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神奇的中美红杉树
Amazing Chinese and American Redwoods

纪迫白垩年一亿，莽莽坤维风景丽。
特西斯海亘穷荒，赤道暖流布温煦。
陆无山岳但坡陀，沧海横流沮洳多。
密林丰蔽蔽天日，冥云玄雾迷羲和。
兽蹄鸟迹尚无朕，恐龙恶蜥横婆娑。
水杉斯时乃特立，凌霄巨木环北极。

——胡先骕

In a world which will continue to change, there is no basis for predicting with certainty what forests may occupy our Pacific shores in the remote future. But surely for many centuries the Coast Redwoods, set aside in California State Parks, will continue to stand as living examples of conservation made possible by contributions to the Save the Redwoods League from people all over the world.

—— Ralph W. Chaney



Amazing Chinese and American Redwoods
神奇的中美红杉树

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神奇的中美红杉树

Editor-in-Chief: Chen Momei

主编: 湛谟美

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Beijing

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序 言

尽管本书以古代植物的谱系作为主题，但是它确实建立了与现代世界极其相关的三个方面的联系。首先，它涉及现在生物多样性的破坏，植物系谱受到严重干扰，诸如由于自然生境的破坏和人类造成的气候变化。现存红杉树在万难中才存活下来，然而它们又遇到了历史上前所未有的、来自人类的挑战。那些小一点的生物和大树共享生存环境，而这些并不出众的生物也面临了类似的威胁。写这本书是希望能引起中美两国的公众对这些自然遗产濒危标志的关注，更加理解它们的重要性，加强对两国红杉自然群落的保护。

其次，这本书也在两国人民的语言和文化的交流上起到桥梁作用。中国和美国是世界上两个重要的大国，它们在某些方面相似，却又并不那么相同。在国际合作和相互了解方面，我们在很多领域有加强交流的必要性。“红杉的保护”，这个主题是生物进化中古老而深厚的一部分，在两个伟大国家生命谱系上具有特殊的生物学意义。作为一个彼此都很感兴趣的重要领域，它顺理成章地成为双方合作的目标。这本书在中英文方面提供了高水平的科学资料，也为两国的学生提供了学习专业语言的绝好材料。此外，它也能增进两国在古往今来的联系上的认知。

第三个联系是发生在科学和自然保护组织之间，本书使得美国加州大学伯克利分校、中国科学院（及其相关研究所）和许多大学、非营利组织保护红杉联盟等机构近百年来进行的大量珍贵合作得以整合、更新。加州大学伯克利分校的教授们，比如杰普生和钱尼，他们曾经参与红杉树的科学研究，更通过保护红杉联盟用实际行动参与红杉的自然保护。钱尼教授与中国的植物学界合作，发现并描述了水杉。最近，谟美（伯克利大学，大学和杰普生标本馆的研究员）发起了一系列的中美植物学合作项目，包括这本精致的著作。在中美两国开展的现代分子遗传学、生理生态学和系统演化学方面的研究，将继续发扬这个长期合作的传统，同时也提高我们

神奇的中美红杉树

保护这些神奇树种及其生境的能力。

布伦特·米什勒

美国加州伯克利大学，加州大学和杰普生标本馆主任，综合生物系教授

序 言

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Preface

This project, even though focused on ancient plant lineages, makes three important connections that are extremely relevant to the modern world. The first relates to the biodiversity crisis, a serious loss of lineages through habitat destruction and human-caused climate change. The living redwood species are tough survivors, but they are threatened as never before in their history due to the activities of *Homo sapiens*. Many smaller, less charismatic organisms that share the environment with these keystone species, and depend on their presence, are threatened as well. This book will hopefully focus public attention in both China and the United States on these endangered symbols of our natural heritage, increase understanding of their importance, and stimulate increased conservation efforts of both the redwoods and the natural communities they support.

The second connection is between people, bridging language and cultural barriers. China and the United States are two large and important countries that are similar in some ways yet very different in others. For international cooperation and understanding, there is a critical need for greater communication on many levels. Conservation of the redwoods, a deep branch of the tree of life now unique to these two great countries, can be seen as an important shared interest and a natural goal for bilateral cooperation. This book, by providing high-quality scientific material in both English and Chinese, will provide excellent practice for students in either country learning a new language, and increase awareness of both the ancient and modern connections between these countries.

The third connection is among scientific and conservation organizations, renewing nearly a century's worth of collaboration among the University of California, Berkeley, The Chinese Academy of Sciences (and its associated institutes) and universities, and Save the Redwoods League. UC Berkeley professors such as Willis Linn Jepson and Ralph W. Chaney were heavily involved in both the science of the redwoods, and their conservation, through their activities in Save the Redwoods League. Professor Chaney collaborated extensively with Chinese botanists on the discovery and description of the dawn redwood. In recent times, Chen Momei (a research associate at the University and Jepson Herbaria at UC Berkeley), has initiated a new series of collaborations between Chinese and American botanists including this fine book. Modern studies of molecular genetics, physiological ecology, and phylogeny—underway in both the United States and China—will continue to enhance this long tradition of collaboration and advance our ability to conserve these amazing trees and their habitats.

Brent D. Mishler

Director of the University and Jepson Herbaria and Professor of Integrative Biology, University of California, Berkeley.

前 言

郑度（自然地理学，中国科学院院士，地理和自然资源研究所）

水杉 (*Metasequoia glyptostroboides*) 原是杉科的单种属植物。水杉属植物在上白垩纪 (K2) 广布于北半球的高纬地区，至新生代的古近纪 (E) 和新近纪 (N)，其分布区有所扩大，种数有 10 余种之多。第四纪冰期来临，该属植物大多灭绝，仅存分布于中国中南部的的水杉一种，成为中国特产的孑遗珍贵树种，也被誉为“活化石”。柏科有另两个单种属植物，即巨杉 (*Sequoiadendron giganteum*) 和北美红杉 (*Sequoia sempervirens*)，产于美国西部的加利福尼亚州。

近二十年来，中美学者和业余爱好人士多次前来中国水杉的故乡，即四川石柱（现属重庆市）、湖北利川和湖南龙山等地参观考察，大家成为很好的朋友。这本关于中国水杉和美国红杉神奇故事的著作，以双语文字分别阐述了有关这三种珍贵针叶树种的 自然历史、生境、群落以及自然保护等内容。它将有助于中美两国人民的相互理解，加深彼此之间的友谊，也将提高人们对于自然和生物多样性保护的认识。让我们共同努力，促进人与自然的和谐发展，建设我们地球家园的美好明天。

布鲁斯·G. 鲍德温 (Bruce G. Baldwin, 维管束植物系统分类和生物系统分类学家，美国加州大学伯克利分校)

以前，杉科除了水杉 (*Metasequoia*)、红杉 (*Sequoia*) 和巨杉 (*Sequoiadendron*) 三种红杉树及其相近的属 (比如 *Athrotaxis*, *Cryptomeria*, *Cunning-*

hamia, *Glyptostrobus*, *Taiwania* 和 *Taxodium*) 外, 还有 *Sciadopity*, 而基于不同基因地区的所有杉科植物的分子系统演化基础研究表明, 它们不是一个自然单系, 除了日本金松 (*Sciadopitys*) 以外, 该科现归属于金松科 (*Sciadopityaceae*)。杉科中的一些属, 如红杉, 比杉科中的其他属更接近柏树, 如 *Cunninghamia*。根据这些新发现, 针叶树种分类学家将柏科 (*Cupressaceae*) 和杉科 (*Taxodiaceae*) 合并为一个单科, 根据国际命名法的优先性原则, 通称为柏科 (*Cupressaceae*)。

这本专著融合了对水杉、海岸红杉和巨杉的历史记载与最新描述, 为广大读者提供了一个欣赏这些宏伟树种的全新视角。更重要的是, 对于中美两国的植物学家、环境保护者以及政府官员而言, 这本书提供了更直接、也更易理解的有关红杉树的信息和长期保护这三种红杉树的重要性, 从而为两国的学者和相关人员建立了更亲密的纽带。

威廉·J. 利比 (William J. Libby, 森林和遗传学, 美国加州大学伯克利分校)

几百万年前, 地球上曾经生长着很多种红杉树。可是当后来人类出现时, 这些红杉树只剩下了稀有的三个种。有两个种存活在美国的西部, 另外的一个种——水杉, 就生长在中国的中南部。今天, 这两个国家的人民需要更密切地互相了解与帮助。这本双语书的出版, 不仅可以在语言和文字上增加两个民族之间的理解, 也可以使两国人民共同学到一些关于红杉树的知识。这是多么具有象征意义的一件事啊!

戴安·M. 欧文 (Diane M. Erwin, 古植物学家, 美国加州大学伯克利分校)

这本书跨越了文化和政治的边界, 是对红杉的发现、它们的自然历史, 以及国际科学合作精神的美好贡献。这种精神持续到今天, 丰富了我们在这

些珍贵的针叶树种群的了解。谌谟美及合作者编译的这本书，介绍了有关活化石水杉发现的历史和其他树种的故事。从最初日本的研究人员三木茂在1941年对水杉化石进行的描述，到1943年王战对活水杉的重大发现，再到1948年，胡先骕和郑万钧对中国水杉的正式描述，中国代表着水杉最后的原始生存地。中国对水杉的保护和发展付出的努力被全世界的植物学家大力称赞。这本书用中英双语发行，对中英文读者都具有特殊的价值。

蒋有绪（植物及森林生态学，中国科学院院士，中国林业科学研究院）

中国的水杉和美国的红杉曾有共同的祖先，这是中美两国古老而又现实的自然与文化的见证。我的挚友谟美，以巨大的热忱，极富创意地把这些联结中美两国古今的故事奉献给人们。我们会记住她为中美两国人民和自然科学所做的贡献。

保罗·C. 西尔瓦（Paul C. Silva，海藻分类学家，资深国际命名法规学家，美国加州大学伯克利分校）

加利福尼亚州的人们享有壮丽的自然环境，拥有美国内陆海拔的最高点和最低点，景色诱人的优胜美地和太浩湖，以及全世界最高大、最古老的树。像圣堂般耸立的海岸红杉和威严的巨杉时刻激励着人们。然而，比起那些在中国偏远地区发现的红杉近亲——活化石水杉这种“古董”而言，它们却显得有些逊色了。科学家们将活化石命名为 *Metasequoia glyptostroboides*，通称为水杉。这种树现在被种植在世界各地，特别是加州大学伯克利分校的校园里。在这样一个中美经济越发相互依赖的时刻，谌谟美适时地编译了这本中英文双语读物，让我们可以从方方面面了解这些宏伟的生物。

Initial Remarks

Zheng Du (fellowship of Chinese Academy of Sciences, Institute of Geographic Sciences and Natural Resources, Chinese Academy of Sciences)

Dawn redwood (*Metasequoia glyptostroboides*) is a monotypic genus of the family Cupressaceae. *Metasequoia* was widely distributed in high latitudes of the Northern Hemisphere in the early Cretaceous period (K2). During the Paleogene Period (E) and Neogene Period (N) of the Cenozoic, its distribution was extended and the genus included more than 10 species. In the Quaternary ice age, the genus became nearly extinct, with only one species—dawn redwood—surviving in central China. This priceless tree species was honored by naming it a “living fossil”. The Cupressaceae includes two other related genera, the giant sequoia (*Sequoiadendron giganteum*) and the coast redwood (*Sequoia sempervirens*), both found in California.

In the past 20 years, many Chinese and American scientists and amateurs have explored the native habitat of dawn redwood—in such places as Shizhu (Chongqing Province), Lichuan (Hubei Province), and Longshan (Hunan Province)—and have become good friends. This monograph on the magnificent Chinese and American redwoods describes the three precious species of conifers, their natural history, habitat characteristics, efforts towards conservation, and other aspects.

Written bilingually in Chinese and English, the book will improve cross-culture understanding between Chinese and American citizens, build friendships, and advance public appreciation of nature and the importance of preserving biodiversity. Let us work together toward harmonious relations between humankind and nature resulting in a better tomorrow for our homeland, planet earth.

Bruce G. Baldwin (Professor of Integrative Biology and Curator of the Jepson Herbarium, University of California, Berkeley)

The family Taxodiaceae traditionally comprised the redwoods (*Metasequoia*, *Sequoia*, and *Sequoiadendron*) and closely related genera (i. e., *Athrotaxis*, *Cryptomeria*, *Cunninghamia*, *Glyptostrobus*, *Taiwania*, and *Taxodium*) along with *Sciadopitys*. Molecular phylogenetic studies based on different gene regions have all shown that members of Taxodiaceae do not constitute a natural (monophyletic) group without inclusion of members of the cypress family, Cupressaceae, and exclusion of the genus *Sciadopitys* (now in its own family, Sciadopityaceae). Some members of Taxodiaceae, such as the redwoods, are more closely related to cypresses and relatives than to other members of Taxodiaceae, such as *Cunninghamia*. In response to these findings, conifer taxonomists now generally treat members of the two families (Cupressaceae and Taxodiaceae) within a single family. The name of that common family must be the Cupressaceae, which has nomenclatural priority over the name Taxodiaceae.

By bringing together historical and modern accounts of *Metasequoia*, *Sequoia*, and *Sequoiadendron*, this volume provides a new perspective on these magnificent trees that will enhance appreciation of redwoods by readers everywhere. Most importantly, this book will serve to build stronger ties between American and Chinese botanists, conservationists and governmental officials, who will now have more readily accessible information on redwoods in their respective countries and on the importance of ensuring that all three modern redwood taxa are preserved.

William J. Libby (Professor Emeritus, Forestry & Genetics, University of California, Berkeley)

Over many millions of years, various species of redwood lived in many regions of Earth. By the time humans arrived, only three species remained. Two survived in the western United States, and one in south-central China. Today, the peoples of these two countries are increasingly interdependent, and increasingly eager to learn about each other. This book provides a way to improve reading comprehension of each other's language, while also learning something about the redwoods that are, in both countries, iconic.

Diane M. Erwin (Museum Scientist, Paleobotany Collection Curator/Manager, Museum of Paleontology, UC, Berkeley)

This book is a wonderful tribute to the Redwood's discovery, their natural history, and the spirit of international scientific cooperation that transcended cultural and political boundaries—a spirit of international collaboration that today continues to enrich our understanding of this majestic group of conifers. Among the book's highlights, Chen Momei and her colleagues have successfully compiled one of the most accurate comprehensive historical accounts of the “living fossil” dawn redwood (*Metasequoia*), from its initial description by the Japanese researcher Miki in 1941 as a fossil species, to Wang's remarkable discovery in 1943 of *Metasequoia* trees growing in China, to the formal description of the Chinese *Metasequoia* by Hu and Cheng in 1948. China represents the last native home of the dawn redwood and so this country's effort to help conserve these trees is loudly applauded and widely appreciated by botanists around the world. This book is printed in both Chinese and English and so is of especial value to readers of these languages.

Jiang Youxu (Fellowship of Chinese Academy of Sciences, Professor of Botany and Forest Ecology, Chinese Academy of Forestry, Beijing)

Chinese dawn redwood and American redwoods share the same ancestor. This ancient natural relationship foreshadows a present-day cultural relationship between China and the United States. My friend, Chen Momei, with her enormous passion and creativity, edited the wonderful stories and produced this monographic book. We will remember her for her contribution to scientific exchange between China and the United States.

Paul C. Silva (Research Botanist, University Herbarium, UC Berkeley)

Californians live in a state blessed with spectacular natural features. Among them are the highest and lowest points of land within the continental United States, the breath-taking beauty of Yosemite and Lake Tahoe, and the tallest, most massive, and oldest trees in the world. The cathedrals of coast redwood (*Sequoia sempervirens*) and the majesty of the giant sequoia (*Sequoiadendron giganteum*) are inspiring. Underscoring the antiquity of these living fossils was the “discovery” of a close relative in a remote region of China, which scientists named *Metasequoia glyptostroboides*, popularly called “dawn redwood”. Specimens of this tree now grace gardens in many parts of the world, including the campus of the University of California in Berkeley. At a time of increasing economic interdependence between China and the United States, it is particularly appropriate that Chen Momei has brought together in a bilingual book various aspects of our knowledge of these magnificent creatures.

致 谢

本书的出版得到了保护红杉联盟的大力支持。该组织友好地赠与我数本自 1918 年建立联盟以来出版的有关红杉树的小册子，并鼓励我将它们翻译成中文。这个世界范围内的组织是非营利性的，旨在保护红杉。没有他们的支持，我是不能完成这本书的编辑工作的。

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在过去的 15 年里，加州大学伯克利分校的多位学者和研究生帮助我翻译了本书的部分章节。他们包括：唐明（第一章第一节），刘艳菊（第一章第二节），潘飞、严人斌（第三章第二节），张芹（第二章第三节）。王沙生教授、张宪春教授和中国科学院昆明植物研究所的陆露参与了部分章节的审稿工作。

我深深地感谢威廉·J. 利比和他的夫人艾里斯。他们不仅参与了水杉的科学考察，而且在很多方面促进了红杉遗传学的研究。

感谢加州大学伯克利分校综合生物系的研究生 Andrew G. Murdock 和 Abby Moore，他们为本书提供了红杉树在分子生物学上的分类地位和资源保护方面的最新信息。此外，我还要感谢 Nate Stephenson, Eric Berlew 博士提供的巨杉生态资料。

我愿将特殊的感谢献给加州大学伯克利分校的本科生们，他们出色的双

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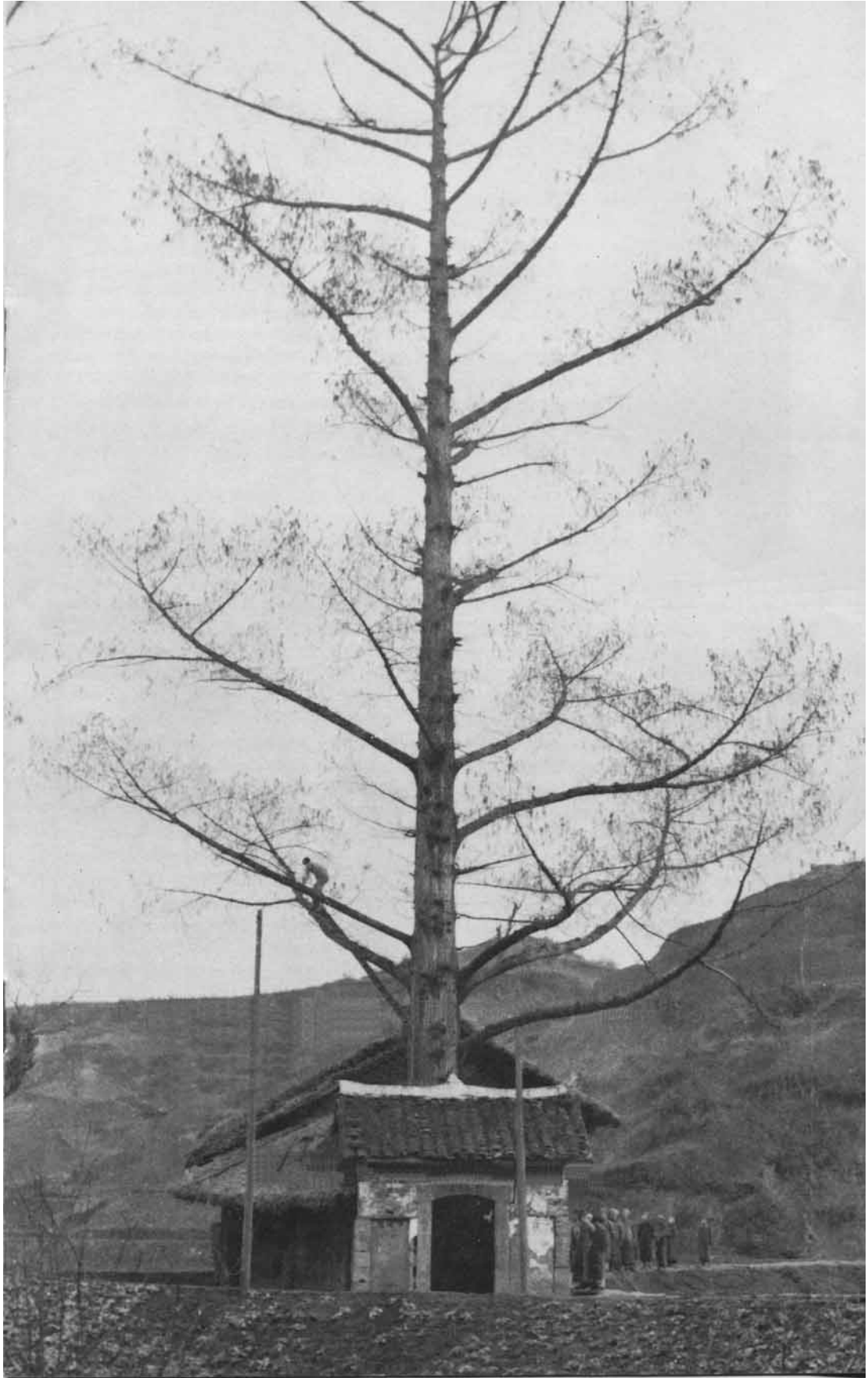
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第一章 活化石水杉
(*Metasequoia glyptostroboides*)

第一节 历史悠久的水杉

拉尔夫·W. 钱尼



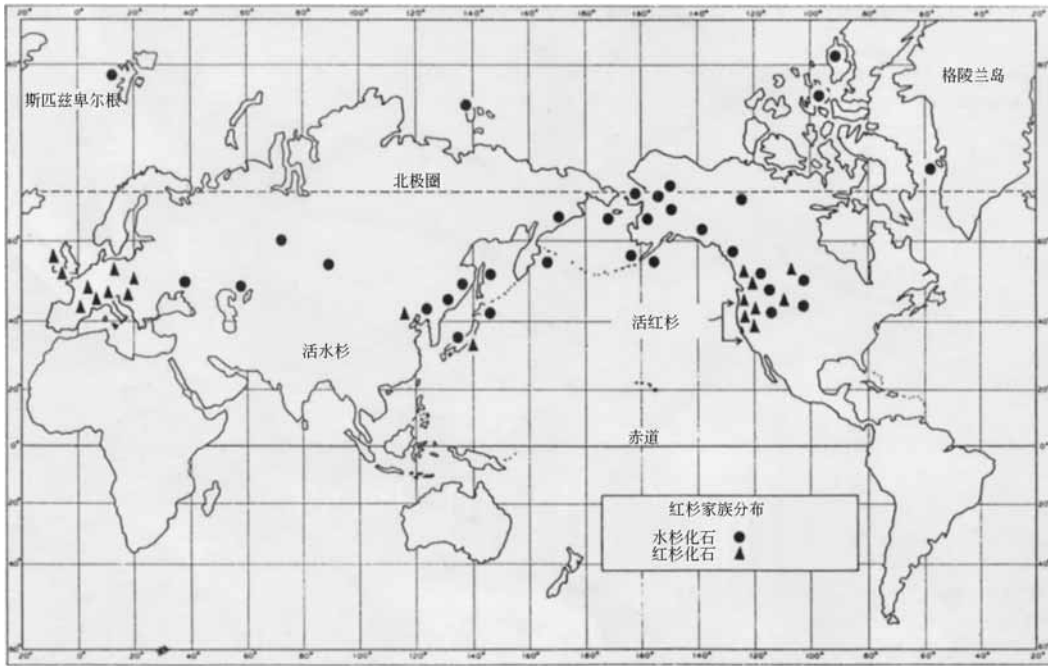


图 1.1 左图：中国中部磨刀溪村的水杉，照片下方的建筑是一座寺庙（这棵水杉依然在那里，但寺庙已被迁移至别处）。

图 1.2 上图：美国俄勒冈 John Day 盆地发现的水杉化石标本，距今约三千万年前，图片由华盛顿卡内基研究所惠赠。

下图：根据化石记录，地图显示了红杉在世界上的分布情况。地图版权归保护红杉联盟所有。

红 杉 林

加州海岸的红杉林是地球上面积最大、最古老的红杉林，它的历史算起来也有两千年之久了。但是，即便现存最古老的北美海岸红杉（*Sequoia sempervirens*）所走过的岁月，相对于整个红杉的历史而言，也只是白驹过隙。据记载，那些尘封在古老湖泊和山谷中的石化红杉的叶子和果实，其历史可以追溯到整整一亿年前。



图 1.3 红杉：加州索诺玛县石林发现的巨型化石原木标本。埋在火山灰里的巨型原木变成了石头。照片由 Santa Rosa 石林惠赠。

地质学上而言，在加州关于红杉最早的化石记录只能追溯至不到两千万年前。更早以前，生活在这里的是一些完全不同的物种。红杉姗姗来迟，直到很晚才出现在美国的海岸上。

五千万年前，亚热带森林的主要树种，如榕树、棕榈、桃花心木、鳄梨等，遍布于从加州到华盛顿的广阔大地上，但随着地球气候逐渐变冷，它们已经从美国的大地上销声匿迹了。目前，这些树种在墨西哥和中美洲都有其近亲，那里有适合它们生存的温暖湿润的气候条件，而同样的气候在加州这样的纬度上已不复存在。

大约两千万年前，红杉遍布于现在内华达山麓的温带森林中。更早时期的

红杉叶子和球果的化石则在俄勒冈州和爱达荷州被发现。

甚至在更加遥远的地质年代——许多树种和动物首次出现的始新世，加拿大和落基山脉曾是红杉树生长的乐土。

在黄石公园著名的石化森林中，分布着足有五千万年历史的红杉树的化石。值得一提的是，在英格兰和西欧的其他地区，红杉是始新世森林中常见的成员，它的叶不如现在的海岸红杉这样舒展好看。

然而，在北极大陆似乎没有关于红杉的可靠记录。显而易见，在很久以前，红杉分布远到加州海岸的北边和东边，直到地球历史的晚期才出现在加州海岸上。旧金山往北 50 英里的红杉林（位于现在的索诺玛县）被五百万年前的火山灰所淹没。那次火山爆发摧毁了当地所有的树木，幸运的是，红杉树连同它的叶子和球果都以化石的形式被完整地保存了下来（图 1.3）。

另一种“红杉”

当美国西部被大片的亚热带森林覆盖时，另一种与海岸红杉不同的“红杉”在更远的北方生活着。那时，阿拉斯加很多地方的气候相当温和，适合温带树种（像栎树、胡桃树、枫树，还有如今生活在美国的其他树木）的生长。

在西伯利亚北部、斯匹兹卑尔根、格陵兰岛和加拿大北部的北极岛屿，相似的森林在陆相岩层里留下了它们曾经生长的痕迹。现在，那些地方因为太冷而不再适合任何树木的生存。与这些落叶阔叶林一起被发现的还有另一种高大乔木的叶和球果化石。这种适于在北方生长的“红杉”，就是现在声名远播的水杉属（*Metasequoia*）的水杉。

许多年来，人们都认为在北半球广泛分布的“红杉”化石与现存的加州海岸红杉是同一个物种。

直到 1941 年，大阪市立大学的古植物学家三木茂指出，来自于日本的这

种“红杉”（即现在所知的水杉）其化石的枝条、针叶以及球果的苞鳞和种鳞都是对生的，而红杉则是螺旋状排列或互生。另一个不同之处在于，日本“红杉”的球果着生于裸露枝条的末端，而不是着生于有叶枝条上。三木茂博士根据上述特征，为日本“红杉”化石定了一个新的属名——*Metasequoia*，水杉属，与真正的红杉属（*Sequoia*）区分开来。其实，人们早就知道在北美岩层中的红杉化石的球果着生于裸露的枝条上，但并没有将其从红杉属中分出来。

“活化石”水杉

1944年，中国中央林业实验所的护林员王战在四川万县（位于中国的中部）磨刀溪村（今湖北利川谋道镇）发现了一棵巨大的裸子植物^①。由于以前从未见过如此大的树，他便采集了一些针叶和球果的标本带回南京。

中央大学林学系教授郑万钧博士马上意识到这些标本所代表的树种在中国林业界还尚未有记载。在与北平（今北京）静生生物研究所的所长胡先骕讨论后，他们惊喜地发现这种树的叶和球果与在日本和满洲里发现的水杉化石种十分一致。水杉的化石在人迹罕至的亚洲内陆活过来了！人们曾经认为水杉在两千万年前就已经灭绝了，而这个重大的发现则将它的历史拉回到一亿年前，拉回到恐龙在地球上徜徉的中生代白垩纪。

“活化石”水杉的发现，堪称是植物学界绝无仅有的惊人发现。

中国之旅

来自中国的关于“红杉树”的种种报道，激起了我极大的好奇心。1948年

^① 有些文献记载为1943年，中国农林部中央林业实验所调查推广组技工（相当于总工程师）王战。

晚冬，我与《旧金山纪事报》的科学主编米尔顿·西尔弗曼一起乘飞机抵达重庆。我们乘船顺江而下到达万县，向南开始漫长的徒步跋涉，翻过三座大山后，终于到达了水杉生长的山谷和水稻田边。我迫不及待地想看看，这里生长的水杉与我在俄勒冈州 John Day 盆地发现的化石种是不是同一个种（图 1.2）。

令人兴奋的是，我们见到了栗树、栎树、枫树和化石植物区系的其他所有成员。有一种仅土生于东亚的连香树（*Cercidiphyllum japonicum*），除了在俄勒冈州分布外，在阿拉斯加、斯匹兹卑尔根和格陵兰岛等地，这种树的化石也与水杉化石在相同的地区被发现。

后来，我发现在湖北利川的水杉坝生活着大量“活化石”水杉，但是都没有距此往北 40 英里的磨刀溪的水杉大。这些生长有水杉的地方与新奥尔良处于同一纬度，海拔高度大约有 4000 英尺。

从距离最近的城市的气象资料来看，水杉生长地很少有极冷的天气，年降雨量大约有 50 英尺（介于加州红杉林带的尤里卡市和新月市之间）。但与加州海岸降雨量不同的是，中国中部的降雨大多发生在夏季。这就解释了水杉另一个惊人的生活习性——秋季落叶，次年春季发芽长出新叶，不像加州红杉的叶子可以保持三至四年。所以，与生长在四川和湖北山谷里的阔叶树种（如栎树、枫树、栗树）一样，水杉是落叶植物，而非常绿植物。

即使在很远处，我们也能通过那些向上生长的枝条辨认出水杉。而海岸红杉的枝条却是向水平方向延伸的，还有许多树种的枝条则是下弯的。

这次考察由“保护红杉联盟”赞助，也是我生平获益最大的一次旅行。通过这次旅行，我们获得了水杉生活所在的森林的第一手资料，使这一珍稀树种在其家乡得到保护变为可能。

最近（1965 年春），中国政府计划把这一地区开辟为永久性的自然保护区，同时还报道了长江以南水杉的经济栽培情况。

水杉的种植实验

根据我们以往对美国红杉的认识，水杉的落叶习性实在令人惊奇(图 1.4)，这就使古植物学家们认为中国的水杉也许可以在比磨刀溪和水杉坝更冷的地区生长。回答这个问题的唯一途径就是看看水杉的幼苗在纬度多高的地方还能生长。



图 1.4 图中左侧三株落了叶的水杉生长在中国中部的水杉坝地区。右边几棵是板栗树。水杉在每年的四、五月间开始长出叶子。

1948 年，在太平洋的西北部种植上了由中国引进的水杉的小树苗。据林

业员报道，在英属哥伦比亚、华盛顿、俄勒冈州，幼苗可以安全地度过冬天。于是，另外一批树苗被送到阿拉斯加东南部。1949年至1950年的冬天，那里异常寒冷。然而，1950年春天，美国森林部门的 R. F. 泰勒博士报道说，尽管一部分树苗到五月末还被埋在积雪中，但是几乎所有的小树苗都还活着。这无疑证明，水杉适合在比其目前的家乡——中国中部——更冷的地方生长。

红杉的分布

通过对水杉和其他植被的历史研究表明，在过去五千万年里，地球逐渐地干冷起来，植物和动物慢慢地向南迁移。大约三四千万年以前，美国西部的气候变得温和，使得原来生活在这里的大多数热带树木灭绝了，从北方来的水杉取而代之，生存了下来。

在中新世，水杉以及海岸红杉的直系祖先曾生长在俄勒冈州东部，现在，那里的降雨量只能满足稀落的桧属植物和北美艾灌丛生长。后来，喀斯喀特山脉隆起，大面积的熔岩流出，覆盖了这些红杉类植物生长的地方。俄勒冈州约翰德河（John Day River）和其他河流切断熔岩，后来，人们在河底沉积物中发现了红杉树的化石。

西部的喀斯喀特山脉阻挡了暖湿气流到达这一地区，结果形成了今天的半干旱高原。蕨类植物和杜鹃花灌木取代了水杉



图 1.5 八年生的水杉，1948 年摄于俄亥俄州克利夫兰市。照片由 C. H. 园地惠赠。

覆盖着地面，植被变成了能够长时间忍耐干寒的类型。

植被类型的变化记录了美国西部历史上的一系列主要事件：山脉隆起，整个地区的面貌发生了翻天覆地的变化。要想红杉树再次在俄勒冈州东部及其临近地区生长起来，除非喀斯喀特山脉被缓慢的侵蚀作用而摧毁。只有到那时，来自太平洋的暖湿气流才能为这个半干旱地区带来红杉生长所必需的湿度和雨量。

红杉还将生存多久？



图 1.6 水杉的故乡——中国湖北省水杉坝村，吴村长的儿子在一棵水杉树前的留影。钱尼摄于 1948 年。

红杉的生存是古生物学家呼吁亟待解决的难题之一。为什么水杉从世界其他地区消失，而唯独在中国中部几个与世隔绝的山谷中生存下来？为什么海岸红杉只局限于太平洋沿岸的加州和俄勒冈州境内生长？这些问题都需要进一步研究后才能找到答案。

我们或许可以做出这样的推论，只有四川的红壤盆地才具有最适合水杉生长的气温、降雨和地形等综合因素。但同时还要意识到，像这种人迹罕至，并且没有因土地贫瘠迫使耕地范围扩大而遭到破坏的地方，在中国已经为数不多。要不是水杉坝偏远的地理环境，所有的水杉可能在几个世

纪以前便被砍光了，那时，我们就只能从遗留下来的化石中去揣度水杉的种种风貌。

幸运的是，水杉在濒临灭绝之前就被人们发现了。此后，“保护红杉联盟”和哈佛大学的阿诺德植物园把成千上万棵树苗引种到美国、欧洲和亚洲其他地区。这一古老的树种生长迅速，作为道路绿化和观赏树种都极具吸引力，以后也有可能成为制造木质纸浆的重要原料。在日本，学校、博物馆和寺庙的附近都栽种了水杉。在未来的岁月中，壮丽的水杉林也许将重归它们曾经生活过的广袤大地。

至于海岸红杉，它们将会一直守卫着太平洋沿岸，因为那里的冬天气候温和、雨量充沛，而雾又为干燥的夏季提供了必要的湿度。这些地区的生存环境，为探寻人类出现之前远古地球的特性提供了主要线索。

在这个永远变化着的世界里，我们无法断言哪一个树种在遥远的未来将遍布太平洋海岸。但可以肯定的是，在以后的若干个世纪里，加州国家公园里的海岸红杉将作为成功保护的范例而生存下来，这将归功于“保护红杉联盟”所有成员的共同努力。

关于作者

拉尔夫·W·钱尼（1890~1971），加州大学伯克利分校古生物学教授，1961年至1971年间任“保护红杉联盟”主席，是世



图 1.7 中国四川省磨刀溪村，钱尼博士与一位中国官员在那棵被发现的水杉树旁。他们正在观察没有长叶的树枝和球果。照片摄于 1948 年 3 月，摄影师为米尔顿·西尔弗曼博士，旧金山纪事报的科学专栏作者。

界上研究史前植物群落的著名专家，也是研究化石和活红杉的最重要的权威人士之一。他曾希望在中国建立水杉自然保护区，使红杉家族的这一成员能像它在加州红杉公园里的近亲那样受到保护。遗憾的是，钱尼博士临终时还认为这一设想无法实现。然而，美国的植物学家于1980年参观了水杉生长的地方，他们是自1948年以来第一批来访的外国人。他们发现水杉生长繁茂，国家禁止砍伐任何水杉，并有5位林业工人专职守护这些中国的国宝。

关于“保护红杉联盟”

自从“保护红杉联盟”于1918年成立以来，已经筹集了6500多万美金，捐赠者来自世界各地。这些资金用来帮助加州32个红杉国家公园、红杉巨杉国家公园，以及其他公共红杉公园购买了超过26万英亩的红杉林地。在未来的漫长岁月里，还有很多事情等待我们去做，以完善这些公园的设施并保护神奇的红杉。



图 1.8 保护红杉联盟，地址：美国加利福尼亚州旧金山的 Sansome 街 114 号 1200 室，邮编：94104，网址：www.savetheredwoods.org。

第二节 寻找中国的古水杉

魏歌林

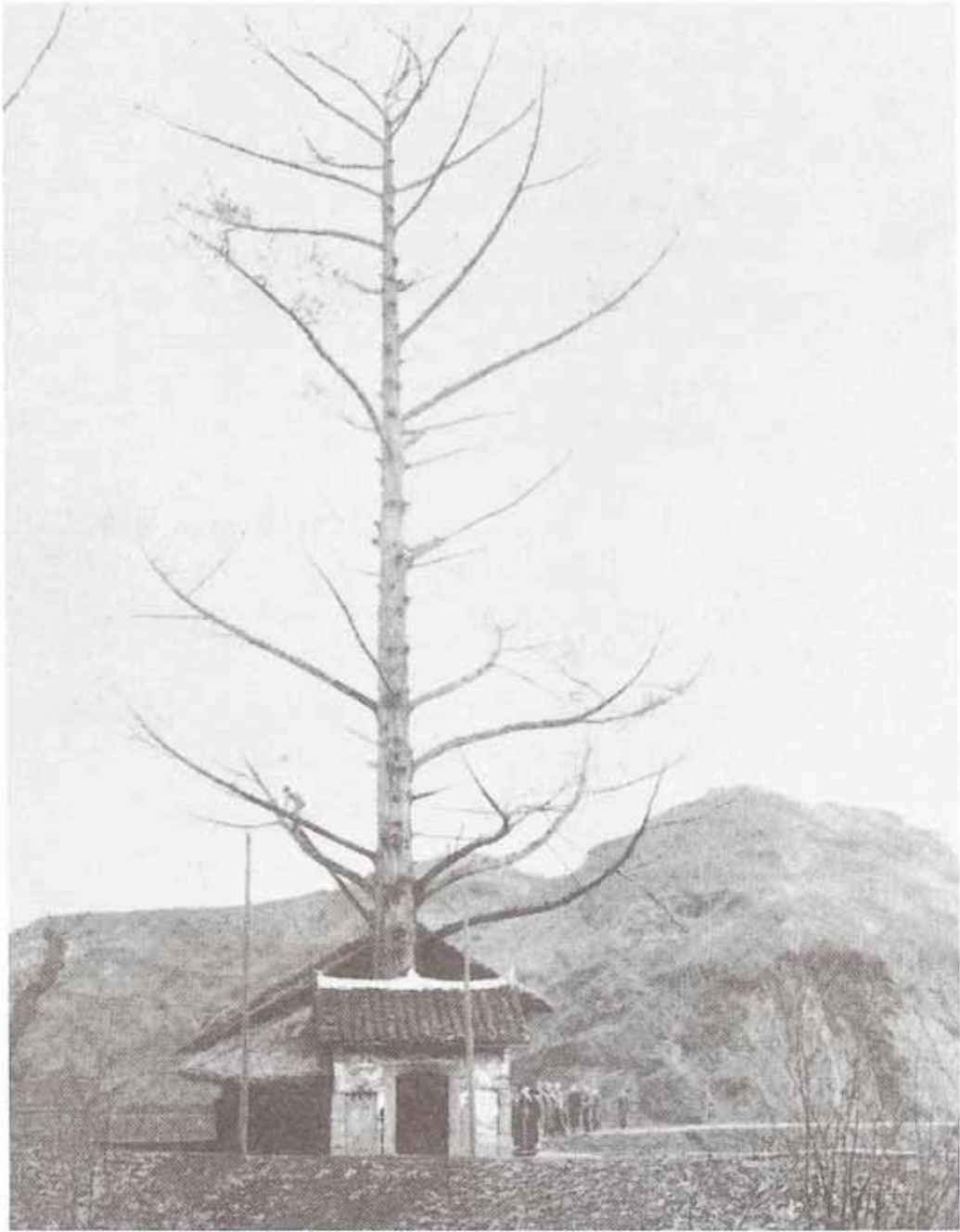


图 1.9 水杉模式标本树和树下的寺庙，钱尼于 1948 年摄于中国四川省的磨刀溪。

一 发 现

我家住在旧金山湾区的东湾，那附近有一个公园，我对水杉的研究还要从穿过公园的一次慢跑说起。公园小径的两旁竖着许多牌子，上面的文字讲述了加州大学伯克利分校的一位教授，不远万里去中国确证水杉——红杉家族的另一个成员——的故事。一段段引人入胜的描述令我停下了脚步。

通过这些标牌上的资料，我才了解到这位教授的中国之行极为艰辛。他多日徒步跋涉于中国农村的群山峻岭间。20世纪40年代，在中国中部的这片土地上，还有路途劫匪和无家可归的难民。在跑步的过程中，我渐渐萌生了一个想法：在五十年后的今天，重循教授的足迹，看看当年他见到的那棵树是否依旧矗立，那一定是件非常有趣的事。20世纪末的中国会有什么不同呢？过去半个世纪的排外政策给这片领土披上了一层神秘的色彩，除了知道那是一个人口稠密的国家以外，美国人民对中国实在是知之甚少。教授曾经拜访的小村庄和小城镇如今又是何种面貌？还有小镇的情形、居民的文化与风俗，以及山川河流等沿途的风光，教授记录的种种都令人神往。

遗憾的是，当我再次返回小径时，几天前还看到的牌子已被挪走。原来竖立牌子的地方已经栽上了一丛小树。树旁的标签上写着：“恐龙森林”。后来我才知道，水杉就是从恐龙时代的白垩纪存活下来的孑遗植物。

我决定去加州大学的植物园看看，它仿佛是镶嵌在东湾山上的一块祖母绿。植物园位于半山坡，占地30英亩，在加州大学的管理下，已经拥有来自世界各国的12,000多种植物。1890年，植物学家爱德华·格林建立了这座植物园，他意识到被人类文明日益侵蚀的不只是红杉，还有大自然赐给加州的全部植物遗产。到1892年，当时还坐落在主校园的植物园已经栽培有500多种本土的树种

和灌木。20 世纪 20 年代，植物园重新扩建并迁移到目前位于草莓谷的位置。

园中加州土生植物区拥有全加州 5000 种树木的四分之一，包括 130 种稀有或濒危树种。在栽培和繁殖加州及世界的濒危树种方面，这座植物园堪称“园中先驱”。所以，这里一定有人知道水杉的信息。

在植物园的礼品店里，我好奇的窥视和有点羞怯的自我介绍帮了大忙，店员直接把我带到了后面的办公室。那里的几位办公人员坐在各自的桌边工作，每个人都专注于面前的计算机显示屏。他们就是那些知晓钱尼教授中国之旅的人。我的到来使原本安静的办公室展开了一场讨论，他们说档案中有关那次中国之旅的资料并不多，但也表示会把有关的资料都寄给我。他们还给了我一张园艺家伊莱恩·赛德拉克的名片，说她能告诉我更多的信息。

值得一提的是，就在加州大学的植物园里，顺着小径而下走到小溪的桥上，能看到七棵水杉。那是 1948 年钱尼教授亲自从中国带回来的，它们被栽种在伯克利的这块土地上。这些年间，我来过这座植物园许多次。早春之际，长到树一般大的杜鹃花开得异常绚烂，有紫色的、红色的、白色的和粉色的。夏季来临，成群结队的蜂鸟在园中美国中部植物区的上空展示着杂技表演。在伯克利的地中海气候之下，树蕨、枪木树（lancewood）、亚麻，以及澳大利亚和新西兰的两种贝壳杉（kauri）树种快乐地生长着。每年三月，沿溪而上来到日本水池，便能看到成对成对的蝶螈在花团锦簇的大百合间交配。然而，之前的每次参观，我都没有发现真正要找的东西。

有一天，我沿着小溪一路走着，就在桥的上方，那不是水杉吗——我第一次确信眼前的树木就是水杉！它们至少有 24 米（80 英尺）高，晚春时的树枝上已经长满了叶子。与海岸红杉及其他大多数针叶类树木所不同的是，水杉是落叶树，每年秋天，它的叶子都会全部脱落。实际上，钱尼第一次在中国见到水杉时正值冬末，所有的水杉都是光秃秃的。但这只是故事的开始。

与海岸红杉和巨杉的叶相比，水杉的叶看起来更为柔软，也更易弯曲。水杉的树皮也极为不同：颜色仍然是红色，但红得更好看，质地也不那么粗糙，使得整棵树看起来不像红杉那样粗犷。与海岸红杉的不同之处还有，水杉的基部不抽枝，这就使得树干的轮廓清晰可见。与它们的美洲近亲相比，水杉的枝从树干较低的位置抽出，枝的直径也没有那么粗。水杉的整体轮廓也更加分明，枝趋于向上弯曲，呈现出欣欣向荣的景象。我用手触摸着每棵水杉，感觉它们比海岸红杉更光滑。想到这些树正是五十年前钱尼教授从中国亲手带回来的，一丝情愫不禁涌上心头……

我随即便打电话给伊莱恩·赛德拉克女士，她非常热情，又提供了很多资料。她对钱尼教授的那次旅行了解颇多。钱尼是与旧金山纪事报的科学作家米尔顿·西尔弗曼一起到中国旅行的。实际上，矗立在植物园小溪边的那些水杉都是钱尼和西尔弗曼从中国带回来的。但赛德拉克并不知道，这些树究竟是由钱尼带回的树苗栽植而成的，还是经采集的种子繁殖的，因为当时钱尼也收集了水杉的种子。她还告诉我有几株水杉被栽培在伯克利的其他地方：一株在伯克利校园的德怀特路和德贝街区；两株在 Northbrae 教堂的后面；一株在伯克利山顶的住宅街区；还有一株生长在活橡树公园。

赛德拉克女士是一位知识渊博的植物学家，除了钱尼以外，她知道美国的学者至少还有两次去中国进行大树种群的考察。1980年，由加州大学植物园园长布鲁斯·巴塞洛缪带领的中美考察队，参观了中国中部地区并带回更多的种子。赛德拉克女士存有那次考察带回的植物名单，她在植物园的任务之一就是利用这些植物为巨杉区建立一个更为完整的生态环境。亚洲植物收集家比尔·马克拉马拉一年前曾到植物园参观，赛德拉克也为其做过介绍。

赛德拉克女士提到的每一株当地的水杉树，我都参观过。骑着自行车去观赏活橡树公园附近的塔形水杉，是多么快乐的事情啊。拍照时，我将自行

车倚放在树根旁以衬托它那不同寻常的庞大（见图 1.10），而这棵树还不满 50 岁。我最喜爱的是加州聋哑研究所旁的那棵孤独的水杉，就在德怀特路上。它欣然对称，屹立在大草坪的中央，显得高大而挺拔。

每次去参观这些单独栽种的水杉，我都像在植物园初次见到水杉时那样兴奋。后来，我了解到更多当地的水杉资料，并一一前去考察；加州大学主校园麦科恩礼堂旁有两棵；梅里特湖边的园艺中心有五棵；奥克兰 Mosswood 公园里有三棵；旧金山 Strybing 植物园有七棵；以及生长在 Point Reyes 的几棵树。Point Reyes 是多数野生植物在太平洋海岸登陆的国家海岸公园，位于马林县附近。在这个半岛中心附近的熊谷（Bear Valley），当我沿着小溪前行时，看见独自挺立的水杉远远高出了其余的树木。第一次见到那棵树竟使我感到无比的熟悉与亲切，就如同与阔别许久的挚友重逢。

生长在海湾区的这些水杉树，都是一棵远在中国内陆的水杉树的后裔。如今，它们矗立在我家附近，高大挺直，顽强地抵御着大风，在地震和火灾后得以幸存，并静默地目睹着人世间的纷乱与嘈杂。人类自认为是地球上唯一有意识的生命，并借此掩饰自负之心，而这些大树的安详与泰然却使我感到，人类也许尚未全然知晓整个宇宙。我越发坚定了去水杉起源地的决心。

我又在另外两个地方收获颇多。一个是班克劳福特图书馆，由售书商及历史学家赫伯特·豪·班克劳福特建立于 1859 年。1905 年，加州大学象征性地购买并接管了他的所有收藏，此后馆藏继续增加。现在，图书馆藏有早期加州考察家法热·塞拉、加斯帕·德·泊特拉和胡安·鲍提斯塔、德·安萨的原始信件及日记，有玛丽安诺·沃雷勒、约翰·弗里蒙特、约翰·苏特及当纳聚会^①的有关文档。整个图书馆拥有记载了北美西部历史的近六千万份手稿，以及

^① 美国历史上的人吃人传说。

一百多万张照片、绘画、素描、地图与杂志。对于钱尼和中美水杉考察的未解之疑，我希望能在那里找到答案。

在图书馆的内部藏室中，我很快就发现了好几篇相关的文章。一篇收集在钱尼作品复印件的卷宗中，包括一次地区文化历史展望的访问抄本。除了有关水杉 (*Metasequoia glyptostroboides*) 更为详细的资料外，访问抄本还包括钱尼及其子女的个人资料，甚至教授在伯克利的地址。从 20 世纪 20 年代到 1971 年去世，他一直生活在伯克利，供养家人，在大学讲课，到世界各地去做科学研究。

我同旧金山纪事报的联系却一无所获。我猜测如果该报的科学作家伴随著名教授去了中国的话，一定有报告在刊物上发表。遗憾的是，报社的电话留言机说图书馆不再配备图书管理员，也不再为公众提供信息服务。

在旧金山图书馆，我幸运地找到了旧金山纪事报的过刊，1865 年以后的每一期都有对应的缩微胶卷。报纸的检索虽已丢失，但仅有的一份复印件可能还保留着。含有从 “Silver, Price” 到 “Simpson, Herbert” 这一部分内容的缩影胶片卡可能被放错了地方，但三个完整的卡片显示的确有西尔弗曼博士写的文章。1948 年 3 月和 4 月的缩微胶卷没有被盗或错放，仍然保持原样。图书馆的打印机还能工作，每次可以复印一页报纸的四分之一。一番周折之后，我终于得到了那次考察的第一手记录。

西尔弗曼博士所写的旅行记录一共有五篇。前两篇是头版报道，详细记载了他们考察的成功以及一路上的种种磨难。他们的行程被旧中国官僚主义的烦冗手续所耽搁，十天的路途（包括几个小时的步行）中经历了恶劣的环境，住处蚊虫肆虐，还面临着遭遇土匪强盗的危险。历尽千辛万苦，他们最终看到了自然状态下生长的水杉，并带回了幼苗。在磨刀溪村附近的水稻田边上，当他们第一次看到那四棵水杉（包括一棵幼苗）时，才吃惊地发现这

些树竟然是落叶树种。时值三月，水杉树都是光秃秃的。最大的一棵水杉被当地人视为神树，并在树下建了一座庙宇。钱尼和西尔弗曼又经过两天艰难的行程到达水杉坝，他们在那里发现了完全野生的水杉树林，这些水杉生长在自然生态的小环境中，其间有很多阔叶树种：栗树、桦树、橡树、槭树，以及连香树。旧金山纪事报还记载了他们如何回到火奴鲁鲁（即檀香山），为了通关，钱尼把那些幼苗叫做“古董”才说服了海关人员。因为植物材料是禁止进口的，但那时尚无法律限制活化石的进口。

当时，这个故事以大字标题出现，继之以好几日的头版新闻，包括地图、照片，以及大量生动的文字，记录了他们的惊人之举和旅途的艰辛。按钱尼博士的话说：“对我而言，发现一株活水杉的惊人程度绝不亚于发现一只活恐龙！”

五十年前的那次考察，奇异、惊险，而又令人神往。我多么期待可以重循旧迹，徒步穿越那莫测的小径，翻越那巍峨的山峦，把五十年前村民全家的合影送给他们，还有如今繁茂地生长在美国的水杉的照片，那些都是中国水杉的后代。

我唯一的遗憾就是没能找到一本真正的旅行日记。我曾去过钱尼在伯克利做教授期间和家人的住址。当天就有一位很有礼貌的先生打电话给我。他自1976年以来就住在这里，知道钱尼在屋旁种了好几棵水杉。可惜钱尼去世以后，这些树由于疏于管理死掉了。在他搬到这里时，树已经被运走了。听了这些我很纳闷，它们真的死了吗？我希望它们不是因为冬天落叶而被误以为死了。这种悲剧在其他地方也曾发生。1995年，英国皇家哥伦比亚博物馆的《发现杂志》上，作者托尔·亨里奇写道：“冬天落叶的针叶树种具有不寻常的特征，这使得一些无知的园主认为树已经死了，便拔掉了它们。”俄亥俄州立大学的查德威克树木园也报道说：“房主秋季打电话说他们的树在渐渐凋亡，我们告诉他们这些树并没有死，只是在秋冬季节会落叶。”

现在的房主对钱尼的三个子女：理查德、埃伦和大卫也一无所知。我因

而无法与他们取得联系。他们在 1919 年至 1923 年出生，有可能已不在人世。1959 年，他们居住在加州的其他地区。

赫伯·卡昂在 1948 年是西尔弗曼博士的同事，可能知道他现在的情况。但由于旧金山纪事报没有图书管理员，我就直接给他写了封信。几天后，我接到卡罗尔·沃尼尔的电话，他是卡昂先生的工作人员。他告诉我五天前西尔弗曼博士刚去世，他的讣告还刊登在两天前的报纸上！讣告报道说“西尔弗曼博士获药理学博士，起初从事药学研究。他获得过许多新闻奖，他与拉夫尔·钱尼于 1948 年在中国四川省的边远山区进行了一次冒险考察，在那里见到了长期以来被认为已经灭绝的树种——水杉，从而在国际上获得了极高的声誉。”得知西尔弗曼博士的逝世，我非常难过，短短几天，也令我永远错过了见到他的机会。在接下来的篇章中，我能讲述的，只是他本可以告诉我的很小的一部分。

活化石水杉



图 1.10 活橡树公园的水杉，1998 年摄于加州伯克利。

活化石水杉



图 1.11 照片来自旧金山纪事报，摄于 1948 年 4 月 5 日。

二 人 与 树

这次奇妙探险的逐步展开使我越发地兴奋，然而，这一切都不能与五十年前钱尼博士的那份热忱相提并论。

钱尼博士是著名的古植物学家。1890年，他出生于芝加哥，1922年起定居伯克利。作为卡内基研究所的研究伙伴，他成为加州大学古植物收藏馆的荣誉馆长。除了在大学讲学，钱尼博士还到世界各地进行野外考察以获得丰富的古植物资料。他的足迹遍及美国中部和南部、中国、朝鲜、日本以及菲律宾。

钱尼曾是规模最大的一次蒙古考察队的成员。在罗伊·查普曼·安德鲁斯的带领下，这个由科学家组成的队伍配备了125匹骆驼、众多车辆及成吨的物资，他们于1925年从北京出发到达戈壁沙漠，但钱尼在这次蒙古之行中没有什么发现，失望之余便来到满洲里（即中国东北）。结果在那里，他发现了水杉化石并采集了标本。钱尼博士以为他找到了红杉早期类型的化石模本，因为科学家在当时尚未意识到还存在水杉这样一个独立的属。

在20世纪20年代，现存红杉类植物仅划分出两个属，每属各有一个种。有关这种树最初的文字记载来源于圣方济会的传教士胡安·克雷斯皮，他于1769年随西班牙考察家加斯帕·德·泊特拉从巴哈加利福尼亚到蒙特利湾区探险时，作了如下记录：“该地区有大量的这类树，由于我们不知道树名，就以其木材颜色取名为：帕罗·科罗拉多（Palo Colorado）红杉。”七年后，德·安萨考察队进入了旧金山湾区，记录者彼得罗·方特将一株非常高的红杉形容为“高耸的塔”。他们描述的其实都是海岸红杉（即北美红杉），拉丁名为 *Sequoia sempervirens*。方特测量了那棵红杉，发现它高达41.9米（137英尺6英寸），基部径围达4.5米（14英尺9英寸）。这棵红杉依然挺立于原先

的小镇，该地也因此命名为帕罗·奥托（Palo Alto）。由于红杉木质美观，加州教会的创始人尤里帕·塞拉神父请求在死后将其遗体放入用红杉做的棺材。

现存红杉家族的另一个属是巨杉，*Sequoiadendron giganteum*。目前，巨杉仅存在于加州内华达山脉西坡上的 72 个孤立的小树林中。19 世纪中期，这些树被美国土著人用作房屋、衣服、交通和工具的原材料，也是他们宗教习俗的象征。Mono 印第安人认为巨杉是神圣的，因而不使用它的木材。Miwork 人也有不伤害活巨杉的禁忌，但可以使用它们脱落的树皮和枝条。

第一个记载巨杉的是一个欧洲人，宾夕法尼亚的印刷商热纳斯·伦纳德。他于 1833 年随同探险家约瑟夫·沃克首次从东向西翻越了内华达山脉，1839 年回到宾夕法尼亚州后，当即报道了他们发现的一些巨杉，但未标明地点：“……我们发现了一些红杉类的树，大得令人难以置信——从一人高处测量的树围达 16 ~ 18 Fathoms（1 Fathom = 6 英尺）。”他所描述的树后来得以确定是在今天的优胜美地国家公园内的玛里波萨树林。这个重大的发现当时却完全没有引起人们的注意。几年后，他在宾夕法尼亚的印刷商店被火灾夷为平地。幸运的是，两个复印件保存了下来，并于 1904 年在克利夫兰重新印刷。

1852 年，猎人 A. T. 陶德的故事则使巨杉首次引起世人注意。他被联邦水利公司雇佣，为正在参加水利工程建设以备加州墨非淘金热发展所需的工人们提供廉价食物。陶德射伤了一头灰熊，追踪途中误入巨杉生长区，也就是现在的 Calaveras 巨杉州立公园的 Calaveras 树林。庞然大树使他目瞪口呆，却无法说服别人相信这一惊人的发现。他只得谎称打死了一头灰熊，好引诱其他人进入树林。这次发现没多久，几个星期后的一些观光者发现了另一棵树，树干上深深地刻着“J. M. 沃斯特，1850 年 7 月”的字样。但沃斯特也未能享有“首度发现”的盛誉，他后来承认是听打猎的朋友们说看到过这些树，又过了十二天后才去的树林。

尽管巨杉仅发现于加州东部的山区，北美红杉却分布于从俄勒冈州南部到加州中部沿太平洋海岸的狭长地带。这些大树中的“长者”可以追溯至两千年前，但其化石记录却能追溯到近两千万年之前。

两千万年之前，加州和俄勒冈州的气候更为温暖，那里生长着与今天完全不同的树种，亚热带树种如无花果、棕榈树、鳄梨树、海岸红杉和巨杉覆盖着美国西部，北至华盛顿州。同时，北冰洋的气候也比较温和，可以生长橡树、胡桃、桦树等温带树种。与这些落叶阔叶树一同被发现的还有第三类红杉类植物的叶和球果化石，科学家们将其视为今天的加州红杉的祖先。

北半球的很多地区其实都发现过红杉类植物的化石。1828年，古植物学之父阿道夫·布朗尼阿特在法国首次发现这类化石。此后，在格陵兰岛、冰岛、不列颠群岛、瑞士、中国北部、日本、斯堪的纳维亚、西伯利亚、阿留申群岛、阿拉斯加、加拿大，以及美国俄勒冈东部至新西兰都有发现。北极地区发现的化石可以追溯到约一亿年以前的白垩纪。这些树在北部地区生活到第三纪始新世（4000万年至6000万年前），在此期间，哺乳类动物首次出现。水杉的化石在不同地区的形成年代有所差异，日本发现的化石可追溯到6000万年前，瑞士的是4000万年前，俄勒冈的则是3000万年前（渐新世时期，约2500万年至4000万年前）。水杉的化石记录到中新世晚期（500万年至2500万年前）及上新世早期（200万年至500万年前）完全消失；在晚于上新世的地层中均无水杉化石记录。

钱尼博士对采自俄勒冈东部 John Day 地区的水杉化石有着深入的研究。他认为在白垩纪时期，欧洲、亚洲和美洲的北部气候温和，类似于现在的加州北部。随着北极的冬季逐渐转冷，植物群落开始南移。水杉得以幸存的原因在于，作为落叶树种，它比其他针叶类树木能更好地适应严寒的环境。古代海洋的缩小或消失，使新大陆开始出现，为那些迁移的森林类群提供了侵入和存活的机会。

但是水杉，在当时并不怎么理想的自然环境中，却在四川和湖北的山谷中幸存了下来。钱尼在旅行之后清楚地认识到，这些与世隔绝的山谷是现今世界上唯一具有水杉生存所必需的气候条件的地区：夏季多雨，气候温和。同样有着潮湿夏季的美国南部生长着水杉的近亲——落羽杉（*Taxodium distichum*）。但是，那里冬季寒冷，气温通常低于零度。而加州虽然气候温和，但多数地区在夏季比较干燥。沿太平洋海岸的狭长地带则是一个例外，这里夏季的雾能提供海岸红杉生存所必需的水分。

环绕水杉坝和磨刀溪的山脉，在冬季阻挡了来自中国北部的寒风，在夏季则阻挡了从西北部吹来的炎热的夏季风。值得注意的是，在上新世，水杉从世界其他地区消失时，这些山脉已经形成，从而为这一狭窄的地区提供了适宜的气候。如果气候改变了，那么水杉便会像生长在世界其他地区的同类一样消失。正是在特定的气候环境下，水杉与化石记载中其他树种在水杉坝山谷中得以保存的事实，为钱尼的“地质时期气候条件变化”理论提供了依据。

钱尼早期在俄勒冈进行工作的同时，红杉家族的化石也得到其他科学家更为精细的分类。早在1928年，日本的清道远藤就指出，某些化石球果由于传统认识被错误地划入 *Sequoia langsdorfi*。他认为应归入一个新种：*Sequoia chinesis*。钱尼博士研究了来自 John Day 峡谷的同类球果，认为是与现今美国红杉属于同一属的古老种 *Sequoia langsdorfi*。1936年，清道远藤对日本和朝鲜的同类球果重新进行了描述，均与五年后由三木茂定义的水杉属特征一致。大阪市立大学的植物学教授三木茂意识到它们独有的特征——小枝和种鳞对生、球果通过长柄生长在枝上——足以创建一个新属，水杉属（*Metasequoia*）。由于三木茂是在第二次世界大战期间的1941年发表的文章，这一新的分类成果五年后才传到美国科学界。

三木茂在文章中提出，日本红杉类化石的独特性与海岸红杉（*Sequoia sempervirens*）极为不同，足以建立一个新属。这一观点很快便为科学家所接

受，所有化石记录的分析也必须重新修订。结果，在北半球发现的化石，包括从格陵兰岛到冰岛，从西伯利亚到阿拉斯加以及美洲大陆，全部都是水杉。海岸红杉的历史可以追溯至两千万年以前，而水杉化石记录则可追溯至两千万年到一亿年前。

有意思的是，在三木茂的论文发表三年前，钱尼的一个学生曾写了一篇文章，将水杉鉴定为“落羽杉”的一个新种。钱尼在 1951 年回忆到：“对于在 Elko 和内华达采集的渐新世时期的 *Sequoia heeri* 化石球果的分类，存在着一些疑问。这些球果着生在长且光秃的茎上，完全不同于现存的海岸红杉的球果。加州大学的研究生詹姆士 F. 阿西雷在他未发表的课程报告（1938）中也指出，这些化石应归入另外一个属，介于红杉属（*Sequoia*）和落羽杉属（*Taxodium*）之间。”钱尼继续写道，他和其他人当时都没有意识到该项工作的重大意义。

新的水杉属在国际上被确立时，中国也流传着四川省有一种新的落叶树种的传闻，1941 年冬天，国立中央大学的林学家甘铎在磨刀溪村见到一种新的落叶树。而三木茂恰恰是在这一年定义了水杉属。甘铎请当地学校的老师杨龙新在叶长出后采集一些标本，但采集到的标本未被鉴定，并可能已经丢失。杨对中国中央林业实验所的王战提到这棵不寻常的树，王战于 1944 年（见本章第一节注释①）前往该地并采集了叶子和球果，并把其中一部分寄给南京国立中央大学的郑万钧教授。郑教授的助手薛纪如于 1946 年两次前往该地区以采集更多的标本。与美国人不同的是，薛纪如是独自前往的。“由于我们没有赞助且每个人都缺少资金，我只能背着简单的行李和标本夹一个人去。”他后来写道。他的旅程可能要比后来任何一次考察都更艰难。想到土匪和强盗便心怀惊恐，“尽管饥渴劳累”仍继续前行。他终于到达了目的地，很是兴奋。但由于是冬天，他只看到“整株树又萎又黄……喜悦之情顿时烟消云散”。更糟糕的是，他事先根本没有考虑如何采集种子。艰难的跋涉之后，

他又冷又饿，疲惫不堪，站在足有 25 米（80 英尺）的大树之下，没有工具，最低的树枝比他的头还要高出近十米。怎么办呢？

好在臂力超群的他用石块砸下了几根树枝，枝条上长着黄色的雄球花和一些雌球果。薛纪如终于采集到了足够多的标本。而这一结果也许会完全不同。他可能会在路途中被土匪杀害，或者因为破坏了被村民认为是代表神的意志的神树而遭到袭击。但是如果没有他的努力和坚持，水杉也许就灭绝了。

郑万钧博士把一些叶子和球果的标本寄给北京静生生物研究所的胡先骕所长。胡博士读过三木茂的文章，发现中国中部边远地区发现的这一新物种同三木茂描述的日本化石植物非常相似。胡博士在 20 世纪 20 年代曾就读于哈佛大学，他于 1946 年寄了一些标本给他的导师，阿诺德植物园的梅若尔博士。正是通过梅若尔博士，钱尼才得悉这一发现。

钱尼博士曾多次申明是五个亚洲人——王战、郑万钧、三木茂、薛纪如和胡先骕发现了活的水杉，而不是西尔弗曼博士和他。在他的文章中，钱尼也赞扬了阿诺德树木园的园长埃尔默 D. 梅若尔博士于 1935 ~ 1946 年的贡献。尽管没有亲自去中国，梅若尔博士却提供了一笔资金，支持薛纪如和华敬灿两位先生在郑博士指导下对中国中部进行深入的野外调查工作。有趣的是，虽然仅有 250 美元，但由于当时中国的通货膨胀，时值 9750 万元。这笔钱实际上来自梅若尔博士自己的科研经费，即由塔希提岛（位于南太平洋，法属波利西亚的经济活动中心）的哈里森·史密斯提供的“阿诺德树木园中国考察专用基金”，哈里森·史密斯先生本人是 1925 年毕业于哈佛的研究生，长久以来，对中国有着浓厚的兴趣。

假如没有国际渠道的资助，结果有可能不堪设想，水杉也许会在一些年后消失。后来，郑博士给梅若尔博士写信表示谢意，强调要不是这 250 美元的支持，薛先生就无法进行第三次考察。

由于有了资金的支持，采集得以顺利进行，大量的叶子和球果标本于1947年寄给梅若尔博士，以补充他于1946年收到的少量标本。树木园的下一步举措就是把种子分装成袋，寄给美国和欧洲的一些研究所。阿诺德树木园成功地萌发了种子，如今他们想知道那些在中国濒临灭绝的水杉，是否足够耐寒而得以在世界各地生长。

正是收到的这些袋装的种子，使钱尼教授第一次知道这种他本以为早在两千万年以前就已经绝灭的树种仍然存活。梅若尔寄来种子几周后，钱尼收到了郑博士直接寄来的种子和叶子，这些材料是在梅若尔的资助下于1947年采集的。我能想象出当收到这些从中国寄来的种子时，洋溢于钱尼办公室的欢愉气氛。旧金山纪事报的西尔弗曼博士当时碰巧在他的办公室。这位科学专栏的记者正在对钱尼博士进行采访，以发表一系列有关古植物学的文章。西尔弗曼博士报道说，十分钟内，钱尼博士一直在查看中国地图和穿越太平洋的航空日程表。他告诉西尔弗曼，“若水杉的存在能得以证实，它将会被列为本世纪最重要的植物学发现。”

直至1948年，还没有一位植物学界的权威学者去实地考察过真正的水杉；所有的分类和鉴定都基于一些叶片和球果。钱尼博士认为梅若尔博士由于年事已高，没有考虑去中国考察，但是他抓住了机会。他异常兴奋，因为马上就意识到这些植物的存在可以为他的“植物是地质时期气候变迁的指标”这一理论提供依据。在这份热忱的感召下，西尔弗曼博士当时就决定同他一起前往。

揭开这一特别的科学发现之谜是多么令人兴奋啊！光是沿着科学家发现第三种红杉类植物的足迹前去中国就非同寻常。通过冗烦的图书馆查询我就发现了这一惊人的巧合。钱尼博士发现自己潜心研究二十年之久的属（*Meta-sequoia*）竟然是错的，正是这个曾经遍布整个北半球并且所有人都认为已经绝灭的属，现如今却被证实还存活在中国的边远地区。“就像发现了活恐龙！”

三 侧 谷

让我们停下来思考一番。当你置身旅途中，沿途不断有完全崭新的世界在你面前一一呈现。你的旅途好比徒步穿越峡谷。峡谷的宽度和高度取决于你的感官、对新思想的接受程度和你的步伐。如果你有日程安排或急于赶路，你就没有机会看到很多，你所看到的峡谷将又深又窄。路上通常还存在侧谷，转进每个侧谷，你都会发现完全不同的另一个世界。这是无法事先预测的。你也许会转入一个很短的死谷，也许会发现一条长而窄的小径，通向一个具有独特地形的宽广



图 1.12 比尔·马克拉马拉（右）和进行植物采集的同伴们在磨刀溪的一棵水杉前留影，摄于 1996 年。照片由安东尼·柯卡姆惠赠。

高原。这条路可能比你旅行的原路更引人入胜。有时，另一个世界会为你展现完全陌生的事物。所以，你必须时常重新确立旅行目标，重新筹划沿路停留歇脚之处。

比尔·马克拉马拉对我而言就是一道迷人侧谷的入口，正是他把我领进了亚洲植物收藏者的世界。比尔是采石山植物园的主任和园长，采石山植物园位于索诺玛县月亮谷的埃伦峡谷附近。

像著名的亚洲植物收藏家约瑟夫 F·洛克一样，比尔的收藏之路纯属偶

然，他从未接受过正规的植物学教育。作为一个大学生，比尔主修英文，他还在诊所做兼职。他热爱植物。当驾车时，他甚至喜欢测试一下自己是否能够回想起途经的每一株植物的拉丁名称。大学毕业后，他漫无目的地在亚洲旅行了数年。回国后，他意识到诊所工作的收入不足以维持全家的生活，便转向从事景观设计，他享受这种手工活的乐趣并且自己做老板。由于具有鉴别植物的超群本领，他被采石山植物园选作赴中国进行植物采集考察的志愿者。后来，他效力于这个植物园，很快就成为该园主任。

参观采石山植物园需事先预约，该园是非盈利性组织，由简·詹森夫人资助。她把名下的 40 英亩土地的一部分捐给植物园，为自己保留了一个乡间休养所，同时继续她对中国野生植物的兴趣爱好。比尔把植物园的日常工作安排得井井有条。

采石山植物园收集和繁殖亚洲野生植物进行资源保存和科学研究。他们把每株植物都加上标签，编入目录，在数据库中录入它们的来源和栽入植物园的日期。每株植物的种子都是比尔亲自在亚洲采集的（至 1998 年，他已经进行了 12 次采集考察）。种子在温室萌发，幼苗在苗圃培育，然后赶在幼苗依赖苗圃肥沃的土壤之前将其移栽到地里。一些剪枝用于插条繁殖，但是植物园自己树上的种子不会用于播种，以避免产生美国杂种后代。唯一采用的除草剂为 Round-up™，用来抑制杂草丛生。由于这里的植物有着惊人的多样性，所以不需使用杀虫剂。

建立植物园的初衷既非为了盈利，亦非纯粹用作园林观赏。在月亮谷茂密森林的掩映下，这座位于山坡上的占地 20 英亩的绿色园地实为玩赏休憩的好去处。我初次来到这里是在二月份，除了一些植物刚刚开始萌芽，其他的大多数仍处于休眠状态。一株生长了七年的桦树已有三四米高。而在中国最常见的一种松树——油松（*Pinus tabulaeformis*）则郁郁葱葱。如此纷繁多样

的情形倒可以让人见识密植条件下植物丰富的多样性，就像在野外的自然环境一样。

园内小径众多，互相连通。曾经用于采石的废弃矿坑如今也灌满清水，呈现出自然池塘应有的风景。头顶的喷水器可以保持湿度，以满足那些源于日本及中国中部和南部的植物。

在采石山植物园，比尔热情地欢迎我的到来。他把去中国考察的幻灯片拿给我看，包括在磨刀溪拍摄的照片（水杉标本树所在地）。他在不到两年前，即1996年10月去的那里。幻灯片中的磨刀溪比我想象的要大得多。钱尼和西尔弗曼报道这个村庄约有一千人。而比尔的幻灯片所展示的规模至少有两倍大。成年人都穿着蓝色的毛式服装，孩子们则穿着色彩艳丽的衣服，和西方的儿童们一样。宽阔的柏油马路两旁排列着水杉树，自钱尼之行以后，这个树种已经作为行道树栽遍中国大地。但幻灯片上磨刀溪的柏油路紧紧环绕着这些树的基部，比尔说用不了一个世纪，这些树就会被束缚而死去。

比尔也给我展示了一个做工漂亮而且质地结实的手工椅子，是典型的中国内地老百姓使用的椅子。这份礼物，是他在获准参观另一类濒危的保护树种——秃杉（*Taiwania flousiana*）时获赠的。这种椅子在海湾地区的任何一家古董店里都可以标上最高价。从他家阁楼上，比尔还拿来一个编制紧致的篮子，在磨刀溪，人们用它来携带婴儿。这个编织物毫无瑕疵，结实耐用，惹人喜爱，质量堪比美国本土人制作的精致的编织物。

比尔游遍了中国南部、西部和西藏。最让他觉得有趣的地区是墨脱。按照官方的说法，中国人已经在这一地区建立了除阿拉斯加之外的世界上最大的自然保护区。非官方报道则认为，这里的村民过着很普通的生活。由于大部分地区没有路，墨脱以西藏的雅鲁藏布江河形成的转弯为中心，这条河在进入印度之后称布拉马普特拉河。在高达七千多米的加拉白垒和南迦巴瓦两

座山峰之间，有一极窄的峡谷，之后，河流沿着南迦巴瓦峰形成一个急转。这里道路非常崎岖，还没有一个探险者或植物采集家成功穿越整个峡谷。1924年，英国植物采集者弗兰克·金登·沃德曾在峡谷的两个入口考察，但在峡谷内只前行了24公里就退了回来。

比尔的图书馆中收集了关于著名的亚洲植物采集家的资料。其他的著名植物学家包括法国人吉恩·皮埃尔·阿曼德·大卫，第一个考察中国内地的西部植物采集者；威廉·希勒布兰德，素称“夏威夷植物学之父”，以及查尔斯·萨金特，他建立了哈佛阿诺德植物园。后两者像比尔和约瑟夫·洛克一样，从未接受过正规的植物学训练。

欧内斯特·威尔逊通常被认为是最伟大的采集家，他曾于20世纪早期代表阿诺德植物园在中国进行了一次旅行考察。当他采集峨眉百合（*Lilium regale*）时，突然发生的意外证明了他的勇气，也说明其他前往亚洲的植物采集者可能面临的种种困难和危险。从长有七千个百合球茎而且随时可能发生滑坡的山群归来时，一块巨石从山的一侧滚落下来击中了威尔逊，砸断了他的腿。从受伤的地方走到最近的医务所花了他整整三天的时间。在用照相机的三角架制作了一个简易夹板后，迎面又过来一支五十头骡子组成的骡队。在这条窄路上，由于害怕再次发生山体坍塌，双方都不愿意退后耽误行程。忍受着疼痛的煎熬，威尔逊让他的中国助手把他横放在路中间，让五十头骡子从他身上跨过。后来，这位英国植物采集者的腿开始感染，并且他拒绝截肢，庆幸的是感染竟被治愈了，但从此留下了后遗症，他的一条腿比另一条短。对此，他自己戏称为“百合腿”。比尔认为如果不是威尔逊后来在一次车祸中丧生的话，他也许会发现水杉。

但是，1922年至1935年间的《美国国家地理杂志》上，约瑟夫·洛克发表的文章一下子把他的个人荣誉凌驾于其他亚洲植物采集者之上。他性格傲

慢，旅行方式独特。洛克在乡下旅行时带着小队士兵以免受土匪的侵犯，还有一小队厨师烹饪他喜爱的风味。在考察时，他的饭菜用瓷器摆放在亚麻桌布上，并用一个可折叠的橡胶浴缸来保持个人卫生。他身着制服领带，从四个中国人抬着的轿椅上走下来的样子给人留下了深刻的印象。

不过洛克博士（于 1932 年在贝勒的德克萨斯大学荣获博士学位）同其他 19 ~ 20 世纪的采集者一样，经历了巨大的磨难和艰难的旅途。他们经常在恶劣的天气状况下连续旅行数月，没有现代化的高科技服装和优越的设备条件。钱尼和西尔弗曼只不过行进了十日，而洛克从他的国家出发，一走就是两年。尽管钱尼和西尔弗曼路途艰险，但让他们的考察真正值得纪念的是活化石。他们所寻找的活植物被认为早在两千万年前就灭绝了。

未知的植物不断被发现。多数在刊物上发表以后，并没有引起重视。水杉和瓦勒迈杉（*Wollemia nobilis*）则不同，后者是一种针叶类植物，最初是由国家公园和野生动物管理局的官员大卫·诺布尔在澳洲发现的。尽管瓦勒迈国家公园离悉尼仅 200 公里（124 英里），直到 1994 年 8 月，诺布尔先生才第一个发现这个拥有亚热带雨林植物的峡谷中有 40 株奇特的树。瓦勒迈杉被确认为南洋杉科的一个新属，其特征介于该科其他两个属之间：南洋杉属（*Arucaria*），如猴谜树；贝壳杉属（*Agathis*），如新西兰的贝壳杉（*Kauri*）。同水杉一样，瓦勒迈杉也被称为“活化石”，因为它比其他现存的任何一个树种都更接近第三纪的植物化石。另外，它的祖先，南洋杉科的其他成员，在恐龙时期即侏罗纪和白垩纪时期广布于世界各地。

有趣的是，1998 年发表在《太平洋园艺》（*Pacific Horticulture*）上的一篇文章把瓦勒迈杉的发现定于 1996 年。事实是如此易变，即便在当代。

目前，比尔的兴趣之一是采集藏药植物。在一次采集考察中，他在康定（四川西部山区通往西藏途中的一个县城）遇到了一位德高望重的医生。比尔

希望能记录下那些渊博的传统藏药知识，尤为重要是草药的治疗。这位藏医每年花三个月的时间骑马去高山上的村子里挨户寻诊。比尔梦想有一天能与他同行。我也很想参加这样的考察。然而，这又是一个偏离水杉旅途的侧谷。

在比尔的建议下，我给成都生物研究所的印开普教授写了一封信。印教授是参与中国西部植物考察的负责人。我希望在他的帮助下，能参观磨刀溪和水杉坝，这两个地方都不对旅游者开放。不到三个星期，我就收到了回信。同五十年前的钱尼一样，当握着这封贴有盖着邮戳的中国邮票的信时，我的双手由于激动而颤抖不已。

四 安 排

中国幅员辽阔，跨越 50 个纬度和 60 个经度，占地 960 万平方公里（370 万平方英里），是世界上面积第三大的国家，仅次于俄罗斯和加拿大。山地占整个国土的 43%。如果沿着一条直线走的话，得跨越 3800 多公里（2400 英里）连绵的山系，然后再跨过另外 1900 多公里（1200 英里）寸草不生的空旷平坦的地带。从西藏的世界屋脊珠穆朗玛峰开始，地势向北一直降低，直到低于海平面的新疆吐鲁番盆地。

中国也有着丰富的动植物资源。广阔的国土上生存着 1000 多种（亚种）鸟类，400 多种哺乳动物，300 种爬行动物，200 种两栖动物。植物种类总数多达 35,000 种，其中有一半以上是中国特有的物种。中国拥有世界上 29% 的裸子植物，22% 的蕨类植物，11% 的被子植物。

同其他国家相似，中国的生物多样性受到全球性过度开发的威胁：持续的农业扩张、滥砍滥伐、污染、过度狩猎，以及在计划生育政策下仍然显著的人口增长。幸运的是，中国政府在建立自然保护区方面做得很好。在现存的 800 个保护区中，有 57 个国家级保护区^①。保护区的面积总计 45 万平方公里（172,000 平方英里），占国土面积的 5%。

要想游遍这些不同的地区，需要一生的时间。我此次只是去四川和湖北两省交界处考察水杉。印教授保证，我可以到达磨刀溪和水杉坝。尽管他的信非常正规，但非英语母语人士的英文仍使我产生了一些疑惑。总的来说，教授提供了两种选择——要么直接从成都乘飞机前往目的地，要么他安排一辆吉普车来接我。他表示可以代我办理有关政府部门的各项手续，并问我是

^① 中国国家级自然保护区截止到 2007 年 8 月为 303 个。

否需要他的陪同。

我希望能尽可能地循着钱尼和西尔弗曼两位博士的足迹。理想的行程应该从上海飞到重庆，然后漂流过河到万县，最后徒步跋涉到磨刀溪。但是，现在那里已经通路。今天的路是否就是五十年前两位美国科学家所走的路线呢？似乎无人知晓。

在那个年代，很少有人到这里旅行。1948年，钱尼返回美国后一个月之内，就给当时在中国广州岭南大学工作的美国昆虫学家林斯里·J. 格瑟特博士写了一封信。钱尼鼓励他去水杉地区进行野外工作。倘若水杉与白垩世地层中的化石记载的树种仍存在于水杉坝这样的自然环境中，那么很有可能一些古代的动物群落也同时存在。

当时仅34岁的格瑟特已经积累了丰富的经验。出生于日本牧师家庭的他曾就读于斯坦福大学和加州大学伯克利分校，在那里遇到了钱尼教授，并获得博士学位。作为40多篇关于昆虫、爬行动物和两栖类文章的作者，他曾在中国进行过三次重要的采集考察。格瑟特同中国科学家有着良好的合作关系。1948年7月，他带领加州科学院-岭南大学水杉考察队，追寻钱尼和西尔弗曼从万县到四川和湖北水杉谷的路线。在1953年7月15日的《科学院汇刊》(*Proceedings of the Academy of Sciences*)的详细资料中，他记录了这两个月的考察工作。他的工作组，包括五个学生、一个警察、两个护卫和四个脚夫，考察了周围的山脉和山谷，共计1219株水杉树。他们采集了很多昆虫标本，但都不是来自某一地质时期或是有特殊用途的标本。

1949年的共产主义革命带来了变化，32年后，来自其他国家的人们顺利地参观了四川和湖北交界的地方并报道给全世界。1981年春季，在加州大学伯克利分校植物园的季刊上，布鲁斯·巴塞洛缪把1980年中美植物考察的情况作了报道。他们乘坐中巴和吉普车从万县抵达磨刀溪和水杉谷，仅用了三四个小

时，钱尼和西尔弗曼曾经花了三天徒步走过这些路程。显然，情况发生了改变。

其他变化还包括汉语拼音，可以用于中英文的翻译。19世纪，最早定居中国的几个欧洲人创建了自己的语音体系，用罗马字母代替汉字。19世纪中期，由维德和圣伊莱斯两个英国人发展起来的另一种体系最受欢迎，因为它模仿了熟悉的英语发音。但是，1949年新中国成立后，政府决定采用以北京地区语音为标准音的新语音系统。修改后的官方汉语体系于1958年生效，称为拼音，是“拼音字母”或语音字母的简称。拼音本身意为拼写。由于该体系并非为讲英语的人设计，所以其中很多罗马字母的发音与英文迥然不同。

省界也重新划定，磨刀溪现在属于湖北而非四川。钱尼和西尔弗曼最初在磨刀溪看到的那株模式树状况良好，但庙宇已经搬走。附近三株其他的树已经被砍掉。水杉坝附近的大片林子仍被肆意砍伐。尽管有五位林业工人保护水杉，周遭的森林却逃不掉被破坏的厄运。钱尼看到的那个原始的北极—第三纪居所（北极指北极起源，第三纪指它繁盛的地质时期）消失了，几百万年以来，它曾经一直巍然屹立于水杉坝之上。

直到最近，才有外国人开始参观该地区，他们都是由中国向导带领专门参观磨刀溪的。比如爱达荷大学的查尔斯·斯麦里同他的妻子和一个学生在1989年来过，比尔·马克拉马拉同他的小组于1996年参观过此地。

我希望能坐船沿着长江顺流而下，而这并非印教授提供的选择之一。尽管我最初的意图是沿着钱尼和西尔弗曼的原路走，但似乎没有人知道他们所走的具体路线。另外，这种特殊安排，包括官方许可的旅行机会很难得，不容错过。

所以我回信申明此行目的是拍照，不需要采集标本，因而也不必有植物学家陪同。但是，如果他能帮忙以合理的价格安排一辆吉普车和一个翻译，我会非常感激。

然而，六个星期过去了，没有一点儿回音。我又给比尔打了一个电话，

他把印教授的助手吕荣森的电子邮件地址给了我。我试着发了一封国际邮件，没想到居然三天后就收到了来自中国的回复。

吕教授代表印教授表达了歉意，印教授正在进行另一个考察。他说只带一个翻译和一个司机（外国人不允许在中国驾车）旅行是可以的，但需要从成都开车去。十天的花费是 2500 美元。

