30. NORWEGIAN SEA CENOZOIC DIATOM BIOSTRATIGRAPHY AND TAXONOMY[1]

PART I
NORWEGIAN SEA CENOZOIC DIATOM BIOSTRATIGRAPHY

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INTRODUCTION AND PREVIOUS WORK

Leg 38 of the Deep Sea Drilling Project marked the first incursion of the *Glomar Challenger* into the high latitude of the Arctic region. Sixteen holes at 17 sites were drilled in the Norwegian-Greenland Sea (Figure 1).

In the past various authors have reported on marine fossil sediments containing diatoms from a variety of outcrops in northern Germany, Jutland, Sweden, and northern Poland. The main objective in these studies was to describe new taxa, and little emphasis was put on the investigation of stratigraphically important species. It must be pointed out that hardly any material has been carefully described for its total diatomaceous content, and in those cases where fossil lists have been presented, there were not any good accompanying illustrations.

This is one of the reasons why we have tried to picture as many taxa and individuals as possible even though quite a few have only been incompletely taxonomically treated. We are fully aware that future investigations will add more comprehensive data on these materials. We also had to use some compromise in handling the *Hemiaulus*, *Coscinodiscus symbolophorus* group, and the full complexity of spores. The reader also will miss most of the larger species of *Coscinodiscus*, *Actinoptychus* to mention a few; the individuals do occur in materials being well preserved and being cleaned and prepared using our methods. The fact that, even today, after nearly a decade of pinpointing diatom stratigraphy, the taxonomic part still represents the largest part of papers and can be documented by diatom studies by modern authors. Hajós and Stradner (1975) and McCollum (1975) only illustrated and treated taxonomically those species which were, in their opinion, the most useful index fossils, or those which were easily identifiable.

Figure 2 lists the names of authors and their respective study area of marine Tertiary land- and sea-exposed sections. Heiberg (1863) studied the famous Cementstone of Mors in Jutland; the same material was studied by a subsequent number of authors (Stolley, 1899; Grunow, 1866; Kitton, 1870, 1871; Prinz, 1881; Prinz and van Ermengen, 1883; Benda, 1972). The age of the Moler Formation is fixed by Berggren (1960) as lower Eocene (Ypressium). Similar floras were described from bottom samples collected during the expedition of R/V *Tegethoff* from Franz Josephs Land to Novaja-Semlja (Grunow, 1884), which were mixed together with Recent material. Badly located and dated floras were described by Cleve-Euler (1941), and later by Cleve-Euler and Hessland (1948) from Scandinavia. Schulz (1927) described floras in lower Eocene tuffaceous sediment from northern Germany and northern Poland. Hustedt (*in* Wetzel, 1935) described a flora from a late Eocene section at the beach near Heiligenhafen (north Germany), and Benda (1965) some pyritized diatoms from the Tarras of Fehmarn (northern Germany) which belongs to the upper early Eocene (upper Ypressium). Paleocene floras are described by Jousé and co-workers from Russia.

PREPARATION OF SAMPLES AND METHOD OF STUDY

Complementary to a set of samples collected for the shore-lab investigation, a set of samples from Sites 338, 343, and 348 were made accessible through the shipboard paleontologists (C. Müller and K. Bjørklund).

All samples were cleaned by a standardized procedure, which allowed the cleaning of approximately 100 samples a day. An uncontaminated, "pea" size piece of the original material was heated in a beaker for 20 min with an equal mixture of concentrated acetic acid and hydrogen peroxide at 100°C. The suspension was poured into the final plastic sample storage bottle (50 ml) and filled with demineralized water. After 2 hr of sedimentation, the overstand water with clay-sized particles was carefully removed with a water vacuum pump. The storage bottle was filled again with demineralized water. This procedure was repeated seven times and removed most of the particles <2 μm. Samples were stored by adding two drops of concentrated formaldehyde to prevent bacterial activity.

For slide preparation, each sample was carefully shaken and one to three drops of residue were pipetted (plastic disposable tips) from the middle of the bottle and placed on a clean 18×18 mm cover glass (thickness less than 0.17 mm). After drying, a small amount of Aroclor No. 4465 (n.d. = 1.66; Xylene solvent, Schrader, 1969) was placed on the cover glass and heated at approximately 150°C until the mounting medium became hard upon cooling. The cover glass was then taken up on a heated slide. For a more detailed description, see Hustedt, 1924; Schrader, 1973a, 1974a.

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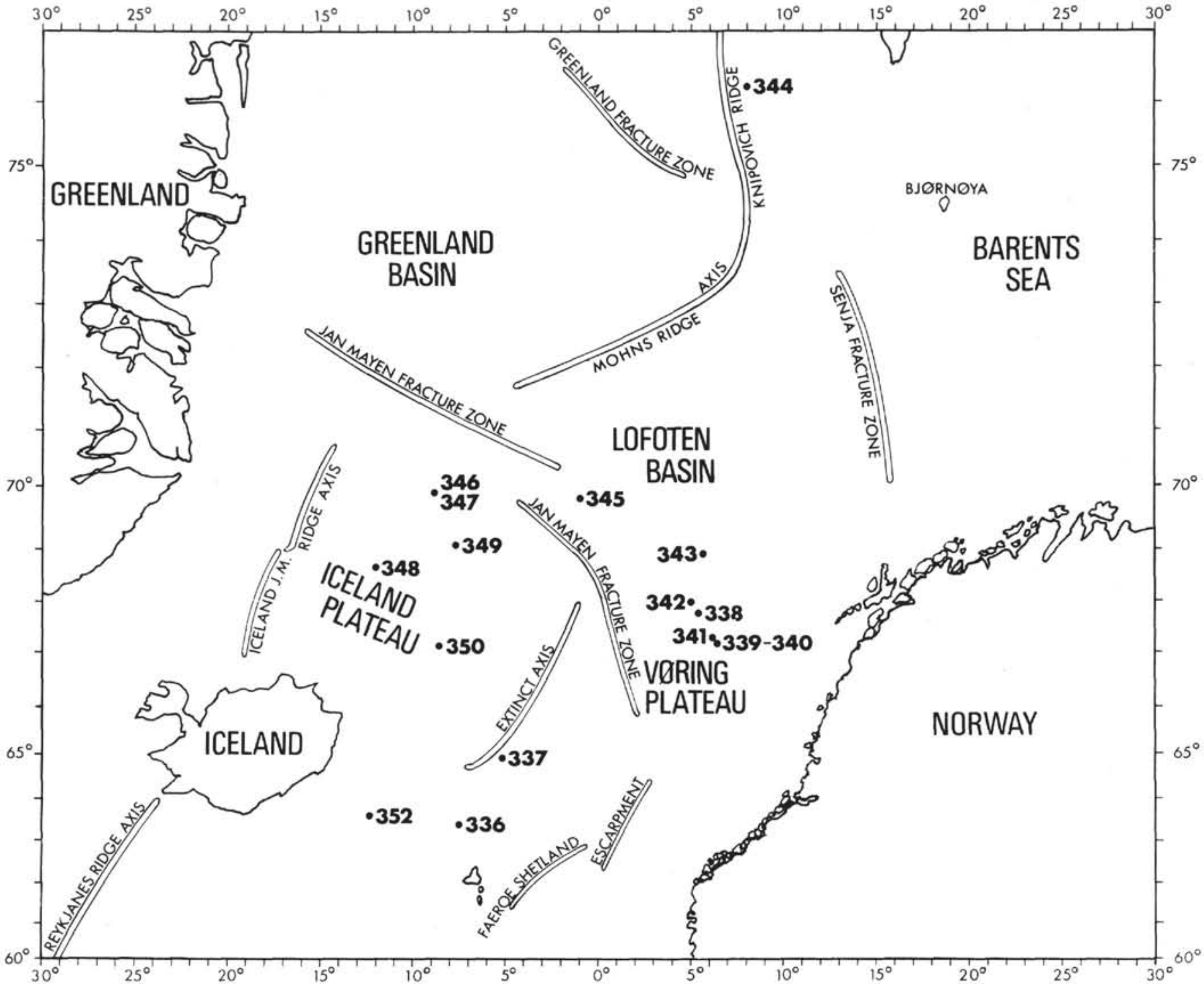


Figure 1. *Index map, showing localities of investigated sites of DSDP Leg 38.*

Investigations were made with a Leitz Orthoplan light microscope with apochromatic optics (Objectives FL Oil 54 ×/0, 95 and Apo Oil 90 ×/1.40). Micrographs were made with an automatic Leitz Orthomat camera using a 10× ocular. Most of the illustrated individuals are located on the slides and marked with a diamond microscopic pencil. Individuals on the plates are pictured at 1500× magnification except for a few at lesser magnification. Line drawings were made using a microscopic drawing attachment after Abbé.

Biometrical studies were made using a Leitz Laborlux microscope with normal 100 × oil immersion objective. The classifications are: B = barren (no diatoms within three traverses of 18,000 × 170 μm per slide), R = 1-2 total or fragmented diatoms within three fields of 500 × 500 μm, F = 3-10 total or fragmented diatoms within one field of 500 × 500 μm, C = 10-20 total or fragmented diatoms within one field of 500 × 500 μm, A = more than 20 total or fragmented diatoms within one field of 500 × 500 μm was made on various Leitz microscopes at 500 × magnification. All these determinations are subjective and partly controlled by sample and slide preparation.

Estimations of preservation of diatom floras were made using the relative abundance of heavily silicified frustules versus lesser silicified frustules.

High abundances of *Thalassiosira gravida*, *Coscinodiscus marginatus*, *Goniothecium* spp., *Pyrgupyxis* spp., and low diversities were used to calculate the calls for: P = poor preservation (only heavily silicified frustules present and most of them being fragmented), M = moderate preservation (heavily silicified frustules common compared to lesser silicified, e.g., abundant *Stephanopyxis* spp.), G = good preservation (well-preserved assemblage with also thinly silicified frustules as *Nitzschia*, *Sceptroneis*). Due to the fact that, up to now, no diatom dissolution factor has been determined, these calls are also subjective and dependent on the personal opinion of the individual investigator, and on his experience with deep-sea sediments.

Abundance calls within the tables for each sample are compiled using the abundance of the species during

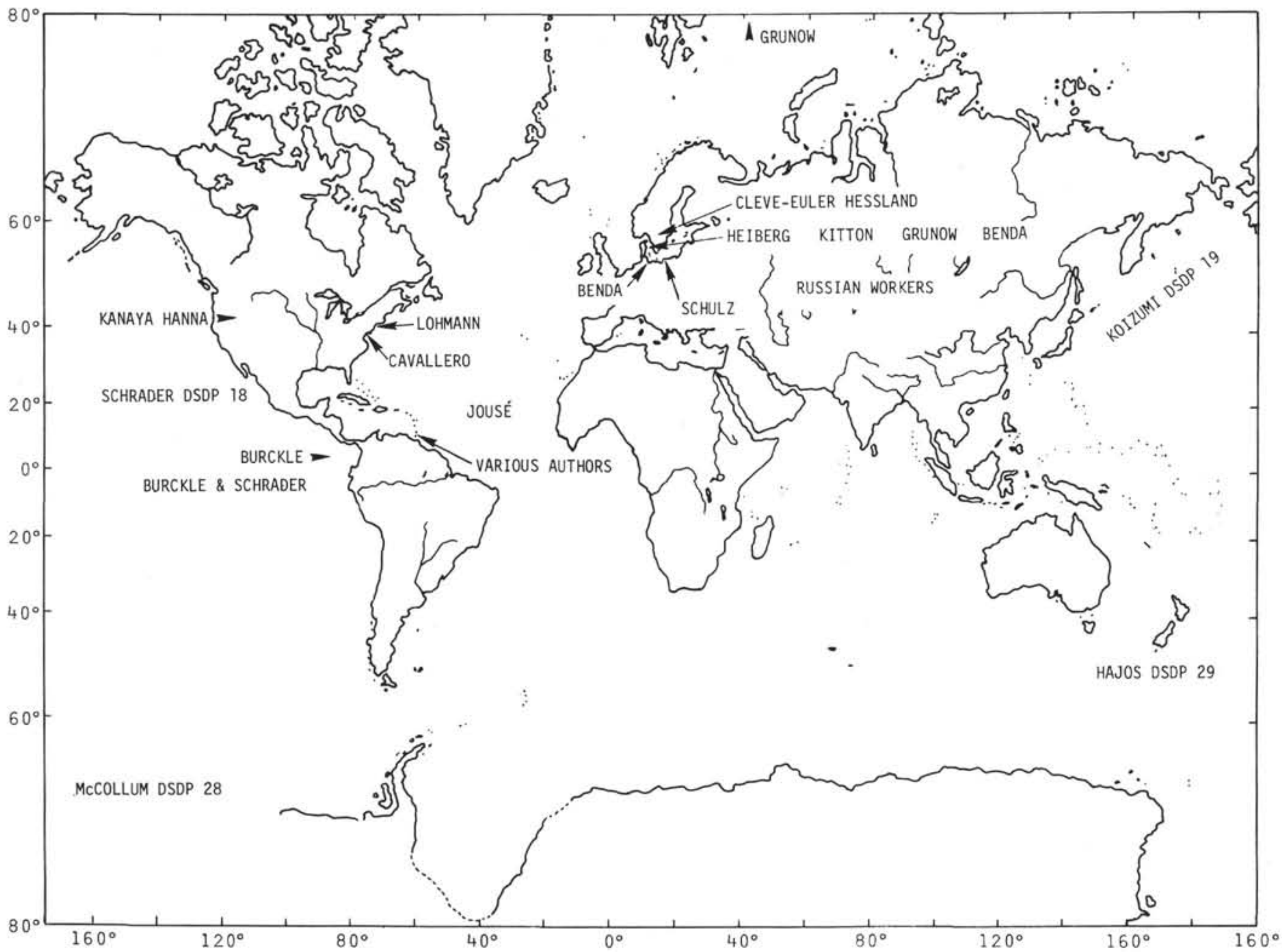


Figure 2. *Index map showing areas of study of marine fossil diatomaceous Tertiary sections used in this paper either for reference and or correlation.*

scanning over the slides with high-power oil immersion: R = only occasional occurrence (1-15 per slide), F = sporadical occurrence (more than 15 per slide), C = common occurrence at least one per field of view (100 × 100 μm), and A = abundant occurrence (more than one per field of view).

Time Ranges of Selected Taxa and Biostratigraphic Zonation

Planktonic marine diatom zonations of Arctic Ocean sediments are not available, and here for the first time an attempt was made to establish an Arctic Ocean diatom zonation from the Eocene to the Recent. The sections selected for this study have been chosen because of their open-marine character and their possible direct comparison with other biostratigraphic studies.

The terminology for the zonation follows that of the International Subcommission on Stratigraphic Classification (1972). Interval zones are recognized and have been defined by the first appearance and disappearance of particular index taxa. In defining zones by the two taxa method, there are four possibilities (Figure 3), and all four have been used in the present study. According to Schmidt (1973), Zones W, X, Y, Z should be given preference in descending order for defining interval zones of marine planktonic "nannofossil" zonations with the potential of reworking. According to Riedel and Sanfilippo (1971), important factors are: (a) the base of each zone is defined by the first occurrence of a taxon that is easily recognizable, of known ancestry, of wide geographic distribution, and represented by numerous specimens in the assemblages in which it is present, (b) each zone should include the first or last occurrences of several taxa, i.e., should be a concurrent range zone. Several points within this statement could not be met within the present study. Most of the centric diatoms are not easily identifiable and an untrained person will have, in some circumstances, considerable problems in identification of specific taxa, therefore a good illustration is needed. The evolutionary lineages are not well understood for the majority of diatom taxa, and much more thorough investigation is needed until the evolution within this highly specialized class will be fully understood. Why, for instance, do marine benthonic diatom assemblages show so little evolution, why are most of these species long-ranging ones (*Grammatophora*, *Rhabdonema*), and why

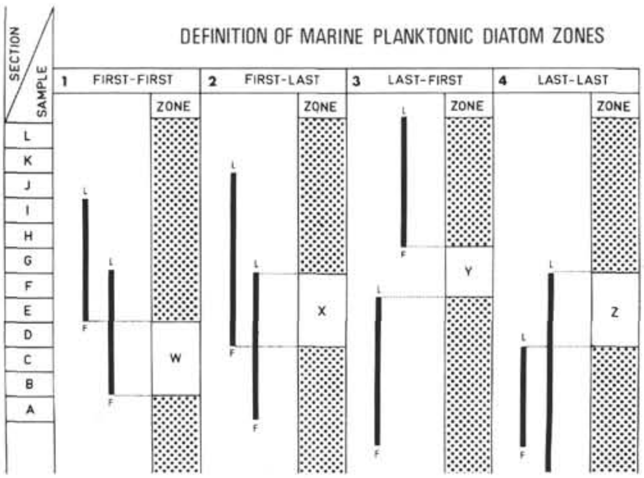


Figure 3. *Types of zonal schemes used for definition of diatom zones, preference is given to zones of type 1 and 2.*

is there no lineage to be found in fresh-water diatom assemblages? On the other hand, due to their specialization with respect to temperature, nutrient, depth range, a wide geographic distribution is found only in those unspecialized long-ranging taxa which are found nearly everywhere (*Coscinodiscus marginatus*). The author's aims are, therefore, to establish numerous regional zonal schemes and try to piece these overlaps together, rather than to establish a worldwide standard zonal scheme.

During the past 5 years considerable progress has been made in defining absolute dates for epoch and age boundaries and in relating these data to the type European standards. Paleomagnetics have played a considerable role in this, but reference can also be made to refinements in geochemical dating techniques, in the increased use of micropaleontological datum levels, and in the effort of several workers to synthesize these data on a worldwide scale (Berggren, 1969, 1972). These advances permit us to discuss, with some confidence, the placement of Neogene epoch and age boundaries, and their relationship to the paleomagnetic stratigraphy.

Foster and Opdyke (1970) extended the paleomagnetic reversal record back to Epoch 11 (middle/late Miocene boundary), and Opdyke et al. (1970) and Opdyke (1972) found reversals back to magnetic Epoch 15. In 1974, Opdyke et al. and Theyer and Hammond extended the reversal record back to magnetic Epoch 19.

Early/Middle Miocene Boundary

The early/middle Miocene boundary is placed at the first appearance of the genus *Orbulina* (*Orbulina* datum). Berggren (personal communication) and Opdyke et al. (1974) are all in general agreement that this boundary is placed at about 16 m.y. B.P. By studying calcareous-siliceous sediments from DSDP Leg 9, Opdyke et al. (1974) were able to determine that the *Orbulina* datum is present just after the first appearance of the diatom *Annellus californicus*. In cores (which are noncalcareous) studied by Burckle (RC 13-22 and 24) *Annellus californicus* first appearance takes place in the upper part of magnetic Epoch 16, and the last occurrence is in the lower part of Epoch 15. In DSDP Leg 9 material, the *Orbulina* datum is approximately halfway between the first and last appearance of *A. californicus*. For this reason, Opdyke et al. (1974) have argued that the early/middle Miocene boundary must be on or near to the magnetic Epoch 16/15 boundary. It is interesting that Theyer and Hammond (1974), using Radiolaria, have come to much the same conclusion.

Middle/Upper Miocene Boundary

Burckle (1972) correlated the middle/upper Miocene boundary to the lower part of magnetic Epoch 11.

Miocene/Pliocene Boundary

Saito (1969) was the first to correlate the Miocene/Pliocene transition with the top of magnetic Epoch 5. This conclusion has been largely substantiated by Berggren (1972).

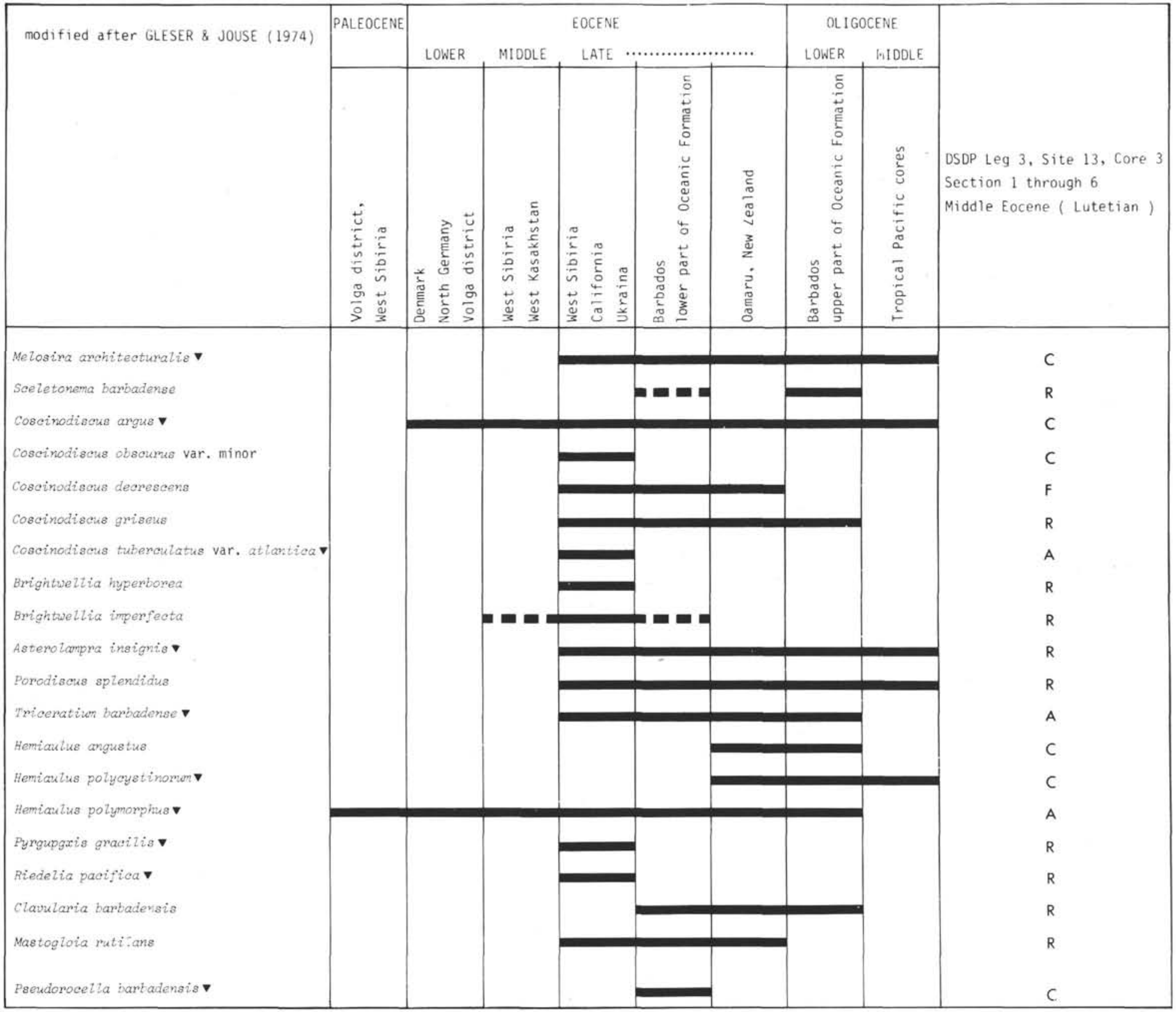
Pliocene/Pleistocene Boundary

The Pliocene/Pleistocene boundary problem has been reviewed by a number of workers (Hays and Berggren, 1971; Cita, 1972). Burckle (1972) reviewed the paleomagnetic evidence for placement of this boundary. Most workers are in general agreement that this transition occurred during the Olduvai Event of the Matuyama Reversed Epoch.

Placement stage boundaries discussed in this report with respect to the magnetic stratigraphy may be summarized as follows: (1) The early/middle Miocene boundary is present at or near to the magnetic Epoch 16/15 boundary, (2) The middle/late Miocene boundary is present in magnetic Epoch 11, (3) The Miocene/Pliocene boundary is present at the end of magnetic Epoch 5, (4) The Pliocene/Pleistocene boundary is present during the Olduvai Event of the Matuyama Reversed Epoch.

Paleogene Epoch boundaries are tentatively placed within this report at those levels where a number of typical Paleogene taxa become extinct. Confidence for placement of these boundaries was obtained by the silicoflagellate zonation (Müller, this volume), and by a composed zonal scheme of Jousé (1974a) being established on equatorial Pacific and Atlantic core material. Further evidence was obtained by the diatom zonation of McCollum (1975) for the Antarctic which is directly correlated to the radiolarian, coccolith, and silicoflagellate zonation (see various chapters in DSDP Volume 28).

The Oligocene-Eocene boundary was placed by Gleser and Jousé (1974) (Figure 4) within four samples from the Bath Cliff section (Jousé, 1974a; Eames et al., 1962), which belongs to the Oceanic Formation (Saunders and Gordey, 1968) of Barbados. The diatom composition of the upper and lower part differs strongly, and by the common occurrence of *Hemiaulus polycystinorum* and *Triceratium barbadense* within the lower part, the lower part is placed (Jousé, 1974a) into the *Hemiaulus polymorphus-Triceratium barbadense* Zone (no lower limit defined), and placed into the late



▼ found in DSDP Leg 38 samples

Figure 4. *Ranges of selected Paleogene diatom species, modified after Gleser and Jouse (1974).*

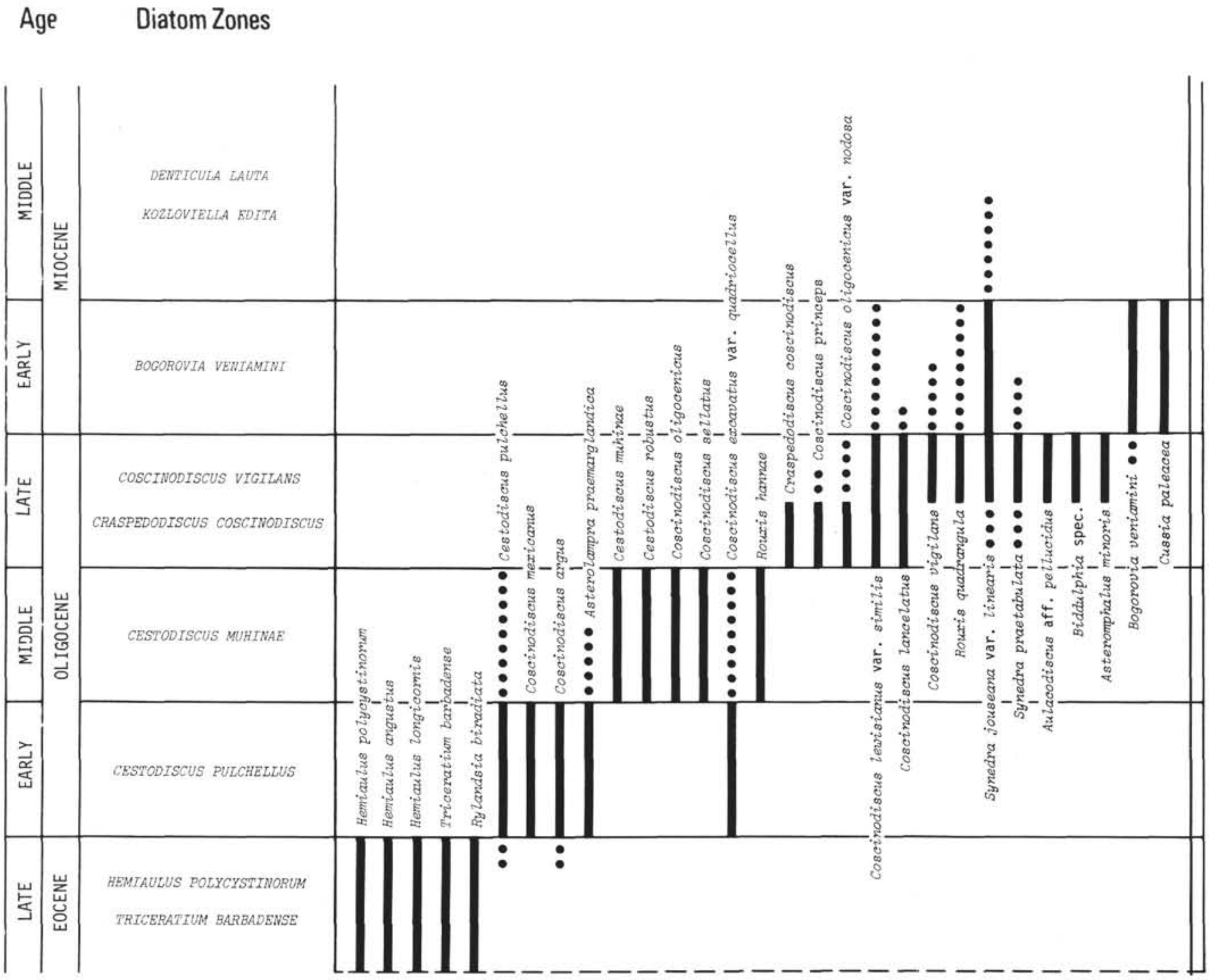


Figure 5. *Ranges of selected diatom species (uncorrected for the late Oligocene through middle Miocene) after Jousé (1974).*

Eocene. The upper part, with common *Cestodiscus pulchellus* and *Coscinodiscus excavatus* var. *quadriocellata*, is placed into a zone of the same name and placed into the early Oligocene (Figure 5). The boundary is placed after Jousé (1974a) at the extinction level of the following species: *Hemiaulus polycystinorum*, *H. longicornis*, and *Triceratium barbadense*, and at the first occurrence of *Coscinodiscus mexicanus* and *Asterolampra praemarylandica*. The same information is presented in Jousé (1974a).

The *Triceratium barbadense* Partial Range Zone is placed together with the *Coscinodiscus oblongus* Partial Range Zone into the late Eocene. Samples from Site 339 and part of 340 do have a different diatom assemblage and, due to the fact that the base of the *Triceratium barbadense* Zone is not defined, these intervals were placed in the middle-late Eocene. An even older sample, which did partly correspond to the diatom flora of the Cementstein of Mors (Benda, 1972), was found at Site 343 and was placed tentatively into the early Eocene.

The Oligocene-Miocene boundary is placed tentatively at that level at Site 338 (Core 19, Section 3) where numerous Paleogene species become extinct such as: *Actinoptychus thumii*, *Asteromphalus oligocaenicus*, *A. symmetricus*, *Cymatosira* spp., *Pseudotriceratium chenevieri*, *Sceptroneis* spp., *Coscinodiscus praenitidus*, and *Thalassiosira irregulata*. This placement is supported by the last occurrence of *Pyrgupyxis* sp. (synonym *Pyxilla* e.p.), which served for definition of the top of McCollum's (1975) *Pyxilla prolongata* Zone, and of *Pyxilla* sp. Zone of Schrader (1975, in press) in the Antarctic. *Pyrgupyxis* sp. and individuals are extremely rare in the well-preserved floras at Site 338. An absolute age of 22.5 m.y. B.P. is used for this boundary (Berggren, 1972).

The Oligocene section at Site 338 ranging from Core 19, Section 3 to Core 26, Section 2 is placed into the late Oligocene because of the coccolith age determination of the "Interval Zone" to belong to NP 24-23 (*J. recurvus* Assemblage) which on the other hand is placed by Martini (1971) and Berggren (1972) into the early-middle

Oligocene (approximate age 31-38 m.y. B.P., Berggren, 1972). The lower part of the Oligocene is missing. Using the coccolith and diatom biostratigraphic data, a hiatus must be placed between Samples 26-2 and 26-3. Thus, no further splitting of the Oligocene was done.

The stratigraphic zonation was established on samples from Sites 338 and 348; other biostratigraphic correlation was done by direct floral assemblage comparison.

The Eocene through Oligocene zonation at Site 338 was partly established by Juliane Fenner (compare authorship on definition of those zones).

For final adjustment of the diatom biostratigraphic zonation to the absolute time scale see the Paleontological Summary (this volume).

Thalassiosira oestrupii Partial Range Zone

Definition: The base of this zone is placed immediately above the extinction of *Rhizosolenia barboi*; the top ranges into the Recent.

Discussion: Other essentially modern floral elements include: *Coscinodiscus marginatus*, *Nitzschia atlantica*, *Rhizosolenia alata*, *R. hebetata* forma *hiemalis*, *R. styliformis*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira nidulus*, *Thal. nordenskioeldii*, *Thal. oestrupii*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The base of this zone falls within the Olduvai Event of the Matuyama Reversed Epoch.

Comparison with zonations of other workers: *Thalassiosira oestrupii* Partial Range Zone correlates with *Rhizosolenia curvirostris*/*Actinocyclus oculatus* zones of Koizumi (1973); Koizumi lists an upper limit of *Rhizosolenia barboi* (synonym *Rhizosolenia curvirostris* var. *inermis*) well into the Pleistocene (almost through *Rhizosolenia curvirostris* Zone of Koizumi, 1973). This was caused by taxonomic misinterpretation (see Schrader and Burckle, 1975). The evolutionary event at which the transition from *R. barboi* to *R. curvirostris* takes place was defined by Schrader and Burckle (1975) as taking place at the upper part of the Olduvai Event, and thus may serve to define the Pliocene/Pleistocene boundary in high latitude sections. *R. curvirostris* was found only to have persisted in the North Pacific and Bering Sea, whereas, it was unstable in other high latitude areas.

The present zone is also correlative with North Pacific Diatom Zone (NPD) I-III of Schrader (1973a), with the *Rhizosolenia curvirostris* and part of the *Actinocyclus oculatus* Zone of Donahue (1970).

Absolute age: 0-1.8 m.y. defined by the correlation to the paleomagnetic stratigraphy and evaluation of sedimentation rates.

Geographical extent: Found in sediments of high latitudes in the northern hemisphere.

Type locality: DSDP Leg 38, Site 348, Sample 5-5, 145-148 cm to Sample 6-5, 15-17 cm.

Rhizosolenia barboi Partial Range Zone

Definition: The base of this zone is defined at the extinction of *Thalassiosira convexa*; the top at the extinction of *Rhizosolenia barboi*.

Discussion: Other floral elements include: *Actinocyclus divisus*, *Coscinodiscus marginatus*, *Melosira sulcata*, *Rhizosolenia alata*, *Rhiz. barboi*, *Rhiz. styliformis*, *Stephanopyxis turris*, *Thalassiosira eccentrica*, *Thal. nidulus*, *Thal. oestrupii*, *Thalassiothrix longissima*, and *T. miocenica*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The base of this zone falls within the lowest part of the Matuyama Reversed Epoch; data defined by second order correlation to the extinction level of *Thalassiosira convexa* in equatorial Pacific section (Burckle, 1972; Koizumi, 1973). The top falls within the Olduvai Event of the Matuyama Reversed Epoch.

Comparison with zonations of other workers: *Rhizosolenia barboi* Partial Range Zone correlates with the *Actinocyclus oculatus* upper part of the *Thalassiosira zabelinae* Zones of Koizumi (1973), with NPD Zone V-VII of Schrader (1973a), and with the lower part of the *Actinocyclus oculatus* Zone of Donahue (1970).

Absolute age: 1.8-2.5 m.y. defined by the correlation to the paleomagnetic stratigraphy and by second-order correlation to the North and Equatorial Pacific diatom zonations.

Geographical extent: Found in sediments of high latitudes in the northern hemisphere.

Type locality: Leg 38, Site 348, Sample 6-5, 115-117 cm to Sample 8-1, 70-72 cm.

Thalassiosira kryophila Partial Range Zone

Definition: The base of this zone is defined at the first occurrence of *Thalassiosira kryophila*; the top at the extinction of *Thalassiosira convexa*.

Discussion: Other floral elements include *Chaetoceros*-spores, *Coscinodiscus marginatus*, *C. symbolophorus* group, *Melosira sulcata*, *Pseudopyxilla americana*, *Rhizosolenia barboi*, *R. hebetata* forma *hiemalis*, *R. styliformis*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira convexa*, *T. kryophila*, *T. nidulus* (first occurrence in the lower part of this zone), *T. oestrupii* (first occurrence in the upper part of this zone), *Thalassiothrix longissima*, *T. miocenica* (first upper part of this zone).

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The base of this zone has not been defined; the top falls within the Matuyama Reversed Epoch to the Gauss Normal Epoch boundary (see above).

Comparison with zonations of other workers: *Thalassiosira kryophila* Partial Range Zone correlates with the *Thalassiosira zabelinae*, lower part/*Denticula seminae*-*Denticula kamtschatika* zones of Koizumi (1973), but the range of *Thalassiosira kryophila* presented on Figure 6 (Koizumi, 1973) must be a misinterpretation because in all DSDP Leg 18 sites it is present only in the Pliocene and Pleistocene interval and was not found ranging into the Miocene. *T. kryophila* was not reported by Schrader (1973a) because of taxonomic uncertainties.

Absolute age: Top 2.5 m.y., base not defined.

Geographical extent: Found in sediments of high latitudes in the northern hemisphere.

Type locality: DSDP Leg 38, Site 348, Sample 8-1, 90-92 cm to Sample 9-2, 50-51 cm.

Coscinodiscus marginatus Partial Range Zone

Definition: The base of this zone is defined by the last common occurrence of *Denticula hustedtii*; the top by the first occurrence of *Thalassiosira kryophila*.

Discussion: Other floral elements include: *Actinocyclus ehrenbergii*, *Actinoptychus undulatus*; *Chaetoceros*-spores, *Coscinodiscus marginatus* (common occurrence), *C. symbolophorus* group, *Rhizosolenia alata*, *R. barboi*, *R. hebetata* forma *hiemalis*, *Stephanogonia hanzawae*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The base of this zone falls within the lowest part of the Gilbert Reversed Epoch, thus close to the Miocene/Pliocene boundary as it has been defined and used in this report, by second-order correlation to the North Pacific (Schrader, 1973a) and Antarctic (McCollum, 1975; Schrader, in press).

Comparison with zonations of other workers: *Coscinodiscus marginatus* Partial Range Zone correlates with the *Denticula seminae*/*Denticula kamtschatika* (lower part) and *Denticula kamtschatika* Zone of Koizumi (1973), with NPD Zone IX-XI of Schrader (1973a). Due to poor recovery over the interval from Core 7 through Core 11 at Site 348, no more detailed subdivision and intensive correlation is impossible at this stage.

Absolute age: Top not defined, base approximately 5.5 m.y. Pliocene/Miocene boundary, using Berggren's (1969) time scale.

Geographical extent: Found in sediments of high latitudes in the northern hemisphere.

Type locality: DSDP Leg 38, Site 348, Sample 9-3, 80-82 cm to Sample 10, CC.

Denticula hustedtii Partial Range Zone

Definition: The base of this zone is defined by the extinction of *Coscinodiscus endoi*; the top by the last common occurrence of *Denticula hustedtii*.

Discussion: Other floral elements include *Actinoptychus undulatus*, *Bruniopsis mirabilis* (extinction at the top of NPD Zone XI in the North Pacific), *Chaetoceros*-spores, *Coscinodiscus norwegicus*, *C. plicatus* group (in the lower part of this zone, extinction of this group at NPD Zone XII base in the North Pacific), *Cymatosira biharensis*, *Denticula hustedtii*, *Goniothecium tenue* (extinction in the middle part of the *Denticula kamtschatika* Zone in the North Pacific), *Mediaria splendida* forma *tenera* (total range NPD Zone XI-XII in the North Pacific), *Nitzschia pseudocylindrus*, *Pseudopyxilla americana*,

Figure 6. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 336-19-2, 110 cm with common volcanic ash, corroded sponge spicules and badly corroded diatoms (left). Distance between two bars 10 μm.*

Rhizosolenia hebetata forma *hiemalis*, *R. styliformis*, *Rouxia californica*, *Stephanogonia hanzawae*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira eccentrica*, *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: This zone falls within the geomagnetic Epoch 5 through second-order correlation through the extinctions of *Coscinodiscus endoi*, *C. plicatus* group.

Comparison with zonations of other workers: *Denticula hustedtii* Partial Range Zone correlates with the *Denticula kamtschatika/Denticula hustedtii* zones of Koizumi (1973) and with NPD Zone XI-XII of Schrader (1973a).

Absolute age: Approximately 5.5-6.5 m.y. obtained through correlation with the paleomagnetic record.

Geographical extent: Found in sediments of high latitudes.

Type locality: DSDP Leg 38, Site 348, Sample 11-1, 20-22 cm to Sample 11-2, 85-87 cm.

Cymatosira biharensis Partial Range Zone

Definition: The base of this zone is defined by the last occurrence of *Actinocyclus ingens*, by the first occurrence of *Nitzschia pseudocylindrica*, by the last occurrence of *Raphoneis margaritalimbata*; the top by the extinction of *Coscinodiscus endoi*.

Discussion: Other floral elements include: *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Chaetoceros*-spores, *Coscinodiscus endoi*, *C. lineatus*, *C. norwegicus*, *C. plicatus* group, *Cussia lancettula* (lower part of the zone), *Cymatosira biharensis*, *Denticula hustedtii*, *Eucampia* aff. *balaustium*, *Goniothecium tenue*, *Hemidiscus karstenii* (upper part of this zone), *Mediaria splendida*, *Melosira sulcata*, *Nitzschia pseudocylindrica*, *N. riedelia*, *Pseudopyxilla americana*, *Raphoneis parallelica*, *Rhizosolenia alata*, *R. hebetata* forma *hiemalis*, *R. barboi*, *R. styliformis*, *Rouxia californica*, *Stephanogonia hanzawae*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira gravida*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation with the paleomagnetic record is possible at this time.

Comparison with zonations of other workers: *Cymatosira biharensis* Partial Range Zone correlates with the *Denticula hustedtii* Zone of Koizumi (1973), and with NPD Zone XIII-XIV of Schrader (1973a). *Actinocyclus ingens* and *Coscinodiscus plicatus* group have a longer range in the North Pacific. Due to poor recovery over this interval of the section, better correlations are not possible.

Absolute age: No absolute ages have been estimated.

Geographic extent: Found in sediments of high latitudes.

Type locality: DSDP Leg 38, Site 348, Sample 11-3, 70-72 cm to Sample 12-3, 95-97 cm.

Goniothecium tenue Partial Range Zone

Definition: The base of this zone is defined by the extinction of *Nitzschia porteri*; the top by the last occurrence of *Actinocyclus ingens*.

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *A. ingens*, *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Chaetoceros* sp., *Coscinodiscus endoi* (first occurrence lower in the section—compare range at Site 338). *C. lineatus*, *C. plicatus* group (mostly *C. flexuosus*), *Cussia lancettula*, *Cymatosira biharensis* (first occurrence lower in the section—compare range at Site 338), *Dactyliosolen* aff. *antarcticus*, *Denticula hustedtii*, *Eucampia* aff. *balaustium*, *Goniothecium tenue*, *Mediaria splendida*, *Melosira sulcata*, *Nitzschia riedelia*, *Pseudopodosira simplex*, *Pseudopyxilla americana*, *Rhaphoneis margaritalimbata*, *R. parallelica*, *Rhizosolenia miocenica* (total range from NPD Zone XXIII-XIV in the North Pacific), *R. styliformis*, *Rouxia californica*, *Stephanogonia hanzawae*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira gravida*, *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation with the paleomagnetic record is possible at this time.

Comparison with zonations of other workers: *Goniothecium tenue* Partial Range Zone correlates with the *Denticula hustedtii* Zone of Koizumi (1973), and with NPD Zone XIV-XV of Schrader (1973a). Due to poor recovery over this section, a better correlation is not possible. Only *Denticula hustedtii* was found of the genus *Denticula*, and supports the interpretation of a late Miocene age.

Absolute age: *Nitzschia porteri* extinction was determined at approximately 6.8 m.y., and *Rhizosolenia miocenica* extinction at approximately 7.3 m.y.

Geographic extent: Found in sediments of high latitudes in the northern hemisphere.

Type locality: DSDP Leg 38, Site 348, Sample 12-4, 90-92 cm to Sample 13-3, 90-92 cm.

Rhizosolenia miocenica Partial Range Zone

Definition: The base of this zone is defined by the first occurrence of *Coscinodiscus norwegicus*, by the first occurrence of *Nitzschia* sp. e; the top by the extinction of *Nitzschia porteri.*

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *A. ingens*, *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Chaetoceros*-spores, *Coscinodiscus lineatus*, *C. norwegicus*, *Denticula hustedtii*, *Goniothecium tenue*, *Mediaria splendida*, *Melosira sulcata*, *Nitzschia porteri*, *N.* sp. e, *Pseudopyxilla americana*, *Rhaphoneis parallelica*, *Rhizosolenia hebetata* forma *hiemalis*, *R. miocenica*, *R. styliformis*, *Rouxia californica*, *R. isopolica*, *Stephanogonia hanzawae*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, *Thalassiosira gravida* var. *fossilis*, *Thalassiothrix longissima.*

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation with the paleomagnetic record is possible at this time.

Comparison with zonations of other workers: *Rhizosolenia miocenica* Partial Range Zone correlates with the *Denticula hustedtii* Zone (lower part) of Koizumi (1973), and with NPD Zone XV-XVI (?) of Schrader (1973a).

Absolute age: No absolute ages have been estimated.

Geographic extent: Found in sediments of the Norwegian Sea.

Type locality: DSDP Leg 38, Site 348, Sample 13, CC to Sample 14-3, 130-132 cm.

Thalassiosira gravida var. fossilis Partial Range Zone

Definition: The base of this zone is defined by the first occurrence of *Thalassiosira gravida* var. *fossilis*, by the last occurrence of *Nitzschia kanayensis*, by the last occurrence of *Nitzschia* sp. d; the top by the first occurrence of *Coscinodiscus norwegicus*, by the extinction of *Nitzschia praereinholdii*, by the first occurrence of *Nitzschia* sp. e.

Discussion: Other floral elements include *Actinocyclus ingens*, *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Chaetoceros*-spores, *Coscinodiscus lineatus*, *C. plicatus* group, *Denticula hustedtii*, *Goniothecium tenue*, *Mediaria splendida*, *Melosira sulcata*, *Nitzschia porteri*, *N. praereinholdii*, *Porosira glacialis*, *Pseudopyxilla americana*, *Rhaphoneis parallelica*, *Rhizosolenia hebetata* forma *hiemalis*, *R. miocenica*, *R. styliformis*, *Rouxia californica*, *R. isopolica*, *Stephanopyxis turris*, *Thalassionema nitzschioides*, and *Thalassiothrix longissima.*

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation with the paleomagnetic record is possible at this time.

Comparison with zonations of other workers: *Thalassiosira gravida* var. *fossilis* Partial Range Zone correlates with the (?) *Denticula hustedtii* Zone of Koizumi (1973) and with the NPD Zone XV-XVII of Schrader (1973a).

Absolute age: No absolute ages have been estimated.

Geographic extent: Found in sediments of the Norwegian Sea.

Type locality: DSDP Leg 38, Site 348, Sample 14-6, 85-87 cm to Sample 15-3, 90-92 cm.

Actinocyclus ingens Partial Range Zone

Definition: The base of this zone is defined by the last occurrence of *Sceptroneis caducea*, and *Nitzschia* sp. 8; the top by the first occurrence of *Thalassiosira gravida* var. *fossilis*, by the last occurrence of *Nitzschia kanayensis*. *Actinocyclus ingens* is a common constituent throughout the zone.

Discussion: This zone is an overlapping composed zone between the basal part of Site 348 and the uppermost siliceous part of Site 338. Other floral elements include: *Actinocyclus ehrenbergii*, *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Coscinodiscus endoi*, *C. lewisianus*, *C. plicatus* (first occurrence at the base of this zone), *Craspedodiscus coscinodiscus*, *Cymatosira biharensis*, *Denticula hustedtii*, *D. punctata*, *Eucampia* aff. *balaustium*, *Goniothecium tenue*, *Macrora stella* (1) (larger form than that one present in the lower part of the section), *Mediaria splendida*, *Nitzschia evenescens*, *N. porteri*, *N. praereinholdii*, *N. riedelia*, *Pseudopyxilla americana*, *Rhaphoneis margaritalimbata*, *R. ossiformis*, *R. parallelica*, *Rhizosolenia miocenica*, *Rouxia californica*, *R. diploneides*, *Thalassionema nitzschioides*, and *Thalassiothrix longissima.*

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation to the paleomagnetic stratigraphy is possible.

Comparison with zonations of other workers: *Actinocyclus ingens* Partial Range Zone correlates with the *Denticula hustedtii* Zone of Koizumi (1973), with NPD Zone XIX-XX of Schrader (1973a), with the *Coscinodiscus yabei* Partial Range Zone of Schrader and Burckle (1975).

Absolute age: No absolute ages have been estimated.

Geographic extent: Found in sediments of the Norwegian Sea.

Type locality: DSDP Leg 38, Site 348, Sample 15, CC to Sample 16-2, 85-86 cm and DSDP Leg 38, Site 338, Sample 8-2, 10-11 cm.

Nitzschia sp. 8 Range Zone

Definition: The base of this zone is defined by the first occurrence of *Nitzschia* sp. 8; the top by the last occurrence of *Sceptroneis caducea* and *Nitzschia* sp. 8.

Discussion: Other floral elements include the same pattern of species as does the above-mentioned *Actinocyclus ingens* Partial Range Zone.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation to the paleomagnetic stratigraphy is possible.

Comparison with zonations of other workers: *Nitzschia* sp. 8 Range Zone correlates with the *Denticula hustedtii* Zone of Koizumi (1973), with NPD Zone XIX of Schrader (1973a), and with the *Coscinodiscus yabei* Partial Range Zone of Burckle (1972).

Absolute age: No absolute ages have been estimated.

Geographic extent: Found in sediments of the Norwegian Sea.

Type locality: DSDP Leg 38, Site 338, Sample 8-2, 58-59 cm to Sample 8-4, 85-86 cm.

Sceptroneis caducea Partial Range Zone

Definition: The base of this zone is defined at the last occurrence of *Denticula hyalina*, at the first occurrence of *Goniothecium tenue*; the top at the first occurrence of *Nitzschia* sp. 8.

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *A. ingens*, *Actinoptychus undulatus*, *Bruniopsis mirabilis*, *Coscinodiscus endoi*, *C. lewisianus*, *Cymatosira biharensis*, *Denticula hustedtii*, *D. punctata*, *Dimerogramma* aff. *dubium*, *Goniothecium tenue*, *Mediaria splendida*, *Nitzschia evenescens*, *N. porteri*, *N. pseudocylindrica* (first occurrence in the middle part of this zone), *Pseudopyxilla americana*, *Rhaphoneis elliptica* (last occurrence in the middle part of this zone), *R. ossiformis*, *R. parallelica*, *Rhizosolenia miocenica*, *Rouxia californica*, *Synedra jouseana*, *Thalassionema nitzschioides*, and *Thalassiothrix longissima.*

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No correlation to the paleomagnetic stratigraphy is possible at this step.

Comparison with zonations of other workers: *Sceptroneis caducea* Partial Zone correlates with NPD Zone XIX of Schrader (1973a) using the extinction data of *Denticula hyalina*, which was badly defined by Schrader (1973a, 1973b). Reexamination revealed a range at Site 173 from NPD Zone XXIV-XIX; it correlates with the *Denticula hustedtii* Zone of Koizumi (1973), and with the *Coscinodiscus yabei/Cussia paleacea* zones of Schrader and Burckle (1975).

Absolute age: Using the extinction level of *Denticula hyalina* at Site 173 and the datum planes of Ingle (1973), a tentative absolute age of 13 m.y. can be assigned to the base of this zone.

Geographic extent: Found in sediments of high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 8, CC to Sample 9-1, 135-136 cm.

Coscinodiscus plicatus group Partial Range Zone

Definition: The base of this zone has been defined at the last occurrences of *Hemiaulus malleolus*, *H. malleus*, *Pseudodimerogramma elongata*, and at the first occurrences of *Rouxia californica*, *Coscinodiscus plicatus* group; the top at the first occurrences of *Goniothecium tenue* and at the last occurrence of *Denticula hyalina.*

Discussion: Other floral elements include *Actinocyclus ingens*, *Bruniopsis mirabilis*, *Coscinodiscus endoi*, *C. lewisianus*, *Cymatosira biharensis*, *Denticula hustedtii*, *D. hyalina*, *D. lauta*, *D. punctata*, *Mediaria splendida*, *Nitzschia evenescens*, *Rhizosolenia styliformis*, *Rouxia californica*, *Stictodiscus* aff. *kittonianus*, *Synedra jouseana*, *Thalassionema nitzschioides*, and *Thalassiothrix longissima.*

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: Using the first occurrence of plicate *Coscinodiscae* as the base for this zone, a tentative correlation can be assigned to the basal part of magnetic Epoch 14 under the assumption that this first occurrence was time correlative in low and high latitudes.

Comparison with zonations of other workers: Approximately correlative with NPD Zone XXI-XX of Schrader (1973a), with the *Denticula nicobarica* Zone of Schrader and Burckle (1975), with part of the *Denticula hustedtii-Denticula lauta* Zone of Koizumi (1973), with the *Denticula antarctica-Coscinodiscus lewisianus* Zone of McCollum (1975).

Absolute age: Using the assumption that the base of this zone is correlative to the basal part of magnetic Epoch 14 a tentative age of 13 m.y. to the top and 13.6 m.y. to the base can be assigned.

Geographic extent: Found in high and intermediate latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 9, CC to Sample 10-1, 135-136 cm.

Denticula hyalina Partial Range Zone

Definition: The base of this zone has been defined at the first occurrences of *Coscinodiscus endoi*, *Denticula hustedtii*, *D. norwegica*, *Rhizosolenia miocenica*, and at the last occurrence of *Denticula punctata* var. *hustedtii*; the top at the last occurrences of *Hemiaulus malleolus*, *H. malleus*, *Pseudodimerogramma elongata*, and at the first occurrences of *Rouxia californica* and *Coscinodiscus plicatus* group.

Discussion: Other floral elements include *Actinocyclus ingens*, *Bruniopsis mirabilis*, *Cestodiscus peplum* (extinction within the middle of this zone), *Coscinodiscus endoi*, *C. lewisianus*, *Craspedodiscus coscinodiscus*, *Cymatosira biharensis*, *Denticula hustedtii*, *D. lauta*, *D. norwegica*, *Hemiaulus malleolus*, *H. malleus*, *Opephora gemmata* (extinction within the middle part of this zone), *Rhaphoneis elliptica*, *R. ossiformis* (first occurrence within the middle part of this zone), *R. parallelica*, *Rhizosolenia bulbosa* (last occurrence within the middle part of this zone), *R. miocenica*, *Stictodiscus* aff. *kittonianus*, *Synedra jouseana*, *Thalassionema nitzschioides*, *Thalassiothrix longissima*, *Macrora stella* (I) appears first within this zone.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The top of this zone is tentatively correlated with the basal part of magnetic Epoch 14, the base has not been correlated.

Comparison with zonations of other workers: Approximately correlative with NPD Zone XXIII of Schrader (1973a), with the *Denticula lauta* Zone of Koizumi (1973), with the *Bogorovia veniamini* Zone of Jousé (1974), with the *Coscinodiscus* species Zone of Schrader and Burckle (1975), with the *Sceptroneis caducea* Zone of Cavallero (1974).

Absolute age: The top was tentatively dated as 13.6 m.y., the base has not been dated.

Geographical extent: Most of the zonal markers have been found in both low and high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 10-2, 55-56 cm to Sample 11-2, 85-86 cm.

Rhizosolenia bulbosa Partial Range Zone

Definition: The base of this zone has been defined by the first occurrences of *Coscinodiscus lewisianus*, *Cymatosira biharensis*, *Dimerogramma* aff. *dubium*, *Hemiaulus malleus*, and at the last occurrences of *Thalassiosira fraga*; the top at the first occurrences of *Coscinodiscus endoi*, *Denticula hustedtii*, *D. norwegica*, *Rhizosolenia miocenica*.

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *A. ingens* (first occurrence in the middle part of this zone), *Bruniopsis mirabilis*, *Cestodiscus peplum*, *Cladogramma dubium*, *Coscinodiscus lewisianus*, *C. marginatus*, *Craspedodiscus coscinodiscus* (first occurrence within the middle part of this zone), *Eucampia balaustium*, *Goniothecium odontella*, *Hemiaulus giganteus*, *Mediaria splendida* (first occurrence in the middle part of this zone), *Opephora gemmata*, *Pleurosigma planktonica*, *Pseudodimerogramma elegans* (last occurrence in the lower part of this zone), *Pseudodimerogramma elongata*, *Rhaphoneis margaritalimbata*, *R. parallelica*, *R. wicomicoensis* (occurrence restricted to the lower part of this zone), *Rhizosolenia bulbosa*, *Sceptroneis caducea*, *Synedra jouseana*, *Thalassionema nitzschioides*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: *Coscinodiscus lewisianus* and *Denticula nicobarica* do occur first at the lower part of magnetic Epoch 18 in the equatorial Pacific and this correlation is used here; the top has not been correlated with the paleomagnetic stratigraphy.

Comparison with zonations of other workers: Approximately correlative with NPD Zone XXIV of Schrader (1973a), with the *Denticula lauta* Zone of Koizumi (1973), with the *Bogorovia veniamini* Zone of Jousé, with the *Denticula antarctica-Coscinodiscus lewisianus* Zone of McCollum (1975), with the *Actinoptychus heliopelta* Zone of Cavallero (1974), and with the *Hemiaulus polymorphus* Zone of Schrader and Burckle (1975).

Absolute age: The base is tentatively dated as 19.5 m.y. B.P. using the correlation with paleomagnetic stratigraphy.

Geographic extent: Elements making up this zone are found in low and high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 11-3, 5-6 cm to Sample 12-3, 90-91 cm.

Thalassiosira fraga Partial Range Zone

Definition: The base of this zone has been defined at the last occurrences of *Dimerogramma fossile*, *Sceptroneis ossiformis*, *Thalassionema hirosakiensis*, and *Thalassiosira spinosa* var. *aspinosa* and at the first occurrences of *Rhaphoneis margaritalimbata*; the top at the first occurrences of *Coscinodiscus lewisianus*, *Cymatosira biharensis*, *Dimerogramma* aff. *dubium*, *Hemiaulus malleus*, and the last occurrence of *Thalassiosira fraga*.

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *Cestodiscus peplum*, *Cladogramma dubium*, *Coscinodiscus lineatus*, *C. marginatus*, *Ethmodiscus rex*, *Goniothecium odontella*, *Hemiaulus polycystinorum*, *Melosira sulcata*, *Nitzschia maleinterpretaria* (last occurrence within the middle part of this zone), *Odontella septentrionalis*, *Rhaphoneis margaritalimbata*, *Rhizosolenia bulbosa*, *R. praealata*, *R. styliformis*, *Rouxia yabei*, *Sceptroneis caducea*, *Synedra jouseana*, *Thalassionema nitzschioides*, *Thalassiosira fraga*, *T. spumellaroides*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: The top has been correlated with the lower part of magnetic Epoch 18; the base has not been correlated with the paleomagnetic stratigraphy.

Comparison with zonations of other workers: *Thalassiosira fraga* is found frequently in high latitudes, further investigation is needed to give further statements. This zone is tentatively correlated with the *Hemiaulus polymorphus* Zone of Schrader and Burckle (1975), with *Craspedodiscus coscinodiscus-Coscinodiscus vigilans* zones of Jousé (1974), with the *Denticula nicobarica-Coscinodiscus* sp. zones of McCollum (1975), with the *Rhaphidodiscus marylandicus* Zone of Schrader (in press).

Absolute age: No absolute ages have been calculated.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 13-1, 55-56 cm to Sample 13, CC.

Nitzschia maleinterpretaria Partial Range Zone

Definition: The base of this zone has been defined at the last occurrence of *Coscinodiscus vigilans*, and at the first occurrence of *Nitzschia maleinterpretaria*; the top at the last occurrences of *Dimerogramma fossile*, *Sceptroneis ossiformis*, *Thalassionema hirosakiensis*, and *Thalassiosira spinosa* var. *aspinosa* and at the first occurrence of *Rhaphoneis margaritalimbata*.

Discussion: Other floral elements include *Cestodiscus peplum*, *Cladogramma dubium*, *Coscinodiscus marginatus*, *C. vetustissimus*, *Dicladia norwegica*, *Dimerogramma fossile*, *D.* aff. *fulvum* (last occurrence within the upper part of this zone), *Ethmodiscus rex*, *Eucampia* aff. *balaustium*, *Nitzschia maleinterpretaria*, *Odontella septentrionalis*, *Opephora gemmata*, *Pleurosigma planktonica*, *Pseudodimerogramma elegans*, *P. elongata*, *Rhaphidodiscus marylandicus*, *Rhizosolenia bulbosa*, *Rouxia yabei*, *Sceptroneis caducea*, *S. ossiformis*, *Synedra jouseana*, *Thalassionema hirosakiensis*, *T. nitzschioides*, *Thalassiosira fraga*, *T. spinosa* var. *aspinosa*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: A tentative correlation with the *Rhaphidodiscus marylandicus* Zone of Schrader and Burckle (1975) can be made, on the other hand, it is correlative to the *Coscinodiscus* sp. Zone (?) of McCollum (1975) which covers most of the early Miocene, and with the lower part of the *Rhaphidodiscus marylandicus-Nitzschia maleinterpretaria* zones of Schrader (in press). *Rhaphidodiscus* is found in most temperate and tropical localities. It has been reported from the California section (Hanna, 1932), Java (Reinhold, 1937), the North Pacific (Schrader, 1973a), Trinidad (Lohmann, 1974), the Calvert Formation of the eastern United States

(Boyer, 1904), the Mediterranean region (Sanfilippo et al., 1973), the Antarctic (McCollum, 1975; Schrader, in press). Andrews (1973) points out that this species is a useful guide to the latest early Miocene and the earliest middle Miocene, a conclusion which cannot be followed from recent results. *R. marylandicus* ranges in the Antarctic and in the Norwegian Sea through most of the early Miocene and becomes extinct in the earliest middle Miocene.

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 14-1, 20-21 cm to Sample 15-1, 20-21 cm.

Coscinodiscus vigilans Partial Range Zone

Definition: The base of this zone has been defined at the last occurrences of *Rhizosolenia norwegica*, *Rouxia californica* (?), and at the first occurrence of *Thalassiosira spinosa* var. *aspinosa*; the top at the last occurrence of *Coscinodiscus vigilans*, and at the first occurrence of *Nitzschia maleinterpretaria*.

Discussion: Other floral elements include *Bruniopsis mirabilis* (11) (a coarser areolated species than the middle Miocene one), *Cestodiscus peplum*, *Cladogramma dubium*, *Coscinodiscus marginatus*, *C. vetustissimus*, *C. vigilans*, *Dicladia norwegica*, *Dimerogramma fossile*, *D.* aff. *fulvum* (first occurrence in the lower part of this zone), *Ethmodiscus rex*, *Eucampia* aff. *balaustium*, *Goniothecium decoratum* (last occurrence in the lower part of this zone), *Odontella aurita*, *O. septentrionalis*, *Opephora gemmata*, *Pleurosigma planktonica*, *Pseudodimerogramma elegans*, *P. elongata*, *Rhaphidodiscus marylandicus*, *Rhizosolenia bulbosa*, *Rouxia isoplica*, *R. yabei*, *Sceptroneis caducea*, *S. ossiformis*, *Stictodiscus* aff. *kittonianus*, *Synedra jouseana*, *Thalassionema hirosakiensis*, *T. lineata*, *T. nitzschioides*, *Thalassiosira spinosa* var. *aspinosa*, *T. fraga*, and *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: Jousé (1974) found *Coscinodiscus vigilans* in equatorial Pacific sediments ranging through her *Coscinodiscus vigilans* and *Bogorovia veniamini* zones of late Oligocene to early Miocene age. Schrader (in press) found it only in late Oligocene sections in the Antarctic. This zone is tentatively correlated, to the *Bogorovia veniamini* Zone of Schrader (in press), to the *Coscinodiscus* sp. Zone of McCollum (1975).

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 15-1, 95-96 cm to Sample 16-2, 10-11 cm.

Rhizosolenia norwegica Partial Range Zone

Definition: The base of this zone has been defined at the last occurrence of *Macrora stella* (2) and at the first occurrence of *Stictodiscus* aff. *kittonianus*; the top at the last occurrences of *Rhizosolenia norwegica*, *Rouxia californica* (?), and at the first occurrence of *Thalassiosira spinosa* var. *aspinosa*.

Discussion: Other floral elements include a very similar flora as the *Coscinodiscus vigilans* Zone (listed above).

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: No direct correlation to the zonations of other workers is possible because the zonal index fossils were, up to now, only observed in the Norwegian Sea.

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 16-4, 67-68 cm to Sample 16, CC.

Synedra jouseana Partial Range Zone

Definition: The base of this zone has been defined at the first occurrences of *Opephora gemmata* and *Rouxia californica* (?); the top at the last occurrence of *Macrora stella* (2) and at the first occurrence of *Stictodiscus* aff. *kittonianus*.

Discussion: Other floral elements include *Actinocyclus ehrenbergii*, *Bruniopsis mirabilis* (2), *Cestodiscus* spp., *Coscinodiscus vetustissimus*, *Dicladia norwegica*, *Dimerogramma fossile*, *Ethmodiscus rex*, *Eucampia* aff. *balaustium*, *Goniothecium decoratum*, *Macrora stella* (2)—there is a break between the range of *Macrora stella*, therefore the lower range is separated from the upper by numerical symbols, *Opephora gemmata*, *Pleurosigma planktonica*, *Pseudodimerogramma elegans*, *Rhizosolenia norwegica*, *R. praebarboi*, *Synedra jouseana*, *Thalassionema hirosakiensis*, *Thalassiosira fraga*, *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: No direct correlation to the zonal schemes of other workers is possible at this moment because of endemism of index fossils. This zone is still in the early Miocene.

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 17-2, 46-47 cm to Sample 17, CC.

Pseudodimerogramma elegans Partial Range Zone

Definition: The base of this zone has been defined at the extinction level of *Actinoptychus thumii*, *Asteromphalus oligocenicus*, *Asteromphalus symmetricus*, *Pseudodimerogramma oligocenica*, *Pseudotriceratium chenevieri*, *Rhizosolenia pokrovskaja*, *Sceptroneis humuncia*, *S. propinqua*, *Coscinodiscus praenitidus*, *Synedra miocenica*, *Thalassiosira irregulata*; the top at the first occurrences of *Opephora gemmata*, *Rouxia californica* (?).

Discussion: Other floral elements include *Bruniopsis mirabilis* (2) (first occurrence in the upper part of this zone), *Cestodiscus peplum*, *Coscinodiscus marginatus*, *Cymatosira fossilis* (last occurrence in the lower part of this zone), *C. robusta* (last occurrence in the lower part of this zone), *Dimerogramma* aff. *furcigerum*, *Pseudodimerogramma elongata*, *Pseudopyxilla americana*, *Rhizosolenia norwegica* (first occurrence in the middle part of this zone), *Thalassionema hirosakiensis*, *Thalassiosira fraga* (first occurrence in the middle part of this zone), *Thalassiothrix longissima*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: No direct correlation to the zonation of other workers is possible at this moment. Due to the high number of extinctions of Paleogene species, the Oligocene/Miocene boundary is arbitrarily placed at the base of this zone.

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 18-1, 50-51 cm to Sample 19-3, 40-41 cm.

Coscinodiscus praenitidus Partial Range Zone

Definition: The base of this zone has been defined at the last occurrence of *Sceptroneis caducea* and the first occurrence of *Thalassionema hirosakiensis*; the top at the extinction level of *Actinoptychus thumii*, *Asteromphalus oligocenicus*, *A. symmetricus*, *Cymatosira compacta*, *Pseudodimerogramma oligocenica*, *Pseudotriceratium chenevieri*, *Rhizosolenia pokrovskaja*, *Sceptroneis humuncia*, *S. propinqua*, *Coscinodiscus praenitidus*, *Synedra miocenica*, *Thalassiosira irregulata*.

Discussion: Other floral elements include *Actinoptychus thumii*, *Asteromphalus oligocenicus*, *A. symmetricus*, *Cestodiscus* spp., *Coscinodiscus vetustissimus*, *C. vigilans*, *Cymatosira compacta*, *C. fossilis*, *C. robusta* (first occurrence in the upper part of this zone), *Goniothecium decoratum*, *Hyalodiscus* aff. *subtilis*, *Odontella* aff. *fimbriata*, *Pleurosigma planktonica*, *Pseudodimerogramma elliptica* and *elegans* (both occurring in the upper part of this zone), *P. oligocenica*, *Pseudopyxilla americana*, *Pseudotriceratium chenevieri* (for detail see taxonomic part), *Rhaphidodiscus marylandicus* (first occurrence in the upper part of this zone), *Rhizosolenia pokrovskaja*, *Sceptroneis caducea* and *ossiformis* (both having their first occurrence in the upper part of this zone), *S. propinqua*, *S. tenue* (last occurrence in the lower part of this zone), *Coscinodiscus praenitida*, *Synedra jouseana*, *S. miocenica*, *Thalassionema hirosakiensis*, and *Thalassiosira irregulata*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: No information available.

Absolute age: No information available.

Geographical extent: Elements of this zone are found in high and low latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 19-3, 140-141 cm to Sample 19-5, 135-136 cm.

Thalassiosira irregulata Partial Range Zone

Definition: The base of this zone has been defined at the last occurrence of *Rutilaria areolata* and *Pseudodimerogramma filiformis*; the top at the last occurrence of *Sceptroneis tenue* and at the first occurrence of *Thalassionema hirosakiensis*.

Discussion: Other floral elements include *Actinoptychus thumii, Asteromphalus oligocenicus, A. symmetricus, Cestodiscus* spp., *Coscinodiscus* aff. *rothii, C. vetustissimus, C. vigilans, Cymatosira compacta, C. fossilis, Goniothecium decoratum, Hyalodiscus* aff. *subtilis, Odontella* aff. *fimbriata, Pleurosigma planktonica, Pseudodimerogramma oligocenica, Pseudotriceratium chenevieri, Pterotheca reticulata, Rhizosolenia pokrovskaja, Sceptroneis humuncia, S. propinqua, Synedra jouseana* (first occurrence in the upper part of this zone), *Synedra miocenica, Thalassiosira irregulata, Rhizosolenia styliformis*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: No information available.

Absolute age: No information available.

Geographic extent: Elements of this zone are found in high latitudes.

Type locality: DSDP Leg 38, Site 338, Sample 19, CC to Sample 20, CC.

Pseudodimerogramma filiformis Partial Range Zone (Fenner)

Definition: The base of this zone is defined at the first occurrence of *Coscinodiscus praenitidus* and *Triceratium cruciformeum*. The top is defined at the last occurrence of *Pseudodimerogramma filiformis* and *Rutilaria areolata*.

Discussion: Other floral elements are: *Actinoptychus thumii, Asteromphalus oligocenicus, A. symmetricus, Coscinodiscus vigilans, C. asteromphalus* var. *princeps, Cymatosira praecompacta, C. compacta, C. fossilis, Cestodiscus muhinae, Fragilaria vøringia, Goniothecium decoratum, G. odontella, Hemiaulus pyxilloides, Pseudodimerogramma oligocenica, Pseudopyxilla directa, Pseudotriceratium* aff. *chenevieri, Rhaphoneis amphiceros, R. parilis, R. angulata, Rhizosolenia hebetata* f. *semispina, R. hebetata* var. *subacuta, R. hebetata* f. *hiemalis, R. pokrovskaja, Rouxia californica, Sceptroneis talwanii, S. humuncia, S. tenue, S. propinqua, Stephanopyxis grossecellulata, S.* aff. *megapora, Thalassiosira lusca, T. irregulata, Triceratium schulzii, T. linearis*. The most common species are: *Actinoptychus undulatus, Coscinodiscus tuberculatus* var. *atlantica, Melosira sulcata, Stephanopyxis grunowii*, and *Synedra miocenica*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: This zone correlates with the late Oligocene of Jousé (1974a, b) from sediments from the Pacific Ocean. For further discussion see *Sceptroneis pupa* Partial Range Zone and "Time ranges of selected taxa and biostratigraphic Zonation" in this chapter.

Absolute age: No information available.

Geographical extent: Part of the character species of this zone are found as well in high as in lower latitudes (Pacific sediments, DSDP Leg 6, Leg 29, and this paper).

Type locality: DSDP Leg 38, Site 338, Sample 21-1, 67-68 cm to Sample 22-2, 115-116 cm.

Sceptroneis pupa Partial Range Zone (Fenner)

Definition: The base of this zone is defined by the first occurrence of *Sceptroneis pupa* and *Cymatosira compacta*. The top of this zone is defined by the first occurrence of *Triceratium cruciforme* and *Coscinodiscus praenitidus*.

Discussion: Other floral elements are *Asteromphalus oligocenicus, A. symmetricus, Actinoptychus thumii, Cymatosira fossilis, C. praecompacta, Fragilaria vøringia, Goniothecium decoratum, G. odontella, G. coronatum, Hemiaulus polycystinorum, Pseudopyxilla directa, Pleurosigma normanii, Pseudotriceratium chenevieri, Rhaphoneis amphiceros, R. parilis, R. angulata, Rhizosolenia hebetata* f. *semispina, R. hebetata* var. *subacuta, R. hebetata* f. *hiemalis, Sceptroneis praecaducea, S. facialis, S. talwanii, S. humuncia, Stephanopyxis grunowii, S.* aff. *megapora, Stictodiscus kittonianus, Stephanopyxis turris, Triceratium schulzii, T. linearus* and *Thalassiosira lusca*. The most common species are: *Actinoptychus undulatus, Coscinodiscus tuberculatus* var. *atlantica, Cestodiscus muhinae, Melosira sulcata, Stephanopyxis barbadensis, Sceptroneis tenue, Synedra miocenica*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: This zone correlates with the "late Oligocene" of Jousé (1974). In the Pacific Ocean in material of DSDP Leg 6 in the described zone, filamentous genera appeared with species such as *Thalassionema* aff. *nitzschioides*. Furthermore *Synedra miocenica* is very common and also *Coscinodiscus vigilans* is present, which seems to be restricted to the late Oligocene and early Miocene. However, in this zone, and also in the higher late Oligocene zone of these Norwegian Sea cores there are a lot of species—as, for example, most of the *Sceptroneis* and *Cymatosira* species—which were never before described from the Pacific sediments of late Oligocene age either by Jousé (1974a, b) or by Hajós (in press).

Absolute age: No information available.

Geographical extent: Part of the characteristic species are found as well in high as in low latitudes (Pacific sediments, Leg 6, Leg 29).

Type locality: DSDP Leg 38, Site 338, Sample 22-3, 22-23 cm to Sample 24-2, 86-88 cm.

Interval Zone (middle Oligocene)

This zone is not defined by diatoms but ranges from Sample 338-24-1, 35 cm to 338-26-2, 109 cm and consists of a nannoplankton ooze. Within this carbonate-rich zone only a few diatoms have been found and no age determination was possible. On the other hand, the coccolith age determination yielded a middle Oligocene age (Müller, this volume).

At the basis of this, nearly diatom-free zone diatoms characteristic for the late Eocene are found with *Monobrachia simplex, Pterotheca crucifera, Sceptroneis grunowii, Trochosira coronata*, and *Triceratium barbadense*. Further species are *Hemiaulus kittonii, H. undulatus, H. curvatulus, Cymatosira praecompacta, C. coronata, Riedelia claviger, Rhizosolenia hebetata* var. *subacuta, Sceptroneis pesplanus, Stephanopyxis grunowii*, and *Synedra miocenica*. The most common species were *Actinoptychus undulatus, Hemiaulus polycystinorum*, and *Stephanopyxis barbadense*.

Above this interval zone the following diatom species, which are typical for the late Oligocene (compare the description and discussion of the *Pseudodimerogramma filiformis* Partial Range Zone and the *Sceptroneis pupa* Partial Range Zone), were found: *Asteromphalus symmetricus, Cymatosira fossilis, Rhaphoneis amphiceros, Sceptroneis facialis, S. praecaducea, S. talwanii*, and *S.* sp. (Plate 24, Figure 21).

Other floral elements are: *Cymatosira coronata, C. praecompacta, Goniothecium decoratum, G. odontella, Hemiaulus curvatulus, Rhizosolenia hebetata* f. *semispina, Rhizosolenia hebetata* var. *subacuta, Riedelia claviger, Sceptroneis pesplanus*, and *Stephanopyxis grunowii*. The most common species are *Synedra miocenica, Stephanopyxis turris*, and *S. barbadense*. Within this interval zone or at its lower contact to the diamites there must be a hiatus, because most or all of the lower Oligocene is missing. The interval zone is dated by nannofossils to belong to NP 24 (upper Oligocene), whereas the diatoms (at the lower contact) indicate a late Eocene age.

Coscinodiscus oblongus Range Zone (Fenner)

Definition: This zone is defined by the range of *Coscinodiscus oblongus*.

Discussion: Other floral elements include: *Coscinodiscus moroensis, Cymatosira coronata, Goniothecium loricatum* (extinction at the top of this zone), *Hemiaulus undulatus, H. polymorphus* var. *frigida, H. polycystinorum, H. kittonii, H. hostilis, Monobrachia simplex, Pseudorocella barbadensis, Pseudostictodiscus angulatus, Navicula udintsevii, Odontotropis* spp., *Pterotheca aculeifera, P.* sp. 1 (last occurrence in the middle part of this zone), *P. crucifera, Riedelia claviger, Rhizosolenia palliola* (last occurrence in the middle part of this zone) *Sceptroneis grunowii, S. mayenica* and *Stictodiscus* sp. (Plate 36, Figures 2, 3) (both with extinction at the top of this zone), *Stephanogonia pretiosa, Triceratium barbadense, Trochosira coronata*; *Triceratium* aff. *weissflogii* and *Trochosira spinosa* (both with extinction at the top of this zone), *Triceratium acutangulum* (with its last occurrence in the upper part of this zone); *Thalassiosira dubiosa* and *Triceratium circonspicuum* occur only in the lower part of this zone. The dominating species are *Stephanopyxis turris* and *S. barbadense, Hemiaulus polymorphus* var. *frigida* and *H. polycystinorum*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: This zone correlates with the "late Eocene" age determination of sediments from the southern Pacific by Gleser and Jousé (1974), with the "middle Eocene" (Lutetian) age determination of DSDP Leg 3, Core 13, Section 1-6 (date by radiolarians, diatoms by Gleser and Jousé, 1974), with the Kellogg diatomaceous sequence of Kanaya (1957), and the lower part of the Oceanic formation of Barbados (Jousé, 1974a).

Absolute age: No information available.

Geographical extent: The character species of this zone are found as well in high as in low latitudes (Sierra Leone Rise, northern California, western Siberia).

Type locality: DSDP Leg 38, Site 338, Sample 26-3, 34-35 cm, to Sample 28-2, 30-31 cm.

Triceratium barbadense Partial Range Zone (Fenner)

Definition: The base of this zone has not been determined; the top is defined at the base of the *Coscinodiscus oblongus* Partial Range Zone (reference and discussions see above).

Discussion: Other species not exceeding the upper boundary of *Triceratium barbadense* Partial Range Zone are: *Trinacria quadratum*, *Pterotheca uralensis*, *Thalassiosira medioconvexa*. Common (besides *Triceratium barbadense*) are *Stephanopyxis turris* var. *frigida*, *S. barbadense*, *Actinoptychus undulatus*, *Hemiaulus polycystinorum*, *H. polymorphus*, *Coscinodiscus radiatus*, *Navicula bendaensis*, *N. sudora*, *N. udintsevii*, *Pterotheca* sp. 1 and sp. 3, *P. aculeifera*.

Subzones: No subzones have been defined.

Paleomagnetic stratigraphy: No information available.

Comparison with zonations of other workers: This zone correlates with the "late Eocene" age determination of Gleser and Jousé (1974), with the "middle Eocene" (Lutetian) age determination of DSDP Leg 3, Core 13, Section 1-6 (date by radiolarians, diatoms by Gleser and Jousé, 1974), with the Kellogg diatomaceous sequence of Kanaya (1957).

Absolute age: No information available.

Geographical extent: Character species of this zone are found in both high and low latitudes (Sierra Leone Rise, northern California, western Siberia).

Type locality: DSDP Leg 38, Site 338, Sample 28-2, 133-134, cm, base not defined.

Correlation to Other Diatom Sections

Planktonic marine diatoms have been used to establish the ages and correlations of other deep-sea drilling sections. They are: the equatorial Pacific (Schrader and Burckle, 1975), DSDP Leg 18 (Schrader, 1973a), and DSDP Leg 19 (Koizumi, 1973) both in the North Pacific, DSDP Leg 28 (McCollum, 1975), and DSDP Leg 29 (included into DSDP Leg 35, Schrader, in press) both in the Antarctic, and a composed zonation of equatorial drill sites in the Atlantic, Pacific, and Indian oceans (Jousé, 1974a, b). Correlation is based on defined ranges of index species, on the proposed correlation (corrected in those cases where more information is available) to the paleomagnetic stratigraphy, to the absolute time scale, or to the epochal scheme. Correlations which are tentative and cannot be proven are due to the lack of original material, different taxonomic interpretations, and poor definition. In this chapter poor definitions are connected with a dashed line, others which have been proven by the author and showed good agreement are connected with a solid line (Figures 7-10).

DIATOMS AT EACH SITE

A short description of site location is followed by documentation about diatom abundance, preservation, and resulting biostratigraphic zonation. Further comments on unconformities, facies changes, and hiatuses are mentioned and discussed. Each site (except Sites 351-352) has accompanying tables, which present information on occurrence. Samples barren in diatoms are tabulated separately. All written information is summarized on the figures.

At this early step only little emphasis was put into the determination and classification of reworked older species. Only in those cases where reworking is obvious, occurrence calls are circled. It was tried to present as complete as possible floral content list on the tables. In cases where only a few taxa are listed on the occurrence tables, only those were observed.

Site 336 (Figures 6 and 11; Tables 1 and 2)

Site 336 lies on the northern flank of the Iceland-Faeroe Ridge and was drilled at an actual water depth of 811 meters below the sea surface. Two sedimentary units and one basalt unit were defined. Well to moderately well preserved diatom assemblages were found in Cores 1, 6, 8, 9, 10, 11, and 12 and are of Pleistocene to Pliocene age. No samples were available in Cores 13-15. Below, well to poorly preserved assemblages were found in Cores 16-19. No diatoms were found below Core 19.

The occurrence of the following index species made the following biostratigraphic subdivision possible: Interval from Core 1 through Core 12: *Denticula seminae*, *Nitzschia fossilis*, *Pseudoeunotia doliolus*, *Rhizosolenia barboi*, *Thalassiosira convexa*, *T. nidulus*, *T. oestrupii*, and *T. usatchevii* placing Sample 1-2, 89 cm into the *Thalassiosira oestrupii* Zone of 0-1.8 m.y. age, Sample 6-2, 30 cm into the *Rhizosolenia barboi* Zone of 1.8-2.5 m.y. age, and Samples 8-2, 50 cm to 12-2, 134 cm into the *Thalassiosira kryophila* Zone of 2.5-(?) age (the base was not age determined). Boundaries between zones were placed between two neighboring diatomaceous samples.

The interval between Cores 16-2 and 18-2 did contain the following age-diagnostic species: *Coscinodiscus praenitidus*, *C. tuberculatus* var. *atlantica*, *Cymatosira* spp., *Hemiaulus* spp., *Pseudotriceratium chenevieri*, *Rouxia obesa*, *Sceptroneis* spp., *Triceratium schulzii*, and *Synedra miocenica* placing this interval into the *Pseudodimerogramma filiformis* Zone of upper Oligocene age. The interval between Cores 18-5 and 19-2 only contained moderately to poorly preserved diatom assemblages and only an Oligocene age could be assigned to this interval. A hiatus was found in the poorly recovered interval between Cores 12-2 and 16-2, where Oligocene material underlies Pliocene material.

Using the above-defined biostratigraphic subdivision, a sediment accumulation rate of 2.8 cm/1000 yr can be calculated for the 0-100 meter interval.

The Pleistocene to Pliocene interval did contain species which have been found in sediments of tropical to subtropical environments: *Pseudoeunotia doliolus*, *Nitzschia fossilis*, and *Rhizosolenia bergonii* which were not observed in the more northern sites. The occurrence of these species demonstrates the influence of the Gulf stream during Glacial and Interglacial times.

