



中国科学院中国孢子植物志编辑委员会 编辑

# 中国淡水藻志

第十六卷

硅藻门

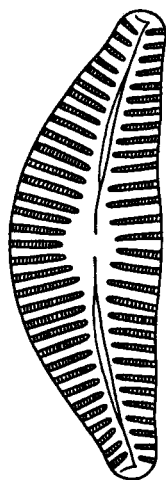
桥弯藻科

施之新 主编

中国科学院知识创新工程重大项目

国家自然科学基金重大项目

(国家自然科学基金委员会 中国科学院 国家科学技术部 资助)



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## 内 容 简 介

本书系统、全面地记述了我国桥弯藻科 11 属 180 种 33 变种, 对每个分类单位均以我国的标本作出了科学的描述, 并附有精美、正确的特征图(或照片), 对某些分类单位的分类问题进行了讨论和解释。同时, 结合国内外对桥弯藻科植物研究的成果, 对它们的细胞结构、形态特征、生殖过程、生态习性 & 系统发育过程也作了较详实的论述。

本书可供生物学、植物学、藻类学、水产科学、环境科学、地质学和地理学等领域的科研人员及高等院校有关专业的师生参考。

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TOMUS XVI  
**BACILIARIOPHYTA**  
CYMBELLACEAE

REDACTOR PRINCIPALIS

SHI ZHIXIN

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# 《中国淡水藻志》第十六卷

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# 序

中国孢子植物志是非维管束孢子植物志，分《中国海藻志》、《中国淡水藻志》、《中国真菌志》、《中国地衣志》及《中国苔藓志》五部分。中国孢子植物志是在系统生物学原理与方法的指导下对中国孢子植物进行考察、收集和分类的研究成果；是生物多样性研究的主要内容；是物种保护的重要依据，对人类活动与环境甚至全球变化都有不可分割的联系。

中国孢子植物志是我国孢子植物物种数量、形态特征、生理生化性状、地理分布及其与人类关系等方面的综合信息库；是我国生物资源开发利用，科学研究与教学的重要参考文献。

我国气候条件复杂，山河纵横，湖泊星布，海域辽阔，陆生和水生孢子植物资源极其丰富。中国孢子植物分类工作的发展和《中国孢子植物志》的陆续出版，必将为我国开发利用孢子植物资源和促进学科发展发挥积极作用。

随着科学技术的进步，我国孢子植物分类工作在广度和深度方面将有更大的发展，对于这部著作也将不断补充、修订和提高。

中国科学院中国孢子植物志编辑委员会

1984年10月·北京

# 中国孢子植物志总序

中国孢子植物志是由《中国海藻志》、《中国淡水藻志》、《中国真菌志》、《中国地衣志》及《中国苔藓志》所组成。至于维管束孢子植物蕨类未被包括在中国孢子植物志之内，是因为它早先已被纳入《中国植物志》计划之内。为了将上述未被纳入《中国植物志》计划之内的藻类、真菌、地衣及苔藓植物纳入中国生物志计划之内，出席 1972 年中国科学院计划工作会议的孢子植物学工作者提出筹建“中国孢子植物志编辑委员会”的倡议。该倡议经中国科学院领导批准后，“中国孢子植物志编辑委员会”的筹建工作随之启动，并于 1973 年在广州召开的《中国植物志》、《中国动物志》和中国孢子植物志工作会议上正式成立。自那时起，中国孢子植物志一直在“中国孢子植物志编辑委员会”统一主持下编辑出版。

孢子植物在系统演化上虽然并非单一的自然类群，但是，这并不妨碍在全国统一组织和协调下进行孢子植物志的编写和出版。

随着科学技术的飞速发展，人们关于真菌的知识日益深入的今天，黏菌与卵菌已被从真菌界中分出，分别归隶于原生动物界和管毛生物界。但是，长期以来，由于它们一直被当作真菌由国内外真菌学家进行研究，而且，在“中国孢子植物志编辑委员会”成立时已将黏菌与卵菌纳入中国孢子植物志之一的《中国真菌志》计划之内并陆续出版，因此，沿用包括黏菌与卵菌在内的《中国真菌志》广义名称是必要的。

