硅藻彩色图集

Colour Plates of the Diatoms

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前　言

硅藻是一类常见的，经济价值高的单细胞藻类(也称微藻)。大多数水生，几乎在所有水体里都能生长，只有少数生活在潮湿的泥土里、树皮上、苔藓中……。硅藻种类繁多，有化石的和现在生存的种类，前者在不同地质年代里有不同的硅藻种类。现在生存的硅藻，由于环境的不同，其种类组成和数量都呈现明显的时空差异，不但海、淡水域随季节而不同，而且，从低纬度到高纬度种类减少，数量增多。随着水深的增大，无论种类组成或是数量均减少。在真光层以下水域则无法进行细胞分裂。

在广袤的海洋中、江河湖泊里，除了沿岸的浅水地带有高等植物和大型藻类外，主要是浮游植物。硅藻是浮游植物中的最主要成员之一。据估算，硅藻和其他浮游的单细胞藻类，年产达5500亿吨。它们具有旺盛的光合作用能力，能把水体中的无机物合成为蛋白质、脂类、糖类及其他化合物，是原初基本物质的生产者，在生物圈的物质和能量循环中居重要地位。它们和其他自养性生物是消耗者的初级能量来源，是需氧动物的氧的来源。据报道，浮游植物每年制造的氧气就有 360 亿吨，占地球大气氧含量的 70% 以上。同时，每年还制造 160 亿吨的总碳酸气、70 亿吨的硅和大约 40 万吨的磷等。所有这些都使地球上的动物界，包括人类在内得到了恩惠。

人们不可能像在陆地上收获作物一样，直接食用这些肉眼见不到而又多如恒河沙数的单细胞藻类。尽管人类可以通过大量培养、分离提取硅藻所含的微量营养物质，诸如脂肪、胡萝卜素、EPA 等，但更多地是通过食物链进行物质和能量的传递。在食物链中经过二、三级，甚至四、五级的转化，才变成人类食用的鱼、虾、贝等经济品种。俗话说："大鱼吃小鱼，小鱼吃虾米"，那么"虾米"吃什么？就是吃这些微型的浮游植物了。有人估

计，海豹长膘 1 磅[①] 需耗半吨硅藻。

硅藻繁殖很快，在某些特定的环境下，生活在水体中的硅藻能以惊人的速度生长、繁殖，有的每隔 4 小时就能繁殖一倍，甚至在短短的几天里可能生成亿万个后代。它们无边无际的繁殖能改变数万平方公里洋面的颜色。最后这些硅藻吸收完水体中的营养物或生活条件的改变，就大批大批地死亡而下沉，使大片的海底、湖底铺上一层硅藻沉积物，有的厚达 300 米。在千百万年间，随着大洋的上升和陆地的移动，这些沉积物变成为丰富的硅藻土矿床。

在德国中生代(Mesozoic)的侏罗纪(Jurassic)地层里(距今 180～135 百万年)，Rothpletz（1869）发现了两种圆箱藻（*Pyxidicula*）。以后的研究表明，自中生代以来各地质时期均有分布。由于其数量丰富，种类繁多，易于保存，对环境因子反应灵敏等特点，近二三十年来，已被人们作为一种主要手段应用于古海洋学、地质学的研究中。随着地质矿产资源调查，勘探事业的进一步发展，对微体古生物研究成果的需求也日益迫切，有关化石硅藻的分类和时间、空间分布的调查工作，正在世界各国争先恐后地向前推进。尤其在深海洋底，由于海水很深，几乎不含石灰质微体化石，因而，硅藻化石几乎成为划分那里的第三纪(Tertiary) 和第四纪(Quaternary) 地层提供了唯一有效的古生物学标志。

值得一提的是，由于水体中硅藻数量巨大，对水面尸体内脏的解剖，可以作为是否是溺死的指标，为法医审案提供科学依据。

无论是硅藻的分类研究，还是应用研究，都是以研究硅藻壳体外形和壳壁上的各种微细构造为基础。硅藻的壳壁是由非晶质氧化硅(SiO_2)和果胶质(Pectin)组成，厚度大多数都在 1 微米以下。沉积物中的硅藻壳(遗骸)或经酸处理后的硅藻壳只有硅质壁而没有果胶。它们的壳体很微小，一般只有十多微米到几十微米。据资料记载，已发现的最小硅藻只有 1 微米，最大的硅藻也仅 3～4 毫米。但其壳壁却呈现千姿百态、绚丽多彩的花纹

