

A Study on the Biological Diversity in Warm Temperate Forest in China

中国暖温带森林生物多样性研究

刘世荣 蒋有绪 史作民 等著

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中国科学技术出版社

责任编辑/张春荣 封面设计/王铁麟



ISBN 7-5046-2571-X



9 787504 625717 >

ISBN 7-5046-2571-X
S · 346 定价: 40.00 元

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China Science and Technology Press

图书在版编目(CIP)数据

中国暖温带森林生物多样性研究/刘世荣等著. —北京:中国科学技术出版社,1998
ISBN 7-5046-2571-X

I. 中… II. 刘… III. 森林-生物多样性—研究—中国—暖温带 IV. S718

中国版本图书馆 CIP 数据核字(98)第 30812 号

科学普及出版社出版

北京海淀区白石桥路 32 号 邮政编码:100081

电话:62179148 62173865

新华书店北京发行所发行 各地新华书店经售

中国科学院印刷厂印刷

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开本:787 毫米×1092 毫米 1/16 印张:15.875 字数:374 千字

1998 年 12 月第 1 版 1998 年 12 月第 1 次印刷

印数:1—1000 册 定价:40.00 元

(凡购买本社的图书、如有缺页、倒页、
脱页者,本社发行部负责调换)

前言

生物多样性是指生命有机体及其赖以存在的生态复合体的多样性和变异性,它包含遗传多样性、物种多样性和生态系统多样性。生物多样性是人类生存和社会经济发展的物质基础,在维持和改善生态环境方面也起着十分重要的作用。生物多样性保护已经成为全球普遍关注的热点问题。

森林是陆地生态系统中最典型、最多样和最重要的生态系统,它在形成和维持生物多样性以及地圈、生物圈动态平衡过程中具有相当重要的作用。陆地生物多样性主要孕育在森林中,仅占全球陆地面积7%的热带森林就拥有地球上半以上的物种。中国地域辽阔,气候多样,孕育了极为丰富的生物多样性资源。据统计,全球物种有500万~5000万,但有科学记述的为140万种。中国物种数约占世界总数的10%,其生物多样性的丰富程度占世界第八位。中国森林面积为1.34亿 hm^2 ,乔灌木树种约为8000种,其中乔木树种为2000种,包括1000多种优良用材和特种经济树种,还有许多特有珍稀种,如水杉、银杏、秃杉、珙桐、连香树、望天树、金钱松和水青树等。此外,中国拥有不同气候区的多样化森林类型,拥有世界上最为完整的温带、亚热带山地垂直森林带谱以及世界分布最北的热带雨林类型。显而易见,中国森林是人类食品、工业及医药业等重要的巨大资源库,对人类未来的生物工程、人类生存和社会经济的持续稳定发展具有至关重要作用。

随着人口激增和社会经济的迅猛发展,对森林资源的需求日益高涨,造成对森林乱砍滥伐、过量开采及无节制的樵采等,结果导致森林及其生境的退化、破坏,以及许多物种的消亡。目前,天然森林遭受大规模破坏,其他森林也呈岛屿状分散在逐步退化的环境中。据统计,世界每年约1110万 hm^2 的热带森林和林地遭到破坏,每年有730万 hm^2 的热带郁闭林和380万 hm^2 的热带疏林被砍伐后变为农地。森林锐减和生境破坏致使10%的植物种濒临灭绝,现在物种的灭绝速率为自然灭绝速率的1000倍。联合国环境规划署预测,到2000年世界范围内的野生生物将减少5%~15%,每年可能失去1.5万~5万个物种,每天可能有40~140个物种灭绝。另据亚马孙河流域热带雨林灭绝种的研究预测,按目前的发展趋势推算到本世纪末,12%的鸟类和15%的植物种类将会消失。如果整个21世纪森林继续退化,亚马孙河流域鸟类和植物种丧失将分别高达69%和66%。中国生物多样性丧失也尤为严重,估计濒危物种数高达4000~5000种,濒危植物物种达15%~20%,超过世界10%~15%的水平,约有5%左右的植物种已在近数十年灭绝。按1物种灭绝导致10~30种其他生物丢失统计,中国4000~5000种植物濒危,将会有4万~15万其他生物的生存产生危机。伴随森林被破坏生境破碎和缩小,野生生物的种内遗传多样性严重丧失,致使野生生物种对病虫害、气候变化、环境胁迫等抵抗力降低。生境面积缩小和片断化,阻碍了种间杂交,限制了种群发展,导致种群萎缩、遗传纯化、遗传多样性衰减。多年来,中国为缓和可利用天然林资源危机与经济发展对木材及其他林产品需求日益增长的矛盾,将多物种复杂结构的天然林和天然次生林改造为大面积的树种单一、结构简化的速