Denticula seminae was found within the *Thalassiosira kryophila* Zone in high amounts, but has not been observed in any of the northern sites. *Denticula seminae*

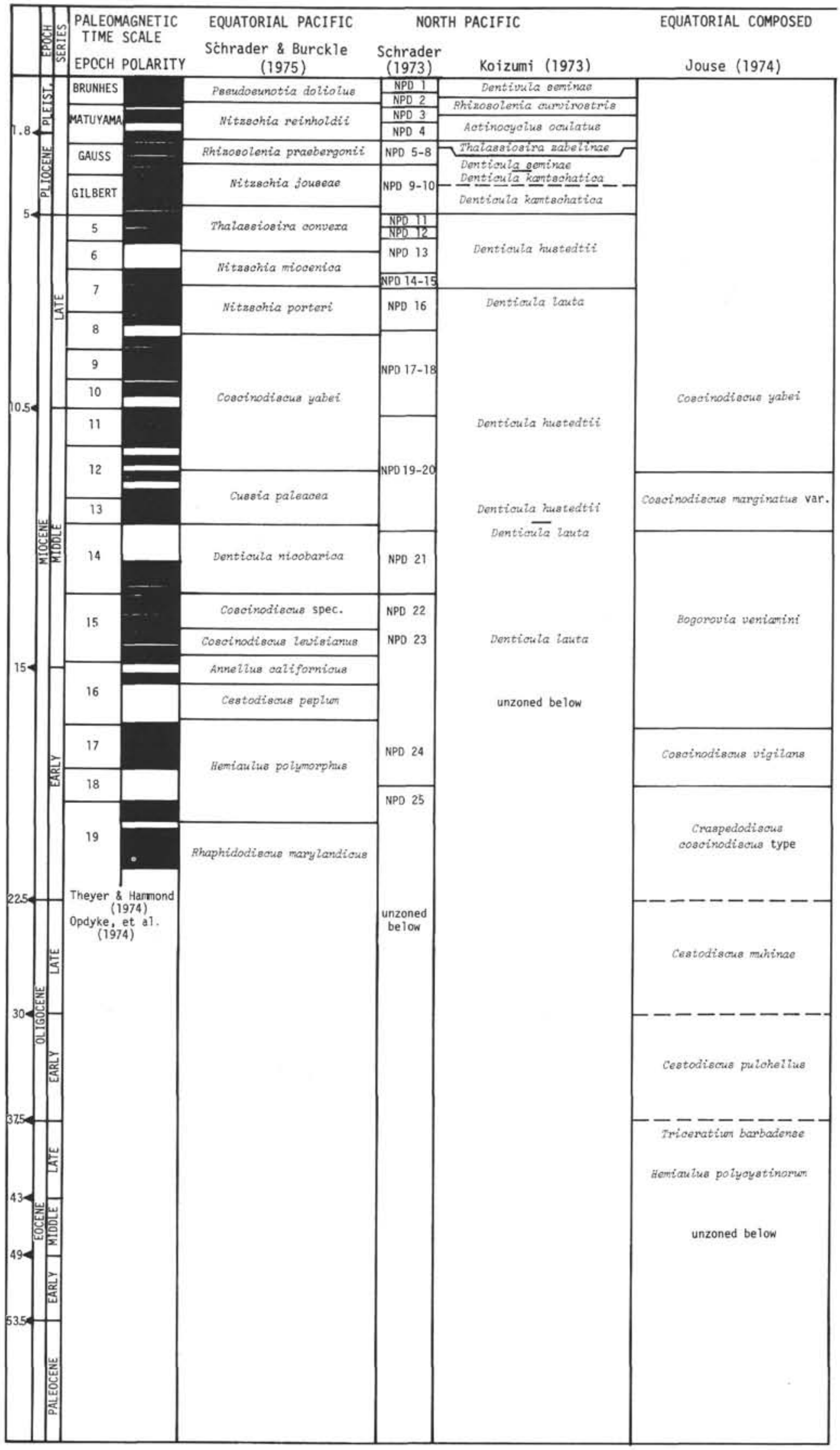


Figure 7. *Estimated time relationship and correlation of Neogene-Paleogene planktonic diatom zones, paleomagnetic stratigraphy, and radiometric time scale.*

NORTHERN CALIFORNIA	ANTARCTIC		
Kanya (1957)	McCollum (1975)	Schrader (1975ms)	THIS PAPER
	Coscinodiscus lentiginosus	*Coscinodiscus lentiginosus*	*Thalassiosira oestrupii*
	Rhizosolenia barboi	*Rhizosolenia barboi*	
	Coscinodiscus kolbei	*Coscinodiscus kolbei*	*Rhizosolenia barboi*
	Cosmiodiscus insignis	*Cosmiodiscus insignis*	
	Nitzschia interfrigidaria	*Nitzschia interfrigidaria*	*Thalassiosira kryophila*
	Nitzschia praeinterfrgidaria	*Nitzschia praeinterfrigidaria*	*Coscinodiscus marginatus*
			Denticula hustedtii
	Denticula hustedtii	*Denticula hustedtii*	*Cymatosira biharensis*
			Goniothecium tenue
	Denticula hustedtii *Denticula lauta*	*Hemidiscus karstenii*	*Rhizosolenia miocenica*
		Coscinodiscus yabei	
	Denticula lauta — *Denticula antarctica*		*Thalassiosira gravida* var. *fossilis*
	Denticula antarctica — *Coscinodiscus lewisianus*	*Denticula dimorpha* *Denticula antarctica* *Denticula nicobarica*	*Actinocyclus ingens* *Nitzschia* spec. 8 *Sceptroneis caducea*
			Coscinodiscus plicatus
		Coscinodiscus lewisianus	*Denticula hyalina*
	Denticula antarctica — *Denticula nicobarica*		
		Denticula lauta *Nitzschia pusilla* *Thalassiosira spumellaroides* *Thalassiosira spinosa*	*Rhizosolenia bulbosa*
	Coscinodiscus spec.	*Rhaphidodiscus marylandicus*	*Thalassiosira fraga*
		Nitzschia maleinterpretaria *Bogorovia veniamini*	*Nitzschia maleinterpretaria* *Coscinodiscus vigilans* *Rhizosoenia norwegica* *Synedra jouseana* *Pseudodimerogramma elegans*
	Pyxilla prolungata	*Pyxilla* species	*Coscinodiscus praenitidus*
			Thalassiosira irregulata
	unzoned below		*Pseudodimerogramma filiformis* *Sceptroneis pupa*
		unzoned below	Interval Zone barren in diatoms NP 24-25
			Coscinodiscus oblongus
Kellogg Diatomaceous Sequence			*Triceratium barbadense*
			Late-Middle Eocene unnamed zone
			Early Eocene unnamed zone
			unzoned below

Figure 7. *(Continued).*

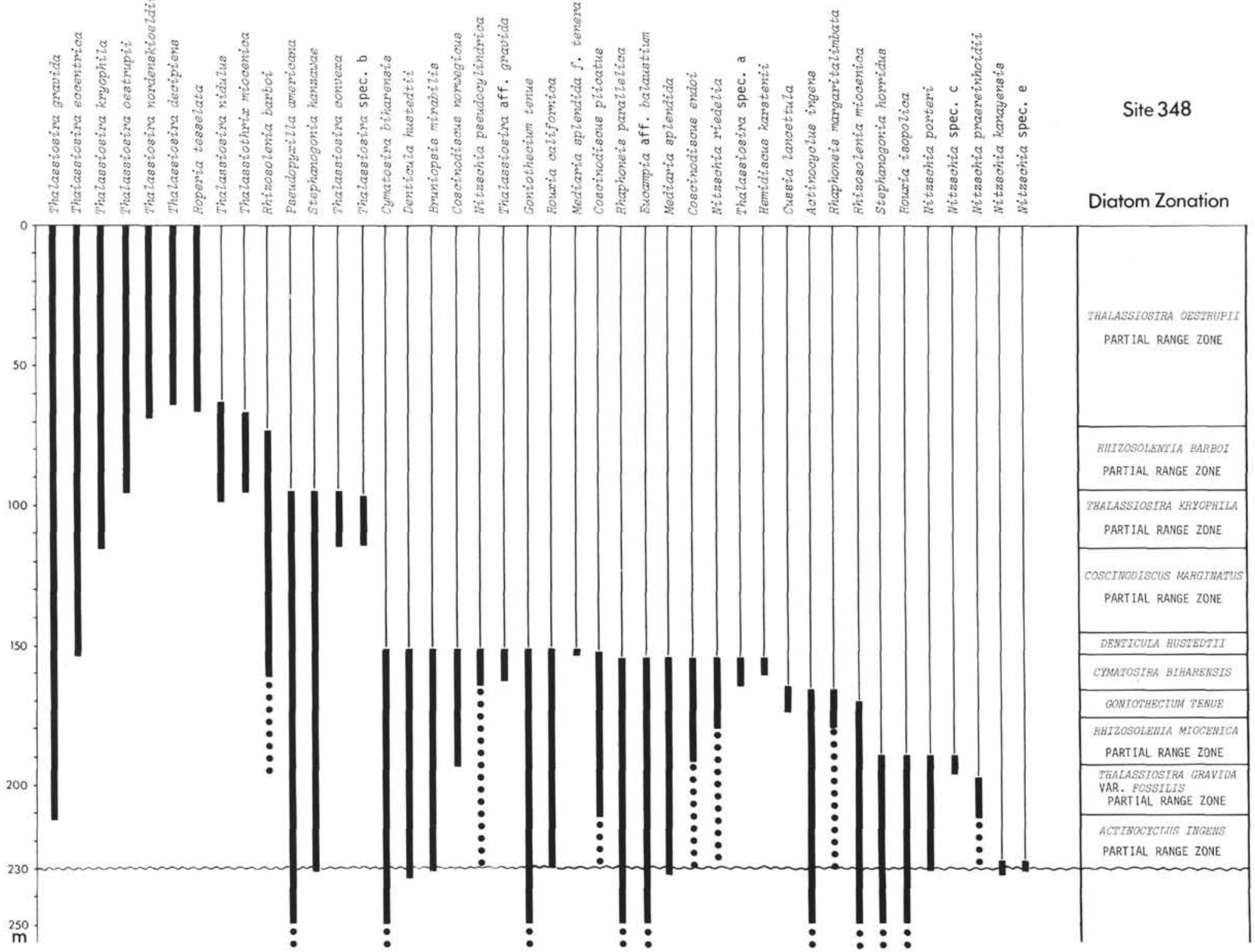


Figure 8. *Ranges of selected diatom species at Site 348 with correlation to the biostratigraphic zonation. Wavy line demonstrates the facies change. Dotted ranges are not well defined.*

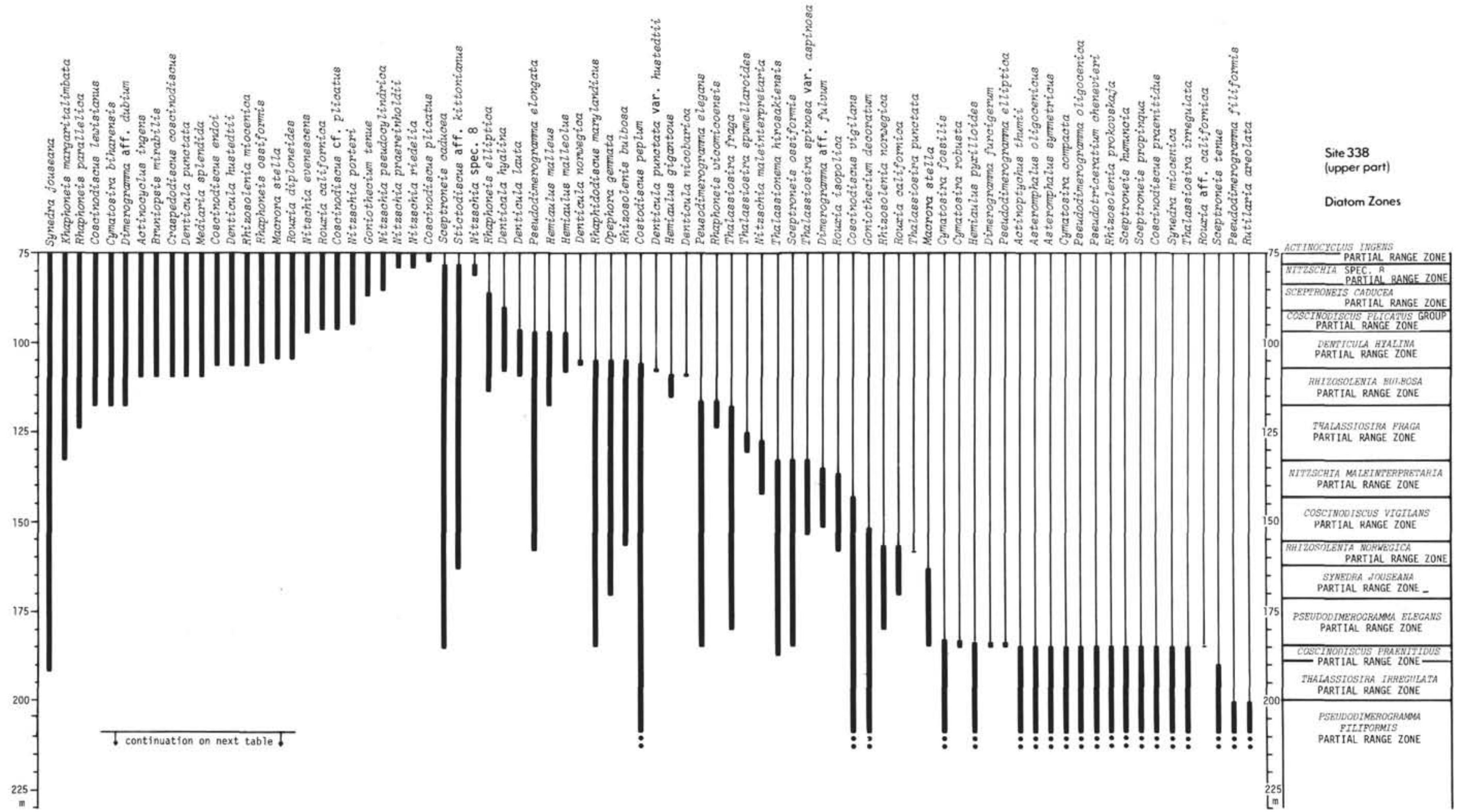


Figure 9. *Ranges of selected diatom species at Site 338 (upper part) with correlation to the biostratigraphic zonation for the late Oligocene-late Miocene interval. Dotted ranges continue into the lower part.*

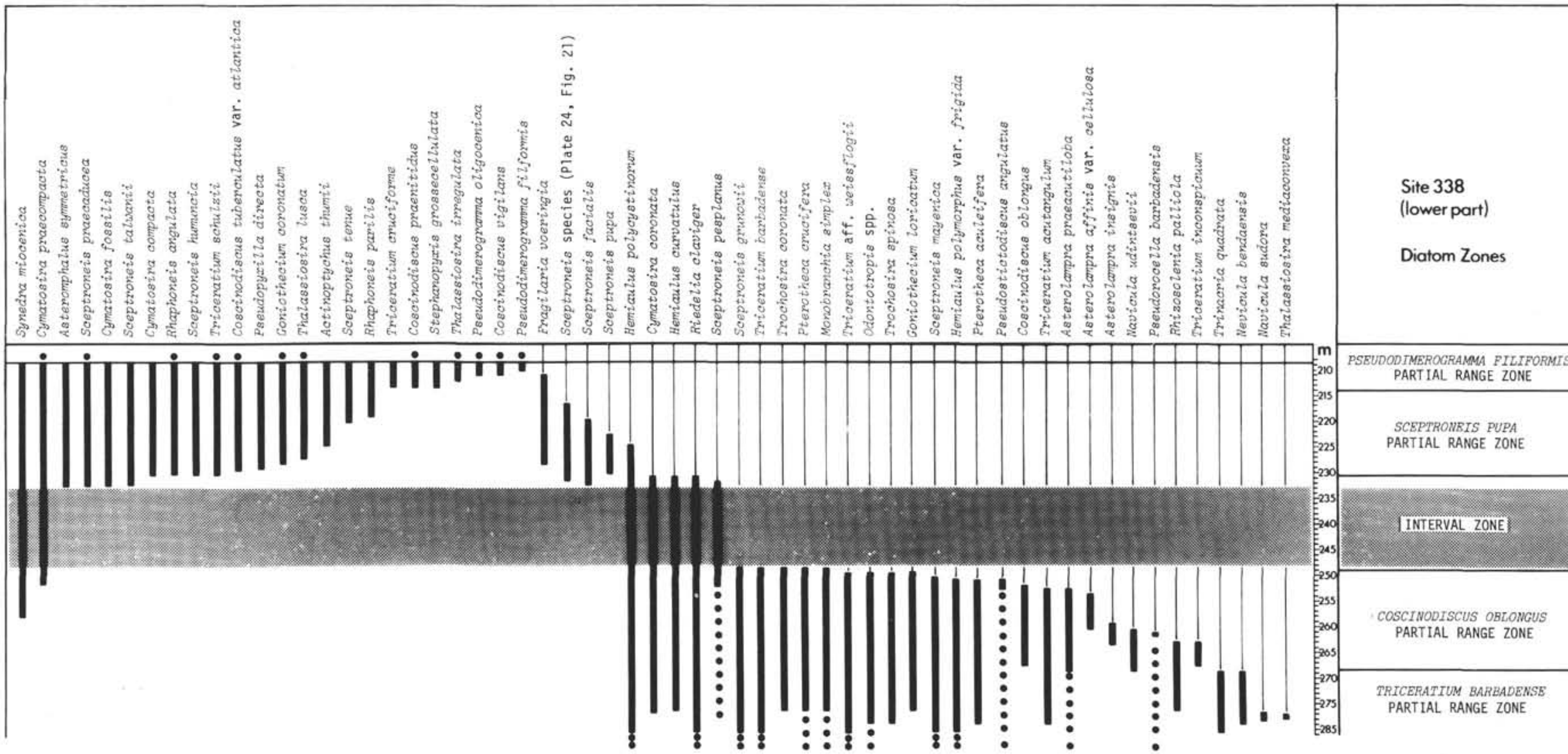


Figure 10. *Ranges of selected diatom species at Site 338 (lower part). Stippled area is barren in diatoms and is placed into the NP 24/25 coccolith zone. Dotted ranges are ill defined because of scarce occurrences.*

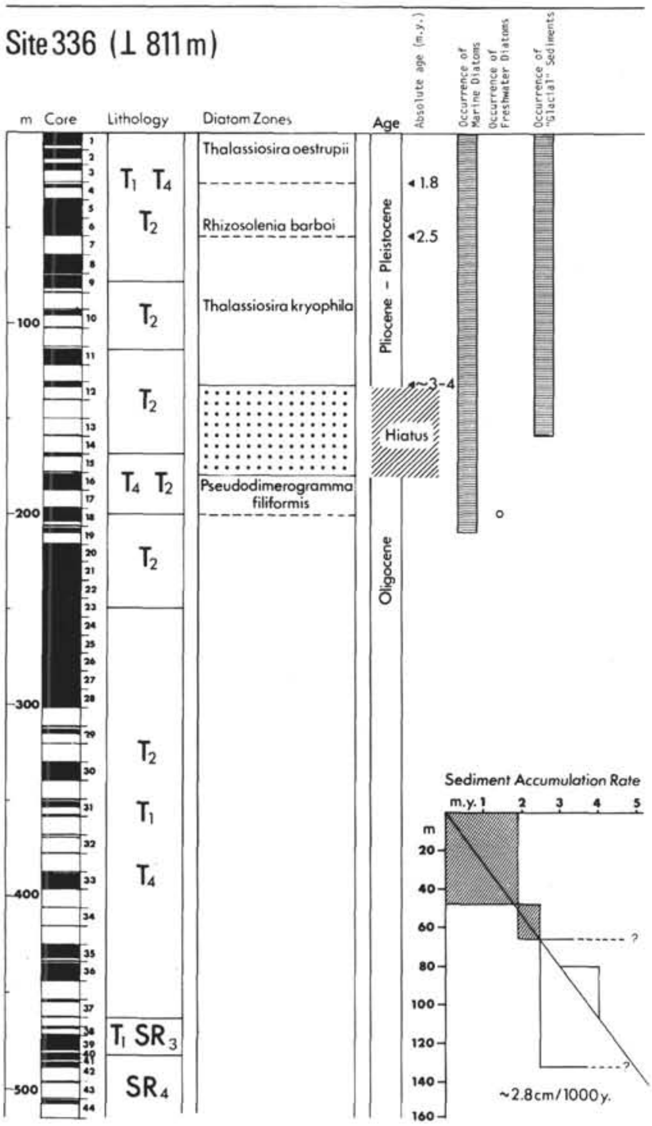


Figure 11. *Site 336 summary figure, lithological symbols are explained in the introductory part of this volume. Black interval in core column represent recovered sections.*

is a direct descendant of *D. hustedtii* (Schrader, 1973b), which had been a cosmopolitan species. *D. seminae* is the only living marine representative of the genus *Denticula* and is present only in the North Pacific. Its maximum abundance in the North Pacific is found in the north boreal diatom complex of Jousé et al. (1971), which corresponds to the area of distribution of subarctic waters. Biometrical investigations (see section on *Denticula*, this report) demonstrate that individuals found at Site 336 do have a similar biometrical range to those found at Site 178 in the Bay of Alaska. No information is available at this time whether this species evolved time congruent in the North Atlantic-Norwegian Sea area, or whether it had been transported from its "homeland" to this area. During the late Pliocene, it became extinct in this area.

Coscinodiscus bathyomphalus was observed here ranging well into the Pliocene (compare range at Site 338). An increase in the admixture of shallow-water material with marine-littoral species was observed in the Oligocene interval indicating that during this period there must have been flourishing marine littoral diatom assemblages at the coasts supplying these displaced skeletons (Figure 6). Displaced fresh-water diatoms were only observed in Sample 18-2, 53 cm (*Melosira islandica*).

Site 337 (Figures 12, 13; Tables 3, 4)

Site 337 is located east of the "extinct" spreading axis in the Norway basin at a depth of 2637 meters below the surface. The drilled sediment section is underlain, in direct contact, by basalt. Marine diatom assemblages were only found in the interval between Samples 9-5, 100 cm and 11-2, 10 cm, and are common to abundant with moderately to well preserved tests (Figure 12).

Occurrence of *Navicula udintsevii*, *Rouxia obesa*, *Huttonia norwegica*, and *Asterolampra punctifera* places this interval into the *Coscinodiscus oblongus* Zone and is of late Eocene age. No diatoms were found in the Glacial sequence. Displaced fresh-water diatoms were found in Sample 10-5, 120-122 cm, and displaced littoral species in Samples 9-5, 100 cm to 10-5, 120 cm.

Because of the scarcity of dated levels, sediment accumulation rates have not been calculated. An absolute age range of approximately 37.5-43 m.y.B.P. can be calculated for the late Eocene using Berggren's (1972) suggested radiometric dates.

Site 338 (Figures 14-16; Tables 5-7)

Site 338 is located on the outer part of the Vøring Plateau in a water depth of 1297 meters below the surface. Structurally the Vøring Plateau is divided into two parts by a buried southwest-northeast escarpment. Site 338 lies west of this escarpment. Hole 338 was drilled through an almost complete sequence of marine sediments of Eocene to Pleistocene age, which overlies basaltic basement. Glacially derived sediments were found in Cores 1 through 6 and were all barren in diatoms.

The detailed biostratigraphic discussion and zonation can be found within the part "Time ranges and biostratigraphic zonation." Therefore here only zonal boundaries are listed with their approximate absolute age whenever possible: Interval (?) to Sample 8-2, 10 cm *Actinocyclus ingens* Zone (?); interval Samples 8-2, 58 cm to 8-4, 85 cm *Nitzschia* sp. 8 Zone; interval Samples 8, CC to 9-1, 135 cm *Sceptroneis caducea* Zone (base 13 m.y.); interval Samples 9, CC to 10-1, 135 cm *Coscinodiscus plicatus* group Zone (13-13.6 m.y.); interval Samples 10-2, 55 cm to 11-2, 85 cm *Denticula hyalina* Zone (top 13.6-base ?); interval Samples 11-3, 5 cm to 12-3, 90 cm *Rhizosolenia bulbosa* Zone (top ? - base 19.5 m.y.); interval Samples 13-1, 55 cm to 13, CC *Thalassiosira fraga* Zone; interval Samples 14-1, 20 cm to 15-1, 20 cm *Nitzschia maleinterpretaria* Zone; interval Samples 15-1, 995 cm to 16-2, 10 cm *Coscinodiscus vigilans* Zone; interval Samples 16-4, 67 cm to 16, CC *Rhizosolenia norwegica* Zone; interval Samples 17-2, 46 cm to 17, CC *Synedra jouseana* Zone; interval Samples 18-1, 50 cm to 19-3, 40 cm *Pseudodimerogramma elegans* Zone (assuming the Miocene/Oligocene bound-

TABLE 1
Diatoms at Site 336

Sample (Interval in cm)	Abundance	Preservation	Sponge spicules	*Actinocyclus divisus*	*A. ehrenbergii*	*Actinoptychus undulatus*	*Arachnoidiscus* spp.	*Asteromphalus arachne*	*A. oligocenicus*	*Cestodiscus mulinae*	*Chaetoceros* bristles	*C.* spores	*Cocconeis* spp.	*Coscinodiscus bathyomphalus*	*C. lineatus*	*C. marginatus*	*C. nodulifer*	*C. praenitidus*	*C. rothii*	*C. symbolophorus*	*C. tuberculatus* var. *atlantica*	*C. vetustissimus*	*Cymatosira compacta*	*C. fossilis*	*C. lorenziana*	*Denticula seminae*	*Detonula confervacea*	*Diploneis* spp.	*Goniothecium decoratum*	*G. odontella*	*Grammatophora* spp.	*Hemiaulus danicus*	*Hemiaulus pungens*	*H. pyxilloides*	*Hyalodiscus* aff. *subtilis*	*Lauderia borealis*	*Mediaria splendida* (?), tender form	*Melosira sulcata*
1-2, 89-91	C	M	F		R						F	F			R												R									R		R
6-2, 30-32	C	G	R	R	R			R			C	C		R													R											
8-2, 50-52	C	G	R	R	R						C	C		R		R										F										R		
8-5, 120-122	C	G	B	R							C	C		R	R		R									F	R											
9-2, 40-42	C	G	F	R	R						F	C		R	R	R										C												F
10-2, 40-42	C	G	F	F	R						F	C		R																								R
11-2, 110-112	C	G	F	F							F	C				R																						R
12-2, 134-136	R	P	R	F							F	C				R						R																R
16-2, 57-59[c]	A	G	F			R			R		C	A				R		R	R	R	R		R	R					R		R			R	R		?	F
16-5, 98-100	A	G	R			F				F	C	C	R			R		R			R		R		R				R		R			R	R		R	
18-2, 53-55	C	G	C		R	R	R					F	R		R	R		R			R							R	R	R		R	R	R	R		?	F
18-5, 84-86	R	P	C				R					F						R													R							F
19-2, 110-112[a]	F	M	C				R					F						R																				F
20-2, 90-92	B	–	C	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
				All samples below barren in diatoms																																		

[a]Ash.

ary occurs at the base; (a tentative absolute age of 22.5 m.y. can be given to the base of this zone); interval Samples 19-3, 140 cm to 19-5, 135 cm *Coscinodiscus praenitidus* Zone; interval Samples 19, CC to 20, CC *Thalassiosira irregulata* Zone; interval Samples 21-1, 67 cm to 22-2, 115 cm *Pseudodimerogramma filiformis* Zone; interval Samples 22-3, 22 cm to 24-2, 86 cm *Sceptroneis pupa* Zone; interval Samples 24-3, 35 cm to 26-2, 109 cm "Interval Zone"—not dated on the basis of diatoms. The coccolith biostratigraphy (Müller, this volume) reveals a middle Oligocene age; interval Samples 26-3, 34 cm to 28-2, 30 cm *Coscinodiscus oblongus* Zone (late Eocene age); interval Samples 28-2, 133 cm to 29, CC *Triceratium barbadense* Zone (late Eocene) (Figure 14).

Sedimentation rates (Figure 16) were calculated using the few absolute dates, based on datum planes being established in the equatorial and North Pacific and for the biogenic siliceous sequence are 1.7 cm/1000 yr. Similar sedimentation rates of 1.5-2.0 cm/1000 yr were calculated for siliceous oozes in the North Pacific (Schrader, 1973a). No calculation was done for the "Glacial" sequence and for the sediment interval in Units 4 and 5.

Two hiatuses were defined and are present in Core 11 and in Core 26 where a gap in biostratigraphic zone occurred and where more than three last and first occurrences of index species were found. The high amount of last occurrences and first occurrences over the Miocene/Oligocene boundary is interpreted as a change in the conditions of the hinterland. From this boundary downwards, the amount of neretic and shallow-water displaced marine diatoms increases compared to the overlying section and may be attributed to lowered sea level.

Displaced fresh-water diatom species (*Melosira granulata* and *islandica*) were found sporadically throughout the total section (compare Tables 5 and 6).

Site 339 (Figure 17; Tables 8, 9)

Site 339 is located on a diapir on the Inner Vøring Plateau at a water depth of 1262 meters below sea level.

Two principal sedimentary units were defined at this site. Glacial sediments were observed in Core 1 through Core 9, the lower part mixed with late Eocene biogenic siliceous ooze. Fresh-water diatoms were found only in Sample 7-2, 70-72 cm, and displaced shallow-water benthonic diatom species were found in almost all samples (*Grammatophora* spp.).

The biogenic siliceous sequence contained a well-preserved, diverse diatom assemblage with good index fossils such as *Coscinodiscus oblongus* (only found in the upper part), and placing Sample 6-2, 60-62 cm into the *Coscinodiscus oblongus* Zone of late Eocene. *Triceratium barbadense* was observed in Samples 6-2, 60 cm and 7-2, 70 cm and places Sample 7-2, 70 cm into the *Triceratium barbadense* Zone of middle Eocene (?). Due to the fact that the base of this zone was not defined at Site 338, the following age determination is exclusively based on the occurrence of species at Site 338 and Site 339. *Triceratium barbadense* is absent in samples below Core 8 and new species were observed, which were not found at Site 338, such as *Pseudorutilaria monomembranacea*, *Coscinodiscus oligocenicus* thus placing Samples 8-2, 20 cm to 12-2, 10 cm lower into the "middle" Eocene section than

TABLE 1 – *Continued*

M. islandica	*Nitzschia atlantica*	*N. cylindrus*	*N. fossilis*	*Pleurosigma* aff. *planktonica*	*Porosira glacialis*	*Pseudoeunotia doliolus*	*Pseudopodosira simplex*	*Psoedupyxilla directa*	*Pseutotriceratium chenevieri*	*Pterotheca reticulata*	*Pyrugpyxis johnsoniana*	*Rhaphoneis amphiceros*	*R. elongata*	*Rhizosolenia alata*	*R. barboi*	*R. bergonii*	*R. hebetata* forma *hiemalis*	*R. praebarboi*	*R. styliformis*	*Rouxia obesa*	*Rutilaria areolata*	*Sceptroneis caducea*	*S. facialis*	*S. humuncia*	*S. propinqua*	*Stephanogonia hanzawae*	*Stephanopyxis turris* group	*S. hyalomarginata*	*S. schenckii*	*Stictodiscus kittonianus*	*Synedra miocenica*	*Thalassiosira convexa*	*T. eccentrica*	*T. gravida*	*T. kryophila*	*T. nidulus*	*T. nordenskioeldii*	*T. oestrupii*	*T. usatchevii*	*Thalassiothrix longissima*	*Trinacria excavata*	*Triceratium condecorum schulzii*
	R					R								R													R						R	C	R		R	F		R		
	R				R										F	R			R														R	F	R	R	R	R		F		
	R														R		R		R													R	R	F	F	R		F		F		
	R				R									R	F	R	R		R								R					R	R	R	R	R		R		C		
	R	R	R		R										R		R		R								R						R	R		R			R	C		
					R												R		F													F		F		R				C		
					R												R		R								R					R				R				F		
					R												R		R								R					R				R				F		
							R					R	R					R	R	R	R	R			R	R	R	R	R		F											R
							R		R	R		R							R			R		R	R		R			R	F											
R				R			R	R	R		R	R					R		R	R	R	R					R				R											R
							R				F																R															
											R																R														R	
															All samples below barren in diatoms																											

TABLE 2
Samples Barren in Diatoms and Sponge Spicules, Site 336

1-5, 1-3 cm	24-2, 50-52 cm
2-2, 50-52 cm	25-2, 50-52 cm
3-2, 86-88 cm	25-5, 85-87 cm
3-5, 90-92 cm	26-2, 40-42 cm
4-2, 64-66 cm	26-5, 28-30 cm
5-2, 37-39 cm	27-2, 30-32 cm
5-5, 86-88 cm	27-5, 14-16 cm
6-5, 80-82 cm	29-2, 40-42 cm
9-5, 120-122 cm	30-2, 30-32 cm
20-2, 90-92 cm[a]	30-5, 40-42 cm
20-5, 40-42 cm	31-2, 40-42 cm
21-2, 120-122 cm	33-5, 30-32 cm
21-5, 100-102 cm	33-6, 67-69 cm
22-2, 30-32 cm	35-2, 110-112 cm
22-5, 80-82 cm	35-5, 134-136 cm
23-2, 100-102 cm	36-2, 100-102 cm
23-5, 40-42 cm	

[a]Sponge spicules common.

samples from Site 338, Core 29. No diatoms were observed in samples from the "Glacial" sequence. Due to poor biostratigraphic zonation and age determination, sedimentation rates have not been calculated.

Site 340 (Figure 18; Table 10)

Site 340 is only 2200 feet away from Site 339 and was located on a topographically steeper part of the diapir. Glacial sediments (~10 m thick) are directly underlain by late Eocene biogenic siliceous ooze which is greatly disturbed. Due to this disturbance, the biostratigraphic interpretation is tentative. Orientation of samples presented here includes various reversals within the Eocene section and was put into descending order by the presence of index fossils such as *Coscinodiscus oblongus*, *C. oligocenicus*, *Navicula bendaensis*, *Pseudorutilaria monomembranacea*, *Sceptroneis* spp., and *Triceratium barbadense*.

Coscinodiscus oblongus Zone	*Triceratium barbadense* Zone
9-2, 60-62 cm	7-2, 100-102 cm
9-5, 60-62 cm	7-3, 65-67 cm
10-6, 60-62 cm	7-5, 60-62 cm
11-2, 60-62 cm	8-5, 60-62 cm
11-5, 60-62 cm	3-2, 60-62 cm
2-2, 60-62 cm	3-5, 40-42 cm

Samples 5-2, 60-62 cm, 6-5, 50-52 cm, 10-2, 60-62 cm were put into an unzoned interval below the interval at Site 338, Core 29. No further detailed studies were done at this site.

Site 341 (Figure 19; Tables 11, 12)

Site 341 is located on the Vøring Plateau at a water depth of 1439 meters below sea level. An extremely thick Pleistocene/Pliocene "Glacial" sequence covers the interval from 0 to 328 meters (Cores 1-24, CC) and consists of terrigenous muds and sandy muds with one block of allochthonous diatomaceous ooze (Figure 19) from Cores 5-6. The base of this block appears to be gradational in Cores 7-1 to 7-3, with increasing downward proportions of clay. The basal boundary has been somewhat arbitrarily established at Sample 7-4, 120 cm.

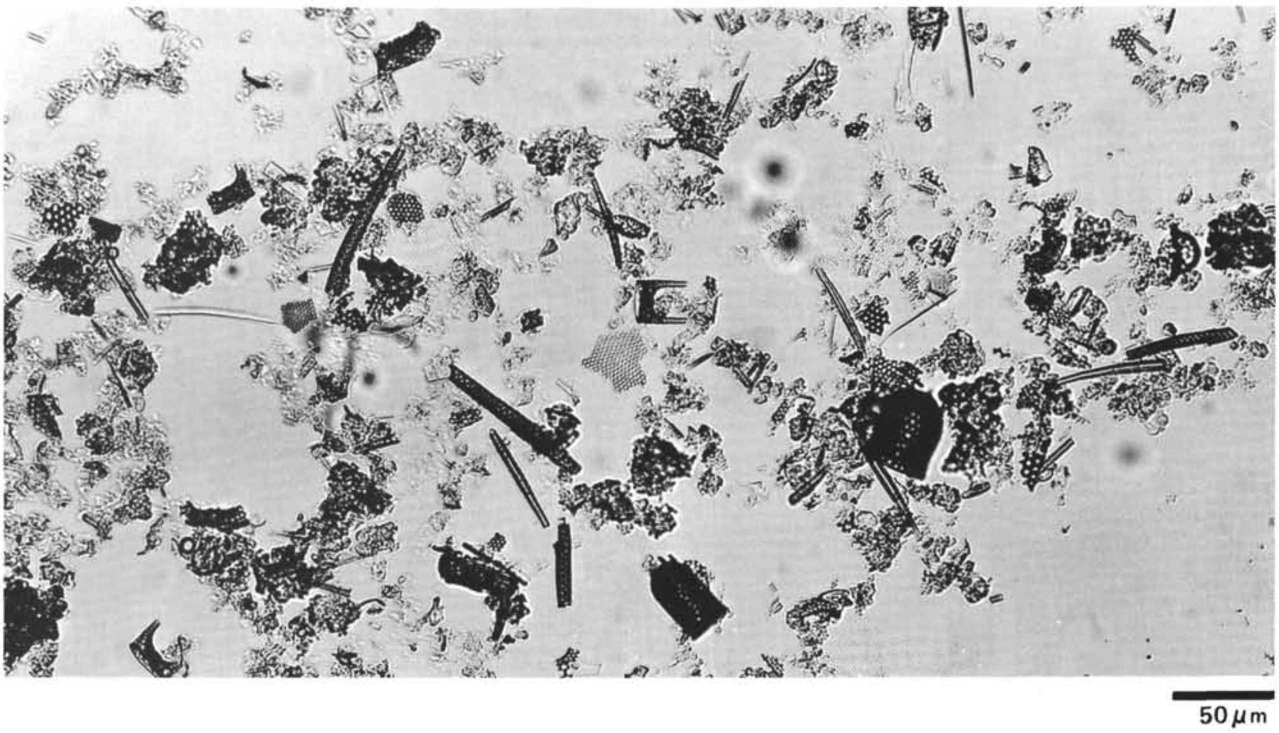


Figure 12. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 337-10-2, 90 cm with abundant* Pyrgupyxis johnsoniana, Stephanopyxis turris *group; diatoms moderately well preserved. Distance between two bars 10 µm.*

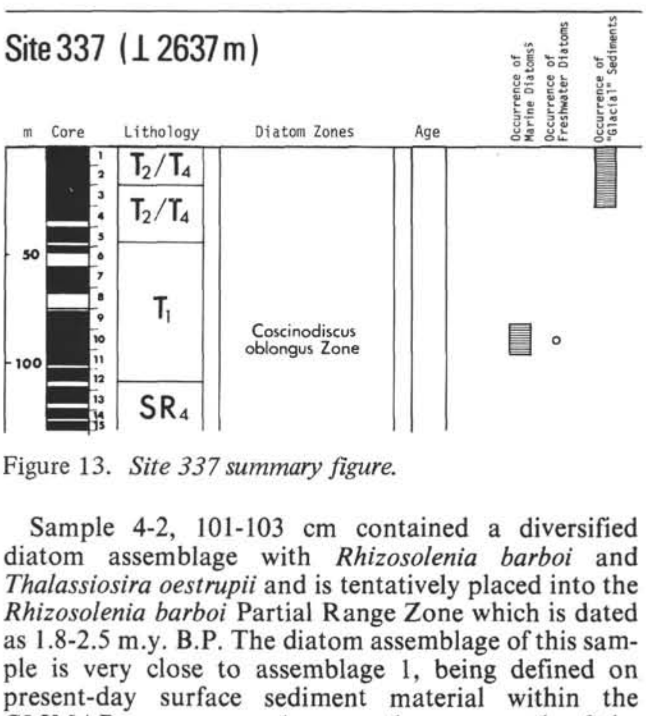


Figure 13. *Site 337 summary figure.*

Sample 4-2, 101-103 cm contained a diversified diatom assemblage with *Rhizosolenia barboi* and *Thalassiosira oestrupii* and is tentatively placed into the *Rhizosolenia barboi* Partial Range Zone which is dated as 1.8-2.5 m.y. B.P. The diatom assemblage of this sample is very close to assemblage 1, being defined on present-day surface sediment material within the CLIMAP program, and covers the area north of the Iceland-Faeroe Ridge to approximately 70°N, and is characterized by the northward flow of the Gulf stream.

The displaced block of biogenic diatomaceous ooze represented in Samples 5-2, 105-107 cm through 7-5, 82-84 cm contained a well-preserved diatom assemblage with index species such as *Coscinodiscus flexuosus*, *Denticula punctata*, *Mediaria splendida*, *Coscinodiscus endoi*, *Goniothecium tenue* and places this block into the *Nitzschia* sp. 8 Range Zone, which, if the correlation to Koizumi's (1973) *Denticula hustedtii* Zone and Schrader's (1973a) NPD Zone XIX is correct, can be dated as being approximately 10-12 m.y.B.P. and as being of middle Miocene age.

The next unit directly overlain by the "Glacial" sequence consists of transitional biogenic siliceous ooze, primarily diatomite, and covers the interval from 328 to 456 meters and deeper (uncored). Cores 26 through 29 are placed into the *Nitzschia* sp. 8 Range Zone which has an approximate early late or late middle Miocene age (10-12 m.y.B.P.). Core 30 is placed into the *Coscinodiscus plicatus* group Partial Range Zone which has a tentative age of approximately 13.5-13 m.y.B.P., and Cores 31-34 are placed into the *Denticula hyalina* Partial Range Zone which has not been absolutely dated, but is still in the middle Miocene and is younger than 15 m.y. No fresh-water diatoms were observed, but reworked older species of Eocene and Oligocene age were found in all diatomaceous samples. Displaced shallow-water marine-benthonic species were found only in the block within the "Glacial" sequence. No facies change was observed in the lower diatomaceous sequence.

The occurrence of sponge spicules is listed in Table 11; samples barren in diatoms are listed in Table 12.

Site 342 (Figure 20; Table 13)

Site 342 is located on the Vøring Plateau on the landward side of the Vøring Plateau escarpment. Glacial muds were recovered in Cores 1 and 2, late early Miocene siliceous ooze in Cores 3-6 above basaltic basement. Diatoms were found in high abundance and

TABLE 3
Diatoms at Site 337

Sample (Interval in cm)	Abundance	Preservation	Sponge spicules	*Archaeomonadaceae* (Plate 25, Fig. 36-41)	*Asterolampra punctifera*	*A.* sp. (Plate 28, Fig. 5)	*A.* sp. (Plate 28, Fig. 2)	*Cestodiscus* sp.	*Chaetoceros bristles*	*C.* spores	*Cocconeis* spp.	*Coscinodiscus symbolophorus* group	*Grammatophora* spp.	*Hemiaulus hostilis*	*H. pyxilloides*	*Huttonia norwegica*	*Melosira islandica*	*M. sulcata*	*Navicula udintsevii*	*Pyrgupyxis johnsoniana*	*Rhizosolenia hebetata* var. *subacuta*	*Riedelia* sp. 1	*Rouxia obesa*	*Sceptroneis grunowii*	*Stephanopyxis turris* group	*Thalassionema* aff. *nitzschioides*	*Thalassiosira dubiosa*	*Trinacria excavata*	*Trochosira spinosa*	*Hemiaulus pungens*
9-5, 100-102[a]	C	G	R		R	R			C	C			R		R	F			R	F			R	R	F				C	
10-2, 90-92	A	G	R		F				C	C	R		R			F		F	R	C		R	R		C	F		R	R	R
10-5, 120-122	A	G	R				R	R	C	C	R		R		R	F	R	R	R	R	R		R	F	R	F				
11-2, 10-12	A	M	B	C					R	C		R		R		R		R		F	F				C		R		R	R

[a]Ash.

TABLE 4
Samples Barren in Diatoms, Site 337

2-2, 70-72 cm
2-5, 90-92 cm
4-2, 80-82 cm
5-2, 38-40 cm
5-5, 52-54 cm
6-2, 112-114 cm
7-2, 78-80 cm
11-5, 110-112 cm
12-2, 35-37 cm

good preservation in the siliceous ooze and contained few age-diagnostic species (Table 13): *Bruniopsis mirabilis*, *Coscinodiscus lewisianus*, *Cymatosira biharensis*, *Opephora gemmata*, *Rhaphoneis parallelica*, *R. wicomicoensis*, *Rhizosolenia bulbosa*, and *Thalassiosira fraga*. The range of the above species did allow the following zonation: Cores 3-5 belong to the *Rhizosolenia bulbosa* Partial Range Zone, and Core 6 belongs to the *Thalassiosira fraga* Partial Range Zone. Both zones are of late early Miocene age (base of *Rhizosolenia bulbosa* Zone dated as 19.5 m.y.B.P.). Reworked older species of Eocene to Oligocene age were observed in Samples 3-2, 70-72 cm, 5-2, 60-62 cm, and 6-2, 70-72 cm. Displaced fresh-water species (*Melosira islandica*) were found only in Sample 6-2, 70-72 cm, and displaced shallow-water benthonic species (*Diploneis* sp.) were found in Core 5. No change in the diatom assemblage was found between the recovered siliceous section. Due to spot coring, sediment accumulation rates have not been calculated. The total recovered siliceous section (from 3-2, 70-72 cm to 6-2, 70-72 cm) is of late early Miocene age.

Site 343 (Figures 21, 22; Tables 14, 15)

Site 343 is located at the eastern margin of the Lofoten Basin at the foot of the Vøring Plateau at a water depth of 3131 meters below sea level. The hole penetrated 253 meters of sediment with four lithologic units. Unit 4 was principally distinguished on the basis of its position between two basalt layers (Core 15-1 to Core 16-3).

Well-preserved diatom assemblages were only recovered at Cores 5-6 and did contain a flora being different from all other Leg 38 material. It is dated only by comparison with the well-known Cementstein flora (Benda, 1972) of Mors, Jutland which has been placed into the early Eocene. An early Eocene age was also assigned to this core by silicoflagellate studies (Müller, this volume). Because of this single occurrence, no further biostratigraphic investigation was made.

Sample 343-5-2, 140-142 cm did contain a well-preserved diverse middle Miocene diatom assemblage with *Denticula hustedtii*, *Mediaria splendida*, *Denticula punctata*, *Pseudodimerogramma elongata*, *Rhaphoneis parallelica*, *Goniothecium tenue*, and *Bruniopsis mirabilis*. Displaced shallow-water benthonic diatom species or displaced fresh-water diatoms were not observed.

A drastic change in composition, and slightly in preservation, was found to occur between Samples 5-6, 110 cm to 6-1, 128 cm; the flora changes from diverse to nearly monotonic composition. Samples barren in diatoms are listed in Table 15 and in Figure 22 (right).

Site 344 (Figure 23; Table 16)

Site 344 on the Knipovich Ridge, the northernmost hole drilled, penetrated 414 meters of sediments and basalt. It was impossible to give any biostratigraphic interpretation on the recovered sediments by means of

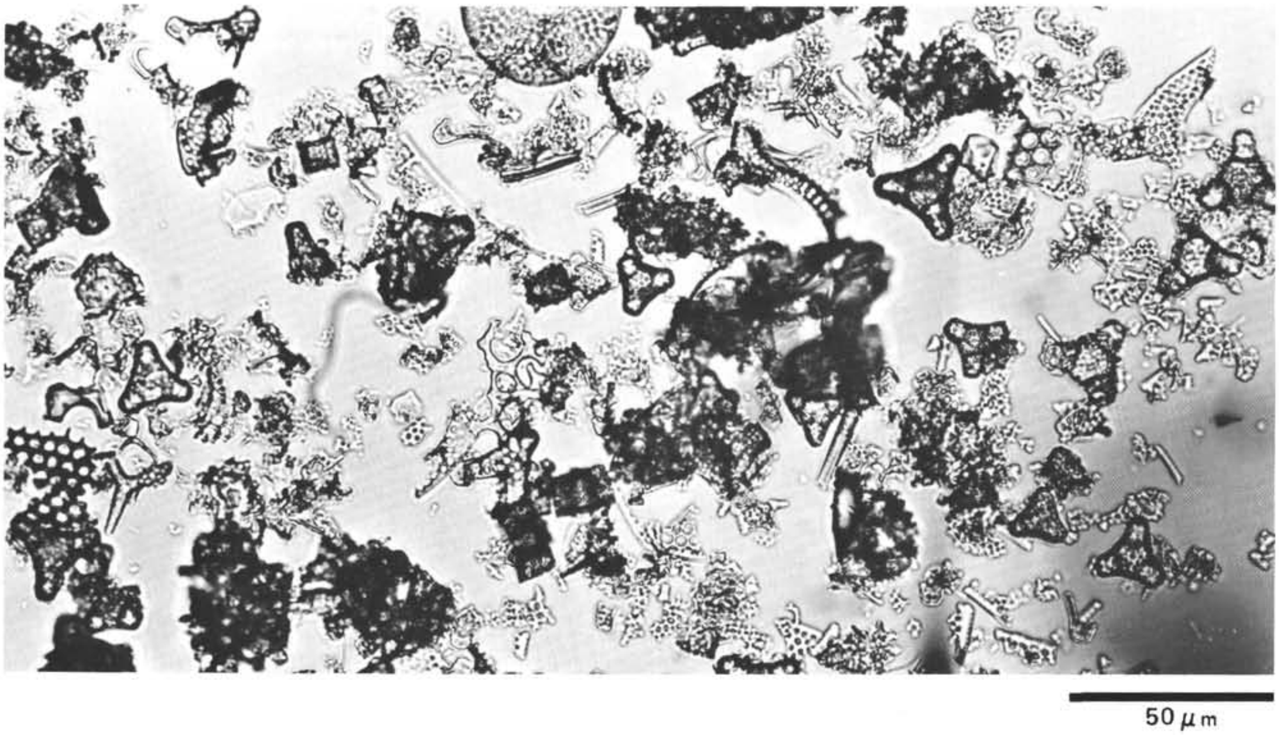


Figure 14. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 338-29, CC with abundant* Triceratium barbadense, *and broken fragments of silicoflagellatae and diatoms. Distance between two bars 10 μm.*

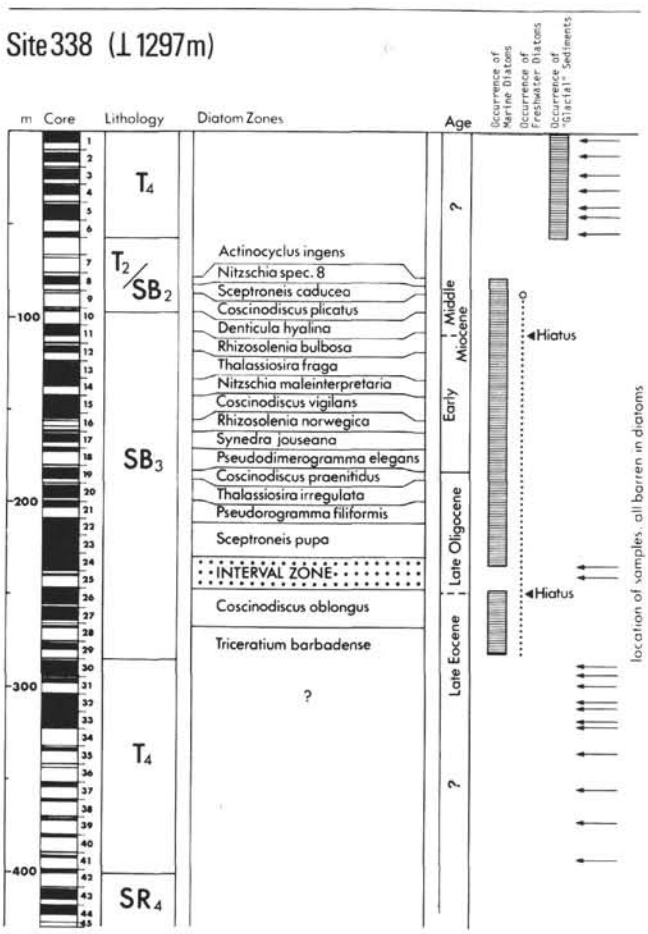


Figure 15. *Site 338 summary figure.*

diatoms. All samples were barren in diatoms (Table 16; Figure 23).

Site 345 (Figure 24; Tables 17, 18)

Site 345 is located in the Lofoten Basin near the eastern flank of Mohns Ridge in a water depth of 3195 meters. Three sedimentological units were cored. Diatoms were only found in the interval of Unit 2 (Cores 6-2, 68 cm to 11-3, 50 cm) with well-preserved diversified assemblages in Cores 6-9, and poor to moderate preserved assemblages in Cores 9-11. Freshwater diatoms were observed in Samples 8-1, 79 cm; 10-1, 40 cm; and 10-3, 50 cm.

Age-diagnostic species were found only in the interval between Samples 6-2, 68 cm to 8-1, 79 cm with *Coscinodiscus vigilans*, *Goniothecium tenue*, *Opephora gemmata*, *Thalassiosira fraga* (Table 18). Therefore, Samples 6-2, 68 cm to 7-2, 59 cm have been placed into the *Rhizosolenia bulbosa* Partial Range Zone; Samples 8-1, 79 cm to 8-3, 62 cm into the *Thalassiosira fraga* Partial Range Zone. Only a tentative early Miocene age could be assigned to the interval between Samples 9-3, 30 cm to 11-3, 50 cm with an absolute age older than 19.5 m.y.B.P.

Displaced marine-benthonic species (*Diploneis* spp., *Cocconeis* spp., *Rhabdonema* spp.) were found in low percentages in all diatomaceous samples. Samples barren in diatoms are listed in Table 18 and indicated by arrows (right) in Figure 24.

Site 346 (Figure 25; Tables 19, 20)

Site 346 is located on the Jan-Mayen Ridge in a water depth of 745 meters. Diatom assemblages were found from Core 5 through Core 11 with ranging abundance

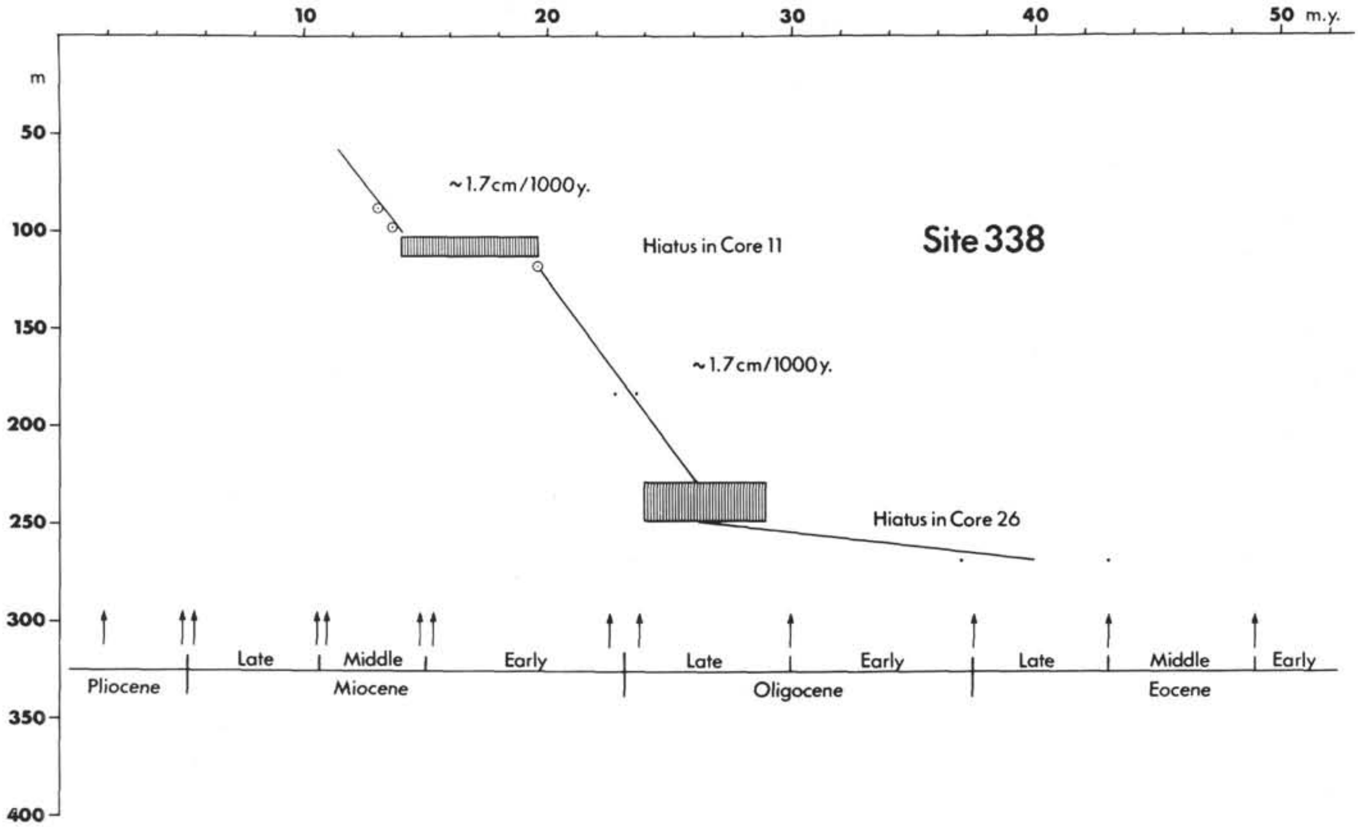


Figure 16. *Sediment accumulation rate at Site 338.*

and preservation. Commonly assemblages are poorly preserved. Therefore, biostratigraphic zonation described below is tentative and is based on using the youngest index species being found in a stratum and interpreting other present index species being reworked. This assumption is evidenced by the simultaneous enrichment of marine benthonic displaced species (*Arachnoidiscus*, *Hyalodiscus*, *Grammatophora*, and *Cocconeis*). The almost constant presence of sponge spicules in small numbers can be also interpreted as being an indication for displacement of shallow material and/or by a dissolution effect. The latter leads to badly preserved assemblages and enriches skeletons, which are more heavily silicified. A sudden increase in individuals of the genus *Goniothecium* (*odontella/decoratum*) in Sample 9-5, 40 cm and deeper is interpreted as a change in facies from shallow to deep.

As mentioned above, the biostratigraphic zonation is tentative and is based for Sample 5-1, 60 cm on the occurrence of *Thalassiosira nidulus* and abundant *Rhizosolenia barboi*, which place Samples 5-1, 30 cm to 5-1, 60 cm into the *Thalassiosira kryophila* and/or into the *Rhizosolenia barboi* zones (age: 1.8 to approximately 3.5 m.y.). The interval between Samples 6-2, 30 cm to 12-1, 105 cm is characterized by abundant *Goniothecium tenue* and under the assumption that individuals of this species in Samples 10-3, 20 cm; 11-2, 25 cm; and 11-4, 40 cm do differ in shape and structure from previously known samples in being more heavily silicified and some being structured (compare Plate 37, Figures 6-10). They were not taken here into the range of *Goniothecium tenue*, and thus the following subdivision was possible. Interval between Samples 5-3, 95 cm to 8-2, 30 cm is of middle Miocene age; interval between Samples 9-5, 40 cm to 11-4, 40 cm can be placed into the *Coscinodiscus plicatus* Zone; and Samples 11-4, 40 cm into the early Miocene with reworked early early Miocene and late Oligocene species (*Trinacria excavata*, *Pseudotriceratium chenevieri*, *Cymatosira* spp.).

No fresh water diatoms were observed.

Site 347 (Figure 26, Table 20)

Site 347 was located only a few kilometers from Site 346 and since the main objective was to drill into basement, little coring was done in the sedimentary sequence. The three samples studied in this report were barren for any kind of siliceous microfossils (Table 20, Figure 26).

Site 348 (Figures 27-30; Tables 21, 22)

Site 348 is located in an area of well-defined linear magnetic anomalies on the Islandic Plateau, east of the 10-m.y. isochron of the Island Jan-Mayen Ridge. Various sequences of coring and washing were used to penetrate a total subbottom depth, including igneous rocks, of 544 meters. Glacially derived sediments were found in Cores 1 through 5 and are of Pleistocene age.

The detailed biostratigraphic discussion and zonation can be found within the part "Time ranges and biostratigraphic zonation." Therefore, only zonal boundaries are listed here with their approximate ab-

TABLE 5
Diatoms at Site 338 (Cores 8-21, CC)

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinocyclus ehrenbergii*	*A. ehrenbergii* var. *tenella*	*A. elliptica*	*A. ingens*	*Actinoptychus splendens*	*A. thumii*	*A. undulatus*	*Anaulus acutus*	*Asterolampra areolata*	*A. marylandica*	*Asteromphalus oligocenicus*	*Asteromphalus symmetricus*	*Biddulphia tuomeyi*	*Bruniopsis mirabilis*	*Cestodiscus peplum*	*C.* sp. a	*Chaetoceros dicladia*	*C.* spores	*C.* sp. 2	*Cladogramma dubium*	*Coscinodiscus bathyomphalus*	*C. endoi*	*C. lewisianus*	*C. lineatus*	*C. marginatus*	*C. nodulifer*	*C. plicatus*	*C.* cf. *plicatus*	*C. praenitidus*	*C. rhombicus*	*C.* aff. *rothii*	*C. symbolophorus*-group	*C. vetustissimus*	*C. vigilans*	*Craspedodiscus coscinodiscus*	*Cymatosira biharensis*	*C. compacta*	*C. fossilis*	*C. lorenziana*	*C. robusta*	*C.* sp. 1	*Denticula hustedtii*	*D. hyalina*	*D. lauta*	*D. nicobarica*	*D. norwegica*	*D. punctata*	*D. punctata* var. *hustedtii*	*Dicladia norwegica*	*Dimerogramma fossile*	*D. furgicerum*	*D.* aff. *dubium*	*D.* aff. *fulvum*	*Ethmodiscus rex*	*Eucampia balaustium*
8-2, 10-11	A	G	F	R			R			R							R				C				R	R		R		R						R			R						C					R								
8-2, 58-59	A	G	F	R	R		R			R							R		R		C		R		R	R	R									R		R	R						C					R					F			
8-3, 2-3	A	G	F	R	R		R			R							R		R		C		R		R	R	R									R		R	R						C					R					F			
8-3, 70-71	A	G	R				R			R			R				R		R		C				R			R			R					R			F						C										R			
8-4, 85-86	A	G	R				R			R			R				R		R		C				R		R	R			R					R			F						C										R			
8, CC	A	G	F	R			R			R							R		R		C				R		R				R				R				F						A					R								
9-1, 65-66	A	G	F		R		F			R							R				C										F								C						A					R					R			
9-1, 135-136	A	G	F		R		F			R							R				C							R			F								C						A					R					R			
9, CC	A	G	F	R	R		C			R							R		R		C		R		R	R	R	R			R				R	R			R						F	R				R					R			R
10-1, 135-136	A	G	F		R		C			R							R				C										R								R						C	R	R			R					R			R
10-2, 55-56[a]	A	G	F	R			F			R											C		R			R									R	R			R							F	R					R			R			
10, CC	A	G	F	R			R		R	F			R				F		R		C		R	R		R		R							R				R						R				R								F	
11-1, 65-66	A	G	R	R			R			F							R		R		C	R	R		R			R							R				R						R	R	R			R							R	R
11-1, 135-136	A	G	F				R			F							R	R			C		R		R			R							R				R						R	R	R										R	R
11-2, 5-6	A	G	F	R	R					F							R	F			C		R		R	R		R							R	R			R						R		R		R						R		R	R
11-2, 85-86	A	G	F	R	R		R			F							R	F			C		R		R	R		R							R	R			R						R		R		R						R		R	R
11-3, 5-6	A	G	F	F			F			F			R				F	F			C	R	F			R		R							R	R			F							R	R			R	R				R			R
11-3, 50-51	A	G	F	F						F			R				F	F			C	R	F			R		R							R	R			F							R	R			R	R				R			R
11-3, 85-86	A	G	F	F						F			R				F	F			C	R	F			R		R							R	R			F					R		R	R			R	R				R			R
11-4, 5-6	A	G	F	R	R		R			R							R	F			C	R	F					F							R	R		R	F					F			R	R		R					R		R	R
11-4, 85-86	A	G	F	R	R		R			R							R	F			C	R	F					F							R	R		R	F					F			R	R		R					R		R	R
11, CC	A	G	F	R						F								R			A	R						R											R					F											R		R	R
12-2, 5-6	A	G	F	R						C								F			A	R	F			R	R	R											R																R			R
12-2, 85-86	A	G	F	R						C								F			A	R	F			R	R	R											R																R			R
12-3, 5-6	A	G	F	R						C								F			A	R	F			R		R											R																R			R
12-3, 90-91	A	G	F	R						C								F			A	R	F			R		R											R																R			R
13-1, 55-56	A	G	F	R														F			A		F					R							R																						R	
13-1, 60-61	A	G	F	R														F			A		F					R							R																						R	
13-1, 125-126	A	G	F	R														F			A		F				R	R							R																						R	
13-2, 20-21	A	G	F	R														F			A		F					R							R																						R	
13-2, 85-86	A	G	F	R						R								F			A		F				R	R							R																						R	
13-3, 5-6	A	G	F	R														F			A		F				R	R							R																						R	
13-3, 85-86	A	G	F	R						F								F			A		F				R	R							R																						R	
13-4, 5-6	A	G	F	R														F			C		F				R	R							R																						R	
13-4, 85-86	A	G	F	R						R								F			A		F				R	R							R																						R	
13-5, 5-6	A	G	F	R						R								F			C		F				R	R							R																						R	
13-5, 85-86	A	G	F	R						R								F			A		F				R	R							R																						R	
13-6, 5-6	A	G	F	R						R								F			A		F				R	R							R																	R					R	
13-6, 85-86	A	G	F	R						R								F			A		F				R	R							R																						R	
13, CC	A	G	F	R						R								F			A		F				R	R							R																	R					R	
14-1, 20-21	A	G	F							R						R		R			C	R	F				R	R								R																	R				R	R
14-1, 95-96	A	G	F							R						R		R			C	R	F				R	R								R																R	R				R	R
14-2, 5-6	A	G	F							R						R		R			C	R	F				R	R								R	R																R				R	R
14-2, 85-86	A	G	F							R								F			A	R	R				R	R								R																R	R			R	R	R
14-3, 5-6	A	G	F							R								F			A	R	R				R	R								R																	R				R	R

14-3, 85-86	A	G	F							R								F			A	R	R				R	R								R																	R	R			R	R	R
14, CC	A	G	F							R								F			A	R	R				R	R								R																	R	R			R	R	R
15-1, 20-21	A	G	F							R								F			A	R	R				R	R								R																	R	R				R	R
15-1, 95-96	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R			R	R	R
15-2, 5-6	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R			R	R	R
15-2, 85-86	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R				R	R
15-3, 5-6	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R			R	R	R
15-3, 85-86	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R					R	R
15-4, 5-6	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R			R	R	R
15-4, 80-81	A	G	F							R							R	F			A	R	R				R	R							R	R	R															R	R				R	R
15-5, 15-16	A	G	F							R							R	F			A	R	R					R							R	R	R															R	R			R	R	R
15-5, 40-41	A	G	F							R							R	F			A	R	R					R							R	R	R																R				F	R
15-5, 140-141	A	G	F							F							R	F			A	R	R				R	R							R	R	R															R	R			R	F	R
15-6, 130-131	A	G	F							R							R	R			A	R	R				R	R							R	R	R															R				R	F	R
15, CC	A	G	F							R							R	F			A	R	R				R	R							R	R																R	R			R	F	R
16-1, 10-11	A	G	F							R							R	F			A	R	R				R	R							R	R																R	R				F	R
16-1, 85-86	A	G	F							R							R	F			A	R	R				R	R							R	R																F	R				R	R
16-2, 10-11	A	G	F							F							R	F			C	R	R					R							R																	F					R	R
16-4, 67-68	A	G	F		R					F			R		R		R	F			C	R	R												R																	F					R	R
16-5, 50-51	A	G	R							R							R	F		R	A							R																								R					R	R
16-6, 95-96	A	G	R							F							R				A		R					R							R	R																F					R	R
16, CC	A	G	F							F							R				A		R					R							R	R																F					R	R
17-2, 46-47	A	G	F	R						F							R	R			C		R												R	R																R	R				R	R
17-2, 135-136	A	G	R	R						F							R	R			A		F												R	R																R	R				R	
17-3, 33-34	A	G	R	R						R							R	R			A														R	R																R	R				R	R
17-3, 110-111	A	G	R	R						F							R	R			A														R	R																R	R				C	R
17-4, 10-11	A	G	R	R						R							R	R			A														R	R																R	R				C	R
17-4, 85-86	A	G	R	R						R							R	R			A														R	R																R	R				C	R
17, CC	A	G	R	R						R							R	R			A														R	R																R	R				C	R
18-1, 50-51	A	G	R																																																							
18-2, 85-86	A	G	R							R							R	F			C		R					R							R																	R					R	
18, CC[a]	A	G	R							R								C			C					R		F							R	R																R					R	
19-2, 10-11	A	G	R							R								F			A														R				R																			
19-2, 85-86	A	G	R							R								F			A														R																							
19-3, 12-13	C	M	F							R								F		R	C							R											R		R		R														R	
19-3, 40-41	A	G	R	R						R								R			C														R		R				F		F										R		R			R	
19-3, 140-141	A	G	R	R	F				R	F	R	R		R	R			R			C					R						R			R		R			R	F	R	F									R		R			R	
19-4, 33-34	A	G	R	R					R	R				R	R			R			C														R	R	R			R	F		F									R		R			R	
19-4, 85-86	A	G	R						R	R				R	R			R			C											R			R	R	R			R			R															
19-5, 65-66	A	G	R							R				R	R			R			C											R			R	R	R			R			R															
19-5, 123-124	A	G	R							R				R	R			R			C											R			R	R	R			R			R															
19, CC	A	G	R						F					R	R			F			C													R	F	R				R	R																	
20-1, 126-127	A	G	R						F					R	R			R			A													R	R	R				R	R																	
20-2, 30-31	A	G	R						F					R	R			F			A													R	F	R				R	R																	
20-2, 100-101	A	G	R						F					R	R			F			A													R	F	R				R	R																	
20-3, 20-21	A	G	R						F					R	R			F			C													R	R	R				R	R																	
20-3, 110-111	A	G	R						F					R	R			F			C													R	R	R				R	R																	
20-4, 100-101	A	G	R						F					R	R			F			C													R	R	R				R	R																	
20-4, 125-126	A	G	R						F					R	R			F			C													R	R	R				R	R																	
20-5, 50-51	A	G	R						F	F				C	F			F			C														R	R	R			R																		
20-5, 100-101	A	G	R						F	F				C	F			F			C														R	R	R			R																		
20, CC[a]	A	G	R						F	F				C	F			F			C														R	R	R			R																		
21-1, 67-68	A	G	R						F	R				F	R			F			C														R	R	R			F	F																	
21-2, 143-144	A	G	R						F	R				F	R			F			C														R	R	R			F	F																	
21, CC	A	G	R						F	R				F	R			F			C														R	R	R			F	F																	

TABLE 5 – *Continued*

Sample (Interval in cm)	*Eucampia* aff. *balaustium*	Genus and species indet. (2)	Genus and species indet. (3)	Genus and species indet. (4)	Genus and species indet. (5)	*Goniothecium decoratum*	*G. odontella*	*G. tenue*	*Grammatophora* sp. 1	*G.* sp. 2	*Hemiaulus danicus*	*H. giganteus*	*H. kittonii*	*H. malleolus*	*H. malleus*	*H. polycistinorum*	*H. pyxilloides*	*H.* sp. a	*H.* sp. b	*Hyalodiscus* aff. *subtilis*	*Lithodesmium rotunda*	*Macrora stella*	*Mediaria splendida*	*Melosira architecturalis*	*M. granulata*	*M. ornata*	*M. sulcata*	*Muelleriella limbata*	*Nitzschia evenescens*	*N. maleinterpretaria*	*N.* aff. *maleinterpretaria*	*N. porteri*	*N. praereinholdii*	*N. pseudocylindrica*	*N. riedelia*	*N.* sp. b	*N.* sp. 8	*Odontella aurita*	*O. calamus*	*O. cornuta*	*O.* aff. *fimbriata*	*O. septentrionala*	*Opephora gemmata*	*Pleurosigma planktonica*	*Pseudodimerogramma elliptica*	*P. elogans*	*P. elongata*	*P. filiformis*	*P. oligocenica*	*Pseudopodosira simplex*	*Pseudopyxilla americana*	*P.* sp. a	*Pseudotriceratium chenevieri*	*Pterotheca reticulata*	*Raphidodiscus marylandicus*
8-2, 10-11	R							R														R	R		R		R		R				R																		R				
8-2, 58-59	R						R	R															R				R						R		R		R	R													R	R			
8-3, 2-3	R						R	R															R				R						R		R		R	R													R	R			
8-3, 70-71							R																R				R					R					F	R												R	R				
8-4, 85-86							R																R				R					R					F	R						R						R	R				
8, CC	R							R															R				R		F			R		R		R		R	R					R						R					
9-1, 65-66								R															R				R		F							R		R												R	R				
9-1, 135-136								R															R				R		F							R		R												R	R				
9, CC																							R				R					R				R		R	R											R	R				
10-1, 135-136																							R				F		R										R											R					
10-2, 55-56[a]							R							R	R							R					R		R															R			R				R				
10, CC							R							R	R							R	R				F																	R						R	F				
11-1, 65-66		R					R							R	R												R											R					R	R						R	R				R
11-1, 135-136							R																				F											R					R	R						R	F				R
11-2, 5-6		R					R							R											R		R											R					R	R			R			R	R				
11-2, 85-86		R					R							R											R		R											R					R	R			R			R	R				
11-3, 5-6							R							R													R																R								F				
11-3, 50-51		R					R							R		R											R																R								F				
11-3, 85-86		R					R							R		R											R																R								F				
11-4, 5-6		R					R					R				R			R				R				F											R				R	R	R			R			R	R	R			
11-4, 85-86		R					R					R				R			R				R				F											R				R	R	R			R			R	R	R			
11, CC		R	R									R				R			R								F															R					R			R	R				
12-2, 5-6			R				R					R			R	R											F															R		R						F	R				
12-2, 85-86							R								R	R											F															R		R		R				F	R				
12-3, 5-6							R								R	R											F															R		R		R				F	R				
12-3, 90-91							R								R	R											F															R		R		R				F	R				
13-1, 55-56							R									R											R															R				R				R	R				
13-1, 60-61							R									R											R																							R	R				
13-1, 125-126							R																				R															R								R	R				
13-2, 20-21							R																				R															R								R	R				
13-2, 85-86				R			R																				R																							R	R				
13-3, 5-6				R			R									R											R															R								R	R				
13-3, 85-86				R			R									R											R			R												R								R	R				
13-4, 5-6				R			R									R											R			R												R								R	R				
13-4, 85-86				R			R									R											R			R												R								R	R				
13-5, 5-6				R			R																				R			R																				R	R				
13-5, 85-86				R			R									R											R			R												R								R	R				
13-6, 5-6				R			R									R											R			R												R								R	R				
13-6, 85-86				R			R									R											R			R												R								R	R				
13, CC				R			R									R											R			R												R								R	R				
14-1, 20-21				R			R									R											F	R		R												R		R		R					R	R			R
14-1, 95-96				R			R									R											F	R														R		R		R	R				R	R			R
14-2, 5-6				R			R									R											F	R														R		R		R					R	R			R
14-2, 85-86				R			R									R											F			R												R	R	R		R	R			R	F				
14-3, 5-6							R									R											F			R												R	R	R		R				R	F				

14-3, 85-86	R			R															F	R					R	R	R		R	R			R	R			
14, CC	R			R															F	R					R	R	R		R	R			R	F			
15-1, 20-21	R			R															F	R					R	R	R		R				R	R			
15-1, 95-96	R			R															F			R			R	R	R		R				R	R			R
15-2, 5-6	R			R															F			R			R	R	R		R	R			R	R			R
15-2, 85-86	R			R															F			R			R	R	R		R				R	R			R
15-3, 5-6	R			R															F			R			R	R	R		R	R			R	R			R
15-3, 85-86	R			R															F						R	R	R		R				R	R			R
15-4, 5-6	R			R															F			R			R	R	R		R	R			R	R			R
15-4, 80-81	R			R															F			R			R	R	R		R				R	R			R
15-5, 15-16	R			R															F			R			R	R	R		R	R			R	R			R
15-5, 40-41	R			R															F			R			R	R	R		R	R			R	R			R
15-5, 140-141	R			R															F						R	R	R		R	R			R	R			R
15-6, 130-131	R			R															F			R			R	R	R		R	R			R	R			R
15, CC	R		R	R													R		F						R	R	R		R				R	R			F
16-1, 10-11	R			R													R		F						R	R	R		R				R	R			R
16-1, 85-86	R		R														R		F						R	R	R		R				R	F			R
16-2, 10-11				R													R		F						R	R	R						R	R			R
16-4, 67-68	R		R							R							R[a]		F						R		R		F					F			
16-5, 50-51			R							R									C						R	R	R			R			R	R			R
16-6, 95-96	R		R							R									F							R	R		F				R	F			R
16, CC	R		R							R									F							R	R		F				R	F			R
17-2, 46-47			R												F				C		R					R			F				R	R			R
17-2, 135-136			R												F				C		R					R			F				R	R			R
17-3, 33-34	R		R							R					F		R		C							R	R		F								
17-3, 110-111	R		R							R					R		R		C							R	R		F								
17-4, 10-11	R		R							R					R		R		C							R	R		F								
17-4, 85-86	R		R							R					R		R		C							R	R		F								
17, CC	R		R							R					R		R		C							R	R		F								
18-1, 50-51																																					
18-2, 85-86			R														R		C								R		R				R	R			
18, CC[a]			R																C								R		F					R			
19-2, 10-11					R														C					R					R					R			
19-2, 85-86																			C					R					R					R			
19-3, 12-13			R																F										F					R			
19-3, 40-41			R								R			R					F			R		R				R	R					R			R
19-3, 140-141		R	R	R			R	R	R		R	R	R	R	R			R	F			R		R			R	R	R			R		R	R		R
19-4, 33-34			R								R	R	R	R					F			R		R				R	R			R		R	R		R
19-4, 85-86			R										R						F					R			R					R		R	R	F	
19-5, 65-66			R										R						F					R			R					R		R	R	F	
19-5, 123-124			R										R						F					R			R					R		R	R	F	
19, CC						R							F						R					R			R					R				R	
20-1, 126-127						R							F						R					R			R					R				R	
20-2, 30-31						R							F						R					R			R					R				R	
20-2, 100-101						R							F						R					R			R					R				R	
20-3, 20-21						R							F						R					R			R					R				R	
20-3, 110-111						R							F						R					R			R					R				R	
20-4, 100-101						R							F						R					R			R					R				R	
20-4, 125-126						R							F						R					R			R					R				R	
20-5, 50-51			R								R		F						F				R	R			R					R			R	R	
20-5, 100-101			R								R		F						F				R	R			R					R			R	R	
20, CC[a]			R								R		F						F				R	R			R					R			R	R	
21-1, 67-68			R	F		R					R	R	R			R			C		R		R	R			R				F	R			R	R	
21-2, 143-144			R	F		R					R	R	R			R			C		R		R	R			R				F	R			R	R	
21, CC			R	F		R					R	R	R			R			C		R		R	R			R				F	R			R	R	

TABLE 5 – *Continued*

Sample (Interval in cm)	*Rhaphoneis amphiceros*	*R. elongata*	*R. elliptica*	*R. gemmifera*	*R. margaritalimbata*	*R. ossiformis*	*R. parallalica*	*R. robustata*	*R. wicomicoensis*	*R.* sp. 1	*R.* sp. 2	*Rhizosolenia alata*	*R. barboi*	*R. bulbosa*	*R. hebetata* forma *semispina*
8-2, 10-11	R				R		R								
8-2, 58-59	R					R	R								
8-3, 2-3	R					R	R								
8-3, 70-71	R					R									
8-4, 85-86	R					R									
8, CC	R					R						R			
9-1, 65-66			R	R	R	R	R					R			
9-1, 135-136			R	R	R	R	R					R			
9, CC	R			R		R						R			
10-1, 135-136									R						
10-2, 55-56[a]	R					R	R								
10, CC															
11-1, 65-66						R	R					R		R	
11-1, 135-136						R						R		R	
11-2, 5-6			R		R		R	R						R	
11-2, 85-86			R		R		R	R						R	
11-3, 5-6	R				R		R							R	
11-3, 50-51	R				R		R							R	
11-3, 85-86	R				R		R							R	
11-4, 5-6	R				R		R							R	
11-4, 85-86	R						R							R	
11, CC	R		R				F								
12-2, 5-6					R		R							R	
12-2, 85-86					R		R		R					R	
12-3, 5-6					R		R		R					R	
12-3, 90-91					R		R		R					R	
13-1, 55-56					R		R		R					R	
13-1, 60-61					R									R	
13-1, 125-126					R									R	
13-2, 20-21					R									R	
13-2, 85-86					R									R	
13-3, 5-6					R									R	
13-3, 85-86					R									R	
13-4, 5-6					R									R	
13-4, 85-86					R									R	
13-5, 5-6					R									R	
13-5, 85-86					R									R	
13-6, 5-6					R									R	
13-6, 85-86					R									R	
13, CC					R									R	
14-1, 20-21														R	
14-1, 95-96	R													R	
14-2, 5-6														R	
14-2, 85-86	R											R		R	
14-3, 5-6	R											R		R	

Sample (Interval in cm)	*R. hebetata* forma *hiemalis*	*R. hebetata* forma *subacuta*	*R. hebetata* var. *subacuta*	*R. miocenica*	*R. norwegica*	*R. pokrovskaja*	*R. praealata*	*R. praebarboi*	*R. styliformis*	*Rouxia californica*	*R. diploneides*	*R. granda*	*R. isopolica*	*R. yabei*	*R.* sp. 1
8-2, 10-11									R	R	R			R	
8-2, 58-59	R			R					R	R	R			R	
8-3, 2-3	R			R					R	R	R			R	
8-3, 70-71				R					F					R	
8-4, 85-86				R					F					R	
8, CC				R					F	R				R	
9-1, 65-66	R			R					R	R				R	
9-1, 135-136	R			R					R	R				R	
9, CC	R								R						
10-1, 135-136									R	R					
10-2, 55-56[a]				R				R							
10, CC								R	R		R				
11-1, 65-66								R	R						
11-1, 135-136	R							F							
11-2, 5-6	R			R				F							
11-2, 85-86				R				F							
11-3, 5-6									R						
11-3, 50-51									R						
11-3, 85-86									R						
11-4, 5-6							R	F							
11-4, 85-86							R	F							
11, CC	R														
12-2, 5-6	R							R	R						
12-2, 85-86	R							R	R						
12-3, 5-6	R							R	R						
12-3, 90-91								R	R						
13-1, 55-56								R	R					R	
13-1, 60-61								R	R					R	
13-1, 125-126								R	R					R	
13-2, 20-21								R	R					R	
13-2, 85-86								R	R					R	
13-3, 5-6								R	R					R	
13-3, 85-86								R	R					R	
13-4, 5-6								R	R					R	
13-4, 85-86								R	R					R	
13-5, 5-6								R	R					R	
13-5, 85-86								R	R					R	
13-6, 5-6								R	R					R	
13-6, 85-86								R	R					R	
13, CC								R	R					R	
14-1, 20-21									R					R	
14-1, 95-96									R					R	
14-2, 5-6									R					R	
14-2, 85-86									R					R	
14-3, 5-6									R					R	

Sample (Interval in cm)	*Rutilaria areolata*	*Sceptroneis caducea*	*S. humuncia*	*S. ossiformis*	*S. propinqua*	*S. tenue*	*Stephanogonia horridus*	*Stephanopyxis hyalomarginata*	*S. marginata*	*S. schenckii*	*S. turris*	*Stictodiscus* aff. *kittonianus*	*Synedra jouseana*	*S. miocenica*	*Thalassionema hirosakiensis*
8-2, 10-11											R				
8-2, 58-59		R									R	R	R		
8-3, 2-3		R									R	R	R		
8-3, 70-71							R				F	R			
8-4, 85-86							R				F	R			
8, CC											R		R		
9-1, 65-66											F		R		
9-1, 135-136											F		R		
9, CC							R	R			R		F		
10-1, 135-136								R				R	R		
10-2, 55-56[a]								R			R	R	F		
10, CC											R		R		
11-1, 65-66											R	R	F		
11-1, 135-136											F	R	C		
11-2, 5-6								R		R	R	R	C		
11-2, 85-86								R		R	F	R	C		
11-3, 5-6								R		R	F		C		
11-3, 50-51		R						R		R	F		C		
11-3, 85-86		R						R		R	F		C		
11-4, 5-6		R						R		R	F		F		
11-4, 85-86		R						R		R	F		F		
11, CC		R								R	R		F		
12-2, 5-6		R						F		R	R		F		
12-2, 85-86		R						F		R	F		F		
12-3, 5-6		R						F		R	F		F		
12-3, 90-91		R						F		R	F		F		
13-1, 55-56		R								R	R		F		
13-1, 60-61		R								R	R		F		
13-1, 125-126		R								R	R		F		
13-2, 20-21		R								R	R		F		
13-2, 85-86		R								R	R		F		
13-3, 5-6		R								R	R		F		
13-3, 85-86		R								R	R		F		
13-4, 5-6		R								R	R		F		
13-4, 85-86		R								R	R	R	F		
13-5, 5-6		R								R	R	R	F		
13-5, 85-86		R								R	R	F	F		
13-6, 5-6		R								R	R	F	F		
13-6, 85-86		R								R	R	F	F		
13, CC		R								R	R		F		
14-1, 20-21		R		R						F	C	R	F		R
14-1, 95-96		R		R						F	C	R	F		R
14-2, 5-6		R		R						F	C	R	F		R
14-2, 85-86		R		R							F	R	F		R
14-3, 5-6		R		R							F	R	F		R

Sample (Interval in cm)	*T. lineata*	*T. nitzschioides*	*Thalassiosira fraga*	*T. irregulata*	*T.* aff. *irregulata*	*T. punctata*	*T. spinosa* var. *aspinosa*	*T. spumellaroides*	*Thalassiothrix longissima*	*Triceratium balearicum*	*T.* sp. a	*T.* sp. b	*Trinacria excavata*	*Trochosira spinosa*
8-2, 10-11		C							C			R		
8-2, 58-59		C							C		R			
8-3, 2-3		C							C		R			
8-3, 70-71		C							F		R			
8-4, 85-86		C							F		R			
8, CC		A							F		R			
9-1, 65-66		A							R		R			
9-1, 135-136		A							R		R			
9, CC	R	A							F					
10-1, 135-136		C							F		R			
10-2, 55-56[a]		C							F		R			
10, CC		A							F					
11-1, 65-66	F	C							F		R			
11-1, 135-136	F	C							F					
11-2, 5-6	F	C							R					
11-2, 85-86	F	C							R					
11-3, 5-6	R	A							F		R			
11-3, 50-51	R	A							F		R			
11-3, 85-86		A							F		R			
11-4, 5-6	F	C							F		R			
11-4, 85-86	F	C							F		R			
11, CC	R	C							R		R			
12-2, 5-6	R	R							R		R			
12-2, 85-86	R	R							F		R			
12-3, 5-6		R							F		R			
12-3, 90-91		R	R						F		R			
13-1, 55-56		R	F						F		R			
13-1, 60-61		R	F						F		R			
13-1, 125-126		R	F						F		R			
13-2, 20-21		R	R					R	F		R			
13-2, 85-86		R	R					R	F		R			
13-3, 5-6		R	R					R	F		R			
13-3, 85-86		R	R					R	F		R			
13-4, 5-6		R	R					R	F		R			
13-4, 85-86		R						R	F		R			
13-5, 5-6		R						R	F		R			
13-5, 85-86		R						R	F		R			
13-6, 5-6		R						R	F		R			
13-6, 85-86		R							F		R			
13, CC		R							F		R			
14-1, 20-21		R	F				C		F		R			
14-1, 95-96		R	F				C		F		R			
14-2, 5-6		R	F				C		F		R			
14-2, 85-86	R	F	F				C		F		R			
14-3, 5-6	R	F	F				C		F		R			

14-3, 85-86	R					R	R								R		R	R			R		R						F	R	F		R	R	F	F				C	F		R		
14, CC	R					R	R								R		R	R			R		R						F	R	F		R	R	F	F				C	F		R		
15-1, 20-21	R					R	R								R		R	R			R		R						F	R	F		R	R	F	F				C	F		R		
15-1, 95-96	R					R	R								R		F	R			R		R						F	R	F		R	R	F					C	F		R	R	
15-2, 5-6	R					R	R								R		F	R			R								F	R	F		R	R	F					C	F		R	R	
15-2, 85-86	R					R	R								R		F	R			R		R						F	R	F		R	R	F					C	F		R	R	
15-3, 5-6	R					R	R								R		F	R											F	R	F		R	R	F					C	F		R	R	
15-3, 85-86	R					R	R								R		R	R			R		R						F	R	F		R	R	F					C	F		R	R	
15-4, 5-6	R					R	R								R		R	R											F	R	F		R	R	F					C	F		R	R	
15-4, 80-81	R					R	R								R		R	R			R		R						F	R	F		R	R	F					C	F		R	R	
15-5, 15-16	R					R	R								R		R	R			R								F	R	F		R	R	F					C	F		R	R	
15-5, 40-41	R					R	R		R						R			R			R		R						F	R	F		F	R	F					F	F		R	R	
15-5, 140-141	R					R	R		R						R		R	R			R								R	R	F		F	R	F					F	F		R	R	
15-6, 130-131	R					R	R		R						R		R	R					R						F	R	F		F	R	F					F	F		R	R	
15, CC	R					R	R		R						R		R	R			R								F	R	F		F	R	F					F	F		R	R	
16-1, 10-11	R					R	R		R						R		R	R			R								F	R	F		F	R	F					F	F		R	R	
16-1, 85-86	R					R	R		R						R		R	R			R								F	R	F		F	R	F					R	F		R	R	
16-2, 10-11	R						R								R		R	R								R			F	R	F		F	R	F					R	F		R	R	
16-4, 67-68	R		R				R					R		F	R	R	R	R								R		R	F	R	F		F		F	C					R	R			
16-5, 50-51	R											R		R	R	R	R									R		R	F		R		R		F	C			R		R	R	R		
16-6, 95-96	R											R		R	R	R					R					R		R	F	R	R		R		F	F					R	R			
16, CC	R											R		R	R	R					R					R		R	F	R			R		F	F					R	R			
17-2, 46-47	R								R			R		R	R						F					R		R	F	R			F			F					R	R	R		
17-2, 135-136	R								R			R		R	R						F					R		R	F		F		F			F					R	R	R		
17-3, 33-34	R								R			R		R	R	R										R		R	F		F		F			F					R	R		R	
17-3, 110-111	R								R			R		R	R	R										R		F	F		F		R			F					R	R		R	
17-4, 10-11	R								R					R	R	R										R		F	F		R		R			F					R	R		R	
17-4, 85-86	R								R					R	R	R										R		F	F		R		R			F					R	R		R	
17, CC	R								R					R	R	R										R		F	F				R			F					R	R		R	
18-1, 50-51																																														
18-2, 85-86	R								R			R		R	R			R								R		R	F		R		R			F						R	R		
18, CC[a]	R											R		R	R			R										R	C				R			F					R	R	R		
19-2, 10-11									R						F														R				R										R		
19-2, 85-86	R								R						F														R				R										R		
19-3, 12-13																																									R	R	R		
19-3, 40-41																					F		R			R		R	F				R								R	R			
19-3, 140-141	F	F			F			R					R	R		R			R		F	R	R	R		R	R	R	F		F	R	R				R	R			R	R	R		F
19-4, 33-34					R								R	R						F		R			R		R	F		F	R	R				R				R	R			
19-4, 85-86	R								R		R																R		F		R	F	F				R						R		
19-5, 65-66	R								R		R																R		R		R	F	F				R						R		
19-5, 123-124	R								R		R		R														R		R		R	F	F				R						R		
19, CC							F	R	R			R	R	R							R		R	C						R	F					R						R		
20-1, 126-127							F	R	R			R	R	R							R		R	R						R	F					R						R		
20-2, 30-31							F	R	R			R	R	R							R		R	C						R	F					R						R		
20-2, 100-101							F	R	R			R	R	R							R		R	C							F					R						R		
20-3, 20-21							F	R	R			R	R	R							R		R	C							F					R						R		
20-3, 110-111							F	R	R			R	R	R							R		R	R							F					R						R		
20-4, 100-101							F	R	R			R	R	R							R		R	R							F					R						R		
20-4, 125-126							F	R	R			R	R	R							R		R	R							C					R						F		
20-5, 50-51	R									R			R	F	R				R			R			R		R		F			C					R						F		
20-5, 100-101	R									R			R	F	R				R			R			R		R		F			C					R						F		
20, CC[a]	R									R			R	F	R				R			R			R		R		F			C					R						F		
21-1, 67-68	F			R				R		R	R		F	R	R				R	R		F		F	C	R	F		R			C					F						R	R	
21-2, 143-144	F			R				R		R	R		F	R	R				R	R		F		F	C	R	F		R			C					F						R	R	
21, CC	F			R				R		R	R		F	R	R				R	R		F		F	C	R	F		R			C					F						R	R	

solute age whenever possible: Interval Samples 1-1, 60 cm to 6-5, 15 cm *Thalassiosira oestrupii* Zone (0.0-1.8 m.y.); Samples 6-5, 115 cm to 8-1, 70 cm *Rhizosolenia barboi* Zone (1.8-2.5 m.y.) (Figure 27); Samples 8-1, 90 cm to 9-2, 50 cm *Thalassiosira kryophila* Zone (2.5-(?) m.y.); Samples 9-3, 80 cm to 10, CC *Coscinodiscus marginatus* Zone (base-5.5 m.y.); Samples 11-1, 20 cm to 11-2, 85 cm *Denticula hustedtii* Zone (5.5-6.5 m.y.); Samples 11-3, 70 cm to 12-3, 95 cm *Cymatosira biharensis* Zone; Samples 12-4, 90 cm to 13-3, 90 cm *Goniothecium tenue* Zone (6.8-7.3 m.y.); Samples 13, CC to 14-3, 130 cm *Rhizosolenia miocenica* Zone; Samples 14-6, 85 cm to 15-3, 90 cm *Thalassiosira gravida* Zone; Samples 15, CC to 16-3, 85 cm *Actinocyclus ingens* Zone.