自“中国孢子植物志编辑委员会”于 1973 年成立以后，作为“三志”的组成部分，中国孢子植物志的编研工作由中国科学院资助；自 1982 年起，国家自然科学基金委员会参与部分资助；自 1993 年以来，作为国家自然科学基金委员会重大项目，在国家基金委资助下，中国科学院及科技部参与部分资助，中国孢子植物志的编辑出版工作不断取得重要进展。

中国孢子植物志是记述我国孢子植物物种的形态、解剖、生态、地理分布及其与人类关系等方面的大型系列著作，是我国孢子植物物种多样性的重要研究成果，是我国孢子植物资源的综合信息库，是我国生物资源开发利用、科学研究与教学的重要参考文献。

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中国科学院中国孢子植物志编辑委员会

主编 曾呈奎

2000 年 3 月 北京



## Preface to the Cryptogamic Flora of China

Cryptogamic Flora of China is composed of *Flora Algarum Marinarum Sinicarum*, *Flora Algarum Sinicarum Aquae Dulcis*, *Flora Fungorum Sinicorum*, *Flora Lichenum Sinicorum*, and *Flora Bryophytorum Sinicorum*, edited and published under the direction of the Editorial Committee of the Cryptogamic Flora of China, Chinese Academy of Sciences (CAS). It also serves as a comprehensive information bank of Chinese cryptogamic resources.

Cryptogams are not a single natural group from a phylogenetic point of view which, however, does not present an obstacle to the editing and publication of the Cryptogamic Flora of China by a coordinated, nationwide organization. The Cryptogamic Flora of China is restricted to non-vascular cryptogams including the bryophytes, algae, fungi, and lichens. The ferns, a group of vascular cryptogams, were earlier included in the plan of *Flora of China*, and are not taken into consideration here. In order to bring the above groups into the plan of Fauna and Flora of China, some leading scientists on cryptogams, who were attending a working meeting of CAS in Beijing in July 1972, proposed to establish the Editorial Committee of the Cryptogamic Flora of China. The proposal was approved later by the CAS. The committee was formally established in the working conference of Fauna and Flora of China, including cryptogams, held by CAS in Guangzhou in March 1973.

Although myxomycetes and oomycetes do not belong to the Kingdom of Fungi in modern treatments, they have long been studied by mycologists. *Flora Fungorum Sinicorum* volumes including myxomycetes and oomycetes have been published, retaining for *Flora Fungorum Sinicorum* the traditional meaning of the term fungi.

Since the establishment of the editorial committee in 1973, compilation of Cryptogamic Flora of China and related studies have been supported financially by the CAS. The National Natural Science Foundation of China has taken an important part of the financial support since 1982. Under the direction of the committee, progress has been made in compilation and study of Cryptogamic Flora of China by organizing and coordinating the main research institutions and universities all over the country. Since 1993, study and compilation of the Chinese fauna, flora, and cryptogamic flora have become one of the key state projects of the National Natural Science Foundation with the combined support of the CAS and the National Science and Technology Ministry.

Cryptogamic Flora of China derives its results from the investigations, collections, and classification of Chinese cryptogams by using theories and methods of systematic and evolutionary biology as its guide. It is the summary of study on species diversity of cryptogams and provides important data for species protection. It is closely connected with human activities, environmental changes and even global changes. Cryptogamic Flora of China is a comprehensive information bank concerning morphology, anatomy, physiology, biochemistry,

ecology, and phytogeographical distribution. It includes a series of special monographs for using the biological resources in China, for scientific research, and for teaching.

China has complicated weather conditions, with a crisscross network of mountains and rivers, lakes of all sizes, and an extensive sea area. China is rich in terrestrial and aquatic cryptogamic resources. The development of taxonomic studies of cryptogams and the publication of Cryptogamic Flora of China in concert will play an active role in exploration and utilization of the cryptogamic resources of China and in promoting the development of cryptogamic studies in China.

