裸子植物结构图集

ATLAS OF STRUCTURE OF GYMNOSPERMS

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中国科学院重点基金资助项目
国家自然科学基金资助项目
中国科学院植物研究所
系统与进化植物学开放研究实验室资助项目

Supported by
The Research Grant of Chinese Academy of Sciences
National Natural Science Foundation of China
The Grant of Laboratory of Systematic and Evolutionary Botany
Institute of Botany, Chinese Academy of Sciences

科学出版社
Science Press
Beijing China
2000

内 容 简 介

本书是以中国科学院植物研究所多年来对裸子植物形态结构研究的成果为基础，并广泛汇集了国内各有关科研单位和大专院校的研究成果，从中精选出具有代表性的显微和超微结构图片800余幅，同时配有部分线条图或模式图编写而成。全书共分十章，第一章为绪言，从第二章至第九章系按不同器官或组织进行分章排列，最后一章是中国学者在现存裸子植物结构方面发表的论文题录。各章节以及每一幅图均附有中文与英文（或拉丁文）两种文字说明。

本书为国内外从事植物分类学与系统植物学、形态学、解剖学、胚胎学、孢粉学、林学、古植物学和保护生物学等有关学科的研究人员、大专院校师生的重要参考书。

Summary

This atlas is mainly derived from the long-standing collections in the morphological and structural studies of the gymnosperms conducted in Institute of Botany, Chinese Academy of Sciences, together with a wide range of research achievements provided by various organizations. Selected from a wide coverage of published figures, over 800 graphs, drawings of light microscope, scanning electron microscope and transmission electron microscope were arranged according to different organs and tissues. The atlas contains ten chapters, the first one for preface, from the second to the ninth chapter for graphs, drawing of organs/tissues, the final chapter for a list of publications on the structure of gymnosperms contributed by Chinese researchers. The atlas, attached with Chinese and English/Latin explanation, is a well-suitable reference book for professional researchers, university students.

图书在版编目（CIP）数据

裸子植物结构图集 / 林金星，胡玉熹主编．－北京：
科学出版社，2000
ISBN 7-03-008281-8

Ⅰ．裸… Ⅱ．①林… ②胡… Ⅲ．裸子植物－生物结构－图集
Ⅳ．Q949.6-64

中国版本图书馆 CIP 数据核字（2000）第 02214 号

科学出版社出版
北京东黄城根北街 16 号
邮政编码：100717

中国科学院印刷厂印刷

新华书店北京发行所发行　各地新华书店经售
*
2000 年 8 月第　一　版　开本：787 × 1092　1/16
2000 年 8 月第　次印刷　印张：16
印数：1—1 200　字数：362 000

定 价：65.00 元

（如有印装质量问题，我社负责调换〈科印〉）

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序

现代生长在地球上的裸子植物，通常可分成四类：苏铁类、银杏、松杉类和买麻藤类。这四类植物在分类系统上，一直存在着各种不同意见。有的将其各目提升为纲或亚纲，有的则定为门或亚门，甚至还有的建议废去“裸子植物”这个词。不过现今大多数学者为了方便起见，乃以科作为单位进行各种描述。裸子植物各科为：苏铁科（包括了Kubitzki（1990）的苏铁科、蕨铁科、波温铁科、泽米科）、银杏科、南洋杉科、松科、杉科、柏科、罗汉松科、三尖杉科、红豆杉科、麻黄科、买麻藤科与百岁兰科，其中苏铁科只有11个属，多散布在亚洲、大洋洲、非洲及南北美洲等地，很少成林。该科除苏铁属和泽米属以外，其余9个属均已成为濒危植物。现存的银杏属原只生长在我国，现在已被广泛种植于世界各国。松杉类各科植物大多已形成大片森林，其覆盖面积几达全球森林覆盖率的一半。裸子植物按其属的数量而论，我国则几乎占有其3/5。现已公认，中国及其周边地区是世界上松杉类植物的分布中心之一，另一中心则为澳大利亚及其东部岛屿。我国有如此众多的裸子植物属种，其中许多是特有属和特有种，这就很值得我们高度重视和系统研究。

回顾半个多世纪以来，我国在裸子植物结构方面的科研工作，已积累了不少成果，但由于大多比较零散，同时又缺乏一些综合性的著作，因此一直未能引起国际学术界的足够重视和较多引用。另外，文字上的障碍，也影响了此等学科在国际上的交流。《裸子植物结构图集》的出版，将极大地弥补这些缺憾。该书比较全面地引用了我国历年来有关裸子植物结构方面的文献，并从这些文章和专著中精选出了大量图片（照片或线条图），用中文和英文给以详细介绍和说明。全书内容相当丰富，它包括了裸子植物的苗端（茎端）、叶、次生木质部（木材）、次生韧皮部、根、花粉、雌雄生殖器官和种子等组织或器官的结构图片，其中一些扫描电镜下摄制的图像，十分清晰和生动。这本图集颇具我国特色，有较大的科研和实用参考价值，而且也是植物学教学上一本非常难得的图示教材。该书的出版，无疑将能促进我国裸子植物各学科进一步地发展。

