TUTKIMUSRAPORTTI
REPORT OF INVESTIGATION 106

Risto Tynni

Diatoms from Lake Pulmankijärvi, northern Finland and the coast of Varangerfjorden, northern Norway

GEOLOGIAN TUTKIMUSKESKUS
GEOLOGICAL SURVEY OF FINLAND

Espoo 1991

GEOLOGIAN TUTKIMUSKESKUS
Tutkimusraportti 106

GEOLOGICAL SURVEY OF FINLAND
Report of Investigation 106

Risto Tynni

DIATOMS FROM LAKE PULMANKIJÄRVI, NORTHERN FINLAND AND THE COAST OF VARANGERFJORDEN, NORTHERN NORWAY

Espoo 1991

Tynni, Risto, 1991. Diatoms from Lake Pulmankijärvi, northern Finland and the coast of Varangerfjorden, northern Norway. *Geological Survey of Finland, Report of Investigation 106.* 34 pages, 3 figures and 42 plates.

The first part of this paper deals with the diatom flora of Lake Pulmankijärvi, 25 km southwest of Varangerfjorden. The lake was isolated from the Arctic Ocean during the Litorina stage but the bottom of the basin is still below sea level. Special attention is paid to any relict diatoms.

The second part of the paper describes the dominant diatoms in the littoral zone of Varangerfjorden, especially brackish and saline forms, although some occurrences interpreted as new species or forms were also encountered in the diatom flora. The marine species are compared with marine forms in Eemian deposits in Finland and with recent species in the western Baltic Sea.

Key words: diatoms, ecology, taxonomy, lacustrine environment, marine environment, Holocene, Lake Pulmankijärvi, northern Finland, Varangerfjorden, northern Norway.

Risto Tynni:
SF-07510 Vakkola, Finland

ISBN 951-690-443-2
ISSN 0781-4240

CONTENTS

OBSERVATIONS ON DIATOMS IN THE PULMANKIJÄRVI AREA, NORTHERN FINLAND

Introduction

Pulmankijärvi, a 10 km long and 1.5 km wide lake in Utsjoki, northernmost Finland, is divided between Finland and Norway approximately at latitude 70, most of it being in Finnish territory. The lake, which is 20—35 m deep, was connected with the Arctic Ocean as a fjord via the lower reaches of the Tenojoki when the sea level was over 15 m higher than it is at present. Pulmankijärvi was isolated from the fjord about 4 500 years ago. The shore level displacement curve for the Varangerfjorden area corresponds to isobases that are slightly lower than Pulmankijärvi. The concept of shore displacement is based on studies undertaken by Donner, Eronen and Jungner (1977) and on radiocarbon dating on mussel shells.

Studies on glacial and postglacial evolution have previously been conducted in the Pulmankijärvi area (Fig. 1), special interest focusing on geomorphology (Mansikkaniemi 1964, 1967, Mansikkaniemi and Mäki 1988). The study of Mansikkaniemi and Mäki (1988) deals with the young meanders of the Pulmankijoki, which discharges into Pulmankijärvi. Test catches made by the Game and Fishery Research Institute demonstrate that flounder, a sea fish, regularly rises along the Tenojoki up to Ala-Köngäs and Pulmankijärvi. Flounder thrives in Pulmankijärvi all year round (Mattsson 1982). The Game and Fishery Research Institute has studied the chemical composition and temperature of the water in Pulmankijärvi. In the early 1980s, the average pH of water in August was neutral, varying in the range 6.7—7.2. The temperature of the surface water was about 10 C and at a depth of 28 m 5.5 C (Niemelä & Vilhunen 1987).

As the bottom of the Pulmankijärvi basin is below sea level, the basin might be expected to offer a habitat for saline and brackish water diatoms, too. According to Fontell (1926), relict halophile diatoms are found in Finland in lakes and ponds close to the sea. However, more recent studies from the area are lacking. The diatoms in Pulmankijärvi present a rewarding subject when considering how diatoms adapt to life as relicts or how rapidly they react to changes in the chemical composition of water. As a starting point, it can be assumed that every year fish and birds transport a small marine diatom flora to Pulmankijärvi, lying as it does near the Arctic Ocean, and that fresh water has a strong impact on the lake basin due to the abundant annual inflow.

The sample material was collected and prepared by Kalevi Hokkanen in 1982. Most of the samples are surface sediments from the bottom of Pulmankijärvi on the Finnish-Norwegian border and from a transversal profile across the southern part of the lake. Some plankton samples and spade samples were also taken from the surficial parts of littoral sediments.

As well as diatom frustules, siliceous cysts of Chrysophycean flagellates were found in bottom sediments of the lake.

COMMON DIATOM SPECIES IN SAMPLES TAKEN FROM LAKE PULMANKIJÄRVI AND THE RIVER PULMANKIJOKI IN 1982

The most common diatom species in the plankton sample from the lake were *Asterionella formosa, Tabellaria flocculosa, Synedra ulna, Stephanodiscus alpinus* + *astraea* var. *minutula* and *Melosira distans* with variants. A very similar diatom flora was found on the bottom sediments (Fig. 2). The number of species on sediments (Table I, column 2) is higher than that in plankton samples (Table I column 1) owing to the greater number and variation in depth of samples of surficial sediments. Species that are common in the bottom sediments, but rare in or totally ab-

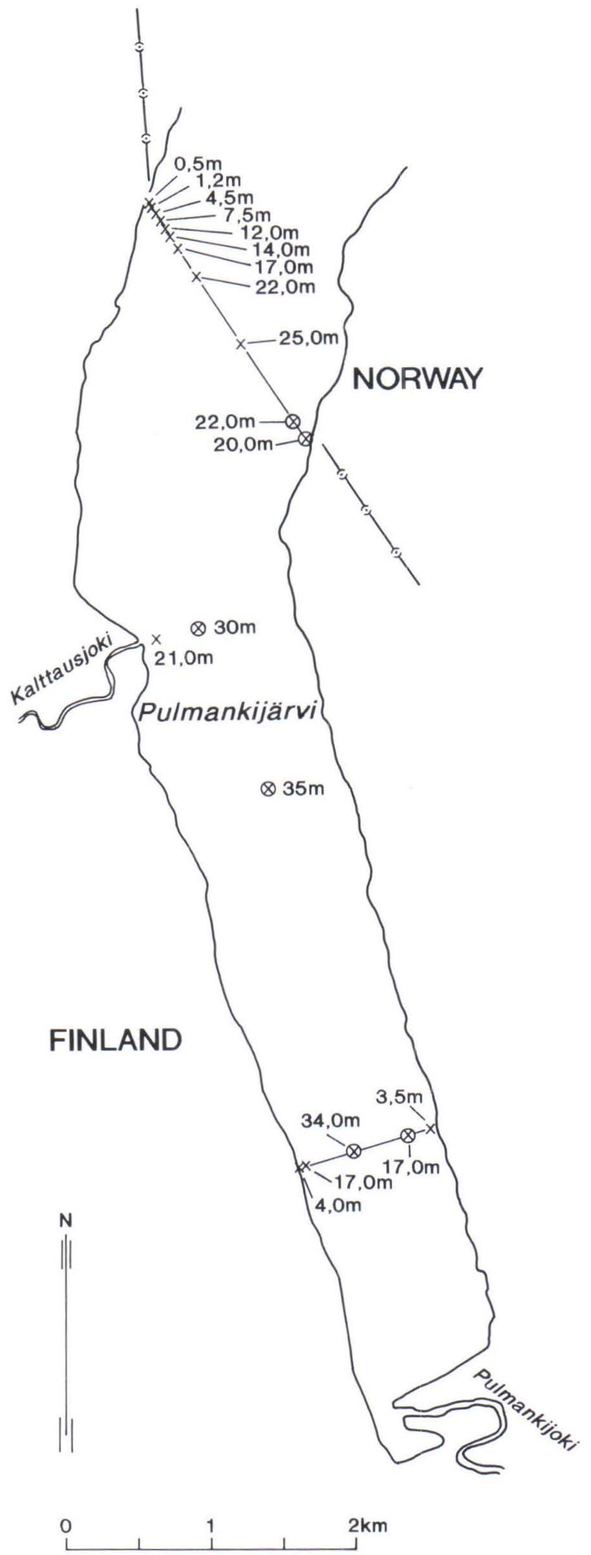

Fig. 1. The study area and the sampling sites.

sent from plankton, include *Surirella robusta, Cyclotella kutzingii* v. *radiosa* and *Diploneis elliptica* v. *ladogensis. Tabellaria fenestrata* is fairly common in plankton and surficial bottom samples although its abundance is clearly lower than that of *T. flocculosa.* The same situation prevailed in the Tornionjoki and Lake Kilpisjärvi (Tynni 1989), presumably because *fenestra* favours warmer water than *flocculosa.*

The flora on the bottom sediments derives mainly from planktonic diatoms sedimented to the bottom but also from epiphytic species such as *Achnanthes affinis* and *laterostrata* that are fixed to benthic vegetation and mineral matter close to the shore line.

As an epiphytic form, *Tabellaria flocculosa* could be expected to favour sites close to the shore line. However, it also occurs as the maximum species in the bottom sediments in the middle of the lake along line 1, except in restricted areas where *Surirella robusta* and *Melosira distans* with variants form the maxima (Fig. 2). *T. flocculosa* tend to enter plankton readily and many diatom species exhibit temporal habitat changes. Detaching from the substrate does not usually prevent epiphytes from growing; on the contrary, it promotes propagation of the species.

Didymosphaenia geminata, a big epiphytic species thriving in flowing water, is common only very close to the shore at depths of less than 4.5 m; deeper than that it is less common. Further from the shore, in deeper parts of the basin, where the coaser diatom frustula have been enriched due to wear, the species becomes more common again.

The proportions of saline and brackish water species are not shown in the diagram in Fig. 2, and, with the exception of some isolated occurrences of *Actinocyclus ehrenbergii* and *Synedra tabulata,* ecologically indisputable marine forms were not encountered anywhere. *Bacillaria baxillifer* occurs as a rare species in Pulmankijärvi. It is halophile and thrives in seas and fresh-water basins. *Rhopalodia gibberula* var. *producta* also occurs as a rare species in the bottom sediments of the lake (Table I). In the bottom samples taken from close to the shore, *Navicula salinarium, Nitzschia tryblionella* var. *victoriae* and *Diatoma elongatum* were more common than the above species. *Navicula salinarium* occurs mainly in brackish water, being, however, euryhaline, i.e. tolerating variation in salinity. *Nitzschia tryblionella* var, *victoriae* and *Diatoma elongatum* grow in both brackish and fresh water as long as the pH is at least 7. The halophile brackish-water diatoms encountered in Pulmankijärvi are probably relict adaptation forms which remained after the basin was isolated from the ocean. Before the isolation of the lake basin, fresh water streaming into the fjord-like estuary of the Tenojoki enabled brackish-water and fresh-water forms to flourish in the area for a long time.

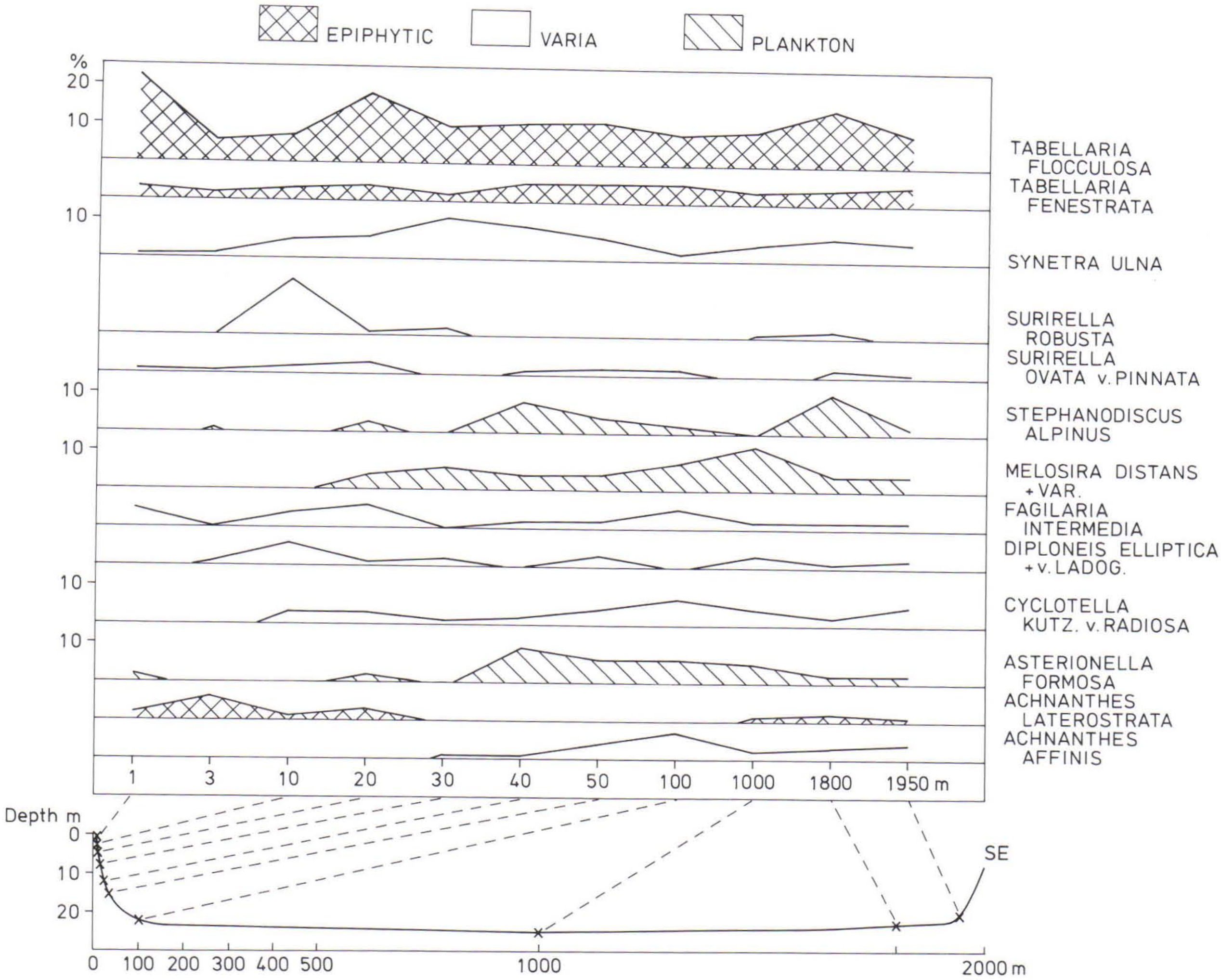

Fig. 2. Diatom diagram of the most common species from a transversal line across Lake Pulmankijärvi.

Taxonomic observations

Plates I-XIV show characteristic or rare diatoms of the Pulmankijärvi area.

The genus *Melosira* Agardt is retained in the nomenclature in accordance with the practice of Hustedt (1930). Simonsen (1979) moved the *Melosira granulata* group to the genus *Aulacosira* Thwaites.

Melosira italica fo, *laevis* Grun, (Pl. I, Figs. 1 and 2) resembles *M. italica* var. *semilaevis* Grun. There are also some similarities with *M. islandica* subsp. *helvetica* in terms of the longitudinal pore rows of the frustule. The density of the pore rows is c. 12/10 μ. According to Hustedt, *M. italica* f. *laevis* is a resting spore of *M. italica* with rounded end plates; these are not visible in Fig. 2, though. Figure 3 shows that the pseudosulcus is surrounded by long teeth unknown in *M. islandica.* The Pulmankijärvi form resembles *M. italica* (ssp. *italica)* fo. *laevis* (Miller 1971) described from the Leveäniemi interglacial deposit, but differs from it in the less well developed teeth construction. *Melosira turgida* (Ehrlich 1973, p. 9) is a form very similar to that of Pulmankijärvi, differing from it, however, in the deeper sulcus and less dense lines of pores.

Melosira italica f. *curvata* Hust, (Fig. 3) is a common form resembling the main form but differing from it in its curved shape.

Melosira distans var. *africana* Müller (syn. *M. distans* var. *pfaffiana* (Reinsch) Grun. (Fig. 5) resembles *M. distans* v. *humilis* with its short longitudinal rows of pores. The species was described as a subfossil from the River Poukani (Cleve-Euler 1951) and as a recent form from Swedish Lapland (Hustedt, 1942). In the Pulmankijärvi area the variant was found in bottom sediments of the lake and in plankton of the Kalttausjoki, which empties into the lake. *M. fennoscandica* Cleve-Euler also resembles the above form.

Cyclotella antiqua W. Smith (Figs. 6 a, b) is a known cold-water form. The ornamentation of the central discus varies. The species is rare in Pulmankijärvi.

Cyclotella iris Brun. (Figs. 9—11), another cold-water form, is more or less oval in shape. The central area in particular is oval with a tangentially bent surface. On September 18, 1982 the species was common in Pulmankijärvi plankton. It included forms with a tangentially strongly bent surface (Fig. 12), corresponding to the form of *Cyclotella vorticosa* Å Berg of Cleve-Euler (1951).

Cyclotella kützingiana var. *radiosa* Fricke (Figs. 12 and 13) is more common than the main form in the Pulmankijärvi area. The radial ornamentation of its centre varies. Morphologically the form resembles the smaller *Cyclotella* cf. *comensis* Grun. presented by Kling & Håkansson (1988), which measures < 10 μ in diameter. Both forms probably belong to the same species.

Cyclotella kützingiana var. *schumanni* Grun. (Fig. 14) is very similar to *C. iris*, but differs from it in being bigger, on average, more rounded and flatter in the central area. There are a few rather big nodules in the central area. The form was rare in Pulmankijärvi. According to Cleve-Euler (1951) it occurs as a pelagic form in big rivers and lakes, e.g. in Lapland.

Cyclotella stelligera fo. *tenuis* Hustedt (Fig. 15) is a small form which has been reported from the River Abisko, Sweden, at least (Hustedt 1942).

Stephanodiscus alpinus Hustedt (Figs. 16—20) closely resembles the Pulmankijärvi form. SEM pictures (Håkansson & Stroermer 1884) reveal details not visible in the Pulmankijärvi material under the light microscope. Theriot & Stroermer (1982) have presented light microscope pictures of material from Lakes Huron and Michigan which resemble those from the Pulmankijärvi occurrence. The Pulmankijärvi form is regular in terms of its discus spines and dense punctae which are radial close to the periphery. The spines are located at punctae sectors and have a density of 12/10 μ on the periphery. Close to the periphery the sectors have two overlapping punctae which continue towards the centre as a short row. In the large central area the punctae are less dense, occurring in radial and diagonally curving lines (clearest in Fig. 16). The diagonal lines are not visible in the pictures of Simonsen (1987, pl. 460: 6, 7; 461: 1—3). At the centre there is a separate group of punctae. The surface of the discus is flat at the margin but the centre rises slightly in a dome-like fashion. The discus is 22—30 μ in diameter, the average being 28 μ.

The form was common in the Pulmankijärvi plankton on August 18. 1982. The reference species (*S. alpinus)* is known as a cold-water form and seems to favour eutrophic conditions (Theriot & Stroermer 1982).

Stephanodiscus astraea var. *minutula* (Kütz.) Grun. (Fig. 21) is coarser than the former in structure and the punctae at the centre occur only in a radial array. It is also smaller, on average, measuring 18 μ. In many places in Pulmankijärvi the form was less common than *S. alpinus.*

Stephanodiscus sp. (Fig. 22) differs from the former in ornamentation having a denser structure of punctae. Close to the periphery the puncta sectors occur in rows of two, continuing then as single rows. Some of the radial sectors are short. The randomly punctuated central area is fairly small. The frustule is 26 μ in diameter. The species is rare in Pulmankijärvi. In its dense ornamentation the form resembles *Stephanodiscus tenuis* Hustedt (1939) although not completely (cf. Håkansson 1976, Håkansson & Stroermer 1984, where the form is considered as a variant of *S. hantzschii* Grun.) It bears a closer resemblance to *Cyclotella astrea* (Ehr.) Kutzing 1849, by Håkansson & Locker (1981, p. 19, 13)

Part of *Tabellaria flocculosa* (Roth) Kützing is an anomalous form (Fig. 24) fairly similar in asymmetry. It occurs in cold waters in Lapland, e.g. at Kilpisjärvi, Porojärvi and Pulmankijärvi. As *Tabellaria flocculosa* is often the dominant form in these areas, even the rare anomaly is readily recognizable. Owing to its high abundance the anomaly can hardly be attributed to adverse growing conditions but rather to factors contributing to the mutation, such as cold water under otherwise profitable conditions in terms of light and nutrients. The anomaly form of *T. flocculosa* resembles *genigulata* Cleve-Euler, a form that has evolved into a variant of *T. fenestrata* and which also favours fairly cold waters.

Anomalous forms of *T. flocculosa* have been found in some places e.g. in a crater lake in northern Canada (Grönlund et al. 1989).

Opephora martyi Heribaud (syn. *Fragilaria pinnata* fo. *subsolitaris* (Grun.) Mayer, *Opephora martyi* Herib. var. *martyi* (Patrick & Reimer 1966) resembles *Opephora swartzii* (Grun.) Petit, but its pseudoraphe is narrower, and it is smaller than the latter, on average. Although several observations have been made in Pulmankijärvi (Fig. 25), the species is fairly rare. It is a fresh-water form but has been found on the coast of Finland probably transported there by rivers.

Fragilaria virescens Ralfs (Fig. 26) is a common fresh-water form, also in the bottom sediments of Pulmankijärvi.

The genus *Eunotia* Rabenhorst is well represented in the area of Pulmankijärvi. Twenty-eight taxa were identified during the study, but the following includes several intermediate forms or deviations from the type species. Owing to its wealth of forms in Finland it might be worthwhile elaborating the systematics of the genus. The forms described from Pulmankijärvi can be fitted into the old nomenclature. *Eunotia bidentula* W. Smith (Fig. 29), *E. papilio* (Grun.) Hust. (Fig. 30) and *E. praerupta* var. *bidens* (W. Sm.) Grun. (Fig. 31) occurred in the surficial sediments of Pulmankijärvi as did most of the other species encountered.

Cocconeis pediculus Ehr. (Fig. 32) is a halophile and alkaliphile form which was found as a rare species in the bottom sediments of Pulmankijärvi.

Cocconeis placentula var. *euglypta* (Ehr.) Cleve (Fig. 33) was common in Pulmankijärvi together with its small main form.

The genus *Achnanthes* Bory is well-represented in the Pulmankijärvi area with 36 taxa, of which one, *A. mölderi*, is presented as a new species. Most of the species were encountered only in the bottom sediments of the lake either on shore or out in the middle of the lake.

Achnanthes borealis A. Cleve (1895), Foged (1977), syn. *A. elliptica* (Cl.) A. Cl. (1932), Mölder & Tynni (1972) (Fig. 48) is fairly common in the bottom sediments of Pulmankijärvi. In structure, the form resembles *A. elliptica* var. *rostrata* A. Cleve, which is slightly bigger with tapering ends and also occurs in bottom sediments (Fig. 49).

A few *Achnanthes clevei* Grunow (Fig. 35) occurred in many places in bottom sediments. An alkaliphile form common in waters of Lapland.

Achnanthes coarctata (Breb.) Grun. (Fig. 36). A large form (43 μ long) but resembling *A. coarctata* in proportions. Only one specimen was encountered in the bottom sediments of Pulmankijärvi.

Achnanthes conspiqua A. Mayer (Fig. 37) is fairly common in bottom sediments of the lake. It has not been presented earlier from northern Finland (Mölder & Tynni 1972) but mainly from coastal areas. According to Hustedt (1957), the species is halophobe, alkaliphile and belongs to the flora of alkaline alpine and Baltic lakes.

Achnanthes gracillima Hustedt (Fig. 39) is an oriental species first described from Japan. However, Krasske (1943, 1949) has presented it also from the Kilpisjärvi area. Foged (1968) presented the species from four sites on the Varanger Peninsula.

The species is fairly common at a depth of 0.5 m on the shore of Pulmankijärvi. As it is not common further south the species is probably a northern cold-water form.

Achnanthes lapponica Hustedt (Fig. 40) is a relatively common form in the littoral zone of Pulmankijärvi. According to Foged (1977), *Achnanthes quadratarea* (Oestrup) Max Möller is its synonym. The form resembles *A. recurvata* presented by Hustedt and both are similar in size and line density. Strong bending of the valve at the ends of the apical axis is typical of *recurvata* species. The Pulmankijärvi form has a large flat central area similar to that of *lapponica*.

Achnanthes laterostrata Hustedt (Fig. 41) is a fairly small form, resembling *A. clevei* in structure, but being smaller and more angular in shape. It is common in the bottom sediments of the lake and less common in plankton of the Kalttausjoki.

Achnanthes mölderi nov. species (Figs. 52 and 53). The valve is narrow and elliptical, the raphe valve has a radial and rather dense line ornamentation. This is lacking from the central area, which has a smooth, laterally extensive surface, excluding two short transapical lines; otherwise the lines extend to close to the raphe. The line density is c. 20/10 μ. The raphe is straight and narrow with the central ends rather far apart. On one side of the pseudoraphe valve there is a smooth horse-shoe shaped area. Otherwise it is bordered by radial lines about 1/3 the width of the valve, making the pseudoraphe fairly wide. It is 23 μ long and 8 μ wide. The transapical lines are less dense than on the raphe valve, c. 16/10 μ. Under a light microscope the lines on both valves seem to be smooth.

A rare form, with only two observations from a depth of 0.5 m in surficial sediments close to the shore.

The species resembles *Achnanthes lanceolata* var. *elliptica* and *A. elliptica* var. *elongata* A. Cl. in outline but differs from them in structure. The name *Achnanthes mölderi* was given in honour of the diatom researcher, Professor Karl Mölder (1899—1975).

The type area is the western shore of Pulmankijärvi, northern Finland, close to the Finnish-Norwegian border.

Achnanthes nodosa A. Cleve (Fig. 43) is an Arctic species presented from the Kilpisjärvi area and elsewhere (Krasske 1949, Tynni 1982). Observations from plankton of the Kalttausjoki discharging into Pulmankijärvi.

Achnantes pinnata Hustedt (Fig. 44) is a small, coarse form, rare in Finland. However, it may be fairly common and it is likely that its pseudoraphe valve has been mistaken for *Fragilaria pinnata*. The species was first presented from Tibet (Hustedt 1922), from North Finland (Cleve-Euler 1934) and later from Shetland, other parts of Europe (Carter & Bailey-Watts 1981) and the U.S.A.

(Patrick & Reimer 1966). It has been found most often in rivers and streams.

Achnanthes pungens (A. Cl.), syn. *A. elliptica* var. *pungens* A. Cl. (Fig. 50) occurred as a rare species in the bottom sediments of the lake. Earlier reported from Lapland, thus being a cold-water form.

Achnanthes sublaevis Hustedt, syn. *A. marginulata* Grun. var. *sublaevis* (Hustedt) Cleve-Euler (Fig. 45) is a rather small form swollen in the middle and at the ends with a fairly dense transapical line ornamentation, c. 25/10 μ.

Although rare, several specimens of it are often encountered in the bottom sediments of the lake. Earlier reported from the Kilpisjärvi area (Krasske 1949, Tynni 1982).

Achnanthes sp. (Fig. 46) and *A. clevei* var. *pulmankiensis* n. var. (Fig. 47) occurred as rare species in the bottom sediments of Pulmankijärvi. The former is probably a small form of *A. clevei*, but the latter resembles the main form except that the axial area of its raphe valve is large. The valve is 30 μ long and 8 μ wide.

Diploneis ovalis (Hilse) Cleve 1891 (Fig. 57) is common in the bottom sediments of the lake. It varies in structure, and some of the forms resemble *D. parma* Cl..

Diploneis ovalis var. *oblongella* (Naeg.) Cleve (Fig. 58) is coarser than syn. *D. oblongella* (Naeg.) A. Cleve (1922) described by Cleve-Euler (1953), showing that this form, too, exhibits marked variations.

Genus *Navicula* Bory is the diatom genus in the Pulmankijärvi area richest in taxa. Although the 59 taxa observed are indentifiable under a light microscope, the flora may also include a number of small forms. The following are some observations on the species.

Section Naviculae orthostichae Cleve.

Navicula cuspidata Kutzing occurred as several specimens in the surficial sediments of Pulmankijärvi and Pulmankijoki . A form with craticula shown in Fig. 60.

Navicula gregaria Donkin (Fig. 61) is a halophile form which is rare in the littoral sediments of Pulmankijärvi and is probably secondary.

Section Naviculae bacillares Cleve

Navicula cocconeiformis Gregory fo. *inflata* n. fo. (Fig. 63) is similar to the main form, except that the central area is enlarged to 1/3 of the total width. The valve is 35 μ long and 14 μ wide. A rare species in the bottom sediments of the lake (line 2, at a depth of 17 m).

Navicula ingrata Krasske (Fig. 64). Hustedt (1961) associated it with the var. *capitata* main form of Krasske (1938). The form was rare in the near-shore bottom sediments of Pulmankijärvi. Krasske (1949) presented the form from the Kilpisjärvi area.

Navicula järnefeltii Hustedt (Fig. 65). A form of variable structure. Single occurrences in the littoral sediments of the lake.

Navicula jungi Krasske (Fig. 66). A small form of constant width with rounded ends, c. 10 μ long and 4 μ wide. The central ridge of the raphe with the ends accentuated, the central ends of the raphe close to each other. A rather wide transversal smooth region in the central area. Transversal lining is dense, >30/10 μ. Rare in the littoral bottom sediments of Pulmankijärvi, line 1, at a depth of 1.2 m. (55.4/112.1). Same morphology as in *N. fennica* Hustedt, but the raphe is different in structure with central ends far apart. *Navicula jungi* presented by Krasske (1938) from Spitzbergen is bigger, 18—20 μ long, than the Pulmankijärvi form, and fairly common in a brackish-water bog pond.

Navicula strömi Hustedt (1961, p. 129, syn. *N. rivularis* Hustedt 1942, p. 112, *N. subcontenta* Krieger 1944, *N. ventraloides* Hustedt 1945) (Fig. 67).

A small form typical of the Bacillares section. It has not been found earlier in Finland although it has been reported from Swedish Lapland (Hustedt 1942). The species is rare in the bottom sediments of Pulmankijärvi.

Section Naviculae minusculae (Cleve) Hustedt.

Navicula subatomoides Hustedt (Fig. 68) and *N. subrotundata* Hustedt (Fig. 69) belong to the diatom flora of the lake.

Section Naviculae microstigmatica (Cleve) Hustedt.

Navicula protracta (Grun.) Cleve (Fig. 70) is a halophile form, rare in the bottom sediments of the lake. It resembles *N. lundströmii* fo. *frieseana* Cl., but is smaller and the punctae of the lines are very weak.

Navicula protracta fo. *elliptica* Gallik (Fig. 71). The form resembles the main form in structure but has wide ends and there is no tapering close to the ends. Rare in the bottom sediments of the lake.

Section Naviculae punctatae Cleve.

Navicula interglacialis Hustedt 1943, 1966, p. 808 (Fig. 72) is a fresh-water form found in Finland in Lake Vesijärvi (Hustedt). Foged (1974) has reported several observations from Iceland.

Navicula jentzschii Grunow (Fig. 73) occurs as a relatively rare species in the bottom sediments of the lake.

Navicula lacustris Gregory (Fig. 74) is fairly common in the bottom sediments of the lake. According to Cleve-Euler (1953), the form is most often encountered in clear-watered basins. Krasske (1949) has reported it from the Kilpisjärvi area.

Navicula lundströmii Cleve fo. *frieseana* (Grun.) Cleve (Fig. 75). The form found in the bottom sediments of Pulmankijärvi is fairly large, 64 μ long. According to Cleve (1894), the length is 32—48 μ, i.e. markedly shorter. According to Hustedt (1966), the length is 34—60 μ. The species is considered as a brackish-water form. Hustedt (1966) found it very common in the littoral sand at Tvärminne.

Navicula plausibilis Hustedt 1966, Foged 1977 (Fig. 76) resembles more the form presented by Foged. It also resembles *N. mutica* var. *intermedia*. The species is rare in the bottom sediments of Pulmankijärvi.

Section Naviculae lineolatae Cleve.

Navicula anglica Ralfs (Fig. 77) occurred as a rare species in the littoral zone of the lake.

Navicula avenaceae Breb. (Fig. 78) was rare in the bottom sediments of the lake.

Navicula cinta Ehrenberg (Fig. 79) was rare in the bottom sediments of the lake. It is halophile and alkaliphile.

Navicula clementis Grunow occurs as a relatively rare species in the bottom sediments of Pulmankijärvi. Krasske (1949) presented the species and var. *brander* Hustedt (Schmidt Atl. Taf. 403, fig. 43) from the Kilpisjärvi area. In Pulmankijärvi there is a form corresponding to *N. constans* Hustedt 1954, 1966 p. 811, fig. 1783 a. It can be considered as a form of the species presented by Grunow (Fig. 80).

Navicula costulata Grunow (Fig. 81) occurred as a rare form in the bottom sediments of the lake. A halophile oligohalobiont.

Navicula lanceolata (Ag.) Kützing (Fig. 83) is a fairly common species in the lake.

Navicula quadripartita Hustedt (Fig. 84) occurred as a relatively rare form in the littoral sand of Pulmankijärvi. According to Patrick & Reimer (1966), *N. hambergii* Hustedt (1924) is the original species, but it has narrower and more tapered valve ends. The species has been reported from the Kilpisjärvi area (Krasske 1949).

Navicula radiosa Kützing var. *maior* nova combination (Fig. 85). The form resembles the main form but is unusually long, c. 125 μ and 12 μ wide. It resembles *N. radiosa* var. *subrostrata* Cleve (syn. *N. lobelia* Jörgensen) and *N. elongata* Poretzky fo. *maior* Tynni (1973 p. 15) encountered in the Oulanka area. In Pulmankijärvi it occurred as a rare form in the bottom sediments.

Navicula radiosa var. *tenella* (Breb.) Grunow (Fig. 86) was rare in the area. In the Kilpisjärvi area, the variant is common (Krasske 1949).

Navicula rhynchocephala Kützing (Fig. 87) and var. *grunowii* A. Cl. (Fig. 88) occur in the bottom sediments. In structure, they resemble *N. viridula* Kütz. and its variants, which also occur in the area.

Navicula salinarum Grunow (Fig. 89) occurred as a relatively rare form in the littoral sediments of the lake. It is a brackish-water form although it has occasionally been encountered in fresh waters (Foged 1974, 1977).

Navicula similis Krasske (Fig. 90) is a small, oval form with a tip at the ends, initially presented by Krasske (1929) from Saxony. The central area has a stigma which may not be visible. Cleve-Euler (1953) presented the form from Luleå, Swedish Lapland and Hustedt (1943) also from Swedish Lapland. Rare in the bottom sediments of Pulmankijärvi. Mölder has reported the species from Alajärvi, Rovaniemi.

Navicula viridula Kützing (Fig. 91) occurred as a rare form in plankton of the Pulmankijoki. An alkaliphile form.

Navicula vulpina Kütz. (Fig. 92) occurred relatively rarely in the littoral sediments of the lake.

Section Naviculae tusculae Hustedt

Navicula tuscula (Ehr.) Grunow (Fig. 93) occurred rarely in the bottom sediments of Pulmankijärvi. It is an alkalibiont and common in the sediments of the Ancylus lake.

Genus *Pinnularia* Ehrenberg.

Section Divergentes Cleve.

Pinnularia divergens var. *parallela* (Brun) Patrick (Fig. 94) is a rather large, wide form with parallel sides. It differs from *P. platycephala* mainly in the structure of the raphe. Relatively rare in the bottom sediments of Pulmankijärvi and Pulmankijoki.

Pinnularia platycephala (Ehr.) Cl. (Fig. 95) occurred as a rare form in the plankton of Pulmankijärvi and in the bottom sediments of Pulmankijärvi and the Pulmankijoki. It is a coldwater form, which has also been reported from the Kilpisjärvi area (Krasske 1949) and the Tornionjoki (Tynni 1989).

Pinnularia similis Hustedt (Fig. 96) was rare in the littoral sediments of Pulmankijärvi. Krasske (1949) found the form in the Kilpisjärvi area. An aerophile form.

Section majores Cleve.

Pinnularia dactylus Ehr. (Fig. 98), 204 μ long and 43 μ wide. Single occurrences in the bottom sediments of Pulmankijärvi and the Pulmankijoki and in the plankton of the Kalttausjoki.

Section Complexae Cleve.

Pinnularia viridis var. *leptogongyla* (Ehr.?. Grun.) Cleve (Fig. 99), 60 μ long and 11 μ wide, line density c. 10/10 μ. Rare in the bottom sediments of the lake. The variant has not been presented from Finland before. Foged (1977) reported the form from an acidic lake in Co. Wicklow, Ireland.

Genus *Caloneis* Cleve.

Caloneis sp. cf. *schröderi Hustedt (Fig. 100), 42* μ long, 8 μ wide, line density 15/10 μ. The form differs from that described by Hustedt (1930, fig. 356) in that its central part is of constant width, not tapering. It differs from *C. bacillum* (Grun.) Mereschk. in having a less dense lining. Rare in the bottom sediments of Pulmankijärvi.

Genus *Neidium* Pfitzer.

Neidium affine var. *amphirhynchus* (Ehr.) Cl. fo. *incurvum* (Greg., Ostrup) Foged (Fig. 101) is rare in the plankton of the Pulmankijoki. The form has also been found in some other freshwater sites in Lapland (Tynni 1976, 1989). Probably a cold-water form.

Neidium ladogensis (Cleve) Foged (Fig. 102) occurred rarely in the bottom sediments of Pulmankijärvi and the Pulmankijoki.

Genus *Gyrosigma* Hassall.

Gyrosigma acuminatum var. *gallica* Grunow, which is more narrow than the main form (Fig. 103), occurred as a rare form in the plankton of the lake and on the surface of the sediments. According to Hustedt (1957), the species is an alkalibiont.

Genus *Amphora* Ehrenberg.

Amphora ovalis var. *libyca* (Ehr.) Cl. (Fig. 104) was fairly common in the bottom sediments of the lake.

Amphora veneta Kützing (Fig. 105), which, according to Hustedt, is a fresh to brackish water species encountered on the coast of Finland, was rare in the bottom sediments of Pulmankijärvi.

Genus *Cymbella* Agardt.

Cymbella cistula (Hempr.) Grunow (Fig. 106) is a large form with 7 nodules in the central area. A rare occurrence in the littoral zone of Pulmankijärvi.

Cymbella cymbiformis (Kütz.) Hustedt var. *arctica* (Lagerstedt) (Fig. 107) resembles *C. affinis*, but is more curved. It differs from the main form in having wider apical tips. Rare in bottom sediments.

Cymbella girodi (Her.) Krenner (Fig. 108) occurred rarely in the littoral zone of Pulmankijärvi. Encountered earlier at Kiutakönkäs on the River Oulankajoki (Tynni 1978).

Cymbella heteroplera (Ehr.) Kützing (Fig. 109, 130 x 36 μ) was rare in the bottom sediments of the lake. A fresh-water form of Arctic and northern regions.

