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第13辑

# 中国南方红豆杉研究

高兆蔚 编著



中国林业出版社

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# 谨将此书

献给中华人民共和国生物制药业

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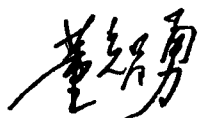
# 序一

南方红豆杉 (*Taxus wallichiana* var. *mairei*) 是古老珍稀的新生代第三纪残存的子遗植物, 同时又是我国红豆杉科植物中自然地理分布区域最广泛的树种之一。该树种集药用原料、珍贵用材和庭园观赏价值于一身, 是目前乔木树种开发利用价值最高的树种之一。尤其南方红豆杉的树皮、树根、枝叶和果实中, 含有紫杉烷二萜类化合物, 具有特殊药用功能, 是提取和人工半合成抗癌物质紫杉醇 (Taxol) 的原料。所以, 这一类树种, 成为国际上诸多学者竞相研究与开发的热点, 被称为是“黄金般”、“国家级”的树种; 其次, 南方红豆杉木材优良, 材质坚硬, 纹理美观, 有光泽, 历来是我国乡土珍贵用材和雕刻工艺品、现代高级家具优良用材。南方红豆杉树形端直、枝叶浓密、四季常青、凌冬不凋、姿态婆娑、苍翠宜人, 秋冬季节果实成熟, 红如珍珠, 也是庭园优良观赏树种。

目前, 南方红豆杉已是国家一级重点保护的濒危植物。由于 20 世纪 80 年代以来, 该树种被人为采伐破坏严重, 滥采乱挖现象比较普遍, 古树大木损失数量在七八成以上, 造成现在植物种群和总体数量大幅度减少, 进入了濒危和遭至绝灭境地。1996 年 6 月和 1999 年 8 月, 国务院相继发布了《中华人民共和国野生植物保护条例》和《国家重点保护的野生植物名录 (第一批)》, 从法规建设方面, 加强了南方红豆杉等野生植物及其生境的保护, 并明令禁止直接利用野生的南方红豆杉植物进行提取紫杉醇和木材的开发利用。惟一的合理合法利用南方红豆杉的途径是人工繁育与栽培, 建立定向培育的人工林基地。

从 20 世纪 90 年代开始, 作者深入南方红豆杉自然地理分布区, 进行大量调查研究, 并在国有林场和集体林区, 开展了多地点多年度的栽培技术试验, 从宏观至微观, 结合定性定量分析, 积极地编写了《中国南方红豆杉研究》专著。从整体性方面, 系统地介绍了南方红豆杉的生物学分类、自然地理分布、生物生态学特性, 人工栽培技术研究, 木材形态解剖特征与物理力学性质、紫杉醇的开发利用与生产过程, 以

及南方红豆杉野生资源保护与人工栽培开发利用对策等七个篇章,结构严谨,内容丰富,资料翔实,文字精练,图文并茂,是当前中国南方红豆杉研究中新颖性成果。它的出版,对于我国南方红豆杉资源保护、人工栽培基地建设和进一步合理利用南方红豆杉资源,发展紫杉醇提取纯化产业等方面,都有重要的理论和现实生产的推动作用。



2006年5月1日

# FOREWORD I

*Taxus wallichiana* var. *mairei* is an aged and especial plant, which survived from the Tertiary of Cenozoic. It is also one of the most extensively distributed plant of *Taxus* family in the natural geography area of China. The plant which has important value of medicine material, rare timber and garden ornamental, is one of the highest exploited arbors, especially its cortex, root, branch and fruit, which contain compound of Taxane diterpenoids, are materials applied to distilling and compounding for Taxol, so this plant has become focus of researching and exploiting for many researchers, which is called golden tree, national treasure. Secondly, *Taxus wallichiana* var. *mairei* possess excellent timber of hard wood, aesthetic texture and luster, which was cherished as rare timber adapted to carving craftwork and making modern rosewood furniture. *Taxus walliachina* var. *mairei* grows erectly with flourish branches and leaves, it is evergreen that shows graceful appearance and delightful color, in autumn and winter, mature fruit grows red, looked like pearl. It is also excellent garden ornamental.