C. K. Tseng

Editor-in-Chief

The Editorial Committee of the Cryptogamic Flora of China

Chinese Academy of Sciences

March, 2000 in Beijing

# 《中国淡水藻志》序

中国是一个国土面积 960 万平方公里的大国，地跨寒带、温带、亚热带和热带，不仅有陆地和海洋，还有 5000 多个岛屿，大陆地形十分复杂，海拔高度自西向东由高而低。中国西部海拔高度在 5000 米以上的土地面积占全国总面积的 25.9%，往东依次为：2000—3000 米的占 7%，1000—2000 米的占 25%，500—1000 米的占 16.9%，东部和东北部及沿海地带都在 500 米以下，约占 25.2%。这期间山地、高原、盆地、平原和丘陵等等连绵起伏。中国又是一个河流丰富的国家，仅流域面积超过 100 平方公里的就有 50 000 条以上；几条大的河流自西向东或向南流入大海。我国的湖泊也很多，已知的天然湖泊，面积在 1 平方公里以上的即有 2800 个，人工湖 86 000 个，还有难以计数的塘堰、水池、溪流、沟渠、沼泽、泉水等等。这些地理特征使得我国各地在日照、气温和降水等方面有极大的差异，产生了种类丰富的植物。我国已知的高等植物，包括苔藓、蕨类和种子植物超过 30 000 种。无数的大小水坑，包括临时积水、稻田、水井、还有地下水、温泉、湿地、草场，以及表面多少覆盖有土壤的或潮湿的岩石、道路和建筑物等，形成无法计算、情况各异的小生境，生长着各种藻类。

中国的淡水藻类，早期是由外国专家采集和研究的。其中，最先于 1884 年由俄国专家 J.Istvanffy 发表的一种绿球藻的报告，是由 N.M.Przewalski 在蒙古采得标本而由圣彼得堡植物园主任 K.Maximovicz 研究的。其后德国的 Schauinsland 和 Lemmermann 采集和研究了长江中下游的藻类(1903, 1907)。瑞典学者和探险家 Sven-Hedin 曾在 1893—1901 年和 1927—1933 年间，几次到我国新疆、青海、甘肃、西藏和北京，其所得材料分别由 Wille(1900, 1922)，Borge(1934)和 Hustedt(1922, 1927)研究发表。1913—1914 年，奥地利的植物学家 Handel-Mazzatti 曾深入我国云南、贵州、四川、湖南、江西、福建 6 省，所得藻类由 H.Skuja 于 1937 年正式发表。前东吴大学任教的美籍教授 Gee 于 1919 年发表了他研究苏州和宁波藻类的文章。俄国的 Skvortzow 自 1925 年起即定居我国，直到 20 世纪 60 年代，他采集和研究过我国东北数省的藻类，还为各地的许多专家研究过不少的中国标本。

中国科学家所发表的第一篇淡水藻类学论文，是 1916—1921 年毕祖高的题为“武昌长湖之藻类”一文，分 4 次在当时的《博物学杂志》上刊登的。其后有王志稼(1893—1981)、李良庆(1900—1952)、饶钦止(1900—1998)、朱浩然(1904—1999)和黎尚豪(1917—1993)。到 1949 年，除西藏、宁夏、西康(今四川)外，所采标本大体上已遍及全国各个省、市和自治区。研究的类群主要是蓝藻、绿藻、红藻、硅藻，兼及轮藻、黄藻和金藻。饶钦止还建立了腔盘藻科(Coelodiscaceae 1941)，即今之饶氏藻科(Jaoaceae 1947)；又发现了两种采自四川的褐藻(1941)：层状石皮藻(*Lithoderma zonata*)和河生黑顶藻(*Spharelaria fluviallis*)。

1949 年后，中国的藻类学发展很快，研究人员增加，所采标本遍及全国，研究的类群不断增加。1979 年饶钦止出版的《中国鞘藻目专志》中记述了在中国采集的 2 属 301