Cymbella incerta (Grun.) Cleve (Fig. 110) occurred rarely in bottom sediments. According to Krasske (1943), the form is northern-alpine.

Genus Gomphonema Agardh.

Gomphonema longiceps Ehr, var. *montana* (Schum.) Cl. (Fig. 111) was the most common of the *Gomphonema* species encountered, occurs in rivers and lakes. In 1983 *G. longiceps* var. *montana* was the most common *Gomphonema* species in the Tornionjoki and Muonionjoki river valleys (Tynni 1989). It was interpreted as a rheophile form probably favouring cold water.

Anomalies were encountered among the large *Gomphonema* forms. The *longceps* type shown in Fig. 112 is curved in the same way as *Gomphocymbella*. In Fig. 113 there is a form bent along the pervalvar axis with a large central area, a separate distinct punctum and a double row of punctae close to the central nodule of raphe. It resembles mainly *G. intricatum* var. *vibrio* (Ehr.) Cl.

Genus *Rhopalodia* O. Müller.

Rhopalodia gibberula var. *producta* (Grun.) Cleve-Euler (Fig. 114) occurred as a very rare form in the littoral zone of Pulmankijärvi. In habitat the species is eurytopic and thrives in saline and fresh waters. It was also encountered in a bog pond in the Kilpisjärvi area. It is most common in the brackish coastal waters of Finland. An alkaliphile form whose occurrence in a bog pond in the Kilpisjärvi area refers to lime-bearing bedrock.

Genus *Bacillaria* Gmelin.

Bacillaria baxillifer (O.F. Müller) Hendey (Fig. 115) occurred rarely in the littoral zone of Pulmankijärvi. The species is known mainly as a marine or brackish-water form but it can also adapt to a fresh-water habitat (Kolbe 1932).

Genus *Nitzschia* Hassall.

Section Tryblionellae (W. Sm.) Grun. Hust.

Nitzschia angustata (W. Sm.) Grun. (Fig. 116) is more rare than the variant *acuta* Grun. In the present work these forms are considered as one form. Fairly common, in the bottom sediments of the lake in particular. An alkäliphile fresh-water form.

Nitzschia apiculata (Gregory) Grun. (Fig. 117) occurred as a very rare form in the bottom sediments of the lake. An alkaliphile brackish-water mesohalobiont.

Nitzschia tryblionella Hantzsch var. *victoriae* Grunow (Fig. 118) occurred as a rare form in the littoral zone and on the bottom of the lake. Most often encountered in Finland in brackish waters and the corresponding sediments, but also in some eutrophic lakes. According to Hustedt (1957), the variant is less halophile than the main form, being oligohalobiont-indifferent.

Section Lanceolatae (Grunow) Lange-Bertalot & Simonsen.

Nitzschia perminuta Grun. Lange-Bertalot (Fig. 119) is a small form with relatively sparse keel punctae, dense transversal lines. Rare in the bottom sediments of the lake.

Nitzschia fonticola Grunow (Fig. 120) occurred rarely in the bottom sediments of the lake. According to Hustedt, the form is an alkalibiont.

Nitzschia gandersheimiensis Krasske (Fig. 121) was rare in the bottom sediments of the lake. A halophile form encountered on the coast of Finland and in some eutrophic lakes (alkaliphile).

Genus *Cymatopléura* W. Smith.

Cymatopleura elliptica (Bréb.) W. Smith (Fig. 122) was rare in the bottom sediments of the lake, however, several observations. The form may belong to the flora of the lake. According to Mölder, the species has been found at 19 sites in Finland. According to Hustedt (1957), the species is an alkaliphile oligohalobiont. In Finland the species is most common in sediments of the Ancylus lake.

Genus *Surirella* Turpin.

Surirella elegans Ehrenberg (Fig. 123) occurred rarely in the bottom sediments of the lake. An alkaliphile form.

S. e. fo. *constricta* n. fo. (Fig. 124) occurred as a rare species together with the main form. A slight contraction between the centre and the more narrow apical end.

Surirella robusta Ehr. (Fig. 125) was rare in the bottom sediments of the lake, whereas Fo *punctata* Hustedt was relatively common. Both are alkaliphile forms.

Genus *Campylodiscus* Ehrenberg.

Campylodiscus hibernicus Ehrenberg forma was fairly common in the bottom sediments of Pulmankijärvi but less common in the sediments of the Pulmankijoki. Figure 126 a shows clearly the spines of the valve. They are radially rooted to the valve, and have short diagonal bifurcations at the tip. According to Hustedt, the main form is an alkalibiont. Observations from lakes in Lapland and sediments of the Ancylys lake.

The species *Campylodiscus levanderi* Hustedt (Simonsen 1987, pl. 130: 1—4) and C. *decorus* var. *pinnata* Peragallo (pl. 64, fig. 6) have small spines on the valve, but their structure is not known in detail.

Tendency of diatoms to become relicts when salinity changes

Diatoms are useful indicators of waters widely differing in chemistry. In accordance with their ecology, certain diatoms react to changes in salinity. This enables diatoms to be correlated with halobion spectra and the sedimentation of geological formations to be interpreted in terms of salinity. The most widely used salinity classifications are those devised by Hustedt (1938, 1957) and Simonsen (1962). They differ from those of Kolbe (1927), Välikangas (1933) and Mölder (1943) in the wealth of detail given. Hustedt's classification has four groups: 1. polyhalobionts (salinity 30 per mil or more), 2. mesohalobionts (salinity from 30 per mil to 0.2 per mil, and their subdivisions euryhaline mesohalobionts, α mesohalobionts and β mesohalobionts), 3. oligohalobionts (less than 0.2 per mil, a. halophile, b. indifferent diatoms) and 4. halophobe (haloxene) species. In the classification by Mölder, the saline water diatoms correspond to the polyhalobionts of Hustedt, the brackish-water diatoms to the euryhaline and α subgroups of mesohalobionts, and the fresh to brackish water diatoms to the β group of mesohalobionts and the halophile forms of oligohalobionts. The fresh-water forms correspond to the indifferent subgroup of oligohalobionts and the halophobe diatoms of Hustedt.

Kolbe (1927, 1932) suggested that there is a gradual change in diatom populations in all types of waters from fresh water to sea water forms. According to Simonsen (1962), however, the scale is not appropriate for a biotope classification as detailed as that proposed by Ekman (1953). The euryhaline forms have a rather large range of tolerance to changes in salinity. According to Kolbe, some fresh-water diatoms thrive in a 1.5 % NaCl concentration but not in a 2 % concentration. Kolbe doubts the existence of forms able to stand changes from fresh water to sea water. *Bacillaria baxillifer* is an example of an euryhaline form, and in Pulmankijärvi it may be a relict from the time when the basin was in connection with the ocean. In central Europe, the appearance of *Bacillaria paradoxa* (syn.) in fresh water coincides with that of migratory birds, and its presence may thus be attributable to the birds (Kolbe 1932, p. 268).

On the basis of diatom studies conducted in the western Baltic Sea, Simonsen (1962) emphasizes the hypotonic tolerance of marine diatoms when salinity gradually decreases and, conversely, the tolerance of fresh-water forms when salinity increases. The five tolerance classes range from slightly tolerant oligoeuryhaline to meioeuryhaline, mesoeuryhaline, pleioeuryhaline and holoeuryhaline forms, which have the highest tolerance, e.g. *Navicula mutica*. This is an oligohalobiont with an optimal habitat containing 0.2 per mil, or less, salt although it tolerates up to 30 per mil salt . In his comprehensive description of this species, Hustedt (1966, pp. 583—589) presents numerous formae of the species with data on their distribution. They are restricted to brackish and fresh waters, which does not support the concept of holoeuryhaline tolerance, at least not under natural conditions.

On the other hand, recent studies have shown that *Navicula rostellata* Kütz. can stand very high variations in salinity, as verified in hypersaline Solar Lake on the Sinai coast and in tests (Fisher 1979). The specimen thrived in a salt concentration as high as 225 per mil and tolerated well the variation in plasmolysis of the cytoplasm caused by the variations in osmotic pressure. According to Fisher, *Bacillaria paradoxa* is sensitive to plasmolysis and dies rather quickly in tests. Therefore, the euryhaline character of the species recorded from natural conditions is due to gradual adaptation or to different ecotypes of the species (Fisher op. cit.).

The tendency of diatoms to become relicts under changing conditions is evident and it is to be expected that some eurytopic diatoms have succeeded at least as well as some animal relicts. A number of cold-water diatoms are known as glacial relicts in central Europe. Cleve-Euler (1943) has given a detailed interpretation of Quaternary evolution on the basis of the current distribution of the diatoms. She considered the occurrences of *Tabellaria binalis* at high elevations to be interglacial relicts. However, the species is unadaptable, at least to pH. It is worth noting that one of the rare occurrences in Finland is in Spitaalilampi, a pond at a high elevation in the Lauhanvuori area (Salomaa and Alhonen 1982). Also Mölder (1943) interpreted the Quaternary evolution in the light of current diatom flora.

Simonsen (1962) presented diatom flora from the Litorina stage (c. 7000 B.P.) from Kieler Bucht in the western Baltic Sea. A similar flora exists in Finnish Litorina deposits, excluding the polyhalobionts that require more saline water and did not thrive in the less saline waters on the Finnish coast.

Terpsinoe americana is one of the main indicators of Litorina deposits in the Baltic Sea area. It occurred there in interglacial time but has not survived as a relict in the present Baltic Sea, although one, possibly recent, observation has been made from the western Baltic Sea (Simonsen 1962). According to Schwarzenholz (1965), *T. americana* was a characteristic diatom in northern Germany during the Holstein interglacial.

It would be possible to study the tendency of saline or brackish-water diatoms to remain as relicts when the salinity of water declines in the uplift area in Finland but adaptation from saline to fresh water is obviously very rare, whereas, according to Kolbe (op.cit.), that from mesohalobe to fresh-water conditions is possible. The studies of Simonsen (op.cit.) suggest that the bulk of the brackish-water diatom flora, such as that in the Baltic Sea, tolerates small fluctuations in salinity fairly well. According to Mölder (1943), the diatom flora in bays near Helsinki and Kemi is mainly stenohaline and thus susceptible to the slightest changes in salinity! As the water in the Arctic Ocean is distinctly more saline than that in the Baltic Sea, the difference in flora between it and a freshwater basin such as Pulmankijärvi is considerable.

The studies by Fontell (1926) suggest that saline or brackish-water relicts might be found in the Pulmankijärvi basin. Nevertheless, no clear relict flora was encountered, only mesohalobionts with high tolerance to salinity variations. Some of the saline-water forms described by Fontell probably derive from redeposited Litorina sediments. The best example is *Terpsinoe americana*, which Fontell presented from a pond near Porvoo. The Pulmankijärvi diatom flora is mainly composed of freshwater forms, many of them alkaliphile. The proportion of mesohalobionts is low, although, in all likelihood, they and some halophile forms belong to the present flora in the lake. In contrast, the even more rare polyhalobionts in Pulmankijärvi probably derive from marine sediments through redeposition. The flora in the lake has been favoured by alkaline conditions, with the result that when the lake basin was isolated from the Arctic Ocean, the Na ions were replaced by the Ca ions. According to Hustedt (1938/1939, p. 297, generalizing), in saline-water diatoms, chlorides can be replaced by sulphates, the Na ions by the Ca ions and alkali chlorides and sulphates by carbonates, especially by Ca hydrocarbonate. The NaCl replacement probably does not apply to marine planktonic diatoms. According to Höfler & Höfler (1963), low osmotic tolerance is characteristic of marine plankton. The sea represents a stable and unchangeable ecosystem in which organisms do not need to have a high tolerance to changing conditions.

DIATOMS FROM THE COAST OF VARANGERFJORDEN, NORTHERN NORWAY

Introduction

The diatom flora in Varangerfjorden was studied with the aid of samples collected from three littoral sites in 1974 and 1982 (Fig. 3); 189 brackish and saline water forms were found. Cleve and Grunow (1880) studied diatoms in the Varangerfjorden area, and their taxonomy, as supplemented by Cleve (1894—95), is still largely in use today. New SEM studies and intensified restudies of the older type species have resulted in new systematic applications. The taxonomy based on SEM studies has caused the nomenclature to be revised. Since, however, the SEM technique was not applied in the present study, the earlier nomenclature is partly retained.

Identification of the diatom flora in the Arctic Ocean is important in efforts to establish the connection of the area that is now Finland to the Arctic Ocean during interglacial time. The salinity of the Arctic Ocean is higher than that of the Baltic Sea during the stages it was in connection with the North Sea only. The temperature of the North Sea also differed from that of the Arctic Ocean, as is shown by differences in diatom flora. Owing to the influence of the Gulf Stream the difference in temperature between the North Sea and the Arctic Ocean north of Scandinavia is insignificant. Cleve-Euler (1940) focused attention on the components of the diatom flora that prevailed in the Baltic area during the last interglacial, one of them being the cold saline component from the Arctic Ocean.

On the basis of the distribution of 26 recent oceanic planktonic diatoms, Hasle (1976) divided them into cold-water, warm-water and cosmopolitan forms. The cold-water planktonic species occur in either the Northern Hemisphere or the Southern Hemisphere. Cosmopolitan forms are smaller planktonic species.

The studies conducted by Cleve and Grunow in the area of the Arctic Ocean constitute a solid foundation for the work on the flora. Meunier (1910) reported observations on the diatom flora in the Barents Sea and Kara Sea. Planktonic diatoms of the northern Atlantic Ocean have been dealt with by Gran (1912) and the diatoms of northern Europe by Ostenfeld (1913). Mention should also be made of the studies made in the White Sea area, the majority by Russian researchers, e.g. Kiselev (1925), Jousé & Poretskii (1937), Zabelina (1939) and Petrov (1967), but some also by Levander (1915, 1916) from Finland.

The diatom flora of the Arctic Ocean contains alien species transported by the Gulf Stream, and hence the diatoms within the sphere of this stream are important to investigations of the flora of the study area. Hustedt (1955) presented a comprehensive marine flora from Beaufort in Northern Carolina, U.S.A. Hendey (1974) described the marine diatom flora of the British Isles. Brockmann (1950) gave a full description of the diatoms of the east coast of the North Sea. Edsbagge (1968) and Aleem (1973) examined the marine diatoms of the south coast of Scandinavia. The compiled works of Hustedt (1930—1966) also shed light on the distribution of the species.

As the present diatom study was made using 1000 x magnification, the smallest details revealed by SEM were not always seen. The species were identified with the aid of the following studies: Bérard-Therriault et al. (1987), Brockmann (1950), Cardinal et al. (1989), Cleve & Grunow (1880), Cleve-Euler (1951—55), Cox (1983 a, b), Fryxell & Hasle (1977), Hasle (1974), Hasle & Fryxell (1977), Hendey (1964), Heurck (1896), Hustedt (1930—62, 1939, 1955), Patrick & Reimer (1966, 1975), Peragallo, H & M. (1890—1908), Schmidt Atl. (1874—1959), Simonsen (1959, 1960, 1987).

COMMON DIATOMS AT VADSÖ AND AT OBSERVATION SITES 3 AND 4

The observations from the Vadsö area (Fig. 3) are from the surface of the sediment (Table II, column 1) and from sites 3 and 4 (Fig. 1, points 2 and 3) in the shallow western littoral zone of Varangerfjorden (Table II, column 2). The floras differ, the former being clearly marine and the latter typically brackish-water with fresh-water forms transported by rivers. Owing to the strong tidal currents in the area, the Vadsö sample represents not only local flora but also that from the more extensive littoral zone and nearby open sea, where the anthropogenic impact of the local population centre is markedly weakened.

The study is based on only one sample taken

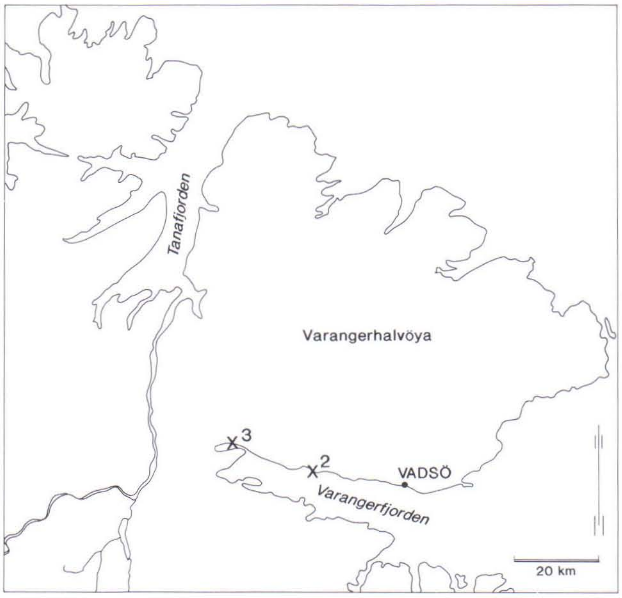

Fig. 3. The study area and sampling sites.

from a clay bottom at a depth of 6 m from northern Varangerfjorden, Vadsö, in August 1982. The sample turned out to be very appropriate in terms of diatoms, containing forms typical of the coast, fewer planktonic forms and very few terrigenous fresh-water diatoms. Most of the diatoms in the Vadsö flora are marine.

The most common forms, in order of declining abundance, were *Nitzschia socialis, Plagiogramma staurophorum, Biddulphia aurita* + var. *obtusa, Navicula digitoradiata, Cocconeis costata, Diploneis fusca, Navicula lyra, Pleurosigma strigosum, Rhabdonema arcuatum, R. minutum, Trachyneis aspera* etc.. None of the species dominated. The total population is listed in Table II.

The samples of Varangerfjorden observation sites 3 and 4 were taken from the shore in summer 1974. The diatom flora at site 3 comprises marine, brackish-water and fresh-water forms with the brackish-water ones dominating, followed by halophile or indifferent fresh-water forms. The abundance of polyhalobionts is low. In order of declining abundance, the species are as follows: *Synedra pulchella* with variants, *Cocconeis scutellum, Achnanthes delicatula* fo. *hauckiana, C. placentula, Surirella smithii, Melosira arctica, Navicula bottnica, Meridion circulare, N. menisculus, N. gothlandica, N. incerta, S. tabulata* etc. (Table II, column 2). As the table does not list the fresh-water forms, the ecological distribution of the total flora is not shown.

The total diatom flora at observation site 3 exhibits many forms known from Finnish Litorina deposits, but the proportion of polyhalobionts requiring higher salinity is lower in the Varangerfjorden samples than in the interglacial clay at Rouhiala in the Karelian Isthmus (Brander 1937 b), the Mga area in Leningrad (Brander 1937 a, Tseremissinova 1960) and in some Ostrobothnian interglacial deposits (Niemelä & Tynni 1975, Eriksson et al. 1980, Grönlund 1988).

The sample from observation site 4 contained only a few epiphytic forms, of which *Cocconeis scutellum, C. costata, Licmophora paradoxa* + var. *tincta* and *L. communis* are the most common. The observations are included in column 2.

TAXONOMIC OBSERVATIONS

Melosira Agardh

Melosira arctica (Ehr.) Dickie. (Hustedt 1930, p. 233, fig. 96). The valve is barrel-like and provided with a keel girdle. The surface of the discus and cylinder wall are very slightly ornamented with rows of nodules parallel to the margin. In the border between the discus and cylinder wall the valve sometimes exhibits angular projections linked with the ring-shaped keels.

A form common at observation site 3. Diameter 15—20 µ, height 8—15µ.

N.B.: The form resembles *M. nummuloides* Ag. in structure. In the mother cell the keels of the adjacent cells do not usually touch each other, cf. Hustedt op. cit.

Plate XVI, fig. 1, 2.

Melosira arctica var. *polaris* (Grunow) n. comb. (Hustedt 1930, p. 273, fig. 116).

Syn. *M. polaris* Grunow. (Hustedt 1930, p. 273, fig. 116). In side view, an elliptical, fairly wide and shallow form. The discus is projecting. There are radial folds in the margin, but not as clearly as in *M. polaris* Grun. presented by Hustedt. The bead-like nodules in the margin of the discus are less regular than in *M. polaris*. The ornamentation is slightly granulate with a radial and encircling array. A weakly developed keel is in the margin of the discus. In the mother cell the keels do not touch each other and two cells are joined together with mucilagious pads at the projecting discus domes. A corresponding structure is not seen in Hustedt's description, as he did not present a side view. The form has features in common with M. *arctica* and could be a variant.

A few observations at site 3. Valve 34 μ in diameter, the theca 8 μ in height.

N. B.: According to Hustedt, *M. arctica* varies in size: diameter 14—30 μ and height 11—17 μ, the small specimens being relatively higher. The form described above does not fit these ranges of variation. As the forms do not show a sharp difference in structure there are grounds for linking it with the common species.

Plate XVI, fig. 3, 4.

Podosira Ehrenberg

Podosira hormoides var. *adriatica* Grunow. (Hustedt 1930, p. 284, fig. 124; Bérard-Therriault et al. 1987, p. 96, fig. 56, 59, 60).

There are about ten specimens in the Vadsö sample, 40—50 μ in diameter. Previously presented from Finnmark (Cleve & Grunow 1880).

Plate XVII, fig. 2.

Podosira hormoides var. *arctica* Cleve. (Hustedt 1930, p. 284). Larger than the above, it occurred as a rare form in the Vadsö sample, 80 μ in diameter. Previously presented from Finnmark (Cleve & Grunow 1880): (*Podosira arctica* Cl.)

Plate XVII, fig. 1.

Podosira maxima (Kütz.) Grun. (Hustedt 1930, p. 285, fig. 126). Rare at observation site 3. Valve about 90 μ in diameter.

Plate XVII, fig. 3.

Phacodiscus Meunier

Phacodiscus punctulatus (Gregory) Meunier (Hustedt 1930, p. 288, fig. 129).

Syn.: *Coscinodiscus punctulatus* Greg.

A lens-shaped valve ornamented with small radial nodules and some larger ones. According to Hustedt, the genus and species are questionable. According to Hendey (1974), the species belongs to the marine diatoms of the British Isles.

Rare in the Vadsö sample.

Plate XIX, fig. 4.

Hyalodiscus Ehrenberg

Hyalodiscus subtilis Bailey. (Hustedt 1930, p. 291, fig. 132, Bérard-Therriault et al. 1987, p. 93, fig. 64—67).

The cross ornamentation of the outer side of the discus is dense but distinctly visible at 1000 x magnification.

Several specimens in the slide made from the sample of observation site 3. Diameter about 100 μ.

Plate XVIII, fig. 1.

Porosira Jörgensen

Porosira glacialis (Grun.) Jörgensen. (Hustedt 1930, p. 314, fig. 153). According to Hustedt, the species belongs to the littoral flora of the Arctic Ocean.

Thalassiosira Cleve

Thalassiosira baltica (Grun.) Ostf. (Hustedt 1930, p. 328, fig. 164).

Very rare in the Vadsö sample, which has only one eroded specimen. As the species has been presented from the coast of Britain (Hendey 1974), its occurrence in the brackish waters of the north coast of Norway is feasible. Late Miocene occurrence in the Mediterranean (Schrader & Gersonde 1978).

Plate XIX, fig. 1

Thalassiosira decipiens (Grun.) Joergensen. (Hustedt 1930, p. 322, fig. 158).

A few observations from the Vadsö sample. Valve 20—25 μ in diameter.

Plate XVIII, fig. 3.

Thalassiosira nordenskiöldi Cleve. (Hustedt 1930, p. 321, fig. 157, Hasle 1978, p. 79, fig. 1, 5—20, Rivera 1981, p. 155, pl. 2, fig. 9; Bérard-Therriault et al. 1987, p. 92, figs. 43, 44).

Very rare at observation site 3. Diameter 18 μ.

According to Hasle (1976), it is a cold-water form encountered in the Atlantic Ocean and Pacific Ocean.

Plate XVIII, fig. 2.

Thalassiosira oestrupii (Ostenfeld) Hasle. (Hustedt 1930, p. 318, fig. 155; Hasle 1972, p. 62).

Syn.: *Coscinosira oestrupii* Ostenfeld.

Fairly common at observation site 3.

Plate XVIII, fig. 8.

Thalassiosira subtilis (Ostf.) Gran. (Hustedt 1930, p. 330, fig. 166).

A few specimens in the Vadsö sample.

Plate XIX, fig. 3.

Cyclotella Kützing

Cyclotella iris Brun. (Schmidt's Atl. Taf. 222, figs. 37—41; Cleve-Euler 1951, p. 51, fig. 67; Mölder & Tynni 1968, p. 153, fig. 6).

An unusually large specimen from Varangerfjorden observation site 3. Discus about 35 μ in diameter. Comparable to Pulmankijärvi forms, pl. II figs. 9—11.

Plate XVIII, fig. 4.

Coscinodiscus Ehrenberg

Coscinodiscus granulosus Grunow. (Hustedt 1930, p. 386, fig. 198).

A small form, with valve 18 μ in diameter.

Fairly common in the Vadsö sample. The species was previously presented from Finnmark by Grunow (Cleve & Grunow 1880).

Plate XX, figs. 1 and 2.

Coscinodiscus marginatus Ehr. (Hustedt 1930, p. 416).

Rare in the Vadsö sample.

Plate XX, fig. 3.

Coscinodiscus rothii var. *normani* (Greg.) V. Heurck. (Hustedt 1930, p. 402, fig. 213).

Rare in the Vadsö sample. Diameter c. 43 μ, areole density in the margin 16/10 μ.

Plate XX, figs. 4, 5; Pl. XIX, fig. 2.

Chaetoceros Ehrenberg

Chaetoceros affinis Lauder, resting spore type (Hustedt 1930, p. 695, fig. 396).

The most common resting spore type in the Vadsö sample.

Plate XX, fig. 6.

Chaetoceros furcellatus Bailey. (Hustedt 1930, p. 749, fig. 433). Elliptical valve plates are occasionally preserved in samples prepared by concentrating. The appendages of the opposite valves are fairly well preserved. At the base the appendages touch each other, but further up they part from each other laterally at an acute angle. A similar appendage structure is shown by *C. decipiens* Cl., in which, however, the angle between the appendages is still wider. Both species have been found in the Arctic Ocean (Cleve 1873, Cleve & Grunow 1880).

Relatively common in the Vadsö sample.

Plate XX, fig. 7.

Odontella Agardt

Biddulphia aurita (Lyngb.) Brébisson & Godey and var. obtusa (Kütz.) Hustedt, according to the present taxonomy *Odontella aurita* (Lyngbye) Ag. (Hustedt 1930, p. 846, figs. 501 and 502; Takano 1984, p. 80, figs. 1—8).

According to Hustedt, the form is common on all coasts of Europe, but the variant is less common. The species also occurs in the western Baltic Sea (Simonsen 1962). Forms have not been encountered in the interglacial deposits of the Baltic area.

The species and the variant are common at Vadsö.

Plate XXI, figs. 1, 2.

Rhabdonema Kützing

Rhabdonema minutum Kützing. (Hustedt 1930, p. 18, fig. 548). A brackish-water form that is usually in colonies in the Vadsö sample.

Grammatophora Ehrenberg

Grammatophora angulosa var. *islandica* (Ehr.) Grunow. (Hustedt 1930, p. 40, fig. 565).

Common in the Vadsö sample. Valve 40—60 μ long.

Plate XXI, fig. 3.

Grammatophora arctica Cleve. (Hustedt 1959, p. 38, fig. 563).

Rare in the Vadsö sample.

Plate XXI, fig. 4.

Licmophora Agardh

Licmophora communis (Heib.) Grunow. (Hustedt 1930, p. 79, fig. 610, Ravanko & Tynni 1974, p. 6, figs. 1—7), forma.

Common at observation site 4. The valvar plan is usually rather narrow. Length 32—52 μ, width c. 7 μ. The line density in the hypotheca is 15/10 μ. According to Hustedt, the density is 11—13/10 μ.

Plate XXI, figs. 5, 8.

Licmophora ovulum Mereschk. (Hustedt 1930, p. 83, fig. 614).

A small form whose lines are indiscernible at 1000 x magnification.

Valve c. 15 μ long. Fairly common at observation site 4.

Plate XXI, fig. 13.

Licmophora paradoxa var. *crystallina* (Kütz.) Grun. (Hustedt 1930, p.77, fig.606).

Valve about 18 μ long. Common at observation site 4.

Plate XXI, fig. 11.

Licmophora paradoxa var. *tincta* (Ag.) Hust. (Hustedt 1930, p. 77, fig. 605).

Valve c. 67 μ long, transversal lining visible only at base. The most common of the *Licmophora* forms at the Varangerfjorden observation sites.

Plate XXI, fig. 7.

Meridion Agardh

Meridion circulare (Grev.) Ag. (Hustedt 1930, p. 93, fig. 627). A common fresh-water form at observation site 3. According to Hustedt, intercalary bands are without septa but more or less well developed. However, the specimens described exhibit unusual intercalary bands which do not follow the periphery of the valve but are contracted on the sides or upper part of the valve, in the latter case resulting in a septal impresssion.

Plate XXII, figs. 1—6.

Plagiogramma Greville

Plagiogramma staurophorum (Greg.) Heib. (Hustedt 1930, p. 110, Fig. 635).

According to Hustedt, it occurs on all European coasts from the Mediterranean to the Arctic Ocean. In the Belt Sea of the western Baltic Sea it is a widespread meioeuryhaline polyhalobiont (Simonsen 1962) The species has also been encountered in the interglacial deposits of Ostrobothnia (Niemelä & Tynni 1979, Grönlund 1988).

Very common in the Vadsö sample. The valve varies greatly in shape and size.

Plate XXI, fig. 6.

Rhaphoneis Ehrenberg

Rhaphoneis nitida (Greg.) Grunow. (Hustedt 1930, p. 177, Fig. 683). Only one find at observation site 3. Valve 20 μ long.

Plate XXI, fig. 10.

Synedra Ehrenberg

Synedra gaillonii (Bory) Ehrenberg. (Hustedt 1930, p. 195, fig. 690).

A few specimens in the samples from Vadsö and observation site 3.

Synedra pulchella (Ralfs) Kütz. fo. *curvata* n. fo.

The elongated valve is fairly constant in width and is slightly arcuate or even U-shaped along the pervalvar axis. On the slides the bent valves are always seen sideways. A dotted transapical lining as in the main form, 12—15/10 μ, central area smooth.

Five specimens, the valves estimated to be 150 μ long. Observation site 3, Varangerfjorden. *S. pulchella* with variants common in the flora.

N. B. The form may be an auxospore, as it corresponds to the main form in maximum size and is comparable with the auxospore of *Synedra affinis* (Hustedt 1930, p. 108). Cleve-Euler (1953) has presented similar curved forms of some *Synedra* species.

Plate XXII, figs. 7, 8, 9.

Rhoicosphaenia Grunow

Rhoicosphaenia marina (W. Sm.) M. Schmidt. (Hustedt 1930—66, II, p. 432, fig. 880).

Fairly common at observation site 3. Length 40—50 μ.

Plate XXIII, fig. 1.

Cocconeis Ehrenberg

Cocconeis arctica Cleve. (Cleve 1883, p. 460, pl. 35, fig. 4; Hustedt 1930, p. 353, fig. 807).

A species varying in shape, whose valve without raphe resembles that of *C. pediculus*, being, however, coarser. A structureless transversal band crosses the raphe valve in the central area. The density of the granula lines 12/10 μ. Fairly common in the flora at Vadsö and observation site 3. The form has previously been presented from Finnmark (Cleve 1895, p. 176).

Plate XXIII, figs. 4, 5, 10.

Cocconeis costata Gregory. (Hustedt 1930—66, II, p. 332, fig. 785).

According to Hustedt, the species occurs on the coasts of Europe up to the Arctic Ocean. According to Simonsen, it is met with in the western Baltic Sea, although only as single occurrences, a polyhalobiont. The species also occurs in the Washington area on the coast of the Pacific Ocean (Tynni 1986). In Finland it is known from some interglacial deposits (Niemelä & Tynni 1979) but not from postglacial deposits.

The species was very common in the Vadsö sample and at observations site 3. Cleve & Grunow (1880) presented it from Finnmark.

Plate XXIII, fig. 2.

Cocconeis decipiens Cleve. (Hustedt 1962, p. 353, fig. 808).

Rare in the Vadsö sample. The species was presented from Finnmark by Cleve and Grunow (1880).

Plate XXIII, fig. 3.

Achnanthes Bory

Achnanthes arctica (Cleve) Hustedt. (Hustedt 1930, p. 423, fig. 876).

An oval, rather large form with wide ends. A few specimens at observation site 3.

Plate XXIV, fig. 1.

Achnanthes delicatula fo. *hauckiana* (Grun.) Lange-Bertalot & Ruppel. (Lange-Bertalot & Ruppel 1980, p. 2, Abb. 1—20).

Very common at observation site 3.

Plate XXIV, fig. 2.

Mastogloia Thwaites

Mastogloia exilis Hustedt var. *rostrata* n. var. (Hustedt 1930—62, p. 553, fig. 985).

It differs from *M. exigua* var. *subcapitata* A. Cl. A small form, the transapical lining is not visible at 1000 x magnification, whereas the marginal chambers (loculi) are. There are four loculi at each side. The form resembles *M. exilis* Hustedt, but differs too much to be linked with it.

Only one find at observation site 3 (34.7/111.7). Valve 18 μ long.

Plate XXIV, fig. 4.

Diploneis Ehrenberg

Diploneis bombus Ehr. (Hustedt 1930—66, II, p. 704, fig. 1086).

Rare in the Vadsö sample. Valve 75 μ long.

Plate XXIV, fig. 6.

Diploneis fusca (Greg.) Cl. (Hustedt 1930—66, II, p. 654, fig. 1053).

According to Hustedt, the species occurs on the coasts of Europe from the Mediterranean to northern Europe. According to Simonsen, it also occurs in the Belt Sea. The species has not been presented from marine deposits in Finland.

Fairly common in the Vadsö sample and the most common of the *Diploneis*. Valve c. 90 μ long.

Plate XXIV, fig. 7.

Diploneis fusca var. *aestiva* (Donk.) Hust. (Hustedt 1930—66, II, p. 657, fig. 1059).

Occurs in the Vadsö sample together with the main form. Valve c. 50 μ long.

Plate XXV, fig. 1.

Diploneis suborbicularis (Greg.) Cleve. (Hustedt, 1930—66, II, p. 612, fig. 1026).

The species resembles *D. coffaeiformis* (A.S.) Cl., but the central area of *D. suborbicularis* with longitudinal channels is wider.

Only two specimens in the Vadsö sample. According to Hustedt (1930), the species occurs mainly in warm seas. Simonsen (1962) has presented it from the western Baltic Sea, and Grönlund (1988) from the interglacial deposits in western Finland.

Plate XXV, fig. 7.

Navicula Bory

Section Naviculae microstigmaticae (Cleve) Hustedt

Navicula comoides (Ag.?) Peragallo. (Simonsen 1962, Taf. 1, figs. 10, 11; Hustedt 1962, p. 304, fig. 1423).

Relatively common in the Vadsö sample. Valve c. 23—38 μ long.

Plate XXVI, figs. 1—2.

Navicula grevillei (Ag.?) Heiberg. (Hustedt 1962, p. 302, fig. 1422).

Fairly common in the Vadsö sample. Valves on the slide usually sideways. Valve 37—60 μ long.

Plate XXVI, figs. 3, 5, 6, 8, 14

Navicula grevillei var. *ovalis* n. var.

The frustule is elliptical on the valve plate, swells markedly at the raphe and declines steeply to the apical ends. The axial area is very small and the transapical lines form a clear boundary surface. The transapical lines are poorly developed, weakly granular and perpendicular to raphe, line density in the middle 17/10 μ, elsewhere c. 22/10 μ. The valve, which is 37 μ long and 13 μ wide, resembles that of microstigmaticae in structure, but also the raphe valve of *Achnanthes taenianta,* differing from it in having shorter polar ends of raphe. In shape it resembles some species of N. minusculae, which, however, are smaller. In terms of transapical ornamentation, the species resembles *N. grevillei.*

Only one observation from the Vadsö sample (34.2/127).

Plate XXVI, fig. 7.

Navicula protracta fo. *elliptica* Gallik. (Hustedt 1962, p. 316, fig. 1435).

An elliptical form, 28 μ long, 7 μ wide, with a rather convex valve plate. In the middle the line density is c. 14/10 μ, at the ends it is higher.

Rare at observation site 3.

Plate XXVI, figs. 11, 13.

Navicula rhombica Gregory (Hustedt 1962, p. 325, fig. 1441).

A rhombic valve plate, narrow raphe, except in the centre. Transapical lining c. 16/10 μ, in the centre somewhat less dense. Length 63 μ.

A few specimens in the Vadsö sample. According to Cleve & Grunow (1880), the form is common in Finnmark (Syn. *N. libellus Greg.* var. *genuina).*

Plate XXVI, figs.4, 9.

Navicula subinflata Grunow. (Hustedt 1962, p. 292, fig. 1415).

Valve 18 μ long. A few occurrences in the slide made of the sample from observation site 3.

Plate XXVI, fig. 12.

Section Naviculae lyratae Cleve

Navicula abrupta (Greg.) Donkin. (Hustedt 1964, p. 516, fig. 1558).

According to Hustedt, it is a cosmopolitan marine form, resembling *N. lyra* var. *atlantica* A. S. Both of them occur at Vadsö, but the latter is more common.

Plate XXVII, fig. 1.

Navicula dissipata Hustedt. (Hustedt 1964, p. 549, fig. 1587). Rare at observation site 3. Encountered on Atlantic coasts and in the western Baltic Sea.

Plate XXVII, fig. 7.

Section Naviculae punctatae Cleve

Navicula solutepunctata Hustedt. (Hustedt 1966, p. 646, fig. 1647; Simonsen 1987, pl. 382: 1—8).

A small form (17 μ) in which the transapical lines are interrupted near to the margin.

Rare at observation site 3. A marine form encountered in the sediments of Norwegian fjords (Hustedt op. cit.). Resembles *Diploneis sejuncta* (A. S.) Jörg.

Plate XXVIII, fig. 2.

Section Naviculae lineolatae Cleve

Navicula ammophila Grunow. (Cleve 1894, p. 29; Peragallo, pl. 12, fig. 13).

A small form (28—30 μ), lines in the central area subradiate, density 10—11, at ends transverse, 12—13/10 μ. Cleve has presented *N. ammophila* var. *intermedia* Grun. 1882, a form with slightly more dense lines from Finnmark.

Relatively common at observation site 3.

Plate XXVIII, figs. 3,4.

Navicula bottnica Grun. (Peragallo pl. 12, fig. 30, Tynni 1975, p. 11, fig. 128).

The ornamentation of the valve bears a resemblance to that of N. *digitoradiata*, but is more slender and dense.

Very common at observation site 3. The length is from 40 to 70 μ. Cleve & Grunow (1880) presented the species from Finnmark, and Fontell (1926) from a littoral pond near Pori. A brackish-water form.

Plate XXVIII, figs. 5—8.

Navicula crucifera Grunow. (Schmidt's Atl. Taf. 46, figs. 50—54).

Rare at observation site 3.