生丰产人工林,导致许多物种和变种消亡,遗传狭窄,多样性大幅度下降,相反遗传脆弱性增强。中国森林中尚有许多未开发利用并具较高经济价值的物种,可提取抗癌药物、抗生素与激素,可作为食物、纤维、油脂、香料、染料等,还拥有许多水果、作物、花卉的野生原型种质资源。例如:海南岛热带林中还保存不少野生稻、原鸟、薯芋、热带果树的野生种质资源,这对我国改良和创造新的经济作物具有十分重要的作用。然而,作为未来生物工程利用的丰富遗传基因库在尚未认识和利用之前就已出现严重的丢失。面对上述森林及其生境破坏的严峻状况,如不采取紧急措施和适宜对策,森林生物多样性消亡的规模和速率必将加速,其后果不堪设想。因此,无论是世界和中国都面临保护、恢复和持续利用森林生物多样性的紧迫任务,这具有十分重要的现实和深远的历史意义。

目前,全球对生物多样性保护予以极大的关注,许多国际组织,像国际自然与自然资源保护同盟(IUCN),联合国环境规划署(UNEP),世界野生生物基金会(WWF)等都积极投入这一领域中来,制定和颁布了一系列的世界生物多样性保护战略、公约和行动计划,并将其付诸实施。例如,IUCN(1978)年出版了世界范围的《植物红皮书》,IUCN、UNEP和WWF1980年联合提出了《世界自然保护策略》。此外,众多科学家已开始从不同角度开展生物多样性的研究。如:生物多样性编目,生物多样性的测度指标和方法,生物多样性的生态系统功能,生物多样性监测与评价,受损和退化生态系统与生境的恢复技术,以及物种濒危机制及其就地、迁地保护技术等。为保护世界各自然地理区的重要生态系统类型,全球已在103个生物地理区建立了276个生物圈保护区,形成了庞大的自然保护网络,我国一些保护区也加入该网络。近十多年来,我国政府十分重视生物多样性保护,不但签署和批准了《生物多样性公约》,而且还率先制定了生物多样性保护国家行动计划。至今我国已经建立了各种类型的自然保护区799个,约占国土面积的7.91%。生物多样性保护是一个崭新的研究领域,生物多样性保护的理论和体系还处在不断发展和完善阶段,我国在生物多样性保护的理论与实践方面尚与国际先进水平存在差距。为促进我国森林生物多样性研究的深入发展,提出适合我国国情的生物多样性保护理论和实用的技术措施,中国林业科学研究院在林业部的资助下,于1993年立项在我国暖温带河南宝天曼国家级自然保护区开展了森林生物多样性保护技术研究。

宝天曼自然保护区是国务院1988年批准的森林和野生动物类型的国家级自然保护区,总面积约53.4km²。这里地域辽阔,林木繁茂,是同纬度生态结构保护最为完整的地区之一,也是中原地带生物多样性的分布中心。宝天曼的植物区系是以温带成分为主,兼有一定的热带分布类群,具有南暖温带与北亚热带过渡、交替的特征。区系成分多方交汇,与华北、华中和西南地区植物区系联系密切,单型属和少型属的比例较高,有一定的原始孑遗种类和被子植物的原始类型。宝天曼现有的201种动物中,东洋界、古北界和广布种约各占1/3,呈现出南北方动物分布上的过渡性。南方区系成分向北方渗透,北方的区系成分向南方扩展,在此形成了一条广阔的南北过渡地带。宝天曼自然保护区的自然地理、生态环境、动植物多样性为研究过渡地区森林生物多样性提供了理想的条件。

