

本书受 国家自然科学基金 资助
贵州大学出版基金

黔渝湘鄂交界地区 苔藓植物物种多样性研究

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贵州科技出版社

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Research on Bryophyte Diversity of the
Intersection converge of Guizhou,
Chongqing, Hulan, Hubei

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贵州科技出版社
贵 阳

图书在版编目(CIP)数据

黔渝湘鄂交界地区苔藓植物物种多样性研究/熊源新

主编. —贵阳:贵州科技出版社,2007.3

ISBN 978-7-80662-667-2

I. 黔… II. 熊… III. 苔藓植物—生物多样性—研究—
中国 IV. Q949.35

中国版本图书馆 CIP 数据核字(2007)第 091438 号

出 版	贵州科技出版社
发 行	
地 址	贵阳市中华北路 289 号
邮政编码	550004
经 销	贵州省新华书店
印 刷	贵阳经纬印刷厂
开 本	889mm×1194mm 1/16
字 数	540 千
印 张	18.375
插 页	20
版 次	2007 年 3 月第 1 版
印 次	2007 年 3 月第 1 次印刷
印 数	1—1000
定 价	78.00 元

序

苔藓植物作为植物界中特殊的一个类群,以其独特的配子体营养排列在植物界演化系统的一个分支顶点,它的系统发育和演化过程在生物进化史上有重要的理论地位。作为植物界大类群之一,苔藓植物的经济用途远不为人知,可和其他高等植物一样,随着森林的砍伐、生态的破坏,种类在不断地消失。由于苔藓植物对环境的生存依赖性远大于其他高等植物,所以作为物种所储存的大量遗传信息——基因的消失,其严重程度远大于其他高等植物。

黔渝湘鄂地区是指贵州东北部、重庆东南角、湖南西北部和湖北西南角交界处,位于东经 $108^{\circ} \sim 110^{\circ}$ 、北纬 $28^{\circ} \sim 30^{\circ}$ 之间的山地。该地由于地理气候较为特殊,苔藓植物非常丰富,2003 年我们在国家自然科学基金的资助下,开展了该区苔藓植物物种多样性的研究工作。将研究工作的部分结果汇编成此书。

该项研究得到了中国知名的苔藓学家、中国科学院北京植物研究所的贾渝研究员、吴鹏程研究员、汪媚芝老师,华东师范大学的朱瑞良教授、王幼芳教授,上海师范大学的曹同教授、郭水良教授,内蒙古大学的白学良教授,齐齐哈尔大学的沙伟博士,中国科学院沈阳应用生态研究所的吴玉环博士,河北师范大学的赵建成博士的帮助,以及台湾东海大学赖明洲教授,美国密苏里植物园何思博士的支持与协助。

野外工作得到了贵州大学生命科学院的苟光前博士、王晓宇副教授及研究生周燕、杨宁、潘峰、季必金、郭彩清、上官法智、王晖等的大力协助,在此一并感谢。

该书第二章的第一部分和第三章由何林执笔,第四章由杨志平执笔,第五章由吴翠珍执笔,其他部分由熊源新撰写和统稿。鉴于水平,书中难免有错误,请读者予以指正。

贵州大学生命科学院

熊源新

2006 年 10 月于贵阳

Abstract

The intersection converge of Guizhou, Chongqing, Hulan, Hubei lies in the central section of China, within the scope of middle subtropics, with the geographical position from 108 ° to 110 °E in longitude and from 28 ° to 30 °N, is the area of the lowest annual average sunshine, annual average amount of solar radiation and annual average dryness fraction (the ratio of annual moisture evapotranspiration to annual precipitation) of the inland district, which also is the one of the lowest wind velocity area in China, therefore this area possibly is one of areas which have the most abundant bryophyte distribution in species diversity.

Species diversity is the foundation of biodiversity. The main purpose of this project is to research the species diversity of bryophyte in this area and get the detailed data of species diversity of bryophyte, such as species constitution, flora composition, endemic elements, new record of distribution and new taxonomical group, by the gathering, identification of bryophyte specimen from this area and constitutional comparison, flora analysis.

This region had not been investigated systematically. From 2004 to 2005, the authors and his companions made bryological survey for several times in this region and 12034 packages of bryophytes were collected. From these specimens, 76 families, 267 genera and 1026 species (including subspecies and varieties) are identified. Among them, 2 species are first found in China.

The text book is based on these 12034 specimen, relative materials and author's research. The main contents include 3 portion:

1. Study on Bryophyte Diversity and Flora of S – W Hubei

Hubei Province lies in the central section of China, within the scope of middle subtropics. S – W Hubei is located in the southwest of Hubei, with the geographical position from 108°23'12" to 110°38'08"E in longitude and from 29°07'10" to 31°24'13"N in latitude. It includes two cities which are En – shi City and Li – chuan City and three counties which are Xuan – en County, Xian – fen County, Lai – feng County. The type of climate in this region is the seasonal mountainous humid one in middle subtropics. The plants are of the feature of transition between south and north that there is not only many kinds of trees in north but also generous ones of in south and this area is also located in the transition zone of east and west for plants, which is favorable for them in the vicinity to invade. It is one of the regions with abundant biotic resources in China.