Navicula digitoradiata (Greg.) A. Schmidt. (Hustedt 1930, p. 301, fig. 518). A brackish to saline-water form common on many coasts. Observations from Baltic Litorina and post-Litorina deposits. The form has been presented less often from interglacial deposits, e.g. from Haapavesi (Grönlund 1988). The species was very common in the Vadsö sample.

Plate XXVIII, fig. 9.

Navicula digitoradiata var. *cyprinus* (Ehr.) W. Sm. (Schmidt's Atl. Taf. 272, figs. 28—32; Peragallo pl. 12, figs. 26, 27. (N. *cyprinus* Sm.).

The form differs from the main form in having angular apical ends. Rare at the Varangerfjorden observation site.

Plate XXIX, fig. 1.

Navicula directa (W. Sm.) Ralfs. (Cleve 1895, p. 27; A. S. Atl. pl. 47, figs. 4, 5; Grönlund 1988, p. 12, fig. pl. 7, figs. 18, 19). About ten specimens in the Vadsö sample. The synonym of the species has been presented from Finnmark (*N. directa* var. *angusta* Grun.).

Plate XXIX, figs. 2, 3.

Navicula directa var. *oceanica* Karsten. (Riznyk 1973, 126). The valve is narrow and linear, but slightly broader in the middle. Apical ends are narrow and somewhat tapered. Length 75 μ, width 8 μ. Transapical lines perpendicular to raphe, c. 7/10 μ. The raphe area is narrow, except in the middle where the lines are shorter and less dense than elsewhere.

Only two observations from the Vadsö sample.

The form resembles the *Navicula longa* type and some narrow *Gomphomena* species (cf. Hustedt 1942, p. 116, Simonsen 1987 pl. 426: 1—8).

Plate XXIX, fig. 9.

Navicula directa var. *subtilis* Greg. (Cleve 1895, p. 27).

Length 90—120 μ, width 8 μ. Line density 9/10 μ. Rare in the Vadsö sample.

Plate XXIX, figs. 7, 8.

Navicula distans (W. Sm.) A. Schm. (Schmidt's Atl. Taf. 46, figs. 11—14, Cleve & Grunow (1880), p. 38, fig. 42, *N. distans* var. *borealis* Grunow).

A fairly large form with radial lines and a large raphe area.

Only one specimen was found at observation site 3. Valve 100 μ long.

Plate XXIX, fig. 5.

Navicula finmarchica Cl. & Grun. fo. *hendey* n. fo.

The form resembles *N. finmarchica* presented by Hendey (1964, pl. 30 fig. 5), which is wide in the middle and differs from the typical species (e.g. Cleve & Grunow 1880, Brockmann 1950).

Only one find in the Vadsö sample.

Plate XXX, fig. 1.

Navicula flanatica Grunow. (Brockmann 1950, p. 18, figs. 41, 42).

The form resembles *N. lanceolata* but differs from it in having divergent lines in the valve tips.

A few observations at site 3. Valve 35 μ long.

Plate XXVIII, fig. 10.

Navicula halophila fo. *robusta* Hust. Hustedt 1961 p. 65.

Length 37 μ, width 8 μ and line density 16—17/10 μ. The lines are almost perpendicular to the raphe, in the middle slightly radial, at the ends convergent. The ends of the raphe are very close to each other.

Rare at observation site 3.

Note: The form resembles *N. halophila* (Grun.) Cl., but the ends of the raphe are farther apart. See also *Navicula britannica* Hustedt & Aleem 1951, p. 184, fig. 1 C, which has, however, a higher line density. According to Cleve (op. cit.), *N. gregaria* links *N. cryptocephala* of section Lineolatae to *N. halophila* of section Orthostichae and thus it could be included in either of the sections, being, however, closer to *N. halophila*. Hustedt (1961) non longer included the species *gregaria* in section Orthostichae.

Plate XXVIII, fig. 12.

Navicula hungarica Grunow. (Cleve 1895, p. 16; Hustedt 1930 a, p. 298, fig. 506).

The form encountered at observation site 3 is slightly exceptional in that its lining is very radiate and the lines are curved. Between the terminal raphe ends the valve is arched. The form is between the main form and var. *lüneburgensis* Grun. The latter has been presented from the River Tana in Finnmark (Cleve 1895).

A halophile form.

Plate XXIX, fig. 11.

Navicula longa (Greg.) Ralfs. (Schmidt's Atl. Taf. 47, fig. 6; Peragallo pl. 12, fig. 1). Synonym *N. directa* var. *remota* Grunow 1880.

The habitus of the valve is similar to that of the *N. directa* W. Sm. species, but the transapical lines of the *longa* are more radial, clearly lineate, and the line density is 5—6/10 μ. See Hustedt 1955, p. 28.

Only a few observations from the Vadsö sample. Valve 95 μ long. Previously presented from Finnmark (Cleve & Grunow 1880: *N. directa* var. *remota).*

Plate XXIX, fig. 10.

Navicula rostellataformis n. sp.

The outline of the valve resembles that of *N. rostellata* Kütz.. Length 52 μ, width 9 μ. In the central area the transapical lines are radial, at the ends convergent. Line density in the middle 10/10 μ, at ends 11/10 μ. In longitudinal direction the striae are densely lineated. The raphe is straight and slightly swollen close to central nodule and the ends are slightly raised as in *N. rostellata* (fig. 4). The proximal ends of the raphe are close to each other. The axial area is narrow, even in the middle. The form resembles *N. arenaria* (see Hendey 1964, pl. 30, fig. 15), which, however, has a broader central area.

Plate XXX, fig. 6.

Navicula salinicola Hustedt. (Hustedt 1939, p. 638, figs. 61—69). A small form (c. 10 μ) with transapical lines in the central area slightly radial, at ends perpendicular to raphe. Line density c. 20/10 μ.

At observation site 3 it forms dense colonies in places. According to Hustedt (1939, 1955), the species is probably cosmopolitan. It has been encountered on the coasts of the North Sea and the west coast of the Atlantic Ocean.

Plate XXX, fig. 7.

Pinnularia Ehrenberg

Pinnularia cruciformis Donk. (Peragallo, pl. 11, fig. 19.; Brockmann 1950, Taf. 5, fig. 9).

Fairly common in the Vadsö sample, usually resting sideways.

Plate XXXII, fig. 1.

Caloneis Cleve

Caloneis brevis (Grev.) Cleve. (V. Heurck 1896 p. 209, pl. 4, fig. 180).

In the form encountered in Vadsö, the valve has rectilinear sides in the centre, otherwise it is similar to the main form.

Plate XXXII, fig. 2.

Caloneis consimilis A. Schmidt. (Cleve 1894, p. 57; Peragallo, pl. 9, figs. 1, 2).

A fairly big form, linear, tapering angularly at the ends. The central area is devoid of transapical lines perpendicular to the raphe. Line density 13/10 μ.

Only one observation from the Vadsö sample.

Plate XXXII, fig. 7.

Caloneis liber (W. Sm.) Cleve. (Schmidt's Atl. Taf. 50, figs. 16—18).

About ten specimens in the Vadsö sample. Valve c. 80—100 μ long.

Plate XXXII, fig. 6.

Trachyneis Cleve

Trachyneis aspera (Ehr.) Cleve. (Peragallo pl. 29, figs. 1, 2).

A marine form not growing in the present-day Baltic Sea but in the Great Belt and Kattegat (Simonsen op. cit.). It is common in the Arctic Ocean, probably in the area affected by the Gulf Stream. Cosmopolitan species.

Common in Vadsö. *T. aspera* var. *intermedia* Grun. previously presented from Finnmark (Cleve 1884). It is characterized by a unilateral raphe.

Plate XXXI, figs. 1, 4.

Trachyneis sp., cf. *tumidula* Grun. (Cleve 1894, p. 192).

A relatively short form with a fairly large central area widening towards and extending almost to the margin. Axial area narrow, with the raphe almost in the middle of it. The thick raphe forks at the central nodule are curved in a crook-like fashion. Length 70 μ, width 20 μ. Line density 12/10 μ

Rare in the Vadsö sample.

Plate XXXI, fig. 2.

Scoliotropis Cleve

Scoliotropis latestriata (Bréb.) Cl. (Peragallo, pl. 28, figs. 13—15).

Rare in the Vadsö sample. Valve 110 μ long.

Plate XXXII, fig. 4.

Auricula Castracane

Auricula complexa (Greg.) Cl. (Peragallo, pl. 42, figs. 14, 15; Hendey pl. 38, fig. 15).

Only two specimens from observation site 3. Valve 100 μ long.

Plate XXXII, fig. 5.

Gyrosigma Hassal

Gyrosigma fasciola var. *arcuata* (Donk.) Cl. (Hustedt 1955, p. 33, pl. 10, fig. 9).

Rare in the Vadsö sample.

Plate XXXIII, fig. 2.

Gyrosigma fasciola var. *sulcata* Grunow. (Grunow 1880, p. 55, Taf. 4, fig. 75; Cleve 1894, p. 116).

On the valve plate the longitudinal lines are distinctly more strongly developed than the transversal ones (16/10 μ as against 20/10 μ).

Rare in the sample from observation site 3.

Plate XXXIII, fig. 1.

Gyrosigma wanspeckii (Donk.) Cleve. (Hustedt 1930, p. 226; Cox 1979).

The most common *Gyrosigma* species in the Vadsö sample.

Plate XXXIII, fig. 3.

Pleurosigma W. Smith

Pleurosigma elongatum var. *fallax* (Grun.) Cl. (Grunow 1880, p. 50, Taf. 3, fig. 66; Cardinal et al. 1989, p. 19, fig. 26, Central bar structure inside the valve).

The valve is only slightly sigmoid, the raphe near the ends is somewhat eccentric and there are short transversal lines on the sides of the central nodule. According to Cleve & Grunow (1880) common on the coast of Finnmark.

Pleurosigma formosum W. Sm. (V. Heurck 1896, p. 254, fig. 268; Navarro 1982, p. 325, figs. 95—99).

A big form with eccentric raphe. Fairly sparse diagonal lines c. 12/10 μ, perpendicular to each other.

Rare in the Vadsö sample.

Plate XXXIV, fig. 1.

Pleurosigma latum Cleve. (Cleve 1880 p. 14 Taf. 3, fig. 68; cf. Grunow 1880 p. 51).

A relatively short form, almost rhombic. *Pleurosigma rhomboides* Cl. (p. 14, Taf. 4, fig. 73) is similar to the former in profile, but differs in the position of the raphe and the line density. They may belong to the same species within the range of variation. These forms resemble short *P. angulatum* forms but are more rounded.

Rare in the Vadsö sample. Diagonal line density 21/10 μ. Valve 132 μ long. The form presented by Cleve from Finnmark measured 18/10 μ, 76 μ. The corresponding figures for the form presented by Grunow were 22/10 μ and 85 μ.

Plate XXXIV, fig. 3.

Pleurosigma strigosum W. Sm. (Hendey 1964, pl. 36, fig. 7).

The species is not common on the coasts of Europe, although the type locality is in Britain. Hustedt (1955) and Patrick & Reimer (1966) presented the form from the Atlantic coast. It also occurs on the coast of the Pacific Ocean (Tynni 1986). It has not been presented from either the western Baltic Sea or interglacial or postglacial deposits in Finland.

Fairly common in the Vadsö sample. The species presented from Finnmark by Cleve & Grunow (1880).

Plate XXXV, fig. 2.

Pleurosigma stuxbergii Cleve & Grunow. (Cleve & Grunow 1880, p. 54, pl. 4, fig. 74; Cleve 1894, p. 41; Cardinal et al. 1989, p. 23).

A rather large form with a fairly dense surface structure. The transversal lines on the valve are markedly more distinct than the diagonal lines. Line densities 21/10 μ and 26/10 μ, respectively. The diagonal lines make an angle of <60 with the apical direction.

A few observations from Vadsö and site 3.

Plate XXXV, fig. 3.

Donkinia (Ralfs) Cox

Donkinia carinata (Donk.) Ralfs var.*longiuscula* n. var. (Main form, Cox 1983, pp. 569—571).

The valve is narrow and elliptical with tapered ends and a screw-like shape. The central area excluded, the raphe is on opposite margins of the valve plate. In the central area it crosses the plane subperpendicularly. The ornamenting lines on the valve are diagonal to the raphe whereas in other species they are longitudinal and transversal (Cox op. cit.).

The profile of the form encountered at Vadsö resembles *D. angusta* Cox p. 570 more than *D. carinata*, but the ornamentation of the former is different. Only two observations from the Vadsö sample. Valve 92 μ long, 8 μ wide, line density 20/10 μ.

Plate XXXVII, fig. 1.

Donkinia lata Cox

Syn.: *Donkinia recta* sensu Karsten 1899, Cox 1981 b.; Hendey (1964), p. 251, pl. 35, fig. 7.

According to Cox (1983), »*Donkinia recta*» is close to *D. cf. baltica* in structure. In the latter the transversal lines are stronger than the longitudinal ones, whereas in *D. lata* the longitudinal lines are clearly visible.

Rare in the Vadsö sample. Valve c. 120 μ long, 16 μ wide.

Plate XXXVII, fig. 2.

Toxonidea Donkin

Toxonidea insignis Donk. (Peragallo, pl. 36, figs. 23, 24; Brockmann 1950, p. 22, Taf. 6, fig. 20).

A few occurrences in the Vadsö sample.

Plate XXXVII, fig. 5.

Tropidoneis Cleve

Tropidoneis lepidoptera (Greg.) Cl. (Cleve 1894, p. 25).

Syn. *Plagiotropis lepidoptera* (Greg.) Reimer.

Relatively common in the Vadsö sample. Valve c. 75—120 μ long, line density c. 16/10 μ. The figures given by Cleve differ somewhat.

Plate XXXVII, fig. 6; XXXVIII, figs. 3, 5.

Amphora Ehrenberg

Amphora (angusta var) *arctica* Grun. (Cleve & Grunow 1880, Taf. 1, fig. 9).

An elongated form with a narrow raphe and transversal lines perpendicular to raphe. Rare in the Vadsö sample. Valve 50 μ long, line density 15/10 μ.

N. B.: It is uncertain whether the form belongs to the *angusta* species, for its smooth dorsal axial area is very large, whereas in *arctica* it is extremely narrow.

Plate XXXIX, fig. 1.

Amphora arcus var. *sulcata* (A. Schmidt) Cleve. (Cleve 1895, p. 127; Peragallo, pl. 50, fig. 5; Bérard-Therriault et al. 1986, p. 414, Figs. 63—65).

A few specimens in the Vadsö sample.

The form is close to *A. lineolata* Ehr. but its transversal ornamentation is coarser and the valve is more arcuate. Cleve & Grunow (1880) presented the main form from Finnmark but not *A. lineolata.*

Plate XXXIX, figs. 2, 3.

Amphora granulata Greg. (Hustedt 1955, p. 40, pl. 14, figs. 8—10, 26, 27).

A narrow form with swollen beak-like tips. The raphe is close to the ventral side. Line ornamentation on the dorsal side is cut by a longitudinal line close to the raphe.

Fairly common in the Vadsö sample. Valve c. 50 μ long, line density 10/10 μ. The form described by Hustedt differs from that presented by Schoeman & Archibald (1987). *A. cymbifera* Greg., however, resembles the form presented by Hustedt.

Plate XXXIX, fig. 4.

Amphora laevissima Gregory. (Peragallo pl. 49, fig. 11).

The raphe of the elongated valve is curved. At the dorsal side there is a transversal beam which does not extend to the raphe The transapical lining on the valve is very dense, >30/10 μ, but does not show up under the microscope used.

Cleve has presented the species from Finnmark (Cleve & Grunow 1880). Very rare at Varangerfjorden observation site 3.

Plate XXXVIII, fig. 7; XXXIX, fig. 9.

Amphora proteus var. *constricta* n. var.

The form differs from the main form in its narrower central area. Two punctate intercalary bands are indistinctly visible between the valves on the ventral side. Raphe area is small but the central area is ventrally enlarged. Line density c. 12/10 μ. A longitudinal fold line in the central area of the ventral side.

N. B.: The form resembles *A. proteus* var. presented by Cleve-Euler (1953, fig. 673) based on the description by Brockmann.

Rare in the Vadsö sample.

Plate XXXIX, fig. 12.

Amphora terroris Ehr. (Cleve 1895, p. 122; Bérard-Therriault et al. 1986, p. 414, figs. 37, 38, 41, 42).

Thick transversal beams, a narrow ventral side and beak-like apical ends are typical of the species. The form resembles *A. costata* W. Sm.

A few occurrences in the Vadsö sample.

Plate XXXIX, fig. 13.

Gomphonema Agardh

Gomphonema kamtschaticum Grunow. (Cleve-Euler 1955, p. 196, fig. 1302 a; Hendey 1977, p. 367, tab. 2; Bérard-Therriault et al. 1986, p. 425, figs. 104—107 (*G. kamtschaticum* Grun. var. *kamtschaticum).*

Only two finds at observation site 3. Valve 50 μ long.

Plate XL, fig. 1.

Nitzschia Hassal

Section Spathulatae Grun.

Nitzschia angularis W. Smith. (Grunow 1880, p. 88, Taf. 5, fig. 98, Peragallo, pl. 73, fig. 6. V.H. 1896, p. 177, Taf. 62, figs. 11—14; Hendey 1964, pl. 39, fig. 6).

Comparatively common in the Vadsö sample, Keel punctae 3—4/10 μ. Grunow (1880), p. 89, suggests that *N. spathulata* Bréb. is closely related to the above form and differs from it only in having a thicker keel. Both species have been reported from Finnmark (Cleve & Grunow op. cit.).

Plate XLI, figs. 1, 2.

Nitzschia distans Gregory. (Peragallo, pl. 73, fig. 3).

Rare in the Vadsö sample. Valve 77 μ long. density of keel punctae c. 3/10 μ.

Plate XLI, fig. 4.

Section Dissipatae (Grun.) Hust.

Nitzschia socialis Gregory. (Peragallo, pl. 72, figs. 7, 8).

A marine form, common in the sea areas of Finnmark (Cleve & Grunow 1880). Hustedt (1955) found the species common on the coast of North Carolina. It also occurs in the sea areas of the British Isles (Hendey 1974). Hustedt (1939) presented the species from the estuary of the Ems on the coast of the North Sea. Aleem (1973) reported the species from the western North Sea off Gothenburg. The species, which has not been found on the North Sea coast of Schleswig-Holstein or from the western Baltic Sea, is known to be cosmopolitan. It also occurs in the Washington area on the coast of the Pacific Ocean (Tynni 1986). It has not been encountered in the present-day Baltic Sea.

Common in the Vadsö sample. Keel punctae 7—8/10 μ, lines 15—16/10 μ.

Plate XL, figs.. 4, 5.

Section Lanceolatae (Grun.) Lange-Bertalot & Simonsen

Nitzschia bergii Cleve-Euler. (Cleve-Euler 1952, p. 89, fig. 1501).

Fairly common at observation site 3. Length 68 μ, keel punctae 18/10 μ.

N. Proshkina-Lavrenko Aleem (1973) is a closely related form. It is 65—75 μ long with small keel punctae 14—16/10 μ.

Plate XLI, fig. 8.

Nitzschia vadsösis n. sp.

Elongated valve, narrowing gradually towards the ends. Valve 54 μ long, 9 μ wide. Keel punctae transapically elongated and irregular in shape varying in density with an average of 5/10 μ. Dense transapical lines, c. 32/10 μ. Resembles *N. recta* Hantzsch in structure, but the Vadsö form has bigger fibulae wider apart and the valve is relatively wider. The fibula structure resembles that presented by Lange-Bertalot & Simonsen (1978) (Fig. 282). Another form with relatively big fibulae wide apart is *N. heideni* var. *pamirensis* Petersen (Foged 1980, pl. 42, fig. 18).

Rare in the Vadsö sample. Probably transported to the sampling site from a fresh-water area.
Plate XLI, fig. 5.
Section Fragilariopsis Hasle
Nitzschia cylindrus (Grun.) Hasle
Syn. *Fragilaria cylindrus* Grun.
Rare in the Vadsö sample. According to Hasle (1976) the species has a bipolar distribution.
Plate XL, fig. 10.
Surirella Turpin
Surirella gemma Ehrenberg. (Hendey 1964, pl. 40, fig. 5).
Rare in the sample from observation site 3.
Plate XLII, fig. 1.

Table I. Diatom flora of the Pulmankijärvi area (1) in the surface water, (2) on the sediments, (3,4) in the coastal surficial sediments, (5) in the plankton of the Pulmankijoki, (6) in the sediments of the Pulmankijoki and (7) in the plankton of the Kalttausjoki. (x) one observation, x rare, xx fairly common, X dominant.

	1	2	3	4	5	6	7
Achnanthes affinis Grun.		xx			xx	x	x
A. biasolettiana Kütz.		x					
A. borealis A. Cl.		xx					
A. calcar Cl.		x					
A. clevei Grun.		x					
A. c. var. rostrata Hust.		x					
A. coarctata Bréb.		x					
A. conspiqua A. Mayer		z					
A. depressa (Cl.) Hust.		x					
A. didyma Hust.		xx					
A. elliptica var. rostrata A. Cl.		x					
A. flexella (Kg.) Brun						x	x
A. f. var. alpestris Brun					x		
A. gracillima Hust.		x					
A. lanceolata Bréb.		xx					
A. l. var. elliptica Cl. & rostrata Hust.		x					
A. lapponica Hust.		x					x
A. laterostrata Hust.		xx					x
A. levanderi Hust.		xx					
A. linearis (W. Sm.) Grun.		x					
A. l. var. pusilla Grun.		xx			x	xx	
A. marginulata Grun.		x					
A. microcephala Kütz.		x					
A. minutissima Kütz.	x	x					
A. m. var. cryptocephala Grun.		x					
A. mölderi n. sp.		x					
A. nitida A. Cl.		xx					
A. nodosa A. Cl.							x
A. obliqua (Greg.) Hust.	x						
A. peragalli Brun et Perag.		x			x		
A. pinnata Hust.		x					
A. pungens (A. Cl.)		x					
A. sp.		x					
A. sublaevis Hust.		x					
A. suchlandtii Hust.		x					
A. östrupi (A. Cl.) Hust.		x					
Actinocyclus eherenbergii Ralfs	(x)						
Amphipleura pellucida Kütz.		x					
Amphora coffeaformis Ag.		(x)					
A. normani Rabenh.		x					
A. ovalis Kütz.	x	xx					
A. o. var. libyca (Ehr.) Kütz.		xx				x	
A. o. var. pediculus Kütz.		x					
A. parallelistriata Manguin		x					
A veneta Kütz.		xx					
Anomoeoneis exilis (Kütz.) Cl.		xx			x	x	x
A. serians v. brachysira Bréb.		xx			x		x
A. styriaca (Grun.) Hust.		x			x		
A. zellensis (Grun.) Cl.		x					
Asterionella formosa Hassal	X	xx			xx	x	x
Bacillaria baxillifer (Müll.) Hend.				x			
Caloneis bacillum (Grun.) Meresch.		xx					
C. obtusa (W. Sm.) Cl.		x			x		
C. silicula (Ehr.) Cl.		x				xx	
C. s. var. truncatula Grun.		x					
C. s. var. tumida Hust.		x					
C. sp. cf. schröderi Hust.		x					
Campylodiscus hibernicus Ehr., fo.		xx				x	
C. noricus Ehr.		xx					
Ceratoneis arcus var. linearis Hol.	x	xx			xx	x	xx
Cocconeis diminuta Pant.		(x)					
C. pediculus Ehr.	(x)						
C. placentula + var. euglypta (E.) Cl.		xx					
C. p. var. intermedia (Her.) Perag.		x					
C. p. var. lineata (Ehr.) Cl.		x					
Cyclotella antiqua W. Sm.	x	x					x
C. bodanica Eulenst.		xx			x	xx	
C. comensis Grun. typ		xx				x	
C. comta (Ehr.) Kütz.		x					
C. iris Brun		xx					
C. kützingiana Twaites		x					
C. k. var. radiosa Fricke	xx	xx					
C. kützingiana var. schumanni Grun.		x					
C. quadriiuncta (Schröt.) Hust.		x					
C. stelligera Cl. & Grun.		x					
Cymatopleura elliptica (Bréb.) W. Sm.		x					
C. solea (Bréb.) W. Sm.		xx					
Cymbella aequalis Smith		x					
C. affinis Kütz.		x				x	x
C. aspera (Ehr.) Cl.		x				xx	
C. caesati (Rabh.) Grun.		x					x
C. cistula (Hempr.) Grun.		xx				x	
C. c. var. maculata (Kütz.) V. H.		x					
C. cuspidata Kütz.		x					x
C. cymbiformis Agardh		xx					
C. c. var. arctica (Lagersted)		x					
C. c. var. nonpunctata Fontell		x					
C. delicatula Kütz.		x					
C. ehrenbergii Kütz.						x	
C. gaeumanni Meister		x				x	x
C. girodi (Hér.) Krenner		x					
C. gracilis (Rabh.) Cl.	x	x					x
C. hauckii ? V. H.		(x)					
C. helvetica Kütz.		x					
C. h. var. compacta (Östr.) Hust.		x					
C. heteropleura (Ehr.) Kütz.		(x)					
C. incerta (Grun.) Cl.		x					
C. laevis Naegli		x					
C. lanceolata (Ehr.) Cl.		x					
C. microcephala Grun.		x			x	x	
C. naviculiformis Auersw.	x	x				x	
C. obtusa Greg.						x	
C. perpusilla A. Cl.	x						
C. prostrata (Berk.) Cl.		x					
C. p. var. auerswaldii (Rabh.) Reimer		x					
C. sinuata Greg.		x					
C. ventricosa Kütz.		x			x		
Denticula tenuis Kütz.		x					
D. t. var. crassula (Naeg.) Hust.		x					
Diatoma elongatum + var. tenuis (Ag.) K.		xx			xx	xx	xx
D. hiemale (Lyngb.) Heib.		x					
D. h. var. mesodon (Ehr.) Grun.		(x)					
Didymosphaenia geminata (Lyngb.) M. S.		x			x	X	x
Diploneis elliptica (Kütz.) Cl.		xx					
D. e. var. ladogensis Cl.		xx					
D. finnica (Ehr.) Cl.		xx					
D. f. var. clevei (Fontell) Hust.		x					
D. oculata (Bréb.) Cl.		x					
D. ovalis (Hilse) Cl.		xx					
D. o. var. oblongella (Naeg.) Cl.		x					
D. parma Cl.		x					
D. puella (Schum.) Cl.		xx					
D. subovalis Cl.		x					
Epithemia argus Kütz.		x					
E. mülleri Fricke	(x)						
E. sorex Kütz.		xx					
E. s. fo. prosboscidea W. Sm.						x	
E. turgida (Ehr.) Kütz.		x				x	
E. t. var. westermanni (Ehr.) Grun.		xx					
E. zebra (Ehr.) Kütz.		xx					
E. z. var. porcellus & saxonica K. & E.		xx				x	x
Eunotia arcus Ehr.		xx				x	
E. a. var. bidens Grun.		x					x
E. bidentula W. Sm.		x					
E. exigua (Bréb.) Rabh.		x					
E. faba (Ehr.) Grun.		x					
E. flexuosa (Bréb.) Kütz.		x					
E. formica Ehr.		x					
E. lapponica Grun.		x					x
E. lunaris (Ehr.) Grun.	x	x					x
E. meisteri Hust.						x	
E. monodon Ehr.		x					
E. m. var. maior (W. Sm.) Hust.		x					
E. papilio (Grun.) Hust.		x					
E. pectinalis Rabh.						x	
E. p. var. minor & ventralis (E.) Hust.		x				x	x
E. polydentula Brun	x						
E. polyglyphis Grun.		xx					
E. praerupta Ehr.		x				xx	
E. p. var. bidens Grun.		x	(x)				
E. pseudopectinalis Hust.		x					
E. robusta Ralfs		x					
E. r. var. diatema (Ehr.) Ralfs		x					
E. r. var. tetraodon (Ehr.) Ralfs		x				xx	

	1	2	3	4	5	6	7
E. sudetica O. Müller		x					
E. triodon Ehr.		x					
E. valida Hust.		x					
E. veneris (Kütz.) O. Müller		x					
E. v. var. rhomboidea (Hust.)						x	
Fragilaria brevistriata Grun.		x			x		x
F. capucina Desm.		x					
F. construens (Ehr.) Grun.		x				x	x
F. c. var. binodis (Ehr.) Grun.		xx					
F. c. var. subsalina Hust.		x					
F. c. var. venter (Ehr.) Grun.		x					
F. crotonensis Kitton		x					x
F. intermedia Grun.	x	xx					x
F. lapponica Grun.		x					
F. leptostauron (Ehr.) Hust.		x					
F. nitzschioides Grun.		x					
F. pinnata Ehr.		x			x		
F. p. var. lancettula (Schum.) Hust.		x					
F. rumpens (Kütz.) Carlson		x					
F. vaucheriae (Kütz.) Petersen		x					
F. virescens Ralfs		xx					
F. v. var. elliptica Hust.		x			x		
Frustulia rhomboides (Ehr.) De Toni		x					
F. r. var. amphipleuroides Grun.	x						
F. r. var. saxonica Rabh.		x					x
F. r. var. saxonica fo. undulata Hust.		x					
F. vulgaris (Thwait.) De Toni		x					
Gomphonema acuminatum Ehr.		x					
G. a. var. brébissonii (Kütz.) Cl.		x					
G. a. var. coronata (Ehr.) W. Sm.		x				x	x
G. angustatum (Kütz.) Rabh.	x						
G. constrictum Ehr.		x					
G. intricatum Kütz.		x					
G. i. var. pumila Grun.	x	x					
G. longiceps var. montana (Sch.) Cl.	x	x			x	x	x
G. olivaceoides Hust.		x					
G. parvulum (Kütz.) Grun.		x					
G. subtile Ehr.					x	x	
G. ventricosum Greg.		x					
Gyrosigma acuminatum (Kütz.) Rabh.		x					
G. a. var. gallica Grun.	x	x					
G. attenuatum (Kütz.) Rabh.		x					
Hantzschia amphioxys (Ehr.) Grun.		x					
H. a. var. maior Grun.		x					
H. .a. var. vivax (Hantz.) Grun.		x					
H. elongata (Hantz.) Grun.		x			x		
Melosira ambigua (Grun.) O. Müll.	x	x					
M. arenaria Moore		x					
M. distans (Ehr.) Kütz.	x	xx		(x)	x		xx
M. d. var. africana Müller		x			x		
M. d. var. alpigena Grun.		xx					
M. d. var. lirata (Ehr.) Bethge	x	x				xx	
M. d. var. l. fo. lacustris (Grun.) Be.					x	x	
M. islandica ssp. helvetica Müller		x					
M. italica (Ehr.) Kütz.	xx	x					x
M. i. fo. laevis Grun.	x	x					
M. i. ssp. subarctica Müller		x					
M. i. var. valida Grun.		x					
M. varians Ag.		x					
Meridion circulare Ag.		x			x	x	x
Navicula anglica Ralfs		x					
N. avenaceae Bréb.		x					
N. bacillum Ehr.		x					
N. b. var. gregoriana Grun.		x					
N. cari Ehr.		x					
N. cinta Ehr.		x					
N. clementis Grun.		x					
N. c. fo. constans (Hust.) n. comb.		x					
N. cocconeiformis Greg.		xx			x		
N. c. fo. inflata n. fo.		x					
N. costulata Grun.		x					
N. cryptocephala Kütz.		x					
N. cuspitata Kütz.		x			x		
N. exigua (Greg.) O. Müll.		x					
N. gregaria Donkin		(x)					
N. hungarica Grun.		x					
N. h. var. capitata (Ehr.) Cl.		x					
N. incerta Grun.		x					
N. ingrata Krasske		x					
N. interglacialis Hust.		x					
N. invicta Hust.		x					

	1	2	3	4	5	6	7
N. jentzschii Grun.		x					
N. järnefeltii Hust.		x					
N. jungi Krasske		x					
N. lacustris Greg.		x					
N. lanceolata (Ag.) Kütz.		xx				x	
N. lundströmii fo. frieseana (Grun.) Cl.		x			x		
N. menisculus Schum.	x	x					
N. minima Grun.		x					
N. oblonga Kütz.		x					
N. paanaensis A. Cl.-E.		x					
N. plausibilis Hust.		x					
N. protracta (Grun.) Cl.		x					
N. p. fo. elliptica Gallik		x					
N. pseudoscutiformis Hust.		x					
N. pupula Kütz.		x			x		x
N. p. var. elliptica Hust.		x					
N. p. var. rectangularis (Greg.) Grun.		x					
N. pusio Cl.		x					
N. quadripartita Hust.		x					
N. radiosa Kütz.	x	x					x
N. r. var. maior n. comb.		x					
N. r. var. tenella (Bréb.) Grun.		x					
N. rhynchocephala Kütz.		x					
N. rotaeana (Rabh.) Grun.		x				x	x
N. salinarium Grun.		x					
N. scutelloides (W. Sm.)		x					
N. scutiformis Grun.		x					
N. seminulum Grun.		x					
N. similis Krasske		x					
N. strömii Hust.		x					
N. subatomoides Hust.		x					
N. subrotundata Hust.		x					
N. tecta Krasske		x					
N. tuscula (Ehr.) Grun.		x					
N. viridula Kütz.					x		
N. vulpina Kütz.		x					
Neidium affine var. amphirhynchus fo. incurvum (Greg., Östr.) Foged					x		
N. hitchcockii (Ehr.) Cl.		x					x
N. iridis (Ehr.) Cl.		x					
N. i. var. amphigomphus (Ehr.) V. H.		x				x	x
N. ladogensis (Cl.) Foged		x				x	
N. productum (W. Sm.) Cl.							x
Nitzschia acula Hantz.	x	x					
N. angustata (W. Sm.) Grun.	x	xx				x	x
N. apiculata (Greg.) Grun.		x					
N. denticula Grun.		x				x	
N. fonticola Grun.		x					
N. frustulum (Kütz.) Grun.		x				x	x
N. gandersheimiensis Krasske		x					
N. gracilis Hantz.							x
N. heufleriana Grun.		x					
N. linearis W. Sm.		x					
N. palea (Kütz.) W. Sm.		x					
N. perminuta Grun.		x					
N. recta Hantz.		x					
N. sigmoidea (Ehr.) W. Sm.		x					
N. sublinearis Hust.		x					
N. tryblionella var. victoriae Grun.		x					
N. vexans Grun.		x					
Opephora martyi Hérib.		x					
Pinnularia acrosphaeria Bréb.		x					
P. balfouriana Grun.		x					
P. borealis Ehr.		x					
P. cardinalis (Ehr.) W. Sm.		x					
P. dactylus Ehr.		x				x	x
P. divergens W. Sm.		x					
P. d. var. elliptica Grun.		x					
P. esox Ehr.		x					
P. gentilis (Donkin) Cl.		x					
P. gibba Ehr.		x					
P. g. fo. subundulata Mayer		x					
P. gracillima Greg.		x					x
P. hemiptera (Kütz.) Cl.		x					
P. interrupta W. Sm.		x					
P. karelica Cl.		x				x	
P. legumen Ehr.		x					
P. maior Kütz.		x					
P. mesolepta (Ehr.) W. Sm.		x					
P. microstauron (Ehr.) Cl.		x					
P. nodosa Ehr.		x					

	1	2	3	4	5	6	7
P. platycephala (Ehr.) Cl.	x	x				x	
P. semicruciata (A. S.) A. Cl.		x					
P. similis Hust.		x					
P. streptoraphe Cl.		x				x	
P. viridis (Nitzsch) Ehr.		x				x	x
P. v. var. intermedia Cl.		x				x	
P. v. var. leptogongyla (Ehr.?) Grun.		x					
Rhoicosphaenia curvata (Kütz.) Grun.		x					
Rhopalodia gibba (Ehr.) O. Müll.		x					
R. g. var. ventricosa (Ehr.) Grun.		x					
R. gibberula var. producta Grun.		x					
R. parallela var. ingens Fricke		x				x	
Stauroneis angeps Ehr.		x					
S. a. fo. gracilis (Ehr.) Cl.		x					
S. javanica (Grun.) Cl.		x					
S. phoenicenteron (Nitzsch) Ehr.		x					
S. smithii Grun.		x					
Stenopterobia intermedia v. capitata Fo.		x					
Stephanodiscus alpinus Hust.	xx	x					
S. astraea var. minutula (Kz.) Grun.	x	x			x		x
S. sp.		x					
Surirella angusta Kütz.		x					
S. biseriata Bréb.		x					
S. capronii Bréb.		x					
S. elegans Ehr.		x					
S. e. fo. constricta n. fo.		x					
S. gracilis (W. Sm.) Grun.		x					
S. linearis W. Sm.		x					x
S. l. var. constricta (Ehr.) Grun.		x					
S. l. var. helvetica (Brun) Meister		x					
S. ovata Kütz.		x					
S. o. var. pinnata W. Sm.	x	x					
S. robusta Ehr.		x					
S. r. var. splendida (Ehr.) V. H.		xx					
S. r. var. s. fo. punctata		x					
S. tenera Greg. + var. nervosa A. Schm.		x					
S. turdiga W. Smith		x					
Synedra acus var. angustissima Grun.		x					
S. amphicephala Kütz.		x					x
S. a. var. austriata Grun.		x					
S. parasitica (W. Sm.) Hust.		x					
S. tabulata (Ag.) Kütz.				(x)			
S. tenera W. Sm.					x		x
S. ulna (Nitzsch) Grun.	xx	x			x	xx	xx
S. u. var. danica (Kütz.) Grun.		x					
Tabellaria fenestrata (Lyng.) Kütz.		xx			x	x	
T. flocculosa (Roth) Kütz.	X	X		X	x	X	
Tetracuclus emarginatus (Ehr.) W. Sm.		x					
T. lacustris Ralf		x					

Table II. Salt and brackish water diatoms identified from Vadsö, Varangerfjorden (column 1) and at site 3 and/or 4 (column 2). x rare, xx fairly common. + Supplementary observations by Cleve and Grunow from Finnmark (column 2). Marine diatoms in the interglacial deposits of Finland according to Brander, Tynni and Grönlund (column 3). + confirmed occurrence. The present-day marine diatoms in the western Baltic Sea partly after Simonsen (1962) (column 4).