在1993年开展暖温带森林生物多样性保护技术研究之前,林业部野生动物与森林植物保护司、中国林业科学研究院、河南省科学院、河南农业大学、河南师范大学与宝天曼自然保护区管理处等近20个单位进行了多学科的自然保护区综合科学考察,并编辑出版了《宝天曼自然保护区科学考察集》。本项目是在此基础上,开展的物种和生态系统水平的森

林生物多样性研究,涉及动植物区系调查及编目、群落数量分类与排序、种间关系、生态位、物种多样性演替动态、珍稀濒危物种保护生物学、森林生物多样性胁迫的社会经济分析、森林生物多样性监测评价体系、区域森林生物多样性保护对策等。

参与本成果编著的有关课题负责人和主要参加人情况如下:

1、林业部重点项目“暖温带森林生物多样性保护技术研究”(编号:93-08-0602)

负责人:刘世荣、蒋有绪 (中国林业科学研究院森林生态环境研究所)

主要参加人:

史作民、陈力、程瑞梅、臧润国 (中国林业科学研究院森林生态环境研究所)

刘玉萃、吴明作、郭宗民、卢炯林、王秀珍、赵勇(河南农业大学)

王正用、朱学凌、刘保东 (河南宝天曼自然保护区管理处)

2、中国林业科学研究院基金项目“我国暖温带森林生态系统生物多样性保护技术研究”

负责人:蒋有绪 (中国林业科学研究院森林生态环境研究所)

主要参加人:

刘世荣、史作民、陈力 (中国林业科学研究院森林生态环境研究所)

周淑芷、王鸿斌、张真、于长青、陆军 (中国林业科学研究院森林保护研究所)

刘玉萃 (河南农业大学)

3、国家人事部留学回国人员基金项目“暖温带森林生态系统生物多样性保护技术研究”

负责人:刘世荣 (中国林业科学研究院森林生态环境研究所)

主要参加人:

史作民、陈力 (中国林业科学研究院森林生态环境研究所)

王正用、朱学凌 (河南宝天曼自然保护区管理处)

本书的著者有:刘世荣(前言,第一章第一节、第三节,第二章,第四章第一、二节,第十章,第十一章,第十二章第一、二节);蒋有绪(第三章,第四章第一、二节);史作民(第四章第一、二节,第五章,第六章,第七章,第八章);刘玉萃、吴明作(第九章第一、二、三、五节,第十章);陈力(第九章第四节);臧润国(第一章第二节);周淑芷、王鸿斌(第四章第三节);王正用、朱学凌(第十二章第三节)。全书统稿由刘世荣、史作民完成。

本书的作者在森林生物多样性形成、动态变化及维持机制方面所做的初步探索和所发现的问题,无疑将会促进森林生物多样性结构与功能研究的深入发展,为暖温带森林生物多样性保护提供对策和技术参考。本专著尚属阶段性研究成果,其中涉及的一些问题有待进一步深入研究。中国林业科学研究院人才培养基金资助了本专著出版,在此深表感谢。

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Abstract

This book is the collection of research achievements of the forest biodiversity carried out at the Bao Tianman National Reserve, which was cooperatively funded by State Forestry Administration, Chinese Academy of Forestry and Ministry of Personnel. This book includes the following 12 chapters, concept, conservation principles and review of biodiversity research (Chapter 1); threatening and its reasons of biodiversity in China (Chapter 2); basic concept of regional biodiversity conservation research (Chapter 3); flora and fauna characteristics of Bao Tianman mountain (Chapter 4); quantitative classification and ordination of plant community of Bao Tianman mountain (Chapter 5); plant community diversity of Bao Tianman mountain (Chapter 6); Changes of plant species diversity along with the restoration processes of *Quercus variabilis* (Chapter 7); characteristics of interspecific association and population niche of plant species of Bao Tianman (Chapter 8); valuable, rare and endangered species and their population biology of warm temperate forest (Chapter 9); threatening and its reasons of forest biodiversity in warm temperate zone of China (Chapter 10); monitoring and assessment of forest biodiversity (Chapter 11) and conservation and sustainable use strategies of forest biodiversity (Chapter 12).