This region had not been investigated systematically. From August to September in 2005, the author and his companions made bryological survey for several times in this region and 1876 packages of bryophytes were collected and 7 sites were made for the preliminary ecological investigation there. From these specimens, 61 families, 157 genera and 388 species (including subspecies and varieties) are identified. Among them, 11 families, 34 genera and 208 species of bryophytes are first found in Hubei Province and 2 species are first found in China.

According to "The areal – types of Chinese genera of seed plants" by Wu Zheng – yi, 15 types of the bryoflora in this region are recognized. Among them, The East Asian elements are the most important ones

with 107 species corresponding to 19.23% of the total. Following the East Asian elements, the North Temperate elements consist of 79 species corresponding to 21.59% of the total. The third one is the Tropical Asian elements including 70 species sharing 19.13% of the total. As a word, the Temperate elements, the Tropical elements and the East Asian elements construct the main body of bryophytes in this region together and this truth shows that this region is the communicating point of bryophytes with different traits. Moreover, the complexity and particularity of the regional bryoflora are also proved by other elements of certain proportion.

For considering the relationship between the bryoflora of S - W Hubei and those of other regions, the author selected six regions. The similarity coefficients of genera between S - W Hubei and Wu - yi Mountains, Jiu - wan Mountains, Shen - nong - jia Mountains, and Fan - jing Mountains are all more than 50%. The results show that the relation between the bryoflora of S - W Hubei and that of these regions is the most closest because of their genera similarity coefficients, while the one between them and that of eastern Tianshan and Changbaishan regions is opposite. This result of comparison is in accordance with the common law of flora.

According to the simple ecological investigation about flora and epiphytic bryophytes in seven communities, it shows that the richness and diversity of bryophytes in communities are related to the community characteristic such as tall tree coverage, air humidity, community orientation, herb coverage, epiphytic height and so on. Moreover, species richness and diversity are usually positive association. The distribution of epiphytic bryophytes in the community shows the common law that they are most abundant with higher diversity at the root, while are lower upward.

2. Study on Species Diversity of Bryophytes in the Southeast of Chongqing

This paper based on the 2130 specimens of bryophytes that collected in the southeast of Chongqing, China. This region has not been investigated systematically. After this study, 62 families, 159 genera and 448 species are identified, including 1 newly genus — *Hageniella* and 90 newly species to Sichuan. In the same time, a endangered taxa of bryophyte is found — *Trichocoleopsis tsinlingensis* Chen ex. M. X. Zhang. There are 17 dominant families such as Hapnaceae with 10 or more than species, and there are 23 dominant genera with 6 or more than species. According to the study on dominant families and genera, it can be concluded that the bryophytes in the southeast of Chongqing of China are temperate.

To be compared with other areas. The bryophyte in the southeast of Chongqing is one of the rich areas in China. For considering the relationship between the flora of bryophytes in this region and other 4 near areas, it can be concluded that this region is very closed to Mt. Jinfo.

According to "the area - types of Chinese genera of seed plants" by Wu Zheng - yi, 14 types of the flora of this region are recognized. East Asia element is the most important one in this region, and the Tropical elements are low so the temperate element is the body flora of the southeast of Chongqing.

To study the flora between this region and other areas, the relationship is very closed to Mt. Jinfo, Mt. Fanjing and Mt. Jizu but is far to the Mt. Jiuwan of Guangxi.

In the southeast of Chongqing, there are nearly half of bryophytes on soil and on humus. To be compared the richness of the 9 sample points in southeast of Chongqing, the species diversity of bryophytes in primary forest are the richest one. According to the study on the influence factors on the species diversity,

the activity of human beings is the most important factor. And other environments compared to impact the species diversity. The species diversity of epiphytic bryophytes is rich in this region, but the bryophytes on rotten log are not so rich.

3. Study on Bryophytes Species Diversity and Bryophytes Flora of N – W Hunan, China

Northwest Hunan is located at $109^{\circ}10' \sim 110^{\circ}22.5'E$ in longitude and $27^{\circ}44.5' \sim 29^{\circ}38'$ in latitude. Located in middle subtropical climatic belt, N – W Hunan's main vegetation is middle subtropical evergreen broad – leaf forests as a result. In topography, northwest part of this region is higher than southeast part. The highest peak of this region is 1 936.5m, which is Dalingshan in Longshan county, while the bottom is the outlet of Dalongxi in Luxi county, only 97.1m above sea level.