北京大学生命科学学院

李正理

1999年10月

Preface

The gymnosperms that presently grow on the earth are generally classified into 4 kinds, viz., Cycads, *Ginkgo*, Conifers, and Gnetales. Their taxonomic positions, since they had been classified into 4 orders in the early time, have always been a debatable concern. Some scientists have raised the designation of order to class or subclass and others had recognized them as division (phylum) or subdivision (subphylum) and they even abrogated the term gymnosperms. Nevertheless, up to date, and just for convenience they are generally recognized as the following families: Cycadaceae, Stangeraceae, Boweniaceae, Zamiaceae, Ginkgoaceae, Araucariaceae, Pinaceae, Taxodiacee, Cupressaceae, Podocarpaceae, Cephalotaxaceae, Taxaceae, Ephedraceae, Gnetaceae and Welwitschiaceae. Although there are only 11 genera in Cycadaceae, yet they are widely distributed in the continents of Asia, Oceania, South and North America, and Africa; and seldom become forest. Aside from *Cycas* and *Zemia*, the other 9 genera are considered as endangered plants. *Ginkgo*, originally grown only in China, are now distributed all over the world. The conifers has become large global forests with a coverage almost reaching half of the total global coverage, and almost 3/5 of the total genera are located in China. It has been generally recognized that China including her peripheral regions owns one of the conifers center in the world while the other centers are in Australia and her east islands. The vast amount of coniferous genera and species in which there many specific genera and species found in China, merit our priority attention.

Reviewing the body of achievements from the botanical research of gymnosperms in the last six decades, quite a good deal of the studies were rather diversified that made it difficult to arouse international academic interests and not many of which were quoted as references, Unfortunately, because of language difficulty and the lack of introducing more review articles to the public, international communications in the relevant field of study are very much limited. Thus, the publication of the "Atlas of the Structure of Gymnosperms" may greatly remedy those defects and regrets. The book embodies quite a comprehensive list of the published references relevant to the researches of gymnosperms in previous years. It contains a collection of pictures (photographs and line-drawings) from various articles presented in systematical illustrations in both Chinese and English explanations.

It is an atlas of individualized characteristics and of practical value. The atlas contains a rich body of materials involving illustrations of the structures shoot tip (stem tip), leaf, the secondary xylem (wood), the secondary phloem, root, pollen, male and female reproductive organs, seeds, etc., especially the SEM micro-photographs which are clearly and vividly discernible. It is not only a very valuable reference for research and also an illustrative teaching material for teaching botany that is hard to obtain. The publication of the atlas by all means further promote the developments of various subjects of studying gymnosperms in our country.

October 1999

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名词缩写说明

Abbreviations

AC = albuminous cell (蛋白质细胞)
AI = apical initial cell (顶端原始细胞)
AM = apical meristem (顶端分生组织)
Ar = archegonia (颈卵器)
AT = accessory transfusion tissue (副转输组织)
AZ = algae zone (藻区)
BC = body cell (体细胞)
Br = bract (苞片)
BS = bud scale (芽鳞)
Ca = cambium (形成层)
CC = cap cell (冠细胞)
Cec = central cell (中央细胞)
CF = crystalliferous phloem fiber (含晶韧皮纤维)
CI = central initial cell zone (中央原始细胞区)
Co = cortex (皮层)
CP = cryatalliferous parenchyma cell (含晶薄壁组织细胞)
Cr = crystal (晶体)
CT = crown columnar tissue (柱状组织)
CW = cell wall (细胞壁)
Cy = cotyledon (子叶)
Cyp = cotyledonary primordium (子叶原基)
E = egg cell (卵细胞)
EC = epithelial cell (上皮细胞或泌脂细胞)
Ec = ectexine (外壁外层)
EE = embryonic epidermis (胚表皮)
EG = embryo cell group (胚细胞群)
EH = epidermal hair (表皮毛)
Em = embryo (胚)
Emc = embryonic cell (胚性细胞)
Emr = embryonic cortex (胚皮层)
EN = egg nucleus (卵核)
En = endodermis (内皮层)
Ent = endotesta (内种皮)
Ep = epidermis (表皮)
ER = endoplasmic reticulum (内质网)
Es = endosperm (胚乳)
ET = embryonal tube (胚管)
Ex = endexine (外壁内层)
Exi = exine (外壁)
Ext = exotesta (外种皮)
FE = fertilized egg (受精卵)
FG = female gametophyte (雌配子体)
FN = free nucleus (游离核)
FR = florin ring (伏罗林环)
GB = golgi body (高尔基体)
GC = generative cell (生殖细胞)
He = heterocysts (异型胞)
HN = harting net (哈氏网)
Hp = hypodermis (皮下层)
HS = hypha sheath (菌丝鞘)
Hv = heterovesicle (异质小泡)
Hy = hypocotyl (下胚轴)
IF = intercellular flange (胞间凸缘)
In = integument (珠被)
Int = intine (内壁)
JC = jacket cell (套层细胞)
LB = lipid body (脂质体)
M = mitochondrium (线粒体)
Ma = margo (塞缘)
Me = mesophyll (叶肉)
Mem = megaspore mother cell (大孢子母细胞)
Mi = microsporophyll (小孢子叶)
Mim = microspore mother cell (小孢子母细胞)
ML = middle lamella (中层)
Mp = micropyle (胚珠)
Ms = mesosperm (中种皮)
Muc = mucilage cell (黏液细胞)
N = nucleus (细胞核)
NC = neck cell (颈细胞)
Nc = nucellus (珠心)
Ne = neocytoplasm (新细胞质)
Nu = nucleolus (核仁)
OD = osmiophilic droplet (嗜锇滴)
Op = open tier (开放层)
OS = ovuliferous scale (珠鳞)
P = plastid (质体)
PA = pit aperture (纹孔口)
PC = parenchyma cell (薄壁组织细胞)
Pcr = protein crystal (蛋白质结晶)
Pct = per-column tissue (环柱组织)
Pe = periderm (周皮)
PE = primary embryo cell (初生胚细胞)
PF = phloem fiber (韧皮纤维)