Boundaries between biostratigraphic zones on Figure 30 are placed between two neighboring samples. Marine planktonic diatom assemblages were found in the interval covered by sediment Units 1 and 2 (Cores 1 through 17, CC), and displaced fresh-water diatoms (*Melosira islandica* and *M. granulata*) were found in Samples 12-1, 120 cm; 12-2, 90; and 13, CC. A drastic floral change occurs between Samples 16-3, 80 cm and 16-3, 85 cm, where *Stephanogonia horridus* is the main floral constituent, besides other elements such as *Goniothecium tenue*, *Melosira sulcata*, *Sceptroneis caducea*, *Stephanopyxis turris*, and *Thalassionema nitzschioides*. All the above-listed species are heavily silicified, are interpreted as being derived from a neretic environment, and represent sediments which have been deposited in shallower waters than those above Core 16-3 (Figure 28).

Samples 17, CC through 16-3, 85 cm is tentatively placed into the *Sceptroneis caducea*, *Nitzschia* sp. 8, and *Actinocyclus ingens* zones and is of middle Miocene age. *Thalassiosira fraga* and *Thalassionema hirosakiensis* are interpreted as being reworked. This correlation gives a tentative absolute age for this interval of 10.5-14 m.y.

Sedimentation rates (Figure 29) were calculated using defined datum levels from the equatorial and North Pacific, and revealed a 4 cm/1000 yr for the "Glacial" unit and a 1.7 cm/1000 yr sedimentation rate for the "biogenic siliceous" unit.

Absence of typical middle Miocene indicator species, *Denticula*, *Coscinodiscus plicatus* group is attributed to the poor recovery and the moderate preservation of floral assemblages below Core 16.

Site 349 (Figure 31; Table 23)

Site 349 is situated on the Jan-Mayen Ridge and lies 915 meters below sea level. The only sample with diatoms came from Sample 1-1, 70-72 cm and contained a well-preserved diatom assemblage with sponge spicules and ash shards in rare abundance. The occurrence of *Thalassiosira kryophila*, *T. oestrupii*, and *T. gravida* placed this sample into the *T. oestrupii* Partial Range Zone and is 0-1.8 m.y. B.P. old. All other samples were barren of diatoms (Figure 31).

Site 350 (Figure 32; Table 24)

Site 350 is situated on the western flanks of the structural continuation of the Jan-Mayen Ridge and was drilled in a water depth of 1275 meters. This hole was rather discontinuously cored and nearly all investigated samples (Table 24; Figure 32) were barren in diatoms. Only Sample 350-12-1, 38-40 cm contained a badly preserved diatom assemblage with *Stephanopyxis turris*, *Pyrgupyxis oligocaenica*, *Thalassionema* aff. *nitzschioides*, *Sceptroneis* spp. (broken pieces), and few corroded sponge spicules. The above-mentioned species only permitted dating this sample as Oligocene in age. Sponge spicules were also found in Sample 10-3, 95-97 cm. No further studies were done at this site.

Sites 351 and 352

No sediment samples were received from these two sites for diatom analysis.

"GLACIAL" SEDIMENTS (FIGURE 33; TABLE 25)

"Glacial" sediments were drilled and cored at each site. Sites are located in Figure 33 in descending latitude from north to south. Absolute ages of diatomaceous sediments within the "Glacial" section are listed, as well as the youngest absolute age below the Glacial section obtained by diatom biostratigraphic investigation. The thickness of glacial sediments varies at the various sites from 320 to 9 meters, and is thickest at Sites 341 and 344. No absolute data were received in most of the "Glacial" sections except at Site 349 (uppermost part 0-1.8 m.y.B.P.), Site 341 (Core 4, ~1.8-2.5 m.y.B.P.), Site 348 (Cores 1 through 6, ~0-1.8 m.y.B.P.), and Site 336 (Core 1-2, ~0-1.8 m.y.B.P., Core 6-2, ~1.8-2.5 m.y.B.P. and Core 8-2, ~2.5-4 m.y.B.P.). Nearly all "Glacial" sections are directly underlain by Neogene or Paleogene biogenic siliceous sediments.

The "Glacial" sediment consists of an almost exclusively terrigenous sequence of interbedded muds and clays. Siliceous sediments, apart from older reworked floras and faunas are, except for Sites 348, 341, and 336, completely absent. However, nannoplankton exist with generally low diversity. The absence of siliceous organisms can be explained either by inaccurate sampling and/or by noncontinuously cored sections.

The base of "Glacial" sediments at Site 336 overlies middle to late Oligocene sediments and within the "Glacial" sections a few horizons were observed with rich diatom floras, which belong to the *Thalassiosira oestrupii* Zone, the *Rhizosolenia barboi* Zone, and the *Thalassiosira kryophila* Zone, which is dated by indirect correlation to the North Pacific and is of approximately 2.5-4 m.y.B.P. These intervals with partly subtropical species can be interpreted to represent sediments being deposited during warmer periods, and inflow of the Gulf Current into the Norwegian Sea (Norwegian Current). Using the biostratigraphic age assignment and placing the base of the "Glacial" sequence at Core 13 (~149.5-159 m below sediment surface), a sedimentation rate of approximately 2.8 cm/1000 yr can be calculated for the 0-100 meter interval. Interpolating to the base, a tentative age of 5 m.y.B.P. can be calculated for the initiation of glaciation. A sedimentation rate of 3 cm/1000 yr was calculated for Site 116 of DSDP Leg 12 by Berggren (1972a), which is situated on the east side of Hutton-Rockall Basin and is closest to the present Site 336. Berggren (1972a), on the other hand, calculates the in-

TABLE 6
Diatoms at Site 338 (Cores 22 to 29)

Sample (Interval in cm)	Ash	Abundance	Preservation	Sponge Spicules	Archaeomonadaceae (spherical type)	A. sp. a-g	Actinoptychus splendens	A. thumii	A. undulatus	Asterolampra affinis var. cellulosa	A. insignis	A. marylandica	A. praeacutiloba	A. vulgaris	Asteromphalus oligocenicus	A. symmetricus	Chaetoceros borsteni	Chaetoceros(?) – Hemiaulus(?) – Testing spore (Plate 38, Fig. 13-21)	C. species (spore) (Plate 38, Fig. 5)	C. species (spore) (Plate 38, Fig. 6)	C. species (spore) (Plate 38, Fig. 7)	C. spore (Plate 38, Fig. 2)	C. spore (Plate 38, Fig. 4)	C. spore (Plate 38, Fig. 13)	C. spore (Plate 38, Fig. 18)	Chasea magna	C. ornata	Cestodiscus mulinae	Coscinodiscus asteromphalus	C. asteromphalus var. princeps	C. moroensis	C. oblongus	C. acculus iridis	C. praenitidus	C. radiatus c. aff. radiatus	C. symbolophorus group	C. tuberculatus var. atlantica	C. vigilans	C. sp. 1	C. sp. 4	Cymatosira biharensis	C. compacta	C. coronata	C. fossilis	C. praecompacta	C. sp. (Plate 25, Fig. 35)	Diploneis sp.	Fragilaria voeringia	Genus and species indet. (5)	Genus and species indet. (6)
22-0, 35-36	T	A	G	F	B	B										R											R	R		F							C	R				R					R		R	
22-1, 89-90	–	A	G	B	B	B			C						R	R					R						R	R	R	F			R				C	R				R					R	R		
22-2, 65-67	R	A	G	F	B	B		R								R	C	R							R		R	C		F			R	R		R	C					R		R	R		R		R	
22-2, 115-116	–	A	M	F	B	B			C						R	R		R	R							R	R	R						R			R					R		R			R			
22-3, 22-23	–	A	M	F	B	B			C							R		R									R	C							R	R	C					R					R			
22-4, 48-49	–	A	M	F	B	B			C							R										R							R		R	R	R					R								
22-5, 20-21	–	A	G	F	B	B		R	C																		R	C							R	R	C													
22-5, 51-53	T	A	G	F	B	B			C								C											C					C		R	R	C					C					R			
22-6, 93-94	–	A	G	R	B	B			C						R	R		R						R				R					R		R		C					R		R				R		
23-0, 9-10	–	A	G	B	B	B			R							R		R								R		R					R			R	R					R						R		
23-1, 63-64	+	A	G	B	B	B										R		R						R				R					R			R	R										R			
23-1, 135-136	T	A	G	B	B	B			R					R		R		R															R		R		R								R					
23-2, 13-14	T	A	G	R	B	B										R		R									R										C					R					R			
23-2, 104-105	–	C	M	F	B	B			R							R		R																	R		C					R					R	R		
23-3, 54-55	–	C	M	F	B	B			R							R		R	R									R							R		R							R	R		R	R		
23-3, 116-117	–	A	G	R	B	B			R							R		R						R			R	R							C	R	C							R						
23-4, 38-39	R	C	M	R	B	B	R		R							R								R									R		R		R													
23-4, 92-93	R	C	M	F	B	B		R	C						R	R												R					C		R	R														
23-4, 134-135	F	A	G	R	B	B		R								R								R	R	R							R		C	R	R					R								
23-5, 49-50	R	A	G	R	B	B			R							R		R						R									R		C	R	R					R					R			
23-5, 106-107	–	A	G	B	B	B			R							R		R					R			R		R					R		C	R						R								
23-6, 17-18	–	C	M	F	B	B												R					R			R	R	R					R		C	R														
23-6, 89-90	R	A	G	R	B	B			R							R		R								R	R	R					R			R														
24-1, 30-31	–	C	G	B	B	B			R														R					R					R		R		R			R										
24-1, 34-35	R	A	G	F	B	B			R							R		R			R					R		R					R				C			R								R	R	
24-1, 130-131	T	C	M	F	B	B			C									R					R	R																R										
24-2, 23-24	F	C	M	F	B	B																R	R			R							R		C	R	R			R										
24-2, 86-88	F	C	M	F	B	B			F							R												R	R				C		C	R						C	R	R					R	
24-2, 108-109	F	C	M	F	B	B															R								R				R																	
24-3, 56-57	F	F	M	F	B	B																											R		R															
24-3, 133-134	F	C	G	F	B	B	R											R																	R	R			R					R						
24-4, 37-38	–	C	G	F	B	B			+							+		+																					+											
barren until:																																																		
26-2, 44-45	–	R	P	F	B	B			+																														+											
26-2, 109-110	F	A	G	B	B	B			C																								R		R	R														
26-3, 34-35	F	A	G	B	B	B			C						R		R	R																	R	R			R		R									R
26-3, 127-128	A	A	G	B	B	B			C																																									R
26-4, 34-35	C	A	G	B	B	B			R								C									R							R																	R
26-4, 130-131	–	A	G	B	B	B			R								R								R							R			R										R					
26-5, 30-31	–	A	G	B	B	B			R				R					R															R										R							
26-5, 63-65	–	C	G	B	B	R			R				R	R	C																	R	R			R							R			R				C
26-5, 112-113	R	C	G	B	B	B			R	R				R								R											R		R								R							R
27-1, 71-72	F	A	G	B	B	R			R				R				C																		R								R							R
27-1, 129-130	F	C	M	B	B	B			R																		R						R			R							R							
27-2, 40-41	–	A	G	R	B	R			R		R		R																		R																			R
27-2, 134-135	R	A	G	B	B	B			R				R																		R					R														
27-3, 44-45	R	A	M	R	B	B			R			R																								R														
27-3, 59-60	F	A	G	R	B	R			R	R	R			R			C												R			R	R			R														
27-3, 137-138	F	A	G	B	B	B			R		R																					R			R				R											
27-4, 57-58	F	A	G	B	B	B			R		R		R	R	R																	R			R															
27-4, 137-138	F	A	G	B	B	B			C								C															R			R	R			R											
27-5, 71-72	–	C	M	R	B	B			C		R			R				R		R									R			C			C	R														R
27-5, 130-131	–	C	M	B	B	B			C																							C	R		C	R														
28-2, 30-31	–	A	G	B	B	R																										R				R			R				R							R
28-2, 133-134	–	A	G	B	B	R			C				R					R																	C	R														
29-1, 54-55	*	A	G	B	B	B			C								C										R								R	R							R							
29-1, 113-114	–	A	G	B	B	R			C								C				R					R	R								R											C				
29-2, 55-56	F	A	M	B	B	B			C																											R							R			R				
29-2, 135-136	–	A	G	R	B	B			R																	R	R			R					C															
29-3, 47-48	–	A	G	B	B	B			C																R	R									R															
29-3, 130-131	–	A	M	B	B	B			C								C																R		R	R										R				

Note: x = trace.

TABLE 6 – *Continued)*

Sample (Interval in cm)	Genus and species indet. (7)	Genus and species indet. (8)	Genus and species indet. (9)	Goniothecium coronatum	G. decoratum	G. loricatum	G. odontella	Hemiaulus curvatulus	H. hostilis	H. kittonii	H. polycystinorum	H. polymorphus var. frigida	H. aff. perlatus	H. undulatus	Hyalodiscus spp.	Melosira architecturalis	M. goretzkii	M. islandica	M. sulcata	M. sp. (Plate 27, Fig. 5)	Monobranchia simplex	Navicula bendaensis	N. sudara	N. udintsevii	Odontella cornuta
22-0, 35-36					R		R								R	R	R		R	R					
22-1, 89-90					R		R								R			R	R	R					R
22-2, 65-67				R	R		R								R				C						
22-2, 115-116																			C						R
22-3, 22-23															R		R		R						R
22-4, 48-49				R	R		R										R		C						
22-5, 20-21															R		R		C						
22-5, 51-53		R					R												C						
22-6, 93-94				R															C						
23-0, 9-10					R		R										R		C						R
23-1, 63-64															R				C						R
23-1, 135-136					R		R												C						R
23-2, 13-14																R			C						
23-2, 104-105																			C						
23-3, 54-55					R		R												F	R					
23-3, 116-117					R		R								R				C						R
23-4, 38-39					R		R								C				R						
23-4, 92-93											R				C				R						
23-4, 134-135					R		R				R				C				R						R
23-5, 49-50				R	R		R								R	R			C						
23-5, 106-109															R				R						
23-6, 17-18					R		R								R				R						
23-6, 89-90				R	R		R								R				R						
24-1, 30-31				R											R	R			R						
24-1, 34-35				R											R			R	R						
24-1, 130-131															R		R		R						R
24-2, 23-24															R				C						
24-2, 86-88			R					R							R				C						
24-2, 108-109															R				R						
24-3, 56-57											R								R						R
24-3, 133-134															+				R						
24-4, 37-38					+		+												+						
barren until:																									
26-2, 44-45																			+						
26-2, 109-110			R							R	C			R							R				
26-3, 34-35			R			R					C					R	R				R				
26-3, 127-128											R	R					R				R				
26-4, 34-35											C					R	R								
26-4, 130-131								R			C	R				R	R				R				
26-5, 30-31								C		R			R				R				R				
26-5, 63-65						R					C	C													
26-5, 112-113	R										C	C			R						C				
27-1, 71-72											C	R					R				R				
27-1, 129-130											C										R				
27-2, 40-41						R					F	R									R				
27-2, 134-135									R		F	R		R	R		R							R	
27-3, 44-45											C				R						R				
27-3, 59-60			R			R		R			C	R		R	R		R				R				
27-3, 137-138						R					R	C					R		R		C				
27-4, 57-58											R	C		R										R	
27-4, 137-138										R	C	C												R	
27-5, 71-72		R	R			R		R		R	C	C		R											
27-5, 130-131			R								C	C		R	R	R	R								
28-2, 30-31	R		R					R		C	C	F				R									R
28-2, 133-134								R	R			C		R	R	R						R		R	R
29-1, 54-55		R	R			R		R			C	C				R						C			R
29-1, 113-114		R				R			R		C	F				R					R	R	C		R
29-2, 55-56											C	F		R									C		C
29-2, 135-136	R										F	C		R	R		R						C		C
29-3, 47-48			R						R		F	C		R		R						R			C
29-3, 130-131											C	C		R		C			R						

Sample (Interval in cm)	Odontella aff. fimbriata	Odontotropis carinata	O. klavsenii	Peripteria tetracladia	Pleurosigma normannii	Pseudodimerogramma elongata	P. filiformis	P. oligocenica	Pseudopyxilla americana	P. baltica	P. carinifera	P. danica	P. directa	P. dubia	P. rossica	P. sp. (Plate 44, Fig. 8)	Pseudorocella barbadense	Pseudostictodiscus angulatus	Pseudotriceratium chenevieri	P. aff. chenevieri	Pterotheca aculeifera	P. crucifera	P. reticulata	P. simplex	P. spada
22-0, 35-36					R		R		R	C		C	R		R					R			R		
22-1, 89-90					R			R		R		C	R	R	R					R			R		
22-2, 65-67				R						R	R		R	C						R			C		
22-2, 115-116					R									R									R		
22-3, 22-23														R	R					R			R		
22-4, 48-49				R	R									R						R			R		
22-5, 20-21																				R			C		
22-5, 51-53					R								R	R									R		
22-6, 93-94										R		R			R					R			R		
23-0, 9-10					R																		R		
23-1, 63-64					R																				
23-1, 135-136										R		R								R			R		
23-2, 13-14	R				R					R		R											R		
23-2, 104-105																							R		
23-3, 54-55																							R		
23-3, 116-117															R					R			R		
23-4, 38-39													R							R			R		
23-4, 92-93																							R		
23-4, 134-135													R							R			R		
23-5, 49-50														R											
23-5, 106-109										R		R											R		
23-6, 17-18																							R		
23-6, 89-90																			R	C			R		
24-1, 30-31										R		R											R		
24-1, 34-35				R						R		R	R		R				R	R			R		
24-1, 130-131										R		R	R										R		
24-2, 23-24															R								R		
24-2, 86-88				R	R															R					
24-2, 108-109																				R			R		
24-3, 56-57																				R					
24-3, 133-134										R		R		R											
24-4, 37-38																									
barren until:																									
26-2, 44-45																									
26-2, 109-110																			R			R		R	
26-3, 34-35		R	R			R													R				R		
26-3, 127-128		R																							
26-4, 34-35		R												R				R			R		R		
26-4, 130-131			R						R									R						R	
26-5, 30-31										R		R									R				
26-5, 63-65										R								R	R						
26-5, 112-113		R	R						R	R		R													
27-1, 71-72		R	R											R	R						R	R			
27-1, 129-130		R												R											
27-2, 40-41			R																			R		R	
27-2, 134-135		R																			R	R		R	
27-3, 44-45														R											
27-3, 59-60		R								R				R		R								R	
27-3, 137-138			R											R	R		R				R				
27-4, 57-58															R		R							R	
27-4, 137-138																									
27-5, 71-72			R											R								R	R		
27-5, 130-131		R												R							R		R		
28-2, 30-31			R											R							R	R			
28-2, 133-134									R												R	R			R
29-1, 54-55			R															R			R	R			
29-1, 113-114	R	R		R																	R	R			
29-2, 55-56		R									R										R				
29-2, 135-136	R	R							R										R		C				
29-3, 47-48		R	R																		R				
29-3, 130-131																				R				R	

Note: X = trace.

TABLE 6 – *Continued*

P. uralensis	P. sp. 1	P. sp. 3	P. sp. 2 McCollum	Pyrgupyxis oligocenica	Raphoneis amphiceros	R. angulata	R. parilis	R. aff. psammicola	R. aff. surirella	Rhizosolenia hebetata f. hiemalis	R. hebetata f. semispina	R. hebetata var. subacuta	R. palliola	Riedelia claviger	Rouxia sp. 2	Rutilaria areolata	Sceptroneis facialis	S. grunowii	S. humancia	S. mayenica	S. pesplanus	S. praecaducea	S. pupa	S. talwanii	S. tenue	S. sp. (Plate 24, Fig. 21)	Stephanopyxis barbadensis	S. grossecellulata	S. grunowii	S. aff. megapora	S. turris	Stephanogonia pretiosa	S. species (1)	S. species (Plate 45, Fig. 2, 3)	Stictodiscus kittonianus	S. sp. (Plate 36, Fig. 2, 3)	Synedra miocenica	Thalassionema aff. nitzschioides	Thalassiosira aff. antarctica	T. dubiosa	T. irregulata	T. aff. irregulata	T. lusca	T. medioconvexa	Triceratium acutangulum	T. barbadense	T. inconspicuum	T. cruciforme	T. schulzii	T. tesselatum	T. aff. weissflogii	T. sp. (3)	Trinacria quadrata	Trochosira coronata	T. spinosa
					R						R	R												R				R	C					C			C				R		R					R	R						
					R				R		R	R												R			R	C	C	R	R			C			C					R							R						
					C	R	R		R	R	R								R					R			R	R	R	R	R			R			R				R							R	R						
				R	R						R	R													R			R		C	R			R			F						R					R	R						
				R	R	R						R																		C					R		A												R						
					R																				R		R			R					R		A																		
											R														R				R		R						A																		
				R	R	R	R	R			R	R							C			C		R	R	R	C				C		R				R												R						
											R														R		R								R		A						R						R						
					R		R	R			R													R	R		R				R						F												R						
				R								R			R		R								F		R										F																		
				R	R						R	R													F		R				R			R			F												C						
					R						R	R	R												C		R				R						F												R						
												R																									F																		
											R	R											R				R										F												R	R					
					R							R							R			R		R		R	R			R	R			R			F												R						
																						R		R			R			R	R						C												R						
				R																		R					R										F												R						
											R						R					R				R	R				R			R			F												R						
											R	R										R				R	R										F												R			R			
										R	R						R					R	R				C										F						R						R			R			
										R	R											R					C							R			C																		
											R	R					R					R		R		R	R										C						R									R			
										R							R						R								C						C															R			
									R	R	R						R					R				R	R				R						C	R																	
								R		R	R	R															R				R						C																		
										R																											F																		
						R		R			R						R		R			R	R	R	R?		R				R						R												R						
					R						R			R		R						R					R				R						F																		
																	R				R					R	F				C																								
					R						C													R			C				R						C																		
											+						+?					R									+						+																		
																		+																																					
				R										C													C				R		R		R											R								R	
				R										R							R						C		R		R				R											R					R			R	R
				R										R													C				C																				R				
														C						C							R		R		C					R										R					R				
														C													R				C				R																			R	
														R				R			R						R				C				R	R									R	R					R			R	
																		R		R							C				C				R	R									R	R								R	
			R									R		C													R				C					R										R					R				
												R		R													R				C				R	R	R			R						R					R			R	R
				R										R													C				F														R	R									
														R													C				F				R											R									
														C				R								R	C				F	R	R													R					R			R	
														R						R							C				F		R	R											R										
														C				R		R							C				F	R	R		R										R	R									
				R										R						R							C				F		R													R									
														R				R		R						R	R				C				R											R								R	
													R	R						R							R				C					R			R							R	R				R			R	
	R			R							R			R				R		R							C				C				R	R									R	R	C				R			R	R
				R								R								R							R				F				R										R	R								C	
R											R			R	R					R	R						C				F	R	R	R	R	R									R	R	R				R			C	
R											R		R	R				C		C							C				F				R					R						R				R	R		R	C	
R	R													R							F						C				C	C			C										R	R							C	R	R
	C			R									R	R						R	F						C				R	R			R	R										R					R		R	R	
																		R		R							C				F													C	R	R									
R	R	R												R						R	R						C				C	R			R					C				R									C		R
	R	R												R				R		R							R				C														R								C		
	C													R				R		R							R				R	C										A					R		R		

Note: x = trace.

TABLE 6 – *Continued*

Sample (Interval in cm)	*Xanthiopyxis acrolopha*	*X. globosa*	*X. oblongus*	*X. ovalis*	*X. panduraeformis*	*X. papillosus*	*X.* sp. (Plate 45, Fig. 8)	*X.* sp. (Plate 45, Fig. 10)	*X.* sp. (Plate 45, Fig. 17)	*X.* sp. 1 Hajos (1968)	*X.* sp. 3 Hajos (1968)	*X.* sp. 4 Wornardt (1957)
22-0, 35-36			R				R			R		
22-1, 89-90		R	R	R	R		C					
22-2, 65-67		R	R	R		R						R
22-2, 115-116				R			C	R		R		
22-3, 22-23						R	C			R		
22-4, 48-49							C	R		R		
22-5, 20-21		R	R				C					
22-5, 51-53				R		R				R		
22-6, 93-94			R					R				
23-0, 9-10							R	R		R		
23-1, 63-64		R					R			R		
23-1, 135-136		R					R	R		R		
23-2, 13-14				R		R	R			R		
23-2, 104-105						R						
23-3, 54-55		R					C			C		
23-3, 116-117		R	R	R			R			C		
23-4, 38-39		R		R						C		
23-4, 92-93										R		
23-4, 134-135		R		R		R	R			R		
23-5, 49-50		R	R	R		R	R	R		R		
23-5, 106-107		R				R	C	R				
23-6, 17-18		R	R				C	R		R		
23-6, 89-90								R				
24-1, 30-31		R		R		R	C	R				
24-1, 34-35		R		R		R	C	R		R		
24-1, 130-131						R	R	R				
24-2, 23-24	R							R		R		
24-2, 86-88		C				R						
24-2, 108-109						R		R				
24-3, 56-57								R				
24-3, 133-134			R					R		R		
24-4, 37-38												
barren until:												
26-2, 44-45												
26-2, 109-110												
26-3, 34-35	R		R									
26-3, 127-128											R	
26-4, 34-35												
26-4, 130-131												
26-5, 30-31			R									
26-5, 63-65												
26-5, 112-113									R			
27-1, 71-72		R	R	R								
27-1, 129-130				R								
27-2, 40-41												
27-2, 134-135				R								
27-3, 44-45												
27-3, 59-60		R										R
27-3, 137-138				R								
27-4, 57-58				R								
27-4, 137-138												
27-5, 71-72												R
27-5, 130-131		R										
28-2, 30-31		R										
28-2, 133-134												
29-1, 54-55												
29-1, 113-114		R										
29-2, 55-56			R									
29-2, 135-136			R	R						R		
29-3, 47-48		R										
29-3, 130-131												

Note: x = trace.

TABLE 7
Samples Barren in Diatoms, Site 338

1-2, 95-97 cm	30-5, 52-54 cm
2-2, 80-82 cm	31-2, 111-113 cm
3-2, 83-85 cm	32-2, 80-82 cm
4-2, 58-60 cm	32-5, 60-62 cm
5-2, 44-46 cm	33-2, 92-94 cm
5-5, 45-47 cm	33-5, 56-58 cm
6-5, 88-90 cm	35-2, 89-91 cm
24-5, 78-80 cm	37-2, 111-113 cm
25-2, 88-90 cm	39-2, 14-16 cm
30-2, 95-97 cm	41-2, 91-93 cm

24-4, 144-145 cm	diatoms – R/P, sponge spicules – C
24-5, 29-30 cm	barren
24-5, 100-102 cm	barren
24-6, 53-54 cm	diatoms – R/P, sponge spicules – F
24-6, 81-82 cm	barren, sponge spicules – F
24-6, 104-105 cm	barren
24, CC	barren, sponge spicules – F
25-1, 140-142 cm	barren, sponge spicules – R
25-2, 22-23 cm	barren, sponge spicules – F
25-2, 106-107 cm	barren, sponge spicules – F
25, CC	diatoms – R/P, sponge spicules – R
26-1, 69-70 cm	barren, common zeolites
26-1, 86-87 cm	barren, common zeolites

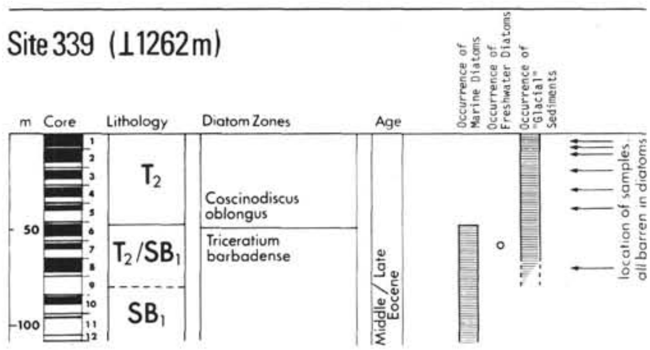


Figure 17. *Site 339 summary figure.*

itiation of glaciation on the northern hemisphere at approximately 3 m.y.B.P. The latter age would not conflict with the results of Site 336, but would demand an immensive increase of sedimentation from the glacial initiation to approximately 2.5 m.y.B.P.

Assuming that the glacial period started approximately 3-4 m.y.B.P., the diatom biostratigraphic results at Site 348 do conflict with this assumption. "Glacial" sediments were found only to a subbottom depth of 70 meters (Core 6), and were dated as 1.8 m.y.B.P. (*Thalassiosira oestrupii* Zone); the underlying interval is of Pliocene age (*Rhizosolenia barboi* Zone 1.8-2.5 m.y.B.P.). The glacial-marine sediments of Unit 1 probably record glacial, interglacial, and postglacial sedimentation. Because of the extensive core deformation of these uppermost soft sediments, the sedimentary history is not too reliable. Calculated sedimentation rates (not corrected for compaction) are of the order of 4 cm/1000 yr for the glacial-marine section and 1.7 cm/1000 yr for the late-early Pliocene section. A special and, from other areas, different sedimentation model can explain the absence of glacially derived particles at this site below 1.8 m.y.B.P. Site 348 is

TABLE 8
Diatoms at Site 339

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinoptychus undulatus*	*A.* sp. (triangular)	*Asterolampra areolata*	*A. decora*	*A. praecutiloba*	*A. vulgaris*	*Cestodiscus muhinae*	*Coscinodiscus oblongus*	*C. moelleri*	*C. oligocaenicus*	*Coscinodiscus symbolophorus* group	*Cymatosira coronata*	*C.* sp. (Plate 23, Fig. 12)	*Cymatosira* sp. (Plate 25, Fig. 25, 26)	*Goniothecium odontella* var. *danica*	*Grammatophora* sp.	*Hemiaulus curvatulus*	*H. pyxilloides*	*H.* sp.	*Melosira architecturalis*
6-2, 60-62	A	G	R	R	F	R	R			F	R	R	–	R	R	R	R	F		R	R	C	
7-2, 70-72	A	G	B		F		R	R		F			–	F	R	R			R	R		C	R
8-2, 20-22	A	G	F		C			R		F		R	–		R	R			F				
10-2, 80-82	A	G	B	F	F		R		R	F		R	R	R					F			C	
12-2, 10-12	A	G	B	F	C					F				F		R	F		F	R			

Sample (Interval in cm)	*M. islandica*	*M. sulcata*	*Monobrachia simplex*	*M. unicornutus*	*Muelleriella limbata*	*Navicula udintsevii*	*Odontotropis clavsenii*	*Peponia barbadense*	*Pseudopodosira simplex*	*Pseudopyxilla directa*	*pseudorocella barbadensis*	*Pseudorutilaria monomembranaceae*	*Pseudostictodiscus angulatus*	*Pseudotriceratium chevevieri*	*Pterotheca spada*	*Pterotheca* sp. (3+4)	*P.* sp.	*Pyrgupyxis johnsoniana*	*Rhizosolenia palliola*	*Riedelia claviger*
6-2, 60-62		F				R	R	R	R	R	R	R	R	R	R	C	F	R		R
7-2, 70-72	R	R				R	R	R			R	R	R			F			R	
8-2, 20-22		R									R			R		R				R
10-2, 80-82		F	R	R	R	R					–		R	R			F			
12-2, 10-12					R	F					R		R	R		F				

Sample (Interval in cm)	*R.* sp. 1	*Rutilaria areolata*	*Sceptroneis grunowii*	*S. mayenica*	*S. pesplanus*	*S. tenue*	*S. tenue* (?) (Plate 24, Fig. 14)	*S.* sp. (Plate 24, Fig. 18)	*Stephanopyxis turris* group	*Stictodiscus kittonianus*	*Synedra* sp. 1	*Thalassionema* aff. *nitzschioides*	*Thalassiosira dubiosa*	*Thalassiosira mediaconvexa*	*Triceratium barbadense*	*Trinacria excavata*	*T. piloelus*	*T. regina*	*Trochosira coronata*	*T. spinosa*
6-2, 60-62	F	R	R	R	R		F		F		F	F	R	R	F	R			R	R
7-2, 70-72	R		F		R	R	F	R	F	R	R	R	F		C	R			R	
8-2, 20-22	R		F				F		F		F				–			F	R	
10-2, 80-82	R	R	R				F				R		R		–	R	R		R	
12-2, 10-12	F		F								F		R			R	R			F

TABLE 9
Samples Barren in Diatoms and Sponge Spicules, Site 339

1-2, 66-68
1-5, 75-77 cm
2-2, 88-89 cm
3-2, 100-102 cm
4-2, 77-79 cm
5-2, 86-88 cm
8-5, 110-112 cm

located on the Icelandic Plateau at a water depth of 1763 meters, east of the Iceland Jan-Mayen Ridge axis. This ridge may serve as a sediment trap for terrigenous sediments derived from Greenland. On the other hand, the Icelandic Plateau is well separated from the influence of the main Norwegian Current, which is controlling distribution of the ice at present. The Irminger Current enters the Norwegian Sea through the Denmark Strait and flows clockwise around Iceland; this current may be responsible for driving away glacial particles. The same may be true for the bottom water outflow through the Denmark Strait. The same sequence of opal-rich sediments was found in *Vema* Cruise 23, Core 74 in the Holocene, and is attributed to the sheltering effect of the surface and bottom current systems.

Initiation and maximum and minimum extent of glaciation have influenced, besides tectonic (diapirs) movements, the sedimentation record in the Norwegian Sea, and only at Site 348 is a complete section present ranging from middle Miocene to the Recent. All other sites are characterized by unconformities separating the Glacial sequence from the underlying Tertiary to Paleogene sequence.

DENTICULA SEMINAE-DENTICULA HUSTEDTII (FIGURES 34, 35)

The differentiation between *Denticula seminae* and *Denticula hustedtii* is based primarily on the number of secondary pseudoseptae and the punctuation. *D. hustedtii* has much coarser punctuation and less secondary pseudoseptae than *D. seminae*. *Denticula seminae* has about 40 striae in 10 μm, which are only

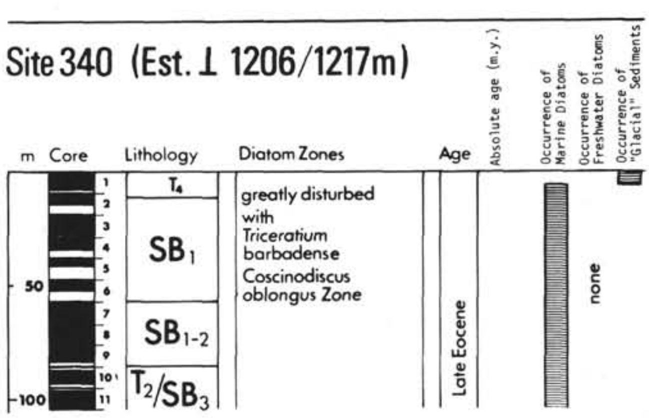


Figure 18. *Site 340 summary figure.*

TABLE 10
Diatoms at Site 340

Sample (Interval in cm)	Abundance	Preservation	Sponge spicules	Actinoptychus undulatus	A. sp. (triangular)	Asterolampra decora	A. praecutiloba	A. punctifera	A. vulgaris	Chaetoceros bristles	C. spores	Coscinodiscus moelleri	C. oblongus	C. oligocenicus	C. symbolophorus group	Cymatosira coronata	C. sp. (Plate 23, Fig. 9)	C. sp. (Plate 25, Fig. 25, 26)	C. sp. (Plate 25, Fig. 27)	Genus and sp. indet. (10)	Hemiaulus curvatulus	H. hostilis	H. sp. (Plate 43, Fig. 15)
2-2, 60-62	A	G	B	R	R	–	–	–	–	C	–	R	R	–	–	R	–	R	–	–	–	–	–
3-2, 60-62	A	G	B	R	–	–	R	–	–	C	–	R	–	–	–	–	–	F	F	–	–	–	–
3-5, 40-42	A	G	B	R	–	–	R	–	–	C	–	R	–	–	–	–	–	F	F	–	–	–	–
5-2, 60-62[a]	A	G	B	R	–	R	–	–	–	C	–	–	–	–	R	R	–	R	–	–	–	–	–
6-2, 50-52	A	G	B	F	–	–	–	–	–	C	–	–	–	–	–	–	–	–	–	–	R	R	–
7-2, 100-102[a]	A	G	R	F	R	–	–	–	–	C	–	–	–	–	R	R	–	–	–	–	R	R	–
7-3, 65-67[a]	A	G	R	F	R	–	–	–	–	C	–	–	–	–	R	R	–	–	–	–	R	R	–
7-5, 60-62	A	G	B	R	–	–	–	–	–	F	–	–	–	R	–	–	–	–	–	–	R	–	–
8-5, 60-62	A	G	B	R	–	–	–	–	–	F	–	–	–	R	–	–	–	–	–	–	–	–	–
9-2, 60-62	A	G	B	F	–	–	–	–	–	F	–	–	R	–	–	–	R	–	–	–	R	–	–
9-5, 60-62	A	G	B	F	–	–	–	–	–	F	–	–	R	–	–	–	R	–	–	–	R	–	–
10-2, 60-62	A	G	B	F	–	–	–	–	R	C	–	–	–	–	–	–	–	–	–	–	–	–	–
10-5, 60-62	A	G	R	F	–	–	R	–	–	C	C	–	R	–	–	R	–	–	R	R	–	R	R
11-2, 60-62	A	G	R	F	–	R	R	R	–	–	–	–	R	R	–	R	–	–	–	–	R	R	–
11-5, 70-72	A	G	R	R	–	R	R	R	–	–	–	–	R	–	R	–	–	–	–	–	R	R	–
1-2, 90-92	B	–	B																				
1-5, 85-87	B	–	B																				

Sample (Interval in cm)	H. spp.	Melosira architecturalis	M. goretzkii	Monobrachia simplex	Navicula bendaensis	N. sudora	Odontotropis clavsenii	Pseudopodosira simplex	Pseudorutilaria monomembranacea	Pseudostictodiscus angulatus	Pseudotriceratium chenevieri	Pterotheca aculeifera	P. sp. Plate 35/17-19	P. spp.	Pyrgupyxis johnsoniana	P. aff. gracilis	Rhizosolenia palliola	Riedelia claviger	R. sp. 1	Stephanopyxis turris group
2-2, 60-62	C	R	–	R	R	–	–	–	R	–	–	–	–	F	–	–	F	R	F	C
3-2, 60-62	C	–	–	R	–	R	R	–	C	R	R	–	–	–	–	–	–	–	R	C
3-5, 40-42	C	–	–	R	–	R	R	–	C	R	R	–	–	–	–	–	–	–	R	C
5-2, 60-62[a]	C	–	–	R	–	–	–	–	C	R	F	–	–	F	–	–	–	R	C	C
6-2, 50-52	C	–	–	–	–	R	R	–	R	–	–	–	–	–	–	–	R	–	R	–
7-2, 100-102[a]	–	R	R	R	–	–	R	–	R	–	F	–	F	–	–	–	R	R	C	C
7-3, 65-67[a]	–	R	R	R	–	–	R	–	R	–	F	–	F	–	–	–	R	R	C	C
7-5, 60-62	C	R	R	R	–	–	R	R	R	–	R	R	R	–	R	–	–	R	F	C
8-5, 60-62	C	–	–	R	–	–	R	–	F	–	F	R	–	–	–	–	–	R	F	C
9-2, 60-62	C	–	–	R	R	–	–	–	–	R	F	–	–	–	–	R	–	R	–	F
9-5, 60-62	C	–	–	R	R	–	–	–	–	R	F	–	–	–	–	R	–	R	–	F
10-2, 60-62	C	R	–	–	–	–	R	–	–	–	F	R	–	–	–	–	–	R	F	F
10-5, 60-62	–	R	R	–	R	–	R	–	–	R	F	F	–	–	–	–	R	F	F	R
11-2, 60-62	C	–	R	R	–	–	–	–	–	–	R	F	–	–	–	F	–	F	F	F
11-5, 70-72	–	R	R	R	R	–	R	–	–	–	R	R	R	–	R	R	–	F	C	R
1-2, 90-92																				
1-5, 85-87																				

Sample (Interval in cm)	Stictodiscus kittonianus	S. sp. (Plate 37, Fig. 2, 3)	Sceptroneis grunowii	S. mayenica	S. pesplanus	S. vermiformis	Thalassiosira dubiosa	Triceratium barbadens	T. schulzii	Trinacria excavata	T. pileolus	T. quadrata	Trochosira coronata	Pseudorocella barbadensis	Goniothecium odontella var. danica
2-2, 60-62	–	–	F	–	R	–	–	C	–	R	R	R	R	–	–
3-2, 60-62	–	–	–	F	–	–	–	A	–	–	–	–	R	–	–
3-5, 40-42	–	–	–	F	–	–	–	A	–	–	–	–	R	–	–
5-2, 60-62[a]	–	–	F	–	–	–	–	–	–	–	–	–	F	–	–
6-2, 50-52	–	–	–	–	R	–	R	–	–	R	R	F	F	–	–
7-2, 100-102[a]	–	–	R	–	–	–	R	C	–	–	–	–	–	–	–
7-3, 65-67[a]	–	–	R	–	–	–	R	C	–	–	–	–	–	–	–
7-5, 60-62	–	–	R	–	–	–	–	A	–	R	R	–	–	–	–
8-5, 60-62	R	–	–	–	–	–	–	A	–	–	–	–	C	–	–
9-2, 60-62	–	–	F	F	R	C	–	–	R	R	–	R	C	–	–
9-5, 60-62	–	–	F	F	R	C	–	–	R	R	–	R	C	–	–
10-2, 60-62	–	–	–	–	–	–	–	–	–	R	–	R	C	–	–
10-5, 60-62	–	–	R	F	R	F	F	F	–	R	–	–	C	–	–
11-2, 60-62	R	–	–	–	–	R	–	F	–	R	–	R	F	–	–
11-5, 70-72	R	R	R	F	R	–	–	F	R	R	R	R	C	R	R
1-2, 90-92															
1-5, 85-87															

[a]Ash.

visible in oblique light, whereas *D. hustedtii* has about 30-32 in 10 μm (Simonsen and Kanaya, 1961), and *D. seminae* has one to four secondary pseudoseptae between the pseudoseptae whereas *D. hustedtii* has one to two (Schrader 1973b). There is a reduction found in the older individuals, which are placed into *D. hustedtii*, to only one secondary pseudoseptum and to 18-24 transapical striae in 10 μm. Basing the differentiation of these two species exclusively on the structure, it is almost impossible by quick check to determine their position; this is the reason why a detailed biometrical study of samples from various parts of the world was done and the number of pseudoseptae, of secondary pseudoseptae, the length and width was measured. Samples came from the North Pacific, DSDP Leg 18 and from the Norwegian Sea, Leg 38. About 20 randomly occurring individuals were measured per sample and individuals oriented by their taxonomic position and location. All triangulars represent *Denticula hustedtii* and all circles, *Denticula seminae* (Figure 34).

High values of the factor y are characterized by high numbers of secondary pseudoseptae and represent *D. seminae* individuals, and high values of x are characterized by low numbers of secondary pseudoseptae per length interval and represent *D. hustedtii* individuals. *Denticula hustedtii* clusters between x = 2-5 and y = 1.5-2.5 and *Denticula seminae* between x = 1.5-2.5 and y = 2-5. There occurs a small overlapping around x = 1.5-2.5 and y = 2-2.5 and this overlapping area represents *Denticula seminae* var. *fossilis* Schrader (1973b), individuals that are distinguishable by their curved apical secondary pseudoseptae. In order to determine the correct taxonomic position, a few individuals per sample should be measured in this way and plotted into the diagram.

Denticula hustedtii is a cosmopolitan species which was found in tropical, subtropical, and high latitude samples. It becomes extinct in tropical areas within the late Miocene (Figure 35), but persists in high latitude samples well into the lowest early Pliocene, and becomes extinct in the Antarctic (McCollum, 1975) at the base of the *Nitzschia interfrigidaria* Zone of McCollum (1975). This is placed at the "c" event of the Gilbert reversed paleomagnetic epoch (approximately 4.38-4.7 m.y.B.P., Berggren, personal communication, 1975). Since *Denticula hustedtii* becomes rare after the top of paleomagnetic Epoch 5, the last common occurrence is used here to define the Pliocene-Miocene boundary. *Denticula hustedtii* evolves in the northern hemisphere into *Denticula seminae* which represents the only living marine representative of this genus, and is found living and in "Recent" sediments only in the northern Pacific and Bering Sea.

Therefore, the occurrence of *Denticula seminae* in the Norwegian Sea is of importance demonstrating a similar evolutionary line than that found in the Pacific. It was found in sediments from Sites 336 and 348 within the Pliocene interval.

SUMMARY AND DISCUSSION FIGURES 36-39, TABLE 26

The present Norwegian Sea is considered (Worthington, 1970) as a typical Mediterranean basin (Figure 36) for which an inflow of light surface water is required to balance the overflow of deep, dense water into the Atlantic. Volume transports have been calculated for outflow water as 10×10^6 m^3/sec for bottom currents through the Denmark Strait, east of Greenland and for Norwegian Sea water over the Iceland-Faeroe Ridge (Steele et al., 1962; Swallow and Worthington, 1969). This outflow is partly matched by inflow into the Arctic Ocean through the Bering Strait (Coachman and Barnes, 1961) and from the Atlantic. Stefánson (1962) has shown that approximately 1×10^6 m^3/sec of Atlan-

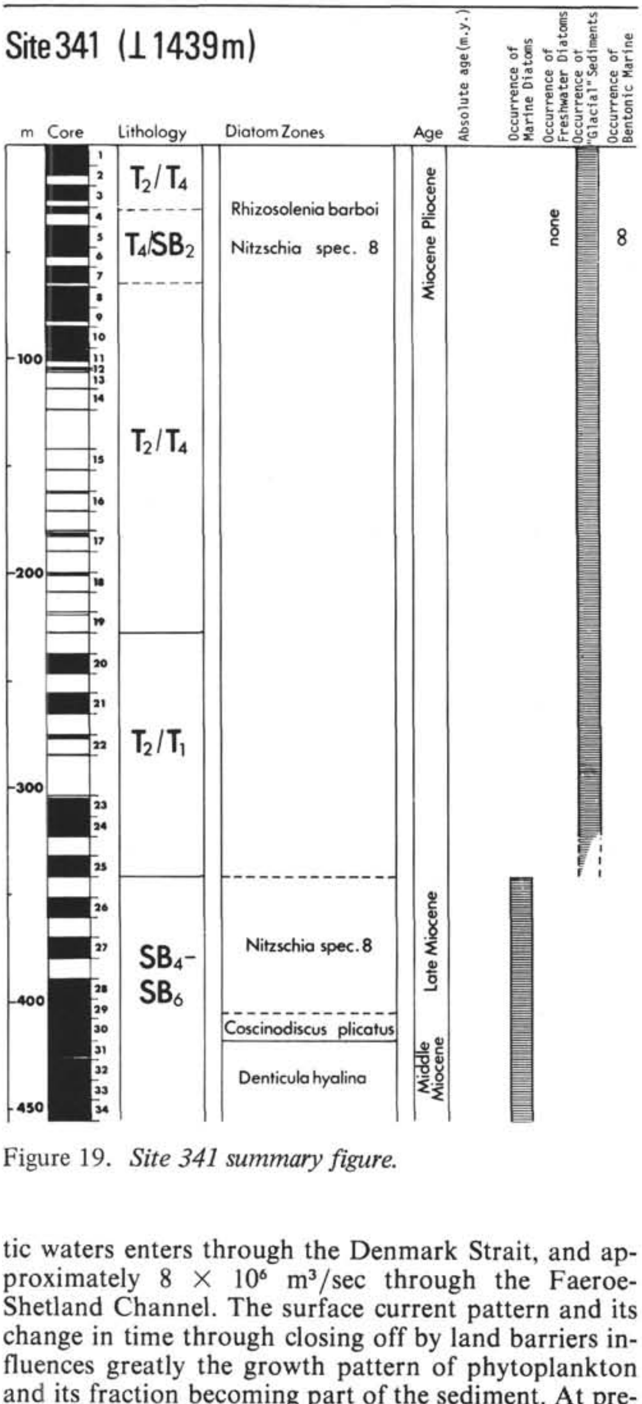


Figure 19. *Site 341 summary figure.*

tic waters enters through the Denmark Strait, and approximately 8×10^6 m^3/sec through the Faeroe-Shetland Channel. The surface current pattern and its change in time through closing off by land barriers influences greatly the growth pattern of phytoplankton and its fraction becoming part of the sediment. At present, diatom skeletons in surface sediments in the Norwegian Sea area (LDGO *Vema* Cruises 23, 27, 28) are only present in higher amounts at those stations, which underlie regions being influenced by the northward-flowing Norwegian Current. This current, on the other hand, is dependent on the development of the Iceland-Faeroe Ridge, which became completely submerged during the Miocene and enabled subtropical Atlantic floras to enter the Norwegian Sea. This can be demonstrated best with the occurrence of *Rhizosolenia bergonii* and *Thalassiosira convexa* at Site 336 in the Pleistocene-Pliocene interval.

No Atlantic floral influence was found at the more northerly Sites 341, 346, 348, and 349. The Iceland-Faeroe Ridge is now approximately 300-400 meters below NN (Jarke, 1958), and is covered only by a thin sediment cover west of Faeroe Islands. Locally, even basement is directly exposed (Schott, 1944; Johnson and Heezen, 1967; Dietrich, 1967; Jones et al., 1970). Strauch (1970) and Lindroth (1963), on the other hand, conclude a land connection from Greenland to Europe even until the early Pleistocene because no north Atlantic benthonic faunas were found in the Westjörnes section of northern Iceland (Strauch, 1963), and because the *Chelydridae* immigrated to North America from Europe over Greenland during the Miocene (Strauch, 1970). For further discussion on the subsidence of the Iceland-Faeroe Ridge see Paleosynthesis chapter (this volume).

Biostratigraphic zonation based exclusively upon diatom analysis is documented in Figure 37 with reference to all Leg 38 sites, intervals are given by core and section number, in some cases only by core numbers. Diatom zonation and its correlation to ages is tentative because of the high proportion of endemic species. Drifting in the eastern North Atlantic and Scandic is assumed to have initiated about 60 m.y. B.P. (Pitman and Talwani, 1972) and the oldest magnetic anomaly was found to be 24 (Avery et al., 1968). Oldest marine planktonic diatoms were found at Site 343 in the Lofoten Basin and were of approximately early-middle Eocene (approximately 49-53.5 m.y.B.P. on the Berggren, 1972, time scale which correlates well with the 60 m.y. date of spreading initiation). A slightly younger age of late-middle Eocene (49-37.5 m.y.) was found at Sites 339 and 340, which are located on the Vøring Plateau east of the Vøring Plateau Escarpment (Figures 38, 39). Sedimentation rates are on the order of 1.7 cm/1000 yr for the Miocene diatomaceous sequence at Site 338 and approximately 1.5-2.1 cm/1000 yr at Site 341. Upper Miocene through Pleistocene sediments are about 3-4 times thicker at Site 341 than they are at Site 338 and demonstrate the importance of the Vøring Plateau Escarpment as an active dam for terrigenous sediments.

Hiatuses were found in all Vøring Plateau sites and are caused either by tectonic activity and/or by bottom current erosion. On the other hand diapirism at Sites 340 and 341 was found to be responsible for the direct contact of late-middle Eocene biogenic siliceous sediments with Pleistocene sediments. In Hole 340 the stratigraphic order of sediments was disturbed. A displaced block of biogenic siliceous sediment within the "Glacial" sequence at Site 341 directly below a section dated as 1.8-2.5 m.y. B.P. (*Rhizosolenia barboi* Zone) leads to the assumption that during this time the Pliocene was a principal time of diapirism.

During the middle Oligocene great changes occurred in the Norwegian-Greenland Sea. The old spreading axis in the Norway Basin became extinct (Johnson and Heezen, 1967; Talwani and Eldholm, 1972) and was superseded by the Iceland Jan-Mayen Ridge, which is presently active, and lies asymmetrically close to Greenland. The oldest age of biogenic siliceous sediments east of the active Iceland Jan-Mayen Ridge is middle Miocene (10-14 m.y. B.P.). A striking unconformity was found at Site 348 (Core 16), Site 346 (Core

TABLE 3
Diatoms at Stie 341

Sample (Interval in cm)	Abundance	Preservation	Sponge spicules	*Actinocyclus ehrenbergii*	*A. ehrenbergii* var.	*A. ingens*	*Actinoptychus thumii*	*A. undulatus*	*A.* sp. (triangular)	*Asterolampra grevillei*	*Bruniopsis mirabilis*	*Cestodiscus peplum*	*C.* sp. a	*Chaetoceros dicladia*	*C. bristles*	*C.* spores	*C.* sp. 2	*Cladogramma dubium*	*Coscinodiscus endoi*	*C. flexuosus*	*C. lineatus*	*C. marginatus*	*C. praenitidus*	*C.* cf. *plicatus*	*C. symbolophorus* group	*C. vetustissimus*	*C. yabei*	*Cymatosira biharensis*	*Denticula dimorpha*	*D. hustedtii*	*D. hyalina*	*D. lauta*	*D. punctata*	*D. punctata* var. *hustedtii*	*Dicladia norwegica*	*Dimerogramma* aff. *fulvum*	*Diploneis* spp.	*Ethmodiscus rex*	*Eucampia balaustium*	Genus and sp. indet. (Plate 12, Fig. 22)	sp. indet. (Plate 20, Fig. 9)	*Goniothecium odontella*	*G. tenue*	*Hemialus danicus*	*H. polycystinorum*
4-2, 101-103	A	G	F			R		R							F	C		R				R			R										R				R	R		R			
5-2, 105-107	A	G	B	R			R	R				F	R		A	F	R	R										R		R			R	R	R		R		F		R		R		R
5-5, 105-107	A	G	B	R			R	R				F	R		A	F	R	R										R		R			R	R			R		F		R		R		R
6-2, 75-77	A	G	B			R		R			R	F			C	F				R		R			R					C		R	R						R					R	
7-2, 82-84	F	M	B	R		R		R	R	R	R			R	C	C	R	R	R	R	R				R	R		R		F				R		R					R	R		R	
7-5, 82-84	A	G	B			F									F	F												R		F		R				R								R	
26-2, 40-42	A	G	B	R		F		R			R				C	C		R		R	R	R						R	R	F	R											R		R	
26-5, 92-94	A	G	F			F		R			R				F	C		R	R	R	R				R	R				C												R			
27-2, 106-108	A	G	F			C		R			R				C	F					F	R		R						F															
27-5, 71-73	A	G	F	R		R		R			R				F	C					F	F						R		C															
28-2, 51-53	A	G	R			F		R							C	C				R										C		R													
28-5, 80-82	A	G	B			R		R							C	C				R		R								F												R			
29-2, 80-82	A	G	F			F		R			F				C	C				F		R			R		F	R		C															
29-5, 70-72	A	G	R			F		R			F				C	C				F	R	R					R	R		C						R									
30-2, 70-72	A	G	R			F		R			F				C	C				F	R	R					R	R		C						R									
30-5, 60-62	C	G	R			F		R			F				C	C				F	R	R					R	R		C						R									
31-2, 107-109	C	G	F			F					R		R		F	C			R							R		R		C						R		R				R			
31-5, 137-139	A	G	B			R					R		R		F	C			R							R		R		C						R		R				R			
32-2, 86-88	A	G	F			F		R							C	C			R			R						R		F						R		R							
32-5, 67-69	C	G	F			F		R			R				C	C			R			F						F		F															
33-2, 97-99	A	G	R	R		R					R				C	C			R			R						R		C															
33-5, 63-65	A	G	R	R		R					R				C	C			R			R						R		C															
34-3, 127-129	A	G	R			F									C	C					R	R			R			R		F	R					R									

TABLE 11 – *Continued*

Sample (Interval in cm)	*H. pyxilloides*	*Mediaria splendida*	*Melosira sulcata*	*Nitzschia evenescens*	*N. kanayensis*	*N.* sp. 8	*Odontella aurita*	*Opephora gemmata*	*Pleurosigma planktonica*	*Porosira glacialis*	*Psuedodimerogramma elegans*	*P. elongata*	*Psuedopodosira simples*	*Psuedopyxilla americana*	*P. directa*	*Pyrgupyxis johnsoniana*	*Rhaphoneis amphiceros*	*R. gemmifera*	*R. margaritalimbata*	*Rhizosolenia barboi*	*R. hebetata forma*	*R. miocenica*	*Rhaphoneis parallelica*	*Rhizosolenia praealata*	*R. praebarboi*	*R. styliformis*	*Rouxia yabei*	*R.* sp. 1	*Sceptroneis tenue*	*Stephanopyxis hyalomarginata*	*S. turris*	*Synedra jouseana*	*Thalassionema hirosakiensis*	*T. lineata*	*T. nitzschioides*	*Thalassiosira irregulata*	*T. oestrupii*	*Thalassiothrix longissima*	*Triceratium balearicum*	*T. barbadense*	*T. condecorum*	*Trinacria excavata*
4-2, 101-103			R												R					F	R		R			R					R				C		F	C				
5-2, 105-107	R											R	R		R								R			R				R	R	R	R		A			F	R	R	R	
5-5, 105-107	R											R	R		R								R			R				R	R	R	R		A			F	R	R	R	
6-2, 75-77		R	R			R						R	R						R	R	R		R	R	R	R		R	R		R				C			C	R			
7-2, 82-84			F					R			R	R	R	R	R		R			R			R	F	R				F		R	F			A			C	R	F		R
7-5, 82-84			F												R										F	R						F			C			F		R		
26-2, 40-42						R							R	R					R						F	R					R	F			C			F				
26-5, 92-94			F			R							R							R			R		F	R									F			C				
27-2, 106-108													R		R										F	R					R				C			F				
27-5, 71-73			R																	R					F	R					R				C			F				
28-2, 51-53													R								R				F										F			F				
28-5, 80-82																								R		R					R				F			F				
29-2, 80-82			R			R							R		R					R	R		R		F						R				C			C				
29-5, 70-72			R			R	R						R								R		R		F	R					F				A			C				
30-2, 70-72			R				R						R								R		R		F	R					F				A			C				
30-5, 60-62			R				R						R								R		R		F	R					F				A			C				
31-2, 107-109			F	R			R										R	R			R	R	R			R					F	R		R	A			F				
31-5, 137-139			F	R			R										R	R			R	R	R			R					F	R		R	A			F				
32-2, 86-88			R		R				R	R			R			R	R		R		R	R	R			R	R				R	F		R	C	R		C				
32-5, 67-69			F		R								R									R	R				R								F			C				
33-2, 97-99			F		R								R	R	R		R						R								R	F			C			C				
33-5, 63-65			F										R	R	R		R	R					R								R	F			C			C				
34-3, 127-129		R	R		R								R		R		R	R	R		R		R			R					R	R			C			C				

TABLE 12
Samples Barren in Diatoms and Sponge Spicules, Site 341

1-2, 94-96 cm	12-2, 80-82 cm
1-5, 62-64 cm	12-5, 80-82 cm
2-2, 91-93 cm	17-2, 80-82 cm
3-2, 93-95 cm	20-2, 60-62 cm
3-3, 82-84 cm	20-5, 70-72 cm
8-2, 97-99 cm	21-2, 102-104 cm
8-5, 93-95 cm	21-5, 127-129 cm
10-2, 80-82 cm	23-5, 91-93 cm
10-3, 50-52 cm	24-2, 63-65 cm
10-5, 80-82 cm	24-5, 104-106 cm
11-2, 80-82 cm	25-2, 88-90 cm

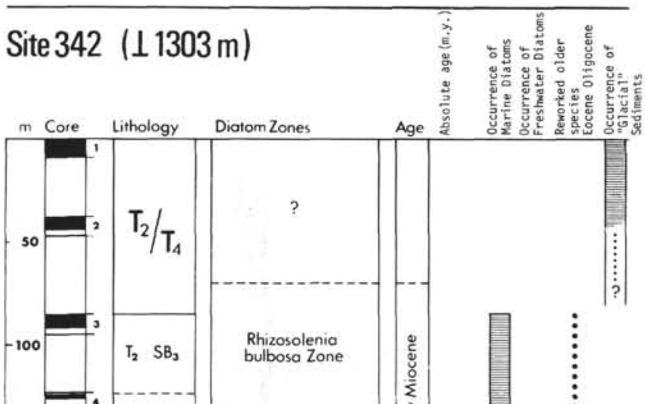


Figure 20. *Site 342 summary figure.*

9), where a drastic floral assemblage change took place. This date coincides with the date of shift of the spreading axis of the Iceland Jan-Mayen Ridge. The change in sediment character from dominantly terrigenous sediments in the Oligocene-early Miocene to pelagic biogenic siliceous oozes in the middle Miocene can be related to the trapping effect of the new ridge between Greenland and the Icelandic Plateau preventing terrigenous sediments derived from Greenland to reach the Icelandic Plateau. This facies change is characterized at Site 348 in a predominance of *Stephanogonia horridus* in the underlying section, and at Site 346 in a predominance of *Goniothecium* spp. Both genera are interpreted as being neretic, they are heavily silicified and thus resist dissolution. The facies change at Sites 348 and 346 can best be correlated with the shift of spreading axis from the Jan-Mayen Ridge to the Iceland Jan-Mayen Ridge at approximately 10-15 (?) m.y.B.P., and this shift probably caused the unconformity at Site 338 between Cores 9 and 10. Here, no indication in facies change was found, but the high rate of last occurrences and first occurrences between these two cores, continuously drilled with only 1 meter of sediment missing, are used for definition of this unconformity.

The first shift of the extinct spreading center in the Norwegian Basin at approximately 25 m.y.B.P. (Talwani and Eldholm, 1972) is documented in the Oligocene section at Site 338 where late Eocene biogenic siliceous sediments directly underlie a middle Oligocene nannoplankton ooze (NP24, Müller, this volume).

Siliceous biogenic sediments range in age from early Eocene to the Recent and document a high primary production blooming in the Greenland-Norwegian Sea since early Eocene. The type of nutrient supply to enable this high primary production is not understood at this moment (Table 27).[2]

Displaced fresh-water diatoms are occasionally found at the various sites (compare site summary figures). Shallow-water benthonic marine diatoms are found sporadically in the Miocene sections with an increase in abundance and diversity over the Miocene-Oligocene boundary, and in the late Oligocene.

[2]References are given in Part II of this chapter.

TABLE 13
Diatoms at Site 342

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinocyclus ellipticus*	*Actinoptychus undulatus*	*Asteromphalus robustus*	*Bruniopsis mirabilis*	*Cestodiscus peplum*	*Chaetoceros bristles*	*Chaetoceros spores*	*Cladogramma dubium*	*Coscinodiscus lewisianus*	*C. marginatus*	*C. symbolophorus group*	*C. vetustissimus*	*Cymatosira biharensis*	*Diploneis sp.*	*Ethmodiscus rex*
3-2, 70-72	C	G	R		R		R		C	C	R			R			R	
4-2, 70-72	R	P	F															
5-2, 60-62	A	G	B	R	R	R	R	R	C	C		R	R	R	R	F	R	R
5-5, 60-62	A	G	B	R	R	R	R	R	C	C		R	R	R	R	F	R	R
6-2, 70-72	A	G	B		R				F	C	R		R					R
1-2, 118-120	B	–	B															
1-5, 78-80	B	–	B															
2-2, 70-72	B	–	B															

Sample (Interval in cm)	*Goniothecium odontella*	*G. tenue*	*Hemiaulus danicus. polycystinorus*	*Melosira islandica*	*M. sulcata*	*Opephora gemmata*	*Odontella septentrionala*	*Pleurosigma planktonica*	*Pseudodimerogramma elongata*	*P. elegans*	*Pseudopodosira simplex*	*Pseudopyxilla americana*	*P. directa*	*Rhaphoneis amphiceros*	*R. parallelica*
3-2, 70-72	R	R	R[a]		F		R		R			R	R		
4-2, 70-72					C										
5-2, 60-62					R	R			R	R	R	R		R	R
5-5, 60-62					R	R			R	R	R	R		R	R
6-2, 70-72	R			R	C			R	R			R	R		
1-2, 118-120															
1-5, 78-80															
2-2, 70-72															

Sample (Interval in cm)	*R. wicomicoensis*	*Rhizosolenia bulbosa*	*R. styliformis*	*Stephanopyxis hyalomarginata*	*Stephanopyxis turris*	*Synedra jouseana*	*S. miocenica*	*Thalassiosira fraga*	*T. eccentrica*	*T. spumellaroides*	*Thalassionema nitzschioides*	*Thalassiothrix longissima*	*Triceratium barbadense*	*T. condecorum*	*T. balearicum*
3-2, 70-72					F					R	C	F	R[a]	R	
4-2, 70-72					C										
5-2, 60-62		R	R[a]	R	R	R	R		R		C	C			
5-5, 60-62		R	R		R	R	R		R		C	C			
6-2, 70-72	R				R	F	R	F			C	F	R[a]		
1-2, 118-120															
1-5, 78-80															
2-2, 70-72															

[a]Reworked.

PART II
DIATOMS AT LEG 38, TAXONOMIC REFERENCES

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References are given for those taxa from Sites 336 through 349 DSDP Leg 38. They are arranged alphabetically, and new descriptions are given for those taxa which have been treated insufficiently in the literature. Additional references are selected from the descriptions and illustrations. Synonyms are mentioned only in the case where they were not cited in the previous works. Many taxa are treated under genus et species indeterminandum, and only numbered in those instances where they were listed in the tables of each site. Others are only illustrated and reference to their occurrence can be obtained from the explanations to the plates. The same method of numbering was used for unidentified species within a genus. We have tried to list and illustrate as many species as possible and are fully aware that further thorough investigation will yield more species. This holds true mainly for the spore genera—*Pterotheca*, *Xanthiopyxis*, *Pseudopyxilla* a.o. The great number of new taxa has to be understood by the provincialism of most of the Norwegian Sea species. Thus fossil diatom taxonomy still is in its reconnaissance state and demands much more intensive studies of Paleogene-early Neogene marine sections with emphasis on taxonomy and not under the view of picturing and listing easily identifiable species. Further, the trend of studying fractionated material in order to achieve a cleaner sample and thus make illustration more easily has to be fully rejected. Most species of the fraction coarser than 40 μm do have long ranges, are not typical for environmental interpretation, and evolve less rapidly.

Our system of a pseudonumerical taxonomic system for all these taxa, which we were not able to treat in a sufficient way, is against the nomenclature rules, but should be understood as an attempt to treat as many of the occurring taxa in a sample as possible and has to be reviewed in the nearest future. The position of the various genera in the "natural" system of diatoms may be resolved using Simonsen's (1972) proposed system for the Centrales; Hustedt (1930, 1958, 1959) may serve as an additional reference.

Age determinations were partly taken from the literature, and present findings were included whenever possible. The following new entries and new combinations were established on DSDP Leg 38 material with their respective authorship.

Asterolampra praeacutiloba n. sp. Fenner
Asteromphalus oligocenicus n. sp. Schrader and Fenner
Asteromphalus symmetricus n. sp. Schrader and Fenner
Coscinodiscus norwegicus n. sp. Schrader
Coscinodiscus praenitidus n. sp. Fenner
Cymatosira compacta n. sp. Schrader and Fenner
Cymatosira cornuta n. sp. Schrader and Fenner
Cymatosira coronata n. sp. Fenner and Schrader
Cymatosira fossilis n. sp. Schrader
Cymatosira praecompacta n. sp. Fenner and Schrader
Cymatosira robusta n. sp. Schrader and Fenner
Denticula norwegica n. sp. Schrader
Dicladia elliptica n. sp. Schrader
Dicladia norwegica n. sp. Schrader
Fragilaria voeringia n. sp. Fenner
Goniothecium coronatum n. sp. Fenner
Goniothecium loricatum n. sp. Fenner
Huttonia norwegica n. sp. Schrader and Fenner
Lithodesmium rotunda n. sp. Schrader
Monobrachia n. gen. Schrader
Monobrachia simplex n. sp. Schrader
Monobrachia unicornuta (Brun) n. comb. Schrader and Fenner
Navicula bendaensis n. sp. Schrader and Fenner
Navicula sudora n. sp. Schrader and Fenner
Navicula udintsevii n. sp. Schrader and Fenner
Nitzschia guttula n. sp. Schrader
Nitzschia pseudocylindrica n. sp. Schrader
Odontella calamus (Brun and Tempère) *n. comb. Schrader*
Odontella cornuta (Brun) n. comb. Schrader
Odontella fimbriata (Greville) n. comb. Schrader
Odontella septentrionala n. sp. Schrader
Pleurosigma planktonica n. sp. Schrader
Pseudodimerogramma n. gen. Schrader
Pseudodimerogramma elegans n. sp. Schrader
Pseudodimerogramma elliptica n. sp. Schrader
Pseudodimerogramma elongata n. sp. Schrader
Pseudodimerogramma filiformis n. sp. Schrader and Fenner
Pseudodimerogramma oligocenica n. sp. Schrader and Fenner
Pseudorutilaria monomembranacea n. sp. Schrader
Pyrgupyxis oligocaenica (Jousé) n. comb. Schrader
Rhaphoneis angulata n. sp. Fenner
Rhaphoneis elliptica n. sp. Schrader
Rhaphoneis ossiformis n. sp. Schrader
Rhaphoneis parallelica n. sp. Schrader
Rhaphoneis robustata n. sp. Schrader
Rhizosolenia bulbosa n. sp. Schrader
Rhizosolenia hebetata var. *volatilis* n. var. Schrader
Rhizosolenia massiva n. sp. Schrader
Rhizosolenia norwegica n. sp. Schrader
Rhizosolenia palliola n. sp. Schrader and Fenner
Riedelia tenuicornis (Greville) n. comb. Schrader and Fenner
Riedelia longicornis (Greville) n. comb. Schrader and Fenner
Riedelia lyriformis (Greville) n. comb. Schrader and Fenner
Riedelia alata (Greville) n. comb. Schrader and Fenner
Riedelia altar (Brun) n. comb. Schrader and Fenner
Riedelia claviger (A. Schmidt) n. comb. Schrader and Fenner
Rouxia granda n. sp. Schrader
Rouxia obesa n. sp. Schrader
Sceptroneis facialis n. sp. Fenner
Sceptroneis humuncia n. sp. Schrader and Fenner
Sceptroneis humuncia var. *tridens* n. var. Fenner
Sceptroneis mayenica n. sp. Fenner
Sceptroneis ossiformis n. sp. Schrader
Sceptroneis pesplanus n. sp. Fenner and Schrader
Sceptroneis propinqua n. sp. Schrader and Fenner
Sceptroneis pupa n. sp. Schrader and Fenner
Sceptroneis talwanii n. sp. Schrader and Fenner
Sceptroneis tenue n. sp. Schrader and Fenner
Sceptroneis vermiformis n. sp. Schrader
Stephanogonia horridus n. sp. Schrader
Thalassiosira dubiosa n. sp. Schrader
Thalassiosira fraga n. sp. Schrader
Thalassiosira irregulata n. sp. Schrader
Thalassiosira lusca n. sp. Schrader
Thalassiosira mediaconvexa n. sp. Schrader
Triceratium latipes n. sp. Fenner
Trochosira coronata n. sp. Schrader and Fenner

Genus ACTINOCYCLUS Ehrenberg (1837)

Actinocyclus divisus (Grunow) Hustedt (1958)
(No illustration)

Description: Hustedt (1958), p. 129-130, pl. 8, fig. 81.
Age: Pleistocene-Recent.

Actinocyclus ehrenbergii Ralfs in Pritchard (1861)
(Plate 14, Figure 17)

Description: Hustedt (1930), p. 525-532.
Age: Not diagnostic.

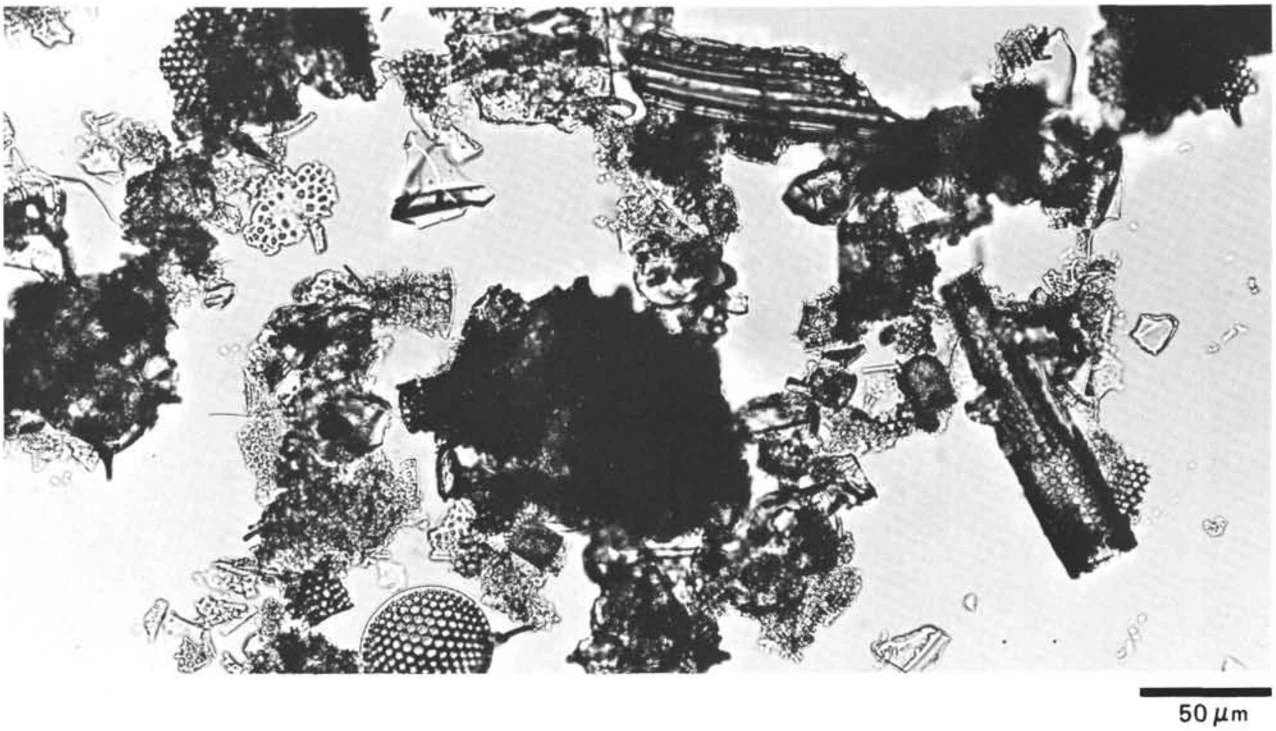

Figure 21. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 343-5-4, 100 cm with glass shards, broken diatoms,* Pyrgupyxis oligocenicus, *and* Coscinodiscus moelleri. *Distance between two bars 10 µm. Diatoms moderately well preserved.*

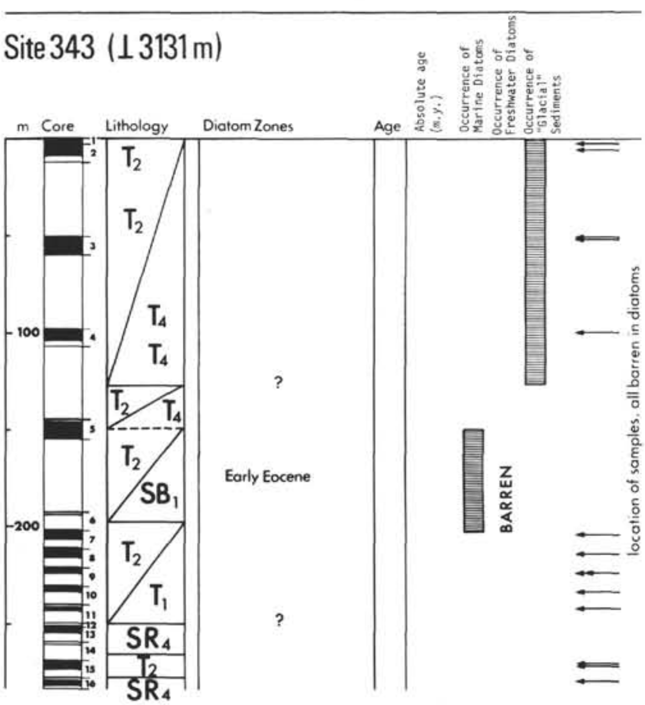

Figure 22. *Site 343 summary figure.*

Actinocyclus ehrenbergii var. tenella (Breb.) Hustedt (1930)
(Plate 14, Figure 15)

Description: Hustedt (1930), p. 530, fig. 302.
Age: Late Miocene-Pliocene.