Taxonomic study on bryophytes of N – W Hunan has not been conducted until the author got there. In total of 1 771 packages of specimens have been collected there, based on these specimens, 387 species (subspecies and varieties are included) of 155 genera in 65 families are identified, among which, 2 families, 16 genera and 175 species are firstly reported for Hunan province. The author describes all the new recorded families and genera to Hunan, and takes photos of some species. Families contained no less than 10 species are defined as predominant family, then here are 12 predominant families including 71 genera and 219 species in N – W Hunan, which formed the main body of bryophytes flora of this region. While genera contained no less than 5 species are defined as predominant genus, therefore, 22 genera with 166 species are confirmed, accounting for 14.19% of the total genera and 41.81% of the total 387 species respectively. According to comprehensive evaluation of abundance, the author compares moss flora of N – W Hunan to that of other 11 regions, and Si index shows that moss flora of N – W Hunan is abundant, which ranked the forth after Dujiangyan, Mt. Jinfo and Mt. Jiuwan, while in terms of bryophytes flora, N – W Hunan champions all other 8 regions by its highest Si index.

According to "The areal – types of Chinese genera of seed plants" by Wu Zheng – yi, 14 types of the bryo – flora in this region are recognized. East Asian elements is the most important one, which contains 153 species corresponding to 42.38% of the total, Followed by temperate elements with 91 species accounting for 25.21% of the total, and tropical elements lists third by 87 species, which accounting for 24.65% of the total. Temperate elements is almost equal to tropical elements, which is in accordance with the geographical location of N – W Hunan in China. Furthermore, 24 species endemic to China are recorded here owing to its unique climate conditions.

For considering the relationship of bryophytes flora between N – W Hunan and other regions, the author firstly chooses 7 regions at longitude orientation and 4 regions at latitude orientation as comparison regions. The similarity coefficient of bryophytes genera between N – W Hunan and Liping Nature Reserve is the highest at longitude orientation while the counterpart between N – W Hunan and Mt. Jinfo is the highest at latitude orientation. The comparison indicates that bryophytes flora of N – W Hunan is in accordance with its location, otherwise, bryophytes of East Asian elements are concentrated around $28^{\circ}N$ in China, furthermore, N – W Hunan is one of the concentration camps of bryophytes of East Asian elements to some extent.

In order to compare the bryophytes composition and structure, the author selected 5 sample sites and 76 species of bryophytes were collected there. Analyzation on α index shows that α index has positive corre-

lation with the number of species, the higher number of species the higher α index, otherwise, α index has no correlation with bryophytes coverage in fact. Bryophytes in secondary forest are richer than in man-made forest.

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第一章 前言

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1 研究范围及内容

黔渝湘鄂地区是指贵州东北部、重庆东南角、湖南西北部和湖北西南角交界处,位于东经 $108^{\circ} \sim 110^{\circ}$,北纬 $28^{\circ} \sim 30^{\circ}$ 之间的山地,地处云贵高原向湘西丘陵过渡的大斜坡地带,突出于成都平原与洞庭湖平原之间,正处于我国整个地势等级的第二台阶和第三台阶的结合部(图 1-1)。该区是我国年均太阳总辐射量最低的地区^[1], $\geq 376.74 \text{ kJ/cm}^2$ 年(图 1-2)。本区也是我国年均日照时数最少的地区, $\geq 1200 \text{ h}$ (图 1-3)。黔渝湘鄂地区也是我国年均干燥度(年水分蒸发量与年降水量之比)最低的内陆地区, ≤ 0.5 (图 1-4)。这些气候条件十分适宜苔藓植物的生长,所以该区是我国苔藓植物现代多度中心之一。