PG = phycocyanobilin grain (藻青素颗粒)
Ph = phloem (韧皮部)
Pi = pith (髓)
Pib = pit border (纹孔缘)
Pic = pit cavity (纹孔腔)
PL = primary leaf (初生叶)
PM = pit membrane (纹孔膜)
Po = pollen (花粉)
Poc = pollen chamber (储粉室)
PP = phloem parenchyma cell (韧皮薄壁组织细胞)
Pr = procambium (原形成层)
PR = phloem ray (韧皮射线)
Prc = prothallial cell (原叶细胞)
PS = primary suspensor (初生胚柄)
PT = prosuspensor tier (原胚柄层)
PV = protein vesicle (蛋白泡)
PW = primary wall (初生壁)
RA = root apex (根端)
RC = root cap (根冠)
RD = resin duct (树脂道)
Re = resinocyst (树脂囊)
RI = root initial (根原始细胞)
Rot = rosette tier (莲座层)
RP = ray parenchyma cell (射线薄壁组织细胞)
RT = ray tracheid (射线管胞)
S = sclereid (石细胞)
S_1 = outer layer of secondary wall (次生壁外层)
S_2 = central layer of secondary wall (次生壁中层)
S_3 = inner layer of secondary wall (次生壁内层)
SA = shoot apex (苗端)
Sa = saccus (气囊)
Sc = scion (接穗)
SC = seed coat (种皮)
SG = starch grain (淀粉粒)
Sp = sperms (精子)
Sia = sieve area (筛域)
Sm = stoma (气孔)
SP = secondary phloem (次生韧皮部)
Spc = spermatogenous cell (精原细胞)
Spw = sporangium wall (孢子囊壁)
ST = spongy tissue (海绵组织)
St = stock (砧木)
Stc = sterile cell (不育细胞)
Stl = stele (中柱)
Su = suspensor (胚柄)
Sut = suspensor tier (胚柄层)
SW = seed wing (种翅)
SX = secondary xylem (次生木质部)
T = tracheid (管胞)
Ta = tapetum (绒毡层)
TC = tube cell (管细胞)
Th = thylakoid (类囊体)
TN = tube nucleus (管核)
To = torus (纹孔塞)
TR = traumatic resin duct (创伤树脂道)
Trt = transfusion tracheid (转输管胞)
TT = transfusion tissue (转输组织)
UT = upper tier (上层)
Va = vacuole (液泡)
VB = vascular bundle (维管束)
Vbs = vascular bundle sheath (维管束鞘)
VC = ventral canal cell (腹沟细胞)
VT = vascular tissue (维管组织)
WP = wood parenchyma cell (木薄壁组织细胞)
XR = xylem ray (木射线)
Xy = xylem (木质部)
Zy = zygote (合子)

1 绪言 Introduction

裸子植物的演化历史十分悠久，早在3亿多年前的古生代泥盆纪就已出现，由于地质气候的多次变迁，曾经繁盛一时的裸子植物，不少种类已相继灭绝，而新的种类又陆续演化出来。现今地球上仅存的裸子植物有近千种，依据Kubitzki, K. (1990)的分类系统，它们分属为17科，82属，其中包括银杏科（1属1种）、松科（12属约200种）、杉科（9属约16种）、柏科(约20属125种)、Phyllocladaceae（1属1种）、南洋杉科(2属约32种)、罗汉松科(17属约125种)、三尖杉科(2属约12种)、红豆杉科(4属约20种)、波温铁科(Boweniaceae)（1属2种）、苏铁科（1属约20种）、蕨铁科（1属1种）、泽米科（8属约100种）、麻黄科(1属35~45种)、买麻藤科(1属约30种）和百岁兰科(1属1种)。显然，与被子植物的种类(12 500属25万种)相比，裸子植物的现存种类要少得多，但它们在陆地上的森林覆盖率却高达50%以上。由此可见，裸子植物对于人类的生存及国民经济建设等方面，均起着极为重要的作用。