种, 81 变种和 33 变型, 其中的 96 种, 38 变种和 32 变型的模式标本产于中国<sup>1)</sup>。

1964 年我国决定编写《中国藻类志》。1973 年, 编写工作正式开始。其后《中国藻类志》决定采用曾呈奎院士建立的分类系统, 将藻类分成如下 12 门(Division): (1) 蓝藻门(Cyanophyta), (2) 红藻门(Rhodophyta), (3) 隐藻门(Cryptophyta), (4) 甲藻门(Dinophyta), (5) 黄藻门(Xanthophyta), (6) 金藻门(Chrysophyta), (7) 硅藻门(Bacillariophyta), (8) 褐藻门(Phaeophyta), (9) 原绿藻门(Prochlorophyta), (10) 裸藻门(Euglenophyta), (11) 绿藻门(Chlorophyta) 和 (12) 轮藻门(Charophyta)。1984 年, 为了工作方便, 又决定将《中国藻类志》分为《中国海藻志》和《中国淡水藻志》两大部分, 各自分开出版。由于各类群在我国原有的工作基础不一致, “志”的编写工作又由不同的主编负责进行, 工作进度和交稿时间难以统一安排, 因此《中国淡水藻志》的卷册编序, 决定不以门、纲、目等分类学类群的次序为序, 而以出版先后为序, 即最先出版者为第一卷, 以下类推。种类较多, 必须分成若干册出版者, 即在同一卷册号之下再分成若干册, 依次编成册号。

1988 年, 由饶钦止主编的《中国淡水藻志》第一卷“双星藻科”(Zygnemataceae) 出版, 此卷记录本科藻类 9 属 347 种, 其中有 219 种的模式标本产于中国。到 1999 年, 已先后出版 6 卷。这 6 卷中, 所有的描述和附图, 除极少数例外, 几乎全是根据中国的标本作出的, 所采标本覆盖了全国省、市、自治区的 80% 到 100%。轮藻门、蓝藻门和褐藻门的分类系统经过了主编修订。包括鞘藻目在内, 上述已出版的各类群中, 中国记录的种的数目, 绝大多数均占全国已知种数的 40% 以上, 如色球藻纲的蓝藻已超过 80%。特有种(endemic species)在许多类群中也很显著, 如鞘藻目和双星藻科的中国特有种几乎占国内已记录的一半!

中国的淡水藻类, 种类十分丰富, 并有自己的区系特点。但是目前在编写和出版《中国淡水藻志》时, 还存在一些问题。

第一, 已出版的 6 个卷册, 由于原来各类群的研究基础不同, 所达到的水平和质量也不一样。例如, 对有些省区, 所记种类太少, 有一个省甚至只有一种; 有许多报道较早的种类, 特别是早期由外国专家发表的, 已难以看到模式标本; 还有许多种类, 只在较早时期报告过一次, 但描述非常简单, 甚至没有附图, 并且还未能第二次采到。对这些情况, 我们尽量在适当的地方加以说明, 更希望再版时有所改进。

第二, 在 12 门藻类植物中, 除原绿藻外, 每一门都有淡水种类。但到目前为止, 还有多类群, 尤其是门以下的某些纲、目和科, 我国还没有开始进行调查研究, 有的几乎是空白。金藻门、隐藻门、甲藻门还有许多种类是由动物学家进行研究的。

第三, 藻类分类学是一门既古老又年轻的科学。百多年来, 已积累了非常丰富的、极有价值的科学知识, 但也存在很多问题。由于不断有许多新属种被发现, 新的研究手段, 特别是电镜研究、培养和分子生物学的研究, 在增加了很多新知识的同时, 也使藻类的系统学和分类学出现许多新问题。只有把传统的形态分类学与近代新兴的科学研究手段结合起来, 才能使藻类分类学得到长足进步, 才能编写出更高质量的《中

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1) 刘国祥与毕列爵于 1993 年正式报道了采自武汉的勃氏枝鞘藻(*Oedocladium prescottii* Islam), 至此鞘藻目(科)所含的 3 个属, 在中国已全有报道。

国淡水藻志》。

总之，我们已取得不少成绩，但肯定还有缺点和错误，希望国内外读者不吝赐教。

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# FLORA ALGARUM SINICARUM AQUAE DULCIS

