



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 四 卷

硅 藻 门

舟形藻科 (I)

李家英 齐雨藻 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)

科 学 出 版 社

北 京

## 内 容 简 介

本卷系统、全面地总结了我国近一个世纪以来有关舟形藻科(I) (除舟形藻属 *Navicula* 和羽纹藻属 *Pinnularia* 外) 的分类学研究成果。记述了双壳缝目舟形藻科(I) 14 属, 253 个分类单位, 其中有 141 种, 88 变种, 16 变型, 8 变种变型。属于我国模式产地的有 16 种, 14 变种, 3 变型, 4 变种变型。对每一个分类单位均以我国的标本进行形态特征、构造描述, 详细记录了生境、产地和分布, 并附有根据我国标本所绘的图或照片, 或二者兼有。有些还在种之下附有简短的讨论和说明。书后附参考文献、英文的各级分类检索表和名称索引。

本卷所收录的分类单位(包括种、变种、变型和变种变型) 就一个国家而言, 是目前全世界同类专著中最多的。

本书可供生物学、植物学、藻类学、环境科学和地质学以及相关学科的研究和教学人员参考。

### 图书在版编目(CIP)数据

中国淡水藻志.第14卷, 舟形藻科.1/李家英, 齐雨藻主编. —北京: 科学出版社, 2010

(中国孢子植物志)

ISBN 978-7-03-029232-2

I. 中… II. ①李…②齐… III. ①藻类-植物志-中国②硅藻门-植物志-中国 IV. Q949.2

中国版本图书馆 CIP 数据核字(2010)第 199861 号

责任编辑: 韩学哲 / 责任校对: 邹慧卿

责任印制: 钱玉芬 / 封面设计: 槐寿明

科学出版社 出版

北京东黄城根北街16号

邮政编码: 100717

p://www.sciencep.com

双青印刷厂 印刷

科学出版社发行 各地新华书店经销

2010 年 8 月第 一 版 开本: 787×1092 1/16

2010 年 8 月第一次印刷 印张: 14 1/4 插页: 10

印数: 1—1 000 字数: 400 000

定价: 80.00 元

(如有印装质量问题, 我社负责调换)

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(2007年5月)

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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；是生物物种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。

我国气候条件复杂，山河纵横，湖泊星布，海域辽阔，陆生与水生孢子植物物种多样性极其丰富。中国孢子植物志的陆续出版，必将为我国孢子植物资源的开发利用，为我国孢子植物科学的发展发挥积极作用。

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%（其中世界最高峰珠穆朗玛峰为 8848 米），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%。这其间山地、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

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<sup>1)</sup> 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。

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。

毕列爵（湖北大学，武汉 430062）

胡征宇（中国科学院水生生物研究所，武汉 430072）

1997年8月18日

# 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 (including the top mountain of the world Qomolangma in 8848m), 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 Shanghao(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.

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<sup>1)</sup> 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.

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 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.

Bi Liejue (Hubei University, Wuhan, 430062)

Hu Zhengyu (Institute of Hydrobiology,CAS, Wuhan, 430072)

August 18, 1997

# 前言

本卷册是《中国淡水藻志》的硅藻门羽纹纲 *Pennatae* 的第三卷, 包括双壳缝目 *Biraphidinales* 舟形藻科 (I) 中的 14 个属, 共计 253 个分类单位, 其中有 141 个种, 88 个变种, 16 个变型, 8 个变种变型, 采集地涵盖了我国的 31 个省、自治区、直辖市和香港特别行政区。

近十多年来, 硅藻分类中经典分类与分子系统学相得益彰, 有许多新的进展, 新的发现。新属、新种、新科、新目, 甚至新纲都逐项被报道。

1999 年, Elisabeth Fourtanier 和 Patrick Kociolek 在著名的《硅藻研究》(*Diatom Research*) 杂志发表了《硅藻属志》(*Catalogue of the Diatom Genera*) 专辑, 报道了硅藻 1016 个属 (其中 907 个属名是有效的)。比此前 Van Landingham (1967—1979) 的《化石与现生硅藻属种及其异名名录》(*Catalogue of the Fossil and Recent Genera and Species of Diatoms and their Synonyms*) 所统计的 886 个属及亚属更为全面。

Fourtanier 和 Kociolek (1999) 还总结了硅藻分类学史, 概述了从 18 世纪 Leeuwenhoek (1703) 第一个报道硅藻, 到 19 世纪硅藻分类学快速发展的经历。特别是 Ehrenberg (1830, 1873)、Kützinger (1833, 1854)、Rabenhorst (1853—1868)、Greville (1827, 1866)、Grunow (1860—1886) 以及此后许多硅藻经典分类的学者发表了奠定今天硅藻分类基础的大量著作。20 世纪又报道了 150 个新属名称。20 世纪 70 年代, 电子显微镜应用于硅藻分类, 使硅藻分类学有了全新的发展, 最重要的是 G. Hasle 关于硅藻中两种突起: 唇形突 (labiate processes, 也称 rimotoportula) 及支持突 (strutted processes, 也称 fulcrotoportula) 的发现及应用, 大大地推进了硅藻分类学和系统学的进步。齐雨藻和张子安也于 1977 年第一次在我国的硅藻研究中应用电子显微镜技术报道了硅藻分类成果。这一时期, 最重要的硅藻分类学著作是 Round、Crawford 和 Mann (1990) 撰写的《硅藻诸属生物学和形态学》(*The Diatoms: Biology and Morphology of the Genera*) 一书。Round 等在他们的著作中记述了 43 个新属, 并对当时已知的各硅藻属都作了配有照片的描述。实际上, 硅藻新属、新种仍在不断增加, 截至 2007 年, Fourtanier 和 Kociolek 以后的几年又有许多新属刊布。Van Landingham (1967) 早就指出每年几乎有 50 种左右新种发表。