Currently, *Taxus wallichiana* var. *mairei* has been ranked as endangered plant provided for first-degree key protection. Since 1980s, the family of *Taxus wallichiana* var. *mairei* have been cut seriously, at the same time, the phenomena of denudation and arbitrary digging are so prevalent that seventy to eighty percent of the aged-trees have been losing. Therefore, the community and total number of the tree decreased dramatically, which put the tree into an endangered plight. The Wild Plant Catalogue of National Key Protecting (the first group) was issued successively by State Department in June, 1996 and August, 1999, so the protection of the wild plants, just like *Taxus wallichiana* var. *mairei*, and their living space have been strengthened by the law. It was public proclaimed that the timber exploitation and Taxol extraction from the wild *Taxus wallichiana* var. *mairei* was forbidden. And the only way to

exploit the plant reasonably is building plantation bases for artificial cultivating.

In this book, a large number of investigations and researches had been made in the natural geographical distribution area of *Taxus wallichiana* var. *mairei* since 1990s. At the same time, the multi-places and multi-years cultivating experiments conducted in the state-running forest farm and collective-running forest zone. Analyzed from macroscope to microscope, along with the quantitative and qualitative analysis, we positively compiled the book of *The Researches of Chinese Taxus wallichiana* var. *mairei* wholly and systematically introduces the biological classification, natural geographical distribution, bio-ecological characteristic, the technical research of artificial culture, timber shape dissection, physical mechanics property, the development and utilization of taxol and production process, countermeasures in the wild resources protection of *Taxus wallichiana* var. *mairei* and artificial culture, in total 7 chapters. With precise framework, affluent content, accurate data, polished letter and luxuriant texts and pictures, this book currently is the novelty achievement in the research of *Taxus wallichiana* var. *mairei*. In addition, it has important theoretical and practical impetus effect for the construction of artificial culture base, the further rational utilization of *Taxus wallichiana* var. *mairei* and the development of taxol distilling and purification industry.

Dong Zhiyong

2006. 5. 1

## 序二

红豆杉属 (*Taxus*) 植物, 自 20 世纪 80 年代发现为新型抗癌药物后, 引起了主产地北美及东亚各国有关单位的重视。但伴随而来的则是自然资源遭受严重破坏, 特别是在保护意识较差的地区, 人为破坏更加严重。

在我国, 红豆杉属植物虽只有 3 种 2 变种, 但分布范围极为广阔, 特别是南方红豆杉, 在秦岭及淮河以南, 横断山以东的山地均有星散分布, 自然资源也较为丰富。1999 年国家林业局根据国内严重砍伐红豆杉和自然资源急剧减少的现状, 将国产的红豆杉属植物全部列为国家一级保护植物, 并开展了资源普查, 已开始建立红豆杉人工繁育基地, 以满足社会的需求。

近几年来, 虽见有一些红豆杉属植物的调查、研究报告, 但专论南方红豆杉的论著极为少见, 而本研究报告是目前国内, 以省为单位进行南方红豆杉自然分布、资源、生长环境、植被类型、生物学特性等深入调查的典范, 并对其林分生长、树干解析、木材材质、繁殖栽培 (包括种子处理、催芽、播种、育苗、扦插等) 技术进行了深入的研究, 取得了丰硕的成果, 填补了我国主要造林树种繁育技术中南方红豆杉的空白, 为国内各产区建立南方红豆杉人工繁育基地提供了珍贵的技术资料。与此同时, 研究报告还对南方红豆杉的保护对策和开发利用提出了可行的建议。为此, 本研究报告应为全国南方红豆杉调查、研究中最优秀的成果, 属国内领先水平。

中国科学院植物研究所 研究员

傅士國

2005 年 10 月



## FOREWORD II

The plants of *Taxus*, after the 1980s' discover for the new anti-cancer medicine, causing the parties concerned value of main-production place North America and all countries in East Asia. But chaperonage since then the natural resources have suffered severe loss from destroying, especially at the region of poor-protection awareness.

The plants of *Taxus* in our country, although only 3 species and 2 varieties, distribute widely, especially *Taxus wallichiana* var. *mairei*, has scattered distribution all at mountainous areas of southern Qinling and Huaihe, eastern Hengduan mountain, the natural resources is also more abundant. The State Forestry Administration has already listed all of domestic *Taxus* as the National Class-First Protection plant, according to natural resources reducing seriously and the current conditions being chopped down in 1999, and carried out the general resources survey, has been building up the artificial breeding and cultivating bases of *Taxus Mairei* to satisfy the need of the society.