我国裸子植物资源十分丰富，仅现存裸子植物就有11科，41属，300多种和变种，约占全世界所有现存裸子植物种类的半数左右。其中特别是许多属种，如银杏属(*Ginkgo*)、银杉属(*Cathaya*)、金钱松属(*Pseudolarix*)、水松属(*Glyptostrobus*)、水杉属(*Metasequoia*)、台湾杉属(*Taiwania*)、福建柏属(*Fokienia*)、侧柏属(*Platycladus*)，以及攀枝花苏铁(*Cycas panzhihuaensiss*)、百山祖冷杉(*Abies beshanzuensis*)和白豆杉(*Pseudotaxus chienii*)等等，均为我国特有的珍稀濒危属种或驰名中外的活化石。这些种类不仅是我国极其珍贵的种质基因资源，而且对研究生物多样性和植物系统发育等都提供了十分宝贵的原材料。

在我国对于裸子植物解剖学、胚胎学和孢粉学的研究已有较长的历史，早在20世纪30年代初开始，先后就有唐耀（1933）对中国裸子植物各属木材的研究、张景钺（1936）对松树树脂细胞的研究、徐仁（1936）对我国华北松杉类植物叶子的解剖研究、王伏雄（1944, 1947, 1948, 1950, 1955, 1960）分别对云南油杉、水松和罗汉松等植物胚胎发育的研究及中国裸子植物孢粉学的研究、喻诚鸿（1948, 1949）对水杉木材构造和我国西康6种松杉类植物木材结构的研究、李正理（1952, 1953, 1954, 1955）对拟紫杉陆均松叶子的结构和银杏受精作用的研究、张英伯（1954）对北美松杉类植物树皮显微结构的研究等，上述成果至今仍受到广泛引用。此后，经历了近半个世纪两三代人的不懈努力，现已取得了大量新的科研成果，特别是近二三十年来，在王伏雄院士的亲自主持下，中国科学院植物研究所组织了多学科的科研人员，对裸子植物进行了系统、全面地研究，所涉及的研究对象为该类群的绝大部分科属。据近年来的不完全统计，我所在国内外重要学术刊物上发表有关裸子植物方面的论文已有百余篇，同时还出版发行了《中国植物志》（第七卷）（1978）、《松树形态结构与发育》（1978）、《银杉生物学》（1990）、《王伏雄论文选集》（1993）、《三尖杉生物学》（1999）等著作。上述研究成果曾引起了国

内外同行的瞩目和强烈反响。此外，国内还有很多大专院校和科研单位，如北京大学、西北大学、中山大学、南京林业大学、中国林业科学院木材工业研究所、中国科学院华南植物研究所等，也都对裸子植物的结构作过大量的研究工作，这些都为探讨裸子植物的分类及其系统演化等方面提供了极其珍贵的资料和重要的科学证据。

本书是以中国科学院植物研究所多年来对裸子植物形态结构的研究成果为基础，广泛汇集了我国各有关科研单位和大专院校的研究成果，从中精选出具有代表性的，在光学显微镜、扫描电子显微镜和透射电子显微镜下的图片800余幅，同时配有少量线条图或模式图编写而成的。全书系按照郑万钧和傅立国（1978）的裸子植物分类系统，并以不同器官或组织进行分章排列，其中不仅有裸子植物各类群重要结构特征的横向比较，而且还有从雌雄配子体发育到胚胎成熟等不同时期的纵向比较。各章节以及每一幅图均附有中文与英文两种说明，最后一章系中国学者在现存裸子植物结构方面（解剖学、胚胎学、孢粉学和实验形态学）发表的论文题录（台湾省学者发表的有关论文尚未包括在内）。本书适合于国内外从事植物分类学与系统植物学、形态学、解剖学、胚胎学、孢粉学、林学、古植物学和保护生物学等有关学科的研究人员、大专院校师生学习和参考。

在本图集编写工作中，得到了国内许多专家学者的大力支持和帮助，其中特别是在申请国家自然科学基金委员会优秀研究成果专著出版基金过程中，洪德元院士和王文采院士给予了热情的鼓励和帮助，值此一并表示衷心地感谢。由于本书的编写时间较短，编著者的业务水平有限，错误与遗漏之处，敬请广大读者批评指正。

林金星 胡玉熹

1999年10月 于北京香山

The gymnosporms have a long evolutionary history which may date back to the Devonian, at least three hundred millions of years. With the change of environmental conditions, some taxa which flourished for a time became extinct and some new taxa appeared as a result of diversification of the ancient group. It was estimated that there exist about one thousand species of the gymnosperms in the world, and the remaining members of which are frequently grouped into four orders containing 82 genera of 17 families in accordance to Kubitzki(1990) classification system. Although the number of extant species is much lower compared with the angiosperms, the gymnosperms covered over 50% of forest area in the world. Needless to say, they are of importance for human survival and economic development.