Actinocyclus ingens Rattray (1890)
(Plate 14, Figure 16)

Description: Kanaya (1971), p. 554, numerous figures; Koizumi (1968), p. 207-208, pl. 32, fig. 5, 6.
Age: Miocene.

Genus ACTINOPTYCHUS Ehrenberg (1841)

Actinoptychus splendens (Shadb.) Ralfs in Pritchard (1861)
(No illustration)

Description: Hustedt (1930), p. 478-479, fig. 265.
Age: Not diagnostic.

Actinoptychus thumii (Schmidt et al., 1874) Hanna (1932)
(Plate 19, Figure 3)

Synonym: *Actinoptychus stellaris* var. *thumii* Schmidt (1874) *in* Schmidt (1886), pl. 90, fig. 3; pl. 100, fig. 6.
Description: Hanna (1932), p. 171, pl. 4, figs. 3-4.
Stratigraphic record: Late Oligocene (this paper)-early Miocene (Hanna, 1932, and this paper).

Actinoptychus undulatus (Bail.) Ralfs in Pritchard (1861)
(No illustration)

Description: Hustedt (1930), p. 475-478, fig. 264.
Age: Not diagnostic.

Actinoptychus species (triangular)
(Plate 35, Figure 23)

Remarks: Triangular *Actinoptychus* individuals of the illustrated type were found frequently in the investigated Oligocene samples. Due to the fact that the taxonomy of the genus *Actinoptychus* is ill defined, no further taxonomic treatment was done on the present individuals.
Age: Oligocene.

TABLE 14
Diatoms at Site 343

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinoptychus* aff. *undulatus*	*Coscinodiscus moelleri*	*C. oligocenicus*	*Goniothecium odontella* var. *danicum*	*Hemiaulus affinis*	*H. elegans*	*Odontotropis clavsenii*	*Pseudostictodiscus angulatus*	*Pterotheca spada*	*Pyrgupyxis oligocaenica*	*Rhizosolenia* sp. Plate 45/22	*Riedelia claviger*	*Riedelia* sp. 1	*Stephanopyxis turris*	*Trinacria excavata*	*T. pileolus*	*T. regina*	*T.* sp. (*quadrata*)	*Trochosira spinosa*
5-2, 140-142	A	G	F		questionable – see text Site 343 – Middle Miocene																	
5-3, 100-102[a]	A	G	B	R	R	F	R	R		R	R	F	F	R	R	R	C	R	R	R		R
5-4, 25-26[a]	A	G	B	R	F	F	R	R		R	R	F	F	R	R	R	C	R	R	F		R
5-6, 110-112[a]	A	G	B		F		F	R	R			F		R		R	A			F		
6-1, 128-130[a]	C	G	B				R			R		R		R		R	C			F		R

[a]Ash.

TABLE 15
Samples Barren in Diatoms, Site 343

1-2, 60-62 cm	9-2, 70-72 cm
2-2, 94-86 cm	9-2, 94-96 cm
3-1, 94-96 cm	10-2, 70-72 cm
3-2, 60-62 cm	11-2, 90-92 cm
4-2, 30-32 cm	15-2, 60-62 cm
7-2, 70-72 cm	15-3, 85-87 cm
8-2, 65-67 cm	16-2, 65-67 cm

Genus ANAULUS Ehrenberg (1844)

Anaulus acutus J. Brun (1896)
(Plate 20, Figure 4)

Description: Brun (1896), p. 231, pl. 20, fig. 15-18.

Genus ASTEROLAMPRA Ehrenberg (1844) (compare Figure 40)

Asterolampra insignis A. Schmidt et al. (1874)
(Plate 21, Figure 15)

Illustration: A Schmidt et al. (1874), pl. 137, fig. 1-3.
Age: Late Eocene-Oligocene.

Asterolampra marylandica Ehrenberg (1844)
(No illustration)

Description: Hustedt (1930), p. 485, fig. 271.

Asterolampra praeacutiloba n. sp. Fenner
(Plate 28, Figures 9-11)

Description: Valve circular, slightly convex with four or five lobes. Valve diameter 20-33 μm. Areolated lobes are cuneate with apices in direction of the center. From these apices run radial, straight ribs which meet more or less exactly in the center of the valve, thus dividing the hyaline central part of valve into equal sectors. In the areolated lobes are 15-16 areolae in 10 μm. At the marginal farthest point of the hyaline sectors is one labiate (?) process.

Discussion: This species differs from the Miocene species *Asterolampra acutiloba* Forti (1913) by its smaller size, lower number of lobes, and the form of the areolated lobes, which in *Asterolampra acutiloba* is truncate with a cuneate top, but in *A. praeacutiloba* it is cuneate beginning from the margin on to the apex of the lobe.

Holotype: Plate 28, Figure 10 from Leg 38, Sample 338-26-5, 63-65 cm; Norwegian Sea.
Paratypes: Plate 28, Figures 9, 11.
Age: Late Eocene-middle Oligocene.

Asterolampra punctifera (Grove) Hanna, 1927a
(Plate 28, Figures 3, 4)

Description: Hanna (1927a), p. 109, pl. 17, fig. 3.

Asterolampra vulgaris Greville (1862)
(Plate 28, Figures 6-8, 12)

Description: Greville (1862), p. 47; pl. 7, fig. 17-20; A. Schmidt et al. (1874) pl. 137, fig. 10, 12; pl. 202, fig. 14-16.
Age: Late Eocene.

Asterolampra sp.
(Plate 28, Figures 2, 5)

Genus ASTEROMPHALUS Ehrenberg (1845) (compare Figure 40)

Asteromphalus oligocenicus n. sp. Schrader and Fenner
(Plate 21, Figures 8, 13, 14; Plate 28, Figure 1)

Description: Cells discoid, valves slightly convex, 24-71 μm in diameter. Valve surface having a central hyaline space occupying approximately a third of the diameter which is produced to form rays which divide the remainder of the valve into five to seven sectors. One ray is narrower than the others. The rays are of equal length. A system of straight lines traverse the central hyaline space radially, joining the concave apices of the peripheral sectors. Two sectors on both sides of the thinner ray are larger than the others and asymmetrical, the lines, which originate from these sectors, unite before the center and continue towards the center in one small line (exception, see Plate 21, Figure 8). Peripheral sectors areolate, areolae fine, hexagonal, arranged in tangential lines, 18-19 in 10 μm. Sectors slightly concave towards the central space. Hyaline rays terminated at the valve margin by a labiate process.

Discussion: This species differs from other *Asteromphalus* species by its nonzig-zagged lines and its similarity to *Asterolampra*.

Holotype: Plate 21, Figure 14 from Leg 38, Sample 338-19-3, 140-141 cm; Norwegian Sea.

Paratype: Plate 21, Figure 13 (700 × magnification); Plate 28, Figure 1.

Age: Late Oligocene.

Holotype: Plate 21, Figure 10 from Leg 38, Sample 338-19-5, 123-124; Norwegian Sea.

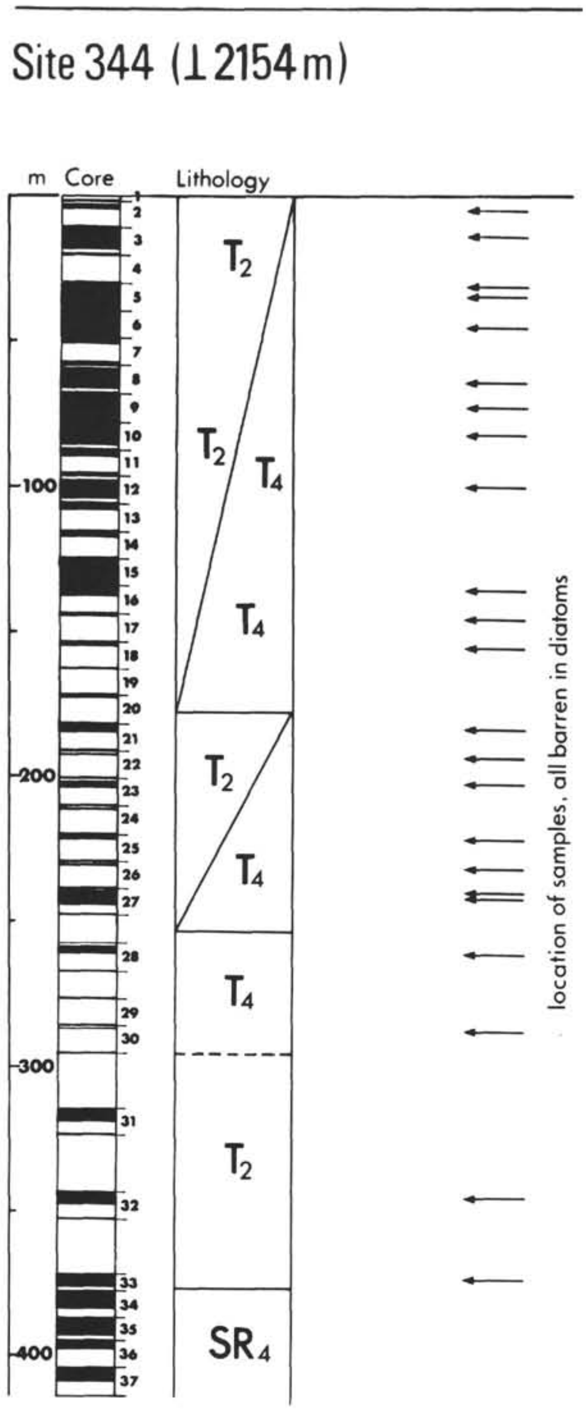

Figure 23. *Site 344 summary figure.*

Paratype: Plate 21, Figures 7, 11, 12.
Age: Late Oligocene.

Asteromphalus robustus (?) Castracane (1886)
(Plate 21, Figure 9)

Remarks: Aberrant form which is placed with hesitation into this species.
Description: Hustedt (1930), p. 496-498, fig. 278.

Asteromphalus symmetricus n. sp. Schrader and Fenner
(Plate 21, Figures 7, 10-12)

Description: Cells discoid, valves slightly convex, 29-48 μm in diameter, circular not asymmetric. Central hyaline space occupying approximately a third of the total valve area. The areolated part of the valve is divided by hyaline rays starting from the central hyaline area in five to six sectors. One of the hyaline rays is narrower than the others and also longer. A system of straight zig-zagged (near the base) lines traverses the central hyaline space radially, joining the middle of the concave front of the areolated sectors. These ribs are all of approximately the same length and reach all the central joining point. The two sectors on both sides of the one narrower, hyaline ray are asymmetrical and are longer. The peripheral sectors are finely areolated. The areolae are polygonal, arranged in tangential lines, and number 9-14 in 10 μm. The areolae decrease in size towards the margin. Sectors slightly concave towards the central space. Hyaline rays terminated at the valve margin by a labiate process.
Discussion: This species is very closely related to *Asteromphalus hungaricus* Pantocsek (1889), pl. 30, fig. 436; pl. 31, fig. 451, but differs in the smaller hyaline central part and its geologic range.

TABLE 16
Samples Studied and Being Barren in Diatoms and Sponge Spicules, Site 344

2-2, 75-77 cm	21-1, 121-123 cm
3-2, 20-22 cm	22-1, 117-119 cm
5-1, 40-42 cm	23-2, 33-35 cm
5-3, 90-92 cm	25-1, 103-105 cm
6-3, 120-122 cm	26-1, 121-123 cm
8-4, 90-92 cm	27-1, 69-71 cm
9-3, 95-97 cm	27-3, 38-40 cm
10-3, 70-72 cm	28-2, 112-114 cm
12-3, 90-92 cm	30-1, 92-94 cm
16-1, 103-104 cm	32-1, 66-68 cm
17-1, 114-116 cm	33-2, 60-62 cm
18-1, 122-124 cm	

Holotype: Plate 7, Figure 10 from Leg 38, Sample 19-5, 123-124 cm; Norwegian Sea.
Paratypes: Plate 7, Figures 7, 11, 12.
Age: Late Oligocene.

Genus BIDDULPHIA Gray (1821)

Biddulphia tuomeyi (Bailey) Roper (1859)
(No illustration)

Description: Hustedt (1930), p. 834-836, fig. 491.
Age: Not diagnostic.

Biddulphia species
(Plate 36, Figure 7)

Genus BOGOROVIA Jousé (1973)

Bogorovia veniamini Jousé (1973)
(No illustration)

Description: Jousé (1973), p. 351, pl. 4, fig. 1-3.
Age: Late Oligocene-early Miocene.

Genus BRUNIOPSIS Karsten (1928)

Bruniopsis mirabilis (Brun) Karsten (1928)
(No illustration)

Description: Brun *in* Brun and Tempère (1889), p. 27, pl. 8, fig. 1 (as *Brightwellia ? mirabilis*); Kolbe (1954), p. 24, pl. 4, fig. 44.
Age: Miocene.

Genus CESTODISCUS Greville (1865)

Cestodiscus muhinae Jousé (1974a)
(Plate 27, Figures 11, 12; Plate 29, Figure 4)

Description: Jousé (1974a), p. 344-345, pl. 1, fig. 1-5.
Age: Late Oligocene.

Cestodiscus peplum Brun (1891)
(Plate 14, Figure 11)

Description: Brun (1891), p. 6, pl. 19, fig. 5.
Age: Miocene.

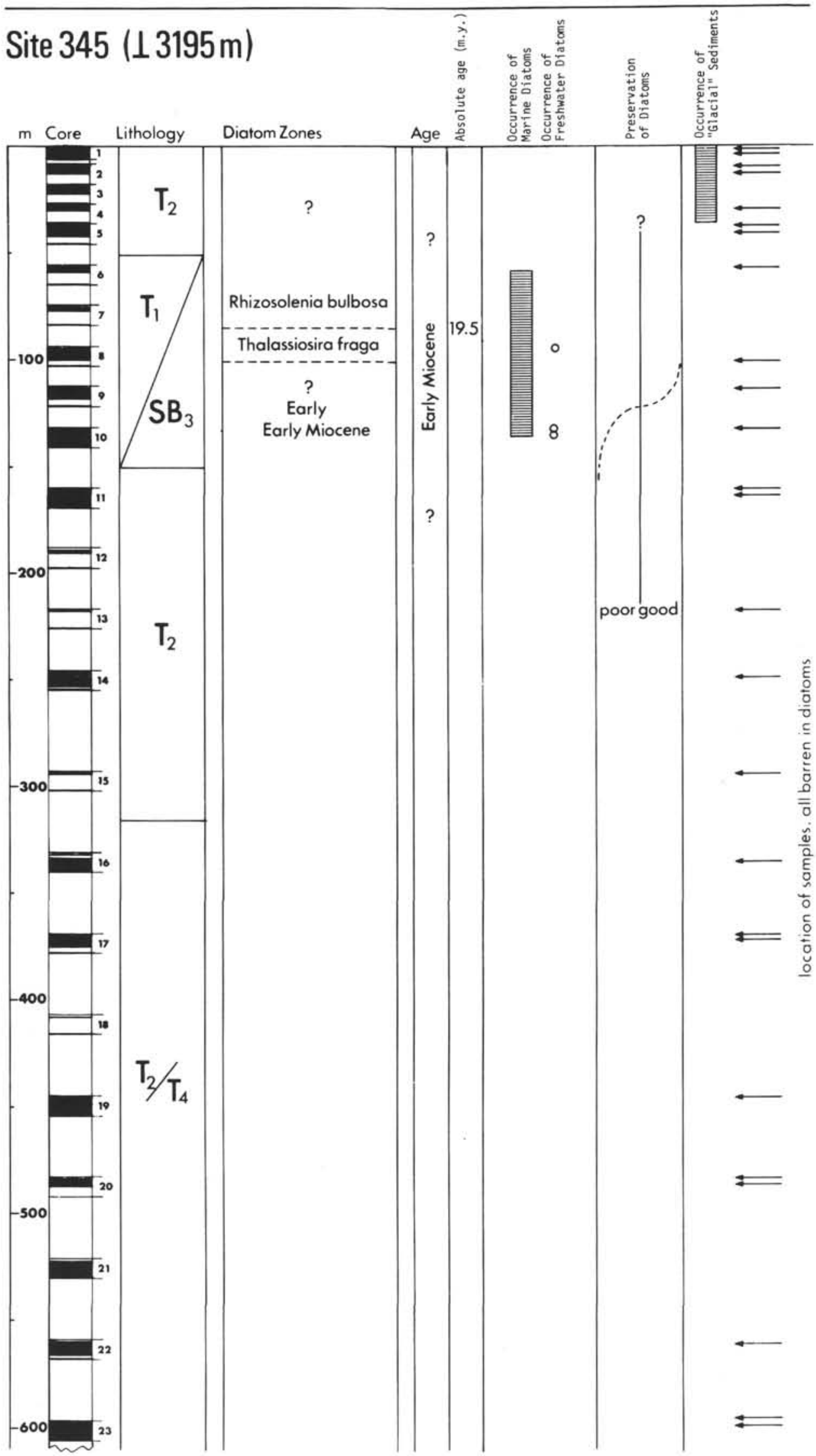

Figure 24. *Site 345 summary figure.*

TABLE 17
Diatoms at Site 345

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinocyclus ehrenbergii*	*Chaetoceros* bristles	*C.* spores	*Cladogramma dubium*	*Cocconeis* spp. (litoral)	*Coscinodiscus lineatus*	*C. vetustissimus*	*C. vigilans*	*Diploneis* spp. (litoral)	Genus and sp. indet. (Plate 4, Fig. 10)	*Goniothecium odontella*	*G. tenue*	*Melosira islandica* (freshwater)	*M. sulcata*	*Odontella aurita*	*Opephora gemmata*	*Pseudodimerogramma elongata*	*Pseudopodosira simplex*	*Pseudopyxilla directa*	*Rhabdonema* spp. (litoral)	*Rhaphoneis margaritalimbata*	*R. parallelica*	*Rhizosolenia hebetata* forma *hiemalis*	*Rouxia californica*	*Stephanopyxis turris*	*Synedra jouseana*	*S. miocenica*	*Thalassionema nitzschioides*	*Thalassiosira fraga*	*Thalassiothrix longissima*	*Triceratium condecorum*	*Trinacria excavata*	*T. pileolus*
6-2, 68-70	A	G	F		C	C	R	R				R	R		R		R			R				R	R		R	F	R		C	–	F			
7-2, 59-61	C	M	R		C	C	R	R		R			R		F			R										R		F		–	R	R		
8-1, 79-81[a]	A	G	R	R	C	C			R						R	R	R		R	R		R						F	F	F	C	R	F			R
8-3, 62-64	C	M	R	R	C	C			R						R	R	R		R	R		R						F	F	F	C	R	R			R
9-3, 30-32	F	M	R			C											F				R							R			R		R			R
10-1, 40-42	F	M	R		C	C					R					R	F						R			R		R			R					
10-3, 50-52	R	M	F		C	C								R			R		R									R			R				R	
11-3, 50-52	R	P	B			C								R														F			R					

[a]Ash.

TABLE 18
Samples Barren in Diatoms, Site 345

1-1, 68-70 cm	19-1, 82-84 cm
1-3, 139-141 cm	19-3, 66-68 cm
2-1, 83-85 cm	20-1, 109-111 cm
2-3, 87-89 cm	20-3, 117-119 cm
4-2, 58-60 cm	22-3, 78-80 cm
5-1, 60-62 cm	23-1, 56-58 cm
5-3, 90-92 cm	23-3, 20-22 cm
6-1, 68-70 cm	24-1, 66-68 cm
8-5, 50-52 cm	24-3, 87-89 cm
9-1, 102-104 cm	25-1, 47-58 cm
11-1, 50-52 cm	26-3, 77-78 cm
13-1, 115-117 cm	27-1, 75-77 cm
14-3, 33-35 cm	27-2, 66-68 cm
15-1, 116-118 cm	28-1, 116-118 cm
16-4, 65-74(?) cm	28-2, 54-56 cm
17-1, 98-100 cm	29-2, 76-77 cm
17-3, 30-32 cm	30-1, 58-59 cm
	30-2, 120-121 cm

Cestodiscus sp. a
(Plate 19, Figure 4)

Cestodiscus sp. b
(Plate 19, Figure 5)

Cestodiscus sp.
(Plate 17, Figure 11)

Genus CHAETOCEROS Ehrenberg 1844 (1845)

Chaetoceros capreolus (Ehrenberg) Castracane (1886)
(No illustration)

Description: Castracane (1886), p. 82, pl. 8, fig. 1.
Age: Not diagnostic.

Chaetoceros dicladia Castracane (1886)
(Plate 12, Figures 15, 16) (?)

Description: Kanaya (1959), p. 117, pl. 11, fig. 1, 2; Hanna and Grant (1926), p. 142, pl. 16, fig. 4.
Synonyms: *Dicladea pylea* Hanna and Grant (1926), *Dicladia capreolatatus* Ehr. *in* Kanaya (1959).

Chaetoceros sp.
(Plate 6, Figure 15; Plate 38, Figures 5-7)

Remarks: Several spores have been found in the present material which can be placed within the genus *Chaetoceros*, but only those have been combined here with *Chaetoceros* which did possess clear fragments of typical *Chaetoceros* bristles. At present, the authors are unable to treat all spores in an appropriate taxonomic way.

Chaetoceros sp.
(Plate 6, Figure 11)

Chaetoceros spores
(Plate 38, Figures 2, 4, 8, 9, 13, 17, 18; Plate 40, Figure 9)

Chaetoceros (?)-Hemiaulus (?) resting spore
(Plate 38, Figures 19-21; Plate 45, Figures 12, 13; Plate 40, Figure 16)

Resting spore
(Plate 45, Figures 15, 16)

Genus CHASEA Hanna (1934)

Chasea ornata Hajós and Stradner (1975)
(Plate 43, Figure 16)

Description: Hajós and Stradner (1975), p. 928, pl. 5, fig. 4, 5.

Genus CLADOGRAMMA Ehrenberg (1854)

Cladogramma dubium Lohmann (1948)
(Plate 12, Figures 3 (?), 5 (?), 9 (?); Plate 13, Figure 6)

Description: Sheshukova-Poretzkaya (1967), p. 192; Schrader (1973a), p. 702, pl. 13, fig. 17, 18, 21.
Age: Miocene.

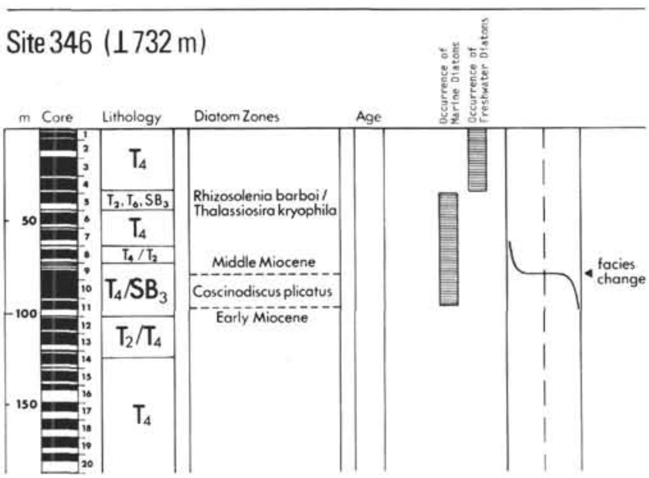

Figure 25. *Site 346 summary figure.*

Genus COSCINODISCUS Ehrenberg (1838)

Coscinodiscus aff. argus
(Plate 33, Figures 3, 4)

Description: Valve circular, flat, with a diameter of 50-100 μm. There is no central area or rosette. Areolae are arranged in radial lines. The inner opening of the areolae is distinctly visible. The areolae number four to five in 10 μm in the central part, increase in size to three to four in 10 μm with increasing distance from the center and suddenly decrease again at the margin where six to seven areolae are found in 10 μm.

The only difference to the species is the finer areolation. Hajós (in preparation) illustrates specimens from the late Eocene and early Oligocene which she names *Coscinodiscus* aff. *radiatus* but which certainly belong to the here described *Coscinodiscus* aff. *argus*.

Age: Late Eocene-Oligocene.

Coscinodiscus asteromphalus Ehrenberg (1844a)
(Plate 34, Figures 2, 3)

Description: Hustedt (1930); p. 452-454, fig. 250.

Coscinodiscus asteromphalus var. brightwellioides Grunow (1884)
(Plate 32, Figure 2)

Description: Pantocsek (1892), pl. 28, fig. 410; Grunow (1884), p. 78.

Age: St. Monica (Miocene)-Oligocene (this paper).

Coscinodiscus asteromphalus var. princeps Grunow in van Heurck (1883)
(Plate 32, Figures 1, 3)

Description: Grunow (1884), p. 78, van Heurck (1883), pl. 128, fig. 1-3.

Remarks: The specimens found in the Oligocene sediments of the Norwegian Sea are even more finely areolated than the fossil specimens of unknown origin Grunow described. The observed specimens have eight to nine areolae in 10 μm and one pore in the central hyaline area or one of the elongated areolae surrounding the central area is protruding into the area instead.

Age: Oligocene-(?).

Coscinodiscus bathyomphalus Cleve (1883)
(Plate 15, Figures 1, 2)

Description: Hustedt (1930), p. 431, fig. 234.

Remarks: The present individuals have been placed with hesitation into this species. Areolae (approx. 12 in 10 μm) are not arranged in radial and irregularly spiral rows but in spiral rows and sometimes in fascicles (Plate 15, Figure 2).

Age: Not yet determined.

Coscinodiscus aff. capensis Grunow (1884)
(Plate 36, Figures 4, 8)

Description: Grunow (1884), p. 86, pl. 4 (D), fig. 29.

Remarks: Grunow (1884) found the species in brackish water of the Baaken's River (South Africa).

Coscinodiscus endoi Kanaya (1959)
(Plate 14, Figure 14)

Description: Kanaya (1959), p. 76-77, pl. 3, fig. 8-11.

Age: Middle-late Miocene.

TABLE 19
Diatoms at Site 346

Sample (Interval in cm)	Preservation	Abundance	Sponge Spicules	*Actinocyclus ehrenbergii*	*Actinoptychus undulatus*	*Arachnoidiscus* spp.	*Chaetoceros dicladia*	*C.* bristles	*C.* spores	*Cladogramma dubium*	*Cocconeis* spp.	*Coscinodiscus margiatus*	*Cymatosira compacta*	*C. fossilis*	*Dimerogramma* aff. *fulvum*	*Goniothecium decoratum*	*G. odontella*	*G. tenue*	*Grammatophora* spp.	*Hemiaulus danicus*	*Hyalodiscus* aff. *subtilis*	*Melosira sulcata*	*Porosira glacialis*
5-1, 30-32	P	R	F		F					R		R										R	R
5-1, 60-62	M	R	F		R		R	R		R		R					R	C				R	
5-3, 95-97[a]	G	C	F					C	A									F				R	
6-2, 30-32[a]	G	C	R					C	C													F	
6-4, 45-47	P	R	R															R					
7-1, 110-112	G	C	F						C								R	R				R	
7-3, 20-22	M	R	F						C													R	
8-2, 30-32	P	R	F					F															
9-5, 40-42	M	F	R			R			F		R		R	R		F					R	F	R
10-1, 40-42	P	R	F						C							R							
10-3, 20-22	P	R	F													F		R					
11-2, 25-27	P	R	F									R				F		R		R			
11-4, 40-42	M	C	F	R					C	R	F		R		R			F	R			F	

Sample (Interval in cm)	*Pseudodimerogramma elegans*	*P. elliptica*	*Pseudopodosira simplex*	*Pseudopyxilla americana*	*P. directa*	*Pseudotriceratium chenevieri*	*Rhaphoneis amphiceros*	*R. elliptica*	*R. elongata*	*Rhizosolenia barboi*	*R. hebetata* forma *hiemalis*	*R. minima*	*R. miocenica*	*Stephanopyxis marginata*	*S. schenkii*	*S. turris*	*Thalassionema nitzschioides*	*Thalassiosira nidulsu*	*Thalassiothrix longissima*	*Triceratium condecorum*	*Trinacria excavata*
5-1, 30-32				C												R	F	R	C		R
5-1, 60-62			R							F							F		F	R	
5-3, 95-97[a]				C												R					
6-2, 30-32[a]											R					R					
6-4, 45-47																R			F		
7-1, 110-112															R						
7-3, 20-22			R				R								R				F		
8-2, 30-32											R								F		
9-5, 40-42	R		R		F			R	R						F	R			R		
10-1, 40-42					R																
10-3, 20-22															F	R					
11-2, 25-27						R					R				F						
11-4, 40-42		R				R		R			R	R	R	R	R	R			F		

[a]Ash.

TABLE 20
Samples Barren in Diatoms and Sponge Spicules, Sites 346 and 347

Site 346	
1-3, 30-32 cm	15-2, 73-75 cm
1-5, 60-62 cm	15-3, 117-119 cm
2-1, 90-92 cm	16-1, 87-89 cm
3-1, 65-67 cm	16-2, 119-121 cm
4-2, 91-93 cm	17-1, 66-68 cm
4-4, 30-32 cm	17-3, 60-62 cm
8-5, 50-52 cm	18-3, 40-42 cm
9-2, 110-112 cm	19-2, 39-41 cm
12-1, 105-107 cm	20-1, 53-55 cm
12-3, 70-72 cm	20-2, 66-68 cm
13-1, 40-42 cm	
13-3, 56-58 cm	**Site 347**
14-2, 42-44 cm	2-1, 30-32 cm
14-3, 92-94 cm	2-3, 85-87 cm
	4-2, 85-87 cm

Coscinodiscus flexuosus Brun (1895)
(Plate 15, Figure 10)

Description: Schrader (1973a), p. 702, pl. 7, fig. 10-13, 15, 16.
Age: Late Miocene.

Coscinodiscus kützingii A. Schmidt (1878)
(Plate 14, Figure 5)

Description: Hustedt (1930), p. 398, fig. 209.
Age: Pliocene-Recent.

Coscinodiscus lewisianus Greville (1866)
(Plate 21, Figure 4, 6 [?])

Description: Kanaya (1971), p. 555, pl. 40.5, fig. 4-6; Lohmann (1848), p. 161, pl. VI, fig. 7.
Age: Early-middle Miocene.

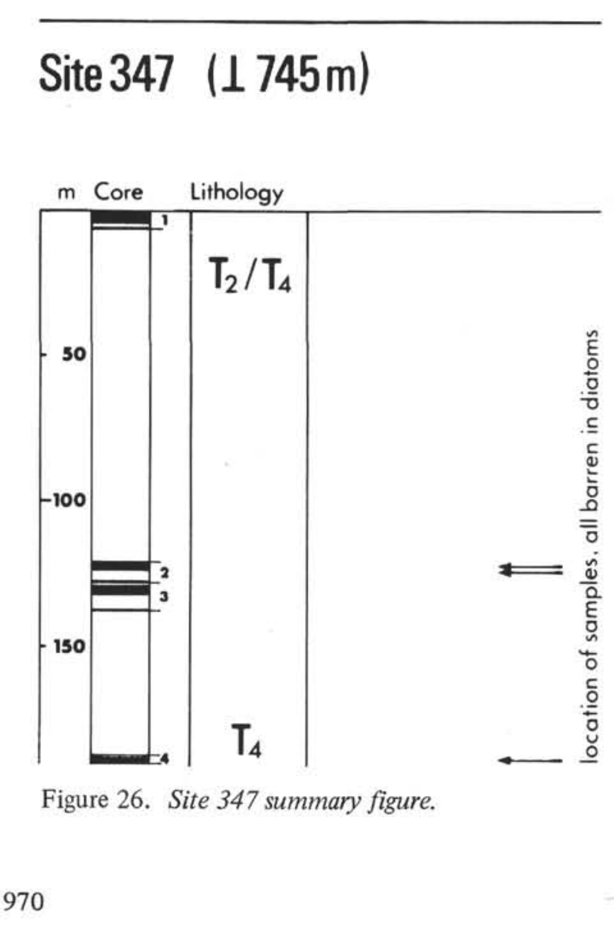

Figure 26. *Site 347 summary figure.*

Coscinodiscus lineatus Ehrenberg (1838)
(Plate 18, Figures 3, 4, 8 [?])

Description: Hustedt (1930), p. 392, fig. 204; Simonsen (1974), p. 17, pl. 9, fig. 3, 4 (for taxonomic discussion see Simonsen (1974); Ross and Sims (1973, p. 99).
Age: Pliocene (?)-Recent.

Coscinodiscus marginatus Ehrenberg (1841)
(No illustration)

Description: Hustedt (1930), p. 416-418, fig. 223.
Age: Not diagnostic.

Coscinodiscus marginatus forma fossilis Jousé (1961)
(No illustration)

Description: Schrader (1973a), p. 703, pl. 20, fig. 12.
Age: Not diagnostic.

Coscinodiscus miocenicus Schrader (1973a)
(Plate 15, Figures 3, 6)

Description: Schrader (1973a), p. 703, pl. 7, fig. 11, 12.
Age: Middle-late Miocene.

Coscinodiscus moroensis Hanna (1927a)
(No illustration)

Description: Hanna (1927a), p. 118, pl. 2, fig. 3, 4.

Coscinodiscus nitidulus Grunow in A. Schmidt, Atlas (1877)
(Plate 35, Figure 22)

Description: Grunow *in* A. Schmidt Atlas (1877), pl. 58, fig. 20; Hanna and Grant (1926), p. 141, pl. 15, fig. 10.
Age: Early Miocene.

Coscinodiscus nodulifer A. Schmidt (1878)
(Plate 14, Figure 2)

Description: Hustedt (1930), p. 426-427, fig. 229.
Age: Miocene-Recent.

Coscinodiscus norwegicus n. sp. Schrader
(Plate 17, Figures 3, 4a,b)

Description: Cells discoid, valves flat, 20-31 μm in diameter. Valves covered with punctae, oriented in radial wavy rows, approx. 14-16 punctae in 10 μm and 16 rows in 10 μm. The punctae are of equal size over the entire valve. The radial structure is interrupted by large, 3-4 μm in diameter, subhyaline rounded areas, scattered somewhat irregularly over the valve surface and forming a more geometrical submarginal ring (compare Figure 4b). Valve punctate structure interrupted over the hyaline spots. Valve margin small distinct, with a small hyaline ring of 1-1.5 μm. No specific central area is present.

Discussion: This species is close to *Coscinodiscus denarius* var. *subtilissima* Forti (1913), but differs in the finer structure and the radial arrangement of the rows without forming fascicles.

Holotype: Plate 17, Figure 3 from Leg 38, Sample 348-14-1, 90-92 cm; Norwegian Sea.

Paratypes: Plate 17, Figures 4a, b.

Age: Late Miocene.

Coscinodiscus oblongus Greville (1866)
(Plate 36, Figures 11, 12)

Description: Greville (1866), p. 4, pl. 1, fig. 9, 10.
Stratigraphic record: Eocene (Kanaya, 1957; Hanna, 1931)-early Oligocene (Greville, 1866)-middle Oligocene (this paper).

Coscinodiscus aff. obscurus A. Schmidt (1878)
(Plate 33, Figure 1)

Description: Hustedt (1930), p. 418-420, fig. 224.

Coscinodiscus occulus iridis Ehrenberg (1839)
(Plate 34, Figure 4)

Description: Hustedt (1930), p. 454-459, fig. 252.

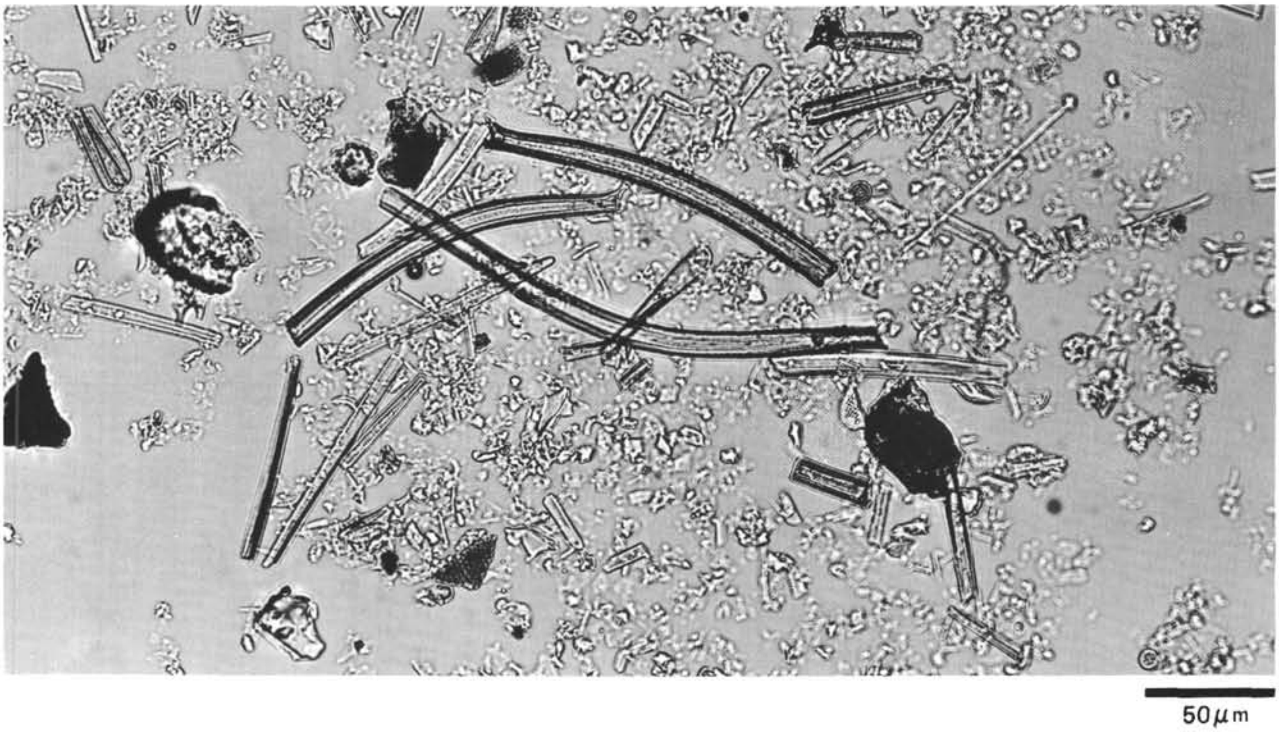

Figure 27. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 348-6-5, 115 cm with abundant* Rhizosolenia barboi, Thalassiothrix longissima. *Distance between two bars 10 μm.*

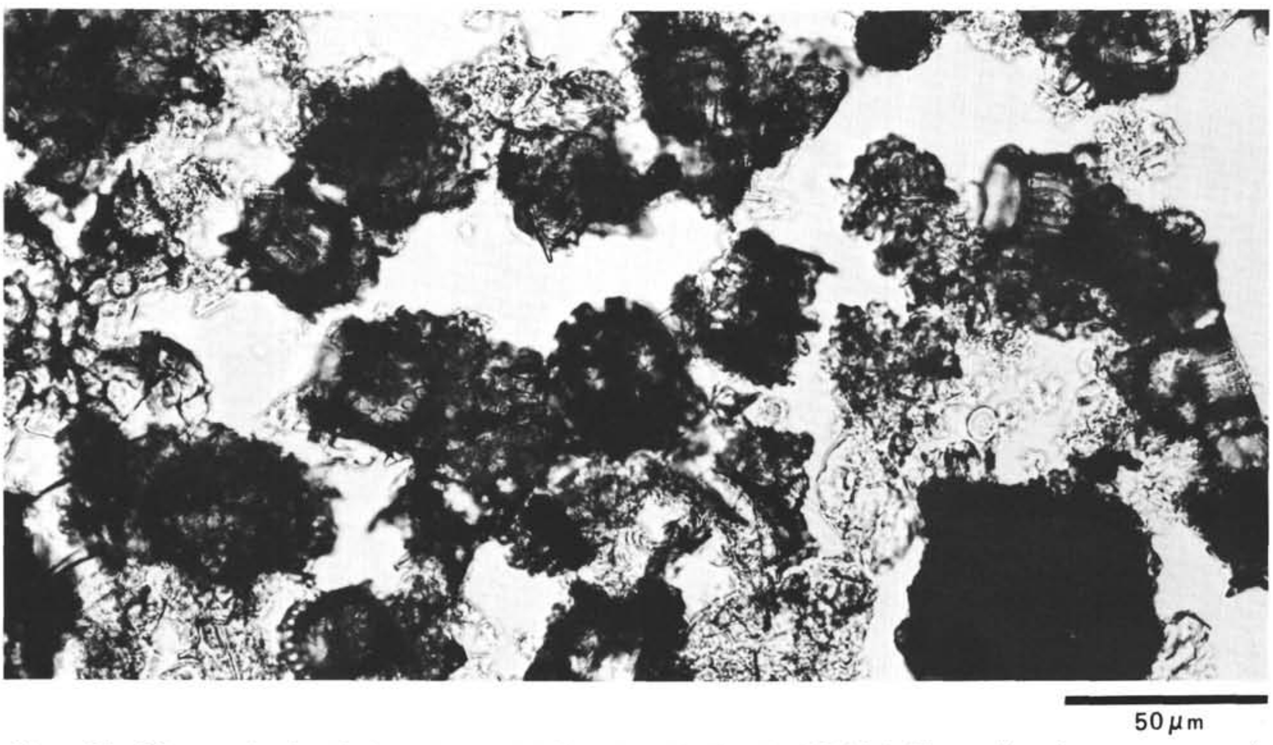

Figure 28. *Micrograph of acid cleaned sample DSDP Leg 38, Sample 348-16-3, 55 cm. Abundant occurrence of* Stephanogonia horridus. *Distance between two bars 10 μm.*

Coscinodiscus aff. occulus iridis Ehrenberg (1839)
(Plate 33, Figure 2)

Description: Hustedt (1930), p. 454-456, fig. 252.

Remarks: The observed specimens include much finer specimens as is given by the original species description. The Oligocene specimens have seven to eight areolae in 10 μm in the central part increasing in size in direction of the margin up to four to five areolae in 10 μm. At the margin they are again finer: seven to eight areolae in 10 μm. But as all the other species characteristics are in good accordance with the species definition, we tend to include these finer areolated ones into the species.

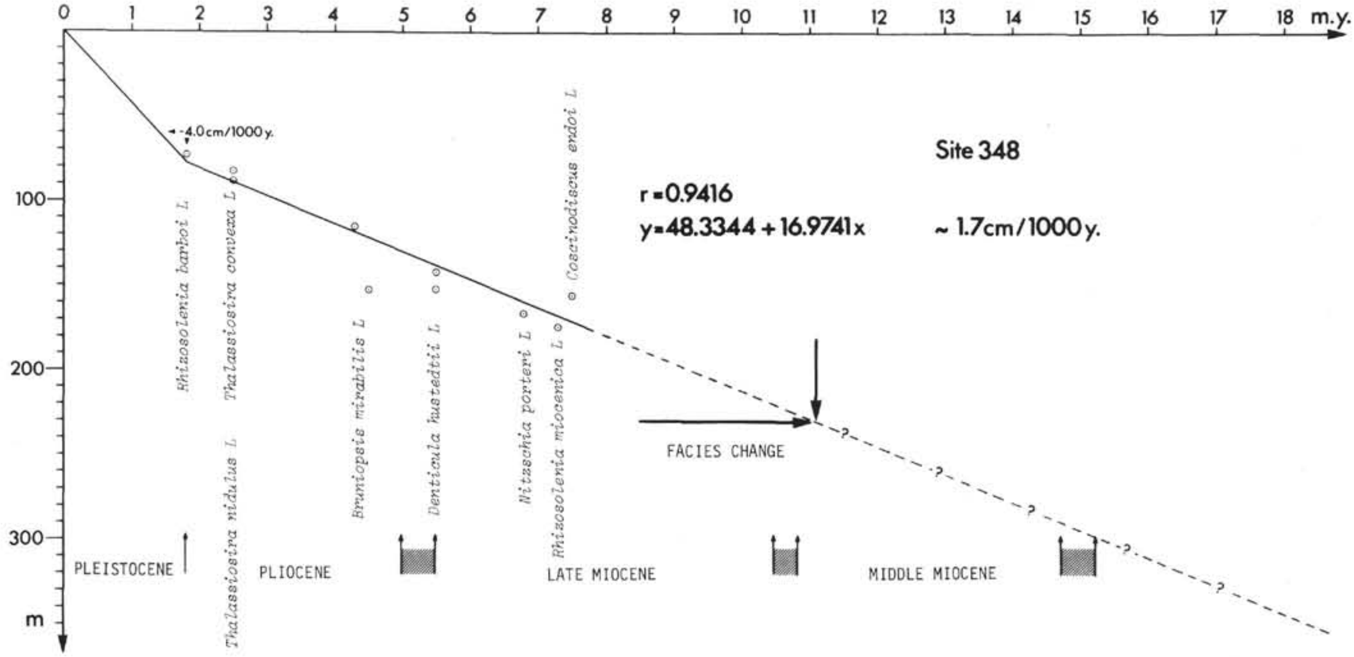

Figure 29. *Sediment accumulation rate at Site 348.*

Coscinodiscus oligocenicus Jousé (1974a)
(Plate 29, Figures 1, 2)

Description: Jousé (1974a), p. 348, pl. 1, fig. 6-8, 16.
Age: Oligocene.

Coscinodiscus plicatus Grunow (1884)
(Plate 15, Figures 5, 8, 9, 11-13)

Description: Kolbe (1954), p. 34-35, no illustration; Schrader (1973a), p. 703, pl. 6, fig. 23.
Age: Late Miocene.

Coscinodiscus cf. plicatus Grunow (1884)
(Plate 15, Figure 7; Plate 17, Figure 8)

Description: This species differs from *C. plicatus* by its finer areolation. Only two specimens were observed in the present material.
Age: Late Miocene.

Coscinodiscus praenitidus n. sp. Fenner
(Plate 14, Figures 7-9, 12; Plate 27, Figure 8; Plate 35, Figure 24; Plate 36, Figure 5)

Description: This species differs from *C. nitidus* by its smaller diameter: 15-25 μm. The areolae are loosely arranged in radial lines leaving free an irregular-shaped central hyaline area in which a row of small processes is found, varying in number from two to four. The number of areolae is four to five in 10 μm. The areolae decrease in size slightly versus the margin. At the margin there are two circles of fine areolae: 8-10 in 10 μm.
Discussion: The present species is close to *C. nitidus*, compare Hustedt (1930), p. 414-416, fig. 22.
Holotype: Plate 14, Figure 9 from Leg 38, Sample 338-19-3, 140-141 cm; Norwegian Sea.
Paratype: Plate 14, Figures 7, 8, 12; Plate 27, Figure 8; Plate 35, Figure 24; Plate 36, Figure 5.
Age: Late Oligocene.

Coscinodiscus radiatus Ehrenberg (1839)
(No illustration)

Description: Hustedt, 1930, p. 420-421, fig. 225.

Coscinodiscus aff. radiatus Ehrenberg (1839)
(Plate 33, Figure 5)

Coscinodiscus rhombicus Castracane (1886)
(Plate 21, Figures 1-3, 5)

Description: Castracane (1886), p. 164, pl. 22, fig. 11; Forti (1913), p. 1568 (34).
Remarks: Grunow's *Cestodiscus rhombicus in* van Heurck (1883), pl. 129, fig. 3 cannot be synonymized with *Coscinodiscus rhombicus* (for more detail see van Landingham [1968], p. 956). The species was described by Castracane (1886) to possess a well-defined central space, which is ornamented by solitary and not in definite order arranged areolae. This criterion was used to separate it from *Coscinodiscus lewisianus*.
Age: Middle Miocene of Monte Gibbio, Italy (Forti, 1913), in this material late-early Miocene.

Coscinodiscus aff. rothii
(Plate 14, Figure 1)

Description: Hustedt (1930), p. 400-406, fig. 211.
Remarks: The present species is almost identical with Hustedt's (1930) diagnosis, but lacks the concentrical swelled valves.

Coscinodiscus subconcavus Grunow in A. Schmidt (1878)
(Plate 17, Figure 12)

Description: Rattray (1890b), p. 466 (18); De Toni (1894), p. 1213.

Coscinodiscus symbolophorus group
(Plate 20, Figure 1)

Remarks: There is a clear evolutionary tendency within this group. Taxonomic revision is still needed. At this moment all individuals having the symbolophorus group characters have been treated under this heading. The present figured species is characterized by its clear hyaline margin and the three distinct labiate processes in the valve center.

Coscinodiscus tuberculatus Grev. var. atlantica Gleser and Jousé (1974)
(Plate 14, Figure 4; Plate 29, Figures 3, 5, 6, 12, 13)

Description: Gleser and Jousé (1974), p. 56; pl. 1, fig. 14-18; pl. 2, fig. 1.
Age: Late Oligocene.

Coscinodiscus vetustissimus Pantocsek (1886)
(Plate 14, Figure 3)

Description: Hustedt (1930), p. 412, fig. 220.
Age: Miocene.

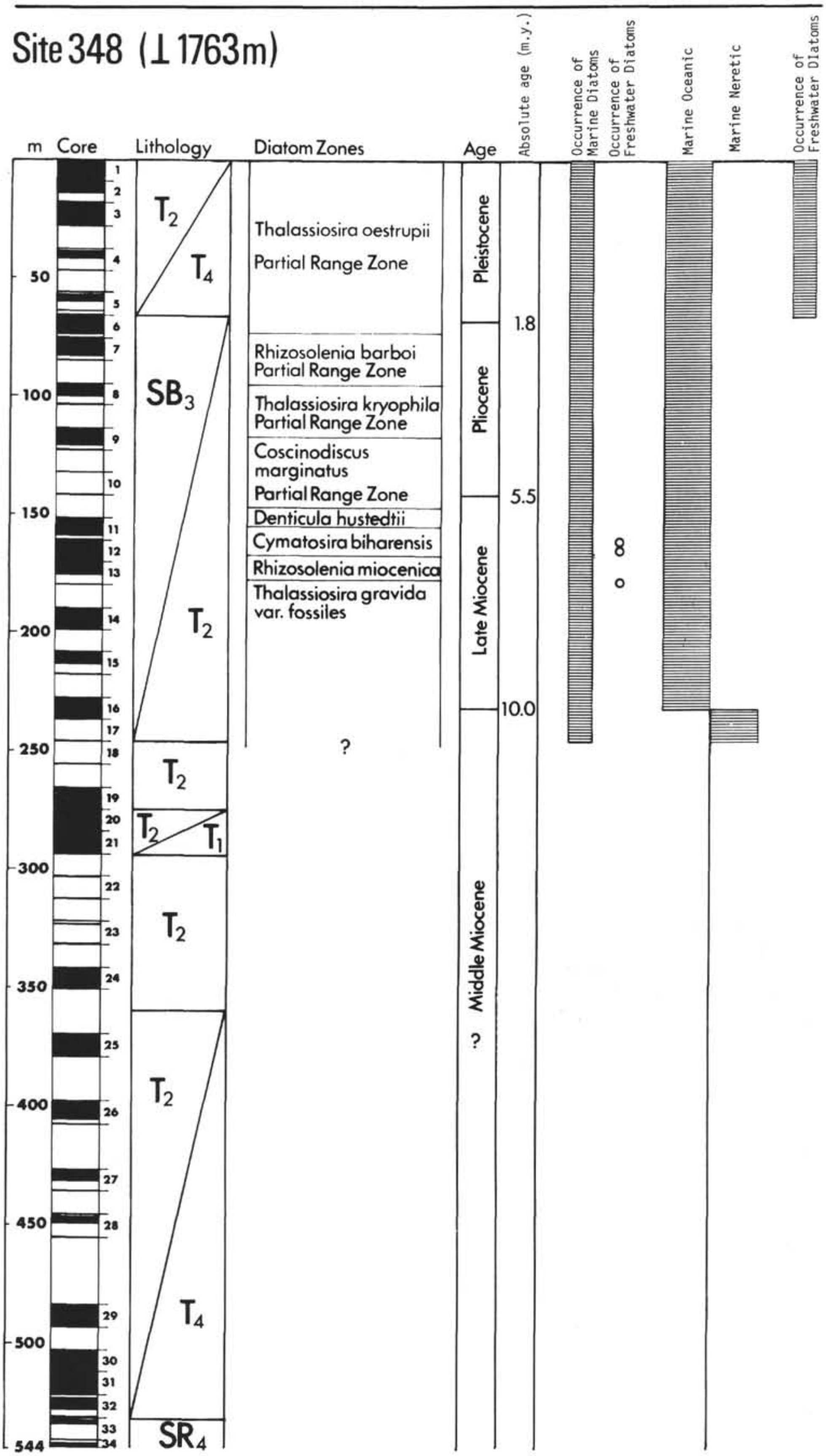

Figure 30. *Site 348 summary figure.*

TABLE 21
Diatoms at Site 348

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinocyclus divisus*	*A. ehrenbergii*	*A. ehrenbergii* var. *tenella*	*A. ingens*	*Actinoptychus undulatus*	*Asteromphalus robustus*	*Bogorovia veniamini*	*Bruniopsis mirabilis*	*Cestodiscus peplum*	*C.* sp. a	*C.* sp. b	*C.* sp. c	*Chaetoceros*-spores	*Cladogramma dubium*	*Coscinodiscus endoi*	*C. lewisianus*	*C. lineatus*	*C. marginatus*	*C. norwegicus*	*C. plicatus*	*C. rhombicus*	*C. symbolophorus* group	*C. vetustissimus*	*C. yabei*	*Cosmiodiscus insignis*	*Cussia lancettula*	*Cymatosira biharensis*	*Dactyliosolen* aff. *antarcticus*	*Denticula hustedtii*	*Dimerogramma* aff. *fulvum*	*D. fossile*	*Eucampia* aff. *balaustium*	Genus and species indet. (1)	*Goniothecium odontella*	*G. tenue*	*Hemidiscus cuneiformis*	*H. karstenii*	*Lauderia borealis*	*Macrora stella*	*Mediaria splendida*	*Mediaria splendida* forma *tenera*	*Melosira granulata*	*Melosira sulcata*	*Nitzschia atlantica*	*N.* aff. *atlantica*	*N. kanayensis*	*N. porteri*	*N. praereinholdii*	*N. pseudocylindrica*
1-1, 60-62	F	M	F	R												R					R																															
2-1, 65-67	A	G	–					R								F				R	R																				R					R	R					
5-2, 127-129	R	P	R													R					R																															
5-3, 56-57	R	P	R													R					R																									R						
5-5, 145-148	F	M	–													F																														R						
5, CC	F	G	R													C																																				
6-1, 60-62	C	G	R																		R																															
6-1, 105-107	C	G	R																		R																											R				
6-2, 45-47	C	G	R																		R																															
6-2, 125-127	C	G	R																		R																															
6-3, 25-27	F	M	–																																																	
6-3, 65-67	F	M	–																																											R						
6-4, 97-99	F	M	R																																											R						
6-5, 15-17	F	M	R																																											R						
6-5, 115-117	A	G	–													F																																R				R
6, CC	A	G	R	R												F				R																										R	R	R				R
7-1, 76-78	A	G	R	R												F				R																										R	R	R				R
7-1, 95-97	A	G	R	R												F				R																										R	R	R				R
7-1, 135-137	C	M	–	F																	R																									R						
7-2, 30-32	C	M	–	F																	R																									R						
7-2, 100-102	C	M	–	F																	R																									R						
7-3, 65-67	C	M	F	F																	C																									R						
7-3, 95-97	C	M	F	R																	C																									R						
7-4, 31-33	C	M	F	R				R													C																									R						
7-5, 85-87	C	G	R					R													F																															
7, CC	C	G	R					R													F																															
8-1, 70-72	C	M	F													F					F																															
8-1, 90-92	C	M	F													F					F				R						R															R						
8-2, 90-92	A	G	–																		R				R																											
8-3, 25-27	F	M	–																		R				R																											
8-3, 70-72	R	M	–																		R																															
8-3, 145-147	C	M	–																		R				R																								R			
8, CC	R	P	C																																											F						
9-2, 25-27	R	P	F																		F																															
9-2, 50-51	A	G	R		R			R								C									F																					R						R
9-3, 80-82	F	M	F																		C																															
9-4, 60-62	C	G	F		R			R								F					F				R							R																				
9-5, 80-82	R	P	F					R													F																															
9, CC[a]	C	M	C		R											F					F																									R						
10-1, 34-36	C	M	C		R											F					F																									R						
10, CC	F	P	C													C																																				
11-1, 20-22	C	G	C					R			R					C						R								R		C														F						R
11-1, 50-52	C	G	C					R			R					C						R								R		C						R						R		F	R					C

Coscinodiscus vigilans A. Schmidt (1888)
(Plate 14, Figure 6; Plate 27, Figure 6)

Description: Kolbe (1954), p. 36, pl. 1, fig. 13, 14; Jousé (1974a), pl. 3, fig. 16; Schrader (in press), p. 57, pl. 12, fig. 5.
Age: Early Miocene-late Oligocene (*Bogorovia veniamini-Coscinodiscus vigilans* Zone of Jousé [1974a]).

Coscinodiscus sp. 1
(Plate 34, Figure 1)

Description: Valve circular, flat, only near the margin intensely concave. Areolae are of more or less constant size all over the valve. The number of areolae is five in 10 μm. The lines of areolae form fascicles with one central row running from the center to the margin and the two neighboring rows are shorter and parallel to the longest one. At the margin in the middle of each fascicle is a labiate (?) process. In the center there is one larger porus surrounded by a circle of smaller and irregular shaped ones. Valve diameter: 88 μm.

Coscinodiscus sp. 2
(Plate 32, Figure 4)

Coscinodiscus sp. 3
(Plate 32, Figure 5)

Description: Hustedt (1930), p. 430, fig. 233.
Remarks: The observed specimens are identical with the smaller areolated ones which Grunow (1884) reported from Franz-Josephs-Land and which he named *C. decrescens* var. *repleta*. Hustedt (1930, p. 430), and for which he proposed a reintegration into *C. decrescens*.
Age: Oligocene-Recent (?).

Genus COSMIODISCUS Greville (1866)

Cosmiodiscus insignis Jousé (1961)
(No illustration)

Description: Jousé (1961), p. 67, pl. 2, fig. 8; Koizumi (1973), p. 832, pl. 4, fig. 7-11.
Age: Pliocene.

Genus CRASPEDODISCUS Ehrenberg (1844a)

Craspedodiscus coscinodiscus Ehrenberg (1844a)
(No illustration)

Description: Kolbe (1954), p. 36, pl. 1, fig. 4; Kanaya (1971), p. 555, pl. 40.4, fig. 1-3.
Age: Middle Miocene.

TABLE 21 – *Continued*

N. riedelia	N. sp. d	N. sp. e	N. sp. 8	Odontella calamus	Odontella sp. a	Podosira glacialis	Pseudopodosira simplex	Pseudopyxilla americana	P. sp. a	Raphidodiscus marylandicus	Rhaphoneis amphiceros	R. margaritalimbata	R. parallelica	Rhizosolenia alata	R. barboi	R. hebetata f. hiemalis	R. hebetata f. semispina	R. hebetata var. subacuta	R. hebetata var. volatilis	R. miocenica	R. norwegica	R. praebarboi	R. styliformis	Roperia tesselata	Rouxia californica	R. isopolica	R. yabei	Sceptroneis caducea	Stephanogonia hanzawae	S. horridus	S. polyacantha	Stephanopyxis turris	Synedra jouseana	Thalassionema hirosakiensis	Thalassionema lineata	T. nitzschioides	Thalassiosira convexa	T. decipiens	T. eccentrica	T. fraga	T. gravida	T. sp. c	T. kryophila	T. nidulus	T. nordenskioeldii	T. oestrupii	T. sp. a	T. sp. b	Thalassiothrix longissima	T. miocenica
																																R						R	R							F			C	
														R									C	R															R		R		R		R	F			A	
																															F																			
																															F															R				
														R		R							R									R						R							R		R			R	
														R		R							R									R				R											F			R	
														R		F							F									R				C								R	R	C			C	F
														R		F							F									R				C								R	R	C			C	F
														R		F							F									R				C								R	R	C			C	F
														R		F							F									R				C								R	R	C			C	F
																							R									R																	C	C
																							R									R													R					C	C
																							R									R													R					C	
																							R									R												R	R					C	
															C								R												R								R	R		F			F	C
															C								F	R								R				F			R						R		C			R	A
															C								F	R								R				F			R						R		C			R	A
															C								F	R								R				F			R						R		C				A
														R	C								R									F							R						R		R			F	R
														R	C								R									F							R						R		R			F	R
														R	C								R									F							R						R		R			F	R
														R	C								R									F							R						R		R			F	F
														R	C								R									F							R						R		R			F	F
														R	C								R									F							R						R		R			F	F
															C	R																R				F														C	R
															C	R																R																		C	R
								R							C																	F				C								R	F					C	
														R	C								R						R			F				C	R							R	F		F			C	R
															C	R																F					R		C					R	R				R	C	
															C	R																F					R		C					R	R				R	C	
								R							C																	F																		C	
								R							C								R									F					R		C					R	R				R	C	
																R																				F												F	F	
																													R			R				A	R		R				R						R	
																F																																	F	
														R	C														R																				F	
															F	R																R																	A	
															F	R																R																	A	
																							F												F													F	
																							R						F			R				C			R			R							F	
								R								R				R			R		R				F			R				C			R			R							F	

Genus CUSSIA Schrader (1974b)

Cussia lancettula Schrader (1974b)
(No illustration)

Description: Schrader (1974b), p. 542, fig. 1, 9, 10, 5.
Age: Pliocene.

Genus CYMATOSIRA Grunow (1862)

Remarks: We are fully aware that the placement of all our new species into *Cymatosira* is problematic. Our criteria to place them into this genus is the genus description presented in Hendey (1964, p. 160) which reads as follows: "Cells united in small packets valve to valve by means of a system of spines. Frustules linear in girdle view, inflated in the middle and at the ends. Valves linear, inflated in the middle, surface punctate, raphe, and pseudoraphe absent." All these criteria were found as a uniting feature in our specimen. On the other hand, we found in the Paleogene species a dimorphism, complicating a correct taxonomic treatment. In these species the two valves of neighboring cells differ in that one frustule has a clear middle inflation while the other has a middle depression. The shape of the valves and the orientation of spines is a reliable morphological feature to separate different species. The following types were found and are arranged in ascending temporal order: (1) *coronata*-type: narrowly lanceolate valves with a reduced elliptical ring of spines, with linearly broadened insertions; (2) *praecompacta*-type: broadly elliptical valves with apiculate apices and a reduced circular to oval ring of spines; (3) *compacta*-type: rectangular to quadratic valves with apiculate apices and a reduced circular ring of spines; (4) *fossilis*-type: spindle-shaped valves with a submarginal ring of spines not entering into the apices; (5) *margino-punctata*-type: spindle-shaped to rectangular valves with a marginal ring of scattered spines. Only a few individuals of this type were observed, thus no final taxonomic treatment was done; (6) *biharensis*-type: narrowly lanceolate valves with a complete marginal ring of small spines and with only a faint indication of a central inflation; (7) *cornutus*-type: broadly lanceolate valves with scattered spines and easy recognizable apical inflations (Figure 41).

This genus differs from *Plagiogramma* and *Dimerogramma* by the presence of a spinous ring, from *Glyphodesmis* by the absence of a pseudoraphe. It differs from similar centric genera (*Rutilaria* and *Pseudorutilaria*) in the absence of a twisted central labiate process and in the presence of spines.

Cymatosira biharensis Pantocsek (1889)
(Plate 8, Figures 1-5, 7)

Description: Pantocsek (1889), p. 66, pl. 3, fig. 42.
Age: Late early Miocene-late Miocene.

TABLE 21 – *Continued*

Sample (Interval in cm)	Abundance	Preservation	Sponge Spicules	*Actinocyclus divisus*	*A. ehrenbergii*	*A. ehrenbergii* var. *tenella*	*A. ingens*	*Actinoptychus undulatus*	*Asteromphalus robustus*	*Bogorovia veniamini*	*Bruniopsis mirabilis*	*Cestodiscus peplum*	*C.* sp. a	*C.* sp. b	*C.* sp. c	*Chaetoceros*-spores	*Cladogramma dubium*	*Coscinodiscus endoi*	*C. lewisianus*	*C. lineatus*	*C. marginatus*	*C. norwegicus*	*C. plicatus*	*C. rhombicus*	*C. symbolophorus* group	*C. vetustissimus*	*C. yabei*	*Cosmiodiscus insignis*	*Cussia lancettula*	*Cymatosira biharensis*	*Dactyliosolen* aff. *antarcticus*	*Denticula hustedtii*	*Dimerogramma* aff. *fulvum*	*D. fossile*	*Eucampia* aff. *balaustium*	Genus and species indet. (1)	*Gonothecium odontella*	*G. tenue*	*Hemidiscus cuneiformis*	*H. karstenii*	*Lauderia borealis*	*Macrora stella*	*Mediaria splendida*	*Mediaria splendida* forma *tenera*	*Melosira granulata*	*Melosira sulcata*	*Nitzschia atlantica*	*N.* aff. *atlantica*	*N. kanayensis*	*N. porteri*	*N. praereinholdii*	*N. pseudocylindrica*
11-1, 140-142	F	M	C					R			F					C						R	R							R		C						R						R		F	R					C
11-2, 85-87	A	G	C					R			F					C						R	R							R		C						R						R		F	R					C
11-3, 70-72	C	M	C					R			R		R			C		R		R		R	R							R		C			R			F		R			R			R						C
11-3, 75-77	C	M	C					R			R		R			C		R		R		R	R							R		C			R			F		R			R			R						C
11-4, 80-82	A	G	C					R			R		R			C		R		R		R	R							F		C			R			F		R			R			R						C
11-5, 40-42	A	G	C					R			R		R			C		R		R		R	R							F		C			R			F		R			R			R						C
11-5, 140-142	A	G	C					R			R		R			C		R		R		R	R							F		C			R			F		R			R			R						C
11, CC	A	G	C					R			R		R			C		R		R		R	R							F		C			R			F		R			R			R						C
12-1, 120-122	C	G	C					R			R					C				R										R		F	R		R			F					R		R	R						
12-2, 90-92	C	G	C					R			R					C				R										R		F	R		R			F					R		R	R						
12-3, 85-87	A	G	C					R								C		R					R						R	R		F			R			F	R				R			R						R
12-3, 95-97	A	G	C					R								C		R					R						R	R		F			R			F	R				R			R						R
12-4, 90-92	A	G	F				R	R			R					C				R			R						R	R	R	F			R			F					R			R						
12-5, 85-87	A	G	F				R	R			R				R	C				R			R						R	R	R	F			R			F					R			R						
12-6, 85-87	A	G	F				R	R			R				R	C				R			R						R	R	R	F			R			F					R			R						
12, CC	A	G	F		R		R	R			R			R	R	C				R			R						R	R	R	F			R			F					F			R						
13-2, 40-42	A	G	F		R		R	R			R			R	R	C				R			R						R	R	R	F			R			F					F			R						
13-2, 90-92	A	G	F		R		R	R			R			R	R	C				R			R						R	R	R	F			R			F					F			R						
13-3, 90-92	C	M	C		R		R	R			R			R	R	C		R		R			R						R	R	R	F			R			F					F			R						
13, CC	C	G	C				R	R			R					C																F						C					R		R							
14-1, 40-42	A	G	F		R			R								C				R		R										C						F								R				R		
14-1, 90-92	A	G	F		R		R	R								C				R		R										C						F					R			R				R		
14-2, 80-82	A	G	F		R			R								C				R		R										C						F								R				R		
14-3, 100-102	C	M	F		R		R	R								C				R		R										C						F					R			R				R		
14-3, 130-132	C	M	F		R			R								C				R		R										C						F								R				R		
14-6, 85-87	A	G	R				R	R								C				R												F						C					R				R				R	
14, CC	A	G	R				R	R								C				R												F						C					R				R				R	
15-1, 85-87	A	G	R					R			R					C				R			R									F						C								R					R	
15-2, 85-87	A	G	R					R			R					C				R			R									F						C								R					R	
15-3, 85-87	A	G	R					R			R					C				R			R									F						C								R					R	
15-3, 90-92	A	G	R					R			R					C				R			R									F						C								R					R	
15, CC	A	G	R		R						R					C																						F									R		R			
16-1, 50-51	A	G	–		R		C				R					C																F						C					R						R	F		
16-1, 85-87	A	G	–		R		C				R					C																F						C					R						R	F		
16-2, 85-87	A	G	R		R		C				R					C																F						C					R						R	F		
16-3, 80-82	A	G	R		R		C				R					C																F						C					R						R	F		
16-3, 85-87	A	M	R													C																R						C					R						R			
16-4, 85-87	A	M	R													C																R						C					R						R			
16-5, 85-87	C	M	–													C																R						C														
16-6, 85-87	C	M	F					R								C																						C														
16, CC	C	M	F					R								C																						C														
17-1, 140-141	A	G	F					R	R	R		F							R						R	R								R		R						R				C						
17, CC	A	G	F					R	R	R		F							R						R	R								R		R						R				C						

[a] Ash.

Cymatosira compacta n. sp. Schrader and Fenner
(Plate 8, Figures 22, 25, Plate 25, Figures 30-32)

Description: Cells united in packets valve to valve, by means of a central ring of spines. Frustules linear in girdle view, inflated in the middle and at the apices. Valves rectangular to quadrangular in shape with apiculate apices. Apical and transapical axis isopol. Valves are 15-36 μm long, 9-18 μm wide. Valve surface irregularly punctated; punctae 9-12 in 10 μm, leaving free a hyaline central area of 4-6 μm in diameter. The central hyaline area is surrounded by a centric ring of spines, approximately 10 in 10 μm. The concentric ring of spines in some individuals reduced to four spines or to none (Plate 8, Figure 25). Ornamentation with punctae also in some individuals reduced.

Holotype: Plate 8, Figure 22 from Leg 38, Sample 338-19-3, 40-41 cm; Norwegian Sea.

Paratype: Plate 8, Figure 25; Plate 25, Figures 30-32.

Age: Late Oligocene.

Cymatosira cornuta n. sp. Schrader and Fenner
(Plate 8, Figure 6; Plate 22, Figure 14)

Description: Valves broadly lanceolate with easy recognizable inflated apices. Valve length: 24-30 μm, width approximately 7 μm. The valves have irregularly scattered punctae. There is a marginal ring of small spines: 14 spines in 10 μm reaching the inflated apices; 4-5 large and heavily silicified spines are scattered over the middle part of the valve.

Discussion: No similar species was observed in the literature.

Holotype: Plate 22, Figure 14 from Leg 38, Sample 342-5-2, 60-62 cm; Norwegian Sea.

Paratype: Plate 8, Figure 6.

Age: Late Oligocene.

Cymatosira coronata n. sp. Fenner and Schrader
(Plate 22, Figure 11; Plate 25, Figures 16-21)

Description: Valve spindle-shaped to narrowly lanceolate with slightly inflated apices. Valves are isopol; valve length: 20-40 μm, width 5-8 μm. The number of punctae in 10 μm is 12-16. The punctation is irregular, leaving free a hyaline, inflated, oval, central area. This broad hyaline, central area is surrounded by an elliptical wreath of spines (9-10 in 10 μm) with linearly broadened insertions.

Discussion: No similar species was observed in the literature.

Holotype: Plate 25, Figure 16 from Leg 38, Sample 340-7-2, 100-102 cm; Norwegian Sea.

Paratypes: Plate 22, Figure 11; Plate 25, Figures 17-21.

Age: Late Eocene.

Cymatosira fossilis n. sp. Schrader
(Plate 8, Figures 14, 15, 21; Plate 25, Figures 15, 28)

Description: Cells united in small packets valve to valve, by means of a submarginal ring of spines. Frustules linear in girdle view, inflated in the middle and at the ends. Valves narrowly lanceolate with

TABLE 21 – *Continued*

N. riedelia	*N.* sp. d	*N.* sp. e	*N.* sp. 8	*Odontella calamus*	*Odontella* sp. a	*Porosira glacialis*	*Pseudopodosira simplex*	*Pseudopyxilla americana*	*P.* sp. a	*Raphidodiscus marylandicus*	*Rhaphoneis amphiceros*	*R. margaritalimbata*	*R. parallelica*	*Rhizosolenia alata*	*R. barboi*	*R. hebetata* f. *hiemalis*	*R. hebetata* f. *semispina*	*R. hebetata* var. *subacuta*	*R. hebetata* var. *volatilis*	*R. miocenica*	*R. norwegica*	*R. praebarboi*	*R. styliformis*	*Roperia tesselata*	*Rouxia californica*	*R. isopolica*	*R. yabei*	*Sceptroneis caducea*	*Stephanogonia hanzawae*	*S. horridus*	*S. polyacantha*	*Stephanopyxis turris*	*Synedra jouseana*	*Thalassionema hirosakiensis*	*Thalassionema lineata*	*T. nitzschioides*	*Thalassiosira convexa*	*T. decipiens*	*T. eccentrica*	*T. fraga*	*T. gravida*	*T.* sp. c	*T. kryophila*	*T. nidulus*	*T. nordenskioeldii*	*T. oestrupii*	*T.* sp. a	*T.* sp. b	*Thalassiothrix longissima*	*T. miocenica*
								R								R				R			R		R				F			R				C			R			R							F	
								R								R				R			R		R				F			R				C			R			R							F	
R								R	R				R	R	R	R							R		R				F			R				C											R		F	
R								R	R				R	R	R	R							R		R				F			R				C											R		F	
R					R			R	C				R	R	R	R						F	R		R				F			R				C											R		F	
R					R			R	C				R	R	R	R						F	R		R				F			R				C											R		F	
R					R			R	C				R	R	R	R						F	R		R				F			R				C											R		F	
R					R			R	C				R	R	R	R						F	R		R				F			R				C											R		F	
			R				R						R	R		R				R			R		R				F			F				C					R	R							F	
			R				R						R	R		R				R			R		R				F			F				C					R	R							F	
							R							R		R				R			R		R				R			F			R	C					F						R		C	
							R							R		R							R		R				F			F			R	C					F						R		C	
R							R	R	R			R								R			R		R				F			F				C					R								C	
R							R	R	R			R											R		R				F			F				C					R								C	
R							R	R	R			R											R		R				F			F				C					R								C	
R					R		F	R	R			R								R			R		R				F			R				C					R								C	
R					R		F	R	R			R								R			R		R				F			R				C					R								C	
R					R		F	R	R			R								R			R		R				F			R				C					R								C	
R					R		F	R	R			R								R			R		R				F			R				C					R								C	
					R		R	R	R				R									R	R		R				R							C													F	
		R					F		R							R						R	R			R				R		F				C					R								F	
		R					F									R							R			R				R		F				C					R								F	
		R					F		R							R							R			R				R		F				C					R								F	
		R					F									R							R			R				R		F				C					R								F	
		R					F									R							R			R				R		F				C					R								F	
						R			R				R			R				R			R													C													C	
						R			R				R			R				R			R													C													C	
									R				R							R			R		R	R						R				C					R								C	
									R				R							R			R		R	R						R				C					R								C	
									R				R							R			R		R	R						R				C					R								C	
									R				R							R			R		R	R						R				C					R								C	
	R					R		R	R							R						R	R				R				R	R				C													C	
	R					R			R				R			R						R							R							C													C	
	R					R			R				R			R						R							R							C													C	
	R					R			R				R			R						R							R							C													C	
	R					R			R				R			R						R							R							C													C	
						F		R												R			R													F													R	
						F		R												R			R							A						F													R	
			R			F								R									R							A						C													F	
																R														A						R														
																R														A						R														
											R			R		R												F		R		F		F		C				C									F	
											R			R		R												F		R		F		F		X				C									F	

acute apex. Apical and transapical axis isopol, valves are 24-40 μm long, 9-13 μm wide. Valve surface punctate, puncta irregularly oriented, leaving an ill-defined hyaline, rounded central area which can have a central process. One submarginal elliptical ring of distinct spines, approx. in 1-2 μm distance from the valve margin, five to eight spines in 10 μm.

Discussion: No similar species has been found in the literature.

Holotype: Plate 8, Figure 15 from Leg 38, Sample 338-19-3, 40-41 cm; Norwegian Sea.

Paratypes: Plate 8, Figures 14, 21; Plate 25, Figures 15, 28.

Age: Late Oligocene.

Cymatosira lorenziana Grunow (1862)
(Plate 8, Figures 8, 9; Plate 22, Figure 16; Plate 23, Figure 35)

Description: Hustedt (1959), p. 127, fig. 648.

Ecological remarks: Frequently found in marine-littoral environment.

Cymatosira praecompacta n. sp. Fenner and Schrader
(Plate 8, Figures 19, 23, 24; Plate 25, Figures 14, 29)

Description: Valves narrowly to broadly spindle-shaped. Valve length 22-40 μm, width 8-12 μm. Apices slightly inflated. Valve covered with an irregular areolation leaving free a central, hyaline, slightly inflated area of 4-6 μm in diameter. This hyaline, central area is surrounded by a centric ring of spines.

Discussion: This species differs from *Cymatosira compacta* by its spindle-shaped valve and from *Cymatosira fossilis* by its central ring of spines.

Holotype: Plate 8, Figure 23 from Leg 38, Sample 338-21, CC; Norwegian Sea.

Paratypes: Plate 8, Figures 19, 24; Plate 25, Figure 29.

Age: Late Eocene-late Oligocene.

Cymatosira robusta n. sp. Schrader and Fenner
(Plate 8, Figures 16, 17)

Description: Cells united in small pockets, valve to valve (usually separate in the present material), by means of a row of submarginal, heavily silicified spines. Frustules linear in girdle view, inflated in the middle and at the ends. Valves narrowly lanceolate with acute apices, apical and transapical axis isopol, 50-60 μm long, 9-11 μm wide. Valve surface punctate, punctae irregularly oriented, most pronounced at the apices; leaving an ill-defined hyaline, central area. One submarginal lanceolate ring of heavily silicified spines, approx. in 2 μm distance from the margin with three to four spines in 10 μm.

Discussion: This species differs from *Cymatosira fossilis* by the robust valves, the lanceolate shape and spine row. No similar species was observed in the literature.

Holotype: Plate 8, Figures 16, 17 (different focus) from Leg 38, Sample 338-19-3, 12-13 cm; Norwegian Sea.

Age: Late Oligocene.

TABLE 22
Samples Barren in Diatoms Site 348

1-3, 70-72 cm	21-1, 50-51 cm
2-3, 70-72 cm	21-3, 95-97 cm
3-1, 52-54 cm	23-1, 135-137
3-3, 92-94 cm	23-3, 49-51 cm
3-4, 65-67 cm	24-1, 103-105 cm
4-1, 83-85 cm	24-3, 118-120 cm
5-1, 89-91 cm	25-1, 45-47 cm
5-1, 110-112 cm	25-3, 88-89 cm
5-2, 93-94 cm	26-2, 117-119 cm
5-3, 8-9 cm	26-3, 93-95 cm
7-4, 96-97 cm	27-1, 60-62 cm
8-4, 90-92 cm	27-3, 55-56 cm
9-2, 135-137 cm[a]	28-2, 100-102 cm
14-4, 85-87 cm[a]	29-1, 30-32 cm
14-5, 85-87 cm[a]	29-3, 50-52 cm
18-1, 0-2 cm	30-3, 20-22 cm
18, CC	31-1, 69-71 cm
19-1, 65-67 cm	31-3, 96-98 cm
19-3, 65-67 cm	31-6, 90-92 cm
20-1, 40-42 cm	32-2, 31-32 cm
20-3, 39-41 cm	

[a]Samples with sponge spicules.

Cymatosira species
(Plate 8, Figures 13, 20; Plate 22, Figures 9, 10, 12, 13, 15; Plate 25, Figures 25-27, 33-35, 42 [?], 43, 44)

All specimens which are listed above as *Cymatosira* species were only scarcely present in the investigated material. As the valves of some *Cymatosira* species are dimorph—as is shown in Platé 25, Figures 17, 27, 43—it is at the moment still impossible to adjoin the two different valves which are belonging together.

Genus DACTYLIOSOLEN Castracane (1886)

Dactyliosolen antarcticus Castracane (1886)
(No illustration)

Description: Castracane (1886), p. 75, pl. 9, fig. 7; Hendey (1964), p. 142-143.
Age: Miocene-Recent.

Genus DENTICULA Kützing (1844)

Denticula hustedtii Simonsen and Kanaya (1961)
(Plate 1, Figures 35-37, 40, 41)

Description: Simonsen and Kanaya (1961), p. 501, pl. 1, fig. 19-25, pl. 2, fig. 36-47; Schrader (1973b), p. 418, pl. 1, fig. 12, 13.
Age: Middle-late Miocene.

Denticula hyalina Schrader (1973a)
(Plate 1, Figure 39)

Description: Schrader (1973a), p. 704-705, pl. 1, fig. 12-22.
Age: Middle Miocene.

Denticula lauta Bailey (1854)
(Plate 1, Figure 34)

Description: Simonsen and Kanaya (1961), p. 500-501, pl. 1, fig. 1-8; Schrader (1973b), p. 419, pl. 1, fig. 11, 20, 23, 24.
Age: Early-middle Miocene.

Denticula nicobarica Grunow (1868)
(Plate 1, Figure 32)

Description: Simonsen and Kanaya (1961), p. 503, pl. 1, fig. 11-13; Schrader (1973b), p. 419-420, pl. 1, fig. 25-27.
Age: Early-middle Miocene.

Denticula norwegica n. sp. Schrader
(Plate 1, Figure 38)

Synonyms: *Denticula punctata* Schrader. *In* Schrader (1973a), p. 705, pl. 3, fig. 16, 17.