① 1 磅 = 453.59 克。

和图案，经千百万年的风霜雨露，仍然完好如初。这不但是分类学家借以认识硅藻的依据，同时也为美学家提供丰富的、取之不竭的素材。

地球这个特定的环境，创造出形形色色、多种多样的生物界。硅藻是地球生物多样性的一个组成部分，由于自然界的不断激烈变化，有些种类灭绝了，它们只能在某一地质年代中见到，有些种类战胜恶劣环境，逃脱无数次浩劫，繁衍至今，甚至可以追溯到千百万年的盘古时代。根据现有资料统计，全世界的硅藻约有 300 个属，11200种（包括仅出现在某一地质年代，现已灭绝的种类）。本图集并非全是中国的记录种类，因为材料来源有中国国内的，也有中国以外地区的，包括公海和大洋底沉积的硅藻遗骸（化石）。这些虽然只是硅藻世界中很小的一部分，但它对硅藻学、水域生态学、地质学、微体古生物学等方面研究提供有益的资料。可供大专院校海洋系、生物系、水产系、地质系师生及从事水产和地质科学的人员阅读参考。最后，在我们赞叹硅藻壳壁构造的神奇、奥秘之余，一定会对我们这个星球生物的多样性有更深刻的认识。

承李少菁教授提出一些宝贵意见，特此致谢！

著　者

1995 年 10 月 30 日

INTRODUCTION

Diatoms are common unicellular algae or the so-called microalgae with high commercial value. Most diatom are aquatic, of which a great majority can grow in all kinds of water areas and only a small part nearly live in the wetland, on the bark of the tree, in the mosses and so on. There are various diatom species including fossil and living diatoms. Fossil diatoms are species vary in different geological ages. For living diatoms, significant tempore and spatial variations of both composition and quantity of species was found because of the difference of their living environment, such as seasonal variation of both sea water and fresh water, the decrease of species and the increase of individual abundance from lower latitude to higher latitude, the decrease of species and their individual abundance with water depth, and the impossibility of cell division in water depth under euphotic layer.

Except some higher plants and macroalgae living only in shallow coastal areas, in the expanse oceans, seas, rivers and lakes, there are phytoplanktons, of which diatom is the major flora. It is estimated that the annual production of diatom and other planktonic unicellular algae is up to 55×10^{10} t/a. Diatoms are primary producers, which can absorb inorganic compounds from water and transform them into protein, lipid, carbohydrate and other compounds through active photosynthesis. In material and energy cycles of biosphere, diatom-original organisms play an important role, it and other oxygen-indepent organisms are the source of primary energy of comsumers and the source of oxygen of oxygen – comsumring animals. It has been reported that phytoplankton can produce 3.6×10^{10} t/a of oxygen (accounting for over 70% of earth oxygen), 1.6×10^{10} t/a of total carbon acid gas, 0.7×10^{10} t/a of silica, and about 4.0×10^{5} t/a of phosphorus, which are great benefits to animals including the human race on the earth.

It is impossible for us to harvest these abundant tiny unicellular algae like we harvest crops at land. Although people can seperate and extract some micronutrients (such as carotene, EPA and polyunsaturated liopids) through agreat mass of culture, more often microalgae should be transformed by two or three levels and even four to five levels in food chain in material and energy before they become human food such as commercial fish, shrimp and mollusca. It is commomly said that "while big fish eat small fish, small fish eat small shripms." What small shrimps eat are the small microphytoplankton. It is estimated that a seacalf will comsume a half ton of diatoms to grow up 1 pound.

Diatoms reproduce very fast, especially under certain special environment they can grow and reproduce in amazing speed; some species can be double in cell numbers every four hours, even multiplying to hundreds of millions of cells in a short of a few days.

The great majority of diatoms can change the colour of ocean surface of hundreds of thousands of square kilometers. Diatoms die and settle on the sea floor down when the nutrient of the water were nearly exhausted by them or the living conditions were changed to be unsuitable for their growth, thus their bones will form the diatom sediments on a large scale on the ocean floor or lake bed. The depth of the diatom sediments may be up to 300 m. These sediments become an abundant diatom ore deposit because of the upward movement of ocean and the movement of land during hundreds of thousands of years.

Two species of *Pyxidicula* were found by Rothpletz (1969) in B.P. sediment strata of Jurassic (180～135 Ma B.P.) in Mesozoic in Germany. Later studies show that it has been distributed in various geological period since Mesozoic age. In recent three decades, diatom has been used as an important indicator in studies of paleo-oceanography and geology because of its great quantities and abundant species, easy preservation in sediments, and its sensitive reaction to environmrnt. Investigation of micropalcontology is becoming more and more necessary with the further development of mineral resources explorations and ivestigations on taxonomy and temporal and spatial distribution of fossil diatoms have been competed all over the world. On the bottom of deep ocean, as there are almost not nay calci-microfossils, so the diatom fossil becomes almost an efficient indicator for paleontology studies of dividing the Tertiary and Quaternary strata.

It should be mentioned that diatom can be used as a good indicator for the judicial bench to scientifically judge whether or not a dead person in water is drown.

Investigations on morphorlogy and fine structure of diatom valvae are essential both for diatom taxonomic studies and application studies. Diatom valve is composed of non－cryatal SiO_2 and pectin, most of which are as thin as below 1 μm. Diatom valves in sediments or acidized diatom valves have silicified valve without pectin. The valves are very tiny, usually from around ten to tens of microns. It was reported that the smallest diatom which has been recorded up to now is 1 μm, and the biggest one is about 3～4 mm. However, diatom valves show various kinds of beautiful appearance with their striae. The valves can remain well after millions, upon millions of years of environmental changes. The beautiful appearance of diatom is a very good ceation source for artists as well as a good taxonomy feacture for diatomists.