China is the third largest country in the world with its land area covering approximately 9.6 million km^2. From north to south, its territory extends from 5 500 km through the cold-temperate, warm-temperate, subtropical and tropical zones. From west to east, it measures 5 200 km, stretching from the Qinghai-Tibetan plateau to the Hubei plain. The great diversity in topographic, climatic and ecological conditions in China results in an exceedingly luxuriant vegetation and rich flora.It was calculated there are 11 families containing over 300 species of 41 genera of the gymnosperms in China, among which many are considered endemic or rare species, e.g. *Ginkgyo*, *Cathaya*, *Pseudolarix*, *Metasequoia*, *Taiwania*, *Fokienia*, *Platycladus*, *Cephalotaxus*, *Pseudotaxus*, and *Cycas panzhihuaensis*, *Abies beshanzuensis* and *Pseudotaxus chienii* etc. These taxa are not only important resources of gene bank, they are also precious materials for evolutionary and phylogenetic researches as well.

Research on anatomy and embryology of gymnosperms in China has a relatively long history, which date back to 1930's. Some pioneer researches provided solid basis for the future investigations, and they were still widely cited nowadays. For instance, Tang (1933) comparatively investigated the wood structure of the gymnosperm, Zhang (1936) firstly found the resin cells in *Pinus* xylem; Xu (1936) made systematic description on leaf structure of pine trees in the northen China; Wang (1944, 1947, 1948, 1950) made detailed studies on embryological development of *Ketelerria evelyniana*, *Glyptostrobus pensilis* and *Podocarpus macrophyllus*; Yu (1948, 1949) described the wood structre of *Metasequoia* and several conifers from Tibet; Li (1952, 1953, 1954, 1955) thoroughly studied leaf structure of *Dacrydium taxoides* and fertilization of *Ginkgo*; Chang (1954) observed the bark structure of northern American conifers. Consequently, a dozen of researchers have been concentrating on such a topic in the last half century, in particular, a research group presided by Prof. Fu-hsung Wang In Institute of Botany, Chinese Academy of Sciences in the last decade has conducted systematic and comparative studies on many taxa including 37 genera of 9 families. As a result, about one hundred of academic papers were published at home and abroad. Several monographes appeared to readers, the examples of which include "Structure and Development of *Pinus*", "Biology of *Cathaya*", "Biology of *Cephalotaxus*" and "Selected Works of Wang Fu-hsuing". These publications have received worldwide attention and postive response from the researchers all over the world. In addition, some other organizations, e.g. Peking University and Chinese Academy of Forestry also performed a series of specific researches and collected a wide set of evidences which contributed tremendously to the systematic and evolutionary study in the gymnosperms.

This atlas is mainly derived from the long-standing collections in the anatomical, embryological and palyonology studies of the gymnosperms conducted in Institute of Botany, Chinese Academy of Sciences, together with a wide range of research achievements provided by various organizations. Selected from a wide coverage of published figures, over 800 graphs, drawings of light microscope, scanning electron microscope and transmission electron microscope were arranged in terms of different organs and tissues according to Cheng and Fu (1978) classification system.The final chapter contains a list of publications on the structure of gmnosperms contributed by Chinese researchers.

It was attempted to provide coverage of comparative characteristics from various taxa, and to supply explanation of development framework for different stages. The atlas, attached with Chinese and English/Latin explanation, is a well-suitable reference book for researchers, university students.

The book has benefited tremendously from the generosity, cooperation and help of many professional colleagues and others who have provided illustrative materials in the form of original pictures or photographs, prints, negatives or slides from their publications for inclusion in the book. In particular, we should acknowledge with gratitude the encouragement and recommendation from the CAS academicians Prof. Hong Deyuan and Prof. Wang Wencai during our application for the publication grant of National Natural Science Foundation of China.