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Preface

Biodiversity means the diversity and variety of organisms and their environments, it includes genetic diversity, species diversity and ecosystem diversity. Biodiversity is the material base of human living and social economic development, it also plays very important roles in maintaining and improving eco-environment. Biodiversity conservation has become a focus of the world-wide concerns.

Forest is the most typical, diversified and important ecosystem type among the terrestrial ecosystems, it plays a significant role in forming and maintaining biodiversity and dynamic equilibrium process between geosphere and biosphere. Terrestrial organisms mainly live in forest. For example, more than 50% species in the world live in the tropical forest which accounts only for 7% of the land area. China has a large territory and diversified climates, leading to a abundant biodiversity resource. There are about 5 million to 50 million species in the earth, but only about 1.4 million species have scientifically described. The species number in China accounts for 10% of the total in the world, and it ranks the eighth place in the world. The forest area in China is about 0.134 billion hm^2 . Number of tree and shrub species is about 8000, and tree species is about 2000 of which over 1000 are good timber and economic species. In addition, there are many endemic and rare species, such as *Metasequoia glyptostroboides*, *Ginkgo biloba*, *Taiwania flousiana*, *Davidia involucrata*, *Cercidiphyllum japonicum var sinensis*, *Parashorea chinensis*, *Pseudolarix kaempferi*, *Tetracentron sinense*. China has various forest types distributing in different climatic zones. At the same time, the vertical full spectrum of mountainous forest in temperate and subtropical zone, and the tropical forest in the farthest north in the world occurs in China as well.

With a rapid increase of population and economic development, the demand for forest resource is increasing. This results in illegal-cutting and over-harvesting, and consequently, the degradation, destruction and loss of forest and its habitat occurs and many species are under endangered situation or extinct. A large area of natural forest is being destroyed, while the remaining forests are becoming isolated forest island scattering in degrading environments. About 10% of total plant species is close to extinct due to the loss of forests and habitat destruction. The current species extinction rate is estimated to be 1000 times higher than that of natural rate. According to the prediction of United Nations Environment Program, 5%~15% of the wildlife species in the world will be lost in 2000, 15000~50000 species will be lost every year, and 40%~140%

species will be lost every day. The loss of biodiversity is also very serious in China. About 4000~5000 species are endangered, with the ratio of 15%~20%, and this is larger than 10%~15% of the world average. Due to forest destruction and habitat fragmentation, intraspecific genetic diversity of wild species lost significantly, leading to a reduction in resistant ability of forest ecosystem to disease, climate change and environmental stresses.

In order to alleviate the crisis of natural forest resource and the increasing conflict between the economic development and the demand of forest products, the natural forest and natural secondary forest with multiple structures and diversified species have been transformed into man-made forest with simplified structure and few species. This practice causes a great loss of many species or reduction in genetic diversity in recent years in China. There are many species with a high economic value and many wild variety of fruits, crops and flowers in the forests have disappeared before they are developed and utilized. The scale and rate of species distinction will be accelerated If effective measures and appropriate strategies are not taken. Therefore, conservation, restoration and sustainable use of forest biodiversity is an urgent and important issue in the world and in China.

The global is paying more attention to biodiversity conservation now, and many international organizations, such as International Union for Conservation of Nature and Natural Resources (IUCN), United Nations Environment Program, World Wildlife Fund (WWF) devoted to this field actively. A series of world biodiversity conservation strategies, conventions and action plans are being taken into effects. In addition, many scientists are working on biodiversity conservation from different angles, such as catalogue, measurement indicators and methods, ecosystem function, monitoring and assessment, restoration techniques of degraded ecosystem and habitat, mechanism of endangered species and *ex situ* conservation techniques. In order to protect important ecosystem types, 276 nature reserves belong to 103 biogeographic regions have been established in the world, forming a large network of nature reserves. Some reserves from China have jointed the network members. In recent decade, China government pay a great attention to biodiversity conservation, not only signs 《Biodiversity Convention》, but also formulate the National Biodiversity Conservation Action Plan. Up to now, 799 nature reserves have been established in China, and the protected areas account for 7.91% of the total area. In order to improve forest biodiversity conservation research for providing conservation principles and practical techniques, Chinese Academy of Forestry started the projects on biodiversity conservation techniques of warm temperate forest in Bao Tianman nature reserve. The project was cooperatively funded by the State Forestry Administration, the Chinese Academy of Forestry and the Department of Personnel.