我欣喜若狂。尽管不可能顺江而下或进行山区跋涉，这次旅行的吸引力也将超过以往中国中部的旅行。在随后的几封邮件中我们谈妥了细节。一次付清包括食宿的所有费用。但作为参观水杉的交换条件，应当地政府要求，我要给当地医院的专家做一次报告。并且最好将报告的复印件提前寄出，以便进行专业翻译。

我当然非常乐意答应这个要求。这真是千载难逢的机会！在出发前几星期我就好奇地想象着，在中国有人正在翻译和学习我的报告呢。



图 1.13 印开普教授，摄于 1998 年。

五 抵达成都

我乘坐直接飞往亚洲的西北航空公司的飞机。在东京两个小时的短暂停留期间，我没有离开机场，直接飞往香港。

第二天上午我离开香港，中午就到达了成都。

钱尼和西尔弗曼当时非常担心万县是否有一个机场。50 年后的我则害怕找不到印教授、吕教授或生物所。在机场，当看到一个戴眼镜的年轻人举着一块写有我名字的白色牌子时，我忐忑不安的心顿时放了下来，真是太让人高兴了！

那个年轻人穿着黄色的尼龙裤子、一件 T 恤衫、一件宽松的皮革夹克衫。我们打了一声招呼，他就跑进一家商店给印教授打电话。然后他招手让我到一辆等候的车里。这是一辆三菱帕杰罗，四轮的運動型多功能车，状态很好。司机叫李潘忠，负责开车接送动植物野外考察者。

接待我的年轻人叫吕莽——吕荣森的儿子，我电子邮件的联络人。小吕是 28 岁的大学研究生，在一家为发电厂制造风扇的工厂工作。作为管理人员，他有很多旅行的机会。他去过巴基斯坦，下个月计划去德国考察，准备从一家德国的大公司买一些设备。他父亲在尼泊尔做研究时，他在那里受过两年正式的英语教育。吕莽在四川考察途中将做我的翻译。他的英文说得还不错，但有时我问他问题，得到的却是一个完全不同的答案。

“你订旅馆了吗？”小吕问我。我说没有，小吕就让司机直接把我们带到所里见教授。

汽车从机场到小镇南端行驶了大约 20 公里（12 英里）的路程。高速公路两旁是树，隔开自行车道。这里似乎有数不清的小商店，整个中国都是

这样。

尽管建筑单调乏味，街道上却充满了生机和活力。大约 30 分钟后，我们来到生物所。我马上就认出了印教授，他和我在比尔·马克拉马拉的照片上看到的一样。他微笑着和我们打过招呼，接着便迈开大步带我穿过堆满箱子的走廊，到了他那阴暗的办公室。二三十平米的房间内摆放着一只沙发、一张 20 世纪 40 年代的老式桌子和一些书架。书架上的杂志和图书全是中文的，看来是有关植物学和生态学的科技论文。

教授一点没有闲下来，从书架上拿下一盒茉莉花茶，把茶叶放在杯子里，又从金属暖瓶中倒了些开水，说，“现在让我们计划一下吧。”

印教授四十来岁，乐观、瘦削，穿着宽松长裤和一件白色的短袖衫。他在桌子上摊开一张近两米的中文版四川省地图，然后以一种简洁有效的态度直奔主题。通过司机的帮助和吕莽的翻译，“五十周年考察”的旅行计划便确立了。到达离水杉谷和水杉坝最近的小镇利川，大约需要一天半的时间。第一个晚上要在大竹度过，那是重庆的一个小镇。如果留一天半的返程时间，尚有六天的时间可驻留在水杉坝及其附近。在当地医院的学术报告需要一天时间。印教授还建议花点时间在重庆旅游。重庆有 3 千万的人口，已经成为世界上最大的城市之一。此外，我还想去峨眉山看看。

其他人甚至对我那肤浅的中文知识感到更为开心。“夏，夏”（谢谢），我对他们的安排表示感谢，结果每个人都捧腹大笑。

“这就是最终计划”印教授宣布。在他的办公室待了不到一刻，一切都安排好了。小吕有点吃力地用英文写着我们的行程，印教授拿出了一张很大的自然保护区资料图。1948 年钱尼博士来考察时，中国尚无国家公园或自然保护区体系；而 50 年后，中国人已经超计划完成了到 2000 年建立 500 个自然保护区的目标。印教授拍摄的许多漂亮的照片也包括在内。他说这是给我的礼

物，他和吕莽都签了名。

通过吕莽，我了解到更多有关生物所的情况。在 400 多名职工中，印教授是级别最高的科学家之一。整个院子共有五个研究所，都是中国科学院的附属所。其他的研究所包括物理所、化学所、地质所和光学所。成都研究中心尽管有好几千位科学家和工作人员，也仅仅是个中等大小的研究所。上海和北京的要大得多。在后来的十多天里，吕莽和我就规模大小的问题讨论过多次。

后来，我发现有三棵水杉长在研究所入口处对面的车道上。近年来水杉已经成为整个四川的行道树。这些人工栽培的树仅有四五米（15 英尺）高，树干很纤细。但我很兴奋——在这里我竟看到了中国的水杉！

六 考察开始

醒来又是一个阴天。早上九点十五分，吕荣森教授到了我的房间。他和印教授差不多年纪，穿着风格相似。我们先去见印教授，他已经开始在办公室工作了。我很快明白了印教授为何节奏如此之快。他非常繁忙，一边给那些经过他办公室的各个合作者安排工作，其间还接了好几个电话，一边安排我们这边的计划。吕教授解释道，印教授正在四川西南筹建一个工厂，经营一种名叫紫杉醇的抗癌药物，所以最近特别忙。这种药进口非常昂贵，虽然可以从紫杉中提炼，但成年的紫杉树在中国几乎灭绝了。

紫杉，另一种古老的树种，是一种早在 2.15 亿年前的三叠纪就已经出现的 *Paleotaxus rediviva* 的后裔。紫杉生长缓慢，树龄很长。由于紫杉是制造箭的最佳选择，过去两千年间，欧洲连绵的战争导致了紫杉灭绝的局面。

目前，紫杉面临着更大的危险。1969 年，研究者首次从 *Taxus brevifolia* 中提取出纯紫杉醇。到了 20 世纪 70 年代中期，这种复合物表现出对细胞增长的抑制作用。这种复合物在卵巢癌的治疗中最为有效，在抗肺癌、乳腺癌、脑癌和皮肤癌方面也有一定前景。尽管紫杉醇也存在于紫杉树的根部和叶子中，但最有效的来源却是太平洋紫杉的树皮。当然，这取决于把什么作为代价。

一棵两百年树龄，树围 3 米（10 英尺）的紫杉树能产约六磅的树皮。这个产量只能提炼出 1/15 克的紫杉醇。而治疗一个病人需要 2 克，这意味着 10 棵两百年树龄的树。美国的卵巢癌、乳腺癌及肺癌病人一年的治疗要毁掉 150 万棵紫杉。

幸运的是，印教授正在为中国创造另一种选择。他计划培育 3 年亚洲紫杉（*Taxus sumatrana*）幼树，然后从其叶子、根和树皮中提炼紫杉醇。他的成功也将有助于拯救美国的紫杉。

吕教授也很忙。他的研究对象是沙棘（Seabuckthorn，拉丁名：*Hippophae*

rhamnoides)，这种植物在中国野生，但因其营养和药用价值，已被成功地栽培于俄罗斯和蒙古。吕教授把我带到标本馆，那里保存有 10 张水杉标本，多是印教授于 70 年代在四川省采集的。在同一个柜子里是好几叠红杉的叶子和球果，是另一位蒲教授于 1992 年 4 月 23 日从加州伯克利采集的。

午饭后，吕莽、李师傅和我一起出发了。路上小吕笑嘻嘻地说，“这将是一次精彩的旅游！”吕莽十分兴奋，他以前从未到过四川的东界。他那出色的幽默感、滔滔不绝的言谈以及他善于社交的性格使我们很快成为很好的伙伴和朋友。

我们所经过的 300 多公里（200 英里）的乡间梯田都栽植着作物。偶尔可以看到玉米地生长在高速路的交界带。一些农民走在隆起的小道上，戴着棕榈叶编织的锥形帽，一些人穿着暗蓝色茄克衫，一些还用长长的扁担挑着水桶。家养的白鹅和鸭子在稻田里游弋，此外还有鸡、狗、山羊和水牛。虽然没有开阔的牧场，乡间的风景却出奇得好。每片土地都种植着庄稼。除了水稻和玉米，偶尔也有白菜、土豆和荷花（它的根可作为蔬菜烹饪，非常可口）。

大多数房子是砖砌的，有着瓦房顶，但是也有水泥的平顶屋，有时单个落成，但通常一个村子里十到二十户人家聚在一起。秋天的田间被染成了黄色和褐色。房子四周围绕着绿色的小树和竹子。从远处可以看到，小城市里有成打的高楼大厦。高速公路从中穿过，几乎看不到出口。

在到达重庆之前的最后几英里，高山出现了，遮掩在灰暗的天空中。

我们到时已经九点了。由于是中秋节的前一天，我们计划要住的政府旅馆已经客满了。吕莽解释说这个节日有着一个传说，一个女人不能同自己心爱的人一起生活，被驱逐到月亮上。在农历八月的第十五日庆祝，作为对自由的庆典。这是人们仰望月亮，点燃鞭炮和品尝月饼的时候。

住宿的问题是暂时的。递上一支烟后，一位年长的绅士坐进车里，指点我们去一家合资旅馆。

七 进入腹地

李师傅和小吕每人有一份特殊的中国早餐：玉米粥和两个包子。我选择了茉莉花茶和一个削好的苹果。我们早早就出发了，期望中午到达利川。但是如同钱尼和西尔弗曼一样，通往水杉的路并非我们预料的那样容易。

到了大竹的东部，生活显得很简单，风景俨然变得乡村化。路上车辆更少，甚至看不到什么机械设备；仅有一些冒着黑烟的出租公共汽车，和铺着帆布的载人的小卡车。田地自然地弯曲成美丽的新月形梯田。人们在水牛旁边耕地。在每个村庄和路旁小镇的前后，人流不断在市场往返，有些人扛着很重的货物。整段高速路被用作人行道。虽是中秋佳节，但并没有任何特别的装饰、活动或仪式。

沿着雾气迷茫的山，我们最后爬到高处，眺望着前方的迷人景致。远处看好像是灌木丛生的山坡，实际上已被高度开垦、种植。许多东西都是拍照的素材，但由于即将到达目的地的激动，我几乎都拿不稳镜头。

经过许多山地农田和村庄后，我们到了万县，这对于吕莽而言只是个小城市。这里有很多高大建筑覆盖了河岸山地，还有成群的人。在每个交叉路口和易于走错路的地方我们都会问路，最后终于抵达了长江。长江大概有四百米宽，在塞满淤泥的河面上漂着许多长船、摆渡和驳船。照完相后，我们穿过了相对较新的混凝土桥。

钱尼和西尔弗曼乘坐一艘叫明太的河船，三天后，即 1948 年 3 月 4 日到达万县。他们一行共五人：一位中国科学家是来自南京的桦青山先生，他在 1947 年去磨刀溪采集过种子；还有一位从重庆来的中文教师，名叫陈文森，充当小组的翻译人员；另外一个是一位朋友的私人管家，姓刘。

他们在万县与一个美国传教士约瑟夫·马特森牧师及其家人碰面。牧师

帮助他们雇了八名脚夫，搬运大量的工具和科学家乘坐的轿子。他们又雇了三个脚夫搬运大量的货币和大米，以免山上买不到足够的食物。



图 1.14 钱尼博士坐在轿子上。摘自《太平洋发现》(*Pacific Discovery*), 1948年9~10月, 钱尼博士惠赠。

从大桥上穿过长江后，我们开始了有点惊险的旅程。在几分钟之内，我

们到了一个五元收费亭。车开了不到 1.6 公里（1 英里），一个穿制服的人告诉我们，前面不到 20 公里（12 英里）的地方，一座小桥倒塌，道路不通。

我们花了几分钟才明白，除了去利川所剩的四个小时的山路外，还有别的选择。我们还可以返回万县，重新琢磨它那没有标牌的、交通拥挤的街道，然后沿着长江行驶 100 公里（60 英里）到达一个叫忠县的小镇，从那里我们可以跨过长江，然后驾几个小时的车到达利川。

这个选择也不坏，我们还有好几天的时间。实在不行的话，去峨嵋山的旅行可以取消。所以在路旁餐馆品尝美味时，我们讨论了这些问题，返回万县找到忠县的入口并没有费什么劲。

这里又增加了冒险的成分。路突然变陡而且泥泞。车子的上下颤动使我不得不紧紧地抓牢门上的扶手。

泥越来越多！我们尽量躲开了好几辆陷在泥里的小车。山峰变陡峭了，风景也险峻了。几乎所有的车不再前进了。也不再有了从相反方向开来的车辆。

连续不断的泥潭，在第四处时，我们陷进去了，困在了偏远的内陆地区，还没有拖车。车轮在旋转，启动器在咆哮，但都没有用。我们还困在那里。李师傅爬出车子重新调整了一下四个轮子的主动齿轮。最后开足马力，我们成功摆脱了困境。后面近 50 公里（30 英里）的泥路时好时坏，李师傅摇着头，但是还算满意。

经历了六个小时的筋疲力竭，我们驶出了淤泥。我们当天到达了目的地：临河山城——忠县。这是一次冒险，不是花了四五个小时去利川，而是十二个小时颠簸在车上，而距离利川我们还有四至五个小时。如果一切顺利的话。

八 在 途 中

小吕计划早起准备早餐以便弥补前一天在路上耽误的时间。他希望我们能赶到利川吃午饭。但是，前一天泥泞的旅程也得付代价，小吕睡过了头。所以在当地餐馆简单地吃了早餐，我们花了十分钟就到了长江。瞧！大约有五六十辆卡车和一些公共汽车正在渡口等着过江。可是摆渡的驳船每趟只能运送七至十辆车。牵引过河只需五分钟，但是装卸花的时间很长。

看来我们可能得在那儿待一天。小吕估计只需等一两个小时。结果，让我吃惊的是，竟只用了三个小时。

长江上游截流对中国是一个巨大的贡献。长江有 6380 公里（3960 英里）长，因而得名。它是仅次于尼罗河和亚马逊河的世界第三长河，比密西西比河还要长 320 公里（200 英里）。长江下游流经中国最发达的工农业区。棉花、小麦、大麦、玉米、大豆和全国 70% 的水稻生长在流域内的肥沃土壤上。

在忠县，河流起初显得波澜不惊。但当最后轮到我们上驳船渡江时，却出现了巨浪。幸运的是，我们有惊无险地渡过了长江。一到对岸，我们立刻延着蜿蜒向上的路爬到越来越高的雾山之脊，最终到了云之上。

看！蓝天和山峦在河谷间交替，美丽的黄绿色峡谷中点缀着传统的农舍和村庄。空气也很清新。风景继续变化着。穿过深邃的峡谷，两旁层峦叠嶂，谷底有着清澈的小溪和森林。我们又一次从各个角度拍摄了照片，真的是标准的国家公园景色。最悦目的莫过于竹子和香蕉树围绕的木石农舍。这些屋舍的椽头悬挂着大串晾晒的玉米和红辣椒。

我以为这些人很富裕，吕莽却不赞同，他说，“他们没有钱，不能像你我

这样旅游。”的确如此。

居住在四川东部这一地区的人是典型的自耕农。除了河运的货车外，视野中再也没有出现机械。但是，这里有烟草田和足够的玉米、水稻、白菜、水果和辣椒。不像北京、上海、广州和重庆，这里的天空是蓝色的。这些节衣缩食的农民拥有清新的空气、宽敞的空间、绿色的环境，以及他们需要的所有食物。但是，目前还没有抽水马桶和自来水。

五十年前就在同一山系的某些地方，钱尼和西尔弗曼一行曾经徒步旅行。那时的风景可能与现在没什么不同。钱尼和西尔弗曼却得在烟雨连绵中越过这些山脉。起先他们乘坐一队脚夫抬着的轿子，但是当道路变陡时，他们就得步行。用西尔弗曼的话说，“我们爬过光滑的岩石，趟过泥泞，滑下山坡，在雨中翻过一道道雾气弥漫的山脊。”

我们开车一天的路程，钱尼和西尔弗曼需要徒步旅行三天，他们大约走了 110 公里（70 英里）。我们最终到达了山的边缘，可以俯瞰利川风光。下面宽阔的峡谷形成低山绿岛，与金色的稻田和树木河流相互交错。路两旁的树看起来像雪松，我们走近一看，发现雪松和水杉间杂生长。九月末时，水杉已变成秋天特有的黄色和铁锈色。这些栽培树木看起来很纤细，和成都生物所的一样，不像我在伯克利看到的那些参天大树。当地所有的人好像都在收割水稻，要么割秸秆，把水稻脱粒到垫子铺底的木仓里，把脱过粒的秆捆成束，把路旁正在晾干的麦子，要么扛着或用自行车拖着大袋水稻上山去市场。

下午早些时候，我们到达了利川小镇。我们直接驾车到当地政府办公室，一幢五层的学校样子的灰色楼房，小镇的副市长何文剑正在那里等候。我们直接被带到会议室饮茶。和印教授三天前所做的一样，何先生立刻为我们制订了参观计划。他说磨刀溪和水杉坝的路不同，所以我们将在第二天早晨去

磨刀溪，下午在医院作报告，后天去水杉坝。

晚餐后，小吕和李师傅便返回旅馆，当地的两个官员带着我在小镇散步。这里只有两条主街，交界路口屹立着一座新建的灯塔，非常大。那太空浅碟形使它看起来像来自于杰特森。路上车辆极少，双人座的人力三轮车用作出租。

我们在一条据何先生称有三百年历史的街道漫步。偶尔有两层木制建筑，嵌着精致的格子窗户。我们讨论起这种传统建筑保存的重要性，这一观念在当代并不怎么被人看重。这种有历史意义的建筑在中国各处正在以很快的速度消失。

自行车仍是当地主要的交通工具。确实，利川之美多源于脚踏车的铃铛声。这里没有私人车辆所带来的乌烟瘴气和拥挤不堪。

由于何文剑是英文专业毕业的，所以我们之间的交谈颇为顺畅。他让我叫他的英文名字约瑟夫。约瑟夫出生并生长在利川，在湖北省会武汉的武汉大学花了四年时间获得学士学位。当钱尼和西尔弗曼参观时，磨刀溪还属于四川省。但 20 世纪 80 年代以前，省界被重新划分，如今，磨刀溪、水杉坝和利川全归湖北省。

大学毕业后，约瑟夫在海南工作了一年，海南省是中国南部海岸的一个岛屿。但是，由于思念家乡，他便回到四川开始了目前的工作，一待就是六年。约瑟夫已经结婚并为他的独生子感到非常骄傲。现在他快三十岁了，洋溢着特别的风采和自信。即使在 GQ 杂志 (*Gentlemen's Quarterly*) 上他也不会显得不合宜。

经过一家医院时，约瑟夫问我是否想进去看看，尽管当时已经十一点了。在入口处，有一个卖中药和西药的店面。一边的橱窗内摆着合成的药片和药剂，而另一边的橱窗内则摆着干根和草药。穿过一个小院子就是办公室，那

里坐着五六个穿白色大褂的医生。他们原来是医学院的学生。护理医生穿着一件简单的运动夹克衫。学生们正在绘制医学图谱，他们递给我看。当然，全是中文，但是我通过布局能明白他们正在阐述病人的病史和身体症状（约瑟夫译为诊断）。给病人开的药方为青霉素、安卞青霉素、维生素 B 和维生素 C（这些药方名全用罗马字母书写），以及一些中药。虽然设施很简单，没有任何技术设备，但在舒适的环境中病人看起来被照看得很好。

谢过主人的陪同后，我们返回到安静的街道，又一次听到自行车的铃铛声。这时，可以看到头顶的星辰和屋顶远处的小山。我与宽厚的主人依依惜别，回到舒适的房间，累得除了睡觉之外再也不能做其他事情了。

九 磨刀溪和模式树

我打算早点起床好观察小镇从睡梦中醒来。四点四十五分，响亮的军乐声就开始从喇叭中传出来。我惊奇地发现即使经历了这么些日子的旅途颠簸，那份最初的热情使我一点也不感觉疲累。我叫醒守夜的服务员，让她把门厅的门打开。就这样，我开始了在中国中部首次没有人陪同的散步。

我们的确打破了这里一般游客的常规。自从离开成都后还没有见到过一个外国人。这里甚至没有卖明信片的。

小镇正在醒来。路边的茶铺正在敞口的火炉上煮粥，老人在街上散步，嘴里叼着烟斗，烟袋管末端固定着的小烟头，手推木车后面放着的新鲜猪肉正被切开来分给街上的小贩。

利川真是个很可爱的城镇，周围簇拥着森林密布的锥形石灰山，有点像桂林一带的地形。利川很小，在周围走走很容易。城镇中心的广场已经活跃起来了。和中国所有的公园一样，人们正在晨练。利川广场有两个足球场大，人们分成五个大组活动。两组在做太极，两组是慢动作的伸展运动，另一组正伴随着传统中国音乐的录音舞剑。一队身着绿色军装的士兵正在做健美操和各种伸展运动。操场的每一个角落，四位瘦削灵活的年轻人正在热身，准备进行非常华丽的杂技武术练习。还有一些人正在慢跑，也有许多人和我一样在观看。

上午八时，我们一行五人在旅馆集合向磨刀溪出发。昨晚陪我们散步的那两名工作人员也想加入这次考察。约瑟夫作为这个小队的向导。在翻越一大片桂林式的山峰后，我们到了更加偏远的山谷，那里长着玉米、烟草和胡椒，显得郁郁葱葱。一路上看到的人都在干活，扛着重东西。我们经过了两

个小市场，然后是平静的河谷，接着，就向上爬到 1800 多米（6000 多英尺）的山上，才开始向磨刀溪走。

七八百米外就可以看到水杉模式树，实际上还未抵达小镇时就可以看到它。它伸出去的枝比附近所有的建筑都高。真的是一棵很壮观的树。车停下来，我开始疯狂地拍照。

钱尼到达此地时，他一定很吃惊。因为直到那时他才知道水杉是落叶植物。当时树上没有叶子。他很快意识到这一特征具有重大的意义。正是因为冬季落叶，水杉才得以度过冰期那种可怕的严寒而存活下来。

当年钱尼参观时，水杉基部屹立着一座小庙，是住在周围的人们祈祷的地方，他们相信树上供奉着一位活神仙。当地村民陈雨梦告诉西尔弗曼，这是他于 1932 年帮助建立起来的庙。依靠小镇的人们捐赠凑齐了 20 盎司的银两建造圣嗣。村民向树求子、祈求健康和丰收。当地人还利用树的长势预言一年庄稼的收成。如果树叶繁茂，他们就相信收成会好。

钱尼和西尔弗曼的到来引起了轰动。几乎整个镇上的人都和他们一起来到树下。这里有一棵很老的树和两棵小些的树，小树有 6~9 米（20~30 英尺）高，还有一棵幼苗生长在水稻田垄上。科学家摆好姿势照相和测量，而一些孩子和一个大人却掉进了水稻田中。人们估计老树高 30 米（98 英尺），直径 3 乘 3 米（10 乘 10 英尺）。利用探木钻，钱尼移出了一薄层树芯来测量树的年龄：结果这棵树有 500~600 年树龄。

比尔·马克拉马拉一行人于 1996 年 9 月 29 日参观了模式树。他们的测量结果表明：树高 34 米（113 英尺），胸围 7 米（23 英尺）。海拔 1268 米（4160 英尺），精确经纬度为 30°25'91"N, 108° 41'01"E。比尔的伙伴们也在树基部留影，同 1980 年中美考察成员一样。现在，我们也在树基拍了照。

我们五人组成各种组合，彼此用相机拍照。树下的庙宇在 1980 年考察之

前就被移走了。法先生对树作了即兴讲演，小吕做翻译，我录了音。他说的数字同发表的略有不同，但是谁能说谁的更为精确呢？谁比较正确又有什么关系吗？约瑟夫解释说固定在树基的6米（20英尺）长的铁杆是20世纪80年代加在树基部的支撑杆，为了保护树不被闪电击倒。

我们没有做任何科学测量。我只是照了一些照片，观察着周围的情景，沉浸在树木生活的精神之中。离树如此之近，它古老的年龄和坚毅使人的生命显得短暂而脆弱，我禁不住感怀时间的短暂以及生命的飞逝。在树的记忆中，不久前，钱尼和西尔弗曼就站在这里。我沉默着，沉浸在人类远大前途的展望之中，我多么希望这种感觉在未来的几个星期甚至几个月内能一直保持下去。

现在，水杉附近有许多农舍。一个堆满瓦砾的水道直接横过树前，大树也不再直接挨着稻田。1996年，比尔带领的植物学家考察时就认为附近建筑造成的人的走动会使树出现一些胁迫。

磨刀溪的名字意为“磨刀”或“把刀磨快的溪水”。根据比尔的研究，这个名字沿用了三国时期的一个故事。一位名叫关羽的著名将军曾到过这里，并且在小溪旁的岩石上磨快了他的刀。因为“磨刀”的中文含义不吉祥，所以改名为“谋道”，意思为寻求真理，这个新名字出现在镇上的公共建筑物上。

午餐后，我们回到街上，我继续让录像机工作着，这令每个人都感到兴奋。我们走到拥挤的露天市场，那里的人们异常兴奋。

“是因为我还是录像机？”

“二者皆有！”吕莽回答道。

天下着蒙蒙细雨，我们返回利川，及时地赶到了医院。我被介绍给院长和负责人。

三十分钟后，我们来到会议室，人们已经坐满了大半个屋子。一些人还

穿着白色大褂，但是我没有办法确定这一百多个观众的职位，多数是医生、护士、技师和管理人员。

我的报告讲述了急救药品的历史，以及我所服务的急诊室和健康组织是如何运作的。吕莽已经把我的报告译为中文。我用英文讲一两句话，他则用中文讲好几段！总的来说，报告还算成功。

晚饭后，约瑟夫和我们前往石灰山参观飞龙洞。一行人驾车开上了通往峡谷的泥泞小路。经过好几所传统的农舍和几位背挎篮子的农民，路走到了尽头。瞧，咆哮的瀑布之上就是巨洞的入口。我们从混凝土路面跨过峡谷底部的河流，继续向悬崖上走到 60 米（200 英尺）高的飞龙洞的入口处。约瑟夫告诉我们，十年前一队国际业余洞窟探勘者参观过该地区，并称这 53 公里（33 英里）的洞是世界上最大的洞，甚至比卡尔斯巴德溶洞还要大。约瑟夫曾经借手电筒勘探了整个洞窟。往里 3.2 公里（两英里）处，有一个比天安门广场还大的厅。洞更深处是山，山里还有更多的洞。天已经很黑了，除了法先生外，我们都朝洞内走了好几百米远，到了“猴子王池塘”。从池塘的倒影可以看到洞内的出口和山的剪影。

由于天黑，我们不得不回到大道上（而不是掉进猴子王池塘！），返回了小镇。尽管这一整天的活动紧张、充实，我看到了很多奇特的景象，但当我闭上眼睛时，脑海中还是模式树的影子。

十 重聚水杉坝

钱尼博士到中国考察后的十年里，他应美国保护红杉联盟的要求将带回的水杉苗插条送给联盟会员，以换取他们 1~2 元的捐款，此后苗木被送到加拿大、纽约、密歇根、宾夕法尼亚、伊利诺伊、印第安那、俄勒冈，甚至远达阿拉斯加和日本等地种植。1958 年，钱尼报告水杉已成功地栽培到世界各大洲（南极洲除外），可以生存在 6℃（-20°F）的地方。

1950 年，钱尼亲自将 100 株水杉幼苗送到日本，这些树现在已经繁殖了上千株。日本人把水杉种植于学校和庙宇周围，钱尼本人赠送了两株红杉树给日本天皇裕仁。他于 1969 年报告说当有幸再次访日时，看到送给天皇的一棵树在 15 年间已长到 30 米（100 英尺）高。

早在 1980 年，罗格斯大学的约翰·库瑟博士发表了许多有关水杉的文章，他写的“水杉不断在生长”的文章曾发表在阿诺德植物园的 *Arnoldia* 杂志 1982 年的夏季刊物上，1968 年 D. 瓦伊曼在 *Arnoldia* 杂志上的文章记载了美国长得最高的 50 株水杉，像 1981 年 11 月报道的美国最高的水杉树为 32 米（104 英尺），是种在弗吉尼亚州的威廉和玛丽学院内的一株，研究表明水杉分布带从阿拉巴马州和乔治亚州一直到新英格兰南部地区，许多树的高度超过 23 米（75 英尺）。该地区较潮湿，类似于中国川东和鄂西边界的气候。很多高大的水杉可以长在小溪边，就像长在加州大学伯克利植物园里的水杉一样，文章还指出许多种子天然萌发的幼苗已经成长在阿拉巴马、弗吉尼亚、德拉威尔、新泽西、马萨诸塞以及罗得岛。说明这些树能在其他新的环境下繁殖，这里的气候类似于中国中部偏僻的山谷。

1990 年，华中农业大学森林系的李鸣鹤在其硕士论文指出，在中国自然

生长的水杉有 5755 株，其中 3 株在湖南，6 株在四川，剩下的分布于湖北，集中在面积为 8 × 11 平方公里的地区，一般分布于 794 ~ 1676 米的海拔高度（2600 ~ 5500 英尺），模式树的树龄为 480 年，树高 34 米，胸径 24 厘米。

李鸣鹤教授与约翰·库瑟教授合作展开水杉遗传基础的研究。开始，在美国种的所有水杉种源都来自单一的模式树，其种子是 1948 年首次考察时带回的。但是，约翰·库瑟博士把李教授用种子萌发的幼苗寄发到美国各地以栽植和播散水杉。

1948 年 3 月，钱尼离开中国前，曾赴南京向政府建议保护孑遗植物水杉，这次访问确实引起南京政府对水杉保护的重视，当即成立了水杉保护委员会，主席由驻南京的美国大使担任，其中还包括了很多中国科学家。新中国成立后，由中华人民共和国林业部继续保护这些树木。

在 1980 年中美考察队之前，西方并不知道中国是如何保护水杉等本土树种的，虽然 20 世纪 80 年代后不少人去磨刀溪参观那株标本树，但据印教授说，我还是继 1948 年钱尼之后的第一位外国访问者，这次访问我到底看到了什么呢？以下是我的记载：

招待所大院的广播宣布着新的一天的开始。小铺迎着第一束阳光开张，一些建筑工地立刻忙碌起来，烧砖的瓦窖也开工了。

第二天早上八点左右，小吕、李师傅、约瑟夫和我一起出发，这次的向导由原先的法先生换为范深厚先生，我们开车到利川林业局接他上车，他是水杉坝的主管官员，将陪我们去水杉坝。

我们第二天进山的路与第一天不同，但一路小雨蒙蒙，景观仍然引人入胜。进入山区前我们路过不少小镇，还经过一个接一个的峡谷，每个都很有特色。在其中一个峡谷，群山环绕中，我们看到山腰处的一个建筑物。那是一座旧道观，已被用作退休之家。穿过院子和菜地，我们来到木制阳台，站

在那里可以清楚地看到细雨中的水杉坝。

我问范先生，他是否知道当年钱尼与西尔弗曼是怎么从磨刀溪到水杉坝的。范先生说他们的路程约 64 公里，一般要走两天，而且路很陡，但现在确实有条不错的小路，只要 6 小时就能到，而且不绕弯路，真不可想象！今天可不可以试试？我不断地问，“去磨刀溪的路在哪里？”但谁也回答不了。约瑟夫接着说，新道就是我们所走的这条，从水杉坝到利川好像没有近道可以转到磨刀溪，因为那是不同的方向。

1948 年，当钱尼和西尔弗曼博士在磨刀溪时，他们的中国朋友华先生说，如再往前去便可看到水杉坝附近有片较大的水杉林，钱尼听后坚持一定要去看那些树。

在水杉林的第一个夜晚，钱尼和西尔弗曼蹲下去小心地把那些从伯克利植物园带来的红杉针叶洒在水杉树下。

50 年后的今天我们来水杉林，这里有 4 名护林员专门保护水杉，他们住在那儿，工作在那儿。车站的下面有 1982 年种植的几株水杉，希望再过几年这些水杉都能开始结实，以便运输到中国其他各省，用于城市用树或森林恢复项目。

现在，当地农民每年从成熟的水杉树上采收数以千斤的球果和种子。政府每年也收购一部分种子运到北京。范深厚说村民只得到很少的回报。保护站也有一个自己的小苗圃，这里我看到几百株约 9 米高的水杉苗木。这些小树是为路旁绿化用的。我在成都生物所见到的三株水杉恐怕也是从这里移栽的。

范先生告诉我们这个坝子里长着 4000 株成熟的水杉，每株均有编号和记录。砍伐这些树的人将至少受到 1~3 年的有期徒刑，所以近年来没有一株遭到砍伐。后来，小吕提到约瑟夫吐露现在因为经费短缺，水杉站面临关闭的可能。然而，所有研究人员都会肯定地告诉你将来政府还是会继续保护水杉，会想方设法筹集资金。

活化石水杉

小河旁，坐落在坝子尽头有一棵二号水杉树。其胸径和树高非常可观，被誉为第二号大树，而且树周围也用铁栏杆围起，有一座桥架设在旁边，附近有几户农家。

钱尼和西尔弗曼在水杉坝时，曾让村长吴崔民和他的三个孩子站在水杉树下照了相片。我带了一张复印照片，这次旅行考察的目标之一就是想找到照片上的这些人。印教授、吕莽和约瑟夫都对照片很感兴趣，因为之前没人见过或听过有关照片的事。



1. 15 吴崔民村长、吴发英和她的两个弟弟。照片摘自《旧金山纪事报》，1948年4月5日。

只有范深厚知道这件事。1980年他陪同布鲁斯·巴塞洛缪的美中考察队来此，那是1948年后第一批来这里考察的外国人。虽然他没有看过真正的照片，但对上面的人很熟悉，因为他一看就知道照片上那个大女儿现在住在利川市，而且知道第二个孩子住在二号大树附近。我们问了附近农民有关她的消息，可惜我们访问那天她不在村子里。

最后，我们开始参观村子里自然环境下生长的水杉。我们向前开车进到水杉坝村里，这里长着很多水杉。这些高大雄伟的树，遍布在村落四周和山腰上。水杉叶子变得有些黄，但还未落叶。这些树如此优美，比路旁栽的那些行道树要高贵得多。茫茫雾色中，水杉、金色的稻田和绿油油的山峦构成的风景令人惊叹。

十一 旅程的尾声

水杉一直被很好地照顾着。虽然水杉坝附近的原始森林已经不复存在，但所有水杉都被很好地保护了起来。与世界其他地方的森林遭到大规模砍伐相比，水杉在这五十年里反而增长繁殖，否则它们很可能在 20 世纪 40 年代就消失了。现在，它们被栽到了中国各地。水杉已种植在世界上 130 个国家



图 1.16 水杉树下的寺庙，摄于 1948 年。钱尼博士惠赠。

和地区，南到阿根廷，北到阿拉斯加，这应该感谢钱尼和梅若尔博士。这种耐寒的树已经生长于广泛的气候条件下，半个世纪以来的栽植经验已经证明，它们在接近水杉坝僻远地区的气候相似的地区可以繁茂生长并结出种子。

要保护水杉并非十分困难。我们对生物间的联系知道得越来越多，也许可以以拯救水杉为例去保护其他濒危物种。未来，人类将会更好地保护地球上的各种动植物。

关于作者

魏歌林 (William Gittlen) 是加州私立凯萨大医院 (Kaiser Permanente) 的急诊大夫。在本书主编和读者心目中，他不仅对红杉自然历史有着满腔热忱，对中国人民也十分友好。

第三节 近期中国古水杉考察记

湛谟美

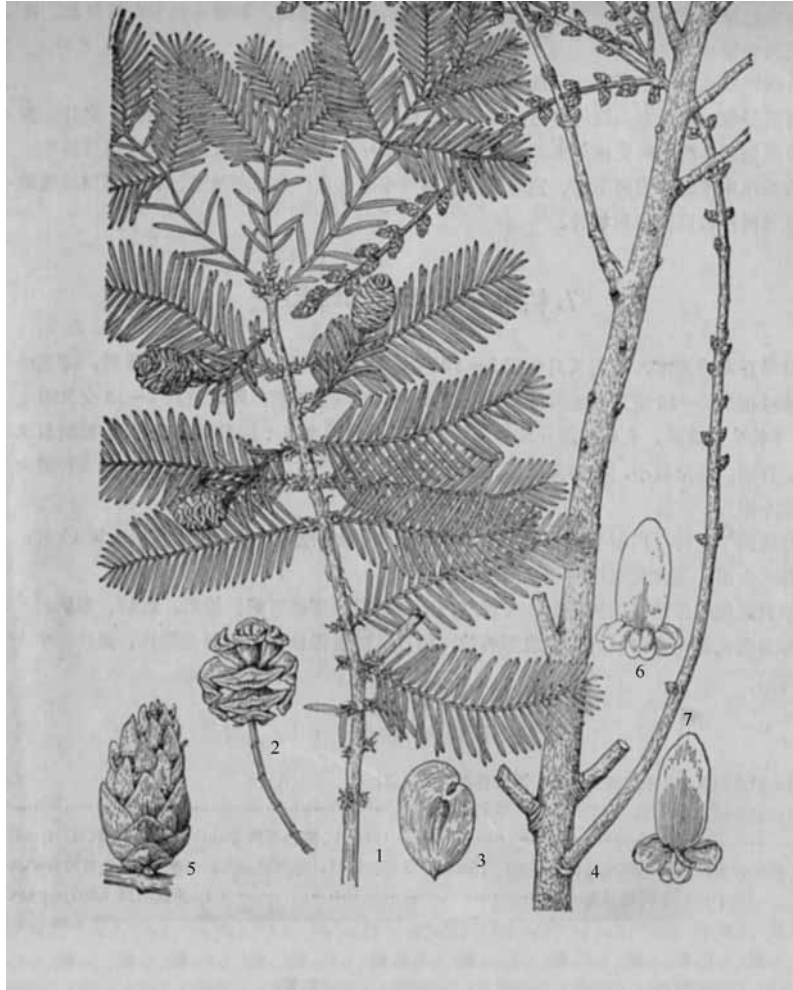


图 1.17 水杉 (*Metasequoia glyptostroboides* Hu et Cheng)。
1. 球果枝; 2. 球果; 3. 种子; 4. 雄球花枝; 5. 雄球花; 6、7. 雄蕊背、腹面 (仿植物志)。

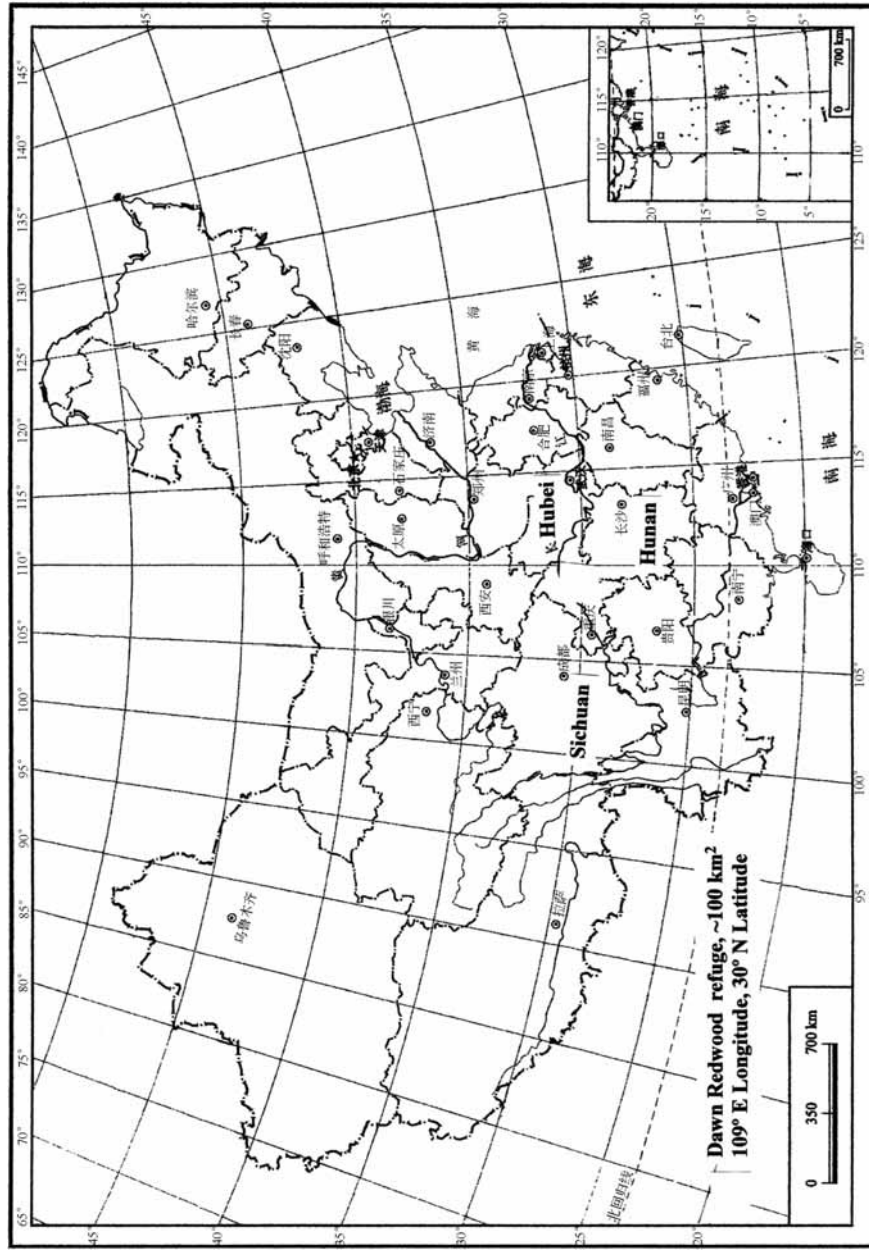


图 1.18 古水杉分布图 (据莫美仿制)。

水杉 (*Metasequoia glyptostroboides* Hu & Cheng, 见图 1.17) 的发现是近代植物学界的一件大事。植物史上, 水杉一直被当作化石 (图 1.19) 种, 直到后来被确认为活生物。通过地质学方面的研究, 科学家最先从上白垩纪地质层中的化石发现了水杉。水杉属曾经包括十个种, 它们广布于北半球温带的亚洲、欧洲和北美洲, 然而, 其中的九种都在最近一次的冰川运动的末期灭绝了。1940 年, 中美植物学和古植物学家考察发现, 古水杉种群仅存的一个种集中在中国中部的山区 (约为北纬 $29^{\circ}5' \sim 31^{\circ}32'$ 和东经 $108^{\circ} \sim 110^{\circ}$ 之间, 图 1.18)。那里地形奇特, 环境极其优美, 还有部分天然古水杉分散在三省交界处的深山谷地里, 分别是湖北省西部的利川、四川省东部的石柱县和湖南省龙山 (图 1.20)。

1941 年, 日本大阪市立大学的植物学博士三木茂将水杉雌果和叶子的独特特征结合起来。在此基础上, 他第一次从发现于中国和北美的化石材料中将水杉描述为化石水杉属 (*Metasequoia*)。不久, 这一观点便被美国加州大学伯克利分校古生物学博物馆的钱尼博士 (图 1.21) 证明。1946 年, 中国中央大学郑万钧教授 (图 1.22) 的同行王战采集到了和水杉化石材料相吻合的水杉活体材料, 后被命名为“活化石水杉”。这个发现使钱尼教授十分惊喜, 于是 1948 年准备修订杉科化石的时候, 钱尼教授在旧金山纪事报的科学记者米尔顿·西尔弗曼陪同下来到了中国中部的湖北利川县磨刀溪 (现称小河水杉自然保护区), 看到了活着的水杉标本树。因为此前水杉被认为已经灭绝了几百万年, 西尔弗曼兴奋地写道: “这就像找到了一只活恐龙一样!”

作为植物界的权威, 中国科学院吴征镒院士指出, 北温带中国植物区系是最丰富多彩的区系之一, 它包括 8500 种乔灌木。中国是世界上唯一具有完整的热带、亚热带、温带和北方森林的国家。一些维管束植物, 如水杉、银杏和连香树在欧洲与北美仅有化石, 冰川运动后却在中国存活下来。因此,

对中国植物区系的研究具有非凡的重大意义，不论是揭示欧洲、北美和亚洲的化石记录以及植被历史，还是为了保护自然资源环境，哪怕仅仅为了了解水杉这个重要物种的特性。

在 1948 年钱尼和西尔弗曼来中国之后，钱尼完成了对杉科化石记录的系统修订，囊括了从过去到现在的所有的红杉种类。他的著作极大地影响了对过去 1 亿年中地球表面的植被模式 and 世界气候变化的理解。

在 21 世纪，新的研究以活化石水杉的分类、外部特征、历史上的地理分布为依据，进一步完善了植物系统；同时，也深入了对水杉与全球气候变化之间关系的理解。例如，研究者们借助水杉叶表皮发育特征的分析研究，揭示了水杉叶片细胞的形态学变化特征，证实了气孔指数和气孔密度可用以指示 CO₂ 浓度的观点，为各个地质时期大气中 CO₂ 浓度的测定提供了一种生物学方法。通过大量关于水杉的实地考察和文献调研，研究者们提供了水杉的历史地理分布和现今的栽培信息。这一研究结果带来了生物学新研究思路的巨大发展，并且为研究者们揭示七八千万年以来大尺度范围内全球气候环境变迁的规律提供了有效的方法。

1973 年，随着中国大陆重新对外开放，已有多批考察团赴中国大陆进行水杉考察。以下便是由加州大学伯克利分校成员带领的三次颇有意义的中国中部古水杉考察之行。从 1987 年到 2002 年，我与先生张昂和教授多次带领这些考察团到中国湖北的利川、湖南的龙山及四川省的石柱地区考察古水杉群的保护情况。

一 美中友好协会组织的第一次水杉考察

1987 年我接受了美中友好协会的邀请，带领由美国加州大学伯克利分校

及植物学界学者组成的考察团队访问湖北省利川的古水杉，团员们各个激动不已，由衷向往像古植物学家钱尼一样亲眼目睹这株活化石——磨刀溪的古水杉树。成员中有索诺玛县植物园园长塔科教授和他十岁的幼子，还有针叶树分子分类学家葡来思教授和他的新婚妻子玛瑞琳、旧金山花园园艺师薛敬德女士以及土耳其植物分类学家珈沙朴理格博士等。经过我与美中友好双方协商，路线是旧金山 - 北京 - 上海 - 南京 - 武汉，由此顺长江而上在万县上岸，抵达磨刀溪之后上船去重庆，再由上海返回旧金山，历时二十天。

在京期间，我们首先访问了北京植物园及中国林业科学研究院。美国植物学家参观了植物园引种的水杉林，并讨论了水杉保护问题。在上海由复旦大学生物系的李林初教授介绍他对杉科 (*Taxodiaceae*) 染色体进行的研究，以及水杉属 (*Metasequoia*)、红杉属 (*Sequoia*) 及巨杉属 (*Sequoiadendron*) 的亲缘关系研究。过去的几十年中，在中国的 26 个省和世界的 50 个国家都种植了水杉。上海是典型的亚热带海洋性季风气候，年无霜期 250 天，年降水量 1000 毫米，这一气候使海岸红杉和水杉都能很好地生长。我们在上海郊区的某些地方可以见到成排的水杉树 (图 1.23)。

随后一行人乘火车从上海至南京，沿途饱览了长江南北两岸的美丽风光，在南京，我们对宏伟整齐的南京市水杉行道树印象颇深 (图 1.24)。世界各大城市绿化无一可与这里的水杉林荫大道相比。考察团又访问了南京植物园和南京林业大学，南京林业大学正是中国树木学专家郑万钧先生最初发现水杉并为之命名的地方。

考察队由南京乘长江客轮起程，与华中农大树木遗传学专业的李明鹤教授取得联系，并获得了湖北省授予进入磨刀溪访问水杉的通行证。上船后，一行人就被长江的风光陶醉了，两岸沿江三十里，借万里长江奔腾之势，形成了山秀、洞幽、江深、矶奇的特色。途中，大家谈论着周围地貌环境的变

化历史，并逐渐理解为什么古前的冰川使大多数的生物都绝灭了，只有在中国内陆留下了像熊猫和水杉这样的活化石。

之后，考察团就从万县上了岸，当时的万县隶属四川，现在隶属重庆。六十年前举世瞩目的钱尼考察团到此考察时，由于部分道路实在难于行走，甚至需坐轿前行，从万县到水杉发现地利川磨刀溪，他们跋涉了三天。而这次该团十人从万县乘大客车仅两小时就抵达磨刀溪的水杉模式标本树，受到当地人民的热烈欢迎。时光飞逝，一晃就是半个多世纪，我们终于见到了伟大古植物学家钱尼 1948 年看到的水杉树（图 1.25）。看到这棵树，大家都极其激动，因为许多美国人认为水杉在远古时代就绝灭了。这棵水杉挺拔而立，约三十余米高（图 1.26），好几人手牵手才能够把它围起来。我们发现 1948 年钱尼记载的庙宇已经不复存在，取而代之的是许多新的房屋。中午，考察队在树下广场吃着当地土家族人为迎接我们而准备的香喷喷的米饭和炖猪肉，别有一番水杉故乡情。1949 年后，长江南岸的许多城乡都在稻田周围种植了水杉，这也成为这一地区农林间作的一种方法（图 1.27）。在我们几次考察水杉的谷地中，常常看到许多水杉和竹子一起生长，这是水杉在本土的生态特质（图 1.28）。小河峡谷中拥有成百上千株水杉树，这里准备建成小河保护公园。但这里的水杉都没有磨刀溪的水杉树高大。当晚考察队赶回万县，次日乘船至重庆，由重庆直飞上海，在上海小憩后回美。

在华中农业大学刘胜祥教授的帮助下，我们了解了湖北利川的水杉生态研究成果。为保护稀有树种，国家于 1985 年成立了湖北利川小河水杉自然保护区，位于北纬 30°10′，东经 108°45′，海拔 900 ~ 1350 米的区域，温度范围从 -15.4℃ 到 35.4℃，平均年气温 12.8℃，年降雨量 1500.9 毫米，年生长日为 230.9 天。小河是一个日照时间较短、低水分蒸发、高降雨量和高相对湿度的地区。因为福宝山和齐岳山使得冬天的寒冷及夏天的炎热不能从东南部

的平原地区传递过来，所以这里冬暖夏凉，非常适合水杉的生长，天然水杉平均直径有 20 厘米左右（图 1.29）。

经刘胜祥研究发现，湖北利川的水杉有三种生态类型。水杉的主要群落在利川县小河地区的一个开阔的河谷中，它位于福宝山以南，齐岳山以东，马前山以西，忠路镇的北面，南北长 30 公里，东西宽 20 公里，面积大约 6 万公顷。水杉沿山谷两侧生长在淤积的土壤上和山脚下弯曲的灌溉渠边。这个地区大约有 5000 株自然生长的水杉，它们的直径平均为 20 厘米。这里的水杉植物群落大概可分为三种生态类型：第一类为水杉 - 尖叶山茶 - 日本金星蕨（Dawn Redwood-Taperleaf Camellia-Parathelypteris nipponica），分布于小矛坝子，海拔 1175 米，15°坡，相对湿度为 87%，溪流入小河，乔木林密度为 0.3 ~ 0.4，最大的水杉（*Metasequoia glyptostroboides*）树粗 76.5 厘米，高 27 米，伴生树有杉木、茅栗、枫香、野漆树、三尖杉、中华槭、尖叶山茶等，40% 为灌木，有尖叶山茶、散生栒子等（图 1.30）。第二类为水杉 - 尖叶山茶 - 秋海棠 - 冷水花（Dawn Redwood-Taperleaf Camellia-Bigonia-Pilea）。乔木有枫香，平均粗约 40 厘米，高 25 米，最大可达 76 厘米粗，高 34 米；灌木有尖叶山茶、蕊帽忍冬、胡椒等。第三类为水杉 - 微毛柃 - 蝴蝶花 - 日本金星蕨（Dawn Redwood-Eurya-Iris-Parathelypteris nipponica），位于小河游家湾，海拔 1090 米。坡度为 15°，相对湿度为 89% ~ 90%，乔木林密度为 0.5 ~ 0.6，平均粗 30 厘米，高 25 米，最大可达 77.5 厘米粗，高 38 米；灌木有微毛柃、杜鹃、湘楠、桂竹等。

之后考察队又对阴沉木进行了考察。阴沉木是古水杉在水中的树桩（图 1.31），在小河向阳大队三队的肥田中，大概六百年前被砍伐的树桩仍留在水稻田中。我们 9 人手牵手测量估计其大小（图 1.32），直径约有 7 米以上。可见在中国近代农业史上推测“水杉毁于水田的垦殖”说法并非不实之词。我

们想，也许脚下的土地就是曾有过大片水杉的水杉之乡。它地处武陵山、巫山、七岳山之中的川湘鄂边境盆地，受地壳运动的干扰较少，且外围有秦岭、大巴山、雪峰山、梵净山及贵州高原，真是万山丛中的一个幽谷(图 1.33)，这无疑成为了史前冰川期水杉得天独厚的避难所。

二 美国保护红杉联盟拍摄水杉之旅

保护红杉联盟是著名的非营利性民间组织，它致力于保护所有红杉和古森林。1999 年，保护红杉联盟组织了一次正式的考察活动，他们计划派遣一个代表团去参观并拍摄龙山和利川小河自然保护区水杉的情况。他们希望这将有助于全世界了解和正确评价红杉。保护红杉联盟相信，通过中美两国科学家的联合研究，可以最大程度分享研究认识的合作成果。作为加州大学伯克利分校杰普森标本馆成员、森林病理学教授、中国林业科学研究院教授，我被邀请担任此次科学考察活动的领队。作为一个地道的中国人、伯克利加州大学的学者和中美友好协会红杉之旅的使者，我欣然接受了这个任务，并且计划了一次为期两周的穿越张家界的龙山及利川古水杉的地质地理之行，包括和政府官员、科学家以及中国民间人士之间的会晤。美国保护红杉联盟代表团的成员有：保护红杉联盟前任行政主管安玛丽女士，中国林业科学院退休教授张昂和，红杉历史学作家殷久先生，加州大学伯克利分校退休林木遗传教授比尔·利比及其夫人艾利斯，摄影师以及《地球观察》电影制片人诺门·卡维兹，电影摄影技师彼得·波朗，华中农业大学森林遗传学教授李明鹤，中国林业科学院森林学研究员郑世楷教授和加州大学伯克利分校植物生态学研究生钱金红等(图 1.34)。

1999 年 5 月 3 日，代表团的成员踏上了令人兴奋的考察旅程。他们首先

飞往北京，在那里受到了中科院北京植物所、北京植物园和中国林业科学院的热情接待。在北京植物园张佐双园长的带领下，代表团参观了樱桃沟一个已有 17 年树龄的水杉人工林（图 1.35 和图 1.36），并同科学院的科学家以及北京城市公园系统的代表进行了座谈，学习和讨论了中国对这种具有历史意义的树种所采取的保护措施。

5 月 7 日，代表团成员飞往中国中部的长沙，并从那里转道前往湖南省的张家界市。5 月 8 日，代表团进入了张家界国家森林公园并乘坐空中缆车观看了整个公园，考察了张家界石英石结构形成的“沙石脊”（图 1.37）等罕见的地质状况。作为国家自然保护区，张家界森林公园每年接待超过两百万的参观者（图 1.38）。在国家公园林业工作人员的带领下，代表团来到金鞭溪和天植山，看到了生长在一个深而隐蔽的山谷里的水杉和古水杉区系中稀有的金钱松树种（*Pseudolarix amabilis*，图 1.39）。

考察队随后来到了湖南武陵源国家公园区，他们要看一看龙山的“田园博物馆”（图 1.40），那里有三棵从古代存活下来的水杉树。到龙山的旅途需要翻越多座山和陡峭的峡谷。湖南龙山县为代表团能顺利看到三棵古水杉提供了交通便利。考察队考察了三棵当地的原始水杉，一株在洛塔乡（图 1.41），两株在泡木村（图 1.42），并分别做了记录。它们的直径为 128 ~ 176 厘米，高度为 36 ~ 44 米，树龄有 500 ~ 800 年。除了观测以外，考察队和龙山当地的科学家、农民以及行政官员就水杉所需要的保护工作进行了广泛的讨论。他们提议建立一个基金会来保护湖南张家界和龙山的古水杉，这样可以对水杉这种珍贵的活化石开展保护工作及科学合作。

考察队的下一站是湖北省。湖北有着中国最富饶的自然资源，而利川县就植物多样性而言是最丰富的地方。直到 1948 年，小河镇附近的村民们一直用水杉木来制作墙体、家具和棺材，还用它来烧火（图 1.43）。1958 年建立

了水杉保护区，以保护村中生长在水稻田旁边的几棵水杉树。沿着村中的小路，考察队参观了几个水杉的种苗温室和苗圃，以及规模不小的种子园（图 1.44），当地的土家族农民很擅长培养水杉种子和树苗，他们把这些种子和树苗卖到其他省份和国际市场，以大量苗木培育推动水杉造林（图 1.45）。

最后一天，考察队来到湖北省利川县的磨刀溪，他们希望能看到郑万钧老先生的学生王战博士第一次采集到水杉球果的那棵树，为保护它建立一个公园。虽然考察队惊讶地发现这棵模式标本树（图 1.46）周围的自然环境已经被严重地破坏了。但是他们发现当地人种了更多的水杉树。因为在 1948 ~ 1999 年之间，磨刀溪人口的增加使模式标本树周围的小环境起了变化。他们与利川林业局的官员们讨论了建造一个国际红杉公园的建议，以期保护和展这棵水杉标本树及相关的红杉、巨杉这些珍贵的活化石树种，并且希望中国与红杉保护联盟合作。

5 月 17 日，考察队回到了旧金山。这次旅程颇有成效，他们参观了目前仅存的水杉原生群落，并且探讨了水杉研究和保护的可能性。当水杉变得众所周知，而且已经遍植亚洲、北美和欧洲的时候，中国水杉原生群落的保护和保存工作成为全世界了解红杉家族独特生命史的一个至关重要的组成部分。

考察队感谢美国保护红杉联盟对这次活动的帮助以及慷慨的中方组织者，他们是美中国际交流基金会湖北省分会、华中农业大学李明鹤教授、上海复旦大学遗传学研究中心李林初教授。

三 2001 年四川省石柱古水杉考察记

已知分散的水杉群落分布在湖北、湖南和四川三省交界处，而四川石柱的水杉很少有人关注。2001 年，谌谟美和张昂和受到春季造访加州的四川省

团的盛情邀请，以及出于对中国罕见的地质历史及四川古迹的仰慕，经林业总局介绍，访问了四川林科院。

此次考察由四川林业局科技处的副处长何萍女士全程陪同，赴石柱考察古水杉，由成都往西穿越富饶的成都平原，这里有体现中国前人治水用水之技策的都江堰，成就了今日成都平原之良田美景，青城山之幽和道教圣地也尽在眼底。按现代人评价，这里风调雨顺，是人类最宜生存居住的地方。再往东行，跨过崇山峻岭，来到了重庆。乘船从重庆顺江东下在长江明珠忠县石宝寨顶登高南望，便可看见长江南岸方斗巍巍，蓝天漂浮的云朵下，有一片美丽、清幽而又神奇的土地（图 1.47）。这便是重庆市石柱土家族自治县，素有绿色县都之称，有男石柱（图 1.48）和女石柱（图 1.49），往西经过涪陵再往西北方向就是水杉生长的方斗山，属于石柱县。

石柱土家族自治县，原名石主县，古为南宾县。位于重庆市东部长江南岸，地处东经 107°59′至 108°34′，北纬 29°39′至 30°32′之间，属三峡库区腹心地带，是三峡库区唯一的少数民族自治县。东接湖北省利川市，南邻彭水县，西南靠丰都县，西北连忠县，北与万州区接壤，县境南北长 98.3 公里，东西宽 56.2 公里，面积 3012.51 平方公里。石柱县属巫山大娄山中山区，七曜山和方斗山平行排列纵贯全境。地势东南高，西北低，呈起伏状下降。黄水镇大风堡海拔高 1934.1 米，西沱镇陶家坝海拔仅 119 米。境内以中山、低山为主，兼有山原、丘陵，属中亚热带湿润季风区，气候温和，雨水充沛，四季分明，具有春早、夏长、秋短、冬迟的特点。日照少，气候垂直差异大，灾害性天气频繁。全县年平均温度 16.5℃，极端高温 40.2℃，极端低温 -4.7℃。全县有松、杉、柏等 197 个树种，其中珍贵树种包括水杉、三尖杉、红豆杉、银杏、桢楠、栲桐等。

石柱县是被誉为“活化石”的古生水杉在四川省的仅存地之一，国家挂

牌保护的水杉母树有 28 株。我们与石柱县林业部门领导考察了一株“天下第一水杉树”（图 1.50），它的旁边即为一座坟墓。附近多为水稻田。由于地理交通不便，来访者明显不如利川地区多。在考察途中，深感道路艰险，万山群绕，真如诗书中形容的“蜀道难，难于上青天”，当时不少路段正在修建中，但近几年来石柱县发展很快，因为政府对库区唯一少数民族地区开发，道路已完全通畅，山清水秀，旅游资源甚多（图 1.51）。最终我们到达了目的地，看到了保护完好的石柱古水杉树，真觉“足临古水杉，身在图画中”，其所处生态自然环境可称首屈一指。

之后，考察队又在四川省林业科学研究所的陪同下参观了四川省卧龙动物活化石——大熊猫，熊猫和水杉的意义一样（图 1.52），是经历第四纪冰川浩劫得以幸存下来的生物，是中国的国宝。

因此，中国植物群落的知识对于鉴别和解释其他地方发现的化石记录以及理解和保护世界植物多样性都是非常重要的。

根据中国科学院植物区系及分类权威专家吴征镒教授的说法，发现水杉的区域是独一无二的，而且对了解中国植物群落的起源至关重要，它也是北极第三纪地质植物区系的代表，特别是云南省的东南和东北部、金沙江谷、四川省的东部、湖北省的西部和南岭地区，代表了一个为热带到亚热带植物提供保护作用的避难所。这个避难所很可能为目前只在中国和世界上其他地区发现的北极第三纪地质植物提供了生长的场所。长久以来，这个植物群落一直都是多种植物的发源地，这些植物和东南亚热带植物群落中的植物是相同的。因此，水杉生长在这样一个地理区域中并不奇怪。

活化石水杉在发现 60 年后成功引种至中国的 26 个省以及世界 50 多个国家和地区，成为中国重要的用材林树种、沿海防护林树种、农田防护林树种、城市绿化树种以及世界上著名的公园及风景景观树种。

美国加利福尼亚州曾经生长着许多种红杉家族的成员，但现在仅有三个树种尚存，且大部分生长在美国国家和州立的红杉公园里。

加州大学伯克利分校也许是世界上唯一的拥有全部三种红杉树树种的校园。伯克利校园内，清凉的泉水和小溪在林地穿过（图 1.53），四五片海岸红杉林沿着穿过校园的草莓溪分布（图 1.54），别致的小木桥在林、泉间搭建，景物交相辉映，错落有致，将学校点缀得如花园一般美丽。

伯克利校园内最大的几棵红杉树直径可达两米以上，能在校园里看到这样的红杉自然生长，不能不令人在赞叹校园美景的同时感慨珍惜环境的裨益。在学校的地质学大楼前，靠近新东亚图书馆，细心的游者会发现几株特别的水杉树（图 1.55），它们的树皮呈灰白色，针叶也稍显秀气些，使之与其他海岸红杉区别开来（图 1.56）。

这些有 60 年树龄的水杉着实来历不凡，它们的成长见证了学校的风雨历程。这些水杉是 1948 年钱尼教授从中国带回的种子生根成长的，现在已经非常壮实了（图 1.57）。此外，还有许多由钱尼教授带来的水杉种子被栽种在伯克利大学的植物园里，现在已被视作植物园里的珍宝。除了水杉和海岸红杉，在伯克利校园的西门前还耸立着几乎是世界上体积最大、寿命最长的生物体——巨杉（图 1.58）。

60 年前，拉尔夫·钱尼在加州大学伯克利分校生物科学大楼对生物进化论的研究做出了卓越的贡献。20 多年来，谌谟美教授主编的这部回忆录也是在这幢大楼完成的（图 1.59），她与许多学者和学生共同完成了这本双语图书，把珍贵的子遗植物科学财富留给后代（图 1.60）。

活化石水杉

水 杉 歌

胡先骕

余自戊子与郑君万钧刊布水杉，迄今已十有三载，每欲形之咏歌，以牵涉科学范围颇广，惧敷陈事实，坠入理障，无以彰诗歌咏叹之美。新春多暇，试为长言，典实自琢，尚不刺目，或非人境庐倚摭名物之比耶。

纪追白垩年一亿，莽莽坤维风景丽。
特西斯海亘穷荒，赤道暖流布温煦。
陆无山岳但坡陀，沧海横流沮洳多。
密林丰藪蔽天日，冥云玄雾迷羲和。
兽蹄鸟迹尚无朕，恐龙恶蜥横婆娑。
水杉斯时乃特立，凌霄巨木环北极。
虬枝铁干逾十围，肯与群株计寻尺。
极方季节惟春冬，春日不落万卉荣。
半载昏昏黯长夜，空张极焰光朦胧。
光合无由叶乃落，习性余留犹似昨。
肃然一幅三纪图，古今冬景同萧疏。
三纪山川生巨变，造化洪炉恣鼓扇。
巍升珠穆朗玛峰，去天尺五天为眩。
冰岩雪壑何庄严，万山朝宗独南面。
冈达弯拿与华夏，二陆通连成一片。
海枯风阻陆渐干，积雪互寒今乃见。

活化石水杉

大地遂为冰被覆，北球一白无从绿。
众芳逋走入南荒，万果沦亡稀剩族。
水杉大国成曹郃，四大部洲绝侪类。
仅余川鄂千方里，遗孑残留弹丸地。
劫灰初认始三木，胡郑肇几继前轨。
忆年远裔今幸存，绝域闻风剧惊异。
群求珍植遍遐疆，地无南北争传扬。
春风广被国五十，到处孙枝郁莽苍。
中原饶富诚天府，物阜民康难比数。
琪花琼草竞芳妍，沾溉万方称鼻祖。
铁蕉银杏旧知名，近有银杉堪继武。
博闻强识吾儒事，笺疏草木虫鱼细。
致知格物久垂训，一物不知真所耻。
西方林奈为魁硕，东方大匠尊东壁。
如今科学益昌明，忆见泱泱飘汉帜。
化石龙骸夸绿丰，水杉并世争长雄。
禄丰龙已成陈迹，水杉今日犹葱茏。
如斯绩业岂易得，宁辞皓首经为穷。
琅函宝笈正问世，东风伫看压西风。



图 1.61 胡先骕教授，照片由胡先骕教授之子胡德焜教授惠赠。
Figure 1.61 Prof. Hu Hsen-Hsu courtesy of Prof. Hu Dekun, the son
of Prof. Hu Hsen-Hsu.

第二章 海岸红杉

(*Sequoia sempervirens*)

第一节 海岸红杉林的乔灌木和花草

威利斯·林·杰普森

海岸红杉

海岸红杉是海岸林带中占主导地位的树种^①。红杉树使这里具有明显的地域特色，无论是在大小、密度、高度上，还是在生物学或者历史意义上，此地的其他树种都不能与之相比。红杉林的平均高度是 46 ~ 76.2 米，但许多红杉树的高度大大超过这一平均值，人们还准确测量到一些 107 米高的红杉。

虽然拥有如此巨大的体型，红杉最有特色的却是远离主干并且非常精致的器官。长约 2.54 ~ 7.62 厘米的狭长叶子着生在末枝上，以这样一种方式形成扁枝。这些树叶能存活 3 ~ 5 个冬天，而不会凋落。但当其完成使命后，扁枝则会脱落。那时，林地上便铺着厚厚的一层扁枝。如果路人拾起一些扁枝仔细观察，就会发现有的是一二年生的，更多的则是三四年生的。他还会找到一些松果，混在地面的堆积层中，这些松果极其之小，浅褐色组织，由 14 ~ 24 层鳞片组成。

两种杉树

红杉，*Sequoia sempervirens*，一种真正的美洲杉，只存在于 5 ~ 2000 英尺的低海拔地区，沿着从蒙特里市 Santa Lucia 山脉北至俄勒冈一线的海岸生长。俄勒冈州的 Curry 市也有一些小树林。在内华达山脉，则生长着另一种名为巨杉（Sierra redwood, *Sequoiadendron giganteum*）的杉树。这种巨杉主要生长在海拔约 1370 ~ 2440 米的偏远树林中。这是一种比红杉还大得多的树种，但它的叶子却非常小，只有大约 7.62 厘米长，呈鱼鳞形或钻形。这些叶子厚厚地覆盖着细枝条，时多时少，因此它的扁枝让人想起柏树。巨杉的球果也比任何一种红杉的都大，有一个鸡蛋的大小。值得注意的是，虽然巨杉和红杉都

^① 加州植物学权威杰普森博士在本文中记载了海岸红杉林的植被概况，并简要介绍了与海岸红杉相近的巨杉的地理分布及树形。加州大学伯克利分校的苔藓分类学家补充了海岸红杉林的主要苔藓种，谏谟美补充了主要美味蘑菇种。

海岸红杉

是杉树，但却有着自身的典型特征，足以将其区分开来。从某种角度而言，它们都是“红”杉，因为它们的心材都是红色的，但红杉长期以来通常是指海岸红杉。从另一种角度来看，它们又都是“巨”杉，远远超过了其他树种的生长尺寸，但巨杉这个术语，长期以来属于 Sierra 种。在地理上，它们相互排斥，红杉仅在太平洋西海岸一带有发现，而巨杉则仅存在于内华达山脉。

在海岸一带的北部森林中，最典型的，或者说生长最茂密的红杉林显然都是海岸红杉的纯种树林。这些古老的树木远远高于其他植物，占据主导地位，似乎没有给别的树种及植物留下充足的空间与阳光。不过令人惊异的是，在它们的树荫下有着数不清的生长繁茂的植物，这些植物能充分利用从它们高大邻居的针叶缝隙中透过的些许阳光。



图 2.1 海岸红杉 (*Sequoia sempervirens*)。



图 2.2 加州红杉和巨杉的分布地图。



图 2.3 巨杉 (*Sequoiadendron giganteum*)。

伴生树种

有三种树，比别的树种与红杉的关系更为密切。它们是花旗松 (*Pseudotsuga menziesii*)，一种针叶树，有的很高大；密花石柯 (*Notholithocarpus densiflorus*)，有与板栗树相似的树叶和绒毛状的橡子；以及浆果鹃 (*Arbutus menziesii*)，



图 2.4 花旗松 (*Pseudotsuga menziesii*)。

具有绿色光泽的树叶和鲜红色的枝干，使得海岸地区的森林色彩瑰丽。花旗松有着强大的繁殖力，所以常在山坡或平地形成密集

的纯种树林。密花石柯是一种侵略性极强的树种。浆果鹃竞争不过前两者，总是被挤到了一边。为了在高大的林冠下获得一小块阳光，浆果鹃的树干变得非常长，并且弯曲，甚至是扭曲，或者弯成奇怪



图 2.5 密花石柯 (*Notholithocarpus densiflorus*)。



图 2.6 浆果鹃 (*Arbutus menziesii*)。

小溪两岸有它们自己的特征树种。在这里，人们能看到有着宽大掌状叶子的大叶枫 (*Acer macrophyllum*)，它的叶子在秋天会变成金黄色；还可以看到红赤杨 (*Alnus rubra*)，它的树叶具有黏性，春天里会从树枝上垂下长长的柔荑花序。

上面提到的这些树种同样有助于补充红杉林带的边界，另外还有其他的树种生活在森林边界，在红杉林中则仅有一点甚至连一棵也没有。譬如加州月桂 (*Umbellularia californica*)。这是一种生

长良好而且材质致密的树，它的树叶和古代桂树有细微的相似之处。它们散发出浓烈的香味，尤其是在被折断的时候。



图 2.7 大叶枫 (*Acer macrophyllum*)。

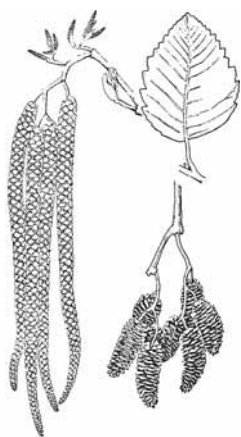


图 2.8 红赤杨 (*Alnus rubra*)。



图 2.9 加州月桂 (*Umbellularia californica*)。

森林边上最可观的树是加州七叶树 (*Aesculus californica*)，四月份时，这种树生长繁盛，呈现出充满活力的鲜绿色；六月份时开满了大大的白色圆锥花序，非常绚烂；随着气温升高，在夏末和秋天，加州七叶树脱皮后留下白

色枝条，巨大的荚果密密地挂在树冠上，静静地等待着第一场大雨。

边缘地带的森林中还有两种很好的栎树，一种是巨大的俄勒冈白栎 (*Quercus garryana*)，有着光滑的白色树干，长满青苔的枝桠向四周伸展；另一种是黑栎 (*Quercus kelloggii*)，在它高高的树冠下是直立的细枝，在圆裂片顶端长有细小刺毛的深裂缺刻的树叶。这两种栎树都是落叶树，广泛生长在边缘地带的森林中。



图 2.10 俄勒冈白栎 (*Quercus garryana*)。



图 2.11 黑栎 (*Quercus kelloggii*)。

五月里给人印象最深的树是西方山茱萸/太平洋四照花 (*Cornus nuttallii*)，绚丽的白色花朵照亮了森林，其实这些都不是花，而是有色的苞片，包裹着微小的花束。在红杉林的另一边，靠近大洋的地方，由另外一些林木组成森林外部的边缘。这块森林包含针叶林的几个大类群，例如海岸芹叶钩吻/异叶铁杉 (*Tsuga heterophylla*)、西特卡云杉/西加云杉、北美云杉 (*Picea sitchensis*)、巨冷杉 (*Abies grandis*) 以及雪松 (*Chamaecyparis lawsoniana*)。有些地区，尤其是更北边的洪堡县北部和迪·诺特县，在红杉密林中可以观察到这些与巨杉明显伴生的树种。

灌 木

红杉林中的一些灌木被认为是红杉的真正伴生种。有两种尤为普遍，它们是加州越橘 (*Vaccinium ovatum*)，具两轮生长于弯曲枝茎上的光泽小叶片，以及一种叶片少而大的小型灌木柠檬叶白珠树 (*Gaultheria shallon*)。这两种灌木都没有坛形花，以显示它们与石南花的亲缘关系。

小溪两边，加州四照花木 (*Cornus sericea*) 常常形成一幅齿状窗帘，在秋天呈现出一道鲜亮的红色风景。红杉林边上还生长着大量半荫的灌木。其中值得一提的是兰花美洲茶 (*Ceanothus thyrsiflorus*) 和淑女花 (*Ceanothus parryi*)，这两种鼠李属灌木都有艳丽的蓝色小花花簇；木蔷薇 (*Rosa gymnocarpa*) 有着像蕨类那样的形状优美的叶子，糙莓 (*Rubus parviflorus*) 有着柔软的黄绿色大叶和具绒毛的鲜红色浆果。

在红杉林的各种灌木中，旅行者最喜欢寻找的是不常见的橙红色悬钩子/小花悬钩子，(*Rubus spectabilis*)，过去从阿拉斯加南移而来。它比大多数灌木都要稀少，而在它仲夏季的成熟期，旅行者在林中寻找就是为了那美味的黄色或粉色浆果。

另一种有点可怕的灌木也值得一提——毒葛 (*Toxicodendron diversilobum*)，



图 2.12 加州越橘 (*Vaccinium ovatum*)。



图 2.13 加州四照花木
(*Cornus californica*)。

遍布山村，既耐阳也耐阴。光滑的三裂叶子使它和其他无毒灌木区分开来。其实，毒葛在典型的红杉林里数量稀少。然而，若旅行者仔细观察，或许能在它最具特点的阶段看见——向上攀援到红杉树干 15 ~ 45 米的高度！并且形成了优美的圆柱状叶，有时，因其强烈的红棕色和猩红色而发出红光。

红杉林中最华丽的灌木是海滨杜鹃 (*Rhododendron macrophyllum*)，以至于旅行者从千里之外赶来，为了欣赏在开花盛期的玫瑰紫色花朵。它的近亲，开白色或粉色花的西方杜鹃花 (*Rhododendron occidentale*) 在森林外就很常见了。

开 花 香 草

当红杉林的林下灌木层不发达时，覆盖着厚厚一层柔软的落叶和枝条的林地上则布满了小型开花植物和蕨类。对大多数开花植物而言，都有小的甚至是迷你的花。有几种开花植物的数量明显很多，在许多林间空地上遍布最多的就是俄勒冈延龄草 (*Oxalis oregana*)。它那可爱的粉色至淡紫色的花儿，还有苜蓿一样的叶子，总能调整角度去适应穿越林冠透射而出的阳光，所以在树林中很容易辨认。在某些地区，第二大类群是翻转花 (*Vancouveria planipetala*)，它的叶子和一种粗糙的大掌叶铁线蕨相似。比前两种稍高一点的是三叶裸花草 (*Achlys triphylla*)，具有粗糙的三瓣单叶和小花簇。

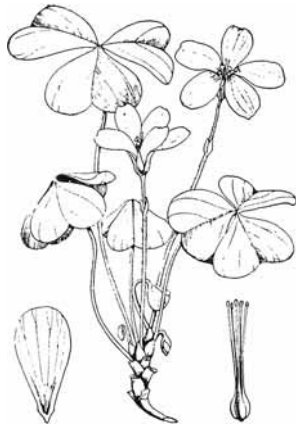


图 2.14 俄勒冈延龄草 (*Oxalis oregana*)。



图 2.15 翻转花 (*Vancouveria planipetala*)。

花 卉

在林地的每一个角落，甚至在腐烂的木头上都可以发现小小的虎耳草属植物，非常优美，植株大部分都很简单，有类似玫瑰的叶子以及一个或多个直立的花梗是该属共有的特征。其中最为普遍的是开纯白小花的单叶黄水枝 (*Tiarella trifoliata* var. *unifoliata*)。在一个恍若仙境般的地方，大片的单叶黄水枝从阴暗的底部向上攀爬，半隐在巨大的树干间，向远处蔓延。同样很常见的是稍大一点的加州矾根草 (*Heuchera micrantha*)，开暗色的花，以及大穗杯花 (*Tellima grandiflora*)，一种纤细的香草，0.5 ~ 1.1 米高，开玫瑰绿的花。



图 2.16 单叶黄水枝 (*Tiarella trifoliata* var. *unifoliata*)。



图 2.17 加州矾根草 (*Heuchera micrantha*)。

如果大部分游人能了解一个植物区系的各种植物所具有的重要性，这将令人无比兴奋。对于这些有着线状茎和柔嫩花朵的森林居民们，人们几乎不会认为它们在身体结构上会与那些称之为红杉的巨大植株有何联系。但是作为活的区系，二者属于一种。花的构造经历了从更新世（或更早之前）到现在的岁月，也许没有什么变化，它们之所以存活下来，仅仅是因为北美红杉 (*Sequoia sempervirens*) 的庇佑。偶尔你可以看到，大大小小的林地上覆盖着的几乎都是纤细的单叶黄水枝群，繁茂的白色花朵改变了林地的地面特征。它们在这块花毯上细线穿织，如此密集地向巨大的红色树干攀伸，以至于遮住了来自高处的阳光。在开花盛期，这片花海给人一种印象，森林是一个有着柔和、神奇光线的地方，而在其他地方，不论陆地或是海洋，都不可能见到。有一个科学哲理能帮助我们更好的理解，因为我们暂时停留在这儿——从遥远的地质年代起就存活下来的微小生命，它们最有意义的生命画卷中。

除了上面所说的丰富的物种外，还有许多与红杉紧密相关的其他物种也很值得注意。荷包牡丹 (*Dicentra formosa*) 具有灰绿色的羽状叶和着生下垂的、粉色花朵的小枝。在早春，美丽荷包牡丹 (*Cardamine californica*) 最先开花，通常早在三月份白色的花朵就装点着森林。红杉紫罗兰 (*Viola sempervirens*) 和它的亲缘种西海岸堇菜 (*Viola glabella*)，都开黄色的花。一种给人印象深刻的植物是彩色鹿蹄草 (*Pyrola picta*)，有着接近玫瑰形的叶子和整齐肥厚的暗色穗状花序。相对而言，更为珍稀的是无叶鹿蹄草 (*Pyrola picta forma aphylla*)，没有叶子，寄生在其他植物的根部。我们还发

现了几种百合科植物：开着浅蓝色花朵的斯密思万寿竹 (*Prosartes smithii*)；两种名为索罗门鹿药 (*Maianthemum stellatum*) 和肥鹿药 (*Maianthemum racemosus*) 的植物；有着大叶片和粉色钟形花的高个安德鲁斯七筋姑珠莲 (*Clintonia andrewsiana*)；有着两片带斑点的在地面蔓延叶片的臭蝮舌 (*Scoliopus bigelovii*)；以及卵叶延龄草 (*Trillium ovatum*)，三片叶的叶腋里包着一朵可变为深玫瑰色的白花。



图 2.18 荷包牡丹 (*Dicentra formosa*)。



图 2.19 斯密思万寿竹 (*Prosartes smithii*)。



图 2.20 索罗门鹿药 (*Maianthemum stellatum*)。



图 2.21 肥鹿药 (*Maianthemum racemosus*)。

兰花虽然非常稀有，仍然可以分为几个种：有着绿色花穗的 Reinorchid (*Piperia unalascensis*)；具宽叶和棕色大花的巨火烧兰 (*Epipactis gigantea*)；白色的 *Phantom orchid* (*Cephalanthera austini*)；以及一种无叶的寄生植物斑唇珊瑚兰 (*Corallorhiza maculata*)，植株羸弱，呈现出红色。

在五六月期间，道格拉斯鸢尾 (*Iris douglasiana*) 是一种在林间很常见的花。

摇曳的野姜 (尾状细辛, *Asarum caudatum*) 那心形的叶子和线形的褐色花朵使其很容易辨认。

印度莨菪 (*Montia parvifolia*) 是一个大类群，大量浅紫色的花朵和多汁的特点使得它很易识别。

西部毒莓 (*Actaea rubra*) 有两英尺高，具不规则分裂的叶片，在秋季有成簇的红色或白色的浆果。

三角叶银莲花 (*Anemone deltoidea*) 两裂或三裂的叶子上开着一朵白色的大花。

太平洋星形花 (*Trientalis latifolia*) 分布广泛，尤为优美的是其卷曲的叶片和数朵浅粉色的花。

西方水迹叶 (*Hydrophyllum tenuipes*)，田基麻科，在林地上以环形的方式



图 2.22 尾状细辛 (*Asarum caudatum*)。



图 2.23 三角叶银莲花 (*Anemone deltoidea*)。

繁殖，特征为卷曲的开暗色花的总状花序和粗糙、具绒毛的叶子。

蕨 类

迄今为止，红杉林中最常见的蕨类是单列耳蕨 (*Polystichum munitum*)，一种非常大、两层、边缘粗糙的植物，常常生长在腐烂的原木和树桩上，或富含腐殖质的土壤中。在这种理想的环境中还有其他许多蕨类：高大的北美狗脊蕨 (*Woodwardia fimbriata*)，精致的加州铁线蕨 (*Adiantum jordanii*) 和掌叶铁线蕨 (*Adiantum aleuticum*)，叶背面有金粉的金蕨 (*Pentagramma triangularis*)；乌毛蕨 (*Blechnum spicant*)、加州鳞毛蕨 (*Dryopteris arguta*)、普通鳞毛蕨 (*Dryopteris expansa*)、加州蹄盖蕨 (*Athyrium filix-femina cyclosorum*)、冷蕨 (*Cystopteris fragilis*)；以及欧亚多足蕨 (*Polypodium glycyrrhiza*)。通常在开阔的林坡上还可发现为数众多的欧洲蕨 (*Pteridium aquilinum*)。



图 2.24 北美狗脊蕨 (*Woodwardia fimbriata*)，加州铁线蕨 (*Adiantum jordanii*)，金蕨 (*Pentagramma triangularis*)，加州鳞毛蕨 (*Dryopteris arguta*)。

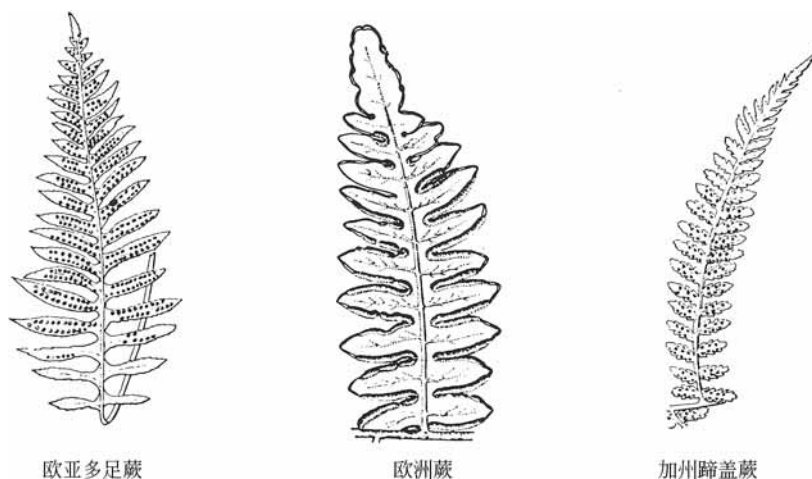


图 2.25 欧亚多足蕨 (*Polypodium glycyrrhiza*), 欧洲蕨 (*Pteridium aquilinum*), 加州蹄盖蕨 (*Athyrium filix-femina* var. *cyclosorum*)。

在离红杉林较远的地方有一块半荫地，其他物种在此占有优势。而远离这个地方的丛林（乡村的灌木丛）或草地，各自又拥有特有的植物。装扮草地的花丛有着非同于红杉林中花系形成的历史衍生方式，却仍然有高度的演化意义。