October, 1999
Xiangshan, Beijing

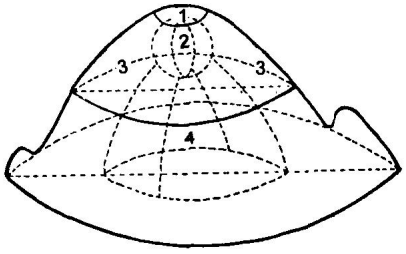
Lin Jinxing & Hu Yuxi

2 苗端 Shoot apex

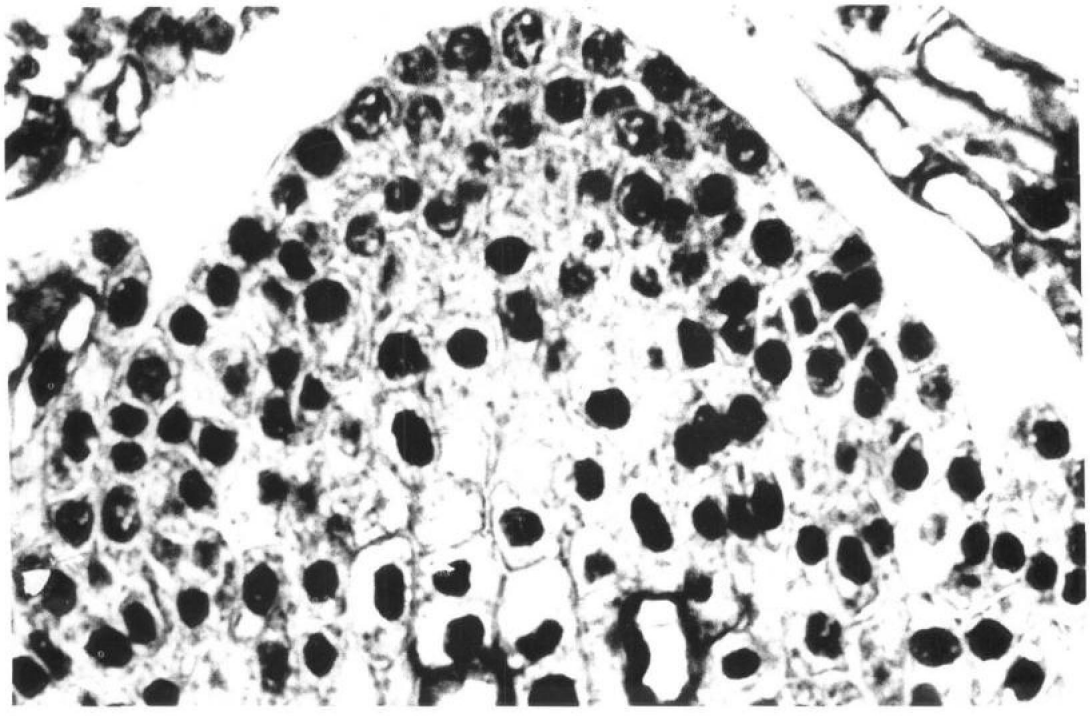
2.1 苗端分区 Zonation of shoot apex

裸子植物营养苗端结构，除南洋杉属和麻黄属为原套-原体结构外，其余均为细胞-组织学分区结构，通常可分为：（1）顶端原始细胞群，（2）中央母细胞区，（3）侧面分生组织区，（4）肋状分生组织区。通过对榧树苗端显微结构，以及淀粉在其苗端分布与消长规律的研究，进一步阐明了裸子植物苗端分区结构的特性。

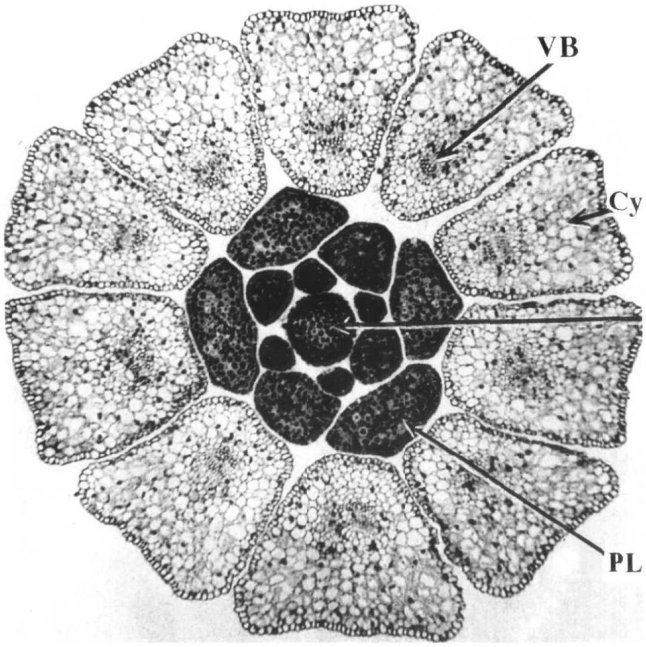
With the exception of tunica-corpus structure of *Araucaria* and *Ephedra*, the structure of vegetative shoot apex in many gymnosperms is cyto-histologic zonation. The zonation may be characterized by dividing (1) the apical initials, (2) the central mother cells, (3) the peripheral zone, (4) the rib meristem. The zonation nature of shoot apex is further clarified with the studies of ultrastructural and histochemical characters in the shoot apex of *Torreya grandis*.



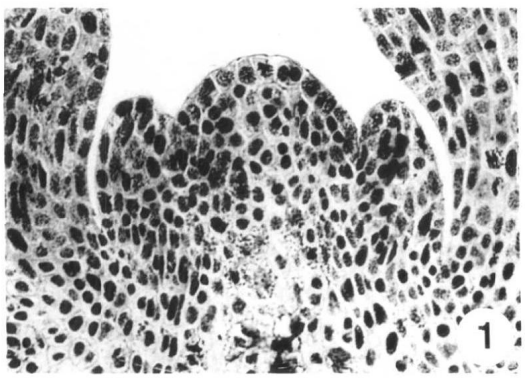
裸子植物营养苗端的分区图解
Diagram of zonation of vegetative shoot apex for gymnosperms

