈现显著下降的趋势，草原牧民的生产、生活方式发生了巨大的变化；与此同时，处于北方草原与农业区之间的农牧交错带的范围不断扩大，其生态脆弱性已经成为当地经济、社会发展的重要制约因素。

实现北方草原经济社会可持续发展应当遵循的一个基本原则是，在实施生态建设、环境保护的前提下，适度发展畜牧业，充分发挥草原生态系统的服务功能，主要措施包括：①实施草原保育与合理利用；②对已经发生退化的草场实施围栏封育，恢复植被结构和生产力；③对于已经发生沙化或盐碱化的草场，应当采取切实有效的措施加以改良；④在气候和土壤条件较好的区域建植人工草地，大幅度提高植被生产力；⑤推行划区轮牧和季节畜牧业，优化畜群结构，维持草畜平衡；⑤加强饲草应急储备库建设和牧草种子生产基地建设；⑥转移草原牧区超载人口，使严重受损的生态系统得到休养生息；⑦制定草原生态建设的财政优惠政策。

实现农牧交错带经济社会可持续发展的主要途径包括：①把人工饲草业-舍饲畜牧业放在经济发展的优先位置；②发展“绿色”农林牧产品精细加工业，建立多元化产业结构；③发挥能源和矿产资源优势，合理利用水资源，限制以破坏环境为代价的产业发展；④推广区域综合治理与生态恢复技术；⑤山、水、路、农、林、牧统一规划，实现生态系统在景观水平上的整合。

生物多样性信息管理与共享

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摘　要：在互联网时代，信息技术为海量数据的处理提供了空前的高效率的手段，将分散的分类学和生物多样性信息放到互连网上进行管理、交流、共享与合作已是大势所趋。一方面，各种多样性信息的管理、发布和利用已离不开网络。NCBI(The National Center for Biotechnology Information)、GBIF(Global Biodiversity Information Facility)、NPDC(National Plant Data Center) 等各种大型在线数据服务网站已成为各种层次上生物多样性信息保存、管理、传播和利用的主要媒介，虚拟标本馆（Virtual Herbarium） 正逐渐成为标本馆服务的重要部分，如AVH（Australia's Virtual Herbarium）。另一方面，随着信息量的快速增长，当前的生物多样性研究也离不开网络信息技术。整合了分子、细胞、解剖、化学等各方面证据的综合分类学（Integrative Taxonomy）正受到越来越多的关注。基于网络的物种志书修订也开始尝试。在线鉴定专家系统如植物方面的ETI（Expert Center for Taxonomic Identification）、动物方面如鸟类的BI（Bird Identification）、鱼类的FI（Fish Identification）已经出现。总之，网络信息技术已成为生物多样性研究必不可少的工具。

中国数字植物标本馆（Chinese Virtual Herbarium，CVH，http://www.cvh.org.cn/）是在科技部自然科技资源平台建设项目“标本数字化”资助建立的植物多样性信息的共享平台。主要包括：1）数字化的标本信息，目前有 210 万号标本的采集信息和鉴定信息已经上网，同时开发了植物标本集成检索系统（测试版）；2）电子植物志，包括《中国植物志》79 卷 125 册，《中国高等植物图鉴》7 册，《西藏植物志》5 卷，《青海植物志》4 卷，《秦岭植物志》3 卷 7 册，《四川植物志》16 卷和《海南植物志》4 卷；3）相关的数据库，如模式标本文献、植物名称作者、采集地新旧地名对照、植物鉴定和描述术语图解、植物分类学文献要览（1949-1990）、中国种子植物名称和分布、中国种子植物科属词典、植物彩色图库、电子检索表（被子植物裸子植物）、国家重点保护野生植物名录（I.II 批）以及国内外主要标本馆地址等 4）植物彩色图片库，目前有植物共 245 科 1486 属 3870 种，计 27731 张图片(http://www.cvh.ac.cn/gallery/)。在此基础上开发了基于 WEBGIS 的植物分布系统软件，可以根据 CVH 中标本的分布信息形成该种的分布图。为进一步开展中国植物区系地理研究提供了丰富的数据。