The special environment of the earth has been creating the diversified world of life with different kinds of organisms of which diatom is a component. Because of the great changes of the naturel world, some diatom species are extingurshed, which can be found in certain geological ages; other species were recorded to be as early as to hoary antiquity ages thousands of millions of years ago, survived to the present after defeating poor environmental attacks. The statistics showed that there are 300 genus and 11200 species of diatom in the world (including the extinct species in a certain geological age). Not all the species in this collection are Chinese records, as the samples are both from China and outside China, including fossil diatom samples from sediments of deep seas and oceans.

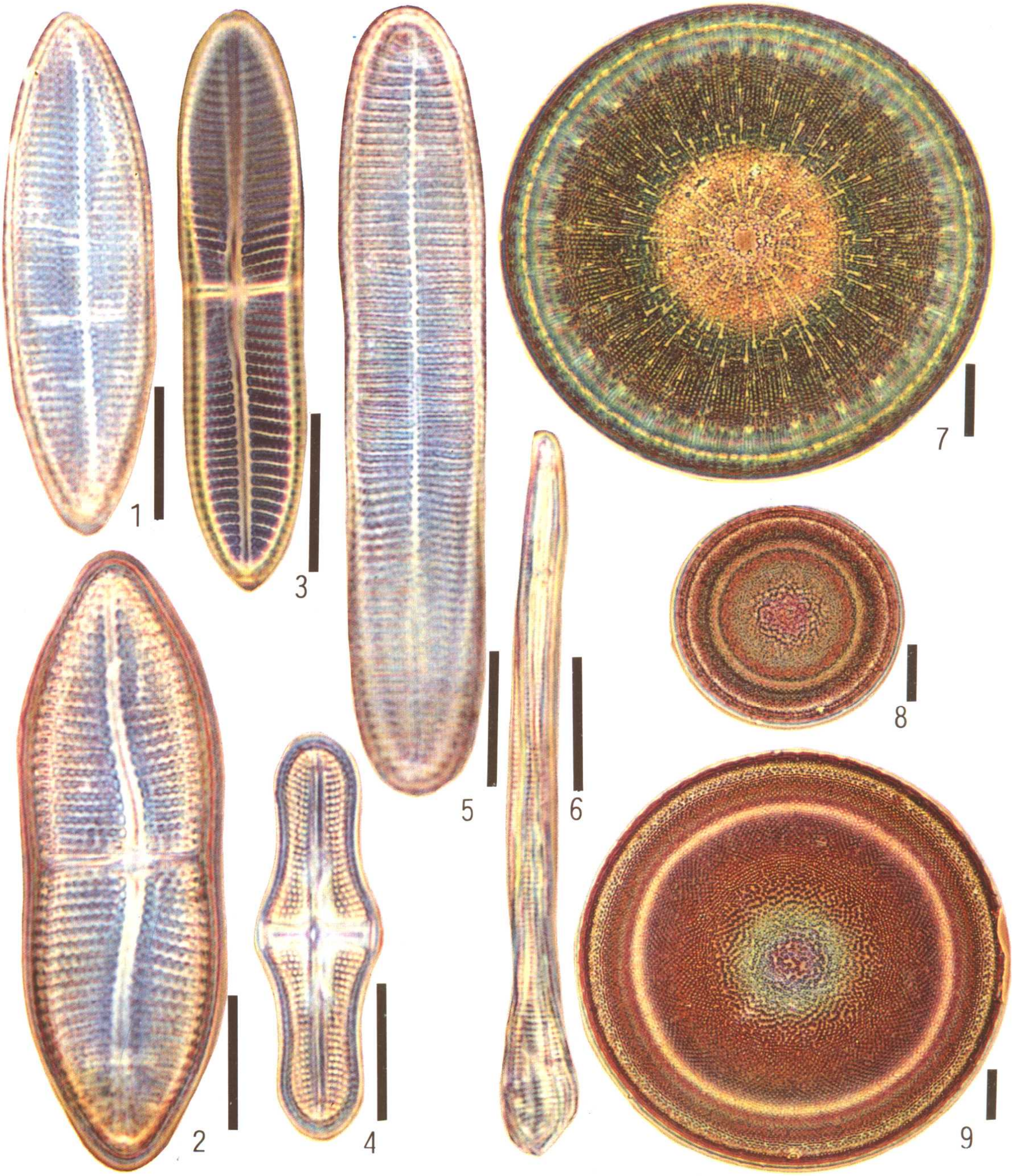
Although the species collected in this colourful collection are only a part of the great diatom world, the collection will supply as a good reference for studies in diatomology, hydroecology, geology, micropaleontology and other fields, which can be used as a reference book for teachers and students of oceanography, biology, fisheries and geology and for researchers of fisheries and geological science.

We are sure that the great diversities of the world's organisms will be further recognized while we are thrilled at finding the mystical, profound and beautiful appearance of diatom valves.