	1	2	3	4
Achnanthes arctica Cl.		x	+	
A. brevipes Ag.	x	x	+	+
A. delicatula (Kütz.) Grun.			+	+
A. hauckiana Grun.		xx		+
A. h. var. rostrata Schultz		x		
Actinocyclus ehrenbergi Ralfs			+	+
A. e. var. crassa (W. Sm.) Hust.		x		
A. kützingii (A. S.) Sim.			+	
A. normani fo. subsalsa (Greg.) Hust.		x		+
Actinoptychus senarius Ehr.			+	+
Amphipleura pellucida Kütz.		x		+
A. rutilans (Trent.) Cl.		x		+
A. r. var. obtusa (Grev.) Hust.		x		
Amphiprora duplex fo. splendida (Hust.)		x		
A. paludosa W. S.	x		+	
Amphora acuta Greg.			+	+
A. angusta Greg.			+	+
A. (a.) var. arctica	x			
A. arenaria Donk.			+	
A. arcus var. sulcata (A. Schm.) Cl.	x			
A. coffeaformis (Ag.) Kütz.			+	+
A. commutata Grun.			+	+
A. crassa Greg.			+	+
A. cymbifera?	x			
A. eunotia Cl.			+	+
A. exigua Greg.		x		+
A. granulata Greg.		x		+
A. laevissima Greg.	x			+
A. lineolata Ehr.				+
A. proteus Greg.		x	+	+
A. p. var. constricta n. var.	x			
A. pusio Cl.			+	
A. robusta/mexicana	(x)		+	+
A. terroris Ehr.	x			+
A. wisei Sim.			+	+
Asterionella ralfsii/kariana	(x)			
Auliscus caelatus Bail.				+
A. c. var. dissolutus Halden			+	
A. reticulatus Grev.				+
A. sculptus (W. S.) Ralfs				+
Auricula complexa (Greg.) Cl.		x		
Bacillaria baxillifer (O. F. Müll.) Hendey	x		+	+
Biddulphia aurita/Odontella a.	xx	x		+
B. a. var. obtusa (Kütz.) Hust.	xx			
B. rhombus (Ehr.) W. Sm.			+	
Caloneis amphisbaena var. subsalina (Donk.) Cl.		x		+
C. brevis (Grev.) Cl.	x		+	+
C. b. var. distoma Grun.		x		
C. consimilis A. S.	x			
C. westii (Sm.) Hendey/formosa (Greg.) Cl.		x		+
C. liber (W. S.) Cl.	x		+	+
Campylodiscus angularis Greg.			+	
C. clypeus Ehr.			+	+
C. c. var. bicostata (W. S.) Hust.			+	
C. fastuosus Ehr.	x		+	+
Cerataulus turgidus Ehr.			+	+
Chaetoceros affinis Laud. ?	x			
C. borealis Bail.				+
C. compressus? Laud.	x			
C. danicus Cl.				+
C. decipiens Cl.				+
C. furcellatus Bail.	x			
C. holsaticus Schütt				+
C. mitra (Bail.) Cl			+	
C. muelleri			+	
C. aff. similis	xx			
C. subsecundus (Grun.)	x		+	
Cocconeis arctica Cl.	x	x		
C. clandestina A. S.	x		+	+
C. costata Greg.	xx	xx	+	+
C. decipiens Cl.	x			
C. notata Petit				+
C. peltoides Hust.			+	+
C. pseudomarginata Greg.	x	x		+
C. quarnerensis Grun.			+	+
C. scutellum Ehr.	x	xx	+	+
C. s. var. parva Grun.		x	+	

	1	2	3	4
C. s. var. stauroneiformis W. Sm.	x	xx		
C. speciosa Greg.			+	
Coscinodiscus apiculatus v. ambigua Grun.			+	
C. asteromphalus Ehr.			+	
C. centralis Ehr.			+	
C. curvatulus Grun.			+	
C. c. var. kariana Cl. & Grun.	x			
C. decrescens Grun.			+	
C. fimbriatus Ehr.			+	
C. granulosus Grun.	x		+	
C. jonesianus var. commutata				+
C. lacustris Grun.			+	+
C. marginatus Ehr.	x			
C. nitidus Greg.				+
C. obscurus A. S.			+	
C. oculus iridis Ehr.			+	+
C. radiatus Ehr.		x		+
C. subtilis/excentricus var. fasciculata		x		
Cyclotella striata (Kütz.) Grun.			+	+
Cymatosira belgica Grun.				+
Diatoma elongatum	x	x	+	+
Dimerogramma fulvum (Greg.) Ralfs			+	
D. minor (Greg.) Ralfs			+	+
Diploneis bombus Ehr.	x			+
D. didyma Ehr.		x	+	+
D. fusca (Greg.) Cl.	xx			+
D. f. var. aestiva	x			
D. interrupta (Kütz) Cl.		x	+	+
D. i. var. heeri (Pant.) Hust.		x	+	
D. litoralis (Donk.) Cl.			+	+
D. notabilis (Grev.) Cl.			+	+
D. papula (A. S.) Cl.			+	+
D. schmidi Cl.			+	
D. smithii (Bréb.) Cl.	x	x	+	+
D. splendida Greg.	x	x		
D. stroemi Hust.	x	x	+	+
D. subcinta (A. S.) Cl.	x		+	+
D. suborbicularis (Greg.) Cl.	x		+	+
D. vacillans (A. S.) Cl.	x		+	
Donkila carinata (Donk.) Ralfs				+
D. c. var. longiuscula n. var.	x			
Donkinia lata Cox	x	x		
Fragilaria harrissoni	(x)			
Gomphonema kamtschaticum Grun.		x		
Grammaophora angulosa Ehr.				+
G. a. var. islandica (Ehr.) Grun.	xx			
G. arctica Cl.	x		+	
G. arcuata Ehr.	x		+	+
G. marina (Lyng.) Kütz.	x		+	+
G. oceanica (Ehr.) Grun.	x	x	+	+
Gyrosigma arcticum (Cl.) Cl.		+		
G. balticum (Ehr.) Rabh.			+	+
G. fasciola (Ehr.) Cl.		x		+
G. f. var. arcuata (Donk.) Cl.		x		
G. f. var. sulcata Grun.		x		
G. sciotense (Sulliv. & Wormley) Cl.		x		
G. strigile (W. Sm.) Cl.				+
G. wansbecki (Donk.) Cl.		x		+
Hantzschia baltica Sim.				+
H. marina (Donk.) Grun.				+
H. virgata (Roper) Grun.	x			+
Hyalodiscus obsoletus Shes.		x	+	
H. scoticus (Kütz.) Grun.	x	x	+	+
H. subtilis Bail.		x	+	
Licmophora communis (Heib.) Grun.		x		
L. ovulum Mereschk.		x		
L. paradoxa var. crystallina (Kütz.) Grun.		x		
L. p. var. tincta (Ag.) Hust.	x	xx		
Licmophora sp.	x			
Mastogloia hustedtiana Sim.				+
Mastogloia exilis Hust. var. rostrata n. var.		x		
M. pumila (Grun.) Cl.			+	+
Melosira arctica (Ehr.) Dickie		xx		+
M. a. var. polaris nov. var.		x		
M. islandica, restr. spor.	(x)			
M. moniliformis (Müll.) Ag.			+	+
M. nummuloides (Dillw.) Ag.		x		+
M. roseana Rabenh.		(x)	(+)	
M. sulcata (Ehr.) Kütz.	x	x	+	+
Navicula abrupta (Greg.) Donk.	xx		+	+
N. ammophila Grun.	x	x	+	

	1	2	3	4
N. arenaria Donk.	x		+	
N. bottnica Grun.		xx		
N. cancellata Donk.	x	x	+	+
N. cinta (Ehr.) Kütz.		x		
N. comoides (Ag.?) Perag.	x			+
N. crucicula (W. Sm.) Donk.		x	+	+
N. cruciculoides Brock.		x	+	
N. crucifera Grun.				+
N. cryptolyra Brock.		x		+
N. crystallina Hust.	x			+
N. digitoradiata (Grun.) A. S.	xx	x	+	+
N. directa W. Sm.	x		+	+
N. d. var. oceanica Karsten	x			
N. d. var. subtilis Greg.	x			
N. dissipata Hust.		x		+
N. distans var. borealis Grund.		x		
N. finmarchica Cl. & Grun.		+	+	+
N. finmarchica fo. hendey n. fo.	x			
N. flanatica Grun.		x		+
N. forcipata Grev.	x	x	+	+
N. gemmifera Sim.				+
N. glacialis (Cl.) Grun.			+	
N. gotlandica Grun.		x		+
N. gregaria Donkin			+	+
N. grevillei (Ag.?) Heib.	x			
N. g. var. ovalis n. var.	x			
N. halophila (Grun.) Cl.	x	x		
N. hennedyi W. Sm.			+	+
N. humerosa Bréb.		x		+
N. hungarica Grun.		x	+	+
N. hustedtiana Sim.				+
N. latissima Greg.			+	
N. libellus Greg.	x			
N. longa (Greg.) Ralfs	x			
N. lyra Ehr.			+	+
N. lyroides Hendey			+	
N. lyra var. atlantica A. S.	x			
N. l. var. elliptica A. S.	x		+	
N. marina Ralfs			+	+
N. menisculus Schuman		x		
N. palpebralis Bréb.		x	+	+
N. peregrina (Ehr.) Kütz.		x	+	+
N. plicata Donk.	x	x	+	+
N. protracta fo. elliptica Gallik		x		
N. pygmaea Kütz.			+	+
N. ramossima (Ag.) Cl.	x		+	+
N. rostellata Kütz.	x		+	+
N. rostellataformis n. var.		x		
N. salinarum Grun.			+	+
N. salinicola Hust.		x		
N. solutepunctata Hust.		x		
N. subforcipata Hust.		x		
N. subinflata Grun.		x		+
Nitzschia acuminata (W. Sm.) Grun.	x	x	+	+
N. angularis W. Sm.	x			+
N. apiculata (Greg.) Grun.		x	+	+
N. bilobata W. Sm.		xx		+
N. closterium (Ehr.) W. Sm.			+	+
N. constricta (Greg.) Grun.	x	x	+	+
N. cylindrus (Grun.) Hasle	x		+	+
N. distans Greg.				+
N. filiformis (W. Sm.) Hust.			+	+
N. granulata Grun.			+	+
N. hungarica Grun.			+	+
N. hybrida (Grun.)	x	x		+
N. longissima (Bréb.) Ralfs				+
N. oceanica (Cl.) Hasle	x			
N. ovalis Arnott			+	+
N. panduriformis Greg.				+
N. punctata (W. Sm.) Grun.			+	+
N. sigma (Kütz.) W. Sm.	x	x	+	+
N. socialis Greg.	xx			
N. tryblionella var. levidensis (W. Sm.) Grun.		x		
N. t. var. victoriae Grun.		x	+	
N. vadsösis n. sp.	x			
N. valida (Cl.) Grun.	x	x		
N. vitrea Norman				+
Opephora marina (Greg.) Petit			+	+
O. schulzi (Brock.) Sim.			+	+
Phacodiscus punctulatus (Greg.) Meun.	x			
Pinnularia ambigua Cl.				+

	1	2	3	4
P. cruciformis (Donk.) Cl.	x		+	+
P. quadratarea A. S.		x	+	+
P. trevelyana Donkin				+
Plagiogramma staurophorum (Greg.) Heib.	xx	x	+	+
Pleurosigma aestuarii (Bréb.) W. Sm.	x	x		+
P. angulatum W. Sm.	x			+
P. a. var. finmarchica Cl.		+		+
P. cuspidatum (Cl.) Peragallo	x			
P. elongatum W. Sm.		x	+	+
P. e. var. fallax (Grun.) Cl.	x			
P. formosum W. Smith	x			
P. latum Cl.		x		
P. strigosum W. Sm.	x			
P. stuxbergii Cl. & Grun.	x	x		
P. subsalsum Wisl. & Kolbe	x			+
Podosira hormoides var. adriatica Grun.	x			
P. h. var. arctica Cl.	x			
P. maxima (Kütz.) Grun.	x			
P. montagnei Kütz.			+	
Porosira glacialis (Grun.) Jörg.	x		+	
Pseudopodosira septentrionalis Loseva			+	
Rhabdonema arcuatum (Lyng.) Kütz.	xx	x	+	+
R. minutum Kütz.	xx	xx	+	+
Rhaphoneis minutissima Hust.	x			
R. nitida (Greg.) Grun.		x	+	
Rhoicosphaenia curvata (Kütz.) Grun.		x	+	+
R. marina (W. Sm.) M. S.	xx	x		
Sceletonema costatum (Grev.) Cl.		x		+
Scoliopleura tumida (Bréb.) Rabenh.			+	+
Scoliotropis latestriata (Bréb.) Cl.	x			+
S. peisonis (Grun.)			+	
Stauroneis gregorii Ralfs		x	+	+
Stephanopyxis turris (Grev.) Ralfs	x		+	

	1	2	3	4
Surirella comis A. Sm.		x		
S. fastuosa Ehr.	x			+
S. gemma Ehr.		x		+
S. smithii Ralfs		xx		
S. striatula Turpin		x	+	+
Synedra camtschatica Grun.			+	
S. c. var. finmarchica Grun.	x			
S. crystallina (Ag.) Kütz.			+	+
S. gailloni (Bory) Ehr.	x	x	+	
S. pulchella (Ralfs) Kütz.		xx	+	+
S. p. fo. curvata n. fo.		x		
S. p. var. lanceolata O'Meara		x		
S. tabulata (Ag.) Kütz.		xx	+	+
S. t. var. fasciculata (Kütz.) Grun.		x		
S. t. var. parma (Kütz.) Grun.		x		
Thalassionema nitzschioides Grun.		x	+	+
Thalassiosira baltica (Grun.) Ostf.	x			
T. decipiens (Grun.) Joergensen	x	x	+	
T. eccentrica (Ehr.) Cl.		x	+	+
T. gravida, restr. spor.	(x)		+	
T. nordenskiöldii Cl.		x		+
T. oestrupii (Ostenfeld) Hasle	x			
T. rotula Meun.	x			
T. subtilis (Ostf.) Gran.	x			
Thalassiothrix frauenfeldii		x		
Toxinidea insignis Donk.	x			
Trachyneis aspera (Ehr.) Cl.	xx		+	+
T. a. var. intermedia Grun.	x			
T. sp. cf. tumidula Grun.	x			
Tropidoneis lepidoptera (Greg.) Cl.	x			+
T. scaligera (Grun.) Cl.	x			+
T. vitrea (W. Sm.) Cl.	x		+	+

ACKNOWLEDGEMENTS

Professor Kauko Korpela, Research Director of the Geological Survey of Finland, and Professor Raimo Kujansuu, Head of the Department of Quaternary Geology, kindly gave me permission to publish the paper as a Report of Investigation of the Geological Survey. In my work I received much valuable assistance from Kalevi Hokkanen. The figures were drawn by Satu Moberg and the manuscript was translated into English by Gillian Häkli. The manuscript was reviewed by Dr. Jouko Niemelä and edited by Stiina Seppänen. To all these persons I express my gratitude.

REFERENCES

Aleem, A.A., 1973. Contribution to the Study of Littoral Diatoms on the West Coast of Sweden. Bot. mar. 16: 193—200.

Backman, A.L. & Cleve-Euler, A., 1922. Die fossile Diatomeenflora in Österbotten. Acta Forestalia Fennica 22, 1—74, 1 Taf., 18 Tab.

Bérard-Therriault, L., Cardinal, A & Poulin, M., 1986. Les diatomées (Bacillariophyceae) benthiques de substrats durs des eau marines et saumâtres du Québec. 6. Naviculales: Cymbellaceae et Gomphonemaceae. Naturaliste can. (Rev. Écol. Syst.), 113: 405—429.

Bérard-Therriault, L., Cardinal, A. & Poulin, M., 1987. Les diatomees (Bacillariophyceae) benthiques de substrats durs des eaux marines et saumâtres du Québec. 8. Centrales. Naturaliste can. (Rev.Écol.Syst.) 114: 81—103.

Brander, G., 1937a. Ein Interglazialfund bei Rouhiala in Südostfinnland. Bull.Comm.géol. Finland 118, 76 p.

Brander, G., 1937b. Zur Deutung der intramoränen Tonablagerung an der Mga, unweit von Leningrad. Bull. Comm. géol. Finlande 119, 93—114.

Brockmann, C., 1950. Die Watt-Diatomeen der schleswigholsteinischen Westküste. Abhandl. Senkenberg. Naturfors. Gesell. 478, 1—26.

Cardinal, A., Poulin, M. & Bérard-Therriault, L., 1989. New criteria for species characterization in the general *Donkinia, Gyrosigma* and *Pleurosigma* (Naviculaceae, Bacillariophyceae). Phycologia 28 (1), 15—27.

Carter, J.R. & Bailey-Watts, A.E., 1981. A taxonomic study of diatoms from standing freshwaters in Shetland. Nova Hedwigia 33, 513—630.

Cheremisinova, E.A., 1960. K voprosu vozraste morskih mezlednikovyh otlozenij na r. Mge Leningradskoj oblasti. Biol. Kom. polzuch. chetver. perioda, 25, 50—70.

Cleve, P.T., 1883. Diatoms collected during the expedition of the Vega. Vega-Expeditiones vetenskapliga iakttagelser, 3.Band. 457—517, 4. plates.

Cleve, P.T., 1894, 1895. Synopsis of the naviculoid diatoms. I and II. Kungl. Vetskaps-akademiens handl. Bd. 26, no. 2 and Bd. 27, no. 3., 194 + 220 p.

Cleve, P.T. & Grunow, A., 1880. Beiträge zur Kenntniss der arctischen Diatomeen. Kongl. Svenska Vet.-Akad. Handl. Bd. 17, No 2, 1—121, VII Taf.

Cleve-Euler, A., 1934. The Diatoms of Finnish Lapland. Soc. Scient. Fennica, Comm. Biol. 4 (14), 154 p.

Cleve-Euler, A., 1940. Das letztinterglaziale Baltikum und die Diatoméenanalyse. Bot. Zentralbl. 60, Beih. Abt. B., 288—334.

Cleve-Euler, A., 1943. Interglaciala övervintrare i sydsvenska höglandssjöar? Till arenariaflorans biologi och spridninshistoria. Bot. Not. 41—74. Lund.

Cleve-Euler, A., 1951—1955. Die Diatomeen von Schweden und Finnland. I-V. Kungliga Svenska Vetensk. Handl. 4. Ser., 2: 1 (1951) 163 p., 3: 3 (1952) 154 p., 4: 1 (1953) 158 p., 4: 5 (1953) 255 p., 5: 4 (1955) 232 p.

Cox, E.J., 1979. Symmetry and valve structure in naviculoid diatoms. Nova Hedwigia, Beih. 64: 193—206.

Cox, E.J., 1983a. Observations on the diatom genus *Donkinia* Ralfs in Pritchard. II. Frustular studies and intraspecific variation. Bot. mar. 26: 553—566.

Cox, E.J., 1983b. Observations on the diatom genus *Donkinia* Ralfs in Pritchard. III. Taxonomy. Bot. mar. 26: 567—580.

Donner, J., Eronen, M. & Jungner, H., 1977. The dating of the Holocene relative sea-level changes in Finnmark, North Norway. Norsk geogr. Tidsskr. 31, 103—128.

Edsbagge, H., 1968. Zur Ökologie der marinen angehefteten Diatomeen. Bot. Gothoburgensia 6, 1—153.

Ehrlich, A., 1973. Quaternary diatoms of the Hula Basin (Northern Israel). Geol.Surv.of Israel, Bull. No. 58, 1—39.

Eriksson, B., Grönlund, T. & Kujansuu, R., 1980. Interglasiaalikerrostuma Evijärvellä, Pohjanmaalla. Summary: An interglacial deposit at Evijärvi in the Pohjanmaa region, Finland. Geologi 32, 65—71.

Fischer, H., 1979. Osmotic behaviour of diatoms of a hypersaline lake in comparison with tidal diatoms. Nova Hedwigia, Beih., 251—264.

Foged, N., 1968. The freshwater diatom flora of the Varanger Peninsula, North Norway. Tromso Museum, 64 p.

Foged, N., 1974. Freshwater Diatoms in Iceland. Bibl. Phycol. 15, 118 p, 36 pls.

Foged, N., 1977. Freshwater Diatoms in Ireland. Bibl. Phycol. 34, 221 p.

Foged, N., 1980. Diatoms in Öland, Sweden. Bibliotheca Phycologica 49, 193 p.

Fontell, C. W., 1926. Om brack- och saltvattendiatomacéers förekomst i sött vatten i närheten av kusten. Acta Soc. Fauna et Flora Fennica. 55, no. 7.

Fryxel, G.A. Hasle, G.R., 1977. The genus*Thalassiosira:* some species with a modified ring of central strutted processes. Nova Hedwigia, Beih., 54: 67—98.

Gran, H.H., 1912. The pelagiske planteliv. *In:* Atlanterhavet, J. Murray and J. Hjort, editors, H. Aschehoug & Co. (W. Nygaard), 252—321.

Grönlund, T., 1988. The diatom flora of the Eemian deposit at Haapavesi, western Finland. Geol. Surv. Finland. Rep. Invest. 79, 14 p.

Grönlund, T., Lortie, G., Guilbault, J.-P., Bouchard, M. A. & Saarnisto, M., 1990. Diatoms and arcellaceans from Lac du Cratere du Nouveau-Quebec, Ungava, Quebec, Canada. Can. J. Bot. 68: 1187—1200.

Håkansson, H., 1976. Die Struktur und Taxonomie einiger Stephanodiscus-Arten aus eutrophen Seen Südschwedens. Bot. Notiser 129: 25—34.

Håkansson, H. & Locker, S., 1981. *Stephanodiscus* Ehrenberg 1846, a Revision of the Species Described by Ehrenberg. Nova Hedwigia, 35. 117—150.

Håkansson, H. & Stoermer, E., 1984. An investigation of the morphology of *Stephanodiscus alpinus* Hust. Bacillaria 7, 159—172.

Hasle, G.R., 1965. Nitzschia and Fragilariopsis species studied in the light and electron microscopes. III. The genus Fragilariopsis. Skr. Norske Vidensk.-Akad. I. Mat.-Nat. Kl. N.S. 21, 1—19, 17 pls.

Hasle, G.R., 1974. Some marine plankton genera of the diatom family Thalassiosiraceae. Nova Hedwigia, Beih., 45: 1—49.

Hasle, G.R., 1976. The biogeography of some marine planktonic diatoms. Deep-Sea Research, Vol. 23, pp. 319—338. Pergamon Press, Printed in Great Britain.

Hasle, G.R. & Fryxel, G.A., 1977. The genus *Thalassiosira:* Some species with a linear areola array. Nova Hedwigia, Beih., 54: 15—66.

Hendey, N.I., 1964. An Introductory account of the smaller Algae of British Coastal Waters, Ser. 4. Part 5. Bacillariophyceae (Diatoms). Fishery Inest. H.M.S.O. 1—317. London.

Hendey, N.I., 1974. A revised check-list of British marine Diatoms. J. mar. biol. Ass. U.K. 54, 277—300.

Heurck, H. van, 1896. A treatise on the Diatomaceae. English edition translated by W.E. Baxer (Reprint 1962). II, XX, 558 p, 1208 figs.

Höfler, K. & Höfler, L., 1963. Diatomeen des marinen Planktons als Isotonobionten. Pubbl. staz. Zool. Napoli 33, 315—330.

Hustedt, F., 1922. Bacillariales aus Innerasien , gesammelt von Dr. Sven Hedin. Southern Tibet, VI, part III, Bot. 107—152.

Hustedt, F., 1930. Bacillariphyta. Dr. A. Pascher: Die Süsswasser-Flora Mitteleuropas 10. Jena.

Hustedt, F., 1930—66. Die Kieselalgen Deutschlands, Österreichs und der Schweiz mit Berücksichtigung des übrigen Länder Europas sowie der angrenzenden Meeresgebiete. I, II, III. Dr. L. Rabenhorts's Kryptogamen-Flora 7: 1—920; 1—845, 1—816.

Hustedt, F., 1938/1939. Systematische und ökologische Untersuchungen über die Diatomeen-Flora von Java, Bali und Sumatra nach dem Material der Deutschen Limnologischen Sunda-Expedition. Allgemeiner Teil. Stuttgart.

Hustedt, F., 1939. Die Diatomeenflora des Küstengebietes der Nordsee vom Dollart bis zur Elbemündung. Abh. Nat. Ver. Bremen 35, 572—677.

Hustedt, F., 1942. Diatomeen aus der Umgebung von Abisko in Swedish-Lappland. Archiv Hydrobiol. 39, 82—174.

Hustedt, F., 1942b. Süsswasser-Diatomeen des indomalayischen Archipels und der Hawaii-Inseln. Internat. Rev. d. Hydrobiol. 42, 1—252.

Hustedt, F., 1944. Neue und wenig bekannte Diatomeen. Ber. Deutsch. Bot. Gesell. 41, 270—290.

Hustedt, F., 1954. Die Diatomeenflora des Interglazials von Oberohe in der Lüneburger Heide. Abh. naturw. Verein Bremen 33, 431—455.

Hustedt, F., 1955. Marine littoral diatoms of Beaufort, North Carolina. Duke University Marine Station, Bull. 6, 67 p.

Hustedt, F., 1957. Die Diatomeenflora des Flusssystems der Weser im Gegiet der Hansestadt Bremen. Abh. naturwiss. Verein Bremen 34 (3): 181—440.

Jousé, A.P. & Poretskii, V.S., 1937. Diatomovye mezlednikovh otlozenii po r. Vage. V ki: Tr. Sov. sektsii Mezdunar. assots. po izuts. tsetvert. perioda, 1, M. 178—205.

Kiselev, I.A., 1925. Fytoplankton Belogo morja. Issled. rus. morei. 2. L. 1—43.

Kling, H. & Håkansson, H., 1988. A ligh and electron microscope study of *Cyclotella* species (Bacillariophyceae) from Central and Northern Canadian lakes. Diatom Research, vol. 3 (1), 55—82.

Kolbe, R.W., 1927. Zur Ökologie, Morphologie und Systematik der Brackwasser-Diatomeen. Pflanzenforschung 7.

Kolbe, R.W., 1932. Grundlinien einer allgemeinen Ökologie der Diatomeen. Ergebnisse der Biologie, 8. Bd.,221—348.

Krasske, G., 1938. Beiträge zur Kenntnis der Diatomeen-Vegetation von Island und Spitzbergen. Arch. Hydrobiol. 33, 503—533.

Krasske, G., 1943. Zur Diatomeenflora Lapplands. Ber. Deutsch. Bot. Ges., 59, 81—88.

Krasske, G., 1949. Zur Diatomeenflora Lapplands II. Ann. Soc. Vanamo 23 (5).

Krieger, W., 1944. Süsswasseralgen aus Griechenland.

Lange-Bertalot, H. & Ruppel, M., 1980. Zur Revision taxonomisch problematischer, ökologisch jedoch wichtiger Sippen der Gattung *Achnanthes* Bory. Archiv f. Hydrobiologie, Suppl. Bd. 60, 1—31.

Lange-Bertalot, H. & Simonsen, R., 1978. A taxonomic revision of the Nitzschia lanceolatae Grunow. 2. European and related extra-european fresh water and brackish water Taxa. Bacillaria 1, 11—111.

Levander, K., 1915—1916. Zur Kenntnis des Küstenplanktons im Weissen Meere. Medd. Soc. Fauna et Flora Fennica 42, 150—159.

Mansikkaniemi, H., 1964. Main features of the glacial development of Pulmanki valley in Northernmost Finland. Ann. Univer. Turku A II: 32 (Rep. Kevo Subartic Res. Stat. I), 322—337.

Mansikkaniemi, H., 1967. Geomorphical analysis of Pulmankijoki-Tana valley in Lapland. Publ. Inst. Geogr. Univ. Turku. 43, 1—27.

Mansikkaniemi, H. & Mäki, O.-P., 1988. Meanderilenkin oikaisu Pulmankijoella Utsjoen Lapissa. Summary: Cut of a meanderloop in the Pulmankijoki river, N-Lapland. Geologi 40, 16—21.

Mattsson, J., 1982. Pulmankijärven kalastus. Riista- ja kalatalouden tutkimuslaitoksen työraportti.

Meunier, A., 1910. Microplankton des mers Barents et de Kara. In Duc d'Orleans Compagne artique de 1907. Bruxelles. 1—355.

Miller, U., 1971. Diatom floras in the sediments at Leveäniemi. in Lundqvist, J. The interglacial deposits at the Leveäniemi mine, Svappavaara, Swedish Lapland. Sveriges Geol. Unders Ser. C. 658, 104—163.

Mölder, K., 1943. Rezente Diatomeen in Finnland als Grundlage quartärgeologischer Untersuchungen. Geologie der Meere und Binnengewesser 6, 148—240.

Mölder, K. & Tynni, R., 1967—1973. Über Finnlands rezente und subfossile Diatomeen. I-VII. Compt. Rend géol. Finlande 39: 199—217, Bull. Geol. Soc. Finland 40: 151—170, 41: 235—251, 42: 129—144, 43: 203—220, 44: 141—159, 45: 159—179.

Navarro, J.N., 1982. A. survey of the marine diatoms of Puerto Rico V. Suborder Raphidineae: Families Achnanthaceae and Naviculaceae (Exluding *Navicula* and *Mastogloia).* Botanica Marina 25, 321—338.

Niemelä, J. & Tynni, R., 1979. Interglacial and interstadial sediments in the Pohjanmaa region, Finland. Geol. Surv. Finland, Bull. 302, 48 p.

Niemelä, E. & Vilhunen, J., 1987. Utsjoen tunturivesien kalakantojen käyttö- ja hoitosuunnitelma. Riista- ja kalatalouden tutkimuslaitos Kalantutkimusosasto.

Ostenfeld, C.H., 1913. Bacillariales. Bulletin trimestriel des résultats acquis pendant les croisiéres périodiques, etc. Conseil permanent international pour l'exploration de la mer, Part 3, 403—508.

Patrick, R. & Reimer, C.W., 1966, 1975. The Diatoms of the United States. Vol. 1. Acad. Nat. Sci. Philadelphia. 688 p., 213 p.

Peragallo, H. & M., 1897—1908. Diátomees Marines de France et des Districts Marimes Voisins. Grezsur Loing, 491 p.

Petrov, J.E., 1967. Sinezelenye i diatomovye vodorosli litorali

Bolsogo Solovetskogo ostrova (Beloe more). Novosti sist. nizs. rast., L., »Nauka»: 15—20.

Ravanko, O. & Tynni, R., 1974. On some species of the genus *Licmophora* in Finland. Mem.Soc.Fauna & Flora Fennica 50, 5—14.

Riznyk, R.Z., 1973. Interstidial diatoms from two tidal flats in Yaquina estuary, Oregon, USA. Botanica Marina XVI, p. 113—138.

Rivera, P., 1981. Beitrage zur Taxonomie und Verbreitung der Gattung *Thalassiosira* Cleve. Biblotheca Phycologica, no. 56, 220 p.

Salomaa, R. & Alhonen, P. 1982. Biostratigraphy of Lake Spitaali järvi: An ultraoligotrophic small lake in Lauhanvuori, western Finland. In The symposium volume of the Third Intern. Symp. Paleolimnology, Finland. Developments in Hydrobiology. W. Junk, The Hague, The Netherlands.

Schmidt, A., 1874—1959. Atlas der Diatomeen-kunde, founded by A. Schmidt, continued by M. Schmidt, F. Fricke, O. Müller, H. Heiden und F. Husedt. Aschersleben-Leipzig-Berlin.

Schoeman, F.R. & Archibald, R.E.M., 1987. Observations on Amphora species (Bacillariophyceae) in the British Museum (Natural History) VI. Some species from the subgenus*Halamphora* Cleve. Nova Hedwigia 44, 377—398. Stuttgart.

Schrader, H.-J. & Gersonde, R. 1978. The late Messinian Mediterranean brackish to freshwater environment diatom floral evidence. Reprint from Hsü, K., Montadert, L. et al. Intial Reports of Deep Sea Drilling Project. Vol. 42, Part I, 761—775.

Schwarzenholz, W., 1965.*Terpsinoe americana* (Bail.) Ralfs eine charakteristische Diatomee für die Holstein warmzeit in Nordwestdeutschland. Abh. Zentr. Geol. Inst., 1, Berlin. 29—35.

Simonsen, R., 1959. Neue Diatomeen aus der Ostsee I. Kieler Meeresforschungen, Bd 15, 74—83.

Simonsen, R., 1960. Neue Diatomeen aus der Ostsee II. Kieler Meeresforschungen, Bd 16, 126—130.

Simonsen, R., 1962. Untersuchungen zur Systematik und Ökologie der Bodendiatomeen der westlichen Ostsee. Int. Revue Ges. Hydrobiol. Systemat Beih. 1—144.

Simonsen, R., 1979. The diatom system: ideas on phylogeny. Bacillaria 2, 9—71.

Simonsen, R., 1987. Atlas and catalogue of the diatom types of Friedrich Hustedt. Volume 1. Catalogue, J. Cramer. Berlin, Stuttgart 1—525. Volume 2. Atlas, Plates 1—395, Volume 3. Atlas, Plates 396—772.

Takano, H., 1984. Scanning electron microscopy of diatoms-VII. *Odontella aurita* and *O. longicruris*. Bull.of Tokai Reg. Fisheries Res.Lab. 113, 79—85.

Theriot, E. & Stoermer, F., 1982. Observations on North American Population of *Stephanodiscus* (Bacillariophyceae) Species Attributed to Friedrich Hustedt. Trans. Am. Microsc. Soc., 101 (4): 368—374.

Tynni, R., 1975. Über Finnlands rezente und subfossile Diatomeen, VIII. Geol. Surv. Finland, Bull. 274, 1—55.

Tynni, R., 1976. Über Finnlands rezente und subfossile Diatomeen, IX. Geol. Surv. Finland, Bull. 284, 1—37, 17 Taf.

Tynni, R., 1978. Über Finnlands rezente und subfossile Diatomeen, X. Geol. Surv. Finland Bull. 296, 1—55, 17 Taf.

Tynni, R., 1982. Piileväsuhteet eräissä Suomen rannikon ja Kilpisjärven pohjan rannalta ulapalle suuntautuvissa linjaprofiileissa. Turun yliopiston maaperägeologian osaston julkaisuja 46, 1—33.

Tynni, R., 1986. Observations of diatoms on the coast of the State of Washington. Geol.Surv. Finland. Rep. Invest. 75, 25 p.

Tynni, R., 1989. Piilevähavaintoja Kilpisjärven Alajärveltä jokiväylää pitkin Perämeren pohjukkaan Tornionjokisuulle. Turun yliopiston maaperägeologian osaston julkaisuja 63, 1—17.

Zabelina, M.M., 1939. Diatomovye vodorosli gruntov Belogo mori v rajone Maloj Piruguby. Tr. Gos. hydrol. inta, 8, 17. 183—200.

Zans, V., 1936. Das letztinterglaziale Portlandia-Meer des Baltikums. Bull. Comm. géol. Finlande 115, 231—250.

PLATE I

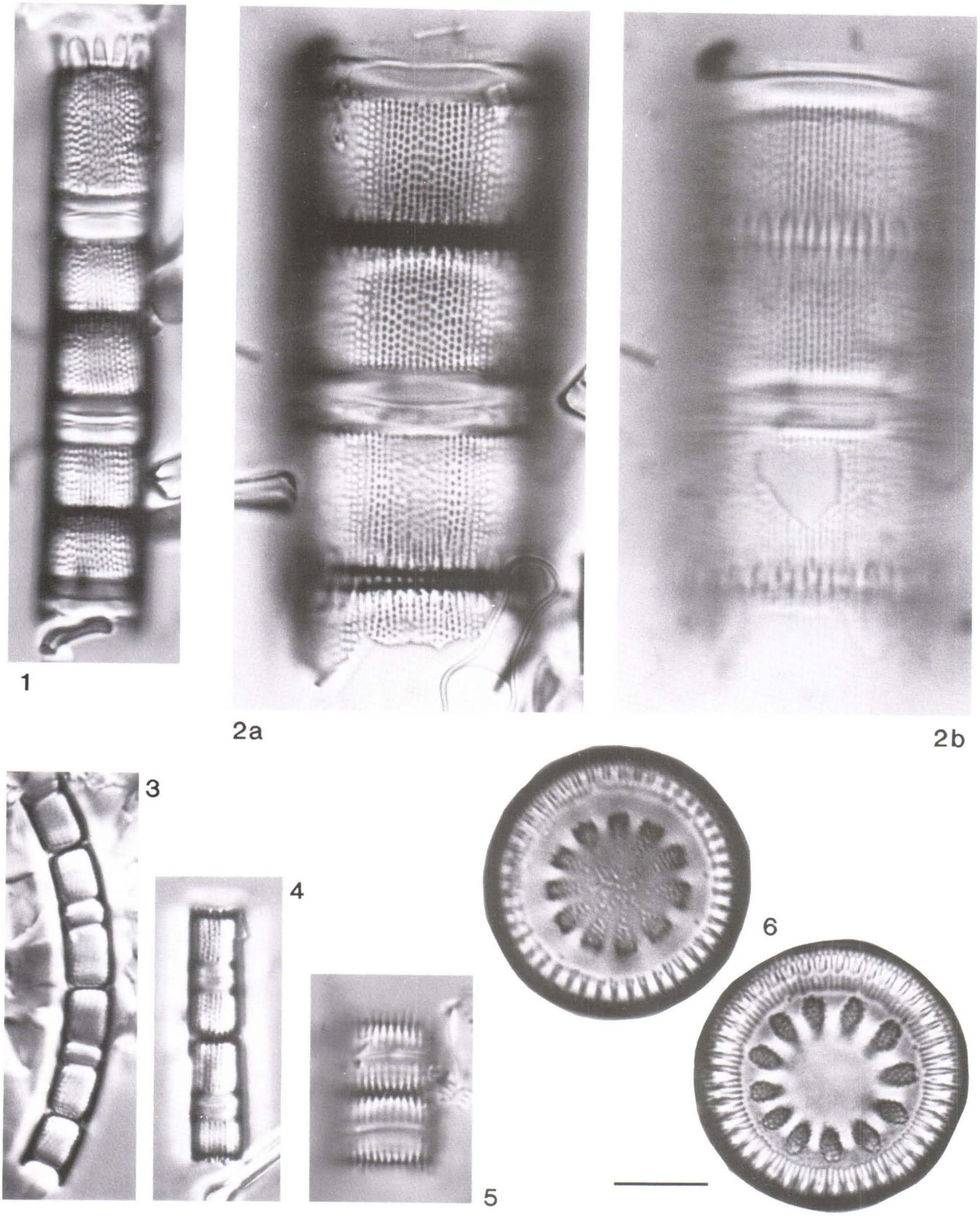

Plate I, 1, 2. *Melosira italica* fo. *laevis*, 3. *M. i.* fo. *curvata*, 4. *M. i.*, 5. *M. distans* var. *africana*, 6. *Cyclotella antiqua*.