In the last few years, there have been some investigations and research papers on *Taxus*, but the treatise on *Taxus Mairei* have seldom been reported. This research paper is a model of inquiring into nature's distribute, the resources, the growth environment, plant type, the biology characteristic etc, local currently, by taking whole province as the unit in China till now. It studies the technique on *Taxus Mairei*'s stand growths, trunk growing analyzing, timber nature, breeding and the cultivation separately (including the seed processing, urging the bud and sowing seeds, cultivating the seedling, cutting, etc), and obtains the plenteous result, which fills a gap in afforestation technique about *Taxus Mairei*. It provides the precious technique data for each cultivated area of *Taxus Mairei*. At the same time, the research paper puts forward the viable suggestion to countermeasure, the development and utilizations.

2 FOREWORD II

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To sum up, the research paper is the best treatise on *Taxus Mairei*'s survey and studies, and attains leading authorities to the same domestic research.

Botanical Institute of the Chinese Academy of Sciences, Researcher Fu Liguo

A handwritten signature in black ink, consisting of the Chinese characters '傅立國' (Fu Liguo) written in a cursive style.

2005. 10

# 前 言

南方红豆杉，又称美丽红豆杉，属于裸子植物门（Gymnospeymae）红豆杉科（Taxaceae）红豆杉属（*Taxus*）植物。学名：*Taxus wallichiana* var. *mairei*，古老的新生代第三纪残存的孑遗植物。1999年8月，国务院已列为第一批国家一级重点保护的珍贵树种。南方红豆杉，不但木材材质优良，是珍贵的乡土用材树种；它又是常绿乔木，树干通直，树姿婆娑，为优美的园庭观赏树种；特别是南方红豆杉的树皮、树根和枝叶，含有抗癌物质紫杉醇，是世界上公认的具有最好抗癌效果的药用树种之一。

紫杉醇是红豆杉树种体内产生的一种独特骨架的双萜类化合物。1971年美国化学家瓦尼（Warni）最早从太平洋（短叶）红豆杉（*Taxus breuifolia*）树种树皮中分离出来，并发现其有较好的抗癌作用。20世纪80年代初期，Horwitz等人进一步证实，它在癌细胞分裂时，与细胞管蛋白结合，从而阻断了癌细胞分裂。经临床试验，具有广谱抗癌效果，对颈部肿瘤、胃癌、肺癌、食道癌、结肠癌、乳腺癌、卵巢癌等具有良好的疗效。尤其是对乳腺癌、卵巢癌的治愈率、有效率均比其它药物为好。1992年12月29日，得到美国食品与药物管理局（FDA）批准后，紫杉醇很快便成为全世界最重要的抗癌药物之一。

目前，全世界红豆杉属植物约9种，主要分布在北半球。野外资源十分紧缺，野生的红豆杉全世界仅1000万株。全球每年至少要生产5000 kg，才能满足要求，而实际当前生产能力350 kg。由于此前几乎没有进行规模化人工种植，野生的红豆杉一开始就成了紫杉醇提取的唯一来源，每提取1 kg的紫杉醇，就需要消耗掉15~30 t的红豆杉树皮，一棵棵被残忍剥皮死去的红豆杉，在东南亚和中国，数以百万计，令人触目惊心。直到20世纪末，我国公布红豆杉为一级重点保护植物，明令禁止直接采集野生红豆杉的树皮、根、枝叶来提取紫杉醇。全国各地红豆杉种类，在濒临灭绝境地的时候，得到了国家法律上的重点保护。

在人工种植红豆杉完全替代野生来源，或者紫杉醇的人工合成取得

成功前，红豆杉灭绝的威胁依然存在。作者着重在 2000 年 9 月前，对南方红豆杉进行野外资源调查，重点对其自然分布、生境条件、生物学特性、作了全面系统的了解，并对于人工繁育栽培技术作了整体性研究，从生产和试验的基础上，提出一整套完善的南方红豆杉人工栽培技术体系，为各地建设规模化人工栽培基地，提供科学依据。

高 兆 蔚

2005 年 10 月于福州

# PREFACE

*Taxus wallichiana* var. *mairei* belongs to the Taxus, Taxaceae, Gymnospermae and is the surviving plant of the ancient Cenozoic Tertiary period. It was listed one of the first-group national first-rate emphatically protective precious tree species by the State Council of the PRC in August, 1999. Its timber quality is fine and it is a precious native timber tree species. It is also an evergreen arbor with a straight trunk and an elegant figure. It is a graceful ornamental garden tree species. Its bark, roots, branches and leaves contain yew alcohol, the anticancer matter. It is generally recognized that *T. Wallichiana* var. *mairei* is one of the medicinal tree species with the best anticancer effects in the world.