随着科学技术的发展, 特别是分子生物学新观点及技术在藻类分类学上的应用, 不仅有新的分类单位被发表, 而且针对整个硅藻系统学也提出了新的观点。

传统的硅藻分类系统是把硅藻门 (或纲) 分为两大类, 即中心纲 *Centricae* (或中心目 *Centrales*) 及羽纹纲 *Pennatae* (或羽纹目 *Pennales*)。20 世纪 70 年代至 90 年代, Simmenson (1979)、Round 等 (1990) 及 Medlin 等 (1993) 根据硅藻的有性生殖特征及壳面结构和壳缝等修改了硅藻的传统分类系统, 将硅藻分为三大类: ①圆筛藻纲 *Coscinodiscophyceae*, 行卵配生殖, 辐射对称; ②脆杆藻纲 *Fragilariophyceae*, 行异配生殖, 无壳缝的羽纹硅藻; ③硅藻纲 *Bacillariophyceae*, 行异配生殖, 具壳缝的羽纹硅藻类。



这一分类系统被广为接受, Round 等 (1990) 的巨著中作了详尽的分析。

分子系统学的研究, 进一步认识到硅藻的进化不是单系的, 而是并系起源的 (Medlin *et al.*, 1993)。他们分析的小亚基 rRNA (SSUrRNA) 序列表明, 硅藻可分为两支: 第 1 分支 (clade I) 为辐射状中心纲; 第 2 分支 (clade II) 为两极中心纲, 即辐射海链藻目及羽纹纲。

Medlin 和 Kaczmarska (2004) 及 Sims、Mann 和 Medlin (2006) 在对硅藻起源、细胞学、形态学和分子生物学研究的基础上, 综合硅藻复大孢子 (auxospore) 细胞中高尔基体、蛋白核特征、动精子结构及细胞壁特征和分子序列分析, 提出了硅藻分类的新系统 (Medlin & Kaczmarska, 2004), 其系统如下。

硅藻门 Bacillariophyta

圆筛藻亚门 Coscinodiscophytina Medlin & Kaczmarska

营养细胞具辐射对称的壳面, 高尔基体通过内质网与线粒体相联 (G-ER-M) 并散布于原生质中 (类型 I)。有性生殖为卵配, 动精子主要是小型配子, 复大孢子壁覆有鳞片。

本亚门具 1 个纲。

圆筛藻纲 Coscinodiscophyceae Round & Crawford, emend. Medlin & Kaczmarska

现存和化石的中心硅藻, 其细胞主要具周生突起 (即唇形突、形成群体的突起), 有的突起很少或次生为中央位; 细胞上的纹饰为中心辐射状。现存硅藻的细胞中高尔基体通常排成 G-ER-M 模式。细胞含有一层被膜的蛋白核, 其上横载并不和内质网相连的一个或几组膜。有性生殖为卵配式, 复大孢子表面覆有鳞片, 动精子主要是小型配子; 精子长形, 内有细长的核及伸长的线粒体, 但在成熟的精子中可能不存在高尔基体 G-ER-M 模式。

本纲有下列各目: 圆筛藻目 Coscinodiscales、环毛藻目 Corethrales、根管藻目 Rhizosoleniales、直链藻目 Melosirales、正裂藻目 Orthoserales、沟链藻目 Aulaserales、金盘藻目 Chrysanthemodiscales、斑环藻目 Stictocyclales、星纹藻目 Asterolamprales、蛛网藻目 Arachnoidiscales、斑盘藻目 Stictodiscales、筛盘藻目 Ethmodiscales 及细柱藻目 Leptocylindrocales。

硅藻亚门 Bacillariophytina Medlin & Kaczmarska

营养细胞壳面主要是两极的或多极的, 中心型或羽纹型, 细胞中高尔基体在细胞核周围 (类型 II)。有性生殖为卵配 (中心型) 或异配或同配 (羽纹型), 主要是整体配 (全融合) (hologamous)。大多数复大孢子壁带纹或具鳞片。

本亚门具 2 个纲。

间藻纲 Mediophyceae (Jousé & Proschkina-Lavrenko) Medlin & Kaczmarska

现存及化石的中心硅藻类具有各种突起 (即唇形突、支持突或喙状突), 主要位于细胞中央或在环带 (annulus) 中, 很少具附加的周缘突起 (海链藻目例外, 细胞具多轮边缘闭塞突); 细胞通常为两极或多极的具放射状纹饰。现存种类的高尔基体位于细胞核周围。在两极或三极的中心类硅藻多形成多个蛋白核的质体, 则与分化 I (clade I) 的情形相同。有性生殖为卵式配, 复大孢子周生。初生壁具硅质鳞片, 或还有硅质的带纹 (海链藻目例外, 其复大孢子同分化 I)。动精子主要是全配式的, 精子通常为类球形, 核和