We would like to thank Professor Li Shaojing for his valuable comments.

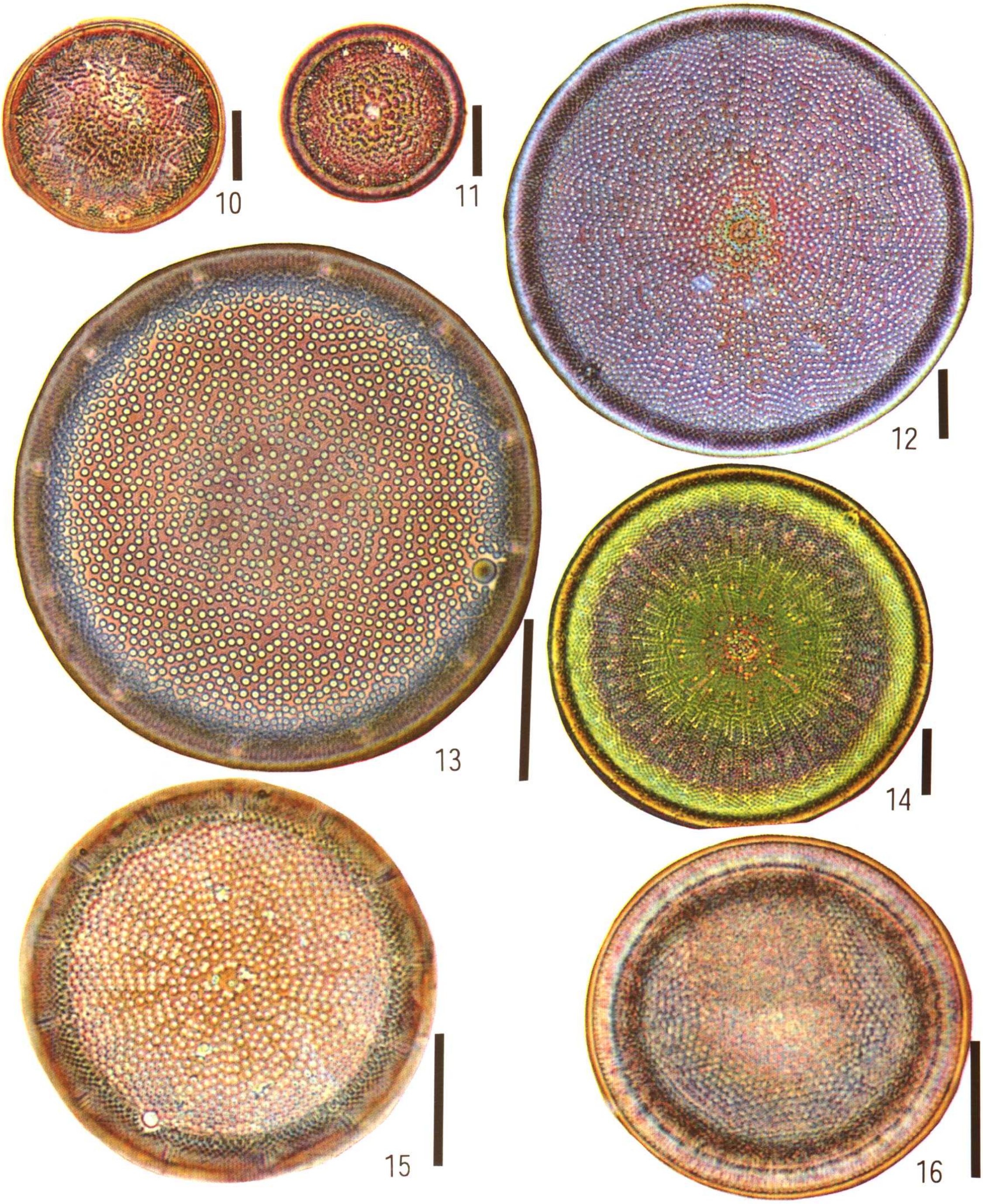
Authors

October 30, 1995

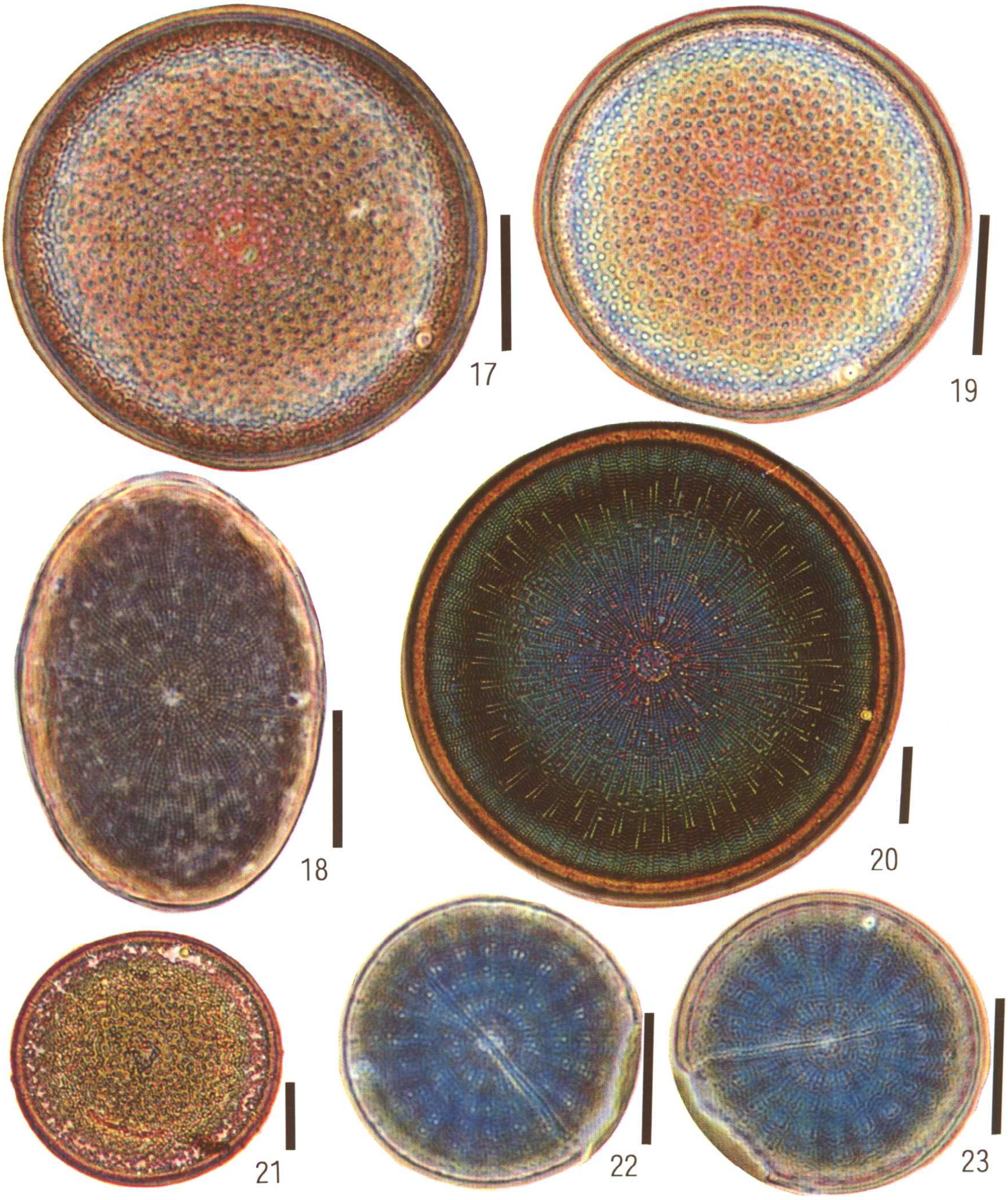


1～3. *Achnanthes brevipes* Agardh 4. *Achnanthes inflata* (Kuetz.) Grunow 5. *Achnanthes longipes* Agardh 6. *Actinella brasiliensis* Grunow 7. *Actinocyclus barklyi* (Coates) Grunow 8, 9. *Actinocyclus confluens* Grunow Scale bar = 10μm