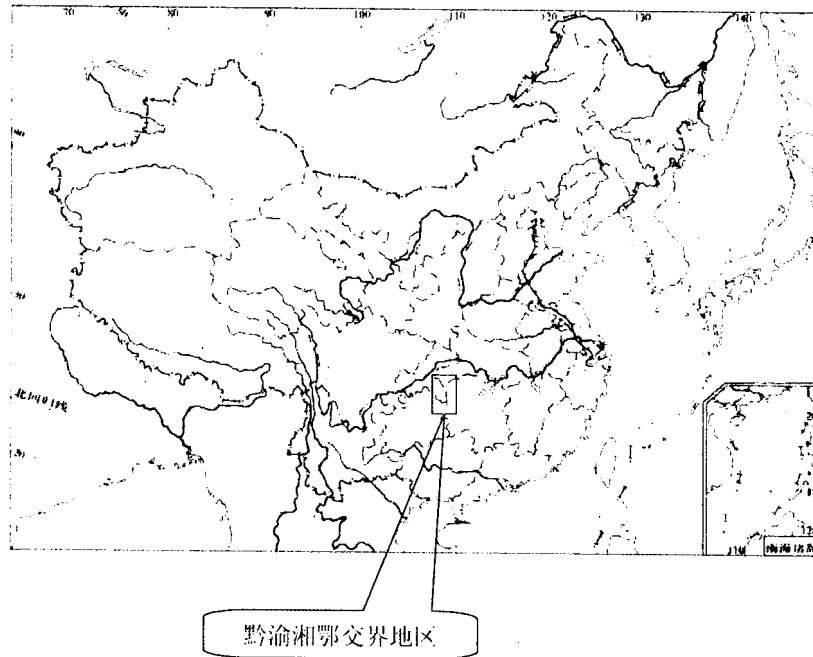


图 1-1 黔渝湘鄂交界地区位置图

作为植物界大类群之一,苔藓植物的经济用途远不为人知,可和其他高等植物一样,随着森林的砍伐、生态的破坏,种类在不断的消失。由于苔藓植物对环境的生存依赖性远大于其他高等植物,所以作为物种所储存的大量遗传信息——基因的消失,其严重程度远大于其他高等植物。开展苔藓植物的研究,特别是基础研究是苔藓工作者的主要任务之一。

2 该区苔藓植物研究的历史及存在的问题

2.1 研究简史

该区由于历史上为黔渝湘鄂的交界地区,长期交通不便,其核心区域一直未有苔藓植物的研究记录。可是又由于该区气候上的特殊性,其西缘和南缘即重庆南川金佛山和贵州梵净山苔藓植物的丰富程度引起了人们的注意,有了一些深入的研究^[2,3,4,5],这两个地区苔藓植物的最早采集记录见