苔 藓 类

约 200 种以上的苔藓类植物分布于北加州的海岸红杉林带的各种基质上，它们包括藓类、苔类以及角藓类。（详见索引 4. 苔藓，由丹尼尔·H. 诺里斯补充）

蘑 菇 类

在北加州的海岸红杉林带的地被、树及倒木上，分布着三百多种蘑菇类。实际上海岸红杉与栎树混交林的蘑菇种类最多，而腐朽木头的多孔菌也比其

他针叶林少，说明海岸红杉的腐朽比较少。这里列举的菇种多为可食蘑菇并且以菌根菌类居多，但可食与否必须请教真菌学者及当地专家而慎用（图 2.30，见彩插）。

在分类上包括 16 科其中约形态特征不同的 9 大类。伞状菌、牛肝菌、齿菌、鸡油菌、胶质耳菇、马勃、多孔菌、绣球花菌、珊瑚菌在荫湿肥沃的土壤上，有的蘑菇产量相当大。

伞 状 菌

伞状菌最多，约占 50%，伞菌科有 7 个：Agaricaceae, Coprinaceae, Strophariaceae, Marasmiaceae, Meripilaceae, Pleurotaceae, Pluteaceae；稍具甜味野蘑菇（*Agaricus arvensis*）；有幼菇甜香而有杏仁味的白菇王子（*Agaricus augustus*）；有种常常长成一大堆，老时淡褐菇盖平平的，不一定能食用的菌，叫红蜡菌（*Hygrophorus puniceus*，图 2.30, b）；有明显菌环且很好吃的是 Tricholomataceae 科蜜环菌（*Armillaria mellea*，图 2.30, c）；有时可见另一种紫色伞菌紫菇（*Clitocybe nuda*）常与鸡油菌长在一起，这是紫色菇中唯一可吃的一种，它被称为长满粗毛的胡子菇。鸡腿菇（*Coprinus comatus*）是在北半球均有分布的品种，特别是沿着路旁或红杉林中的小路最为常见。

牛 肝 菌

恐怕只有在美国西海岸才见得到这么多种可食用的牛肝菌：*Boletus aereus*, *B. appendiculatus*, *B. edulis* 和 *B. zelleri*。特别是这种美丽奇特、多姿的牛肝菌。我给它取名叫黑盖红柄牛肝，新鲜时应即食，否则就会被虫蛀光。真正被誉为海岸红杉菇王的是美味牛肝菌（*Boletus edulis*）。它也

海岸红杉

有许多外国名字：Cepe（法国），King Bolete（美国），Porcini（意大利），Steinpilz（德国），Penny Bun（英国），Stensopp（瑞士），Borowik（波兰），Herkkutatti（芬兰），Rodellón（西班牙）。旧金山居民得天独厚，在每年12月到次年2月间，旧金山真菌学会常组织他们去门朵希诺海岸红杉森林采集，收获丰富。

齿 菌

红杉林中还有齿菌，它们属于 Hericiaceae, Hydnaceae 科，多数的物种在菌盖下面为刺状，因而取名为刺猬菌（*Dentinum repandum*）。另外还有猪耳菌（*Gomphus clavatus*）（中文又名陀螺菌），属 Gomphaceae 科，除此以外还有许多种猴头菌（*Hercium*）。至于是否可食用，见解不一。

鸡 油 菌

最为丰富的要算鸡油菌类，它属 Cantharellaceae 科；黄鸡油菌（*Cantharellus cibarius*）是加州最著名的野生菇，每年年底至次年早春，它们大量出现在海岸红杉与栎树的混交林。其他种类还有白鸡油菌（*Cantharellus subalbidus*）和灰号角或称黑鸡油菌（*Cantharellus cornocopioides*），从上向下俯视的时候，长在林地上的黑鸡油菌就像地面上的一个黑洞，假若您没有好的眼力，在林中真找不到它。

黑鸡油菌采摘时期很长，自十一月至次年三月均可见。一至二月份还可去加州北部的盐点湖州立公园采集管形鸡油菌（*Cantharellus tubaeformis*），它们通常生长于红杉与石砾树的混交林。

胶 质 菌

这里有两种胶质菌，它们属于 Exidiaceae 科和 Tremellaceae 科。常见的有金耳 (*Tremella aurantialba*)，橙黄色至金黄色。虎掌菌 (*Pseudohydnum gelatinosum*)，白色，小巧，多汁。它们都是很好的药材。

马 勃 菌

常见网络马勃菌 (*Lycoperdon peratum*)，属 Lycoperdaceae 科，可食用，但是应在幼嫩时食用。

多 孔 菌

下面提到的这些科都是腐木菌：Polyporaceae，Ganodermataceae，Fomitopsidaceae，Schizophyllaceae。多孔菌大都是很好的药材，含有多糖，比如铁杉灵芝 (*Ganoderma tsugae*) 的药物价值类似于中国灵芝。此外，还有两种常见的腐朽菌，一种是裂褶菌 (*Schizophyllum commune*)，还有一种多孔菌 (*Polyporus hirtus*)，它们多生长在腐朽木上。

绣 球 菌

属于 Sparassidaceae 科，在 12 月份加州北部的红杉林里可以采到，是蘑菇采集者的最爱。它就像一簇白花，总是长在树上，是很好的抗肿瘤药物。绣球菌是一个最常见的物种 (*Sparassia crispa*，图 2.30，j)。

珊 瑚 菌

从九月到十二月，珊瑚菌可以在加州红杉林或者针阔混交林里采到。常见物种有红珊瑚菌 (*Ramaria araiospora*)，呈长形，顶端分叉，颜色初鲜红，后渐褪色，甚至失色变白。

关于作者

著名的加州植物学家威利斯·林·杰普森博士是1920年保护红杉联盟的发起者之一，并且一直作为委员致力于该联盟的发展，直到他1946年去世。作为加州大学伯克利分校的植物学教授，杰普森博士曾著有《加利福尼亚州的树木》、《加利福尼亚州的森林》、《加利福尼亚州开花植物手册》，以及植物学方面的诸多权威书籍和论文。杰普森博士任加利福尼亚州植物协会主席长达十年。同时，他也是伦敦皇家艺术协会的成员。

丹尼尔·H. 诺里斯，植物学研究员，曾经是汉堡州立大学的教授，1991年退休。他的研究课题是苔藓的鉴定和物种的描述。除了南极洲外，他研究了各大洲区系的主要标本采集，他最出色的考察是在巴布亚-新几内亚。直到现在，他仍然能够一对一地教授学生鉴别苔藓。

第二节 一棵倒下的海岸红杉的故事

富亦苗



图 2.31 这棵倒下的红杉树位于加州 Homboldt 的 Richardson Grove 公园。

年 轮

每年，树木都会在原有的基础上增加一层或者添加一轮木材，由此而增长树龄。正常情况下一圈代表一年，人们据此可以判断树龄。

这棵位于理查森谷地公园的红杉树，有 1200 多年的历史。这期间，它经历了一些人类历史上最激动人心的重大事件，其中一部分就记录在留存下来

的树桩上。

图 2.32 的每个数字显示了事件发生的年份以及同一时期这棵树的大致年龄。图上的字母表示树木遭受到的伤害。

1933 年 3 月 13 日凌晨 5 点 30 分，这棵树倒了下来。虽然没有风，但是泥土却被几次大雨泡软了。大树向北倾斜了 12 米，那一侧的根已于 1820 年或更早的时候被大火烧死。从图中 I 到 K 的区域可以看到，它曾经试图修复这个因火烧造成的巨大伤疤，但是在点 I 处可以看到它又重新长出一个强壮的拱形树基，起支持作用，见 c-b。点 K 由于离向下倒的轴太远而无需长出树基。虽然拱形树基 c-b 每年向北延展的长度超过 3.81 厘米，但是仍不足以支撑大树 500 吨的重量。加固基处的木材是典型的“应压木”。

红杉的倾斜造成倾斜一侧的生长环比相反方向要宽一些。如果这棵树没有受到从点 I 到点 K 所示的伤害，树的横截面将呈现为卵形。

一般来说，红杉向四周生长，生长轮会因此形成年轮。而倾斜的树木，生长轮有可能不连贯，远离倾斜方向一边的环将比实际年龄短。

年轮不仅记录了每年树木直径的增长情况，还记录下了树木遭受到的任何伤害。当形成层（一种介于树皮和木质部之间的薄壁细胞层）被破坏后，会在伤口上形成组织，并留下了永久的印记。一些死亡组织可能腐烂或者被火烧掉，但是受伤的确切年份可通过统计那些标记着愈伤组织、伤口或器官形成的环而推算出来。I-K 处的巨大伤疤暴露在外，保留了一百多年，使树缺乏边材和对生长必需的内层树皮。

虽然红色的心材部分在生理上已经死亡，但它们却起到了机械支撑的作用。同样，干燥含纤维的外皮是死的，却起到了保护的作用。起源于形成层的年轮使树皮向外推进，同时使树皮破裂形成特有的脊状突起。

海岸红杉

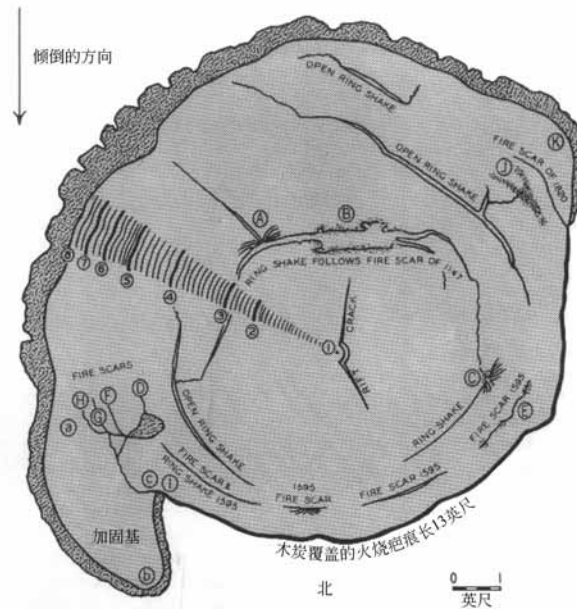


图 2.32 倒木的横切面。数字表示年份，字母表示遭受的伤害。

在树木生命历程中的人类历史

- (1) 728 年，从树木开始生长至比最初地面高出约 15 英尺的树桩部分。
公元 700 年左右，幼苗或者是萌芽条开始生长。
- (2) 1066 年，罗马人征服英格兰。
- (3) 1215 年，玛戈纳·卡塔签约。
- (4) 1492 年，欧洲人发现美洲。
- (5) 1776 年，签署独立宣言。
- (6) 1861 年，美国内战开始。
- (7) 1914 年，第一次世界大战开始。
- (8) 1932 年，独裁者上台。外层最近一圈年轮形成。紧接着，1933 年 3

月份，在开始新一轮的生长之前，这棵树倒了下来。

在树木生命历程中发生的事件

(A) 在 1147 年火灾中遭受的伤害完全愈合了，但留下了一个弱点，并且后来还产生了辐射状的裂缝。

(B) 1147 年火灾疤痕延展成为“荡开的环”，并且“纤维状白色腐朽”感染了四周的木头。在古老的大型红杉中这些现象都很普遍，并且是内应力的一种结果。如果这棵树没有产生环的振荡，那么中间的裂缝将会更长，也会开裂得更宽。

(C) 火烧伤口愈合。在愈合老龄心材的“心材褐色腐朽”之前，沿着环产生了一个裂缝。

(D) 1595 年的火烧疤痕。从伤口两边一起发出的新枝给树皮造成了一些压力。

(E) 与 D 相似。1595 年的大火，在四个方面都有说明。

(F) 1789 年的大火。

(G) 1806 年的火烧疤痕。1789 年、1806 年和 1820 年的三次大火使加固基的形成推迟。这意味着在这棵树倒下之前，它开始了 100 多年的倾斜。

(H) 1820 年的火烧疤痕。这场大火可能很严重。树上从 H 到 J 的地方都被烧毁了，大火烧光了树皮、边材和部分心材。但早先的大火也很有可能对巨大疤痕有作用，并且可能使这个疤痕开始形成；而证据已经被后来的这次大火烧毁了。

(I) 加固基所在的位置和 1820 年火灾的疤痕相遇。

(J) 于 1820 年或更早些的大火之后心材褐色腐朽。

(K) 毁于 1820 年的表面上开始了新的生长；1848 年、1866 年、1833 年和 1895 年的大火中断了其生长。位于倾斜轴后面的这一点并没有受刺激而形成加固基。

加固基的形成

(a) (b) (c) 加固基形成。

(a) 112 道环被挤成 20 厘米大小（见加固基放大图）。

(b) 在穿过 b 的垂直线上，100 道环占了 91.5 厘米，这意味着生长速度的增加加速了加固基的形成。

(c) 60 道环挤在一起，只有 11.5 厘米。而在穿过 b 的垂直线上，那 60 道环占了 51 厘米。

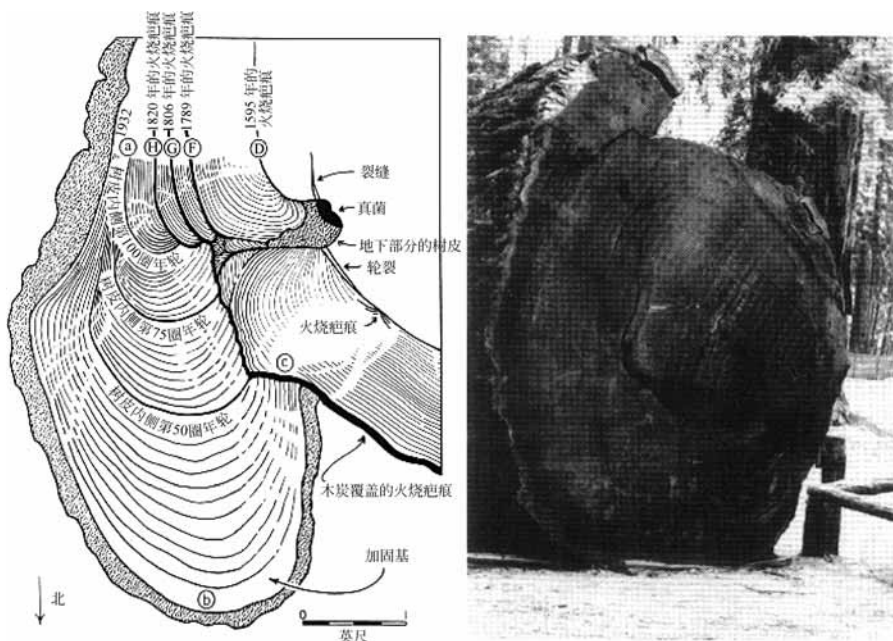


图 2.33 加固基的横截面放大图（左图）。大树以加固基为支撑，向外生长（右图）。

海岸红杉

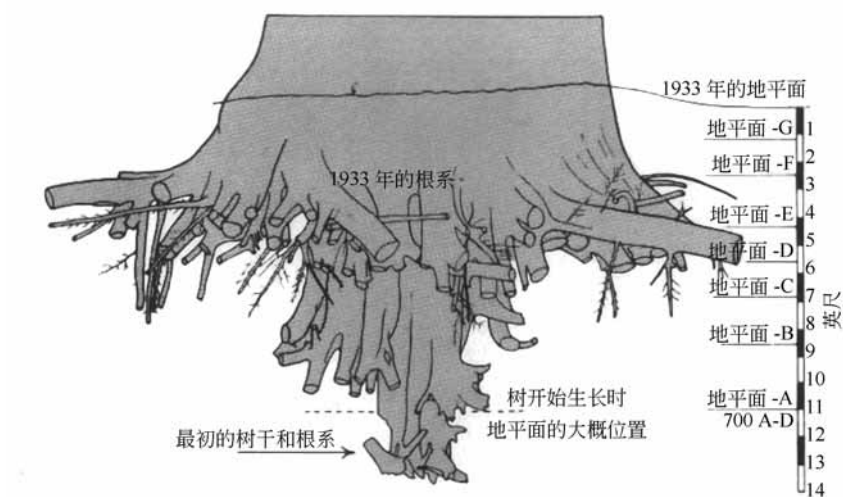


图 2.34 图中显示了新形成的平面与相应的根系扩展。现在的平面比最初升高了 3 米。

根 系

在公元 700 年左右，这棵树刚开始生长之际，地平面比现在大概要低 3 米。这意味着在图 2.34 右边说明中所显示的主根，实际上却是最初的树干和原有的根系。红杉树是没有主根的。

树林的主体生长在一块平地或者由洪水堆积起来的河床上。在这棵树活着的时候，7 次大洪水和许多次小的洪水沉积了足够多的淤泥，使地面升高 3 米以上。虽然每一次洪水来临后，树基都会被部分掩埋，但它却能通过产生一个新的、更高的根系来适应新的地面。在土壤剖面上很容易定位出这些地平面。

一千年或更早以前，一次大洪水留下了大量的淤泥，大约有 76.2 厘米深，如图 2.34 中 B 层所示。尽管根系继续发挥作用，但最终还是形成了新的根系以适应更高的地面。在一个世纪（或更早）之后，另一场洪水产生了平

面 C。其他多次洪水使平面升高到 D、E、F、G，最后升到了 1933 年这一层。每次地平面的升高都伴随有一系列新的根系形成，同时树干下面的部分停止直径生长。这就解释了老的地表下的树干其尺寸上的不连续变化，每个直径都代表了在一个独立的地平面阶段的生长情况。较早期根系的树桩保留了下来，这在图示中能清楚地看到。朝向外的树根是洪水发生的结果。大树通过重新调整它的根系以适应新的土壤层。

在 1933 年的时候，根系大概已有 300 多岁。从 1933 年往前数第 3 的部分根系以及在这之前的一些根系已没有生命，它们交织在一起，组成了一个疏松的重叠结构，但是仍然被很好地保存下来。幸运的是，这棵树较粗一端的木材保留完好，并且被完整地取出来。

如果树的中间部分腐朽并且被分解掉了，那么这里就会出现一个大洞并扩展到最初的地面，也就是亲代种子长成的那个地平面。譬如洪堡红杉公园的高岩石地和史蒂芬谷地的红杉。在洪水带来的淤泥抬高底面水平之前，每个树桩中心的洞都至少有 13 英尺深。

理查森谷地公园里的其他树也有相似的地下树干，可以通过检查那些有大块火烧痕迹的树得知。每一段暴露的树干都在地面上呈直线形，而不是像普通的辐射形展开。

这棵树和其他几棵树使得重现伊尔河床的历史成为可能。加州伯克利大学林业学院的 Paul Zinke 博士做了进一步研究，已经能够标明以前洪水发生的时间及规模。

海岸红杉

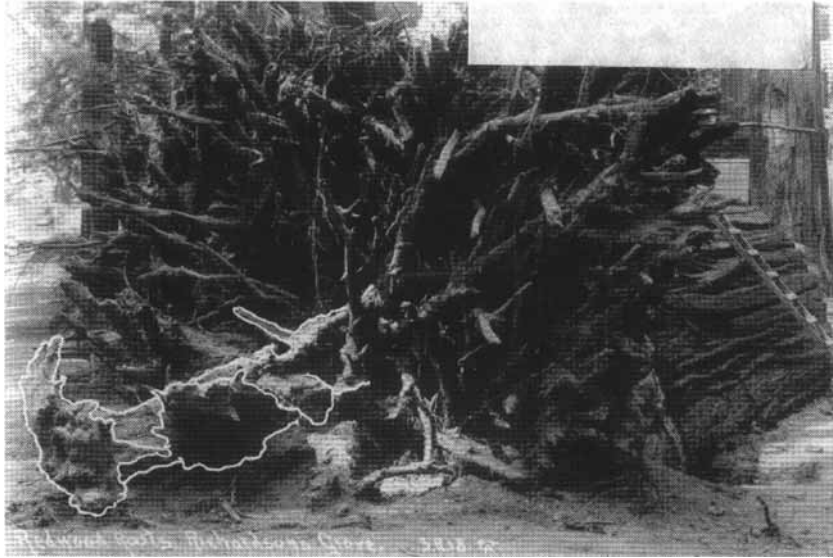


图 2.35 海岸红杉没有主根。看上去像是主根的部分（白线标记）是残余的树干。



图 2.36 照片由 Tibketts 摄于 Richardson Grove 公园，20 世纪 30 年代。

一棵倒下的海岸红杉的故事

海岸红杉

关于作者

从 1919 ~ 1954 年，富亦苗 (Emanuel Fritz) 一直是加州伯克利大学森林系的教授。他获得了荣誉退休教授的头衔，并以 102 岁的高龄成为大学里最年长的教授。他于 1931 年加入保护红杉联盟，并于 1980 年当选为名誉副主席。

Fallen 红杉林位于加州洪堡的理查森谷地公园。Fritz 教授当时为了将这棵倒下的大树用于展览，整整花了 30 多天去清扫和检查它的树根。Fritz 教授终其一生致力于海岸红杉的研究，并向人们传授这种神奇树种的知识。

第三节 加州红杉公园和自然保护区

约翰·B. 德威特

红杉家族的三个成员

经植物学家确认，红杉家族有三个属，每个属有一个种。其中的两

种——海岸红杉 (*Sequoia sempervirens*) 和巨杉 (*Sequoiadendron giganteum*) 是加州土生土长的。这两个树种都是常绿针叶林，心材红色，微红色的纤维树皮含有丰富的单宁。

虽然海岸红杉和巨杉为近亲，但在很多方面存在差异。海岸红杉生长在加州海岸北部的狭长地带，雾气缓解了夏天的炎热和干旱，地面从不结冰。而巨杉则以块状分散在内华达山脉西坡，既耐热又耐冷。海岸红杉比较高，而巨杉体积较大。最古老的海岸红杉经测定约有 2200 年，最古老的巨杉经测定有 3300 年，当然实际上很多树可能超过这个年龄。

红杉家族的第三个成员是水杉 (*Metasequoia glyptostroboides*)，最初被鉴定为化石。1946 年以前，也就是在中国边远地区发现水杉以前，学术界认为水杉已经绝迹了。在 1948 年，古植物学家拉尔夫·钱尼博士（他后来担任红杉联盟主席）不远万里来到中国探寻这些活化石，并将一些水杉的枝叶带回美国。如今，很多地方由于栽植有这种子遗植物而增色不少。



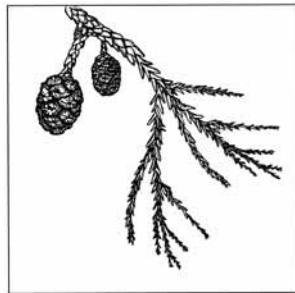
图 2.37 洪堡州立红杉公园里宏伟的洛克菲勒海岸红杉森林。

海岸红杉

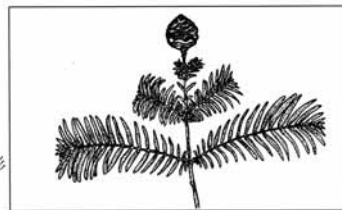
与加州红杉和其他大多数针叶林不同，水杉冬天落叶，春天长出新叶。这种树需要夏季的雨水才能存活，而冬天能耐受冰点温度。现在，大约有 3000 棵水杉在其自然生存的地区受到中国政府的保护。



图 2.38 海岸红杉 (*Sequoia sempervirens*)。



巨杉



中国水杉

图 2.39 左上：巨杉 (*Sequoiadendron giganteum*)；右下：中国水杉 (*Metasequoia glyptostroboides*)。

海岸红杉

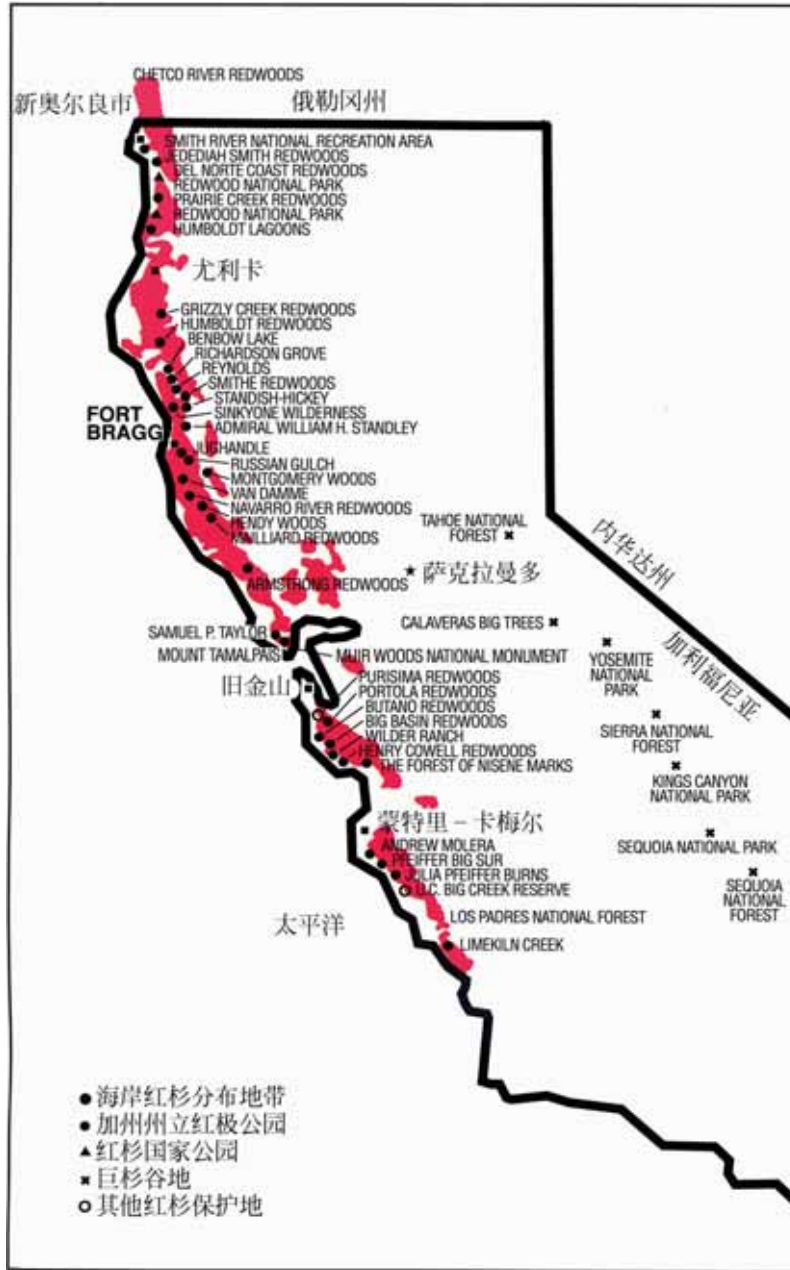


图 2.40 红杉分布和国家公园地图。

加州红杉公园和自然保护区

加州海岸红杉

古植物学家对世界上大部分地区发现的球果和茎的化石进行研究后，断定红杉和其祖先在 1 亿 6 千万年前就存在于地球上。像我们现在所熟知的红杉，2 千万年以前就在加州生长，它们代表了极为独特同时又异常美丽的孑遗植物群，那时，在地球上还有恐龙活动。

大约一百万年以前，移动的冰川将海岸红杉圈定在现在的范围内。冰川留下一片界限分明的区域，叫做红杉带，高大树木在这里未受气候的干扰而生长茂盛。当欧洲殖民者来到加州时，这条红杉带大约有 724 公里长，从俄勒冈州边界沿加州海岸到加州蒙特雷县南端的 Santa Lucia 山脉。带宽根据地形的变化从 8 ~ 32 公里不等。海岸红杉喜潮湿的海岸地带，这样可以远离从太平洋吹来的风和带咸味的空气。树林生长在低于 610 米的高度，那里冬季雨量充足，夏季多雾，全年气候温和，优良肥沃的淤积地也极有利于植物生长。在条件最适宜的河床沿岸，生长着最宏伟的红杉林。

海岸红杉，常称为高树，其树冠高高耸立于其他树之上。在良好的生长条件下，20 年的树木高度可达 15 米，直径可达 0.3 米。成熟的树一般为 60 ~ 90 米高，胸径 3 ~ 4.6 米（按标准树木量法，胸高取从地面 4 英尺 8 英寸处，即 1.423 米）。超过 90 米的树在河边平地和河岸上很常见。海岸红杉是世界上经测定最高的树，它耸立在红杉湾两岸的红杉国家公园的高树丛林里，1964 年由国家地理协会测定为 367.8 英尺高。还有其他几棵树也达到了这个高度，包括在洪堡红杉国家公园的创始者丛林中的创始者树，它的命名是为了表示对保护红杉联盟创始者的敬意。

海岸红杉的根系宽而浅，最敏感的部分就分布在地表以下几厘米处。老

海岸红杉

树的厚皮有防火作用，木质的低树脂含量又增强了这种保护作用。在大树基部，贯穿树干基部的大树洞穴见证了红杉林曾经发生过大火。值得一提的是红杉不罹菌病，很少有严重的虫害。成熟的海岸红杉几乎每年都结果产仔，树龄为 20 ~ 250 年的树最适合结仔。红杉的种子很小，10 万粒还不足 1 磅。海岸红杉一般是在倒木和损伤后进行出芽繁殖。母树受损伤后几周内即可从根系出芽，其他树种很少具备这种能力。相比那些只能依靠种子进行繁殖的树种，出芽繁殖是海岸红杉的优越之处。

与海岸红杉一起构成森林的物种还有北美黄杉 (*Pseudotsuga menziesii*)、异叶铁杉 (*Tsuga heterophylla*)、密花石柯 (*Notholithocarpus densiflorus*)、浆里鹃 (*Arbutus menziesii*)。开着粉红色花朵、长着紫色茎的细小红杉酢浆草铺满林地，还有具革质绿叶、在夏天结出暗紫色果实的白株树 (*Gaultheria shallon*)，以及大片的蕨类。杜鹃和落叶杜鹃在五六月间鲜花怒放，色彩绚烂。美莓 (*Rubus spectabilis*) 和卵叶越桔 (*Vaccinium ovatum*) 为野生动物和人类探访者提供食物。

将海岸红杉圈定在加州海岸范围内的同时，冰川也将巨杉圈定在内华达山脉中度海拔的高岭。巨杉生长在西坡、海拔 1220 ~ 2560 米、近 420 公里长的区域内，最北端的林丛仅有 6 棵树，位于 Placer 县 Tahoe 国家森林公园的阿美丽加河河岔中部；最南端在 Tulare 县 Keru 河谷。巨杉丛林适宜夏季气候干燥、土壤排水性强、冬季零度以下气温时间短的环境。它们喜欢平缓的山坡，以及与溪流和草地相连的湿润地带。

海岸红杉被称为高树，巨杉则相应地被称为大树，成熟的巨杉可达 76 ~ 90 米高，胸径达到 6 ~ 9 米。最大的巨杉是巨杉国家公园的将军树，是世界上最高的树，其高度为 83.82 米。1981 年林务人员测算出谢尔曼将军树的材积为 148.9 立方米 (63000 板尺)，而且这棵树还在继续生长。生长在巨杉公园

海岸红杉

的格兰特将军树几乎与之同样大小。像海岸红杉一样，巨杉有抗火、抗菌、抗虫的能力，但它只能靠种子繁殖。周期性的大火为种子的发育提供了理想的矿化土壤条件，而松鼠则是巨杉种子的播种能手。

巨杉与兰伯氏松 (*Pinus lambertiana*)、西黄松 (*P. ponderosa*)、北美翠柏 (*Calocedrus decurrens*) 等松柏类树种混交。*Sierra* 森林没有海岸红杉那么茂密，所以在远处就可以看见红光发亮的巨杉树皮。春天，美国西部山茱萸 (*Cornus nuttallii*) 开花时，成为最引人注目的林下层植物。在巨杉林中还生长着落叶杜鹃、茅莓 (*Rubus parviflorus*)、醋栗树 (*Ribes roezlii*)，以及很多开小花的植物。

人类发现和边疆开拓

最先发现海岸红杉和巨杉的是美国土著人的祖先，他们当中有游牧的猎人、渔民和一万年前从北美来的移民。这些人不像最早来这里的欧洲人见到红杉和巨杉时那么惊奇，因为他们来自太平洋西北岸的古老的北美花旗松和芹叶钩吻森林，那里的一些树木几乎与红杉一样高，然而在体积上就不能与巨杉相提并论了。

第一个来加州的欧洲探险家是胡安·罗德里格斯·卡布里罗船长，他于 1542 年将 *Alta California* 命名为松树海岸。不论卡布里罗还是其他越洋来太平洋海岸探险的欧洲人，他们都没有注意或报道水杉。最先发现红杉的欧洲人是唐·加斯珀。他于 1769 年率领第一支欧洲陆地探险队沿加利福尼亚海岸而上。同年 10 月，他们到达了蒙特里海湾，也就是今天的 *Watsonville* 镇附近，在那里，他们发现了红杉。其中一个队员米格尔·克斯坦佐写到，这是他和同伴看见过的最大、最高、最奇特的树。法兰西传教士胡安·克雷斯皮写到，

虽然在颜色上这种树与雪松相似，但两者截然不同。既然探险队中没有谁见过这种树，所以他们就根据颜色取名为红树（Palo Colorado）。

发现红杉很久以后，边远的居民才发现巨杉。在加州被确定为墨西哥的一个省之后，美国毛皮捕猎者和探险者开始跨越内华达山脉。1833年，徒步探险队穿过 Merced 或优胜美地谷附近的 Tuolumne 巨杉丛林。1839年，探险队的队员泽纳斯·伦纳德出版了一本游记，描绘了这些树的惊人景象：“红杉高大得令人难以置信”。1840~1850年间，另外几个探险队也曾来到巨杉林，他们的报告虽然完全属实，却令人难以相信，反而没有引起重视。即使在1854年，一整棵红杉树被砍倒后运往纽约进行展览，还是被大多数人当成故弄玄虚。

英国植物学家 A. B. 兰伯特为海岸红杉冠以第一个植物学名称。通过研究1790~1795年间温哥华探险队收集的一个标本，他得出结论，认为这是落羽杉属的一种。落羽杉顾名思义，像水杉一样是落叶的。于是兰伯特冠以海岸红杉的物种名为 *sempervirens*，常绿的意思。1847年，著名的匈牙利植物学家史蒂芬再次描述了海岸红杉，将它归于属而保留了 *sempervirens* 这个种名。属名是为了纪念 Sequoyah，一个切诺基印第安人，他因发明了本民族的字母而闻名。



图 2.42 直径达 5.5 米的红杉巨人，于 1833 年 7 月 10 日被伐，地点在加州 Fort Bragg。

巨杉的植物名称固定下来并不容易。它的第一个名字来源于英国，因这种树当时在英国的公园和花园中相当流行，便以著名的威灵顿公爵的名字命名为威灵顿巨杉。美国人不甘示弱，将它命名为华盛顿巨杉。但这个名字已经命名了棕

属，所以不能再用于其他物种。后来，植物学家确定这种树与海岸红杉是近亲，应该与*Sequoia*在同一属，问题似乎得以解决。1940年，植物学家重新审议后将巨杉单独归于一属，成为 *Sequoiadendron giganteum*。

红杉的采伐

加州海岸北部的土著人用海岸红杉建房和做独木舟。通常是用斧头直接砍倒树木，有时则要借助火在树木的基部燃烧来砍伐。用火烧或斧砍制成厚板和独木舟的过程非常艰辛，所以红杉林还不至于面临灭绝的危险。

希拉 - 内华达山脉下的一些印第安人用巨杉的树皮做屋顶，因为当时的砍伐技术还停留在手工伐木的水平上，根本无法砍伐像巨杉那么高大的树木。19世纪中期，当这些树再一次被发现时，伐木工人也发现它们的木质其实很脆弱。巨杉虽然可以用作建材，但它们不是优良木材，不如当地海岸红杉的材质好。倒下的巨杉给伐木工人带来了大量的零碎木材，它们充其量只能做一些篱桩和盖屋板用。

海岸红杉的砍伐活动早在1820年就开始了。1827年，据一名法国游客报道，在索诺玛县海岸的罗斯城堡，俄国人砍了一棵直径6米的树。那里所有的房屋都是用当地的红杉建造的，包括桶和大盆。殖民者将红杉木卖给住在更南的西班牙人和墨西哥定居者。罗斯公司也曾经使用栎树造船，但不是很成功。

生活在红杉带的欧洲居民最早是用手工伐木，他们使用与印第安人相似的技术在伐木现场将木头锯成板。1830~1840年，在旧金山海湾，沿 Sausalito 和 Mill 谷周围人们开始使用锯子锯木。1834年，在 Big sur 县人们就用双刃金属片锯木。同年，在索诺玛县 Santa Rosa 河谷，约翰·库柏建起第一座水力锯木

厂。1849 年安装了第一把圆锯。

1848 年加州从墨西哥割让出来后，于 1850 年并入美国，1860 ~ 1900 年间，联邦政府通过宅基地法案、先买权和公开出售法案、木石法案，将大部分红杉林地转为私人所有。宅基地法案规定，在附带一些条件的情况下，人均可拥有 160 公顷。木石法案规定的附带条件更少，只支付 2.5 美元就可以拥有 1 公顷土地。然而这些法案背后，申报者在获得林地的过程中有很大的欺骗性，因为没有进一步确定那些申报的人是代表个人还是代表公司。一个木材大王后来宣称他以一瓶麝香葡萄酒一公顷的价格从下等地区游民那里获得了大量的土地。

随着对木材需求的增加，木材公司占地面积的逐渐扩大，更为有效的伐木方法被采用，工厂也越来越多。最初人们用牛和马将木材拉至木材厂，但集材铁路和带有笨重发动机的蒸气集材机很快代替了牲畜，更多的木材能通过滑道到达楞场。蒸汽机车随后又被柴油机取代。至少在一个地区曾用电力操作过伐木机械。这些伐木方法导致广阔的红杉林地区被成片砍伐。

红杉原木去皮后，人们用火清除留下的树皮和采伐剩余物。通过反复的燃烧，然后播种草籽将采伐过的土地变成牧场。20 世纪初期，连续生产木材的观念随着林业专业化趋势得到逐步发展，在 1850 ~ 1910 年期间，伐木被认为是土地的短期效益，只是将其转为农业和居屋这一真正用途的准备。

旧金山湾和蒙特里湾周围的红杉首先消失。然后消失的是从海上最容易到达的索诺玛县和门德西诺县海岸的红杉，再后来就是洪堡和迪·诺特县海岸红杉。1917 年，随着美国 101 公路的建成，伐木工人更容易深入到洪堡县内陆的红杉地带，砍伐量不断增加。值得庆幸的是，公路的延伸也让有保护意识的人士亲眼目睹这种壮观的森林正在被毁灭。1905 ~ 1929 年间，红杉砍伐量稳定增长到平均每年 5 亿板尺。大萧条期间，砍伐量降到 1.35 亿板尺。

1949 ~ 1958 年又猛增到每年 10 亿板尺。到 1960 年，很多小木材厂由于很难获取木材被迫关闭。从 1965 年起砍伐量萎缩，而建材需求量还保持强劲势头。现今很多红杉木材是后来人工种植的，只有很少一部分古红杉树属私人所有。由保护红杉联盟拯救的古红杉在各个公园得到永久性的保护。



图 2.43 由几位妇女组成的保护红杉委员会，她们在加州洪堡县的留影。照片摄于加州 Eureka 的巨杉公园，曾用于 1917 年 9 月 6 日的地方性报纸 Humboldt Standard。

保护红杉树

海岸红杉林面积广大，幽深高远，人类涉足极为不易，因而很少有人想到要保护它们。相反，比起海岸北部的大红杉林而言，人们接近巨杉则容易得多，而且巨杉由于单棵树木，例如发现之树、森林之母（当树皮被剥下来去进行展览时死亡）等著称于世，所以人们便将保护红杉类树木的重点主要放在巨杉上。通过宣传，巨杉在欧洲和美国东海岸也更为出名。地理位置则是另一个原因，巨杉生长在内华达山脉，引起了约翰·米瑞和其同事的注意，他们致力于保护优胜美地和希拉 - 内华达山脉的其他树木。米瑞向公众介绍大树时内容详尽、言谈动人，使那里成为无与伦比的世界旅游胜地。

卡拉威尔斯北部丛林（现在是卡拉威尔斯大树州立公园的一部分，第一个著名的巨杉丛林）的土地所有者考虑建一个宾馆以吸引游客，但不砍伐树林。其实在 1899 年，原来的土地所有者将北部丛林卖给了一个木材公司的经理，虽然他承诺不砍伐任何一棵树，但当地的居民和游客还是被激怒了。这次事件引发了一场将卡拉威尔斯丛林变成州立公园的运动。正如约翰·米瑞所言，卡拉威尔斯大树是森林之王，贵族至尊，理应属于全世界，既然生长在加州，我们便不能逃脱作为保卫者的责任。值得庆幸的是美国人民能够承担此任。

1900 年前，希拉 - 内华达山脉归联邦政府所有，因此不需要花钱来购买公园。1964 年，国会和林肯总统毫不犹豫地建立了优胜美地公园（包括优胜美地河谷和玛丽波萨大树丛林）。

由于国家公园管理机构还没有成立，优胜美地起初划归加州，作为国家公园来管理。加州政府马上任命弗雷德里克·罗·欧梅斯泰德（纽约国家公园规划主任，世界上著名的公园设计和管理专家）来主持委员会的工作，并对公园进行管理。这项任命对在加州工作的欧梅斯泰德来说是莫大的荣幸。他写了一篇报告提交给委员会及州政府，对形成一种关于风景和自然公园的新思想产生了很大的影响。

遗憾的是，欧梅斯泰德于 1865 年返回纽约，优胜美地委员会的工作几乎完全停顿下来，最后因公园管理不善导致约翰·米瑞和其他人于 1906 年将它转交联邦政府。这样，优胜美地国家公园归属于联邦政府，由美国骑兵部队管理。

1890 年，国会将优胜美地河谷周围更大的地区划为国家公园。南太平洋铁路的社会活动家是保护沿希拉景区巨杉的主要力量。对于这次保护运动来说，旅游当然也是一个重要的动力。铁路部门显然有兴趣建立和保护公园，

以便吸引游客到西部来。

具有讽刺意味的是，木材商购买北部丛林引起了保护者的高度关注，使他在 26 年内没有砍伐一棵树。然而，他于 1925 把丛林卖给一个木材公司。此事，以及在 1928 年竞选中获得批准的筹集债券资金的计划，激励着红杉联盟和新成立的卡拉威尔斯丛林协会重新努力，用募捐活动所获得的主要捐献资金，将卡拉威尔斯大树林的南部丛林买下来。直到 1931 年，保护红杉联盟资助该州购买北部丛林，卡拉威尔斯大树林才成为国家公园。1954 年国家公园进一步扩大。

为从砍伐者斧头下拯救红杉而进行的最早期的努力中，有一些成员的身份令人吃惊，他们是 1852 年加州立法院的亨利·A. 克拉布，接下来是 1879 年内政部长卡尔·舒尔茨，俩人促成了国家红杉公园的建立，但他们都未能争取足够的公众支持来实现其目标。

保护红杉运动在圣塔克鲁兹县大盆地展开。1902 年，通过 *Sempervirens* 俱乐部和菲比·A. 赫斯特女士的努力，建立了第一个红杉公园，并命名为加州红杉公园，即现今著名的大盆地国家红杉公园，也是整个系统里最出名的红杉公园。

1907 年，在马林县的 Muir 森林，壮观的红杉林被捐献出来作为国家纪念物。为表示对约翰·米瑞的敬意，美国国会议员威廉·肯特将这份财产作为礼物捐献出来。这位议员刚开始还拿不定主意能否这样做，因为政府从来没有作为礼物接受过公园。最后，他的慷慨礼物被接受了，510 英亩（约 4 千平方米）的纪念物成了联邦政府保护的第一个海岸红杉林。这无疑是肯特对联邦政府保护红杉的贡献，他是 1916 年立法创建国家公园服务部的发起人，也是献身保护红杉联盟的创始者。

海岸红杉



图 2.44 威廉·肯特和斯蒂芬·马瑟在红杉森林里，摄于 1923 年 3 月。



图 2.45 纪念 Bolling Grove——洪堡红杉州立公园的第一个红杉保护地的活动。1921 年 8 月 6 日，由保护红杉联盟的建立者们举行。

加州北部海岸保护红杉的工作开始于 1917 年。101 公路修成以后，几位杰出的红杉保护者来到洪堡和迪·诺特县观看壮观的红杉林。他们分别是：加州大学古生物学家、后来任卡内基学院院长约翰·C. 梅里曼，以及来自纽约的保护协会领导人玛丽森·格兰特和亨利·费尔弗雷德·奥斯本。他们看到沿路森林大面积地毁坏，而且没有一棵树是由公众机构所有或保护，感到非常震惊。

这些伟大的保护者深深地感到，为了红杉独特的美和科学意义，迫切需 要对其进行保护。他们在《国家地理杂志》上发表的一篇文章还刊登了一些红杉的照片，号召政府和民众保护红杉。与此同时，他们在 1918 年春组织了保护红杉联盟，其目标是在几个代表性的地区拯救原始红杉林免于毁灭，并与国家公园管理机构合作建立红杉公园。联盟的第一个举措即是建议国会立即建立国家红杉公园。

1920 年，美国众议院通过决议，责成内政部长调查并报告生长着典型海岸红杉的一片或几片土地建立国家红杉公园的可能性。国会对确定这样的土地或它的价钱是否将捐献给联邦非常感兴趣。此外，也需要对维持一个国家公园的费用进行估价。

美国林业机构承担了这次调查，地区林务员保罗·G. 雷丁顿与国家公园管理机构的主任及红杉联盟的官员一起草拟了一份详细报告。委员会对四个地区进行了认真的研究考虑。它们是：洪堡和迪·诺特县的低克拉马斯河，洪堡县伊尔河南岔，洪堡和迪·诺特县的草原溪、红木溪，以及洪堡县大环礁湖。

深入研究之后，委员会建议在克拉马斯河下游流域近 260 平方公里（64,000 英亩）的土地上建立联邦政府红杉公园。他们指出这个地区有一块 708 万立方米（30 亿板尺）的红杉林基本上还保持着原貌。克拉马斯河两边

的山脊可作为公园主界限。这一区域已于 1880 ~ 1900 年间以每英亩 2.5 美元的价格售出，主要归私人所有。

除了克拉马斯河，委员会还建议在伊尔河岔南部和布尔溪宽阔的丛林争取 7.28 平方公里（1800 英亩）的红杉林，他们指出大部分的地方可以由保护红杉联盟、个人或由加州无偿地捐献给联邦政府。

由联邦基金拨款购买大片私人所有的土地用于建立国家公园，当时还没有先例。由于国会未同意购回红杉林，这份报告没有获得进一步的实施，国家红杉公园未能成立。

保护红杉联盟在全国范围内发起了一场活动，号召会员捐款购买私人所有红杉林地。即使联邦政府对此兴趣不大，但公众对保护海岸红杉的事业则异常积极，并且行动迅速。1920 ~ 1928 年间，保护红杉联盟购买了很多红杉林地，形成了我们今天所知的加州红杉公园系统的核心。

在早期捐献当中，最有名的是洪堡红杉公园里面积为 36 平方公里（9000 英亩）的洛克菲勒森林。著名的人类学家小约翰·洛克菲勒通过保护红杉联盟捐献了两百万美元。保护红杉联盟用这笔捐献和其他个人捐款，以及 1928 年国家公园的债券资金，从太平洋木材公司购买了这片壮观的红杉林。

洪堡红杉公园的肯特·马德丛林是用国会议员威廉·肯特捐献的资金购买的，他是第一任国家公园管理机构的主任。1931 年，美国黄金俱乐部通过保护红杉联盟捐献国家公园资金，在洪堡红杉林购买了 10 平方公里（2550 英亩），这个丛林在国家森林系统中排名第三，保护着近 21 平方公里（5130 英亩）的红杉林地。早期通过保护红杉联盟购买的其他丛林成为洪堡红杉国家公园森林的先驱和核心。

1923 年 6 月，保护红杉联盟在草原溪国家红杉公园获得了第一块丛林。到 1943 年红杉联盟与加州国家公园委员会合作在草原溪购买了另外的 24 平方

公里（5936 英亩）古红杉林。1925 年和 1934 年间用政府资金和红杉联盟的捐款购买了迪·诺特县海岸红杉公园的 8.8 平方公里（2186 英亩）红杉林。

1928 年，保护红杉联盟积极促进与加州国家公园的联络，同年加入了加州国家公园委员会的组织，不同的州际公园由各个不同的委员会或机构管理。1928 年结合为加州国家公园系统而得到巩固。今天，加州国家公园系统成为世界上最优秀的组织之一，保护着广大的自然资源和历史遗址，公园提供的教育和娱乐设施，造福着加州人民及世界各地的游客。

1930 年国家公园管理局准备再次提议建立国家红杉公园，对北部红杉林进行研究，并于 1937 年提议建立一个面积达 109 平方公里（27,000 英亩）的国家公园，包括迪·诺特县米尔溪地区最好的一片树林。但国会又一次没有采取行动。该范围内最好的一部分林地在三十年代后期由保护红杉联盟获得，就是现在人们所熟悉的杰地亚·史密斯国家红杉公园。

1946 年，加州女议员海伦·加黑甘·道格拉斯提出了一项法案，旨在建立总面积超过 1133 平方公里（280 万英亩）的 F. D. 罗斯福纪念林。提议所涉及的地区包括沿着海岸南部从俄勒冈海岸线到索诺玛县的 Bodega 湾附近，包括大部分的红杉林区和大面积的北美花旗松林地。除了四片明显分水岭的纪念林（这些林地已有计划归入州立红杉公园）之外，这个区域本应成为美国林业总局管辖下的经济林。1948 年的议员选举中，海伦被理查德·尼克松击败，法案也跟着流产。

通过联邦立法建立国家红杉公园屡屡受挫的同时，保护红杉联盟仍继续购买红杉林和土地以扩大加州红杉公园。第二次世界大战后的几年里，基本依赖于红杉木的林产品工业发展，在海岸北部占主导地位。保护红杉联盟与木材工业二者间的关系主要是通过争取合作、互相尊重双方的观点来维系的。从一开始，保护红杉联盟就相信达到目的的最好办法是进行正式而友好的谈

判。通过向森林所有者作出公道的赔偿而获得希望用作公园的土地，保护红杉联盟获得了一些木材公司的尊重。太平洋木材公司、迪·诺特公司、Sage Land and Improvement 公司、路易丝安娜 - 太平洋公司、哈蒙德木材公司，还有其他一些公司也配合保护者的努力，将最好的红杉林区留给保护红杉联盟，使其能够筹集到资金以合理的市场价格购买它们。

当保护红杉联盟陆续建立一个又一个红杉公园的时候，政府暂缓了通过立法来建立国家公园的工作。1961 年，保护红杉联盟、Sierra 俱乐部和国家地理协会又一次萌生了建立国家红杉公园的想法，促使内政部长斯图尔特·尤德尔起草国家红杉公园的提议。全国地理协会拨款 64,000 美元给国家公园管理机构进行红杉调查，以便弄清保留下来的红杉原始林的分布情况，确定国家红杉公园的位置。1964 年调查完成，结果表明在加州曾经有近 8100 平方公里（200 万英亩）红杉林生长茂盛，现在只有 1214 平方公里（30 万英亩）没有被砍，其中 202 平方公里（5 万英亩）是受保护红杉联盟保护的。



图 2.48 1968 年 10 月 2 日，林登·约翰逊总统签署了建立红杉国家公园的议案，图为在白宫举行的仪式。作者以及其他重要人物出席此会。

国家公园管理机构的报告一经公布，就在公众和议员中产生很大反响，赞成成立国家红杉公园的呼声很高。大量的研究工作一个接着一个，50 多年的艰苦工作、规划伴随着来自木材公司的不妥协反对，终于在 1968 年，约翰逊总统签署了议会法案，决定建立国家红杉公园。

120 平方公里（3 万英亩）公园包括海岸线、森林和一条狭窄河道走廊，保护着矗立在红杉河岸边的高大树木。立法授权将三个加州红杉公园、草原溪、迪·诺特海岸和杰地亚·史密斯纳入国家公园的范围内。这三个公园保护着

这一地区最好的红杉林的核心部分，使国家红杉公园名副其实。

1968 年划定的界限没有包括足够的土地来保护红杉河和米尔溪。保护者又花了十年的时间加紧工作来扩大国家森林公园，以保护毗邻的流域面积及保留下来的红杉原始林和米尔溪。1978 年，卡特总统签署扩大国家红杉公园的法案，增加必要的流域面积，把公园扩大到 194 平方公里（48,000 英亩）。这个不平凡的法案提出了红杉砍伐地的恢复问题及其他措施，用以减少因扩大公园对当地经济产生影响。15 年以后，国家红杉公园恢复工程建立了一个实验室，该实验室发现了很多关于红杉林和红杉生态的宝贵信息。

国家红杉公园的创立是保护红杉联盟的里程碑。为了建立国家红杉公园，保护红杉联盟做了 60 多年的工作。通过这些年的辩论和努力，从民众那里筹集资金，为公园购置土地。在保护红杉联盟成立后的 75 年期间，它捐献了 7500 万美元，在加州红杉公园、国家红杉公园以及其他公园和保护区保护着 1012 平方公里（25 万英亩）的海岸红杉林。

今天，保护红杉联盟还在继续推进它的工作，与加州公园、娱乐部门和国家公园管理机构合作，确保对红杉树和已经获得成功保护的公园进行长期保护。保护红杉联盟的基本目标是以 70 多年专业公园设计者的研究为基础，沿着合理的流域面积边界将所有的红杉公园建成生态单位。

这种将巨大红杉林作为世界意义的风景资源来保护的运动，在保护史上是独一无二的。也许就是



图 2.55 牛顿·比肖伯·德鲁雷（1889 ~ 1978）于 1920 ~ 1940 年和 1960 ~ 1971 年两度担任保护红杉联盟秘书长。



图 2.56 牛顿·奥布里·德鲁雷 (1891~1959) 于 1941~1959 年间担任保护红杉联盟秘书长。

因为红杉这种树木本身的独一无二性。今天耸立在加州所有公园保护下的森林是曾经生长在地球上广大地区的古红杉林的幸存者。这些森林的永久性保护既要依靠公众长盛不衰的兴趣和公园管理机构的力量，也需要政府将它们作为灵感和美感的自然区域加以保护的决心。保护红杉联盟将继续作为大树的卫士起着主要作用。我们将共同承担责任，将这一天赐瑰宝完好无损地代代传承下去。

关于作者



图 2.57 约翰·B. 德威特。

1959 年，约翰·B. 德威特在加州伯克利大学分校获得野生动物保护专业的后，在优胜美地国家公园、仁尼尔国家公园和死亡之谷国家纪念地担任园林管理员。1960~1964 年，他担任土地法检查员、信息官员、土地管理局的土地审批员。1964 年，他成为保护红杉联盟的工作人员，1971 年成为红杉联盟第三任秘书长和联盟主席。

海岸红杉公园

杰地亚·史密斯州立红杉公园，位于加州克雷森特城北部美丽的史密斯河畔，连接美国 199 号公路。好蓝山路是一条风景优美的砾石路，两边排列着高大的红杉树，这也是公园的一个显著特征。在公园多处纪念林中，有一处 20 平方公里（5000 英亩）的国家丛林，以向战时保卫国家而牺牲的人们表示敬意。斯陶特纪念林是为了纪念弗兰克·D. 斯陶特而捐献的，里面生长着公园里最大的海岸红杉树（高 104 米，直径 7 米）。除了红杉林以外，公园里还有太平洋西北部的乔木和灌木，游人沿着公园风景优美的小路，徜徉其中是再美妙不过的了。公园面积将近 38 平方公里（9500 英亩），有 108 处野营活动地。史密斯河可以提供游泳、划船、垂钓和其他娱乐活动。

迪·诺特州立海岸红杉公园，毗邻太平洋，面积 26 平方公里（6400 英亩），位于杰地亚·史密斯公园南部，连接美国 101 号公路。除了大量红杉地区典型的植物和野生动物外，公园也因其可以从多条山路欣赏到美妙的大海观景而闻名。这里有两处最好的观景山路，丹南森溪山路和海岸山路。丹南森溪穿过一片原始红杉林与小岩石沙滩连接，是拾贝壳和观察当地海洋生物的理想之地。春天是杜鹃花的天地，有的杜鹃花可以长到 9 米高，使这片云雾缭绕的加州雨林绚丽多姿。这里还有美丽的米尔溪野营地可供游客使用。

草原溪州立红杉公园，有各种不同的风景以及各种度假活动。公园面积 51 平方公里（12,500 英亩），位于奥瑞克北部，与美国 101 号公路相连。这里有两个野营地，一个在麋鹿草原，另一个在金陡壁沙滩，121 公里（75 英里）长的山路穿过美丽的丛林。公园最具独特魅力的地方是为盲人设置的自

海岸红杉

助导向的山路，可触摸的提示写在指示牌上和布莱叶盲文手册上（在公园总部可以索取）。在公园临海方向高耸的绝壁下面有一个 10 公里长的黄金绝壁沙滩，极为壮观。蕨类峡谷，是悬崖峭壁中的幽深峡谷，生长着茂盛的五指蕨。驱车沿着加州巴瑞路（没有铺路）陡峭的山坡上耸立着高大的红杉，给游客留下深刻印象。这里茂密的森林大都是原始红杉林，很多树的高度超过 90 米，还有壮观的北美花旗松原始林。这个公园也是两群吃牧草和沙滩杂草的罗斯福麋鹿的家园。

国家红杉公园，保护着经测定世界上最高的海岸红杉。大树耸立云天，高 112.1 米，分布在红杉湾两边，从巴德山驶入美国 101 号公路，有一条美丽的环形山路穿过雌鸟约翰逊谷地。国家红杉公园面积 316 平方公里（7.8 万英亩），包括红杉林地、悬崖和沙滩，杰地亚·史密斯红杉公园、迪·诺特州立海岸红杉公园和草原溪红杉公园与之毗邻。植树造林工程使公园里被砍伐一空的土地重新披上绿装，恢复了异常迷人的原始之美。海岸山路穿过国家红杉公园和加州红杉公园，沿太平洋连绵 80 公里。国家红杉园游客服务中心位于奥瑞克城附近的红杉湾口，美国 101 号公路边。

洪堡环礁湖国家公园，位于加州尤里卡北部美国 101 号公路沿线，在国家红杉公园信息中心与 Patrick's Point 国家公园之间。环礁湖地区巨大的魅力在于它的多样性，游客可以在沙滩、山岬、绵延起伏的农田、红杉林以及三个海岸环礁湖之间徜徉。公园 24 公里长的海岸线包括淡水环礁湖的沙滩、石头环礁湖、干环礁湖以及大环礁湖。洪堡环礁湖仅限白天游玩，可以划船、垂钓、游泳、野餐和观察野生动物。环境野营活动可以在石头环礁湖进行，也可以在环礁湖南端的 Patrick's Point 国家公园进行。Patrick's Point 国家公园还有印第安文化遗址，可以追寻洪堡县北部美国土著人的历史。

灰熊河红杉州立公园和欧文·契特汉姆纪念谷地，在佛图纳东南的美国

101 号公路东 40 公里处，美丽的万杜真河的 36 号公路沿线。历史陈列使人们联想到公园过去曾作为四轮马车和牛车的休息站，以及威尤特印第安人的故乡。游客可以欣赏到原始红杉风光和很多纪念林，还可以进行徒步旅行、野餐、跋涉和垂钓活动。公园还有一个小的野营基地。契特汉姆丛林只能在白天从 36 号公路到达。

洪堡州立红杉公园是加州最大的红杉州立公园，包括一块最为广阔的原始红杉林。游客可以看到壮观的古红杉树，很多都有 90 多米高。向东行使在 45 公里长的巨人公园路大道上，壮观的景象交错出现。公园游客服务中心免费提供巨人路的观光游览车。很多纪念林都有方便行走的小路，其中包括伊尔河的创始者丛林，它以保护红杉联盟创始者的名字命名。在创始者公园，设置有指示牌，介绍红杉地区典型的植物。**Pepperwood** 的牛顿·比肖伯·德鲁雷纪念林覆盖着茂盛的绿色酢浆草和蕨类。在洛克菲勒古红杉林中，可以步行到达布尔溪公园北部，或者沿 **Canoe** 溪从美国丛林园林俱乐部步行到公园南端。洪堡红杉公园有三个设备完善的野营基地，分别是隐泉、奥比溪和公园总部。公园里有很多妙趣横生的山路，还有一些乡间风光的环境野营地。虽然一些游客只满足于观赏公路两旁的大树和伊尔河岔南端毗邻的丛林，洪堡红杉公园值得深入参观。

宾波湖州立休闲区是嘎比威利北部沿伊尔河岔南端的宾波大坝上的一个小湖泊，连接 101 号公路。宾波湖有一个野营活动基地，是夏天游泳野餐的理想去处。

理查森谷地州立公园，在美国 101 号公路嘎比威利南 14.5 公里处，是理想的野营和游泳去处。常年吸引着众多游客。**Lookout** 和 **Toumey** 山路穿过伊尔河对岸的公园，沿途是美丽的景观。橡树坪野营地颇受游人欢迎。

森尤荒野公园，沿着门德西诺县的遗忘海岸（因僻远无人涉足故名）可

体验到独特的荒野情趣。这个 28.3 平方公里（7000 英亩）的公园因原来聚居该地区的土著美洲人而得名。背包旅行者喜欢穿行于冰冷海滩和陡峭的海岸山顶间的之字形山路。公园管理处位于内地，在马托尔河的两岸，生长着极佳的红杉原始林，是本世纪初门德西诺县大部分地区红杉原始林被砍伐时遗留下来的。穿过遗忘海岸山路，景色壮观，对季节性的徒步旅行者很有挑战性。

史密斯红杉自然保护区，位于 101 号公路，莱格特北部 6.5 公里处。这个壮观的原始红杉林是沿红杉公路往北穿过门德西诺县的游客遇到的第一个主要红杉丛林。在伊尔河垂钓和游泳是非常受欢迎的活动，但仅限白天开放。**Standish-Hickey 度假地**，沿州立 101 红杉公路，位于红杉公园最南端。沿伊尔河南端，地处美国 101 号公路莱格特以北 1.6 公里处。69 米高的迈尔斯·斯坦迪什船长树是公园里最大的红杉树，耸立在通向 11 米高的瀑布的山路两旁。米尔溪之形山路非常崎岖，通向壮观的乡村风景地。**Standish Hickey SRA** 有野营基地，在夏季的晚上可以举行篝火晚会。**威廉将军度假地**，是一个小巧迷人的红杉林，其间小溪蜿蜒，不失为野餐的理想去处。它位于 **Branscomb 路**，**Laytonville** 以西 23 公里处。

加各汗斗州立自然保护区，位于 1 号公路沿线，布莱格和门德西诺县之间。3.6 平方公里（900 英亩）的自然保护区保护着独特的生物和地理资源。五层波蚀台地展示着最完整的加州海岸地理演变，记录着一百多万年间海平面的变化情况。在台地顶部像水泥般结实的砂砾层上覆盖着一层纯沙，支撑着一片微型森林，这里完全成熟的树也只有几英尺高。游客可以根据指示牌的说明从太平洋进入微型森林的中心。加各汗斗溪海滩也有停车场。

俄罗斯峡谷公园，位于门德西诺县北部太平洋沿线，连接州 1 号公路。从高高的悬崖上可观赏锯齿形的小湾和海洋切割出来的半月形海岸，其间的

山岬和沙滩是野餐的理想去处。俄罗斯峡谷生长着茂密的红杉次生林及典型的红杉区林下层植物。景色优美的自行车道穿行于峡谷下游，有很多徒步行走的山路，其中一条通向美丽的瀑布（当春天流量丰沛时最为壮观），瀑布沿着峡谷壁和周围的山基流下。峡谷里有一个设施完备的小型野营地。

婉丹州立公园，位于小河镇北部，州 1 号公路。小河穿过蕨类峡谷，红杉次生林生长茂盛。之字形山路从蕨类峡谷延伸到山基上的一片小森林，此处因土壤贫瘠，所以树木矮小。宽阔的沙滩边上有一些潮塘，保护那里的海域不受海岬太平洋涨潮和生长迅速的海藻的影响，是理想的潜游场所。婉丹州立公园在蕨类峡谷低纬度区有一个完善的小型野营地。

蒙特利森林保护区，位于尤克雅以西 18 公里的大河入口处，接 Orr spring 路。4.6 平方公里（1142 英亩）保护区内生长着一大片红杉原始林，其中一棵经测量高达 110 米。蒙特利丛林由于有林下植物大狗脊蕨（*Woodwardia fimbriatus*）而闻名。两英里长的环形山路沿蒙特利河蜿蜒，穿过保护区内的纪念林。这里是理想的野餐去处，仅限白天开放。

纳瓦拉河州立红杉公园，内有 18 公里长的美丽的红杉林，位于纳瓦拉河畔与州 128 号公路连接。保罗·蒂米克野营地的设施完备。纳瓦拉河是春天漂独木舟，夏天游泳，冬天垂钓的理想去处。夏天，这里没有像沿门德西诺县海岸浓雾笼罩的现象。

翰蒂州立森林公园，位于伯恩威尔和费罗之间的纳瓦拉河畔，与 128 号州际公路相连。公园入口处在 128 号州际公路西端与 Greenwood Ridge 路相连。沿着美丽的纪念林可以看到很多高达 90 米、直径 5 米的大树。山路有布莱叶盲文说明，盲人坐轮椅也可以来参观。翰蒂州立森林公园设施完备，已经发展成适宜旅游的野营地。纳瓦拉河两岸也是夏季理想的野餐去处。

马里亚德州立红杉保护区，在克拉弗代尔以西 12.5 公里处与 128 州道及

石路相连。保护区以著名的保护主义者约翰·沃德·马利亚德的名字命名。近 1 平方公里（240 英亩）的红杉林环绕着宁静的溪谷。这是格西亚河的发源地。

阿姆斯特朗红杉保护区，位于古那威尔镇附近的俄罗斯河沿岸，是游人密集的红杉公园。沿着设有自助游说明的山路穿过保护区内的一些参天大树，抵达帕森琼斯树，该树高 95 米，估计有 1200 ~ 1500 年树龄。红杉林剧院是一个天然圆形剧场，非常著名。保护区仅限白天开放。

奥斯汀河度假地，与阿姆斯特朗红杉保护区的北边相连。野餐和野营设施齐全，是徒步旅行、骑马、背包旅行者的天堂。公园面积 20 平方公里（5000 英亩），生长着各种野花，春天鲜花盛开，绚丽多姿。公园内有 32 公里长的徒步旅行山路，野营地设施完备，还有原始的乡村风光野营地。

罗斯城堡历史公园，在杰纳尔镇以北 18 公里处，连接 1 号州道。1812 年，该公园由俄罗斯人和阿拉斯加的土著为在阿拉斯加生活的俄罗斯人种植粮食、捕获海獭而建。公园游客服务中心设有展览并讲解堡垒周围美洲土著、俄罗斯人、阿拉斯加人、西班牙人和墨西哥居民的历史，以及该地后来的历史。堡垒本身已大范围修复，还将陆续重建一些旧有的建筑物。除了 Fort Ross、旅客中心以及许多讲解活动，公园还有美丽的红杉林、陡峭的海岸山坡。礁脉野营地在堡垒南 8 公里，包括供应饮水的 25 个原始野营地。此野营地不准带狗。

塞缪尔·泰勒州立公园，位于马林县中部，从旧金山北部出发一个小时的车程。在美丽的森林峡谷谷底，生长着美丽的红杉丛林，春夏之交各种野花争相开放。每年 1 月份在河里能看见铁头鲑鱼游动。公园面积 11 平方公里（2700 英亩），提供完善的野营地和野餐地。鬼悬崖营地设施完备，有蓄栏、拴马架和喂水槽，可供 105 人骑马。野餐地可容纳 100 多人。

塔马帕斯峰州立公园，其中心地区在马林县的塔马帕斯山（770 米），旧金山以北 24 公里，在海湾地区非常有名，其中 18 个可以步行去的野营地必须预约。公园面积 25 平方公里（6200 英亩），有 322 公里（200 英里）维护得很好的徒步旅行山路，其中很多与米瑞国家森林纪念地的山路（它们在州公园的环绕中）和金门国家度假地相连。从这些山路上可以欣赏到旧金山湾太平洋的迷人景色。

米瑞国家森林纪念地，位于旧金山以北 27 公里处，与 1 号州道连通，通过美国 101 号公路可以便捷抵达，也是游人最多的红杉公园之一。虽然在纪念地入口处的游客服务中心周围可能会比较拥挤，但与它只有几步之遥的原始红杉林还是非常宁静和宽敞的。米瑞森林是 1907 年由国会议员威廉·肯特为纪念约翰·米瑞向国家捐献的。从那时起，世界各地的游客纷纷前来欣赏其自然之美。

阿拉米达县红杉公园群，位于奥克兰和伯克利的山脉上，包括红杉地区公园、琼昆·米尔公园、利昂娜高地公园、罗伯特度假地，保护着大片的红杉次生林。这些树是 1850 年砍伐以后重新生长出来的。森林再植活动在这些公园还在进行，以便使将来的游客能够看到如第一批欧洲探险者所看到过的红杉林。

加州大学伯克利植物园，又称史蒂芬·马德丛林，位于草莓谷加州大学伯克利植物园，面积虽然不大，但红杉丛林的景致非常迷人。20 世纪 30 年代初期栽植，供植物专业的学生使用，白天开放。

伯特拉州立红杉公园，面积 10 平方公里（2500 英亩），位于圣马特奥县 Skyline 与 Putano 山间的盆地，旧金山南面。从 Alpine 路可以和 35 号州道相连。公园内可以野营、野餐、徒步旅行。沿着 32 公里的山路有一片美丽的红杉原始林。沿着皮特斯河道和帕萨迪罗河的 Iverson 山路，可到达公园里最好

的纪念林。

布它诺州立公园，位于旧金山和圣塔克鲁兹之间，与圣马特奥县的 1 号州道相通，红杉林长势茂密。**Butano** 是野营、徒步旅行和自然研究的好去处，特别是在鲜花盛开的夏季。公园有野营地和 56 公里长的山路。

圣马特奥县红杉公园群，包括帕萨迪罗县公园、Huddart 公园、纪念公园、萨姆·麦当劳公园和遗产丛林，保护着一片片美丽的原始红杉林，以及崎岖的海岸山基 - 峡谷地貌，并提供野营、野餐、游泳、徒步旅行的设施。

普瑞斯玛红杉保护区，位于圣马特奥县半月湾东边 Skyline 山的西坡，面积 10 平方公里（2520 英亩）。自然保护区内幽深的峡谷生长着次生红杉林和北美花旗松林。峡谷内蜿蜒着一条 24 公里的山路。

大盆地州立红杉公园，建于 1902 年，是加州公园系统最老的一座公园，占地 73 平方公里（18130 英亩），生长着旧金山南部一些最大的红杉林。它是典型的原始森林，这样的森林曾经茂盛生长在圣塔克鲁兹地区。在公园中心地的 Nature Lodge 小博物馆展览着大盆地的历史和自然特点。公园居住着大量的野生动物，如鹿、浣熊、松鼠和各种鸟类。35 公里的小路森林茂密，峰峦开阔，有瀑布，还可看到圣塔克鲁兹山的全景。在晴日从霍华德·金山路可欣赏整个 Waddell 河流域，以及太平洋的壮丽景色。该山路是由著名的红杉摄影家霍华德·金设计和建筑的，他自愿为大盆地红杉公园无偿工作数月之久。从古堡岩石公园的 Skyline Ridge 到大盆地 Waddell 河口，有一条 60 公里长的山路。大盆地红杉公园有 190 个野营点和若干个集体野营地，从 9 号和 236 号州道可抵达公园。

亨利·克威尔州立红杉公园，位于圣塔克鲁兹以北的圣·洛伦佐河畔，与州际 9 号公路相连，面积 17 平方公里（4100 英亩）。24 公里的山路使观光

者有机会欣赏大面积的原始红杉林。Cathedral 红杉树的景观独特，从现已消失的树的根冠萌芽长出一圈成熟红杉树。游客服务中心陈列着很多有趣的历史资料。

尼森斯·玛克斯森林，位于 Aptos 镇以北陡峭的海岸山地，面积 40 平方公里（1 万英亩），与 Sequel 公路相连，是一个宁静的次生红杉林公园。19 世纪后期，这里遭到严重的砍伐。此后，红杉林得到保护。在这风景宜人的红杉林，蜿蜒着 48 公里的山路，还有很多野餐地，白天开放。

圣塔克鲁兹县红杉公园，包括迪·拉维加公园和西哈维公园。

安德鲁·莫丽拉州立公园，位于卡梅尔以南 34 公里处的大苏尔河河口，与州 1 号公路相连，面积 19 平方公里（4800 英亩）。红杉生长在小苏尔河的河岔南端。宽阔的草地是野餐绝妙之处，沙滩和峭壁构成这里独特的景观主体。安德鲁公园为徒步旅行的游人提供野营地过夜。

法伊弗·大苏尔公园，位于卡梅尔以南 42 公里处，与州立 1 号公路相连，面积 3 平方公里（800 英亩），是野营、野餐、跋涉、垂钓的好去处。徒步旅行的山路穿过很多红杉林地，包括一条沿大苏尔河有指示牌的山路，以及一条法伊弗瀑布山路通向美丽的法伊弗瀑布。公园有 200 个设施完备的野营地，3 个团体野营地，1 个团体野餐地，可容纳 200 多人。

朱莉娅·法伊弗·本恩公园，位于卡梅尔以南 60 公里处，与州立 1 号公路相连，面积 8 平方公里（2040 英亩），有很多种优良的红杉林。在公园的最南端，浓荫蔽天的峻峭峡谷内，清冷溪流边生长着茂密的红杉林。野餐和徒步跋涉是公园内两项最受欢迎的活动。Mc Way 河延伸到大海，景观壮丽。Partington 谷山路穿过很多壮观红杉纪念林。1970 年，6.8 平方公里（1680 英亩）的水下海滩划归公园。如今，几个沿太平洋海岸的加州公园包括有水下自然保护地。

海岸红杉

加州大学大溪保护区，位于大苏尔海岸州立 1 号公路旁，卡梅尔以南 80 公里的大溪桥处。保护区包括 6 公里近海区，保护着很多种植物和海洋生物。该大学将它们作为自然遗产管理，用于教育和科研工作，特别是用于火生态和群落演替的教学。1985 年，保护区被大火烧毁 243 平方公里（6 万英亩）。进入保护区要经过许可。

第三章 巨 杉
(*Sequoiadendron giganteum*)

第一节 希拉 - 内华达山及巨杉

堪谟美

希拉 - 内华达山位于加利福尼亚东侧，长 640 公里，宽约 60 ~ 130 公里，是美国境内（不含阿拉斯加）最高的山峰。白头山脉高 4418 米，山沿西北走向，坐落于加利福尼亚州的贝克费尔德市附近的 Tehachapi 关口，始于火山的 cascades 山脉，一直向西北延伸到 Lassen 峰，是美国最大的一个地震带。希拉 - 内华达山东坡是由大盆地削起，西坡逐渐下降到加州中央谷地附近的丘陵，丰富的降雨对周围经济乃至水利发电十分重要。高山、深岩、冬天积雪使得跨山旅行十分艰难。顶峰 Donner Pass 山口海拔 2161 米，是穿越山脉最主要的通道，在 19 世纪中下叶被成千上万的淘金者和偷渡者使用。世人多知希拉 - 内华达山风景如画，特别是南部的太浩湖、优胜美地公园、巨杉及王谷国家公园，都是常年游人如织的旅游胜地。

明显的地质差别和巨大的海拔高度，从海拔 300 米的山脚到海拔 4418 米的内华达山脉顶端，形成了这一带丰富多样的环境：从干热的西边界的盆地，到冰雪覆盖的荒凉的高山高地。地质上的多样性也为 1200 多种维管束植物物种提供了生存条件，这些物种也组成了很多独特的植物群落。这个地区不仅包括了大量著名的巨杉树林，还有辽阔的山区森林，惊人的高山生活环境，橡树林地和茂密的灌木丛。森林带谱根据海拔分布生态系可分为如下：

山脚林地低山森林带

优胜美地的最低海拔在公园最西面的 El Portal，大约海拔 550 米。这里夏季干热，冬季极少有降雪甚至无雪，植物有绿叶浆果鹃（图 3.9）、蓝橡、灰松林，以及内陆常绿橡林。

满是茂密的硬叶草灌木的灌木丛群落是地中海低地气候独有的特征——那里冬季多雨，降雨量占到年降雨量的绝大多数；而且一年中，除了干热的

夏季外，温度都比较温和。很多密灌丛群落中的物种表现出对火和干旱的独特适应能力，而火和干旱对在山脚环境下生长的生命都有极大的影响。

作为一位科学家，作者把亲自研究和比较北美与东亚的区系当作一种精神上的享受，特别是用到了有关希拉 - 内华达和中国喜马拉雅生态系的经验。她与森林病理学家科布教授合作研究糖松疱锈病，并在加大布拉杰特森林研究站工作了 20 年。

这是一个非常好的森林生态设施研究站，位于加州希拉 - 内华达山西坡（北纬 38°52'；西经 120°40'），海拔 1330 米处于森林研究站研究范围为干燥暖型的地中海型气候（14 ~ 17℃），冬季温暖（2 ~ 9℃），年降雨量 166 厘米，多数降雨在秋季到次年春季这几个月，降雪在 12 月到次年 3 月间。

加大布拉杰特森林研究站以针叶混交林植被为主，由五种针叶树种和一种阔叶树按不同比例组成。这里有六种本地的乔木：白冷杉（图 3.5，见彩图），北美翠柏（图 3.4），花旗松，糖松（图 3.3），西黄松（图 3.2），加州黑橡树（图 3.7），巨杉也在北部的希拉 - 内华达林区零星分布。

巨杉森林

中部和南部的希拉 - 内华达巨杉谷地呈现一个针叶混交林，由白冷杉和高海拔的红冷杉，还有糖松组成了巨杉谷地，巨杉作为第三个种混交在这类森林中，虽然它们的领地常常多于其他物种。在低山或干旱地区的巨杉群中还混交有西黄松（*Pinus ponderosa*），北美翠柏（*Calocedrus decurrens*），加州黑橡树（*Quercus kelloggii*），花旗松（*Pseudotsuga menziesii*），加州短叶红豆杉（*Taxus brevifolia*）。

整个希拉 - 内华达山脉的西坡有 67 ~ 75 处巨杉谷地，从 Placer County 谷

地到帝王河（约 90 公里）有 8 个独立的巨杉谷地。而帝王河以南开始有一连串巨杉谷地，直至 Tulare County。这些巨杉谷地森林的大小不等，从 Placer County 的 6 株巨杉组成的小树林到很大的巨杉山脉，面积达到 1000 公顷，每块谷地拥有 2 万株巨杉。

希拉 - 内华达山脉的北部，海拔约 1400 ~ 2000 米的地方常有巨杉谷地森林大片出现，南坡尤多。而帝王河以南的主要巨杉谷地常出现在海拔高于 2450 米的地方，个别达到 2700 米。这种情况常在北坡出现。总的来说，巨杉谷地森林约 14,600 公顷，其中 90% 为公有 (Stephenson, 1996)。巨杉因具有罕见的体积及超长的树龄而闻名，它是世界上现存最大的生物体，树体积 1500 立方米，高 93.6 米 (307 英尺) (Van Pelt, 2001)。巨杉年龄精确测量为 3266 年，记载于第三版《加利福尼亚州陆地植被》中 (Fites-Kaufman et al. 2007)。

高山森林地带

红冷杉林生长于巨杉和王谷国家公园森林带中上层（海拔 2133.6 ~ 2743.2 米，即 7000 ~ 9000 英尺）的纯林。这些雄伟的巨树组成了地盖贫瘠的黑森林。从将军高速公路远眺雄伟的巨杉森林（图 3.1）。

在山区上部，混针叶林被红冷杉纯林和黑松纯林取代。冬季积累的厚雪和限制阳光到达地面的茂密树冠都使得红色冷杉林缺乏多样的草本植物组成。只有最耐阴的草本植物能够在这些高大的树木下努力生存。黑松分布十分不寻常，它们既适应湿润的低地，也可以适应梯地和山脊的干燥环境。在较为潮湿的地方，这些树林可以为生长在地表上的茂盛的草本和野花提供营养。

在山区森林上部以上，亚高山带森林圈定了内华达树木生命的极限。在加州红杉国家公园，这些亚高山带森林包括最南部的狐尾松林，它们是生长

巨 杉

在“白色山脉”东部另一种长生的狐尾松的近亲。内华达狐尾松的倒木甚至
可以保持完整长达数千年之久，这得益于高海拔地区极低的温度和干燥的环
境。“白色山脉”的北部，零星的美国白皮松松林为数众多的克拉克星鸟们
提供了至关重要的食物来源。

在高海拔地区光秃秃的布满岩石和沙质的山坡上，狐尾松分散生长。暴
露在极端的温度、充足的光照、狂风暴雨和夏天长时间的干旱之下，这些树
的外型已经适应了这里极端的环境。

在山区、亚高山带、高山带，因土壤湿度过高或土层过浅而不适合树木
生长的地区，有众多草场。湿地草场中有种类繁多的草、蒲和野花，为许多
小型哺乳动物、鸟类和昆虫提供了栖息地；而旱地草场也是生存在高海拔地
区动物的食物和居所的重要来源。

多石高山带

在多岩石的高山地带，除了最顽强的植物以外，短暂的生长季节和严冬
使其他植物都无法在这里生长，低矮的树木让位给多年矮生草本植物。这里
的植物往往紧贴地面，以获取地表的温度。到了冬季，积雪隔绝了严寒和干
燥的焚风。在短暂的夏季，在即将面临寒冷和暴风雪威胁的情况下，各种美
丽的鲜花依然竞相争艳，抢在冬季到来之前播下自己的种子。

三个巨杉国家公园

作者：约翰·B. 德威特

卡拉威尔斯州立巨杉公园位于希拉 - 内华达山脉西坡大约 1524 米（5000
英尺）高处，与州 4 号公路相连，保护着两片壮观的巨杉林。北部丛林任何

季节都适宜参观，自从 1850 年以来，就成为游客参观的首选地。从比弗河野餐地到南部丛林有 3.2 公里的山路。南部树林完全保持原始状态。两片树林都有壮观的原始巨杉，周围的森林包括原始兰伯氏松、西黄松和西部山茱萸。卡拉威尔斯州立巨杉公园全年开放，四季景色宜人。夏季可开展野营、跋涉、游泳垂钓活动，冬天可以跋涉、越野滑雪（根据下雪量）。

优胜美地国家公园除了优胜美地河谷和其他一些自然景观，公园还保护着三处巨杉林。Tuolumne 和 Merced 树林位于公园西边与大栎树地路相连（从州 120 号公路上栎树地路入口处可达）。托罗尼树林在大栎树地路的单行段上，大约有 20 棵成年巨杉，其中一棵有 91 米高，接近这种树的最高记录。从大栎树地路步行 3.2 公里可达 Merced 树林。这里也有将近 20 棵成年巨杉，不同季节还有很多五彩缤纷的野花。Mariposa 树林在公园的南端，在南入口处附近（从州 41 号公路可达）。这是一片很大的树林，包括数百棵成年巨杉，形成一个自然历史博物馆，林中还有两条设有指示标志的山路。在夏季的几个月里，有轨电车可以将游客载到树林。查询更多信息，请联系优胜美地国家公园，网址：www.nps.gov/yose。

巨杉帝王谷国家公园位于希拉 - 内华达山脉西侧，优胜美地国家公园南端。公园里保护着两处最大的巨杉树林：面积有 13 平方公里（3100 英亩）的帝王谷山地红杉林，还有面积 7 平方公里（1800 英亩）的巨杉森林。起初在这里建立公园是为了保护格兰特将军国家公园、巨杉国家公园和其他许多巨杉林地。世界上 5 棵最大的巨杉中有 4 棵生长在“巨杉森林”，包括世界上最大的谢尔曼将军。“格兰特巨杉林”中的“格兰特将军”树，是世界第二大。从 Fresno 经过州 180 号公路很容易到达帝王谷国家公园。从 Visalia 经过州 198 号公路可以到达巨杉国家公园南面。将军高速路穿过“格兰特巨杉林”和“巨杉森林”，把两个公园连起来。从希拉山的东边则无法到达这两个公

巨 杉

园。巨杉帝王谷公园全年提供服务，园内有野营基地、游客服务中心、由公园向导组织的活动，并可在园内住宿和用餐。查询更多信息，请联系巨杉和王峡谷国家公园，网址：www.nps.gov/seki。

优胜美地巨杉和王峡谷国家公园的植物管理项目主要包括：了解公园的植被，保护稀有物种，恢复森林的自然防火系统和丛林生态系统，监控外来植物入侵，恢复受到干扰的栖息地和自然地貌，并且监控管理由休闲娱乐和行政性用途造成的影响。

第二节 优胜美地国家公园里的巨杉

托马斯·哈维



图 3.19 优胜美地国家公园里的巨杉可能是最先被早期探险者所发现的巨杉。1833 年由约瑟夫·沃克带领的马队。

发 现

优胜美地国家公园里的巨杉可能是最先被早期探险者所发现的巨杉。1833年，由约瑟夫·沃克带领的考察队有可能已经穿过了托伦小树林或莫斯特小树林，因为他们记载了一个在内华达山区的旅途中经过的深谷，与优胜美地山谷十分相像。一位叫泽那斯·里奥那德的记录员在旅行日志中写道：“在过去两天的旅行中，我们发现了一些大得难以置信的红杉树，这些树的树干从地面算起有26~33米高。”里奥那德的旅行日志发表于1839年，但是印刷店被大火烧毁了，只有两个复印件被保存了下来。在1904年更多的发现被报道之前，这两个复印件都没有得到足够的重视。奇怪的是，沃克的考察队中竟然没有人能让别人留意这个独一无二的发现。