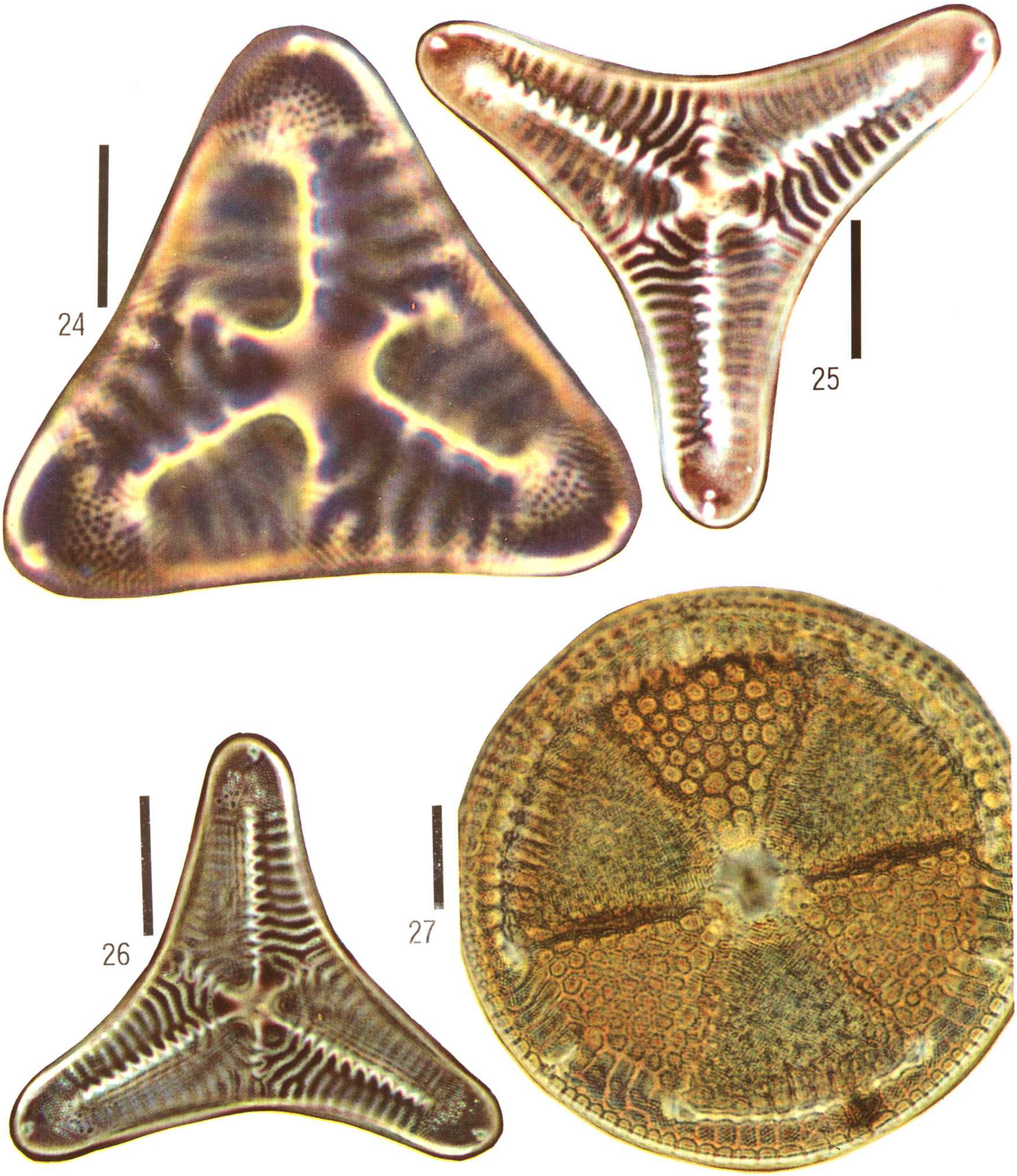
Plate 2 **图版 2**



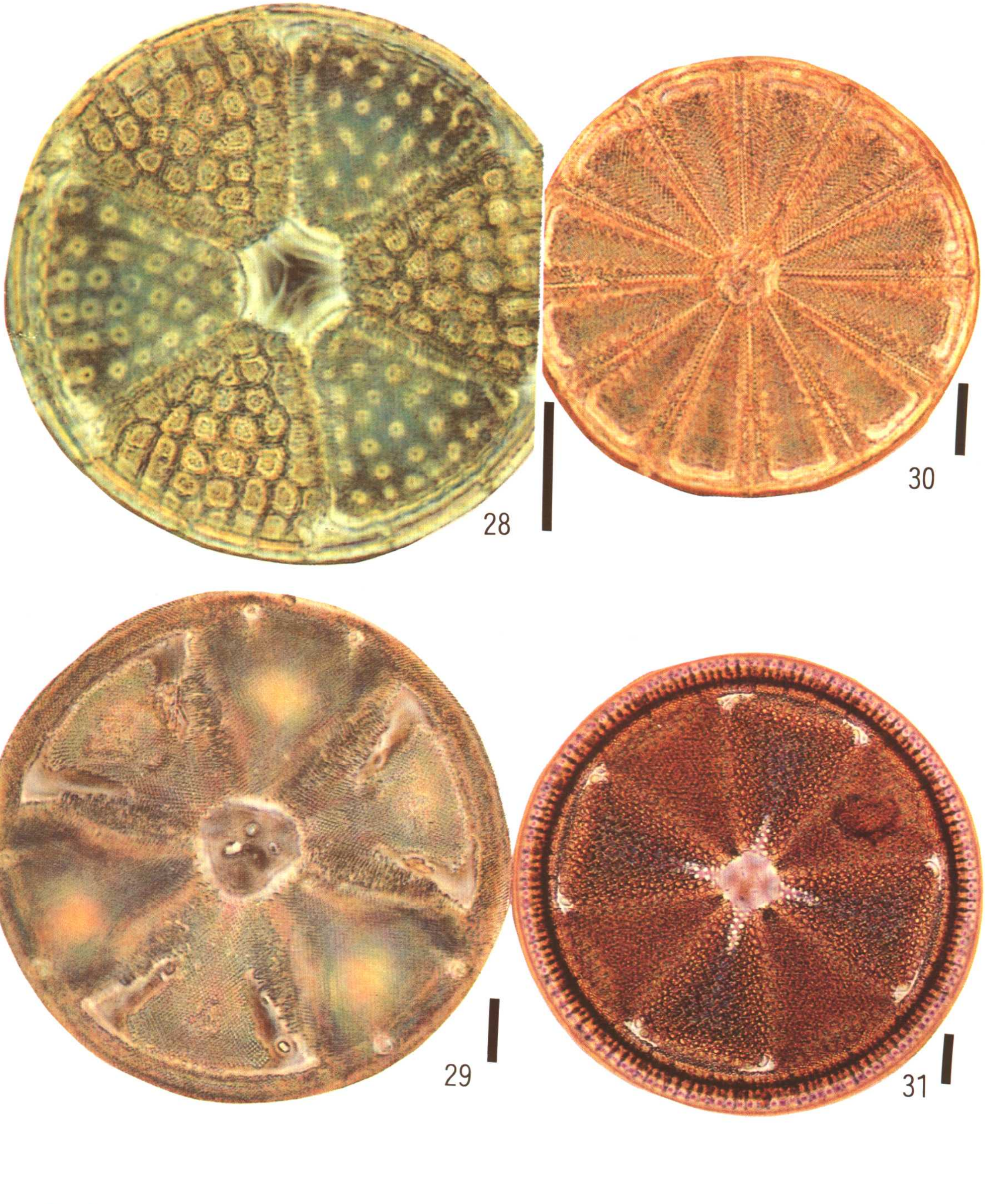
10, 11. *Actinocyclus disseminatus* Pantocsek 12 ~ 15. *Actinocyclus ehrenbergii* Ralfs 16. *Actinocyclus oliverianus* O' Meara