In 1988, Bao Tianman was ratified by the State Council as a national nature reserve

for protecting forest and wildlife. The total area is about 53.4km². It is one of the protected completely area at the same latitude region and biodiversity distribution center in central China. The flora has distinct both warm temperate characteristics and transitional characteristics from deciduous broad-leaved forest to evergreen broad-leaved forest and close relationships with central China flora and southwest China flora, include many genera that have one or few species and some endemic and original species. Fauna analysis of 201 animals shows that Palearctic region species, Oriental region species and Cosmopolitan species account for 1/3, respectively, and has obvious transitional characteristics. Geological and ecological conditions and plant and animal species diversity of Bao Tianman provide an ideal site for transitional region forest biodiversity research.

Before the start of this project, about 20 units, including the Department of Wildlife and Forest Plants Conservation, the State Forestry Administration, Chinese Academy of Forestry, Henan Academy of Sciences, Henan Agricultural University, Henan Normal University and Bao Tianman National Nature Reserve Administrative Bureau have jointly made a scientific survey at the Nature Reserve. 《Essentials on the Collection of Scientific Investigation for Bao Tianman Nature Reserve》 has been published. Based on the previous research, we carried out forest biodiversity research at species and ecosystems levels. The research focused on the following aspects: investigation and catalogue of flora and fauna, classification and ordination of plant community, interspecific association, population niche, successional dynamic of species diversity, population biology of valuable, rare and endangered species, threatening social and economic indicators of forest biodiversity, monitoring and assessment system of forest biodiversity and conservation strategies of regional biodiversity.

The following projects have contributed research results to this book:

1. "Study on Conservation Techniques of Warm Temperate Forest Biodiversity in China", funded by the State Forestry Administration. The project led by Prof. Shirong Liu and Youxu Jiang, Institute of Forest Ecology, Environment & Protection, Chinese Academy of Forestry. The main collaborators include Assistant Professor Zuomin Shi, Assistant Professor Li Chen, Assistant Ruimei Cheng and Associate Professor Runguo Zang (Institute of Forest Ecology, Environment & Protection, Chinese Academy of Forestry), Professor Yucui Liu, Assistant Professor Mingzuo Wu, Assistant Professor Zongmin Guo, Professor Jionglin Lu, Assistant Professor Xiuzheng Wang and Assistant Professor Yong Zhao (Henan Agricultural University), Advanced Engineer Zhenyong Wang, Engineer Xueling Zhu and Engineer Baodong Liu (BaoTianman Nature Reserve Administrative Bureau).
2. "Study on Ecosystem Biodiversity Conservation of Warm Temperate Forest in China". The Project funded by Chinese Academy of Forestry, led by Professor Youxu Jiang (Institute of Forest Ecology, Environment & Protection, Chinese Academy of Forestry). The main collaborators include Professor Shirong Liu, Assis-

tant Professor Zuomin Shi, Assistant Professor Li Chen, Professor Shuzhi Zhou, Associate Professor Hongbin Wang, Associate Professor Zhen Zhang, Associate Professor Changqing Yu and Associate Professor Jun Lu (Institute of Forest Ecology, Environment & Protection, Chinese Academy of Forestry), and Professor Yucui Liu (Henan Agricultural University).

3. "Study on Conservation Techniques of Warm Temperate Forest Ecosystem Biodiversity in China". The project funded by the Department of Personnel, led by Professor Shirong Liu (Institute of Forest Ecology, Environment & Protection, Chinese Academy of Forestry). Assistant Professor Zuomin Shi and Assistant Professor Li Cheng from the Institute of Forest Ecology and Environment, and protection, Chinese Academy of Forestry, and Advanced Engineer Zhenyong Wang, Engineer Xueling Zhu and Engineer Baodong Liu from the BaoTianman Nature Reserve Administrative Bureau participated in the project.