这让A. T. 唐得以在历史上留名。他于1852年来到位于母脉村的名叫“北克莱沃斯”的巨杉林。据说他没法让那些在孟菲斯联邦水利公司的同事相信他的巨大发现。于是唐编造了一个故事，说他射杀了一只巨大的灰熊，并等着他们帮忙把灰熊从树林里抬出来。这个谎言把那些深信不疑的人引诱到有巨杉的地方。1852年6月发表在《索诺拉·赫雷德》上的文章向整个加州宣布了这个发现，并把它作为有效的发现日期，因为里奥那德那份更早的记载很少有人读过，也没有引起很多人的注意。很快，唐的发现传遍了全世界。

随后，奇怪的事情发生了。许多早期的探险家站出来宣称他们于更早的时候已经发现了那些树。这些故事都有一个共同点：他们写于或者讲述于1852年以后。所以，沃克考察队的成员似乎更有理由宣称：他们是第一批看到这些树的欧洲人。但是，他们没有证据。

巨 杉

当然，当地的印第安人已经和这些巨杉一起生活了数个世纪。他们曾用“哇乌那”（Wawona）来命名这些树。这个名字是模仿一种猫头鹰的叫声，这种鸟被认为是巨杉的守护神。“哇乌那”最著名的用法是命名玛里波萨小树林中倒下的隧道树。

玛里波萨小树林大约在 1850 年就已经被欧洲人发现了。梅杰·伯尼曾经被认为是发现者，但随着时间推移，公众的认可又一次转移到了另一个人身上。这一次，盖伦·克拉克很快成为了一位名人。1857 年，他让公众注意到了玛里波萨小树林，并以它所在的县为其命名。所以一般认为，他第一次是从东北方向进入这片小树林，并看到了山脊上的巨杉标本树。这一切使他的名字一直被铭记到了今天。

1857 年，克拉克在“哇乌那”建立了驿站，并担任到玛里波萨小树林和优胜美地山谷的向导。大约在 1861 年，他在树林中建造了一个小旅馆，这个小屋的地点正是今天国家公园纪念馆的所在地。克拉克起先于 1853 年来到加州淘金，后因患病，决定到山区度过他生命中最后的日子。但他又非常幸运地康复了。他一直担任玛里波萨小树林和优胜美地山谷的守护人，直到 96 岁，死后被埋在优胜美地山谷中他亲自种植的四棵巨杉树下。



图 3.20 由 120 号及 41 号高速公路进入优胜美地国家公园。

优胜美地的三个巨杉小树林

优胜美地国家公园里的三个巨杉小树林大小不等。靠近中央西部边界是小一些的莫斯特小树林和托伦小树林，而靠近公园的南部边界是相对大一些的玛里波萨小树林。三个小树林的景观奇异，它们有着自己独一无二的特征，有着独特的样本或者美妙的景观。实际上，任何一棵树都不尽相同，细致观察就能发现一个树节、一个断顶，或者一个非同寻常的树皮图案。

拥有数百棵巨杉的玛里波萨小树林离优胜美地山谷只有 56 公里远。这个小树林有许多令人惊奇的地方，特别是那棵最大的树——“灰色巨人”。“灰色巨人”带着一种神秘感。它那粗壮的、满是树节的树枝向各个方向伸展开来。有一个树枝直径达 1.8 米，比周围其他树的树干还要粗。这棵树已有大约三千年的树龄，可谓老树中的老树。

托伦小树林中的巨杉位于原来大橡树路的单行道部分。在这个小树林里有 20 株直径大于 3 米的大型标本树。以前，在小树林的东边有一棵大树，横跨在隧道树路上，现在大家把它叫做“逝世的巨人”。穿过这个巨大树桩的隧道挖掘于 1878 年。在山下隧道树路的尽头是一个停车场。从那里向东走很短一段路，就可以看到用铁丝保护着的两棵巨杉。再向东走同样的距离，刚过北克兰河，又有一棵惊人的树——几乎所有的树皮和根部的树干都被烧光了，但是它仍然活着，显示了这种树的强大生命力。

沿着北克兰河再走远点，有一棵被雷击过的树。在小树林的最北边有一棵最高的巨杉，大约有 91 米高，很少有巨杉超过这个高度。作为倒下的树的优良标本，“倒下的巨人”沿着 Old Stage Coach 躺在这个小树林的西北边。

莫斯特小树林位于托伦小树林以南大约 6.4 公里的地方，里面有大约 20

巨 杉

一棵巨杉。从大橡树路走一段 3.2 公里长的泥泞小路就能到达那里。这个小树林有着特殊的魅力，因为那里的树都生长在湿度很小的山谷中。色彩缤纷而又非常精致的野花生长在巨杉的根部，成为一道美丽的风景。在这个小树林中，有一棵直径达 2.1 米粗的花旗松。这是意料之外的景象，因为这已经接近于花旗松生长范围的南部边界。

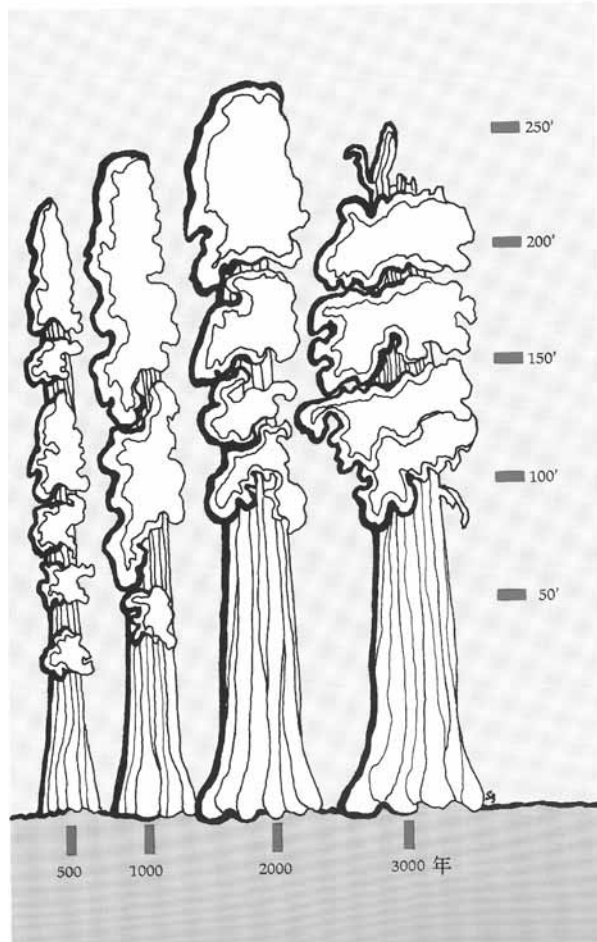


图 3.21 巨杉惊人的高度和年龄。

关于巨杉的描述

巨杉在一粒很小的种子里面以胚芽的形式开始它的生命。胚芽的尺寸如此之小，它与成年巨杉树的大小比例如同成年巨杉树与地球的大小比例。91,000个这样的种子才重 0.45 千克（1 英镑）。巨杉的种子看起来很像一个燕麦片， $\frac{3}{4}$ 的部分是两边的侧翼，黑色的中心部分是胚芽。每一个种子可以发芽生长出一颗仅 2.54 厘米（一英寸高）的小幼苗。

大多数的幼苗有 4 片线形叶，叶片的数量可能会在 3 ~ 6 片之间变化。在几个星期以内，幼苗会长出一些次级的叶片。这些幼嫩的叶片也都是直线形的，而且非常的软。成熟的叶片则有所不同，它们都呈锥状，而且又硬又尖。巨杉早期的生长主要集中在根部而不是嫩芽，因为只有树根抵达土壤深处，有了足够的湿度时，幼苗才有可能在内华达山区干燥的夏秋两季中存活下来。同样重要的是，必须有一个坚固的根部用来供应水分和营养，使得巨杉树在年轻的时候能保持快速生长并在成年后维持生命。

随着时间的流逝，幼小的树苗长成了年轻的大树，它们那漂亮的圆锥形呈现出独特的、丰满的尖顶。这一阶段将持续到树木 100 岁左右，到那时，它们就可以结出用于繁殖的球果。然而，有些树在 10 ~ 15 岁的幼年时期就能繁殖。

几个世纪过去了，这些树长到了它们的最大高度，并且开始形成圆顶状的树冠。这也是巨杉生命中一个与众不同的阶段。在几公里远的地方，你就可以在地平线上认出这些巨杉。虽然这些巨杉再过几百年就到千岁了，它们仍然处在生命中的青春期。

在一片古老树林中，巨杉最终的形态是断顶结构。经历了多次森林大火

的老树们在其顶端有一段或多段已经死亡的树干。大多数断顶是由温度极高的林火引起的，这些大火在树的根部留下火疤，火疤会切断百分之五十的水分供应，造成这些树的顶端死亡并形成断顶。一个新枝可能代替断顶成为生长的主导，但当后续的林火增大树的伤疤，或者出现大面积干旱时，这些新枝同样有可能死亡。经历了这一切的老树虽然有许多死枝，但仍然顽强地活了下来，默默见证着它们所经历的磨难。

林火伤疤多在巨杉的上坡面广泛地生长。这是因为大量的木质部在这个面上进行自然积聚。许多倒下的巨杉或它们折断的枝条从山上滚落下来，堆积在其他巨杉的树干部。森林失火时，由于这些死树或枝条的存在，火的温度就会很高，而且持续的时间很长，以致把树根部的树皮和树下的植被层全部烧毁。后来发生的火灾有可能扩大这些伤疤，甚至形成一些奇形怪状的部分。一些树干的外表面，超过 90% 的面积被大火烧成了黑色，剩下的底部或者活着的树疤和组织维持着上部树枝的生长。球果和木质部会以跟存活部位相当的速度继续生长。

甚至在死亡以后，巨杉仍然为森林留下一道壮丽的景观。巨大的树桩在森林里到处都是。隧道树和“逝世的巨人”就是这种伟岸之状的典范。倒下的大树也能给人留下深刻的印象，因为它们能让人真切地感受到巨杉那几乎令人难以置信的庞大。走在这些倒下的巨大植物旁，那一个个原本用高度和周长这类抽象数字概况的巨大形象，突然间变得真实起来。它们死后的顽强同样给人留下深刻的印象。根据年轮计算，有一棵树被确认为屹立了两千年之久，它死去的树干并没有腐烂，而且仍然坚固。这种生命的持久力驱使约翰·穆厄去搜寻那些现已死亡但曾经存在的小树林。他虽然还没有找到，但搜寻仍然继续着。

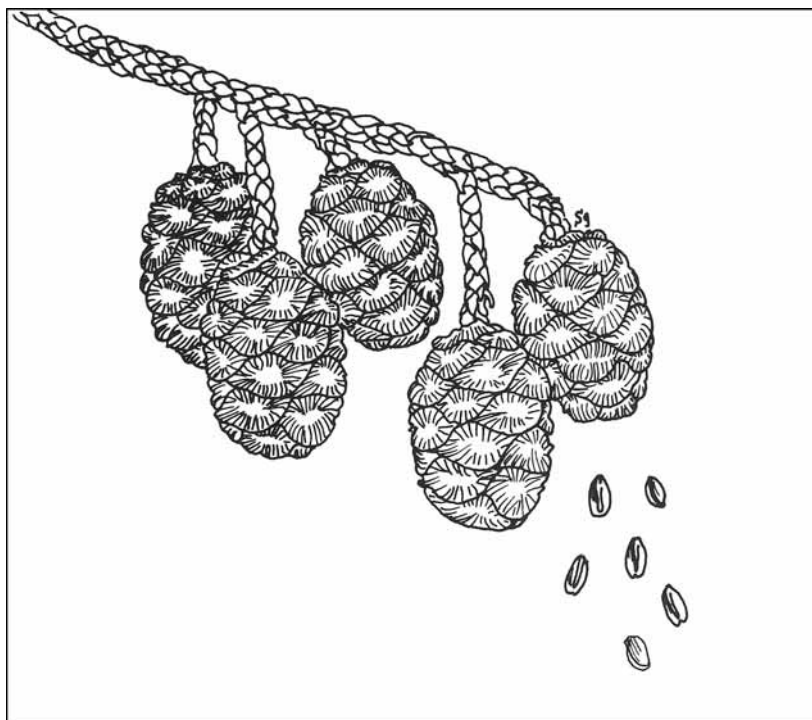


图 3.22 巨杉球果和种子。

巨杉的大小

无论过去还是现在，巨杉都是地球上最大的生物。记录显示，最大的一棵巨杉是美国加州红杉国家公园中的“谢尔曼将军”树。它的树干有 1444 立方米（51,000 立方英尺），如果做成宽和高分别为 0.6 米（2 英尺）和 1.2 米（4 英尺）的木板，它们连起来的长度能够达到 175 英里。

由于具有快速生长和极长寿命的特性，巨杉大概在树龄 800 年的时候达到最大高度。如果继续生长到几千年，那么 800 年之后的生长则成放射状。也就是说树木开始横向发展，而不是纵向发展。例如玛里波萨小树林中的

巨 杉

“灰色巨人”，树干 18 米（60 英尺）以下部分的直径几乎有 4.8 米（16 英尺），从 18 米到 37 米（120 英尺）高的部分直径有 4 米（13 英尺）。“谢尔曼将军” 61 米（200 英尺）以下的部分直径有 3.6 米（12 英尺）。这些巨大的圆柱呈平行结构支撑着上部绿色的树冠。

虽然巨杉的近亲——海岸红杉的高度有时候超过 15 米（50 英尺），但巨杉的高度还是很让人惊讶。迄今为止，人类所知最高的巨杉有 98 米（320 英尺）高，这棵树后来被雷电击断了树冠的一部分，并被由此而产生的大火烧毁了一部分。但现在仍有一部分巨杉的高度达到了 94.5 米（310 英尺），它们是现在记录的保持者。

测量方法的不同使得巨杉的直径变化很大。由于巨杉的根部非常大（根部膨胀），需要对靠近地面部分的直径的测量值进行说明。如果测量地面水平直径，那么斜坡上的树的直径将大于同一棵树处于水平位置时的直径。因此，有时出于比较的目的，会测量垂直于树轴的直径。生长在山坡上的树木，通常测量它在地面 1.37 米（4.5 英尺）以上部分的直径。这个高度只是树木胸高直径的一部分。但对于巨杉而言，这个高度仍然位于树的粗大部分。为了解决这个问题，人们发明了两种方法：一种是选取一个高于根部膨胀部分的高度，例如 3 米（10 英尺）；另一种方法就是在根部膨大部分的上部测量直径，但这有可能处于树干非常高的位置。所有这些方法的关键在于，为了评估测量值，必须同时给出直径和地表以上测量处的高度。

有记载的巨杉地表部分的最大直径是 11 米（35.7 英尺），这棵树是康沃斯盆地中的一棵名叫“布尔”的巨杉。“灰色巨人”的直径也差不多，靠近地面部分有 9 米 30.7 英尺。这两棵树都生长在接近水平的地面上，特别是“灰色巨人”。当在距离树基 6 米（20 英尺）高的地方进行测量时（这样就高于根部膨大部分），最大直径约为 6 米（20 英尺）。当在距离树基 1.3 米

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(4.5 英尺) 的位置测量时, 巨杉的最大直径在 8~9 米 (25~29 英尺) 之间。

甚至一些大的巨杉的树枝也非常大。“灰色巨人”最大树枝的直径有 1.8 米 (6 英尺)。“谢尔曼将军”有一个树枝直径达 2 米 (6.8 英尺), 长达 46 米 (150 英尺)——比密西西比东部最大的树还要大, 但对于巨杉自身而言, 这只是并不显眼的一部分。

这些看似不可思议的尺寸可以说出一大堆, 通过这些数字我们也能对巨杉的大小有一个初步的印象。但是, 要想真正感受这些尺寸的大小却很难。也许, 要明白一棵 91 米 (300 英尺) 高, 基部 9 米 (30 英尺) 粗的树究竟有多大, 最简单的方法就是在脑海中把这棵树从树林里移走, 置于别的情景中。想象你正在看足球比赛, 那么这棵树可以覆盖两端球门线之间的部分, 它的一些树枝可以延伸到看台三分之一处。现在, 让我们再把这棵树移到旧金山, 但是让它保持正常的直立位置。那么, 我们将只能在圣弗朗西斯旅馆 30 层的餐厅里才能看到这棵树的断顶。我们再假设把这棵直立的树移到一个典型的居民区, 也许就在家门前。那么这棵树将完全把道路堵住, 使你看不见隔街邻居的房子。如果把这棵树沿树干对半劈开, 放在房子的边上, 它还是要比两层楼房高出 3 米 (10 英尺)。好了, 在对巨杉的尺寸有了正确认识之后, 我们可以把这棵脑海中的树放回树林中了。

巨杉的年龄

通过数巨杉一圈圈的年轮, 我们可以对树龄进行合理的估计。年轮通常是一年生的, 虽然有时年轮并没有围住整棵树, 所以从一个半径到另一个半径的年轮可能稍有不同。另外, 必须对树木需要多长时间才能长到我们数年轮的这一高度做出一个估计。有了这些变量, 我们就不难理解, 为什么对树

龄进行估计的方法再好，得出的也是一个估计值。

在近期所砍伐的树桩上看到的年轮和用一种叫增量钻孔器的仪器从完整无缺的树干中钻出的木材上看到的年轮是相似的。但在树桩上数出的年轮更为可靠，因为从树桩上我们可以观察到早期树木生长速度的变化。用增量钻孔器（取木钻）取出木材，可以在不砍倒树的前提下，通过一定的转换，得到一个相对可靠的树龄估计值。

这两种方法都有一个共同的前提条件：木本植物必须生长在一个有寒冬的地方。巨杉和其他大多数的树木一样，在它们的树干中有三个不同的组织层，包括外层树皮、树皮下正在生长的分裂形成层和组成成年树大部分的木质部。形成层只有几个细胞那么厚，不足 1 厘米（1/32 英寸），它向外分裂生长出树皮，向内分裂生长出木质部。这个过程与季节变化密切相关。

春天，白天时间延长和气温上升，细胞开始在形成层中分裂。靠近树木中心的木细胞相对较大，并且细胞壁的颜色很淡。正像它们的名字一样，这些早期木材的细胞壁比较薄，只能长成密度最低的木材。随着夏天的来临和降水量的减少，木细胞变小了，它们的细胞壁相对较厚，颜色呈深褐色。当生长季节结束的时候，这种晚期木材的生长也终结了。这两个阶段的细胞形成了一个年轮。一般来说，因为颜色较淡、多孔渗水的早期木材毗邻前一年生的密度较大的深色木材，两道年轮是很容易区分开的。通过测量这两层木材之间的距离，就可以知道树木的年生长量。

树木生长环境极大地影响着这种放射状生长的速度。一棵直径 2 米（6 英尺）的树生长在夏季和秋季水量充足的地方，可能只有几百年的树龄；但是一棵生长在干旱山脊的同样高度的巨杉就有超过 1000 年的树龄。但是，一般来说，从 100 到 800 年树龄的巨杉每过一百年，直径会增大一英尺。也就是说，一棵直径 1.2 米（4 英尺）的巨杉就有 400 年的树龄，一棵直径 2 米（6

英尺) 的巨杉就有 600 年的树龄。

巨杉并不是已知生物中最古老的物种，但它仍然有着极为悠久的历史。迄今为止，生长在西南部干旱山区的狐尾松被认为是最古老的物种。一些狐尾松已经生长了至少 4600 年，有一些可能已经超过了 5000 年。在康沃斯盆地一个被砍过的巨杉树桩代表了最老的巨杉，通过数它的年轮，人们，确认这棵树至少有 3200 年的树龄。约翰·穆厄通过数被火烧过的树节后估计，一些巨杉有可能活到了 4000 岁。

巨杉的命名

巨杉曾经有许多不同的名字，三个最常用的名字是：大树、内华达红杉和巨杉。另外一些不太常用的名字有：*Wellingtonia*、猛犸树和它独特的印第安名字“哇乌那”(Wawona)。后一个名字由于被用来命名玛里波萨小树林中的那棵著名的隧道树而变得众所周知。“哇乌那”树在 1969 年倒下了，但它仍然是一道迷人的风景。有的时候，人们也用一个特殊的老称谓“gigantean”作为巨杉的一般名字。但是，现在巨杉的学名为 *Sequoiadendron giganteum*。

和巨杉的长寿相比，自从巨杉被发现起，人们也一直在争论着要给它起一个合适的科学名称。至少有 13 个科学名已经被用来命名这种巨大的树。从 1853 年的 *Wellingtonia gigantean* 开始，已经有 11 个名字被建议用来命名巨杉。其中，最著名的学名是 *Sequoia gigantea*。它的简洁一直受很多人的青睐，而其他一些名字逐渐地被弃用了。但是，*Sequoiadendron giganteum* 是最被大多数人所接受的名字，它的字面意思为“巨大的美洲杉树”。

很明显，在针叶树的红杉家族中，海岸红杉和巨杉的亲缘关系最近。由于海岸红杉也是一种美洲红杉，*Sequoia sempervirens*，所以巨杉的命名不但契

巨 杉

合了巨杉的科学名，而且点出了它和海岸红杉的亲缘关系。

Sequoia 这个名字于 1847 年首次被奥地利植物学家 S. L. 恩德里彻用于命名海岸红杉。这个名词可能是 Sequoyah 的拉丁文，而 Sequoyah 是一位杰出的切罗基族印第安人的名字，他为族人的语言发明了书写形式。还有的人认为，*Sequoia* 这个词由拉丁文“sequor”而来，这个词在拉丁语中的意思为“部下”，并且可能暗指两种美洲红杉是曾经繁盛一时的许多古老杉树的幸存者。

巨杉和海岸红杉的比较

虽然海岸红杉和巨杉被认为是近亲，但它们还是有很多不同的地方。一般来说，它们有以下相似点：都是常绿针叶树种，结球果，略带红色的纤维状树皮，没有树脂细胞，富含丹宁酸，以及略带红色的心材。下面的表格具体列出了这两种巨型树种的相同点和不同点。

		巨 杉	海岸红杉
特 征	大小	成年树树基部直径为 8~9 米（25~30 英尺）	成年树树基部直径为 4.7~5.5 米（12~18 英尺）
	直径	基部直径最长可达 11 米（35 英尺）	基部直径最长可达 7 米（23 英尺）
	高度	最高 94 米（310 英尺）	最高 113 米（370 英尺）
	树龄	已知最大树龄 3200 年，据称最大树龄可达 4000 年	已知最大树龄 1400 年，据称最大树龄可达 2000 年
	树皮	亮黄褐色，有很深的褶皱，褶起部分最厚 0.75 米（2.5 英尺），但一般在树基部为 0.3~0.6 米（1~2 英尺）厚	暗灰红色，有较浅的褶皱，在树基处褶皱有 0.15~0.3 米（1/2~1 英尺）厚
	树叶	呈小尖锥形，0.25~1.3 厘米（1/10~1/2 英寸）长，覆盖树干的所有部位，常绿，随小枝一起落下	有两种，一种和巨杉的树叶类似，另外一种为扁平针状，呈两排分布，常绿，随小枝一起落下

巨 杉

续表

		巨 杉	海岸红杉
特 征	根	可以伸展到树木周围 46 米（150 英尺）的范围，大多数在近地表几英寸的土壤内	可以伸展到树木周围 15 米（50 英尺）的范围，大多数在近地表几英寸的土壤
	树节	很少，并且从树上砍下后，不会再生长树叶	从树上砍下后，会再生长树叶
繁 殖 和 生 长	球果	5~7.6 厘米（2~3 英寸）长，在第二个季节成熟，可以一直生长超过 20 年，并保持常绿，通常有 34 片呈螺旋状分布的鳞瓣	大约 2.5 厘米（1 英寸）长，在第一个季节未成熟，脱落，有 14~24 片呈螺旋状分布的鳞瓣
	种子	在鳞瓣上呈两排排列，平均每个球果中有 200 粒种子	在鳞瓣上呈一排排列，平均每个球果中有 60 粒种子
	繁殖方式	种子	种子，根芽，或者冠芽
	对阴暗环境的耐受力	幼苗不能在阴暗环境中生长	幼苗可以适当忍耐阴暗环境
	伴生状况	通常混生于其他的针叶树中	通常只生长在海岸红杉林中
	染色体	每个体细胞含 22 对	每个体细胞含 66 对
栽 培 和 经 济 用 途	经济用途	作为观赏类植物，广泛种植于温带地区。老树的木材易碎，小树的木材和海岸红杉相似。倒下的树很少被使用	作为观赏类植物，广泛种植于热带地区。木材以抗腐性著称，常用于建造房屋和其他建筑

巨 杉

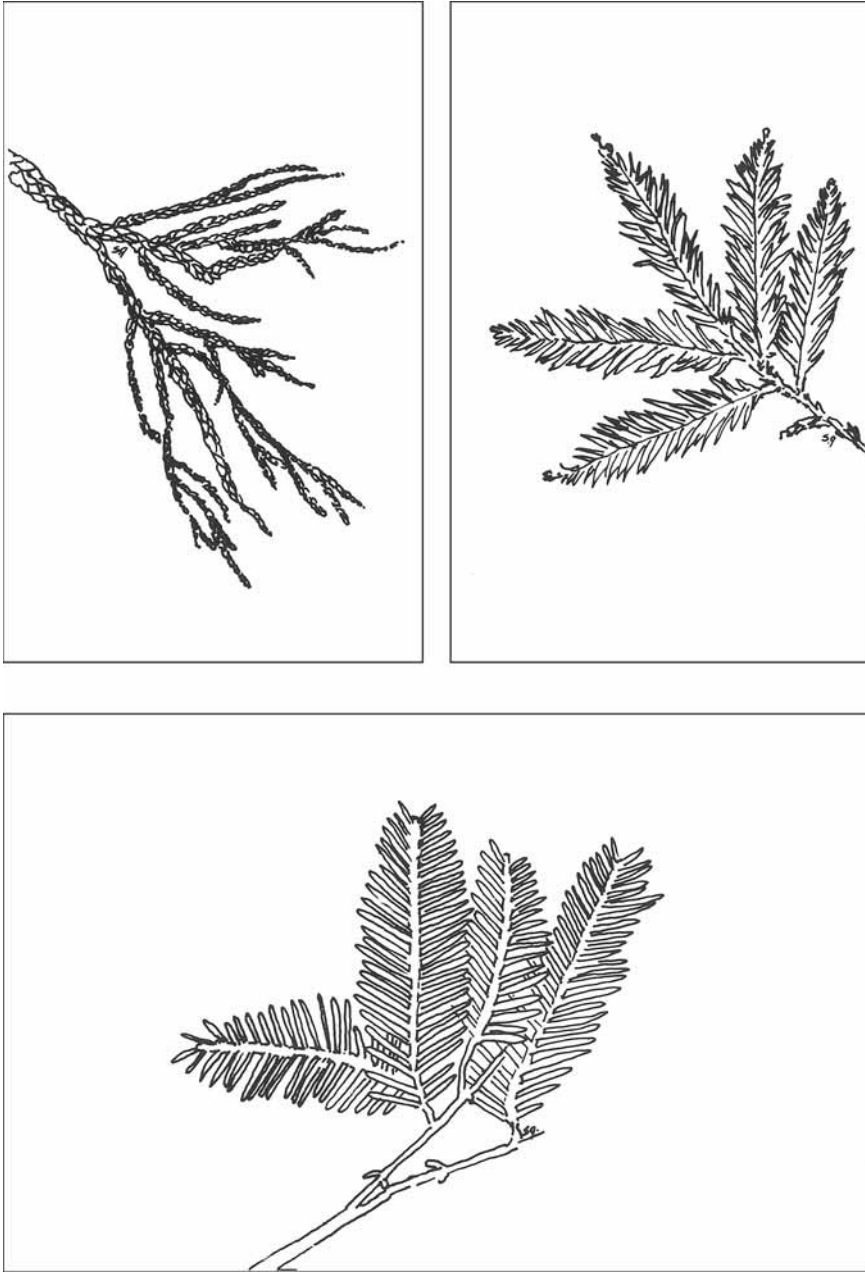


图 3.23 左上：巨杉叶；右上：海岸红杉叶；下图：水杉叶。

化石记载和红杉家族的其他种类

在针叶树中，有一个家族的树被称为红杉 (*Taxodiaceae*)。它们曾经在地球上盛极一时，现在，大多数红杉只生长在东半球和美国一些较偏僻的地方。在已知的 15 种红杉家族成员中，有四种发现于美国，它们是：巨杉，海岸红杉，南方杉和池柏。家族的其他成员大多生长在中国和日本，另外有一种只生长在塔斯马尼亚岛。

与美国的红杉关系最近的中国红杉被称为水杉（黎明红杉）。科学家认为它是海岸红杉最近的亲缘植物。实际上，很多年来，那些研究化石标本的古植物学家都持有这种错误观点。其实，与海岸红杉最亲近的植物应该是巨杉，因此，大多数人认为巨杉、海岸红杉和水杉这三个树种才是广义上所谓的红杉。

人类和水杉之间有着非常奇妙的联系。正如前文所述，1941 年，人们发现了它在岩石中的化石，并认为它已经灭绝了。同年，日本的古植物学家三木茂首先将这种植物命名为“黎明水杉”。但是 1946 年，从中国传来了令人吃惊的消息。一位叫王战的中国林业研究人员报告，这种水杉仍然活着，就在四川省一个偏远的山谷中，谷中的其他树木都被砍光了。蜂拥而至的植物学家们在那里找到了一些生长良好的水杉。1948 年，著名的古植物学家拉尔夫·钱尼从中国带回了水杉的种子。现在，美国的许多地方都因这些远古时代的植物而变得格外美丽。

水杉有一些独特的特征，使它区别于海岸红杉。最显著的特征即它是落叶树木，每年秋天，水杉针状的树叶都会枯黄落下。海岸红杉的种名叫“*sempervirens*”，意思是“常绿的”。每片叶片实际上也只在树上停留 3~4 年，但是整棵树在它的一生中都是绿色的。这两种树都通过掉落小枝的形式来落

巨 杉

叶，而不是掉落单片树叶。

水杉的叶片在枝上呈两列对生。海岸红杉的叶片也呈两列生，但却是交替的。这个区别也存在于球果中：水杉球果的鳞瓣是相对反方向而生；而海岸红杉的球果鳞瓣是呈螺旋状生长的。在水杉的原生群落里，水杉可以长到 43 米（140 英尺）；而海岸红杉是所有树当中长得最高的，它可以长到 113 米（370 英尺）高。



图 3.24 加州巨杉分布图。

优胜美地国家公园里的巨杉

巨杉的分布

整个巨杉的本土分布范围在加州内华达山脉的西坡，一个长 400 公里 (250 英里)，宽 24 公里 (15 英里) 的狭长地带。大多数巨杉分布在海拔 1520 ~ 2130 米 (5000 ~ 7000 英尺) 之间，海拔 853 米 (2800 英尺) 和 2712 米 (8900 英尺) 处也有分布。75 个巨杉小树林分别用不同的名字区分开来。最北边的普雷厄县小树林，共有 6 棵巨杉，位于海拔 1600 米 (5250 英尺) 处。向南 400 公里的一个叫“鹿溪”的小树林里面仍然有一些巨杉，虽然小树林的其他部分已经被砍伐。北面 2/3 的范围里有 8 个相对较小的巨杉林。其余 90% 的树林位于南面 1/3 的范围里，里面通常有上千棵巨杉。最大的巨杉林是国王谷国家公园里的红杉山林。巨杉林的总体覆盖面积超过 142 平方公里 (35,000 英亩)，其中 95% 的土地为公有。

巨杉出现在不同的小树林里，有的分布得很分散，这一现象自从被发现以来，一直吸引着人们的注意力。是什么导致了巨杉的这种散状的分布呢？约翰·穆厄很早就提出，最近的几次冰川运动有可能把曾经连在一起的红杉带分割开来。还有一些人认为，4000 ~ 5000 年前，内华达山脉地区炎热干燥的气候使分布在水分充足地区以外的巨杉都灭绝了。还有一种可能就是巨杉迁移到了内华达山脉的不同地方，产生了内华达山脉西坡的分散的小巨杉林。这三种可能性并不矛盾。所以，最有可能的情况是，这三种可能性或者同时、或者分别、或者部分地起作用。

虽然有些小巨杉林看起来生长得很健康，并且在老树死亡的时候，有足够的小树去替代它们，但许多巨杉林缺少这种替代的小树。导致这一状况的原因当然多种多样，而且非常复杂，但是这些不再繁殖的小巨杉林有一个共

同点就是从未经历过森林火灾。虽然火会烧毁大多数的树，但是巨杉实际上也受益于适当强度和频率的林火。

巨杉的生态学和生命史

生态学是研究生物和生存环境两者之间依赖性的一门学科，使我们得以理解巨杉在自然界中的地位。巨杉战胜了那些足以毁掉其他生命力不够顽强的树种的灾难，存活了下来。这种庞大的树和其他生物一样面临着生命史中至关重要的阶段。从挣扎破土而出的幼苗到成年，巨杉都在对抗着各种逆境。幼苗有可能在伸出地面的时候就因夏日阳光的暴晒而死去；森林昆虫，如骆驼蟋蟀和毛虫可能会吃光树叶，也可能围满并缠死巨杉幼小的树干；高温会灼伤树干以致使根枯死。最具破坏性的因素是干旱，它造成根和树叶枯萎，导致树苗死亡。

那些克服了以上所有困难的树苗将开始它们长达 3000 年的生命旅程。但在树龄达到 400 年之前，其死亡率都很高。困扰树苗的干旱和其他负面因素一直影响着它们，但是邻近树木造成的光照不足开始成为最大的影响。巨杉的成长需要足够的阳光，如果树木生长的地方接受不到全日照的 1/4，小树的生长将很危险。等到树再长大一些就不会受其他树木的影响了。巨杉的树冠会高出森林里的其他树木，只有下部的一些枝叶会脱落，这可以使巨杉抵挡森林火灾。

巨杉会很快地长出非常厚的树皮，把生长组织隔离在树皮下，防止被火灼烧。厚的树皮和没有树枝的下部树干使巨杉能够抵挡普通的森林大火，对非常严重的森林火灾就无能为力了。一棵成年红杉的树皮在树基部通常有 0.3 米（一英尺）厚，个别可以达到 0.45 ~ 0.6 米（1.5 ~ 2 英尺）厚。只有 100 年以上树龄的巨杉，树皮才厚得足以抵挡火灾，这些林火通常可以将邻近的白冷杉毁于一旦。

巨 杉

普通程度的森林大火能帮助巨杉繁殖。火可以把森林地表清理干净，这样巨杉细小的种子可以在对树苗生长最有利的富含矿物质的土壤中生长。虽然种子也能在落下的树枝和地表的树叶上发芽，但树苗经常会死亡，因为有机废物会产生先前提及的许多负面影响。另外，没有被火清理过的土壤中含有会导致疾病的有机物。火产生的高温可以对土壤进行消毒，这就有利于种子幼小的根部组织快速穿过土壤，吸收用以维持生命的水分。

为了使种子打开并脱落，巨杉的球果必须非常干燥。火可以产生上升的干燥热空气，使得巨杉闭合的球果打开。种子就落在被火清理过的地面上。这样一来，在巨杉生命的各个阶段，它不是忍受着火就是得益于火。但是它的繁殖不仅仅依赖于火。

巨杉一年四季都会撒落下种子，这些种子如果落在裸露的土壤里，就可以长出新树。有些巨杉倒下后根被从土壤中拔起，留下的深坑将为树苗提供一个非常合适的生长环境。约翰·穆厄曾经指出，仅仅是倒下的巨杉就足以小树提供足够合适的土壤。但当我们在森林中调查这种小树替代老树的现象时，在老树留下的坑中却只找到很少的小树苗，不足以弥补老树留下的空缺。所以，这种想法虽然很诱人，但还没有被证实。

另一些种子落下并不是借助火的力量，这主要有两种情况。花旗松鼠以松果为食，松树、杉树和巨杉的球果它们都吃。所不同的是它们吃松树和杉树的种子，吃巨杉的球果时却只吃球果的鳞瓣。虽然有一小部分种子被吃掉了，但大多数种子落到了地面上。

另一种情况是由于小甲虫的活动。这种有长角的小甲虫在寻找食物的时候会碰触巨杉的球果。这虽然会破坏一些种子，但是甲虫基本上是从球果中心钻过。这样一来，水分很难输送到球果，它就会干枯。球果一干枯，球果的鳞瓣就会分开，种子就落了下来。一棵成年巨杉每年能结 1500 个球果，而

巨 杉

每个球果里有大概 200 个种子，在花旗松鼠和小甲虫的作用下，会有不计其数的种子落下。

除了甲虫以外，其他许多昆虫也和树相互影响。超过 140 种昆虫的生存直接或间接地依赖于巨杉。它们有可能一生都在半空中巨大的树枝上度过。大多数的昆虫都非常小，并有着和树叶相同的颜色，从而逃脱捕食者的注意。成千上万的绿色小蚜虫靠食用树叶中的汁液生存，蚜虫可能被绿色草蜻蛉的贪婪幼虫吃掉，而后者又可能被强盗蝇吃掉，所有这些又都被蝇虎吃掉，而蝇虎又是鹰的食物。这样，从主要的食物生产者巨杉到食肉动物鹰就连成了一条生物链。

和捕食链一样富有戏剧性的是，巨杉上的食物链也能被叶子的缓慢分解和巨杉产生的木材抵消。每年，树叶和小枝落到地面，被地表层上看不见的细菌和霉菌消耗掉。同时，也会有巨杉倒下，在腐烂分解——这个森林的主要环节中被消耗掉，虽然这个过程可能会持续几个世纪。

幸存者的纪念碑

巨杉是绿色植物中的佼佼者，实际上，它也是所有植物中最高大的。它雄伟地矗立，傲视着其他树木。这是一个奇迹——其他物种早已灭绝，而它却存活了下来。它坚定庄严地屹立在干燥的山坡上和湿润的草场边。它第一个问候早上升起的太阳，最后一个目送日落。虽然有许多外力可能导致它的灭绝，但巨杉仍然顽强地挺立着。它之所以存活了下来是因为它已经适应了逆境，并掌握着对未来的主动权。一棵树在它的一生中撒下数百万颗种子，只是为了有小树能够替代自己。如果条件合适，它还能繁衍出更多的小树。当人们抬头欣赏这些幸存者时，会发现它们生长得很好。

巨 杉

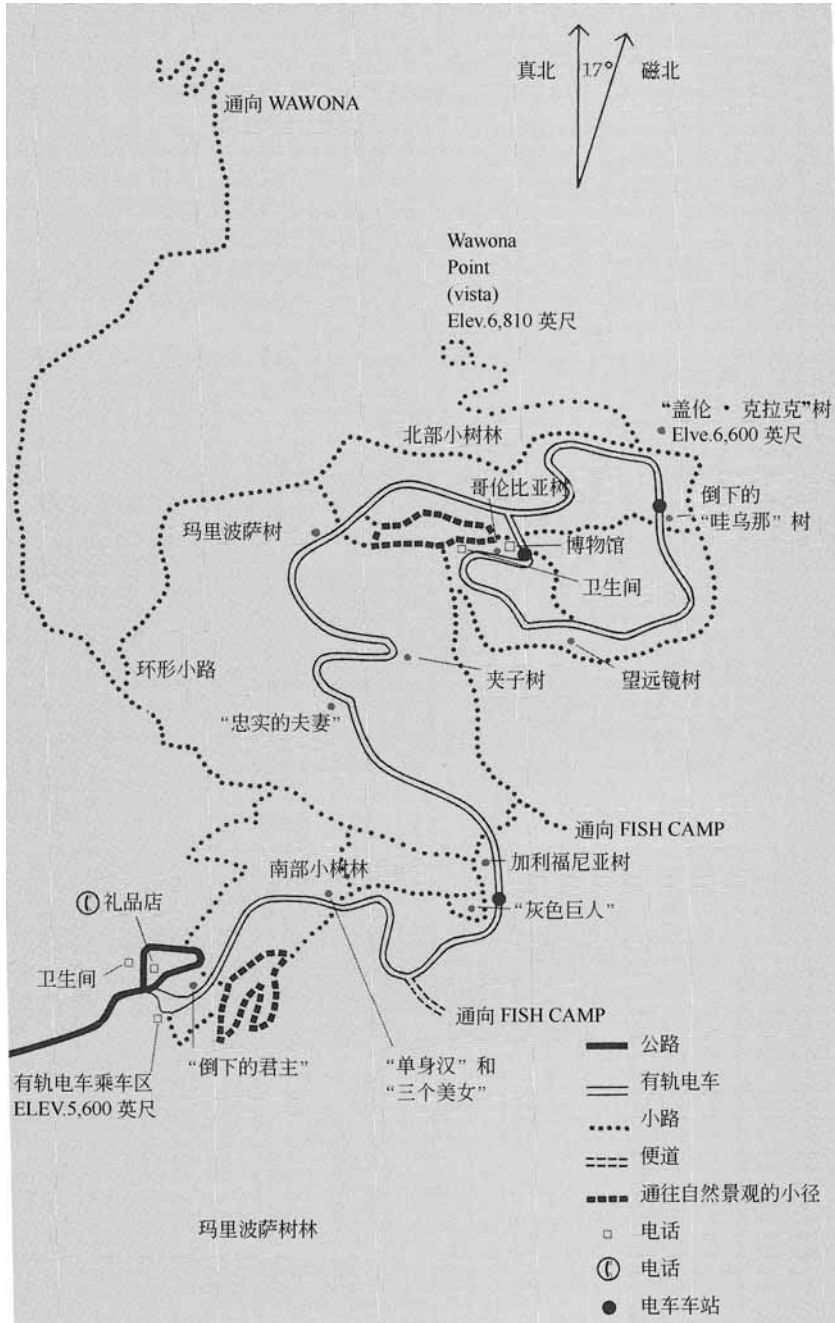


图 3.25 地图标明了这些不同的有趣的地方和有特殊名称的红杉的位置。

在玛里波萨树林里能看到什么，该做些什么？

玛里波萨树林位于优胜美地国家公园南入口附近。从 Fresno 出发经 41 号高速公路向北，或从优胜美地山谷公园的小路向南，都可以到达那里。

南面的入口向东两英里处，就可以看到这些宏伟的巨杉了。它铁锈褐色的树皮与附近别的树的暗灰色树皮形成了鲜明的对比。在小树林入口处的停车场停好车后，你可以沿着两条著名的自然小路步行，或者搭乘在夏季运营的有轨电车。电车驾驶员会对小树林进行讲解，并在各个景点停车，你可以步行到小树林中你感兴趣的地方。图 3.25 标明了一些特殊的地点和比较特别的红杉的位置，下面将逐一说明这些有趣的巨杉。

“倒下的君主”——这棵树非常值得注意，因为它很久以前就倒下了，并且保持得几乎完整无缺。年老的巨杉因其木材易碎闻名。这是巨杉木不适合作木料的一个原因。实际上，木材都被分割成很小的块，许多圣乔君谷葡萄园中的葡萄藤桩就是巨杉。“倒下的君主”在树基以上 3 米（10 英尺）处的直径是 4.6 米（15 英尺）左右。边材和树皮早就腐烂了，如果没有腐烂的话，树的直径可能会达到 5.5 米（18 英尺）。巨杉的心材腐烂得很慢，对树的残留物中放射性碳年代测定表明，这棵树已经有 2000 年的树龄。在“倒下的君主”生命中的各个时期，马车曾经从它的树干边上驶过，通过马车上的阶梯还能到达树的顶部。走在这个倒下的巨人的旁边，思考着多少年前它曾经巍然屹立过，仍然是一种令人难忘的经历。倒在它上部的杉树暗示我们，这棵巨杉至少在几百年前就倒下了。

“走廊树”——这棵不同寻常的树验证了巨杉的忍耐力。多次的火灾和可能的腐烂已经侵蚀了树基，产生了足以让人通过的树洞。剩下的支撑木显示

巨 杉

了新木材的重新生长，它们填补了空缺。支撑木也继续支撑着这棵体型巨大的树：近 76 米（250 英尺）高，树基上部 3 米（10 英尺）处的直径达 4.6 米（15 英尺）。

“三个美女”——这三棵巨杉的名字很好听，它们显示了巨杉在间距非常小的情况下，也有可能长得很大。经常有 5 到 10 棵的巨杉群在彼此间距不到 15 米（50 英尺）的情况下生长。通常存在于单棵树木间的竞争被合作所取代了。这些树的树根缠绕在一起，相互支持，而不是保持独立。“三个美女”可能是一片茂密巨杉林的幸存者，这片巨杉林是好几个世纪前的一场大火后生长起来的。

这三棵树都高于 61 米（200 英尺），最高的将近 79 米（260 英尺）。看着这些树被清晨的阳光照亮，是在玛里波萨小树林收获的意外之喜。

“灰色巨人”——这棵表面粗糙的树是玛里波萨小树林中最大也是最老的树。虽然它只有 60 多米（200 英尺）高，它巨大的树干像一个笔直的圆柱一样矗立着。树基部的直径有 9.4 米（31 英尺），树基上部 18.3 米（120 英尺）高处的直径近 5 米（16 英尺）。在 9.2 米（60 英尺）的高处，树干的直径仍然超过了 4 米（13 英尺）。“灰色巨人”旁的许多树都还没有这根枝粗。

“灰色巨人”经受了内华达山脉地区的风暴和人类活动的影响。这个地区的第一条路恰好从这棵树的根上经过。好心的人们竖起各种各样的栅栏不让人接近树的基部。但是如同 1930 年挖洞种植灌木以掩盖布满树基周围装有倒刺的线一样，为安栅栏而挖掘的洞严重影响了树根的生长。虽然有各种各样的损坏，这棵树还是存活了下来，并且到现在为止生长得很好。它的树龄估计在 2500 ~ 3000 年。

“加利福尼亚树”——在这棵树上可以很明显地看出过去人们在大树中挖隧道的习惯。这棵树中的隧道挖通于 1895 年。14 年前，人们在著名的“哇

“哇乌那”树中挖通了隧道。当冬天来临的时候，积雪阻塞了通往“哇乌那”树所在小树林的马车道，聪明的车夫把“哇乌那”树的标志放在了“加利福尼亚树”上。就这样，“加利福尼亚树”在很长一段时间里一直被当成“哇乌那”树的替代者，直到1932年，道路被重新布置好。这条老路现在被用作人行道，而且你可以看到树上的巨大伤口逐渐愈合的痕迹。

“加利福尼亚树”有70多米（230英尺）高，树基上部3米（10英尺）处的直径有4.6米（15英尺）。和“哇乌那”树一样，大火留下的疤痕被扩大以做隧道。“加利福尼亚树”位于“灰色巨人”东北面大约90多米（100码）的地方。

“忠实的夫妻”——这个名字对于这两棵一直长得很靠近的树来说再合适不过了。它们甚至比“三个美女”长得还要靠近，显示了巨杉的相互嫁接能力。虽然森林中的许多树都会这样，但巨杉天生的巨大体型使其成为惊人的景象。联合在一起的树干在树基部的直径几乎有12米（40英尺），这对孪生的圆柱有将近76米（250英尺）高。

“梅泽”树——在从“忠实的夫妻”上山的路的拐弯处，耸立着一棵相对年轻的巨杉，它以首任国家公园服务处主管斯蒂芬·梅泽的名字命名。国家公园服务处于1916年建立，梅泽从那时起到1929年，一直在那里工作。作为一个加州人，用加州最大的树之一授予他荣誉，是再恰当不过的了。

“梅泽”树是螺旋顶巨杉年轻时的生长方式的很好例证。这种尖锐的外部轮廓是由于顶端的迅速生长超过了侧面的蔓延生长。这样生长的树木被认为是贯顶的，而那些所有的枝条都以同样的速度生长的树木，被认为是下延的。橡树是后一种生长方式的典型代表，恰好解释了圆形外观的形成。巨杉在垂直方向上的迅速生长基本保证了它获得足够的阳光。如果它不得不在树荫下生长，那么它将很快死去，因为巨杉不耐阴。

“夹子树”——多次的火灾已经毁掉了这棵树的树基，使它像一个老式的夹子。它地表树基上部 3 米（10 英尺）处的直径为 4.9 米（16 英尺），高 82.3 米（270 英尺）。裂口伤痕在 21.3 米（70 英尺）高处，直径为 4.9 米。虽然看起来火是造成开口的主要原因，但火并没有杀死这棵树。虽然大部分原来的根和树干的连接部位已经被严重损毁，但“夹子树”看起来非常健康，并能产出相当多的球果。

“玛里波萨树”——这是另一棵很好的标本树，高 76 米（250 英尺），地表树基上部 3 米处的直径为 5.3 米（17.5 英尺）。这棵树不仅长得很雄伟，而且它很好地显示了新生木材和树皮是如何治愈由火造成的伤疤。需要注意的是，新的生长是如何从仍然有存活组织的一侧开始覆盖旧的伤疤的。

在优胜美地国家公园西面，有一个以淘金热闻名的玛里波萨县。这棵树和整个小巨杉林都以县的名字来命名。这个县名来自于早期西班牙人称之为“拉斯·玛里波萨斯”的一条小河，玛里波萨的意思是“蝴蝶”。

整篇文章，我们都在对比巨杉的尺寸。但是，对巨杉直径有意义的测量却很难。困难来自于大树基部凸出部分或者粗大部分的的不一致性。标准的做法是测量 1.37 米（4.5 英尺）高处的直径，这称为胸高直径。但在巨杉的胸高处测量往往会包括粗大部分。因此，为了使直径的测量更标准化以利于比较，在玛里波萨小树林中，树直径的测量都在地表上部 3 米（10 英尺）的地方进行。

“巨杉旅馆”区——路的北面相对比较平坦的地方曾经是 1933 年建成的“巨杉旅馆”的所在地，它为公园的参观者提供餐饮和住宿服务。为了减少对玛里波萨小树林的发展和资源的影响，原来的旅馆在 1982 年被夷为平地。这片被扰乱的土地富含矿物质，有足够的阳光和水分，这也许能够说明为什么在这一区域内有大量年轻的巨杉。近距离察看树叶，你能发现它们的尖锥形

状。如果有一棵大树的枝条，你就能比较它的树叶和那些只有几十年树龄的树的树叶了。

“象腿树”——这棵倒下的树揭示了巨杉一个意想不到的特性：它们没有直根。这种地球上最大的生物像钉子一样站立着。浅浅的、分布广泛的根是对山上稀薄土壤的很好适应。巨杉的树根通常只延伸到土壤中几英尺的深度。有些树的树根从树基部伸展出 46 米（150 英尺），使树能吸收到足够的土壤水分用于生长。当树倒下的时候，浅浅的圆盘状的树根便暴露了出来，就像“象腿树”那样。

“日落树”——在旅馆的后面，矗立着一棵一直饱受风吹雨打的巨杉。在它的根部有一个被火烧成的伤疤，周长有 15 米（50 英尺），对巨杉来说算是一个很大的疤痕了。这严重损害了根和树干中的水分运输，造成了上部枝叶的死亡，所以许多老的巨杉都呈现出断顶的样子。落下的枝叶不可避免地积聚在树基部。当大火来临的时候，这些现成的燃料就会烧得特别旺。

取名“日落树”是因为这棵树位于小巨杉林的西边，它是最后一棵被夕阳照到的树。虽然只有 60 多米（200 英尺）高，“日落树”在树基上部 3 米（10 英尺）处的直径有 5.2 米（17 英尺），非常粗大。

“美国老兵”树——这棵树是为了纪念 1921 年在第一次世界大战中死去的无名老兵。它也是一个经历了火灾和风暴存活下来的好例子，这棵老树每年继续长出新的叶子和球果。这棵树还有非凡的外形，树基上部 3 米（10 英尺）高处的直径为 5.5 米（18 英尺），高 76 米（250 英尺）。

“海沃弗德”树——因为像巨穴一样的中心空洞大得可以掩蔽马，所以这棵树在早期马车时代以“掩蔽树”而闻名。早年的报道说，有 15 匹马在暴风雨天气找到了这个几乎有 2.8 米（30 平方英尺）大的洞作为掩蔽所。它高 82 米（270 英尺），是这个小树林中比较高的树，树基上部 3 米（10 英尺）高处

的直径有将近 5 米（16.5 英尺）。

博物馆——这个地方的小巨杉林给盖伦·克拉克留下了很深的印象，1861 年，他在今天博物馆的位置上修建了他的木屋。这个小屋于 1885 年被另一所小屋所取代，后者于 1902 年扩建。扩建后的小屋于 1930 年重建，现在作为玛里波萨小树林的公园博物馆。现在博物馆内的展品讲述着巨杉生态系统的故事。夏天的时候，自然主义者会来此讲述这里的情况。花上几分钟在门廊里坐坐，思考一下 100 年前这里的景象，那时候，克拉克住在这个遥远的山中天堂，前院里都是这些宏伟的巨杉。

“格兰特将军”树——在博物馆门廊的正前方，是一棵很好的巨杉标本树，它的名字是“格兰特将军”，但不要和国王谷国家公园中的“格兰特将军”树混淆起来。后者有 77 米（255 英尺）左右高，胸高直径有将近 8.8 米（29 英尺），是第二大巨杉，也被称为美国的圣诞树。而玛里波萨小树林中的“格兰特将军”树高约 82.2 米（270 英尺），树基上部约 4.3 米（14 英尺）处的直径为 3 米（10 英尺）。科学家用树干的总体积来计算树的大小。虽然没有数据记载玛里波萨小树林中“格兰特将军”树的体积，但国王谷国家公园中“格兰特将军”树的体积为 1345 立方米（47,500 立方英尺）。

“谢尔曼将军”树——“格兰特将军”树左边是雄伟的“谢尔曼将军”树。它也大概有 82.2 米（270 英尺）高，树基上部 3 米（10 英尺）处的直径为约 4.1 米（13.5 英尺）。也不要把它和最大的巨杉——美国加州红杉国家公园中的“谢尔曼将军”树混淆起来。后者有 84 米（275 英尺）高，胸高直径为 7.6 米（25 英尺）。它将近 1444 立方米（51,000 立方英尺）的树干体积为它赢得了迄今为止世界上最大生物的名号。

“倒下的巨人”——这棵倒下的巨杉一直完好无损，直到 1934 年重新修路时才被砍掉。砍伐后人们可以看到覆盖在砍伐表面的神奇树液。树液被氧

巨 杉

化后由红色变成了深紫色。树液中有许多不同的化学物质，它们使得心材有一定的抗腐蚀能力。虽然可以经受许多世纪，但最终，这些化学物质将会分解，木材也会腐烂。大约 7.6 ~ 10 厘米（3 ~ 4 英寸）厚的浅色边材形成树干外层，不含有红色的化学物质。边材在树木倒下后腐烂得非常快，有的时候只需要几十年。于 1873 年倒下的“倒下的巨人”的边材已经腐烂了，只剩下没有腐烂的心材。

“哥伦比亚”树——从博物馆向西望去，过了“倒下的巨人”，在马路的右侧有三株巨杉。其中最大的一棵也是整个小巨杉林中最大的，它的表面有一个火灾造成的倒 V 字形伤疤。“哥伦比亚”树接近 88 米（290 英尺）高，地表树基上部 3 米（10 英尺）处的直径为约 5 米（16.5 英尺）。

在别的小巨杉林中，巨杉有时能达到 94 米（310 英尺）高。这个上限主要是由顶端枝叶的水分供给情况决定的。虽然在巨杉林带，每年的降雨量有 127 ~ 152 厘米（50 到 60 英寸），但这里的夏末和秋季却几乎是无雨的。这个干旱的阶段给上端枝叶造成了很大的影响，减缓了它们的生长。如果火再切断了与根部的联系，一些顶端枝叶将会死亡，造成断顶。

“四个警卫”——从博物馆向西走一小段路，有四棵站成一排的巨杉。它们都有 60 多米（200 英尺）高，地表树基上部 3 米（10 英尺）处的直径在 2.6 ~ 3.2 米（8.5 ~ 10.5 英尺）之间。这个有趣的模式是怎样形成的呢？树木长成一条直线有几种可能的解释。

在一个非常潮湿的气候环境中，火很少能够清除森林地被物，一棵倒下的树在腐烂的过程中可能会成为种床。这些树被称为“护士树”，因为它们用腐烂的树干维持着小树苗的生长，直到这些树苗的根部触及到有矿物质的土壤。但在一个相对干燥的气候环境中，例如内华达山脉，火可能烧毁整棵倒下的树，形成直线型的种床。巨杉的树苗在被火烧得很热的土壤中能很好地

存活。后一种解释也许能说明“四个警卫”长成一排的原因。

“倒下的犹他州”树——巨杉会因为很多原因而死亡。一些巨杉由于其他大树倒在它们身上而直立着死亡。导致这些树倒下的原因有很多，而且通常不止一个。虽然有一些巨杉是在地表上部几英尺处突然折断，但缺少足够的根部支持是一个根本问题。造成根部没有足够的支撑，并使树最终倒下的原因有火灾造成的伤疤、腐烂的树根、蚂蚁侵蚀造成的窟窿、河流的地下阻断、冰雪的过重负荷、猛烈的狂风，或者是以上这些原因的结合。有火疤的巨杉大多朝有火疤的一侧倒下。和湿润草坪相邻的巨杉大多朝草坪的方向倒下。大多数的巨杉在冬季或早春时节倒下，那时候，风暴和潮湿的土壤是它们最终倒下的原因。

1935年4月7日早晨7点，一场暴风过去数天后，“倒下的犹他州”树倒下了。虽然它在一个平静的日子里倒下，但我们相信暴风减弱了根部的支撑作用。而且，暴风通常会吹干树叶。当水被重新带回到树叶中时，有可能不够平均，就造成了树上部的不平衡。

和其他植物一样，即使这样它们的根部仍然和土壤联系在一起，所以树的一部分仍然活着。“倒下的犹他州”树正是这样，在倒下后的三年里，它仍然有着绿色的叶子。

“倒下的马厩树”——这棵雄伟的老树比“倒下的犹他州”树早死亡一年。很久以前，大火就已经烧毁了树基部的大部分木材，以至于正像它的名字所说的那样，它一直被用作马厩。当它倒下的时候，它断裂成三个主要的部分。这对老的巨杉来说很平常，因为它们以木质的脆而闻名。和“倒下的犹他州”树一样，“倒下的马厩树”在倒下后的两年里仍然有新枝长出。虽然树倒下的日期并不是树的死亡日期，但一般树倒下后就和死亡没有什么区别，除非一些根系保持得完好无损。

说一些有趣的题外话。几年前，艾特威尔·米尔小树林中的一棵小巨杉倒下了，但根部和树干仍然保持着连接。然后，活着的树枝开始向上生长，现在看起来像一排天然生长的小树。

“倒下的马萨诸塞”——在 1927 年春天倒下之前，这个庞然大物一定有着巨大的身形，它曾经是这个巨杉林中最大的树之一，估计高度为 85 米（280 英尺），地表树基上部 3 米（10 英尺）处的直径为 8.5 米（28 英尺）。

除了由于火和腐烂造成的树干支撑力减少，19 世纪 70 年代的道路建设也严重损害了巨杉的根部。随后，早春的暴风雪使“马萨诸塞”树承载了太重的积雪，这是导致它倒下的最终原因。它倒下的时候，摔在山地上碎成了很多部分。

“望远镜”树——如果你想知道这棵树是怎样得到这样一个名字的，就必须走到它里面去。在那里你能看到它的中间全部是空的，以至于你可以在树里面看到天空。造成这一现象的可能过程是：首先是心材腐烂，然后遭受了一场大火。虽然巨杉的心材能很好地抵抗腐烂，但老的心材，如中心部分的心材，随着时间的推移抗腐蚀性也将降低。一旦腐烂降低了心材的密度，一场从树基开始的大火，或者由于雷电而从树顶开始的大火就能烧毁树的中心。现在，“望远镜”树中很明显的空洞可能需要多次的大火才能形成。树基部周长的一半几乎已经被火烧毁，但树的外壳仍然包含着对任何树来说都至关重要的三个层面：树皮、形成层和边材。

“望远镜”树大概只有 58 米（190 英尺）高，地表树基上部 3 米（10 英尺）处的直径为 5 米（16.5 英尺）。它曾经很有可能高于 61 米（200 英尺），但后来逐渐变成了一个中空的圆柱并丢失了一大部分树顶。即使这样，这棵树仍然存活了下来。

倒下的“哇乌那”树（隧道树）——毫无疑问，世界上最著名的巨杉就是

“哇乌那”树。从1881年隧道开始挖掘，到1969年这棵树倒下，成百上千的游客从世界各地赶来看这棵可以从中间开车经过的树。虽然其他的巨杉也被挖成隧道，但“哇乌那”树是最著名的。斯克里布纳兄弟在1881年，只花了75美元就挖好了隧道。他们选择了一棵火烧后留下大疤的巨杉，高72.6米（235英尺），地表树基上部3米（10英尺）处的直径为6.1米（20英尺）。这个隧道有8米（26英尺）长，2.4米（8英尺）宽，3米（10英尺）高。

在1968~1969年的严冬，这棵世界上最著名的树倒下了。也许在某种程度上是由于树基部那个巨大的隧道。人们估计它已经存活了2200年。它把无数的人吸引到玛里波萨小树林来，并让人们在“朝圣”的过程中发现了没有被砍伐过的巨杉林具有更重大的意义和价值，这减少了它死亡的悲剧性。

“盖伦·克拉克”树——虽然它不是一棵特别大的巨杉，高73米（240英尺），地表树基上部3米（10英尺）处的直径为4.7米（15.5英尺），“盖伦·克拉克”树在许多方面都是不同寻常的。令人惊诧的是，它没有火造成的伤疤，可能是因为它靠近山脊顶部，那里很少有枯枝落下堆积在树旁。它银色的外表让人非常震惊。并且它可能是盖伦·克拉克看到的第一棵树，因为他第一次是从北面进入小树林的。

我们用“盖伦·克拉克”树来结束这个故事再恰当不过了。正是盖伦·克拉克第一次把人们带到玛里波萨小树林来目睹巨杉的风采。他选择了在巨杉的包围中生活，他可能把它们看成“人”，并且渐渐地了解它们，就像朋友一样。正如以他的名字命名的这棵树有着不同寻常的银色树皮一样，每棵树都有一些独一无二的地方。然而每棵树都静静地、高贵地矗立着，分享着一种特殊的甚至超越它们高度的高贵，这是一种只有真正的君主才拥有的高贵。



图 1.19 水杉球果，种子化石（左：钱尼采，右：刘燕菊采）。下为水杉叶子，标本由欧文·戴安博士提供，照片由谌谟美拍摄自加州大学伯克利分校古生物标本馆。

Figure 1.19 Dawn redwood cone. Fossil seeds (Left: collected by Chaney, right: collected by Liu Yanju.) Bottom: Dawn redwood leaves, specimen provided by Erwin Diane. Photograph taken by Chen Momei.



图 1.20 湖南龙山地貌。（张昂和摄）

Figure 1.20 Topography of Long Shan, Hunan. (Zhang Anghe)



图 1.21 拉尔夫·钱尼博士，照片由加州大学伯克利分校古生物学博物馆惠赠。

Figure 1.21 Dr. Ralph Chaney, courtesy of the University of California Museum of Paleontology, Berkeley.



图 1.22 郑万钧教授，照片由中国工程院院士蒋有绪惠赠。

Figure 1.22 Prof. Cheng Wanchun, courtesy of academician Jiang Youxu, the Chinese Academy of Engineering Academician.



图 1.23 上海行道树水杉。(湛谟美摄)
Figure 1.23 Shanghai street dawn redwood. (Chen Momei)



图 1.24 南京水杉绿化行道树。(湛谟美摄)
Figure 1.24 Nanjing street dawn redwood. (Chen Momei)



图1.25 湖北利川磨刀溪的水杉1号树。(张昂和摄)
Figure 1.25 Lichuan Modaoxi dawn redwood type tree, Hubei. (Zhang Anghe)



图 1.26 摘自郑万钧（中国林业科学研究院）主编的《中国树木志》，照片为李鹏拍摄于1980年。
Figure 1.26 From *Flora of Wooden Tree in China*, the Monographic author: Cheng Wanchun, Chinese Academy of Forestry, Photo by Li Peng in 1980.



图 1.27 江苏水稻田里水稻与水杉间种。(张昂和摄)

Figure 1.27 Dawn redwood interplant with rice in rice field, Jiangsu Province. (Zhang Anghe)



图 1.28 水杉常常与竹林长在一起 (湖北利川)。(谌漠美摄)

Figure 1.28 Dawn redwood with bamboo forest, Lichuan Hubei. (Chen Momei)



图 1.29 湖北利川小河天然林，古水杉平均直径为20厘米。(张昂和摄)

Figure 1.29 The average diameter of the dawn redwoods in Xiaohu Natural Forest in Hubei is 20cm. (Zhang Anghe)



图 1.30 湖北利川小河保护区的天然古水杉生境。(张昂和摄)

Figure 1.30 Natural ancient dawn redwood forest. Habitat in Xiaohu, Lichuan, Hubei. (Zhang Anghe)



图 1.31 湖北利川小河水杉伐根（阴沉木）。（湛谟美摄）

Figure 1.31 Xiaohe rice paddy with dawn redwood old trunk and root (yin-chen-mu), Lichuan, Hubei. (Chen Momei)



图 1.32 中国林业科学研究院郑世锴教授（右）和比尔·利比教授（左）站在水杉砍伐后留下的伐根上。（湛谟美摄）

Figure 1.32 Chinese Academy of Forestry Prof. Zheng Shikai (right) and Prof. Bill Libby are standing (left) on a dead trunk. (Chen Momei)



图 1.33 生长有古水杉的湖南龙山洛塔地貌。(谌谟美摄)

Figure 1.33 Luota geomorphology, in Long Shan Mountain, Hunan Province, is the hometown of dawn redwoods. (Chen Momei)



图 1.34 第二次考察队成员，包括摄影师、制片人、加州大学伯克利分校的教授、中国林科院教授、保护红杉联盟的工作人员、张家界公园工作人员及外交官。(张家界外事人员惠赠)

Figure 1.34 The members of the second expedition for dawn redwoods, including the film maker, the photographer, professors from UC Berkeley, the Chinese academics, the staff of Save the Redwoods League, the officer of Zhangjiajie National Park and diplomat. (Courtesy of local officer)



图 1.35 水杉在北京植物园已有 26 年的种植历史。(赵博士摄)
Figure 1.35 The dawn redwoods have been planted in Beijing Botanical Garden for 26 years. (Dr. Zhao)



图 1.36 北京植物园的水杉林景观。(张佐双摄)
Figure 1.36 Dawn redwoods landscape in Beijing Botanical Garden. (Zhang Zuoshuang)



图 1.37 张家界公园里处处可见由石英石结构形成的“沙石脊”。(谌谟美摄)
Figure 1.37 The “Sandstone ridge” formed by quartz rocks can be seen everywhere in Zhangjiajie National Park.
(Chen Momei)



图 1.38 隐蔽的山谷：金鞭溪山谷。(谌谟美摄)
Figure 1.38 The hidden valley: Jinbian Creek Valley.
(Chen Momei)



图 1.39 稀有的树种：金钱松。(湛谟美摄)
Figure 1.39 Rare tree species: Golden larch (*Pseudolarix amabilis*). (Chen Momei)



图 1.40 远眺湖南龙山盆地中的古水杉。(湛谟美摄)
Figure 1.40 The ancient dawn redwoods in Hunan Long Shan basin from a distance. (Chen Momei)



图 1.41 在龙山洛塔县的古水杉。(张昂和摄)
Figure 1.41 One ancient dawn redwoods grow in Luota Village in Long Shan. (Zhang Anghe)



图 1.42 龙山泡木村水稻田边的两株古水杉。(谌谟美摄)
Figure 1.42 Two ancient dawn redwoods grow in gorgeous rice paddy at Paomu Village in Long Shan. (Chen Momei)



图 1.43 考察队住在小河镇附近的农户住家，农民用水杉木材造房屋、棺材、家具及薪材。(湛谟美摄)
Figure 1.43 The expedition team was visiting in the villagers' homes in Xiaohé. The villagers make houses, coffins, furniture, and firewood with dawn redwoods. (Chen Momei)



图 1.44 湖北利川小河水杉自然保护区的母树种子园。(湛谟美摄)
Figure 1.44 The dawn redwood Seed-Orchard in Xiaohé Reservation in Lichuan, Hubei. (Chen Momei)



图 1.45 水杉附近的农田。(谌谟美摄)
Figure 1.45 Farmland among the dawn redwoods. (Chen Momei)



图 1.46 湖北利川的水杉标本树。(张昂和摄)
Figure 1.46 Dawn redwood type tree in Lichuan, Hubei. (Zhang Anghe)



图 1.47 石柱是一片美丽而又神奇的土地。(谌谟美摄)

Figure 1.47 Shizhu County has rich resources for tourism, including gorgeous and beautiful landscape. (Chen Momei)



图 1.48 男石柱自然沙脊。(石柱县林业局惠赠)

Figure 1.48 Male “shi zhu” (“Sandstone ridge” natural statue). (Courtesy of Dept. Shizhu forestry)



图 1.49 女石柱自然沙脊。(石柱县林业局惠赠)

Figure 1.49 Female "shi zhu" ("Sandstone ridge" natural statue). (Courtesy of Dept. Shizhu Forestry)



图 1.50 年逾古稀的科学家来到四川石柱的“中国壹号水杉母树”。(何萍摄)

Figure 1.50 Senior forest scientists beside "No.1 Ancient Dawn Redwood Type-tree" in Shizhu, Sichuan. (He Ping)



图 1.51 石柱县山青水秀，旅游资源甚多。(石柱县林业局惠赠)
Figure 1.51 With gorgeous landscapes, Shizhu County has rich resources for tourism.(Courtesy of Dept. Shizhu Forestry)



图 1.52 熊猫和水杉都是冰期遗留的活化石。(谌谟美摄)
Figure 1.52 Panda and *Metasequoia* both survived the ice age in the Quaternary Period. (Chen Momei)



图 1.53 清凉的泉水流经红杉树林，加州大学伯克利分校的校园。(Joshua Marker 惠赠)
Figure 1.53 Cool springs run through a Coast redwood communities, UC Berkeley campus. (Coutesy of Joshua Marker)



图 1.54 沿着草莓谷生长的海岸红杉树，加州大学伯克利分校的校园。(谌谟美摄)
Figure 1.54 Coastal redwood along Strawberry Creek, UC Berkeley campus. (Chen Momei)



图 1.55 水杉生长在伯克利校园的地球科学大楼前,与东亚图书馆隔路相望。(谌谟美摄)
Figure 1.55 Dawn redwoods planted between Earth Science Building and the crossroad near East Asia Library, UC Berkeley campus. (Chen Momei)



图 1.56 水杉翠绿的树叶薄而柔软。(谌谟美摄)
Figure 1.56 Dawn redwoods have soft, thin, bright green leaves, UC Berkeley campus. (Chen Momei)



图 1.57 一棵挺拔的水杉矗立在伯克利的校园里（已结种子）。(湛谟美摄)

Figure 1.57 One of the original dawn redwood tree brought by Chaney is still standing tall (with cone and seeds) on UC Berkeley campus. (Chen Momei)



图 1.58 美丽的巨杉耸立在伯克利校园的西校门前。(湛谟美摄)

Figure 1.58 Giant Sequoia is standing beautifully in front of the West Gate, UC Berkeley campus. (Chen Momei)



图 1.59 加州大学伯克利分校的生命科学大楼。(谌谟美摄)
Figure 1.59 Valley Life Science Building, UC Berkeley campus. (Chen Momei)



图 1.60 挺拔的海岸红杉映衬着伯克利校园的萨瑟塔。(谌谟美摄)
Figure 1.60 Sather Tower, UC Berkeley. (Chen Momei)



图 2.26 臭菘 (*Lysichiton americanum*)。
Figure 2.26 Skunk Cabbage (*Lysichiton americanum*).



图 2.27 加州七筋菇 (*Clintonia andrewsiana*)。
Figure 2.27 Clintonia (*Clintonia andrewsiana*).



图 2.28 俄勒冈延龄草 (*Trillium ovatum*)。
Figure 2.28 Coast Trillium (*Trillium ovatum*).



西洋杜鹃 Western Azalea
(*Rhododendron occidentale*)



沙龙白珠树 Salal
(*Gaultheria shallon*)



先锋紫罗兰 Pioneer's Violet
(*Viola glabella*)



兰花朵朵 Blue Blossom
(*Ceanothus thyrsiflorus*)



橙色悬钩子 Salmonberry
(*Rubus spectabilis*)



西四照花木 Western Dogwood
(*Cornus nuttallii*)



太平洋杜鹃 Rhododendron
(*Rhododendron macrophyllum*)



掌叶铁线蕨 Five-Finger Fern
(*Adiantum pedatum*)

图 2.29 海岸红杉林中的花卉与蕨类。
Figure 2.29 Flowering herbs and ferns in the redwood forest.



a variety of mushrooms



b *Hygrophorus puriceus*



c Honey mushrooms



d *Boletus zelleri*



e *Hericium erinaceus*.



f *Cantharellus cibarius*



g *Tremella aurantialba*



h *Lycoperdon perlatum*



i *Trametes versicolor*



j *Sparassis crispa*



k *Ramaria araiospora*

图 2.30 海岸红杉林分布的蘑菇种类。(谌谟美摄, 除鸡油菌外)

Figure 2.30 A variety of mushrooms in Coast Redwood Forests. (Chen Momei, except f. *Cantharellus*)



a



b

图 2.41 a. 布袋兰 (*Calypso bulbosa*); b. 洪堡百合 (*Lilium humboldtii*).
Figure 2.41 a. Calypso orchid (*Calypso bulbosa*); b. Humboldt Lily (*Lilium humboldtii*).



图 2.46 在美国国会为是否建立红杉国家公园而辩论时，保护红杉联盟已经帮助加州州立公园获得了许多很有价值的红杉森林。这些红杉树在今天的杰地亚·史密斯州立红杉公园里。

Figure 2.46 While the U.S. Congress debated establishing a Redwood National Park, the Save the redwoods League helped to acquire many outstanding redwood forest lands for the California State Parks. These redwoods are in Jedediah Smith Redwoods State Park.

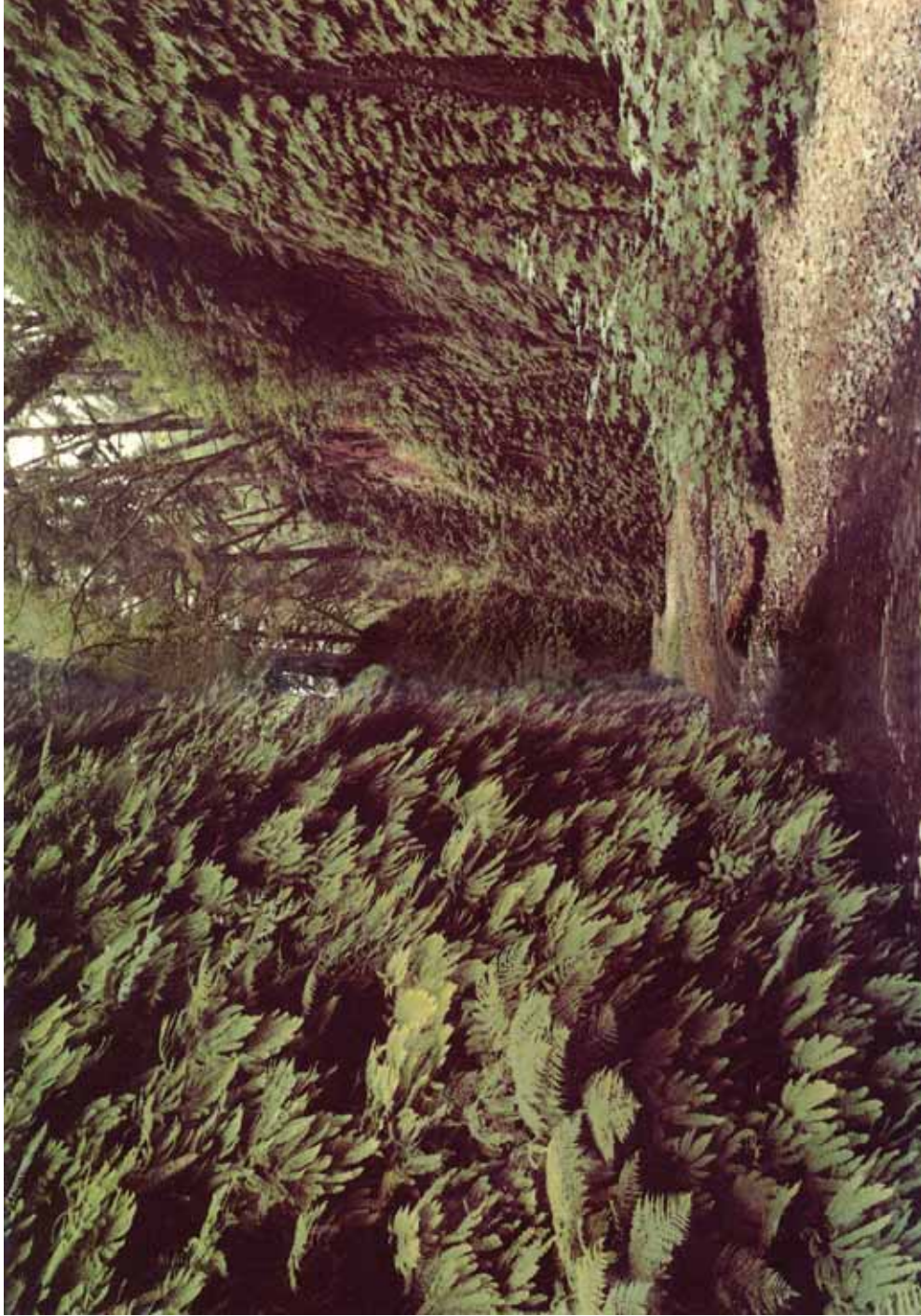


图 2.47 Fern Canyon 在 1965 年加入了草原溪州立红杉公园。摄影：Howard King。
Figure 2.47 Fern Canyon was added to Prairie Creek Redwoods State Park in 1965. Photo by Howard King.



图 2.49 红杉森林景观。
Figure 2.49 Redwoods Forest View.



图2.50 1977年保护红杉联盟向国家公园捐赠了一百万美元，用于将Skunk Cabbage Creek的红杉树加入红杉国家公园。

Figure 2.50 In 1977 the Save the Redwoods League donated one million dollars to the National Park Service to add these redwoods at Skunk Cabbage Creek to Redwood National Park.



图2.51 草原溪州立红杉公园。

Figure 2.51 Prairie Creek Redwoods State Park.

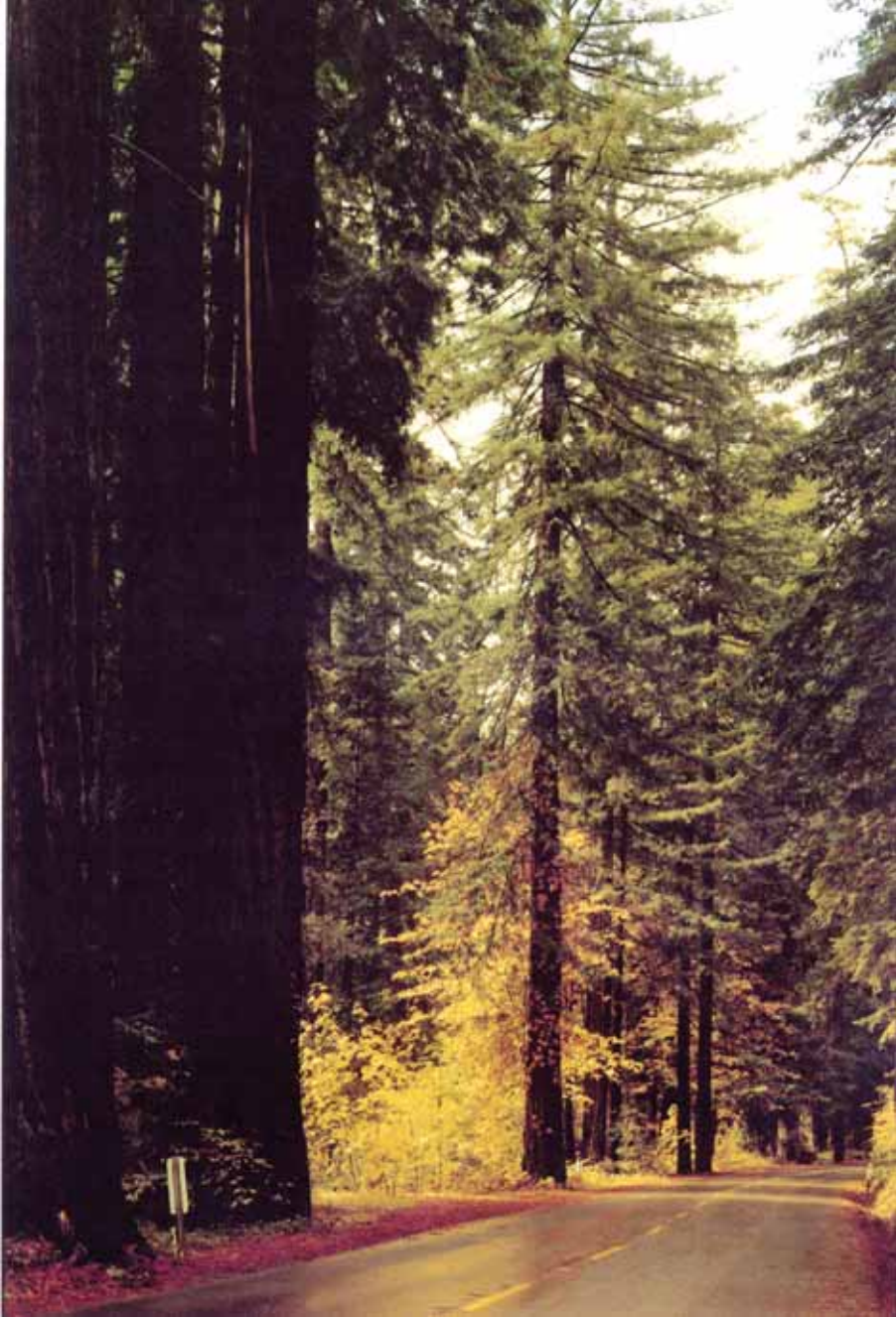


图 2.52 巨人之路，洪堡州立红杉公园。
Figure 2.52 Avenue of the Giants, Humboldt Redwoods State Park.



图 2.53 Berry Creek 瀑布, Big Basin 州立红杉公园。
Figure 2.53 Berry Creek Falls, Big Basin Redwoods State Park.



图 2.54 McWay Creek 瀑布, Julia Pfeiffer Burns 州立红杉公园。
Figure 2.54 McWay Creek Falls, Julia Pfeiffer Burns State Park.