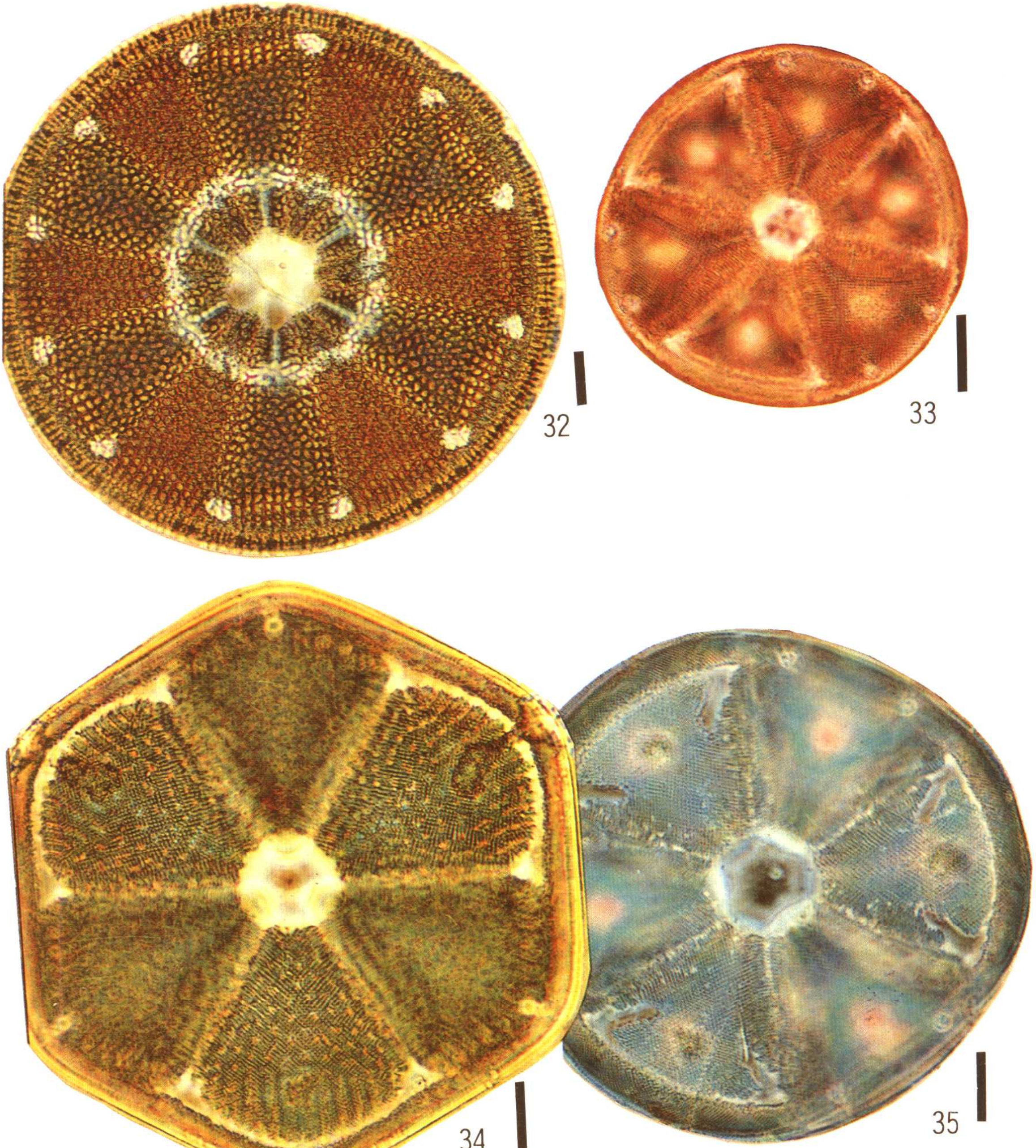
17. *Actinocyclus pruniosus* Castracane 18. *Actinocyclus roperii* (Breb.) Grunow 19. *Actinocyclus rotula* Brun 20. *Actinocyclus splendens* Rattray 21. *Actinocyclus* sp. 22, 23. *Actinocyclus subtilis* (Greg.) Ralfs