The book is consisted of 12 chapters which are organized in a logical sequence. The contributors of this book, who have long been engaged in population ecology, community ecology, forest vegetation and ecosystem research, are listed as followings: Professor Shirong Liu, Professor Youxu Jiang, Assistant Professor Zuomin Shi and Li Chen, Associate professor Runguo Zang Professor Yucui Liu Assistant Professor Mingzuo Wu, Professor Shuzhi Zhou, Associate Professor Hongbin Wang, Advanced Engineer Zhenyong Wang, Engineer Xueling Zhu.

The insight into the formation, dynamic changes and maintaining mechanisms of forest biodiversity in this book will improve the understanding of structure and function of forest biodiversity, and provide strategies and technical references to biodiversity conservation of warm temperate forest. Finally, the authors would like to extend their sincere thanks to the State Forestry Administration, the Chinese Academy of Forestry, and the Department of Personnel for their financial supports to the research and the publication of this book.

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第一章 生物多样性概念、保护原理及研究进展^①

生物多样性是本世纪最后 10 年生态与环境科学领域中三大研究重点议题(全球气候变化、生物多样性和持续生态系统)之一。生物多样性是人类赖以生存的条件,是社会经济持续稳定发展的基础。目前,人类为利用和保护世界生物多样性,需求以生态学以及更广泛的社会、经济、政治和法律等知识,采取迅速行动和适宜对策已成为当前国际社会极大关注的重大环境问题之一。

第一节 生物多样性的概念、价值及其意义

生物多样性是生物之间的多样化和变异性及生态复杂性,它是包括地球上所有植物、动物、微生物物种、各个物种所拥有的基因和各种生物与环境相互作用形成的生态系统及它们的生态过程的多样性和复杂性的综合概括(McNeely 等, 1990; 世界资源研究所等, 1992)。它可划分为三个不同的层次:遗传多样性、物种多样性和生态系统多样性。其中,遗传多样性是地球上所有生物所携带的遗传信息的总和,蕴藏在全球的动物、植物和微生物个体的基因中;物种多样性是指地球上有机体的复杂多样性,估计全球生物约有 500 万~5000 万种,但科学描述的仅有 150 万种(May, 1992);生态系统多样性是指生物圈内生物、生物群落及其生态过程的多样性,以及生态系统内生境差异(McNeely 等, 1990)。

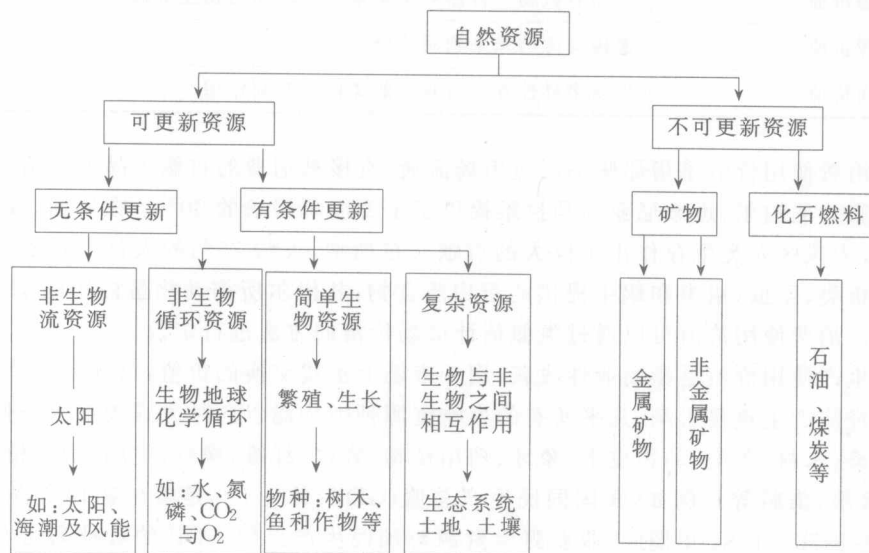


图 1-1 自然资源构成(Gilbert et al., 1990)

① 本章第一节、第三节由刘世荣执笔;第二节由臧润国执笔。