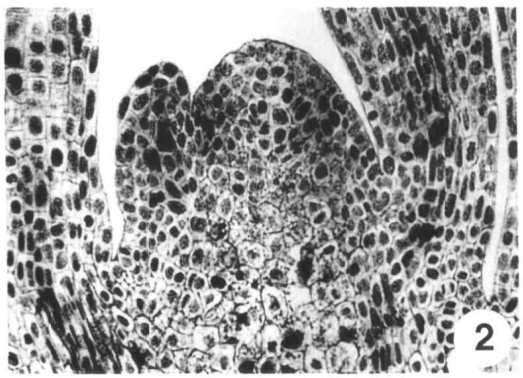


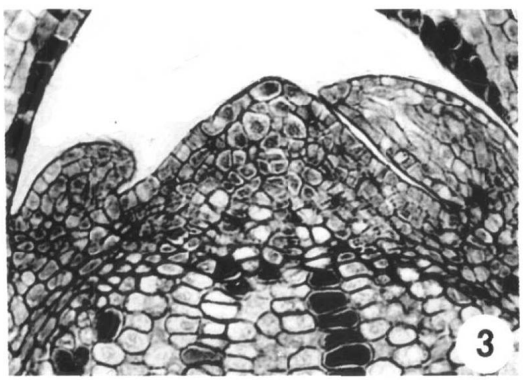
台湾杉苗端纵切面 Longitudinal section of shoot apex of *Taiwania cryptomerioides* (X280)

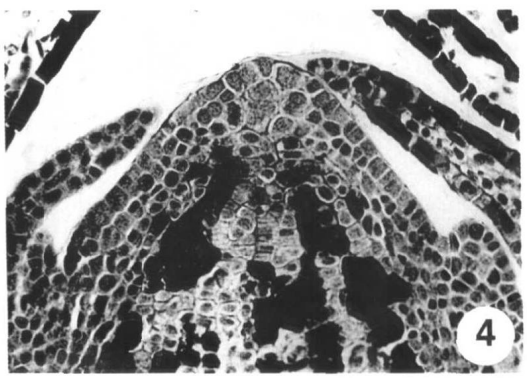


油松近苗端横切面
Transection of near shoot apex of *Pinus tabulaeformis* (X45)

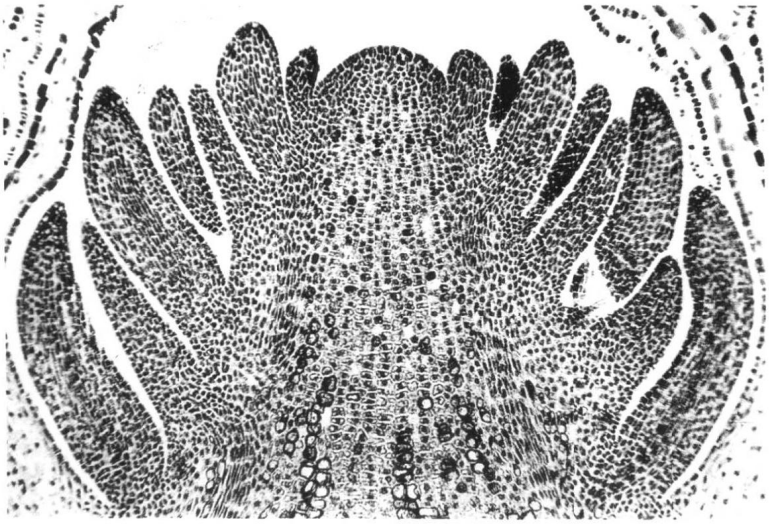




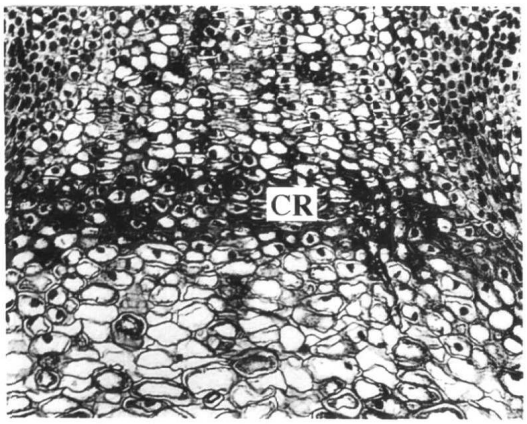




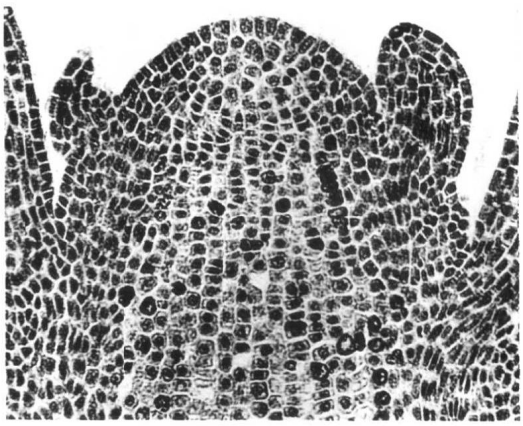
(1)油松出苗后 3 天的苗端结构(示无分区结构),(2)油松出苗后 15 天的苗端结构 (示已开始出现分区结构), (3)油松冬季休眠期苗端结构, (4)油松新芽形成期苗端结构
(1)Shoot apex when seedling is 3 days old, (2) in 15 days, (3) resting period, (4) new terminal bud formation period of *Pinus tabulaeformis* (X150)



银杉顶芽纵切面
Longitudinal section of terminal bud of *Cathaya argyrophylla* (X60)