Yew alcohol is a unique skeletal diterpenoids compound producing in the body of yew species. In 1971, the American chemist Warni separated yew alcohol from *T. brevifolia* bark at the earliest and found it possessed better anticancer effects. At the beginning of 1980s, Horwitz et al. further confirmed that yew alcohol combined with the protein in cell ducts when cancer cells divided, which blocked the cancer cells' division. The clinical experiment demonstrated that yew alcohol had a broad-spectrum anticancer effect and a fine curative effect on the cervical tumor, gastric cancer, cancer of lung, carcinoma of esophagus, carcinoma of colon, mammary cancer and oophoroma. Especially its cure rate and effective rate were better than those of other drugs for the mammary cancer and oophoroma. Yew alcohol has quickly become one of the most important anticancer drugs in the world after the approval of the FDA on Dec. 29, 1992.

At present, there are about 9 species of Taxus plants all over the world, mainly distributing in the Northern Hemisphere. Its field resources are quite short. There are only 10 million wild yew plants in the whole world. 5000 kg of yew alcohol should be yearly produced to meet needs, but the present actually productive capacity only reaches 350 kg. The artificial planting of scale has been hardly conducted in the past, so at the beginning the wild yew became the only source of abstracting yew alcohol. Abstracting 1 kg of yew alcohol needs to consume 15 ~ 30 t

of yew bark. It was startling that millions of yew trees were killed by being cruelly peeled in Southeast Asia and China. Up to the end of the last century, China announced yew as the first-rate emphatically protective plant and prohibited people from directly collecting the bark, roots, branches and leaves of wild yew trees to abstract yew alcohol. The yew species all over the country were emphatically protected by the national law when they were on the verge of extinction.

The threat against the yew extinction will still exist before artificially planting yew trees entirely replaces wild yew trees or artificially synthesizing yew alcohol succeeds. This book emphatically investigated the field resources of *T. wallichiana* var. *mairei* before Sept. 2000, wholly and systematically comprehended its natural distribution, habitat conditions and biological characteristics, conducted the integral study on its artificial breeding and cultural techniques, and based on the production and experiment, put forward a whole set of perfect artificially cultural technique system of *T. wallichiana* var. *mairei* to provide a scientific basis for building the scale artificially cultural bases in every area.

The following appendix to this book is the key material in the book: Investigation on the Resources of the Precious Tree Species-*T. wallichiana* var. *mairei* and Study on Its Breeding and Cultural Techniques. The results of this research were appraised by the national-level experts and professors in 2000. Mr. Fu Ligu, the research fellow of the Plant Research Institute of the Chinese Academy of Sciences, pointed out that the monographs on *T. wallichiana* var. *mairei* were very few and this research report should be the most excellent result of the ones of investigating and studying *T. wallichiana* var. *mairei* all over the country. The features of this book are as follow: easy to understand; both pictures and texts are excellent; based on the practice; and summing up the experience. The book possesses a certain reference sense for the national forestry scientific and technical personnel as well as universities and colleges to carry out the study on yew, conduct the directive cultivation and instruct the productive practice.

Gao Zhaowei

in Fuzhou in October, 2005



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1. 福建省上杭县步云乡马坑村南方红豆杉群落及其生长环境概貌。分布区域海拔高900~1200m, 面积14hm<sup>2</sup>; 胸径大于10cm以上1026株。其中140cm胸径以上4株, 130~140cm的2株, 120~130cm以上4株, 110~120cm的5株, 100~110cm的4株, 90~100cm的12株, 80~90cm的19株。平均年龄多在400~600年以上, 是目前南方红豆杉天然群落保护得较好的一片 (1999年8月摄)

2. 福建省上杭县步云乡马坑村崇头自然村 (1999年8月摄)



3. 南方红豆杉群落植被组成。福建省上杭县步云乡马坑村崇头自然村(分别于1998年8月与2003年3月摄)

4. 福建省闽侯县大湖乡半山村旁, 在海拔820m的地方, 一片阔叶树与南方红豆杉混交林植被外貌(摄于1999年10月)





# NANFANGHONGDOUSHAN

5. 南方红豆杉群落植被情况(福建省清流县温郊乡温家山村, 2001年7月摄)

6. 福建省明溪县南方红豆杉群落植被情况(2005年8月摄)