Biodiversity Information Management and Web-based Sharing

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Abstract: China is one of the mega-diversity countries worldwide. According to *Flora Reipublicae Popularis Sinicae*, there are 31142 plant species, 52% of which are endemic to China. In order to provide sound basis for plant conservation and sustainable use in China, we set up the Chinese Virtual Herbarium (CVH, http://www.cvh.org.cn). In the CVH, there are 4 major components, namely digitized specimens, plant database, e-floras and photos. From the digitized specimen module, you can find information for more than 2 million regular specimens and 3000 type specimens; For plant database module, a number of databases are ready for query, such as national plant checklist, botanical literature database, Chinese herbaria database and interactive keys; E-floras include *Flora Reipublicae Popularis Sinicae, Flora of China, Flora of Tibet, Flora of Qinghai, Flora of Qinling Mt., Flora of Sichuan and Flora of Hainan;* Over 27700 plant color photos were uploaded to CVH, which belong to 245 families 1486genera and 3870 species(http://www.cvh.ac.cn/gallery/). In addition, we also developed a searching engine for major international herbaria and related databases. From late 2006, we started to prepare a CD ROM for *Catalogue of Life China*. Now, we have the trial version and will complete the first version in late 2007, which will include a national checklist for higher plants, vertebrate and some fungi and bacteria.

生物多样性、密度、生物量与生产力的相互关系：演替的观点

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摘　要：常见的空间关系是否在时间上也同样存在？为了尝试回答该问题，本文将检测在空间上常见的密度-生物量-生产力-多样性之间关系是否也能在时间上出现。对长期监测数据和已有文献综合分析显示，当研究了完整的演替循环时，多样性、密度和生产力相互之间通常是正相关，但都与生物量呈单峰关系。这些关系与人们经常观测到的空间上格局相一致。关于这些因子指标之间是如何互相影响的空间相关性解释可能也可以用来解释时间上的格局。然而，所有这些群落指标同时随着物理因子和时间而改变，我们需要通过实验来验证它们之间真正的 因果关系。

Interactive effects of diversity, density and biomass on productivity: insights from succession

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Abstract: Do commonly observed spatial relationships also exist over time? As an example of attempting to answer this question, this article examines whether the frequently observed density-biomass-productivity-diversity relationships over space can also be seen over time. Syntheses of long-term data and literature show that when the full successional cycles are examined, diversity, density, and productivity are usually positively related to each other but unimodally related to biomass. These relations are consistent with frequently observed patterns over space. The explanations proposed for the spatial relationships regarding how these variables affect each other may also apply to the temporal patterns. However, as these community variables are temporally correlated and change simultaneously with physical factors and with time, identifying any causal relationships among them need experimental confirmation.

内蒙古草原 AM 真菌多样性的季节动态变化及其对不同草地管理的响应

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摘　要：丛枝菌根(Arbuscular mycorrhiza, AM)真菌广泛分布于草地生态系统中，并与约 84%的草原植物形成互惠共生体，因此，AM 真菌在草地生态系统演替过程中发挥重要的生态功能。内蒙古草原处于干旱和半干旱地区，是我国最大的草原(面积约 791,000 km2)，具有非常重要的生态意义和经济价值。通过对本地区 AM 真菌多样性季节动态变化及其对放牧、增温、降雨等不同草地处理的响应研究，为草原生态系统的演替和恢复提供理论基础。

AM 真菌的季节动态变化：在锡林郭勒草原定位站的大针茅固定样地内选择 5 种常见植物(大针茅、羊草、冰草、糙隐子草、知母)，每种植物建立 10 个 1m × 1m 的固定样方，在植物生长季节(5-10 月)内每月取 1 次样，进行植物根系 AM 真菌侵染率和根围土样 AM 真菌多样性研究，结果表明：在 6 月份植物生长速度最快时，AM 真菌侵染率最高，而在 9 月份植物即将停止生长时，AM 真菌孢子数量最多；不同植物根围土壤中 AM 真菌组成没有明显差异；侵染植物根系内和根围土壤的优势 AM 真菌种类不同，可见不同的 AM 真菌发挥的功能不同。

AM 真菌对放牧的响应：在锡林郭勒草原定位站的固定羊草、退化恢复、放牧样地进行了 AM 真菌根系侵染率及多样性的比较研究，结果表明：锡林郭勒草原具有丰富的 AM 真菌物种多样性(21 个分类单元)，但是 AM 真菌的孢子密度相对较低(8-21 spores/100g soil)；过度放牧显著降低植物根系内 AM 真菌的侵染率和土壤中的孢子密度、种的丰度和种类组成；围封禁牧对 AM 真菌多样性的恢复有明显的作用；可见，放牧对 AM 真菌的侵染率及多样性产生了显著影响，而围封是一种有效的保护措施。