PLATE II

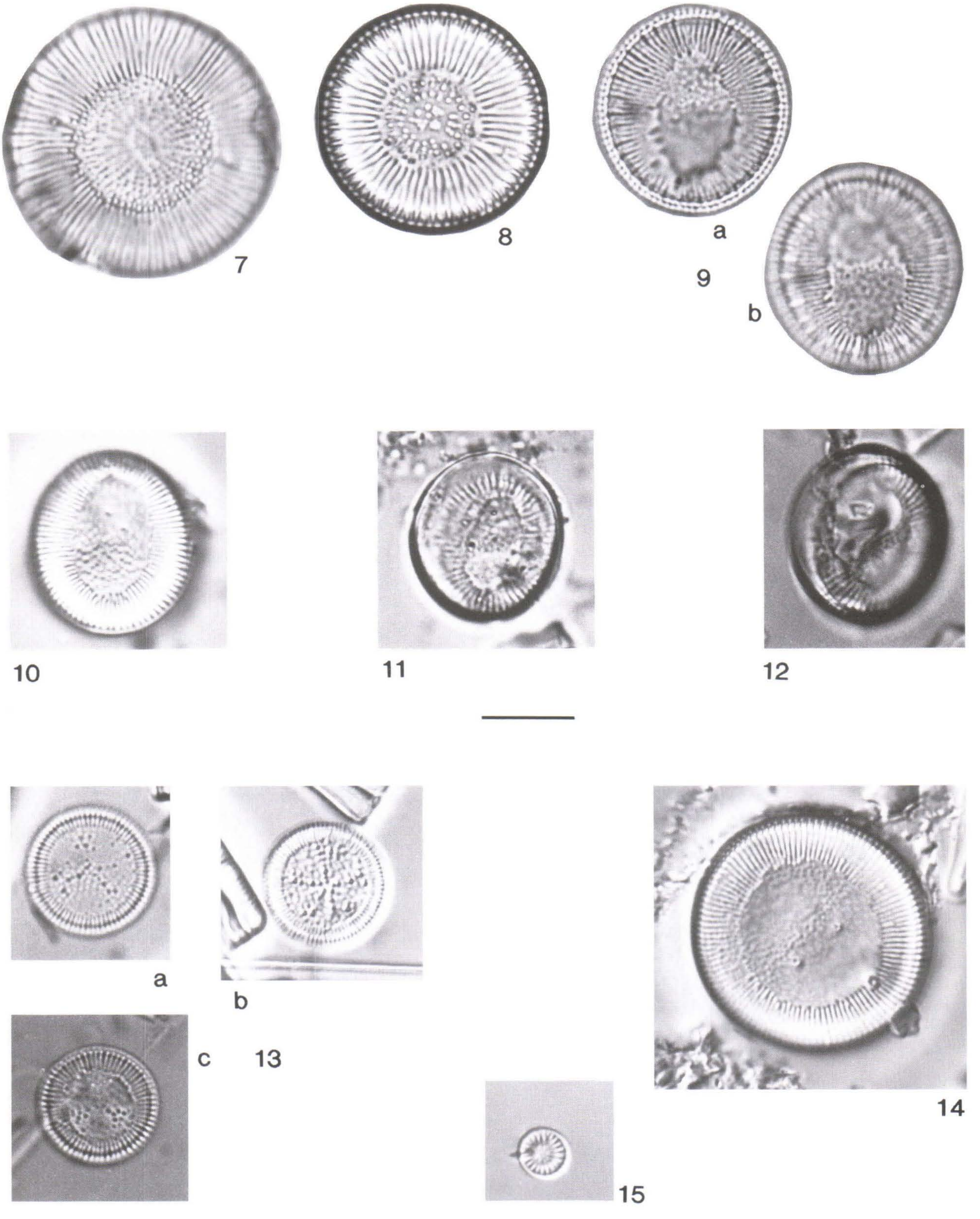

Plate II, 7. *C. bodanica,* 8. *C. comta,* 9, 10. *C. iris,* 11. *C. i., restring spore,* 12. *C. vörticosa-typ.,* 13. *C. kützingiana* var. *radiosa,* 14. *C. k.* var. *schumanni,* 15. C. stelligera fo. *tenuis.*

PLATE III

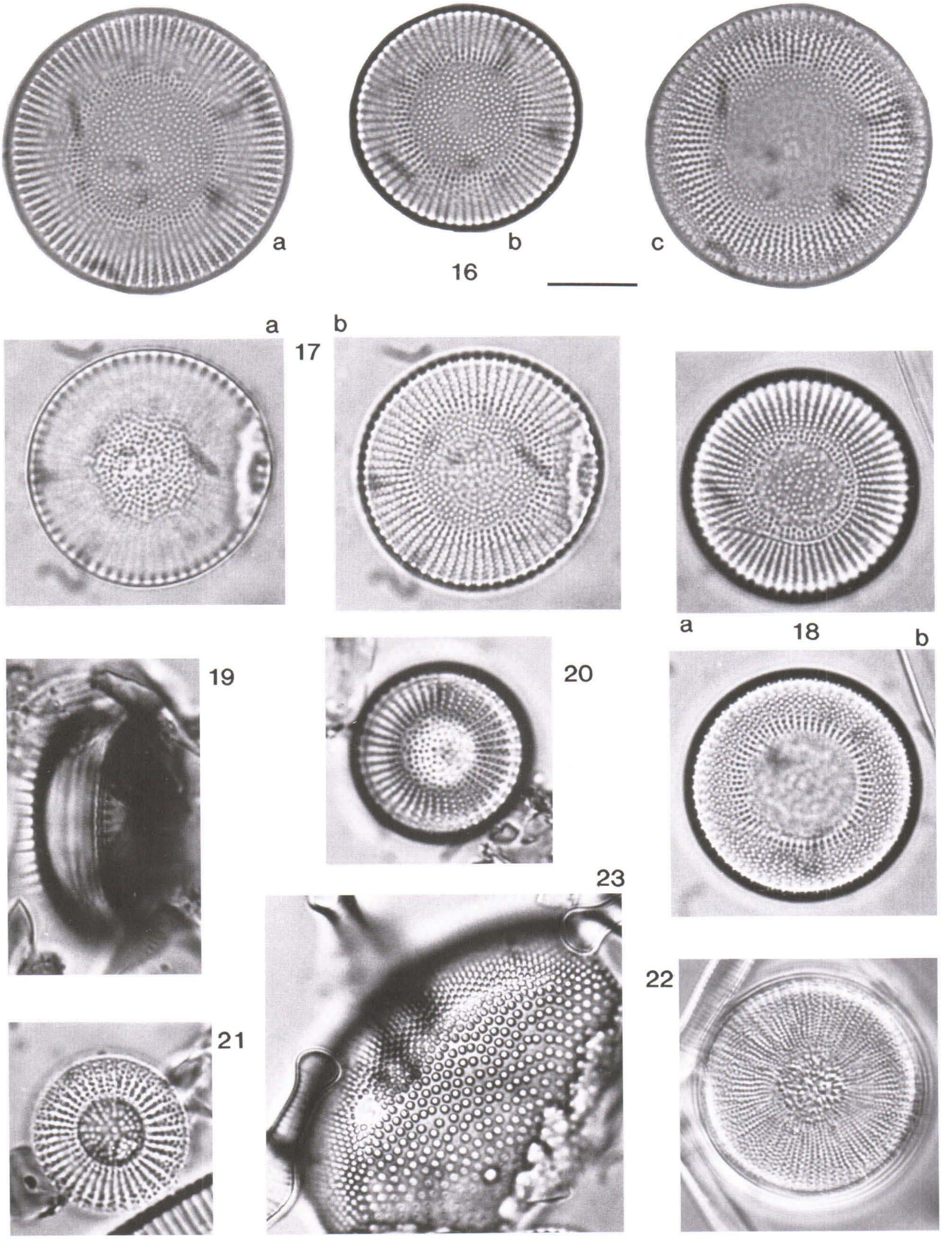

Plate III, 16—20. *Stephanodiscus alpinus,* 21. *S. astraea* var. *minutula,* 22.*S. sp.,* 23. *Actinodiscus senarius.*

PLATE IV

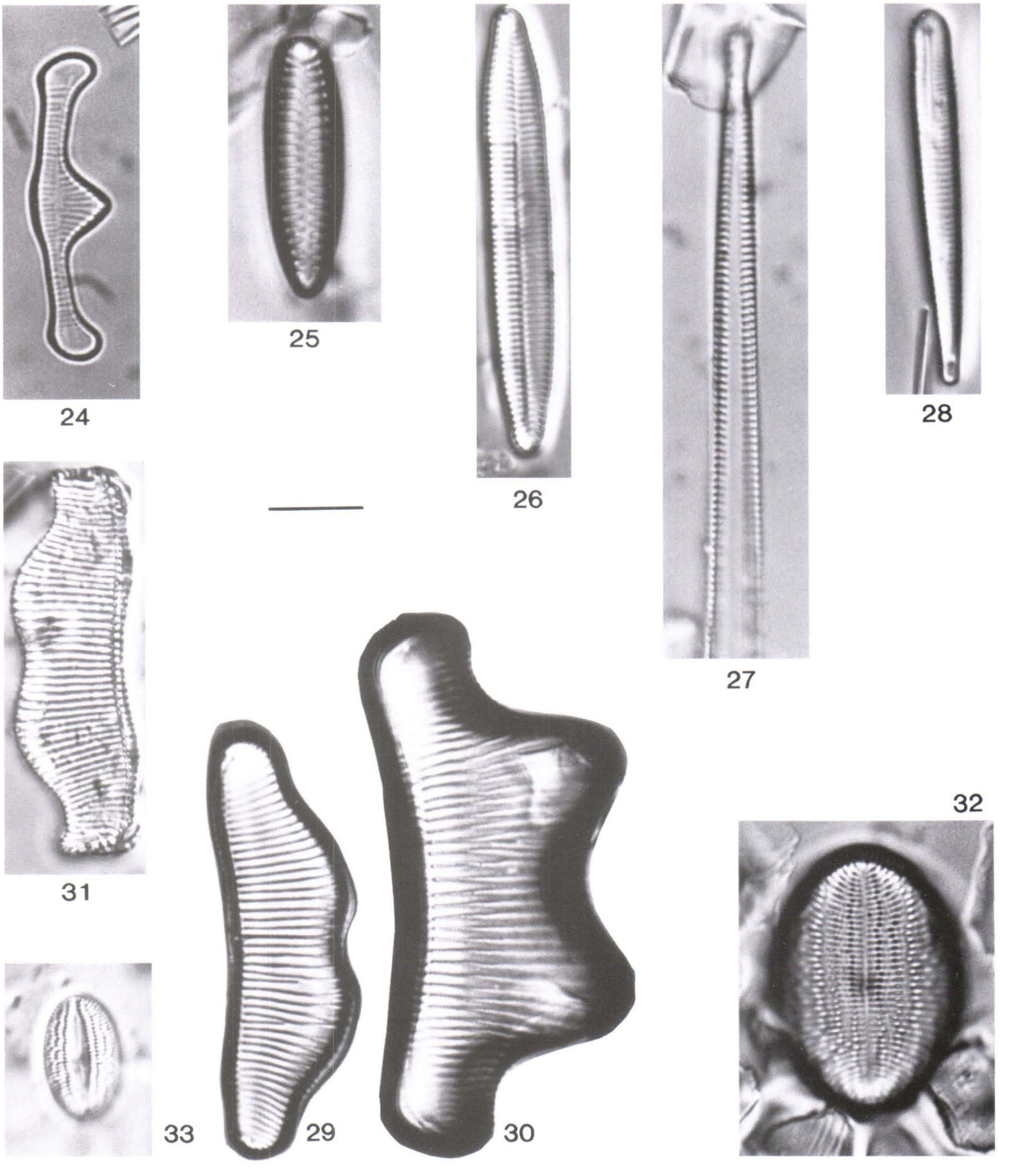

Plate IV, 24. *Tabellaria flocculosa, anomalons form*, 25. *Opephora martyi*, 26. *Fragilaria virescens*, 27. *Synedra tabulata*, 28. *Peronia heribaudi*, 29. *Eunotia bidens*, 30. *E. papilio*, 31. *E. praerupta* var. *bidens*, 32. *Cocconeis pediculus*, 33. *C. placentula* var. *euglypta*.

PLATE V

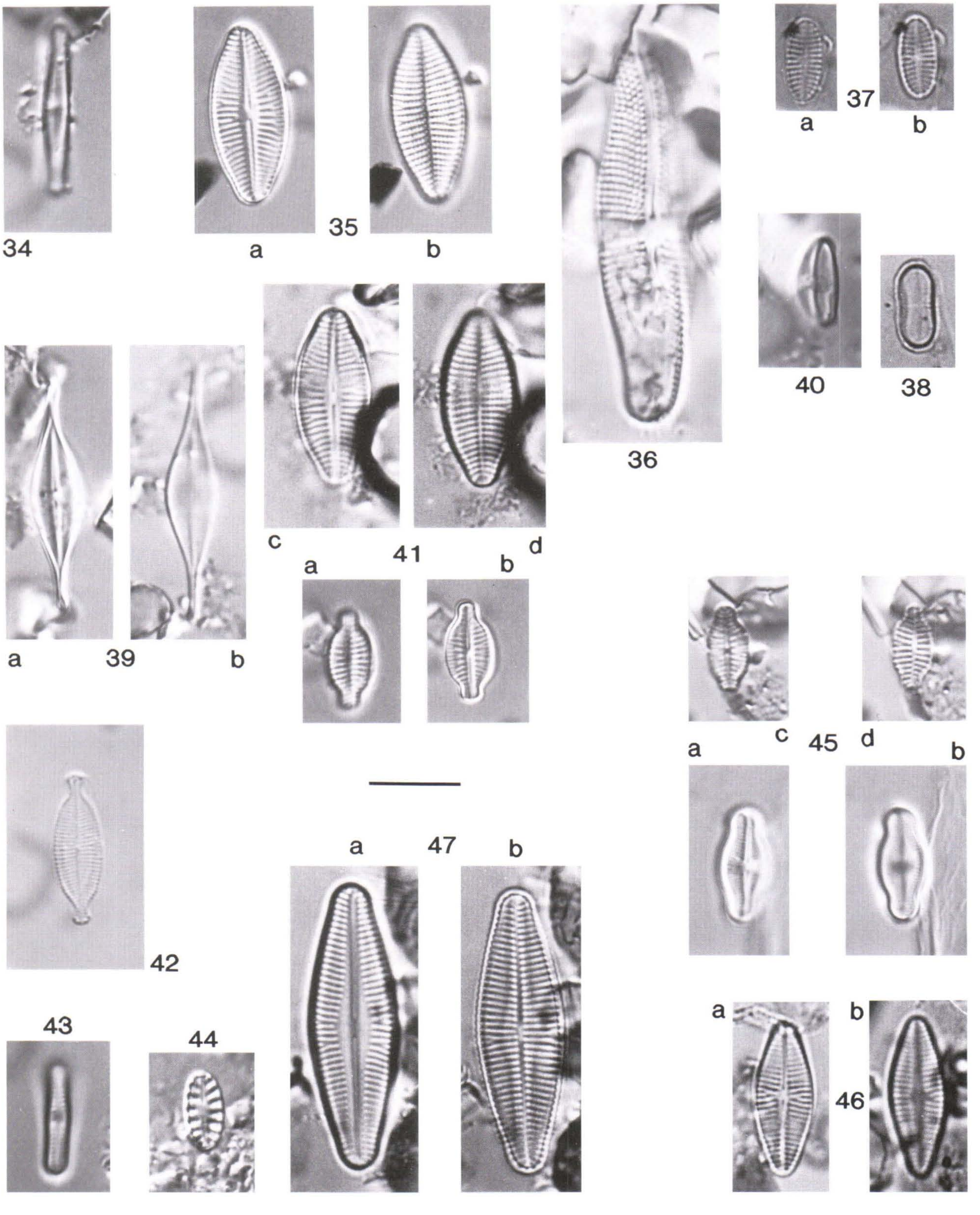

Plate V, 34. *Achnanthes affinis,* 35. *A. clevei,* 36. *A. coarctata,* 37. *A. conspiqua,* 38. *A. didyma,* 39. *A. gracillima,* 40. *A. lapponica,* 41. *A. laterostrata,* 42. *A. nitida,* 43 *A. notosa,* 44. *A. pinnata,* 45. *A. sublaevis,* 46. *A. sp.* 47. *A. clevei* var. *pulmankiensi n.* var.

PLATE VI

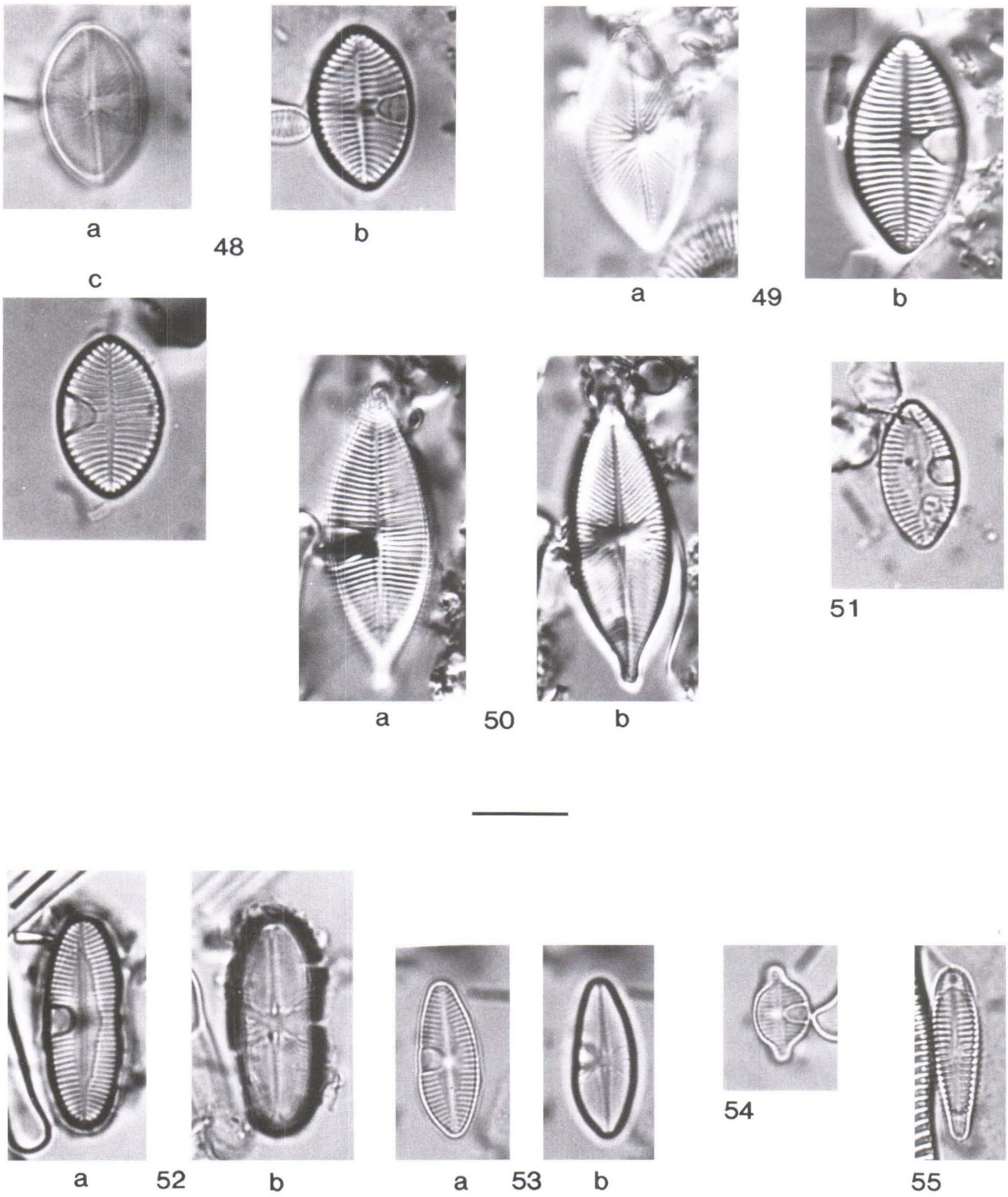

Plate VI, 48. *A. borealis,* 49. *A. elliptica* var. *rostrata,* 50. *A. pungens,* 51. *A. östrupi,* 52, 53. *A. mölderi* n. sp., 54. *A. peragallo,* 55. *Rhoicosphaenia curvata.*

PLATE VII

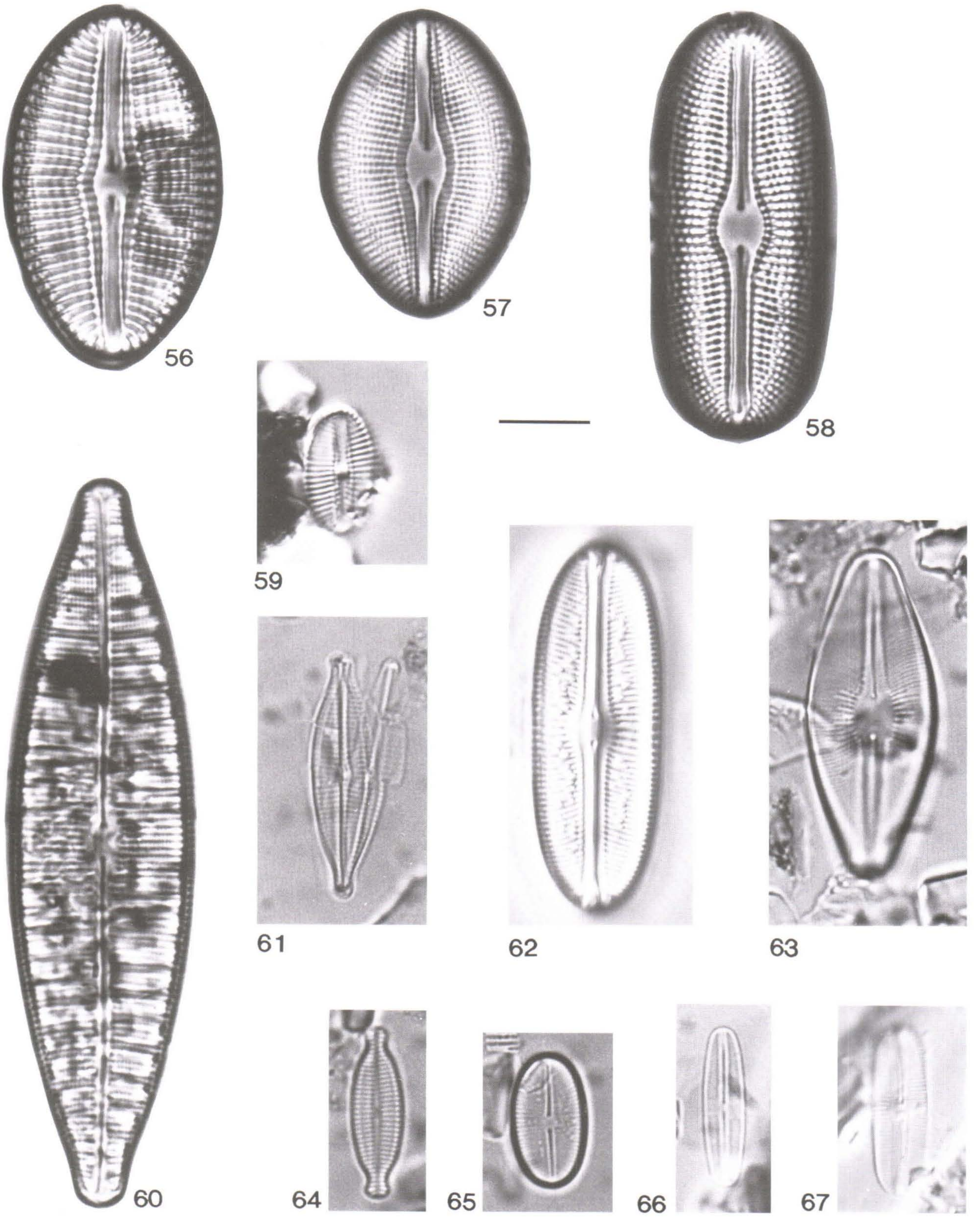

Plate VII, 56. *Diploneis elliptica,* 57. *D. ovalis,* 58. *D. o.* var. *oblongella,* 59. *D. puella,* 60. *Navicula cuspidata + craticula,* 61. *N. gregaria,* 62. *N. bacillum,* 63. *N. cocconeiformis* fo. *inflata n. fo.,* 64. *N. ingrata,* 65. *N. järnefeltii,* 66. *N. jungi,* 67. *N. strömi.*

PLATE VIII

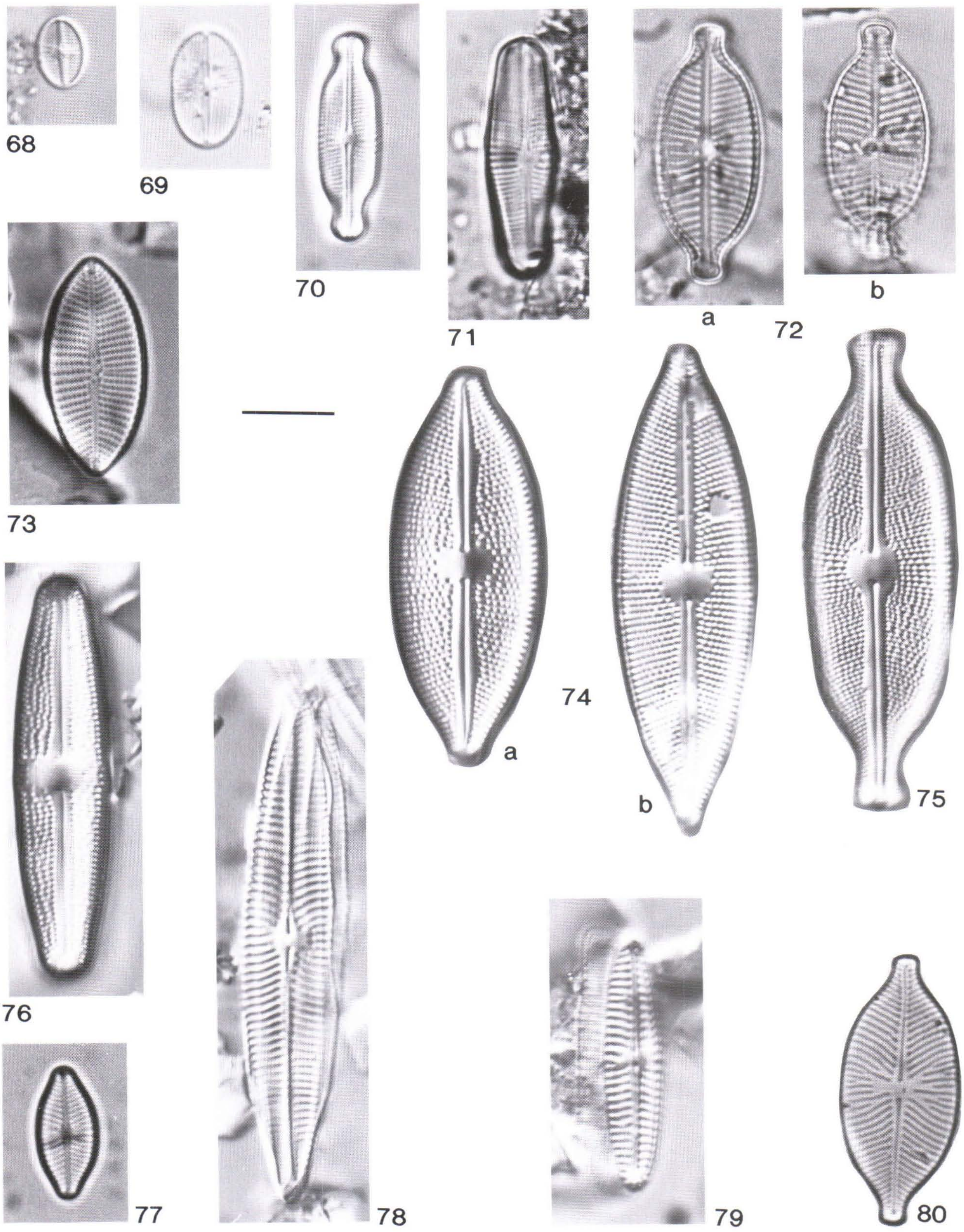

Plate VIII, 68. *N. subatomoides,* 69. *N. subrotundata,* 70. *N. protracta,* 71. *N. p.* fo. *elliptica,* 72. *N. interglacialis,* 73. *N. jentzschii,* 74. *N. lacustris,* 75. *N. lundströmi* fo. *frieseana,* 76. *N. plausibilis,* 77. *N. anglica,* 78. *N. avenaceae,* 79. *N. cinta,* 80. *N. clementis* fo. *constans* n. comb.

PLATE IX

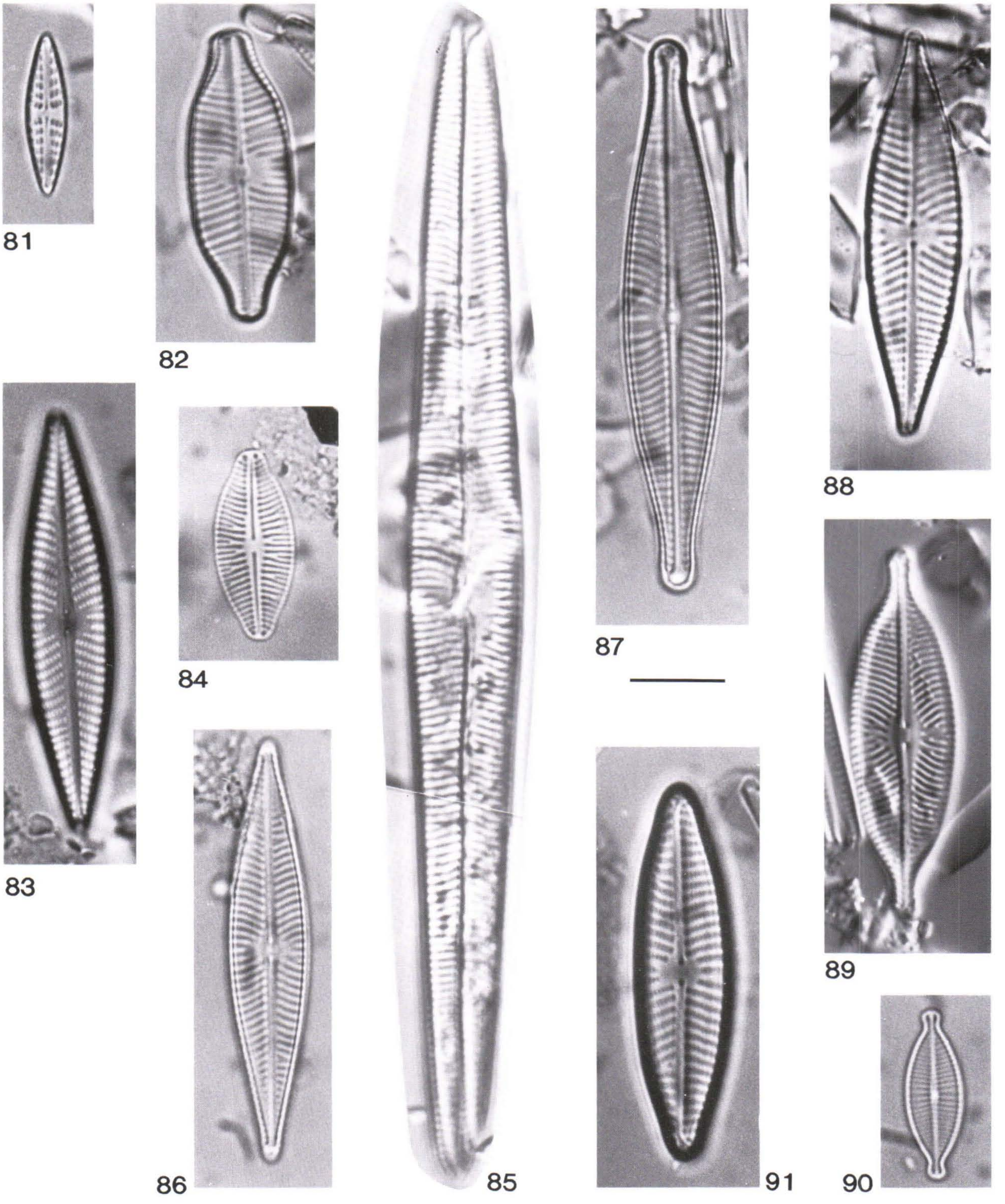

Plate IX, 81. *N. costulata,* 82. *N. dicephala,* 83. *N. lanceolata,* 84. *N. quadripartita,* 85. *N. radiosa* var. *maior n.* var, 86. *N. radiosa* var. *tenella,* 87. N .rhynchocephala, 88. N. r. var. grunowi, 89. N. salinarum, 90. *N. similis,* 91. *N. viridula.*

PLATE X

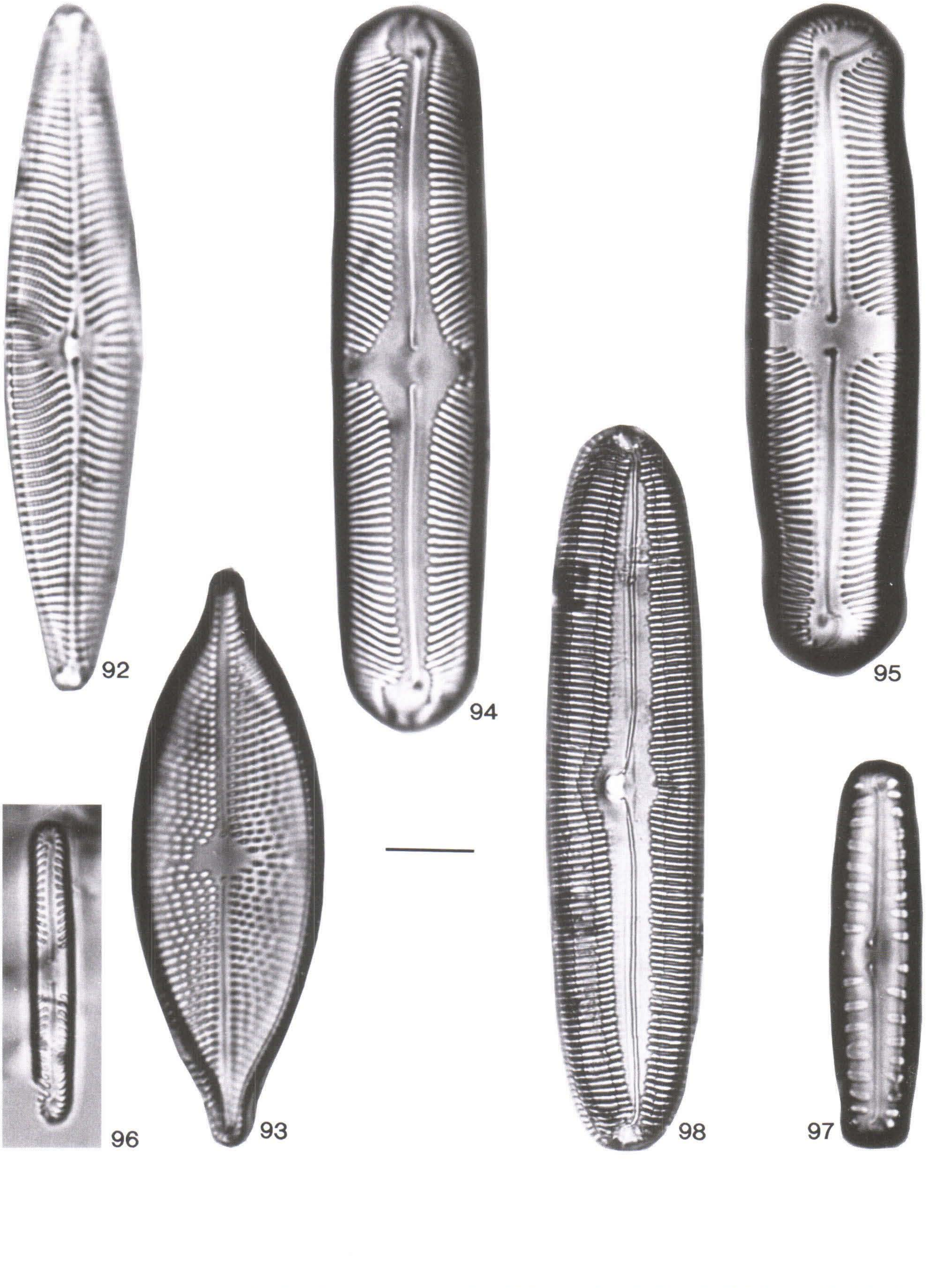

Plate X, 92. *N. vulpina,* 93. *N. tuscula,* 94. *Pinnularia divergens* var. *parallela,* 95. *P. platycephala,* 96. *P. similis,* 97. *P. borealis,* 98. *P. dactylus.*

PLATE XI

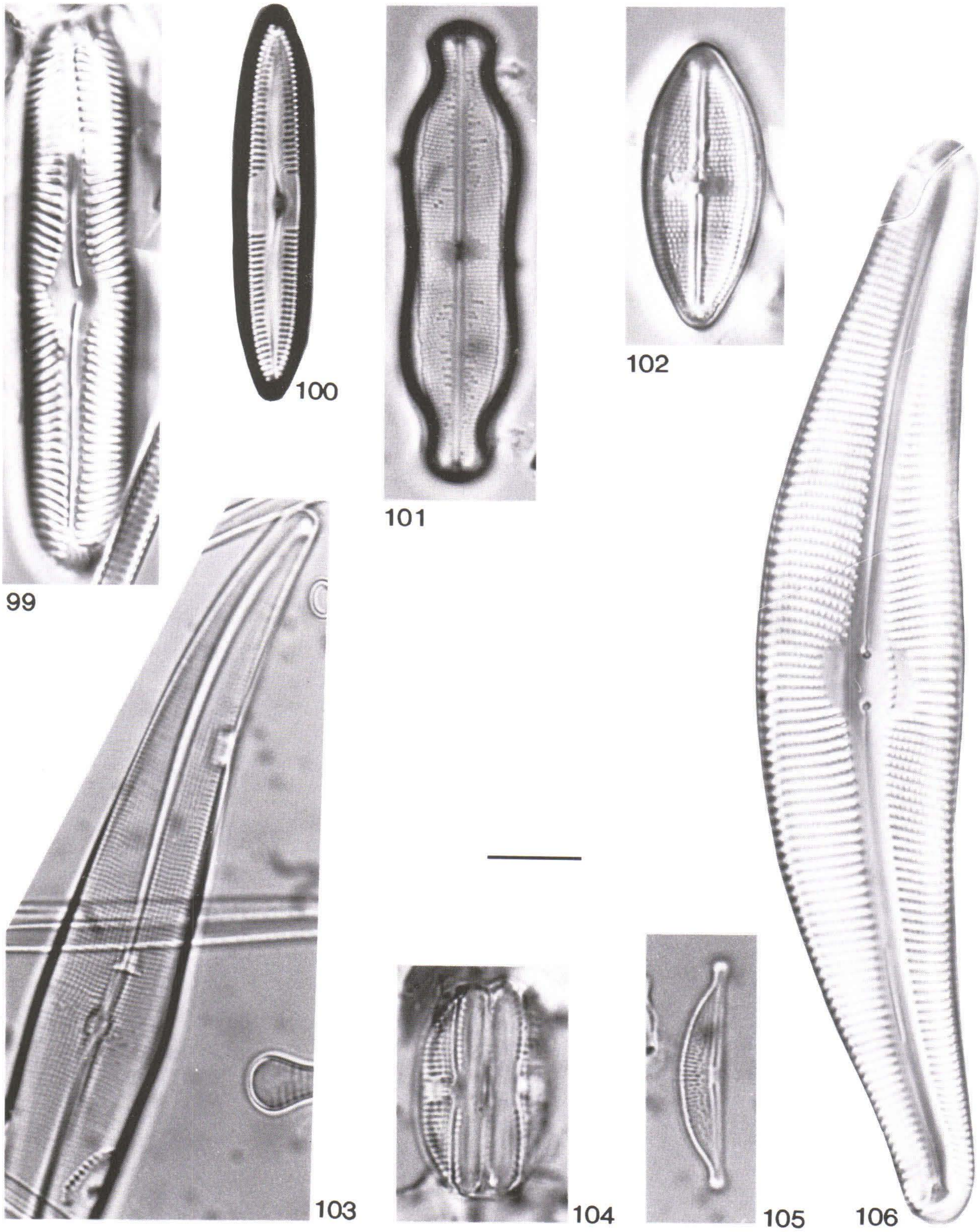

Plate XI, 99. *P. viridis* var. *leptogongyla,* 100. *Caloneis* sp. cf. *schröderi,* 101. *Neidium affine* var. *amphirhynchus* fo. *incurvum,* 102. *N. ladogensis,* 103. *Gyrosigma acuminatum* var. *gallica,* 104. *Amphora ovalis* var. *libyca,* 105. *A. veneta,* 106. *Cymbella cistula.*

PLATE XII

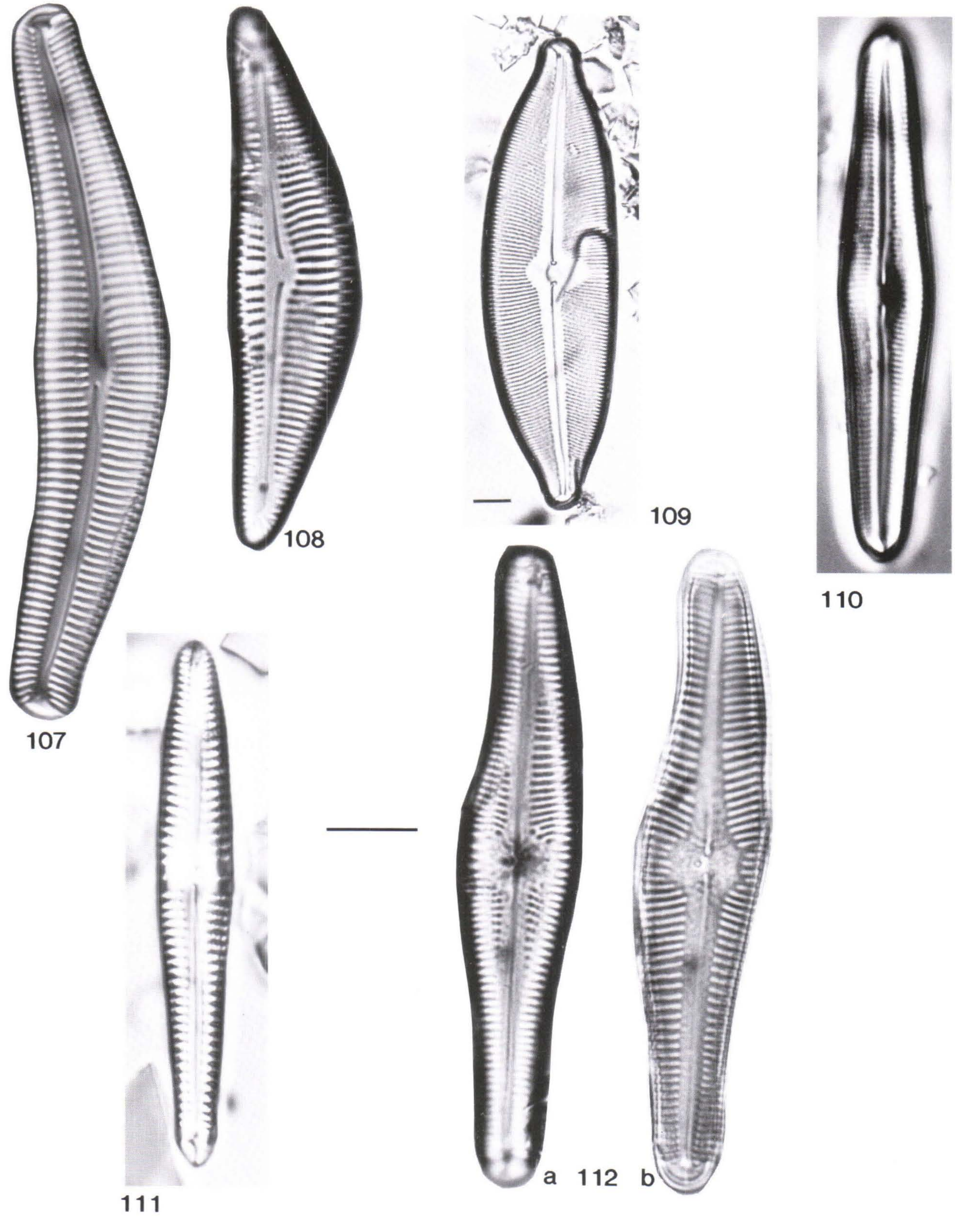

Plate XII, 107. *C. cymbiformis* fo. *arctica,* 108. *C. girodi,* 109. *C. heteropleura,* 110. *C. incerta,* 111. *Gomphonema longiceps* var. *montana,* 112. *G. l.,* anomal. typ.