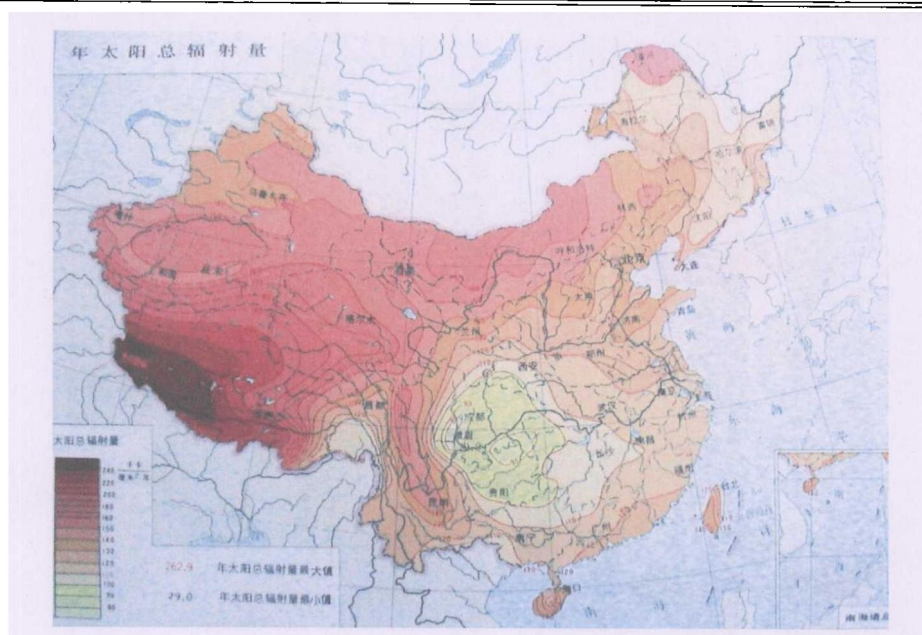


图 1-2 中国年太阳总辐射量

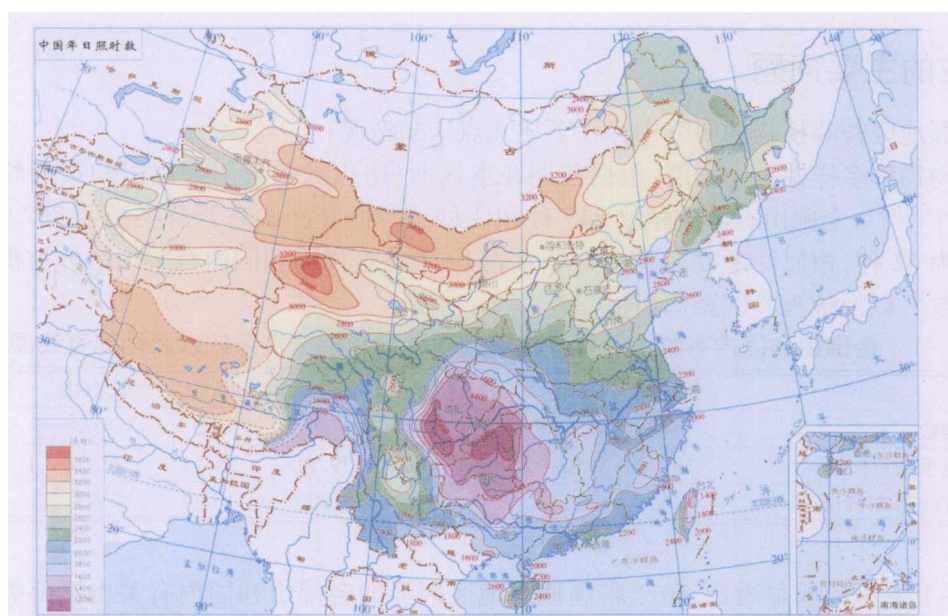


图 1-3 中国年日照时数

于 20 世纪 30 年代;蒋英(1930)、焦起源(1931)等在梵净山采集标本,并由 B. Bartram 研究后于 1935 年发表记载了苔藓植物 41 种,以后梵净山的苔藓植物又有多次研究^[4,5,6,7,8],其中重要的有钟本固、姜守忠(1983)B. C. Tan(1994)等。上述研究共记录了梵净山苔藓植物 50 科、126 属、261 种和变种、亚种。在南川金佛山最早采集苔藓植物标本的是四川大学教授方文培^[3],1935 年陈邦杰等也在该区进行过苔藓植物的采集,以后也有多次研究^[9,10,11]。其中重要的有胡晓云、吴鹏程(1991)等。

上述文献共记录了该区的南、西北缘地区的苔藓植物共 328 种和变种和亚种。

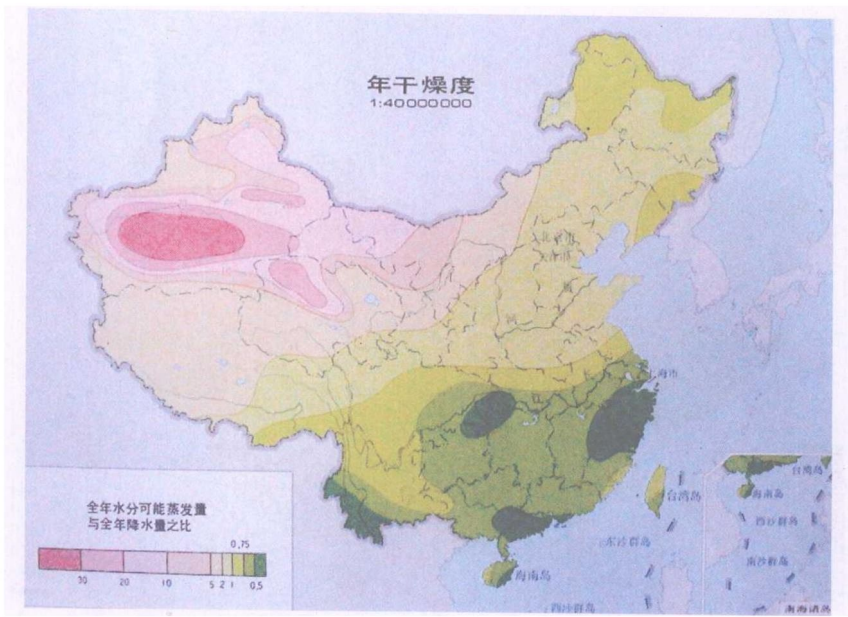


图 1-4 中国年干燥度

2.2 存在的主要问题

黔渝湘鄂地区苔藓植物的研究中存在下述几点未知情况：
苔藓植物物种多样性丰富程度：根据前期在本区西、南边缘的南川金佛山和贵州梵净山苔藓植物的研究工作^[5,6,7]，金佛山有藓类植物 245 种和变种、亚种，梵净山有苔藓类植物 202 种，两者之间相同的种数为 62 种，相似性系数为 20.134%。表 1-1 是金佛山和国内有关山区藓类植物共有种数和相似性系数^[5]以及地理直线距离(图 1-5)。

表 1-1 金佛山和国内有关山区藓类植物相同种数和相似性系数以及地理直线距离表

	神农架	秦岭	鸡足山	武夷山	黄山	长白山	梵净山
共有种数	94	80	74	71	62	67	62
相似性系数(%)	38.68	32.92	30.45	29.21	25.51	27.57	20.13
地理直线距离(km)	400	550	760	1 000	1 050	2 400	180

从表 1-1 中可以明显看出：位于黔渝湘鄂地区西界的金佛山和国内有关山区藓类植物的共有种数和相似性系数，均正常地随地理直线距离的增加而减少，但和位于同区南缘的梵净山例外！距离最近而相似性系数最小。该现象只能说明两个问题：①本区工作做得不够，该区藓类植物的物种种数应该远大于现有数字，至少共有种数要远大于现有数字。②该区藓类植物的物种种数极为丰富。两地已知的藓类植物物种数近于 400，已大于上表中有关山区的藓类植物物种数。预计随着项目的开展，黔渝湘鄂地区的苔藓植物物种数将远大于已知数目。