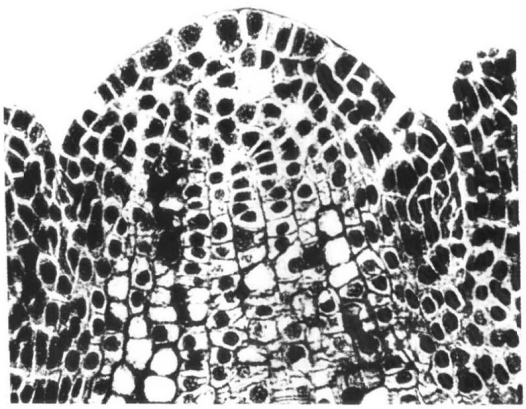


银杉顶芽基部的冠区
The crown region of terminal bud of *Cathaya argyrophylla* (X150)

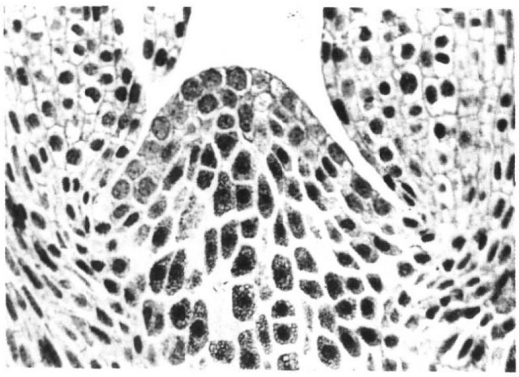


银杉营养苗端
Shoot apex of *Cathaya argyrophylla* (X150)

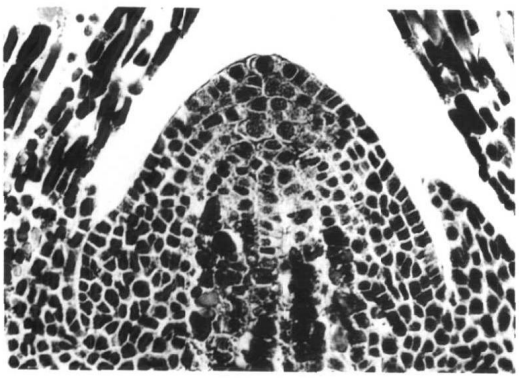
银杉苗端（生长期 II）
Shoot apex of *Cathaya argyrophylla* (growth period II) (X200)



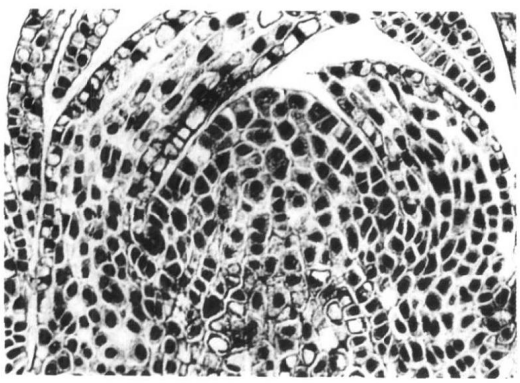
银杉苗端（休眠期）
Shoot apex of *Cathaya argyrophylla* (resting period) (X200)



油松幼苗苗端 Shoot apex of seedling of *Pinus tabulaeformis* (X150)

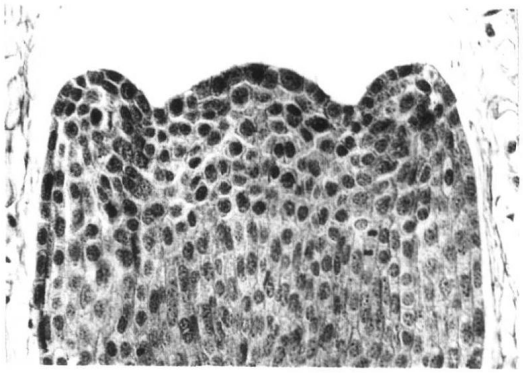


白皮松苗端（新芽形成期）Shoot apex of *Pinus bungeana* (new terminal bud formation period)(X150)

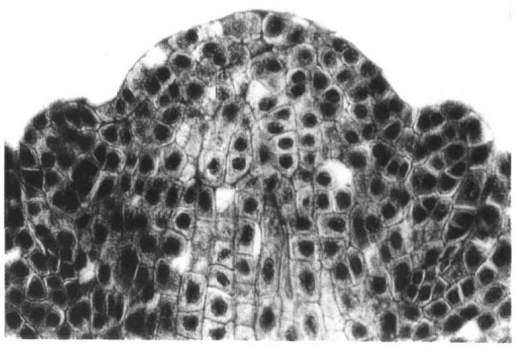


白皮松苗端（休眠期）Shoot apex of *Pinus bungeana* (resting period)(X150)

油松后期胚苗端 Shoot apex of late embryo of *Pinus tabulaeformis* (X150)



三尖杉苗端 Shoot apex of *Cephalotaxus fortunei* (X210)



篦子三尖杉苗端 Shoot apex of *Cephalotaxus oliveri* (X210)