图 2.58 加州 101 号公路旁的理杰特小镇附近有棵 96 米高的红杉树可通过汽车，这个叫做“驾车穿过树公园”的景点自开放 60 年来已经吸引了很多游客。(张昂和摄)

Figure 2.58 There is a huge redwood tree so big that cars can drive through its base. Located near California Hwy 101 near Leggett town, this tourist attraction named "Drive Thru Tree Park" opened 60 years ago. Tree height 96 m. (Zhang Anghe)



图 2.59 波林红杉地位于洪堡县。照片为紧邻着红杉林茂密的“巨树大道”（254 号公路）。（蒞谟美摄）
Figure 2.59 Bolling Grove, located in Humboldt County, CA. Coast redwood is located along the Avenue of the Giants (254 road). (Chen Momei)



图2.60 “永生巨树”(左)逃过了伐木人的锯子和1908年的森林大火,1964年的洪水和闪电将树冠折断(被折断的一部分树冠放置在树前)。这棵950多年树龄的红杉高76米,位于“巨树大道”北边的路段。(张昂和摄)

Figure 2.60 “The Immortal Tree” (left) has survived loggers, forest fires in 1908, flood of 1964, and lightning that removed its top (one section of dead top is shown). Situated in the northern half of Avenue of the Giants, it is over 950 years old, and is currently around 250ft (76m) tall. (Zhang Anghe)

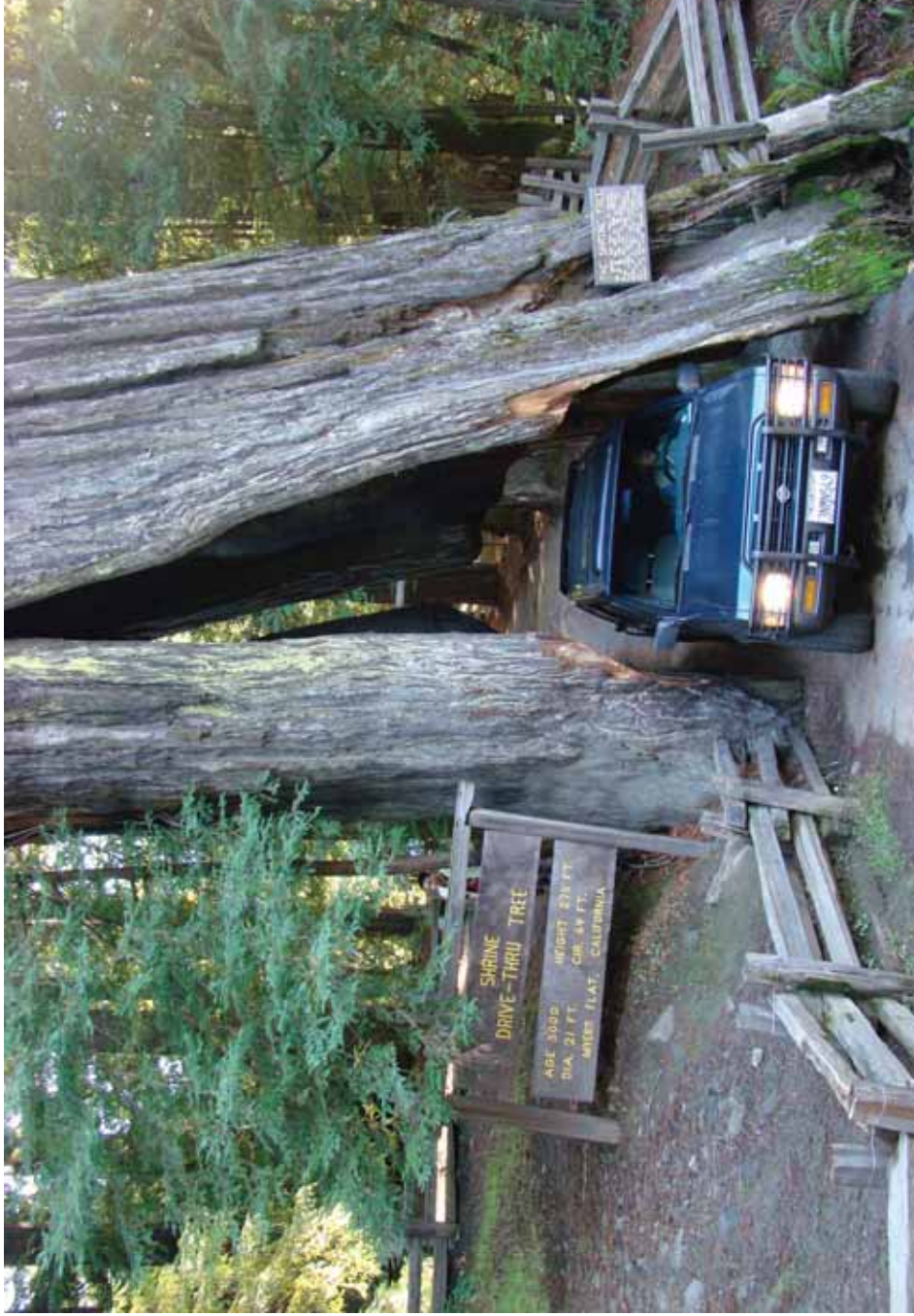


图 2.61 加州大学伯克利分校的学生官驾车通过“光明之树”。这棵红杉坐落在洪堡县的梅尔斯，树高 83.8 米，直径 6.4 米。（张昂和摄）
Figure 2.61 UC Berkeley student Gong Jian drove his jeep through "Shrine Drive-Thru Tree", located at Myers Flat, Humboldt County, CA. Tree height 275 ft (83.8 m), diameter 21 ft (6.4 m). (Zhang Anghe)



图 2.62 图为巨树大道的风景，通往 Eel Rock 和 Fort Seward 岔口。(堪 谟 美 摄)
Figure 2.62 Along Avenue of the Giants, near the intersection to Eel Rock and Fort Seward. (Chen Momei)

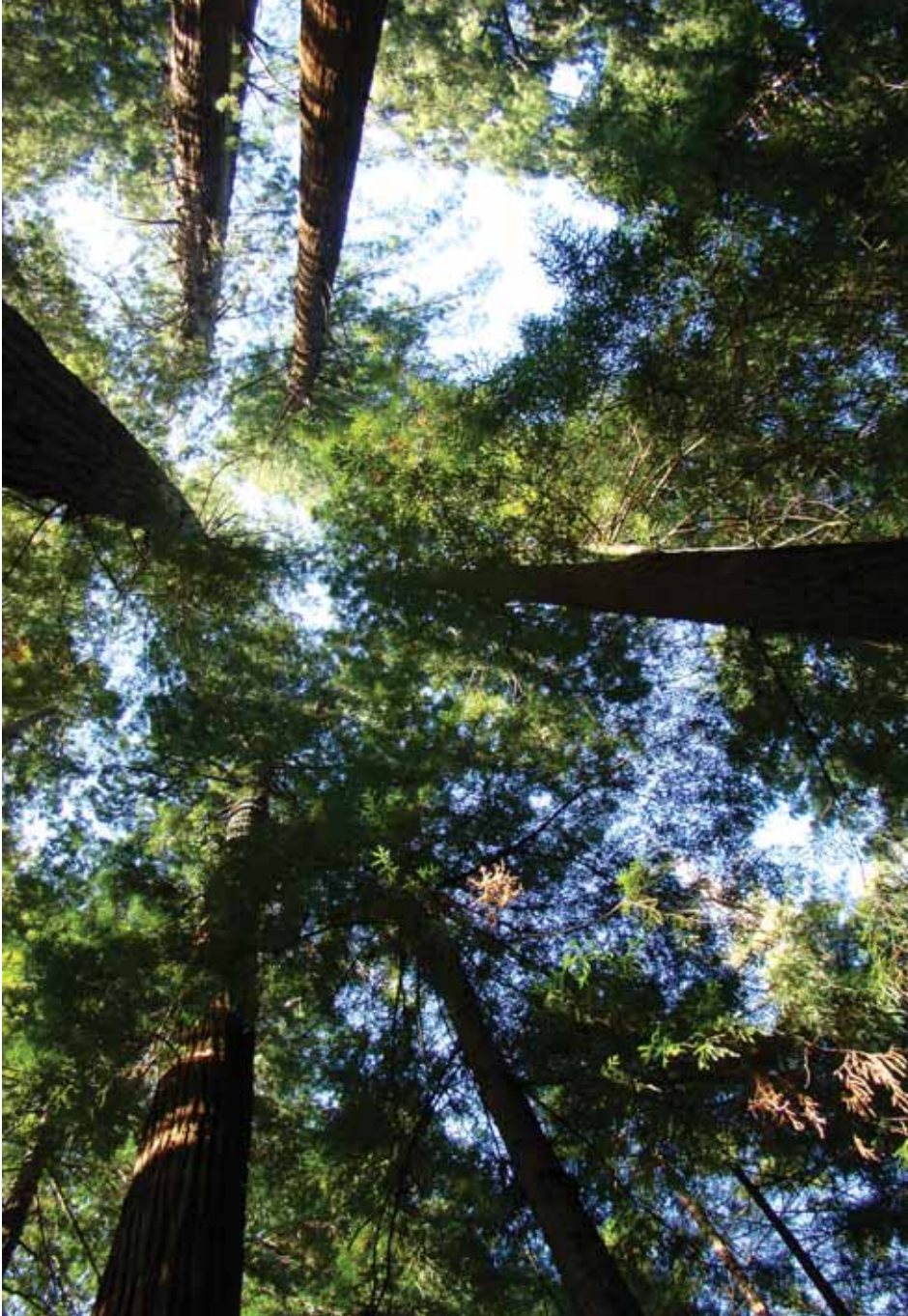


图 2.63 加州洪堡县红杉国家公园是雄伟的海岸红杉林的腹地。(张昂和摄)

Figure 2.63 The heart of California's magnificent coastal redwoods beats right here in Humboldt County, where you ramble among the ancient groves in Redwood National Park. (Zhang Anghe)



图 3.1 眺望国王峡谷，巨杉 (*Sequoiadendron giganteum*)。(湛谟美摄)
Figure 3.1 View point of Kings Canyon National Park, Giant sequoia (*Sequoiadendron giganteum*). (Chen Momei)



图 3.2 西黄松 (*Pinus ponderosa*)。
Figure 3.2 Ponderosa pine (*Pinus ponderosa*).



图 3.3 糖松 (*Pinus lambertiana*), 位于王峡谷国家公园。(官坚摄)

Figure 3.3 Sugar pine (*Pinus lambertiana*), located at Grant Grove Village, Kings Canyon National Park. (Gong Jian)



图 3.4 北美翠柏 (*Calocedrus decurrens*), 位于将军高速公路附近, 王峡谷国家公园。(官坚摄)

Figure 3.4 Incense-cedar (*Calocedrus decurrens*), located at near general highway, Kings Canyon National Park. (Gong Jian)

图3.5 白冷杉 (*Abies concolor*), 位于将军高速公路巨杉国家公园。(湛谟美摄)
Figure 3.5 White fir (*Abies concolor*), located at near Giant Sequoia National Park, General highway. (Chen Momei)



图3.6 加州红冷杉 (*Abies magnifica*), 位于Wolverton的巨杉国家公园。(湛谟美摄)
Figure 3.6 Red fir (*Abies magnifica*), located at Wolverton Giant Sequoia National Park. (Chen Momei)





图3.7 加州黑橡树 (*Quercus kelloggii*), 位于格兰特将军树附近。(湛谟美摄)
Figure 3.7 California black oak (*Quercus kelloggii*), located at near General Grant tree. (Chen Momei)



图3.8 扭曲松 (*Pinus contorta* var. *murrayana*)。 (Nate Stephenson 惠赠)
Figure 3.8 Logepore pine (*Pinus contorta* var. *murrayana*). (Courtesy of Nate Stephenson)



图3.9 左：绿叶浆果鹃 (*Arctostaphylos patula*, 谌谟美摄)；右，绿叶浆果鹃的果实 (Morse Keir 惠赠)。
 Figure 3.9 Left: Green Leaf Manzanita (*Arctostaphylos patula*, Chen Momei); right: fruit of Green Leaf Manzanita (Courtesy of Nate Stephenson).



图3.10 山四照花 (*Cornus nuttallii*)。(谌谟美摄)
 Figure 3.10 Mountain Dogwood (*Cornus nuttallii*). (Chen Momei)



图3.11 杜鹃 (*Rhododendron macrophyllum*)。(保护红杉联盟惠赠)
 Figure 3.11 California rose-bay *Rhododendron macrophyllum*). (Courtesy of Save the Redwoods League).



图3.12 鸢尾 (*Iris hartwegii*)。 (John Game 惠赠)

Figure 3.12 Hartweg's Iris (*Iris hartwegii*). (Courtesy of John Game)



图3.13 雪植 (*Sarcodes sanguinea*)。 (谌谟美摄)

Figure 3.13 Snow Plant (*Sarcodes sanguinea*). (Chen Momei)



图3.14 黑羊肚菌 (*Morchella elata*)。 (官坚摄)

Figure 3.14 Black Morel (*Morchella elata*). (Gong Jian)



图3.15 巨杉国家公园腹地的巨杉森林博物馆位于 Tulare County。(张昂和摄)
Figure 3.15 Giant Forest Museum, Tulare County. (Zhang Anghe)

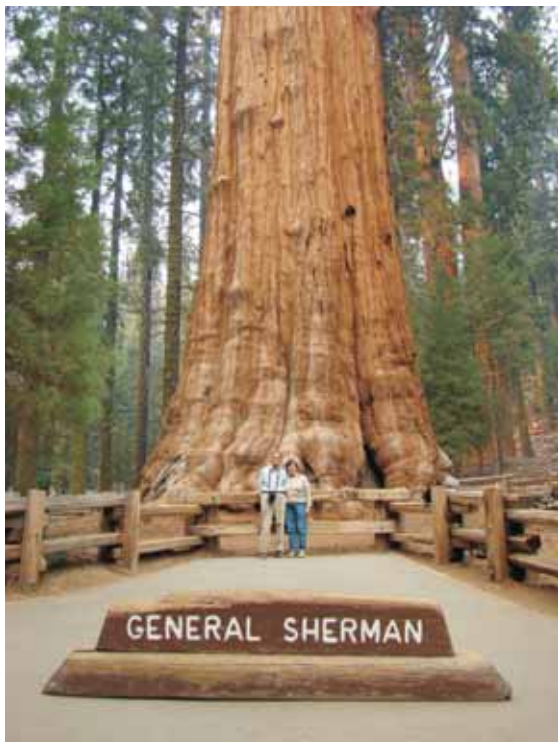


图 3.16 谢尔曼将军树，高 83.8 米，底部最大直径 11.1 米。根据 2002 年的测量，树的体积可达 1487 立方米，是全世界最大的树，也是世界上最大的单体生物。座落在巨杉公园的巨杉森林。据估计树龄在 2300~2700 年。(Nate Stephenson 惠赠)

Figure 3.16 General Sherman Tree, height 275 feet (83.8 m), maximum diameter at base 36.5 feet (11.1 m). As of 2002, the volume of its trunk measured about 1487 cubic meters, making it the largest (by volume) tree in the world, and the largest non-clonal organism by volume. The tree is located in the Giant Forest of Sequoia National Park. The tree is estimated to be between 2,300 and 2,700 years old. (Courtesy of Nate Stephenson)



图 3.17 远观谢尔曼将军树。(张昂和摄)
Figure 3.17 Setting of the General Sherman Tree. (Zhang Anghe)

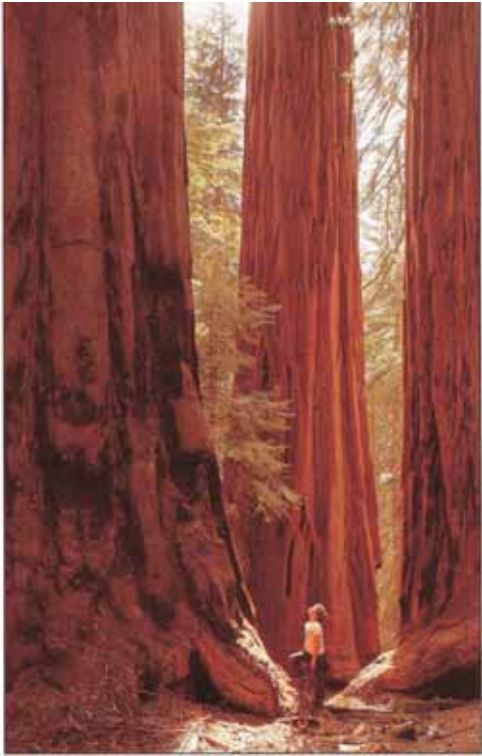


图 3.18 巨杉国家公园。
Figure 3.18 Giant Forest of Sequoia National Park.

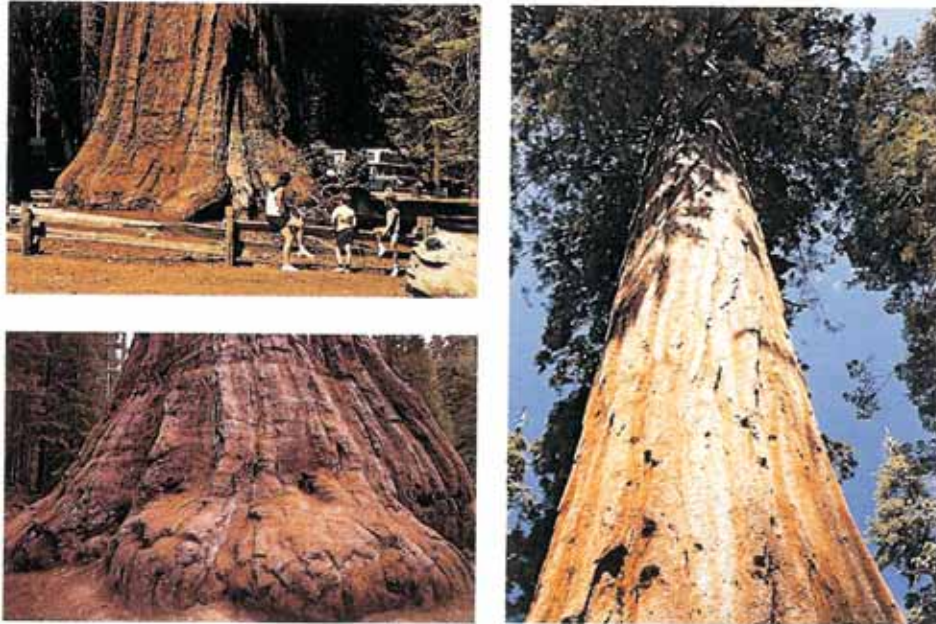


图3.26 左上：“灰色巨人”巨杉树下；左下：大象的脚；右：粗大的巨杉树干。
 Figure 3.26 Upper left: Base of Grizzly Giant; lower left: The Elephant's foot; right: Large size trunk of giant sequoia.



图3.27 左：巨杉幼树；右上：巨杉年轮；右下：巨杉树干段面。
 Figure 3.27 Left: Young sequoias; upper right: Sequoias growing ring; lower right: Sequoias trunk section.



图 3.28 左: Se-quo-yah (是一位杰出的切罗基族印第安人的名字); 右: Wawona 树, 巨杉独特的印第安名字 Wawona 音译为“哇乌那”。

Figure 3.28 Left: Se-quo-yah (Cherokee); right: Wawona Tree.

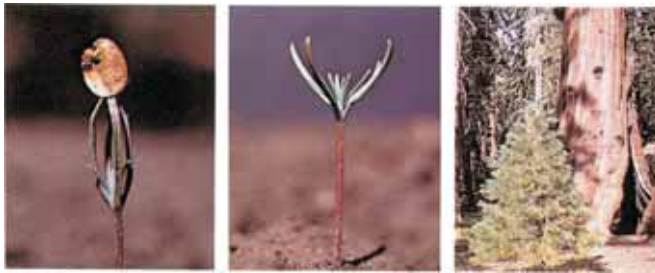


图3.29 左: 巨杉发芽; 中: 巨杉幼苗; 右: 约75年生的巨杉幼树。

Figure 3.29 Left: Sequoia germination; middle: Sequoia seedling; right: young sequoia, approx. 75 years old.



图 3.30 巨杉“避护”树。

Figure 3.30 The “shelter” tree.

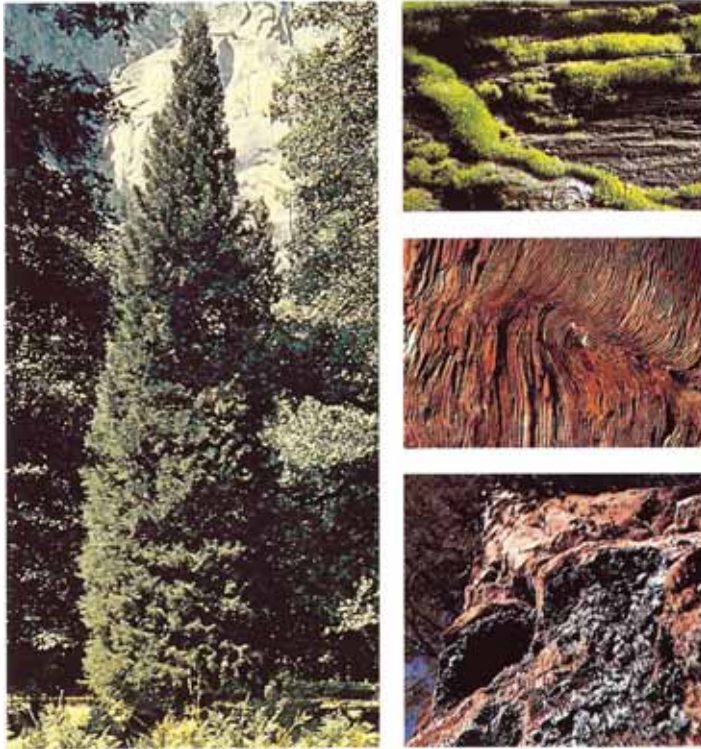


图3.31 左：山谷中约100年巨杉幼树；右上：苔藓长在巨杉倒木上；右中：巨杉木质纹理；右下：巨杉火烧疤痕。

Figure 3.31 Left: Sequoia in young valley, approx. 100 years old; upper right: Moss on fallen Sequoia; middle right: Sequoia wood pattern; lower right: Sequoia burn scar.

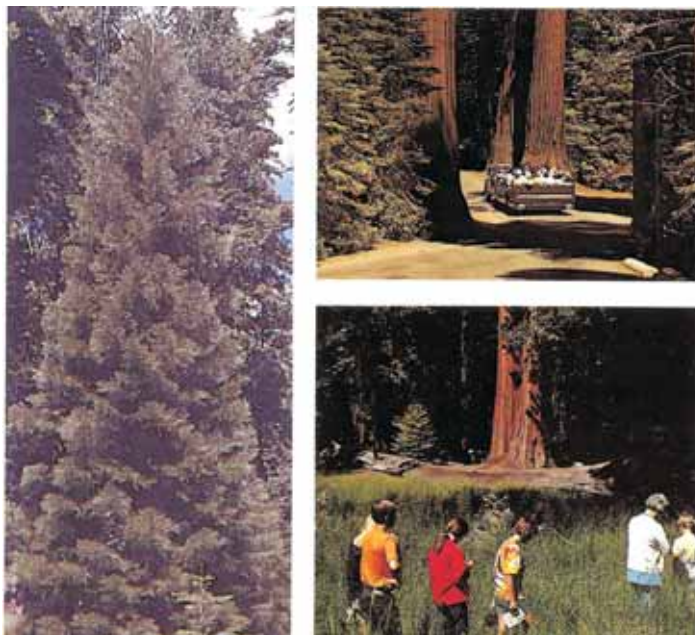


图3.32 左：“梅泽”树；右上：游览车在玛里波萨树林；右下：学生在巨杉林学习。

Figure 3.32 Left: Mather tree; upper right: Train in Mariposa Grove; lower right: students learn from Sequoia forests.



图 3.33 冬天时的“灰色巨人”巨杉树。
Figure 3.33 Grizzly Giant-Winter.



图 3.34 上：“四个警卫”；下：玛里波萨树林的公园博物馆。
Figure 3.34 Up: The Four Guardsmen; down: Mariposa Grove museum.

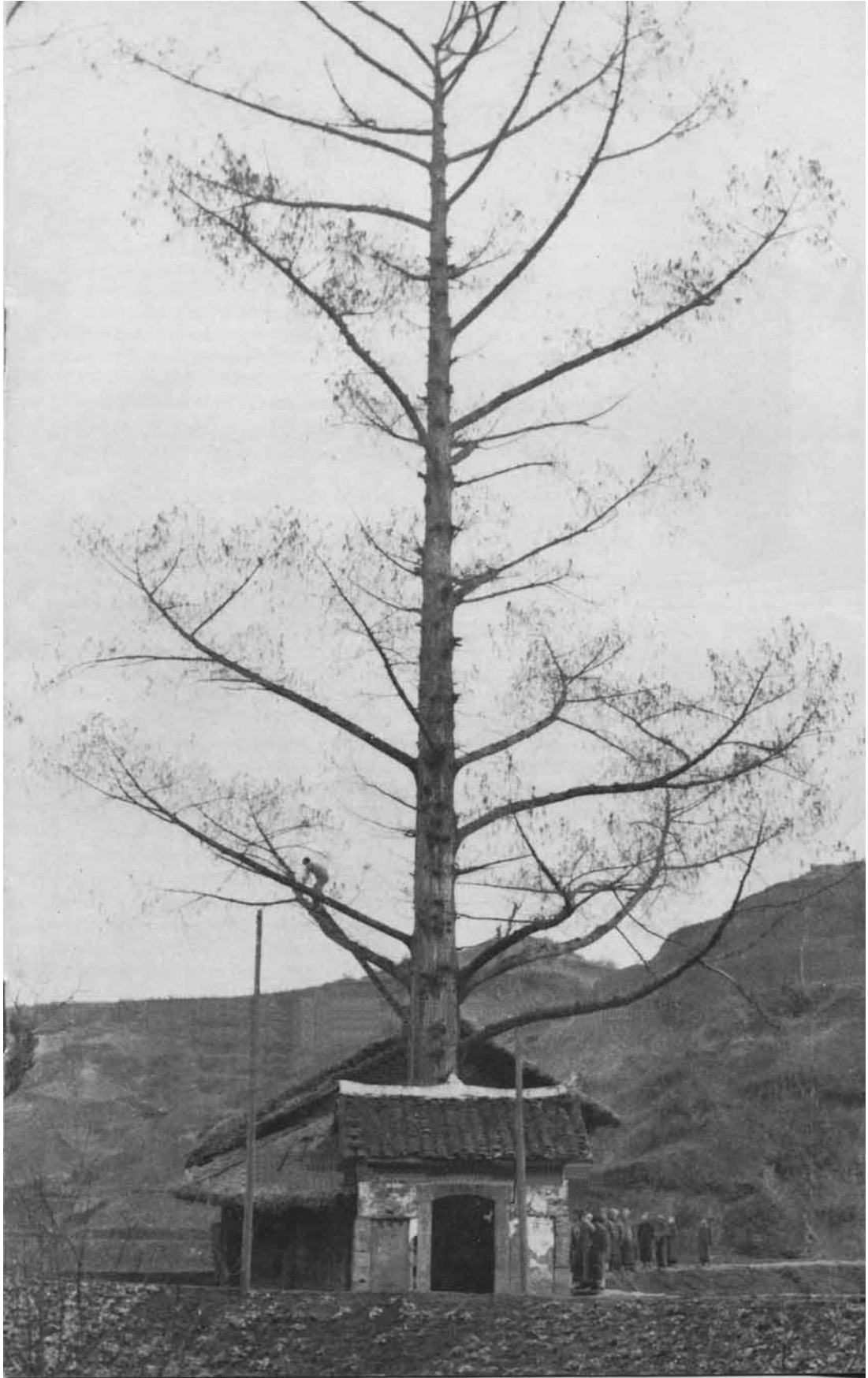


图 3.35 “格兰特将军”树。
Figure 3.35 Galen Clark Tree.

Chapter I Living Fossil Dawn Redwood
(*Metasequoia glyptostroboides*)

Section 1 Redwoods of the Past

Ralph W. Chaney



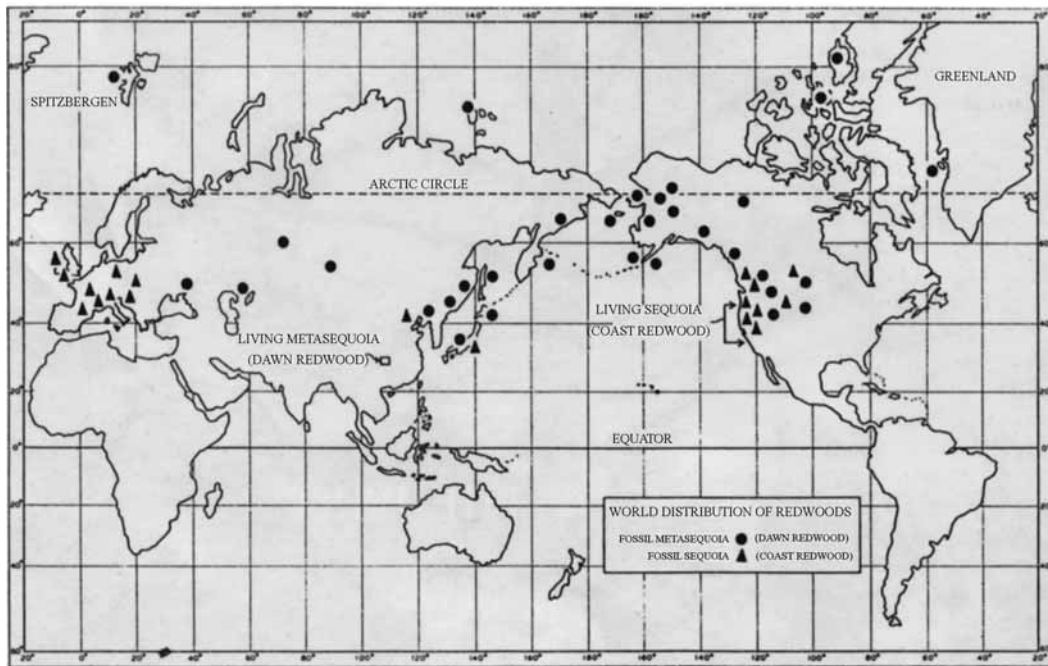


Figure 1. 1 Dawn Redwood at Modaoxi in Central China. Building at base is a temple (the tree is still there but the temple has been removed).

Figure 1. 2 Above; *Metasequoia* fossil twigs from the John Day Basin in Oregon ,imprinted in rock 30 million years old. About 1/2 natural size. Photograph courtesy Carnegie Institution of Washington.
 Bottom; Map Showing world distribution of redwoods according to fossil record.

The Redwood Forest

The redwood forest of the California coast contains trees whose age may be measured up to 2000 years, in the case of the largest and oldest. But the time represented by the life of even the oldest living Coast Redwood, *Sequoia sempervirens*, is only a fragment of the total history of its ancestors. The record of their history, occurring as petrified logs, impressions of leaves and fruits buried in the sediments of ancient lakes and valleys, goes back fully 100 million years.



Figure 1.3 Giant-sized *Sequoia* logs buried in volcanic ash and turned to stone in The Petrified Forest, Sonoma County, California. Photograph courtesy The Petrified Forest, Santa Rosa.

Geologically speaking, the Coast Redwood is a fairly late arrival on our shores, for its earliest fossil record in California is in rocks less than 20 million years old. Still earlier, wholly different trees lived here.

Most of these earlier trees have living relatives in Mexico and in Central America, where they have survived in a warm and humid climate no longer found at our latitude. Fig, palm, avocado, and mahogany were members of the subtropical forest which extended from California into Washington 50 million years ago and which disappeared from the United States as earth climate became gradually colder.

It was then, some 20 million years ago, that we have the first record of *Sequoia* in a temperate forest which oc-

cupied what is now the foothills of the Sierra Nevada. Its foliage and cones have been found in rocks deposited still earlier in Oregon and Idaho.

Canada and the Rocky Mountains were the home of redwood at an even more remote epoch, the Eocene, when so many trees and modern types of animals made their first appearance.

The famous petrified forest on Specimen Ridge in Yellowstone Park includes fossils of *Sequoia* trees which are fully 50 million years old. It is worthy of note that in England and other parts of Western Europe, *Sequoia* with foliage somewhat less delicate and spreading than ours was a common member of the Eocene forest.

While there appear to be no reliable records of *Sequoia* in arctic lands, it is clear that its distribution formerly covered areas far to the north and east of the California coast and that the redwood forest as we know it has been here during only the later chapters of earth history. A redwood forest 50 miles north of San Francisco, in what is now Sonoma County, was buried in volcanic ash about 5 million years ago. Here all of the trees were overturned. Their wood is completely preserved along with foliage and cones.

Another Kind of Redwood

At the time when the western United States was covered by a subtropical forest, redwoods of a kind different from ours lived in the far north. At many points in Alaska the climate appears to have been sufficiently mild to permit the growth of temperate forests containing oaks, walnuts, maples and other trees now living in the United States.

In northern Siberia, Spitzbergen, Greenland, and the arctic islands north of Canada, a similar forest left records of its occurrence in the rocks of lands now too cold for trees of any kind. With these deciduous hardwoods are found the fossil foliage and cones of redwoods of a northern type. This is now known as *Metasequoia*, the Dawn Redwood.

For many years the fossil redwoods from all these widely scattered regions in the northern hemisphere were considered to be identical with the living Coast Redwoods

of California.

In 1941 it was pointed out by Dr. Shigeru Miki, professor of botany at Osaka City University, that similar redwood fossils from Japan show an *opposite* arrangement of shoots, needles and cone-scales, whereas *Sequoia sempervirens* has a *spiral*, or alternate, arrangement. An additional difference is the attachment of the cones at the end of naked stalks instead of on needlebearing twigs.

A new generic name, *Metasequoia*, was applied to the redwood fossils with these characters, to distinguish them from the true *Sequoia*.

Fossil redwood cones attached to naked stalks had long been known from the rocks of North America but they had not previously been considered to belong to a genus other than *Sequoia*.

Living *Metasequoia*

In 1944 C. Wang, a forester employed by the Ministry of Agriculture of the Chinese National Government, came upon an enormous tree near the village of Modaoxi, in the province of Sichuan in Central China. Since he had never seen one like it, he took back to Nanjing with him specimens of its needles and cones.

Dr. W. C. Cheng, professor of forestry at National Central University, realized at once that these specimens represented a tree never before recorded by botanists in the forests of China.

Consultation with Dr. Hu Hsenhsu director of Fan Memorial Institute of Beijing, resulted in the amazing discovery that the foliage and cones of this tree were identical with the fossil specimens of *Metasequoia* from Japan and Manchuria. Here was a *fossil come to life* in the unexplored interior of Asia, a tree thought to have become extinct 20 million years before, a member of a race whose history is now known to extend back for a 100 million years into the past, to the days when dinosaurs roamed over the earth.

Never has there been a more dramatic botanical discovery than the finding of the living Dawn Redwood by forester Wang Chan.

Journey to China

My curiosity was aroused by reports of redwood trees in China. With Milton Silverman, science editor of the *San Francisco Chronicle*, I flew to Chongqing in late winter of 1948, went down the river by boat to Wanxian, and made the long walk south over three mountain ranges to the valleys and rice paddies where Dawn Redwoods were living. I was particularly anxious to see whether they were growing with the same kinds of trees I had found in the fossil record in the John Day Basin of Oregon.

So it was a great pleasure to see chestnut, oak, and maple, all members of the fossil flora, and also a tree found with *Metasequoia* fossils not only in Oregon but in Alaska, Greenland, and Spitzbergen—the katsura, now native only in eastern Asia.

I found that living Dawn Redwoods are especially numerous in the region known as Shuishanba, though none of the trees there is as large as the giant at Modaoxi, some 40 miles to the north. These occurrences are at the same latitude as New Orleans, and at an elevation of about 4000 feet.

Judging from climatic records of the nearest cities, freezing temperatures come infrequently, and rainfall reaches a total of about 50 inches a year, intermediate between that of Eureka and Crescent City in the redwood belt of California. But unlike the rainfall of the California Coast, most of the precipitation in Central China falls during the summer. This accounts for another surprising characteristic of the Dawn Redwood: unlike the Coast Redwood which bears its foliage for three or four years, the Dawn Redwood sheds its leaves in the fall, and buds out with a new crop of leaves in the spring. Like its hardwood associates in the valleys of Sichuan and Hubei, the oaks, maples, and chestnuts, *Metasequoia* is a *deciduous* tree rather than an *evergreen*.

Even at a distance the redwoods of China can be distinguished by their ascending branches. Our Coast Redwoods show horizontal branching and many trees have branches reflexed.

This trip, financed by the Save the Redwoods League, was one of the most profitable I ever made, for it resulted in firsthand knowledge of the forest in which Dawn Redwood is living, and made possible a start on the conservation of this rare tree in

its native home.

Recent word (spring of 1965) from continental China tells of government plans to set aside this area as a permanent reserve on somewhat the basis of our national parks. Commercial planting of *Metasequoia* south of the Chang jiang River is also reported.

Metasequoia Planting Experiments

The deciduous habit of *Metasequoia*, surprising in the light of our previous knowledge of the American redwood, led paleobotanists to consider the possibility that the redwood of China might live in regions much colder than Modaoxi and Shuishanba. The only way to answer this question was to see how far north seedlings would grow.



Figure 1.4 The three leafless trees to the left are *Metasequoia* at Shuishanba, Central China, growing beside a rice paddy. To the right are chestnut trees. *Metasequoia* leaves appear in April or May.

In 1948 small trees raised from seeds brought from China were planted in the Pacific Northwest; when reports from foresters in British Columbia, Washington and Oregon indicated that these seedlings had survived the winter there, additional trees were sent to southeastern Alaska. The winter of 1949 ~ 1950 was an exceptionally cold one in that region, but the spring of 1950 brought the report from R. F. Taylor of the United States Forest Service that nearly all the small trees were still living, though some were still partly buried in the snow as late as May. Clearly *Metasequoia* is a tree suited to live in regions much colder than its present home in China.

Redwood Distribution

Study of *Metasequoia* and other vegetation of the past indicates that a gradual cooling and drying of the earth has taken place during the past 50 million years. Forests and the animals which lived then have been shifting slowly southward. Thirty or forty million years ago the climate in western United States became sufficiently temperate to eliminate most of the earlier tropical trees. In their place there came down from the north the Dawn Redwood.

In eastern Oregon, where today rainfall is sufficient only for growth of scattered juniper trees and sagebrush, there lived in Miocene time both the Dawn Redwood and the immediate ancestor of our Coast Redwood. Since then the Cascade Range has been raised and great lava flows have covered the areas in which these redwoods lived. Their fossil remains may be found where the John Day and other rivers have cut through the lavas and exposed the sediments containing them at the surface.



Figure 1.5 *Metasequoia*; eight years old (planted in Cleveland Ohio in 1948). Photograph courtesy C. H. Fields.

The Cascades to the west now prevent rain-bearing winds from reaching this region, which is today a semi-arid plateau as a result. Instead of a redwood forest, with ferns and azaleas covering the ground, the vegetation is of a type suited to long months of drought or cold.

This change in plant life records a series of major episodes in the history of western America, in the course of which our mountains have been uplifted and the whole aspect of the country altered. Before redwoods can again live in eastern Oregon and in adjacent areas, the Cascade Range must be worn away by the slow process of erosion. Only then will the winds from the Pacific bring to this semi-arid region the rains which are necessary for the growth of *Sequoia* and *Metasequoia*.

How Long Will Redwoods Survive?



Figure 1.6 Son of Wu, Headman of village of Shuishanba, Hubei, China, standing at the base of the native *Metasequoia*. Photograph taken by Dr. Chaney, March, 1948.

Problems of survival are among the most difficult which the paleontologist is called upon to solve. Why the Redwood has disappeared from the whole of the earth except in several secluded valleys of Central China, why the Coast Redwood is confined to the borders of the Pacific in California and Oregon, are questions which answered only after much further study.

We may suppose that the combination of temperature, rainfall, and topography most favorable to the growth of *Metasequoia* has persisted only in the Red Basin of Sichuan. But it must also be borne in mind that this inaccessible area is one of the few regions in China which has not been cleared of its forests by the land-hungry millions of Chinese farmers. Were it not for the remoteness of

Shuishanba, all of the Dawn Redwoods might have been cut down centuries ago, and our knowledge of this tree would be confined to what we can learn from its fossil remains.

Fortunately, in the case of the *Metasequoia*, it was discovered before becoming extinct. Since then thousands of tree have been distributed in America Europe, and Asia by Save-the-Redwoods League and the Arnold Arboretum. The trees grow rapidly, are attractive for street and ornamental planting, and may prove to be an important source of wood pulp. In Japan many *Metasequoias* are planted near schools, museums and temples. In future ages there may once again be noble forests of Dawn Redwoods over wide areas where they once lived in the past.

As for the Coast Redwood, it is making its last stand on the borders of the Pacific, where rain falls in abundance during the mild winters and where fogs supply necessary moisture during the dry summers. The environments in these regions of survival give us major clues as to the nature of the earth in the remote past, before man came to live upon it.

In a world which will continue to change, there is no basis for predicting with certainty what forests may occupy our Pacific shores in the remote future. But surely for many centuries the Coast Redwoods, set aside in California State Parks, will continue to stand as living examples of conservation made possible by contributions to the Save the Redwoods League from people all over the world.

About Ralph W. Chaney

Ralph W. Chaney (1890 ~ 1971), Pro-



Figure 1.7 Dr. Ralph W. Chaney and Chinese official standing at the base of the Dawn Redwood Discovery Tree, Modaoxi, Sichuan Province, China. They are examining a leafless twig and cones from this rare botanical discovery. Photograph taken by Dr. Milton Silverman, Science Writer for the San Francisco Chronicle, March, 1948.

fessor of Paleontology at the University of California, Berkeley, and President of the Save the Redwoods League from 1961 to 1971, was a world famous expert on prehistoric plant communities. He was also one of the world's foremost authorities on both fossil and living Redwoods. He hoped that a Dawn Redwood sanctuary could be established in China, so that this member of the Redwood family would be protected as its relatives are in California's Redwood Parks. Sadly, at the time of Dr. Chaney's death he thought this protection would be impossible. In 1980, however, American botanists visited the area in which the Dawn Redwoods grow. They were the first foreigners to see them since 1948. They found the Metasequoias flourishing. No Metasequoia was allowed to be cut, and five forest workers were employed to look after these Chinese national treasures.

About Save the Redwoods League

Since it was founded in 1918, the Save the Redwoods League has raised more than 65 million dollars from contributors all over the world. These funds have been applied to help purchase more than 260,000 acres of Redwood forest lands for the 32 California Redwood State Parks, for Redwood and Sequoia National Parks, and for other public Redwood parks in California. Much is still to be done to complete these Redwood parks and protect our magnificent Redwoods for public enjoyment for centuries to come.



Figure 1. 8 Save the Redwoods League. 114 Sansome Street, Suite 1200, San Francisco, California 94104, [www. savetheredwoods. org](http://www.savetheredwoods.org).

Section 2 The Chinese Redwood

William Gittlen

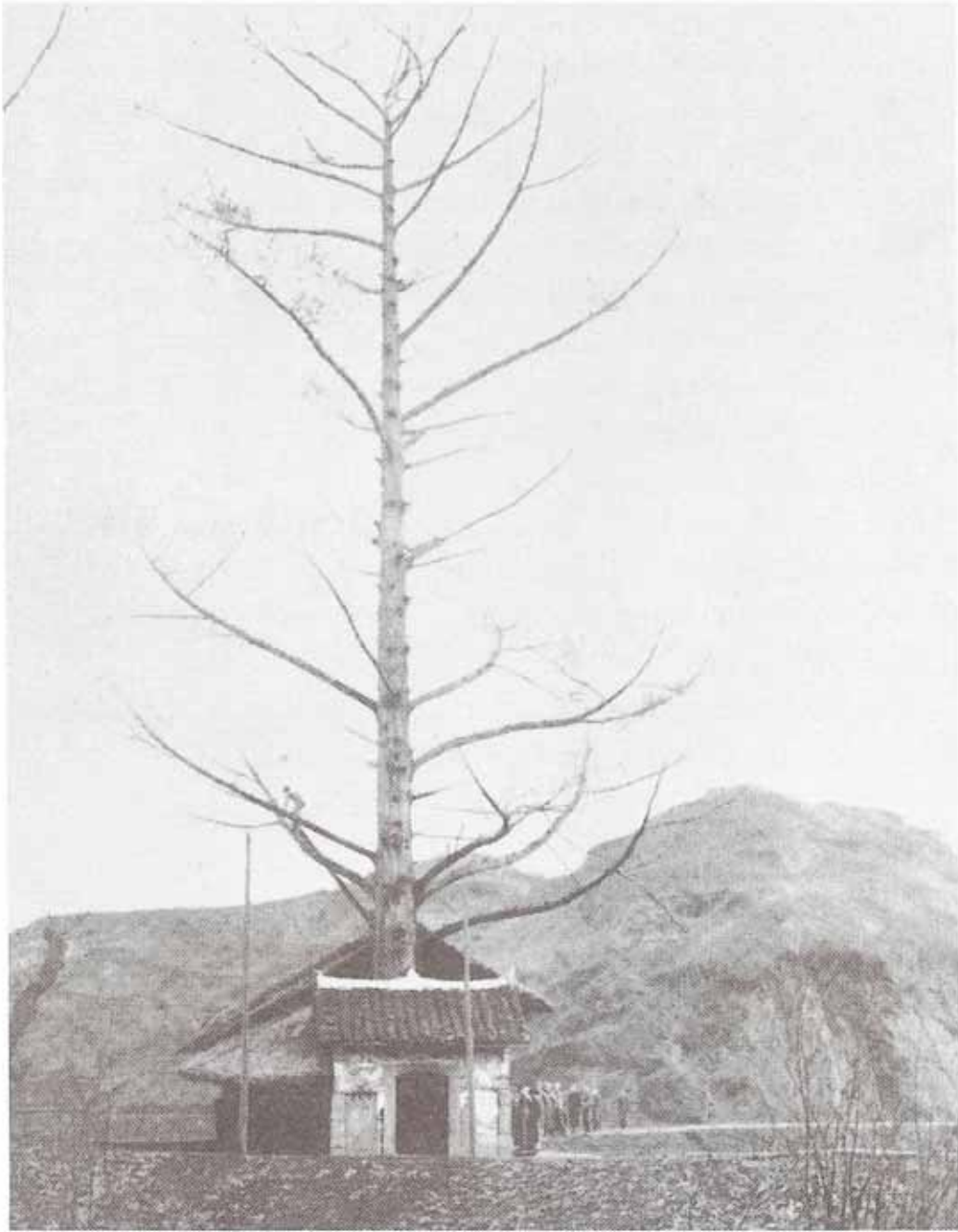


Figure 1.9 The type tree and its temple, Modaoxi (Modao Creek), 1948. Photograph by Ralph Chaney.

I. Discovery

My search for the dawn redwood began while jogging through a park near my home in the East Bay of the San Francisco Bay area. It was a case of good timing. Along the edge of the path were a series of signs relating the story of a University of California, Berkeley professor traveling to China to identify the dawn redwood, a third type of redwood tree. The story was fascinating. It stopped me in my tracks.

I read enough of the display to learn that the professor had traveled in China under most difficult conditions. He had hiked several days through high mountains in the hinterland of rural China. It was the 1940's, and in this area of central China there were roadside bandits, and homeless refugees. As I continued my run, I conceived an idea. How interesting it would be to retrace his steps fifty years later to learn if the magnificent trees that the professor had traveled so far to see were still standing. How different would China be at the end of the twentieth century? The past half century of xenophobic policies had created a land of mystery to the outside world. What would the villages and towns he visited be like today? People in the United States know so little about China, by far the most populous country in the world. As interesting as the status of the trees would be the conditions of the towns, the customs and culture of the inhabitants, and the views of the hills, mountains, rivers, and valleys along the way. Surely the man kept a diary of his travels.

Unfortunately, when I returned to the parkway less than a week later, the placards I had so recently chanced upon had been removed. In their place had been planted a cluster of small trees. Next to them stood a label that read: "Dinosaur Forest." Only later was I to learn that the dawn redwood itself was a holdover from the Cretaceous period, the age of the dinosaurs.

I decided to visit the U. C. Botanical Garden, a jewel of the East Bay hills. Run by the university, there are over twelve thousand species of plants from all over the world growing on thirty hillside acres. The Garden was founded in 1890 by botanist Edward Greene, who realized that not only redwoods, but the entire legacy of California's indigenous plants was falling prey to encroaching civilization. This Garden

was on the main campus, and by 1892, over five hundred native trees and shrubs had been planted. In the 1920's, momentum grew to enlarge the Garden and move it to its present site in Strawberry Canyon.

The area of California native plants in the Garden contains one quarter of the state's five thousand species, including one hundred thirty kinds of plants that are rare or endangered. The Garden is a leader in cultivating and propagating threatened plants from California as well as from around the world. Surely someone here must have information about the dawn redwood.

A curious peek and timid introduction in the gift shop led to my being delivered directly into the heart of the back offices. There, several people were mesmerized by computer screens, each at his own desk working silently alone. Yet, here were people who knew of the professor's trip—professor Ralph W. Chaney, that is. A discussion developed among the people in the office. The staff said they didn't think they had much in their files, but what they did have they would send me. I was handed the business card of Elaine Sedlack, horticulturist, and I was told she would be able to tell me more.

Best of all, right here in the U. C. Botanical Garden, down the path to the bridge over the creek, there were seven dawn redwoods that had been brought back from China in 1948 by Dr. Chaney himself, and planted here in Berkeley. Over the years, I had been to this garden many times. In early spring there was the extraordinary bloom of the tree-sized rhododendrons bursting forth in purple, red, white, and pink blossoms. In the summertime, the Central American portion of the Garden offered acrobatic aerial displays by hordes of hummingbirds. Tree ferns, lancewood, flax and even the small kauri trees of the Antipodes appeared happy growing in Berkeley's Mediterranean climate. And every March, the walk up the creek to the Japanese pool allowed observation of newts coupling together among the large lily pads. However, on all of my prior visits, my eyes did not see what I was now looking for.

On this day, I walked along the creek and then, just above the bridge, there they were—my first known sighting of dawn redwoods! They were at least eighty feet tall, and being late spring, were in full foliage. Unlike sequoia trees and most other con-

fers, these redwoods are deciduous, losing all their needles every fall. In fact, when Chaney first found the dawn redwoods in China, it was at the end of winter, and all the trees were bare of greenery. But that's getting ahead of the story.

Dawn redwood needles have a softer and more limp look than the coast redwood and the giant sequoia. The bark too, is quite different; still red, but finer, less coarse, giving the tree a very gentle appearance. Unlike the coast redwood, the base of the dawn redwood does not sprout, which allows a clear view of the attractive trunk. The branches themselves begin lower on the trunk than their "American" counterparts, and tend not to be as thick in diameter. The overall silhouette is distinctive also, with the branches tending to curve upwards, presenting a somewhat optimistic visage. I touched each of the trees with the palms of my hands. They felt smoother than the redwoods of California. It was quite inspiring to think that these very trees had been hand-carried by Dr. Chaney from China fifty years ago.

My next step was a telephone call to Elaine Sedlack who offered a wealth of additional information. She indeed knew about Dr. Chaney's journey in the 1940's. He had traveled to the area with Milton Silverman, a science writer for the *San Francisco Chronicle* newspaper. Indeed, the trees at the Botanical Garden, all with their feet by the creek, were brought back from China by them. She did not know whether the trees were planted from the several small seedlings that they hand-carried or propagated from seeds, which they had also collected. Other trees had also been planted in other parts of Berkeley. A dawn redwood could be found at the Dwight Way and Derby Street area of the U. C. campus; two trees were behind the Northbrae Community Church; one was on a residential street at the top of the Berkeley hills; and one lived at Live Oak Park.

Ms. Sedlack, an energetic, knowledgeable, and dedicated botanist, knew of at least two other expeditions to the group of big trees in China since the time of Dr. Chaney's trip. She proved to be quite engaging and enthusiastically helped me in my quest for more information. There was the 1980 Sino-American expedition, led by then curator of U. C. Botanical Garden, Bruce Bartholomew, which visited the area and returned with more seeds. Ms. Sedlack had a list of the understory plants brought

back from the 1980 expedition, and one of her tasks at the garden was to create a more complete environment in the area of the great trees with some of these plants. She also provided an introduction to Bill McNamara, an Asian plant collector who had traveled to the area only one year prior.

I made pilgrimages to each of the local trees Ms. Sedlack had disclosed. What a joy to be able to ride my bicycle to nearby Live Oak Park to admire its towering dawn redwood. I took photographs with my bicycle propped up by its roots to show the extraordinary size of this tree, which was not quite fifty years old. My favorite tree was the lone dawn redwood along Dwight Way by the side of the old California Institution for the Deaf and Blind. Delightfully symmetric, it appeared quite majestic standing alone in the middle of a large lawn.

Each of my sojourns to the individual trees proved to be as inspiring as my first sighting at the Botanical Garden. I even learned of still more local dawn redwoods, and I visited each of them; two by McCone Hall on the U. C. main campus; five at the Lakeside Horticultural Center by Lake Merritt; three at Oakland's Mosswood Park, seven at San Francisco's Strybing Botanical Garden; and another tree growing at Point Reyes. Point Reyes, a National Monument of mostly wild lands on the Pacific coast, is in nearby Marin County. As I walked along the creek in Bear Valley near the center of this peninsula, the lone dawn redwood growing there stood out from the rest of the forest. Seeing the tree for the first time brought me the same joy as greeting a long-lost close friend. These dawn redwoods of the Bay Area, all descendants of a tree growing in a remote area of central China, now grew near my home, standing straight and tall, strong against the wind, undamaged by earthquake or fire, silently witnessing the daily human hub-bub with complete equanimity. While we humans soothe our egos with the belief that we are earth's only sentient beings, the serenity and steadfastness of these great trees moved me to feel that our species may not have all the answers. I was becoming increasingly determined to travel to their place of origin.

Two more areas of investigation proved fruitful and provided me with the necessary background to go exploring in China. First, the Bancroft library. Founded in 1859 by Herbert Howe Bancroft, a California bookseller and historian, the University of

California assumed control by purchasing his entire collection in 1905, and it has continued to acquire more items ever since. There are original letters and diaries of early California explorers including Father Serra, Gasparde Portolá, and Juan Bautista de Anza. There are archives of Mariano Vallejo, John Fremont, John Sutter, and the Donner party. In all, there are nearly sixty million manuscripts, plus more than a million photographs, paintings, drawings, maps, and periodicals—all of which document the history of North America's far west. If there was any further information on Dr. Chaney or the Sino-American expedition to the dawn redwoods, I hoped I would find it there. True, I was searching for information regarding expeditions to a place half way across the globe. But wouldn't the library want to document significant journeys undertaken by California scientists?

Once within the inner sanctum of the library, I uncovered several relevant articles. There was a volume of collected reprints of works by Dr. Chaney. This included a transcription of an interview with him from a Regional Cultural History Project. Besides providing further details about the dawn redwood, known to scientists by its scientific name, *Metasequoia glyptostroboides*, also included was a certain amount of personal information about Dr. Chaney and his three offspring, even the professor's Berkeley address. He lived in Berkeley from the time of the 1920's to the time of his death in 1971, raising his family, lecturing at the University, and traveling throughout the world to do his scientific research.

A fruitless path of investigation was contacting the *San Francisco Chronicle*. If the science writer from the Chronicle accompanied the renowned paleobotanist to China, surely he must have written reports for publication. Unfortunately, the newspaper's telephone answering machine reported that the library no longer had a librarian or provided informational services to the public.

My luck improved at the San Francisco Library. Here there were back issues of the *S. F. Chronicle*, with reels of microfilm holding every edition all the way back to 1865. The index to the newspapers could have been missing, but the one and only copy was exactly where it was supposed to be. The microfiche card containing the table of contents from "Silver, Price" to "Simpson, Herbert" could have also been

misplaced, but there it was, with three entire cards listing articles by Dr. Milton Silverman. The reels of microfilm for March and April 1948, could as easily as not have been stolen or mishandled, but there they were, in pristine condition. And the library's printer was functioning, allowing instant copying of one quarter of a page of newspaper at a time. Despite all the potential snafus, I had in front of me on-the-spot accounts of their expedition.

There were five articles by Dr. Silverman on his journey with Dr. Chaney. The first two were front-page stories, relating in great detail both the success of their expedition and the trials and tribulations of their passage. They had bureaucratic delays in obtaining transport; they had experienced rigorous conditions along their ten-day trek (whereas a few hour walk had been predicted); they had suffered lodgings replete with vermin; and they had dangerous encounters with bandits. Nonetheless, their expedition achieved its goals of observing dawn redwoods in their natural state and returning with seedlings. When they first saw the four metasequoias (including a small seedling) growing on the edge of rice paddies near the village of Modaoxi, they were shocked to discover that unlike other redwoods, these trees were deciduous. Being March, the trees were devoid of all foliage. The largest tree they saw was considered by the locals to contain a holy spirit, and the villagers had built a temple at its base. The scientists continued on two difficult days to Shuishanba where they found intact groves of trees living in their natural ecological niche among hardwoods: chestnut, birch, oak, maple, and katsura (*Cercidiphyllum japonicum*). The newspaper accounts even described how upon his return to Honolulu, Chaney convinced customs officials to call the seedlings "antiques" in order to allow importation. Importing plant material was prohibited, but there were no laws governing the importation of living fossils.

At the time, the story made headlines, followed by several more days of front-page news. There were maps and photos and dramatic, well-written accounts highlighting both the amazing nature of their feat and the hardships of their journey. In Dr. Chaney's words, "To me finding a living dawn redwood is at least as remarkable as discovering a living dinosaur."

My initial excitement of the possibility of recreating the journey was multiplied. Their expedition had been exotic, dangerous, remote, and successful. So could mine be today. I would hike along treacherous paths, over high mountain passes, and deliver to the local villagers photographs of their kin taken fifty years ago, as well as photos of dawn redwoods, descended from their tree, which were alive and well in California.

The only disappointment thus far was not being able to unearth an actual diary of the journey. I deposited a letter in the mailbox of the Berkeley hills home that had been the residence of Dr. Ralph Chaney and his family during his years as a Berkeley professor. A very polite man called me that very day, eager to talk, but with very little information to impart. He had lived in the home since 1976, and he was aware that Chaney had planted several dawn redwoods on the property. Unfortunately, in the intervening years since Chaney had passed away, the trees had been neglected and had died. When the current owner moved in, they had already been cut down and removed. Of course, I wondered to myself, had they really died? I hoped they had not merely been presumed dead and then destroyed simply because they were observed in their winter phase. Such a tragedy had occurred in other places. In the 1995 *Discovery Magazine*, a publication of the Royal British Columbia Museum, author Thor Henrich wrote, "But as a conifer which sheds its needles in winter, its unusual nature has lead some unknowledgeable gardeners to uproot them, thinking they had died." A report from O. S. U. 's Chadwick Arboretum stated, "Homeowners will call our office in the fall concerned about the decline of their tree and we reassure them the tree is not dying, just losing its leaves until spring."

The current homeowner also knew nothing of the three Chaney children: Richard, Ellen, or David. I had no further way of attempting to contact them. As they were born between 1919 and 1923, it was even possible that they were no longer living. At the time of the cultural history transcription in 1959, all three resided in other areas of California.

Since the *San Francisco Chronicle* no longer had a librarian, I wrote Herb Caen. He had been a colleague of Dr. Silverman's in 1948, and he might possibly know his

current whereabouts. Within a few days I received a telephone call from Carole Vernier, one of Mr. Caen's staff, who informed me that Dr. Silverman had just died five days prior, and his obituary had appeared in the newspaper two days before! The obituary reported that Dr. Silverman had a Ph. D. in pharmacology and had originally headed for a career in medicine. He had won many journalism awards, but he "gained international renown along with Ralph Chaney, for an adventurous expedition they led in 1948 to one of the most remote parts of China's Sichuan province, where they discovered a family of trees long thought to be extinct." I felt badly about Dr. Silverman's death so close to the time that I might have been able to talk with him. In the following pages I am certain that I am able to relate only a small portion of the stories that he would have been able to tell me.

Living Fossil Dawn Redwood



Figure 1. 10 The dawn redwood of Live Oak Park , Berkeley , CA , 1998.

The Chinese Redwood

Living Fossil Dawn Redwood



Figure 1. 11 From the San Francisco Chronicle, April 5, 1948.

II. The Man and the Tree

My growing excitement that accompanied the gradual unraveling of this fascinating adventure could not compare with Dr. Chaney's enthusiasm fifty years earlier.

Dr. Chaney was a renowned paleobotanist. Born in Chicago in 1890, he began to reside in Berkeley in 1922. As a research associate of the Carnegie Institute, he had become the Honorary Curator of the University of California's Paleobotanical Collection. Besides lecturing at the university, he traveled to various parts of the world on field excursions to obtain material to enrich the collection. He had visited Central and South America, China, Korea, Japan, and the Philippines.

Chaney was but one member of the largest of all Mongolian expeditions. Led by Roy Chapman Andrews, this group of scientists left Peking for the Gobi desert in 1925 with one hundred twenty-five camels, numerous vehicles, and tons of supplies. After being disappointed by his inability to find much of interest in Mongolia, Chaney traveled to Manchuria. Ironically, while there he had found and collected fossil specimens of dawn redwoods without really knowing what they were. No one did then. The scientists were not yet aware that there was a separate genus of metasequoia. Dr. Chaney believed he was looking at a fossilized version of an earlier type of sequoia tree.

In the 1920's there were only two known genera of living redwood trees, each with only one species. The first written record of any such tree was by Juan Crespi, the Franciscan missionary who accompanied Spanish explorer Gaspar de Portolá on his 1769 journey of exploration from Baja California to Monterey Bay. "In this region there is a great abundance of these trees, and as we know not the names of the trees, we gave them that of the color of their wood, *palo colorado*, redwood." Seven years later the De Anza expedition entered San Francisco Bay, and its diarist, Pedro Font, documented a very high redwood "rising like a tower." Both of these men were describing coast redwoods, *Sequoia sempervirens*. Font measured the tree his group had discovered and found it to be one hundred thirty-seven feet, six inches tall and at the base fourteen feet, nine inches in circumference. The tree still stands in a town named

after this tree, Palo Alto. Because of the beauty of the wood, Father Juniper Serra, the founder of the California missions, made a special request to be laid to rest in a redwood coffin.

The other genus of known living redwoods was the giant sequoia, *Sequoiadendron giganteum*. Today these trees are found in only seventy-two isolated groves on the western slopes of California's Sierra Nevada range. These trees were used by the indigenous Americans prior to the middle of the nineteenth century for shelter, clothing, transportation, tools, and as symbols in their religious practices. The Mono Indians thought the tree sacred and deferred from using them at all. The Miwoks had taboos against disturbing living trees, but used their fallen bark and branches.

The first written record by a European of these great trees of the mountains was by a Pennsylvania printer, Zenas Leonard, who in 1833 had accompanied the explorer Joseph Walker on the first east-to-west crossing of the Sierra Nevada by whites. Once back in Pennsylvania in 1839, Leonard published his account of some large trees they had encountered without identifying the location: ". . . found some trees of the redwood species, incredibly large—some of which would measure from 16 – 18 fathoms [one fathom equals six feet] around the trunk at the height of a large man's head from the ground." It is believed that he was describing trees found in today's Mariposa Grove within Yosemite National Park. This discovery went completely unnoticed, and within a few years of this publication, his Clearfield, Pennsylvania print shop burned to the ground. Luckily, two copies of his account were saved and reprinted in Cleveland in 1904.

The first account of the giant sequoias that received notice by the general public was the story of A. T. Dowd, a professional hunter. He had been hired by the Union Water Company to provide cheap food for its workers who were building a water project to serve the needs of the gold mining boom town of Murphys, California. Dowd shot and wounded a grizzly bear, and in tracking it was led to the base of a massive sequoia in what is now known as the Calaveras Grove in Calaveras Big Trees State Park. He was absolutely flabbergasted by the size, but he had difficulty in convincing others of the veracity of his find. The only way he could get others to believe him was

to lure them to the area with a story that he had killed a great bear and needed help to carry it out. "There is the large grizzly," he shouted, pointing to the great tree. The glory of this 1852 discovery was short-lived for within a few weeks, sightseers who came to the grove found another tree with "J. M. Wooster, June 1850," carved into the bark. However, even Wooster also could not take credit for the "discovery". He later admitted that he had gone to the grove twelve days after hearing about the big trees from friends who had seen them while hunting.

While the giant sequoias are found only in the mountains of eastern California, the *Sequoia sempervirens* are found in a narrow band that stretched along the Pacific coast from southern Oregon to central California. The largest and oldest of these trees had been dated to be about two thousand years old. However, the fossil record of these same trees goes back almost twenty million years.

Greater than twenty million years ago, there were completely different kinds of trees living in California and Oregon. The climate was warmer, and trees such as figs, palms, avocado, and mahogany grew in subtropical forests that covered the western United States as far north as the state of Washington. At the same time, the climate of the Arctic region was sufficiently mild to contain temperate forests of oak, walnuts, and birch. With these deciduous hardwood trees, scientists have found fossils of foliage and cones of a third type of redwood that was considered to be an ancestor of today's redwoods of California.

In fact, fossilized redwoods have been found all over the northern hemisphere. The first such fossil was discovered by the father of paleobotany, Adolphe Brongniart, in 1828 in France. Since then, others have been found in Greenland, Iceland, the British Isles, Switzerland, northern China, Japan, Scandinavia, Siberia, the Aleutians, Alaska, Canada, and across the United States from eastern Oregon to New Jersey. Fossils found in the Arctic have been dated from the Cretaceous period, one hundred million years ago. The trees lived in these northern regions as late as the Eocene epoch of the Tertiary period (forty to sixty million years ago). During this period, mammals first appeared. Fossils of the trees have been found in Japan dating from sixty million years ago, those in Switzerland from forty million years ago, and in

Oregon from thirty million years ago (the Oligocene epoch , which dates from about forty to twenty-five million years ago). Metasequoias disappear from the fossil record completely by the end of the Miocene (twenty-five to five million years ago) and beginning of the Pliocene (five to two million years ago) ; no dawn redwood fossils appeared anywhere in the world in rocks younger than the Pliocene. Dr. Chaney himself had extensively studied the “sequoia” fossils from the Miocene era found in the John Day area in eastern Oregon.

It was Dr. Chaney’s theory that during Cretaceous times , the northern parts of Europe , Asia , and America had a temperate climate not unlike that of northern California today. As the Arctic winters turned colder , plant communities migrated south. Dawn redwoods probably survived better than other conifers because of being deciduous and , therefore , better able to adapt to the colder conditions. As the ancient seas shrank or disappeared , new areas of land became uncovered , allowing these migrating communities of forest to invade and survive.

Only in the protected valleys of Sichuan and Hubei provinces did metasequoias survive in an otherwise unfavorable world. It became apparent to Chaney after his trip that these isolated valleys were the only places in today’s world with the necessary climatic conditions for the dawn redwood to thrive ; a mild uniform climate with a summer rainy season. In the south of the United States where there are similar wet summers lives a close relative of the dawn redwood , the swamp cypress (*Taxodium distichum*). However , the winters are cold there with temperatures frequently below freezing. In California , there is a mild uniform climate , but for the most part the summers are dry. An exception is along the coast where summer fog provides the moisture needed for the coast redwoods’ survival.

The mountain ranges surrounding Shuishanba and Modaoxi protected these areas from the cold winter winds of northern China as well as the hot summer winds that would otherwise come from the north and west. It is compelling that these mountains were formed during the Pliocene when metasequoias disappeared from other parts of the world. It is these mountains that preserve the proper climate in this limited area. If the climate were to change , the trees there would become extinct , as they had in all

other parts of the world. It was the existence of intact groves of the metasequoias living with other trees from the fossil record in the valleys and ravines of Shuishanba under specific climate conditions that allowed Chaney to substantiate his theory of shifting climatic conditions in geologic time.

At the same time of Chaney's early work in Oregon, the fossil record was being more accurately classified. As early as 1928, a Japanese man named Seido Endo pointed out that certain fossil cones were not properly referable to *Sequoia langsdorfi*, as had been the conventional wisdom. He assigned them to a new species: *Sequoia chinensis*. These same types of cones had been studied by Dr. Chaney in the John Day Valley. He had thought them *Sequoia langsdorfi*, an ancient species of the same genus as our current American redwoods. In 1936, Endo further delineated characteristics of these cones from deposits in Japan and Korea, all of which proved to be consistent with diagnostic characteristics of the genus *Metasequoia*, a new term recognized and coined by Shigeru Miki five years later. Miki realized that these unique features were sufficient to create a separate genus: the *Metasequoia*. The trees had an opposite arrangement of the leafy twigs and cone scales and the cones were attached to tree branches by long stems called peduncles. Because Miki, a professor of botany at Osaka City University, wrote his paper in 1941 during WWII, there was a further delay of five years before this new classification reached the scientific community in the United States.

Miki showed that these unique features of the redwood fossils of Japan differed sufficiently from *Sequoia sempervirens* to justify a new genus. All the scientists who read his paper immediately agreed. Revisions then had to be made in the analysis of the fossil record, and it turned out that the fossils discovered across the northern hemisphere from Greenland to Iceland and from Siberia to Alaska and the continental United States were all *Metasequoia*. Whereas the fossils of *Sequoia sempervirens* stretched back twenty million years, the fossil record of the metasequoias reached from twenty to one hundred million years ago.

Ironically, one of Chaney's students wrote a term paper that recognized a new kind of "*Taxodium*" three years before Shigeru Miki's publication. In 1951, Chaney

recollected, “Meanwhile there were some misgivings regarding the status of fossil cones of *Sequoia heeri* collected in the Bridge Creek flora and at Elko, Nevada, in beds of Oligocene age; these cones, attached to long, naked stems, differed so much from those of the living *Sequoia sempervirens* that James F. Ashley, a graduate student at the University of California, actually stated in an unpublished course report (1938) that they might properly be placed in a genus intermediate between *Sequoia* and *Taxodium*.” Chaney went on to write that neither he or anyone else realized the significance of this work at the time.

At the exact time that the new genus of *Metasequoia* was being recognized, rumors arose regarding a new kind of large coniferous tree growing in Sichuan province of central China. A Chinese forester from National Central University named T. Kan chanced upon a new type of deciduous coniferous tree in the winter of 1941 in the village of Mo-tao-chi. It is incredible that 1941 is the exact year that Miki coined the term *Metasequoia*. Kan asked a local schoolteacher named Lung-hsin Yang to collect specimens when foliage was available. Specimens were collected, but never identified and were probably lost. Yang mentioned the unusual tree to Tsang Wang of the Central Bureau of Forest Research of China, who visited the area in 1944 and brought back leaves and cones. Some of these were given to Dr. Wan-Chun Cheng of the National Central University in Nanking. His assistant, C. Y. Hsieh, was then sent to the area twice in 1946 to make additional collections. Unlike the Americans, Hsieh traveled alone. “Since we had no funds and everybody was quite hard-up, I could only go to the place on my own, carrying a few pieces of simple baggage and specimen clips,” he later wrote. His trips were perhaps more harrowing than any of the later expeditions. Alarmed by stories of bandits and murder, he continued on “despite hunger, thirst and exhaustion.” Although he was excited to finally arrive at the tree, it was winter, and he saw only the “withered and yellow appearance of the whole tree. . . My excitement cooled,” he reminisced. It hadn’t occurred to him to consider in advance how he was going to obtain seeds. There he was, cold, hungry, and exhausted from the rigorous trek, standing under the eighty-foot trees from which he had been sent to collect specimens, with no tools, and the lowest branches twenty to thirty

feet over his head. What was he to do?

Fortunately, he must have had a strong arm, as he succeeded in knocking down branches from the tree by throwing rocks, branches that were loaded with yellow male cones and also some female cones. It could have turned out differently. He could have been killed by bandits or even attacked by villagers for assaulting the tree which they believed contained a holy spirit. But for his success, the dawn redwood is not extinct today.

Mr. Hsieh succeeded in collecting enough material to enable Dr. Cheng to send some to his friend Dr. Hu Hsen-Hsu, Director of the Fan Memorial Institute of Biology in Beijing. Dr. Hu had read Miki's paper, and he made the remarkable connection that this newly discovered living tree in remote central China was the identical plant that Miki described as a fossil in Japan. Dr. Hu had been a student at Harvard in the 1920's, and in 1946 he sent some of the specimens to his old mentor, Dr. Merrill of the Arnold Arboretum. It was through Dr. Merrill that Ralph Chaney learned of the discovery.

Dr. Chaney repeatedly asserted that the five Asians—Wang, Cheng, Miki, Hsieh and Hu were really those responsible for the discovery of living metasequoias, not Dr. Silverman and himself. In his writings, Dr. Chaney also lauded the contribution of Dr. Elmer D. Merrill, Director of the Arnold Arboretum from 1935 ~ 1946. Although not traveling to China himself, Dr. Merrill arranged a grant to support additional field work in central China by Mr. Hsieh and C. T. Hwa, under the guidance of Dr. Cheng. Interestingly, the grant was only for two hundred and fifty U. S. dollars, which because of inflation at that time in China was worth nine million seven hundred fifty thousand “dollars” in Chinese currency. The money for the grant actually came from a fund Dr. Merrill had at his disposal, the “Arnold Arboretum Restricted Chinese Exploration Fund,” provided by a Mr. Harrison Smith of Tahiti, himself a graduate of Harvard in 1925 and long interested in Chinese matters.

The possibilities for “what if” logic are endless in this international path of financial support. It is not at all far-fetched to consider that without further funding, the *Metasequoia* could have gone on to extinction within the next few years to dec-

ades. Dr. Cheng later wrote a letter of thanks to Dr. Merrill, stressing that without the two hundred fifty dollar grant, the third exploration by Mr. Hseih would not have been possible.

The grant was made, the collections did take place, and ample specimens of foliage and cones reached Dr. Merrill in 1947, supplementing the small specimen sent to him in 1946. Following established practice of the Arboretum, packets of seeds were widely distributed to institutions in the United States and Europe. The Arnold Arboretum had been successful in germinating seeds; now they hoped to see if metasequoias, on the verge of extinction in China, would prove hardy enough to grow in various locations around the world.

It was by receiving these seed packets that Dr. Chaney first learned of the existence of this tree, a tree he had thought had been extinct for over twenty million years. The seeds from Merrill arrived within weeks of seeds and foliage that were sent directly to Dr. Chaney by Dr. Cheng, the latter having been collected by the 1947 expeditions funded by Merrill. I could imagine the excitement in Dr. Chaney's office when these seeds from China arrived. Dr. Silverman of the *Chronicle* happened to be in his office at the time. This newspaper reporter was in the midst of conducting a series of interviews with Dr. Chaney in order to write a series of articles about paleobotany for his newspaper. Dr. Silverman reported that within ten minutes Chaney was looking at maps of China and trans-Pacific airline schedules. "If this is confirmed," he told Silverman, "it will rank as the greatest botanical discovery of the century."

As of 1948, no leading scientist had yet seen the actual trees; all of the classification and identification had taken place on the basis of bits of foliage and cones. Dr. Chaney reported that Dr. Merrill was too old to consider going at the time, but "I jumped at the chance." Chaney was excited as he immediately realized that the existence of these trees could lend credence to his theory of plants being indicators of changing climatic conditions through geologic time. His enthusiasm must have been infectious, as Dr. Silverman decided then and there to go along with him.

How exciting to unearth this extraordinary scientific occurrence. It would have been remarkable enough merely to follow in the footsteps of a scientist discovering a

third type of redwood tree. Only by rather tedious library exploration did I discover this astounding coincidence. At almost the identical time that Chaney learned a genus he had studied for over twenty years of his life turned out to be erroneously labeled, this very genus, once extant over the northern half of the globe and now thought by everyone to be extinct, turned out to be living in a remote area of China. “It is like finding a dinosaur alive!”

III. Side Canyons



Figure 1. 12 Bill McNamara (on the right) and fellow plant collectors in front of the Type tree, Modaoxi, 1996. Courtesy of Anthony Kirkham.

Stop and consider this. When you go on a trip, completely new worlds open up along the way. Your travels could be compared to walking through a canyon, with the width of the canyon's floor and the height of the canyon walls being determined by the limitations of your senses, your openness to new ideas, and the pace you take. If you have your own agenda or are hurrying to get somewhere else, you will not see much. Your canyon will be deep and narrow. Every so often there are side canyons, and by turning into any one of them, you could discover a whole other world. There is no way to know ahead of time. You could turn in to a short dead-end or you might find a

long narrow path that eventually leads to a huge plateau with completely different terrain. This route could be more fascinating than the original path you, as a traveler, were following. Sometimes another world could be revealed that was totally unknown to you. You must constantly reassess the goal of your journey as well as where to stop and linger along the way.

Bill McNamara represented the opening of one fascinating side canyon for me, as he introduced me to the world of Asiatic plant collectors. Bill is the director and chief curator of the Quarryhill Botanical Garden near Glen Ellen in Sonoma County's Valley of the Moon.

Like the famous Asian plant collector Joseph F. Rock, Bill's fortuitous path to

collecting never involved a formal botanical education. As a college student, Bill majored in English, yet he held part-time jobs working in nurseries. He loved plants. As a hobby, while driving down roads, he would test himself by seeing if he could recollect the Latin name of every plant he passed. After graduating from the university, he traveled aimlessly in Asia for several years. Upon return, realizing that nursery work would not provide sufficient funds to raise a family, he turned to landscaping, enjoying both the manual work and being his own boss. Recognized for his skills in plant identification, he was selected to go as a volunteer on a plant collection expedition to China. Afterwards, he began to work for the garden that had sent him, Quarryhill, and quickly became the director.

The Quarryhill Botanical Garden, open by appointment only, operates as a non-profit organization, funded by Jane Jansen. She donated all the land, which is just a part of the forty-acre property, maintaining for herself a rural retreat while simultaneously furthering her own interest in the wild plants of China. Bill has complete control of the day-to-day running of the garden.

The goal of Quarryhill is to obtain and propagate wild Asian plants for the purposes of preservation and scientific study. Every plant is tagged and catalogued, and a data base is maintained of where each plant originated and when each was planted. The seeds for every single plant were collected personally by Bill (by 1998 he had been on twelve collecting expeditions) in Asia. The seeds are germinated in the small greenhouse, raised as seedlings in the nursery, and then placed quickly in the ground before the plants become dependent on the rich nursery soil. Some cuttings have been utilized to create clones, but no seeds from the garden have been used for risk of creating unwanted, Americanized hybrids. The only herbicide used is Roundup™, employed to prevent excessive weeds, and with the incredible diversity of plants, no insecticide has been needed.

The garden is not about profits. Its chief purpose does not involve aesthetics. Yet the twenty-acre garden set amidst the forest-clad hillsides of the Valley of the Moon is a joy to behold. On my first visit in February, most of the plants were dormant, yet on many buds were just beginning to open. The seven-year-old birch trees had grown to

ten to fifteen feet tall. The *tabula formis* pines (the most common pine growing throughout China) provided a rich greenery, while the state of dormancy of most of the rest of the plants allowed the ability to see the rich diversity of densely planted species, planted as they naturally occur in the wild.

Paths criss-cross the garden, and the old pits from the land's prior days as a rock quarry have been filled with water, creating natural-appearing pond environments. Overhead sprayers are also used to create a humidity more in keeping with the conditions of the plants' origins in Japan and the south and west of China.

Bill gave me a warm welcome at the Quarryhill Botanical Garden. He showed me slides from his own expeditions to China, including his visit to Mo-tao-chi (now Modaoxi). He had been there less than two years before, in October of 1996. His slides revealed the town of Modaoxi to be much larger than I had expected. Chaney and Silverman had reported a village of about one thousand people. As of Bill's trip, the size of the town had at least doubled. The adults were wearing mostly blue Mao peasant shirts, and the children were in bright, colorful clothes of the West. The broad paved main street was lined by dawn redwoods, which since Chaney's trip have been planted throughout China as an urban tree. Unfortunately, the slides showed the Modaoxi pavement tightly encircling the trees at their bases, and Bill predicted that within a century, the trees will effectively be girdled and killed.

Bill also showed me a beautifully hand-crafted sturdy chair, typical of the chairs used by the "poor" people of the Chinese interior. It had been presented to him as a gift by the guard of another rare, endangered tree that Bill was privileged to see in China, *Taiwania flousiana*. The chair would certainly fetch a top price in any Bay area antique shop. Also, from the top of a bureau in his home, Bill took down and showed me a tightly woven basket used in Modaoxi for carrying babies. The basketwork was flawless, sturdy, and attractive, and comparable in quality to the incredible basketwork produced by Native Americans.

Bill has traveled throughout southern and western China as well as Tibet. The area that interests him the most is the area of Madog. Officially, the Chinese have created the largest nature reserve there outside of Alaska. Unofficially, village life pro-

ceeds in this area as usual. For the most part roadless, Madog is centered around the bend of the river known as the Tsangpo in Tibetan (which is called the Yarlung in Chinese), and which becomes the Brahmaputra as it enters India. The land is in disputed territory between China and India, showing up as China mostly on Chinese maps. The land is so rugged that no explorer or plant collector has successfully traversed the entire canyon. There is a narrow gorge between two towering peaks: 24,440 foot Gyala Peri and 25,440 foot Namcha Barwa, before the river completes a hairpin turn around the latter. In 1924, English plant collector, Frank Kingdon-Ward, walked the upper and lower sections, but was turned back by the fifteen-mile inner gorge.

Bill McNamara has collected a library full of accounts of the great botanical collectors of Asian plants. Other famous botanists include the Frenchman Jean Pierre Armand David, the first Western plant collector to explore the Chinese hinterland; William Hillebrand, the “father of Hawaiian botany”; and Charles Sargent, who built Harvard’s Arnold Arboretum. Both of the latter two, like Bill and Joseph F. Rock, had no formal botanical training.

Often considered the greatest collector of all, Ernest Wilson represented the Arnold Arboretum, traveling in China during the early twentieth century. One incident that occurred while he was collecting the regal lily (*Lilium regale*) demonstrated his courage as well as the difficulties an Asian plant collector could face. While returning through avalanche-prone hills with seven thousand lily bulbs, a boulder crashed down the hillside and struck Wilson, breaking his leg in two places. It was a three-day journey from where he lay injured to the nearest medical help. After a splint was improvised from his camera tripod, a mule train with fifty animals appeared along the narrow trail, wanting to proceed in the opposite direction. Neither party wanted to delay passage because of the fear of another avalanche. Racked with pain, Wilson had his Chinese helpers place him across the trail, and he allowed each of the fifty mules to stepped over him. The English plant collector’s leg went on to develop gangrene. After Wilson refused amputation, the infection did successfully resolve, but it left one leg shorter than the other. He called his deformity his “lily limp”. Bill mused that if Wilson’s life had not somewhat later been cut short by a car accident,

he may have discovered the metasequoia.

It was the publication of Joseph Rock's articles in the *National Geographic* between 1922 and 1935 that catapulted his personal fame above the other Asian plant collectors. His personality was arrogant and his traveling style outlandish. Rock would travel through the countryside with a small army of soldiers for protection from bandits and a small army of coolies to provide the lifestyle he enjoyed. While on expeditions, his meals would be served on china with linen tablecloths, and his hygiene maintained by a fold-up rubber bath tub. He was known to have stepped down from his sedan chair, carried by four Chinese, wearing a suit and tie.

To be fair, Dr. Rock (he received an honorary doctorate from University of Texas in Baylor in 1932), like the other collectors of the 19th and early 20th century in China, endured great hardships and incredibly difficult travel conditions. He and the others would travel for months at a time, often in terrible weather, without the luxury of modern high-tech clothing and equipment. Chaney and Silverman were only on the trail for ten days, while Rock was once away from his Chinese home for over two years. Although Chaney and Silverman endured severe conditions, what served to make their expedition truly memorable was the fossil connection. The living plant they sought was thought to have been extinct for greater than twenty million years.

Unknown plants are continually being discovered. Most do not receive any attention from the press. It was different with the dawn redwood and it was different with *Wollemia nobilis*, a species of conifer discovered in Australia by National Parks and Wildlife Service field officer David Noble. Although the Wollemi National Park is only one hundred twenty-four miles from Sydney, it was not until August of 1994, that Mr. Noble became the first person to notice about forty strange trees in a gorge containing subtropical rain forest. The Wollemi pine has now been recognized as a new genus of the Araucariaceae family, with characteristics halfway between two other genera of this family: *Araucaria*, the genus of the monkey puzzle tree, and *Agathis*, the genus of the kauri of New Zealand. Similar to *Metasequoia glyptostroboides*, the Wollemi pine has been classified as a "living fossil" as it is more nearly related to Tertiary fossils than to any living tree. Additionally, its ancestors, other members of the Arau-

cariaceae family, were distributed worldwide during the Jurassic and Cretaceous periods, the age of the dinosaurs.

Interestingly, a 1998 article published in *Pacific Horticulture* dates the discovery of the Wollemi pine as 1996. How quickly facts can become lost, even in modern times.

Currently, one of Bill's interests is collecting Tibetan medicinal plants. On one of his collecting expeditions, he had met a highly respected Tibetan doctor in Kang Ding, a village in the mountains of western Sichuan on the road to Tibet. Bill hoped to record on video some of this man's vast knowledge of traditional Tibetan medicines, in which herbal treatments play a large role. This Tibetan physician travels an annual three-month house-call circuit on horseback, riding to high mountain villages. Bill dreams of one day being able to accompany him. I would gladly join such an expedition. However, this is one more side canyon that strays away from the path to the metasequoias.

At Bill's suggestion, I wrote a letter to Prof. Yin Kaipu of Chengdu Biologic Institute. Prof. Yin was the director of botanical expeditions in western China. I hoped with his help I could receive authorization to visit Modaoxi and Shuishanba, neither village being on the list of areas open to tourism. Within three weeks, I received a return letter. Like Chaney fifty years earlier, my hands shook with delight when I held this envelope covered with canceled Chinese stamps.

IV. Making Arrangements

China is huge. The country straddles fifty degrees of latitude and sixty degrees of longitude. Covering 3.7 million square miles, it has the third largest area of any nation in the world, after Russia and Canada. Mountains make up forty-three percent of the country. It is possible to travel in a straight line twenty-four hundred miles across unbroken mountain chains and then another twelve hundred miles through featureless, empty, flat terrain. From the lofty heights of Mount Everest in Tibet, the land descends to the north all the way down to Xinjiang Province's Turpan Depression, which is below sea level.

There is a rich variety of plants and animals as well. There are more than one thousand species and subspecies of birds, over four hundred species of mammals, three hundred species of reptiles, and two hundred species of amphibians. Total plant species number thirty-five thousand. More than half of these are found nowhere else on earth. China contains twenty-nine percent of the world's gymnosperms, twenty-two percent of the world's ferns, and about eleven percent of the world's angiosperms.

Similar to all other nations, the biodiversity of China is experiencing the global threat of unsustainable exploitation: ongoing agricultural expansion, deforestation, pollution, over-hunting, and even with the one-child policy, continued population growth along with growing aspirations. Fortunately, the Communist government has done remarkably well in creating natural reserves. Of the eight hundred reserves now in existence, fifty-seven are protected at the national level^①. The one hundred seventy-two thousand square miles that have been set aside amounts to five percent of the total land mass.

It would take a lifetime to travel to each of these diverse areas. I was headed for but one specific region in the borderlands of Sichuan and Hubei provinces to view the dawn redwood. Prof. Yin's letter presented concrete proof that it would be possible to reach Modaoxi and Shuishanba. Although very clearly formatted, the non-native Eng-

^① Up to August 2007, 303 reserves are protected at the national level.

lish left some ambiguity. Basically, the professor laid out two alternatives—either I could fly to the area directly from Chengdu or he could arrange a jeep to take me by road. He offered to arrange the necessary authorization from the government. Prof. Yin also asked whether I wanted him to accompany me.

My hope had been to duplicate Dr. Chaney and Dr. Silverman's footsteps as much as possible. The ideal itinerary would include flying to Shanghai and on to Chongqing (Chungking), and then floating the river to Wanxian before hiking through the mountains to Modaoxi. However, now there was a road. Did today's road follow the path that the American scientists had taken fifty years earlier? No one seemed to know.

Few outsiders have traveled to the area in the intervening years. Within a month of returning to the United States in 1948, Chaney wrote to Dr. J. Linsley Gressitt, an American entomologist on the faculty of Lingnan University, Guangzhou, China. Chaney encouraged him to undertake field work in the area of the metasequoias. If dawn redwoods still existed in Shuishanba in their natural setting amidst the same trees that were present in the fossil record of the Cretaceous period, possibly some of the fauna from that ancient period had survived as well.

Only thirty-four years old at the time, Gressitt already had accumulated a lifetime of experience. Born of missionary parents in Japan, Gressitt had studied at Stanford and at U. C. Berkeley where he both met Chaney and received his Ph. D. Author of more than forty scientific papers on insects, reptiles, and amphibians, he had already undertaken three major collecting expeditions in China. Gressitt had a good working relationship with Chinese scientists, and in July, 1948, leading the California Academy-Lingnan University Dawn Redwood Expedition, he followed the exact path of the Chaney and Silverman expedition from Wanxian to the dawn redwood valleys of Sichuan and Hubei provinces. Documented in detail in the July, 15, 1953 "Proceedings of the Academy of Sciences", his account tells of his two-month visit to the area. His party, which included five students, a police officer, two armed guards, and four porters explored most of the surrounding hills, ravines, and valleys, and counted one thousand two hundred nineteen dawn redwood trees. The group collected hundreds of

insect specimens, but none proved to be from a bygone era or of special use.