综上所述，该区是我国苔藓植物分布的重要地区，边缘地区的前期工作证明了该区苔藓植物的丰富程度，该区的大部分地区和核心地带尚未作过苔藓植物的标本采集，研究工作十分薄弱。所以开展黔渝湘鄂交接地区苔藓植物的研究对发展我国西部的基础学科，澄清黔渝湘鄂地区苔藓植物物种组成，有着非常重要的意义。同时能对我国苔藓植物的现代分布格局的形成、区系的划分提供重要的依据。对现代苔藓植物区系特别是中国苔藓植物区系形成的历史过程和系统演化过程以及对

中国苔藓植物区系的发展有重要的理论价值。

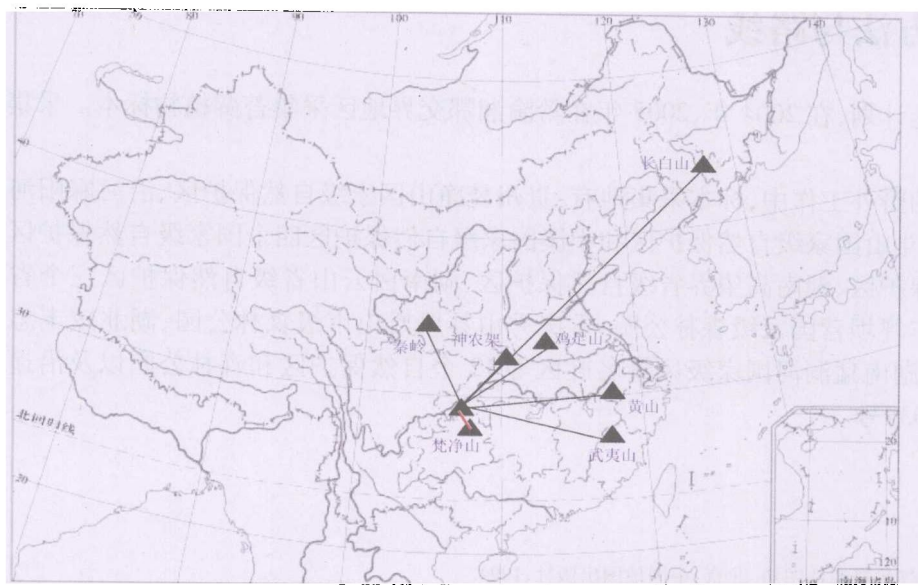


图 1-5 梵净山、金佛山和中国其他有关地区的地理直线距离

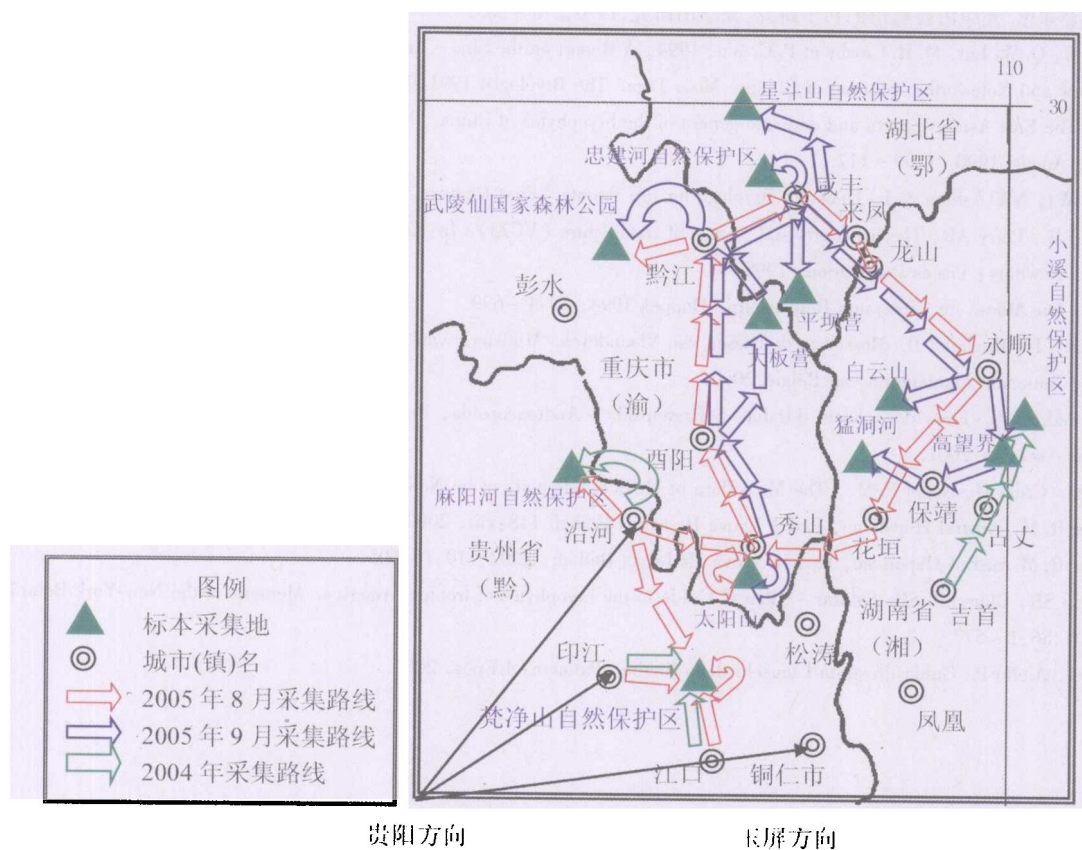


图 1-6 黔渝湘鄂交界地区苔藓植物标本采集的地点和路线

3 研究方法路线

根据预定计划,在2004年,2005年在黔渝湘鄂交界地区采集苔藓植物标本。采集地点和路线见图1-6。

在两年的野外工作中,标本采集地有:贵州梵净山国家级自然保护区、沿河麻阳河国家级自然保护区、湖北星斗山国家级自然保护区和小溪国家级自然保护区四个国家级自然保护区。重庆酉阳县大板营自然保护区、湖南高望界省级自然保护区、湖南白云山省级自然保护区三个省市级自然保护区。湖北咸丰坪坝营国家森林公园、重庆秀山县凤凰山市级森林公园、湖北咸丰忠建河大鲵县级自然保护区、湖南猛洞河国家级风景名胜区等12个自然保护区和森林公园以及沿途。共采集苔藓植物标本12 034号。

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4 标本各采集地点简介

4.1 梵净山国家级自然保护区

梵净山位于贵州东北部铜仁地区江口、印江、松桃三县交界处,不仅是贵州的第一山,更是武陵山脉的主峰,梵净山山体庞大,地势高耸,层峦叠嶂,最高峰凤凰山海拔 2 572m,金顶海拔 2 493m,而东坡山麓的盘溪口海拔仅 500m,高差达 2 000 余米。以凤凰山、金顶的峡谷地形为中心、四周逐层散布低中山,低山和丘陵等各种地貌类型。山势雄伟,坡陡谷深,自然保护区东西宽约 21km,南北长约 27km,总面积 567km²,是云贵高原向湘西丘陵的过渡地区。正处在我国的亚热带中心。年平均气温 6~17℃,年平均降水量 1 100~1 600mm,相对湿度年平均 80% 以上,具有我国典型的中亚热带季风山地湿润气候特征。是中国 14 个加入联合国“人与生物圈”世界性自然保护区的成员之一。