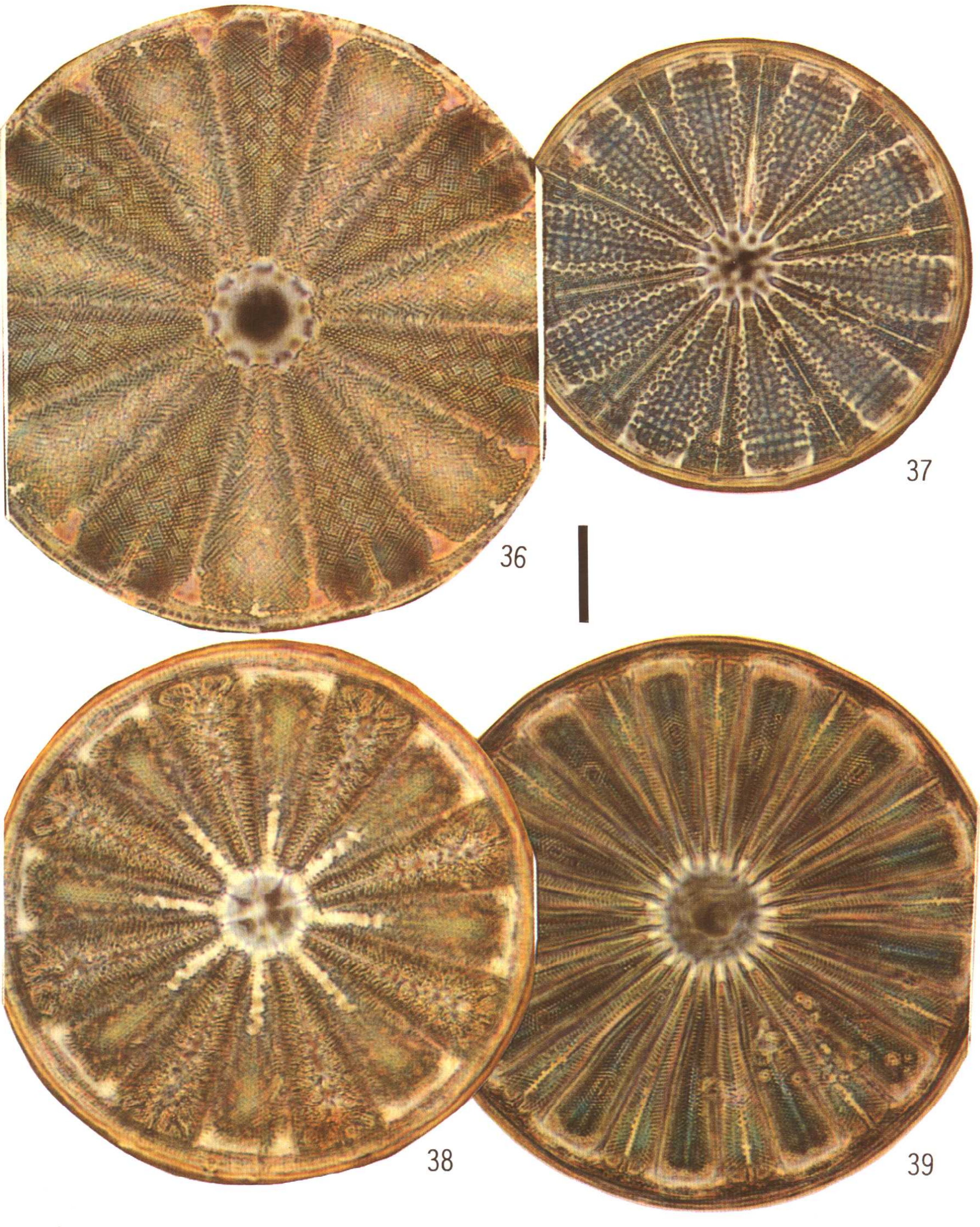
24～26. *Actinoptychus annulatus* (Wall.) Grunow 27. *Actinoptychus africanus* Leuduger－Frotmorel



28. *Actinoptychus bismarkii* A. Schmidt 29. *Actinoptychus boliviensis* Janisch 30. *Actinoptychus capensis* Grunow 31. *Actinoptychus heliopelta* Grunow



32. *Actinoptychus heliopelta* var. 33. *Actinoptychus hexagonus* Grunow 34. *Actinoptychus gruendleri* A. Schmidt 35. *Actinoptychus grunowii* A. Schmidt



36. *Actinoptychus maculatus* (Grove et Sturt) A. Schmidt 37, 38. *Actinoptychus splendens* (Shadb.) Ralfs 39. *Actinoptychus splendens* var. *helionyx* Grunow