Because of the changes brought by the Communist revolution in 1949, it would be thirty-two years before other foreigners would successfully visit the borderlands of Sichuan and Hubei provinces to report to the world. In the Spring 1981 issue of the U. C. Berkeley Botanical Garden Quarterly, Bruce Bartholomew related his experiences leading the Sino-American Botanical Expedition of 1980. This group of scientists traveled to Modaoxi and to the valley of the dawn redwood from Wanxian by minibus and jeep. What had taken Chaney and Silverman three days by foot took Bartholomew's expedition between three and four hours by road. Clearly, things had changed.

One of the changes was the spelling used for translation. Several of the early Europeans who had taken up residence in China in the nineteenth century had created their own phonetic systems for writing Chinese in roman letters. A system developed by two Englishmen named Wade and Giles in the mid-1800's became the most popular, because it so closely resembled familiar English sounds. However, after the Communist Party took over control of China in 1949, the new leaders decided to adopt a phonetic system based on the Mandarin pronunciation prevalent in the Beijing area. This official Chinese system was put into effect in 1958 and was called pinyin, which is an abbreviation for "pinyin zimu" or phonetic alphabet. Pinyin itself means spelling. As this system was not designed with English speakers in mind, several of the roman letters used are pronounced quite differently than in English.

The provincial borders had also been redrawn and Modaoxi was now in Hubei rather than Sichuan. The "Type" tree as the original large metasequoia that Chaney and Silverman had seen in Modaoxi is called, was in good condition, but the temple had been removed. The three other nearby trees had been cut down. Deforestation around the larger collection of trees near Shuishanba was continuing. Although there were five forest workers employed to protect the metasequoias themselves, the surrounding forest was being stripped. The original *Arcto-Tertiary habitat* (Arcto for arctic origin and tertiary for the geologic period of its dominance) in the ravines surrounding Shuishanba that Chaney was so delighted to have seen intact after millions

of years was no more.

Other foreigners did not again begin to visit the area until recently. The few that have come have been brought by Chinese guides for only brief visits to Modaoxi. Charles Smiley of the University of Idaho came with his wife and a student in 1989. And Bill McNamara had visited with his group in 1996.

The ideal arrangement of steaming down the Chang Jiang by boat was not one of Prof. Yin's suggested alternatives. And although my original intention was to trek the same trail as Chaney and Silverman, no one seemed to know the exact route they had taken. Moreover, the opportunity to have special arrangements made, including authorization for travel, seemed too good to pass up.

So I stated that my purpose was to take photographs. No specimens would be collected so a botanist would not be necessary. However, I explained that Prof. Yin's assistance in arranging for a jeep and a translator at a reasonable price would be most helpful.

Unfortunately, six weeks went by without a response. Another call to Bill McNamara provided me with an alternative, an E-mail address of Lü Rongsen, one of Prof. Yin's associates. An international E-mail was dispatched, and much to my surprise, three days later, a response arrived. From China!

Professor Lü apologized for Dr. Yin, who had been away on another expedition. Indeed, it would be possible to travel with only a translator and a driver (foreigners are not allowed to drive in the Peoples Republic of China), but it would be necessary to bring a vehicle from Chengdu. Ten days would cost about twenty-five hundred dollars.

I was ecstatic. Although it would not be possible to float down the river or undertake a rigorous mountain trek, the journey would be undertaken completely beyond the reaches of tourism into the hinterlands of central China. Several more E-mail exchanges completed the details. Paying the one fee would cover all of the expenses, including food and lodging. However, in exchange for granting authorization to visit the trees, the local government authorities requested that being a physician, I would make a presentation to the professional staff of the local hospital. If I would send a

copy of my report ahead of time, the translator could practice with the technical language.

Of course, I was delighted to comply. What an opportunity! During the weeks prior to my departure it was intriguing to think that in some apartment building in China, a man was translating and practicing a speech that I had written.

V. Arrival in Chengdu



Figure 1. 13 Prof. Yin Kaipu, 1998.

I flew on Northwest Airlines, the pioneer of direct aviation to Asia. After a two-hour layover in Tokyo, during which time I had no need to leave the airport, I boarded a packed plane to Hong Kong.

The next morning's departure for Chengdu arrived none too soon.

Chaney and Silverman had been preoccupied with worries whether there would be an airfield in Wanxian. Fifty years later, I was fearful that I would not be able to locate Prof. Yin or Lü or the Institute of Biology. At the airport, I could not have been happier when I saw a bespectacled young man holding up a large white sign with my name on it.

My greeter was wearing yellow polyester pants, a T-shirt, and a loose-fitting tan

jacket. We barely said hello before he quickly walked to a shop to telephone Professor Yin. Then he whisked me to a waiting car and driver. The car was a four-wheel drive sports utility vehicle, a Mitsubishi Pajaro, in excellent condition. The driver was Li Pan Zhong, one of several men who resided with their families at the Institute and served as chauffeurs for its various botanical and zoological field expeditions.

My host turned out to be Lü Mang, the son of Lü Rongsen, my E-mail connection. This younger Lü was a twenty-eight year old university graduate, employed by a factory that made fans for power stations. He held a managerial position which allowed many opportunities to travel. He had already taken a trip to Pakistan, and the following month he was scheduled to go to Germany to investigate buying some equipment for his factory from a large German firm. He had formally studied English in Nepal for two years while his father was there doing botanical research. Lü Mang would serve as my translator on the journey across Sichuan. He seemed to speak fairly good English, yet at times when I asked one question, I found I received an answer to an entirely different one.

“Do you have a hotel reservation?” Lü asked me. As I had none, Lü had the driver transport us directly to the Institute to meet the professor.

We drove the twelve or so miles from the airport into the south end of town. The highway was bordered with trees behind which were separate lanes for bicycles. There was a seemingly infinite number of small businesses, a situation that was repeated throughout China.

Although the buildings were drab and monotonous, the street life was full of color.

In about thirty minutes we arrived at the Institute. I recognized Prof. Yin immediately, as I had seen him in Bill McNamara's photographs. He greeted us with his amiable grin, and striding quickly, guided me through several spartan passageways lined with piles of cardboard boxes containing who knows what, to his dingy office. The approximately sixteen-by-twenty-foot room contained a couch, a 1940's vintage metal, industrial-size desk, and a few bookcases. The journals and books on the half-filled shelves were all in Chinese and seemed to be scientific treatises concerned

botanical and ecological subjects.

Without missing a beat, the professor took jasmine leaves from a pouch on his bookcase, placed them in a glass, and poured hot water from his metal thermos. “Now we will plan everything,” he said.

Prof. Yin was a pleasant appearing slender man in his forties, dressed in light-weight slacks and a white short-sleeved shirt. He unfolded a six-foot map of Sichuan province on his desk, written in Chinese characters. He proceeded to direct our discussion with a terseness and an air of efficiency. With our driver looking on and Lü Mang translating, an itinerary was established for the Fiftieth Anniversary Expedition. It would take a day and a half to reach Lichuan, the town that was nearest to the valley of the dawn redwood and Shuishanba. The first night would be spent in Dazhu, a small town beyond Chongqing. Allowing a day and a half for the return, there remained six days in and around Lichuan. One day would be needed for the presentation at the local hospital. Prof. Yin suggested spending time touring Chongqing. With its greater municipal population of thirty million, it had become the largest city in the world. I also intended to visit Emei Shan.

The others were even more delighted with my minimal smattering of Chinese words. “Xia, xia,” I said, thanking them for the arrangements, and everyone smiled and laughed cordially.

“This is the final plan,” Prof. Yin announced, and in less than fifteen minutes of being in his office, it was set. Lü, with a little difficulty, wrote out our itinerary in English while Prof. Yin brought out a coffee-table-style publication of natural reserves in Sichuan. At the time of Dr. Chaney’s 1948 expedition there was no system of national parks or reserves in China. Now the Chinese had already succeeded in surpassing their goal of creating over five hundred nature reserves by the year 2000. Prof. Yin had taken many of the beautiful photographs included in this gorgeous volume. He said that it was a present for me, and both he and Lü Mang signed it.

Through Lü Mang it was possible to learn a bit more about the Institute of Biology. Prof. Yin was one of the highest-ranking scientists among the over four hundred

men and women working at the Institute. Altogether, there were five institutions occupying the numerous brick buildings on the shared campus, all part of the Chinese Academy of Sciences. The other institutes studied physics, chemistry, geology, and optics. Even with several thousand scientists employed, the Chengdu center was only a moderate-size institute. Shanghai and Beijing were much bigger. Over the next ten days, Lü Mang and I would have many discussions regarding what was considered big.

Later, I discovered three metasequoia trees growing by the driveway opposite the entrance to the Institute. In recent years dawn redwoods had become urban trees throughout Sichuan. These were such transplants, only about fifteen feet tall and quite spindly. Yet, I was excited. Here I was, touching a dawn redwood tree in China!

VI. The Expedition Begins

I awoke to another overcast day. It was Prof. Lü Rongsen who came to my door at 9:15 a. m. He was about the same age as Prof. Yin and dressed in similar fashion. He would serve as my escort for the morning. First stop was to see Prof. Yin, who was already at work in his office. It became obvious to see why Prof. Yin's step was so quick. He was a very busy man. He was shouting orders to various coworkers who briefly passed through his office, and in between, accepting several phone calls as well as planning our morning. Prof. Lü explained that Professor Yin had been especially busy recently as he had been organizing the creation of a factory in southwest Sichuan to process taxol, a cancer-treating agent that has been quite expensive for China to import. The source of taxol is yew trees, but mature yew trees had, unfortunately, become nearly extinct in China.

The yew is another venerable tree. It is a descendent of *Paleotaxus rediviva*, a tree known from Triassic age fossils that are more than two hundred million years old. The yew is a slow-growing tree that can live to an extremely old age.

As yew was the favorite choice for making arrows, the past two thousand years of intermittent European warfare served to all but eradicate *Taxus baccata*, the European yew.

Now the yew faces an even greater danger. Pure taxol was first isolated in 1969 from *Taxus brevifolia*, the Pacific yew. By the mid-seventies, this compound was showing success as an inhibitor of cell growth. Best experimental results were in the treatment of ovarian cancer, but the compound also showed promise in fighting lung, breast, brain, and skin cancers. Although taxol is also present in the roots and needles of yew trees, the bark of the Pacific yew proved to be the most cost-effective source. Of course, that depends on what are counted as costs.

A two hundred year old yew tree with a ten-inch diameter yields about six pounds of bark. This amount yields only one fifth of a gram of taxol. In order to treat one patient, two grams are needed, which would require ten two hundred year old trees. One year's treatment of American ovarian, breast, and lung cancer patients

would necessitate the destruction of 1.5 million trees.

Fortunately, Prof. Yin was working to create another option for China. His plan was to raise three-year saplings of Asian yews (*Taxus sumatrana*), which his factory would then pulverize to extract taxol from their leaves, roots, and bark. His success could help save American trees.

Professor Lü himself was busy. His normal work involved the seabuckthorn plant which grew wild in China, but was being successfully cultivated for its nutritional and medicinal benefits in Russia and Mongolia.

Prof. Lü led me to the Institute's herbarium which contained about ten sheets of *Metasequoia glyptostroboides* specimens, most of which had been collected by Prof. Yin in Sichuan province in the 1970's. In the same cabinet were several folders containing needles and cones of *Sequoia sempervirens*, collected from Berkeley, California, of all places, by a Dr. Pu on April 23, 1992.

After lunch, we were off, Lü Mang, Mr. Li, and myself. As we got underway, young Lü said grinning widely, "This is going to be a wonderful trip!" Lü Mang was truly excited; he had never traveled to the eastern reaches of Sichuan province before. His excellent sense of humor, his loquaciousness, and his easy sociability made me appreciate Lü as a wonderful companion and friend.

Our two hundred mile ride passed through terraced countryside with every inch planted. At times corn fields could be seen growing within the highway's median strip. Farmers were walking on raised footpaths, some with cone-shaped woven palm-leaf hats, some in dark blue Mao jackets, some carrying water buckets suspended on long shoulder poles. White domestic geese and ducks floated in flooded rice paddies, and there were chickens, dogs, goats, and water buffalo. The rural landscape was remarkable in its absence of open pasture. Every square foot was planted in crops. Besides rice and corn, there were occasional fields of cabbages, potatoes, and also lotus (its tan root is eaten as a cooked vegetable, very tasty).

Most of the houses were made of brick with tile roofs, but there were also stucco, flat-roofed dwellings, sometimes situated alone, but more frequently grouped in small villages of ten to twenty homes. While the fields were colored autumnal yellow

and brown, the collections of houses were surrounded by the greenery of small trees and bamboo. Often in the distance, small cities could be seen with dozens of monolithic high-rises that the expressway sped past without even an exit.

Once within the final miles before Chongqing, mountains appeared, shrouded in the dusky air.

It was 9:00 P. M. by the time we arrived. As it was the day before the Moon Festival, the government hotel where we had planned to stay was full. Lü Mang explained that the holiday involved a myth about a woman who was not able to be with her lover and was banished to the moon. It was celebrated on the fifteenth day of the eighth lunar month and served as a celebration of freedom. It was a time to gaze at the moon, light firecrackers and eat moon cakes.

Our accommodation problem was short-lived. In exchange for a cigarette, an elderly gentleman got into our vehicle with us and guided us to a joint-venture hotel.

VII. Into the Hinterland

Li and Lü had a typical Chinese breakfast of rice porridge and two baos (lightly cooked muffins with pork inside) each for breakfast. I opted for a peeled apple and jasmine tea. We were off for an early start. Lichuan by noon was our goal. But like Chaney and Silverman before us, the path to the metasequoias did not turn out to be as easy as predicted.

To the east of Dazhu, life appeared simpler. The landscape became strictly rural. There were fewer vehicles on the road, and even less machinery visible; only a few hackneyed buses belching black smoke and small trucks serving as tarp-covered people carriers. The fields were beautifully terraced into curvilinear crescents that followed the natural contours. Men were plowing behind water buffalo. Before and after each village and roadside town, there were streams of people ambling gently to and from the markets, some carrying the usual enormous loads. The entire width of the highway was used as a walkway. Although it was the Festival of the Moon, there was no sign of any special decorations, events, or rituals.

Misty mountains formed a backdrop, and eventually we climbed high over a pass to a magnificent vista, into which we then descended. What appeared from the distance to be miles of brush-covered slopes turned out to be highly settled land, terraced and cultivated. There was always more photographic potential, but in the frenzy to reach our destination, it was nearly impossible to capture on film.

After passing many mountain homesteads and villages, we descended into the megalopolis of Wanxian, a small city to Lü Mang. There were massive high-rises covering the riverbank hillsides, and swarms of people. By asking directions at every intersection and round-about, we eventually reached the Chang Jiang, meaning Long River. It was perhaps a quarter mile across, and in its silty waters there were a variety of long boats, ferries, and barges. After a photo stop, we crossed what appeared to be a relatively new concrete bridge.

Chaney and Silverman had arrived in Wanxian on March 4, 1948, after a three-day trip on a small river boat called the Ming Tai. Their party consisted of five per-

sons. Accompanying the two Americans were a Chinese scientist from Nanjing named Mr. Hwa Ching Tsan, who had been to Modaoxi the year before to collect seeds, a Chinese schoolteacher from Chongqing named Wilson Chen, who would serve as the group's translator, and a friend's Chinese "houseboy" named Liu.



Figure 1. 14 Dr. Chaney in his sedan chair. From *Pacific Discovery*, September-October, 1948, courtesy of Dr. Chaney.

They were met in Wanxian by an American missionary, the Reverend Joseph Matson, and his family. He helped them hire eight bearer coolies to carry their enormous amount of gear as well as sedan chairs to carry the scientists! They hired three more coolies to carry the massive amount of currency needed to pay the others and some extra rice, in case food was not obtainable in the mountains.

It was after crossing the Chang Jiang on a massive bridge that our own adventure began. Within minutes, we arrived at a five-yuan toll booth, and not more than a mile later, at the toll slip collection area, a uniformed official told us that less than twelve miles ahead, a small bridge had collapsed, making the road impassable.

It took some minutes for us to understand there was an alternative. Instead of four hours of mountainous travel over the sixty miles remaining to Lichuan, we now could return to Wanxian, renegotiate its signless, heavily trafficked streets, then drive sixty miles back along the Chang Jiang to a town called Zhong Xian where we could cross the river. From there a few more hours drive could bring us to Lichuan.

The alternative did not seem at all bad to me. We had several days margin. The trip to Emei Shan could be canceled, if need be. So we buoyed our spirits with a tasty lunch at a roadside eatery, and without too much difficulty picked our way back through Wanxian traffic to the entrance of our unpaved detour.

Here the adventure intensified. The road got bumpier, then muddier. The bouncing of the vehicle caused me to clutch the handle of my door even tighter.

Mud and more mud! We were able to dodge several small vehicles that were already stuck. The mountains got steeper and the views more gorgeous. Almost all other vehicles dropped out. And there were no more vehicles coming from the other direction.

One pocket of mud followed the next. On about the fourth, we became grounded. Tires spun and the engine roared, but to no avail. We were stuck. We sat in the hinterlands of China where there were no tow trucks. Mr. Li climbed out of the vehicle and repositioned the four-wheel drive hubs. Yes! Using all the power and traction that the low-range provided, we were successful. Up and out, no problem. Thirty miles of mud followed, at times better, at times worse, with Mr. Li shaking his head, but al-

so enjoying it.

After six hours of intermittent handgrip clutching, we came out of the mud. We arrived at our destination for the day: the hilly, riverside city of Zhong Xian. Yes, it was an adventure. Instead of a four to five hour trip to Lichuan, we had spent twelve bumpy hours in our vehicle, and we were still four to five hours from Lichuan. That is, if all went well.

VIII. On the Path

Lü planned to awaken early to prepare morning coffee in his room in order to make up for some of the lost time from the day before. He was now hoping we would arrive in Lichuan in time for lunch. However, the mud ride the day before had taken its toll, and Lü overslept. So after a brief delay for breakfast at a local cafe, a ten-minute drive brought us to the Chang Jiang. Lo and Behold! There was a line of about fifty to sixty trucks and a few buses waiting for the ferry to take them across. It appeared that the barge that was serving as the ferry could carry seven to ten vehicles per trip. It only took about five minutes for it to be towed across the river, but loading and unloading took much longer.

It seemed probable that we would be there the entire day. Lü guessed we would only wait for an hour or two. In the end, much to my surprise, it took but three hours.

The isolation of the upper reaches of the Chang Jiang is a tribute to the vastness of China. Measuring three thousand nine hundred sixty miles, the Chang Jiang is aptly named. It is the world's third longest river after the Nile and the Amazon, and is two hundred miles longer than the Mississippi/Missouri system. The well-known lower half flows through China's most industrialized and agriculturally developed area. Cotton, wheat, barley, corn, beans, as well as seventy percent of the country's rice is grown within its fertile basin.

Here at Zhong Xian the river appeared quite placid. Yet, when it finally became our turn to drive onto the barge and be tugged across the Chang Jiang, the formidable current was revealed. Fortunately, we crossed without further incident. Once on the opposite bank, we immediately began to ascend switchbacks that took us away from the river, up into higher and higher ridges of misty mountains, and eventually above the clouds.

Yes! Blue sky and mountain terrain that alternated between isolated river canyons and beautifully terraced yellow and green valleys that were dotted with traditional farm houses and villages. Finally, the air was clear. The landscape continually changed. We passed through a narrow canyon, then a river valley bordered by gentle

hills, which was followed by a deep chasm of rock and forest with a small clear river at the bottom of a deep gorge. Once again, there were photographs in every direction. National park caliber scenery. Most pleasing to the eye were the wood and stone farmhouses bordered by bamboo and banana trees. From the rafters of these habitations huge columns of corn and red peppers were hanging out to dry.

Lü Mang refused to accept my argument that these people were the wealthy ones. "They have no money," he retorted, "and cannot travel like you and I." True.

The people of this region of eastern Sichuan were definitely subsistence farmers. Excluding the stream of passing cargo trucks (probably a swollen stream secondary to the bridge-collapse detour), there were no machines in sight. Yet, there were flowering fields of tobacco and abundant corn, rice, cabbage, fruits, and peppers. Unlike the urban centers of Beijing, Shanghai, Guanzhou, and Chongqing, here the sky was blue. These poor farmers had clean air, lots of space, surrounding greenery, and all the food they could eat. Most, however, did not have flush toilets or running water.

It was somewhere through these same mountains that Chaney and Silverman's party had hiked fifty years ago. It probably did not look very different then. They had to climb up and over these mountain ridges, mostly in the rain. At first they were carried in their sedan chairs by a tag team of trotting coolies, but as the trails got steeper, they were forced to walk. In Silverman's words, "We clattered over slippery rocks, sloshed through mud, slid down precipitous slopes, and crossed one rain-drenched, mist-covered ridge after another."

What took one day for us to cross in our car, had taken Chaney and Silverman three days to hike. We eventually arrived at the edge of the mountains and descended to a viewpoint overlooking the Lichuan area. The broad valley below consisted of green islands of low hills rising among golden rice fields and criss-crossed by tree-lined roads and creeks. The trees lining the roads appeared to all be cedars, but upon closer inspection, the cedars were interspersed with metasequoias. Being late September, the metas had turned an autumnal yellow and rust. These planted trees appeared

rather spindly, like the ones at the Institute in Chengdu, without the majestic figure of the Berkeley trees that I already knew. The entire local population seemed to be involved in the rice harvest, either cutting stalks, thrashing rice into mat-backed wooden bins, tying the spent stalks into bundles, raking drying rice on the roadside, or carrying or bicycling huge bags of rice uphill to market.

By late afternoon, the small town of Lichuan appeared. We drove directly to the local government office, a fifties-style, school-like dingy building. There, He Wen Jian, the town's vice mayor, was expecting us. We were immediately ushered into his conference room for tea. Similar to Prof. Yin three days before, Mr. He immediately set out to formulate a plan for my visit. He explained that Modaoxi and Shuishanba were down different roads leading back into the mountains. We would go to Modaoxi the following morning, make our hospital presentation in the afternoon, and the next day go to Shuishanba.

After dinner, Lü and Li returned to the hotel, but the two local officials guided me on a perfectly pleasant walk through town. There were only two main streets, and at their intersection stood a recently constructed light tower. It was huge. Its space-age saucer shape made it appear as if it were something out of the Jetsons. There were very few cars; bicycle-powered, two-passenger pedicabs served as taxis.

We walked down a street that He reported was three hundred years old. There were occasional two-story wooden buildings with beautiful lattice-work windows. We discussed the importance of preservation, which was not a popular concept in the current era. Such historic buildings were rapidly disappearing everywhere in China.

Bicycles were still the backbone of local transportation here. Indeed, much of the charm of Lichuan came from the ringing bells of the pedaled carriages. There was not the inevitable smog or congestion that the private auto would necessarily bring.

We were able to converse easily, as He Win Jian had been an English major in school. He asked me to call him by his English name, Joseph. Born and raised in Lichuan, Joseph had completed a four-year degree at the University of Wuhan, the capital city of Hubei province. When Chaney and Silverman had visited, Modaoxi had been in Sichuan province. But, sometime between 1948 and 1980, the provincial bor-

ders had been redrawn, and now Modaoxi, Shuishanba, and Lichuan are all in Hubei province.

After university, Joseph had spent one year working in Hainan, an island province off the south coast of China. However, he missed his family, and he returned to Lichuan to his present job, which he had held now for six years. He was married and very proud of his one infant son. Now in his late twenties, he exuded a definite style and flare. He would not appear out of place in GQ magazine.

We passed a Chinese hospital, and Joseph asked if I would like to come in for a visit, even though it was 11:00 p. m. Once inside the entrance gates, we passed both a Chinese and a Western pharmacy. They were housed in matching rooms, yet the cupboards of the first contained bottles of synthetic pills and potions, which the latter's shelves held dried roots and herbs. We walked through a well-tended, courtyard garden and then up to a small office where five or six white-coated doctors were sitting. Those with the white coats on turned out to be medical students. The attending staff physician was wearing a simple sport jacket. The students were writing in medical charts, and they handed me one to review. Of course, it was all in Chinese, but I could see from the layout that they had written an elaborate history and physical on this patient with pneumonia (Joseph translated the diagnosis). The patient was being given Penicillin, Ampicillin, Vitamins B and C (these medications were all written in roman letters) as well as Chinese medicine. While the setting was simple and bare of any technologic apparatus, the patients appeared to be well-cared for in comfortable surroundings.

After thanking our hosts for the tour, we returned to the quiet streets, again to be serenaded by the jingle of bicycle bells. There were stars overhead, and the silhouettes of the surrounding hills could be seen over the rooftops. Reluctantly, I said goodbye to my gracious hosts, and returned to my very pleasant rooms, too tired to do anything except sleep.

IX. Modaoxi and the Type Tree

I planned to rise early in order to observe the town awakening. No problem, as at 5:45 a. m. loud martial music began blaring from loudspeakers in the courtyard directly outside my hotel window. I was surprised that my enthusiasm was preventing me from feeling tired, even after so many long days on the road. It was I who needed to wake the sleeping desk clerk in order for her to unlock the lobby door. Thus, I began my first unescorted walk in central China.

We were definitely beyond the orb of the tourist here. There had not been a single non-Chinese person in evidence since leaving Chengdu. There were not even postcards for sale.

The town was just awakening. Sidewalk cafes were cooking bao over their small open fires, old men were walking through the streets smoking small cigars positioned upright at the end of three-inch pipes, and fresh pork was being cut and distributed to street sellers from the backs of hand-pulled wooden carts.

Lichuan was really quite a lovely town. It was surrounded by conical, wooded, limestone hills that had an appearance similar to the topography around Guilin, an area that is famous for having the most picturesque scenery in all of China. And Lichuan was also small enough to walk around easily. The public square in the center of town was already swarming with activity. As in public parks all across China, people were doing their morning exercises. On the square in Lichuan, which was the size of two football fields, were five large classes already in progress. Two were doing Tai Chi, two were doing slow-motion stretching exercises, and one was performing an exercise with swords accompanied by recorded music of Chinese anthems played by traditional instruments. There was also a group of soldiers in green fatigues doing calisthenics and various stretches. In one corner of the square, there were four thin, flexible young men, dressed in nylon athletic warm-ups, doing very flashy and acrobatic martial art moves. A couple of lone runners were jogging the perimeter, and clusters of people were observing, just like me.

At 8:00 a. m. our group of five assembled at the hotel for our trip to Mod-

aoxi. Both of the officials from my dinner and tour the night before wanted to join us. Joseph acted as our guide. After passing through quite a large area of Guilin-like hills, we reached more isolated valleys containing verdant fields of corn, tobacco, and peppers. People were working all along the way, carrying large loads. We passed through two small market towns, then a peaceful river valley, and then we climbed up and up, over six thousand feet, before dropping down to isolated Modaoxi.

The Type tree was visible from a half mile away, before we actually reached the town. Its branches spread out higher than all the nearby buildings. It was massive. We stopped, and I began a frenzy of photo-taking.

When Chaney arrived at this exact site, he was stunned. It was not until that moment that he learned for the first time that *Metasequoia glyptostroboides* was deciduous. It was the middle of March, and the dawn redwoods were bare of all foliage. He quickly realized that it all made sense. It was because the trees dropped their needles in winter that they were able to survive the terrible freezes of the ice ages.

At the base of the Type tree at the time of Chaney's visit stood a small temple where people from the surrounding area came to pray, believing that the tree contained a living god. A local villager, Cheng Yu Men, told Dr. Silverman that he had helped build the temple in 1932. By seeking contributions, the townspeople had amassed twenty ounces of silver, which they used to build the shrine. The villagers prayed to the tree for fertility, for good health, and for good harvests. The locals also used the tree to predict the outcomes of their crops. If the tree's foliage was abundant, they believed their harvests would be bountiful.

Chaney and Silverman's visit had caused quite a stir. Almost the entire town came out to the great tree with them. The one very large tree, two smaller dawn redwoods, each standing twenty to thirty feet tall, and one small seedling were growing on the banks between rice paddies. The scientists posed for photos and took measurements while some children and one adult fell into the dirty rice paddy water. The men estimated the height of the great tree at ninety-eight feet and the diameter at ten feet and ten inches. By using an increment borer, Chaney removed a thin core which he used to calculate the tree's age: between five and six hundred years old!

Bill McNamara's group visited the Type tree on September 29, 1996. Their measuring instruments revealed that the tree stood one hundred thirteen feet high and twenty-three feet in circumference at breast height. Its altitude was shown to be 4160 feet and its exact position $30^{\circ}25'91''\text{N}$, $108^{\circ}41'01''\text{E}$. The group members also posed for photographs at the base, just as the Sino-American expedition members had in 1980, and so did we.

It was our turn. We did various groupings of the five of us and took photos with each others' cameras. The temple was now gone, having disappeared sometime prior to the visit of the 1980 expedition. Mr. Fa gave an impromptu speech about the tree, which Lü Mang translated, and which I captured on video. His figures varied slightly from what was published, but who was to say whose numbers were more accurate? Does it matter who is right? Joseph explained that the twenty-foot metal pole attached to the base of the tree's trunk was a grounding rod that had been added to the base of the tree during the 1980's in order to protect it from lightning.

We did not perform any scientific measurements. I merely took part in the photo session, observed the surroundings, and soaked in the tree's living spirit. Standing so close to this tree, whose great age and fortitude dwarfs our human lifespan and human frailty, forced me to reflect on the rapid passage of time and the fleeting quality of human existence. It was not very long ago in the tree's memory that Chaney and Silverman had stood right where I was standing. Time passes so quickly, why worry about the little things? After several years of research and planning, suddenly here I was. I remained speechless. I felt immersed in a much broader perspective of being, which I hoped I could maintain in the weeks and months to come.

Now there were many nearby farmhouses. There was a canal littered with debris running directly in front of the tree. There were no longer any immediately adjacent rice paddies. Bill's group of botanists in 1996 felt that the increased foot traffic because of the nearby buildings was possibly causing the tree to show some signs of stress.

The name Modaoxi means "grinding knife" or "the stream where the knife was sharpened." According to Bill McNamara's research, the name derived from a story

that took place during the Three Kingdom period. A famous general named Guan Yu visited the area where the town is now located and sharpened his knife on a rock near a stream. The current and official name of the town is actually Moudao. Because *mod-ao* means “knife-grinding” in Chinese and suggests sinister quality, the name was changed to the word “*moudao*” which means truth-seeking. This name could actually be seen written in Chinese on the public buildings of the town.

After lunch, we returned to the streets, and I kept my video camera rolling to everyone’s delight. We entered a crowded outdoor produce market and the crowds grew even more intense.

“Is it me or is it the camera?”

“Both!” Lu Mang replied.

In a light drizzle, we returned to Lichuan in time to be rushed to the hospital where people were waiting for us outside. I was introduced to the chief-of-staff and the top administrator.

After thirty minutes, we were led downstairs where the crowd was now seated, filling a rather large room. A few people were dressed in white coats, but there was no way for me to determine the exact positions of the one hundred to one hundred fifty people assembled in the audience. There were doctors, nurses, technicians, and administrative personnel.

My talk described the history of emergency medicine and also how the emergency department and the health maintenance organization that I work for operated. Lü Mang had already translated my speech word-for-word into Chinese. I would say a sentence or two in English, and he would say several paragraphs in Chinese!

On the whole the presentation seemed a success. After supper, Joseph was intent on visiting the Flying Dragon Cave. Then, Lü, Li, Fa, Joseph, and I piled back into the Mitsubishi and headed out of town on a dirt road that led to a beautiful gorge amidst the green limestone hills.

Beyond several traditional farmhouses and farmers with basket backpacks, the road came to a dead-end. There stood the entrance to a massive cave above a roaring waterfall. We crossed over the river at the bottom of the gorge on a concrete walk-

way. We then proceeded up a cliff to the two hundred foot high entrance of the Flying Dragon Cave. Joseph said that a group of international spelunkers had visited the area ten years ago and had said that this thirty-three mile cave was the largest cave in the world, even larger than Carlsbad. Joseph himself had once traversed the entire length with a flashlight to guide him. Two miles inside, there was a hall larger than Tiananmen Square. Deeper still inside the cave, there was an area of mountains inside which there were still more caves. It was getting pretty dark, but all of us, except Fa, walked into the cave several hundred yards to the "Monkey King Pool." By looking into the pool's reflection, one could see what looked like the cave's outlet and the silhouette of the mountain beyond.

Forced to retreat by darkness, we returned to the road (but not by falling into the Monkey King Pool!) and back to town. Despite all the activities of the day and the wonders we had seen, when I closed my eyes, it was the image of the mighty Type tree that filled my visual field.

X. The Reunion at Shuishanba

In the ten years following his expedition, Dr. Chaney offered to send seedlings propagated from cuttings to interested Save the Redwoods League members in exchange for a one or two dollar contribution to the League. Seedlings were sent to Canada, New York, Michigan, Pennsylvania, Illinois, Indiana, Oregon, and as far away as Alaska and Japan. By 1958, Chaney was reporting that metasequoias had been successfully planted on every continent of the world except Antarctica, and had been able to survive temperatures down to twenty degrees below Fahrenheit.

Chaney himself sent one hundred trees to Japan in 1950, and from these trees greater than one thousand dawn redwoods had been propagated. They were growing next to schools and temples and in botanical gardens throughout Japan. In 1952, Chaney personally delivered two redwood trees to Emperor Hirohito. He reported in 1969 that he was privileged to revisit these trees and see that one of the emperor's trees had grown to nearly one hundred feet tall.

Dr. John Kuser of Rutgers University began publishing articles on his research regarding *Metasquoia glyptostroboides* in the early 1980's. His paper "*Metasquoia Keeps on Growing*," published in the Summer 1982 issue of *Arnoldia*, the magazine of the Arnold Arboretum, followed up on D. Wyman's 1968 *Arnoldia* article that listed fifty of the tallest introduced dawn redwoods in America. As of November, 1981, the tallest tree being reported was a one hundred four foot specimen growing at the College of William and Mary in Williamsburg, Virginia. Metasequoias were found to be growing best in a belt from northern Alabama and Georgia up to southern New England, with many trees reaching heights greater than seventy-five feet. This area has wet, humid summers very similar to the borderlands of Sichuan and Hubei provinces. Many of the largest trees stood on the edge of creeks, similar to the giant trees in the U. C. Berkeley Botanical Garden. This article also reported that seedlings had already sprouted naturally from seed below trees in Alabama, Virginia, Delaware, New Jersey, Massachusetts, and Rhode Island. It made sense that trees were thriving and reproducing on their own in areas that had a somewhat similar climate to the isolated

valleys of central China.

In the early 1990's, Professor Li Minghe of Huazhong Agricultural University in Wuhan, wrote his Masters dissertation on native metasequoias. At the time of his research, he had counted 5 755 "big" native trees growing naturally in China: three in Hunan, six in Sichuan, and the remainder in Hubei. They were distributed in an area eight by eleven square miles, and were growing at an elevation of 2600 to 5500 feet. He reported the Type tree to be four hundred eighty years old, one hundred twelve feet in height, and 7.8 feet in diameter.

Professor Li has been working with John Kuser of Rutgers University to expand the genetic base of the dawn redwoods. Initially, all of the metasequoias growing in the United States had originated from the single Type tree and the seeds brought back by the first expeditions in 1948. However, Dr. Kuser sent seedlings propagated from Professor Li's seeds across the country for planting and propagation.

Before leaving China in March of 1948, Chaney had flown to Nanjing to lobby for preservation of the remnant trees and forest of a bygone era that he had traveled so far to see. It was his visit that made the government aware of the need for protection. The Metasequoia Conservation Committee of China was established. Chaired by the American ambassador, it contained many top Chinese scientists. After the Communist Revolution, the Forestry Ministry continued to work to insure protection of the trees.

The West did not learn what had happened to the native trees in China until the Sino-American Expedition of 1980. Since then, other visitors had been brought to Modaoxi to see the Type tree. According to Prof. Yin, I would be the first foreigner to enter the village of Shuishanba in the center of the valley of the dawn redwood since 1948. What would I find?

The blaring of loudspeaker in the hotel's courtyard announced the beginning of a new day. At first light the cafes began to open, some construction sites were immediately busy, and the hearths of the brickwork kilns were lit.

At 8:00 a. m. , Lü, Li, and I were joined by Joseph, but replacing Mr. Fa was Fan Shen Hou. We drove to a building containing the Division of Forestry offices to

pick him up. He was the bureau chief in charge of Shuishanba, and he would serve as our guide for the day.

Our expedition took a different route into the mountains than the day before, but this direction was equally spectacular. In a light rain, we first passed several small towns in the greater Lichuan valley before climbing into the mountains. We proceeded through one isolated valley after the next, each with its own character. In one such valley, we discovered a square, stately building delightfully situated on a hillside surrounded by mountains. It was an old Taoist temple which now was being used as a retirement home. We walked through its courtyards and gardens and onto some old wooden balconies that allowed an expansive view of the valley as well as the heights above that were curtained with mist.

I asked Mr. Fan if he knew the path that Chaney and Silverman had taken to hike from Modaoxi to Shuishanba. He said that their route of about forty miles, which took them two days to walk, was quite roundabout. Now, he claimed, there was a decent path from one to the other that could be hiked in only six and a half hours! Incredible! Could it be hiked today? Although I repeated the question, "Where is the trail to Modaoxi?" throughout the day, I never received an adequate answer. They did not seem to be able to show me the way. Joseph said this new path followed our road, that is, the road we took from Shuishanba to return to Lichuan, but nowhere did there seem to be a turn-off for Modaoxi.

When Dr. Chaney and Silverman were in the village of Modaoxi in 1948, their Chinese colleague, Mr. Hua, declared that a few more days farther on, near Shuishanba, there was a whole forest of metasequoias. Chaney insisted that they continue hiking in order to see them.

During their first evening in the valley of the dawn redwoods, Chaney and Silverman both dropped to their knees to carefully place a small sample of needles from a California redwood (that Chaney had brought from his own Berkeley garden) at the base of one of the metasequoias.

Now, fifty years later, we were entering the valley of the dawn redwood. Our first stop was the metasequoia station, where four forestry workers, employed to protect and

preserve the dawn redwoods, lived and worked. Just below the station, there was a grove of several hundred metasequoia trees that had been planted in 1982. The hope was that within a few more years, these trees would begin to produce viable seeds that could be shipped to other areas of China for urban tree planting or other reforestation projects.

Local people currently collected thousands of pounds of cones and seeds yearly from mature trees that grow in the valley. A portion of these were bought by the government each year and sent to Beijing. Fan said that the villagers were paid very little in return. The station also managed a small nursery, where I saw another several hundred seedlings, each under three feet tall. These young trees were used for roadside planting. Probably the three metasequoias I first observed at the Chengdu Academy of Sciences began their lives here.

Fan reported that in the valley there stood about four thousand mature trees in all, each of which had been numbered and accounted for. The penalty for cutting any of these trees was one to three years in jail, so lately none had been cut. Lü reported later that Joseph had confided that because of budgetary restraints, the metasequoia station may lose its funding and be forced to close. However, all of the Institute's scientists were convinced that the government would somehow manage to continue to protect the metasequoias, regardless of any financial concerns.

A narrow path next to the river on the valley bottom led to reach a tree labeled metasequoia number two. Like the Type tree, it also had a metal grounding rod affixed to its trunk. This was the second largest tree. There was a bridge across the river here, as well as several traditional farmhouses.

When Chaney and Silverman were in Shuishanba in 1948, Chaney took a photo of Mr. Wu Tsa Ming, the headman of the village, posing with his three children at the base of a dawn redwood tree. I had brought a copy of this photo with me to China and one of the goals of the Fiftieth Anniversary Expedition was to find the people pictured in it. Prof. Yin, Lü Mang, and Joseph had all been very interested in this photo, as none of them had ever seen it or heard about it before.

Fan Shen Hou already knew of these photos. He had accompanied Bruce

Bartholomew's Sino-American expedition of 1980, the first group of foreigners to this valley since 1948. Although he had never seen the actual photograph, he was familiar with it, for he immediately knew that the older daughter pictured now lived in Lichuan, and he believed the second child lived close by Tree Number Two. We had asked the people in the nearby farmhouses about her, but she apparently was not in the vicinity on the day of our visit.



Figure 1. 15 Headman Wu, Wu Faying, and two of her younger brothers. From the San Francisco Chronicle, April 5, 1948.

Finally, however, we began to view what we had come to see—metasequoias growing in their natural environment. As we drove down the valley towards the tiny village of Shuishanba, there were more and more of them. The native tall, majestic dawn redwoods appeared intermittently along the valley floor and also on the surrounding hillsides. Their foliage was turning a pale yellow, and the trees had yet to drop any of their needles. They were graceful trees, so much more noble than the planted specimens we had been seeing along the roadsides. The entire setting was breathtaking, the trees, the golden rice terraces, and the green mountains that were shrouded in mist.

XI. The Journey's End



Figure 1. 16 The temple at the base of the Type tree, 1948. Courtesy of Dr. Chaney.

The metasequoias themselves have fared well the past fifty years. Although the diverse primary forest around Shuishanba no longer remains, the dawn redwood trees are all protected. In contradistinction to the decimation of forests elsewhere in the world, the past fifty years have witnessed an unparalleled proliferation of *Metasequoia glyptostroboides*. They could easily have become extinct in the 1940's. Instead they have now been planted along roadsides throughout China. Thanks to the efforts of Drs. Chaney and Merrill, the trees are also growing in over one hundred thirty countries around the world. Metasequoias have been planted as far north as Alaska and as far south as Argentina. These hardy trees are now growing in a wide range of climatic conditions, but the last half century has shown that they truly thrive and produce viable seed in climates similar to the isolated valleys near Shuishanba.

It is not difficult to feel protective of such a magnificent species. As we learn more about the interrelationship of all living things, perhaps the successful effort to save the metasequoia will serve as an example for other endeavors. Perhaps humans will become better at cultivating, preserving, and protecting the rest of our planet's diverse plant and animal kingdoms.

About author

William Gittlen was an emergency doctor at Kaiser Permanente, California, and he is surprisingly enthusiastic about natural redwoods discovery story. He is very friendly with Chinese people, his spirit was inspiring to the public, and he became a sincere friend of Chen Momei.

Section 3 Three Recent Expeditions to the
Ancient Dawn Redwoods

Chen Momei

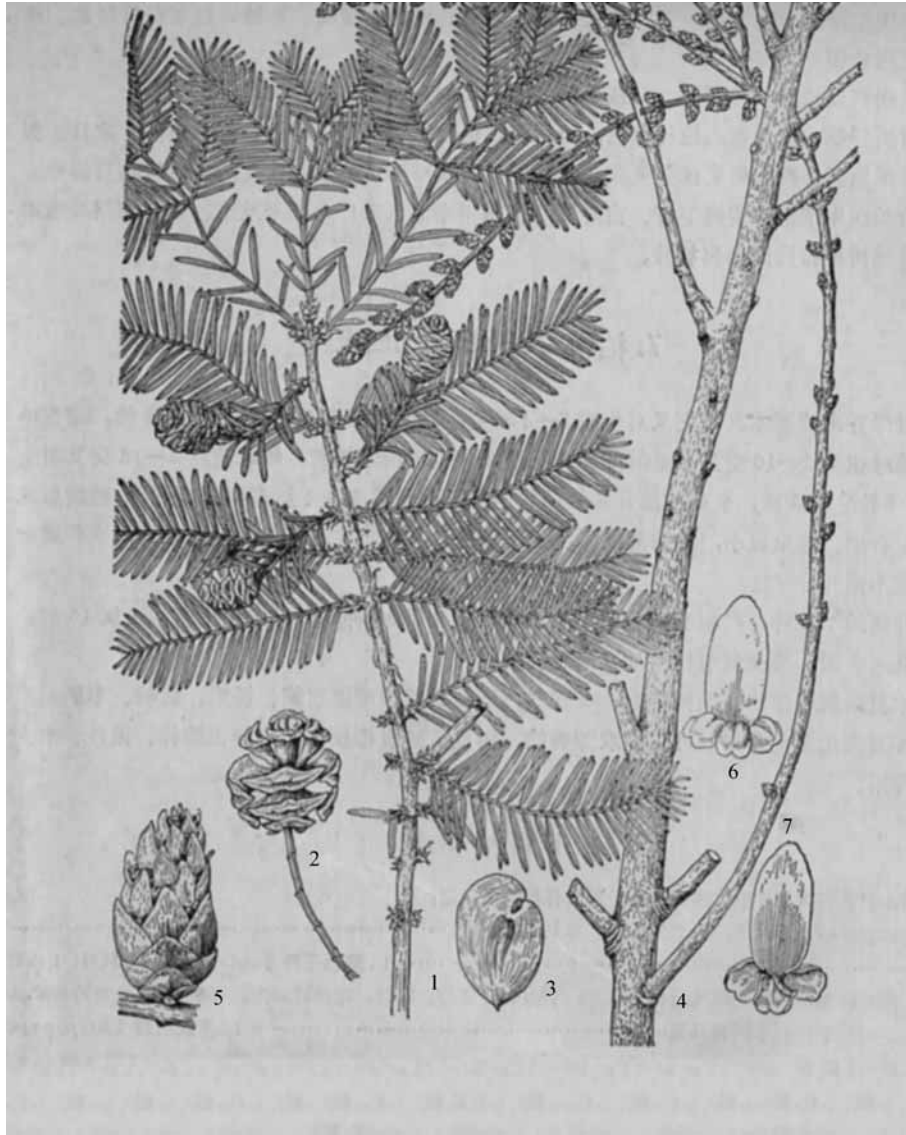


Figure 1. 17 *Metasequoia glyptostroboides* Hu et Cheng.
1. Cone-bearing branch; 2. Cone; 3. Seed; 4. male-cone-bearing twig; 5. male cone;
6 & 7. stamen (Copy from Chinese Flora).

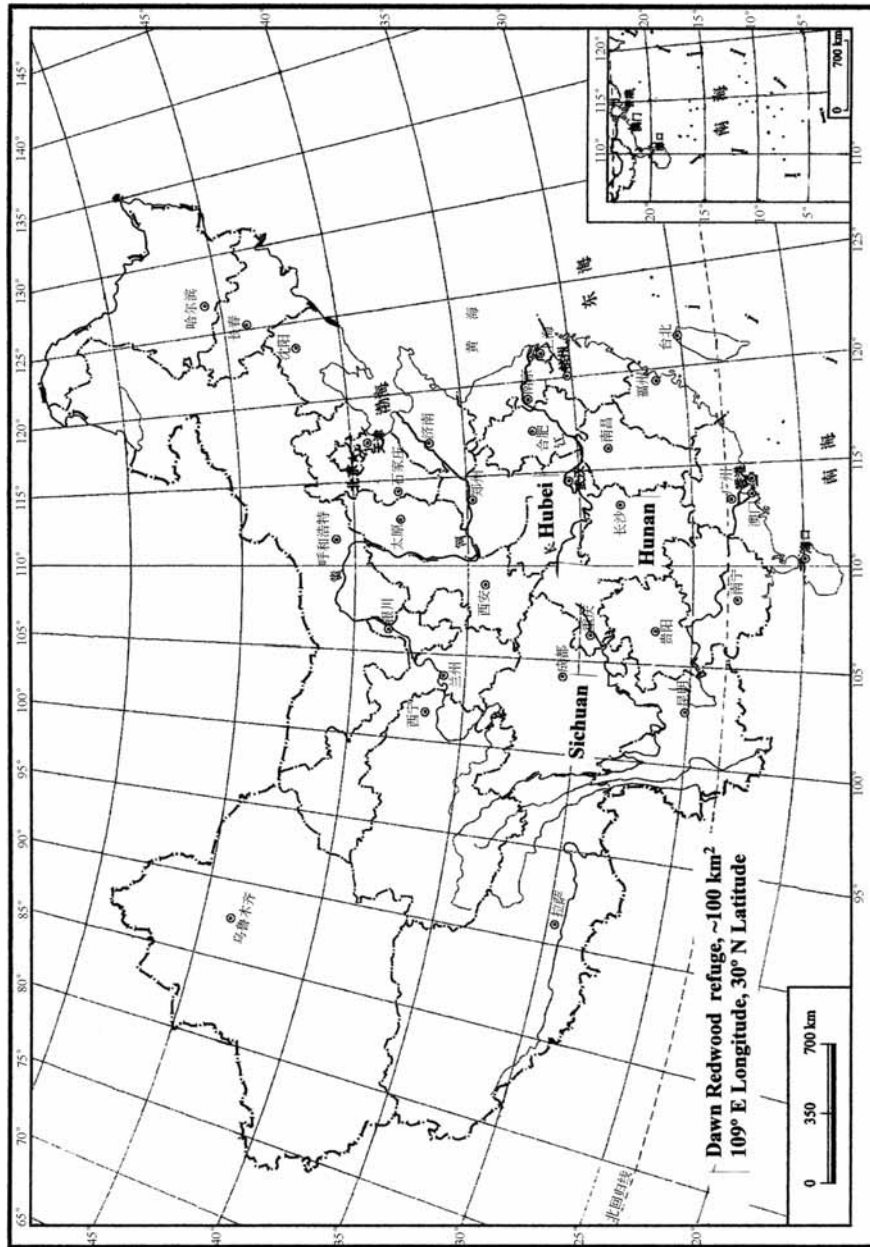


Figure 1.18 Ancient Dawn Redwood Distribution Region

The discovery of the dawn redwood (*Metasequoia glyptostroboides*, Fig. 1. 17) is the most significant event in modern botany. *Metasequoia* is a good example of a species that was first known as a fossil (Fig. 1. 19) before it was known as a living plant. First identified from strata of the upper Cretaceous, the genus *Metasequoia* was widely distributed in the north temperate latitudes of Asia, Europe and North America. *Metasequoia* once included as many as ten species, all but one of which became extinct by the end of the most recent period of glaciations. In 1940, Chinese and American botanists and paleobotanists found that the once broad range of the genus had been reduced to a small refugial enclave in the mountains of central China (north temperate zone latitude $29^{\circ}5' \sim 31^{\circ}32'$, east longitude $108^{\circ} \sim 110^{\circ}$). Here the sole surviving species, dawn redwood, occurs in extremely wonderful landscape areas. It persists in only one modest-sized stand and several scattered occurrences near the juncture of three provinces: Lichuan in West Hubei (Fig. 1. 26), Longshan in Hunan (Fig. 1. 20), and the deep valleys of Shizhu County of East Sichuan (Fig. 1. 47).

In 1941, Dr. Shigeru Miki, professor of Botany at Osaka University first described the genus *Metasequoia* from fossil materials from China and North America, based upon a combination of unique features of the female cone and leaves, soon verified by Dr. Ralph Chaney (Fig. 1. 21), at the Museum of Paleontology of the University of California at Berkeley. A short time later, in 1946, Wang Zhan, a colleague of professor Cheng Wanchun (Fig. 1. 22) of the National Central University, collected living materials that matched the fossil description of *Metasequoia*. These plants were later named *Metasequoia glyptostroboides*. While preparing a revision of fossil Taxodiaceae in 1948, Professor Chaney made a trip to central China to see living specimens of the newly described dawn redwood. Accompanied by Dr. Milton Silverman, science editor of the San Francisco Chronicle, Professor Chaney visited the type locality of *Metasequoia*. Pondering the fact that dawn redwoods had been considered extinct for million of years, Dr. Silverman wrote, "it was like finding a dinosaur alive!"

According to Professor Wu Zhen Yi, a member of the Chinese Academy of Sciences and an authority on the flora of China: "The flora of China is the most diverse

in the North Temperate Zone and is one of the richest in the world. It includes some 8 500 species of trees and shrubs. China is the only country in the world that includes unbroken transitional zones connecting tropical, subtropical, temperate, and boreal forests. Some genera of vascular plants such as *Metasequoia*, *Ginkgo*, *Cercidiphyllum* which are known only as fossils in Europe and North America, have survived in China. Therefore, knowledge of the flora of China is essential for interpreting the fossil record and understanding the vegetational history of North America, Europe, and Asia, for protecting the plants adequately, for utilizing them well economically, and simply for learning the properties of a significant fraction of the world's plants. ”

Chaney proceeded to refine according to their degrees of hardness the classification of fossils from the Taxodiaceae family, which included all species of the redwoods from ancient times to the present. His proposal extensively influenced the understanding of changes in global surface vegetation patterns as well as corresponding climate variations during the past 100 million years.

In the 21st Century, new research continues to refine the systematics based on morphological characteristics, and historical geographical distribution of both living and living fossil species, as well as furthering understanding of their relationship to global environmental change. For example, researchers are studying and using stomata index and stomata density to estimate CO₂ concentration. This concept helps researchers to develop a biological method to investigate the CO₂ concentration in the atmosphere during each geological period. From numerous practical investigations and references of dawn redwoods, historical geographical distribution and recent cultivation information has been provided. This has led to the development of new biological research thoughts and concepts; thereby researchers can now efficiently study 70 million years of global climate change regulation.

In 1973, mainland China reopened its borders to interested California and Harvard researchers. Since that time, there have been several expeditions to visit the dawn redwood. The following story is about three expeditions led by members of the University of California at Berkeley to see this ancient tree in the center of China. From 1987 to 2002, Chen Momei and Zhang Anghe led these expeditions to Hu-

bei Lichuan, Hunan Longshan, and Sichuan Shizhu Counties to see the condition and current conservation status of the dawn redwood.

I The First Expedition Organized by US/China Friendship Association

In 1987, Chen MoMei received an invitation from the China-US Friendship Association to lead the University of California, Berkeley expedition to see dawn redwood in China. We were all excited about the trip. All members of the expedition were very interested to see this important species in its homeland with their own eyes. The expedition was to consist of American botanists to see the living fossil in Hubei. This team included the director of the Sonoma County Botanical Garden, John M. Tucker and his young son, conifer molecular phylogeneticist Robert Price, and his newly married wife Marilynn. Also accompanying the expedition was a San Francisco Botanical Garden horticulturist, Mrs. Xue Jingde, and Dr. Baki Kasapligil a plant taxonomist, and four others. After discussing with the US-China Friendship Association and the Chinese botanists, the group decided on the schedule that would include travel to Beijing, Shanghai, Nanjing, Wuhan, and travel by ship along Yangtze River boarding at Wanxian and then to Chongqing, and finally return to San Francisco from Shanghai. The whole trip was planned for 20 days.

During the visit to Beijing, we visited the well known ecological Beijing Botanical Garden, and the Chinese Academy of Forestry. While at this latter stop, we discussed issues involving the conservation of the dawn redwood. While in Shanghai, the group visited Fudan University's Department of Biology and Genetic Research Institute. Professor Li Linchu hosted the group at Fudan University, and gave a lecture to the group about research on chromosomes in the redwood family, Taxoideaceae. He described relationships in the family among the three redwood genera, *Metasequoia*, *Sequoia*, and *Sequoiadendron*, and other members of the family. Within recent years, dawn redwood has been planted in 26 provinces in China and 50 countries throughout the world. Shanghai is a place with subtropical oceanic-and-monsoon climate, with a frost-free period of 250 days throughout a year. It has 1000mm precipitation each year, which allows both coast redwood and dawn redwood to grow well in Shanghai.

During our visit to Shanghai, the group visited an area in the suburbs where a large group of dawn redwoods had been planted (Fig. 1. 23).

From Shanghai the group travelled by train to Nanjing. Around the railroad, we enjoyed the breath-taking scenery south and north of the Yangtze River shore. In Nanjing, we were very impressed by the enormous landscape of the city's Dawn Redwood Road (Fig. 1. 24). No urban forestation in the world surpasses this view in Nanjing. Then, we visited the Nanjing Botanical Garden. Interestingly, Nanjing was the first garden in China to have a coast redwood, a tree that is endemic to coastal California and extreme southwest Oregon on the Pacific Coast of the U. S. The group also visited Nanjing Forestry University. This is the place where Professor Cheng Wanchun, an expert on Chinese tree flora and its systematic studies, originally discovered and named the dawn redwood.

In Wuhan our group visited the Central China Agricultural University to meet Professor Li Minghe. Professor Li gave us assistance in obtaining a visa to visit Lichuan to see the native population of dawn redwood. We had just started sight-seeing along the Yangtze River, but were very impressed with the powerful river and its neighboring mountains. Our group had a chance to observe the many caves dotting the neighboring hillsides, the deep river, the forms in the rocks and the many monkeys along the river. During the trip, the group discussed the history of the landscape and possible changes in the surrounding biota. We began to understand why a living fossil, such as the dawn redwood, could exist in this type of environment.

We landed in Wan County, which at that time was part of Hubei province. This county is now in Sichuan province. Forty years prior to this trip, Chaney's expedition to this region had been news around the whole world. At that time, it was very difficult for Chaney to travel from Wan County to Modaoxi town, the location of the discovery of dawn redwood. He had to travel by sedan chair in the difficult road. At that time, this trip took him 3 days. However, when we travelled the same distance by bus, the same trip only took 2 hours. After arriving at Modaoxi, the whole town gathered to see the group. Our group was able to see the type tree of dawn redwood, the same tree Chaney had seen in 1948 (Fig. 1. 25). "Time flies like an arrow;" more

than half a century passed. Today, our group was extremely amazed and fascinated to see this geologically significant tree that most scientists had thought extinct. It appeared that the tree was at least 30 meters high (Fig. 1. 26). We then surrounded the tree holding hands in hands joyfully. We noticed that the small temple that sat at the base of the tree, as shown in the photograph by Chaney in 1948, had disappeared, and was replaced by new houses. At lunch, we all had very delicious serving of rice and braised pork to welcome the travellers, a tradition of the local *Tu* minority people. The group enjoyed this local custom of the *Tu* minority. After 1949, most towns or villages south of the Yangtze river had planted dawn redwood around their rice fields, and it had become a method of agroforestry in this region (Fig. 1. 27). At several visited dawn redwood's valleys, we could observe many dawn redwood trees growing with bamboo (Fig. 1. 28). The village in the Xiaohe valley was in the process of becoming *Xiaohe Conservation Park*, where thousands of native dawn redwoods are located. But they are not as tall as the discovery tree at Modaoxi. That night our group returned to Wan County, where we returned to the Yangtze river to travel to Chongqing. From Chongqing, we flew back to Shanghai, then returned to the US.

In this trip, we obtained research information on the ecology of dawn redwood in Lichuan County in Hubei from Liu Sheng xiang, a professor of Central China Agriculture University. *Hubei Lichuan Xiaohe Dawn Redwood Reserve* was established in 1985 by the State Department of People's Republic of China. It is located at approximately north latitude $30^{\circ}10'$, east longitude $108^{\circ}45'$, elevation 900 ~ 1350m, with minimum low temperature at -15.4°C and maximum high temperature is 35.4°C ; average annual temperature 12.8°C , annual precipitation 1500.9mm; 230.9 growing days. Xiaohe is a short-day, low evapotranspiration, high precipitation and high relative humidity location, sheltered by Qiyue Shan and Fubao Shan mountains. Thus protected from winter storms and summer's warm temperatures flowing from flat land area to the southeast, with no serious winter cold nor hot summer weather, it is very suitable for dawn redwood growth, the average diameter of natural dawn redwood is 20 cm (Fig. 1. 29).

The main population of *Metasequoia glyptostroboides* is in Xiaohe, an open river

valley, located south of Fubao Mountain, East of Qiyue Mountain, west of Majian town, north of Zhonglu town, the valley extending south to north about 30 km, east to west 20 km, about 60 thousand ha. The *Metasequoia glyptostroboides* trees grow along both sides of the valley on alluvial soil and in foothill creek drainages. There are about 5,000 remaining native *Metasequoia glyptostroboides* in this area, with an average diameter of 20 cm. There are three plant associations including native *Metasequoia glyptostroboides*: (1) Dawn Redwood-Taperleaf Camellia-Parathelypteris nipponica; (2) Dawn Redwood-Taperleaf Camellia-Bigonia-Pilea; (3) Dawn Redwood-Eurya-Iris-Parathelypteris nipponica. The first association is located at Xiao Mao Ba Zi's Gang Chang wan, elevation 1175m, slope 15°, relative humidity 87%, steam flow into Xiaohe river, tree-level canopy density as 0.3 ~ 0.4. The largest *Metasequoia glyptostroboides* diameter is 76.5cm, and they can grow as high as 27m. avg. height. Their associated species include *Cunninghamia lanceolata* Chinese-fir, *Castanea seguinii* seguin chestnut, *Liquidambar formosa* (Formosa sweetgum), *Toxicodendron succedaneum* (wax tree), *Cephalotaxus fortunei* (chinese plumyew), *Acer chinensis*, and *Camellia cuspidata* (sharp leaf camellia). The first association contains 40% *Camellia cuspidata* and *Cotoneaster divaricatus* (spreading cotoneaster) (Fig. 1. 30). The second association is composed of mostly *Liquidambar formosa* in the canopy, which have an average diameter of 40cm, average height of 25m, and has maximum diameter of 76cm, height of 34m. It includes *Camellia cuspidata*, *Lonicera pileata* (privet honeysuckle), and *Lindera glauca* (greyblue spicebush) in the understory. The third association is located at Xiaohe, You Jia Wan 1090m, slope 15°, humidity 89% ~ 90%, with canopy density of dawn redwood 0.5 ~ 0.6. Their average diameter and height are 30cm and 25m respectively. The largest diameter is 77.5cm and the tallest is 38m. Its understory contains *Eurya hebeclados* (downybranched eurya), *Rhododendron* sp., *Phoebe hunanensis* (Hunan phoebe), *Phyllostachys bambusoides* (Giant timber bamboo).

In this main population, we investigated the Ying Chen Stump, in the Xiang Yang-3 community in Xiaohe. There is one (or perhaps a close two or three) dawn redwood stumps remaining in a rice paddy (Fig. 1. 31), having been cut about six

hundred years ago. Nine of us surrounded the stump outer circumference, holding hands to estimate its size (Fig. 1.32). The diameter was estimated to be greater than 7m. This reinforced a traditional belief of the Chinese that the cultivation of rice field has destroyed much of the habitat of the largest bottomland dawn redwoods. We wondered if we were standing on the land where plentiful dawn redwood had once survived. Xiaohe's location in a remote isolated valley of Wuling Shan, Wu Shan, Qiyue Shan, lying on the boundaries of Sichuang, Hunan, and Hupei, minimized its exploitation for export downriver. In addition, as a valley surrounded by the mountain of Qinglin, Daba Shan, Xuefeng Shan, Fanjing Shan, and Guizhou Gao Yuan, this favorable geographic characteristic has created a protecting shelter for dawn redwood during the ice age (Fig. 1.33).

II The Expedition Organized by the Save the Redwoods League

The Save the Redwoods League is a non-profit organization dedicated to the preservation of all redwoods and ancient forests. In 1999 the League set out to film dawn redwoods in the Long Shan and Lichuan Xiaohe natural preservation regions.

The League proposed sending a delegation to visit and film the area where the dawn redwood has survived, in part visiting the trees League-president Chaney had first saw 50 years earlier. They hoped this would increase worldwide understanding and appreciation of all redwoods. The Save the Redwoods League thought this objective would stimulate scientists and others in China and the United States to conduct collaborative research and share their findings with the public at large. As a Research Associate at the University & Jepson Herbaria, UC Berkeley, and Professor of Forest Pathology, Chinese Academy of Forestry, Beijing, Chen Momei was invited to lead the filming expedition. Being a native of China, and a member of the USA/PR of China Friendship Association, she eagerly accepted the position and planned a two-week visit to China that included meetings with government officials, scientists, and local enthusiasts. Besides Prof. Chen, the delegation also included: Mary Angle, Executive Director of the Save the Redwoods League; Zhang Anghe, Emeritus Professor of Chinese Academy of Forestry, Beijing; Joe Engbeck, author & historian of redwoods;

Bill Libby, Professor Emeritus, Forestry & Genetics, UC Berkeley; Iris Libby, photographer; Raymond Chavez, Earthviews-Documentary Film Producer; Cinematographer; Li Minghe, Professor of Forest Genetics, Central China Agricultural University, Wuhan; Zheng Shikai, Silviculture Researcher, Chinese Academy of Forestry, Beijing and Qian Jinhong, candidate in plant ecology, UC Berkeley (Fig. 1. 34).

On May 3, 1999 the delegation embarked on the exciting expedition. The group flew to Beijing where they were hosted by the Chinese Academy of Forestry (the National Forestry Research Center). They visited a 26-year-old dawn redwood plantation at the Beijing Botanical Garden (Fig. 1. 35 and Fig. 1. 36) and held meetings with Academy scientists, Garden officials, National Herbarium staff, and representatives of the Beijing City Park System to discuss the protection measures undertaken by China on behalf of the historic redwood species.

On May 7th, the group flew to Changsha in South-Central China and continued on to Zhangjiajie City, in Hunan Province. The group took an airway tram into Zhangjiajie National Park and enjoyed the marvelous geology, especially the “sandstone ridge” formed by quartz rock mechanics (Fig. 1. 37). The Zhangjiajie National Park is an extraordinary natural area that hosts over two million visitors annually (Fig. 1. 38). The National Park Foresters took the group to Jinbian Creek and Tianzi Shan to see planted dawn redwoods and their associated species growing in a deep and secluded valley (Fig. 1. 39).

The expedition then traveled to the Hunan *Wulingyuan National Park* area to see the Long Shan “field museum” of three very large *Metasequoia glyptostroboides* (Fig. 1. 40). The journey to Long Shan required extensive travel over many mountains and precipitous deep gorges. The County of Long Shan, Hunan provided transportation for the group to see the three dawn redwoods. The team investigated the three local dawn redwoods, one in Luota Village (Fig. 1. 41), the other two in Pao mu Village (Fig. 1. 42). They have noted their heights to be 36 ~ 44m, diameter 128 ~ 176cm and estimated age approximately 500 ~ 800 years. In addition to observations, the group had extensive discussions with Long Shan scientists, farmers, and administrators about the need for ongoing conservation of *Metasequoia glyptostrobo-*

ides. A proposal was discussed to establish a foundation to continue protecting the planted dawn redwoods of Zhangjiajie and the three large dawn redwoods of Long Shan, Hunan.

The next destination for the group was the largest natural population of *Metasequoia glyptostroboides*, in Hubei province. Hubei has some of the richest natural resources in China and Lichuan County is the wealthiest area in terms of vascular plant diversity. Near the town of Xiaohe, up until 1948, villagers used native dawn redwoods for covering walls, making furniture and coffins, and as firewood (Fig. 1.43). In 1958, dawn redwood reserves were established to protect the few remaining trees growing near the rice fields of the village. Along the village road the group visited several dawn redwood seedling houses and nurseries in converted rice paddies (Fig. 1.44). The local *Tu* farmers are doing well cultivating the seeds and rooted cuttings of dawn redwood for sale in other provinces as well as to international markets. The consequences of increasing seedlings for support the development of dawn redwood plantation (Fig. 1.45).

On the last among the native dawn redwoods, the expedition traveled to Maodaoxi, Lichuan County, Hubei Province, to see the “discovery tree” from which the first collections were made by Cheng’s colleague Dr. Wang Zhan. The group was dismayed to find that the natural area immediately surrounding the type tree (Fig. 1.46) had been dramatically altered because of Xiaohe’s growing population, they also discovered people devoted to planting more dawn redwood trees. The group talked extensively with the Maodaoxi and Lichuan Forestry Bureau officers about the possibility of creating an international redwoods park, about one hectare in size, to conserve the type tree of the *Metasequoia glyptostroboides* surrounded either by its native associated species with coast redwood and giant sequoia, and discussed Chinese cooperation with Save the Redwoods League for conservation and development of the living fossil treasures.

On May 17th, the research expedition returned to San Francisco, having had a very productive trip visiting the naturally occurring dawn redwoods and exploring the possibilities for ongoing research and preservation of *Metasequoia glyptostroboides*.

While the dawn redwood is now widely known and cultivated throughout Asia, North America, and Europe, the protection and preservation of the remnant populations in China is a critical component to understanding the unique life history of redwoods worldwide.

The expedition is grateful to the Save the Redwoods League for sponsorship and to their generous Chinese hosts, which included: the Hubei Province Branch of the US/China Foundation for International Exchange, Professor Li Ming he at the Central China Agricultural University, and Professor Li Linchu of the Genetics Research Institute at the Shanghai Fudan University.

III 2001 Shizhu Dawn Redwood Exploration in Sichuan Province

It is known that large old dawn redwoods occur in the intersection of Hubei, Hunan, and Sichuan provinces. Among the three, the dawn redwoods of Shizhu County in Sichuan have been examined the least. In 2001, Zhang Anghe and Chen Momei received an invitation from a Sichuan province delegation during their visit in California, to visit their province's Chinese Academy of Forestry. Out of our fascination with China's unique geographic history and the historic sites in Sichuan, we started our trip to Sichuan.

We were delighted to have He Pin, the vice director of divisions of science and technology of the Forestry Department of Sichuan, to accompany us. On our trip to Shizhu to observe their ancient dawn redwoods, we headed west from Chengdu, and passed by fertile plateau country. We saw the ancient water-control method, that should also credit for the stunning landscape of the today's Chengdu plateau. There, we could view the entire sacred land of Taoism and feel the calmness of Qincheng Mountain. It is exactly what we would describe as a desirable living environment with timely wind and rain. On our way to the east, over the lofty ranges, we arrived in Zhong Xian (the Pearl County of Chang Jiang). From Baoshi County to see south to a beautiful landscape-Greenish county Shizhu County (Fig. 1.47). There is a male "shi zhu" (Fig. 1.48) and a female "shi zhu" (Fig. 1.49). We then headed to the west side to the big County Fuling and to the northwest point of the FangDou Moun-

tain. It belongs to Shizhu County.

The *Tu* minority of Shizhu Municipality County, formally known as Shizhu County, was originally Nanbing County. It is located east of Chongqing city and is on the south bank of the Yangtze River. The exact location is east longitude $107^{\circ} 59'$ to $108^{\circ} 34'$, north latitude $29^{\circ}39'$ to $30^{\circ}32'$, in the middle of the Three Gorges Reservoir Region; it is the only municipality county there. Shizhu Municipality County connects to Lichua City to the east, Pangshui County to the south, Zhong Xian to the northwest, Fengdu County to the southwest, and Wanxian City to the north. The county is 98.3 km long from north to south, 56.2 km wide from east to west, with a total area of 3012.51 square kilometers. Shizhu County belongs to the center of Wu Mountain and Dalou Mountain, parallel to Qizhuo Mountain and Fengdou Mountain. Its topography is higher in the southeast and lower in the northwest. Dafengbao, Huangshui Town, in the southeast, is 1934.1 m above sea level and Taojiaba, Xituo Town, in the northwest, is only 119 m above sea level. The region is mainly composed of mountains of average and low heights, highlands and hills. It belongs to a tropical monsoon area in the middle of the east-Asia zone. It has mild climate, with abundant rainfall, and four distinctive seasons with an early spring, long summer, short autumn, and late winter. It has limited sunlight, and a distinct contrast in climate based on the elevation, with a high frequency of hazardous extreme weather. The average annual temperature of the entire county is 16.5°C , with a record high of 40.2°C , and record low of -4.7°C . There are 197 species of trees throughout the whole county, including pine, Chinese-fir, and cypress. Among the tree species, the more precious ones are dawn redwood, *Cephalotaxus fortunei* (fortune plumyew), *Ginkgo biloba* (gingko), Phoebe (*Phoebe hunanensis*) and *Davidia involucrata*.

Shizhu County is one of the few places in the world that has apparently-native dawn redwoods growing. It has 28 dawn redwoods that are on the protection list of China. We observed the “world’s biggest dawn redwood” under the companionship of the leaders from Shizhu County’s Department of Forestry (Fig. 1.50). Next to that dawn redwood is a tomb, surrounded by rice fields. Since the commute there is inconvenient, visitors are noticeably fewer than that in the Lichuan area. Throughout

the exploration, the road was dangerous.

We were surrounded by mountains. Poetry and paintings have described it as “the road to Sichuan is as difficult as ascending the sky”. During we visit, most of the roads were under construction. In recent years, however, Shizhu County has been developing rapidly, thanks to the local government’s emphasis on the development of the only Tu minority in the Three Gorges area. Furthermore, the roads are fairly well constructed. With gorgeous landscape, Shizhu County has rich resources of tourism (Fig. 1. 51). Finally, we arrived to our destination and saw the properly protected dawn redwood. At that moment, we all felt like we were in a drawing.

Afterwards, we visited Wolong National Nature Reserve in Sichuan to see another living fossil, the panda (Fig. 1. 52). As meaningful as the dawn redwood itself, the panda also survived the ice ages of the Quaternary Period. As an icon of the world’s endangered species, the panda has become a national treasure of China.

According to Professor Wu Zhengyi, an expert on Chinese flora, the region where dawn redwood was discovered is unique, and important for the understanding of the origin of Chinese flora. The *Metasequoia* region is geologically representative of the Tertiary Period plant flora, especially in the southeast and northeast of Yunan province, the Valley of Jinsha River, in the eastern part of Sichuan and Nanling region. This region served as a refuge for the protection of many plants during the Tertiary Period. Over time, this has been the place of origin for many plant species. These plants are very similar to those in Southeast Asia flora. No doubt that *Metasequoia* chooses a special place to live.

Fifty years after the discovery of dawn redwood, the species that was successfully transferred to more than 26 provinces in China and more than 50 countries across the world. It has become an important tree for wood supply, coast protection, farmland protection, city landscape architecture, and famous natural parks around the world.

Up on the hills of the UC Berkeley campus, we have a few *Metasequoia* (60 years old) growing in the UC Botanical Garden. These trees were from the seeds that Chaney brought back from China in 1948. Redwoods once covered the west coast of North America in hundreds of different redwood species. Now only three species

remain, mostly in protected national and state parks.

The UC Berkeley campus is the one campus that has the three existing species of redwood trees. There are four to five communities of coastal redwood along Strawberry Creek (Fig. 1. 54). Several communities of trees decorate the campus like a flower garden, accompanied by cool springs (Fig. 1. 53) and streams. Coastal redwoods grow in clusters along Strawberry Creek where it flows west through campus, shading a scenic bridge and small waterfalls.

The largest redwoods on UC Berkeley campus have diameters that span more than 2 meters. When one marvels at these beauties on campus, one may realize the importance of environmental protection. At the front of the Earth Science Building and crossroad near East Asia Library careful observers might notice the uniqueness of the dawn redwoods located there (Fig. 1. 55). Their characteristics that differentiate them from the coastal redwoods include their grayish-white bark and soft, thin leaves that resemble needles (Fig. 1. 56).

The story of those 60-years old dawn redwoods is truly amazing because the seeds were brought to the United States by Professor Chaney. The dawn redwood trees are now living in the United States. Having once gone through a difficult history, the trees are now standing tall and majestic on the UCB campus (Fig. 1. 57). At the same time, additional dawn redwood trees seeds, also brought over by Professor Chaney, were planted at the UC Berkeley Botanical Gardens and US, and are now considered treasures there. In addition to the dawn redwoods and the coastal redwoods, another kind of redwood, the earth's largest giant sequoia, can also be found standing at the front of West Gate of the UC Berkeley campus (Fig. 1. 58).

Chaney's collection reside in the Valley Life Science Building at UC Berkeley, an intellectual treasure for all humans (Fig. 1. 59). Many subsequent scholars contributed to this bilingual book to devote precious wisdom to future generations (Fig. 1. 60).

Chapter II Coast Redwood
(*Sequoia sempervirens*)

Section 1 Trees, Shrubs and Flowers of the Redwood Region

Willis Linn Jepson

The dominating tree of the coastal forest belt is the Redwood. It gives a distinctive character to the country, and no other tree of this region approaches it in size, in density, in height, or in biological or historical interest. The forests of it average 150 to 250 feet high, but many individuals exceed these figures and trees 350 feet in height have been carefully measured.

Although possessing such magnificence in stature, its most characteristic organs, aside from the main axis, are in great part rather delicate. The narrow leaves are about one-half to three-fourths of an inch long and are borne on the ultimate branchlets in such a way as to form flat sprays. These leaves live over three to five winters but never drop singly. Instead, the sprays fall after their work is done. The forest floor is thus deeply littered with these old sprays and if the traveler picks up a few, he will see by looking at them carefully that they represent one or two, or usually three or four years' growth. Mixed with the ground litter he will also find cones, and these are surprisingly small, light-brown structures three-fourths of an inch long, sometimes an inch long, consisting of some 14 to 24 scales.

Two Species of Sequoia

The redwood, a true sequoia with the specific name *sempervirens*, grows only at low altitudes, 5 to 2000 feet, along the coast from the Santa Lucia Mountains in Monterey County north to the Oregon line, a few groves occurring in Curry County, Oregon. In the Sierra Nevada it is replaced by another species of sequoia, namely the GIANT SEQUOIA (SIERRA REDWOOD, *Sequoiadendron giganteum*), which is found chiefly in isolated groves at altitudes varying from 4500 to 8000 feet. This is a more massive tree than the redwood, and has very small scale-like or awl-like leaves about one-fourth of an inch long, sometimes a little more, sometimes a little less, which thickly clothe the fine branchlets all around, so that a spray of the foliage reminds one of a cypress. Its cones are larger than those of the redwood, being in bulk about the size of a hen's egg. Both of these species, it must be remembered, are sequoias, but each has marked characteristics, which separate them as quite distinct species. Both are redwoods in the sense that the heartwood is red in each, but the

term redwood as a folk name belongs by long usage to the coastal tree. Both are Big Trees in the sense that they outclass in size practically all other arborous growth, but here again the term Big Tree is by long usage sanctified to the Sierran species. Geographically they are mutually exclusive. Redwood is found only in the Coast Ranges, Big Tree only in the Sierra Nevada.

The typical or most intensely developed redwood groves of the northern coastal woodlands come as near as possible to being pure stands of *Sequoia sempervirens*. These ancient trees tower above all other vegetation, and are so dominant as seemingly to leave no room nor sunlight for other trees and plants. Nevertheless it is astonishing to note how many species of



Figure 2.1 Coast Redwoods (*Sequoia sempervirens*).

plants thrive in their shade, species which are able to make efficient use of whatever sunshine filters between the needle-leaves of their giant neighbors.



Figure 2.2 The distribution of Coast Redwoods and Giant Redwoods in California.



Figure 2.3 Giant Sequoia (*Sequoiadendron giganteum*).

Associated Trees



Figure 2.4 Douglas-fir (*Pseudotsuga menziesii*).

Three species of trees, more frequently than any other species, are intimately associated with the redwood. They are the Douglas-fir (*Pseudotsuga menziesii*), a conifer sometimes attaining rather great size; the Tan oak (*Notholithocarpus densiflorus*) with chestnut-like leaves and woolly acorns; and the Madrone (*Arbutus menziesii*) with shiny green leaves and rich-red limbs which give a fine and colorful glow to the Coast Range wood-

lands. Vigorously reproductive, the Douglas-fir establishes dense and often pure colonies on favored slopes or in rich flats. In competition with the tan oak, an extremely aggressive tree, and with the Douglas-fir, the madrone is always thrust to one side. In its effort to reach a small patch of light in the high forest canopy the trunk may become extremely long and curved, or twisted, or bent into odd shapes. Sometimes a fire or the impact of climatic factors may take out the susceptible and highly resinous Douglas-fir and leave these curious shapes of the madrone standing free and isolated in an open glade, suggesting strange enigmas in the forest complex.



Figure 2.5 Tan Oak (*Notholithocarpus densiflorus*).

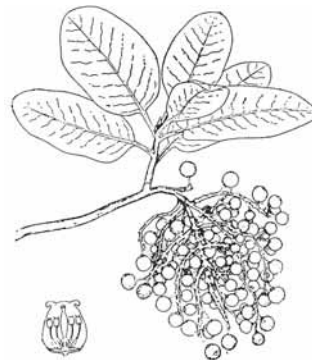


Figure 2.6 Pacific Madrone (*Arbutus menziesii*).

The stream banks have their own characteristic species. Here we have the BIG-LEAF MAPLE (*Acer macrophyllum*) with broad palmate leaves turning a brilliant yellow in the fall, and the RED ALDER (*Alnus rubra*) with viscid leaves and springtime clusters of long pendulous catkins.

The tree species just mentioned also help to make up the inner border forest of the redwood belt, and in addition there are other kinds of trees, for the most part occurring in the border forest, but only slightly or not at all in the redwood forest. One of these is the

California Laurel (Bay, Pepperwood, *Umbellularia californica*). It is a large dense tree when well developed and has leaves with a remote resemblance to those of the classical laurel. They are pungently aromatic, especially when broken.

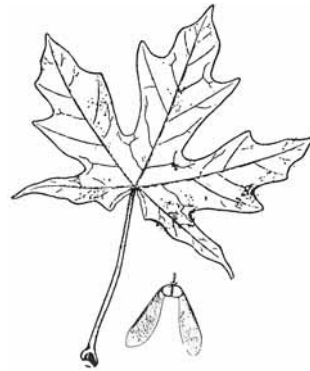


Figure 2.7 Big-leaf Maple (*Acer macrophyllum*).

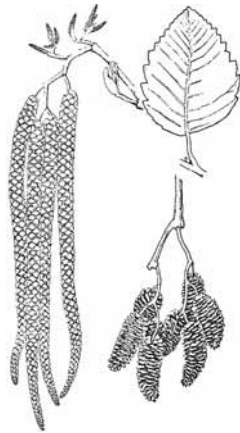


Figure 2.8 Red Alder (*Alnus rubra*).



Figure 2.9 California Laurel (*Umbellularia californica*).

The most friendly tree in the border forest is the California Buckeye (*Aesculus californica*), vivid with bright-green foliage in April, splendidly dowered with large panicles of white flowers in June and, responsive to the heat, stripped down nakedly to its white branches in late summer and autumn, its great pods hanging thickly over

the crown and waiting patiently for the first rains.

In the border forest are also two fine oaks, the massive Oregon Oak (*Quercus garryana*) with wide spreading, mossy branches and smooth white trunks, and the California Black Oak (*Quercus kelloggii*), with erect slender branches in its tall crown and with deeply lobed leaves bearing little bristles on the tips of the lobes. Both of these oaks are deciduous trees and are abundant in the border forest.



Figure 2. 10 Oregon Oak(*Quercus garryana*).



Figure 2. 11 Black Oak(*Quercus kelloggii*).

In May the most striking tree of all is the Western Dogwood (*Cornus nuttallii*) which illuminates the forest with showy white flowers although these are not flowers after all, but colored bracts which surround the central cluster of small but real flowers.

On the opposite side of the redwood belt, next to the ocean, are other trees which form an outer border forest. This forest contains several magnificent species of the cone-bearing class, such as the Coast Hemlock (*Tsuga heterophylla*), the Sitka Spruce (*Picea sitchensis*), the Grand Fir (LOWLAND FIR, *Abies grandis*) and the Port Orford Cedar (*Chamaecyparis lawsoniana*). In some areas, especially northward, in northern Humboldt County and in Del Norte County, these species may be observed as distinct associates of *Sequoia sempervirens* in heavy redwood stands.

Shrubs

Certain of the shrubs in the redwood belt may be regarded as true associates of the redwood itself. Two of these are especially abundant; both have little urn-shaped flowers proclaiming their relationship to the heathers. They are the California Huckleberry (*Vaccinium ovatum*) with small shiny leaves disposed in two ranks on curving stems and the Salal (*Gaultheria shallon*), a smaller shrub with fewer, larger leaves.

On the edges of the streams the Creek Dogwood (*Cornus sericea*) often forms a dense curtain and contributes a bright red note in the autumn, while on the borders of the redwood forest itself are found a number of shrubs requiring only partial shade. Among them may be mentioned the Blue Blossom (*Ceanothus thyrsiflorus*), and the Lady-bloom (*Ceanothus parryi*), both with showy clusters of tiny blue flowers, the Wood Rose (*Rosa gymnocarpa*), with delicate fern-like leaves, and the Thimbleberry (*Rubus parviflorus*), with large velvety yellow-green leaves and downy bright red berries.

Of all of these shrubs of the redwood glades, the traveler may have the most eager relish for and seek out the less frequent Salmon Berry (*Rubus spectabilis*) which has migrated in past ages southward from Alaska. It is less frequent than most of the shrubby species but the traveler searches the forest for its luscious yellow or pink berries which mature in midsummer.

Since it is everywhere in hill country, here also must be mentioned the much-feared Poison Oak (*Toxicodendron diversilobum*), so tolerant of both sun and shade. Its



Figure 2. 12 California Huckleberry (*Vaccinium ovatum*).



Figure 2. 13 Creek Dogwood (*Cornus californica*).

(*Rhododendron occidentale*), with whitish or pinkish flowers, is not uncommon in the outer border forest.

three-parted glossy leaves distinguish it from other harmless shrubs, but it is relatively a rarity in typical redwood forest. Travelers sufficiently observant, however, may see it in one of its most remarkable phases, climbing redwood trunks to heights of 50 to 150 feet! And forming truly wonderful columns of foliage, sometimes ablaze with all the intensity of its lurid browns and scarlets.

The showiest of all shrubs in the redwood forest is the California Rosebay (*Rhododendron macrophyllum*), which makes so fine a spectacle that travelers journey for a thousand miles to see it in the height of its rose-purple bloom. Its cousin, the Western Azalea

Flowering Herbs

Where the redwood forest is not dominated by an understory of shrubs, its floor, spongy with a very deep layer of leaf and twig mould, is, over considerable areas, completely covered with small flowering plants and ferns. The flowering plants have, for the most part, small, inconspicuous or even minute flowers. Several species are notably abundant, the Redwood Sorrel (*Oxalis oregana*) in many glades easily taking first place. Its pretty pink-lavender blossoms and clover-like leaves always adjusted to the light filtering down through the forest canopy so from great a distance, readily distinguish it. Next in order of abundance in certain areas is the Inside-out Flower (*Vancouveria planipetala*), whose leaves resemble a large coarse maidenhair fern. Somewhat taller than the other two is the Deer-foot (*Achlys triphylla*) with its single ragged three-parted leaf and cluster of inconspicuous flowers.