AM 真菌对增温和增雨的响应：在多伦草原的人工增温和增雨实验研究结果表明：增温和增雨对植物根内 AM 真菌的侵染率影响较小，但是显著影响了两种优势 AM 真菌 Glomus etunicatum 和 G. ambisporum 的相互竞争；AM 真菌的侵染和孢子密度存在明显的年度和季节动态的变化；经过 2 年的处理，加热显著降低了非优势种的比例并降低了 AM 真菌群落的多样性。

Dynamics and response to different treatments of AM fungi in Inner Mongolia steppe

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Abstract: Arbuscular mycorrhizal (AM) fungi are widely distributed and form mutualistic symbioses with most vascular plants in grassland ecosystems. Therefore, AM fungi play an important ecological role in determining plant diversity and species composition in terrestrial ecosystems. The basic aims of this study were to understand how AM fungal colonization and species composition vary in response to different managements of natural grassland ecosystem and seasonal dynamics in Inner Mongolia steppe.

To study the seasonal dynamics of AM fungi, five common grass species, Stipa grandis, Leymus chinensis, Agropyron cristatum, Cleistogenes squarrosa and Anemarrhena asphodeloides, were selected in Stipa grandis plot. The results indicated that AM fungal root length colonization rate was the highest in June, and spore density was the highest in September. There was not host specificity of AM fungi. AM fungus composition was different between the roots and soil.

AM fungal structure and diversity were investigated in ungrazed, restored degraded and overgrazed plots. A higher number (21 taxa) of AM fungi were isolated, and lower spore density (8-21 spores/100g soil) was found. AM fungal colonization and composition were conspicuously affected by long-term overgrazing. The spore density and species richness of AM fungi significantly decreased by long-term overgrazing. It suggests that the AM fungal diversity and colonization are greatly affected by long-term overgrazing, and fencing is better way for restoration of AM fungi in severely degraded grassland in natural ecosystem.

The influence of heating and watering on AM fungal community was performed in natural grassland. Results indicated that heating and watering had little effect on the AM colonization, but they had significant effect on the relative abundance of two dominant AM fungi Glomus etunicatum and G. ambisporum. AM fungal colonization and spore composition were conspicuously affected by seasonal and inter-year changes. Heating showed significantly negative effect on inter-year changes of proportion of non-dominant species and diversity of the AM fungal community.

生物多样性与生态系统功能关系的研究现状与趋势

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摘　要：自上个世纪以来，人类活动的强烈干扰已经引发了有史以来第六次生物大灭绝，从而导致了全球范围内物种分布的改变。这种由人类活动引起的生物多样性的变化（物种丧失或外来种侵入），显著地改变了生态系统的结构与功能，以及生态系统对环境变化响应的范围，并对其服务功能产生了深刻的影响。由于人类自身生存与发展的需要，生物多样性与生态系统功能的关系已成为当今全球范围内倍受关注的重要研究领域。本报告中，我们从生物多样性和生态系统功能的基本概念入手，接着从生物多样性与生态系统生产力和稳定性的关系，多样性-稳定性争论，生物多样性与生态系统功能关系研究的几个主要发展阶段与贡献，生物多样性的生态系统功能实验研究进展，该领域目前存在的主要问题、挑战与未来的发展方向，以及中国科学院内蒙古草原生态系统定位研究站建立的生物多样性与生态系统功能的大型实验平台及主要进展等方面，对国内外开展的相关研究工作进行了介绍，目的在于进一步加强国内外学者之间的学术交流，不断提升我国在这一研究领域的国际地位。

生物多样性与生态系统功能：不仅仅局限于生态位互补与采样作用

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摘 要：人类活动导致了全球范围内的物种数量急剧减少，由此而引发的生物多样性丧失是否导致生态系统功能损害的问题开始受到广泛关注。因此，生态工作者最近投入了大量精力研究生物多样性与生态系统功能的内在联系。其中，大量研究工作集中于物种多样性对群落生物量的影响。很多实验结果表明，物种多样性的提高对群落整体生物量的增加具有促进作用。对此现象存在两种解释：生态位互补（生物种多样性的提高使群落生态位得到更充分的利用，从而促进群落生物量）；以及，采样作用或正选择作用（物种丰富的群落中出现高产量优势物种的机率增加，从而提高群落生物量）。