## FOREWORD

China is a big country with an area of 9,600,000 km<sup>2</sup>, covering not only land and ocean, but also 5 thousand islands, with a territory across the cold, temperate, subtropical and tropical belts of the northern Hemisphere. The topography of China is very complicated. In the main, the land runs from high to low gradually along the direction from the west to the east. Of the whole area of the country, 25.9% in the western part are at an altitude of 5,000m, and then successively from the west to the east, 7% at 2,000 to 3,000m, 25% at 1,000 to 2,000m, 16.9% at 500 to 1,000m, and 25.2% in the eastern, north-eastern and coastal regions below 500m. There are countless rises and falls of the land to make the various topographical reliefs into mountains, plateaus, basins, plains and mounts. China is a country full of rivers and rivulets too. There are over 50,000 rivers with their basins of 100 km<sup>2</sup>. The principal rivers overflow from the west to the eastern or southern seas of the country. The lakes and ponds are also numerous. The number of ever-known natural lakes of an area more than 1km<sup>2</sup> is no less than 2,800, and the artificial reservoirs are believed to be 86,000. And the ponds, pools, streams, ditches, swamps and springs are uncountable. All the above fundamental characteristics comprehensively lead to a very complicated variation of the sunshine, temperature and precipitation in different localities in China, and thus produce a very rich flora of higher plants, including the bryophytes, ferns and seed plants of more than 30,000 species. In addition, there are innumerable pits of different size marshes, grasslands and rocks, roads and buildings with more or less moisture or soil, all of which forms quite a big number of niches for the freshwater algae inhabitants.

Chinese freshwater algae was collected and studied by foreign experts in the earlier years. The first paper published was written by Russian scientist (J.Istvanffy) in 1884 and the specimens were collected by Russian Military Officer N.M. Przewalski from Mongolia and studied by K. Maximovicz. Later two Germany phycologists, H.Schauinsland and E.Lemmermann, collected and studied the algae of the middle and lower reaches of Yangtze River (1903,1907). Sven-Hedin, a Swedish scholar and explorer, traveled through Xinjiang, Qinghai, Gansu, Xizang (Tibet), and Beijing for several times in 1893—1901 and 1927—1933. The specimens he obtained were studied and published separately by N. Wille (1900,1922), O. Borge(1934), and F. Hustedt(1922, 1927). In 1913—1914, the famous Austrian botanist H.Handel-Mazzatti collected Chinese plants thoroughly in his journey in Yunnan, Guizhou, Sichuan, Hunan, Jiangxi and Fujian Provinces. Among those, the algal material were published formally by the phycologist, H. Skuja(1937). About the same period, N. Gee, an American teacher of the Soochou University, Suzhou, Jiangsu province

published his paper about the freshwater algae from Suzhou and Ningbo, Zhejiang province. And B. V. Skvortzow, a Russian naturalist, settled from Russia to China in 1925 till the 1960s of the 20th century. He collected and studied tremendous algal materials both collected from the NE-provinces from China and those presented by a number of experts from various localities of China.

The first paper of Chinese freshwater algae titled as "Algae from Changhu Lake, Wuchang, Hubei" by Bi Zugao, was published in *Journal of Natural History* separately in 4 volumes in 1916—1921. From then on, Wang Chichia (1893—1981), Li Liangching (1900—1952), Jao Chinchih (1900—1998), Zhu Haoran (1904—1999) and Li Shanghai (1917—1993) were the successors. Up to 1949, specimens were collected almost over all the provinces, municipalities and autonomous regions of China with few exceptions as Xizang(Tibet) and Ningxia. The groups were examined carefully concerning the cyanophytes, chlorophytes, rhodophytes, diatoms; and at the same time some attention has been given to charophytes, xanthophytes and chrysophytes too. By C. C. Jao, a new family, the Coelodiscaceae (1941), now the Jaoaceae (1947) was established, and two very rare freshwater brown algae, *Lithodera zonata* and *Sphacelaria fluviatilis* were discovered (1941).