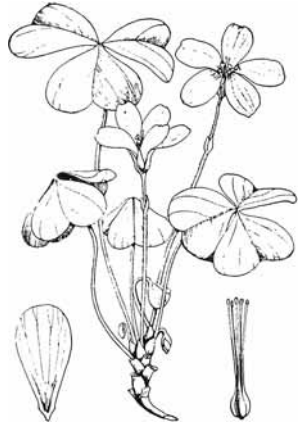


Figure 2. 14 Redwood Sorrel (*Oxalis oregana*).



Figure 2. 15 Inside-out Flower (*Vancouveria planipetala*).

Everywhere on the floor of the groves and even swarming on rotting logs, one meets with little saxifrages, exceedingly dainty plants, rather humble for the most part, all characterized by a basal rosette of leaves and one or more erect flower-stems. By far the most common of these is the Sugar Scoop (*Tiarella trifoliata* var. *unifoliata*) with tiny pure white flowers. Acres and acres of it, a faëry land of faintly glowing light, stretch away to distant levels half-seen through the giant trunks rising so somberly from the cañon bottoms.

Fairly abundant also are the California Alum Root (*Heuchera micrantha*), a somewhat larger plant with dull-colored flowers, and Fringe-cups (*Tellima grandiflora*), a slender herb, one and one half to three and one-half feet high, with greenish rosy flowers.

All these herbs have, considered as a plant formation, a meaning that would give most travelers a tingling thrill could they know all its significance. It would scarcely be possible for these delicate denizens of the forest, in their thread-like stems and ting flowers, to be more remote in body structure from the colossal individ-



Figure 2. 16 Sugar Scoop (*Tiarella trifoliata* var. *unifoliata*).



Figure 2. 17 California Alum
Root (*Heuchera
micrantha*).

uals that we call redwoods. And yet the two, as living formations, belong together. This flower formation has come down with perhaps little change, and has survived and survived only because of association with the stands of *Sequoia sempervirens*. One may see, at times, two, five or even fifteen acres of forest level covered with an almost pure growth of the frail sugar scoop, its white flowers in such profusion as to change the character of the woodland floor. From that flowering carpet, woven of such tiny threads, rises the immensity of the red columns of the trees in such close order as to shut out from a great height all direct rays from the sun. From that flowery expanse in the peak of its anthesis is given back to him who knows the forest a soft, strange light, such as was never seen elsewhere on land or sea. And here a scientific philosophy serves well our understanding, because we pause here, in very truth, in the presence of one of the most significant pictures of tiny living things that has anywhere on this planet survived from a far back geological age.

In addition to the foregoing abundant species there are many others closely associated with the redwoods and sufficiently frequent to deserve notice here. The Bleeding Heart (*Dicentra formosa*) has gray-green feathery leaves and sprays of pendulous pink flowers. In early spring the Milkmaids (*Cardamine californica*) are the first to show their blossoms, dotting the forest with white often as early as March. The Redwood Violet (*Viola sempervirens*) and its cousin, the Pioneer's Violet (*Viola glabella*) both have yellow flowers. A rather striking plant is the White-veined Shin-leaf (*Pyrola picta*), with basal rosette of leaves and neat spikes of dull-colored chubby flowers. It has a rarer relative, *Pyrola picta forma aphylla*, leafless and parasitic on the roots of other plants. Of the Lily family we find the Fairy Lantern (*Prosartes smithii*) with hanging pale-green flowers; the two ranked Slim Solomon (*Maiarthemum stellatum*) and Fat Solomon (*Maianthemum racemosum*), tall *Clintonia*

andrewsiana with large leaves and pink bells, the curious Slink-pod (*Scoliopus bigelovii*) with two mottled leaves spread on the ground; and the Coast Trillium (*Trillium ovatum*) with three leaves subtending a single white flower changing to deep rose.



Figure 2. 18 Bleeding Heart (*Dicentra formosa*).



Figure 2. 19 Fairy Lantern (*Prosartes smithii*).



Figure 2. 20 Slim Solomon (*Maianthemum stellatum*).



Figure 2. 21 Fat Solomon (*Maianthemum racemosum*).

The orchids, although rare, are represented by several species: the Reinorchid (*Piperia unalascensis*) with narrow spikes of greenish flowers; the tall Stream Orchis (*Epipactis gigantea*) with broad leaves and large brownish flowers; the white Phantom Orchid (*Cephalanthera austiniæ*); and the parasitic Coral-root (*Corallorhiza maculata*), a slender, ruddy, leafless plant.

The Mountain Iris (*Iris douglasiana*) is a fairly common flower from May to June.

The trailing Wild Ginger (*Asarum caudatum*) is easily recognized by its heart-shaped leaves and spidery brownish flowers.

Indian Lettuce (*Montia parvifolia*) is an abundant species recognizable by its many light-purple blossoms and its delicately succulent character.

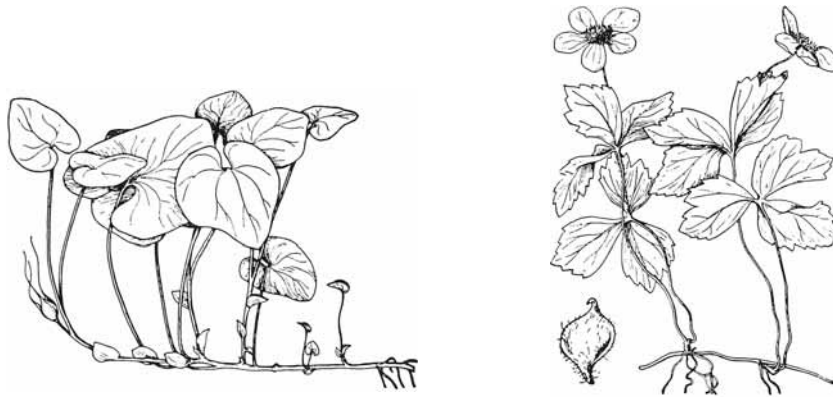


Figure 2. 22 Wild Ginger(*Asarum caudatum*). Figure 2. 23 Glade Anemone(*Anemone deltoidea*).

The Western Baneberry (*Actaea rubra*) stands about two feet high, with irregular several-parted leaves and in the fall a single spike of red or whitish berries.

The Glade Anemone (*Anemone deltoidea*) has a single large white flower rising above two or more three-parted leaves.

The Pacific Star-flower (*Trientalis latifolia*) is abundant and exceedingly dainty with its single whorl of leaves and several pale-pink flowers.

The Western Waterleaf (*Hydrophyllum tenuipes*), forming circular colonies on the forest floor, is recognizable by its curly racemes of dull colored flowers and its rough, hairy leaves.

Ferns

By far the most common fern of the redwood groves is the Sword Fern (*Polystichum munitum*), a rather large, two-ranked, rough-edged plant, often growing on decaying logs and stumps, as well as in the rich humus soil. Many other ferns also

find this an ideal habitat, among them the tall Chain Fern (*Woodwardia fimbriata*), the delicate California Maidenhair (*Adiantum jordanii*) and Five-finger Fern (*Adiantum aleuticum*) the Gold Fern (*Pentagramma triangularis*) with fronds golden-powery beneath; the Deer Fern (*Blechnum spicant*); California Wood Fern (*Dryopteris arguta*); Common Wood Fern (*Dryopteris expansa*); Lady Fern (*Athyrium filix-femina cyclosorum*); Bladder Fern (*Cystopteris fragilis*); and the Licorice Fern (*Polypodium glycyrrhiza*). Often on openly wooded hill slopes the Bracken (*Pteridium aquilinum*) may be abundant.

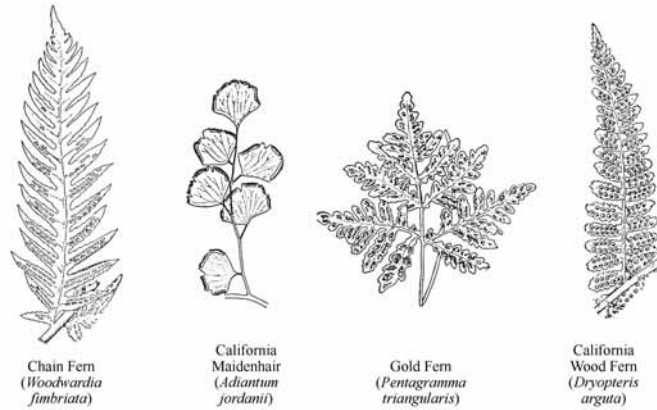


Figure 2. 24 Chain Fern (*Woodwardia fimbriata*), California Maidenhair (*Adiantum jordanii*), Gold Fern (*Pentagramma triangularis*), California Wood Fern (*Dryopteris arguta*).

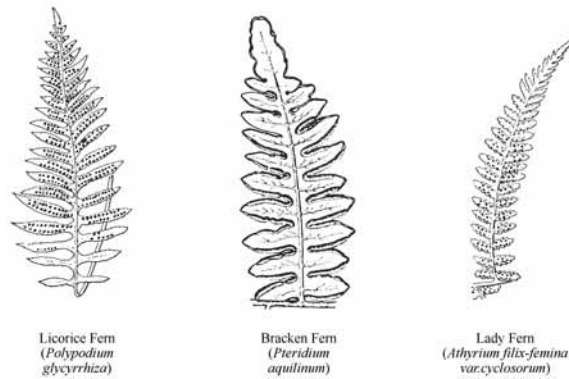


Figure 2. 25 Licorice Fern (*Polypodium glycyrrhiza*), Bracken Fern (*Pteridium aquilinum*), Lady Fern (*Athyrium filix-femina* var. *cyclosorum*).

Beyond the redwood forest lies a border belt of semi-shade, wherein quite other species predominate, and out beyond this border region usually lies either chaparral (bushy country) or grassland, each again with its own characteristic vegetation. The lovely flower colonies that grace the grasslands have a lineage very different historically from the flower formations that belong with the redwoods-but still a highly significant history.

Mosses

More than 200 species of bryophytes (mosses, liverworts and hornworts) occupy various substrates in the *Sequoia* zone of northern California. (see Index of Moss in Coast Redwood area, written by Daniel H. Norris)

Mushrooms

In the coastal redwood forests of Northern California, there are over 300 species of mushrooms growing on the ground vegetation, on the trees, and on the fallen logs. In actuality, most mushrooms are found in mixed oak and coastal redwood forests, although there are less pore fungi (decayed fungi on wood) in coastal redwood forests than in conifer forests. This means that coastal redwoods are healthier, stronger, and able to sustain a rich diversity of species of mycorrhizal fungi. Most of the mushroom species listed here are edible mushrooms, but for science of edibility, you should gain knowledge from mycologists and experts on local edible mushrooms. (Fig. 2. 30, see color plate).

According to scientific classification, there are 16 families, and 9 morphological characteristics, which include Gills, Boletus, Teeth, Cantharells, Jelly fungi, Puffballs, Pore fungi, Leather fungi, Coral Mushrooms.

Gills

About half of the mycorrhizal and edible mushrooms are Gills mushrooms. They include seven families: Agaricaceae, Coprinaceae, Strophariaceae, Marasmiaceae,

Meripilaceae, Pleurotaceae, Pluteaceae. There are many species, such as the sweetly flavored Horse Mushroom (*Agaricus arvensis*); a young bud with a delicious and almond-like taste that many have affectionately given the name of The Prince mushroom (*Agaricus augustus*); clusters of mushrooms on the forest ground, which are light brown colored with a flat-like cap and an obvious annual in the stalk, some one not for sure edible such Scarlet Waxy Cap (*Hygrophorus puniceus*, Fig. 2. 30, b) and mostly identified as edible-the Honey mushroom (*Armillaria mellea*, Fig. 2. 30, c); and a purple colored mushroom that often grows with Cantharellus fungi and is the only purple colored mushroom that is edible, called the Blewit mushroom (*Clitocybe nuda*).

Boletus

Probably only on the west coast of America can you find mushrooms that are as edible as the *Boletus aereus*, *B. appendiculatus*, *B. edulis*, and *B. zelleri* (Fig. 2. 30, d). In particular, the beautiful and uniquely colored *B. zelleri* mushroom is given the name 'black cap red stalk bolete'. It must be eaten quickly after being picked or it'll be consumed by insect larvae. King bolete (*Boletus edulis*) is the most highly complimented mushroom in the world. There are few who dislike it. It has many foreign names, Cepe (France), King Bolete (United States), Porcini (Italy), Steinpilz (Germany), Penny Bun (England), Stensopp (Sweden), Borowik (Poland), Herkkutatti (Finland), Rodellón (Spanish). Every year, from December to February, San Francisco Mycology Society would lead many members to go to the Mendocino coastal redwood region to forage for this bolete and other mushrooms (Fig. 2. 30, d).

Teeth fungi

Teeth fungi belong to the Hericiaceae and Hydnaceae families. The mushroom fruiting body beneath the cap is teeth-like, such as Hedgehog fungus (*Dentinum repandum*). In the same family, there is also Pig's Ear Fungus (*Gomphus clavatus*), and also many species of *Hericium* Such as *H. erinaceus* (Fig. 2. 30, e). Concerning edibility, people have different opinions.

Cantharelles

The most abundant redwood mushrooms, not only in species but also in quality, are several kinds of Cantharelles fungi. The Yellow cantharelle (*Cantharellus cibarius* Fig. 2. 30, f) is the most famous wild edible mushroom in California, and in the early spring, it is found the most in mixed coastal redwood and oak forests. Other types include the White cantharelle (*Cantharellus subalbidus*) and the Black cantharelle (*Cantharellus cornucopioides*), which resembles a small black hole on the forest ground and can be easily missed if you don't have a vigilant eye. The Black cantharelle has another interesting characteristic - it grows for a long range of time, from November to March of the next year. Also, during February in Northern California's Salt Point Lake, one can find many Yellowfoot cantharelle mushrooms (*Cantharellus tubaeformis*). They usually grow in tan oak with coastal redwood forests.

Jelly Fungi

Jelly Fungi belong to two families: Exidiaceae and Tremellaceae. Common jelly fungi are the Golden Ear mushroom (*Tremella aurantialba* Fig. 2. 30, g), which is orange-yellow to golden-yellow in color, and the Tiger Paw jelly mushroom (*Pseudohydnum gelatinosum*), which is white, fine, and squishy. They are both good medical resource.

Puffball fungi

An example, the Netline puffball (*Lycoperdon perlatum* Fig. 2. 30, h), should only be eaten when it is very young.

Pore fungi

These following families are most wood decay fungi: Polyporaceae Ganodermataceae, Fomitopsidaceae, Schizophyllaceae. Pore fungi are the source of almost all medicinal herbs. For example, Hemlock Lingzhi (*Ganoderma tsugae*) is a medicinal herb, whose

value is similar to that of Chinese Lingzhi, (*Ganoderma lucidum*). Additionally, other species are the Yun-Zhi fungus (*Trametes versicolor* Fig. 2. 30,i) and *Polyporus hirtus*.

Cauliflower Fungi

Cauliflower Fungi belongs in the Sparassidaceae family. In December, this fungus often grows in northern California, and it is very sought after by foragers. It resembles a white flower, and always lives on trees. Cauliflower fungi also have medicinal value, as it has a large amount of antineoplastic constituent. A common species is *Sparassis crispa* (Fig. 2. 30,j).

Coral fungi

Coral fungi can be found on the ground in coniferous or mixed forests in California, from September to December. A species is *Ramaria araiospora* (Fig. 2. 30,k), which is slender and forks at the tips. It is red in color at the tips, but the redness fades nearer the base, becoming yellow or orange in color.

About the author

Dr. Willis Linn Jepson, world-famous California botanist, was one of the original incorporators in 1920 of the Save the Redwoods League and served as a councilor of the League until his death in 1946. Professor of Botany at the University of California, Berkeley, Dr. Jepson was the author of *The Trees of California*, *The Silva of California* and *A Manual of the Flowering Plants of California* besides other authoritative books and articles in this field. Dr. Jepson was president for ten years of the California Botanical Society. He was also a Fellow of the Royal Society of Arts, London.

Daniel H. Norris Research Botanist was a professor at Humboldt State University, and retired from teaching in 1991. Moss identification and species description are his current primary concerns. His research has been in floristics with major collections from every continent except Antarctica. His most remarkable expedition was to Papua New Guinea. He is still available to help students learn mosses one-on-one.

Section 2 Story Told by a Fallen Redwood

Emanuel Fritz

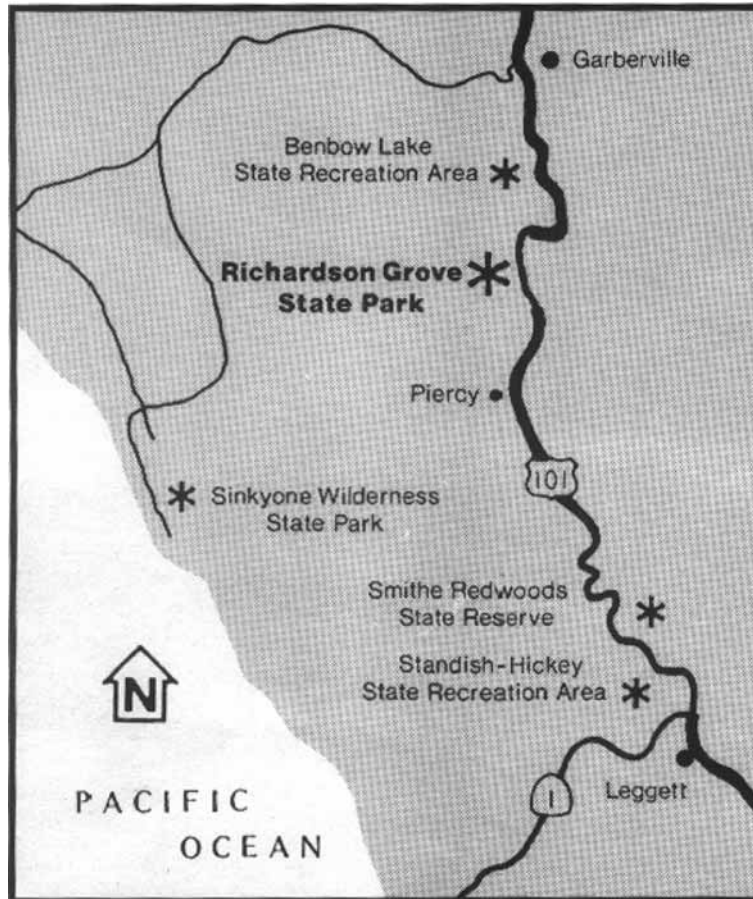


Figure. 2. 31 The fallen Redwood is located in Richardson Grove State Park , Humboldt County , California.

The Growth Rings

Each year a tree increases its girth by adding a new layer, or ring, of wood outside the old. Normally one growth ring is formed each year, making it possible to tell how large the tree was during any year of its life.

In its more than 1200 years of existence this tree had lived through some of the most stirring and significant events in the history of the human race. A few are

marked on the stump at Richardson Grove at the appropriate rings.

Each numeral on Figure 1 indicates the year of an event and gives an idea of the size of the tree at the time. The letters on the drawings refer to injuries the tree suffered.

The tree fell at 5:30 am March 13, 1933. The air was still but the ground had been softened by heavy rains. The tree leaned 40 feet to the north, its roots of that side having been killed by fires in 1820 and earlier. The tree was making a strong effort to heal the great fire scar, stretching from points marked I to K, but at point I greater effort was made to build out a strong supporting buttress, c-b. Point K was too far back of the falling axis to make a buttress there of any value. Buttress c-b was being extended northward more than one-half inch each year but it was unable to give enough support to help hold up the tree's 500 tons. The wood of the buttress is a specialized type known as "compression wood."

Leaning redwoods produce wider growth rings in the direction of the lean than at other points. Had this tree been uninjured from points I to K it would have assumed an egg-shaped cross section.

Normally a redwood makes growth in all directions and the growth rings would then be annual rings. On leaning trees the growth rings may be discontinuous and the ring count on the side away from the lean would fall short of the actual age.

The growth rings record not only that annual increase in diameter but also any injuries the tree suffers. When an injury kills the cambium - the thin cell layer between bark and wood - a callus forms over the wound but leaves a permanent mark. Some of the dead tissue may decay or burn off, but the exact year of the injury can be determined by counting back to the ring marking the beginning of the callus, or wound, tissue. The great fire scar, I-K, remained exposed considerably more than 100 years, the tree being thus deprived of sapwood and inner bark essential for life and growth.

The red "heart" wood is physiologically dead but serves as mechanical support. The dry, fibrous outer bark likewise is dead, but serves as protection. Annual growth originating in the cambium causes the bark to be pushed outward and crack to

Coast Redwood

form characteristic ridges.

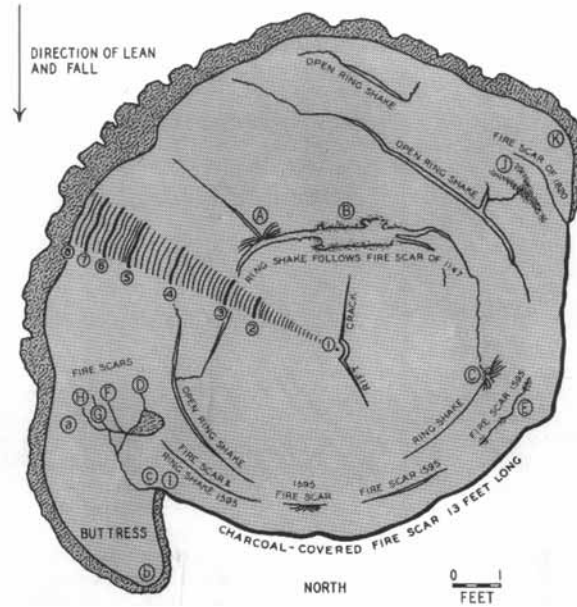


Figure 2.32 Diagram of stump cross section. Numerals indicate years, letters refer to injuries.

Human History In The Life Of The Tree

- (1) 728 Stump section started when the tree was then about 15 feet high above the original ground level. The seedling or sprout started about 700 AD.
- (2) 1066 Norman conquest of England.
- (3) 1215 Magna Carta signed.
- (4) 1492 Europeans discover America.
- (5) 1776 Declaration of Independence signed.
- (6) 1861 Civil War began.
- (7) 1914 World War I began.
- (8) 1932 Rise of the dictators. Outer and last growth ring formed. The tree fell the following March before 1933 growth began.

Events In The Life Of The Tree (Letters refer to injuries in tree)

(A) Completely healed injury made by fire in 1147 left a weakness which later caused radial crack.

(B) "Ring Shake" developed along fire scar of 1147 and "stringy white rot" infected surrounding wood. Ring shakes and radial cracks are normal in large old redwoods and develop as a result of internal stresses. Had this tree not developed ring shakes, the central rift crack would have been longer and the separation wider.

(C) Healed fire wound. Preceding healing "brown heart rot" attacked old heart wood and subsequently a crack developed along the ring.

(D) Scar of fire 1595. Subsequent new growth coming together from two sides of wound has imprisoned some bark in a depression.

(E) Similar to D. Fire of 1595, manifested at four points.

(F) Scar of fire of 1789.

(G) Scar of fire of 1806. The fires of 1789, 1806, and 1820 delayed formation of the buttress. This indicates that the tree started to lean more than 100 years before its fall.

(H) Scar of fire of 1820. This fire must have been severe. It killed the tree from H to J, burning off bark, sapwood and some heart wood. Very likely, however, however, earlier fires contributed to the great scar and may have begun it; the evidence has been burned off.

(I) Where buttress and 1820 fire scar meet.

(J) Brown heart rot ("dry" rot) following fires of 1820 and earlier.

(K) New growth working its way over surface burned in 1820; interrupted by fires in 1848, 1866, 1883, and 1895. This point, being behind the axis of the lean, was not stimulated to form a buttress.

Buttress Formation

(a) (b) (c) Buttress is formed.

(a) 112 rings are crowded into 8 inches (see buttress enlargement).

Coast Redwood

(b) On a vertical line through b, 100 rings occupy 36 inches indicating an accelerated growth rate to hasten formation of the buttress.

(c) Sixty rings are crowded into 4-1/2 inches. On the vertical line through b these 60 rings occupy 20 inches.

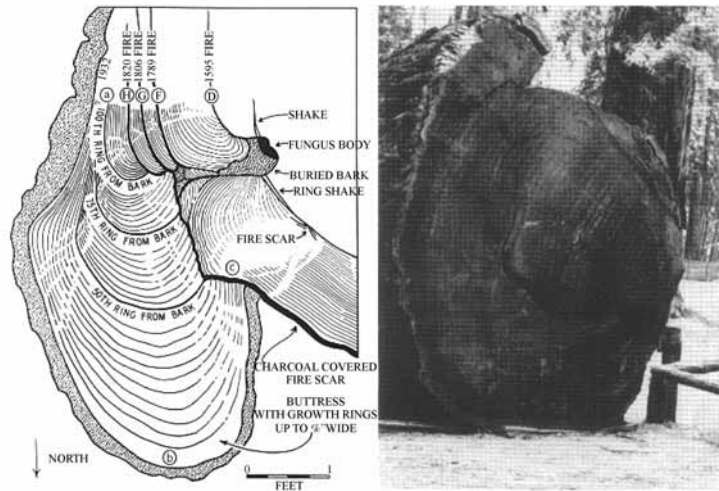


Figure 2.33 Left: Diagrammatic enlargement of the buttress.
Right: Buttress which the tree built out as support can be seen in photograph.

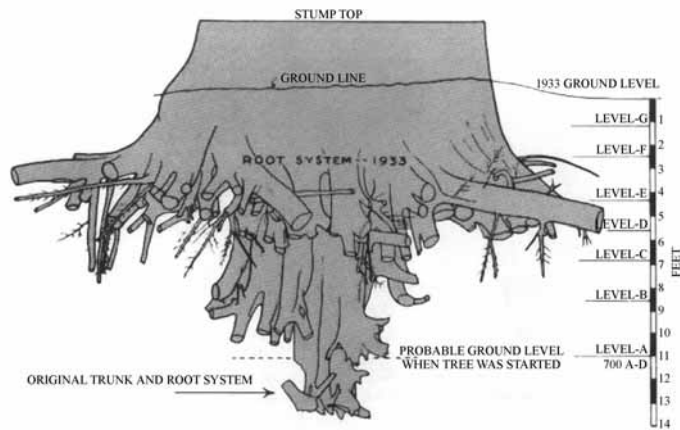


Figure 2.34 Diagram showing successive ground levels with corresponding development of new root systems. Original ground level was 11 feet lower than present.

The Root System

When this tree started life around the year 700, the ground level was about 11 feet lower than at present. This is indicated in the illustration above which shows what appears to be a taproot at the right but in reality is the original trunk and past root systems. Redwood trees do not have taproots.

The main grove stands on a flat or high river bench built up by past floods. Seven great floods and a number of minor ones occurring during the life of this tree deposited enough silt to raise the ground level more than 11 feet. Each time the base of the tree was partially buried but was able to adapt itself to the new level by originating a new and higher root system. The ground levels were easily located on the soil profile.

A heavy flood a thousand or more years ago left a heavy deposit of silt, perhaps 30 inches deep, represented by level-B in figure 3. The root system continued to function but a new system was eventually formed to fit the higher ground level. A century or more later, another flood brought the level to C. Other floods raised the level to D, E, F, G, and finally to the 1933 level. Each time a new set of roots was formed and the trunk below ceased its diameter growth. This accounts for the abrupt changes in the size of the old subsurface trunk, each diameter representing growth at a separate ground level stage. The stubs of the earlier root system remain and are clearly visible in the illustration. Roots pointing outward occur as aftermath of floods. They are an attempt by the tree to readjust its root system to the new soil level.

The 1933 root system is approximately 300 years old. The one preceding and part of the third-last system are well preserved, though dead, and make up a loose cribwork. Fortunately, the wood in the butt of this tree remained sound and was pulled up intact.

Had the central portion become decayed and the decayed wood disintegrated, there would be a huge hole extending to the original ground level, the level at which the parent seed gave rise to the tree. Examples of this can be seen on stumps

Coast Redwood

in High Rock and Stephens Groves, in Humboldt Redwoods State Park. The central hole in each stump was at least 13 feet deep before flood silts raised the bottom level.

Other trees in Richardson Grove have similar subsurface trunks, as may be noted by examining the trees that have large fire scars. The exposed central trunk in each case exhibits straight grain at the ground line instead of the usual outward flare of the butts.

The tree and several others have made it possible to reconstruct the flood history of the Eel River basin. Dr. Paul Zinke, University of California Forestry School has made further studies from which he has been able to date past floods and their magnitudes.

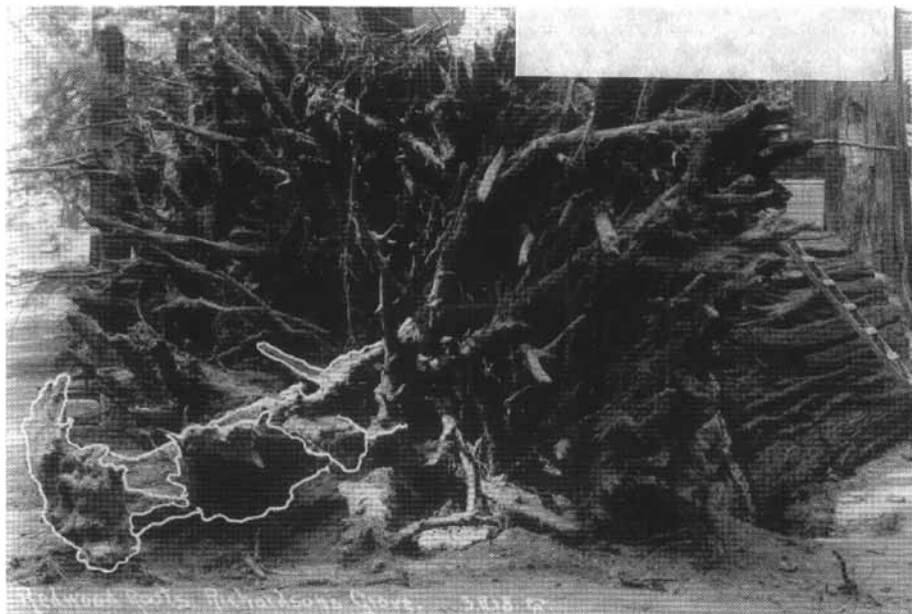


Figure 2.35 Coast Redwood has no taproot. What appears to be one (outlined by white line) is the remnant of the buried trunk.

Coast Redwood



Figure 2. 36 Photograph taken in Richardson Grove in the 1930s. Photograph by Tibbetts.

About The Author

Emanuel Fritz (1886 ~ 1988) was Professor of Forestry at the University of California at Berkeley from 1919 to his retirement in 1954. He retained the title of Professor Emeritus, and eventually became the University's oldest faculty member at 102 years of age. He joined the Save the Redwoods League Council in 1931 and was made Honorary Vice-President in 1980. Professor Fritz spent his life studying the Coast Redwood and teaching others about this magnificent tree.

The Fallen Redwood is in Richardson Grove State Park, Humboldt County, California. Professor Fritz prepared the fallen tree for the exhibit. It took him 30 days to clean the roots to examine them.

Section 3 California Redwood Parks and Preserves

John B. Dewitt

Three Kinds of Redwoods

Botanists recognize three genera of Redwood trees, each of which consists of one species. Two of these, Coast Redwood (*Sequoia sempervirens*) and Giant Sequoia (*Sequoiadendron giganteum*), are native to California. Both species are evergreen conifers, and have red heartwood and reddish fibrous bark containing an abundance of tannin.



Figure 2. 37 Coast Redwoods in the spectacular Rockefeller Forest in Humboldt Redwoods State Park.

Although the two Redwoods are close relatives, they differ in many ways. The Coast Redwood grows in a narrow strip along California's northern coast, where fog tempers the heat and drought of summer and the ground never freezes, while the Giant Sequoia grows in scattered pockets along the west slopes of the Sierra Nevada and withstands both heat and cold well. The Coast Redwood is taller, and the Giant Sequoia is more massive. The oldest measured Coast Redwood is about 2200 years old; the oldest measured Giant Sequoia is about 3300 years old, although many living trees probably exceed this measurement.

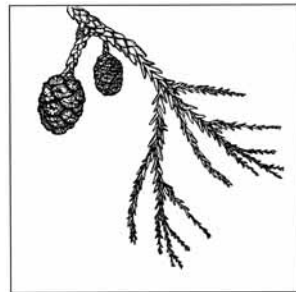
The third Redwood is *Metasequoia glyptostroboides* (Dawn Redwood), which was first identified as a fossil, and was presumed extinct until 1946 when living Dawn Redwoods were discovered in a remote area of China. In 1948 Dr. Ralph Chaney, paleobotanist (and later President of Save-the-Redwoods League), traveled to see these 'living fossils' and brought cuttings of

Coast Redwood

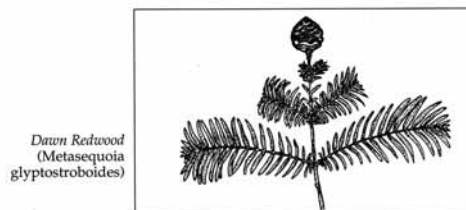
the Dawn Redwood from China to the United States. Today many communities are graced with these relic trees. In contrast to the California Redwoods and most other conifers, the Dawn Redwood is deciduous, shedding its needles in the winter and sprouting bright green foliage in spring. These trees require summer rainfall to survive, and they can withstand freezing temperatures in winter. Approximately 3000 Dawn Redwoods are presently protected by the Chinese government in their native area.



Figure 2. 38 Coast Redwood (*Sequoia sempervirens*).



Giant Sequoia
(*Sequoiadendron giganteum*)



Dawn Redwood
(*Metasequoia glyptostroboides*)

Figure 2. 39 Left: Giant Sequoia (*Sequoiadendron giganteum*); Right: Dawn Redwood (*Metasequoia glyptostroboides*).

Coast Redwood



Figure 2. 40 Redwood distribution and national park map.

California's Redwoods

Study of the fossilized leaves, cones, and stems which have been found over a good part of the world has enabled paleobotanists to determine that Redwoods and their ancestors have existed on earth for 160 million years. Redwood forests, as we know them today, have been present in California for about 20 million years. They represent a unique and beautiful relic flora from the days when dinosaurs roamed the earth.

About a million years ago advancing ice sheets confined the Coast Redwoods to their modern range. The glaciers left untouched a well-defined area, now known as the Redwood Belt, where the tall trees flourished undisturbed. When European settlers arrived in California, this Redwood Belt was about 450 miles long and extended down the California coast from the Oregon border to the Santa Lucia Mountains at the southern tip of Monterey County, California. The Belt varies in width from less than 5 miles to more than 20 miles, depending on the terrain. The Coast Redwood prefers a moist coastal habitat just beyond reach of wind and salt air from the Pacific Ocean. The trees grow best in elevations lower than 2000 feet, in areas of heavy winter rains, summer fog, moderate year-round temperatures, and good alluvial soils. The most magnificent Redwood groves develop along riverside flats where growing conditions are most favorable.

The Coast Redwood, often called the Tall Tree, towers over all other living trees. In favorable situations, trees 20 years old reach 50 feet in height and a foot in diameter. Average mature trees are from 200 to 300 feet high with diameters of 10 to 15 feet at breast height (the standard measure of trunk size; "breast height" is set at 4'8" above the ground). Trees over 300 feet high are common on riverside flats and benches. A Coast Redwood is the world's tallest measured tree. It stands in the Tall Trees Grove in Redwood National Park on the banks of Redwood Creek, and was measured by the National Geographic Society in 1964 at 367.8 feet tall. Several other Coast Redwoods approach this height, including the Founders Tree in the Founders Grove at Humboldt Redwoods State Park, which was named in honor of the

founders of the Save the Redwoods League.

The root system of the Coast Redwood tree is broad and shallow, with the most sensitive area lying just a few inches below the surface of the soil. The thick bark of older trees is relatively fire resistant, and the low resin content of the wood provides extra protection. The large hollows or “goosepens” frequently found in the base of large trees provide evidence of many past fires in the Redwood forest. Redwood is exceptionally free from fungus diseases, and there are few insects which harm it seriously. The mature Coast Redwood produces cones and seeds nearly every year, with optimum seed production occurring in trees between 20 and 250 years of age. Redwood seeds are minute-100,000 weigh less than one pound. Coast Redwoods commonly regenerate from sprouts on injured or fallen trees. Few other trees have this ability to sprout from the root crown, often within just a few weeks of damage to the parent tree. This gives the Coast Redwood an advantage over many other tree species that reproduce only by seed.

The Coast Redwood shares the forest with a variety of other trees, including the majestic Douglas-fir (*Pseudotsuga menziesii*), hemlock (*Tsuga heterophylla*), tan oak (*Notholithocarpus densiflorus*), and madrone (*Arbutus menziesii*). Carpeting the forest floor are the delicate Redwood sorrel (*Oxalis oregana*), with its pink flowers and purple stems, and the salal (*Gaultheria shallon*), with its leathery green leaves and blackish-purple summer fruit, as well as a multitude of ferns. Salmonberry (*Rubus spectabilis*) and huckleberry (*Vaccinium ovatum*) provide forage for wildlife and for human visitors, and rhododendrons (*Rhododendron macrophyllum*) and azaleas (*R. occidentale*) create a glorious burst of color from May to June.

The same glaciation which restricted the Coast Redwood to the coast of California also restricted the Giant Sequoia to the middle elevation ridges of the Sierra Nevada. Giant Sequoias can be found growing over an area about 260 miles long, on the western side of the Sierra at elevations of 4000 to 8400 feet. The northernmost grove, containing only six trees, lies near the middle fork of the American River in Tahoe National Forest in Placer County. The southernmost limit of the Giant Sequoia range is in the Kern River basin in Tulare County. Giant Sequoia groves flourish in a

dry summer climate and well-drained soil, where winter temperatures do not stay below zero for long. They prefer gentle slopes and well-watered spring areas adjoining small streams and meadows.

As the coast Redwood is called the Tall Tree, the Giant Sequoia is often known as the Big Tree. Mature trees stand from 250 to 300 feet tall, and reach 20 to 30 feet in diameter at breast height. The largest Giant Sequoia, the General Sherman Tree in Sequoia National Park, is also the world's largest tree, 275 feet tall and 26.5 feet in diameter at breast height. Foresters estimated the volume of the General Sherman at 630,000 board feet in 1981, and it is still growing. The General Grant Tree, also in Sequoia National Park, is of nearly the same size. The Giant Sequoia is resistant to fire, fungus, and insects like its coastal relative, but sprouts only from seed. Periodic fires create ideal mineral soil conditions for seed germination, and squirrels are great planters of Giant Sequoia seed.

Giant Sequoias are found intermingled with sugar pines (*Pinus lambertiana*), ponderosa pines (*P. ponderosa*), and incense cedars (*Calocedrus decurrens*). The Sierra forest is less dense than the coastal Redwood forest, and the giant trees with their bright-red bark can be seen from a great distance. The Pacific Dogwood (*Cornus nuttallii*) is a most noticeable understory plant when it blooms in the spring. Azaleas, thimbleberry (*Rubus parviflorus*), gooseberry (*Ribes roezlii*), and a multitude of smaller flowering plants also share the forest with the giant trees.

Human Discovery & Settlement of the Frontier

The first people to view the Coast Redwoods and the Giant Sequoias were the ancestors of today's Native Americans - the nomadic hunters, fishermen, and gatherers who migrated across North America about 10,000 years ago. These first discoverers were probably less astonished by the Coast Redwoods than were the first Europeans to see them, because they came to the Redwoods through the ancient Douglas-fir and hemlock forests of the Pacific Northwest. Some of these trees were almost the equals of the Coast Redwoods for height, although none had ever been seen which rivaled the Giant Sequoia for sheer mass.

The first European explorer to see California was Captain Juan Rodriguez Cabrillo, who in 1542 named the region of Alta California “coast of pines.” Neither Cabrillo nor any of the other Europeans who explored the Pacific coast by sea noticed or reported Redwoods. Don Gaspar de Portola is credited with that discovery. In 1769 he led the first European land expedition up the coast of California and in October of the same year his party arrived at Monterey Bay, near what is today the town of Watsonville. There they encountered their first Coast Redwood. One member of the party, Miguel Costanso, wrote it was “the largest, highest, and straightest tree” he and his comrades had ever seen. A Franciscan missionary, Fray Juan Crespi, recorded that “although the wood resembles cedar somewhat in color, it is very different.” Since none of them had ever seen such trees before, they named them “Palo Colorado” (red tree) for their color.

It was not until much later that frontiersmen discovered the Giant Sequoia. California had been settled as a province of Mexico, American fur trappers and explorers began to cross the Sierra Nevada. In 1833 the Walker expedition passed through the Merced or the Tuolumne grove of Giant Sequoias near Yosemite Valley, and in 1839 Zenas Leonard, a member of that expedition, published a book based on his journal in which he reports, the astonishing sight of these trees, “of the Redwood species, incredibly large.” During the 1840’s and 50’s several other parties happened upon Giant Sequoia groves, but their reports, although perfectly true, were so fantastic that they were not taken seriously. Even after an entire tree was cut down and shipped to New York for display in 1854, it was considered generally to be a hoax.

The Coast Redwood received its first botanical name from the British botanist A. B. Lambert. He studied a single specimen collected by the Vancouver expedition of 1790 ~ 1795, and concluded that it was a species of bald cypress, *Taxodium*. The bald cypress itself (*Taxodium distichum*), as its name implies, is deciduous like the Dawn Redwood, and so Lambert gave the Coast Redwood the species name *sempervirens*, which means “evergreen.” In 1847 noted Hungarian botanist Stephen Endlicher redescribed the Coast Redwood and assigned it to its own genus, *Sequoia*,

keeping the species name *sempervirens*. The generic name honors Sequoyah, a Cherokee Indian famous for inventing an alphabet for his people.

The botanical name of the Giant Sequoia was not established so easily. The first name was bestowed on the tree in Britain, where it had become a popular addition to parks and gardens. It was called *Wellingtonia gigantea* after the famous Duke of Wellington. Americans retaliated with the name *Washingtonia gigantea*, but that name could not be



Figure 2. 42 The diameter of this Redwood giant, cut near Fort Bragg, California, on July 10, 1833, was 18 feet.

used because it had already been given to a genus of palms. Botanists settled the matter finally by deciding that the tree was so close a relative of the Coast Redwood that it should be in the same genus, *Sequoia*. In the 1940's the botanists revised their opinions, and the Giant Sequoia was assigned its own genus, becoming *Sequoiadendron giganteum*.

Logging of the Redwoods

The native Americans of the northern California coast used Coast Redwood lumber for their houses and canoes. Some trees were cut down with the help of fires set around their bases, but most often fallen trees were used. Planks and canoes were shaped using fire and adzes. So laborious was this process that the Redwood forests were in no danger of being diminished by it.

Some Indians of the Sierra Nevada foothills used Giant Sequoia bark for the roofs of their houses, but the Big Trees were far too large to be cut down with hand axes. They were still too large for available logging techniques when they were rediscovered in the mid-1800's, and would-be loggers found as well that their wood was very brittle. The giant trees fell with such force that the logger was left with a very large quantity of shards and splinters, not suitable for much more than fenceposts and shingles. Giant sequoias have since been used for lumber, but they are not the out-

standing timber tree in their region that the Coast Redwoods are in theirs.

Logging operations in the Coast Redwoods began as early as the 1820's. A French traveler in 1827 reported seeing the Russians at Fort Ross, on the Sonoma County coast, cut a tree 20 feet in diameter. All of the buildings at the Fort were constructed of the local Redwood, as were its barrels and vats, and the colony sold Redwood lumber to the Spanish and Mexican settlers farther south. The Ross Company also used the native tan oaks for a shipbuilding project which was less successful.

Among the European settlers in the Redwood belt, the earliest logging was done by hand, and the logs were made into boards on the spot by techniques similar to those the Indians used. By the 1830's and 40's there were sawpits for whipsawing logs around Sausalito and Mill Valley, on San Francisco Bay. Whipsawyers sawed lumber in the Big Sur country in 1834. In that same year the first water powered sawmill was built by John Cooper in the Santa Rosa Valley in Sonoma County. The first circular saw was installed in 1849.

California joined the United States in 1850 after being ceded from Mexico in 1848, and between 1860 and 1900 the federal government transferred into private ownership most of its Redwood forest land, under the Homestead Act, the Pre-emption and Public Sale Act, and the Timber and Stone Act. Under the Homestead Act, 160 acres per person could be patented without cost under minimal requirements, and under the Timber and Stone Act land could be acquired for only \$2.50 an acre under even fewer requirements. There was considerable fraud in the acquisition of forest land under these Acts, since no real attempt was made to determine whether persons filing claims were acting for themselves or were fronts for larger companies. One timber baron later boasted that he had acquired his vast holdings "for a bottle of muscatel an acre" - they pay he had given the skid row bums who claimed 160 acres of forestland each for him.

With the increased demand for lumber and the expansion of lumber company holdings, more efficient methods of logging and milling were developed. Oxen and horses were originally used to skid logs to the mills, but logging railroads and steam yarders with "Bull" donkey engines soon replaced them, and these were capable of

carrying larger loads of logs over skid roads to the landings on the railroads. Steam equipment was succeeded by diesels, and in at least one area by electrically operated logging machinery. These logging methods made possible the clear-cutting of extensive areas of Redwood forest.

Fire was used to clean up the bark and slash after the Redwood logs were peeled. Widespread attempts were also made to convert cut-over lands to grazing lands by repeated burning and seeding with grass. The concept of sustained-yield logging only evolved with professional forestry in the early 1900's. Between 1850 and 1910 logging was often considered just a short-term use of the land, a preliminary to converting it to its "real" uses for agriculture and housing.

Redwoods around San Francisco Bay and Monterey Bay disappeared first, then those along the Sonoma and Mendocino Country coasts which were most accessible by sea, then the coastal Redwoods of Humboldt and Del Norte Counties. In 1917 the construction of the Redwood Highway (U. S. 101) made the Redwood forests further inland in Humboldt County easily accessible to the loggers, and cutting there increased. Fortunately the high way also made it easier for conservation-minded people to see the magnificent forests that were being destroyed.

The rate of Redwood cutting increased steadily to an average of about 500 million board feet per year in the period of 1905 to 1929. During the Depression years the cut dropped to a low of 135 million board feet per year. From 1947 through 1958 it rose rapidly to a peak of over a billion board feet each year. By 1960 many smaller mills had been forced to close for lack of easily accessible Redwood timber. Since 1965 the volume cut has declined while the demand for Redwood as a building material remains voracious. Most Redwood lumber produced today is second-growth, since only a tiny fraction of the ancient old-growth Redwood forest is now in private ownership. The old-growth Redwoods saved by the League are protected in perpetuity in public parks.



Figure 2. 43 A Committee of California ladies interested in saving the Redwoods of Humboldt County gathered in 1917. This photo was taken in Sequoia Park , Eureka , California , and appeared in the Humboldt Standard on September 6 , 1917.

Save the Redwoods

Most of the first efforts to save Redwoods in public parks were directed toward the Giant Sequoias. They were more accessible to visitors than the great Coast Redwood groves of the north coast, and they were also better known to the public through much publicity on the East Coast and in Europe. The Coast Redwood forest seemed so huge, dark, and forbidding that few people thought of protecting it. The Giant Sequoias, by contrast, became known as individuals - the Discovery Tree, the Mother of the Forest (which was killed when its bark was removed to make an exhibit), and others. Location was another factor. The Giant Sequoias grow in the Sierra Nevada, and came to the attention of John Muir and his colleagues who were working to protect Yosemite and the rest of the Sierra. Muir's extensive and eloquent writings introduced the Big Trees to a wide public, and they developed into an unsurpassed, world-famous tourist attraction.

The owners of the Calaveras North Grove (now part of Calaveras Big Trees State Park, and the first well-known grove of Giant Sequoias) thought of building hotels and attracting visitors, not of logging their trees. In fact, when in 1899 the original

owner sold the North Grove to the owner of a lumber company, even though he had agreed not to cut any of the Sequoias in the grove, the local residents and visitors alike were outraged. This event sparked the movement to preserve the Calaveras Groves as a state park, and it was of the Calaveras Big Trees that John Muir said, "These kings of the forest, the noblest of a noble race, rightly belong to the world, but as they are in California, we cannot escape the responsibility as their guardians. Fortunately, the American people are equal to this trust. . ."

The Sierra Nevada was still mostly in federal ownership before 1900. Thus no federal funds were needed to purchase parklands there, and Congress and President Lincoln did not hesitate to establish Yosemite Park (including Yosemite Valley and the Mariposa Grove of Big Trees) in 1864.

Yosemite was originally granted to the State of California, to be managed as a state park, since the National Park Service did not yet exist. The Governor of California promptly appointed Frederick Law Olmsted, a principal designer of New York City's Central Park and the world's leading expert on park design and management to lead the commission which would manage the park. That Olmsted was working in California at this moment was a remarkable stroke of luck. He wrote a report on the park which, although it was never presented formally to the commission or to the state government, was influential in establishing the new idea of scenic and especially wilderness parks.

Unfortunately, Olmsted returned to New York in 1865, and the Yosemite Commission became almost completely inactive. Eventually the mismanagement of the park became so evident that John Muir and others succeeded in having it transferred back to the federal government in 1906, when Yosemite National Park was consolidated under the federal government and administered by the U. S. Cavalry.

In 1890 Congress established as national parks a much larger area around Yosemite Valley, and the area which is now Sequoia National Park. The Southern Pacific Railroad's lobbyists were a major force in this move to protect Giant Sequoias along with the most magnificent Sierra scenic areas. Tourism, again, was an important motive; the railroad had an obvious interest in creating and preserving parks

which would attract visitors to the west.

Calaveras Big Trees did not become a state park until the Save the Redwoods League helped the State purchase the North Grove in 1931. Ironically, the lumberman whose purchase of the North Grove had so stirred protectionist sentiment held the property for twenty-six years without cutting one tree. However, in 1925 he did sell the grove to an active lumber company, and this, as well as the prospect of the State Park Bond funds that were approved in the election of 1928, spurred the League and the newly-formed Calaveras Grove Association to renewed efforts. The South Grove at Calaveras Big Trees was purchased-again with major financial contributions from the Save the Redwoods League and an enthusiastic campaign by the Calaveras Grove Association - and added to the state park in 1954.

There were a surprising number of very early attempts to save the Coast Redwoods from the logger's ax. The first was made by Henry A. Crabb of the California legislature in 1852. He was followed by the Secretary of the Interior, Carl Schurz, in 1879. Both men urged the establishment of a national Redwood park, but neither was able to gather enough public support to achieve that end.

The movement to save the Coast Redwoods began in earnest at Big Basin in Santa Cruz County. In 1902, through the efforts of the Sempervirens Club and Mrs. Phoebe A. Hearst, the first state Redwood park was established and named, simply, California Redwood Park. It is now known as Big Basin Redwoods State Park, and is one of the most popular Redwood parks in the entire system.

In 1907, the spectacular Redwoods at Muir Woods in Marin Country were dedicated as a National Monument. The property was a gift from Congressman William Kent to the United States government in honor of John Muir. As the government had never accepted a gift of park land before, the Congressman had some trouble convincing it to do so. Finally his generous gift was accepted, and the 510-acre monument became the first Coast Redwood forest to be protected by the federal government. This was by no means Kent's only contribution to the protection of Redwoods by the federal government, for in 1916 he was author of the legislation which created the National Park Service, and he was a dedicated founder of the Save the Redwoods League.

Coast Redwood



Figure 2.44 William Kent and Stephen T. Mather in the Redwoods, March 1923.



Figure 2.45 Dedication of the Bolling Grove, the first Redwood Memorial Grove, in Humboldt Redwoods State Park, August 6, 1921, attended by founders of the Save the Redwoods League.

The drive to preserve the Redwoods on the northern coast of California began in 1917, after the completion of Highway 101, when several prominent conservationists traveled to Humboldt and Del Norte counties to view the magnificent Redwood groves there. These were John C. Merriam, University of California paleontologist and later President of the Carnegie Institute, and Madison Grant and Henry Fairfield Osborn, who were both leaders in conservation from New York. They saw widespread destruction of the forests along the new highway, and were appalled to find that not one tree was owned by any public agency or protected for public enjoyment in any way.

These great conservationists were impressed by the urgent need to preserve Redwood groves in public parks for their unique beauty and scientific interest. In an article which appeared in the National Geographic magazine, they revealed the Coast Redwoods to the American public, and made a plea for the preservation of the Redwood forest. Together, in the spring of 1918, they organized the Save the Redwoods League. Its objective was to rescue from destruction representative areas of primeval Redwood forests, and to cooperate with state and national park services in establishing Redwood parks. One of the League's first actions was to recommend to Congress the immediate creation of a Redwood National Park.

In 1920, the U. S. House of Representatives passed a Resolution directing the Secretary of the Interior to investigate and report to the House the possibility of securing a tract or tracts of land containing typical Coast Redwoods with a view to establishing a Redwood National Park. The Congress was also interested in determining whether such land or its purchase price would be donated to the United States. A cost estimate for maintaining a national park was also requested.

The U. S. Forest Service conducted the investigation, with District Forester Paul G. Redington working out the details with Director Stephen T. Mather of the National Park Service and the officers of Save the Redwood League. The committee gave serious consideration to four areas; the Lower Klamath River in Humboldt and Del Norte counties; the South Fork of the Eel River in Humboldt County; Prairie Creek and Redwood Creek in Humboldt and Del Norte counties; and Big Lagoon in Humboldt County.

After further study the committee recommended the establishment by the Federal government of a Redwood National Park of approximately 64,000 acres in the lower Klamath River drainage. They reported that this area had a stand of over three billion board feet of Redwood which was almost entirely "untouched by the ax." The ridges on both sides of the Klamath were proposed as the boundaries for the main park area. The proposed site was mainly privately owned land which had been sold off for \$2.50 an acre between 1880 and 1900.

In addition to the Klamath River unit, the committee recommended the acquisition of some 1800 acres on the South Fork of the Eel River and the grove along Bull Creek Flat. They reported that the greater part of this separate unit could be donated without cost to the federal government by the Save the Redwood League, private individuals, and possibly the State of California.

There was no precedent for the appropriation of federal funds to purchase large tracts of privately owned land for park purposes. No progress resulted from this report, and no Redwood National Park was established, because Congress refused to buy back Redwood lands.

The Save the Redwoods League had already initiated a nationwide membership drive calling for donations to buy privately owned Redwood lands. Despite the lack of interest from the Federal government, public response to the cause of protecting the Coast Redwoods was positive and immediate, and between 1920 and 1928, the League purchased many Redwood groves which formed the core of the California Redwood State Park System as we know it today.

Famous among these early acquisitions is the 9000 acre Rockefeller Forest at Humboldt Redwoods State Park. The distinguished philanthropist John D. Rockefeller, Jr. donated \$2 million through the Save the Redwoods League. His donation was matched by other private donations and funds from the 1928 State Park Bond Act to purchase this magnificent Redwood forest from the Pacific Lumber Company.

The Kent-Mather Grove, also in Humboldt Redwoods State park, was purchased in 1921 with funds donated by Congressman William Kent and Stephen T. Mather, first Director of the National Park Service. In 1931 the Garden Club of America,

through the League, matched the State Park funds to purchase the initial 2552 acres of the Garden Club of America Grove at Humboldt Redwoods. This grove is now the third largest Redwood grove in the State Park System, protecting 5130 acres of magnificent Redwood lands. Other groves, purchased through the League during this early period, formed the beginnings of the Avenue of the Giants and the core of Humboldt Redwoods State Park.

In June of 1923, Save the Redwoods League acquired the first Redwood grove at Prairie Creek Redwoods State Park, and by 1943 the League had purchased an additional 5936 acres of spectacular old-growth Redwood forest at Prairie Creek in cooperation with the California State Park Commission. Between 1925 and 1934, matching funds from the state and League donations also acquired 2816 acres of Redwood forest now protected in Del Norte Coast Redwoods State Park.

In 1928, the League enthusiastically promoted the first California State Park Bonds, and participated in the organization of the California State Park Commission that same year. Various state parks had been administered by separate commissions and agencies were consolidated in 1928 in the California State Park System. Today California's State Park System is one of the finest in the world, and protects a wide range of natural habitats and historical sites. The parks provide both education and enjoyment for Californians and for visitors from all over the world.

In the 1930's the National Park Service studied the northern Redwoods with the renewed intention of establishing a Redwood National Park. In 1937, a proposal was made for a national park of over 27000 acres which included "a superlative stand of these magnificent trees" in the Mill Creek area of Del Norte County. Again, Congress did not take action. The finest part of the property in the study area was acquired by the Save the Redwoods League in the late 1930's, and is now known as Jedediah Smith Redwoods State Park.

In 1946, Congresswoman Helen Gahagan Douglas of California introduced a bill to establish the Franklin Delano Roosevelt Memorial Redwood Forest with a total area of over 2,800,000 acres. The proposed area followed the coast south from the Oregon line to the vicinity of Bodega Bay in Sonoma County, including most of the Red-

wood region and a large area of Douglas fir lands as well. It would have been devoted to economic use under the U. S. Forest Service except for four memorial park units comprising complete watersheds, which were already planned for acquisition in the Redwood state parks. When Helen Gahagan Douglas was defeated by Richard Nixon in the 1948 Congressional election, the bill died.

While federal legislative efforts to establish a Redwood National Park foundered in politics year after year, the Save the Redwoods League continued to purchase Redwoods and land for inclusion in the California State Redwoods Park. In the years after the Second World War, the forest products industry of the north coast, based primarily on Redwood lumber, expanded, and has remained dominant in the region. The relationship between the League and the lumber industry has been characterized by attempts to cooperate and to maintain a mutual respect for opposing viewpoints. From the start the League followed its belief that the best way to attain its objectives was to employ dignified and friendly negotiations. By offering fair compensation to owners of properties which it wished to acquire for parks, the League gained the respect of some of the lumber companies. The Pacific Lumber Company, the Del Norte Company, the Sage Land and Improvement Company, Louisiana-Pacific Corporation, the Hammond Lumber Company, and others have cooperated with efforts of conservationists by holding some of the finest Redwood forest areas until the League could raise funds to purchase them at their fair market value.

While the Save the Redwoods League continued to build the Redwood State Parks grove by grove, there was a lapse in the legislative movement to create a national park. In 1961, the League, the Sierra Club, and the National Geographic Society revived the idea of a Redwood National Park, and urged the Secretary of the Interior, Stewart L. Udall, to prepare a Redwood National Park proposal. The National Geographic Society made a \$ 64,000 grant to the National Park Service for a Coast Redwood survey to locate remaining old-growth Redwoods and to determine an appropriate site for a Redwood National Park. When the survey was completed in 1964, it showed that of the original 2,000,000 acres of Redwood forest that once flourished in California only 300,000 acres remained uncut, with 50,000 of those acres in state

parks protected by the Save the Redwoods League.



Figure 2. 48 On October 2, 1968, President Lyndon B. Johnson signed the act establishing Redwood National Park, in a ceremony at the White House, which was attended by the author and other dignitaries.

The release of the National Park Service report stirred public and Congressional sentiment in favor of creating a Redwood National Park. Numerous studies followed, and in finally in 1968, after more than 50 years of hard work, planning, and intransigent opposition from the lumber industry, President Johnson signed into law an act of Congress that established Redwood National Park.

The 30,000-acre park included coastline, forest, and a narrow corridor protecting the Tallest Tree on Redwood Creek. The legislation also authorized the inclusion within

the national park boundaries of three California State Redwood parks, Prairie Creek, Del Norte Coast, and Jedediah Smith. These three great parks protect the very heart of the finest Redwoods in the area and are essential for a Redwood National Park worthy of the name.

The 1968 boundary did not include enough land to insure adequate watershed protection for Redwood Creek or Mill Creek. For 10 years conservationists pressed for an expanded Redwood National Park to protect adjoining watersheds and the remaining old-growth Redwoods of Redwood and Mill Creeks. In 1978 President Carter signed the Redwood National Park Expansion Act, adding essential watershed lands and enlarging the park by 48000 acres. This unique legislation also provided for the rehabilitation of cutover lands, and other measures to reduce the local economic impacts resulting from park expansion. Fifteen years later, the Redwood National park rehabilitation projects provide a laboratory in which much valuable information about Redwood forests and the Redwood ecosystem is being discovered.

Creation of Redwood National Park was a milestone for the Save the Redwoods League, which had supported establishment of a Redwood National Forest for more

than sixty years. Through all of those the years of debate and deliberation the League raised funds from private citizens and purchased Redwood lands for public parks. In the 75 years since it was founded in 1918, the League has contributed more than seventy-five million dollars to purchase and protect more than a quarter of a million acres of Coast Redwood forest land in the California Redwood State Parks, in Redwood National Park, and in other public parks and preserves.

Today, the league continues to advance its work, in cooperation with the California Department of Parks and Recreation and the National Park Service, to guarantee the long-term protection of the trees and the parks which it has successfully preserved. The League's primary objective, based upon more than 70 years of study by professional park planners, is to complete all of the Redwood parks as ecological units along logical watershed boundary lines.

The movement to preserve the great Redwoods as scenic resources of worldwide importance is unique in the history of conservation. Perhaps this is so because the trees themselves are unique, and the forests which now stand protected in public parks throughout California are the survivors of the ancient Redwood forests that once covered vast areas of earth. Permanent protection of these groves depends upon the continued interest of the public, the strength of our public park agencies, and the determination of our government to hold them invio-



Figure 2. 55 Newton Bishop Drury (1889 ~ 1978), Save the Redwoods League Secretary 1920 ~ 1940 and 1960 ~ 1971.



Figure 2. 56 Aubrey Drury (1891 ~ 1959), Save the Redwoods League Secretary 1941 ~ 1959.

late as natural areas for the inspiration and beauty which they prove to all people. The Save the Redwoods League will continue to play a major role as guardian of these great trees. We all share the responsibility of passing on to future generations these natural treasures unimpaired. The Redwoods are the world's greatest forests, and deserve to survive on spaceship earth into the future.

About the author



Figure 2. 57 John B. Dewitt.

John B. Dewitt received his bachelor's degree in Wildlife Conservation from the University of California at Berkeley in 1959. He has served as a Ranger-Naturalist in the National Park Service in Yosemite National Park, Mount Rainer National Park, and Death Valley National Monument. From 1960 to 1964 he served as Land Law Examiner, Information Officer, and Land Appraiser with the Bureau of Land Management. He joined the staff of the Save the Redwoods League in 1964, and became

the League's third Secretary and Executive Director in 1971.

Coast Redwood Parks

Jedediah Smith Redwoods State Park is located along the beautiful Smith River north of Crescent City, California, and is reached via U. S. 199. The Howland Hill Road, a scenic gravel road lined on both sides with enormous Redwoods, is one of the park's outstanding features. Among the park's many Memorial Groves is the 5000-acre National Tribute Grove which honors the men and women who defended our country in wartime. The Stout Memorial Grove, donated in memory of Frank D. Stout, contains the park's largest measured Redwood, the Stout Tree; 340 feet high and 22 feet in diameter. In addition to the magnificent Redwoods, Jedediah Smith Redwoods State Park protects a wide variety of Pacific Northwest trees and shrubs which are best appreciated by walking and hiking along the park's many beautiful trails. The park is nearly 9500 acres in size and has 108 campsites. The Smith River provides swimming, boating, fishing, and many other recreational opportunities.

Del Norte Coast Redwoods State Park is a 6400-acre Redwood forest bordering the Pacific Ocean. It lies south of Jedediah Smith Redwoods State Park on the U. S. Route 101. In addition to offering a wide variety of foliage and wildlife typical of the Redwood forest region, the park is noted for its dramatic ocean views which can be enjoyed from many trails. Two of the most spectacular are the Damnation Creek Trail and the Coastal Trail. The Damnation Creek Trail, which passes through a forest of old-growth Redwoods, descends to a small rocky beach, ideal for beachcombing and observing the local marine life. The springtime display of rhododendrons - some growing up to 30 feet high - adds bright color to this misty California rain forest. The beautiful Mill Creek Campground is available for visitor use.

Prairie Creek Redwoods State Park offers diverse scenery and a wide variety of vacation activities. Its 12,500 acres are located north of Orick off U. S. Route 101. It has two campgrounds, one at Elk Prairie and one at Gold Bluffs Beach, and more than 75 miles of trail through many beautiful memorial and honor groves. One of the park's unique attractions is the self-guided Revelation Trail for the blind,

where “touchable” features are described both on signs and in Braille handbook (available at park headquarters). Below high bluffs on the park’s ocean front is the magnificent 6-mile long Gold Bluffs Beach. Fern Canyon, shown in the centerfold of this book, is a deep canyon in the bluffs which supports a lush growth of delicate five-finger fern. A drive along the Cal Barrel Road (unpaved) gives visitors the full visual impact of the park’s towering Redwoods on steep slopes. This dense forest is largely composed of old-growth Redwoods, many exceeding 300 feet in height, and spectacular old-growth Douglas-fir forest. The park is also the home of two herds of Roosevelt Elk that graze the meadows and the beach grasses.

Redwood National Park protects the world’s tallest measured Coast Redwood. This majestic tree, stretching 367.8 feet into the sky, is located alongside Redwood Creek. From the Bald Hills Road, off U. S. Route 101, there is a short and beautiful loop trail through the Lady Bird Johnson Grove. Redwood National Park contains 78,000 acres of Redwood forest land, bluffs, and beaches, which adjoin Jedediah Smith, Del Norte Coast and Prairie Creek Redwoods State Parks. Reforestation projects, to help restore the formerly cutover lands in the park to their pristine beauty, are of great interest. The Coastal Trail passes through Redwood National Park and California Redwood State Parks for 50 miles along the Pacific Ocean. The Redwood National Park visitor center is located off U. S. 101 at the mouth of Redwood Creek, near the town of Orick.

The **Humboldt Lagoons State Park** lies along U. S. Route 101 north of Eureka, California, between the Redwood National Park information center and Patrick’s Point State Park. The great charm of the lagoon region is its diversity. Visitors can enjoy sandy beaches, rocky headlands, rolling farmland, Redwood forest, and three coastal lagoons separated from the ocean by sandbars. The parks’ 15 miles of coastline includes beaches at Freshwater Lagoon, Stone Lagoon, Dry Lagoon, and Big Lagoon. The Humboldt Lagoons State Park is for day use, including boating, fishing, swimming, picnicking, and wildlife observation. Environmental camps are available at Stone Lagoon; camping is also available at Patrick’s Point State Park at the south end of the lagoons. Patrick’s Point State Park also includes an Indian cultural site

which relates and interprets the history of the native Americans of northern Humboldt County.

Grizzly Creek Redwoods State Park and Owen C. Cheatham Memorial Grove are southeast of Fortuna, 25 miles east of U. S. Route 101 on State Route 36 along the beautiful Van Duzen River. Historical displays recall the park's past as a rest stop for stagecoaches and cattle drives, and as the home of the Wiyot Indians. Visitors enjoy the primitive Redwood scenery and many memorial groves, as well as hiking, picknicking, and wading and fishing in the Van Duzen River. Grizzly Creek Redwoods State Park includes a small campground; Cheatham Grove (which appears on the cover of this book) is accessible by trail from State Route 36 for day use only.

Humboldt Redwoods State Park is the largest of the California Redwood State Parks. It includes the greatest expanse of contiguous old-growth Redwood forest in existence. Visitors can introduce themselves to the park's magnificent ancient Redwoods, many of them more than 300 feet tall, by driving along the 28-mile Avenue of the Giants Parkway, a spectacular scenic alternate to the U. S. Route 101 freeway. A free auto tour guide to the Avenue of the Giants is available at the park visitor center. Many memorial and honor groves provide easy walking trails, including the Founders Grove along the Eel River, named for the founders of the Save the Redwoods League. A self-guided nature trail in the Founders Grove describes the typical plant life of the Redwood region. The Newton B. Drury Memorial Grove at Pepperwood is an outstanding grove carpeted with lush green oxalis and ferns. Longer walks in the heart of this ancient Redwood forest are available in the Rockefeller Forest, toward the north end of the park on the Bull Creek flats, and in the Garden Club of America Grove toward south end of the park along Canoe Creek. Humboldt Redwoods has three developed campgrounds, at Hidden Springs, at Albee Creek, and at the Park Headquarters. There are also several backcountry environmental camps. Although many visitors are content to see only the Avenue of the Giants and the groves immediately adjoining the South Fork of the Eel River, Humboldt Redwoods State Park is well worth an extended visit. Many miles of interesting trails are developed throughout the park.

Benbow Lake State Recreation Area is a small lake above Benbow Dam, along the South Fork of the Eel River just north of Garberville on U. S. Route 101. Benbow Lake has a campground, and is ideal for summer swimming and picnicking.

Richardson Grove State Park, nine miles south of Garberville on U. S. Route 101, is a favorite camping and swimming area, and attracts many visitors year-round. The Lookout and Toumey trails, running the length of the park on opposite sides of the Eel River, provide scenic vistas, and the Oak Flat campground is very popular.

Sinkyone Wilderness State Park provides a unique wilderness experience along Mendocino County's Lost Coast (so-called for its remoteness and inaccessibility). This 7000-acre park is named for the Native American who originally inhabited the region. Backpackers enjoy the trails swithbacking between cold ocean beaches and the top of the steep coastal ridges. Park headquarters are inland, along the Mattole River, surrounded by fine old-growth Redwoods, a remnant of the old-growth Redwood forest which was logged in most of Mendocino County by the early years of this century. The Lost Coast Trail through the park is spectacular and challenging to seasoned hikers.

Smithe Redwoods State Reserve lies about 4 miles north of Leggett on U. S. 101. This stately grove of old-growth Redwoods is the first major grove to be encountered by visitors driving north through Mendocino County along the Redwood Highway. Fishing and swimming in the Eel River are popular activities in this park, which is for day use only.

Standish-Hickey State Recreation Area is the southernmost of the Redwood parks along the U. S. Route 101, the Redwood Highway. It is situated about a mile north of Leggett on U. S. Route 101, along the South Fork of the Eel River. One of the park's largest Redwoods, the 225-foot Captain Miles Standish Tree, stands along a hiking trail which also leads to a 35-foot waterfall. The Mill Creek Loop is a rugged trail leading to a spectacular view of the surrounding country. Standish-Hickey SRA has a campground, and campfire programs are held nightly during the summer

months.

Admiral William H. Standley State Recreation Area is a small and lovely grove of Redwoods crossed by a stream which is ideal for picknicking. It is located about 14 miles west of Laytonville, on the Branscomb Road.

Jughandle State Reserve is located between Fort Bragg and Mendocino on State Route 1. The 900-acre reserve protects a unique biological and geological resource. Five wave-cut terraces display one of the most complete natural records of geological succession on the California coast, recording more than a million years of changing ocean level. The tops of the ancient terraces, covered with nearly pure sand over a cement-like layer of hardpan, support a miniature forest, whose fully mature trees are only a few feet tall. A self-guided nature trail leads visitors from the Pacific Ocean into the heart of this pigmy forest. The parking area also provides access to Jughandle Creek Beach.

Russian Gulch State Park lies along the Pacific Ocean north of Mendocino on State Route 1. Its high cliffs offer scenic views of jagged coves and ocean-carved arches, and its headlands and sandy beach provide many ideal picnic spots. Russian Gulch itself is a canyon densely forested with second-growth Redwood and the typical understory plants of the Redwood Region. A scenic bike path runs along the lower part of the canyon, and many hiking trails, including one to a fine waterfall (best when the spring runoff is still high) follow the canyon walls and surrounding ridges. A small, developed campground lies in the canyon.

Van Damme State Park is just north of the town of Little River, on State Route 1. Fern Canyon, carved by Little River, is lush with second-growth Redwood Forest. A loop trail leads up Fern Canyon to an area of pigmy forest, its trees stunted by lack of soil nutrients, on the ridge above. Its broad sandy beach, edged with tidepools and protected from the full force of the Pacific swells by headlands and a dense growth of kelp, is a favorite spot for skindivers. Van Damme State Park has a developed campground in the protected lower end of Fern Canyon.

Montgomery Woods State Reserve lies at the headwaters of Big River, about 11 miles west of Ukiah on the Orr Springs road. The 1142 -acre reserve protects an

impressive stand of old-growth Redwoods, including one tree which has been measured at more than 360 feet in height. The groves at Montgomery Woods are noted for their understory of large chain ferns (*Woodwardia fimbriata*). A two-miles long loop trail winds along Montgomery Creek and through the Reserve's memorial groves. The Reserve is a favorite site for picnics. No overnight use is permitted.

Navarro River Redwoods State Park offers 11 miles of beautiful Redwood groves and Navarro River frontage, along State Route 128. Developed campsites are available at Paul M. Dimmick Wayside Campground. The river is a popular place for canoeing in the spring, swimming in the summer, and fishing in the winter months. It provides a warm inland escape from the dense summer fog common along the Mendocino County coast.

Hendy Woods State Park is located between Boonville and Philo off State Route 128, along the Navarro River. The park entrance is just west of State Route 128 on the Greenwood Ridge Road. A walk through the beautiful memorial groves reveals many trees of more than 300 feet in height and more than 16 feet in diameter. A wheelchair-accessible nature trail also has Braille signposts for the visually impaired. Hendy Woods State Park has a fine developed campground, and the picnic area on the banks of the Navarro River is a favorite all summer long.

Mailliard Redwoods State Reserve is about 20 miles west of Cloverdale, off State Route 128 on Fish Rock Road. Named for distinguished conservationist John Ward Mailliard, Jr., it is a 240-acre Redwood grove surrounding a peaceful creek, which is the source of the Garcia River.

Armstrong Redwoods State Reserve is a very popular and heavily-used Redwood park on the Russian River near Guerneville. A self-guided nature trail leads through some of the giants in the Reserve to the Parson Jones Tree, 310 feet high and estimated to be 1200 to 1500 years old. The Redwood Forest Theatre, a natural amphitheatre, is a popular facility. No overnight use is allowed in the Reserve.

Austin Creek State Recreation Area adjoins Armstrong Redwoods State Reserve to the north, and has excellent picknicking and camping facilities. This beautiful park is a paradise for the hiker, horseback rides, and backpacker. Many wild-

flower species flourish in the 5000-acre park, provide a wonderful display of spring bloom. There are 20 miles of hiking trail in the park, a developed campground, and some primitive backcountry environmental campsites.

Fort Ross State Historic Park is eleven miles north of Jenner on State Route 1. Fort Ross was established in 1812 by Russian and native Alaskan settlers, to grow food for the Russian settlements in Alaska and to hunt sea otters. The park visitor center displays and interprets the history of the native American, Russian, Alaskan, Spanish, and Mexican settlers around the Fort, as well as the later history of the area. The Fort itself has been restored extensively, and work still continues to reconstruct some of the buildings which originally stood there. In addition to Fort Ross, the visitor center, and many interpretive activities, the park includes a handsome Redwood grove and the steep coastal hillside above it. The Reef Campground, five miles south of the Fort, has 25 primitive campsites, with drinking water. No dogs are allowed at this campground.

Samuel P. Taylor State Park is an hour's drive north of San Francisco in central Marin County. During spring and summer a great variety of wildflowers bloom around the fine Redwood groves at the bottom of this beautifully wooded canyon. In January the annual run of steelhead trout can be seen along the creek. The park contains 2700 acres, and provides developed campsites and many inviting picnic areas. Devil's Gulch Camp is a unique camp with facilities for up to 105 campers on horseback, including a corral, hitching racks, and watering troughs. A picnic area suitable for groups of up to 100 people is also available.

Mount Tamalpais State Park centered on Mount Tamalpais (2526 feet) in Marin County, is about 15 miles north of San Francisco, and is extremely popular with Bay Area residents. Its 18 walk-in campsites must be reserved in advance. The park covers 6200 acres and offers 200 miles of well-maintained hiking trails, many of which connect with the trails in Muir Woods National Monument (which is surrounded by the State Park) and in the Golden Gate National Recreation Area. The trails provide striking views of the Pacific Ocean and of San Francisco Bay.

Muir Woods National Monument is 17 miles north of San Francisco on State

Route 1. The monument is easy to reach from U. S. 101, and is one of the most heavily visited of all of the Redwood parks. Although there may be crowds around the visitor center near the monument entrance, the peaceful and spacious old-growth Redwood forest is only a short walk away. Muir Woods was donated to the United States in 1907 by Congressman William Kent, to honor naturalist John Muir. Since that time visitors from all over the world have enjoyed its natural beauty.

Alameda County Redwood Parks: Redwood Regional Park, Joaquin Miller Park, Leona Heights Park, and Roberts Recreation Area, in the hills above the cities of Oakland and Berkeley, protect stands of second-growth Redwoods which have grown back since these hills were logged in the 1850's. Reforestation is still proceeding in these parks, so that in the future visitors can see the Redwood forests in these hills as the first European explores saw them.

The **Stephen T. Mather Grove** at the University of California's Berkeley Botanical Garden in Strawberry Canyon is a small and attractive Redwood grove, planted in the early 1930's and used by students of botany. It is open daily to the public.

Portola Redwoods State Park is a 2500-acre natural basin lying between Skyline and Butano Ridges in San Mateo County, south of San Francisco. The park is reached from Alpine Road, off State Route 35. Camping, picnicking, and hiking are available at Portola Redwoods. Along its 20 miles of hiking trails are beautiful stands of old-growth Redwoods. The Iverson Trail provides access to some of the park's finest memorial groves, along Peters Creek and Pescadero Creek.

Butano State Park is located between San Francisco and Santa Cruz, off State Route 1 in San Mateo County. Heavily forested with Redwoods, Butano is a peaceful place for camping, hiking, and nature study, especially in the spring when its many wildflowers are in bloom. The park has campsites and 35 miles of trails.

San Mateo County Redwood Parks: Pescadero Creek County Park, Huddart Park, Memorial Park, Sam McDonald Park, and Heritage Grove protect beautiful stands of old-growth Redwoods and the rugged ridge-and-canyon topography of the Coast Ranges, and provide facilities for camping, picnicking, swimming, and hiking.

Purisima Creek Redwoods Open Space Preserve lies on the western slopes of Skyline Ridge just east of Half Moon Bay in San Mateo County. This 2520-acre preserve has 15 miles of hiking trails in a steep, intimate canyon forested with second-growth Redwood and Douglas-fir.

Big Basin Redwoods State Park, established in 1902, is the oldest park in the California State Park System. It encompasses 18,130 acres and some of the largest Redwoods south of San Francisco. The park is typical of the primeval Redwood forest which once flourished throughout the Santa Cruz area. The Nature Lodge, a small museum in the heart of the park, displays exhibits of Big Basin's history and natural features. The park is inhabited by a wide variety of wildlife - deer, raccoons, squirrels, and an abundance of birds. Its 35 miles of hiking trails offer dense forest, open ridgetops, waterfalls, and panoramic views of the Santa Cruz Mountains. The Howard King Trail offers magnificent views of the whole Waddell Creek drainage, and of the Pacific Ocean on clear days. This trail was planned and constructed by } Redwood photographer Howard King, who has donated many months of volunteer work to Big Basin Redwoods State Park. The Skyline-to-the Sea Trail runs 37 miles from Skyline Ridge in Castle Rock State park to the mouth of Waddell Creek in Big Basin. Big Basin Redwoods State Park has 190 campsites and several group camps, and is accessible from State Routes 9 and 236.

Henry Cowell Redwoods State Park lies along the San Lorenzo River just north of Santa Cruz, on State Route 9. Its 15 miles of trails give visitors ample opportunity to explore the large old-growth Redwoods protected in the 4100-acre park. The Cathedral Redwoods are a particularly interesting sight: a ring of mature Redwoods which sprouted from the root crown of a single, now-vanished, tree. The visitor center provides many interesting natural history exhibits.

The **Forest of Nisene Marks** is a quiet second-growth Redwood park of 10,000 acres in steep coastal mountains north of Aptos, off Soquel Drive. This area was logged heavily in the late 1800's, but since then the Redwoods have been undisturbed, and some of the trees in the lower elevations of the park have diameters of up to 6 feet. 30 miles of hiking trails and many picnic areas in the lovely Redwood groves

are available for visitors. No overnight camping is permitted.

Santa Cruz County Redwood Parks: De Laveaga Park and Harvey West Park.

Andrew Molera State Park is about 21 miles south of Carmel on State Route 1, at the mouth of the Big Sur River. Redwoods grow along the South Fork of the Little Sur River in this 4800-acre park. A large open meadow, excellent for picnicking, a sandy beach, and rocky cliffs dominate the spectacular scenery. Andrew Molera State Park has hike-in campgrounds for overnight stays.

Pfeiffer Big Sur State Park, 26 miles south of Carmel on State Route 1, is a very popular park for camping, picnicking, hiking, and fishing. Its hiking trails pass through a great variety of Redwood forest settings, and include a self-guided trail along the Big Sur River, and the Pfeiffer Falls Trail which leads to the beautiful waterfall for which it is named. The 800-acre park has more than 200 developed campsites, three group campsites, and a group picnic area which can accommodate up to 200 people.

Julia Pfeiffer Burns State Park, 37 miles south of Carmel on State Route 1, is 2040 acres containing some fine examples of Redwood forest. Here at their southernmost limit, the Redwoods flourish beside cool streams in steep, shaded canyons. Picnicking and hiking are the favored activities in Julia Pfeiffer Burns State Park. McWay Creek makes a spectacular plunge into the ocean, and the Partington Canyon Trail passes through many beautiful Redwood memorial groves. 1680 acres of underwater seacoast were added to the park in 1970. Several California State Parks along the Pacific Ocean now include underwater natural preserves.

The University of California's **Big Creek Reserve** is located off State Route 1 on the Big Sur Coast, 50 miles south of Carmel at Big Creek Bridge. The reserve includes four miles of ocean front and protects a variety of flora and marine life. The University administers the property as a natural reserve for educational and scientific purposes, and in particular for the study of fire ecology and succession. The reserve was burned by the 60,000-acre Big Sur Wildfire of 1985. Visits to the reserve are allowed by permit.

Chapter III Giant Sequoia
(*Sequoiadendron giganteum*)

Section 1 Sierra Nevada Mountain Range and Giant Sequoia

Chen Momei

The Sierra Nevada mountain range, 640 km long and 60 – 130 km wide, is found in Eastern California. It rises to 4418 m at Mt. Whitney, the highest peak in the United States outside Alaska. The mountains extend northwest from Tehachapi Pass near Bakersfield, California, to the beginnings of the volcanic cascades range near Lassen Peak. A tilted fault-block in structure (the largest in the United States), the Sierra Nevada's eastern front rises sharply from the Great Basin, while its western slope descends gradually to the hills bordering the Central Valley of California. Heavy winter precipitation is economically important to the surrounding areas; and also generates hydroelectric power. High, rugged, and frequently snow-bound in winter, the mountains are a formidable barrier to overland travel. Donner Pass 2161m, the principal pass across the mountains, was used by thousands of California-bound gold-seekers and immigrants in the middle and late 1800s. The Sierra Nevada are known for their magnificent scenery (especially in the High Sierra South of Lake Tahoe and in Yosemite, Sequoia, and Kings Canyon national parks) and for their year-round resorts.

Extreme topographic differences and a striking elevation gradient, ranging from 300m in the foothills to 4418m along the Sierra crest, create a rich tapestry of environments, from the hot, dry lowlands along the western boundary to the stark and snow-covered alpine high country. This topographic diversity in turn supports over 1200 species of vascular plants, which make up dozens of unique plant communities. These include not only the renowned groves of massive giant sequoia, but also vast tracts of montane forests, spectacular alpine habitats, and oak woodlands and chaparral. Forest zones are arrayed elevationally as follows :

Foothill and lower montane forest

The lowest elevations in Yosemite are found on the western boundary of the park at the El Portal Administrative Site, which is at approximately 550 m. This is the foothill woodland zone, an area that is hot and dry in the summer with very little or no snow in the winter. Plants within this zone include green leaf manzanita (Fig 3.9), blue oak, interior live oak, and gray pine.

Dominated by dense thickets of sclerophyllous (thick leaved) shrubs, chaparral communities are characteristic of lowland Mediterranean climates, where winter rains provide most of the precipitation and, but for the hot dry summers, temperatures are relatively mild. Many of these species exhibit specific adaptations to fire and drought, both of which have a strong influence on life in the foothill environment.

Being a scientist, the author considers it a spiritual enjoyment to study and compare the floras of North America and East Asia, and to explore the forest pathology and mycology of Himalayan and Sierra-Nevada ecosystems. The author did research with Dr. Fields Cobb on White Pine Blister Rust at Blodgett Forest Research Station (BFRS) for 20 years.

This is an especially superior forest ecological research station. This station is located on the western slope of the Sierra Nevada mountain range in California (38° 52'N; 120°40'W). The study area lies within BFRS at an elevation of 1330 m. The climate is Mediterranean with dry, warm summers (14 ~ 17 °C) and mild winters (0 ~ 9°C). Annual precipitation averages 166 cm, most of it coming from rainfall during fall and spring months, while snowfall typically occurs between December and March. Pre-suppression era median point fire interval in the area is 9 ~ 15 years (Stephens and Collins, 2004). The soil developed from granodiorite parent material and is productive for the region. Soil productivity is relatively uniform across the study site and surrounding areas. Heights of co-dominant canopy trees typically reach 31 m in 50 years (BFRS data, <http://nature.berkeley.edu/forestry/>, 20 March 2005). Olson and Helms (1996) provided a detailed description of BFRS, its management, and trends in forest growth and yield.

Vegetation at BFRS is dominated by a mixed conifer forest type, composed of variable proportions of five coniferous and one hardwood tree species (Tappeiner, 1980). The study site is located on a mild (5% ~ 10%) northeast facing slope. There are six native overstory tree species present: white fir (*Abies concolor*, Fig 3.5), incense-cedar (*Calocedrus decurrens*, Fig 3.4), Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), sugar pine (*Pinus lambertiana*, Fig 3.3), ponderosa pine (*Pinus ponderosa*, Fig 3.2), and California black oak (*Quercus kelloggii*, Fig 3.7).