PLATE XIII

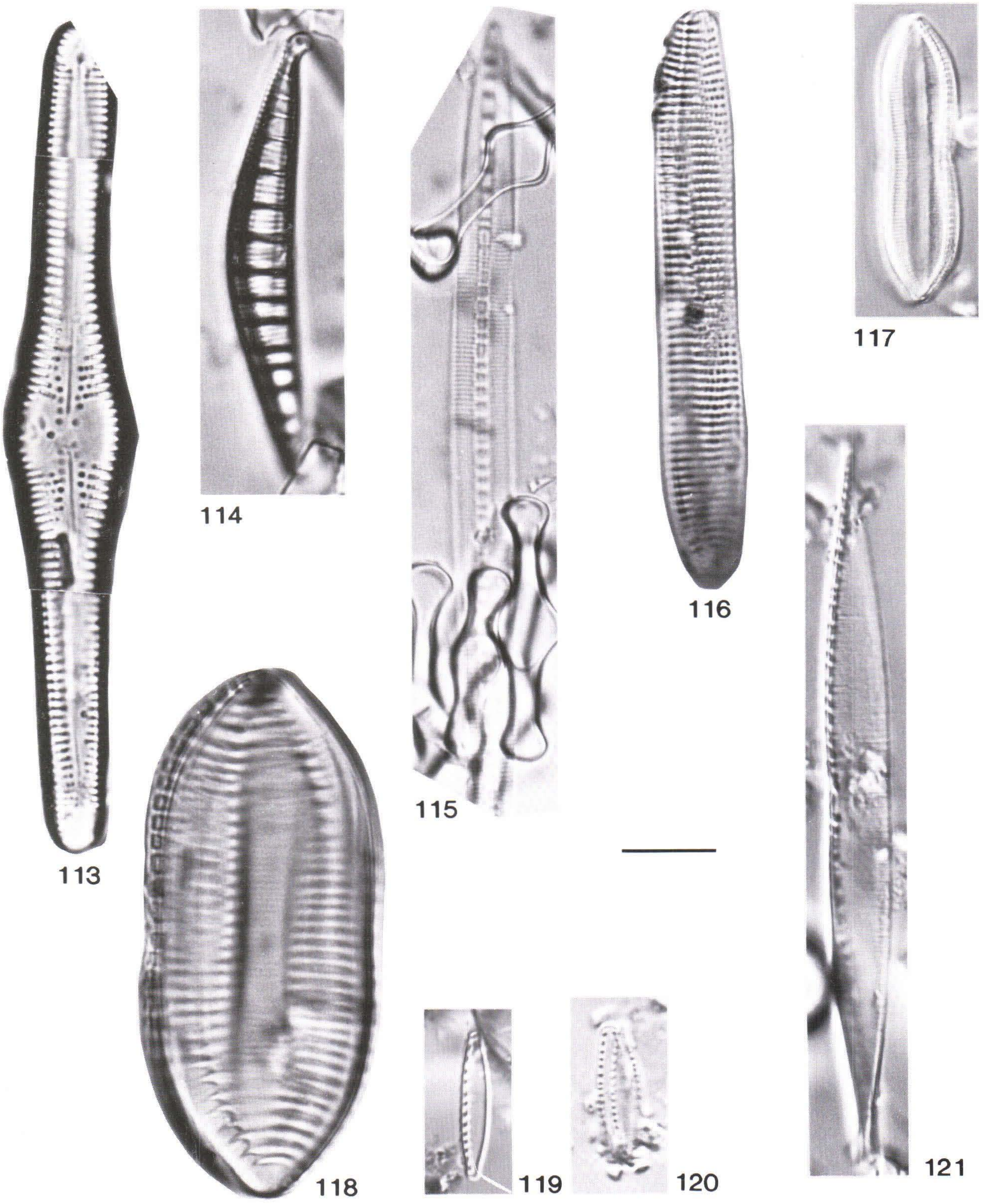

Plate XIII, 113. *G. intricatum* var. *vibrio,* anom. typ., 114. *Rhopalodia gibberula* var. *producta,* 115. *Bacillaria baxillifer,* 116. *Nitzschia angusta,* 117. *N. apiculata,* 118. *N. tryblionella* var. *victoriae,* 119. *N. perminuta,* 120. *N. fonticola,* 121. *N. gandersheimiensis.*

PLATE XIV

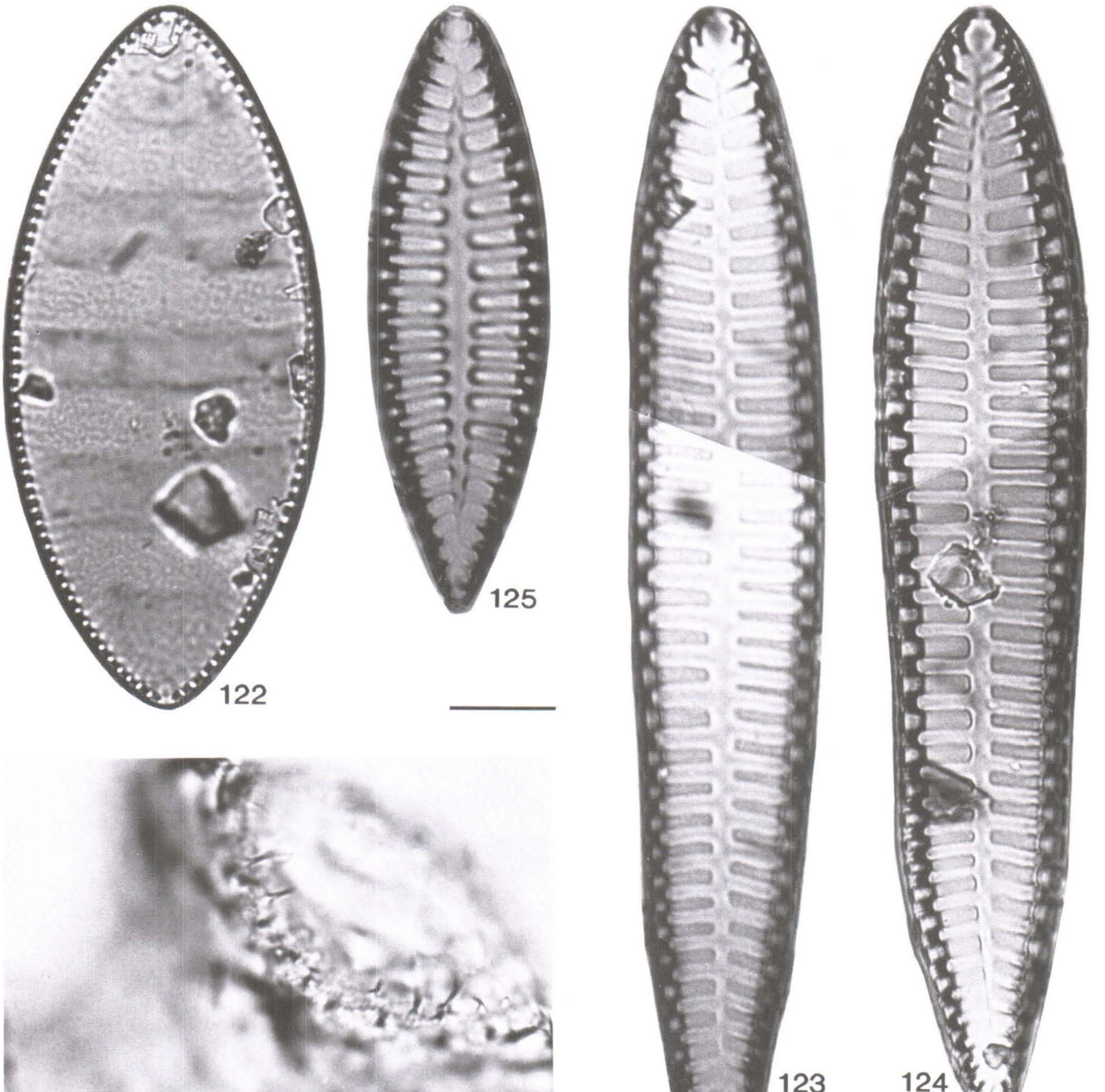

Plate XIV, *122. Cymatopleura elliptica,* 123. *Surirella elegans,* 124. *S. e.* fo. *constricta* n. fo., 125. *S. robusta,* 126a,b. *Campylodiscus hibernicus,* forma.

PLATE XV

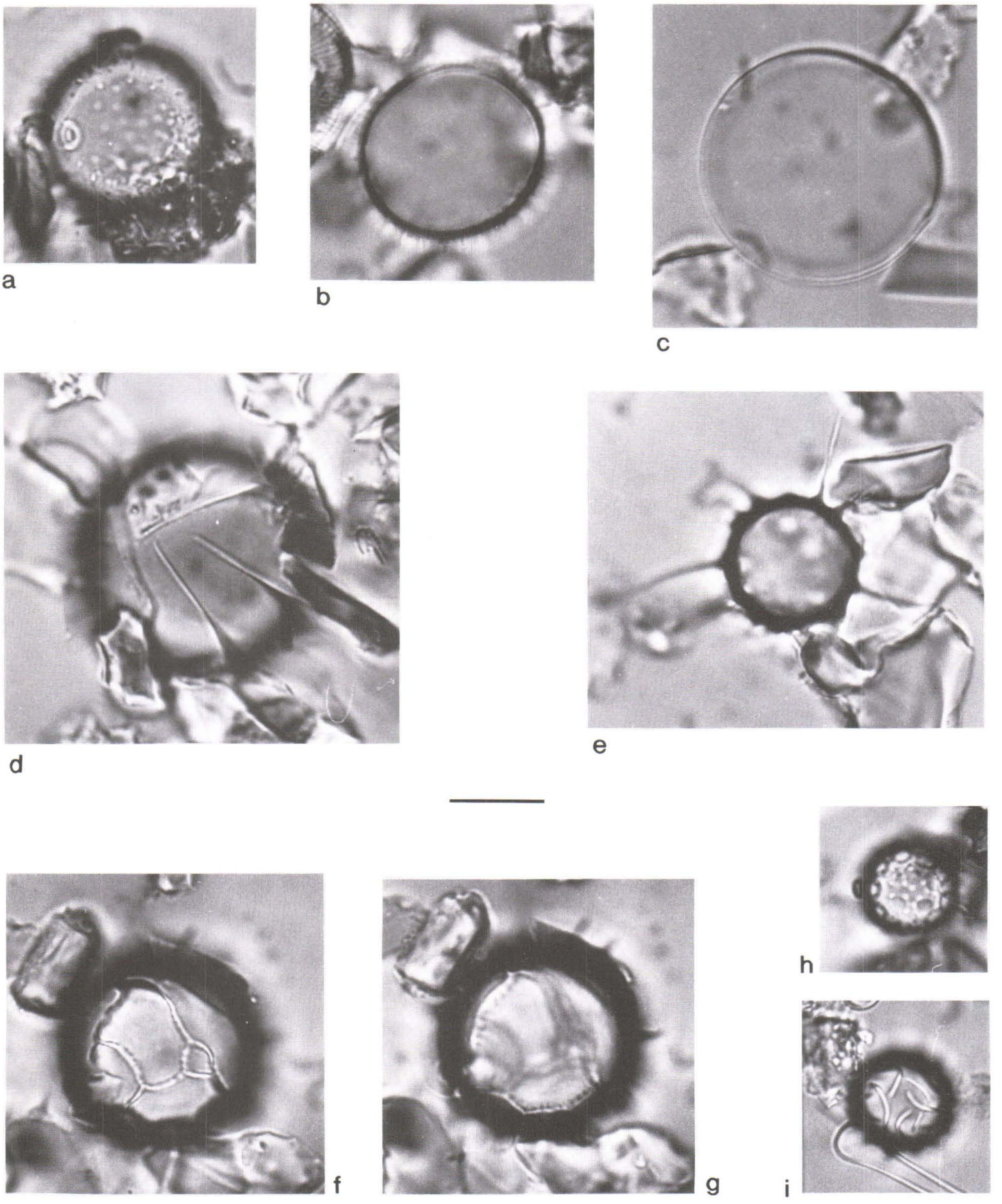

Plate XV. *Chrysophycean* cysts.

PLATE XVI

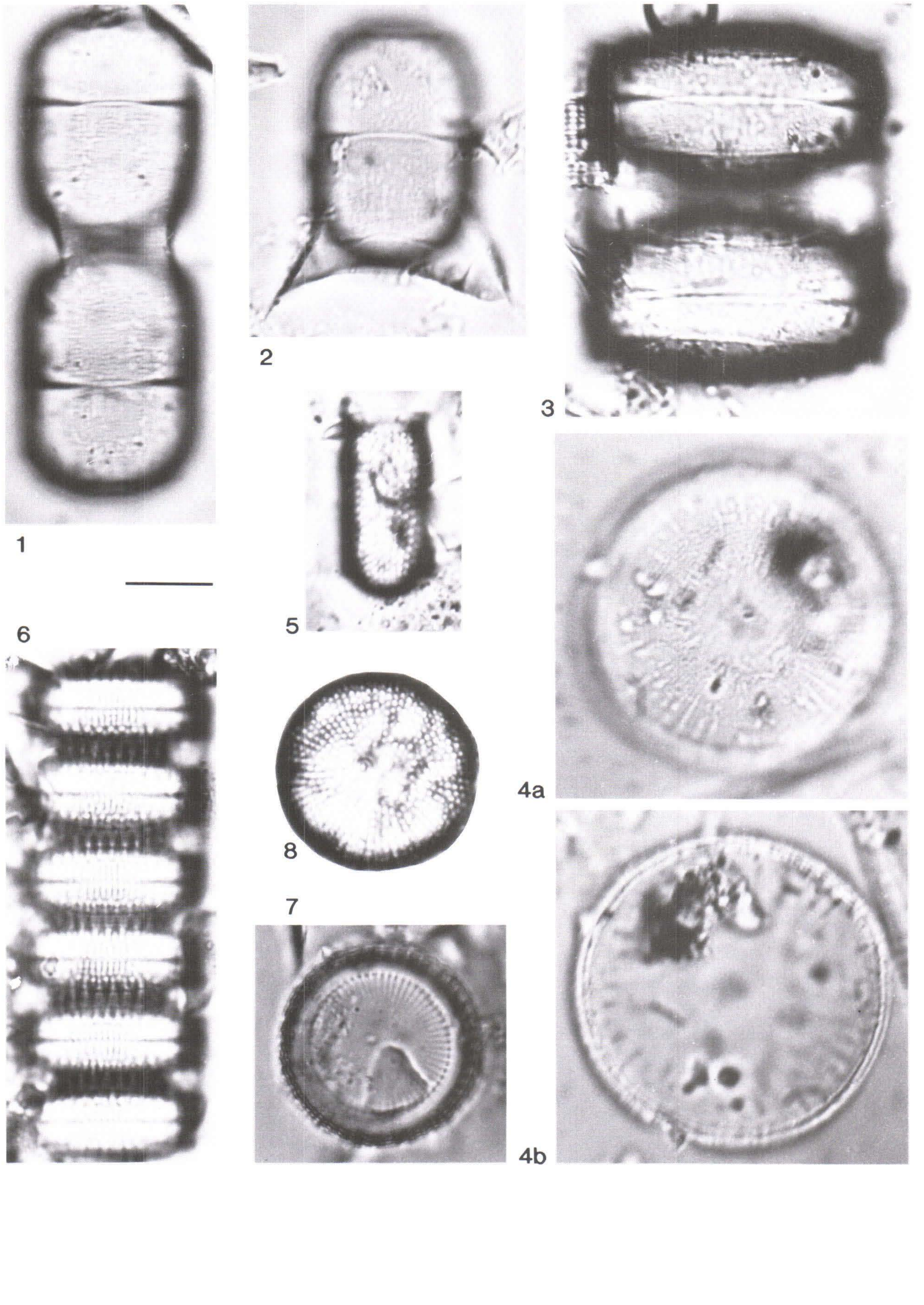

Plate XVI, 1, 2. *Melosira arctica,* 3, 4. *M. a.* var. *polaris,* 5. *M. islandica,* restring spore, 6, 7. *Paralia sulcata,* 8. *Melosira roseana.*

PLATE XVII

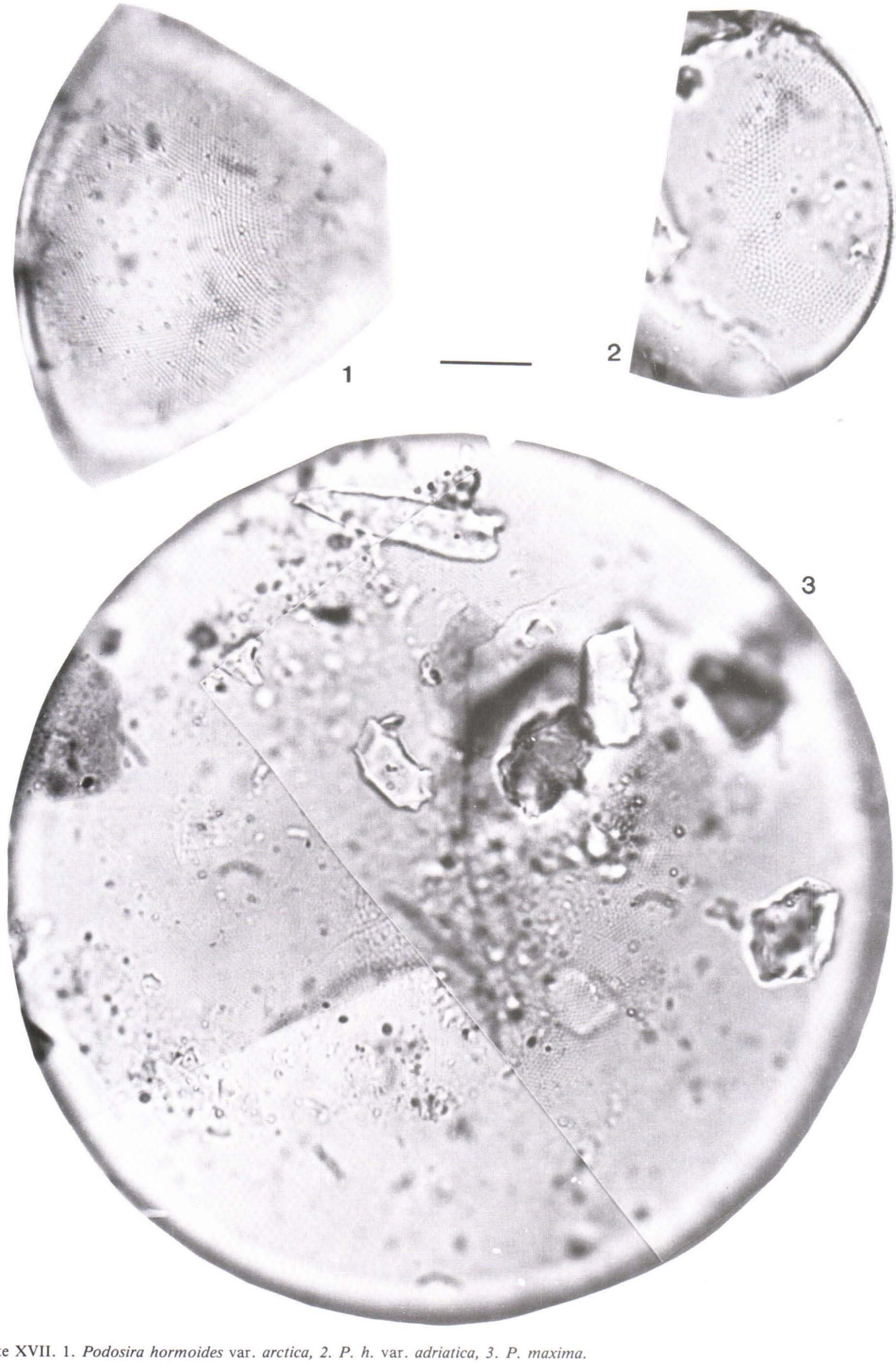

Plate XVII. 1. *Podosira hormoides* var. *arctica*, 2. *P. h.* var. *adriatica*, 3. *P. maxima*.

PLATE XVIII

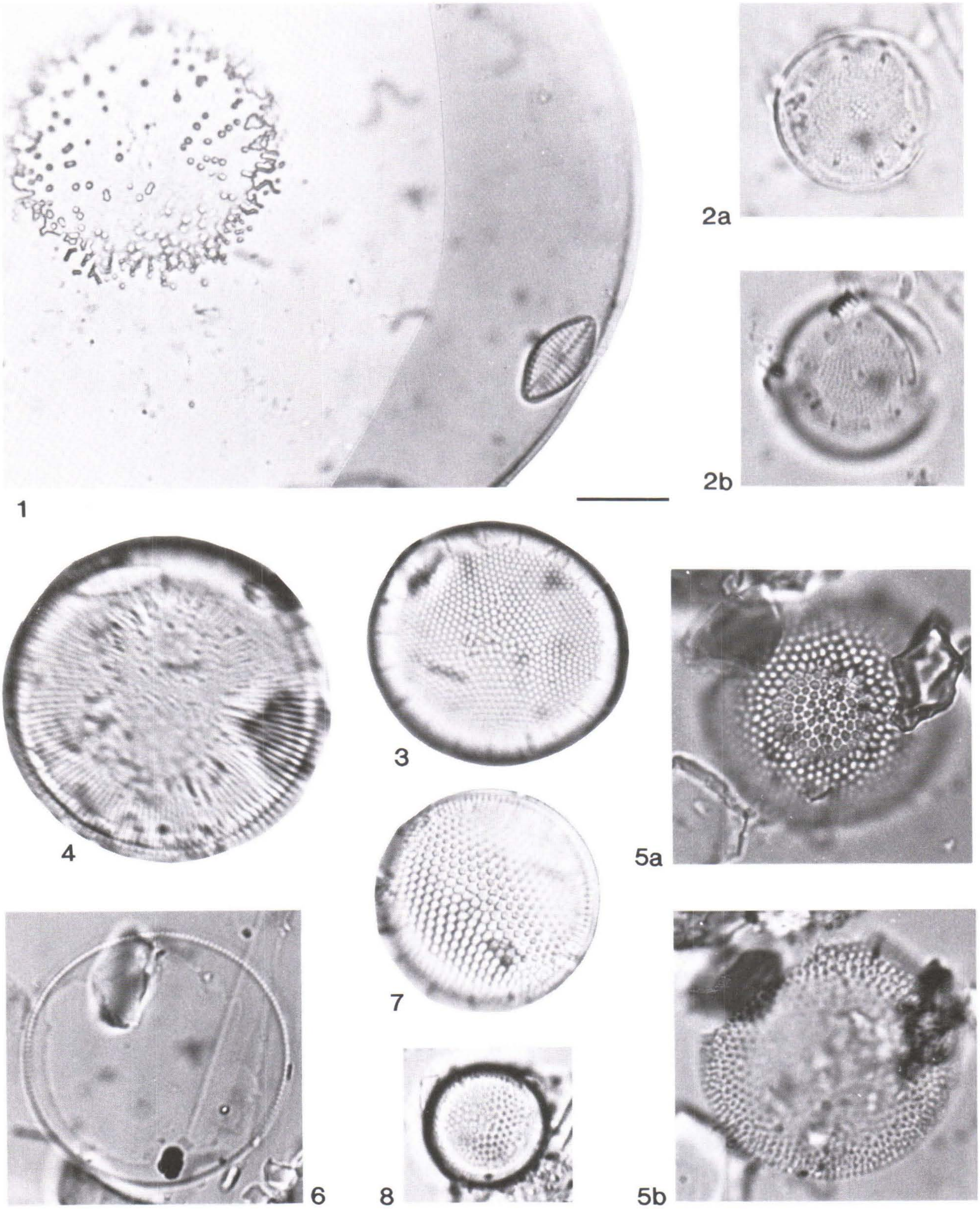

Plate XVIII, 1. *Hyalodiscus subtilis,* 2a, b. *Thalassiosira nordenskiöldi,* 3. *T. decipiens,* 4. *Cyclotella iris,* 5a, b. *T. gravida,* restr. spor. 6. *T. sp.,* 7. *T. eccentrica,* 8. *T. oestrupi.*

PLATE XIX

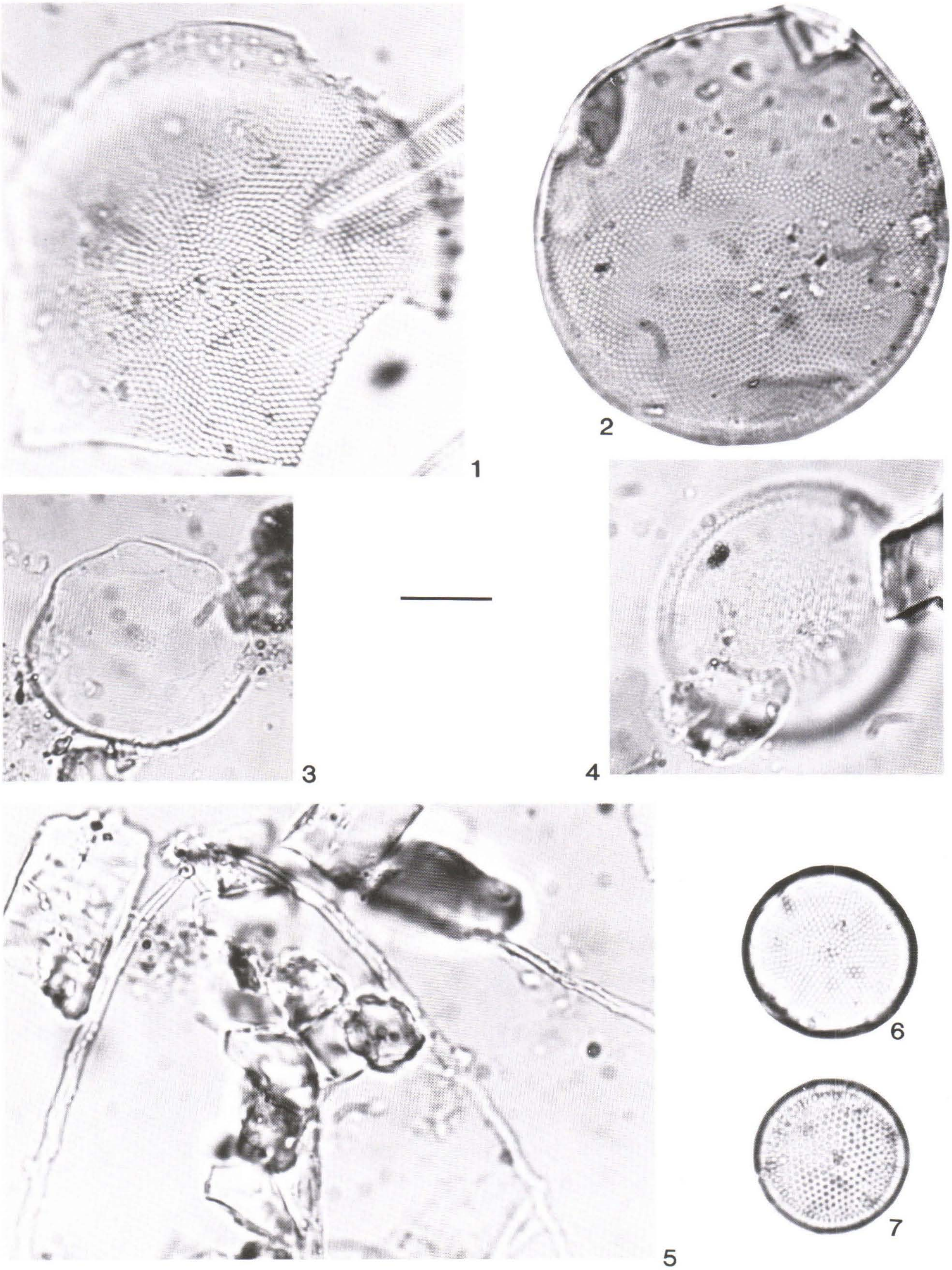

Plate XIX, 1. *Thalassiosira baltica,* 2. *Coscinodiscus rothii* var. *normani,* 3. *Thalassiosira subtilis,* 4. *Phacodiscus punctulatus,* 5. *Chaetoceros compressus?,* fragm., 6. *C. curvatulus* var. *kariana,* 7. *T. eccentrica.*

PLATE XX

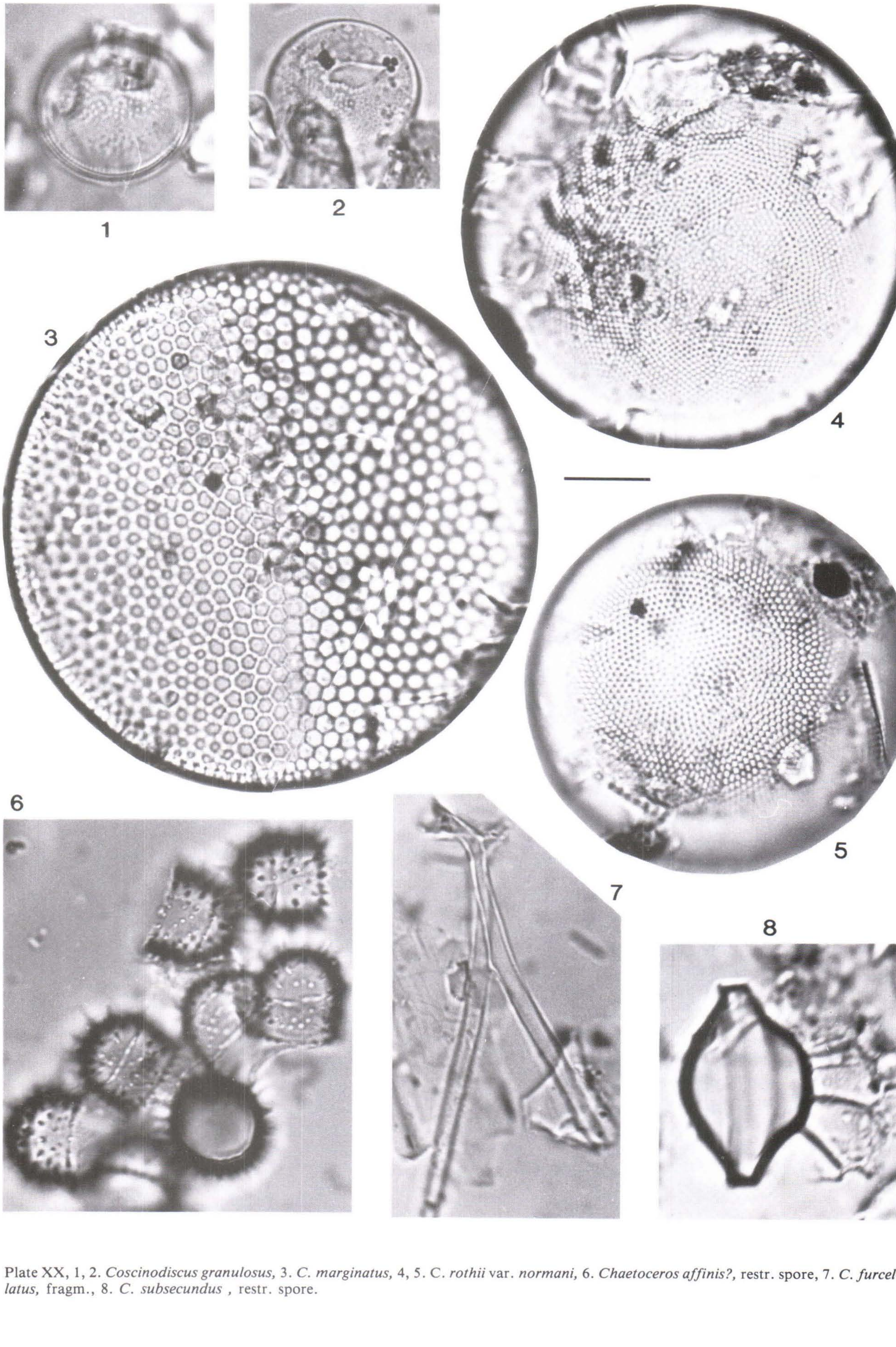

Plate XX, 1, 2. *Coscinodiscus granulosus,* 3. *C. marginatus,* 4, 5. *C. rothii* var. *normani,* 6. *Chaetoceros affinis?,* restr. spore, 7. *C. furcellatus,* fragm., 8. *C. subsecundus* , restr. spore.