4.2 麻阳河国家级自然保护区

麻阳河国家级自然保护区(下称“麻阳河自然保护区”)位于沿河自治县西部麻阳河、洪渡河流域,与黎芝峡西岸毗邻,面积 31 113hm²。地理位置为北纬 28°37'30"~28°54'20",东经 108°6'45"~108°19'45",分布着 74 群 700 多只国家一级保护动物黑叶猴和其他珍稀动植物,两河峡谷险峻幽深。两岸森林密布,以原始的常绿阔叶林为主。溪流泉涌,变幻多彩,空气清新,冬暖夏凉,气候宜人。麻阳河自然保护区是乌江中下游少数保存植被较好的地段之一。有维管束植物共 117 科 292 属 478 种,其中种子植物较丰富,共有 99 科 236 属 409 种和 18 个变种,蕨类植物 18 科 30 属 51 种。具备各类不同用途的资源植物 382 种。有国家保护植物 7 种,一级保护动物 2 种,二级保护动物共 23 种。麻阳河自然保护区是动植物的天然宝库。

4.3 湖北星斗山国家级自然保护区

星斗山位于为利川、恩施、咸丰三县(市)交界地。主峰海拔 1 795.2m,最低海拔 610m,总面积 68 339hm²,星斗山地处我国西南高山向东南低山、丘陵过渡的第二和第三阶梯地带,经纬度约为东经 109°07',北纬 30°03'。这里土壤肥沃,腐殖质含量丰富。年平均气温 14.3℃,年有效活动积温 4 431℃,年均降水量 1380mm,相对湿度 83%,无霜期 264 天。由于优越的气候条件和复杂多样的自然地貌,使该区植物得以聚集和分化演替。不仅具有古、老、稀的特征,而且具有东西南北中各带相互渗透的过渡特点。该区植被区系庞杂,起源古老,植物种类十分丰富。据中国林业科学院北京植物研究所、南京林学院、等有关部门反复考察,该区有维管束植物 2 037 科 883 属 2 033 种。其中:蕨类植物 30 科 59 属 132 种;裸子植物 8 科 22 属 28 种;被子植物 162 科 763 属 1 873 种。