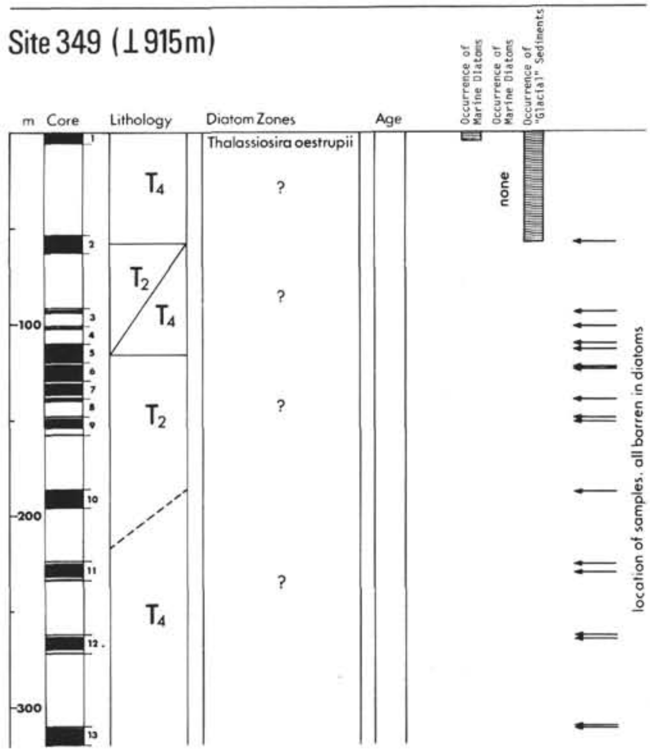

Figure 31. *Site 349 summary figure.*

TABLE 23
Samples Barren in Diatoms, Site 349

1-3, 65-67 cm	9-1, 126-128 cm
2-3, 85-87 cm	9-3, 70-72 cm
3-2, 40-42 cm	10-1, 34-36 cm
4-1, 105-107 cm	10-2, 14-16 cm
5-1, 55 57 cm	11-2, 64-66 cm
5-3, 95-97 cm	11-5, 75-77 cm
6-2, 102-104 cm	12-1, 116-118 cm
6-3, 28-30 cm	12-3, 23-24 cm
7-3, 135-137 cm	13-1, 124-126
8-1, 75-77 cm	13-2, 10-12 cm

Description: Valves elliptical with acute apices, 40-55 μm long, 7-9 μm wide in the middle of the valves. Pseudoseptae about five in 10 μm, secondary pseudoseptae absent. Valve surface with broadly punctate transapical striae, approx. 16-17 in 10 μm. Punctae in quincunx-arrangement, so that oblique rows are formed. Raphe marginal.
Discussion: This species is placed into the genus *Denticula* because of the presence of clearly developed pseudoseptae and its marginal raphe. No similar species was found in the literature, except in Schrader (1973a, pl. 3, fig. 16, 17): a species from the North Pacific which was identified as *Denticula punctata* with hesitation.
Holotype: Plate 1, Figure 38 from Leg 38, Sample 338-10, CC, Norwegian Sea.
Age: Miocene.

Denticula punctata Schrader (1973a)
(Plate 1, Figures 33, 42, 43)

Description: Schrader (1973a), p. 705, pl. 1, fig. 25-30; pl. 3, fig. 16, 17.
Age: Middle-late Miocene.

Denticula punctata var. hustedtii Schrader (1973b)
(Plate 1, Figure 44)

Description: Schrader (1973a), p. 705, pl. 1, fig. 23, 24; Schrader (1973b), p. 420, pl. 1, fig. 18.
Age: Middle-late Miocene.

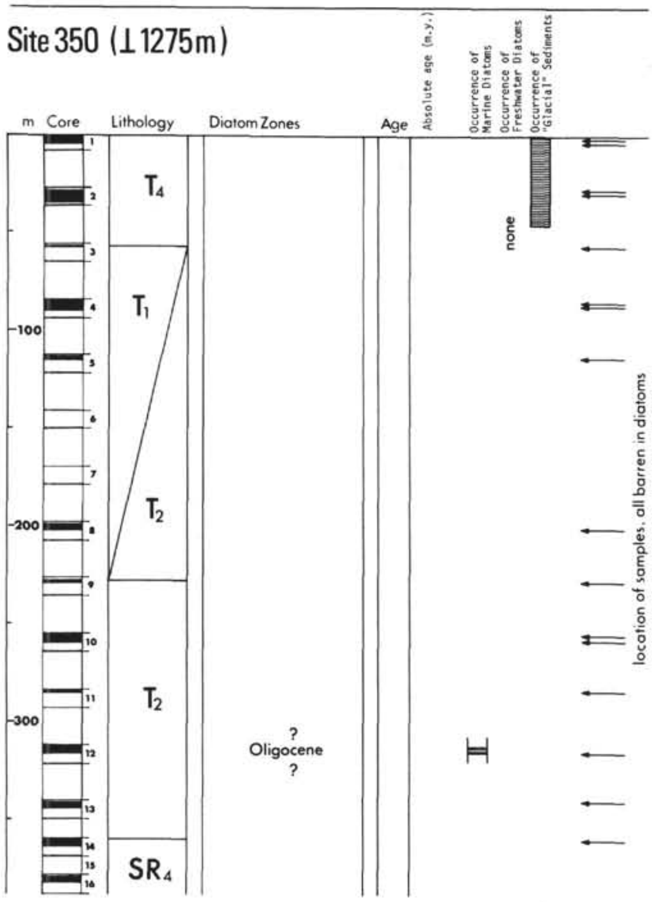

Figure 32. *Site 350 summary figure.*

TABLE 24
Samples Barren in Diatoms and Sponge Spicules, Site 350

1-1, 96-98 cm
1-3, 70-72 cm
2-1, 95-97 cm
2-3, 110-112 cm
3-1, 139-141 cm
4-1, 45-47 cm
4-3, 55-57 cm
5-1, 62-64 cm
8-3, 85-87 cm
9-2, 85-87 cm
10-1, 105-107 cm
10-3, 95-97 cm
11-1, 37-39 cm
12-3, 84-86 cm
13-1, 114-116 cm
14-1, 75-77 cm

Denticula seminae (Semina) Simonsen and Kanaya (1961)
(No illustration)

Description: Simonsen and Kanaya (1961), p. 503, pl. 1, fig. 26-30.
Age: Pliocene-Recent.

Genus DICLADIA Ehrenberg (1844)

Dicladia elliptica n. sp. Schrader
(Plate 6, Figure 16)

Description: Frustule rectangular, 40 μm in diameter, 20 μm in height, dimorph. Valves elliptical, 40-50 μm in length and 15-20 μm in width. One valve has four marginal, massive horns approx. 35 μm long with ramous bi- or polyfurcate ends. The other valve is slightly convex like the upper, but without any appendices. The structure consists of irregularly arranged scattered punctae. The upper valve is larger than the lower.

Discussion: No similar species was found in the literature.

Holotype: Plate 6, Figure 16 from Leg 38, Sample 348-17-1, 140-141 cm, Norwegian Sea.

Age: Not yet determined.

Dicladia norwegica n. sp. Schrader
(Plate 6, Figures 13, 14)

Description: Frustule rounded in valvar plane, 12-14 μm in diameter and 11-15 μm in height. Valves dimorph, rounded to slightly elliptical. One valve with a ring of massive horns around the margin, elongated with bi- to polyfurcate ends. The other valve without any appendix and with a scattered not oriented punctate structure.

Discussion: Much confusion consists in the literature where to place spores of different kinds. We follow here Ehrenberg (1844a) and van Heurck (1896) and keep *Dicladia* as a valid "paleontological" genus, well aware that for some species the true nature is of a typical *Chaetoceros* spore and is occasionally found inside a vegetative *Chaetoceros* chain (Castracane, 1886).

Holotype: Plate 6, Figure 14 from Leg 38, Sample 338-10-2, 55-56 cm, Norwegian Sea.

Paratype: Plate 6, Figure 13.

Age: Not yet determined.

Genus DIMEROGRAMMA Ralfs *in* Pritchard (1861)

Remarks: Hustedt (1959, p. 118) states that all species inhabit the marine littoral environment and form chains.

Dimerogramma aff. dubium Grunow in van Heurck (1880)
(Plate 3, Figures 12, 15, 16, 17a, b)

Description: Hustedt (1959), p. 122, fig. 645.

Remarks: The present species has approx. 12-13 transapical striae in 10 μm, arranged slightly radial towards the apices. Structure somewhat reduced. Valves longer than in the diagnosis of Hustedt (1959) stated, here 20-75 μm long.

Ecology: *Dimerogramma dubium* is a marine littoral species common today in the Mediterranean Sea.

Age: Not yet determined.

Dimerogramma fossile Grunow in Cleve and Möller (1877-1882)
(Plate 5, Figures 12, 13, 22)

Description: Pantocsek (1886), p. 33, pl. 8, fig. 37; pl. 27, fig. 265.

Age: Middle Miocene.

Dimerogramma aff. fulvum (Gregory) Ralfs in Pritchard (1861)
(Plate 7, Figures 19, 20)

Remarks: The present individuals do differ from *D. fulvum* by the finer *radial* transapical structure, here 16 in 10 μm, and by the smaller valves, here: 12-16 μm long. For *D. fulvum* description compare Hustedt (1959), p. 120-121, fig. 643.

Age: Not yet determined.

Dimerogramma furcigerum Grunow in van Heurck (1880)
(Plate 7, Figure 6)

Description: Hustedt (1959), p. 121-122, fig. 644.

Remarks: Hustedt (1959) states that this species is common today in littoral environments of warmer oceans, e.g., Mediterranean Sea.

Age: Not diagnostic.

Genus DIPLONEIS Ehrenberg (1840)

Various species have been found. All do inhabit marine littoral environment and are displaced in the present material.

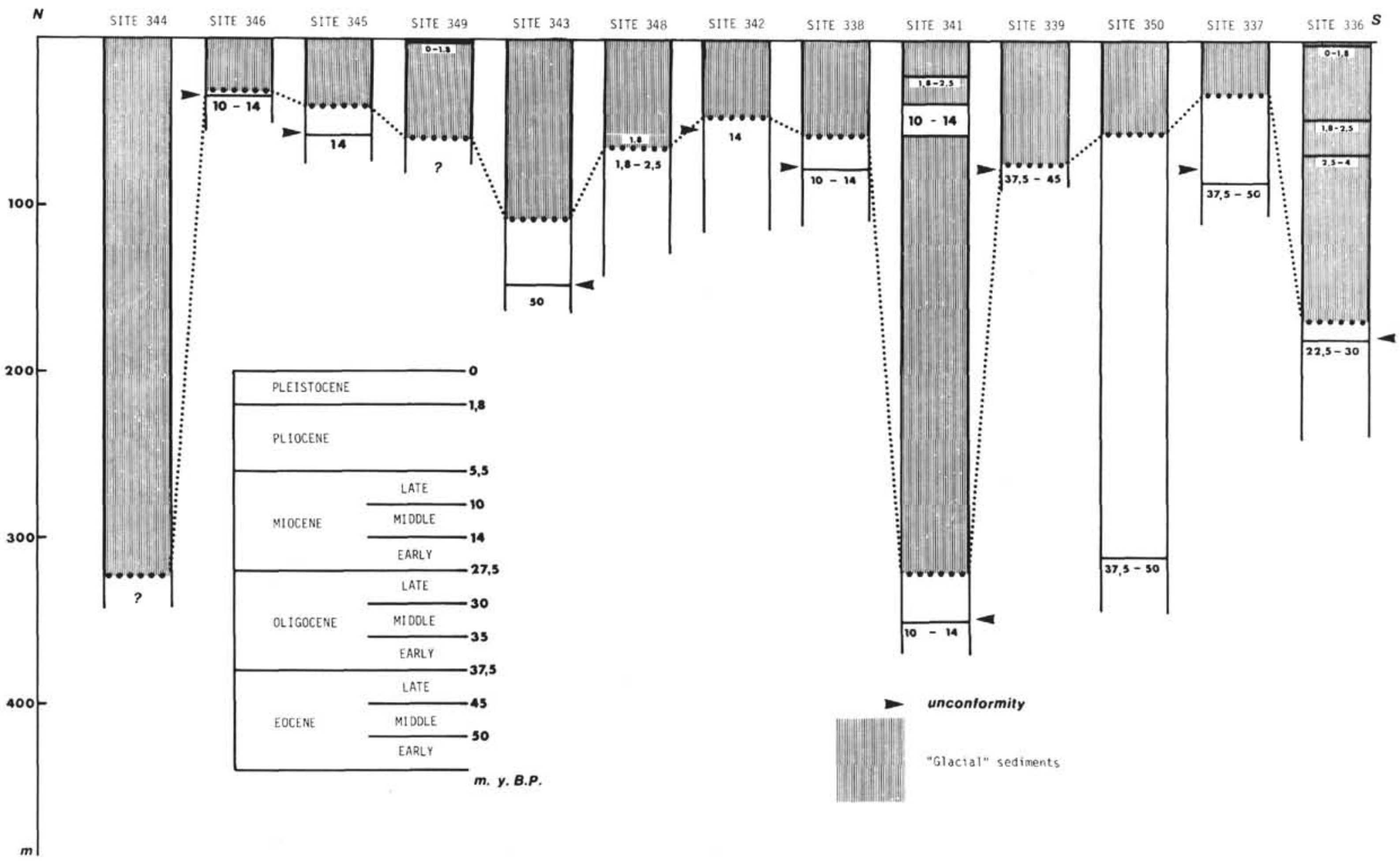

Figure 33. *"Glacial" sediments at Leg 38 drill sites. Sites oriented from north to south. Ages determined by diatom zonation within the "Glacial" section and below, are inserted.*

TABLE 25
Thickness of "Glacial" Sediments at Various Sites

Site[a]	Thickness of Glacial Sediment (m)
344	320
346	32
345	40
349	60
343	108
348	64
342	47
338	57
341	323
339	75
350	50
337	35
336	168.5

[a]Sites listed from north to south.

Genus ETHMODISCUS Castracane (1886)

Ethmodiscus rex (Rattray) Hendey (1953)
(No illustration)

Description: Hendey (1953), p. 51-57, pl. 1, fig. 1-6.
Remarks: Found only in fragments.
Age: Not diagnostic.

Genus EUCAMPIA Ehrenberg (1839)

Eucampia balaustium Castracane (1886)
(Plate 10, Figures 17, 18)

Description: Castracane (1886), p. 97, pl. 98, fig. 5; remarks *in* Hustedt (1958), p. 136-137, pl. 5, fig. 40-43.
Age: Miocene-Recent.

Eucampia aff. balaustium
(Plate 10, Figures 15, 16)

Description: See under the species.
Remarks: These individuals are different in their smaller valve mantle and their finer structure.

Genus FRAGILARIA Lyngbye (1819)

Fragilaria voeringia n. sp. Fenner
(Plate 25, Figures 22-24)

Description: Valves linear with broadly rounded apices. Valve length: 10-30 μm, width 2-4 μm. Valve surface striate in transapical direction. The transverse striae are grading into radial arrangement near the apices. The striae are inconsistent across the pseudoraphe forming a narrow zig-zag line. The number of striae is 15 in 10 μm with approx. 18 punctae in 10 μm.
Holotype: Plate 35, Figure 22 from Leg 38, Sample 338-24-1, 34-35 cm, Norwegian Sea.
Paratypes: Plate 25, Figures 23, 24.
Age: Middle-late Oligocene.

Genus and species indet. (1)
(Plate 15, Figure 4)

Description: Schrader (1973a), p. 713, pl. 12, fig. 1-6.
Age: Pliocene.

Genus and species indet. (3)
(Plate 4, Figure 10)

Genus and species indet. (4)
(Plate 12, Figure 23)

Genus and species indet. (5)
(Plate 13, Figure 12)

Remarks: Valve circular, flat, or slightly convex. Valve diameter 40-63 μm. Valve hyaline with single or double punctae scattered irregularly and very loose over the valve. Only along the margin the punctae are more dense and form a ring of one row of punctae. Here are up to four punctae in 10 μm.

The described species is identical with the undetermined diatom species "forma indeterminata 3" of Hajós (1968, p. 208) from the marine upper diatomaceous horizon of Szurdokpüspöki, although her specimen was smaller and the marginal punctae lay closer to each other. Similar is also *Poretzkia circularis* Jousé (1974a), but which is more densely punctate.
Age: Oligocene.

Genus and species indet. (6)
(Plate 45, Figures 5, 11, 14)

Description: Valve in girdleband view with one strongly convex side, which has a central depression on the top. There is a bunch of fine spines at the deepest point of the depression. The neighboring elevations bear loosely scattered short spines. The other side is flat with a central flattened elevation which is decorated with scattered short spines. This elevation is 1/4 of the valve diameter. Valve diameter: approx. 40 μm.
Discussion: A probably identical specimen was illustrated by Hajós (in preparation) under the name *Xanthiopyxis* cf. *acrolopha* from late Eocene to Oligocene sediments from the southwestern Pacific. It will be very difficult to differentiate this species in valve view, but in girdleband view it has a very characteristic shape.
Age: Late Eocene-middle Oligocene.

Genus and species indet. (7)
(Plate 45, Figure 1)

Genus and species indet. (8)
(Plate 33, Figure 6)

Age: Oligocene.

Genus and species indet. (9)
(Plate 36, Figures 6a, b)

Description: Valve oval-shaped, convex, coarsely and irregularly areolated: five to six areolae in 10 μm. Also irregularly distributed between the areolae lie smaller points, probably spines. The areolae decrease in size from the center to the margin where seven areolae are found in 10 μm. Longest valve axis: 25-31 μm.
Discussion: This species differs from *Coscinodiscus obovatus* Castracane (1886) in the arrangement of areolae, and from *Coscinodiscus ovalis* Roper in size and arrangement of areolae.
Age: Eocene-middle Oligocene.

Genus and species indet. (10)
(Plate 22, Figures 7, 8)

Genus and species indet.
(Plate 12, Figure 22)

Genus and species indet.
(Plate 22, Figure 32; Plate 23, Figure 39)

Genus and species indet.
(Plate 20, Figure 9)

Genus and species indet.
(Plate 3, Figure 9)

Genus and species indet.
(Plate 3, Figure 18)

Genus and species indet.
(Plate 8, Figure 10)

Remarks: Lanceolate valves of this type, without structure, have been observed occasionally.

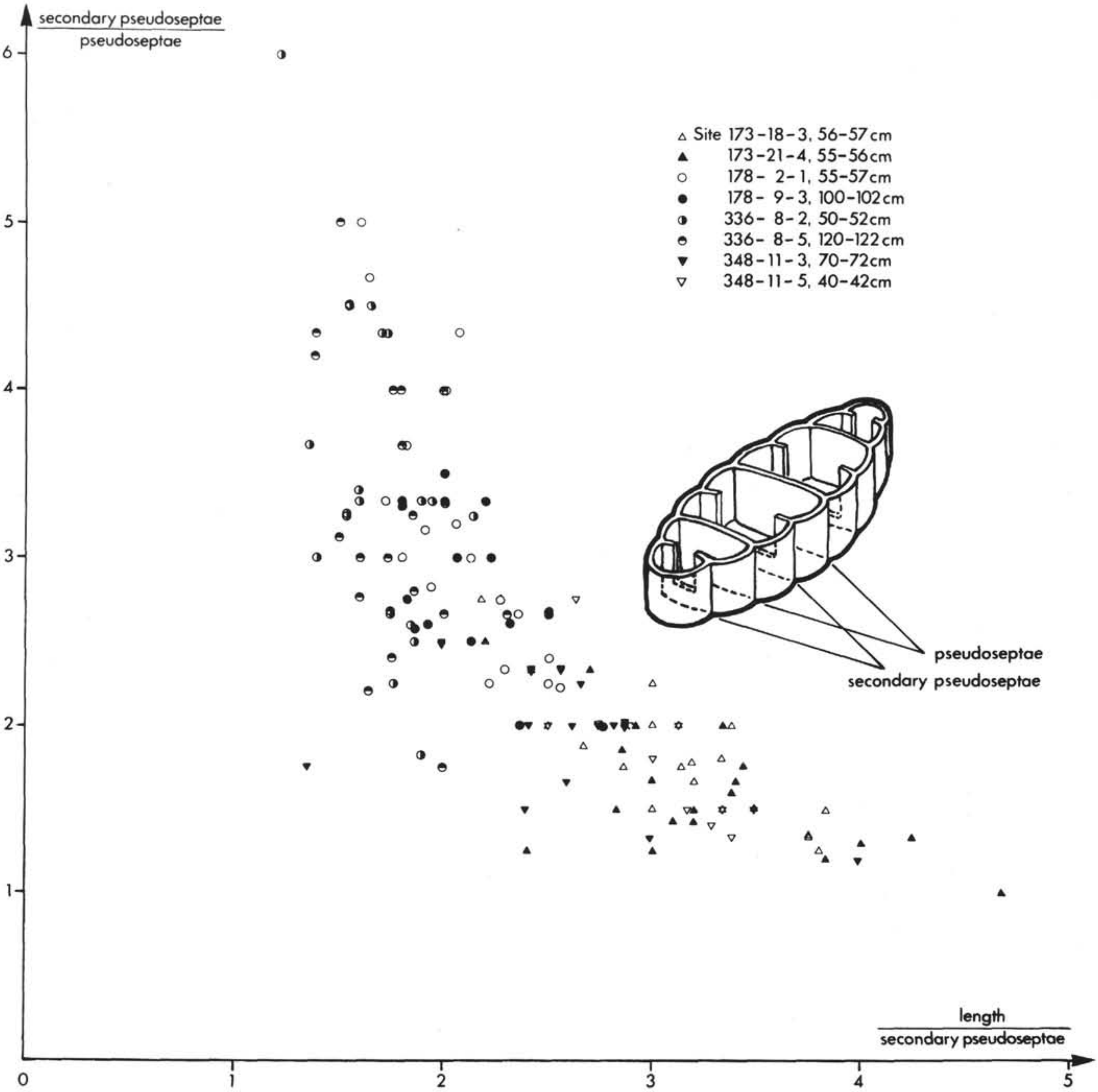

Figure 34. *Biometrical parameters of* Denticula seminae *and* D. hustedtii *in Neogene-Quaternary samples of DSDP Legs 18 and 38.*

Genus GONIOTHECIUM Ehrenberg (1841)

Description: Tsumura (1959).

Goniothecium coronatum n. sp. Fenner
(Plate 44, Figure 7)

Description: Valve elliptical with rounded ends. Valve length 40-99 µm, width 20-29 µm. The central elevation is followed on both sides by a curved elevation which bears spines in an elliptical arrangement. This characteristic ellipse of spines may also be bent. This characteristic is only visible in valve view. In girdle view this species is not distinguishable from *Goniothecium odontella*. The ends of the valve do not follow the falling trend of the ridges, but raise up to the high of the second ridge.

Holotype: Plate 33, Figure 7 from Leg 38 Sample 338-24-1, 34-35 cm; Norwegian Sea.

Goniothecium decoratum Brun (1891)
(Plate 6, Figures 3, 5; Plate 37, Figures 1-5, 11-14)

Description: Brun (1891), p. 28, pl. 12, fig. 6.
Age: Eocene-Oligocene.
This species was found by Brun (1891) quite frequent in Oamaru samples and rare in the "Pöplein"-material.

Goniothecium loricatum n. sp. Fenner
(Plate 38, Figure 1)

Description: Cells heavily silicified. Valves dimorph, one being convex the other slightly concave. The convex valve is hyaline with

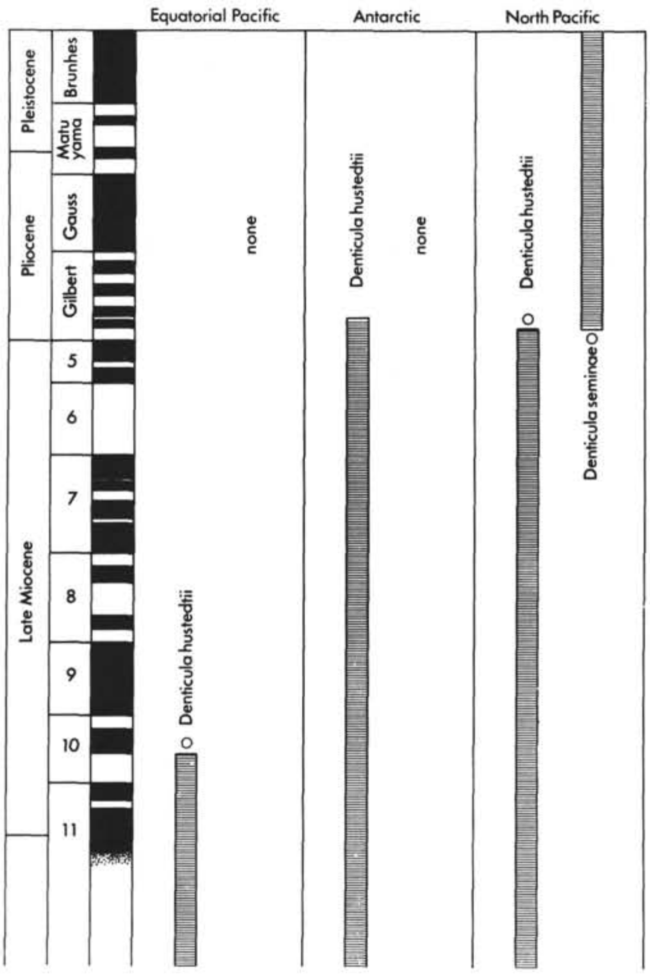

Figure 35. *Ranges and correlation to the paleomagnetic stratigraphy of* Denticula seminae *and* D. hustedtii.

isolated spines scattered over the surface. The concave valve has a central elevation which is surrounded by a furrow and has radial rows of punctae: 14-15 punctae in 10 μm. The rest with isolated, scattered punctae. The concave valve bears large apical horns. Valve length 30-65 μm, height 30-40 μm.

Discussion: No similar species was observed in the literature.

Holotype: Plate 38, Figure 1, Leg 38, Sample 338-26-5, 63-65 cm; Norwegian Sea.

Age: Late Oligocene.

Goniothecium odontella Ehrenberg (1844a)
(Plate 6, Figures 1, 2, 4)

Description: Karsten (1928), p. 301, fig. 419A.

Age: Oligocene-Miocene.

Goniothecium odontella var. danica Grunow ex van Heurck (1896)
(Plate 44, Figures 10, 11)

Remarks: The present *Goniothecium* differs from other species by its armed outer margin.

Illustration: van Heurck (1896), p. 428, fig. 148.

Age: Eocene.

Goniothecium tenue Brun (1894)
(Plate 6, Figures 6-10; Plate 37, Figures 6-10)

Description: Brun (1894), p. 77, pl. VI, fig. 5, 6; Koizumi (1973), p. 833, pl. 7, fig. 7-9.

Remarks: Part of the species described in Schrader (1973a), pl. 23, fig. 12, 13 has to be placed under this species. Included into the species were also individuals which possessed a pennate transapical structure. These have been found frequently in the lower part of Site 346 and have been listed separately as *Goniothecium tenue* var. *structuralis*.

Age: Late Miocene (Koizumi, 1973).

Genus HEMIAULUS Ehrenberg (1844 [1845])

Hemiaulus curvatulus Strelnikova (1974)
(Plate 43, Figures 10, 11)

Description: Strelnikova (1974), p. 96-97; pl. 47, fig. 14-16.

Hemiaulus danicus Grunow in Cleve and Möller (1878)
(Plate 10, Figures 11, 12)

Description: Grunow (1884), p. 13 (65), pl. 2, fig. 40.

Age: Eocene (Grunow, 1884) - Oligocene.

Hemiaulus hostilis Heiberg (1863)
(Plate 45, Figure 4)

Description: Heiberg (1863), p. 48, pl. 1, fig. 11.

Age: Eocene-Oligocene.

TABLE 26
Summary of Results

Site	Longitude	Basement Depth Below Sea Floor (m)	Water Depth From Sea Level (m)	Biogenic Siliceous Sediments (m) From	To	Youngest-Oldest Age of Biog. Silic. Sedim. (m.y.B.P.)
336	07°47.3'W	476.4	811	197	216	30-35
337	05°20.5'W	113.0	2637	–	–	37.5-45
				66.5	228	
338	05°23.3'E	401.8	1297	249	285	10-14 37.5-45
339	06°19.1'E	–	1262	58	108	37.5-50
340	06°18.4'E	–	1206	0	104.5	37.5-50
				38	57	
341	06°06.6'E	–	1439	332.5	456	10-14
342	04°56.0'E	153.2	1303	85	147	14-22
343	05°45.7'E	252.7	3131	147.5	202.5	50-53.5
344	07°52.5'E	378.5	2154	–	–	–
345	01°14.3'W	762.0	3195	65	139	14-22.5
346	08°41.1'W	–	732	35	101.5	10-14
347	08°41.8'W	–	745	–	–	–
348	12°27.7'W	526.8	1763	73.5	256	0 10-14
349	08°05.8'W	–	915	–	–	–
350	08°17.7'W	361.7	1275	–	–	35-20(?)

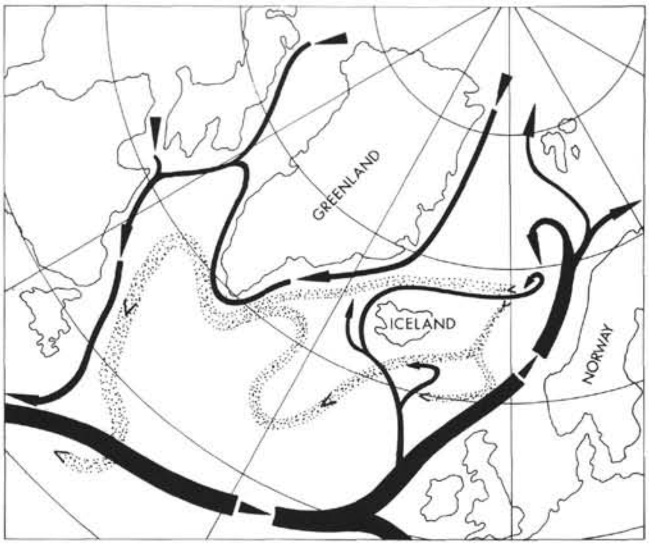

Figure 36. *Main circulation of surface currents (black) entering the Norwegian Sea and bottom currents leaving the Norwegian Sea (dashed). From Dietrich and Ulrich (1968) and Worthington (1970).*

Hemiaulus kittonii Grunow (1884)
(Plate 10, Figure 19)

Description: Strelnikova (1974), p. 96, pl. 42, fig. 12-24.
Age: Cretaceous-Oligocene.

Hemiaulus malleolus Pantocsek (1886)
(Plate 10, Figures 5, 14 and 6 [?])

Description: Pantocsek (1886), p. 48, pl. 8, fig. 66.
Age: Miocene.

Hemiaulus polycistinorum Ehrenberg (1854 [1856])
(Plate 10, Figures 20, 21)

Description: Grunow (1884), p. 13; Schmidt et al. (1874-ff), pl. 143, fig. 23-29.

Hemiaulus polymorphus Grunow (1884)
(No illustration)

Description: Grunow (1884), p. 66, pl. II (B), fig. 42-50.

Hemiaulus polymorphus Grunow var. frigida Grunow (1884)
(No illustration)

Description: Grunow (1884), p. 66, pl. II (B), fig. 47-49.

Hemiaulus pungens Grunow (1884)
(Plate 10, Figures 7-9; Plate 43, Figure 9 [?])

Description: Grunow (1884), p. 63, pl. 5, fig. 56; Cleve-Euler (1951), p. 125, fig. 274.
Age: Not yet determined.

Hemiaulus undulatus Jousé (1951)
(No illustration)

Description: Strelnikova (1974), p. 98, pl. 47, fig. 7-9.

Hemiaulus sp. a
(Plate 10, Figure 10)

Remarks: Broad elliptical valves, with short processes and very short spines on top. No similar species was observed in the literature, except in A. Schmidt, pl. 118, fig. 25 from marine recent collection of Java, without correct taxonomic position; due to the fact that the present species has a clear spine it has to be placed into *Hemiaulus*.

Hemiaulus sp.
(Plate 10, Figure 13)

Hemiaulus sp.
(Plate 43, Figure 15)

Hemiaulus sp. (giganteus)
(Plate 10, Figure 4)

Description: Cells large, heavily silicified. Valves elliptical, 20-22 μm long, poles produced to form long robust, centrical processes. Processes straight and slightly convergent, terminated by a small, short spine and is approx. 56 μm long. Valve surface convex, valve mantle deep. Structure consists of large areolae which cover also mostly all parts of the processes, in straight, parallel lines on the processes and radially orientated on the valve.
Remarks: This species is mostly found only in fragments and is identical with *Hemiaulus* sp. 1 Schrader (1973a).

Hemiaulus sp. (pyxilloides)
(Plate 10, Figures 1-3)

Description: No complete cells or valves have been found. Only fragmented processes with parts of the valve were found and these demonstrated that the processes are bent and decrease in diameter towards the valve. Processes long, 70-73 μm, concentric with large areolae in longitudinal lines, six to eight areolae in 10 μm. Two-thirds from the initiation of the process to its termination a distinct large massive spine is located. Another spine is on top of the termination of the process.
Discussion: This species is close to the genus *Pyxilla*, but differs from the latter by the bent initiation of the process. No similar species has been found in the literature.
Age: Oligocene.

Genus HEMIDISCUS Wallich (1860)

Hemidiscus cuneiformis Wallich (1860)
(No illustration)

Description: Hustedt (1930), p. 904-907, fig. 542.
Age: Miocene-Recent.

Hemidiscus karstenii Jousé (1962)
(No illustration)

Description: Abbott (1972), p. 110-112, pl. 1, fig. D-F.
Age: Miocene.

Genus HUTTONIA Grove and Sturt (1887)

Huttonia norwegica n. sp. Schrader and Fenner
(Plate 22, Figures 40, 41)

Description: Valves linear elliptical with broadly rounded apices. Surface with an irregular punctation. At each apex is a broad, truncate ocellus, diagonally placed. Valve length 62-72 μm, width 9-10 μm.
Discussion: No similar species was found in the literature. This species was placed within the genus *Huttonia* because of the diagonally placed ocelli.
Holotype: Plate 22, Figure 41 from Leg 38, Sample 337-10-5, 120-122 cm; Norwegian Sea.
Paratype: Plate 22, Figure 40.
Age: Oligocene.

Genus HYALODISCUS Ehrenberg (1845)

Hyalodiscus radiatus (O'Meara, 1877) Grunow in Cleve and Grunow (1880)
(No illustration)

Description: Grunow (1884), p. 41, fig. 93; Hustedt (1930), p. 295, fig. 135.

Hyalodiscus aff. subtilis Bailey (1854)
(Plate 19, Figures 1, 2)

Description: Hustedt (1930), p. 291-293, fig. 132.
Age: Not diagnostic.

Hyalodiscus aff. szurdokpuespoekiensis Hajós (1968)
(Plate 40, Figures 18, 19)

Description: Hajós (1968), p. 83, pl. 9, fig. 9.

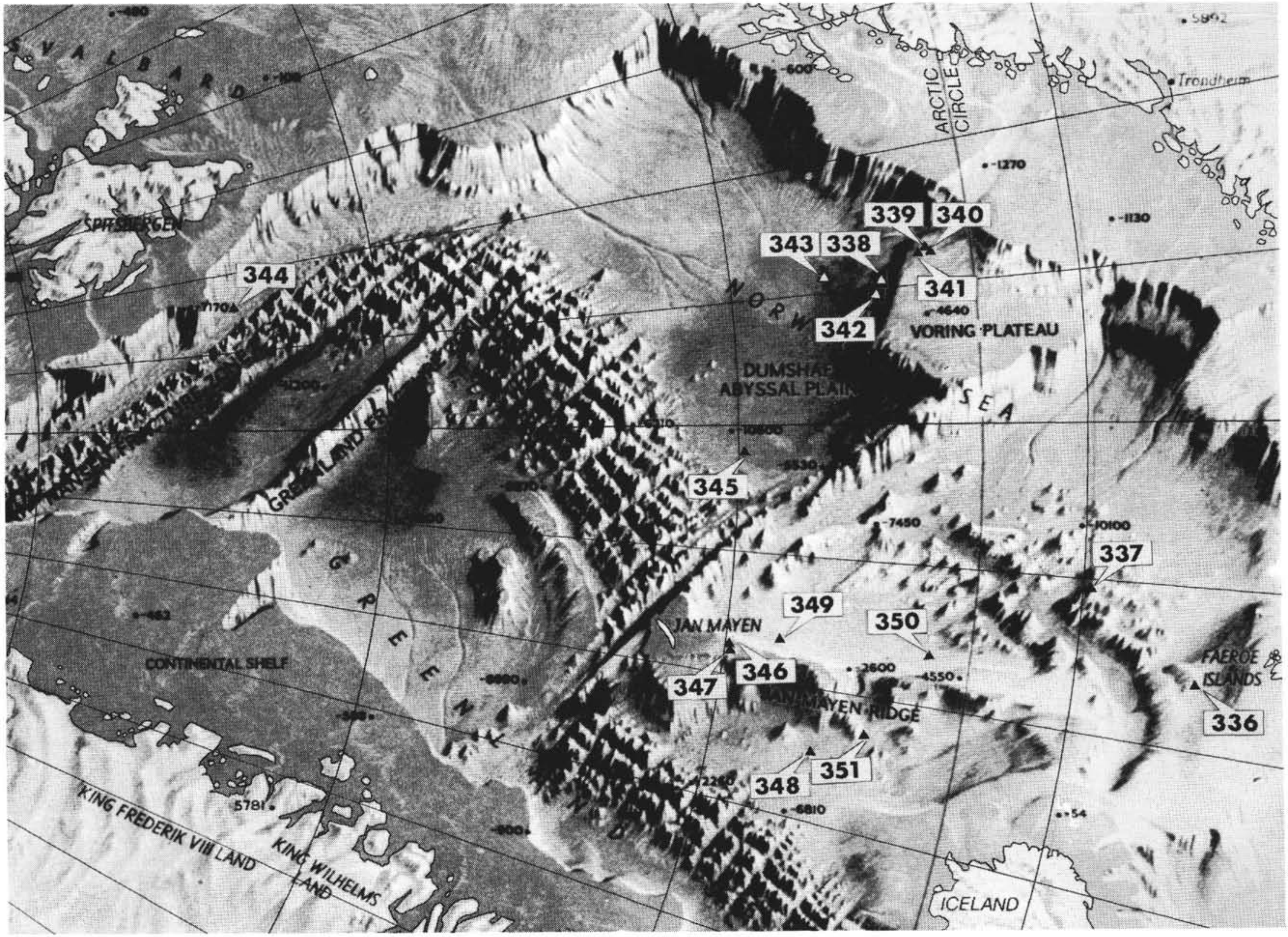

Figure 37. *Zonal and geologic age assignments of Leg 38 cores from the Norwegian Sea. Numbers are core and section designations.*

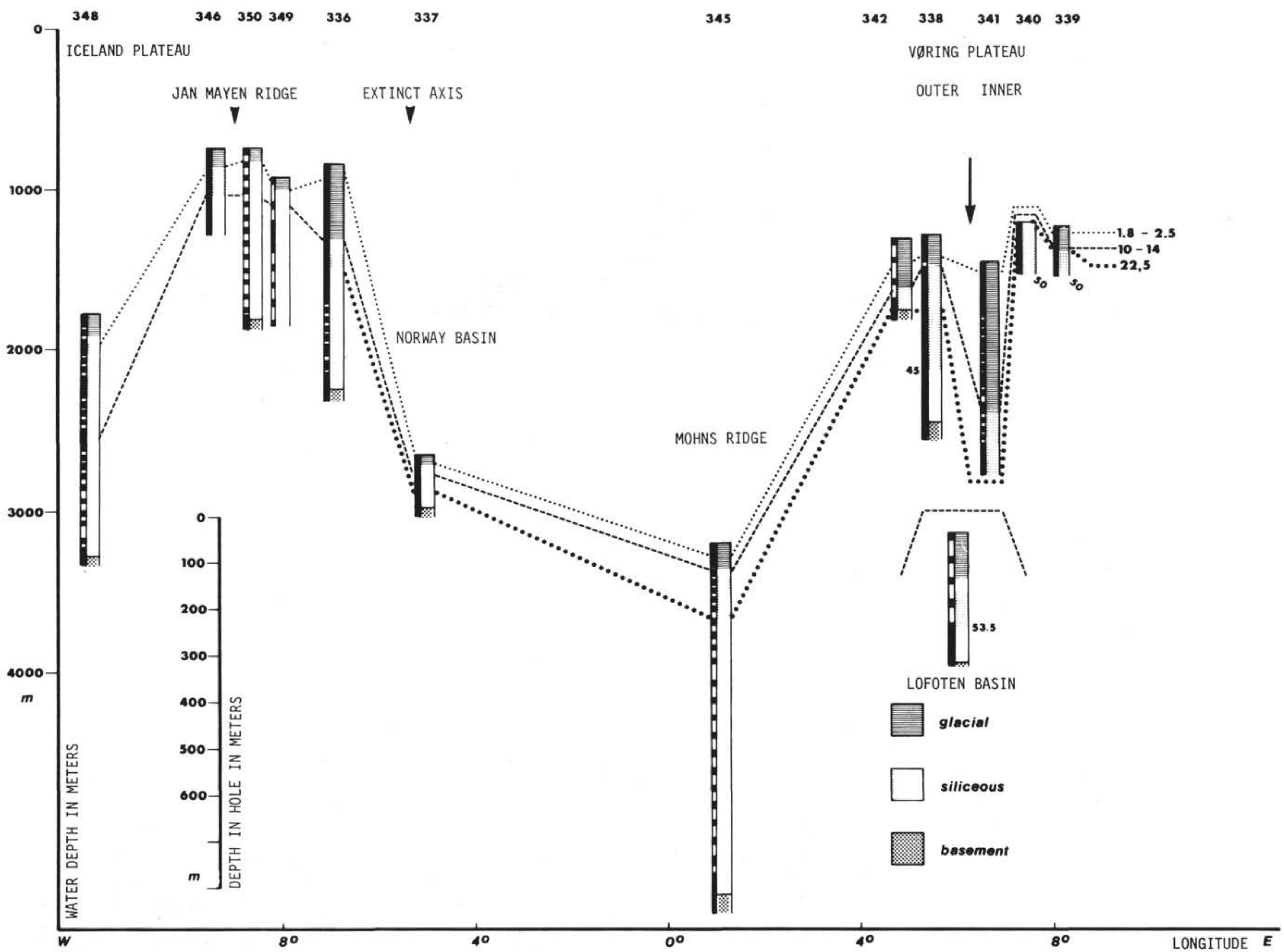

Figure 38. *Location of Leg 38 drill sites on the Norwegian-Greenland sea floor. Section from the Arctic Ocean Floor map of the National Geographical Society (1971).*

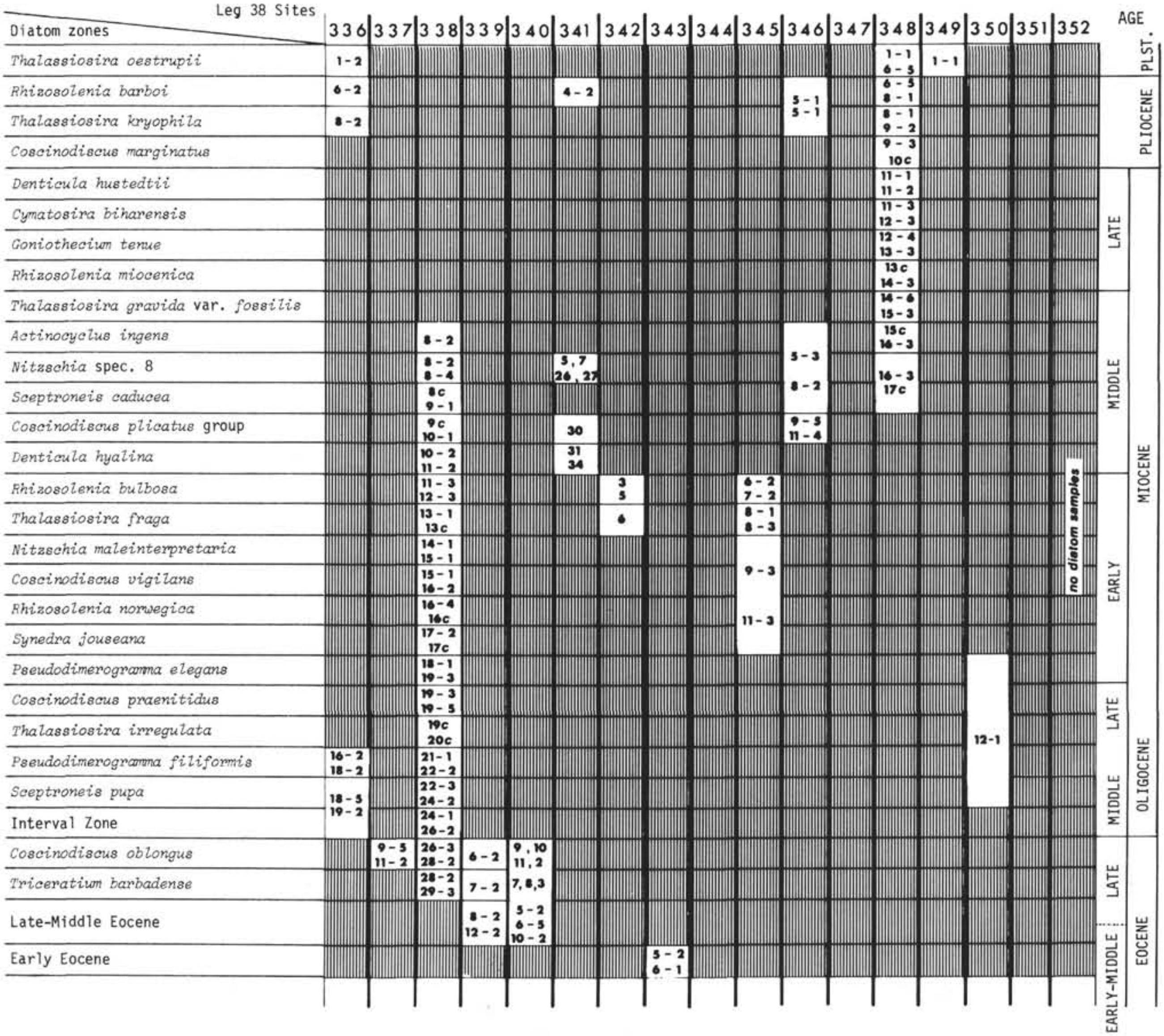

Figure 39. *Distribution and age correlation of "Glacial" sediments, and of siliceous sediments from DSDP Leg 38 drill sites. Sites orientated from east to west and placed into the respective water depth.*

Genus LAUDERIA Cleve (1873)

Lauderia borealis Gran (1900)
(No illustration)

Description: Hustedt (1930), p. 549-550, fig. 313.
Age: Pleistocene-Recent (as spores).

Genus LITHODESMIUM Ehrenberg (1840)

Lithodesmium rotunda n. sp. Schrader
(Plate 11, Figure 5)

Description: All cells observed were solitary (fossil material), rectangular in girdle view. The valves are triangular, each side with strongly convex margins, so that in some individuals a circular shape is present. Each angle is furnished with a short process with an apiculate apex. The valve surface has a central spine which arises from a small elliptical base (labiate process). The valve surface is areolate. The areolae are arranged in radiating lines from the central hyaline small area, nine areolae in 10 μm and approx. nine radial rows in 10 μm. The valve mantle is steep. The valves are strongly silicified and measure approx. 40 μm in diameter.

Discussion: No similar species was found in the literature.
Holotype: Plate 11, Figure 5 from Leg 38, Sample 338-16-4, 67-68 cm; Norwegian Sea.
Age: Not yet determined.

Genus LIRADISCUS Greville (1865)

Liradiscus ovalis Greville (1865)
(Plate 40, Figure 10)

Description: Greville (1865), p. 5, pl. 1, fig. 15, 16; Hanna (1927), p. 114, pl. 19, fig. 4-6.

Genus MACRORA Hanna (1932)

Macrora stella (Azpeitia) Hanna (1932)
(Plate 12, Figures 13, 14)

Description: Hanna (1932), p. 196, pl. 12, fig. 7.
Age: Early-middle Miocene.

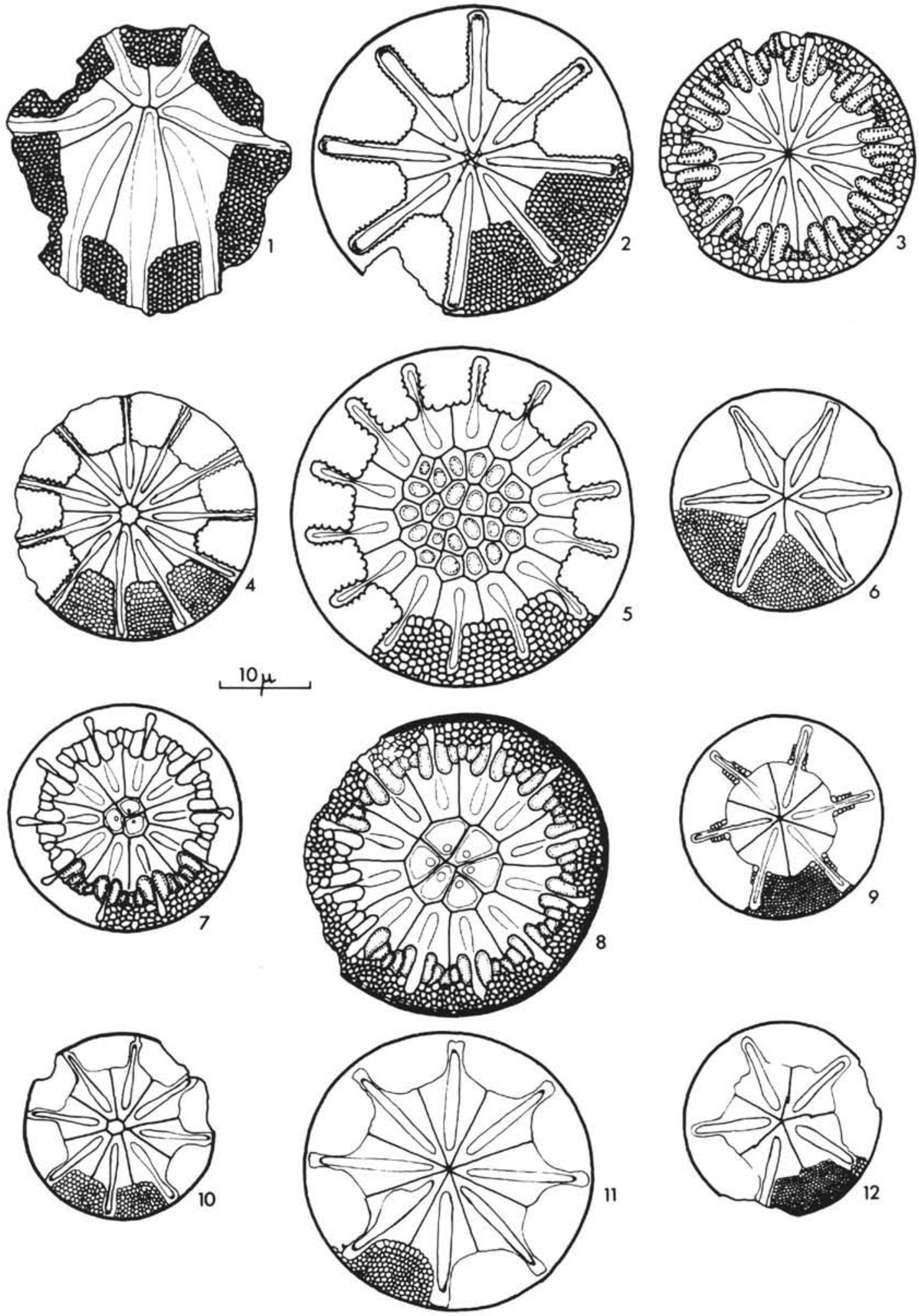

Figure 40. *Drawings of* Asteromphalus *and* Asterolampra *species, found in late Eocene to early Oligocene sediments. (1)* Asteromphalus *sp., (2)* Asterolampra *sp., (3)* Asterolampra vulgaris, *(4)* Asterolampra affinis *var.* cellulosa, *(5)* Asterolampra insignis, *(6)* Asterolampra praeacutiloba, *(7)* Asterolampra vulgaris, *(8)* Asterolampra vulgaris, *(9)* Asterolampra affinis *var.* punctifera, *(10)* Asterolampra affinis *var.* cellulosa, *(11)* Asterolampra marylandica, *(12)* Asterolampra affinis *var.* punctifera*(?). All species were extremely rare and mostly covered by other particles which prevented good micrographs.*

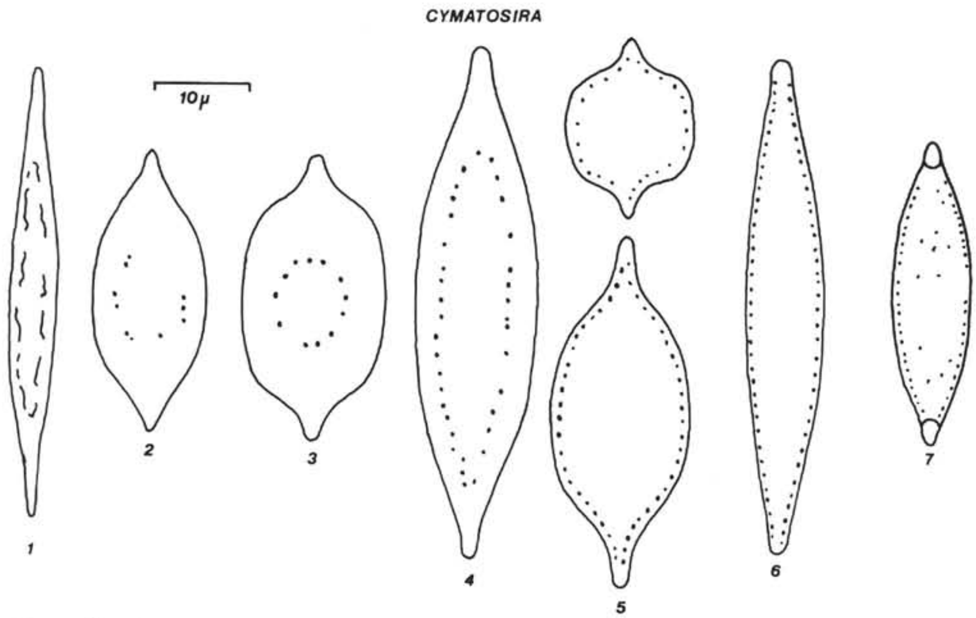

Figure 41. Cymatosira-*types. Only valve outline and spines drawn from micrographs. (1)* = coronata *type, (2)* = praecompacta *type, (3)* = compacta *type, (4)* = fossilis *type, (5)* = margino-punctata *type, (6)* = biharensis *type, (7)* = cornutus *type.*

Genus MEDIARIA Sheshukova-Poretzkaya (1962)

Mediaria splendida Sheshukova-Poretzkaya (1962)
(Plate 8, Figure 18)

Description: Sheshukova-Poretzkaya (1967), p. 306, pl. XLVII, fig. 14, pl. XLVIII, fig. 8.
Age: Miocene.

Genus MELOSIRA Agardh (1824)

Melosira architecturalis Brun (1892)
(Plate 14, Figure 13; Plate 29, Figures 7, 8; Plate 35, Figures 1-4)

Synonym: *Cyclotella hannae* Kanaya (1957).
Description: Brun *in* Schmidt et al. (1874), pl. 177, fig. 45-50; Kanaya (1957), p. 82-84, pl. 3, fig. 10-14.
Remarks: The observed specimens harmonize in size and structure with those reported from Gleser and Jousé (1974) from Eocene sediments of the equatorial Atlantic and with those of Hajós (in preparation) from Eocene and early Oligocene sediments from the southwest Pacific. While those described by Kanaya from the Eocene of the Mt. Diablo area (Calif.) are coarser areolated. This species was very common in the late Oligocene sediments from the Norwegian Sea.
Age: Eocene-late Oligocene.

Melosira goretzkii Tscherem. ex Gleser et al. (1974)
(Plate 41, Figure 10; Plate 44, Figure 1)

Illustration: Gleser et al. (1974), pl. 34, fig. 8.
Age: Late Eocene-middle Oligocene.

Melosira granulata (Ehr.) Ralfs in Pritchard (1861)
(No illustration)

Description: Hustedt (1930), p. 248-252, fig. 104, 105.
Ecological remarks: This species is a planktonic fresh-water one and is displaced in marine sediments.
Age: Not diagnostic.

Melosira islandica O. Müller (1906)
(Plate 27, Figures 9, 10)

Description: Hustedt (1930), p. 252-256, fig. 106.
Ecological remarks: Common in eutrophic fresh-water lakes of the northern hemisphere.
Remarks: This species plus *M. granulata* was used for reference of fresh-water material displacement.

Melosira ornata Grunow in van Heurck (1882)
(Plate 14, Figure 10)

Description: Hustedt (1930), p. 274, fig. 117; Forti (1913), p. 1542.
Age: Not yet determined.

Melosira sulcata (Ehrenberg) Kützing (1844)
(Plate 12, Figure 17)

Description: Hustedt (1930), p. 276-278, fig. 118-120.
Age: Not diagnostic.

Melosira sp.
(Plate 27, Figure 5)

Remarks: This species is very close to the unnamed specimens in A. Schmidt et al. (1874), pl. 178, fig. 40, 41.
Age: Not yet determined.

Genus MONOBRACHIA n. gen. Schrader

Description: Cells solitary, only found separated. Valves with a dome-like footpart, which is in valve view elliptical and which protrudes into an elongated process, which is rounded in diameter. The process terminates into a rounded top apex without any spines. Valves have scattered, isolated pores and an irregular network of massive ribs. The process is asymmetrically inserted into the footpart.
Generotype: Plate 41, Figure 16—*Monobrachia simplex* n. sp. from Leg 38, Sample 338-29, CC.
Remarks: This genus has been included in the past partly into the genus *Hemiaulus* from which it clearly differs in the possession of only one process and in the absence of claws on top of the process.
Age: Found only in marine-fossil samples of Paleogene age.

Monobrachia simplex n. sp. Schrader
(Plate 41, Figures 15, 16, 18, 20)

Description: Cells solitary, only found in separate valves. Valve with an elliptical footpart, 12-17 µm in longest diameter. A single process of 4-6 µm in diameter and 40-70 µm length ejects from the footpart in an eccentric position and grades into a smaller broadly rounded top apex. Top apex without any spines. Valve structure consists of isolated scattered pores which grade into longitudinal rows on the process (here approx. 12 in 10 µ). Only two to four rows are present on the process. The footpole and the process covered with a

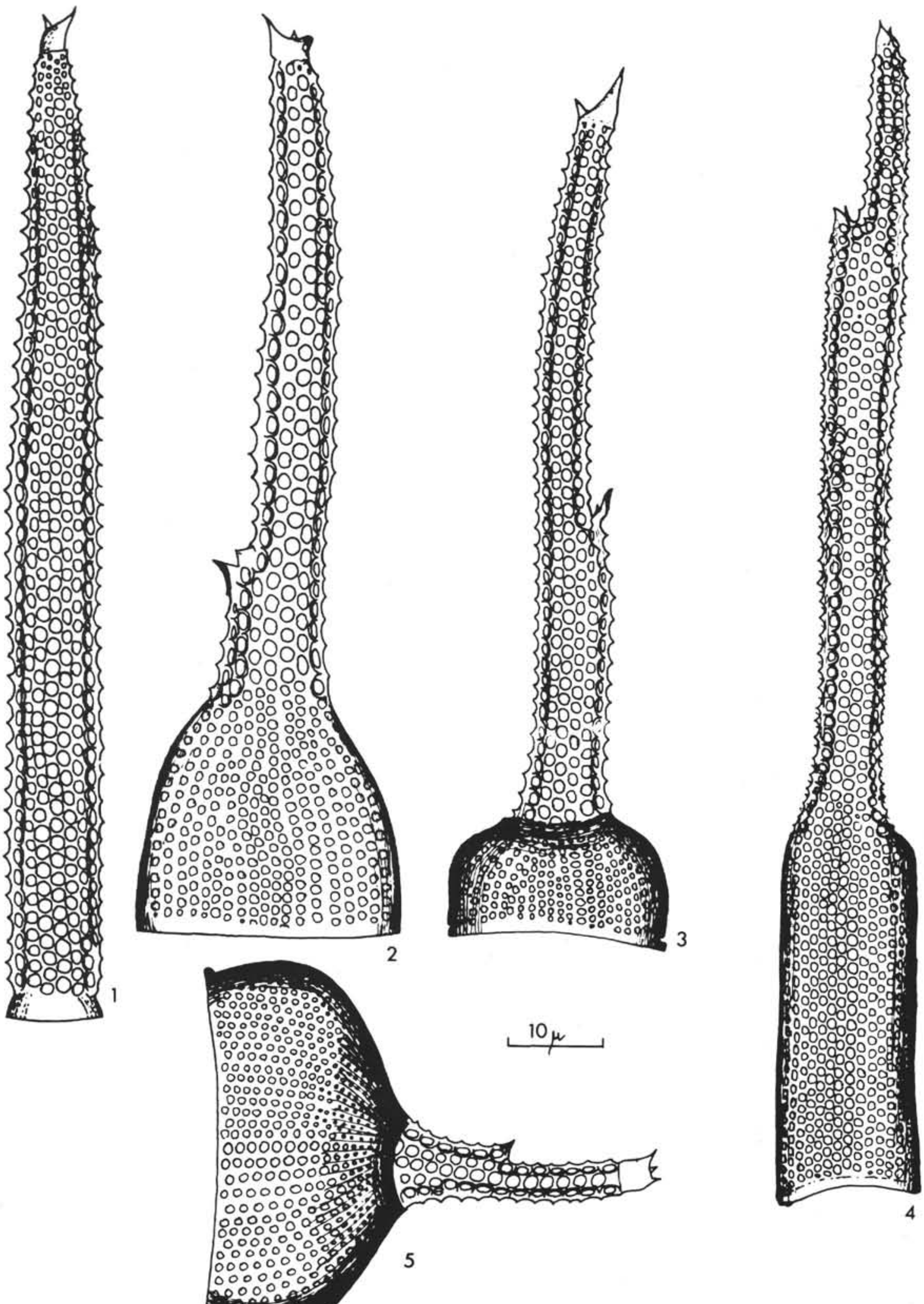

Figure 42. *Drawings of* Pyrgupyxis *sp. (1)* Pyrgupyxis gracilis (Tempere and *Forti), Hendey, (2)-(3)* Pyrgupyxis johnsoniana *(Greville) Hendey, (4)* Pyrgupyxis gracilis *var.* saratoviana *(Pantocsek) Hendey, (5)* Pyrgupyxis *sp. All individuals from the Oceanic Formation of Barbados and Oamaru, New Zealand. Same individuals were also observed in the present materials.*

network of ribs. Basal part of the footpole free of any kind of ornamentation, hyaline.

Discussion: This species differs from *Monobrachia unicornuta* in its smaller size and in its "more" symmetrical valves.

Holotype: Plate 41, Figure 20 from Leg 38, Sample 340-8-5, 60-62 cm, Norwegian Sea.

Paratype: Plate 41, Figures 15, 16, 18.

Age: Late Eocene.

Monobrachia unicornuta (Brun) n. comb. Schrader and Fenner
(Plate 42, Figures 13, 14)

Basionym: *Hemiaulus unicornutus* Brun (1890-1893), p. 175-176, pl. 24, fig. 3.

Age: Late Eocene.

Genus MUELLERIOPSIS Hendey (1972)

Muelleriopsis limbata (Ehrenberg) Hendey (1972)
(No illustration)

Description: Hendey (1972), p. 87, pl. 1-2.

Age: Eocene.

Genus NAVICULA Bory (1822)

Navicula bendaensis n. sp. Schrader and Fenner
(Plate 22, Figures 34, 35; Plate 24, Figure 4)

Derivatio nominis: Named after Dr. L. Benda of Hannover.

Description: Valve with parallel margins and elongated thinner rostrate apices with broadly rounded ends. Valve striated: 15-16 transapical striae in 10 μm, which become slightly bent towards the apices at the valve-ends. Transapical striae representing thin chambers with inner openings. Axial area small at the rostrate apices widened with parallel margins and forming a broad elliptical central area. Central area with elongated shadows on both sides. Central pores close together. Raphe bars straight. Apical pores bent in the same direction. Valve length 50-60 μm, width 5-7 μm.

Discussion: This species differs from *Navicula sudora* by its smaller width, finer striation, broader hyaline fringe and its shape.

Holotype: Plate 24, Figure 4 from Leg 38, Sample 338-28-2, 133-134 cm, Norwegian Sea.

Paratypes: Plate 22, Figures 34, 35.

Age: Late Eocene.

Navicula sudora n. sp. Schrader and Fenner
(Plate 24, Figure 3)

Description: Valves elongated with parallel margins in the middle of the valves and cuneate apices. Valve 58 μm long, and 7 μm wide, apices broadly rounded. Valve striate with 13-14 striae in 10 μm, transapical over the middle part of the valve and bent slightly towards the apices. Striae represent small chambers with one line of marginal inner pores and one line of raphe neighbored inner openings. Axial area not widened to form a central area, small. Central pores close together, raphe bars straight.

Discussion: This species differs from *Navicula udintsevii* by its coarser structure and the lacking of a central area. It differs from *Navicula bendaensis* by its shape and coarser structure.

Holotype: Plate 24, Figure 3 from Leg 38, Sample 340-3-2, 60-62 cm; Norwegian Sea.

Age: Late Eocene.

Navicula udintsevii n. sp. Schrader and Fenner
(Plate 22, Figure 33; Plate 24, Figures 1 [?], 2)

Derivatio nominis: Named after Dr. Gleb Udintsev, Co-Chief DSDP Leg 38.

Description: Valves linear to spindle-shaped with parallel margins in the middle part. Apices rounded. The valve is finely striate: 20-21 transapical striae in 10 μm which become slightly bent towards the apices at the valve ends. The raphe is distinct with straight raphe bars. Axial area wide, lanceolate, widened in the middle of the valve forming a central area. Central area with elongated shadowed areas on both sides. Central pores close together. Apical pores bent to the same side. One apical line crosses the transapical small chambers, being the apical line of the small inner openings. Valve length 53-79 μm, width 8-10 μm.

Discussion: This species differs from *N. bendaensis* and *N. sudora* by its chambered structure and its shadowed areas.

Holotype: Plate 24, Figure 2 from Leg 38, Sample 337-10-5, 120-122 cm; Norwegian Sea.

Age: Late Eocene.

Genus NITZSCHIA Hassall (1845)

Nitzschia atlantica (Paasche) Hasle (1972)
(Plate 1, Figure 10)

Description: Hasle (1965), p. 9-11, pl. 1, fig. 1-5.

Ecological remarks: Paasche (1960) found that this species had a wide distribution in the Norwegian Sea in arctic and polar waters, and it seemed to be most common in waters of 2°C or less (Paasche, 1961).

Age: Pliocene-Recent.

Nitzschia aff. atlantica (Paasche) Hasle (1972)
(Plate 1, Figure 27)

Description: See above.

Remarks: The present species has a somewhat reduced structure, with approx. 21 costae in 10 μm, which are recognizable in the light microscope.

Age: Not yet determined.

Nitzschia evenescens Schrader (in press)
(Plate 1, Figures 28, 29)

Description: Schrader (in press), p. 78, pl. 2, fig. 22, 23.

Age: Miocene.

Nitzschia guttula n. sp. Schrader
(Plate 1, Figures 8, 9)

Description: Valves elliptical with convex margins and rounded slightly cuneate apices; 22-30 μm long, 8-9 μm wide; apical axis heteropole, one pole being broader than the other. Transapical costae straight over most of the valve surface, grading to two to three curved ones near the apex, 10 in 10 μm. Intercostal membranes with two finely poroid rows, 30-34 poroids in 10 μm. Number of costae equal to number of keel punctae, one middle keel puncta is larger than the others. Apical fields covered by two to three strongly curved, asymmetrical ribs and intercostal membranes, somewhat hidden by the diffraction of the strongly silicified valve margin.

Discussion: This species differs from allied species (*Nitzschia ritscheri*; *N. heteropolica*) by the finer poroid intercostal membranes and the more silicified frustules.

Holotype: Plate 1, Figures 8, 9 from Leg 38, Sample 338-8-3, 70-72 cm, Norwegian Sea.

Age: Late Miocene.

Nitzschia januaria Schrader (in press)
(Plate 1, Figure 2)

Description: Schrader (in press), p. 80, pl. 2, fig. 25-29.

Age: Middle-late Miocene.

Nitzschia kanayensis Schrader (1974b)
(Plate 1, Figures 21 [?], 22, 23)

Description: Schrader (1974b), p. 547, fig. 6/23, 25, 28.

Age: Late Miocene.

Nitzschia maleinterpretaria Schrader (in press)
(Plate 1, Figure 30)

Description: Schrader (in press), p. 80, pl. 2, fig. 9, 11-19, 21, 24.

Age: Early-middle Miocene.

Nitzschia aff. maleinterpretaria
(Plate 1, Figure 31)

Remarks: This species differs from *N. maleinterpretaria* by its size and by the finer areolation.

Description: Schrader (in press), p. 80, pl. 2, fig. 9, 11-19, 21, 24.

Age: Early-middle Miocene.

Nitzschia porteri Frenguelli (1949)
(Plate 1, Figure 26)

Description: Frenguelli (1949), p. 116, pl. 1, fig. 33, 34.
Age: Late Miocene.

Nitzschia pseudocylindrica n. sp. Schrader
(Plate 1, Figures 3-5, 12, 15-18)

Description: Valves elliptical with parallel margins and broadly rounded apices, 18-24 μm long, 4-5 μm wide. Transapical costae straight over the middle of the valve and curved near the apices. The number of transapical costae is: 12-13 in 10 μm. The intercostal membranes have one row of distinct pores, 16-19 in 10 μm. Number of costae equal to the number of keel punctae, 12-13 in 10 μm. The number of curved costae near the poles is approx. two to three. Apical field covered by three to four apical, longitudinal ribs which are recognizable in the light microscope.
Discussion: This species differs by its intercostal membranes with only one row of punctae from allied species (*N. curta*, *N. cylindrica*).
Holotype: Plate 1, Figures 4, 5 (same specimen) from Leg 38, Sample 348-11-3, 70-72 cm, Norwegian Sea.
Paratype: Plate 1, Figures 3, 12, 15, 17, 18.
Age: Pliocene.

Nitzschia riedelia Schrader (1974b)
(Plate 1, Figures 14a, b, 19)

Description: Schrader (1974b), p. 549, fig. 6/20-21.
Age: Pliocene-late Miocene.

Nitzschia aff. sublineata (van Heurck) Hasle (1972)
(Plate 1, Figure 1)

Description: Hasle (1965), p. 27-30, various figures.
Remarks: The present taxonomic assignment is most questionable since *N. sublineata* is an endemic Antarctic species, living close to the ice. No reports were found which describe this species from Arctic waters.
Age: Not yet determined.

Nitzschia sp. a
(Plate 1, Figure 20)

Remarks: Only a few specimens have been observed and of those the figured specimen represents the only intact one. Further study is needed to clear its taxonomic position.

Nitzschia sp. b
(Plate 1, Figure 11)

Nitzschia sp. c
(Plate 1, Figure 13)

Nitzschia sp. d
(Plate 1, Figure 24)

Nitzschia sp. e
(Plate 1, Figure 25)

Nitzschia sp. 8 (Schrader, 1974b)
(Plate 1, Figures 6, 7)

Remarks: Only fragmented and partly dissolved specimens have been observed and are close to *N.* sp. 8 of Schrader (1974b).
Age: Not yet determined.

Genus ODONTELLA Agardh (1832)

For taxonomic details see Ross and Sims (1971); Simonsen (1972, 1974).

Odontella aurita (Lyngbye) Agardh (1832)
(No illustration)

Description: Hustedt (1930), p. 846-849, fig. 500-502 as *Biddulphia aurita*.

Odontella calamus (Brun and Tempère) n. comb. Schrader
(Plate 20, Figure 7 [fragment])

Basionym: *Biddulphia calamus* Brun and Tempère (1889), p. 26-27.
Description: Brun and Tempère (1889), p. 26-27, pl. 5, fig. 15.
Age: Pliocene (?).

Odontella cornuta (J. Brun) n. comb. Schrader
(Plate 20, Figure 5)

Basionym: *Biddulphia cornuta* Brun (1894), p. 74.
Description: Brun (1894), p. 74, pl. 6, fig. 3.
Age: Miocene.

Odontella fimbriata (Greville) n. comb. Schrader
(Plate 20, Figure 6)

Basionym: *Biddulphia fimbriata* Greville (1865), p. 6.
Description: Greville (1865), p. 6, pl. 1, fig. 4.
Remarks: Greville has clearly demonstrated that more than two spines are characteristic for *O. fimbriata*, due to the fact that mostly spines are broken off in the present material and valves are fragmented, the present species is placed with hesitation into *O. fimbriata*.
Age: Oligocene.

Odontella septentrionala n. sp. Schrader
(Plate 11, Figures 1, 2)

Description: Frustules rectangular, valves tetrapolar with strongly concave margins and one pair of extrusions: one pair subrostrate, the other pair broadly rounded. The extrusions are 36-60 μm long, 28-52 μm wide. At two angles of the valve (at the longer diagonal line) ocelli are slightly protruding from the valve surface. At the other two angles are small robust spines, alternating over the diagonal line. The center of the valve is slightly protruded. The valve is covered with polygonal areolae, 6 in 10 μm, which are arranged in radial rows.
Discussion: No similar species were observed in the literature.
Holotype: Plate 11, Figure 1 from Leg 38, Sample 338-11-4, 5-6 cm; Norwegian Sea.
Paratype: Plate 11, Figure 2.
Age: Early Miocene-middle Miocene.

Odontella sp. a
(Plate 20, Figure 2)

Remarks: This species with uncertain taxonomic position was found mostly in fragments.

Genus ODONTOTROPIS Grunow (1884)

Odontotropis klavsenii Debes
(No illustration)

Description: Hustedt (1930), p. 858, fig. 510a; Schulz (1935), p. 393.

Odontotropis carinata Grunow (1884)
(No illustration)

Description: Hustedt (1930), p. 857-858, fig. 510.

Genus OPEPHORA Petit (1888)

Opephora gemmata (Grunow) Hustedt (1959)
(Plate 3, Figures 10, 11)

Synonyms: 1866 *Sceptroneis* (?) *gemmata* Grunow, p. 146; 1896 *Grunowiella gemmata* (Grun) van Heurck, p. 332.
Description: Hustedt (1959), p. 136-137, fig. 657.
Age: Early Miocene-middle Miocene.

Genus PEPONIA Greville (1863)

Peponia barbadensis Greville (1863)
(Plate 36, Figures 10, 13)

Description: Greville (1863), p. 76, pl. V, fig. 25.
Age: Late Eocene.

Genus PERIPTERA Ehrenberg (1844b)

Periptera tetracladia Ehrenberg (1844b)
(Plate 6, Figure 12; Plate 39, Figures 5, 6)

Description: Hanna (1932), p. 205, pl. 13, fig. 8.
Age: Not determined.

Periptera sp. 1
(Plate 39, Figure 7)

Genus PLANKTONIELLA Schütt (1893)

Planktoniella sol (Wallich) Schütt (1893)
(Plate 18, Figure 9)

Description: Hustedt (1930), p. 465, fig. 259; Gerloff (1970), p. 203-204, numerous figures; Fryxell and Hasle (1972), p. 310, fig. 34-36.
Age: Pliocene-Recent.

Genus PLEUROSIGMA Smith (1852)

Pleurosigma planktonica n. sp. Schrader
(Plate 5, Figure 25)

Description: Valves lanceolate, slightly sigmoid with subobtuse apices. Raphe sigmoid. The valve is 110-150 μm long, 26-29 μm wide. The central area is small and circular. The valve surface is striate. The striae are oblique and transverse; the oblique striae crossing each other at an angle of about 65°. The striae are equidistant, numbering 16-17 in 10 μm. The axial area is distinct, approx. 1-2 μm wide. The raphe is distinct with central pores penetrating into the central nodule.
Holotype: Plate 5, Figure 25 from Leg 38, Sample 338-8-2, 10-11 cm; Norwegian Sea.
Age: Not yet determined.

Genus POROSIRA Jørgensen (1905)

Porosira glacialis (Grunow) Jørgensen (1905)
(Plate 16, Figures 1-4, 13; Plate 17, Figure 1)

Description: Koizumi (1973), p. 833, pl. 4, fig. 15-18; Jousé (1962), pl. 2, fig. 1, pl. 79, fig. 11 (only represented in resting spores).
Age: Pliocene-Recent.

Genus PSEUDODIMEROGRAMMA n. gen. Schrader

Description: Frustules solitary, valves elliptical-longitudinal, with heteropole valves. One apex being hyaline with a distinct (labiate ?) process and the other one similarly structured as the valve surface. Pseudoraphe distinct, small. Structure consists of distinct large areolae oriented in transapical rows, which are inconsistent in orientation across the pseudoraphe. Some valves club-like.
Type species: *Pseudodimerogramma oligocenica* n. sp. from Leg 38, Sample 338-21, CC; Norwegian Sea (diagnosis, see below).
Distribution: Only found in sediment samples from the Norwegian Sea of Cenozoic age.
Discussion: *Pseudodimerogramma* is a distinct genus and is closely related to *Dimerogramma* from which it differs in the heteropolar valves. Other closely related genera are *Licmophora*, from which it differs in the absence of septae, and *Sceptroneis*, from which it differs in valve shape and structure of the hyaline apical field. No similar species have been observed in the literature.

Pseudodimerogramma elegans n. sp. Schrader
(Plate 3, Figure 14)

Description: Frustules rectangular. Valves elliptical with parallel margins and broadly cuneate apices. Valves 24-41 μm long, approx. 6 μm wide. Margins in some specimens slightly concave. Apices dimorph: footpole with a clear hyaline triangulate pole field and a distinct large process (labiate ?) close to the end of the pseudoraphe and with one marginal row of punctae. The headpole shows a continuation of the normal valve structure in radial arrangement. Pseudoraphe distinct, very narrow. Transapical striae parallel, grading into radial arrangement towards the apices, approx. 10-11 in 10 μm. They consist of small punctae, which are oriented in margin parallel rows. Each transapical row consists of three punctae. Rows are inconsistent in orientation across the pseudoraphe. Approx. 13 punctae in 10 μm.
Discussion: This species differs from *Pseudodim. oligocenica* in its symmetrical valves, clearly hyaline footpole and in its geological range.
Holotype: Plate 3, Figure 14 from Leg 38, Sample 338-12-2, 85-86 cm; Norwegian Sea.
Age: Early Miocene-middle Miocene.

Pseudodimerogramma elliptica n. sp. Schrader
(Plate 3, Figure 5)

Description: Frustules rectangular. Valves elliptical with slightly convex margins, symmetrical and broadly rounded apices. Valve 28 μm long, 6 μm wide. Apices dimorph, footpole with a clear hyaline semicircular pole field and a distinct process near the end of the pseudoraphe and with one marginal row of punctae. Headpole with a continuation of the normal valve structure in radial arrangement. Pseudoraphe distinct, very narrow. Transapical striae parallel, grading into radial arrangement towards the apices, 12 in 10 μm. They consist of small punctae which are oriented in slightly convex apical rows. Each transapical row consists of three to four punctae. Rows are inconsistent in orientation across the pseudoraphe. Approx. 10-12 punctae in 10 μm.
Discussion: This species differs from all other *Pseudodimerogramma* species in the elliptical valve outline and the broadly rounded apices.
Holotype: Plate 3, Figure 5 from Leg 38, Sample 338-19-3, 40-41 cm, Norwegian Sea.
Age: Late Miocene-early Miocene.

Pseudodimerogramma elongata n. sp. Schrader
(Plate 3, Figures 19, 20)

Description: Frustules rectangular. Valves longitudinal with slightly concave margins, inflated over the middle and cuneate apices. Valves 80-120 μm long, 5-6 μm wide over the inflated middle part. Apices inflated and dimorph. The smaller footpole with a helmet-shaped hyaline large area with ghosts of continuating transapical and radial structure and one centrally situated solitary process, and a distinct single marginal row of punctae. The headpole shows a continuation of the normal valve structure in radial arrangement. The pseudoraphe is distinct and narrow. The transapical striae are parallel, grading into radial arrangement towards the headpole; their number in 10 μm is: 9-10. They consist of large punctae: three to four per row, approx. 10 in 10 μm, which are oriented in rows parallel to the margin. Rows are inconsistent in orientation across the pseudoraphe. The headpole is broadly rounded in some individuals.
Discussion: This large species has not been observed in the literature.
Holotype: Plate 3, Figure 19 from Leg 38, Sample 338-11-4, 5-6 cm; Norwegian Sea.
Paratype: Plate 3, Figure 20.
Age: Early Miocene-middle Miocene.

Pseudodimerogramma filiformis n. sp. Schrader and Fenner
(Plate 3, Figures 21, 22 [same individual, Figure 22 = 700×])

Description: Valves linear, heteropole with slightly broadened round ends. Valves 170-190 μm long, approx. 4 μm wide, slightly inflated over the middle. The footpole has a distinct hyaline area, approx. 4-5 μm long, and one centrally situated solitary (labiate?) process. The headpole shows a continuation of the normal valve structure in radial arrangement. The pseudoraphe is distinct but very narrow. Transapical striae parallel, grading into radial arrangement towards the headpole. There are 10 striae in 10 μm. They consist of small punctae, two to four in one row, 12-15 in 10 μm, which are oriented in longitudinal rows. The transapical rows are inconsistent in orientation across the pseudoraphe.
Discussion: This species differs from *Pseudodim. elongata* in its larger linear valves and in the structure of the poles.
Holotype: Plate 3, Figures 21, 22 from Leg 38, Sample 338-21, CC; Norwegian Sea.
Age: Late Oligocene.

Pseudodimerogramma oligocenica n. sp. Schrader and Fenner
(Plate 3, Figures 6-8, 13)

Description: Frustules rectangular. Valves broadly club-like with slightly concave margins and broadly rounded cuneate apices. Valves 27-34 μm long, 6-9 μm wide in the middle part. Apices dimorph: footpole (the smaller one) with a hyaline triangular pole field with ghosts of scattered punctae and with a solitary process closely situated to the end of the pseudoraphe. Headpole with a continuation of the normal valve structure in radial arrangement. Pseudoraphe distinct small, becoming narrower towards the apices. Transapical striae parallel, eight to nine in 10 μm, consisting of large areolae which are oriented in wavy rows parallel to margin. Number of areolae approx. 8-10 in 10 μm. Striae grading to radial orientation towards the apices. One row of marginal areolae surrounding the hyaline footpole. Transapical striae are inconsistent in orientation across the pseudoraphe.

Discussion: No similar species have been observed in the literature.

Holotype: Plate 3, Figure 8 from Leg 38, Sample 338-21, CC; Norwegian Sea.

Paratype: Plate 3, Figures 6, 13.

Age: Late Oligocene.

Pseudodimerogramma sp.
(Plate 5, Figure 21)

Genus PSEUDOPODOSIRA Jousé (1949)

Pseudopodosira simplex (Jousé) Strelnikova (1974)
(Plate 12, Figures 24, 25)

Description: Strelnikova (1974), p. 51-52, pl. 2, fig. 10, 11.

Age: Not diagnostic.

Genus PSEUDOPYXILLA Forti (1909)

Pseudopyxilla americana (Ehrenberg) Forti (1909)
(Plate 9, Figure 7)

Description: Forti (1909), p. 14, pl. 1, fig. 6, 7.

Age: Miocene (?).

Pseudopyxilla baltica (Grunow) Forti (1909)
(Plate 44, Figures 3, 6, 9)

Description: Forti (1909), pl. 1, fig. 6, 7.

Pseudopyxilla directa (Pantocsek) Forti (1909)
(Plate 9, Figures 8, 9; Plate 44, Figure 12)

Synonym: *Pyxilla directa* Pantocsek (1892), pl. 32, fig. 458.

Description: Forti (1909), p. 13 (only table).

Age: Not yet determined.

Pseudopyxilla dubia (Grunow) Forti (1909)
(Plate 44, Figures 13, 14)

Description: Forti (1909), p. 12, pl. 1, fig. 22.

Pseudopyxilla rossica (Pantocsek) Forti (1909)
(Plate 12, Figures 19, 20; Plate 44, Figures 2, 4, 5 [?])

Illustration: Forti (1909), pl. 1, fig. 13.

Pseudopyxilla sp.
(Plate 12, Figure 21; Plate 44, Figure 8)

Genus PSEUDORUTILARIA Grove and Sturt (1886)

Remarks: We have included into this genus all species which possess elongated valves which form chains by thin siliceous membranes which do possess large window-like openings and lack the twisted Rutilaria process.

Pseudorutilaria monomembranacea n. sp. Schrader
(Plate 22, Figures 1-6)

Description: Cells united by thin membranes to form chains, membranes with broad elliptical openings. Valves narrowly lanceolate, 30-70 μm long, 5-6 μm wide, with broadly rounded apices. Areolation coarse and not oriented. One single areola is of approx. 1 μm in diameter. The apices are hyaline, prolonged as is the central part of the valves. A snake-like hyaline membrane forms a pseudoseparation of the valve in apical direction. This line is sometimes interrupted and represents the basal part of the single connecting membrane.

Discussion: No similar species has been observed in the literature.