PLATE XXI

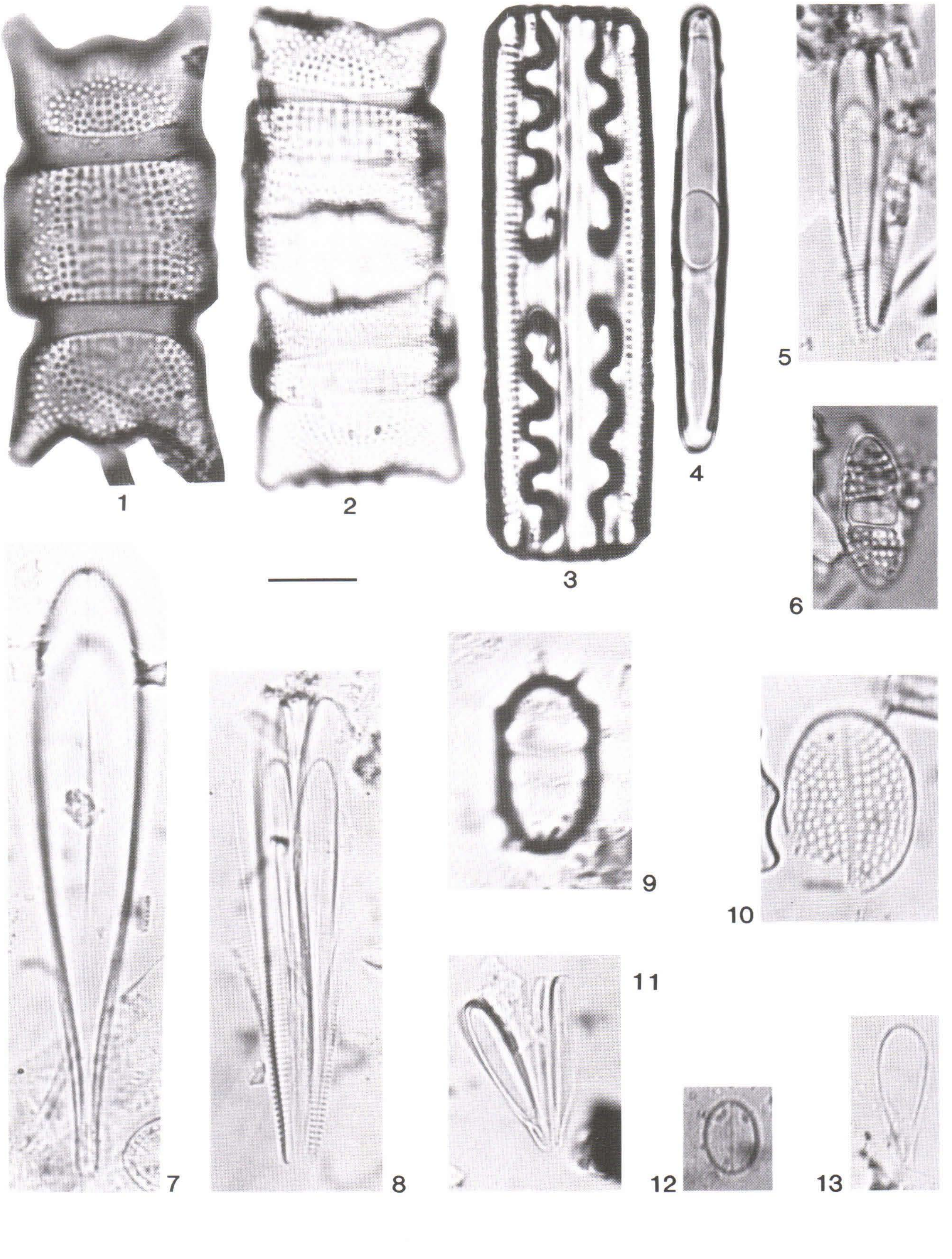

Plate XXI, 1. *Odontella aurita,* 2. *O. aurita* var. *obtusa,* 3. *Grammatophora angulosa* var. *islandica,* 4. *G. arctica,* 5, 8. *Licmophora communis,* 6. *Plagiogramma staurophorum,* 7. *L. paradoxa* var. *tincta* 9. *Biddulphia* typ., 10. *Rhaphoneis nitida* 11. *L. paradoxa* var. *crystallina* 12. *R. minutissima,* 13. *L. ovulum.*

PLATE XXII

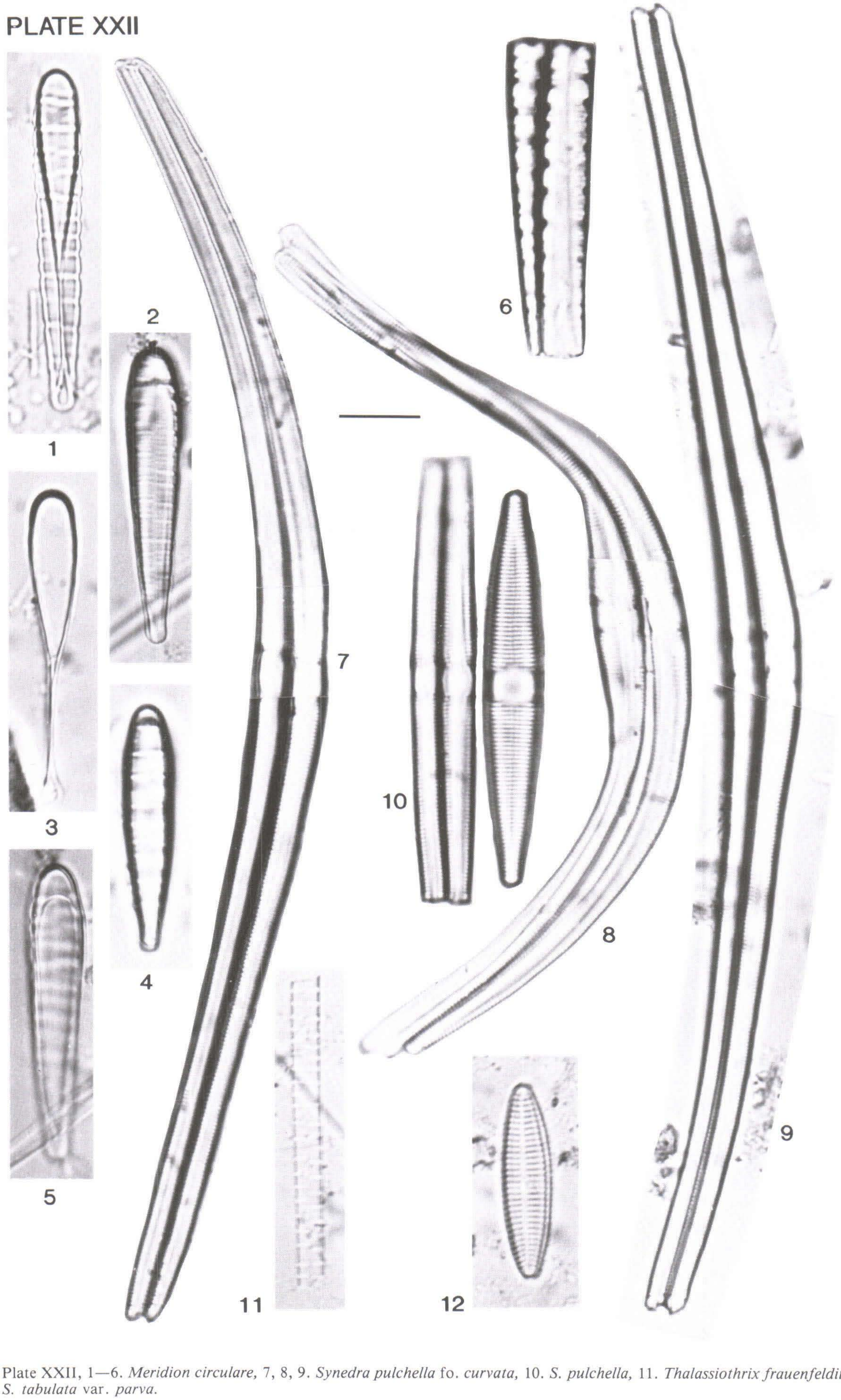

Plate XXII, 1—6. *Meridion circulare,* 7, 8, 9. *Synedra pulchella* fo. *curvata,* 10. *S. pulchella,* 11. *Thalassiothrix frauenfeldii,* fragm., 12. *S. tabulata* var. *parva.*

PLATE XXIII

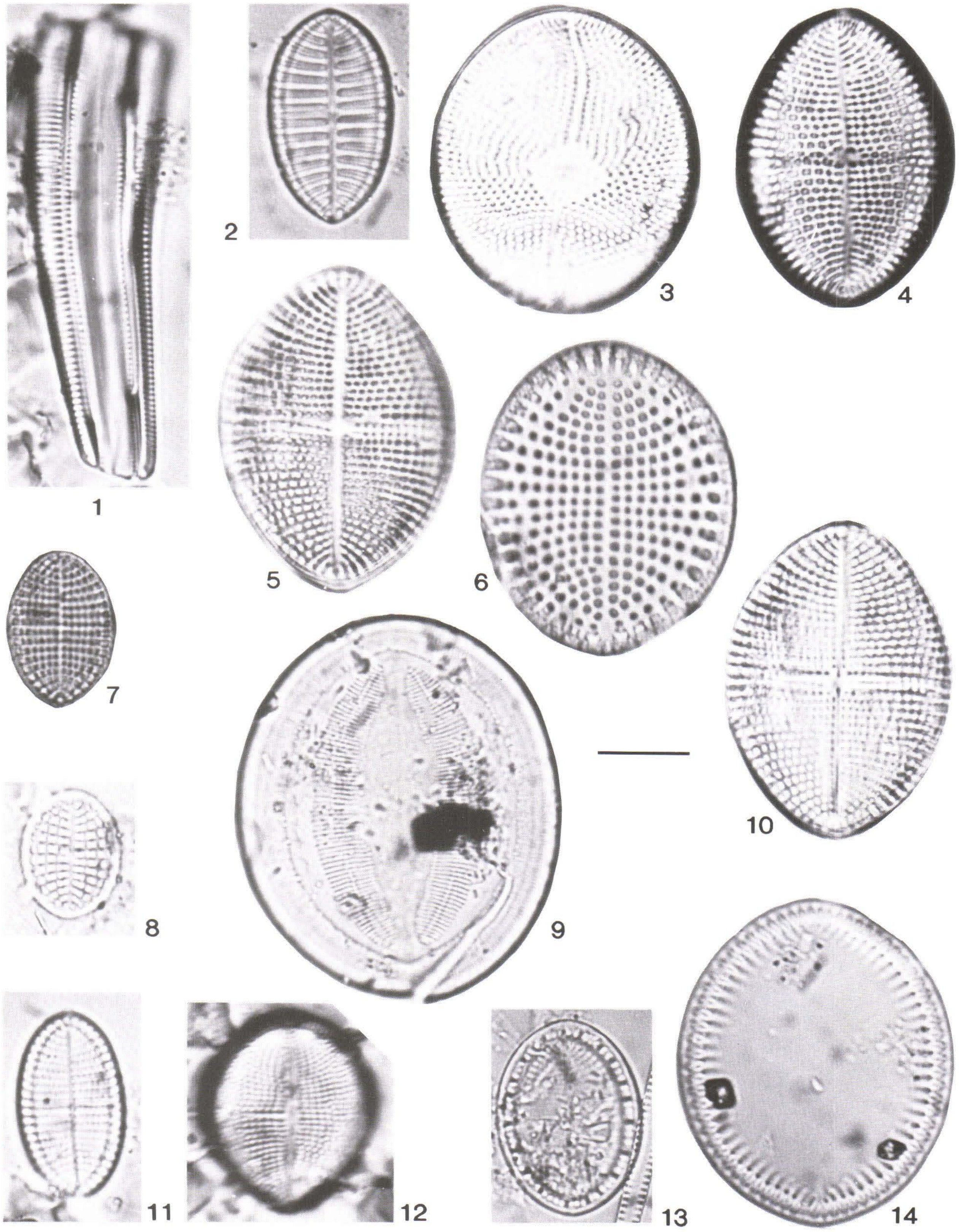

Plate XXIII, 1. *Rhoicosphaenia marina,* 2. *Cocconeis costata,* 3. *C. decipiens,* 4, 5, 10. *C. arctica,* 6. *C. scutellum,* 7. *C. scutellum* var. *parva,* 8. *C. reticulata,* 9. *C. pseudomarginata,* 11. *C. scutellum* var. *stauroneiformis.* 12. *C. pediculus,* 13. *C. scutellum* var. *ornata,* 14. *C. scutellum,* annulus.

PLATE XXIV

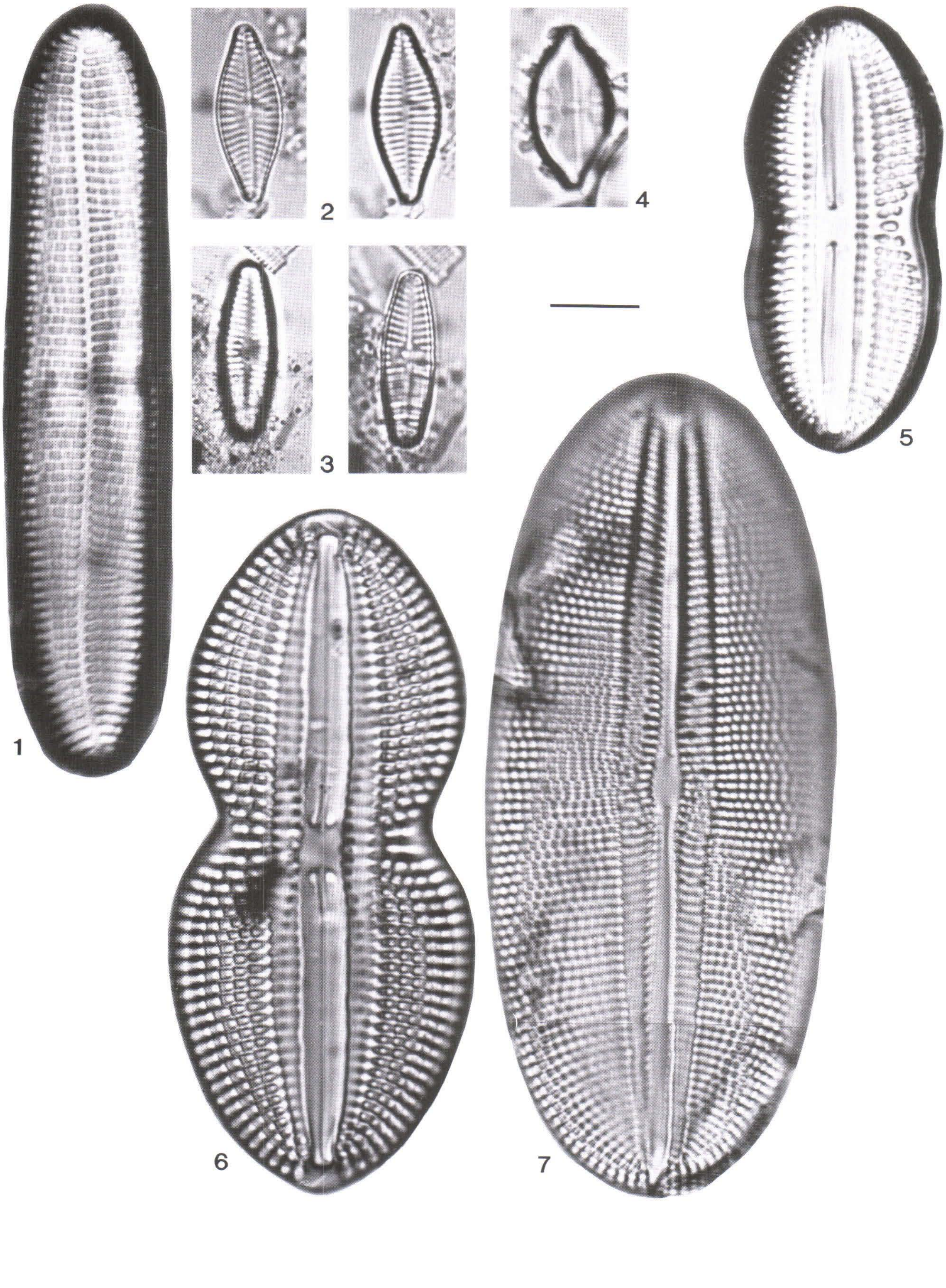

Plate XXIV. 1. *Achnanthes arctica*, 2. *A. delicatula* fo. *hauckiana*, 3. *A. A.* sp., 4. *Mastogloia exiqua* var. *rostrata* n. var., 5. *Diploneis didyma*, 6. *D. bombus*, 7. *D. fusca*.

PLATE XXV

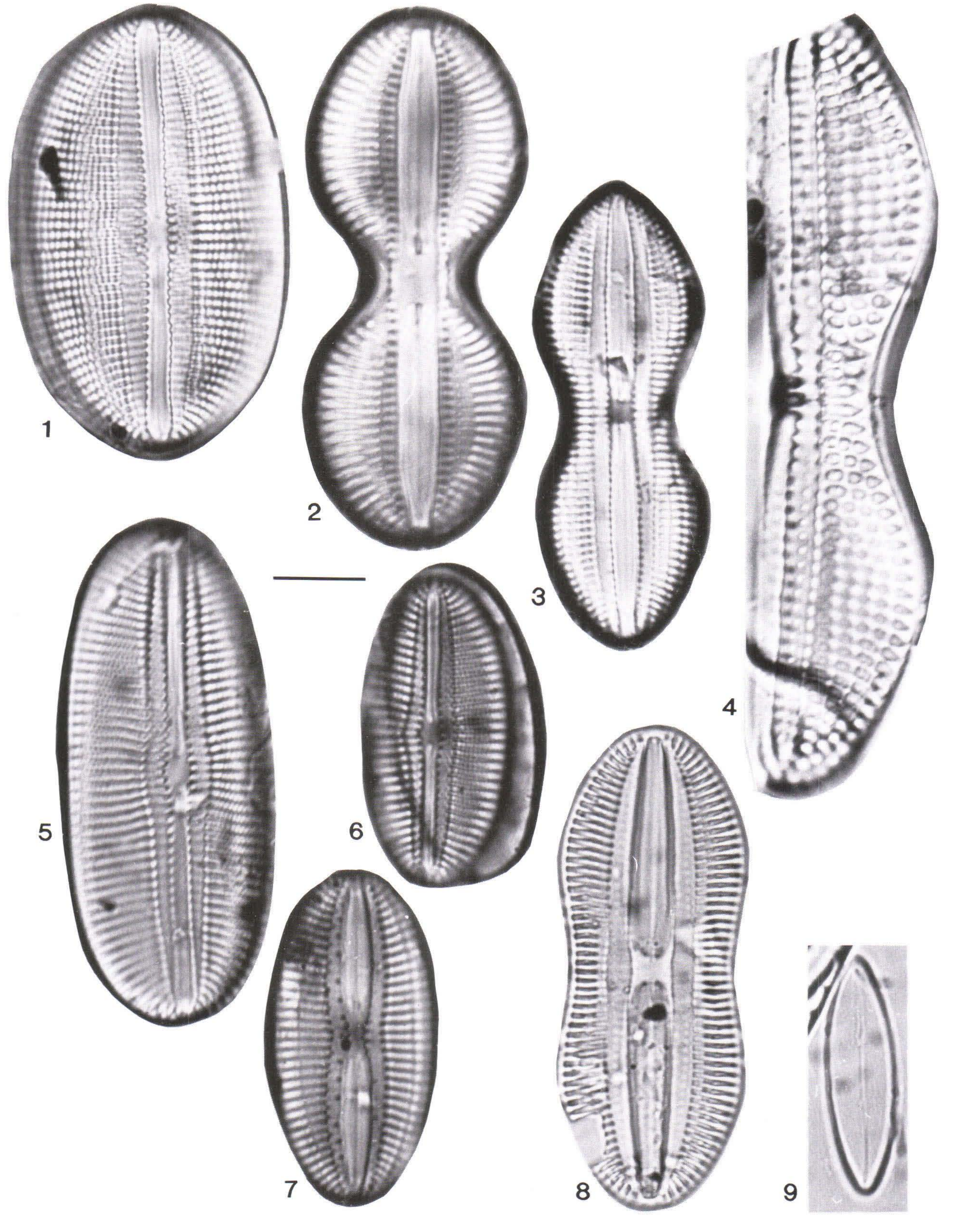

Plate XXV. 1. *D. fusca* var. *aestiva*, 2. *D. interrupta*, 3, 4. *D. splendida*, 5, 6. *D. smithii*, 7. *D. suborbicularis*, 8. *D. subcinta*, 9. *Amphipleura rutilans*.

PLATE XXVI

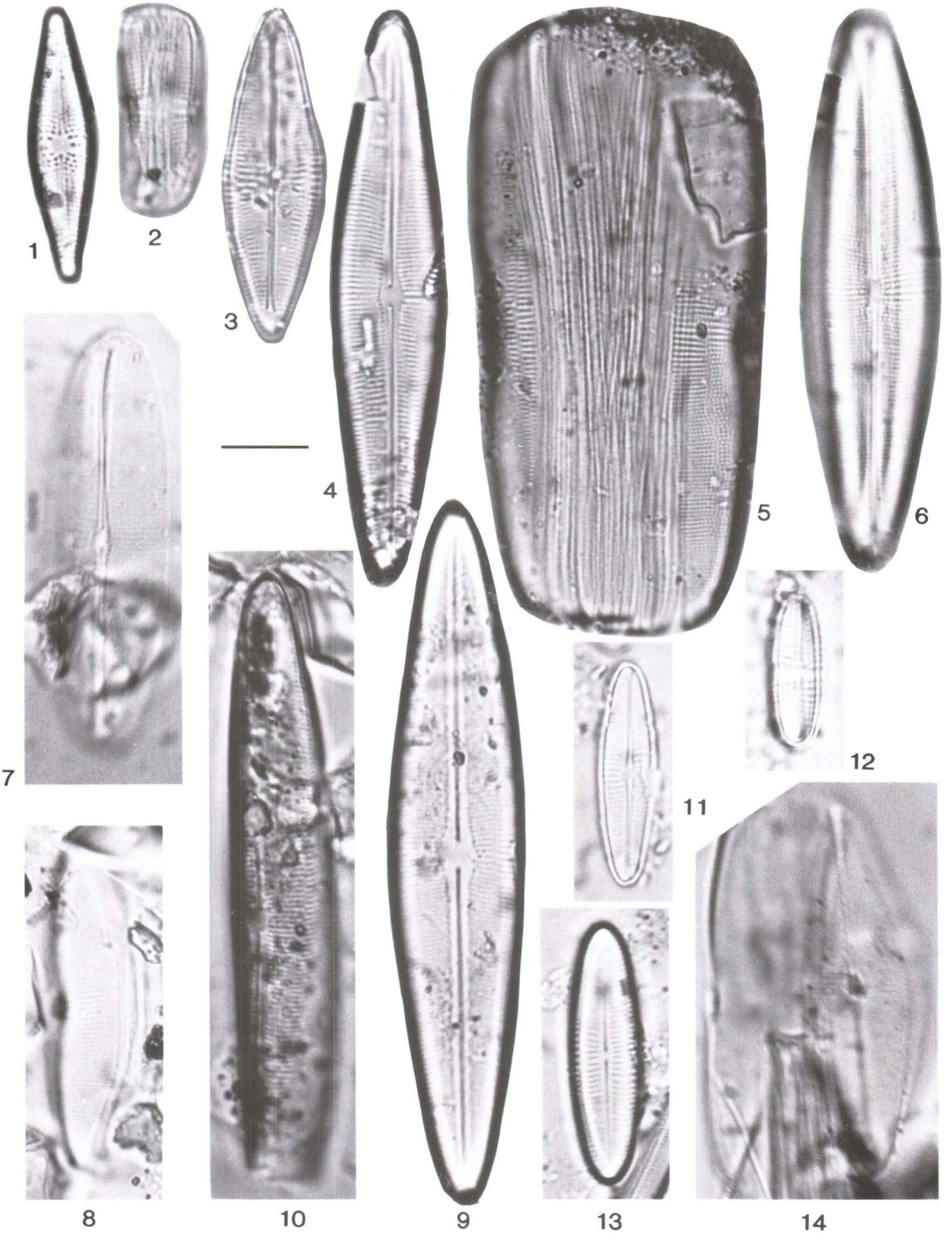

Plate XXVI. 1, 2. *Navicula comoides,* 3, 5, 6, 8. *N. grevillei,* 4, 9. *N. rhombica,* 7. *N. grevillei* var. *ovata n.* var., 10. *N. plicata,* 11, 13. *N. protracta* fo. *elliptica,* 12. *N. subinflata,* 14. *N. grevillei.*

PLATE XXVII

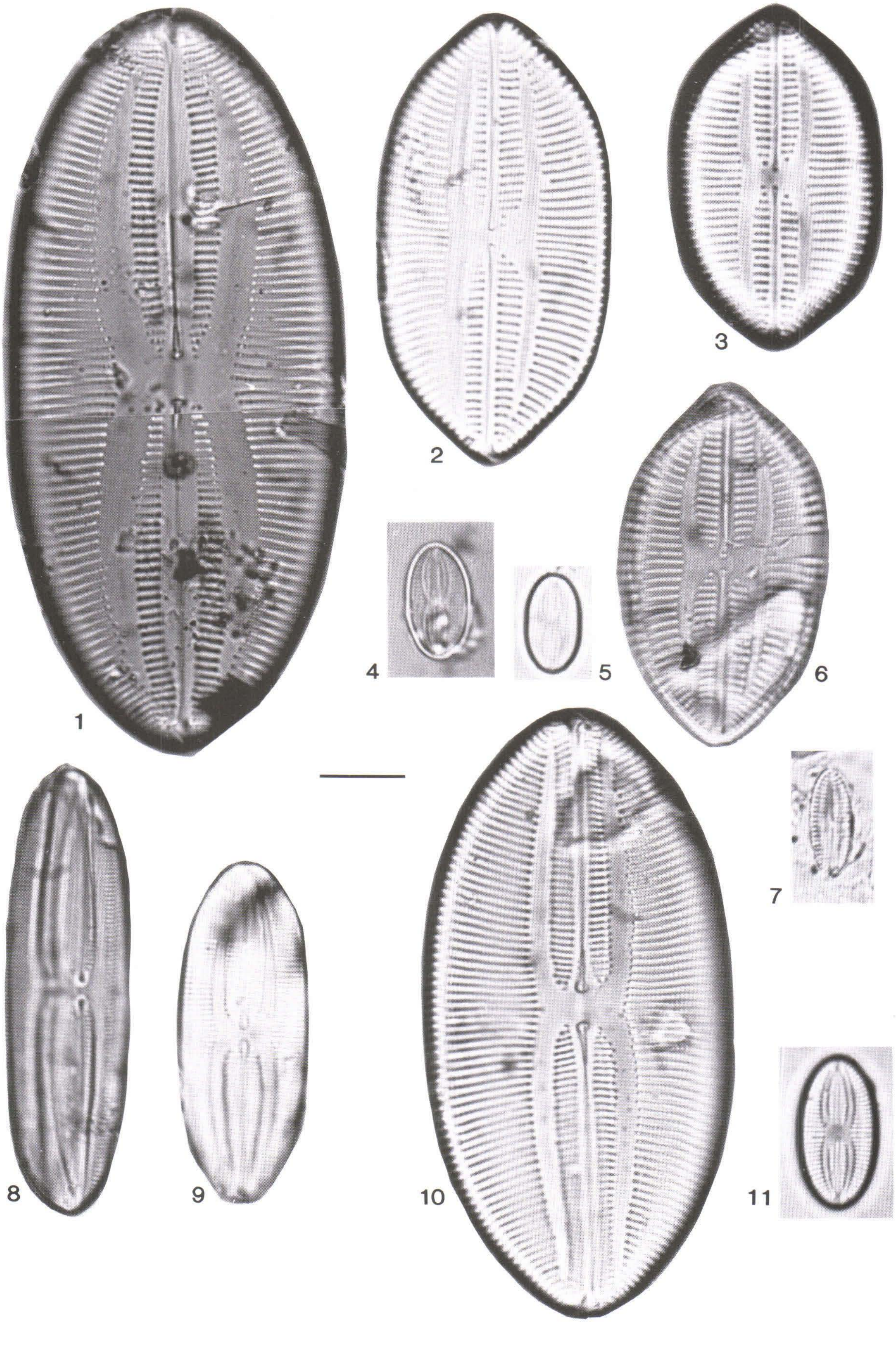

Plate XXVII. 1. *N. abrupta,* 2, 3, 6. *N. lyra* var. *atlantica,* 4, 5. *N. cryptolyra,* 7. *N. dissipata,* 8, 9, 11. *N. forcipata,* 10. *N. lyra* var. *elliptica.*

PLATE XXVIII

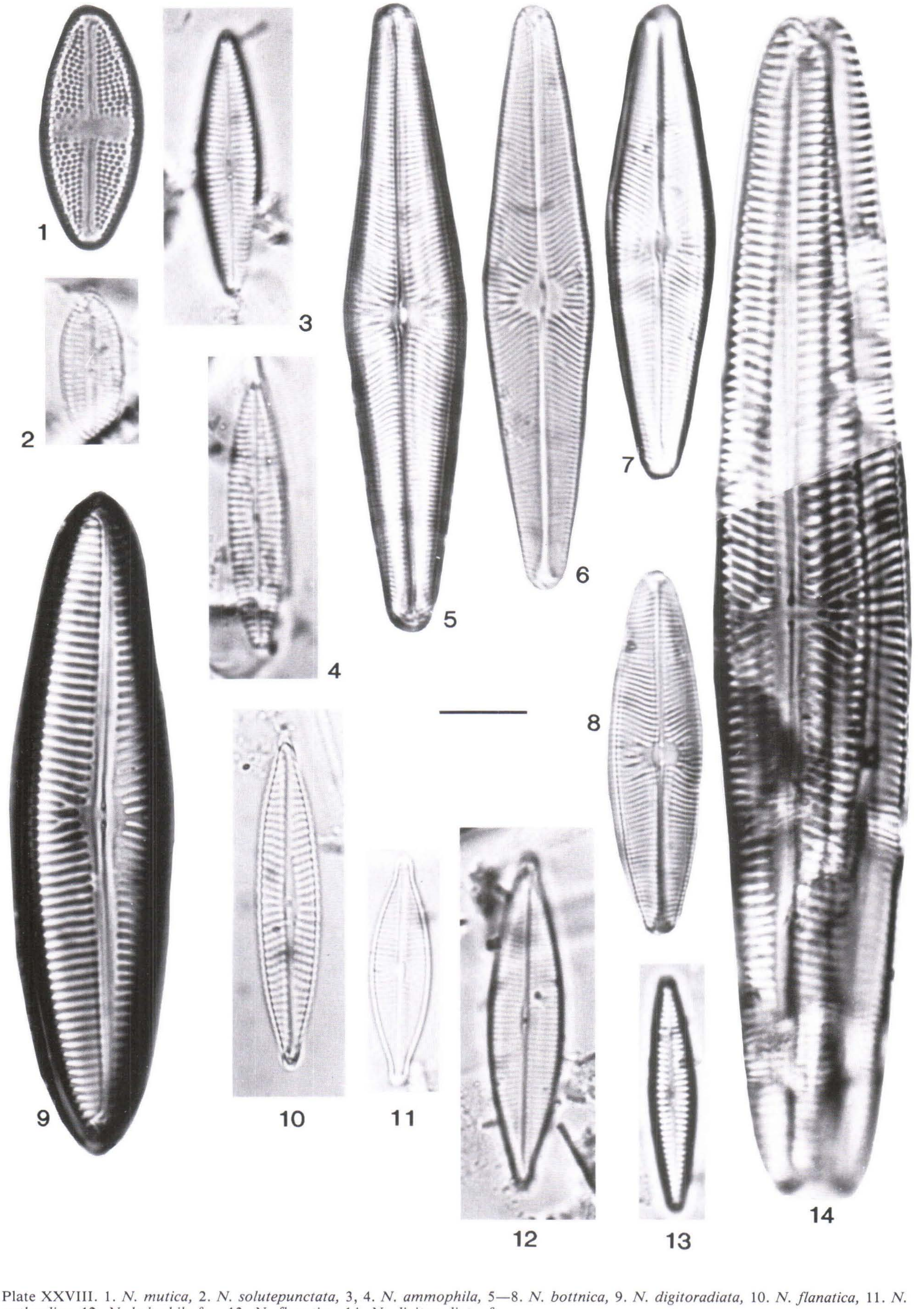

Plate XXVIII. 1. *N. mutica,* 2. *N. solutepunctata,* 3, 4. *N. ammophila,* 5—8. *N. bottnica,* 9. *N. digitoradiata,* 10. *N. flanatica,* 11. *N. gotlandica,* 12. *N. halophila* fo., 13. *N. flanatica,* 14. *N. digitoradiata,* fo.

PLATE XXIX

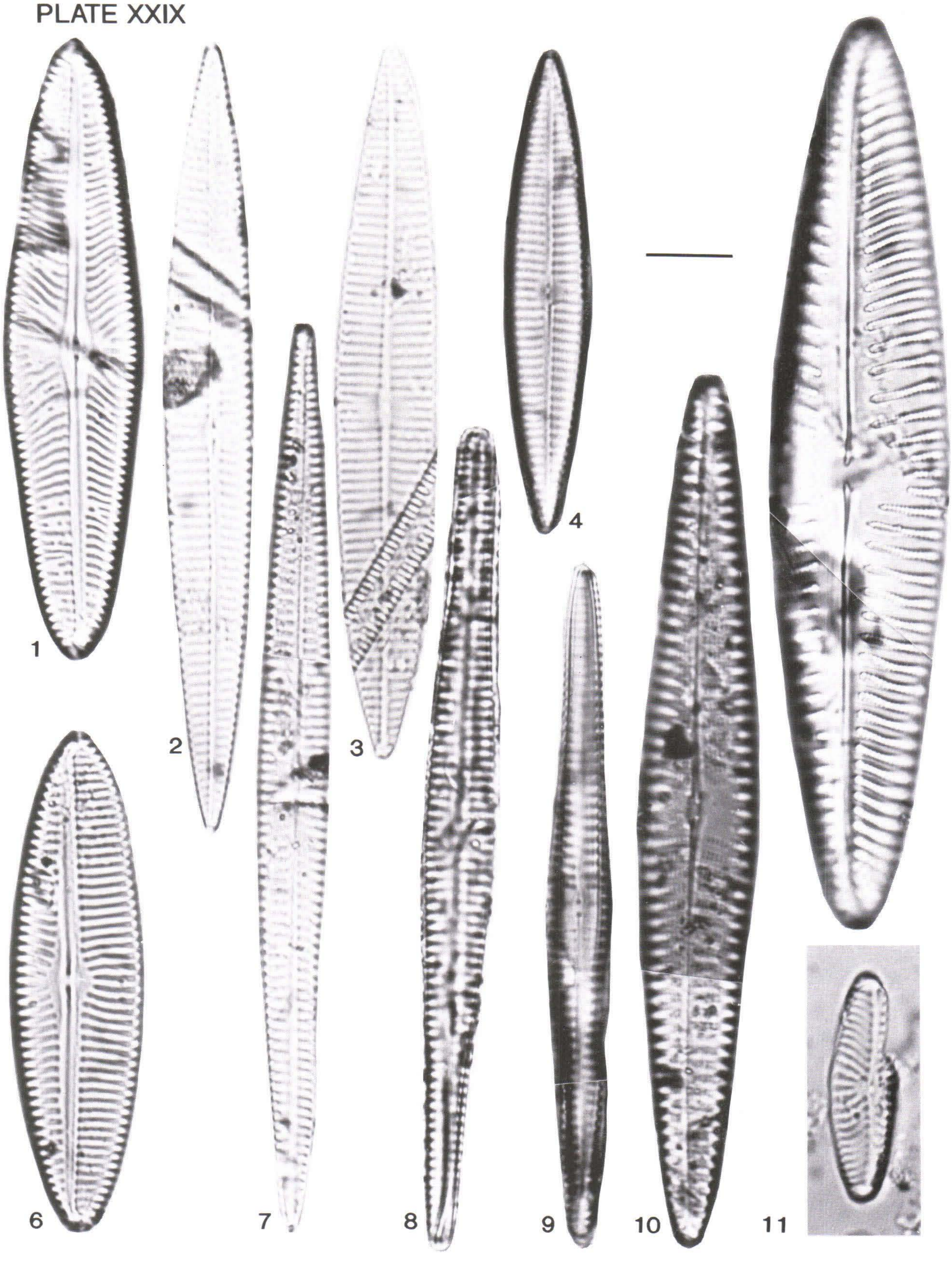

Plate XXIX. 1. *N. digitoradiata* var. *cyprinus,* 2, 3. *N. directa,* 4. *N. ramossima,* 5. *N. distans,* 6. *N. digitoradiata,* 7, 8. *N. directa* var. *subtilis,* 9. *N. directa* var. *oceanica* 10. *N. longa,* 11. *N. hungarica.*

PLATE XXX

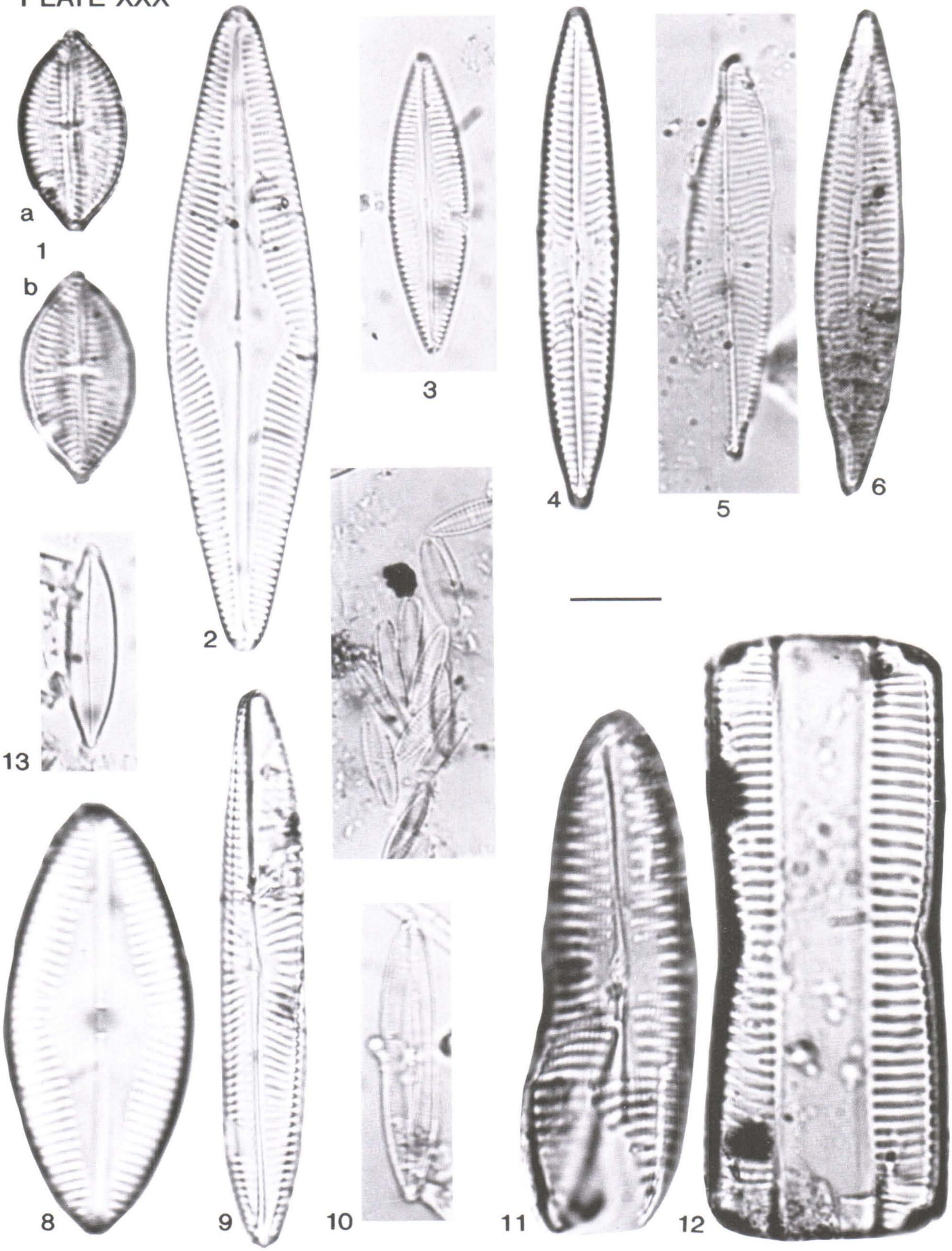

Plate XXX. 1. *N. finmarchica* fo. *hendey, n.* fo., 2. *N. palpebralis,* 3. *N. p.* var. *minor,* 4, 5, 9. *N. rostellata,* 6. *N. rostellataformis n.* sp., 7. *N. salinicola,* 8. *N. solida,* 10. *N.* sp., 11, 12. *N. cancellata.*