The development of phycology in China was more rapid than ever from 1949 on. The faculties were enlarged, specimens were obtained over all the country and the group's studies were increased. In 1979, Jao published his monograph *Monographia Oedogoniales Sinicae*. In his big volume Jao described 301 species, 81 varieties and 33 forms belonging to 2 of the 3 of the world genera from China. Among them, the types of 96 species, 38 varieties and 32 forms are inhabited in this country<sup>1)</sup>.

In 1964 a resolution of editing the *Flora of Chinese Algae* was made by the Chinese phycologists. The work was actually put into being since 1973. It was decided in 1978 that the system published by Academician Tseng Chenkui would be adopted in the FLORA. Accordingly, the algae are to be divided into 12 Divisions: (1) Cyanophyta, (2) Rhodophyta, (3) Cryptophyta, (4) Dinophyta, (5) Xanthophyta, (6) Chrysophyta, (7) Bacillariophyta, (8) Phaeophyta, (9) Prochlorophyta, (10) Euglenophyta, (11) Chlorophyta and (12) Charophyta. In 1984, for the convenience in practical work, phycologists agreed that the FLORA could be written separately into two parts, the FLORA of Marine Algae and that of the freshwater forms. Because the achievements of researches of the different algal groups are not at the same level, so the work could not be done according to the taxonomic sequence of the algal groups. We may try to publish first the group we have gotten more information and better results about it. And, at the same time, the numbers of the sequence of the volumes of the FLORA are also arranged not basing upon the taxonomic series but upon the priority of publications. Thus one volume may be separated

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1) Liu Guoxiang and Bi Liejue reported *Oedocladium prescottii* Islam from Wuhan in 1993, so all the 3 genera of the Oedogoniales(-aceae) have been reported in China since then.

into two or more parts if necessary.

In 1988, the first volume of the *Flora Algarum Sinicarum Aquadulcis* "Zygnemataceae" edited by Jao Chinchih was published. In it, 347 species of 9 genera were described, and the types of 219 species were all collected from China. Up to 1999, six volumes of the FLORA had been published, from those we may know it may be concluded that the specimens collected and used are at least 80% and at most 100% from the provinces, municipalities and autonomous regions in China. The descriptions and drawings with very few exceptions are all based on Chinese materials. The taxonomic systems of Chroococophyceae, Charophyta and Euglenophyta had been more or less modified by the editors. The percentage of the number of species in each volume, including the Oedogoniales, to that of the world records is remarkably as large as over 40%. The extreme one is 80% in Chroococophyceae. The number of endemic species is also distinct, for example, in Oedogoniales and Zygnemataceae, they are both over 50%.

The flora of Chinese freshwater algae are plentiful, and the floral composition is evidently peculiar. However, there were still quite a lot of problems to be solved in the editing of the FLORA.

First, in some examples the record of provincial distribution of the country is insufficient. It is unreasonable for a big province to have recorded only a single species. In a number of old literatures, the species description is usually either too simple or lacking, and the drawings are also wanting. For many species, it is very hard to check up with more information because it was reported only once for a very long time. And, an unconquerable difficulty is that the majority of the types, especially in the earlier publications, could not hope some improvements can be made in the successive volumes.

Second, except the Prochlorophyta, freshwater algae could be found in each of the 12 Divisions of algae. Unfortunately, there are a number of subgroups under the Divisions which have not yet been studied especially in the Xanthophyta, Chrysophyta and Cryptophyta. Many dinophytes are investigated by zoologists. In addition, some genera with reputation as "big" taxa, such as the *Navicula*, *Cosmarium*, and *Scenedesmus*, etc., have yet not been collected and studied enough in China.

Third, the taxonomy of algae is a science both old and young. In the past hundreds of years, numerous and valuable information was accumulated. New conceptions in taxonomy and systematics are arising in proceedings of the additions of new taxa, and particularly new facts and ideas are appearing from the new means such as the electron microscopy, culture and molecular biology. The suitable way may be making comprehensive studies in these fields. Unfortunately, this is at present nearly a blank in the phycology research of freshwater algae in China. The combination of traditional and modern methodology is of course necessary and urgent. It is universally hope that more improvements could be achieved in the following volumes.

For the flaws and mistakes in both of the volumes ever published and those to follow, any



suggestions and corrections are welcomed by the authors.

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