作者认为，根据现有实验结果就作出生物多样性对生态系统功能有普遍促进作用的结论还委实过早。值得一提的是，密度补偿（种群密度可能随物种多样化降低）和副选择作用（低产量优势物种出现的机率也可能随群落多样化而增加）的存在可能导致上述生物多样性与生态系统功能间正向关系的脱离。密度补偿和副选择作用，以及前文所述的生态位互补和正选择效应代表着物种竞争过程中出现的各种不同结果。作者认为，目前的研究工作中并没有给予密度补偿和副选择作用足够的重视。密度补偿现象往往需要通过几个世代的物种竞争过程才能得到体现，而目前大多数实验工作对实验群落的观测时间不超过一个世代周期。此外，尽管关键种在群落中的个体数量或生物量不高，它们对生态系统功能却有巨大影响。在研究除生物量以外的生态系统功能时，关键种的存在可能会使副选择作用在群落中得到更为普遍地体现。

为证实以上观点，作者利用快速增殖的微生物实验系统进行了两组实验室试验。一组实验检测了噬菌单细胞生物和轮虫物种数量变化对群落生物量的影响。实验结果表明，密度补偿导致了群落生物量与物种多样性之间的微弱关联。 同时，亦无证据表明生态位互补和选择作用的存在。另一组实验测试了细菌多样性对有机物降解以及噬菌单细胞生物生物量的作用。结果证实，有机物降解以及噬菌单细胞生物生物量几乎不受细菌多样性的影响，而副选择作用是造成这一现象的最合理解释。

Biodiversity and Ecosystem functioning: Beyond Complementarity and Positive Selection (Sampling) Effects

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Abstract: Human activities have impacted most natural ecosystems on Earth, leading to unprecedented rates of species extinction around the globe. Driven by concerns that biodiversity loss may impair services provided by ecosystems to the human society, ecologists have recently devoted considerable efforts into understanding the relationship between biodiversity and ecosystem functioning (BEF). Much of this research has focused on the effects of changing species diversity on aggregate community biomass. Many experimental studies on this subject have shown that aggregate community biomass tends to increase as the number of species increases in the community, a phenomenon that can be explained by two mechanisms: niche complementarity (larger production associated with increased complementary niche use in diverse communities) and positive selection (or sampling) effects (larger production associated with higher probabilities that diverse communities contain dominant productive species).

Here I argue that it is still premature to conclude that there exists a general positive BEF relationship. In particular, strong density compensation (the decline of population density with species diversity) and negative selection effects (the increased likelihood of diverse communities containing dominant species that contribute little to ecosystem functions) may result in the magnitude of ecosystem functioning being decoupled from the level of species diversity. Density compensation and negative selection effects, as well as complementarity and positive selection effects, represent different outcomes of the same competitive sorting process. Competition with little niche overlap leads to niche complementarity, whereas competition with considerable niche overlap leads to density compensation (where all species were more or less equally affected by competition), positive selection effects (where species with large contributions to ecosystem functioning dominate), and negative selection effects (where species with small contributions to ecosystem functioning dominate). I suggest that current BEF studies have underappreciated the potentially important roles of density compensation and negative selection effects. While the emergence of density compensation often requires multiple generations' competitive interactions, existing BEF experiments, conducted mostly in plant communities, rarely lasted for one full generation. Also, given the common presence of keystone species which, despite their low abundance or biomass, can impose large influences on ecosystem functions, negative selection effects are likely to be common when examining ecosystem functions other than aggregate community biomass.

I use two of my own experiments to support my arguments. Both experiments were conducted in laboratory microcosms using fast reproducing microbial species. One experiment investigated the response of aggregate community biomass to changes in the number of species of bacterivorous protists and rotifers. Community-wide density compensation resulted in aggregate community biomass being independent of species diversity, with little evidence for complementarity or selection effects. Another experiment explored the effects of changing bacterial diversity on bacteria-mediated organic matter decomposition and biomass production of a bacterivorous protist. Both decomposition and bacterial consumer abundance were unaffected by bacterial diversity, a resulted accounted for by negative selection effects.