In harvested openings throughout the forest, BFRS has planted giant sequoia since the mid-1960s. BFRS is not within an existing native sequoia grove, but is within the expanded range of past giant sequoia populations (Harvey, 1985). An isolated native grove (Placer grove) exists approximately 48 km to the north, while the closest grove to the south is within 200 km. Climatic conditions are very similar between BFRS and native groves.

Giant sequoia forest

The giant sequoia (*Sequoiadendron giganteum*) groves of the central and southern Sierra Nevada present a special case of mixed-conifer forests. These groves are typically dominated by white fir, or at higher elevations by red fir, with sugar pine as an important component (Rundel 1971). Giant sequoias are commonly third in abundance in these groves, although their basal area often exceeds that of other species. Drier or lower elevation areas of giant sequoia groves often include ponderosa pine (*Pinus ponderosa*), Jeffrey pine, incense cedar (*Calocedrus decurrens*), and black oak (*Quercus kelloggii*) as associated species. Douglas fir (*Pseudotsuga menziesii*) is present in some of the northern groves, and the North Calaveras Grove is notable for an extensive understory of California Yew (*Taxus brevifolia*). The natural occurrence of giant sequoia is restricted to some 67 to 75 groves (depending on how they are defined) on the west slope of the Sierra Nevada (Rundel 1972b; Willard 2000). From Placer County to the Kings River, there are eight disjunct groves, separated by as much as 90 km. South of the Kings River there is a much more continuous belt of groves, never separated by more than about 7 km, extending through Tulare County. The size of individual groves varies greatly from the tiny Placer County Grove with just six trees to the large Redwood Mountain and Giant Forest Groves that are approximately 1000 ha in area and contain more than 20,000 giant sequoias each. The northern disjunct groves largely occur at elevations of 1400 to 2000 m, with south-facing slopes favored. The major group of groves south of the Kings River generally occurs at higher elevations up to 2450 m, with individual trees reaching 2700 m, and favor north-facing slopes. Overall, giant sequoia groves occupy about

14, 600 ha, with roughly 90% of this area in public ownership (Stephenson 1996). Giant sequoias have attained a special fame because of their huge size and longevity. They are the largest trees in existence, with bole volumes of nearly 1500 m³ and heights measured up to 93.6m (307 feet) (Van Pelt 2001). Precise tree dates as old as 3266 years have been measured in giant sequoia. Fites-Kaufman et al. (2007) is the chapter on vegetation of the Sierra Nevada from the 3rd edition of the Terrestrial Vegetation of California.

Upper montane forest

Red fir forests grow in pure or nearly pure stands in the mid to upper elevation forest belt 2133.6m to 2743.2m (7000 to 9000 feet) of Sequoia and Kings Canyon National Parks. These stately trees typically form a dark forest with scant ground cover. Far View Giant Sequoia mountain from General highway (Fig 3.1).

In the upper montane zone, the mixed coniferous forest is replaced by nearly pure stands of red fir (Fig 3.6) and lodgepole pine (Fig 3.8). Characterized by deep snow accumulation during the winter months and a dense canopy that limits the amount of sunlight that reaches the forest floor, the red fir forests lack a diverse herbaceous component. Only the most shade tolerant herbs thrive beneath the towering trees. Lodgepole pines have an unusual distribution, growing in both moist lowlands and in drier sites on benches and ridges. In wetter sites, these forests can support a rich amalgam of herbs and wildflowers in their understory.

Above the upper-most edge of the montane forests, subalpine woodlands define the limit of tree life in the Sierra. In Sequoia National Park, these include southern populations of foxtail pine, a close relative of the long-lived bristlecone pine which can be found in the White Mountains to the east. Downed pieces of foxtail pine wood can persist intact for thousands of years, preserved by the extremely cold and dry conditions that characterize the high elevations. To the north, stands of whitebark pine provide a critical food source for the ubiquitous Clark's nutcracker.

Foxtail pine grows in scattered stands on bare rocky or sandy slopes at high elevations. Exposed to extremes of temperature, unlimited sunlight, severe winds and

Giant Sequoia

storms, and long summer droughts, these trees have shapes sculpted by the elements.

Where soils are too saturated or shallow to support tree growth, numerous meadows can be found in the montane, subalpine and alpine zones. Wet meadows support a remarkably diverse assemblage of grasses, sedges and wildflowers, which provide essential habitat for many small mammals, birds, and insects. Dryland meadows, too, are an important source of food and shelter for animals of the higher elevations.

Rocky alpine

In the rocky alpine zone, where the short growing season and harsh winter conditions exclude all but the hardiest of plants, stunted trees give way to low-growing, perennial herbs. Here plants often form ground-hugging mats or hummocks to take advantage of the warmer surface temperatures. In winter, the snowpack provides insulation from sub-freezing temperatures and desiccating winds. During the brief summer, when freezing temperatures and snowstorms remain a threat, surprisingly showy flowers burst forth in the race to set seed before winter returns.

Three parks with Giant Sequoias

Calaveras Big Trees State Park located off State Route 4 at approximately 5000 feet elevation on the western slope of the Sierra Nevada, protects two majestic stands of Giant Sequoia. The North Grove is accessible in any season, and has been a favorite destination of visitors since the 1850's. The South Grove, reached by a 2-mile foot trail from the Beaver Creek picnic area, has remained in a completely natural state. Both offer magnificent examples of the old-growth Giant Sequoia and its surrounding forests, including old-growth sugar pine, ponderosa pine, and western Dogwood. Calaveras Big Trees State Park is open year-round, and is a wonderland in any season. Summer activities include camping, hiking, swimming, and fishing, while in winter, hiking and cross-county skiing (depending on the season's snowfall) are favored.

Yosemite National Park in addition to Yosemite Valley and its many other magnificent scenic features, Yosemite National Park protects three groves of Giant

Sequoias. The Tuolumne and Merced Groves are located on the western side of the park, off the Big Oak Flat Road (reached from the Big Oak Flat entrance on State Route 120). The Tuolumne Grove is on the one-way section of the old Big Oak Flat Road, and includes about 20 large Giant Sequoias, one of which is nearly 300 feet tall, near the record height for this species. The Merced Grove is reached by a two-mile foot trail from the Big Oak Flat Road. It also contains about 20 large Giant Sequoias, as well as many colorful wildflowers in season. The Mariposa Grove is at the south boundary of the park, near the south entrance (reached from State Route 41). It is a large grove, containing hundreds of large Giant Sequoias, and provides a museum with natural history exhibits, two self-guided nature trails, and, in the summer months, a tram system which carries visitors into the Grove. For more information, contact Yosemite National Park, Yosemite National Park, CA 95389. www.nps.gov/yose/naturescience/plants.htm.

Sequoia and Kings Canyon National Parks lie on the western flank of the Sierra Nevada, south of Yosemite National Park. Two of the largest groves of Giant Sequoias are protected in these parks, Redwood Mountain Grove (3100 acres) in Kings Canyon and Giant Forest (1800 acres) in Sequoia. The parks were originally established here to protect the Grant Grove of Giant Sequoias (General Grant National Park) and the Giant Forest and many other sequoia groves (Sequoia National Park). Four of the world's five largest trees grow in Giant Forest, including the General Sherman Tree, the world's largest. The world's second largest tree is the General Grant Tree in the Grant Grove. Kings Canyon National Park is easily reached via State Route 180 from Fresno, and Sequoia National Park on the south is reached via State Route 198 from Visalia. The General's Highway loops run through Grant Grove and Giant Forest, connecting the two parks. There is no road access to either park from the east side of the Sierra. Campgrounds, visitor centers, ranger-led activities, and concession facilities including lodging, and food are available year-round in Sequoia and Kings Canyon National Park.

For more information contact Sequoia and Kings Canyon National Parks, Three Rivers, CA 93271. www.nps.gov/seki/naturescience/plants.htm.

Giant Sequoia

Yosemite, Sequoia and Kings Canyon have vegetation management programs that focus on understanding the parks' flora and vegetation, protecting rare species, restoring natural fire regimes to forest and chaparral ecosystems, monitoring and controlling invasive non-native (exotic) plants, restoring disturbed habitats and landscapes, and monitoring and managing impacts from recreational and administrative uses.

Section 2 The Sequoias of Yosemite National Park

Thomas H. Harvey



Figure 3. 19 They were probably the first ones ever seen by early explorers. 1833 led by Joseph Walker.

Discovery

The giant sequoias of Yosemite were probably the first ones ever seen by early explorers. In 1833, a party led by Joseph Walker may have passed through either the Tuolumne or Merced Grove, for they remarked of a deep valley which fits the general description of Yosemite Valley in the general area of their passage over the Sierra. A clerk on the trip, Zenas Leonard, wrote in his journal, "In the last two day's of traveling we have found some trees of Redwood species incredibly large-some of which would measure from 16 to 18 fathoms (96 to 108 ft.) round the trunk at the height of a large man's head from the ground." Leonard's journal was published in 1839, but the printing shop burned down and only two copies were saved. Neither copy received much attention until 1904 by which time other more publicized discoveries had been made. It is still a mystery, however, that none of the Walker party were able to impress others with this unique discovery.

This left the way open for A. T. Dowd to go down in history books, for in 1852 he came upon the North Calaveras Grove of giant sequoias in the Mother Lode Country. The story goes that he was unable to convince his fellow employees at the Union Water Company in Murphys of his magnificent find. Dowd made up a story about having shot a huge grizzly bear and needing help to bring in the meat. This lured the unsuspecting confirmers to the site of the big trees. An article in the *Sonora Herald* in June of 1852 proclaimed to California the discovery that is generally accepted as the "effective discovery date," because Leonard's earlier account went unread or unheeded. Dowd's find soon was known around the world.

Then a curious thing happened. Numerous early explorers stepped forward to claim they had seen the trees at an earlier date. Tales of these earlier discoveries all had one thing in common: They were written or being told after 1852. No record has come to light of the thoughts of the Walker party, whose members seemingly have a legitimate claim to being the first Europeans to have seen these trees.

The native Indians, of course, had lived with the giant sequoias for centuries. One name the Indians used for these trees was "wawona." It is an imitation of the

hoot of an owl, the guardian spirit of the giant sequoias. The most famous application of the name “wawona” is to the fallen tunnel tree in Mariposa Grove.

The Mariposa Grove appears to have been discovered by Europeans around 1850. Major Burney is given credit, but once again public recognition shifted through history to another. In this case, Galen Clark looms as a prominent person. In 1857 he brought attention to the Mariposa Grove and named it after the county in which it occurs. It is generally accepted that he first entered the grove from the northeast and encountered the magnificent specimen on the ridge that bears his name to this day.

In 1857, Clark established a stage station at Wawona and served as a guide to the Mariposa Grove and Yosemite Valley. He built a hospice in the grove, probably in 1861, and that cabin site is where the Park’s Museum now stands. Clark originally came to California in 1853 to search for gold. He became ill and decided to go to the mountains to spend his last days. He recovered, however, and until the age of 96 he served as guardian of Yosemite Valley and the Mariposa Grove. When he died, he was buried beneath the four giant sequoias he had planted in Yosemite Valley.

Giant Sequoia

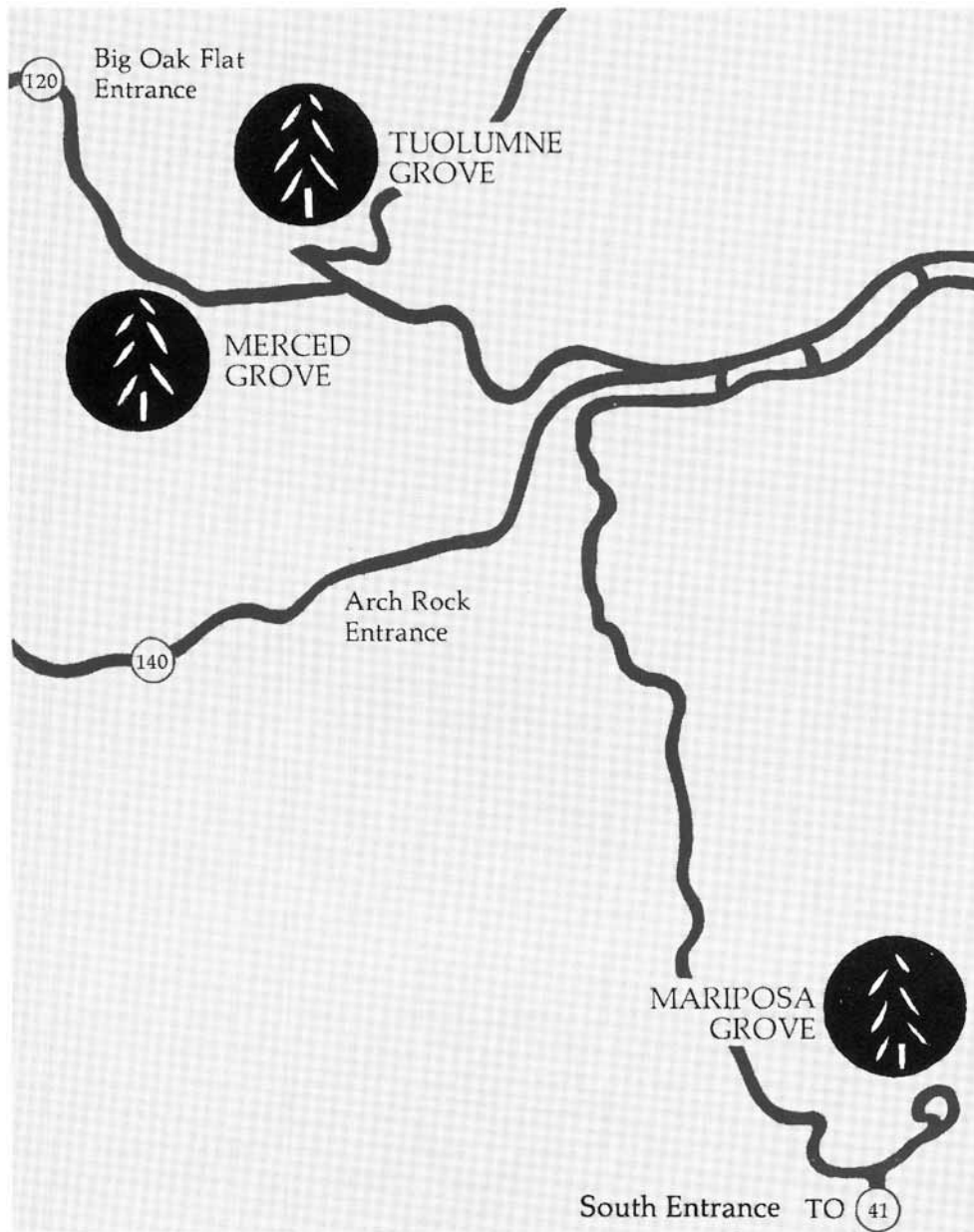


Figure 3. 20 From Hyw 120 or 140 enter to Sequoias of Yosemite National park.

Yosemite's Three Giant Sequoia Groves

The three groves of giant sequoias that are located within Yosemite Park's boundaries vary in size. The two smaller ones—the Merced and the Tuolumne Groves—are near the central western border, while the relatively larger Mariposa Grove is near the southern border of the Park. Each grove is different, having its own unique attributes, with striking specimens or awe-inspiring views. Indeed, each tree is different and a close inspection may reveal a burl, a snag top, or an unusual bark pattern.

The Mariposa Grove with its hundreds of large trees is only 35 miles from Yosemite Valley. Within this grove are numerous points of wonder. Of special interest is the Grizzly Giant, the largest tree in the grove. The Grizzly Giant summons a sense of mystery, its gnarled and mighty branches protruding in all directions. One of them is six feet in diameter, greater than the trunks of most other kinds of trees in its vicinity. It is probably approaching 3000 years of age, a veteran in lineage noted for veterans.

The Tuolumne Grove of giant sequoias is located on the one-way section of the old Big Oak Flat Road. There are about 20 large specimens ten feet or more in diameter within this grove. In the past a massive tree grew on the eastern edge of the grove. Now known as the Dead Giant, it straddles the Tunnel Tree Road. The tunnel through this giant stump was cut in 1878. At the downhill end of the Tunnel Tree Road is a parking lot from which a short walk (less than 100 yards) to the east brings one to a fused pair of giant sequoias. An equal distance from the fused pair further east and just across North Crane Creek is an amazing tree. Almost all of its bark and much of the basal trunk has been burned away yet the tree lives on, demonstrating the strong persistence of its kind.

Farther down North Crane Creek is a lightning-struck tree, and at the northern edge of the Grove is its tallest tree, almost 300 feet in height. The giant sequoia rarely exceeds this height. Finally, an excellent specimen of a downed tree, the Fallen Giant, lies along the Old Stage Coach Road at the northwest edge of the grove.

The Merced Grove is about four miles south of the Tuolumne Grove and consists

Giant Sequoia

of about 20 large giant sequoias. It is currently reached by foot down a two-mile dirt road that takes off from Big Oak Flat Road. This grove has a special charm, for the trees are growing in a moist little valley. Colorful and delicate wildflowers abound at the bases of the giants, forming a pleasing contrast. Within this grove is a seven foot in diameter Douglas fir. It is an unexpected sight, for this large specimen is near the southern limit of the species' range.

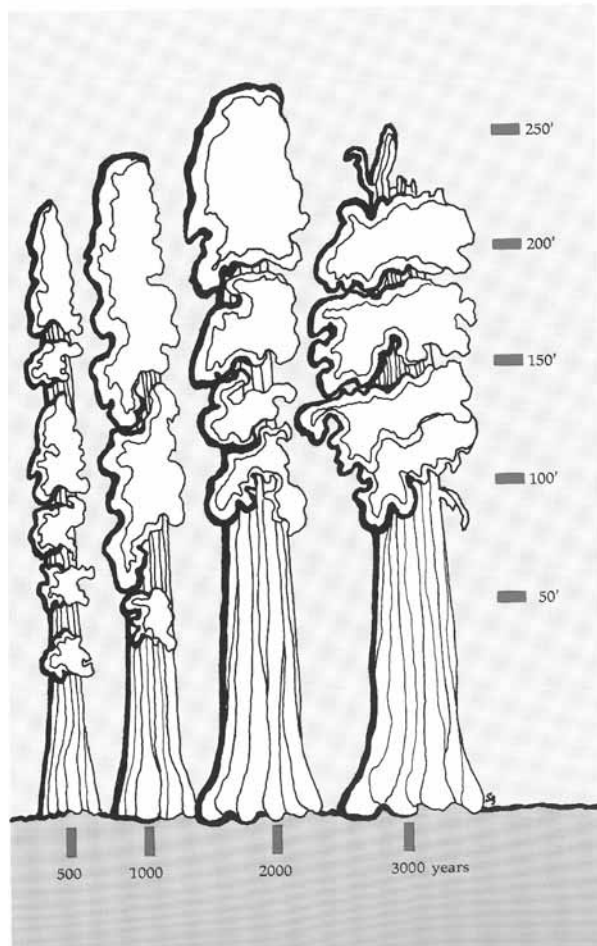


Figure 3. 21 Measuring for Giant sequoias heights (feet) and years.

Description of the Giant Sequoia

The giant sequoia begins life as an embryo in a tiny seed, so tiny in comparison to the mature tree that the ratio in size of the embryo to the mature sequoia is the same as the mature tree is to the earth. It takes over 91,000 such seeds to weigh a pound. The seed looks much like a flake of rolled oats with over 3/4's of it the wings and the dark central core the embryo. Each seed may germinate to produce a diminutive seedling only an inch high.

Most seedlings have four linear seed leaves, though the number may vary from three to six. Within a few weeks the seedling adds secondary leaves. These juvenile leaves are also linear and rather soft, in contrast to the adult leaves that are awl-shaped, fairly hard, and sharply pointed. At this early stage, most of the growth is concentrated in the roots rather than the shoots, for only those seedlings whose roots reach adequate soil moisture have a chance of surviving the dry summers and autumns of the Sierra. Equally important, a solid root structure must be present to supply the water and nutrients that will allow the rapid growth of the young tree and later sustain it in maturity.

As the years pass the seedlings grow into young trees with a graceful conical form. Often called spire-tops, these striking trees have a distinct, full, sharply-pointed top. This stage of growth carries the tree until it is about 100 years old. Already they may bear cones with viable seeds, with a few capable of reproducing at the tender age of 10 or 15 years.

Centuries roll by, and the tree approaches its maximum height and starts to develop a rounded dome-like crown. This, too, is a distinctive phase in the giant sequoia's life, and such mature trees can be recognized on the skyline from miles away. Generally, these trees are a few centuries short of 1000 years of age and still in the prime of life.

The final form recognized throughout an old forest are the snag tops. Veterans of many fires characteristically exhibit one or more dead stems at the top of the tree. Most such snag tops result from the fires that are hot enough to cause fire scars at the

Giant Sequoia

base. Fire scars may sever as much as 50% of the trunk-to-root connections. With its source of water partially cut off, the top of the tree dies back producing a snag top. A new branch may take over as leader, but it too may die when later fires rage and enlarge the scar or when extensive drought prevails. From such experiences many old trees persist with several dead leaders, mute testimony to the tribulations they have survived.

Most fire scars are most extensively developed on the upslope side of a giant sequoia. This is due to the natural accumulation of heavy fuel on that side.

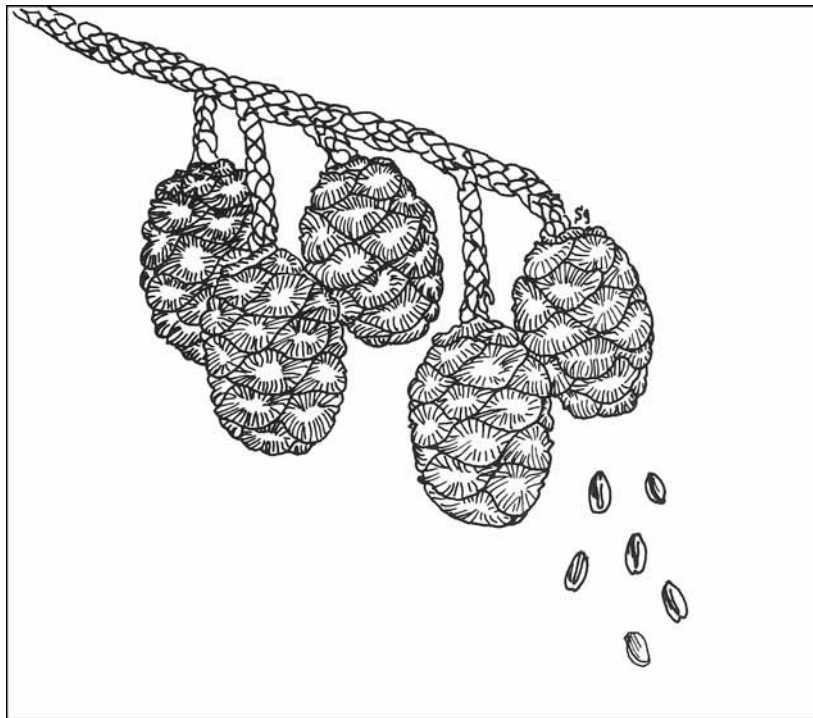


Figure 3. 22 Giant sequoia cones and seeds.

Size of the Giant Sequoia

The giant sequoia has the distinction of being the largest living thing in the world, past or present. The individual with the record size is the General Sherman

Giant Sequoia

Tree in Sequoia National Park. It has a volume of about 51,000 cubic feet which, if made into a 2-by-4, would yield a board almost 175 miles long.

Through the combined attributes of rapid growth and longevity, the giant sequoia reaches its maximum height in about 800 years. If it lives on to be several thousand years old then the subsequent growth is radial. In other words, the tree adds bulk rather than height. The Grizzly Giant of Mariposa Grove, for example, is almost 16 feet in diameter at 60 feet high and over 13 feet at 120 feet above the base. The General Sherman is over 12 feet in diameter 200 feet above the base. Thus, these great columns appear as parallel structures supporting the green canopy above.

Although its close relative the coast redwood is sometimes over 50 feet taller, the giant sequoia still reaches impressive heights. The maximum height reported to date that is considered reasonable is 320 feet for a tree that subsequently had several feet knocked off its top by lightning and the resultant fire. There are, however, several living trees at 310 feet in height which are the current record holders.

The diameters of a giant sequoia vary greatly depending on how they are measured. Due to the unusually large spread of the tree's base (the butt swell) the reported values for diameters close to the ground need to be interpreted. If a ground level diameter is measured it will be greater for a tree on a slope than for that same tree on the level. Therefore, diameters taken perpendicular to the axis of the tree are preferred for comparative purposes. Diameters for forest trees are usually taken at 4.5 feet above the ground on the uphill side. This height is part of the dbh which stands for diameter at breast height. With large giant sequoias, however, 4.5 feet is still usually in the area of the butt swell. To circumvent this, two methods have been developed. One method selects an arbitrary height, such as ten feet, which generally places the diameter measurement above the butt swell. The other method simply takes diameter measurements above the butt swell, however far up the trunk that might be. The point of all this is that when a diameter value is given, the height above the ground must be known in order to evaluate the measurement.

The maximum diameter reported for the giant sequoia is 35.7 feet at ground level for the Boole Tree in the Converse Basin. The Grizzly Giant is not far behind at 30.7

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feet at ground level. Both trees are on nearly flat ground, especially the Grizzly Giant. When measurements are taken 20 feet above the base, and thus well above the butt swell, maximum diameters are about 20 feet. Diameters of the largest trees taken at 4.5 feet above the base are from 25 to 29 feet in diameter.

Even the branches of several of the large giant sequoias are remarkable for their size. The Grizzly Giant's largest branch is 6 feet in diameter, while the General Sherman has a branch 6.8 feet in diameter and 150 feet in length. The latter branch is larger than the largest specimens of many tree species east of the Mississippi, yet, in itself, is an inconspicuous part of the tree.

These dimensions can be rattled off and some impression of the giant sequoia's size can be gained. Truly understanding such dimensions, however, is difficult. Perhaps the easiest way to comprehend a tree that is 300 feet tall and 30 feet across at its base is to mentally remove the tree from the forest and put it in other surroundings. Imagine for a moment that you are watching a football game. Our free-floating tree on its side will cover the field from goal line to goal line. Some of its branches will reach into the best seats 1/3 of the way up the stadium. Now let's move the tree to San Francisco, but keep it upright in its normal position. We will have to be in the restaurant in the tower 30 stories above the St Francis Hotel lobby to look across the snag-top of the tree. Or imagine that we have moved the upright tree into a typical residential neighborhood, perhaps right in front of your house. The tree will completely block the street, and you won't be able to see your neighbor's house across the street. If we mentally cut a cross section out of the tree's trunk and set it on its side, it will still be ten feet higher than the top of the two-story houses. Now we can put the tree back in the forest with an enlightened appreciation of its awesome size.

Age of the Giant Sequoia

A reasonably close estimate of a tree's age can be obtained by counting its growth rings. These rings are usually yearly, although sometimes rings fail to encircle the entire tree and therefore counts made of the rings may differ slightly from one radius to the next. In addition, an estimate has to be made of how long it took the

tree to reach the height on its trunk where the count is being made. Given these types of variables, it is understandable why age determinations are only estimates, albeit good ones.

The annual rings are apparent in both a recently cut stump or a core removed from an intact trunk with an instrument known as an increment borer. The ring counts made on a stump are the most reliable, for variations in growth rate during the tree's early years can be observed. The core removed with an increment borer, however, can be interpreted and a fairly reliable estimate made without cutting down the tree.

Both methods are based on the nature of growth of a woody tree stem in an area that has cold winters. The giant sequoia is like the majority of trees in having three distinct layers of tissue in its trunk. These consist of an outer bark, the growing and dividing cambium layer just beneath the bark, and the wood that forms the major portion of the mature tree. The cambium is a layer only a few cells thick and less than 1/32 of an inch across that divides and produces bark to the outside and wood to the inside. This activity occurs on an annual basis.

As the increased day length and warm temperatures of spring affect the tree, cell division begins in the cambium layer. The wood cells toward the center of the tree are relatively large and the walls light in color. This early wood, as it is called, has relatively thin walls and produces the least dense wood. As the summer progresses and available water diminishes, the size of the wood cells decreases. Their walls are relatively thick and their color dark brown. This late wood production is finally terminated when the growing season ends. These two bands of cells constitute an annual ring. One ring is generally easy to distinguish from another because the light porous early wood of the new year abuts the dense dark wood of the preceding year. By measuring the distance between two such abutments the amount of annual growth can be determined.

The quality of the site where the tree grows greatly affects this radial growth rate. A tree six feet in diameter growing in a good site, one with summer and fall water supply, may be only a few hundred years old; while another sequoia, also six

feet in diameter, atop a dry ridge may be over 1000 years old. In general, however, giant sequoias from 100 to 800 years of age are a foot in diameter for every 100 years of age. In other words, a tree four feet in diameter will be 400 years old, one six feet in diameter 600 years of age.

Giant sequoias are not the oldest known living things but they are still among the ancient ones. To date, the bristlecone pines of the southwestern arid mountains are accepted as the oldest. Some of them live to be at least 4600 years of age and a few may reach 5000 years in their lifetimes. The oldest known giant sequoia is represented by a cut stump in the Converse Basin which, when the annual rings were counted, was determined to be at least 3200 years of age. Some may live to be 4000 years old as John Muir suggested from a count he made of a burned snag.

Naming the Giant Sequoia

The giant sequoia has been called a lot of different things. Three common names have often been used: big tree, Sierra redwood and giant sequoia. Lesser known common names include Wellingtonia, mammoth tree, and the distinctive Indian name Wawona. The latter name was best known throughout the world as the specific name of the famous tunnel tree in the Mariposa Grove. The Wawona Tree fell in the early months of 1969 but it is still an intriguing sight to see. The old specific name “gigantea” is occasionally used as a common name, but the technical or scientific name is now *Sequoiadendron giganteum*.

In contrast to the enduring nature of the tree itself, humans have debated over giving it a proper scientific name ever since its discovery. No less than 13 scientific names have been applied to this gigantic tree. Starting with *Wellingtonia gigantea* in 1853, it passes through or at least had a total of 11 other names proposed for it. The most famous scientific name was *Sequoia gigantea*. Its simplicity continues to appeal to many, and others are slow to leave it on technical grounds. However, *Sequoiadendron giganteum* is most generally accepted. Literally translated it means “the giant sequoia tree.”

It is clearly in the redwood family of conifers with the coast redwood as its clo-

Giant Sequoia

sest relative. Inasmuch as the coast redwood, *Sequoia sempervirens*, is also called a sequoia, the designation giant sequoia fits both the scientific name of the big tree and points to its close relationship to the coast redwood.

The name *Sequoia* was first applied to the coast redwood in 1847 by the Austrian botanist S. L. Endlicher. The term is probably a Latinized version of Sequoyah, the name of a remarkable Cherokee Indian who developed a written version of his people's language. Others contend, however, that sequoia was derived from the Latin "sequor" which means following, and could refer to the fact that the two sequoias of America are the remnants or followers of once widespread and numerous ancestors.

Comparison of the Giant Sequoia with the Coast Redwood

Although the coast redwood and giant sequoia are considered to be close relatives, there are numerous differences. In general, their similarities are: evergreen, cone-bearing, reddish fibrous bark, absence of resin cells, abundance of tannin, and reddish heartwood. The following chart expands on the similarities and differences between these two majestic trees.

		Giant Sequoia	Coast Redwood
Char- acte- ristic	Size	Mature trees 25-30' near base	Mature trees 12-18' near base
	Diameter	Base diameter up to 35'	Base diameter up to 23'
	Height	Up to 310'	Up to approximately 370'
	Age	Oldest known 3200 years Greatest reported age 4000 years	Oldest known 1400 years Greatest reported age 2000 years
	Bark	Rich cinnamon-brown color, deeply furrowed, as much as 2.5' thick at ridges, but generally 1-2' thick at base of large trees	Dull grey-red, shallowly fissured, 1/2 to 1 foot thick at base of trunks of large trees
	Leaves	Small awl-shaped 1/10 th to 1/2" long, appressed all around the stem; evergreen, falling with branchlets	Of two kinds, one resembling giant sequoia, others flat, needlelike in two rows; evergreen, falling with branchlets

Giant Sequoia

Continued

		Giant Sequoia	Coast Redwood
Char- acte- ristic	Roots	Spread to 150' from base of tree, most in upper few feet of soil	Spread to 50' from base of tree, in upper few feet of soil
	Burls	Few burls and when cut from tree will not grow leaves	When cut from tree will grow new leaves
Repr- oduc- tion and Growth	Cones	2-3" long, mature second season, may be retained green and growing for over 20 years, usually 34 scales arranged in spirals	About 1" long, mature and shed at end of first season, 14-24 scales arranged in spirals
	Seeds	In two rows on scales, average 200 per cone	In one row on scales, average 60 per cone
	Reproduction	Only by seeds	By seeds and by root or crown sprouts
	Shade Tolerance	Young trees not tolerant of shade	Young trees moderately tolerant of shade
	Neighbors	Usually in with other conifers	Often in nearly pure stands
	Chromosomes	22 per body cell	66 per body cell
Culti- vation and Comm- ercial	Commercial uses	Extensively used as an ornamental throughout temperate parts of the world Wood brittle in old trees but equal to coast redwood in young trees. Few downed trees being utilized	Extensively used as an ornamental throughout warmer parts of the world Wood noted for resistance to decay, much used in home and other construction

Giant Sequoia

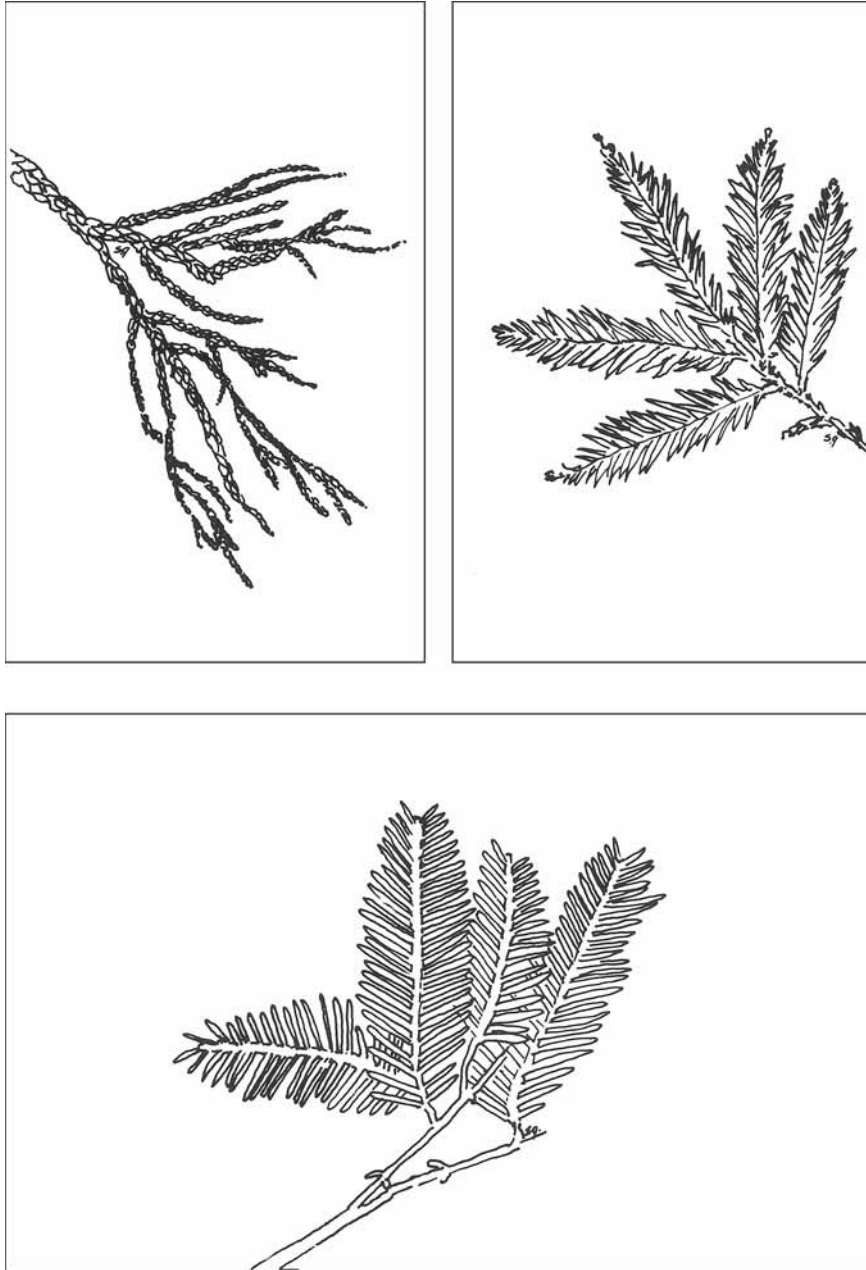


Figure 3. 23 Left up : Foliage of *Sequoiadendron giganteum*; Right up : Foliage of *Sequoia sempervirens*; Below : Foliage of *Metasequoia glyptostroboides*.

The Fossil Record and Other Redwoods

Among the conifers there is a family of trees known as Taxodiaceae, or redwoods. Once widespread throughout the world, most members have retreated to a few isolated parts of the Orient and the United States. Fifteen different species are currently recognized. Four species of the fifteen are found in the United States: The giant sequoia, the coast redwood, the southern, and the pond cypresses. The other trees of the family are mainly in China or Japan, and one interesting group is native only to Tasmania.

The redwood of China that is most closely related to the United States redwoods is called the dawn redwood (*Metasequoia glyptostroboides*). Scientists consider it to be the closest relative of the coast redwood and, in fact, was misidentified as that for many years by paleobotanists who examined fossil specimens. The closest relative to the giant sequoia is the coast redwood, so these three tree species-giant sequoia, coast redwood and dawn redwood-are most generally accepted as “the” redwoods.

Mankind has had a most fascinating association with the dawn redwood. As implied earlier, it was first found as a fossil in the rocks and was presumed extinct. This was in 1941 when Shigeru Miki, a Japanese paleobotanist, first gave the name dawn redwood to the species. Then startling news came from China in 1946. Tsang Wang, a Chinese forester, reported that the tree was alive and well in a remote deforested valley in Szechuan Province. Excited bontanists who rushed to the scene found several healthy trees. In 1948 the famed paleobotanist Ralph Chaney brought seeds from China, and many American communities are now graced with these pleasing relics of ancient days.

The dawn redwood has several distinct characteristics that distinguish it from the coast redwood. The most outstanding feature is its deciduous habit, for each autumn its needle-like leaves turn brown and fall. The coast redwood's species name is *sempervirens* which means “evergreen.” Individual leaves actually remain on the tree only three or four years, but the tree is green throughout its life. Both trees lose their leaves by having the branchlets fall rather than individual leaves.

Giant Sequoia

The leaves of the dawn redwood are two ranked (a row on each side of a branchlet) and opposite one another. The leaves of the coast redwood are also two ranked, but the leaves are alternate. This distinction carries over into the cones, where the cone scales are in opposite pairs in the dawn redwood but in spirals in the coast redwood. In its native haunts the dawn redwood may reach heights of 140 feet; while the coast redwood is the tallest of all trees, approaching 370 feet in height.

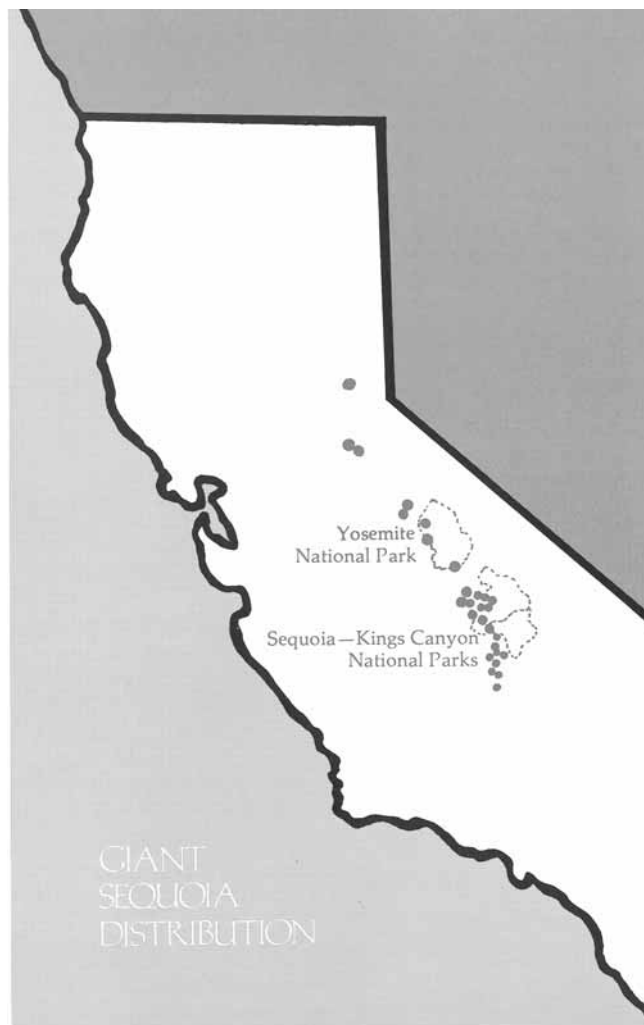


Figure 3. 24 Distribution map of Giant Sequoias in California.

Distribution of the Giant Sequoia

The entire native range of the giant sequoia is an area only 250 miles long by 15 miles wide on the western slope of the Sierra Nevada of California. Primarily found at elevations between 5000 and 7000 feet, the lowest elevation tree grows at 2800 feet and the highest at 8900 feet. Seventy-five groves are recognized by name throughout the range. The most northerly, the Placer County Grove, consists of only six trees growing at an elevation of 5250 feet. About 250 miles to the south is the Deer Creek Grove which was logged in part, but still has several large giant sequoias. Eight of the groves are in the northern 2/3 of the range and are relatively small in extent. The remaining 90% of the groves are in the southern 1/3 of the range and often contain thousands of large sequoias. The largest grove is the Redwood Mountain Grove of Kings Canyon National Park. Altogether the giant sequoia groves cover over 35000 acres, of which over 95% is in public ownership.

The fact that the giant sequoia occurs in distinct groves, some widely separated, has intrigued people since first it was noted. What could account for this disjunct distribution? John Muir was among the first to suggest that the most recent glaciers may have divided up a once continuous belt of sequoias. Others propose that a hotter, drier period in the Sierran climate 4000 to 5000 years ago eliminated sequoias except for those on moister sites. And finally there is the possibility that the giant sequoias migrated over the Sierran in different places and thus gave rise to separate groves or clusters of groves on the western slope. None of these ideas excludes the others, so it may well be that all three factors have operated either together or separately or at specific parts of the range during the past.

Although some of the groves appear to be in a healthy condition and have enough young trees to replace the old ones when they die, many small groves lack adequate replacements. The factors that contribute to this situation are no doubt numerous and complex, but one common feature of these non-reproducing groves is the absence of fire. Although fire may kill most trees, the giant sequoia actually is favored by fire of the proper intensity and frequency.

Giant Sequoia Ecology and Life History

Ecology, the study of the interdependence of living things and their environments, yields an understanding of the giant sequoia's place in nature. Its story is one of survival in the face of disasters which would destroy other, lesser trees. This mammoth tree is faced, as are all other living things, with crucial periods in its life history. From struggling seedling to aged giant, the tree is confronted with adverse forces. The seedling just emerging from the forest floor may die aborning as it lifts its first leaves to the summer sun. Forest insects such as camel crickets or caterpillars may chew off the leaves or girdle the diminutive stem. Heat cankers may dry and kill the stem attack the roots. And the greatest of all destructive forces—drought—may cause the roots and leaves to wither and the young seedling will die.

Those seedlings that circumvent all the above hazards may then start a living journey that can last over 3000 years. Up until about 400 years, however, death rates are high. Drought and other factors that adversely affected them as seedling are still present, but shading from adjacent trees starts to take the greatest toll. Giant sequoias require abundant light. If the tree grows where less than 1/4 of full sunlight falls upon it, then the young tree is in trouble. Later on, an older tree can compensate for shade. Only the lower branches will be lost on a giant with its top above the rest of the forest and this loss of lower branches enables such a tree to withstand one of the scourges of the forest-fire.

The giant sequoia quickly grows an unusually thick bark that insulates the living tissue beneath the bark from the heat of fire. This, coupled with shade-killed branches that drop, enables older trees to withstand all but the worst holocausts. The bark on a mature sequoia is often a foot in thickness near the base of the tree, and may reach two and one-half feet on exceptional specimens. It is thick enough on trees only a hundred years old to allow them to withstand a fire that kills adjacent white fir.

Fire, to which the giant sequoia is tolerant, also aids in the trees' reproduction. Fire sweeps the forest floor clean so that the minute seeds of the giant sequoia may come to rest on rich mineral soil where seedlings do best. Although the seeds can

germinate in the fallen branches and leaves on the forest floor, the seedlings often die because any of the several factors discussed earlier are more prevalent in the organic litter. In addition to those factors, however, is the threat of disease organisms in the soil and litter in areas not cleared by fire. Particularly hot fires sterilize the soil and make it easier for young roots to penetrate quickly to life-sustaining moisture.

In order to open and shed seeds, giant sequoia cones must be completely dry. Fire causes hot drying air to rise and open up the closed sequoia cones high in the air. The resultant shower of seeds falls on a favorable seedbed prepared by the same fire. Thus, at practically all stages in its life history, the giant sequoia either tolerates or is favored by fire. It does not depend only on fire, however, for regeneration.

The giant sequoias shed seeds throughout the year which, if they fall on exposed soil, may produce new trees. One of the major factors in turning up new soil is the falling of trees. As their roots are pulled from the earth, the pit that remains provides a suitable substrate for seedling sequoias. John Muir once suggested that just the falling of giant sequoias would provide enough suitable soil for young sequoia trees. When large forests are examined for such replacement, however, there are too few seedlings in the pits to replace all the trees that have fallen; so the idea, while intriguing, is unproven.

The seeds that fall without the aid of fire come mainly from two sources. The Douglas squirrel eats the cones of pines and firs as well as sequoias. The difference is that while it eats the actual seeds of pines and firs, it prefers the fleshy cone scales of the giant sequoia cones. Though a few seeds are eaten, most fall to the ground.

The second source of seeds is due to the action of a minute beetle. This small long-horned beetle attacks the giant sequoia cones in search of food. Although it may destroy a few seeds, the beetle generally tunnels through the central axis of the cone. By so doing, the transport of water to the cone is severed and the cone dries out. As the cone dries, the cone scales separate and the seeds are set free. Inasmuch as a mature tree may add 1500 cones a year, and there are about 200 seeds per cone, there is a tremendous seed source available for release by the action of the Douglas squirrel and this beetle.

Giant Sequoia

Many other insects interact with the tree in addition to the beetle. Over 140 insect species have been found to depend directly or indirectly on the giant sequoia. They may live their entire lives on one vast branch high in the air. Most are remarkably small and are foliage colored insects, so that they escape notice. A small green aphid may occur in the tens of thousands feeding on juices in the foliage. In turn, it is fed upon by voracious larvae of the green lacewing, which fall prey to robber flies; these are consumed by flycatchers, which subsequently are eaten by hawks. Thus, the chain of life is linked from the grand food producer, the giant sequoia, to the ultimate consumer, the carnivorous hawk.

As dramatic as the predator food chain may be, it is more than offset by the slow, quiet decomposition of leaves and wood produced by the giant sequoia. Each year the leaves and twigs fall to the ground to be consumed by the unseen bacteria and fungi in the forest floor. Each year giant sequoias fall and though it may take many centuries they, too, will be consumed in the subtle process of decay, the major process of the forest.

A Monument to Survival

The giant sequoia stands supreme among the green plants-in fact, among all living things in that it is the largest of them all. It towers above its neighbors with a quiet majesty, a majesty born of the centuries of survival when others failed. It stands with solid grandeur on dry mountain slopes and moist meadow borders. It is the first to greet the morning sunrise and the last to witness the sunset. The giant sequoia persists even though numerous forces drive it toward extinction. It survives because it has adjusted to the present adversities and holds claim on the future. A single tree in its lifetime will spill millions of seeds with the humble objective of replacing only itself. If conditions are right it will do more than that, and those who appreciate great trees will look upon these survivors and find them good.

Giant Sequoia

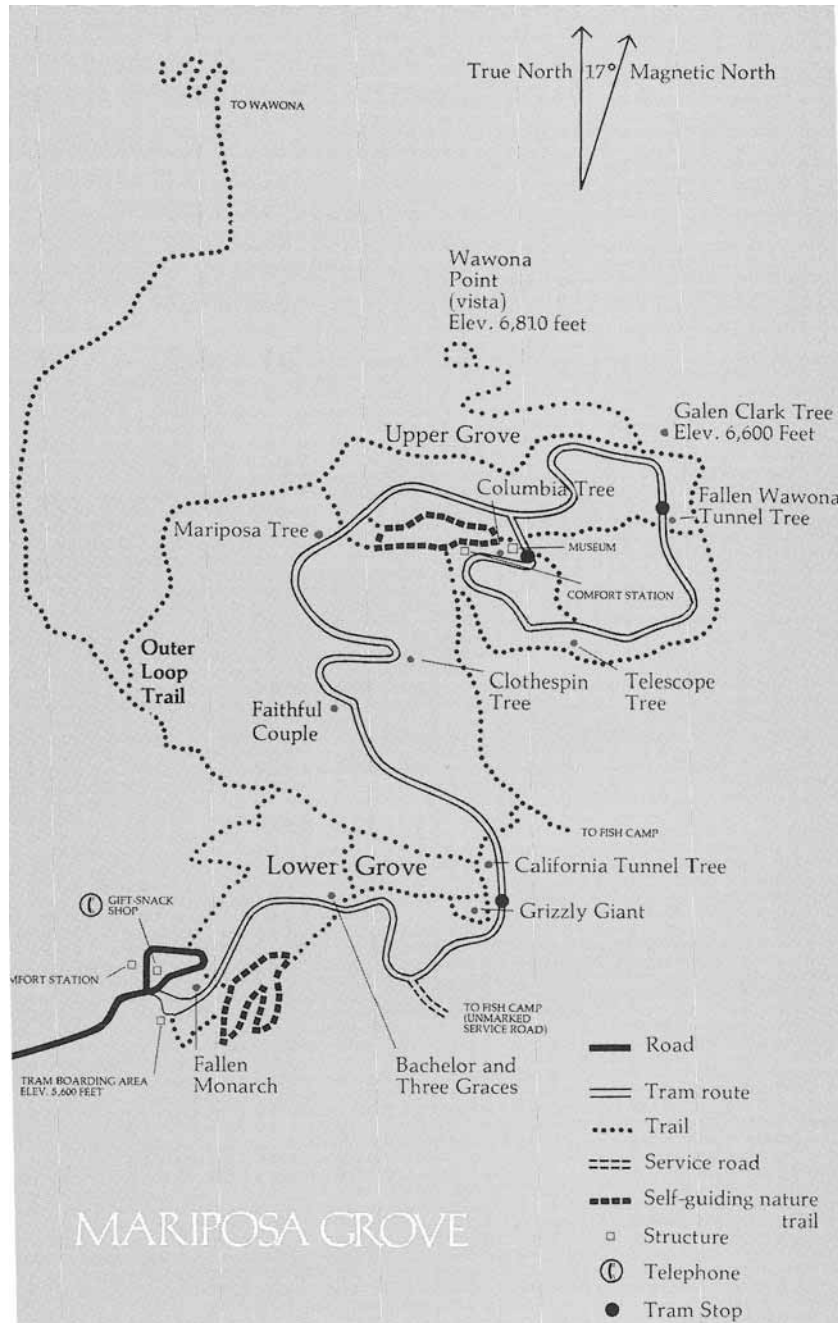


Figure 3. 25 Map of grove with these trees located and tram stops shown.

What to See and Do in the Mariposa Grove

The Mariposa Grove, located near the south entrance of Yosemite National Park, can be reached by traveling north on Highway 41 from Fresno or by going south on the park road from Yosemite Valley. About two miles east of the south entrance, these magnificent trees first come into view. Their rusty brown bark contrasts starkly with the dull grey of adjacent species. After parking in the lot near the entrance to the grove, you may either walk the trail-including the two posted nature trails-or ride the tram that operates during the summer months. The tram operators provide a running commentary on the grove, stopping at various viewpoints where you may disembark and walk to other points of interest in the grove. The map on Figure 3.25 shows the locations of these various points of interest and sequoias with special attributes that are described below.

The Fallen Monarch- This tree is remarkable for it fell long ago and remained almost entirely intact. Old growth giant sequoias are noted for their brittle wood, a factor that reduced their value for lumber. In fact, the wood was generally cut into fairly small pieces, and many of the grape stakes in San Joaquin Valley vineyards are giant sequoias. The Fallen Monarch is a little over 15 feet in diameter at 10 feet above the base. The sapwood and bark have long since decayed, but were they placed back on the tree the diameter would probably be an impressive 18 feet. Giant sequoia heartwood is slow to decay, and remnants of trees measured by radio-carbon dating have yielded specimens up to 2000 years old. At various times in the Fallen Monarch's history, stagecoaches were driven on the trunk and stairs provided access to the upper side. Walking along side this fallen giant, contemplating how long ago it once stood, is still a most impressive experience. The fir tree leaning over its upper section suggests the great tree fell at least several hundred years ago.

The Corridor Tree- This unusual specimen testifies to the endurance of the giant sequoia. Repeated fires and possible decay have eaten away at the base creating gaping holes large enough to walk through. The remaining flying buttresses show regrowth of new wood starting to fill in the gaps. The buttresses also continue to sup-

port a tree of grand proportions: almost 250 feet tall and 15 feet in diameter at 10 feet above the ground.

The Three Graces-These three well-named trees are an excellent example of the giant sequoia's capacity to grow to great size in close proximity. Frequently, groups of five to ten trees grow within 50 feet of one another. What would ordinarily be competition between individuals is resolved by cooperation. The roots of the trees fuse together and support one another rather than remain independent. The Three Graces probably are the survivors of a once dense stand of giant sequoias that seeded in after a fire many centuries ago.

All of the Three Graces are over 200 feet tall, with the tallest one nearly 260 feet in height. To see these trees highlighted by the morning sun is one of the many unexpected treats the Mariposa Grove offers.

The Grizzly Giant-This rugged tree is the largest and oldest tree in the Mariposa Grove. Although it is only a little over 200 feet tall, its massive trunk rises impressively in an almost straight column. The great column, nearly 31 feet across at the base, tapers to about 16 feet in diameter at 60 feet above the base, and is still over 13 feet across at 120 feet above ground level. The first large limb at 95 feet above the ground is 6 feet in diameter. Many of the trees near the Grizzly Giant are not equal to just this one branch.

The Grizzly Giant has endured many centuries of Sierran storms and the impact of human activity. The first roads in the area went right over the roots of the great giant. Well-meaning people employed barriers of all sorts to keep other people away from the base of the tree. They dug fence holes that severed the roots, as did holes for the shrubs planted in 1930 to conceal barbed wire strewn around the base of the trunk. Through all these indignities, the noble tree has survived and is growing well. Its estimated age is between 2500 and 3000 years.

The California Tree-The past propensity of people to cut tunnels through large trees is apparent in this tree. The tunnel was cut through in 1895, 14 years after the famous Wawona Tree was tunneled. When winter snows blocked the stagecoach road to the upper grove where the Wawona Tree is located, clever drivers placed the

Wawona Tree sign at the California Tree. Thus, for many years it served as a substitute until the road was relocated in 1932. The old road now serves as a footpath and you can view up close the gradual healing of the great wound.

The California Tree is slightly over 230 feet tall and has a diameter of almost 15 feet at 10 feet above the ground. As with the Wawona Tree, burn scars were enlarged to make the tunnel in the California Tree. It is located about 100 yards northeast of the Grizzly Giant.

The Faithful Couple-The name Faithful Couple is an apt one for these two trees that have grown closer together through the years. Even more than the Three Graces, these trees exhibit the ability of giant sequoias to graft to one another. Though many trees in the forest can do this, the naturally great size of the giant sequoia makes it a particularly striking sight. The combined trunk is nearly 40 feet in diameter near the base and the twin columns reach almost 250 feet high.

The Mather Tree-At the bend in the road uphill from the Faithful Couple stands a relatively young giant sequoia named after Stephen T. Mather, the first Director of the National Park Service. Mather served from the establishment of the Park Service in 1916 until 1929. As a Californian, it is appropriate that he be honored with one of the California's biggest trees.

The Mather Tree is a good example of the giant sequoia's younger growth form called a spire-top. This sharply pointed outline results from the rapidly growing tip which is exceeding the lateral, spreading growth. Trees with this growth habit are identified as excurrent, while those in which all the terminal shoots grow at the same rate are called decurrent. An oak tree is a good example of the latter type, which accounts for the rounded profile of these trees. The rapid vertical growth of the giant sequoia generally assures it ample sunshine. It would soon die if forced to live too long in the shadow of other trees, for the giant sequoia cannot tolerate shade.

The Clothespin Tree-Repeated fires have consumed the base of this tree so that it resembles an old-fashioned clothespin. At 10 feet above the ground the tree is 16 feet across and it towers to almost 270 feet in the air. The gaping wound is 70 feet high and 16 feet across at the base. Although fire appears to be the major factor that crea-

ted the opening, fire has not killed the tree. Even though the majority of the original connections between roots and stem have been severed, the Clothespin Tree is in apparent good health and produces cones in adequate numbers.

The Mariposa Tree- This tree is another fine specimen standing about 250 feet tall and a magnificent 17 1/2 feet in diameter at 10 feet above the ground. Not only is the tree magnificent, but it demonstrates rather well how new growth of wood and bark gradually heal fire scars. Notice how this new growth from the sides of the tree where living tissues still survive is beginning to cover the old wound.

The tree as well as the grove was named after the famous gold rush county of Mariposa to the west of Yosemite National Park; the grove lies within Mariposa County. The county took its name from a stream that the early Spaniards had called Las Mariposas, meaning "the butterflies."

Throughout this paper we have been comparing sizes of the giant sequoias. Meaningful measurements of giant sequoia diameters however, can be difficult to make. The difficulty arises from the inconsistency of the bulge, or butt swell, at the bases of large trees. Standard forest practice is to measure at 4 1/2 feet, which is called the dbh (for diameter at breast height), but measuring large giant sequoias at breast height generally would include the butt swell. Therefore, in order to somewhat standardize diameter measurements for better comparison, Mariposa Grove diameters have been made at 10 feet above the ground.

Big Trees Lodge Area-The large relatively level area to the north of the road was the former site of the Big Trees Lodge built in 1933 to provide meals and lodgings to Park visitors. To reduce development and resource impact in the Mariposa Grove the lodge structure was razed in 1982. The presence of mineral soil, adequate sunshine and moisture on this disturbed site probably accounts for the large number of young sequoias in this area. On close inspection of their foliage, you can see and feel the sharp awl-shaped leaves. If a branch from a large tree is available, compare its leaves with those of trees just a few decades old.

The Elephant's foot-This fallen sequoia reveals an unexpected attribute of these gigantic trees; They lack a tap root. The largest of living things stands much like a

nail on its head. Shallow, widespread roots are a necessary adaptation to the thin soils of the mountains, and giant sequoia roots are usually only in the top few feet of the soil. The roots from some trees reach out over 150 feet from the base, enabling the tree to absorb adequate soil moisture for growth when it is available. When a tree falls over, it exposes this shallow disk of roots, as in the Elephant's Foot.

The Sunset Tree-Behind the Lodge stands a giant sequoia that has been battered by the elements. At its base a fire scar stretches over 50 feet of the perimeter, heavy scarring even for a giant sequoia. Such a massive severance of the water transport connections between roots and trunk causes the upper branches and leader to die, so that many old sequoias exhibit a snag-top growth form. Inevitably, fallen wood will accumulate at the base of an old tree, and when fire strikes it burns this ready fuel source especially hot.

The Sunset Tree was named because it stands on the western edge of the grove and is the last to be lit by the setting sun. Through only a little over 200 feet high, the Sunset Tree is a robust 17 feet in diameter at 10 feet above the base.

The American Legion Tree-This tree was dedicated to the unknown dead of the First World War in 1921. It is another good example of a forest veteran that has survived fire and storm and continues to put out new leaves and cones each year. A tree of fairly remarkable dimensions, it is over 18 feet in diameter at 10 feet above the mean base and 250 feet tall.

The Haverford Tree-Because the cavernous central cavity is large enough to shelter horses, in early stage coach days the tree was known as the Shelter Tree. Old reports say as many as fifteen horses found shelter during stormy weather in the almost 30 square foot cavity. At 270 feet, it is one of the taller trees in the grove and is a respectable 16 1/2 feet in diameter at 10 feet above the ground.

The Museum-Galen Clark was so impressed with this idea of the grove that he built his cabin at the present museum site in 1861. This cabin was replaced by another in 1885, which was enlarged in 1902. This structure was rebuilt in 1930 and now serves as the Park Museum for the Mariposa Grove. Exhibits inside the present Museum tell the story of the giant sequoia ecosystem. During the summer a naturalist

is there to help interpret the area. Take a few minutes to sit on the porch and contemplate what it must have been like over a hundred years ago when Clark lived in this remote mountain haven with these magnificent trees in his front yard.

The General Grant Tree-Directly in front of the museum porch is a fine specimen of the giant sequoia. It bears the name of General Grant, but do not confuse it with the General Grant Tree of King Canyon National Park. The latter, also known as the Nation's Christmas Tree, is about 255 feet tall and has a dbh of almost 29 feet, making it the second largest giant sequoia. The General Grant Tree in Mariposa Grove is about 270 feet tall and has a diameter at 10 feet above the base of almost 14 feet. Scientists use total trunk volume to determine largeness, and while there is no figure on the Mariposa Grove General Grant, the Kings Canyon General Grant has a volume of 47, 500 cubic feet.

The General Sherman Tree-To the left of the General Grant Tree is the splendid General Sherman Tree. It, too, towers to almost 270 feet and is about 13 1/2 feet in diameter at 10 feet above ground level. Again, do not confuse this with the largest tree in the world by trunk volume is 275 feet tall and has a dbh of 25 feet. Its trunk volume of nearly 51, 000 cubic feet has earned it the title of the largest living thing in the world, past or present.

The Fallen Giant-This fallen Giant sequoia was intact until cut in 1934 during rerouting of the road. The cut enables one to see the dark exudate that coats the cut surfaces. When oxidized the exudate changes from a reddish substance to a very dark purple. Many different chemicals are in the exudate and they serve to make the heartwood relatively resistant to decay. Eventually the chemicals break down and the wood will decay, although it may take many centuries. The sapwood, the light colored wood three to four inches thick forming an outer cylinder, is without the reddish chemicals. This wood decays rather quickly on fallen logs, sometimes within a few decades. The Fallen Giant, which toppled in 1873, has lost its sapwood to decay and only the heartwood remains.

The Columbia Tree-Looking west from the Museum beyond the Fallen Giant and to the right of the road are three giant sequoias. The largest one with an inverted

V-shaped fire scar is the tallest sequoia in the grove. The Columbia tree is almost 290 feet in height and about 16 1/2 feet in diameter at 10 feet above the ground.

In other groves, giant sequoias sometimes reach heights of 310 feet. This upper limit to growth seems due in large part to problems of water supply to the top branches. Although 50 to 60 inches of rain fall each year in the giant sequoia belt, it is essentially a rainless place during the late summer and fall. This period of drought places a stress on the upper branches, slowing their growth. Then, if fires sever root connections, some top branches will die to produce a snag-topped tree.

The Four Guardsmen-A short walk to the west of the Museum four giant sequoias stand in a row. All of them are over 200 feet in height and they are between 8 1/2 and 10 1/2 feet in diameter at 10 feet above the ground. How did this interesting pattern develop? There are several possible explanations for trees growing in a straight line.

In a very wet climate where fires seldom clear the forest floor, a fallen tree in the process of decay may serve as a seedbed. Such trees are called "nurse trees" as they sustain young seedlings with their decomposing trunks until the seedlings' roots reach the mineral soil. But in a relatively dry climate such as the Sierra, fire may entirely consume a fallen tree and thus prepare a linear seedbed. Seedlings of giant sequoias survive best in soils that are heated the hottest. Thus, this latter explanation perhaps best explains the Four Guardsmen as they stand at attention all in a row.

The Fallen Utah Tree-Giant sequoias die for a variety of reasons. Some die standing while many large ones topple over. The factors that lead to their fall vary and are not always operating singly. Lack of sufficient root support is the basic problem, although a few have their trunks snap several feet above the ground. Factors involved in making insufficient root support and ultimately falling are fire scars, decayed roots, carpenter ant galleries, undercutting by streams, extreme heavy loading by snow and ice, strong winds, or a combination of several of the above. Most giant sequoias with fire scars fall toward the side with the scar. Most sequoias adjacent to wet meadows fall toward the meadow. Most sequoias fall in the winter or early spring when storms and wet soil are the final factor in their failure.

The Utah Tree fell at 7:00a. m. on April 7, 1935, a few days after a wind storm. It fell on a calm day. We believe, however, that the storm weakened its support. Further, a wind storm tends to dry out leaves. As water was carried back to the leaves, it may have ascended unevenly creating an unbalanced upper portion.

As with many plants, even though they have not lost root connections to the soil, parts of them can remain alive. So it was with the Utah Tree that had green foliage on three years after it fell.

The Fallen Stable Tree-This grand old tree fell to its death the year before the Utah Tree succumbed. Fire had previously destroyed the wood in much of the base so that's its name implies, it had been used as a stable. When it fell, it broke into three main sections, a common occurrence with old growth giant sequoias as they are noted for their brittle wood. As with the Utah Tree, it, too, had new shoots growing two years after its fall. Though the date of falling technically may not be the date of death for a tree, unless some root connections remain intact, the tree is as good as dead.

An interesting aside is that a small (approximately two foot dbh) sequoia in the Atwell Mill Grove fell several years ago, but the roots remained connected with the stem. The living branches subsequently grew skyward and at present look like a line of miniature trees.

The Fallen Massachusetts Tree-This fallen mammoth must have been a tremendous sight to see before it fell in the spring of 1927. Once it was one of the largest trees in the grove at 28 feet in diameter at 10 feet diameter at 10 feet above the ground and an estimated 280 feet in height.

In addition to loss of support due to fire and decay, road construction in the 1870's had severed its roots. Then a spring storm dumped a heavy load of snow on the Massachusetts Tree and that was the final straw. In falling, it broke into many sections on hilly land.

The Telescope Tree-To understand how this tree got its name, you have to walk inside it. There you can see it has a hollowed-out center so that you can look up through it and see the sky above. The Processes that probably produced this phenom-

enon were heart rot followed by fire. Although the heartwood of a giant sequoia resists decay fairly well, the older heartwood, i. e., that nearest the center, becomes less resistant with the passage of time. Once decay had decreased the density of the central heartwood, a fire starting at the base or possibly from the top due to lightning, could burn out the center of the tree. Repeated fires probably were necessary to create the size of cavity that is now evident in the Telescope Tree. About half the basal perimeter has been destroyed by fire, but the outer shell of the tree consists of the three vital layers for any tree-the bark, the growing cambium, and the sapwood.

The Telescope Tree is only about 190 feet tall and 16 1/2 feet in diameter at 10 feet above the ground. It probably was well over 200 feet tall before it was covered into a hollow cylinder and lost much of its top. Through it all, however, the tree survives.

The Fallen Wawona Tree (Tunnel Tree)-Undoubtedly, the most famous, widely known tree in the world is the Wawona Tree. From 1881 when the tunnel was first cut, until 1969 when it fell, hundreds of thousands of people traveled from over the world to the tree that you could drive through. Although other sequoias have been tunneled, the Wawona Tree was preeminent. The Scribner brothers cut the tunnel in 1881 for only \$75. They selected a large tree (its diameter was almost twenty feet at ten feet above ground level, and it was 235 feet tall) with large burn scars. The tunnel was 26 feet long, 8 feet wide and 10 feet high.

In the heavy winter of 1968 ~ 1969, the most famous tree in the world fell, probably in part due to massive tunnel through its base. It had survived an estimated 2200 years. Perhaps the fact that it served to bring countless thousands to the Mariposa Grove and that perhaps in their pilgrimage they also found the deeper values of a forest of uncut giant trees offset the tragedy of its death.

The Galen Clark Tree-Although not a particularly large giant sequoia (about 15 1/2 feet in diameter at 10 feet above the base and 240 feet tall) the Galen Clark Tree is unusual on several counts. It is unusually free of fire scars, possibly because it is near the top of the ridge where little fuel may roll down hill and lodge against the tree. Its silvery appearance is striking. And it is likely the first tree that Galen Clark saw because he first entered the grove from the north.

Giant Sequoia

It is fitting that we end this narration with the Galen Clark Tree. Galen Clark, more than anyone else, first brought people to witness the giant sequoias of the Mariposa Grove. He chose to live alone among them, and it is likely that he saw them all as individuals and grew to know them well, almost as friends. Just as the bark on the tree named on his honor is an unusual silvery color, so each tree has something unique about it. And yet each one stands in quiet dignity, sharing a special nobility that transcends even their size, the nobility of true monarchs.

索引 (Index)

1. 水杉 (Dawn Redwood)

中国古水杉考察记 (Three Recent Expeditions to the Ancient Dawn Redwood)

<i>Latin Name</i>	<i>English Common Name</i>	<i>Chinese Common Name</i>
<i>Actindia sp.</i>		
<i>Akebia trifolia</i>		三叶木通
<i>Arhraxon sp</i>		葶草
<i>Begonia sp</i>		塑料秋海棠
<i>Berberis julianiae</i>		小檗
<i>Berchemia sp</i>		勾儿茶
<i>Camellia cuspidata</i>	Sharp leaf camellia	尖叶山茶
<i>Camiellia chinensis</i>	Sharp leaf camellia	中华槭
<i>Castanea seguinii</i>	Seguin chestnut	茅栗
<i>Cephalotaxus fortunei</i>		三尖杉
<i>Clematis sp.</i>		铁线莲
<i>Cotoneaster divaricatus</i>	spreading cotoneaster	散生栒子
<i>Cunninghamia , lanceolata</i>	Chinese Fir	杉木
<i>Elaeagnus bockii</i>		长叶胡颓子
<i>Epimedium sagittatum</i>		淫羊霍
<i>Eurya hebeclados</i>	Downybranched eurya	微毛翎
<i>Evonymus alatus</i>		
<i>Ficus heterophylla</i>		异叶榕
<i>Gonostegia hirta</i>		糯米团
<i>Hedera nepalensis var. sinensis</i>		长青藤
<i>Impatiens sp</i>		黄金风
<i>Iris japonica</i>	Japanese Iris	蝴蝶花

<i>Kameris sp.</i>		三脉马兰
<i>Lindera glauca</i>	greyblue spicebush	胡椒
<i>Liquidambar formosa</i>	Formosa sweetgum	枫香
<i>Liriope sp.</i>		土麦冬
<i>Lonicera pileata</i>	privet honeysuckle	蕊帽忍冬
<i>Onychium japonicum</i>		乌蕨
<i>Ophiopogon sp.</i>		沿阶草
<i>Out floor some Smilax sp.</i>		菝葜
<i>Oxalis sp.</i>		酱草
<i>Parathelypteris nipponica</i>		日本金星蕨
<i>Phegopteris decurtivepinnata</i>		延羽卵果蕨
<i>Phoebe hunanensis</i>	Hunan phoebe	湘楠
<i>Phyllostachys bambusoides</i>	giant timber bamboo	桂竹
<i>Pilea sp.</i>		冷水花
<i>Pittosporus schniahum var. glabratum</i>		崖花海棠
<i>Rhododerdron sp.</i>		杜鹃
<i>Rose sp.</i>		
<i>Rubus flageliflorus</i>		少花乌泡
<i>Smilax sp.</i>		菝葜
<i>Spiraea chinensis</i>		中华绣线菊
<i>Spiraea glauca var. fortunei</i>		光叶绣线菊
<i>Toxicodendran succedaneum</i>	Wax Tree	野漆树
<i>Trachycarpus fortunei</i>	Windmill Palm	棕榈

2. 海岸红杉 (Coast Redwood)

海岸红杉林的乔灌木和花草 (Trees, Shrubs and Flowers of the Coast Redwood Region)

Latin Name	English Common Name	Chinese Common Name
<i>Acer macrophyllum</i>	Big-leaf Maple	大叶枫

<i>Adiantum aleuticum</i>	Five-Finger Fern	五指蕨
<i>Adiantum jordanii</i>	California Maidenhair	
<i>Alnus rubra</i>	Red Alder	红赤杨
<i>Anemone deltoidea</i>	Glade Anemone	三角叶银莲花
<i>Arbutus menziesii</i>	Pacific Madrone	浆果鹃
<i>Asarum caudatum</i>	Wild Ginger	尾状细辛
<i>Athyrium filix-femina</i> var. <i>cyclosorum</i>	Lady Fern	淑女蕨
<i>Ceanothus thyrsiflorus</i>	Blue Blossom	兰花朵朵
<i>Clintonia andrewsiana</i>	Clintonia	加州七筋菇
<i>Cornus sericea</i>	Creek Dogwood	加州四照花木
<i>Cornus nuttallii</i>	Western Dogwood	西四照花木
<i>Dicentra formosa</i>	Bleeding Heart	美丽荷包牡丹
<i>Dryopteris arguta</i>	California Wood Fern	加州木蕨
<i>Gaultheria shallon</i>	Salal	沙龙白珠树
<i>Heuchera micrantha</i>	California Alum Root	
<i>Lysichiton americanum</i>	Skunk Cabbage	臭菘
<i>Maianthemum racemosum</i>	Fat Solomon	肥鹿药
<i>Maianthemum stellatum</i>	Slim Solomon	索罗门鹿药
<i>Notholithocarpus densiflorus</i>	Tan Oak	密花石柯
<i>Oxalis oregana</i>	Redwood Sorrel	奥立岗延龄草
<i>Pentagramma triangularis</i>	Gold Fern	金蕨
<i>Polypodium glycyrrhiza</i>	Licorice Fern	欧洲蕨
<i>Prosartes smithii</i>	Fairy Lantern	斯密思万寿竹
<i>Pseudotsuga menziesii</i>	Douglas-fir	花旗松
<i>Pteridium aquilinum</i>	Bracken Fern	欧亚甘草蕨
<i>Quercus garryana</i>	Oregon Oak	奥立岗白栎
<i>Quercus kelloggii</i>	Black Oak	黑栎
<i>Rhododendron macrophyllum</i>	Rhododendron	太平洋杜鹃
<i>Rubus spectabilis</i>	Salmonberry	橙色悬钩子
<i>Sequoiadendron giganteum</i>	Giant Sequoia	巨杉
<i>Tiarella trifoliata</i> var. <i>unifoliata</i>	Sugar Scoop	糖黄水枝

<i>Tnillium ovatum</i>	Coast Trillium	奥立岗延龄草
<i>Umbellularia californica</i>	California Laurel	加州州桂
<i>Vaccinium ovatum</i>	California Huckleberry	加州卵叶越桔
<i>Vancouveria planipetala</i>	Inside-out Flower	翻转花
<i>Viola glabella</i>	Pioneer's Violet	先锋紫萝兰

3. 巨杉 (Giant Sequoia)

巨杉林 (The Giant Sequoia Redwood Forest)

Latin Name	English Common Name	Chinese Common Name
<i>Abies concolor</i>	White Fir	白冷杉
<i>Abies magnifica</i>	Red Fir	加州红冷杉
<i>Arbutus menziesii</i>	Pacific Madrone	浆果鹃
<i>Arctostaphylos patula</i>	Manzanita	熊果树
<i>Calocedrus decurrens</i>	Incense Cedar	北美翠柏
<i>Cornus nuttallii</i>	Mountain Dogwood	山四照花
<i>Erysimum capitatum</i>	Western Wallflower	糖芥
<i>Iris hartwegii</i>	Hartweg's Iris	鸢尾
<i>Notholithocarpus densiflorus</i>	Tan Oak	密花石柯
<i>Lotus crassifolius</i>	Buck Lotus	
<i>Pinus contorta var murrayana</i>	Lodgepole Pine	扭叶松
<i>Pinus lambertiana</i>	Sugar Pine	糖松
<i>Pinus ponderosa</i>	Ponderosa Pine	西黄松
<i>Pseudotsuga menziesii</i>	Douglas Fir	花旗松
<i>Quercus kelloggii</i>	California Black Oak	加州黑橡树
<i>Rhododendron macrophyllum</i>	California rose-bay	加州杜鹃
<i>Sarcodes sanguinea</i>	Snow Plant	雪植
<i>Sequoiadendron giganteum</i>	Giant Sequoia	巨杉
<i>Taxus brevifolia</i>	California Yew	加州短叶红豆杉
<i>Umbellularia californica</i>	California Laurel	加州桂
<i>Veratrum californicum</i>	Corn Lily	

4. 苔藓 (Moss)

海岸红杉林中的苔藓 (Mosses of the Coast Redwood)

Habitat-based Classifications

Moist logs and highly organic , mostly Shaded Soils :

Buckiella undulata

Calypogeia muelleriana

Conocephalum conicum

Dicranum howellii

Marchantia polymorpha

Pellia neesiana

Plagiothecium denticulatum

Tetraphis pellucida

Dry logs and coniferous tree trunks :

Aulacomnium androgynum

Dicranoweisia cirrata

Hypnum circinale

Lepidozia reptans

Mineral soil of trail and streambanks :

Atrichum selwynii

Bryum pseudotriquetrum

Campylopus introflexus

Cephaloziella turneri

Didymodon vinealis

Ditrichum ambiguum

Epipterygium tozeri

Gyrothya underwoodiana

Isothecium stoloniferum

Lunularia cruciata

Pogonatum contortum

Pohlia nutans

Pseudotaxiphyllum elegans

Solenostoma rubrum

Weissia controversa

5. 蘑菇 (Mushroom)

可食用和药用蘑菇 (Edible and Medicinal Mushrooms)

海岸红杉林生态系统 (Coast Redwood Ecological System)

Latin Name	English Common Name	Chinese Common Name
<i>Agaricus arvensis</i>	Horse Mushroom	野蘑菇
<i>Agaricus augustus</i>	The Prince	大紫蘑菇
<i>Agaricus bisporus</i>	Button Mushroom	双孢蘑菇, 白蘑菇
<i>Agaricus campestris</i>	Meadow Mushroom	草地蘑菇
<i>Agaricus subrutilescens</i>	Wine-Colored Mushroom	紫红蘑菇
<i>Aleuria aurantia</i>	Orange Peel Fungus	桔皮盘菌
<i>Armillariella mellea</i>	Honey Mushroom	蜜环菌
<i>Auricularia auricula</i>	Wood Ear; Tree Ear	木耳
<i>Boletus aereus</i>	Queen Bolete	皇后牛肝菌
<i>Boletus appendiculatus</i>	Butter Bolete	奶油牛肝菌
<i>Boletus edulis</i>	King Bolete; Cep; Porcini	美味牛肝菌
<i>Boletus zelleri</i>	Zeller's Bolete	黑蓝红柄牛肝
<i>Cantharellus cibarius</i>	Chanterelle	鸡油菌
<i>Cantharellus subalbidus</i>	White Chanterelle	白鸡油菌
<i>Cantharellus tubaeformis</i>	Funnel Chanterelle	黄腿鸡油菌
<i>Clitocybe nuda</i>	Blewit	
<i>Coprinus comatus</i>	Shaggy Mane	鸡腿菇

<i>Craterellus cornocopioides</i>	Horn of Plenty	灰号角
<i>Cryptoporus volvatus</i>	Cryptic Globe Fungus; Veiled Polypore	隐孔菌
<i>Dentinum repandum</i>	Hedgehog Mushroom	刺猬菌
<i>Fistulina hepatica</i>	Beefsteak Fungus; Ox Tongue	牛舌菌
<i>Flammulina velutipes</i>	Velvet Foot	金针菇
<i>Ganoderma applanatum</i>	Artist's Conk	树舌灵芝
<i>Ganoderma oregonense</i>	Varnished Conk	奥立岗灵芝
<i>Ganoderma tsugae</i>	Varnished Conk	松杉灵芝
<i>Gomphus clavatus</i>	Pig's Ears	陀螺菌
<i>Grifola frondosa</i>	Hen of the Woods	灰树花
<i>Hericium abietis</i>	Conifer Coral Hericium	冷杉猴头菌
<i>Hericium coralloides</i>	Coral Hericium	珊瑚状猴头菌
<i>Hericium erinaceus</i>	Lion's Mane Hericium	猴头菌
<i>Hericium ramosum</i>	Comb Hericium	分枝猴头菌
<i>Hygrophorus puniceus</i>	Scarlet Waxy Cap	红蜡伞
<i>Lactarius fragilis</i>	Candy Cap	脆香乳菇
<i>Laetiporus sulphureus</i>	Sulfur Shelf; Chicken of Woods	硫磺菌
<i>Lepiota rachodes</i>	Shaggy Parasol	
<i>Lycoperdon perlatum</i>	Common Puffball	网纹马勃
<i>Lyophyllum decastes</i>	Fried Chicken Mushroom	荷叶离褶伞
<i>Marasmius oreades</i>	Fairy Ring Mushroom	硬柄小皮伞
<i>Morchella elata</i>	Black Morel	黑羊肚菌
<i>Pleurotus ostraeus</i>	Oyster Mushroom	普通平菇
<i>Pseudohydnum gelatinosum</i>	Toothed Jelly Fungus	虎掌刺银耳
<i>Ramaria araiospora</i>	Red Coral mushroom	红珊瑚菌
<i>Russula xerampelina</i>	Shrimp Russula	虾味红菇
<i>Schizophyllum commune</i>	Split-Gill	裂褶菌
<i>Sparassis crispa</i>	Cauliflower Mushroom	灰树花
<i>Stropharia rugosoannulata</i>	Wine-Red Stropharia	酒红色球盖菇
<i>Suillus luteus</i>	Slippery Jack	褐环粘盖牛肝菌

神奇的中美红杉树

<i>Trametes versicolor</i>	Turkey Tail; Many-Colored Polypore	杂色多孔菌
<i>Tremella aurantialba</i>	Red Coral mushroom	
<i>Tremella mesenterica</i>	Witch's Butter	金黄银耳
<i>Tricholoma magnivelare</i>	White Matsutake; Matsutake	白色松茸

各章节原文献来源 (Original Citation Sources)

第一章 (Chapter 1)

第一节 (Section 1)

原著:拉夫尔·钱尼(Ralph W. Chaney),《历史悠久的水杉》(*Redwoods of the Past*), 保护红杉联盟于1984年出版, 本书采用的为1990年的第三版。

Previously published as: Ralph W. Chaney, *Redwoods of the Past*. Save the Redwoods League. 1948. Third revised edition, 1990.

第二节 (Section 2)

原著:魏歌林(William Gittlen),《寻找中国的古水杉》(*The Chinese Redwood*)。

Previously published as: William Gittlen, *The Chinese Redwood*.

第三节 (Section 3)

原著:谌谟美(Chen Momei),《近期中国古水杉考察记》(*Three Recent Expedition to the Chinese Ancient Dawn Redwood*), 未发表。

Previously notes: Chen Momei, *Three Recent Expedition to the Chinese Ancient Dawn Redwood*, unpublished.

第二章 (Chapter 2)

第一节 (Section 1)

原著:威利斯·林·杰普森(Willis Linn Jepson),《海岸红杉林的乔灌木和花草》(*Trees, Shrubs and Flowers of the Redwood Region*), 保护红杉联盟于1934年出版。本书在第56次印刷版本(1984)的基础上, 用新的学名修改了原著的

分类名称(Bruce Baldwin, 2009), 丹尼尔·H. 诺里斯和谌谟美教授补充了苔藓及蘑菇的物种及索引(2009).

Previously published as: William Linn. Jepson, *Trees, Shrubs and Flowers of the Redwood Region*. Save the Redwoods League, 1934. Revised with updated taxonomy and modernized for this book based on the 56th printing, 1984. Additional Daniel H. Norris wrote the index of moss, classified by habitat and Chen Momei wrote several kinds edible mushrooms and with the index in this section(2009).

第二节(Section 2)

原著:富亦苗(Emanuel Fritz),《一棵海岸红杉倒木的故事》(*Story Told by a Fallen Redwood*), 保护红杉联盟印刷出版, 本书根据1995年第49次印刷的版本做了适当的修改。

Previously published as: Emanuel Fritz, *Story Told by a Fallen Redwood*. Save the Redwoods League, 1959. Slightly revised and modernized for this book based on the 49th printing, 1995.

第三节(Section 3)

原著:约翰·B. 德威特(John B. Dewitt)《加利福尼亚州红杉公园和自然保护区》(*California Redwood Parks and Preserves*), 保护红杉联盟于1982年第一次出版, 本书根据1993年的版本做了适当的修定和更新。

Previously published as: John B. Dewitt, *California Redwood Parks and Preserves*. Save the Redwoods League. The first printing was in 1982. Slightly revised and modernized for this book based on the print version of 1993.

第三章(Chapter 3)

第一节(Section 1)

原著:谌谟美(Chen Momei),《希拉-内华达山及巨杉》(*Sierra Nevada Mountain Range and Giant Sequoia*)。生态学的参考文献引自:

<http://www.nps.gov/seki/naturescience/plants.htm>

Previously notes: Chen Momei, *Sierra Nevada Mountain Range and Giant*

Sequoia. The ecological references in this section were adapted from :
<http://www.nps.gov/seki/naturescience/plants.htm>

第二节 (Section 2)

原著:托马斯·H. 哈维 (Thomas H. Harvey), 《优胜美地国家公园的巨杉》(*The Sequoias of Yosemite National Park*)。1978年由优胜美地协会与国家公园服务部合作出版。在本书编写过程中做了适当的修定和更新。

Previously published as: Thomas H. Harvey, *The Sequoias of Yosemite National Park*. This book was published by the Yosemite Association in cooperation with the National Park Service, 1978. Slightly revised and modernized for this book.

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* W. C. Cheng and Zheng Wanjun are the same person. Dr Chaney first used W. C. Cheng in this book, Chapter I, section 1, *Redwoods of the Past*.