Holotype: Plate 22, Figure 3 from Leg 38, Sample 340-8-5, 60-62 cm; Norwegian Sea.

Paratypes: Plate 22, Figures 1, 2, 4-6.

Age: Late Eocene.

Genus PSEUDOSTICTODISCUS Grunow
in van Heurck (1880-1885)
(Plate 110, Figure 9 in litt.)

Pseudo-Stictodiscus picus Hanna
(Plate 35, Figures 25, 26, 28)

Illustration: Proshkina-Lavrenko, The diatoms of the USSR, Fossil and Recent, v. 1, pl. 16, fig. 11.

Age: Late Eocene-middle Oligocene.

Genus PSEUDOTRICERATIUM Grunow (1884)

Pseudotriceratium chenevieri (Meister) Gleser
(Plate 11, Figures 7-9; Plate 26, Figure 5)

Description: Strelnikova (1960), pl. 9, fig. 3; for further detail see Gleser et al. (1974), pl. 28, fig. 12.

Age: Eocene-early Miocene.

Pseudotriceratium aff. chenevieri
(Plate 26, Figures 6, 8, 9; Plate 27, Figures 4, 13)

Remarks: It was not possible at this moment to clear the taxonomic position of various *Pseudotriceratium* sp. being described under *Triceratium* in the literature and having a similar range, similar valve shape, and structure.

Genus PTEROTHECA (Grunow) Forti (1909)

Pterotheca carinifera (Grunow) Forti (1909)
(Plate 9, Figure 6 [broken at spine!]; Plate 43, Figure 12)

Description: Hanna (1926), p. 119, pl. 20, fig. 9, 10.

Age: Not determined.

Pterotheca aculeifera Grunow (1880)
(Plate 43, Figures 1-4)

Description: Van Heurch (1896), p. 430, fig. 151; Kanaya (1957), p. 109-110, pl. 8, fig. 1, 2.

Age: Late Cretaceous (Strelnikova, 1974)-middle Oligocene (this paper).

Pterotheca reticulata Sheshukova-Poretzkaya (1967)
(Plate 12, Figures 1, 2, 11; Plate 38, Figures 10-12, 14-16; Plate 45, Figure 6)

Description: Sheshukova-Poretzkaya (1967), p. 229, pl. 36, fig. 6a-c; pl. 8, fig. 4a-c.

Age: Miocene.

Pterotheca spada Brun and Tempère (1889)
(Plate 41, Figures 4, 5, 12, 13)

Description: Brun and Tempère (1889), pl. 1, fig. 7; Strelnikova (1974), p. 113, pl. 56, fig. 9-11.

Pterotheca sp.
(Plate 35, Figure 15 (1); Plate 35, Figure 16 (2);
Plate 35, Figures 17, 18 (3); Plate 35, Figure 19 (4);
Plate 36, Figure 9; Plate 38, Figure 3 (5);
Plate 43, Figures 5-8 (*simplex*); Plate 43,
Figure 14; Plate 43, Figure 13)

Genus PYRGUPYXIS Hendey (1969) (compare Figure 42)

Pyrgupyxis aff. gracilis (Temp. and Forti in Forti) Hendey (1969)
(Plate 43, Figure 23)

Description: Forti (1909), p. 24, pl. 2, fig. 5-8.

Age: Eocene-Oligocene.

Pyrgupyxis oligocaenica (Jousé) n. comb. Schrader
(Plate 41, Figures 2, 3; Plate 43, Figures 17-19, 20-22)

Illustration: Gleser et al. (1974), pl. 26, fig. 10, 11; pl. 30, fig. 13, 14; pl. 31, fig. 12.

Remarks: All "true" *Pyxilla* species have been placed by Hendey (1969) into the new genus *Pyrgupyxis*. No separation into varieties has been made in this paper.

Age: Eocene-Oligocene.

Genus RAPHIDODISCUS Smith (1887)

Raphidodiscus marylandicus Christian (1886)
(Plate 7, Figure 16)

Description: Andrews (1973), p. 231-243, pl. 1-5.
Remarks: Andrews (1973) stated that this species flourished to a worldwide occurrence during a relatively short time within the Miocene (N 8-N 10) without any known ancestors, descendents, or other obviously close relatives.
This statement cannot be followed: The species was found in DSDP Leg 29 materials to range through most of the early Miocene and the same holds true in the present material. *Raphidodiscus* is close in shape and structure of the raphe to *Rouxia* and detailed study will demonstrate the evolutionary transition of an elongate *Rouxia* to a subcircular shape. This species never becomes abundant and is present in most cases in broken, but typical fragments.
Age: Early to middle Miocene.

Genus RHAPHONEIS Ehrenberg (1844a)

Rhaphoneis amphiceros (Ehrenberg) Ehrenberg (1844a)
(Plate 2, Figure 9; Plate 7, Figures 4, 12, 21 [?]; Plate 23, Figures 15, 17, 18, 20, 24, 26, 36, 37)

Description: Hanna (1932), p. 211-212, pl. 15, fig. 3-5; Hustedt (1959), p. 174-176, fig. 680; Andrews (1975), pl. 1, fig. 9-12.
Age: Late Oligocene-Recent.

Rhaphoneis angulata n. sp. Fenner
(Plate 7, Figure 7; Plate 23, Figures 28-30, 31 [?])

Description: Valve lanceolate, with rounded ends, not capitate or with elongated ends as in *Rhaphoneis amphiceros*! Pseudoraphe is lanceolate. The striae are not consistent across the pseudoraphe. The striae are more or less perpendicular to the pseudoraphe or only weakly bent in direction of the apices. Valve length: 10-27 μm, width 7-11 μm. The number of punctae is 10-11 in 10 μm; the number of striae is 7-8 in 10 μm.
Discussion: This species differs from *Rhaphoneis gemmifera* var. *brevis* (Pantocsek 18 Bd. pl. XII, fig. 101) found in the Tortonian material of Kékkö in its shape and the nearly straight striae.
Holotype: Plate 7, Figure 7 from Leg 38, Sample 338-19-3, 40-41 cm; Norwegian Sea.
Paratypes: Plate 23, Figures 28-30.
Age: Middle-late Oligocene.

Rhaphoneis aff. cocconeides Schrader (1973a)
(Plate 23, Figure 34)

Description: Schrader (1973a), p. 709, pl. 25, fig. 9, 10.

Rhaphoneis elliptica n. sp. Schrader
(Plate 7, Figure 18)

Description: Valves broadly elliptical with broadly rounded apices. Length 35-46 μm, width 18-21 μm. Transverse striae made up of rows of large punctae: eight in 10 μm. The striae are arranged slightly radiate towards the apices. The punctae become more dense towards the margin and are scattered at the middle of the valves more or less arranged in irregularly apical rows. There are approx. seven to eight transapical striae in 10 μm. The pseudoraphe is distinct, lanceolate, and slightly widened in the middle. The apical fields are semicircled, finely punctate, with the puncta in radial arrangement and with a solitary (?) labiate process.
Discussion: This species differs from *Rhaphoneis surirella* by its lanceolate pseudoraphe. No similar species have been observed in the literature.
Holotype: Plate 7, Figure 18 from Leg 38, Sample 338-9-1, 65-66 cm; Norwegian Sea.
Age: Middle Miocene-late Miocene.

Rhaphoneis elongata (Schrader) Andrews (1975)
(Plate 2, Figures 1-4; Plate 22, Figures 42, 43)

Description: Schrader (1969), p. 24, pl. 8, fig. 9 (as *Rhaphoneis amphiceros* var. *elongata* Schrader (non Peragallo and Peragallo, 1901); Andrews (1975), p. 26, pl. 1, fig. 2 (pictures and description unchanged transferred from Schrader, 1969).
Age: Oligocene.

Rhaphoneis gemmifera Ehrenberg (1844a)
(Plate 7, Figure 14a)

Description: Lohmann (1948), p. 181, pl. 11, fig. 1.
Remarks: The found and pictured specimen is placed into this species because of the arrangement of striae: perpendicular to the pseudoraphe and is only weakly bent. This is unlike *Rhaphoneis amphiceros* although the number of punctae would better fit to the latter: approx. 10 punctae in 10 μm.
Age: Early Miocene to late Miocene.

Rhaphoneis margaritalimbata Mertz (1966)
(Plate 5, Figures 23, 24)

Description: Mertz (1966), p. 27, pl. 6, fig. 1-3.
Age: Late Miocene-Pliocene.

Rhaphoneis ossiformis n. sp. Schrader
(Plate 5, Figure 20 [same individual at different focus])

Description: Frustules rectangular. Valves linear lanceolate with broadly rounded, rostrate apices and slightly convex margins in the middle. Valves 68-72 μm long, 6-8 μm wide over the headed apex, and six to seven over the middle part. The number of transverse striae is 10 in 10 μm, composed of rows of distinct punctae (two to four in one row), straight, grading into radial orientation towards the apices. Number of punctae approx. 10 in 10 μm arranged in marginal apical rows. The pseudoraphe is wide, nearly parallel to the valve margin, and approx. occupying 1/2 of the valve. No distinct apical pore fields with fine striation are present. The regular valve structure continues without interruption to the apex. One process at each apex is neighbored to the very end of the pseudoraphe.
Discussion: This species is placed into the genus *Rhaphoneis* due to its broad pseudoraphe, the structure, ornamentation and rectangular frustule shape. It differs from *R. margaritalimbata* by its valve shape.
Holotype: Plate 5, Figure 20 from Leg 38, Sample 338-8-2, 58-59 cm; Norwegian Sea.
Age: Middle Miocene.

Rhaphoneis parallelica n. sp. Schrader
(Plate 5, Figures 15-19)

Description: Frustules rectangular. Valves linear lanceolate with parallel to slightly concave margins. Valve length 20-60 μm, width: 5-12 μm, apices cuneate. The transapical striae are parallel to radial near the apices, 11-12 in 10 μm, composed of single punctae. Punctae arranged in apical rows parallel to the margin. There are three to four punctae in one row. The pseudoraphe is wide, linear-lanceolate and covering approx. 1/2 of the valve surface. The transapical structure continues at the apex without any interruption. One eccentrical process (labiate ?) is situated near the very end of each apex, but within the pseudoraphe.
Discussion: This species is close to *R. ossiformis*, but differs from it by the parallel margins and differs from *R. surirella*, *R. surirelloides* by the wide linear-lanceolate pseudoraphe.
Holotype: Plate 5, Figure 18 from Leg 38, Sample 348-15-1, 85-87 cm; Norwegian Sea.
Paratypes: Plate 5, Figures 15-17, 19.
Age: Late Miocene-early Pliocene.

Rhaphoneis parilis Hanna (1932)
(Plate 23, Figures 7, 16, 25)

Description: Hanna (1932), p. 214, pl. 16, fig. 2-4; Lohmann (1938), p. 93-94, pl. 22, fig. 5.
Stratigraphic range: Late Oligocene (this paper); middle Miocene (Hanna, 1932); late Pliocene (Lohmann, 1938).

Rhaphoneis aff. psammicola Riznyk (1973)
(Plate 23, Figures 32, 33)

Description: Riznyk (1973), pl. 15, fig. 3; pl. 20, fig. 4.
Remarks: Valve broadly oval shaped, 12-14 μm long, and 8-9 μm wide. The pseudoraphe is distinct, lanceolate, in the middle part up to 1 μm wide. Punctae are 12-13 in 10 μm. The number of striae is 11-12 in 10 μm. The striae are consistent across the pseudoraphe and more or less straight, but radially arranged. The observed specimens are finer in structure and less broad than the type.

Rhaphoneis robustata n. sp. Schrader
(Plate 5, Figure 14)

Description: Frustules rectangular. Valves elongated, elliptical with slightly convex margins and broadly rounded apices. Valve length: 44-50 μm, width: 8-10 μm. Transapical striae parallel, 6 in 10 μm, becoming slightly radial towards the apices. They are composed of single large areolae. The areolae are arranged in parallel marginal rows. There are two to four areolae in one row, eight in 10 μm. The pseudoraphe is narrow and lanceolate. The finely striate apical pore field at both ends has a (labiate ?) process each.

Discussion: No similar *Rhaphoneis* species was observed in the literature.

Holotype: Plate 5, Figure 14 (same individual) from Leg 38, Sample 338-11-3, 5-6 cm; Norwegian Sea.

Age: Middle Miocene.

Rhaphoneis aff. surirella Grunow in van Heurck (1880)
(Plate 23, Figure 38)

Description: Hustedt (1959), p. 173-174, fig. 679.

Rhaphoneis wicomicoensis Lohmann (1948)
(Plate 7, Figure 11)

Description: Lohmann (1948), p. 183, pl. 11, fig. 9.

Age: Early to middle Miocene (Lohmann, 1948).

Rhaphoneis sp. 1
(Plate 2, Figure 10)

Remarks: Only a single valve was observed with a broad lanceolate pseudoraphe. No similar specimen was observed in the literature, but due to trace occurrence no further taxonomic treatment was done.

Rhaphoneis sp.
(Plate 23, Figure 6)

Rhaphoneis sp. 5
(Plate 5, Figure 21)

Genus RHABDONEMA Kützing (1844)

Rhabdonema species
(Plate 2, Figures 11-13; Plate 7, Figures 5, 13; Plate 22, Figure 37; Plate 23, Figures 5, 22, 23, 27)

Remarks: All illustrated specimens were placed within *Rhabdonema* because of their *Rhaphoneis*-like punctated valves with finely punctate apical pore fields, symmetrical valves and a clear defined lanceolate pseudoraphe. Separated valves of the genera *Rhaphoneis* and *Rhabdonema* are not distinguishable from each other. As complete cells of *Rhabdonema* were found scarcely in the investigated material, all those individuals have been placed under *Rhabdonema* which could not definitely be associated with already described *Rhaphoneis* species.

Genus RHIZOSOLENIA Ehrenberg (1841)

Rhizosolenia barboi Brun (1894)
(Plate 9, Figure 17)

Description: Donahue (1970), p. 136.

Age: Miocene-Pliocene.

Rhizosolenia bergonii Peragallo (1892)
(Plate 41, Figure 14)

Description: Hustedt (1930), p. 575-577, fig. 327.

Age: Late Miocene-Recent.

Rhizosolenia bulbosa n. sp. Schrader
(Plate 9, Figures 1, 2)

Description: Valves incomplete (as far as the 20 individuals found), barrel-shaped, narrow at the base 12-10 μm in diameter, with inflated apex, approx. 15-20 μm wide in diameter. Apical process with radial rows of either double punctae or rectangular punctae, about 2-6 in 10 μm. Punctae approx. 7-13 in 10 μm, punctate rows separated by radial hyaline ribs. The apical process has an apical spine at the top. The spine tapers towards the top, with a central canal, 10 μm long.

Discussion: No similar *Rhizosolenia* species has been observed in the literature.

Holotype: Plate 9, Figure 1 from Leg 38, Sample 338-11-1, 135-136 cm; Norwegian Sea.

Paratype: Plate 9, Figure 2.

Age: Early Miocene-middle Miocene.

Rhizosolenia hebetata forma hiemalis Gran (1904)
(No illustration)

Description: Hustedt (1930), p. 590-592, fig. 337.

Rhizosolenia hebetata forma semispina (Hensen) Gran (1908)
(Plate 7, Figure 2; Plate 9, Figure 15)

Description: Hustedt (1930), p. 592, fig. 338.

Age: Not diagnostic.

Rhizosolenia hebetata var. subacuta Grunow (1884)
(Plate 7, Figures 1, 3)

Description: Grunow (1884), p. 96, pl. 5, fig. 49, 50.

Age: Not yet determined.

Rhizosolenia hebetata var. volatilis n. var. Schrader
(Plate 9, Figure 3)

Description: Only broken specimens were found. The valves are cylindrical tapering towards the apex. The apical process is heavily silicified and has radial punctae rows. The apical process has an apical spine on the top. The spine owns a central canal and two excavations near its base.

Discussion: This variety differs from the species by the excavations on the spine.

Holotype: Plate 9, Figure 3 from Leg 38, Sample 348-16, CC; Norwegian Sea.

Age: Late Miocene (?).

Rhizosolenia massiva n. sp. Schrader
(Plate 41, Figure 19)

Description: Cells cylindrical, valves conical with two oblique straight margins, approx. 100-150 μm in length and 20-30 μm in diameter at its base. Straight sides terminate into a massive spine (of 40-70 μm length), which has a thin canal. Base of the spine straight. Valve surface striate with concentrically arranged rows of punctae (approx. 12 rows in 10 μm). Valves heavily silicified.

Discussion: No similar heavily silicified species has been observed in the literature.

Holotype: Plate 41, Figure 19 (700×) from Leg 38, Sample 336-18-2, 55-56 cm; Norwegian Sea.

Age: Oligocene.

Rhizosolenia aff. minima Schrader (in press)
(Plate 41, Figure 17)

Remarks: The present individuals differ from the species in their hyaline area near the apex of the valves.

Rhizosolenia miocenica Schrader (1973a)
(Plate 9, Figures 5, 11, 13, 14)

Description: Schrader (1973a), p. 709, pl. 10, fig. 2-6, 9-11.

Age: Middle-late Miocene.

Rhizosolenia norwegica n. sp. Schrader
(Plate 9, Figures 4, 10)

Description: Valve cylindrical, greatly widened at the base (all observed specimens were broken at the base) 14 μm in diameter, constricted near the middle: 6 μm in diameter and apical process slightly widened and tapering towards the apex. The apical process has incomplete radial rows of scattered small pores. The pores are arranged in double lines separated by a hyaline rib structure which is reduced in some individuals. The apical process has an apical spine at the top. The spine tapers towards the top and is 12-20 μm long with a central canal and thin wings on its outside. The spine is twisted in some individuals.

Discussion: This species is close to *R. bulbosa*, but differs markedly by the smaller apical process. No similar species was observed in the literature.

Holotype: Plate 9, Figure 4 from Leg 38, Sample 338-17, CC; Norwegian Sea.
Paratype: Plate 9, Figure 10.
Age: Early Miocene.

Rhizosolenia palliola n. sp. Schrader and Fenner
(Plate 41, Figure 11)

Description: Cells cylindrical, valves strongly conical with two oblique margins, slightly concave sides and terminating in a very short spine which has a truncate apex. Spine only 4 μm long with a basal convex wall. Valve surface finely striate with radially arranged rows of small punctae (14 punctae in 10 μm). Punctae grade to become larger and more scattered near the apex. On both sides of the concave margins there is a velum-like membrane, which is completely hyaline and may be reduced in some specimens. Valves approx. 20-40 μm long, and 12-17 μm in diameter at their base.
Discussion: No similar species was observed in the literature.
Holotype: Plate 41, Figure 11 (same individual at different focus) from Leg 38, Sample 338-28-2, 133-134 cm; Norwegian Sea.
Age: Late Eocene.

Rhizosolenia pokrovskajae (Jousé) Strelnikova (1974)
(Plate 7, Figures 8, 9)

Description: Strelnikova (1974), p. 80, pl. 28, fig. 1-9.
Age: Cretaceous (Strelnikova, 1974)-Oligocene.

Rhizosolenia praebarboi Schrader (1973a)
(Plate 7, Figure 10; Plate 9, Figure 16)

Description: Schrader (1973a), p. 709-710, pl. 24, fig. 1-3.
Age: Late Oligocene-middle Miocene.

Rhizosolenia styliformis Brightwell (1858)
(Plate 9, Figure 12)

Description: Hustedt (1930), p. 584-588, fig. 333-335.
Age: Not diagnostic.

Genus RIEDELIA Jousé and Sheshukova-Poretzkaya (1971)

In the present material we found complete specimens which were placed prior into the genus *Hemiaulus*. *Riedelia* is close in valve shape to *Hemiaulus*, but differs in the not polygonal areolated valve, which here are punctate with isolated punctae. It further differs in the not distinct single spine. In the genus *Riedelia* mostly two spines are present; and finally the absence of any pseudoseptae is typical for *Riedelia*. Jousé and Sheshukova-Poretzkaya (1971) place the present genus close to *Rhizosolenia* which must be rejected. Following is a list of new combinations:

Hemiaulus ?? *tenuicornis* Greville (1865), Description of new and rare diatoms XV. Trans. Microsc. Soc. London, v. 13, n.s., 29-30.
= *Riedelia tenuicornis* (Greville) n. comb. Schrader and Fenner.
Hemiaulus longicornis Greville (1865), l.c., 31.
= *Riedelia longicornis* (Greville) n. comb. Schrader and Fenner.
Hemiaulus lyriformis Greville (1865), l.c., 30.
= *Riedelia lyriformis* (Greville) n. comb. Schrader and Fenner.
Hemiaulus alatus Greville (1865), l.c., 31-32.
= *Riedelia alata* (Greville) n. comb. Schrader and Fenner.
Hemiaulus altar Brun (1893-1896), Diatomees Miocenes. Le Diatomiste, v. 2238.
= *Riedelia altar* (Brun) n. comb. Schrader and Fenner.
Hemiaulus claviger A. Schmidt (1888), Atlas, pl. 143, fig. 5, 6.
= *Riedelia claviger* (A. Schmidt) n. comb. Schrader and Fenner.

Riedelia claviger (A. Schmidt) n. comb. Schrader and Fenner
(Plate 41, Figures 6-8, 9; Plate 42, Figures 3, 4, 10, 11, 15)

Basionym: *Hemiaulus claviger* A. Schmidt (1888), pl. 143, fig. 5, 6.
Synonym: *Riedelia mirabilis* Jousé (1971a), p. 20-22, pl. 1, fig. 1-3.
Remarks: This species differs from others in the knob-like dome in the middle of the valves and in the structure of the processes. The processes do have two lines of rectangular chambers, which grade towards the base of the processes into clothed lines.
Age: After Jousé and Sheshukova-Poretzkaya (1971) early Eocene-middle Oligocene.

Riedelia tenuicornis (Greville) n. comb. Schrader and Fenner
(Plate 42, Figure 1)

Basionym: *Hemiaulus* ?? *tenuicornis* Greville (1875), p. 29-30.

Riedelia (?) sp. (1)
(Plate 41, Figure 1)

Remarks: These fragments were found frequently (compare tables) but only as fragments. They may belong to *Rhizosolenia*, *Chaetoceros*, or *Riedelia*; final decision cannot be made.

Riedelia sp.
(Plate 42, Figures 5, 8, 9)

Genus ROPERIA Grunow in van Heurck (1881)

Roperia tesselata (Roper) Grunow in van Heurck (1881)
(No illustration)

Description: Hustedt (1930), p. 523-524, fig. 297.
Age: Pliocene-Recent.

Genus ROUXIA Brun and Héribaud (1893)

Rouxia granda n. sp. Schrader
(Plate 7, Figure 17)

Description: Valves linear-elliptical with broadly rounded apices. The valves are 70-85 μm long, 13-15 μm wide. The valve surface is slightly convex with a central depression. The raphe bars are well developed with a rectangular, narrow central area: 1-1.5 μm wide and narrow apical areas. The transapical ribs number 9-10 in 10 μm, and become radial at the very end of the apex. The transapical ribs are crossed by two apical ribs. The marginal rib forms the inner margins of the chamber openings, the other one a separation between a marginal and central structure. The poles are isopol with a hyaline sharp triangulate field. The outer chamber membranes are hyaline, no pore structure was observed even in oblique light.
Discussion: This species is close to *Diploneis rouxioides* Schrader (1969) but differs markedly by the absence of furrows, and the hollow apical canals neighboring the raphe.
Holotype: Plate 7, Figure 17 from Leg 29, Sample 280A-4-4, 120-121 cm, Antarctic Ocean (no complete specimens were found in the Norwegian Sea material; therefore Antarctic Leg 29 material was used).
Age: Oligocene.

Rouxia isopolica Schrader (in press)
(Plate 7, Figure 14b)

Description: Schrader (in press), p. 91, pl. 5, fig. 9, 14, 15, 20.
Age: Middle-late Miocene.

Rouxia obesa n. sp. Schrader
(Plate 24, Figures 5, 6)

Synonym: *Rouxia rouxioides* Hajós non Schrader, Hajós (in preparation), pl. 25, fig. 10, 11.
Description: Valves broadly lanceolate, 26-35 μm long, 10-12 μm wide. Valve surface plain, raphe bars well developed, central pores separated and forming a narrow rectangular central area. Apical axis narrow. Valves isopol with broadly rounded apices. The transapical ribs form large rectangular chambers, 8-10 in 10 μm, which possess one large elliptical inner pore. Transapical chambers crossed by an apical rib, being parallel to the margin, forming a lanceolate inner structural part.
Discussion: This species differs from others by its broadly lanceolate shape, by its chambered structure. There cannot be a connection drawn between this species and *Diploneis rouxioides* Schrader as has been done by Hajós (in preparation).
Holotype: Plate 24, Figure 6 from Leg 38, Sample 337-10-5, 120-122 cm; Norwegian Sea.
Paratype: Plate 24, Figure 5.
Age: Oligocene.

Rouxia sp.
(Plate 7, Figure 15; Plate 22; Figure 38;
Plate 22, Figure 39)

Genus RUTILARIA Greville (1863)

Rutilaria areolata Sheshukova ex. Gleser et al. (1974)
(Plate 8, Figures 11, 12; Plate 37, Figure 16)

Reference: Gleser et al. (1974), pl. 33, fig. 3a, b.
Age: Oligocene.

Rutilaria epsilon Kitton in litt. Greville (1863)
(Plate 37, Figure 15)

Description: Greville (1863), p. 94, pl. IV, fig. 1.
Age: Not yet determined.

Rutilaria sp. 1
(Plate 37, Figure 15)

Remarks: Only a few fragments of this type were observed.
Age: Not yet determined.

Genus SCEPTRONEIS Ehrenberg (1844a)
The genus *Incisoria* Hajós *in* Hajós and Stradner (1975, p. 937) is rejected and included in the genus *Sceptroneis*

Sceptroneis aff. caducea Ehrenberg (1844a)
(Plate 4, Figures 11-16)

Description: Hustedt (1959), p. 130, fig. 651.
Remarks: The present individuals differ from *S. caducea* by the shape of their valves and their coarser punctation. Future investigation of samples of the Calvert formation (with common *S. caducea*) is needed to clarify their taxonomic position.
Age: Miocene.

Sceptroneis facialis n. sp. Fenner
(Plate 24, Figures 19, 20)

Description: Valves only found in fragments. Valve clavate with a broadened headpole. The upper margin of the headpole is concave. The apical pore field is more or less circular and is surrounded by punctae, which are arranged in radial lines and decrease in size from the margin to the center. The number of punctae is 10-12 in 10 μm; the number of striae is 8-9 in 10 μm. The striae are inconsistent across the middle forming a zig-zag line (axial area).
Discussion: This species is closely related to *Sceptroneis humuncia* and *S. talwanii*, but differs from the latter by the shape and position of the apical pore field of the headpole.
Stratigraphic range: Middle Oligocene.
Holotype: Plate 23, Figure 19 from Leg 38, Sample 338-23-6, 89-90 cm; Norwegian Sea.

Sceptroneis grunowii Anissimova (1937)
(Plate 22, Figures 26-28; Plate 23, Figure 8; Plate 25, Figures 7, 9)

Description: Hajós and Stradner (1975), p. 936, pl. 11, fig. 14, 15.
Stratigraphic range: Late Cretaceous (Hajós and Stradner, 1975; Strelnikova, 1974, p. 110, pl. III, fig. 8, 9) to late Eocene (this paper).

Sceptroneis humuncia n. sp. Schrader and Fenner
(Plate 2, Figures 5-7; Plate 24, Figures 17, 26)

Description: Frustules in girdle view cuneiform. Valves broadly clavate, 90-106 μm long, 9-11 μm wide over the middle and the headpole. Valve margin between headpole and middle concave. The valve becomes narrower in direction of the truncate footpole. The headpole is trapezoid with a concave upper margin. Valve striate, six to seven slightly radial opposed transapical striae. The striae are broadly punctate: 9-12 in 10 μm forming apical lines parallel to the margin, leaving a distinct narrow axial area, which becomes even more narrow towards the apices. Apical pore fields rectangular, finely radially striate. Each pore field has one larger pore (labiate process?) both eccentrically and on the same side of the axial area.
Discussion: This species was placed into the genus *Sceptroneis* because of its valve shape and structure arrangement. No similar species has been found in the literature.
Holotype: Plate 2, Figure 7 from Leg 38, Sample 338-20-2, 30-31 cm; Norwegian Sea.
Paratype: Plate 2, Figures 5, 6 (same specimen).
Age: Middle-late Oligocene.

Sceptroneis humuncia n. sp. var. tridens n. var. Fenner
(Plate 24, Figure 27)

Description: Valve clavate but not very much constricted in transapical direction below the headpole. The outer margin of the headpole is three lobate. The axial area is distinct separating striae of alternative arrangement. There are approx. 10 punctae in 10 μm and one larger porus at the basis of the fine-punctate apical pore-field. The number of striae is six to seven in 10 μm. The striae are not perpendicular to the axial area but are bent in direction of the apices.
Discussion: This variation differs from *Sceptroneis humuncia* by the nearly lacking constriction below the headpole and the three-lobated headpole.
Holotype: Plate 24, Figure 27 from Leg 38, Sample 338-22-2, 65-67 cm; Norwegian Sea.
Age: Middle-late Oligocene.

Sceptroneis mayenica n. sp. Fenner
(Plate 22, Figures 22-25; Plate 23, Figures 1-4; Plate 25, Figures 6, 8)

Description: Valve narrowly lanceolate with produced rounded apices which become capitate in the longer forms. The valve length is 12-40 μm, width 3-5 μm. There are 10-12 transapical striae in 10 μm, becoming radial at the apices. The striae are consistent across the pseudoraphe and consist of areolae which number 9-14 in 10 μm in transapical direction. The axial area is distinct but very narrow. Valves are heteropolar, with a larger capitate headpole and a smaller capitate footpole. The headpole has a large subrounded pore field (hyaline, no structure was observed even in oblique light). The valve structure continues into the footpole.
Discussion: This species differs from *S. grunowii* by its striae which are consistent across the axial area.
Holotype: Plate 25, Figure 8 from Leg 38, Sample 340-3-2, 60-62 cm; Norwegian Sea.
Paratypes: Plate 22, Figures 22-25; Plate 23, Figures 1-4; Plate 25, Figure 6.
Age: Late Eocene.

Sceptroneis ossiformis n. sp. Schrader
(Plate 2, Figures 14-17)

Description: Frustules in girdle view cuneiform, valves broadly clavate; 21-60 μm long, 5-6 μm wide over the middle and 7-11 μm wide over the headpole. Underneath the headpole the valve is constricted in transapical direction with slightly concave margins and cuneate subrostrate poles. Valves coarsely punctate: 11-12 in 10 μm; 8-9 transapical striae. Striae slightly radial at the poles, leaving a triangular finely striate pole field. Axial area distinct, becoming narrower near the apices.
Discussion: This species was placed into the genus *Sceptroneis* because of its valve shape and structure arrangement. No similar species was observed in the literature.
Holotype: Plate 2, Figure 16 from Leg 38, Sample 338-19-3, 140-141 cm; Norwegian Sea.
Paratypes: Plate 2, Figures 14, 15, 17.
Age: Late Oligocene-early Miocene (?).

Sceptroneis pesplanus n. sp. Fenner and Schrader
(Plate 22, Figures 30, 31; Plate 25, Figures 10, 11)

Description: Valves linear-elliptical with convex margins, a capitate headpole, and a truncated footpole. Valve length: 35-50 μm, width over the middle 4-5 μm. Valves coarsely structured with transapical ribs seven to nine in 10 μm, grading into radial arrangement towards the apices. The ribs form the borders of broad chambers open to the inside with a large pore neighbored to the pseudoraphe. The outer chamber membrane is hyaline (?). The ribs are inconsistent across the middle forming a zig-zag line (axial area). The headpole has a rounded, hyaline (?), apical porefield. The valve structure continues into the cuneate footpole.
Discussion: This species differs from other *Sceptroneis* species (*S. grunowii, S. mayenica*) by its cuneate footpole and coarse structure.
Holotype: Plate 25, Figure 11 from Leg 38, Sample 340-6-5, 50-52 cm; Norwegian Sea.
Paratypes: Plate 22, Figures 30, 31; Plate 25, Figure 10.
Age: Late Eocene.

Sceptroneis praecaducea Hajós and Stradner (1975)
(Plate 23, Figures 9, 21; Plate 22, Figure 36; Plate 25, Figure 13)

Description: Hajós and Stradner (1975), p. 936, pl. 13, fig. 13, 14; pl. 14, fig. 1-4.
Age: Late Cretaceous (Hajós and Stradner, 1975)-late Oligocene (this paper).

Sceptroneis propinqua n. sp. Schrader and Fenner
(Plate 4, Figures 1-8)

Description: Frustules in girdle view cuneiform. Valves narrow to broadly lanceolate with lateral margins tapering gently towards the capitate apices. The apices more or less rounded. The headpole being slightly larger than the footpole. Valve length: 55-80 μm, width over the middle 10-12 μm. Valve coarsely punctate: 9-10 punctae in 10 μm, evenly spaced and arranged in regular, slightly radial rows, both transverse and longitudinal. The axial area is small and becomes narrower towards the apices. The apical pore fields are finely striate, each with one larger (labiate?) process.
Discussion: This species is very close to *Raphoneis*, but differs by the heteropolar valves. No similar species has been found in the literature.
Holotype: Plate 4, Figures 4, 5 (same specimen) from Leg 38, Sample 338-21, CC; Norwegian Sea.
Paratype: Plate 4, Figures 1-3, 6-8.
Age: Late Oligocene.

Sceptroneis pupa n. sp. Schrader and Fenner
(Plate 22, Figures 17-21; Plate 24, Figures 11-13)

Description: Valve fusiform, slightly irregular, sometimes linear-elliptic and with convex margins. The poles are broadly rounded. Valve length 16-35 μm, width 5-7 μm at the middle part. The number of chambers is five to six in 10 μm. The chambers are in alternative position forming a zig-zag middle line (axial area). The chambers grade from transapical orientation in the middle part to radial arrangement near the apices. The chambers do possess one large inner pore neighbored to the zig-zag line. On top of the ends of the transapical ribs a spine is situated (compare Plate 24, Figure 12 flaming points at the right side). The valves are heteropole with a broader headpole and a smaller footpole. Headpole and footpole striate; striae in radial arrangement.
Discussion: This species was placed within the genus *Sceptroneis* because of its heteropolarity and arrangement of structure. No similar species was found in the literature.
Holotype: Plate 22, Figures 19, 20 (same specimen) from Leg 38, Sample 336-16-5, 98-100 cm; Norwegian Sea.
Paratype: Plate 22, Figures 17, 18, 21; Plate 24, Figures 11-13.
Age: Middle Oligocene.

Sceptroneis talwanii n. sp. Schrader and Fenner
(Plate 24, Figures 28-30)

Description: Valves clavate with a narrow and truncate footpole and a broadening also truncate headpole, which has a concave margin. Valve length: 70-140 μm. Width of headpole 10-12 μm, of the footpole 4-5 μm. Valve is coarsely punctate. The number of transapical striae is six in 10 μm, which are arranged alternatively at the pseudoraphe, forming a zig-zag middle line. The apical pore field is of rectangular shape and is finely striate: ca. 18 striae in 10 μm. At the basis of each of the pore fields is one larger pore (labiate process?) at the same side of the axial area, respectively.
Discussion: This species differs from *Sceptroneis humuncia* by its narrower transapical axis and especially by the very long and narrow footpole which bears only one puncta on each side of the axial area.
Holotype: Plate 24, Figure 30 from Leg 38, Sample 338-22-1, 89-90 cm; Norwegian Sea.
Paratype: Plate 24, Figures 28, 29.
Age: Middle-late Oligocene.

Sceptroneis tenue n. sp. Schrader and Fenner
(Plate 3, Figures 1 [aberrant structure], 2, 3, 4; Plate 24, Figures 14 [?], 15 [?], 16 [?]; Plate 25, Figures 12, 22, 24)

Description: Valves narrow, club-shaped, beneath the headpole valves constricted in transapical direction, in the middle swelled up. 45-90 μm long, 3-5 μm wide over the middle. Transapical ribs eight to nine in 10 μm, coarsely punctate, in most cases only one apical marginal row of large punctae. Axial area narrow constricted towards the poles. Headpole hyaline(?) and with distinct "muceous" pore. Footpole narrow and rounded.
Discussion: This species differs from *Sceptroneis caducea* and *Opephora gemmata* Ehrenberg by the narrower valves and the finer transapical striation. More closely related is *Grunowiella palaeocaenica* Jousé (1951), which differs only by a coarser striation. Placement of this species into the genus *Sceptroneis* was done in following strictly Hustedt's (1959, p. 130) genus description.
Holotype: Plate 3, Figure 4 from Leg 38, Sample 338-20, CC; Norwegian Sea.
Paratype: Plate 3, Figures 1-3.
Age: Late Oligocene.

Sceptroneis vermiformis n. sp. Schrader
(Plate 22, Figure 29; Plate 25, Figures 1-4)

Description: Valves clavate, linear with rounded ends. The headpole is subcapitate. Typical is that the greatest width of the valve lies between the middle part of the valve and the footpole. Valve length: 24-70 μm; greatest width 4-6 μm. Valve punctate. The punctae are arranged in transapical striae which grade into radial arrangement at the apices. There are seven to nine punctae in 10 μm in transapical direction. The number of striae is nine in 10 μm. The punctae are arranged in longitudinal lines. The striae are consistent across the narrow axial area. The pore field of the headpole is rounded, hyaline(?). The valve structure continues into the footpole.
Discussion: This species differs from all other *Sceptroneis* species in its shape.
Holotype: Plate 25, Figure 2 from Leg 38 Sample 340-9-5, 60-62 cm; Norwegian Sea.
Paratypes: Plate 22, Figure 29; Plate 25, Figures 1, 3, 4.
Age: Late Eocene.

Sceptroneis sp. (teratological form?)
(Plate 2, Figure 8)

Remarks: The present material demonstrated a large variety in *Sceptroneis*. The scarce occurrence of the present form does not permit an exact taxonomic clearance.

Sceptroneis sp.
(Plate 4, Figure 9 [aberrant form of *Sceptroneis caducea*?])

Sceptroneis sp.
(Plate 23, Figures 10-14, 19)

Sceptroneis sp. (footpoles)
(Plate 24, Figure 21)

Sceptroneis sp.
(Plate 24, Figures 18, 23 [footpole])

Sceptroneis sp.
(Plate 25, Figure 5)

Genus SYNEDRA Ehrenberg (1830)

Synedra aff. ulna (Nitzsch) Ehrenberg (1838)
(Plate 45, Figure 11)

Description: Hustedt (1959), p. 195-201, fig. 691.

Synedra jouseana Sheshukova-Poretzkaya (1962)
(No illustration)

Description: Schrader (1973a), p. 710, pl. 23, fig. 21-23, 25, 38.
Age: Late Oligocene-early Miocene.

Synedra miocenica Schrader (in press)
(Plate 5, Figure 2; Plate 45, Figures 19-21)

Description: Schrader (in press), p. 94, pl. 1, fig. 1.
Age: Late Oligocene-early Miocene.

Synedra pulchella (Ralfs) Kützing (1844)
(Plate 5, Figures 10, 11)

Description: Hustedt (1930), p. 191-192, fig. 688.

Remarks: After Hustedt (1930) euryhalin, common in brackish and fresh waters.
Age: Not determined.

Synedra sp. (1)
(Plate 24, Figures 7, 8)

Remarks: No similar *Synedra* species could be observed in the literature. Thus, it could not be cleared if this species derived from fresh-water environment or if it is marine.

Genus STEPHANOGONIA Ehrenberg (1844)

Stephanogonia hanzawae Kanaya (1959)
(Plate 12, Figures 10, 12 [girdle view];
Plate 13, Figures 5, 7, 8 [valve view])

Description: Kanaya (1959), p. 118-119, pl. 11, fig. 3-7.
Age: Miocene (*Coscinodiscus yabei* assemblage of Kanaya, 1959).

Stephanogonia horridus n. sp. Schrader
(Plate 12, Figures 4, 6-8)

Description: Cells solitary, rectangular. Valves rectangular 12-15 μm in diameter and 16-20 μm in height. Valve surface convex and covered with polygonal large areolae in radial arrangement. Areola approx. 2-3 μm large. Areolae grade to long elliptical areolae near the valve margin with parallel borders. They are 6-8 μm long and 3-4 μm wide on the steep valve mantle. There are several isolated spines on the valve margin.
Discussion: This species differs from all other by its rectangular shape, its slightly convex valve surface and its large areolate structure.
Holotype: Plate 12, Figure 6 from Leg 38, Sample 348-16, CC; Norwegian Sea.
Paratype: Plate 12, Figures 4, 7, 8.
Age: Late Miocene.

Stephanogonia pretiosa Hanna and Grant (1926)
(No illustration)

Description: Hanna and Grant (1926), p. 166, pl. 20, fig. 10.
Age: Late Eocene (this paper)-Miocene (Hanna and Grant, 1926).

Stephanogonia sp.
(Plate 39, Figures 4, 8)

Description: Valve circular, hyaline, with a wide central depression which has a small elevation in its central part. The central depression occupies more than half of the valve diameter. From the rim of the depression run approx. 10 broad, radial ribs to the margin leaving rhombic to elliptic cavities between them. The margin is distinct and hyaline. Valve diameter: 60-62 μm, margin width: 2-3 μm.
Discussion: This species differs from *Stephanogonia polyacantha* by its large umbilicate, hyaline, central area and the straight and regular radiating ribs towards the margin.
Age: Late Oligocene.

Stephanogonia sp.
(Plate 13, Figures 1-4, 9, 10; Plate 45, Figures 2, 3)

Remarks: This genus and the species included into it are ill defined. For this reason, no further treatment has been done. In order to demonstrate the variety and morphologic features the above-listed individuals have been illustrated. This genus together with the genus *Cladogramma* need drastic revision.

Stephanogonia sp. 1
(Plate 39, Figures 1, 2)

Description: Valve circular, strongly convex with a relief of anastomosing ribs and spines. The valve between the ribs is hyaline. The ribs form a circle around the central area of approximately one-third of the valve diameter. From this ring run radial ribs versus the margin. Approximately half way between ring and margin they bifurcate. At the points where the ribs bifurcate and branch off the ring spines are situated.
Valve diameter: 10-20 μm.
Discussion: No similar species was observed in the literature.
Age: Oligocene.

Genus STEPHANOPYXIS Ehrenberg (1844)

Stephanopyxis barbadensis (Grev.) Grunow (1844)
(Plate 30, Figures 11, 15, 16?)

Description: Grunow (1844), p. 91; Hanna (1927), p. 120, pl. 20, fig. 14.

Stephanopyxis grossecellulata Pantocsek (1886)
(Plate 31, Figure 6)

Description: Pantocsek (1886), pl. 20, fig. 180.
Age: Late Oligocene.

Stephanopyxis grunowii Grove and Sturt in A. Schmidt, Atlas (1888)
(Plate 20, Figure 8; Plate 31, Figure 3)

Description: A. Schmidt, Atlas (1888), pl. 130, fig. 1-5.

Stephanopyxis hyalomarginata Hajós (in preparation)
(Plate 19, Figures 6, 9)

Description: Hajos (in preparation), p. 16, pl. 19, fig. 11, 12.

Stephanopyxis marginata Grunow (1884)
(Plate 20, Figure 3)

Description: Grunow (1884), p. 90, pl. 5, fig. 17.

Stephanopyxis aff. megapora Grunow (1884)
(Plate 31, Figure 4)

Description: Grunow (1884), p. 89, pl. E, fig. 24.

Stephanopyxis schenckii Kanaya (1959)
(Plate 19, Figures 7 [700×], 8)

Description: Kanaya (1959), p. 67-68, pl. 2, fig. 2-4.

Stephanopyxis spinosissima Grunow (1884)
(Plate 31, Figure 5)

Description: Grunow (1884), p. 90-91; A. Schmidt, Atlas, pl. 123, fig. 18.

Stephanopyxis turris (Greville and Arnott) Ralfs in Pritchard (1861)
(Plate 30, Figures 1-10, 14; Plate 37, Figures 17-19)

Description: Hustedt (1930), p. 304, fig. 140; Grunow (1884), p. 87.
Age: Not diagnostic.

Stephanopyxis turris var. arctica Grunow (1884)
(Plate 31, Figures 1, 1a)

Description: Grunow (1884), p. 89, pl. E, fig. 18, 20-22.

Stephanopyxis sp.
(Plate 30, Figure 12)

Description: Valve circular, convex, coarsely areolated: four to five areolae in 10 μm. Areolae arranged in straight lines crossing each other under an angle of 60°. Submarginal there is a ring of about 10 spines and slightly eccentrically there is another spine. Valve diameter: 30-40 μm.
Discussion: This species differs from *S. barbadensis* only by its central process.

Stephanopyxis sp.
(Plate 30, Figure 13)

Description: Valve circular, convex with radially arranged areolae, decreasing in size from the center: five to six areolae in 10 μm to the margin: six to seven areolae in 10 μm. Halfway between center and margin there is a circle of approx. seven spines, sometimes irregular. At the center there are two or three spines. Valve diameter: 35-40 μm.

Stephanopyxis sp.
(Plate 31, Figure 2)

Genus STICTODISCUS Greville (1861)

Stictodiscus kittonianus Greville (1861)
(Plate 35, Figure 27)

Description: Greville (1861), p. 77, pl. 10, fig. 2, 3; A. Schmidt, Atlas, pl. 74, fig. 16-18.
Age: Oligocene.

Stictodiscus aff. kittonianus
(Plate 13, Figure 11)

Remarks: The present individuals are close to *S. kittonianus*; they but differ in their geological range and in the possession of more than two to three rows of areolae between the ribs and their larger diameter.
Age: Not yet determined.

Stictodiscus sp.
(Plate 36, Figures 2, 3)

Description: Valve circular, strongly convex. Valve diameter 11-35 μm. Areolae arranged in radial rows of differing length. Interstitial mashes—at the beginning of a row respectively—are scattered over the whole valve. There are eight areolae in 10 μm. Some specimens were found still in connection with the girdleband, at which the areolae are arranged in straight, vertical rows.
Age: Eocene-Oligocene.

Genus THALASSIONEMA Grunow (1881)

Thalassionema hirosakiensis (Kanaya) Schrader (1973a)
(Plate 5, Figures 3, 4, 6, 7)

Description: Kanaya (1959), p. 104-106, pl. 9, fig. 11-15 (as *Fragilaria hirosakiensis*).
Age: Early-middle Miocene.

Thalassionema lineatum Jousé (1971)
(Plate 5, Figures 5, 9)

Description: Jousé (1971), p. 15-16, fig. 3.
Age: Miocene.

Thalassionema nitzschioides Grunow in van Heurck (1881)
(Plate 5, Figure 8)

Description: Hasle and Mendiola (1967), p. 111, fig. 5, 27-34, 39-44.
Age: Early Miocene (?)-Recent.

Thalassionema aff. nitzschioides
(Plate 24, Figures 9, 10)

Remarks: The Oligocene individuals differ from the species by the indistinct marginal pores, by the hyaline apices. To clear its taxonomic position submicroscopical investigation is needed.

Genus THALASSIOSIRA Cleve (1873)

Thalassiosira convexa Muchina (1965)
(No illustration)

Description: Donahue (1970), p. 136-137, pl. 3, fig. a-f; Schrader (1973a), p. 712, pl. 11, fig. 37, 38.
Age: Late Pliocene, Tropical Indian Ocean Diatom Zones 10 through 7 (Schrader, 1974).

Thalassiosira decipiens (Grunow) Jørgensen (1905)
(Plate 17, Figure 9)

Description: Hustedt (1930), p. 322-323, fig. 158.
Age: Pliocene-Recent.

Thalassiosira dubiosa n. sp. Schrader
(Plate 35, Figures 4-6)

Description: Cells solitary, valves 3-12 μm in diameter, slightly convex in the middle with a steep mantle. Valve margin with one ring of solitary spines, six to eight in 10 μm, within this one ring a larger (labiate?) spine. Central part distinct, convex, 2-6 μm in diameter with radial rows consisting of primary and secondary lines of small punctae. Approx. 10-12 radial rows in 10 μm, and approx. 15 punctae in 10 μm. Valves very small and mostly broken into pieces.
Discussion: No similar *Thalassiosira* species was found in the literature.
Holotype: Plate 35, Figure 6 from Leg 38, Sample 338-28-2, 133-134 cm; Norwegian Sea.
Paratypes: Plate 35, Figures 4, 5.
Age: Late Eocene.

Thalassiosira eccentrica (Ehr.) Cleve (1904)
(Plate 18, Figures 2, 5, 7, 9, 6 [?])

Description: Fryxell and Hasle (1972), p. 302 ff, numerous figures; Simonsen (1974), p. 9, pl. 2, fig. 1-3.
Age: Miocene (?)-Recent.

Thalassiosira aff. eccentrica (Ehr.) Cleve (1904)
(Plate 18, Figure 1)

Description: See under the species.
Remarks: This species differs in finer structure: 9 areolae in 10 μm, and the different development of the margin from *Thalassiosira eccentrica*. More individuals are needed to clear the correct taxonomic position.

Thalassiosira fraga n. sp. Schrader
(Plate 16, Figures 9-12)

Synonym: *Thalassiosira* sp. 10 Schrader (in press), pl. 15, fig. 6, 7, 8.
Description: Valve convex, 12-27 μm in diameter. Areolae hexagonal forming a closed network only in the middle of the valves, grading towards the margin to scattered and solitary arrangement. The areolae rows run radial with approx. seven to eight areolae in 10 μm in the middle of the valves. Margin distinct, approx. 1-2 μm wide, striated, approx. 14 striae in 10 μm, with solitary spines and one labiate (?) process.
Discussion: No submicroscopic investigations have yet been made on most of the described fossil *Thalassiosira* species and thus the placement of most of these species is problematic until proof of strutted tubuli. And even then it has to be tested if spores of *Thalassiosira* do possess strutted tubuli? No similar species has been observed in the literature.
Holotype: Plate 16, Figure 9 from Leg 38, Sample 338-14-1, 20-21 cm; Norwegian Sea.
Paratype: Plate 16, Figures 10-12.
Age: Early to middle Miocene.

Thalassiosira gravida Cleve (1896)
(Plate 16, Figures 5, 6; Plate 17, Figure 2)

Description: Hustedt (1930), p. 325-326, fig. 161; Sheshukova-Poretzkaya (1967), p. 147-148, pl. 15, fig. 1; Hasle (1968), p. 196, fig. 3, 4; Koizumi (1973), p. 834, pl. 7, fig. 19-21.
Remarks: No separation of the species from its forma *fossilis* Jousé (1961), p. 63, pl. 1, fig. 9 was done in the present material. All recovered individuals had the larger areolae (approx. six to seven in 10 μm) and a distinct finely striated margin of 2-3 μm width. Only as spores present!
Age: Late Miocene-Recent (*Denticula seminae* through *Thalassiosira zabelinae* Zone of Koizumi (1973); North Pacific Diatom Zones I through V of Schrader (1973a).

Thalassiosira irregulata n. sp. Schrader
(Plate 20, Figures 10-12)

Description: Cells solitary, valves 14-46 μm in diameter, slightly convex with a plain central part. Valve margin finely striate (approx. 1-2 μm wide). One labiate process near the margin within a marginal circle of solitary spines. No distinct central area, but one or two strutted tubuli in the center. Areolae are rounded, decreasing in size gradually from the center to the margin (approx. 1 in 10rμm over the center and 16 in 10 μm near the margin. In the larger valves it is 7 a eolae in 10 μm near the center and 10-12 in 10 μm near the margin. Areolae oriented in disorder, at specific focus orientation seems to be spiral.
Discussion: No similar *Thalassiosira* species was found in the literature.
Holotype: Plate 20, Figure 11 from Leg 38, Sample 338-21, CC; Norwegian Sea.

Paratypes: Plate 20, Figures 10, 12
Age: Late Oligocene.

Thalassiosira aff. irregulata n. sp.
(Plate 20, Figure 13)

Remarks: This species differs by its areolae, which are oriented in radial rows. Further treatment is needed to define its correct taxonomic position.

Thalassiosira kryophila (Grunow) Jørgensen (1905)
(No illustration)

Description: Hustedt (1930), p. 324-325, fig. 160.
Age: Pleistocene-Recent.

Thalassiosira lusca n. sp. Schrader
(Plate 35, Figures 1-3)

Description: Cells solitary, valves 15-30 μm in diameter, slightly convex with a plain central part. Valve margin striate with eight striae in 10 μm and approx. 2 μm wide. One indistinct, labiate(?), larger process is near the margin within a circle of solitary spines. Central area is distinct, 4 μm in diameter, and is separated from the valve structure by a ring and consists of a few solitary, isolated spines within a hyaline area. Areolae are rounded and are approx. of equal size over the valve surface (13 in 10 μm). Areolae are arranged in wavy radial rows with primary and secondary rows (12 in 10 μm).
Discussion: No similar *Thalassiosira* species was found in the literature (*Thalassiosira gravida* has similar valves but is much finer areolated and has less silicified frustules).
Holotype: Plate 35, Figure 2 from Leg 38, Sample 346-11-4, 40-42 cm; Norwegian Sea.
Paratype: Plate 35, Figures 1, 3.
Age: Late Oligocene.

Thalassiosira mediaconvexa n. sp. Schrader
(Plate 36, Figure 1)

Description: Cells solitary, valves 20-30 μm in diameter, middle part convex and elevated from the valve marginal area. Valve margin with one ring of solitary spines (12 in 10 μm), within this one ring one larger spine. Marginal area approx. 4 μm wide, striated, 14 striae in 10 μm. Central part distinct, convex, 16-20 μm in diameter with radial rows of large punctae, which decrease in size towards the margin, 14 punctae in 10 μm and 13 rows in 10 μm.
Discussion: This species is close to *Thalassiosira dubiosa* but differs from it by the larger valves and by the distinct punctate rows.
Holotype: Plate 36, Figure 1 from Leg 38, Sample 339-6-2, 60-62 cm; Norwegian Sea.
Age: Oligocene (?).

Thalassiosira nidulus (Tempère and Brun) Jousé (1961)
(Plate 17, Figures 13, 16)

Description: Sheshukova-Poretzkaya (1967), p. 140-141, pl. 11, fig. 8a-b; pl. 14, fig. 1a-b; Schrader (1973a), p. 712, pl. 11, fig. 1-7; Koizumi (1973), p. 834, pl. 7, fig. 25, 26.
Age: Pleistocene-Pliocene (*Rhizosolenia curvirostris* through upper part of *Denticula kamtschatica* Zone of Koizumi [1973]); lower part of North Pacific Diatom Zones III through VII of Schrader (1973a).

Thalassiosira nordenskioeldii Cleve (1873)
(No illustration)

Description: Hustedt (1930), p. 321-322, fig. 157.
Age: Pliocene-Recent.

Thalassiosira oestrupii (Ostenfeld) Proshkina-Lavrenko (1956)
(Plate 17, Figures 6, 7, 14, 15)

Description: Hustedt (1930), p. 318, fig. 155 (as *Coscinosira oestrupii*); Hasle (1960), p. 8, fig. 5-7, 11.
Age: Pliocene-Recent.

Thalassiosira punctata Jousé (1961c)
(Plate 19, Figure 10)

Description: Koizumi (1973), p. 834, pl. 8, fig. 7-9.
Age: Miocene.

Thalassiosira symmetrica Fryxell and Hasle (1972)
(No illustration)

Description: Fryxell and Hasle (1972), p. 312, fig. 37-46.
Age: Miocene(?)-Recent.

Thalassiosira sp. a
(Plate 17, Figure 17)

Thalassiosira sp. b
(Plate 17, Figures 5, 10)

Thalassiosira sp. c
(Plate 16, Figures 7, 8)

Remarks: The two individuals are tentatively placed associate to *T. gravida*, but differ markedly by the hyaline margin, the finer areolation and the present central depression. Further detailed study especially of the Russian literature is needed to clear the taxonomic position.

Genus THALASSIOTHRIX Cleve and Grunow (1880)

Thalassiothrix longissima Cleve and Grunow (1880)
(No illustration)

Description: Hasle and Mendiola (1967), p. 114, fig. 20.
Age: Oligocene-Recent.

Thalassiothrix miocenica Schrader (1973a)
(Plate 5, Figure 1)

Description: Schrader (1973a), p. 713, pl. 23, fig. 2-5.

Genus TRICERATIUM Ehrenberg (1841)

Triceratium acutangulum Strelnikova (1974)
(Plate 26, Figure 7)

Description: Strelnikova (1974), p. 83, pl. 32, fig. 1-10.
Age: Cretaceous (Strelnikova, 1974)-middle Oligocene.

Triceratium antediluvianum (Ehr.) Grunow (1868)
(No illustration)

Description: Hustedt (1930), p. 810-812, fig. 472.
Ecological remarks: Inhabits marine littoral environments and is today common along the Atlantic coasts up to the west coast of Norway. Displaced in hemipelagic sediments.
Age: Not diagnostic.

Triceratium balearicum forma biquadrata (Janisch) Hustedt (1930)
(No illustration)

Description: Hustedt (1930), p. 814-816, fig. 477.
Ecological remarks: Inhabits marine littoral environment preferably coast lines of warmer oceans, Mediterranean Sea.
Age: Not diagnostic.

Triceratium barbadense Greville (1861)
(Plate 26, Figures 1-4)

Description: Kanaya (1957), p. 100-101, pl. 7, fig. 1-4.
Remarks: Specimens of this species were extremely small in the investigated material. Specimens with 7-10 μm length of a side were more common than the larger ones.
Stratigraphic records: Barbados (Greville [1861]; Schmidt [1887] as *Triceratium inconspicuum* Greville; Kanaya [1957] Eocene, Mt. Diablo, Calif.)
Age: Eocene-Early Oligocene(?)

Triceratium cruciforme A. Schmidt (1887)
(Plate 27, Figure 2)

Illustration: A. Schmidt, Atlas (1887), pl. 77, fig. 41.
Remarks: Valve quadrilobate. Centrum small, convex with areolae in radial arrangement. The four lobes are rectangular to elliptically rounded, slightly convex, outflanking the small central area, from which they are separated by a hyaline ring. The areolae on the lobes are arranged in straight, parallel rows. There are eight to nine areolae

in 10 μm. Maximum length of the valve 22 μm. Diameter of the central area: 7 μm.
Age: Late Oligocene.

Triceratium favus Ehrenberg (1841)
(No illustration)

Description: Hustedt (1930), p. 798-801, fig. 462-463.
Age: Not diagnostic, found in Oligocene samples of Leg 38.

Triceratium favus forma quadrata Grunow in A. Schmidt (1885)
(No illustration)

Description: Hustedt (1930), p. 800-801, fig. 464.
Ecological remarks: Common in marine littoral environment, displaced in hemipelagic sediments.
Age: Not diagnostic, found in Oligocene samples of Leg 38.

Triceratium inconspicuum Greville (1861b)
(No illustration)

Description: Greville (1861b), p. 70, pl. 8, fig. 10.
Age: Late Eocene.

Triceratium inelegans Greville (1866)
(Plate 11, Figure 6)

Description: Greville (1866), p. 8, pl. 11, fig. 21.
Age: Not yet determined.

Triceratium latepes n. sp. Fenner
(Plate 26, Figure 12)

Description: Valve triangular with extremely elongated corners have capitate angles. apices. Length of side is 60-70 μm. The valve is almost flat. The areolae are arranged in radial rows and are round to polygonal in shape. A central round but smaller areola is present. The valve is coarsely areolated: four to five areolae in 10 μm. Only at the capitate parts of the angles the areolae decrease in size to 8 in 10 μm. The outermost part of the broad front of the angles is finely striate: 24 striae in 10 μm.
Discussion: No similar species was found in the literature.
Holotype: Plate 26, Figure 12 from Leg 38, Sample 338-22-2, 65-67 cm; Norwegian Sea.
Age: Middle Oligocene.

Triceratium schulzii Jousé (1949)
(Plate 11, Figure 3; Plate 27, Figures 14, 15)

Description: Proshkina-Lavrenko (1949), v. 2, p. 161, pl. 58, fig. 3.
Age: Late Cretaceous (Hajós, in preparation)-Oligocene.

Triceratium tesselatum Greville (1861b)
(Plate 11, Figure 4; Plate 27, Figure 3)

Description: Greville (1861b), p. 71, pl. VIII, fig. 14, 15.
Age: Not yet determined.

Triceratium sp. 1
(Plate 26, Figures 10, 11)

Remarks: The present species differs from *Pseudotriceratium chenevieri* by its flat valves and its spiral arrangement of areolation.
Age: Late Eocene-lower early Oligocene.

Triceratium sp. 2
(Plate 27, Figure 1)

Triceratium sp. 3
(Plate 27, Figure 7

Genus TRINACRIA Heiberg (1863)

Trinacria excavata Heiberg (1863)
(No illustration)

Description: Hustedt (1930), p. 887-888, fig. 532.
Age: Eocene-Miocene.

Trinacria pileolus (Ehr.) Grunow (1884)
(No illustration)

Description: Hustedt (1930), p. 885-886, fig. 529.
Age: Eocene-Oligocene

Trinacria quadrata (working name, not yet described)
(No illustration)

Description: This species is close to *Trinacria pileolus*, but differs in its quadrangular shape.
Age: Late Eocene.

Genus TROCHOSIRA Kitton (1871)

Trochosira coronata n. sp. Schrader and Fenner
(Plate 29, Figures 9-11; Plate 35, Figures 7-13, 20, 21)

Description: Cells united by siliceous threads. Valves dimorph, one valve with central siliceous threads, the other without, valve diameter varies from 8-17 μm. Number of areolae is 18-22 in 10 μm. The areolae are arranged in radial rows. Margins are finely striate with 24-26 striae in 10 μm with a circle of marginal spines (in some individuals missing, Plate 35, Figure 10). Central processes varying in number from two to five.
Discussion: This species is close to *Coscinodiscus solidus* Strelnikova (1974) but differs from the litter by its smaller size and finer structure.
Holotype: Plate 35, Figure 9 from Leg 38, Sample 338-28-2, 133-135 cm; Norwegian Sea.
Paratype: Plate 29, Figures 9-11; Plate 35, Figures 7, 8, 10-13, 20, 21.
Age: Late Eocene.

Trochosira spinosa Kitton (1870-1871)
(Plate 12, Figure 18)

Description: Sheshukova-Poretzkaya (1967), p. 137-138, pl. 11, fig. 6, pl. 13, fig. 4.
Age: Eocene-Oligocene.

Genus XANTHIOPYXIS Ehrenberg (1844)

Xanthiopyxis oblonga Ehrenberg (1844a)
(Plate 39, Figures 9, 10; Plate 40, Figure 5)

Description: Hanna (1927), p. 124; Hanna (1932), p. 226.

Xanthiopyxis ovalis Lohmann (1938)
(Plate 40, Figure 1)

Description: Lohmann (1938), p. 91, pl. 20, fig. 6; pl. 22, fig. 12.

Xanthiopyxis panduraeformis Pantocsek (1886)
(Plate 45, Figure 8)

Description: Pantocsek (1886), fig. 297.

Xanthiopyxis papillosus Hajós (1968)
(Plate 40, Figures 4, 11, 12)

Description: Hajós (1968), p. 116, pl. 28, fig. 4.

Xanthiopyxis sp. A Wornardt (1967)
(Plate 40, Figures 2a,b)

Description: Wornardt (1967), p. 73, fig. 154, 154a.
Remarks: Wornardt believes this species to be restricted to the early and middle Pliocene. In the material investigated here it was found in the lower Oligocene.

Xanthiopyxis sp. 1 Hajós in Hajós and Stradner (1975)
(Plate 40, Figures 3, 7)

Description: Hajós and Stradner (1975), p. 927, pl. 4, fig. 13.

Xanthiopyxis sp.
(Plate 40, Figures 6, 8, 13, 14; Plate 45, Figures 8, 9, 10, 17)

No diatoms
Archaeomonadaceae

Genus et species indet. (a)
(Plate 39, Figure 3)

Genus et species indet. (b)
(Plate 39, Figure 11)

Genus et species indet. (c)
(Plate 25, Figures 36, 37)

Genus et species indet. (d)
(Plate 25, Figure 38)

Genus et species indet. (e)
(Plate 25, Figure 39)

Genus et species indet. (f)
(Plate 25, Figure 40)

Genus et species indet. (g)
(Plate 25, Figure 41)

Genus PSEUDOROCELLA Deflandre

Association taken from Jousé (1974a)

Pseudorocella barbadensis Deflandre
(No illustration)

Association taken from Jousé (1974a).
Age: Late Eocene-early Oligocene.

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PLATE 1

Magnification 1500×.

Figure 1	*Nitzschia* aff. *sublineata* (van Heurck) Hasle. Sample 338-8-3, 70-72 cm.
Figure 2	*Nitzschia januaria* Schrader. Sample 338-8, CC.
Figures 3-5	*Nitzschia pseudocylindrica* n. sp. 3. Sample 348-11-3, 70-72 cm. 4, 5. (Same specimen) Sample 348-11-3, 70-72 cm (Type).
Figures 6, 7	*Nitzschia* sp. 8 Schrader. Sample 338-8-2, 58-59 cm.
Figures 8, 9	*Nitzschia guttula* n. sp. (type). Sample 338-8-3, 70-72 cm.
Figure 10	*Nitzschia atlantica* (Paasche) Hasle. Sample 348-2-1, 65-67 cm.
Figure 11	*Nitzschia* sp. b. Sample 338-9, CC.
Figure 12	*Nitzschia pseudocylindrica.* Sample 343-5-2, 140-142 cm.
Figure 13	*Nitzschia* sp. c. Sample 343-5-2, 140-142 cm.
Figures 14a, 14b	*Nitzschia riedelia* Schrader. 14a. Sample 348-8-2, 90-92 cm. 14b. Sample 348-11-3, 70-72 cm.
Figures 15-18	*Nitzschia pseudocylindrica.* 15. Sample 348-11-3, 70-72 cm. 16-18. Sample 348-11-1, 50-52 cm.
Figure 19	*Nitzschia riedelia.* Sample 348-11-3, 70-72 cm.
Figure 20	*Nitzschia* sp. a. Sample 348-11-4, 80-82 cm.
Figure 21	*Nitzschia kanayensis* Schrader (?). Sample 348-8-2, 90-92 cm.
Figures 22, 23	*Nitzschia kanayensis.* 22. Sample 348-8-2, 90-92 cm. 23. Sample 348-16-1, 85-87 cm.
Figure 24	*Nitzschia* sp. d. Sample 348-16-1, 85-87 cm.
Figure 25	*Nitzschia* sp. e. Sample 348-14-1, 90-92 cm.
Figure 26	*Nitzschia porteri* Frenguelli. Sample 348-14-1, 90-92 cm.
Figure 27	*Nitzschia* aff. *atlantica* (Paasche) Hasle. Sample 348-6-1, 60-62 cm.
Figures 28, 29	*Nitzschia evenescens* Schrader. Sample 338-13-1, 55-56 cm.
Figure 30	*Nitzschia maleinterpretaria* Schrader. Sample 338-14-1, 20-21 cm.
Figure 31	*Nitzschia* aff. *maleinterpretaria.* Sample 338-17-1, 135-136 cm.
Figure 32	*Denticula nicobaria* Grunow. Sample 338-8-2, 10-11 cm.
Figure 33	*Denticula punctata* Schrader. Sample 338-10-1, 135-136 cm.
Figure 34	*Denticula lauta* Bailey. Sample 338-10-2, 55-56 cm.
Figures 35-37	*Denticula hustedtii* Simonsen and Kanaya. 35. Sample 338-8-2, 58-59 cm. 36. Sample 348-11-1, 20-22 cm. 37. Sample 348-15-3, 90-92 cm.
Figure 38	*Denticula norwegica* n. sp. (type). Sample 338-10, CC.
Figure 39	*Denticula hyalina* Schrader. Sample 338-9, CC.
Figures 40, 41	*Denticula hustedtii.* 40. Sample 348-11-1, 20-22 cm. 41. Sample 343-5-2, 140-142 cm.
Figures 42, 43	*Denticula punctata.* Sample 338-11-3, 5-6 cm.
Figure 44	*Denticula punctata* var. *hustedtii* Schrader. Sample 343-5-2, 140-142 cm.

PLATE 1

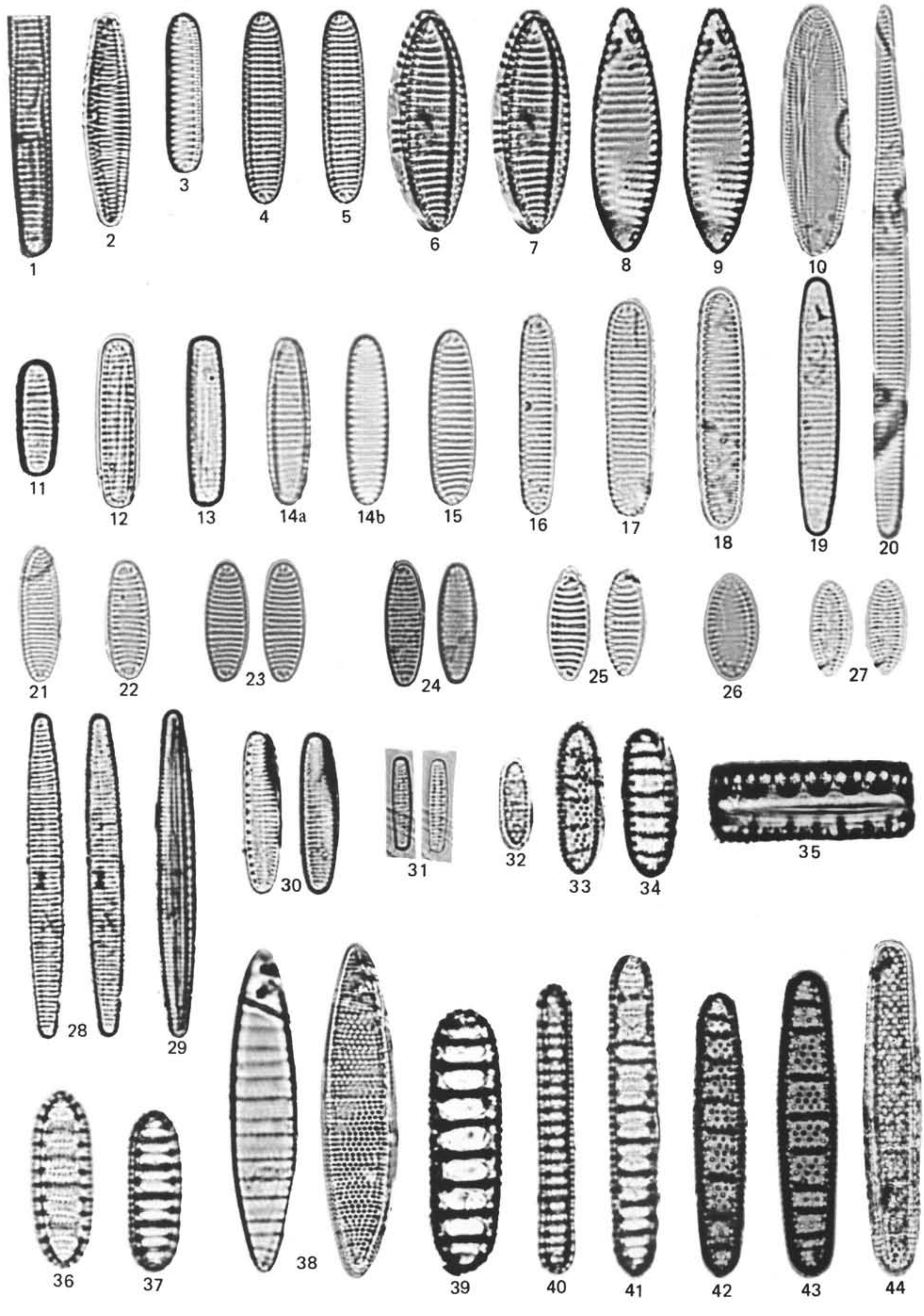
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PLATE 2

Magnification 1500×.

Figures 1-4	*Rhaphoneis elongata* (Schrader) Andrews. Sample 338-19-3, 140-141 cm.
Figures 5, 6	*Sceptroneis humuncia* n. sp. Sample 338-21, CC.
Figure 7	*Sceptroneis humuncia* n. sp. (type). Sample 338-20-2, 30-31 cm.
Figure 8	*Sceptroneis* sp. (teratological specimen). Sample 338-14-2, 85-86 cm.
Figure 9	*Rhaphoneis amphiceros* (Ehr.) Ehrenberg. Sample 338-19-3, 140-141 cm.
Figure 10	*Rhaphoneis* sp. 1. Sample 338-21, CC.
Figure 11	*Rhabdonema* sp. Sample 338-21, CC.
Figures 12, 13	*Rhabdonema* sp. 12. Sample 338-20, CC. 13. Sample 338-19-3, 140-141 cm.
Figures 14-17	*Sceptroneis ossiformis* n. sp. 14. Sample 338-19-3, 140-141 cm. 15. Sample 338-14-1, 20-21 cm. 16. Sample 338-19-3, 40-41 cm (type). 17. Sample 338-19-3, 40-41 cm.

PLATE 2

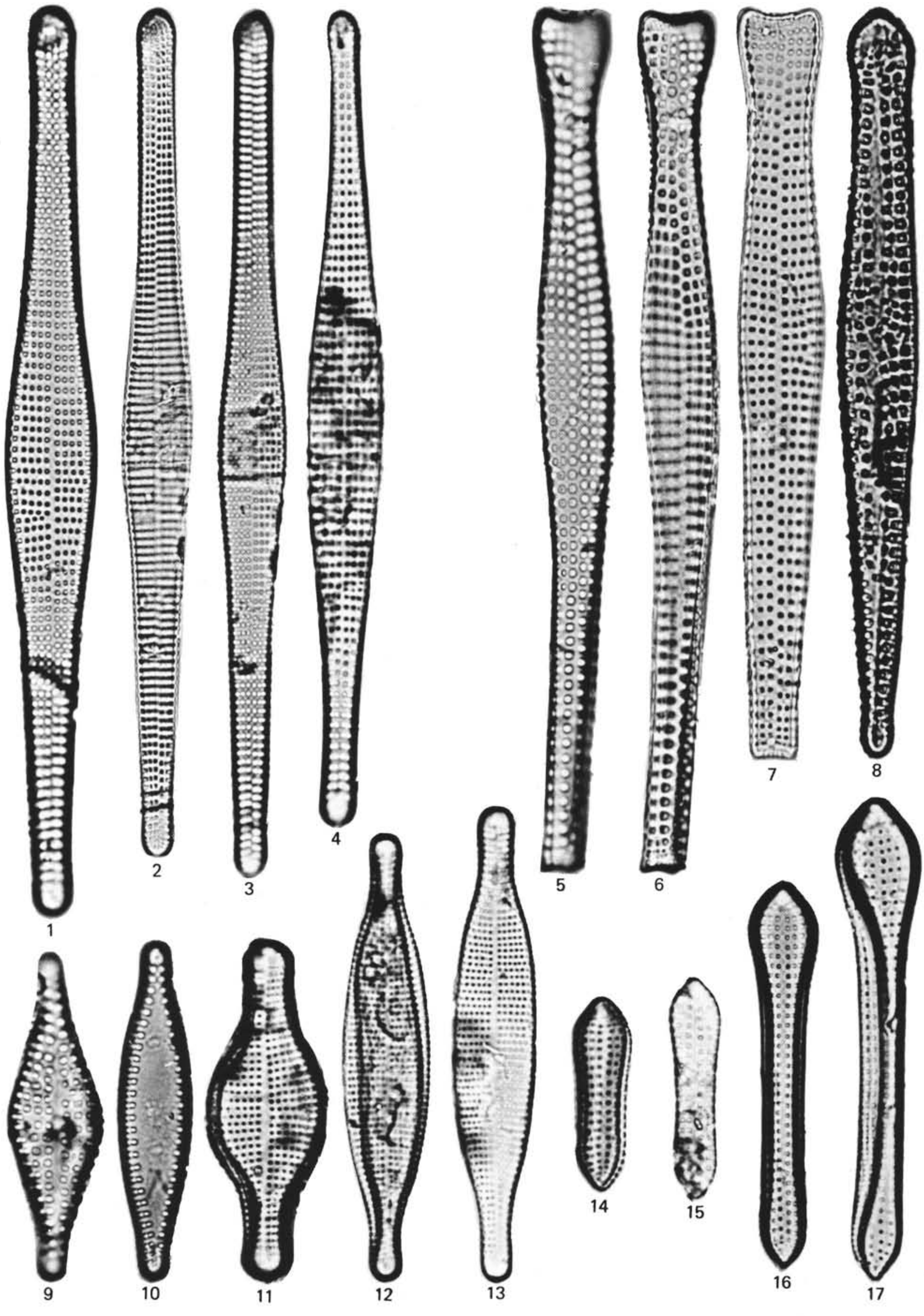

PLATE 3

Magnification 1500×; Figure 22, 700×.

Figures 1-4	*Sceptroneis tenue* n. sp. 1-3. Sample 338-21, CC. 4. Sample 338-20, CC (type).
Figure 5	*Pseudodimerogramma elliptica* n. sp. (type). Sample 338-19-3, 40-41 cm.
Figures 6-8	*Pseudodimerogramma oligocenica* n. sp. 6. Sample 338-21, CC. 7. Sample 338-14-1, 20-21 cm. 8. Sample 338-21, CC (type).
Figure 9	Genus and species indet. Sample 338-19-3, 140-141 cm.
Figures 10, 11	*Opephora gemmata* (Grunow) Hustedt. Sample 338-11-1, 65-66 cm.
Figure 12	*Dimerogramma* aff. *dubium* Grunow. Sample 338-8-2, 58-59 cm.
Figure 13	*Pseudodimerogramma oligocenica* n. sp. Sample 338-21, CC.
Figure 14	*Pseudodimerogramma elegans* n. sp. (type). Sample 338-12-2, 85-86 cm.
Figures 15, 16	*Dimerogramma* aff. *dubium.* Sample 338-8-2, 58-59 cm.
Figures 17a, b	*Dimerogramma* aff. *dubium.* 17a. Sample 338-10-1, 135-136 cm. 17b. Sample 338-11-4, 5-6 cm.
Figure 18	Genus and species indet. Sample 338-19-3, 40-41 cm.
Figure 19	*Pseudodimerogramma elongata* n. sp. (type). Sample 338-11-4, 5-6 cm.
Figure 20	*Pseudodimerogramma elongata* n. sp. Sample 338-10-2, 55-56 cm.
Figures 21, 22	*Pseudodimerogramma filiformis* n. sp. (type). Sample 338-21, CC (700×).

PLATE 3

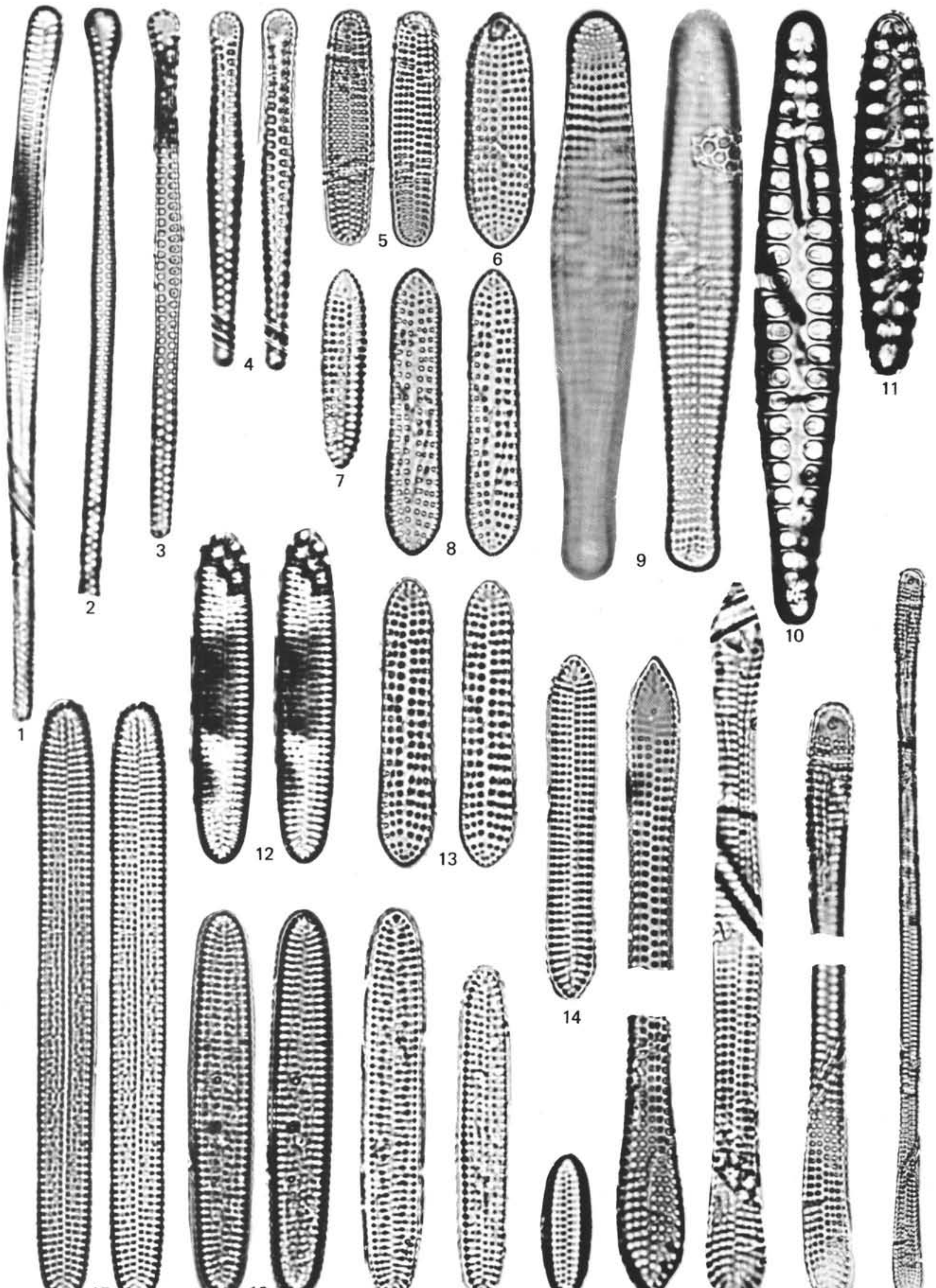

PLATE 4

Magnification 1500×.

Figures 1-8	*Sceptroneis propinqua* n. sp. 1, 6, 7, 8. Sample 338-21, CC. 2, 3. Sample 338-19-3, 140-141 cm. 4, 5. Sample 338-21, CC (type).
Figure 9	*Sceptroneis* sp. Sample 338-16-5, 50-51 cm.
Figure 10	Genus and species indet. Sample 338-11, CC.
Figures 11-16	*Sceptroneis* aff. *caducea* Ehrenberg. 11, 16. Sample 348-17-1, 140-141 cm. 12. Sample 338-15-1, 95-96 cm (girdle view). 13. Sample 338-16-4, 67-68 cm. 14. Sample 338-17-2, 135-137 cm. 15. Sample 338-15-1, 95-96 cm.