4.4 湖南小溪国家级自然保护区

湖南小溪国家级自然保护区地处永顺县东南部,总面积 24 800hm²,其中核心区 6 133hm²。小溪自然保护区地层发育不齐全,以远古代地层为主,缺失中生代地层和新生代地层,远古代地层出露有板溪群和震旦系。区内位于扬子准台地八面山褶皱带之武陵褶皱束与江南地轴的交接部位,为褶皱构造和断裂构造。这种地层发育,使境内层峦叠嶂,奇峰耸峙,陡险崎岖,飞瀑悬泻,溪谷纵横,地形破碎。地理分布极为狭窄,一旦破坏极难恢复。区内生长着大片亚热带低海拔常绿阔叶原始森林,动植物种类繁多。区内共有植物 221 科 2 702 种,有陆生脊椎动物 70 科 208 种,有昆虫 144 科 738

种。区内有珙桐、红豆杉、伯乐树、银鹊树等国家一级、二级重点保护植物 43 种,有金钱豹、云豹、白颈长尾雉等国家一级、二级保护动物 36 种,被权威专家学者考察论证为“中南十三省唯一免遭第四纪冰川侵袭的低海拔常绿阔叶原始森林资源宝库和天然物种基因库”。

4.5 湖北咸丰坪坝营国家级森林公园

咸丰坪坝营国家级森林公园面积 154km²,其中有原始森林 8 000hm²,原始次生林 4 000hm²,人工林 4 670hm²。森林覆盖率 96% 以上。群山逶迤,沟壑纵横,树木丰茂,山花遍野,洞穴密布,溪瀑如织。古、奇、秀、幽、野的景致极具特色。区内地形复杂,相对高差大。最高海拔 1 911.5m,最低海拔 720m,海拔 1 200m ~ 1 400m 的地貌单元占总面积的三分之二。属典型的南温带湿润性季风气候,年平均气温 11.8℃,极端最高气温 35℃,年降水量 800 ~ 2 400mm,无霜期 250 天左右,相对湿度 85%,冬无严寒,夏无酷暑,雨量充沛,气候宜人。是“鄂西林海”的核心部分,是“华中生物避难所”的重要组成部分。日前探明的植物种类为 2 100 余种,其中有珙桐、红豆杉、大树杜鹃等十余种珍稀树木,有天麻、党参等珍贵药材及能食用的野菜、野果达 200 种;发现的动物约 240 种,其中有金钱豹、香獐、果子狸、锦鸡等国家保护动物近 20 多种,野猪、野兔不计其数,被称为“野兽比人多”的地方。

4.6 重庆酉阳县大板营自然保护区

大板营自然保护区位于酉阳土家族苗族自治县北面的大板营,是神龙架支脉的延伸,山上有 900 多公顷原始森林,古木参天,四季葱郁。这里是地球上同纬度地区森林面积最大,生态植被保存最完好的神秘地方。大板营海拔较高,气候反差大,平均海拔 1 600m 以上,最高处是 1 895m 的灰阡梁子,有些地方的树木即使在盛夏之际,仍然保持着春天的茂盛。有的地方由于海拔差异,显现出“一山有四季,十里不同天”的垂直气候特征,生活着香獐、云豹、猕猴、武陵鲵、小灵猫、红腹锦鸡等国家珍贵保护动物,生长着成片的珙桐和香果树、中华蚊母树等古老珍稀植物,是我国不可多得的动植物基因库。

4.7 湖南高望界自然保护区

高望界自然保护区地处湘西古丈县东北部,地处云贵高原古陆块东北边缘的湘西武陵山脉中段山区腹地。东经 109°48'09" ~ 110°13'46",北纬 28°35'52" ~ 28°45'30",总面积 20 002hm²。境内山地由高望界、鲤鱼池、小高望界、笔架山等主体部分组成。最高处高望界海拔 1 146.2 m,最低处罗依溪镇海拔 190m。高望界自然保护区处于云贵高原向江南丘陵过渡地带,是中国生态区系核心地带——华中区的重要组成部分,又位于全球 200 个生物多样性的地区之一的武陵山区,在我国生物多样性的保护与研究上占有重要地位。境内地貌独特,地势崎岖陡峭,沟壑纵横,溪河密布,保存有我国面积大且十分完整的亚热带低海拔原始次生常绿阔叶林。高望界自然保护区属中亚热带常绿阔叶林带,植物资源丰富。其悠久的地质历史和丰富的水热资源为植物的生存繁衍提供了得天独厚的条件,保护区内有维管束植物 221 科 2 648 种;木本植物 95 科 235 种。