PLATE XXXI

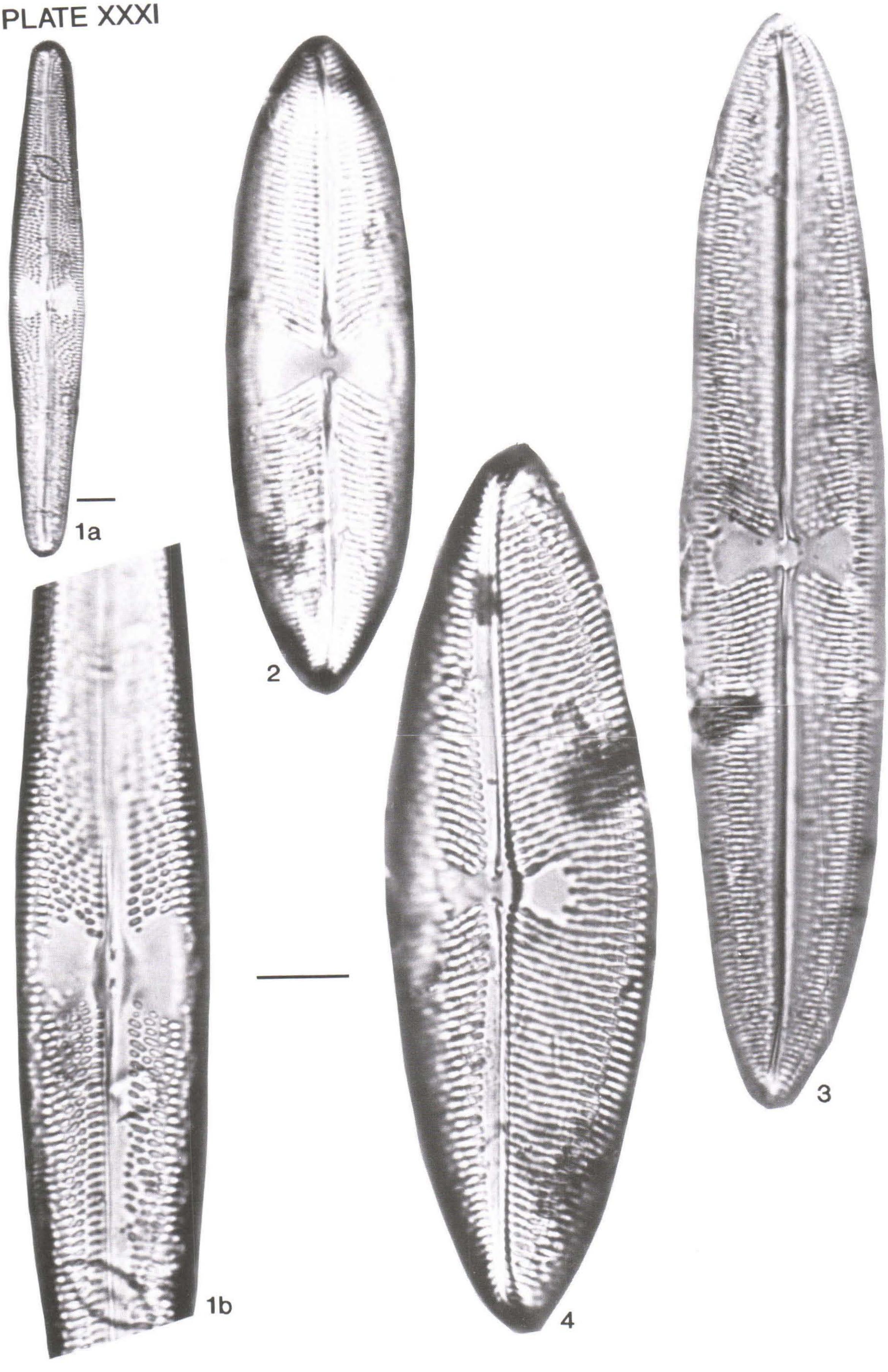

Plate XXXI. 1a, b, 3. *Trachyneis aspera,* 2. T. cf. *tumidula,* 4. *T. aspera* var. *intermedia.*

PLATE XXXII

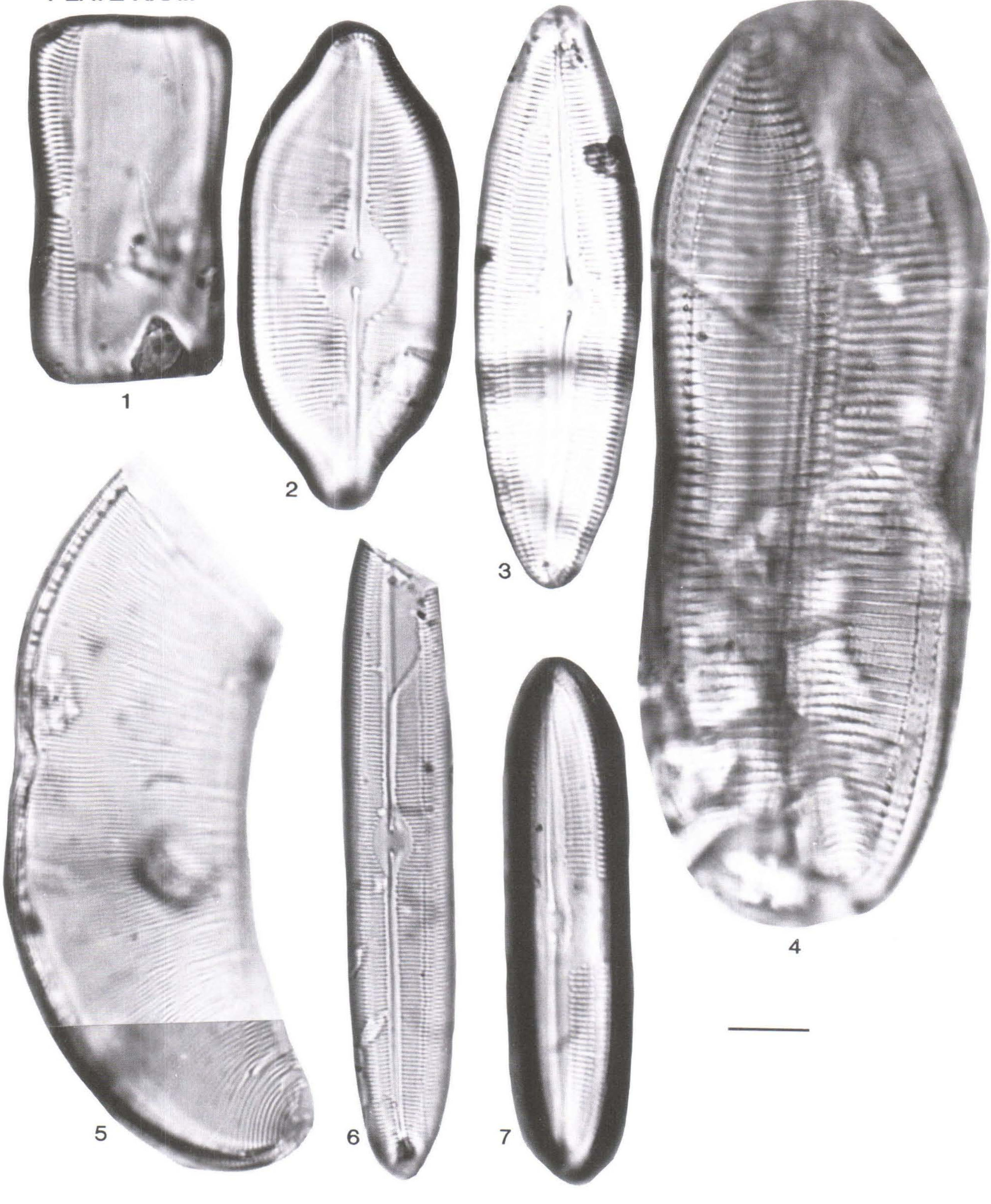

Plate XXXII. 1. *Pinnularia crucicula*, 2. *Caloneis brevis*, 3. *C. westii*, 4. *Scoliotropis latestriata*, 5. *Auricula complexa*, 6. *C. liber*, 7. *C. consimilis*.

PLATE XXXIII

Plate XXXIII. 1. *Gyrosigma fascicula* var. *sulcata,* 2. *G. f.* var. *arcuata,* 3. *G. wanspecki,* 4. *Pleurosigma cuspidatum.*

Plate XXXIV. 1. *P. formosum*, 2. *P. strigosum?*, 3. *P. latum.*

PLATE XXXV

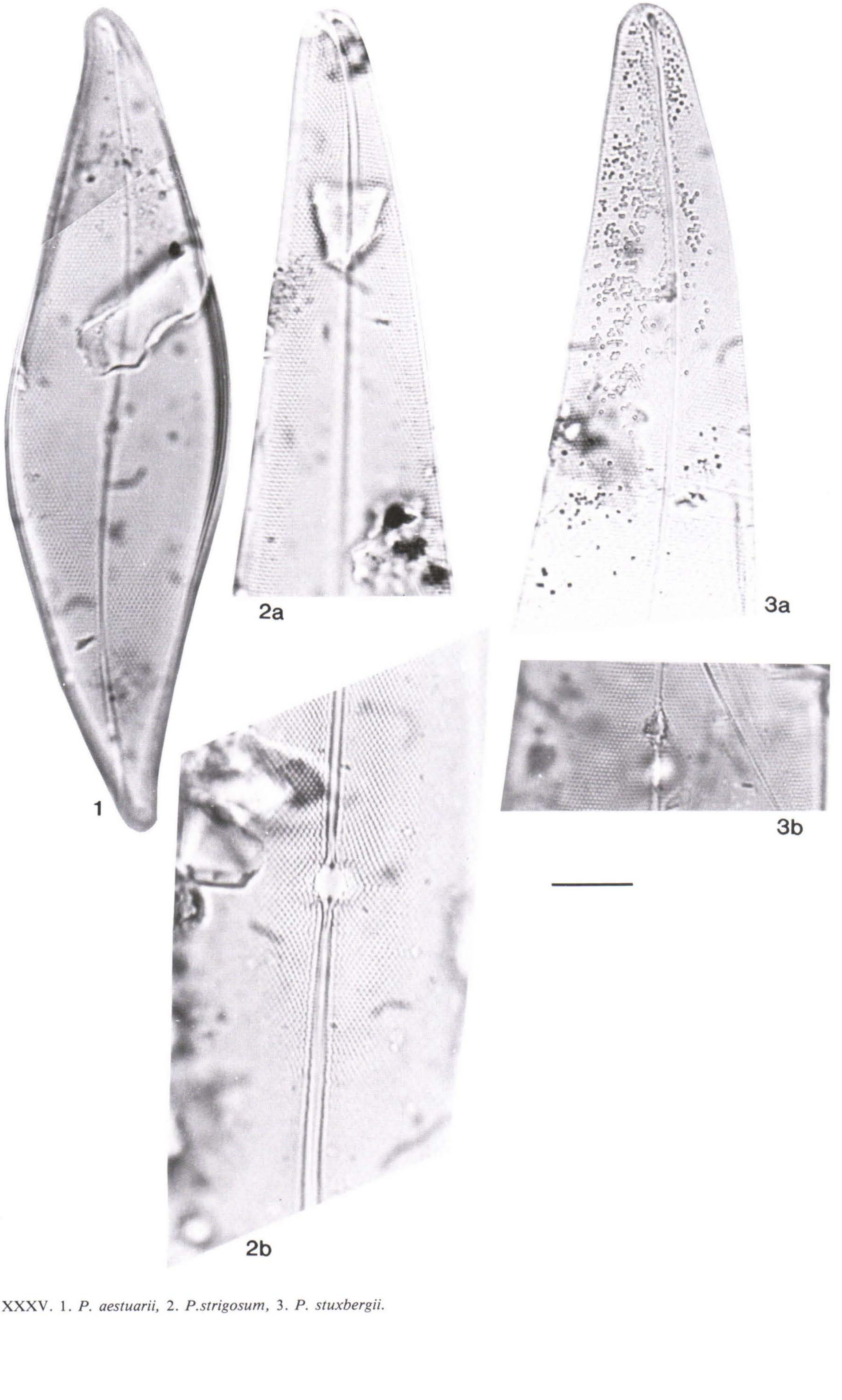

Plate XXXV. 1. *P. aestuarii,* 2. *P.strigosum,* 3. *P. stuxbergii.*

PLATE XXXVI

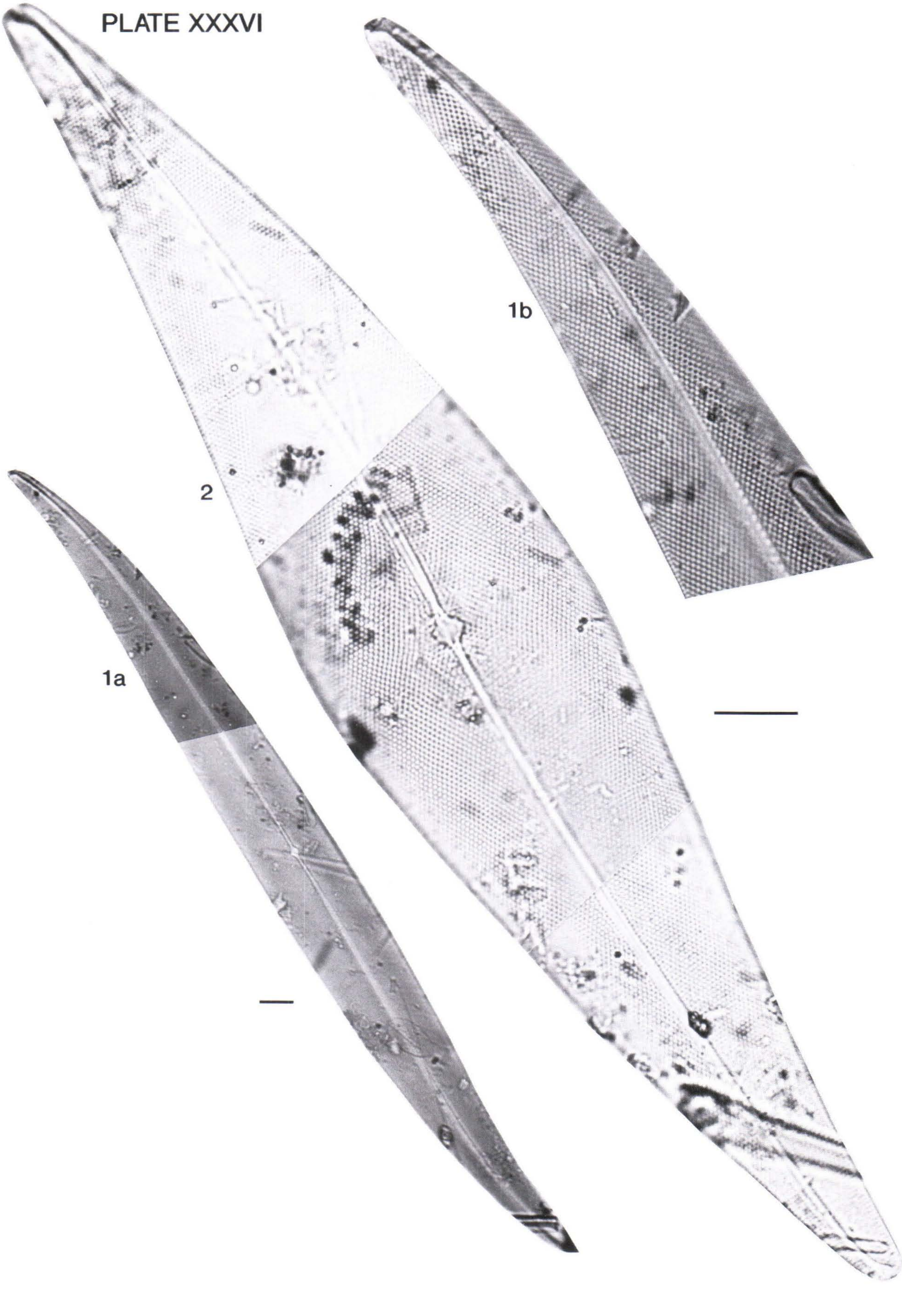

Plate XXXVI. 1a,b. *Pleurosigma elongatum*, 2. *P. angulatum*.

PLATE XXXVII

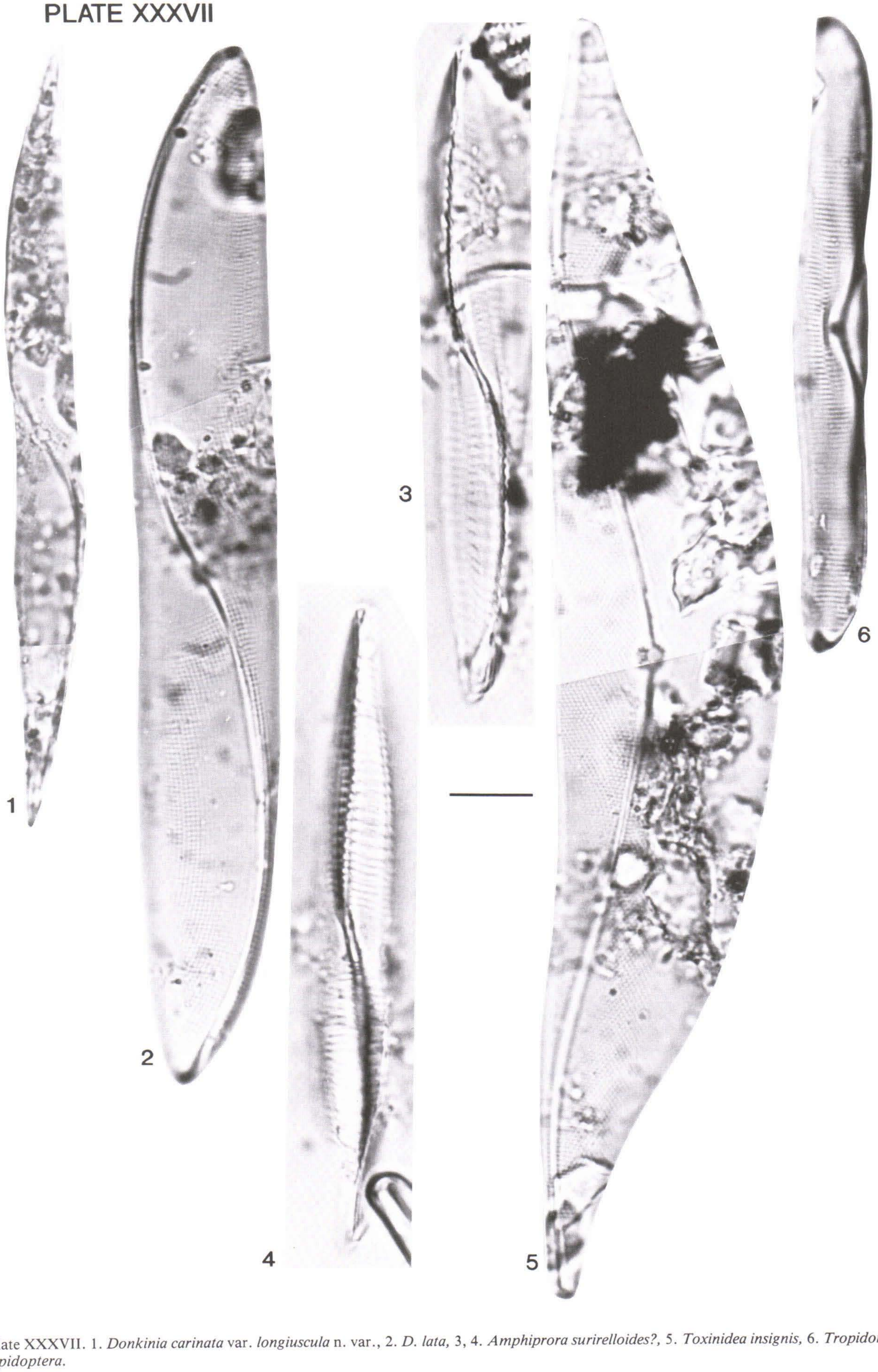

Plate XXXVII. 1. *Donkinia carinata* var. *longiuscula* n. var., 2. *D. lata,* 3, 4. *Amphiprora surirelloides?,* 5. *Toxinidea insignis,* 6. *Tropidoneis lepidoptera.*

PLATE XXXVIII

Plate XXXVIII. 1. *Amphiprora splendida,* 2. *Tropidoneis vitrea,* 3, 5. *T. lepidoptera,* 4. *Amphiprora sp.,* 6. genus and species indet. 7. *Amphora laevessima.*

PLATE XXXIX

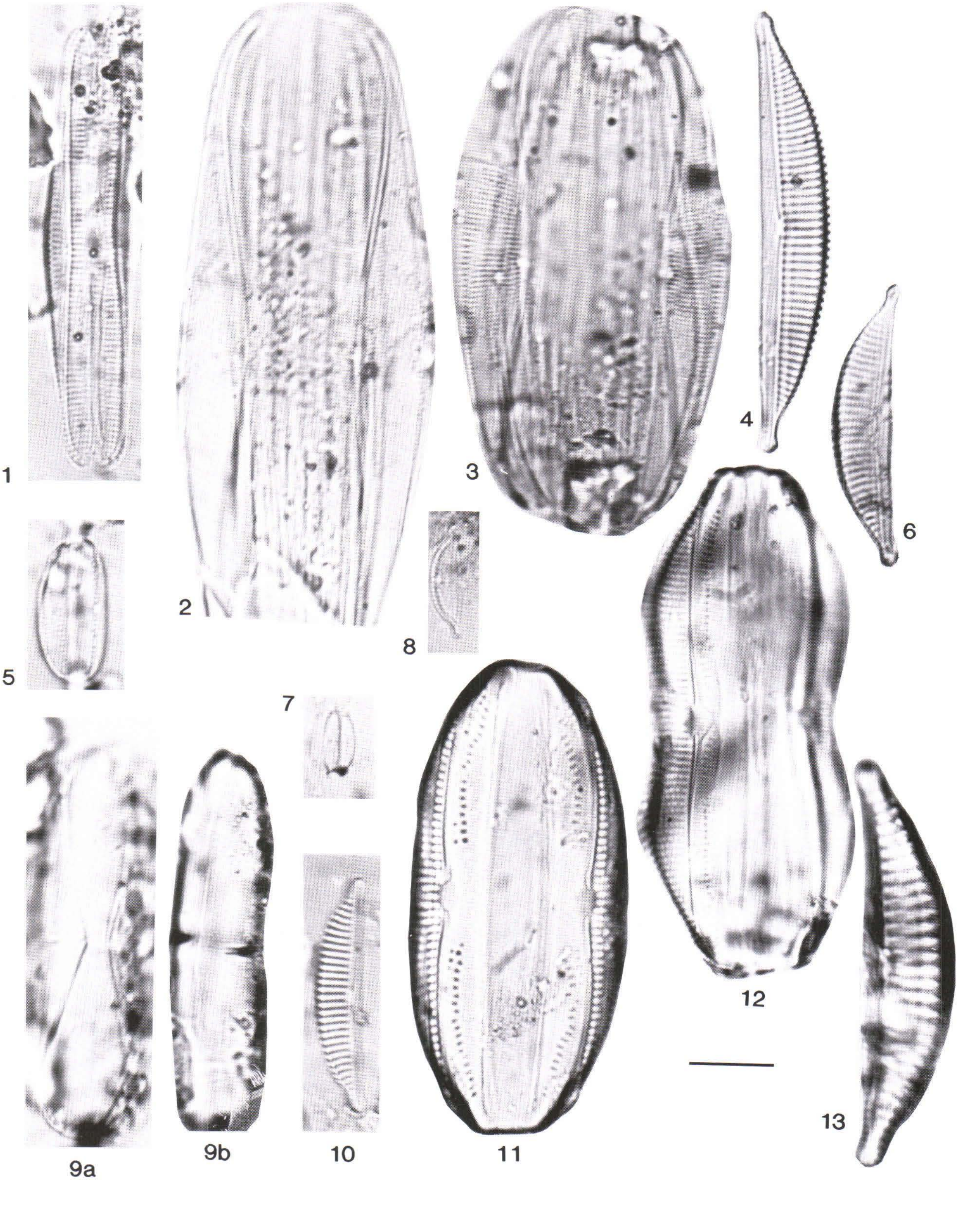

Plate XXXIX. 1. *Amphora (angusta var.) arctica,* 2, 3. *A. arcus* var. *sulcata,* 4. *A. granulata,* 5. *A. ovalis* var. *pediculus,* 6. *A. exigua,* 7. *A. perpusilla,* 8. *A. sp.,* 9. *A. laevissima,* 10. *A. exigua,* 11. *A. proteus,* 12. *A. p.* var. *constricta,* 13. *A. terroris.*

PLATE XL

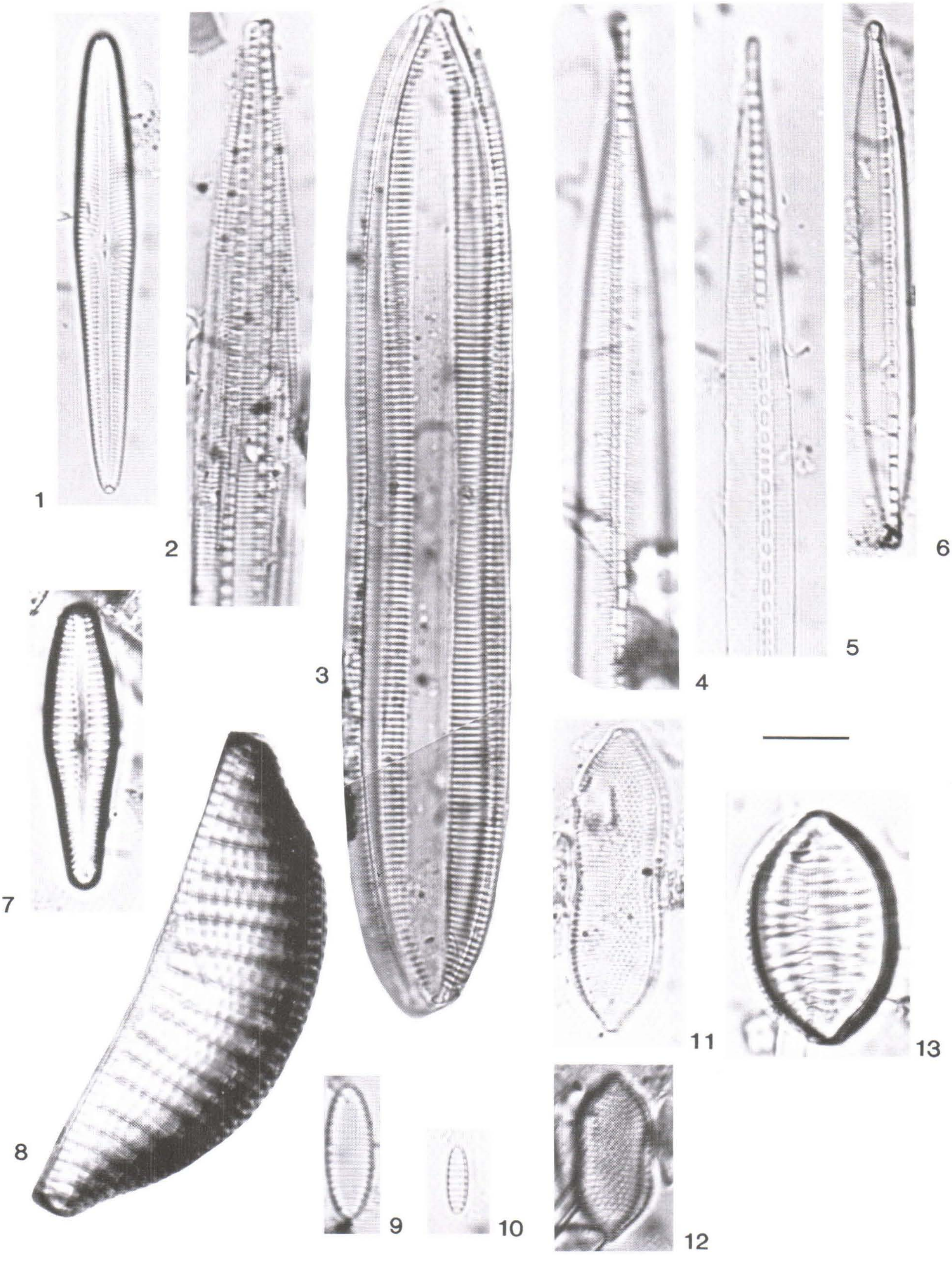

Plate XL. 1. *G. kamtschaticum,* 2, 4, 5. *Nitzschia socialis,* 3. *N. acuminata,* 6. *N. angularis,* 7. *G. longiceps* var. *montana,* 8. *Epithemia turgida* var. *westermanni,* 9. *Nitzschia oceanica,* 10. *N. cylindrus,* 11, 12. *N. constricta,* 13. *N. tryblionella* var. *victoriae.*

PLATE XLI

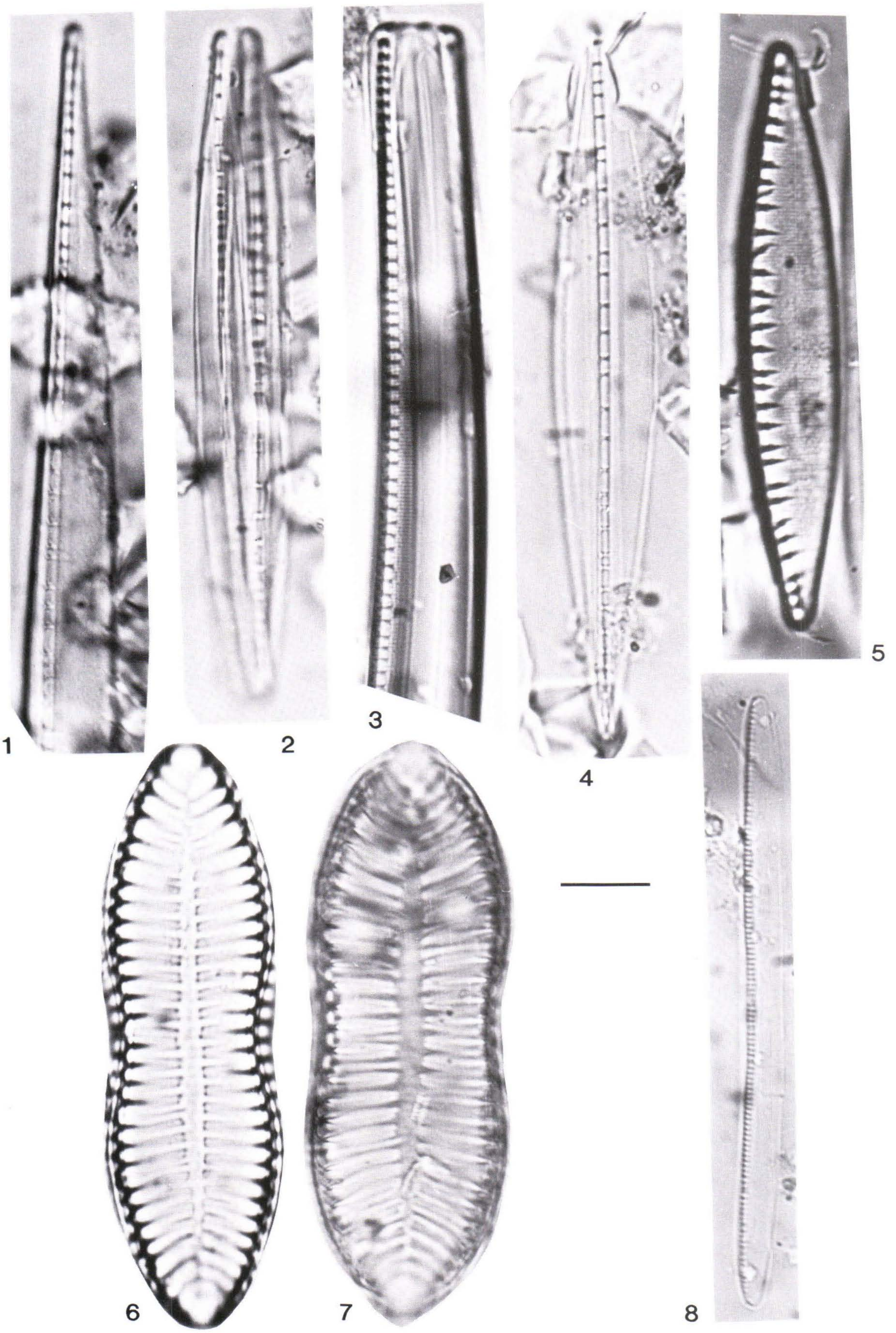

Plate XLI. 1, 2. *N. angularis,* 3. *N. sigma,* 4. *N. distans,* 5. *N. vadsösis* n. sp., 6, 7. *Surirella smithii,* 8. *N. bergii.*

PLATE XLII

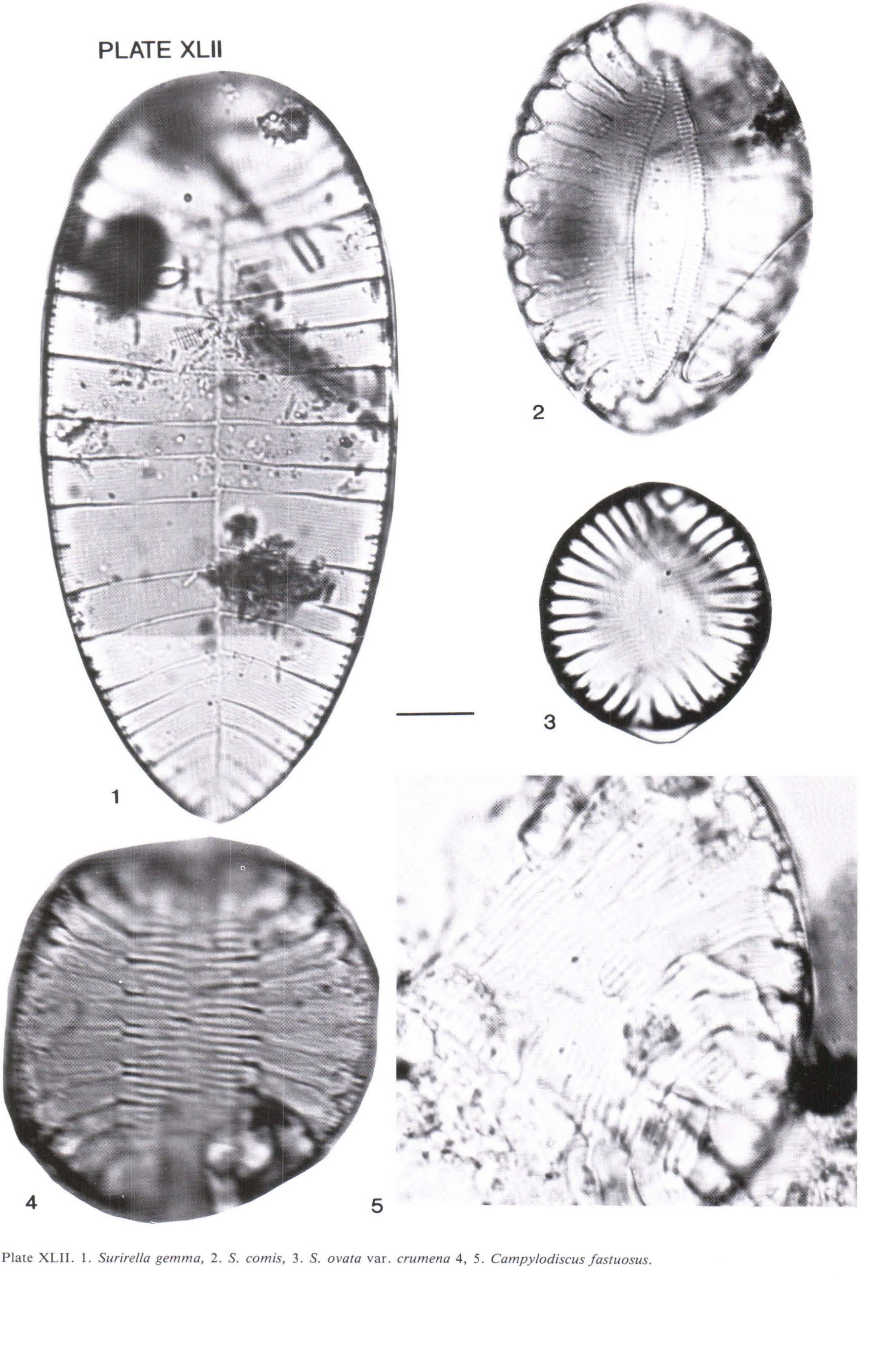

Plate XLII. 1. *Surirella gemma*, 2. *S. comis*, 3. *S. ovata* var. *crumena* 4, 5. *Campylodiscus fastuosus*.

Tätä julkaisua myy

GEOLOGIAN
TUTKIMUSKESKUS (GTK)
Julkaisumyynti
02150 Espoo
☎ 90-46931
Teleksi: 123 185 geolo sf
Telekopio: 90-462 205

GTK, Väli-Suomen
aluetoimisto
Kirjasto
PL 1237
70101 Kuopio
☎ 971-205 111
Telekopio: 971-205 215

GTK, Pohjois-Suomen
aluetoimisto
Kirjasto
PL 77
96101 Rovaniemi
☎ 960-297 219
Teleksi: 37 295 geolo SF
Telekopio: 960-297 289

Denna publikation säljes av

GEOLOGISKA
FORSKNINGSCENTRALEN (GFC)
Publikationsförsäljning
02150 Esbo
☎ 90-46931
Telex: 123 185 geolo sf
Telefax: 90-462 205

GFC, Mellersta Finlands
distriktsbyrå
Biblioteket
PB 1237
70101 Kuopio
☎ 971-205 111
Telefax: 971-205 215

GFC, Norra Finlands
distriktsbyrå
Biblioteket
PB 77
96101 Rovaniemi
☎ 960-297 219
Telex: 37 295 geolo SF
Telefax: 960-297 289

This publication can be obtained
from

GEOLOGICAL SURVEY
OF FINLAND (GSF)
Publication sales
SF-02150 Espoo, Finland
☎ 90-46931
Telex: 123 185 geolo sf
Telefax: 90-462 205

GSF, Regional office of
Mid-Finland
Library
P.O. Box 1237
SF-70101 Kuopio, Finland
☎ 971-205 111
Telefax: 971-205 215

GSF, Regional office of
Northern Finland
Library
P.O. Box 77
SF-96101 Rovaniemi, Finland
☎ 960-297 219
Telex: 37 295 geolo SF
Telefax: 960-297 289

ISBN 951-690-443-2
ISSN 0781-4240

Vammala 1992
Vammalan Kirjapaino Oy