PLATE 4

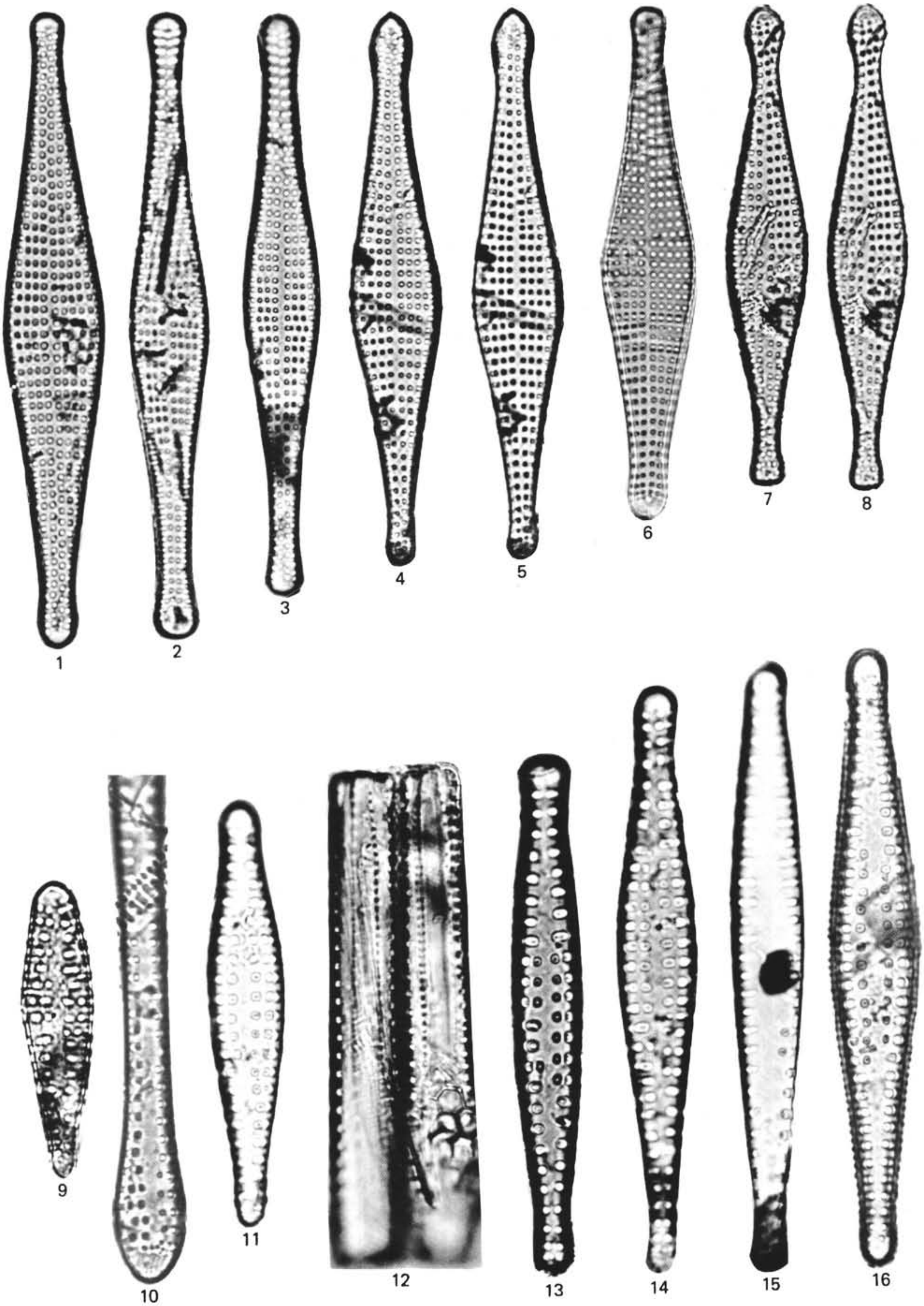

PLATE 5

Magnification 1500×; Figure 1 (left), 700×; 2, 700×.

Figure 1	*Thalassiothrix miocenica* Schrader. Sample 348-6-5, 115-117 cm (left 700×).
Figure 2	*Synedra miocenica* Schrader. Sample 338-21, CC (700×).
Figures 3, 4	*Thalassionema hirosakiensis* Kanaya. 3. Sample 338-14-1, 20-21 cm. 4. Sample 338-15-1, 95-96 cm.
Figure 5	*Thalassionema lineatum* Jousé. Sample 348-8-2, 90-92 cm.
Figures 6, 7	*Thalassionema hirosakiensis.* 6. Sample 338-19-5, 123-124 cm. 7. Sample 348-17-1, 140-141 cm.
Figure 8	*Thalassionema nitzschioides* Grunow. Sample 338-14-2, 85-86 cm.
Figure 9	*Thalassionema lineatum.* Sample 348-12-3, 85-87 cm.
Figures 10, 11	*Synedra pulchella* (Ralfs) Kützing. Sample 348-14, CC.
Figures 12, 13	*Dimerogramma fossile* Grunow. 12. Sample 338-14-1, 20-21 cm. 13. Sample 338-14-2, 85-86 cm.
Figure 14	*Rhaphoneis robustata* n. sp. (type). Sample 338-11-3, 5-6 cm.
Figures 15-19	*Rhaphoneis parallelica* n. sp. 15. Sample 348-12-1, 120-122 cm. 16. Sample 348-14, CC. 17. Sample 348-11-3, 70-72 cm. 18. Sample 348-15-1, 85-87 cm (type). 19. Sample 338-11, CC.
Figure 20	*Rhaphoneis ossiformis* n. sp. Sample 338-8-2, 58-59 cm (type).
Figure 21	*Pseudodimerogramma* sp. 1. Sample 348-11-3, 70-72 cm.
Figure 22	*Dimerogramma fossile* Grunow. Sample 348-17-1, 140-141 cm.
Figures 23, 24	*Rhaphoneis margaritalimbata* Mertz. Sample 348-12-4, 90-92 cm.
Figure 25	*Pleurosigma planktonica* n. sp. (type). Sample 338-8-2, 10-11 cm.

PLATE 5

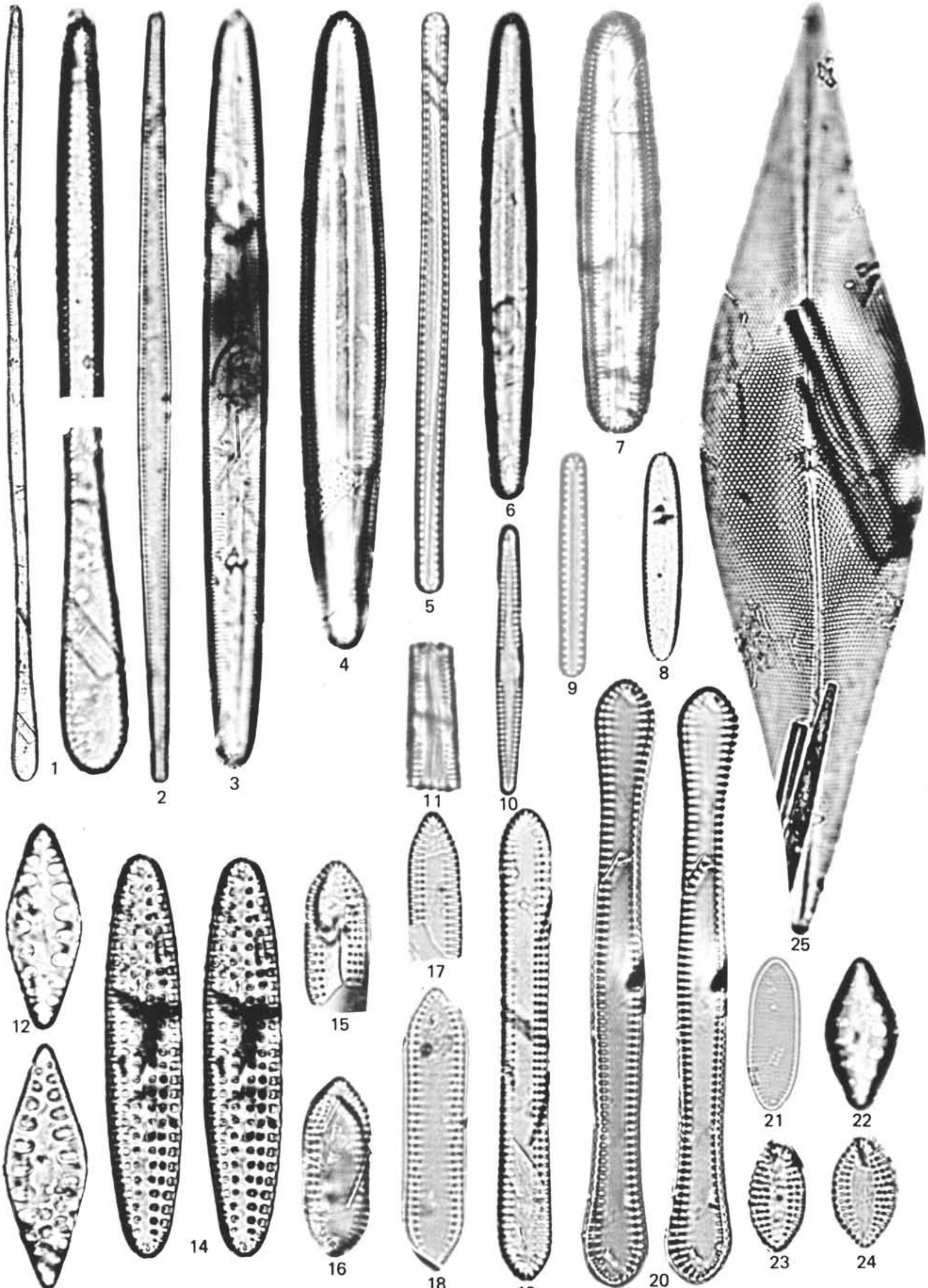

PLATE 6

Magnification 1500×; Figure 16, 700×.

Figures 1, 2	*Goniothecium odontella* Ehrenberg. 1. Sample 348-11-3, 70-72 cm. 2. Sample 348-17-1, 140-141 cm.
Figure 3	*Goniothecium decoratum* Brun. Sample 338-20, CC.
Figure 4	*Goniothecium odontella.* Sample 348-8-2, 90-92 cm.
Figure 5	*Goniothecium decoratum.* Sample 338-21, CC.
Figures 6-10	*Goniothecium tenue* Brun. 6. Sample 348-16, CC. 7. Sample 348-14-1, 90-92 cm. 8. Sample 348-12-1, 120-122 cm. 9, 10. Sample 348-16-5, 85-86 cm.
Figure 11	*Chaetoceros* sp. 2 Schrader. Sample 338-11-1, 65-66 cm.
Figure 12	*Periptera tetracladia* Ehrenberg. Sample 348-17-1, 140-141 cm.
Figures 13, 14	*Dicladia norwegica* n. sp. 13. Sample 338-15-1, 95-96 cm. 14. Sample 338-10-2, 55-56 cm (type).
Figure 15	*Chaetoceros* sp. Sample 348-11-3, 70-72 cm.
Figure 16	*Dicladia elliptica* n. sp. (type). Sample 348-17-1, 140-141 cm (700×).

PLATE 6

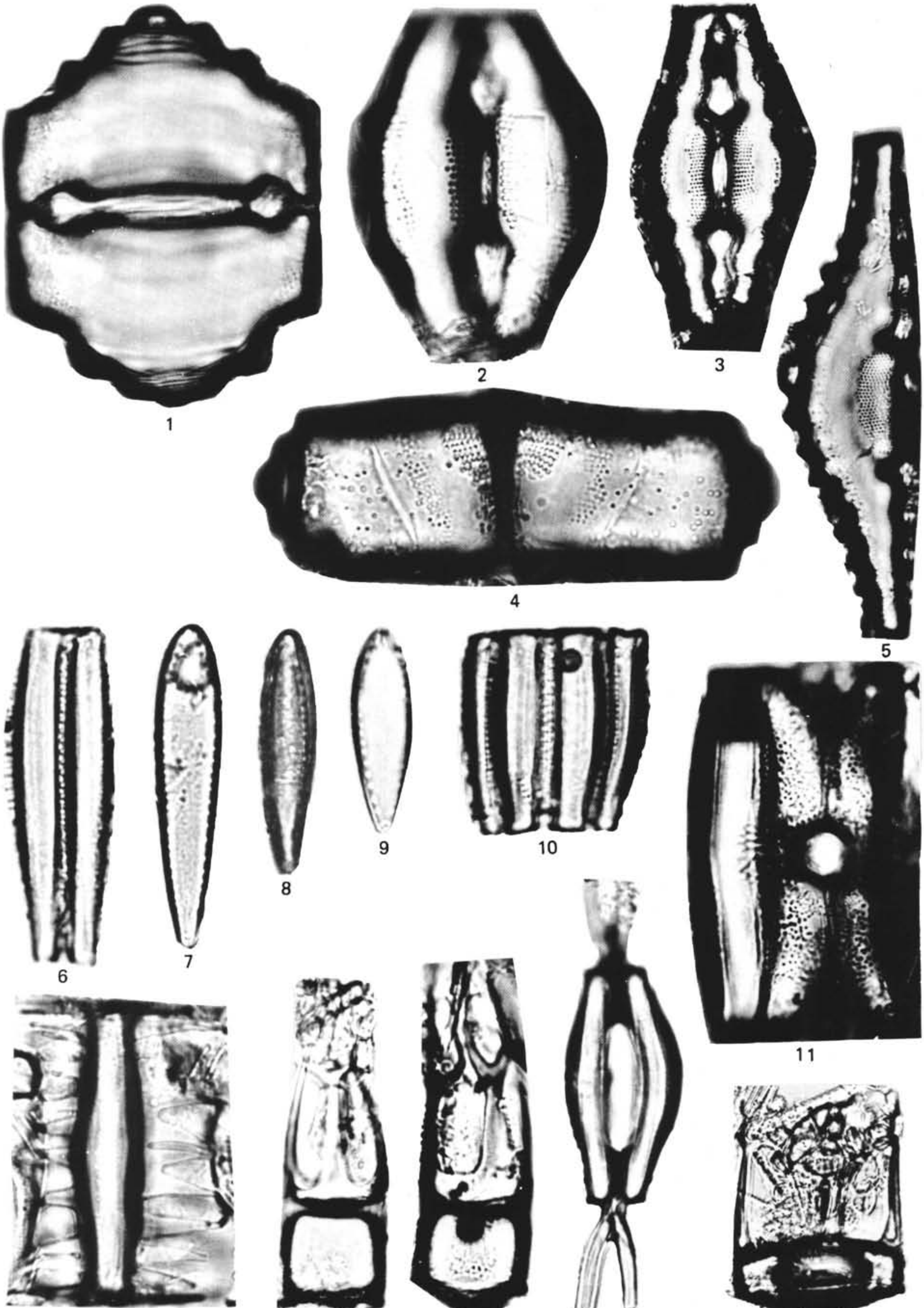

PLATE 7

Magnification 1500×.

Figure 1	*Rhizosolenia hebetata* var. *subacuta* Grunow. Sample 338-21, CC.
Figure 2	*Rhizosolenia hebetata* forma *semispina* (Hensen) Gran. Sample 338-19-3, 140-141 cm.
Figure 3	*Rhizosolenia hebetata* var. *subacuta*. Sample 338-21, CC.
Figure 4	*Rhaphoneis amphiceros* (Ehr.) Ehrenberg. Sample 348-17-1, 140-141 cm.
Figure 5	*Rhabdonema* sp. Sample 338-21, CC.
Figure 6	*Dimerogramma furcigerum* Grunow. Sample 338-16-5, 50-51 cm.
Figure 7	*Rhaphoneis angulata* n. sp. (type). Sample 338-19-3, 40-41 cm.
Figures 8, 9	*Rhizosolenia pokrovskajae* (Jousé) Strelnikova. Sample 338-21, CC.
Figure 10	*Rhizosolenia praebarboi* Schrader. Sample 338-21, CC.
Figure 11	*Rhaphoneis wicomicoensis* Lohmann. Sample 338-12-2, 85-86 cm.
Figure 12	*Rhaphoneis amphiceros*. Sample 348-17-1, 140-141 cm.
Figure 13	*Rhabdonema* sp. Sample 338-19-3, 140-141 cm.
Figure 14a	*Rhaphoneis gemmifera* Ehrenberg. Sample 338-9-1, 65-66 cm.
Figure 14b	*Rouxia isopolica* Schrader. Sample 338-15-1, 95-96 cm.
Figure 15	*Rouxia* sp. Sample 338-21, CC.
Figure 16	*Raphidodiscus marylandicus* Christian. Sample 338-15-1, 95-96 cm.
Figure 17	*Rouxia granda* n. sp. (type, left individual). Sample 280A-4-4, 120-121 cm.
Figure 18	*Rhaphoneis elliptica* n. sp. (type). Sample 338-9-1, 65-66 cm.
Figures 19, 20	*Dimerogramma* aff. *fulvum* (Greg.) Ralfs. 19. Sample 338-14-2, 85-86 cm. 20. Sample 348-12-1, 120-121 cm.
Figure 21	*Rhaphoneis amphiceros* (?). Sample 338-11-4, 5-6 cm.

PLATE 7

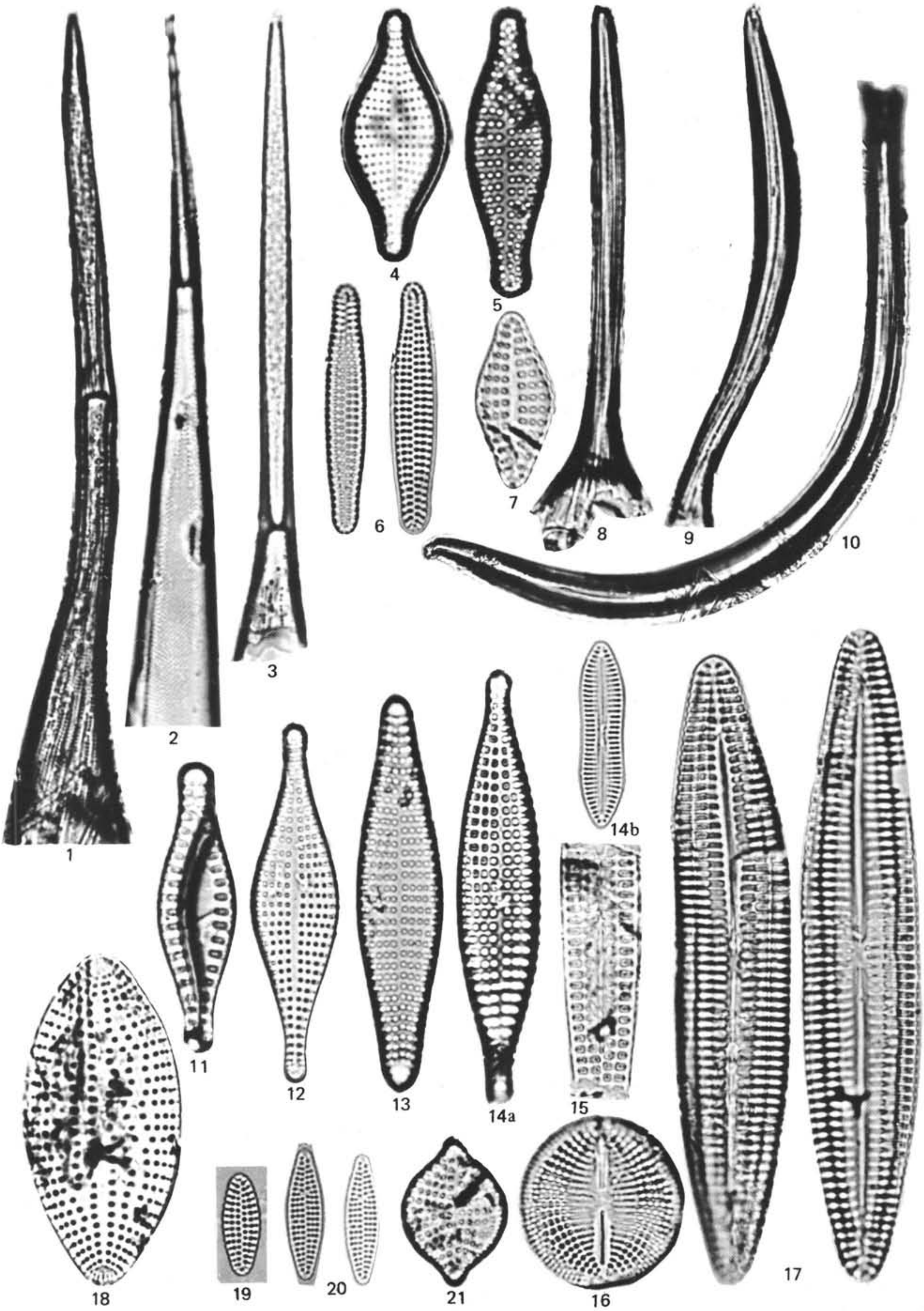

PLATE 8

Magnification 1500×.

Figures 1-5	*Cymatosira biharensis* Pantocsek. 1, 2. Sample 348-11-4, 80-82 cm. 3. Sample 348-11-3, 70-72 cm. 4. Sample 348-12-3, 85-87 cm. 5. Sample 348-11-4, 80-82 cm.
Figure 6	*Cymatosira cornuta* n. sp. Sample 338-11-4, 5-6 cm.
Figure 7	*Cymatosira biharensis* (girdle view). Sample 348-12-3, 85-87 cm.
Figures 8, 9	*Cymatosira lorenziana* Grunow. 8. Sample 338-19-5, 123-124 cm. 9. Sample 338-19-3, 140-141 cm.
Figure 10	Genus and species indet. Sample 348-11-1, 20-22 cm.
Figures 11, 12	*Rutilaria areolata* Sheshukova. Sample 338-21, CC.
Figure 13	*Cymatosira* sp. Sample 338-19-3, 140-141 cm.
Figures 14, 15	*Cymatosira fossilis* n. sp. (15) type. Sample 338-19-3, 40-41 cm.
Figures 16, 17	*Cymatosira robusta* n. sp. Sample 338-19-3, 12-13 cm (16) type.
Figure 18	*Mediaria splendida* Sheshukova-Poretzkaya. Sample 348-12, CC.
Figure 19	*Cymatosira praecompacta* n. sp. Sample 338-21, CC.
Figure 20	*Cymatosira* sp. Sample 338-21, CC.
Figure 21	*Cymatosira fossilis* n. sp. Sample 338-19-3, 40-41 cm.
Figure 22	*Cymatosira compacta* n. sp. Sample 338-19-3, 40-41 cm (type).
Figures 23, 24	*Cymatosira praecompacta* n. sp. 23. Sample 338-21, CC (type). 24. Sample 338-19-3, 12-13 cm.
Figure 25	*Cymatosira compacta* n. sp. Sample 338-20-2, 30-31 cm.

PLATE 8

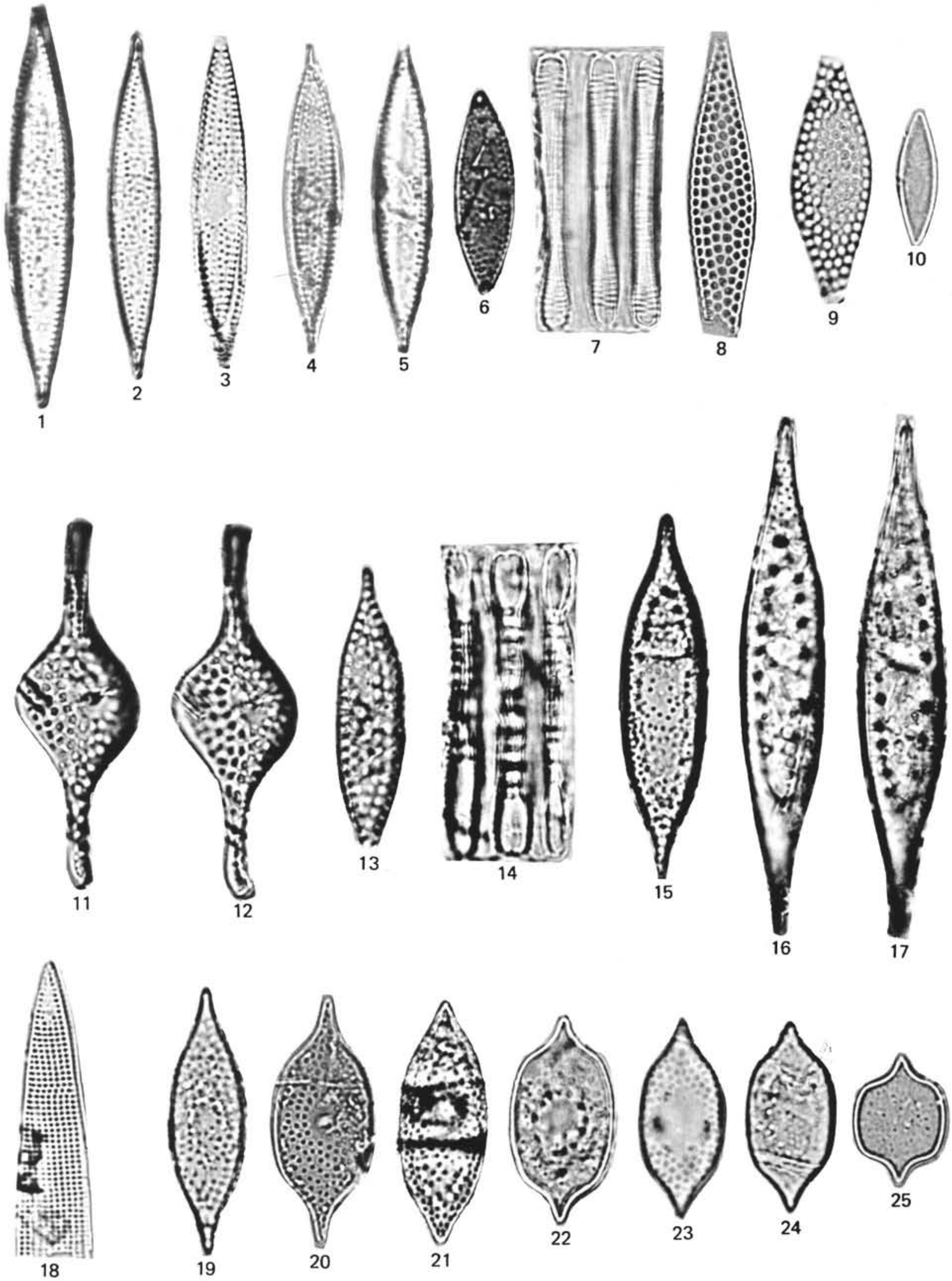

PLATE 9

Magnification 1500×; Figure 9, 700×.

Figures 1, 2	*Rhizosolenia bulbosa* n. sp. 1. Sample 338-11-1, 135-136 cm (type). 2. Sample 338-11-2, 5-6 cm.
Figure 3	*Rhizosolenia hebetata* var. *volatis* n. sp. (type). Sample 348-16, CC.
Figure 4	*Rhizosolenia norwegica* n. sp. (type). Sample 338-17, CC.
Figure 5	*Rhizosolenia miocenica* Schrader. Sample 348-11-1, 50-52 cm.
Figure 6	*Pterotheca carinifera* (Grunow) Forti. Sample 348-11-1, 20-22 cm.
Figure 7	*Pseudopyxilla americana* (Ehr.) Forti. Sample 338-8-3, 70-72 cm.
Figures 8, 9	*Pseudopyxilla directa* (Pantocsek) Forti. 8. Sample 348-11-3, 70-72 cm. 9. Sample 348-16, CC (700×).
Figure 10	*Rhizosolenia norwegica* n. sp. Sample 348-17-1, 140-142 cm.
Figure 11	*Rhizosolenia miocenica.* Sample 348-12, CC.
Figure 12	*Rhizosolenia styliformis* Brightwell. Sample 348-17-1, 140-142 cm.
Figures 13, 14	*Rhizosolenia miocenica.* Sample 338-19-3, 140-141 cm.
Figure 15	*Rhizosolenia hebetata* forma *semispina* (Hensen) Gran. Sample 348-17-1, 140-142 cm.
Figure 16	*Rhizosolenia praebarboi* Schrader. Sample 348-6-5, 115-117 cm.
Figure 17	*Rhizosolenia barboi* Brun. Sample 348-11-4, 80-82 cm.

PLATE 9

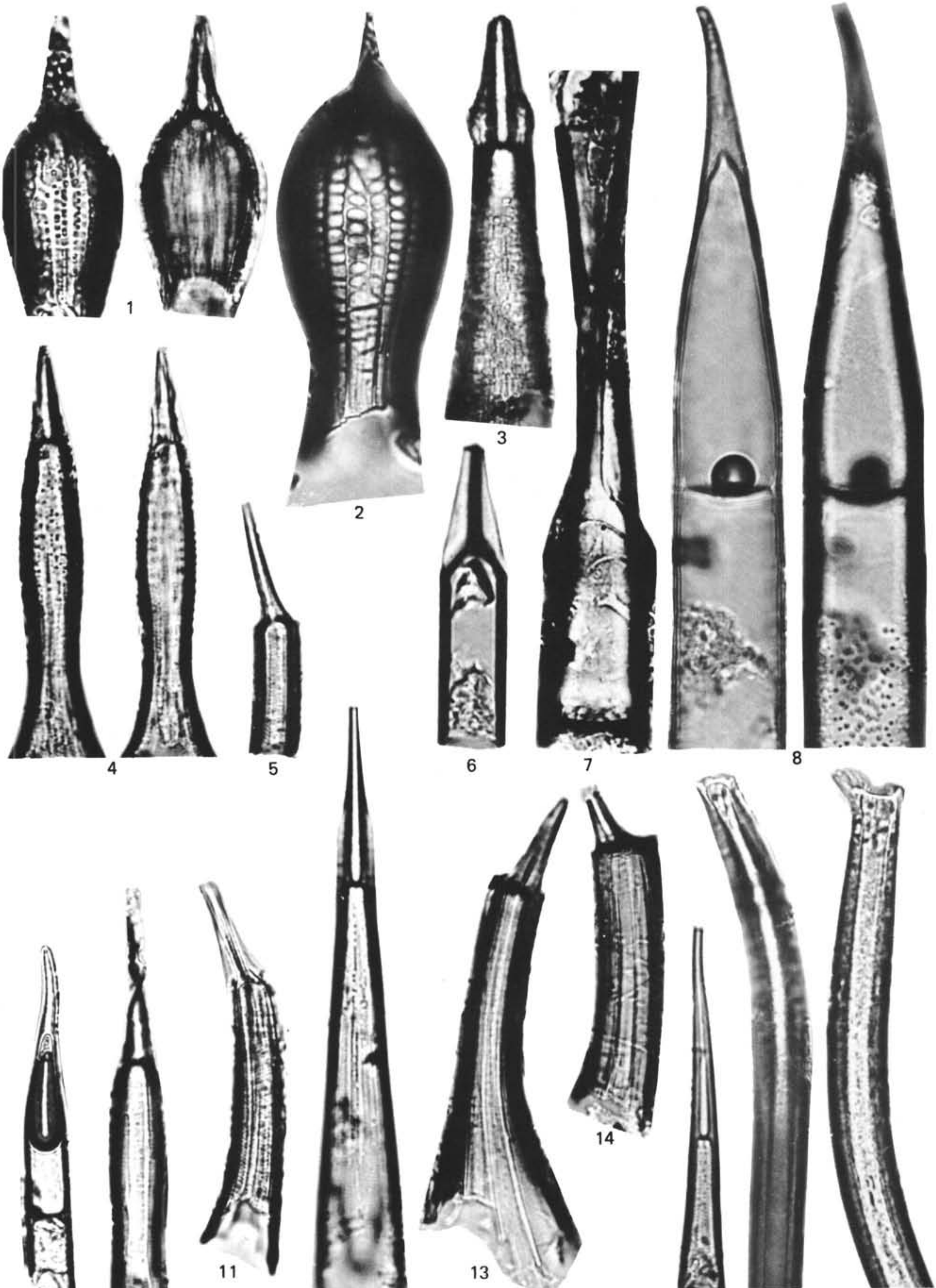

PLATE 10

Magnification 1500×; Figure 14, 700×, 20, 700×.

Figures 1-3	*Hemiaulus* sp. (*pyxilloides*). 1. Sample 338-19-3, 40-41 cm. 2, 3. Sample 338-21, CC.
Figure 4	*Hemiaulus* sp. (*giganteus*) (type). Sample 338-11-4, 5-6 cm.
Figure 5	*Hemiaulus malleolus* Pantocsek. Sample 338-10-2, 55-56 cm.
Figure 6	*Hemiaulus malleolus* (?). Sample 338-19-3, 40-41 cm.
Figures 7-9	*Hemiaulus pungens* Grunow. Sample 338-19-3, 140-141 cm.
Figure 10	*Hemiaulus* sp. a Schrader. Sample 338-21, CC.
Figures 11, 12	*Hemiaulus danicus* Grunow. 11. Sample 338-19-3, 140-141 cm. 12. Sample 338-21, CC.
Figure 13	*Hemiaulus* sp. Sample 338-11-4, 5-6 cm.
Figure 14	*Hemiaulus malleolus.* Sample 338-10-2, 55-56 cm (700×).
Figures 15, 16	*Eucampia* aff. *balaustium* Castracane. 15. Sample 348-12-1, 120-121 cm. 16. Sample 348-12, CC.
Figures 17, 18	*Eucampia balaustium.* Sample 338-11-1, 135-136 cm.
Figure 19	*Hemiaulus kittonii* Grunow. Sample 338-19-3, 140-141 cm.
Figures 20, 21	*Hemiaulus polycystinorum* Ehrenberg. 20. Sample 338-19-3, 140-141 cm (700×). 21. Sample 338-11-4, 5-6 cm.

PLATE 10

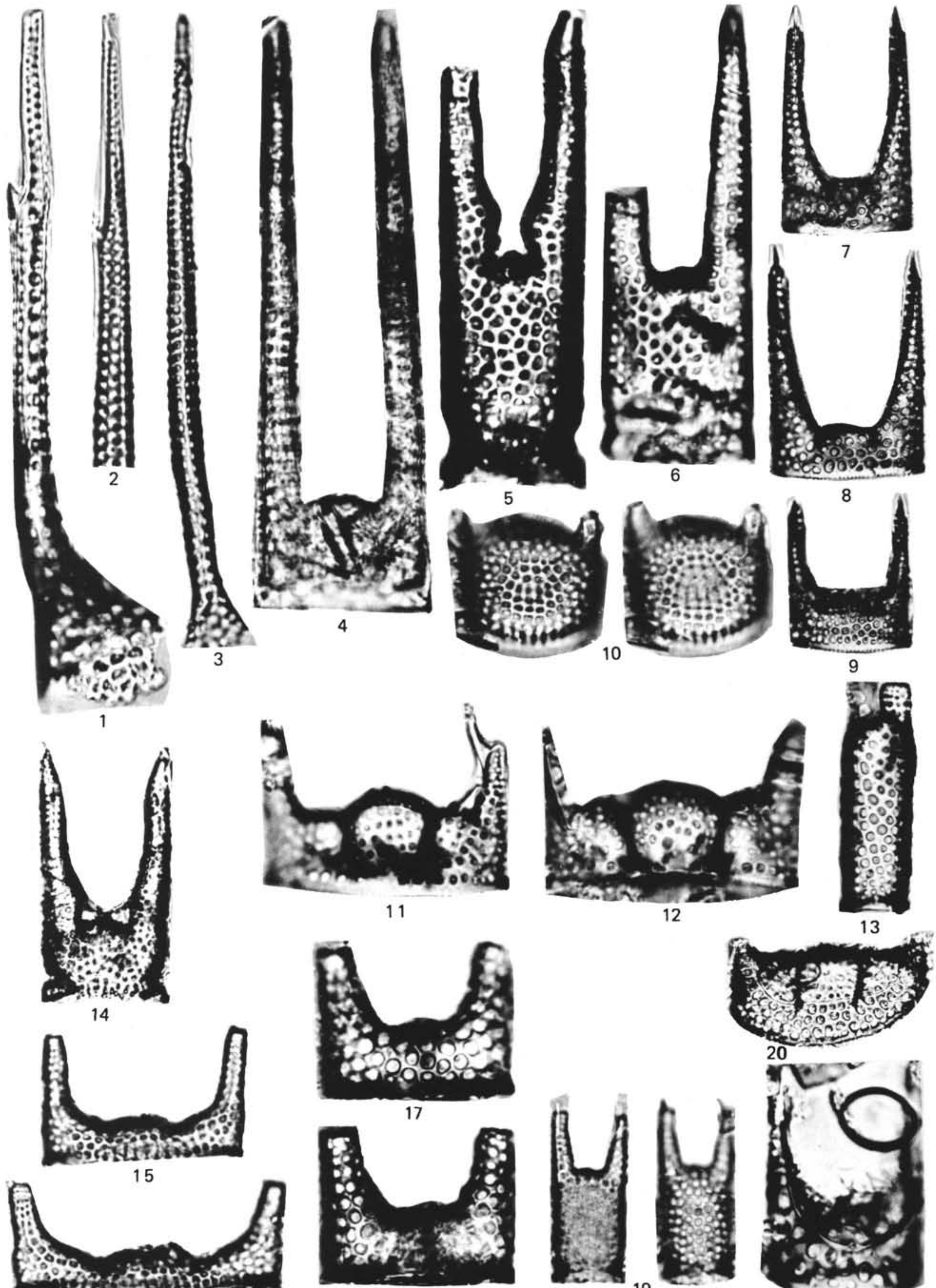

PLATE 11

Magnification 1500×; Figure 4, 700×.

Figures 1, 2	*Odontella septentrionala* n. sp. 1. Sample 338-11-4, 5-6 cm (type). 2. Sample 338-14-1, 20-21 cm.
Figure 3	*Triceratium schulzii* Jousé. Sample 338-20, CC.
Figure 4	*Triceratium tesselatum* Greville. Sample 338-10-2, 55-56 cm (700×).
Figure 5	*Lithodesmium rotunda* n. sp. (type). Sample 338-16-4, 67-68 cm.
Figure 6	*Triceratium inelegans* Greville (?). Sample 348-17-1, 140-142 cm.
Figures 7-9	*Pseudotriceratium chenevieri* (Meister) Gleser. 7. Sample 338-19-3, 140-142 cm. 8, 9. Sample 338-21, CC.

PLATE 11

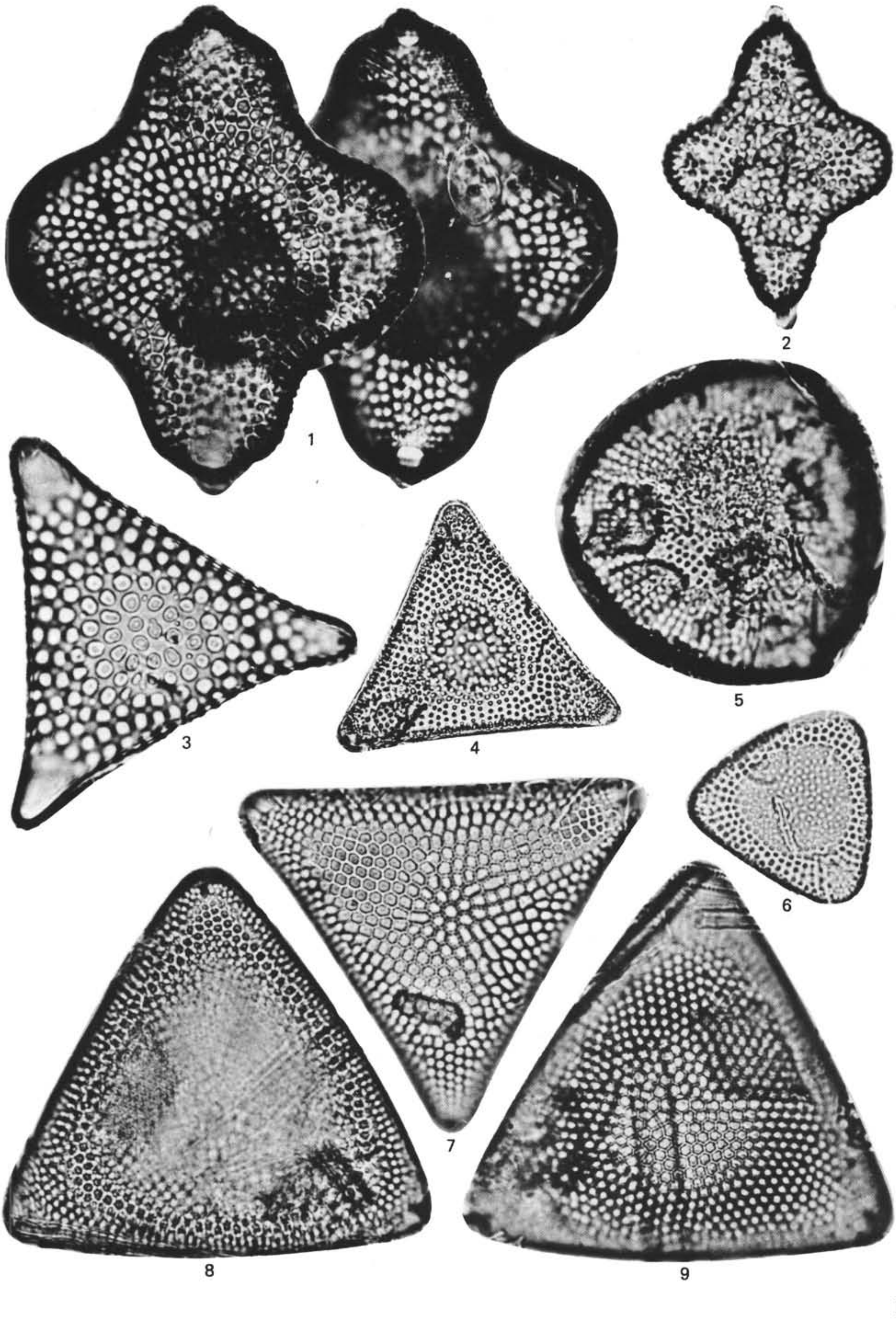

PLATE 12

Magnification 1500×; Figure 23, 700×.

Figures 1, 2	*Pterotheca reticulata* Sheshukova-Poretzkaya. 1. Sample 338-21, CC. 2. Sample 348-14, CC.
Figure 3	*Cladogramma dubium* Lohmann. Sample 348-11-1, 50-52 cm.
Figure 4	*Stephanogonia horridus* n. sp. Sample 348-16-5, 85-86 cm.
Figure 5	*Cladogramma dubium* Lohmann. Sample 338-11-2, 5-6 cm.
Figures 6-8	*Stephanogonia horridus* n. sp. (6 type). Sample 348-16, CC.
Figure 9	*Cladogramma dubium.* Sample 348-11-1, 50-52 cm.
Figure 10	*Stephanogonia hanzawae* Kanaya. Sample 348-11-1, 50-52 cm.
Figure 11	*Pterotheca reticulata.* Sample 338-21, CC.
Figure 12	*Stephanogonia hanzawae.* Sample 348-8-1, 90-92 cm.
Figures 13, 14	*Pseudorocella barbadensis* Deflandre. Sample 348-17-1, 140-142 cm.
Figures 15, 16	*Chaetoceros dicladia* Castracane. 15. Sample 338-19-3, 40-41 cm. 16. Sample 338-19-3, 12-13 cm.
Figure 17	*Melosira sulcata* (Ehrenberg) Kützing. Sample 338-20, CC.
Figure 18	*Trochosira spinosa* Kitton. Sample 338-19-3, 140-141 cm.
Figures 19, 20	*Pseudopyxilla rossica* (Pantocsek) Forti. Sample 348-11-3, 70-72 cm.
Figure 21	*Pseudopyxilla* sp. Sample 348-8-1, 90-92 cm.
Figure 22	Genus and species indet. Sample 338-11-1, 135-136 cm.
Figure 23	Genus and species indet. Sample 338-14-2, 85-86 cm (700×).
Figures 24, 25	*Pseudopodosira simplex* (Jousé) Strelnikova. 24. Sample 348-12-3, 85-87 cm. 25. Sample 348-12-1, 120-122 cm.

PLATE 12

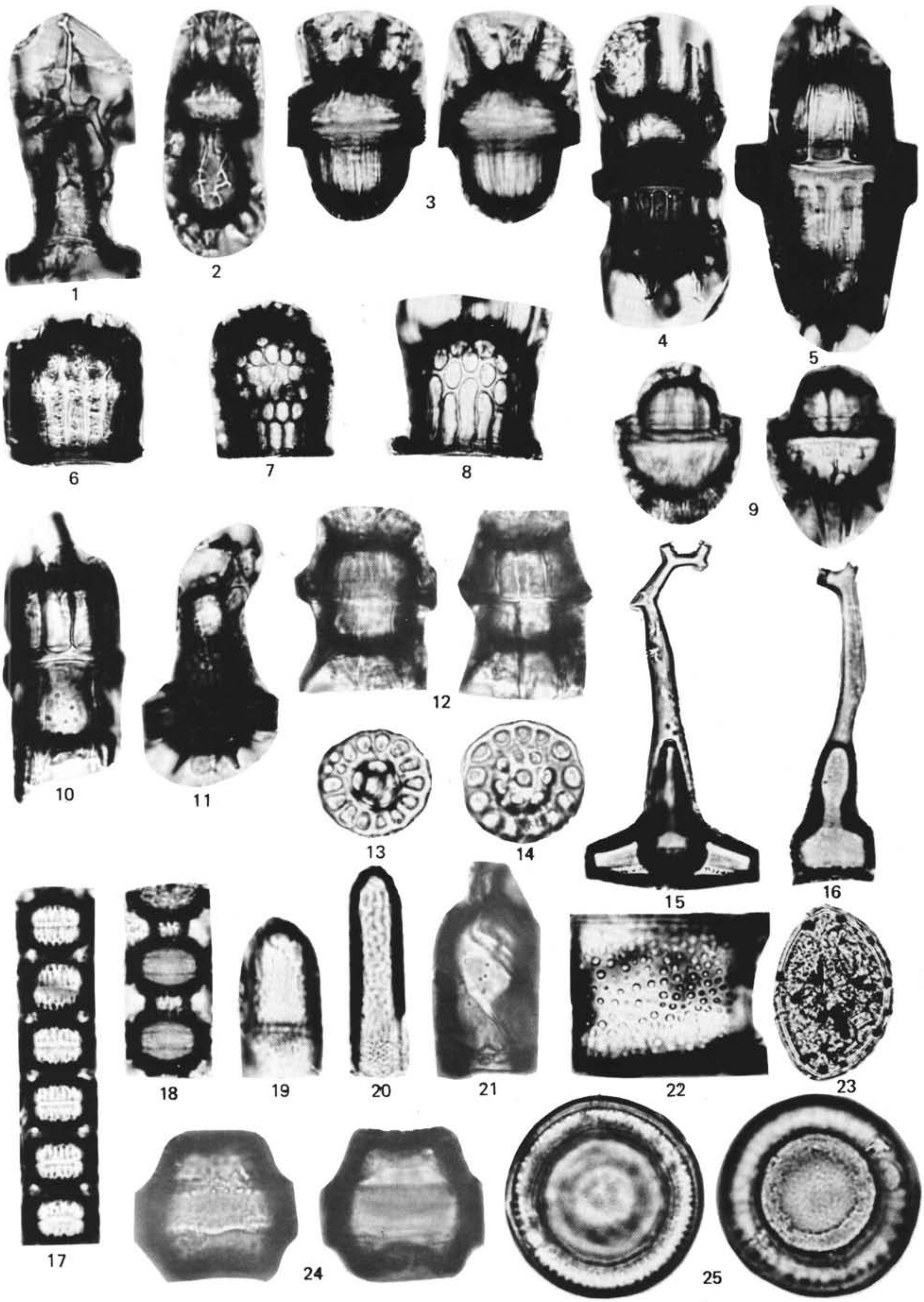

PLATE 13

Magnification 1500×.

Figures 1, 2	*Stephanogonia* sp. 1. Sample 348-17-1, 140-141 cm. 2. Sample 348-17, CC.
Figure 3	*Stephanogonia* sp. Sample 348-5-2, 140-142 cm.
Figure 4	*Stephanogonia* sp. Sample 348-5-2, 140-142 cm.
Figure 5	*Stephanogonia hanzawae* Kanaya. Sample 348-11-1, 20-22 cm.
Figure 6	*Cladogramma dubium* Lohmann. Sample 338-11-1, 135-136 cm.
Figures 7, 8	*Stephanogonia hanzawae*. Sample 348-8-1, 90-92 cm.
Figures 9, 10	*Stephanogonia* sp. 9. Sample 348-16, CC. 10. Sample 338-14-1, 20-21 cm.
Figure 11	*Stictodiscus* aff. *kittonianus* Greville. Sample 338-8-2, 10-11 cm.
Figure 12	Genus and species indet. (5). Sample 338-19-3, 140-141 cm.

PLATE 13

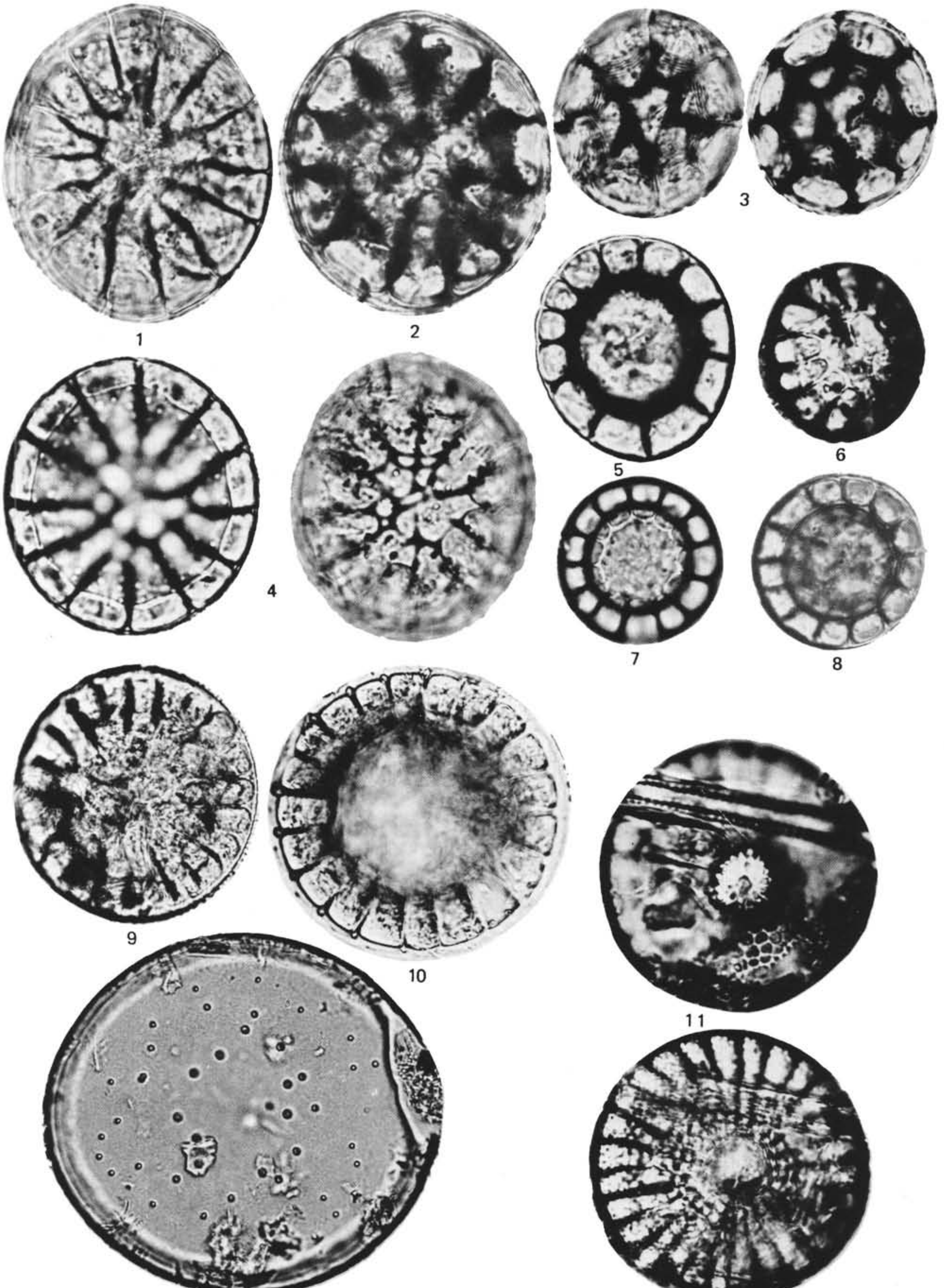

PLATE 14

Magnification 1500×.

Figure 1	*Coscinodiscus* aff. *rothii* (Ehrenberg) Grunow. Sample 338-20, CC.
Figure 2	*Coscinodiscus nodulifer* A. Schmidt. Sample 348-17-1, 140-141 cm.
Figure 3	*Coscinodiscus vetustissimus* Pantocsek. Sample 338-20, CC.
Figure 4	*Coscinodiscus tuberculatus* var. *atlantica* Gleser and Jousê. Sample 338-21, CC.
Figure 5	*Coscinodiscus kützingii* A. Schmidt. Sample 348-6, CC.
Figure 6	*Coscinodiscus vigilans* A. Schmidt. Sample 338-21, CC.
Figures 7-9	*Coscinodiscus praenitidus* n. sp. 7, 8. Sample 338-19-5, 123-124 cm. 9. Sample 338-19-3, 140-141 cm (type).
Figure 10	*Melosira ornata* Grunow. Sample 338-19-3, 140-141 cm.
Figure 11	*Cestodiscus peplum* Brun. Sample 338-13-1, 55-56 cm.
Figure 12	*Coscinodiscus praenitidus* n. sp. Sample 338-11-2, 5-6 cm.
Figure 13	*Melosira architecturalis* Brun. Sample 338-21, CC.
Figure 14	*Coscinodiscus endoi* Kanaya. Sample 348-11-3, 70-72 cm.
Figure 15	*Actinocyclus ehrenbergii* var. *tenella* (Breb.) Hustedt. Sample 338-19-3, 140-141 cm.
Figure 16	*Actinocyclus ingens* Rattray. Sample 338-8-2, 10-11 cm.
Figure 17	*Actinocyclus ehrenbergii* Ralfs. Sample 348-14-1, 90-92 cm.

PLATE 14

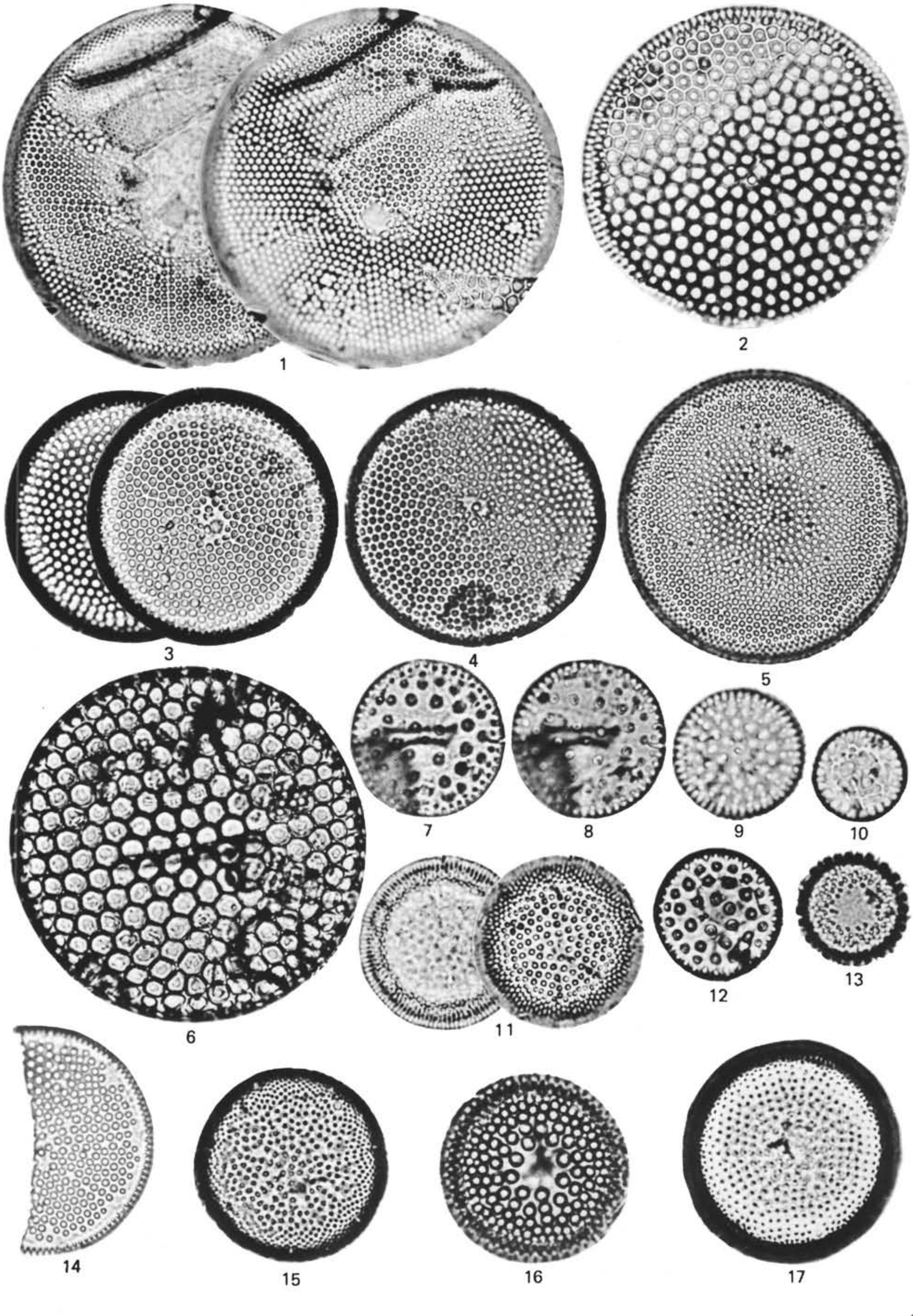

PLATE 15

Magnification 1500×.

Figures 1, 2	*Coscinodiscus bathyomphalus* Cleve. Sample 338-10, CC.
Figure 3	*Coscinodiscus miocenicus* Schrader. Sample 338-8, CC.
Figure 4	Genus and species indet. (1). Sample 348-17-1, 140-141 cm.
Figure 5	*Coscinodiscus plicatus* Grunow. Sample 348-12-4, 90-92 cm.
Figure 6	*Coscinodiscus miocenicus.* Sample 348-12-1, 120-122 cm.
Figure 7	*Coscinodiscus* cf. *plicatus.* Sample 348-11-4, 80-82 cm.
Figures 8, 9	*Coscinodiscus plicatus.* 8. Sample 348-12-4, 90-92 cm. 9. Sample 338-8-2, 10-11 cm.
Figure 10	*Coscinodiscus flexuosus* Brun. Sample 348-12-4, 90-92 cm.
Figures 11-13	*Coscinodiscus plicatus.* 11. Sample 348-11-3, 70-72 cm. 12, 13. Sample 348-12, CC.

PLATE 15

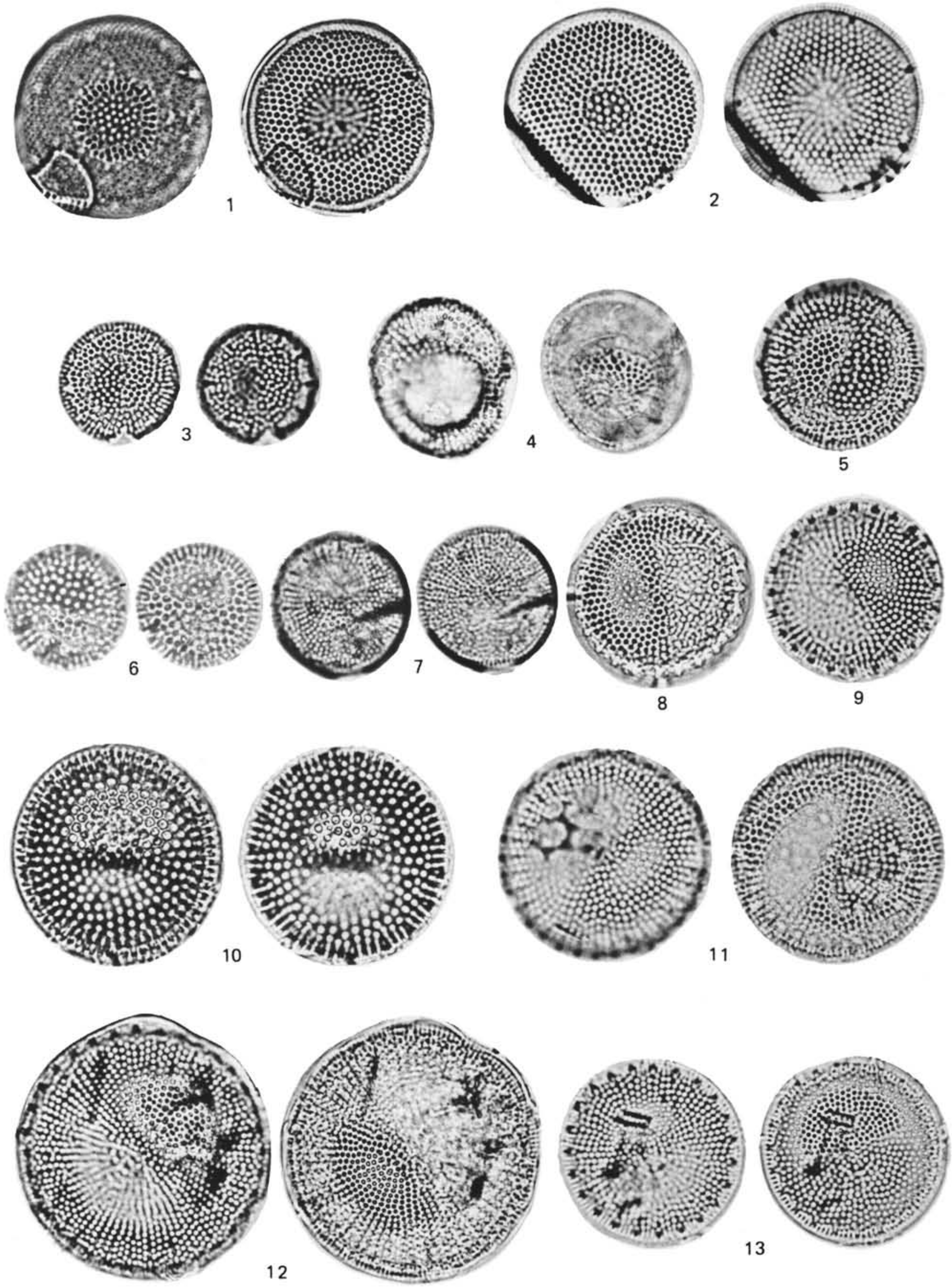

PLATE 16

Magnification 1500×.

Figures 1-4	*Porosira glacialis* (Grunow) Joergensen. 1. Sample 348-2-1, 65-67 cm. 2. Sample 348-12-3, 85-87 cm. 3, 4. Sample 348-15, CC.
Figures 5, 6	*Thalassiosira gravida* Cleve. Sample 348-2-1, 65-67 cm.
Figures 7, 8	*Thalassiosira* sp. c. 7. Sample 348-11-3, 70-72 cm. 8. Sample 348-11-1, 20-22 cm.
Figures 9-12	*Thalassiosira fraga* n. sp. 9. Sample 338-14-1, 20-21 cm (type). 10. Sample 338-13-1, 55-56 cm. 11. Sample 338-14-1, 20-21 cm. 12. Sample 348-17-1, 140-142 cm.
Figure 13	*Porosira glacialis*. Sample 348-16-1, 85-87 cm.

PLATE 16

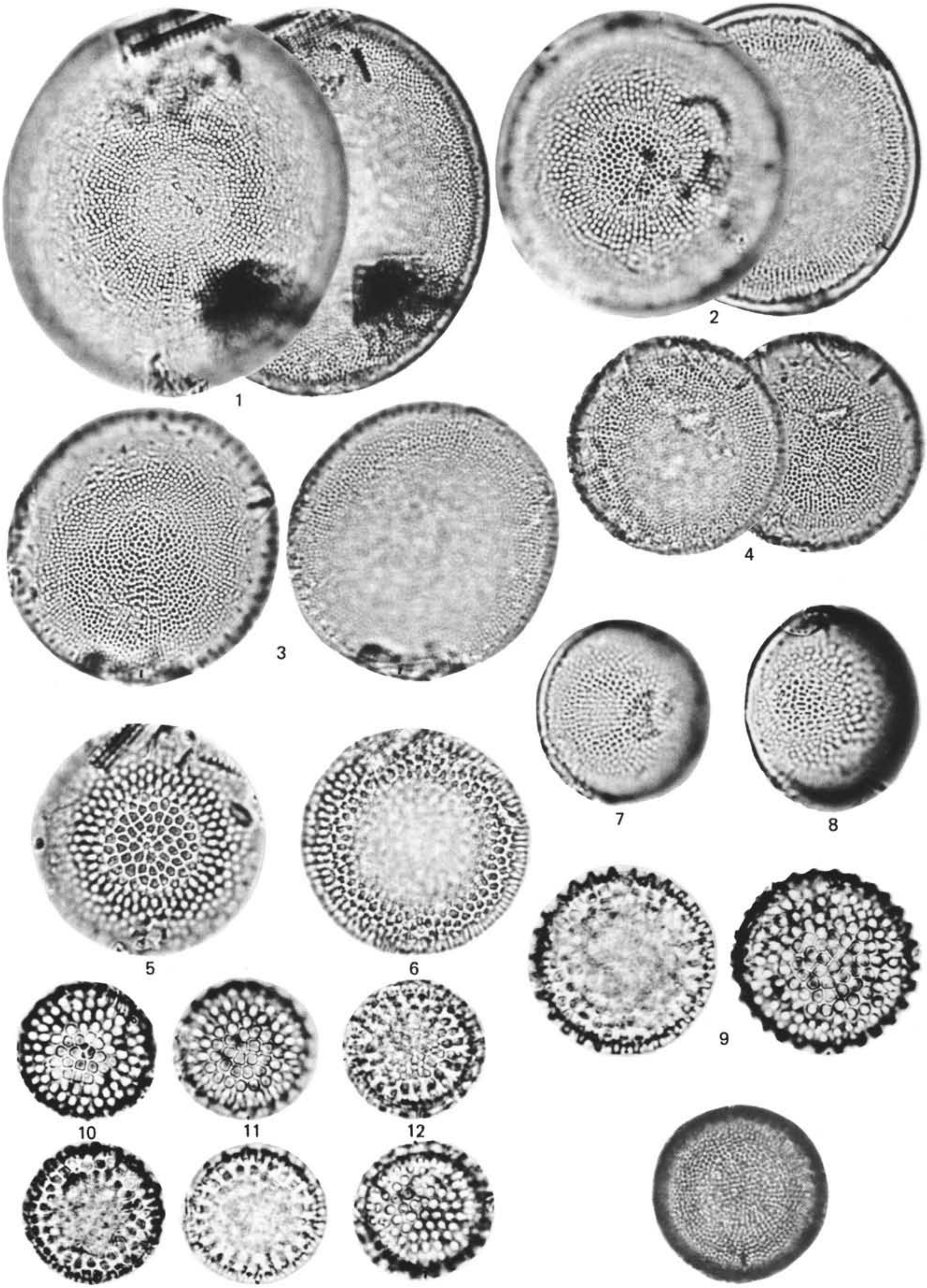

PLATE 17

Magnification 1500×.

Figure 1	*Porosira glacialis* (Grunow) Joergensen. Sample 348-14, CC.
Figure 2	*Thalassiosira gravida* Cleve. Sample 348-14-1, 90-92 cm.
Figure 3	*Coscinodiscus norwegicus* n. sp. (type). Sample 348-14-1, 90-92 cm.
Figures 4a, 4b	*Coscinodiscus norwegicus* n. sp. 4a. Sample 348-11-1, 20-22 cm. 4b. Sample 348-11-3, 70-72 cm.
Figure 5	*Thalassiosira* sp. b. Sample 348-8-2, 90-92 cm.
Figures 6, 7	*Thalassiosira oestrupii* (Ostenfeld) Proshkina-Lavr. 6. Sample 348-6-1, 60-62 cm. 7. Sample 348-8-1, 90-92 cm.
Figure 8	*Coscinodiscus* cf. *plicatus* Grunow. Sample 338-8-3, 70-72 cm.
Figure 9	*Thalassiosira decipiens* (Grunow) Joergensen. Sample 348-11-3, 70-72 cm.
Figure 10	*Thalassiosira* sp. b. Sample 348-8-2, 90-92 cm.
Figure 11	*Cestodiscus* sp. Sample 348-12-4, 90-92 cm.
Figure 12	*Coscinodiscus subconcavus* Grunow. Sample 338-10-2, 55-56 cm.
Figure 13	*Thalassiosira nidulus* (Temp. and Brun) Jousé. Sample 348-8-1, 90-92 cm.
Figures 14, 15	*Thalassiosira oestrupii.* Sample 348-2-1, 65-67 cm.
Figure 16	*Thalassiosira nidulus.* Sample 348-5-5, 145-147 cm.
Figure 17	*Thalassiosira* sp. a Schrader. Sample 348-11-3, 70-72 cm.

PLATE 17

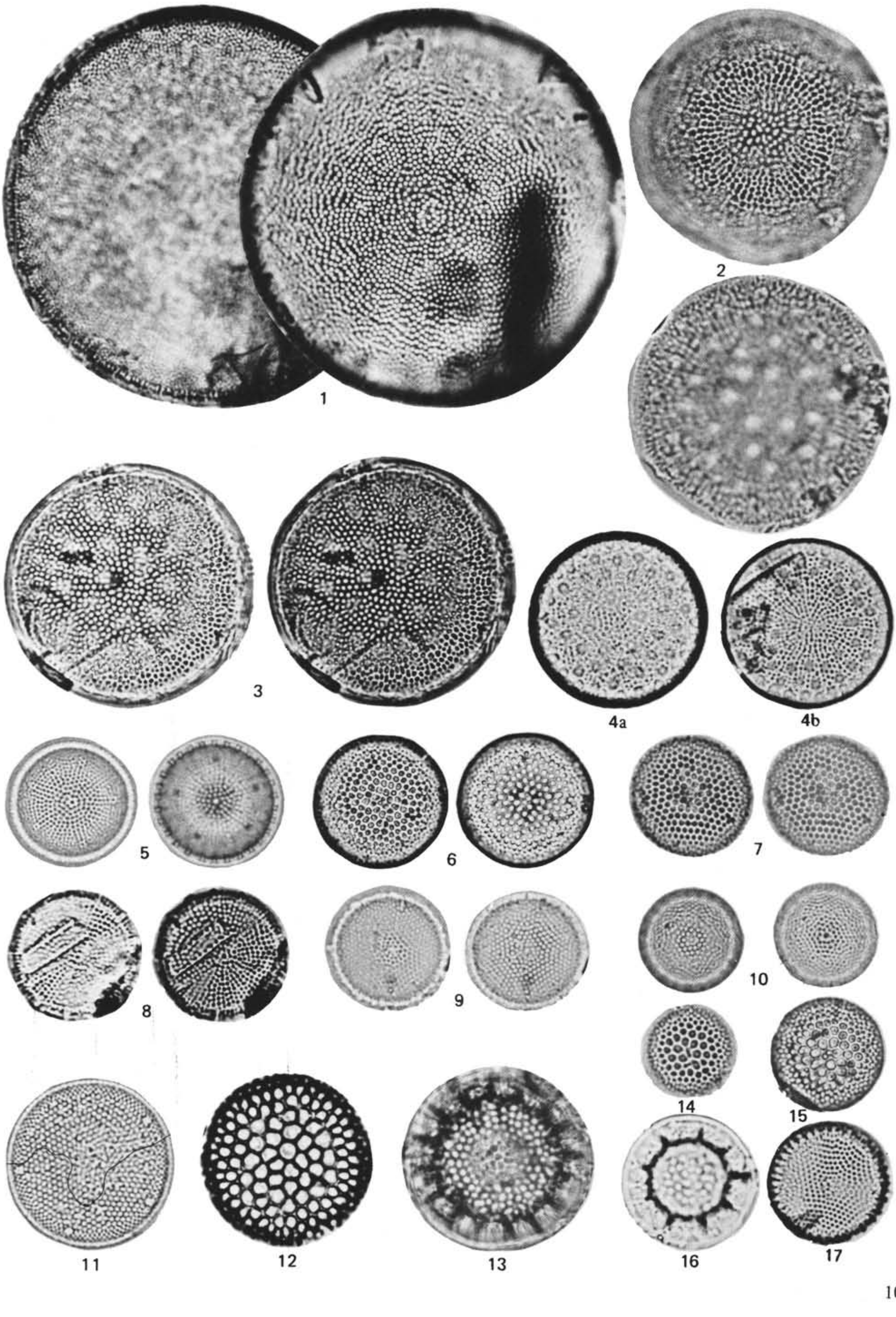

PLATE 18

Magnification 1500×.

Figure 1	*Thalassiosira* aff. *eccentrica* (Ehr.) Cleve. Sample 348-8-1, 90-92 cm.
Figure 2	*Thalassiosira eccentrica* (Ehr.) Cleve. Sample 348-6, CC.
Figures 3, 4	*Coscinodiscus lineatus* Ehrenberg. Sample 348-2-1, 65-67 cm.
Figures 5-7	*Thalassiosira eccentrica.* 5, 6. Sample 348-8-2, 90-92 cm. 7. Sample 348-6, CC.
Figure 8	*Coscinodiscus lineatus* (?). Sample 348-14-1, 20-21 cm.
Figure 9	*Thalassiosira eccentrica.* Sample 348-8-2, 90-92 cm.

PLATE 18

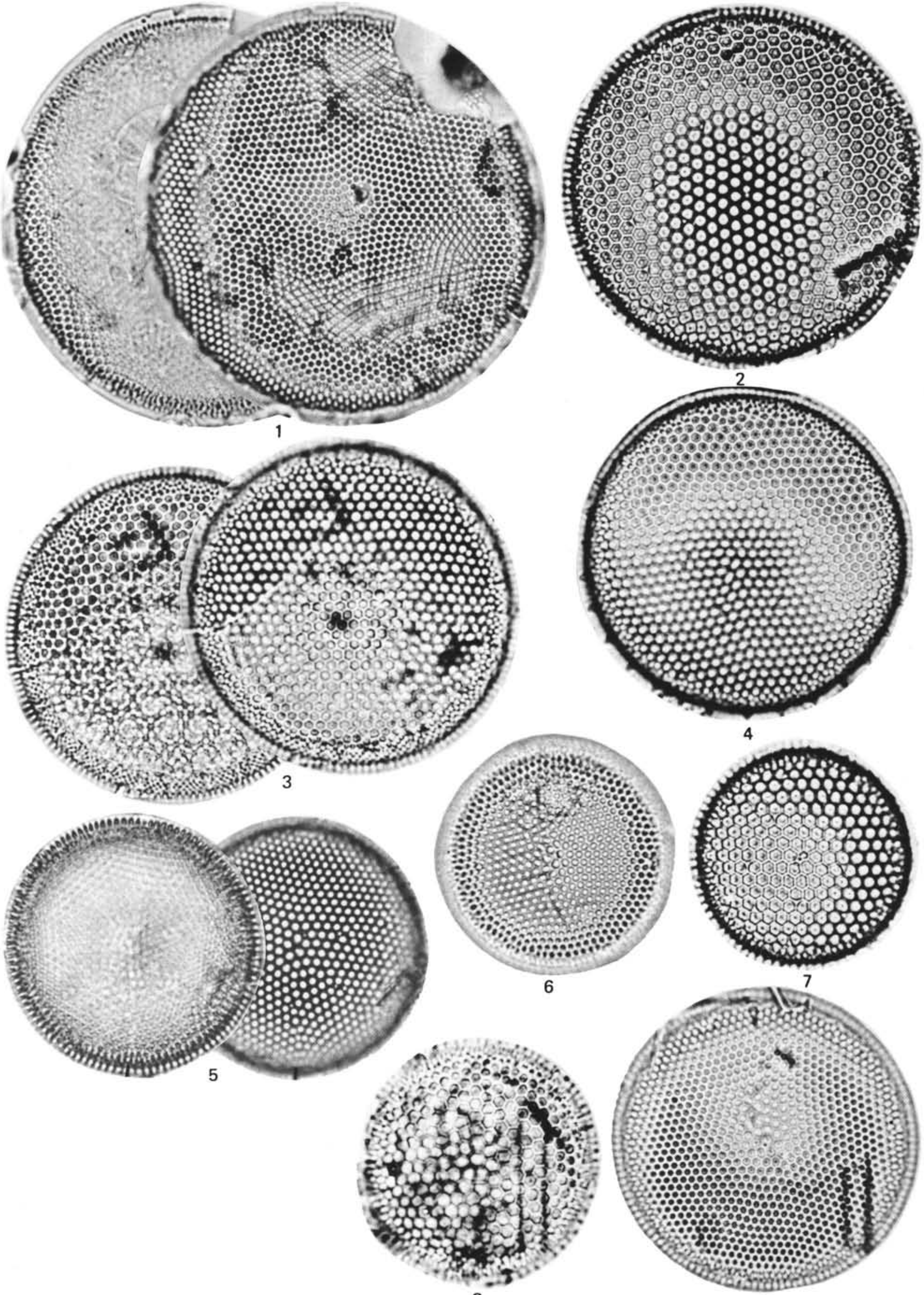

PLATE 19

Magnification 1500×; Figures 7, 9; 700×.

Figures 1, 2	*Hyalodiscus* aff. *subtilis* Bailey. 1. Sample 338-21, CC. 2. Sample 338-20, CC.
Figure 3	*Actinoptychus thumii* (Schmidt) Hanna. Sample 338-21, CC.
Figure 4	*Cestodiscus* sp. (a). Sample 348-11-3, 70-72 cm.
Figure 5	*Cestodiscus* sp. (b). Sample 348-12, CC.
Figure 6	*Stephanopyxis hyalomarginata* Hajós. Sample 338-16, CC.
Figures 7, 8	*Stephanopyxis schenkii* Kanaya. 7. Sample 338-11-2, 5-6 cm (700×). 8. Sample 338-19-3, 40-41 cm.
Figure 9	*Stephanopyxis hyalomarginata.* Sample 338-10-2, 55-56 cm (700×).
Figure 10	*Thalassiosira punctata* Jousé. Sample 338-19-3, 40-41 cm.

PLATE 19

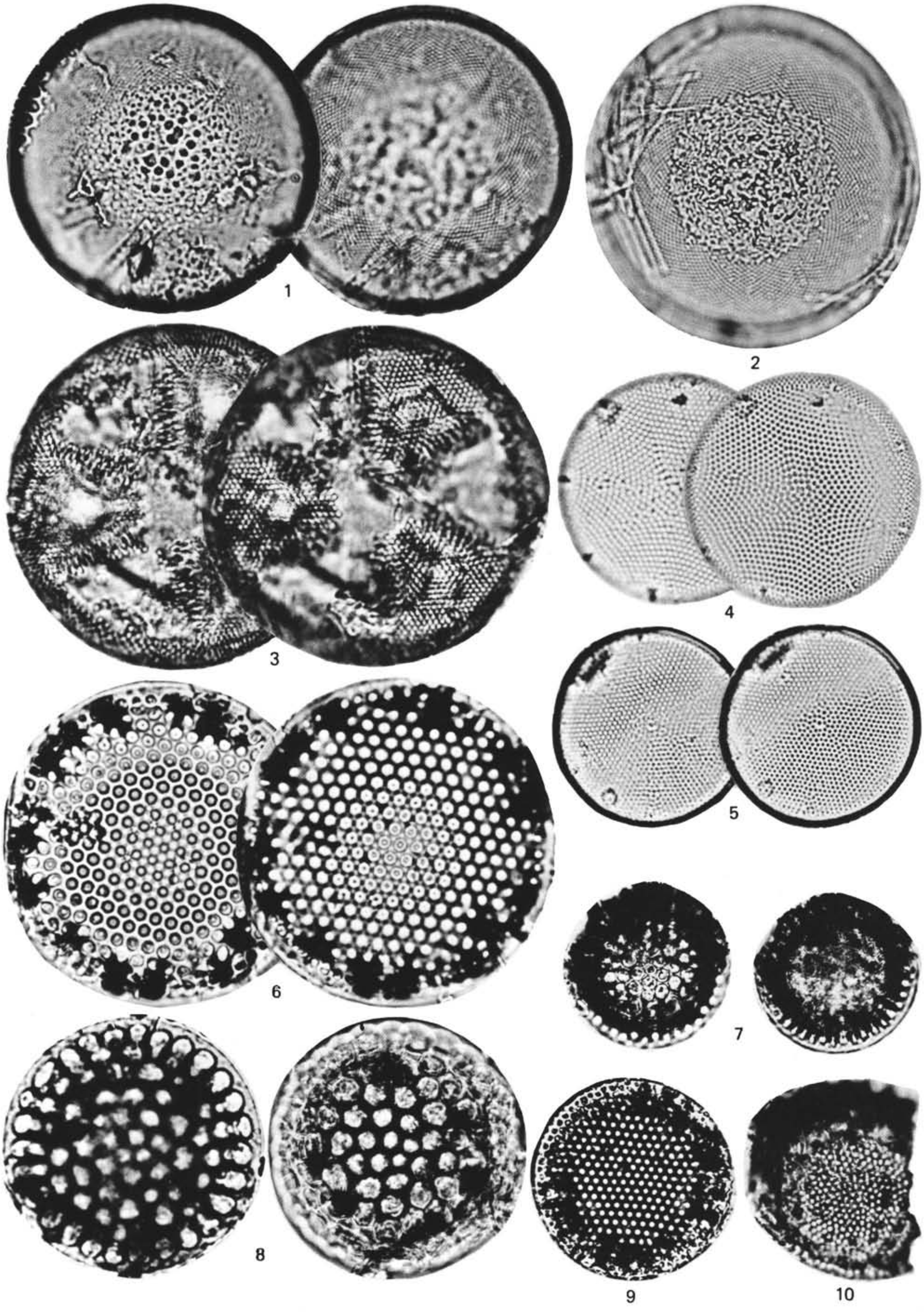

PLATE 20

Magnification 1500×; Figures 5, 8, 700×.

Figure 1	*Coscinodiscus symbolophorus* group. Sample 338-11-1, 135-136 cm.
Figure 2	*Odontella* sp. a. Sample 348-11-4, 80-82 cm.
Figure 3	*Stephanopyxis marginata* Grunow. Sample 338-21, CC.
Figure 4	*Anaulus acutus* Brun. Sample 338-19-3, 140-141 cm.
Figure 5	*Odontella cornuta* (Brun) n. comb. Sample 338-20, CC (700×).
Figure 6	*Odontella* aff. *fimbriata* (Greville) Sample 338-19-2, 10-11 cm.
Figure 7	*Odontella calamus* (Brun and Tempère) n. comb. Sample 348-12-1, 120-122 cm.
Figure 8	*Stephanopyxis grunowii* Grove and Sturt. Sample 338-19-3, 140-141 cm (700×).
Figure 9	Genus and species indet. Sample 338-11-1, 65-67 cm.
Figures 10-12	*Thalassiosira irregulata* n. sp. (11: type). Sample 338-21, CC.
Figure 13	*Thalassiosira* aff. *irregulata*. Sample 338-19-3, 140-141 cm.

PLATE 20

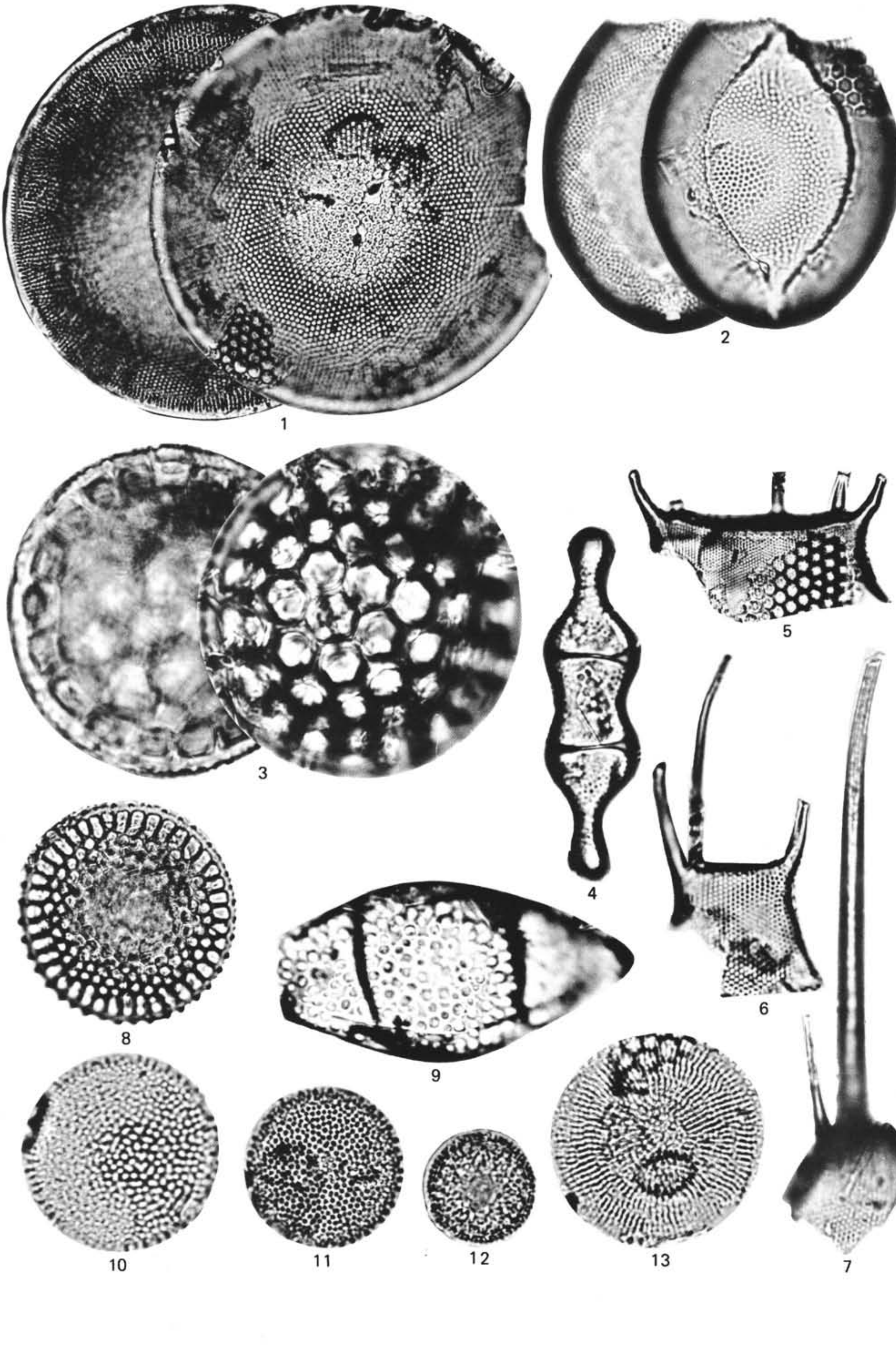

PLATE 21

Magnification 1500×; Figure 13, 700×.

Figures 1-3	*Coscinodiscus rhombicus* Castracane. Sample 338-19-3, 140-141 cm.
Figure 4	*Coscinodiscus lewisianus* Greville. Sample 338-10, CC.
Figure 5	*Coscinodiscus rhombicus.* Sample 348-17-1, 140-141 cm.
Figure 6	*Coscinodiscus lewisianus* (?). Sample 338-11-2, 5-6 cm.
Figure 7	*Asteromphalus symmetricus* n. sp. Sample 338-19-3, 40-41 cm.
Figure 8	*Asteromphalus oligocenicus* n. sp. Sample 338-19-3, 140-141 cm.
Figure 9	*Asteromphalus robustus* Castracane (?). Sample 348-17-1, 140-141 cm.
Figures 10-12	*Asteromphalus symmetricus* n. sp. 10. Sample 338-19-5, 123-124 cm (type). 11. Sample 338-19-5, 123-124 cm. 12. Sample 338-21, CC.
Figures 13, 14	*Asteromphalus oligocenicus* n. sp. 13. Sample 338-20, CC (700×). 14. Sample 338-19-3, 140-141 cm (type).
Figure 15	*Asterolampra insignis* A. Schmidt. Sample 338-19-3, 140-141 cm.

PLATE 21

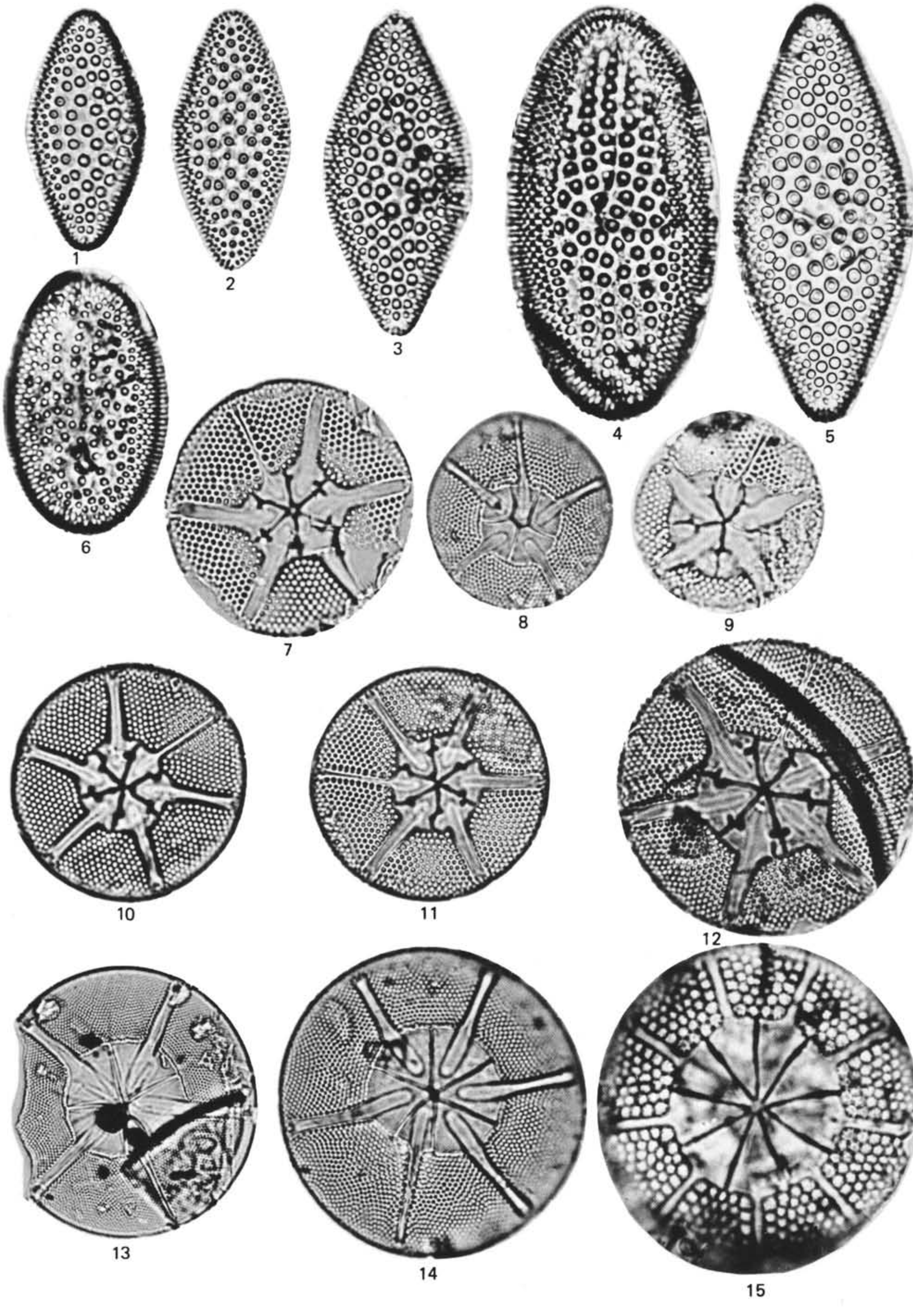

PLATE 22

Magnification 1500×.

Figures 1-6	*Pseudorutilaria monomembranacea* n. sp., (3) type. Sample 340-8-5, 60-62 cm.
Figures 7, 8	Genus and species indet. (10). Sample 336-18-2, 55-57 cm.
Figure 9	*Cymatosira* sp. Sample 338-29, CC.
Figure 10	*Cymatosira* sp. Sample 338-27, CC.
Figure 11	*Cymatosira coronata* n. sp. Sample 338-29, CC.
Figure 12	*Cymatosira* sp. Sample 338-29, CC.
Figure 13	*Cymatosira* sp. Sample 338-27, CC.
Figure 14	*Cymatosira cornuta* n. sp. (type). Sample 342-5-2, 60-62 cm.
Figure 15	*Cymatosira* sp. Sample 338-27, CC.
Figure 16	*Cymatosira lorenziana* Grunow. Sample 336-16-5, 98-100 cm.
Figures 17-21	*Sceptroneis pupa* n. sp. 17-20. Sample 336-16-5, 98-100 cm. 21. Sample 346-11-4, 40-42 cm.
Figures 22-25	*Sceptroneis mayenica* n. sp. 22-24. Sample 338-29, CC. 25. Sample 336-28-2, 133-134 cm.
Figures 26-28	*Sceptroneis grunowii* Anissimova. Sample 337-10-5, 120-122 cm.
Figure 29	*Sceptroneis vermiformis* n. sp. Sample 338-28-2, 133-134 cm.
Figures 30, 31	*Sceptroneis pesplanus* n. sp. Sample 338-29, CC.
Figure 32	Genus and species indet. Sample 346-11-4, 40-42 cm.
Figure 33	*Navicula udintsevii* n. sp. Sample 337-10-5, 120-122 cm.
Figures 34, 35	*Navicula bendaensis* n. sp. Sample 338-28-2, 133-134 cm.
Figure 36	*Sceptroneis praecaducea* Hajós and Stradner. Sample 338-23-6, 89-90 cm.
Figure 37	*Rhabdonema* sp. Sample 338-18-2, 55-56 cm.
Figure 38	*Rouxia* sp. Sample 338-18-2, 55-56 cm.
Figure 39	*Rouxia* sp. Sample 338-18-2, 55-56 cm.
Figures 40, 41	*Huttonia norwegica* n. sp. (41) type. Sample 337-10-5, 120-122 cm.
Figures 42, 43	*Rhaphoneis elongata* (Schrader) Andrews. Sample 336-16-2, 57-59 cm.

PLATE 22

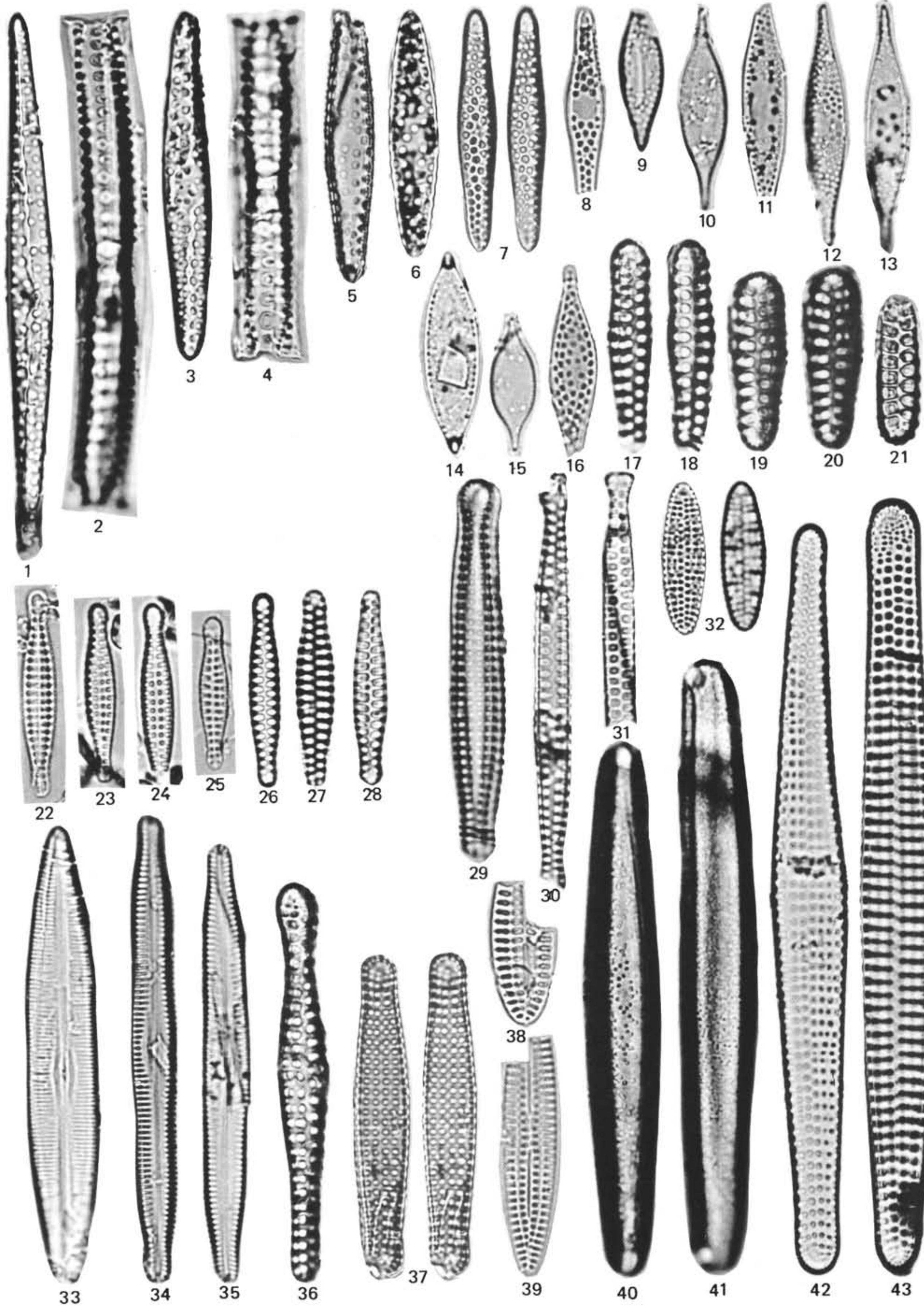
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PLATE 23

Magnification 1500×; Figures 22 and 24, 1200×.

Figures 1-4 — *Sceptroneis mayenica* n. sp.
1. Sample 338-28-2, 48-50 cm.
2. Sample 338-28-2, 48-50 cm.
3. Sample 338-28-2, 48-50 cm.
4. Sample 338-26-5, 63-65 cm.

Figure 5 — *Rhabdonema* sp.
Sample 338-22-2, 65-67 cm.

Figure 6 — *Rhaphoneis* sp.
Sample 338-22-2, 65-67 cm.

Figure 7 — *Rhaphoneis parilis* Hanna.
Sample 338-22-2, 65-67 cm.

Figure 8 — *Sceptroneis grunowii* Anissimova.
Sample 338-26-5, 63-65 cm.

Figure 9 — *Sceptroneis praecaducea* Hajós and Stradner (footpole).
Sample 338-24-2, 86-88 cm.

Figures 10, 11 — *Sceptroneis* sp. (headpole).
10. Sample 338-24-2, 86-88 cm.
11. Sample 338-24-2, 86-88 cm.

Figures 12, 13 — *Sceptroneis* sp. (headpole).
12. Sample 338-24-2, 86-88 cm.
13. Sample 338-22-2, 65-67 cm.

Figure 14 — *Sceptroneis* sp. (headpole).
Sample 338-24-2, 86-88 cm.

Figure 15 — *Rhaphoneis amphiceros* Ehrenberg.
Sample 338-22-2, 65-67 cm.

Figure 16 — *Rhaphoneis parilis* Hanna.
Sample 338-22-5, 51-53 cm.

Figures 17, 18 — *Rhaphoneis amphiceros.*
17. Sample 338-22-2, 65-67 cm.
18. Sample 338-22-5, 51-53 cm.

Figure 19 — *Sceptroneis* sp.
Sample 338-22-2, 65-67 cm.

Figure 20 — *Rhaphoneis amphiceros.*
Sample 338-22-2, 65-67 cm.

Figure 21 — *Sceptroneis praecaducea* Hajós and Stradner.
Sample 338-24-2, 86-88 cm.

Figure 22 — *Rhabdonema* sp.
Sample 338-22-5, 51-53 cm (1200×).

Figure 23 — *Rhabdonema* sp.
Sample 338-22-2, 65-67 cm.

Figure 24 — *Rhaphoneis amphiceros.*
Sample 338-22-5, 51-53 cm (1200×).

Figure 25 — *Rhaphoneis parilis* Hanna.
Sample 338-22-2, 65-67 cm.

Figure 26 — *Rhaphoneis amphiceros.*
Sample 338-22-2, 65-67 cm.

Figure 27 — *Rhabdonema* sp.
Sample 338-22-2, 65-67 cm.

Figures 28-31 — *Rhaphoneis angulata* n. sp.
28. Sample 338-22-2, 65-67 cm.
29. Sample 338-22-2, 65-67 cm.
30. Sample 338-22-5, 51-53 cm.
31. Sample 338-24-2, 86-88 cm.

Figures 32, 33 — *Rhaphoneis* aff. *psammicola* Riznyk.
32. Sample 338-24-2, 86-88 cm.
33. Sample 338-22-5, 51-53 cm.

Figure 34 — *Rhaphoneis* aff. *cocconeides* Schrader.
Sample 338-22-2, 65-67 cm.

Figure 35 — *Cymatosira lorenziana* Grunow.
Sample 338-24-2, 86-88 cm.

Figures 36, 37 — *Rhaphoneis amphiceros* (Ehr.) Ehrenberg.
36. Sample 338-22-0, 35-36 cm.
37. Sample 338-23-3, 116-117 cm.

Figure 38 — *Rhaphoneis* aff. *surirella* (Ehr.) Grunow.
Sample 338-24-1, 34-35 cm.

Figure 39 — Genus and species indet.
Sample 338-23-0, 9-10 cm.

PLATE 23

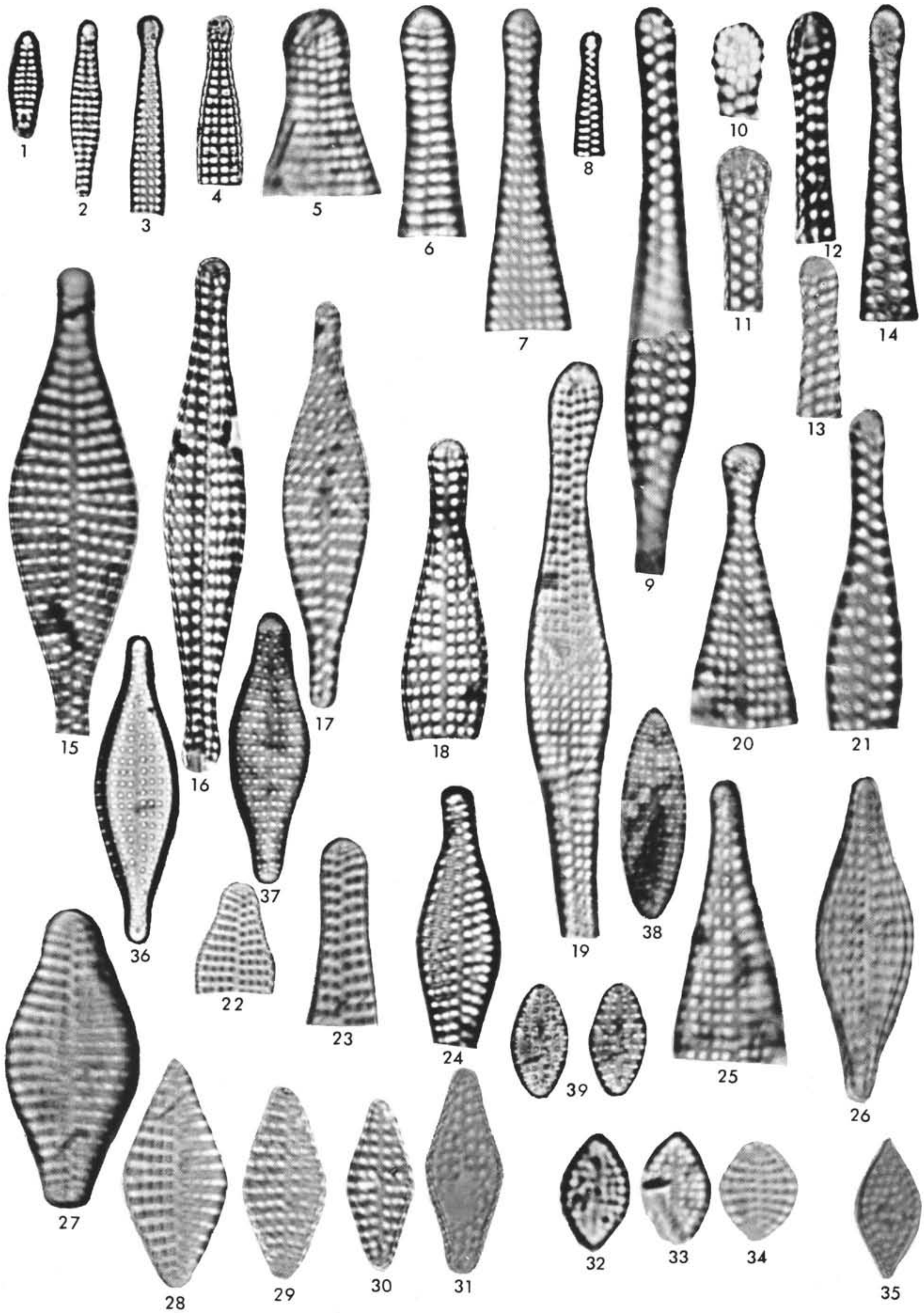
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PLATE 24

Magnification 1500×; Figure 29, 1000×.

Figures 1, 2	*Navicula udintsevii* n. sp. 1. Sample 337-9-5, 100-102 cm. 2. Sample 337-10-5, 120-122 cm (type).
Figure 3	*Navicula sudora* n. sp. Sample 340-3-2, 60-62 cm.
Figure 4	*Navicula bendaensis* n. sp. Sample 338-28-2, 133-134 cm.
Figures 5, 6	*Rouxia obesa* n. sp. 5. Sample 337-9-5, 100-102 cm. 6. Sample 337-10-5, 120-122 cm (type).
Figures 7, 8	*Synedra* sp. 1. Sample 339-6-2, 60-62 cm.
Figures 9, 10	*Thalassionema* aff. *nitzschioides.* 9. Sample 337-10-5, 120-122 cm. 10. Sample 338-24-1, 34-35 cm.
Figures 11-13	*Sceptroneis pupa* n. sp. Sample 338-24-2, 86-88 cm.
Figure 14	*Sceptroneis tenue* (?) n. sp. Sample 339-6-2, 60-62 cm.
Figure 15	*Sceptroneis tenue.* Sample 338-22-5, 51-53 cm.
Figure 16	*Sceptroneis tenue.* Sample 338-22-5, 51-53 cm.
Figure 17	*Sceptroneis humuncia* n. sp. Sample 338-22-2, 65-67 cm.
Figure 18	*Sceptroneis* sp. Sample 339-7-2, 70-72 cm.
Figures 19, 20	*Sceptroneis facialis* n. sp. 19. Sample 338-23-6, 89-90 cm (type). 20. Sample 338-24-2, 86-88 cm.
Figure 21	*Sceptroneis* sp. (footpoles). Samples 338-22-5, 51-53 cm and 338-28-2, 48-50 cm.
Figure 22	*Sceptroneis tenue* n. sp. (footpole). Sample 338-24-2, 86-88 cm.
Figure 23	*Sceptroneis* sp. (footpole). Sample 338-24-2, 86-88 cm.
Figure 24	*Sceptroneis tenue* n. sp. (footpole). Sample 338-24-2, 86-88 cm.
Figure 25	*Sceptroneis humuncia* n. sp. (headpole). Sample 338-22-2, 65-67 cm.
Figure 26	*Sceptroneis humuncia* n. sp. var. *tridens* n. var. Sample 338-22-2, 65-67 cm.
Figures 27-29	*Sceptroneis talwanii* n. sp. 27. Sample 338-22-5, 51-53 cm. 28. Sample 338-24-2, 86-88 cm. 29. Sample 338-22-1, 89-90 cm (type) (1000×).

PLATE 24

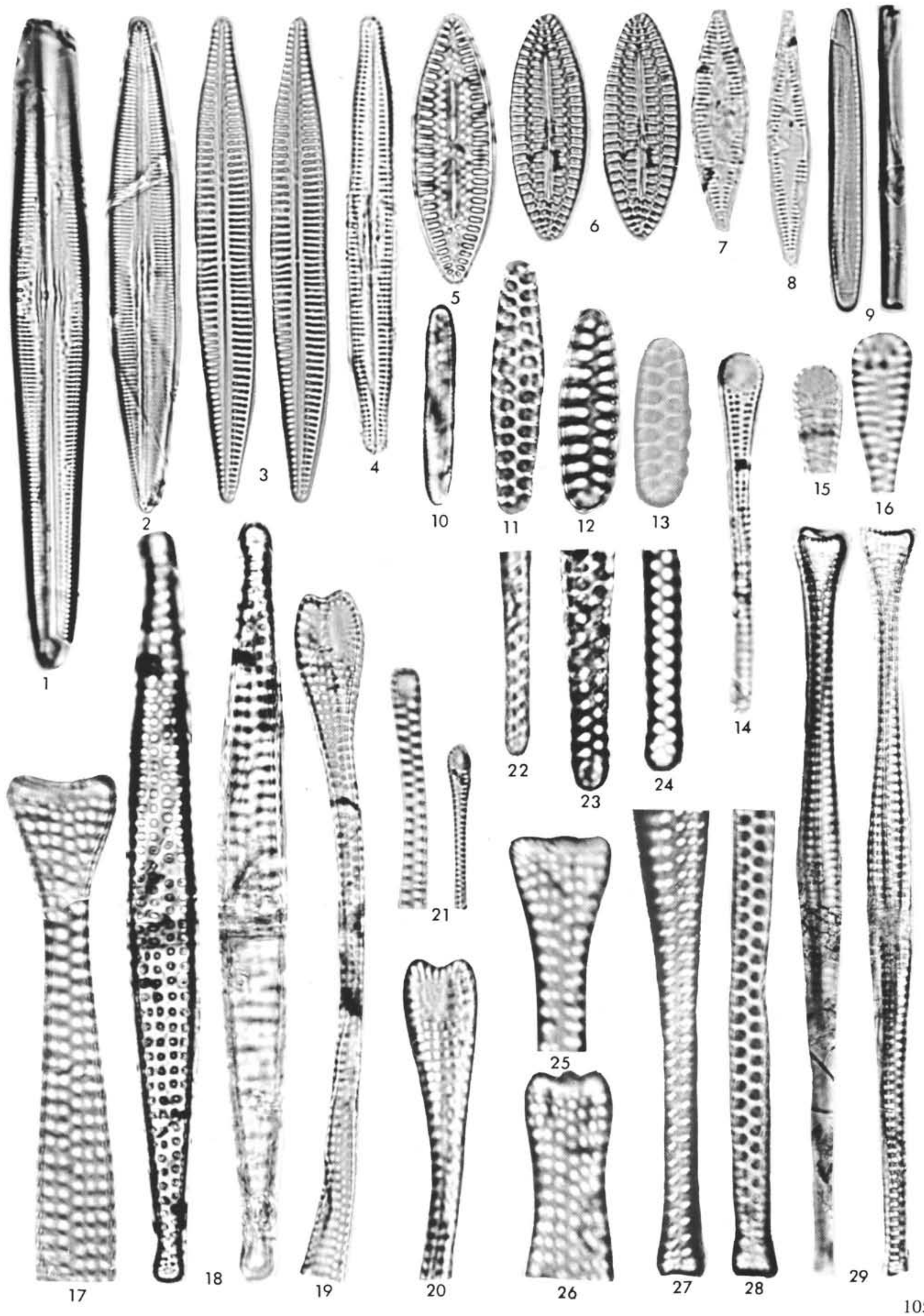

PLATE 25

Magnification 1500×; Figure 32, 1200×.

Figures 1-4	*Sceptroneis vermiformis* n. sp. (2) type. Sample 340-9-5, 60-62 cm.
Figure 5	*Sceptroneis* sp. Sample 338-22-2, 22-23 cm.
Figure 6	*Sceptroneis mayenica* n. sp. (type). Sample 340-11-2, 60-62 cm.
Figure 7	*Sceptroneis grunowii* Anissimova. Sample 337-11-2, 10-12 cm.
Figure 8	*Sceptroneis mayenica* n. sp. Sample 340-3-2, 60-62 cm.
Figure 9	*Sceptroneis grunowii*. Sample 337-10-5, 120-122 cm.
Figures 10, 11	*Sceptroneis pesplanus* n. sp. 10. Sample 340-11-2, 60-62 cm. 11. Sample 340-6-5, 50-52 cm (type).
Figure 12	*Sceptroneis tenue* n. sp. Sample 338-23-2, 13-14 cm.
Figure 13	*Sceptroneis praecaducea* Hajós and Stradner. Sample 338-23-6, 89-90 cm.
Figure 14	*Cymatosira praecompacta* n. sp. Sample 338-22-2, 65-67 cm.
Figure 15	*Cymatosira fossilis* n. sp. Sample 338-22-2, 65-67 cm.
Figures 16-21	*Cymatosira coronata* n. sp. 16. Sample 340-7-2, 100-102 (type). 17. Sample 340-3-2, 60-62 cm. 18-21. Sample 338-26-5, 63-65 cm.
Figures 22-24	*Fragilaria voeringia* n. sp. 22. Sample 338-24-1, 34-35 cm (type). 23. Sample 338-23-2, 104-105 cm. 24. Sample 338-23-0, 9-10 cm.
Figures 25, 26	*Cymatosira* sp. Sample 339-6-2, 60-62 cm.
Figure 27	*Cymatosira* sp. Sample 339-6-6, 60-62 cm.
Figure 28	*Cymatosira fossilis* n. sp. Sample 338-24-2, 86-88 cm.
Figure 29	*Cymatosira praecompacta* n. sp. Sample 338-23-3, 54-55 cm.
Figures 30-32	*Cymatosira compacta* n. sp. 30. Sample 338-24-2, 86-88 cm. 31. Sample 338-22-2, 115-116 cm. 32. Sample 338-22-5, 51-53 cm (1200×).
Figure 33	*Cymatosira* sp. Sample 338-23-1, 135-136 cm.
Figure 34	*Cymatosira* sp. Sample 338-26-5, 63-65 cm.
Figure 35	*Cymatosira* sp. Sample 338-26-5, 63-65 cm.
Figures 36, 37	*Archaeomonadaceae* Genus and species indet. (c). Sample 338-27-1, 71-72 cm.
Figure 38	*Archaeomonadaceae* Genus and species indet. (d). Sample 338-27-3, 59-60 cm.
Figure 39	*Archaeomonadaceae* Genus and species indet. (e). Sample 338-27-3, 59-60 cm.
Figure 40	*Archaeomonadaceae* Genus and species indet. (f). Sample 338-27-3, 59-60 cm.
Figure 41	*Archaeomonadaceae* Genus and species indet. (g). Sample 338-27-2, 40-41 cm.
Figure 42	*Cymatosira* (?) sp. Sample 340-2-2, 60-62 cm.
Figures 43, 44	*Cymatosira* sp. 43. Sample 339-7-2, 70-72 cm. 44. Sample 339-10-2, 80-82 cm.

PLATE 25

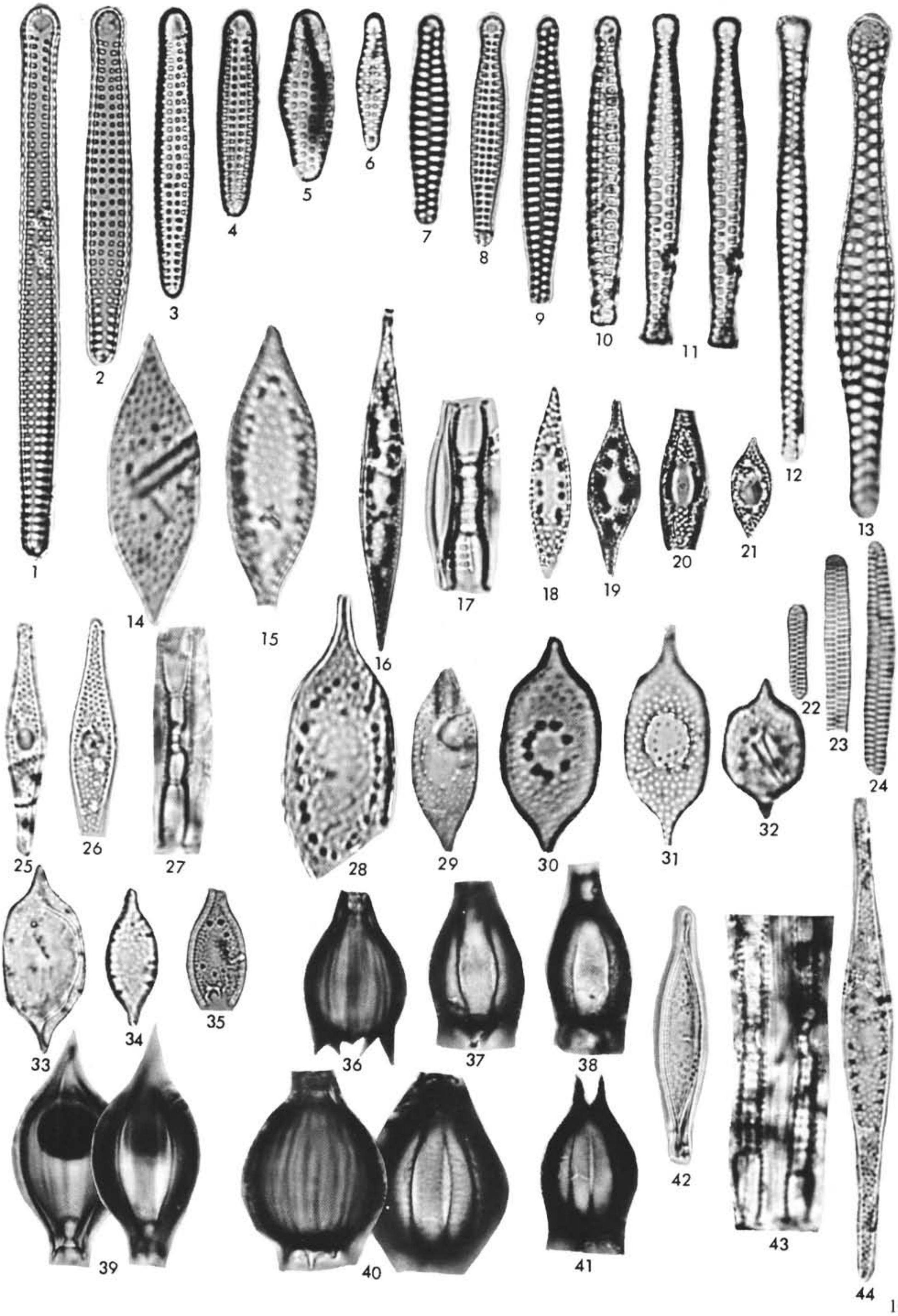
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PLATE 26

Magnification 1500×; Figures 1, 8: 1000×; 9: 1200×.

Figures 1-4	*Triceratium barbadense* Greville. Sample 338-28-2, 48-50 cm (1000×).
Figure 5	*Pseudotriceratium chenevieri* Meister. Sample 338-26-5, 63-65 cm.
Figure 6	*Pseudotriceratium* aff. *chenevieri*. Sample 338-24-2, 86-88 cm.
Figure 7	*Triceratium acutangulum* Strelnikova. Sample 338-26-5, 63-65 cm.
Figures 8, 9	*Pseudotriceratium* aff. *chenevieri*. 8. Sample 338-22-2, 65-67 cm (1000×). 9. Sample 338-22-2, 65-67 cm (1200×).
Figures 10, 11	*Triceratium* sp. 1. Sample 338-26-5, 63-65 cm.
Figure 12	*Triceratium latepes* n. sp. Sample 338-22-2, 65-67 cm (type).

PLATE 26

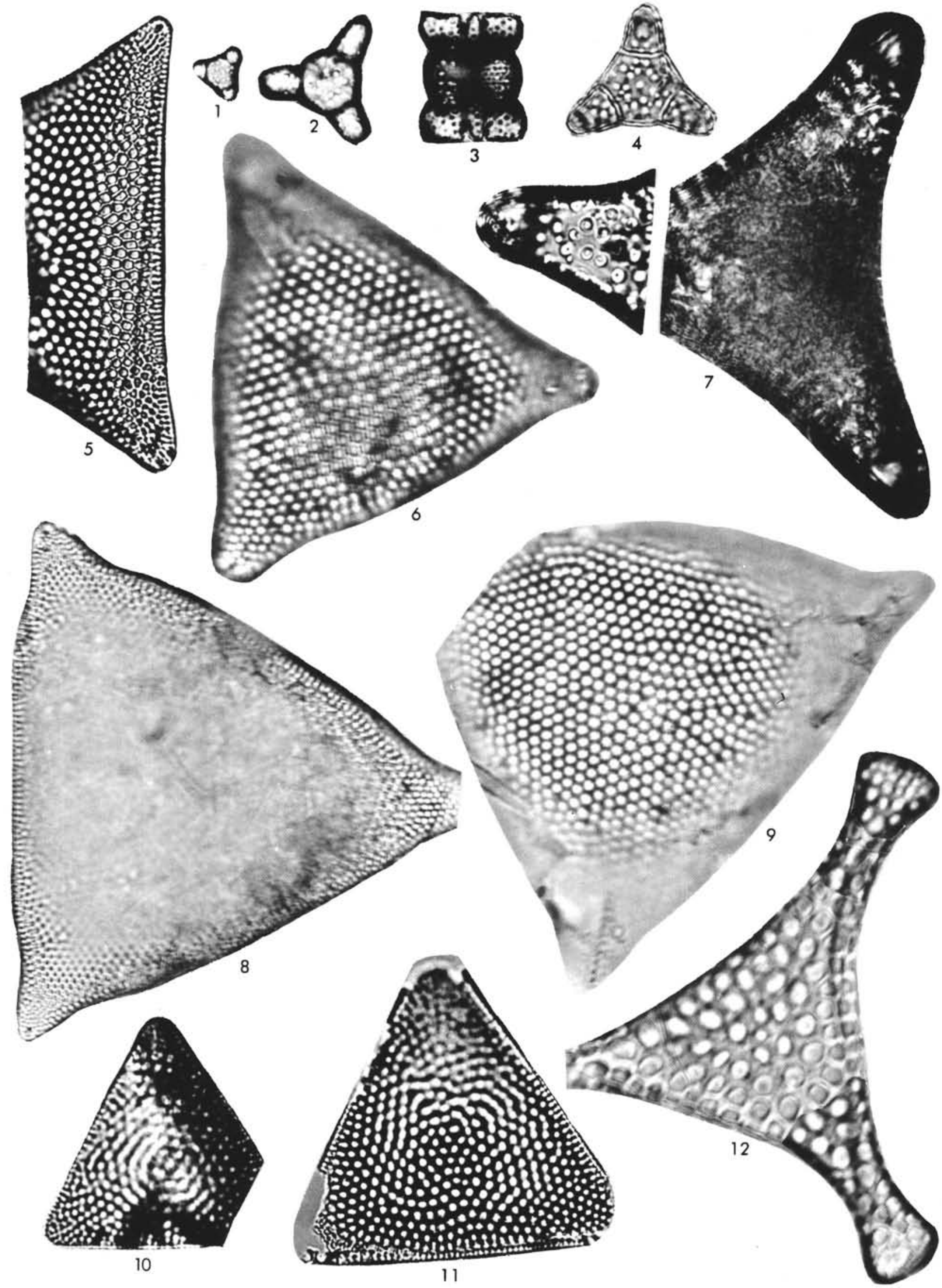


PLATE 27

Magnification 1500×.

Figure 1	*Triceratium* sp. 1. Sample 338-29, CC.
Figure 2	*Triceratium cruciforme* A. Schmidt. Sample 338-22-2, 115-116 cm.
Figure 3	*Triceratium tesselatum* Greville. Sample 338-28-2, 133-134 cm.
Figure 4	*Pseudotriceratium* aff. *chenevieri* (Meister) Gleser. Sample 346-11-4, 40-42 cm.
Figure 5	*Melosira* sp. Sample 338-23-3, 54-55 cm.
Figure 6	*Coscinodiscus vigilans* A. Schmidt. Sample 338-22-1, 89-90 cm.
Figure 7	*Triceratium* sp. 3. Sample 338-27, CC.
Figure 8	*Coscinodiscus praenitidus* n. sp. Sample 338-22-2, 115-116 cm.
Figures 9, 10	*Melosira islandica* (freshwater) O. Müller. 9. Sample 338-22-1, 89-90 cm. 10. Sample 338-24-1, 34-35 cm.
Figures 11, 12	*Cestodiscus muhinae* Jousé. 11. Sample 338-24-1, 34-35 cm. 12. Sample 338-23-3, 116-117 cm.
Figure 13	*Pseudotriceratium* aff. *chenevieri.* Sample 338-24-3, 56-57 cm.
Figures 14, 15	*Triceratium schulzii* Jousé. 14. Sample 338-23-4, 134-135 cm. 15. Sample 338-23-1, 135-136 cm.

PLATE 27

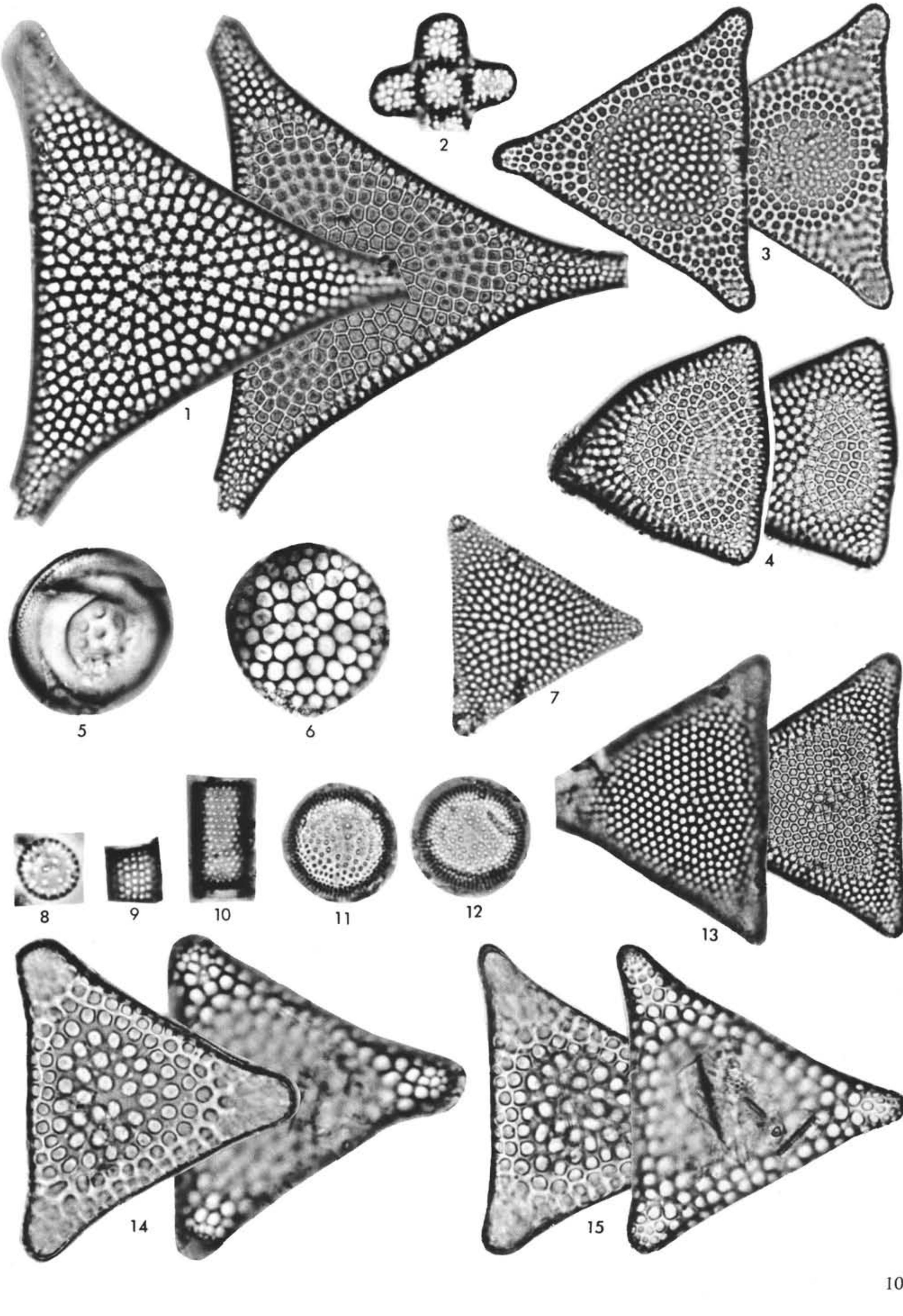


PLATE 28

Magnification 1500×.

Figure 1	*Asteromphalus oligocenicus* n. sp. Sample 338-22-6, 93-94 cm.
Figure 2	*Asterolampra* sp. Sample 337-11-2, 10-12 cm.
Figures 3, 4	*Asterolampra punctifera* (Grove) Hanna. Sample 337-10-2, 90-92 cm.
Figure 5	*Asterolampra* sp. Sample 337-9-5, 100-102 cm.
Figures 6-8	*Asterolampra vulgaris* Greville. 6. Sample 338-26, CC. 7. Sample 339-10-2, 80-82 cm. 8. Sample 338-26-5, 63-65 cm.
Figures 9-11	*Asterolampra praeacutiloba* n. sp. 9. Sample 340-10-6, 60-62 cm. 10. Sample 338-26-5, 63-65 cm (type). 11. Sample 338-26-5, 63-65 cm.
Figure 12	*Asterolampra vulgaris.* Sample 340-10-2, 60-62 cm.

PLATE 28

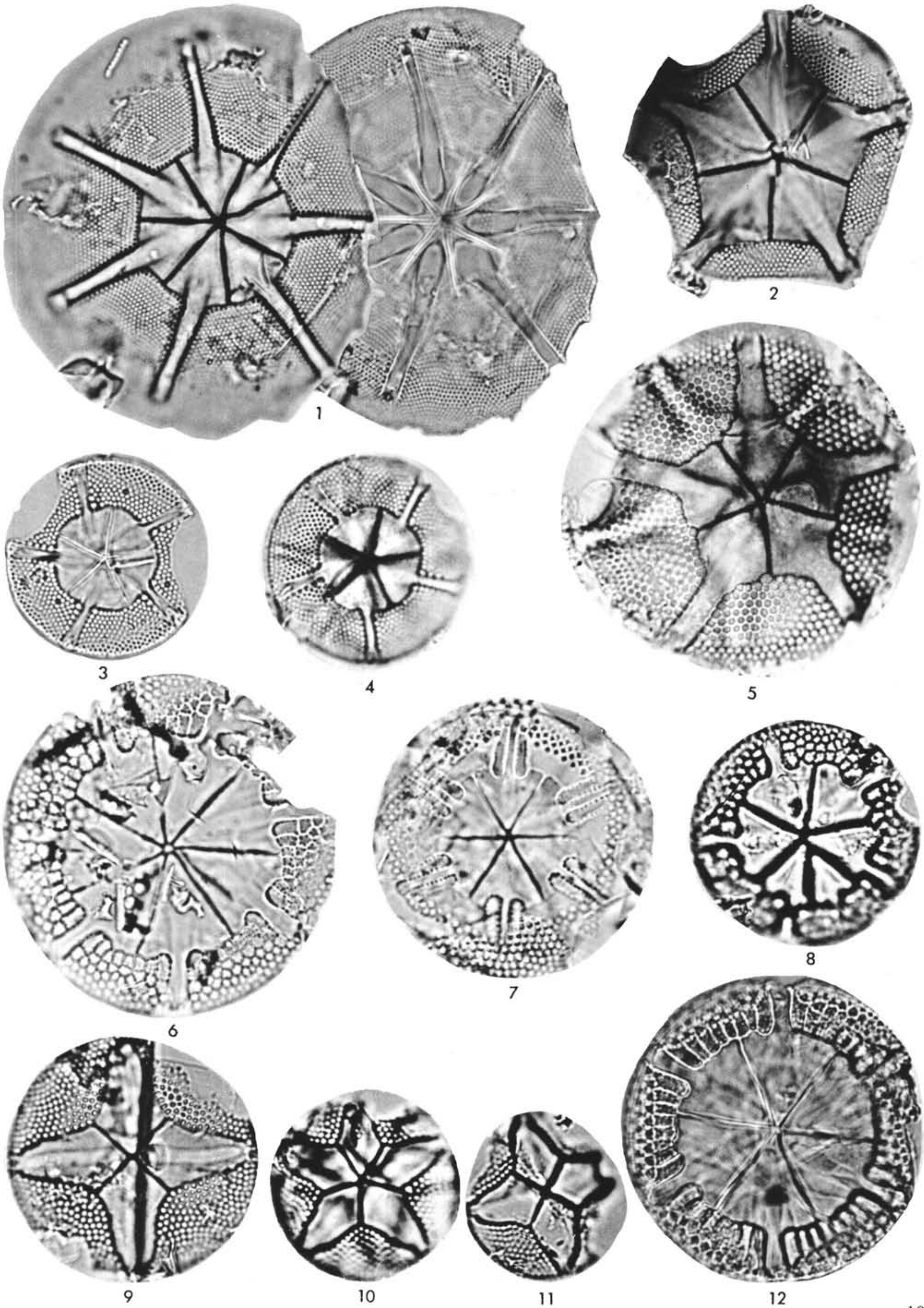


PLATE 29

Magnification 1500×; Figure 4, 700×.

Figures 1, 2 — *Coscinodiscus oligocenicus* Jousé.
1. Sample 343-5-3, 100-102 cm.
2. Sample 339-10-2, 80-82 cm.

Figure 3 — *Coscinodiscus tuberculatus* var. *atlantica* Gleser and Jousé.
Sample 338-23-4, 134-135 cm.

Figure 4 — *Cestodiscus muhinae* Jousé.
Sample 339-6-2, 60-62 cm.

Figures 5, 6 — *Coscinodiscus tuberculatus* var. *atlantica* Gleser and Jousé.
5. Sample 338-23-0, 9-10 cm.
6. Sample 338-23-3, 54-55 cm.

Figures 7, 8 — *Melosira architecturalis* Brun.
Sample 338-28-2, 48-50 cm.

Figure 9 — *Trochosira coronata* n. sp.
Sample 338-28-2, 48-50 cm.

Figures 10, 11 — *Trochosira coronata* n. sp.
10. Sample 338-28-2, 48-50 cm.
11. Sample 338-26-5, 63-65 cm.

Figures 12, 13 — *Coscinodiscus tuberculatus* var. *atlantica* Jousé.
12. Sample 338-22-2, 65-67 cm.
13. Sample 338-22-2, 65-67 cm.

PLATE 29

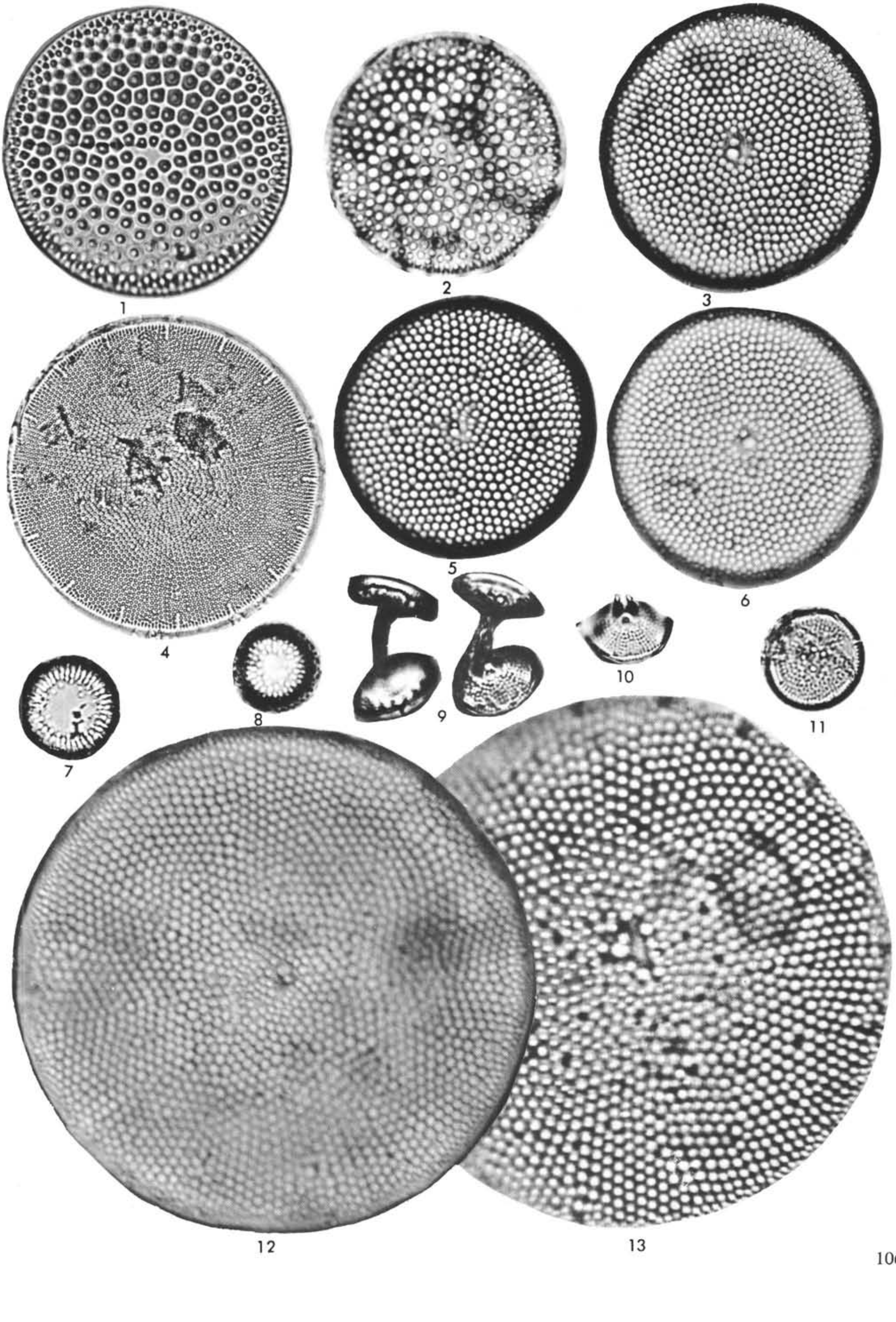


PLATE 30

Magnification 1500×.

Figures 1-10	*Stephanopyxis turris* (Greville and Arnott) Ralfs. 1. Sample 338-28-2, 48-50 cm. 2. Sample 338-26-5, 63-65 cm. 3. Sample 338-22-5, 51-53 cm. 4, 5. Sample 338-28-2, 48-50 cm. 6. Sample 338-26-5, 63-65 cm. 7. Sample 338-24-2, 86-88 cm. 8. Sample 338-22-2, 65-67 cm. 9. Sample 338-28-2, 48-50 cm. 10. Sample 338-24-2, 86-88 cm.
Figure 11	*Stephanopyxis barbadensis* (Greville) Grunow. Sample 338-28-2, 48-50 cm.
Figure 12	*Stephanopyxis* sp. Sample 338-22-5, 51-53 cm.
Figure 13	*Stephanopyxis* sp. Sample 338-22-5, 51-53 cm.
Figure 14	*Stephanopyxis turris* (Greville and Arnott) Ralfs. Sample 338-28-2, 48-50 cm.
Figures 15, 16(?)	*Stephanopyxis barbadensis* (Greville) Grunow. 15. Sample 338-28-2, 48-50 cm. 16. Sample 338-12-6, 90-92 cm.

PLATE 30

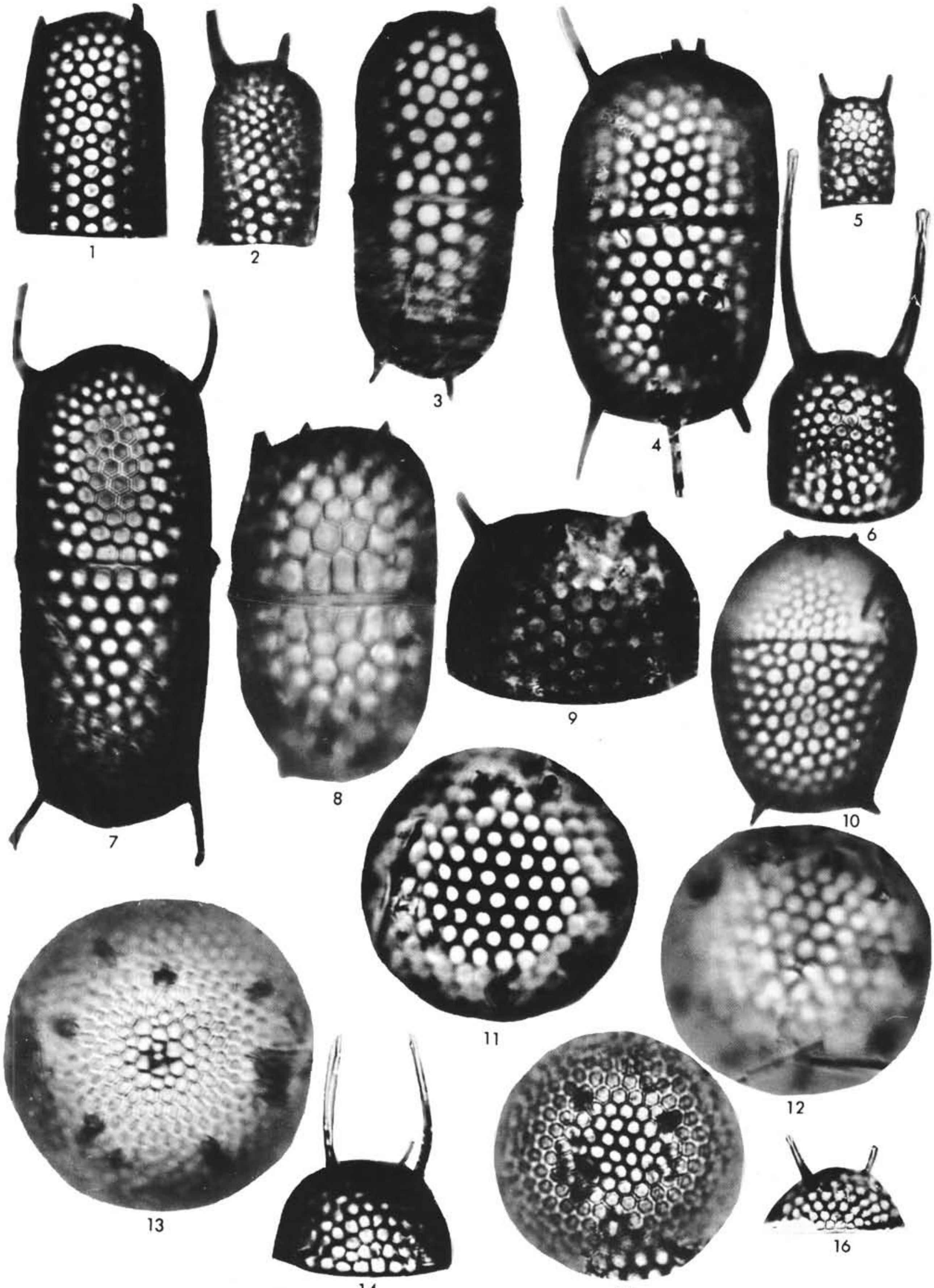


PLATE 31

Magnification 1500×, Figures 3: 750×; 5: 500×.

Figure 1	*Stephanopyxis turris* var. *arctica* Grunow. Sample 338-28-2, 48-50 cm.
Figure 1a	Areola.
Figure 2	*Stephanopyxis* sp. Sample 338-22-2, 65-67 cm.
Figure 3	*Stephanopyxis grunowii* Grove and Sturt. Sample 338-22-2, 65-67 cm (750×).
Figure 4	*Stephanopyxis* aff. *megapora* Grunow. Sample 338-22-2, 65-67 cm.
Figure 5	*Stephanopyxis spinosissima* Grunow. Sample 338-22-2, 65-67 cm (500×).
Figure 6	*Stephanopyxis grossecellulata* Pantocsek. Sample 338-22-2, 65-67 cm.

PLATE 31

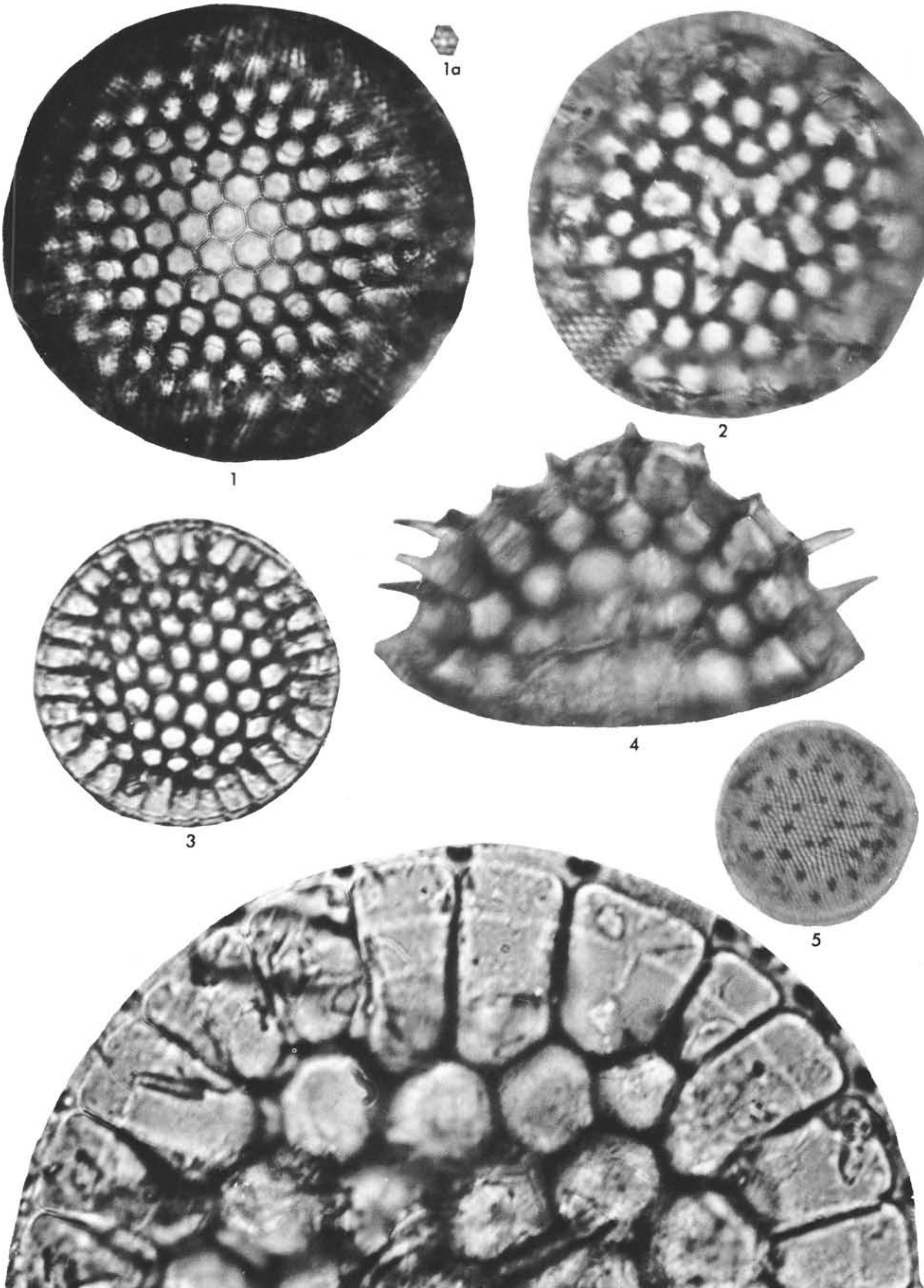
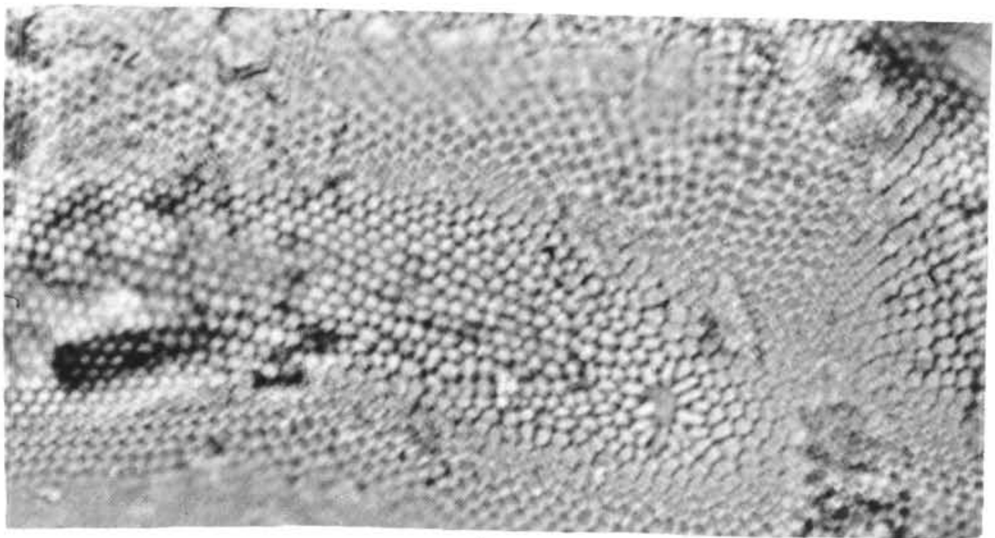


PLATE 32

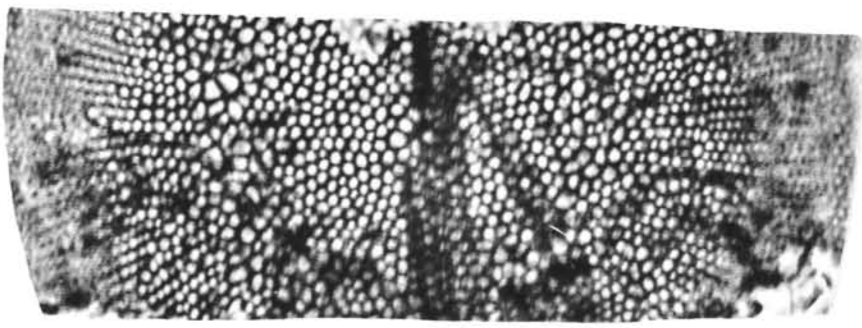
Magnification 1500×, Figure 2, 750×; Figure 4, 1200×.

Figure 1	*Coscinodiscus asteromphalus* var. *princeps* Grunow *in* van Heurck. Sample 338-22-2, 65-67 cm.
Figure 2	*Coscinodiscus asteromphalus* var. *brightwellioides* Grunow. Sample 338-22-5, 51-53 cm (750×).
Figure 3	*Coscinodiscus asteromphalus* var. *princeps.* Sample 338-22-2, 65-67 cm.
Figure 4	*Coscinodiscus* sp. 2. Sample 338-22-2, 65-67 cm (1200×).
Figure 5	*Coscinodiscus* sp. 3. Sample 338-22-2, 65-67 cm.
Figure 6	Central part of a *Coscinodiscus* sp. Sample 338-26-5, 63-65 cm.

PLATE 32

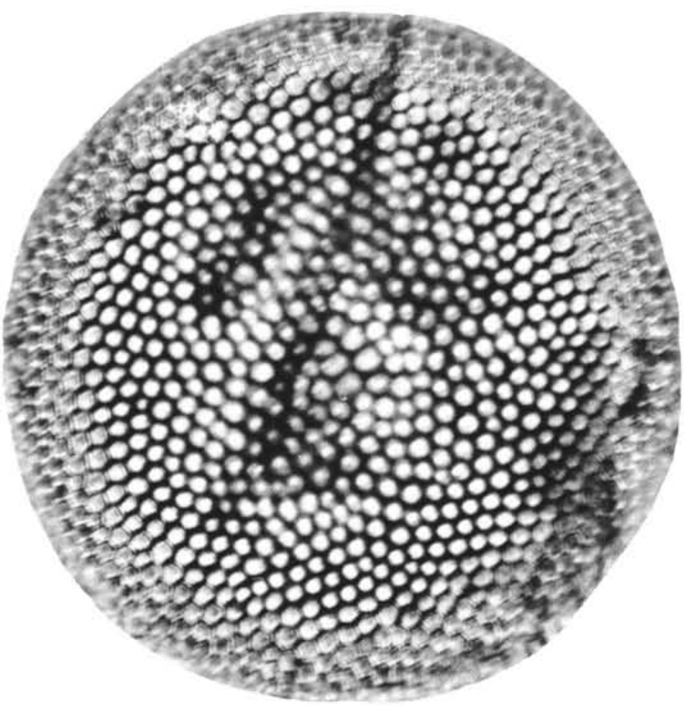


1

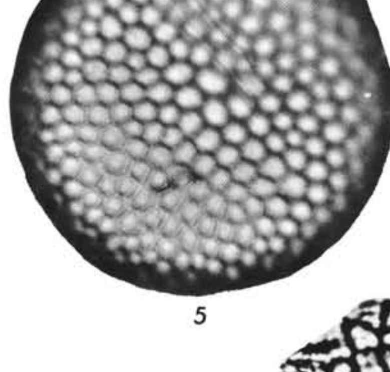


2

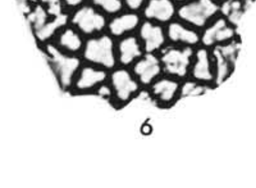
3



4



5



6

PLATE 33

Magnification Figures 1, 3, 6, 1500×; 4, 5, 1200×; 2, 750×.

Figure 1	*Coscinodiscus* aff. *obscurus* A. Schmidt. Sample 338-22-5, 51-53 cm.
Figure 2	*Coscinodiscus* aff. *occulus-iridis* Ehrenberg. Sample 338-22-2, 65-67 cm (750×).
Figures 3, 4	*Coscinodiscus* aff. *argus* Ehrenberg. 3. Sample 338-26-5, 63-65 cm. 4. Sample 338-26-5, 63-65 cm (1200×).
Figure 5	*Coscinodiscus* aff. *radiatus* Ehrenberg. Sample 338-22-5, 51-53 cm (1200×).
Figure 6	Genus and species indet. (8) (broken specimen). Sample 338-22-5, 51-53 cm.

PLATE 33

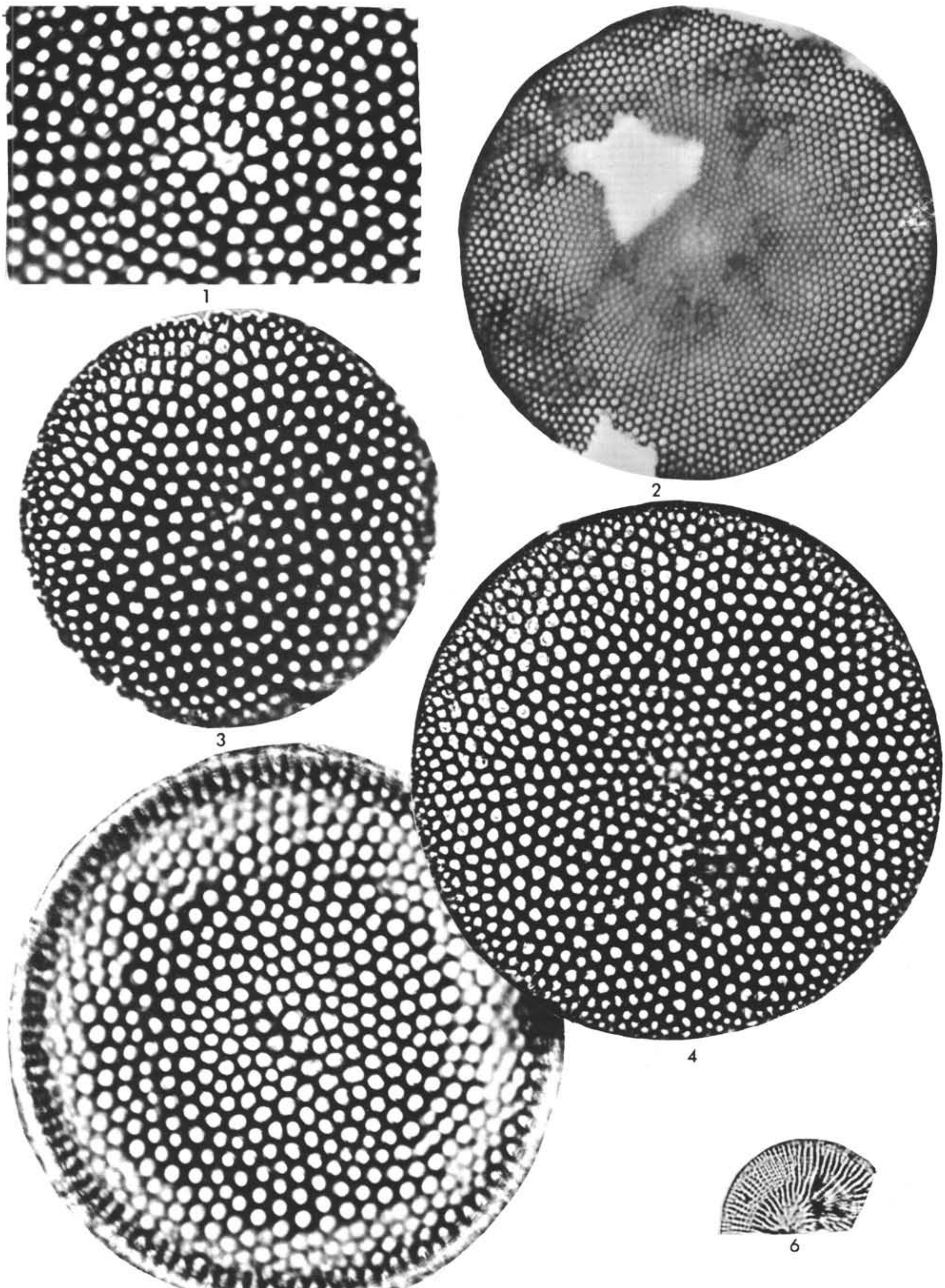


PLATE 34

Magnification Figures 1, 4, 1500×; 3c, 1000×; 2, 3a, b, 750×.

Figure 1	*Coscinodiscus* sp. 1. Sample 338-28-2, 48-50 cm.
Figures 2, 3	*Coscinodiscus asteromphalus* Ehrenberg. 2. Sample 338-24-2, 86-88 cm (750×). 3a, b. Sample 338-24-2, 86-88 cm (750×). 3c. 1000×.
Figure 4	*Coscinodiscus occulus-iridis* Ehrenberg. Sample 338-22-2, 65-67 cm.

PLATE 34

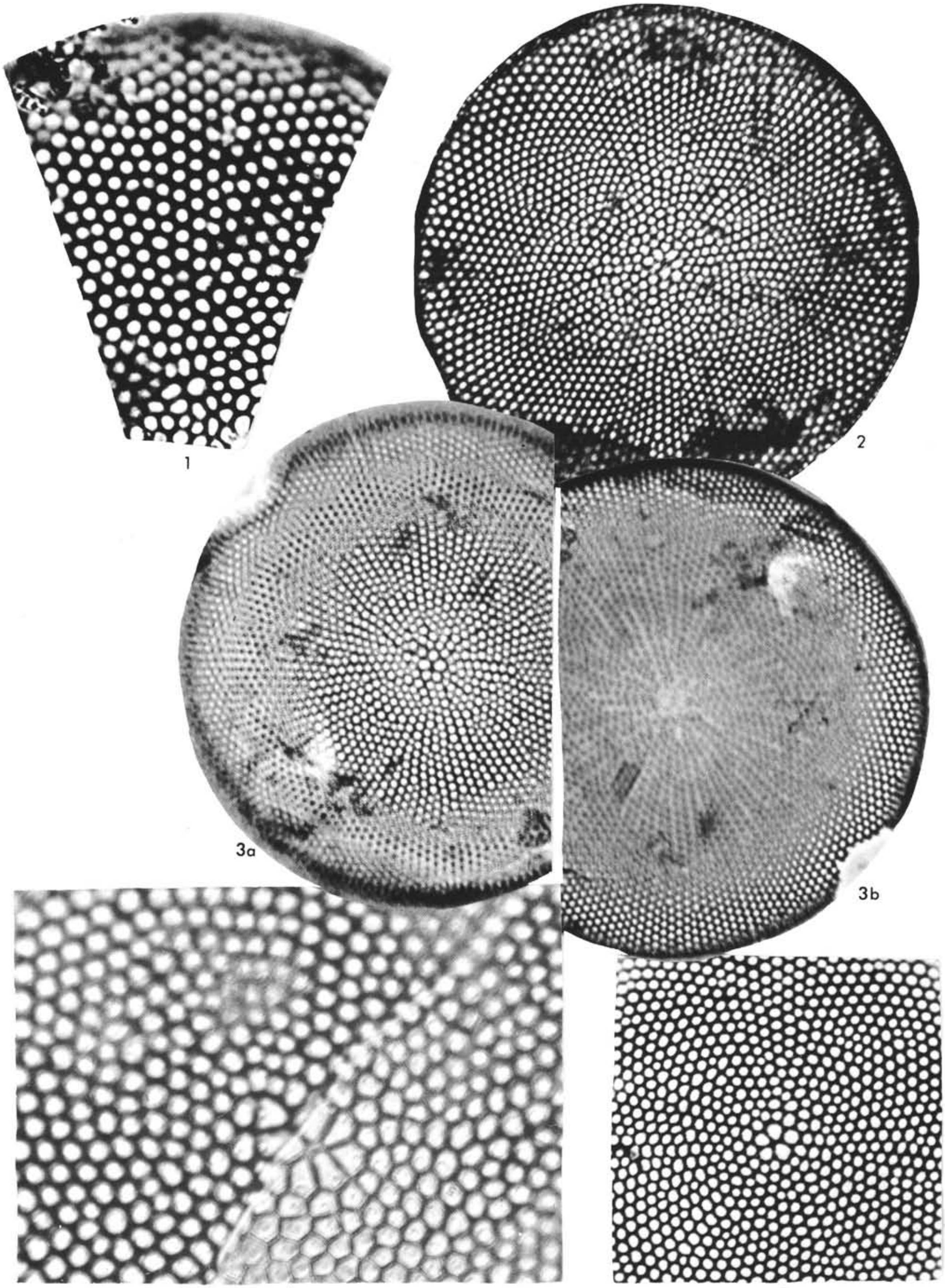


PLATE 35

Magnification 1500×.

Figures 1-3	*Thalassiosira lusca* n. sp. Sample 346-11-4, 40-42 cm (2) type.
Figures 4-6	*Thalassiosira dubiosa* n. sp. Sample 338-28-2, 133-134 cm (6) type.
Figures 7-13	*Trochosira coronata* n. sp. 7, 8. Sample 338-28-2, 30-32 cm. 9. Sample 338-28-2, 133-135 cm. 10, 11. Sample 338-28-2, 30-32 cm. 12, 13. Sample 338-28-2, 133-135 cm.
Figure 14	*Melosira architecturalis* Brun. Sample 338-29, CC.
Figure 15	*Pterotheca* sp. (1). Sample 338-29, CC.
Figure 16	*Pterotheca* sp. (2). Sample 337-10-5, 120-122 cm.
Figures 17, 18	*Pterotheca* sp. (3). Sample 338-27, CC.
Figure 19	*Pterotheca* sp. (4). Sample 338-27, CC.
Figures 20, 21	*Trochosira coronata* n. sp. Sample 338-28-2, 133-135 cm.
Figure 22	*Coscinodiscus* sp. 4. Sample 336-16-2, 57-58 cm.
Figure 23	*Actinoptychus* sp. (*triangular*). Sample 341-7-2, 82-83 cm.
Figure 24	*Coscinodiscus praenitidus* n. sp. Sample 336-18-2, 55-56 cm.
Figures 25, 26	*Pseudostictodiscus picus* (Hanna). Sample 338-27, CC.
Figure 27	*Stictodiscus kittonianus* Greville. Sample 338-28-2, 30-32 cm.
Figure 28	*Pseudostictodiscus picus*. Sample 338-27, CC.

PLATE 35

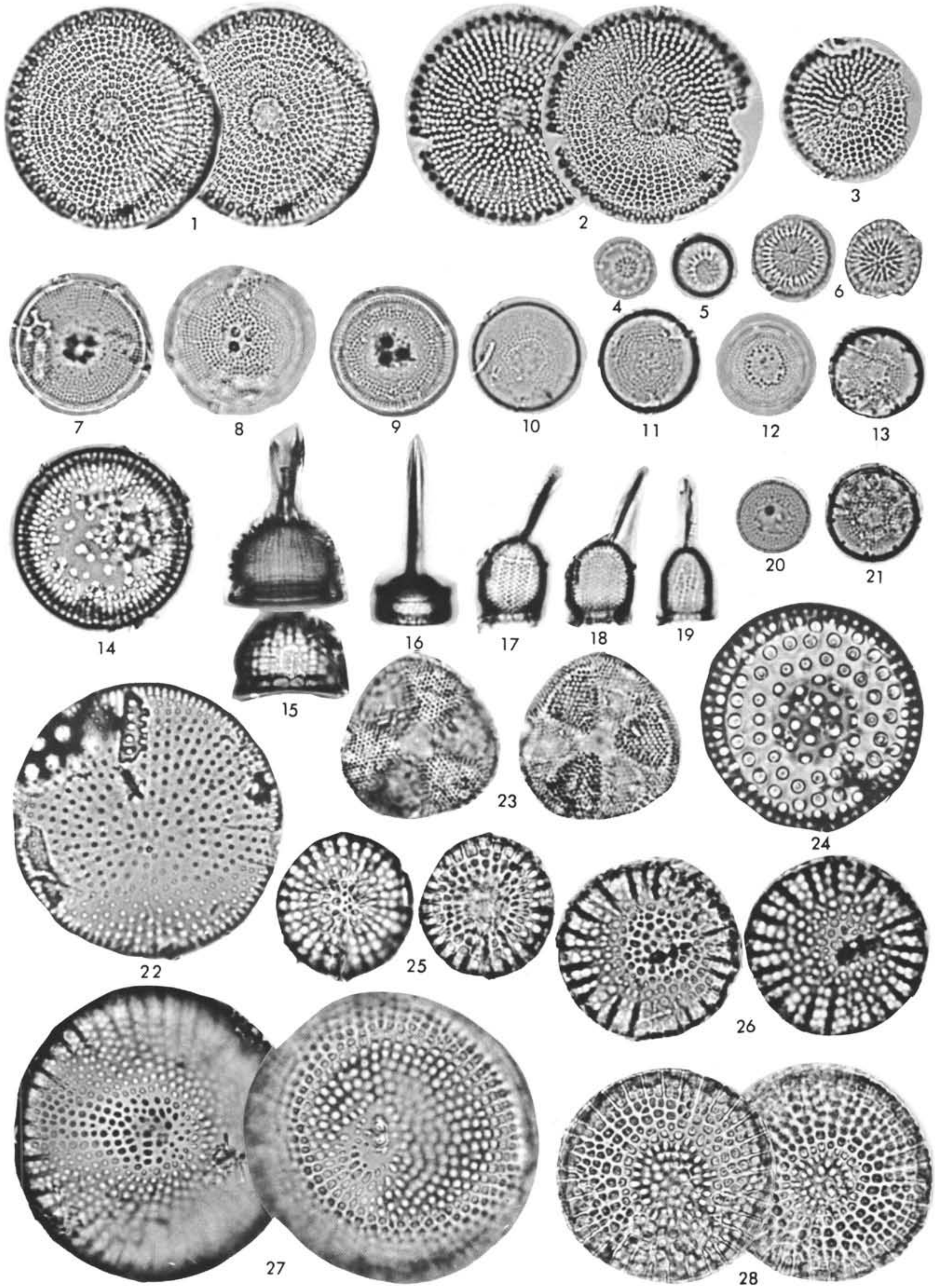


PLATE 36

Magnification 1500×, Figure 11: 1000×.

Figure 1	*Thalassiosira mediaconvexa* n. sp. Sample 339-6-2, 60-62 cm.
Figures 2, 3	*Stictodiscus* sp. Sample 338-26-5, 63-65 cm.
Figure 4	*Coscinodiscus* aff. *capensis* Grunow. Sample 338-24-2, 86-88 cm.
Figure 5	*Coscinodiscus praenitidus* n. sp. Sample 338-22-2, 65-67 cm.
Figures 6a, b	Genus and species indet. (9). 6a. Sample 338-28-2, 48-50 cm. 6b. Sample 338-24-2, 86-88 cm.
Figure 7	*Biddulphia* sp. Sample 340-9-5, 60-62 cm.
Figure 8	*Coscinodiscus* aff. *capensis*. Sample 338-22-2, 115-116 cm.
Figure 9	*Pterotheca* sp. Sample 340-11-2, 60-62 cm.
Figure 10	*Peponia barbadense* Greville. Sample 339-6-2, 60-62 cm.
Figures 11, 12	*Coscinodiscus oblongus* Greville. 11. Sample 338-28-2, 48-50 cm (1000×). 12. Sample 338-28-2, 48-50 cm.
Figure 13	*Peponia barbadense*. Sample 339-6-2, 60-62 cm.

PLATE 36

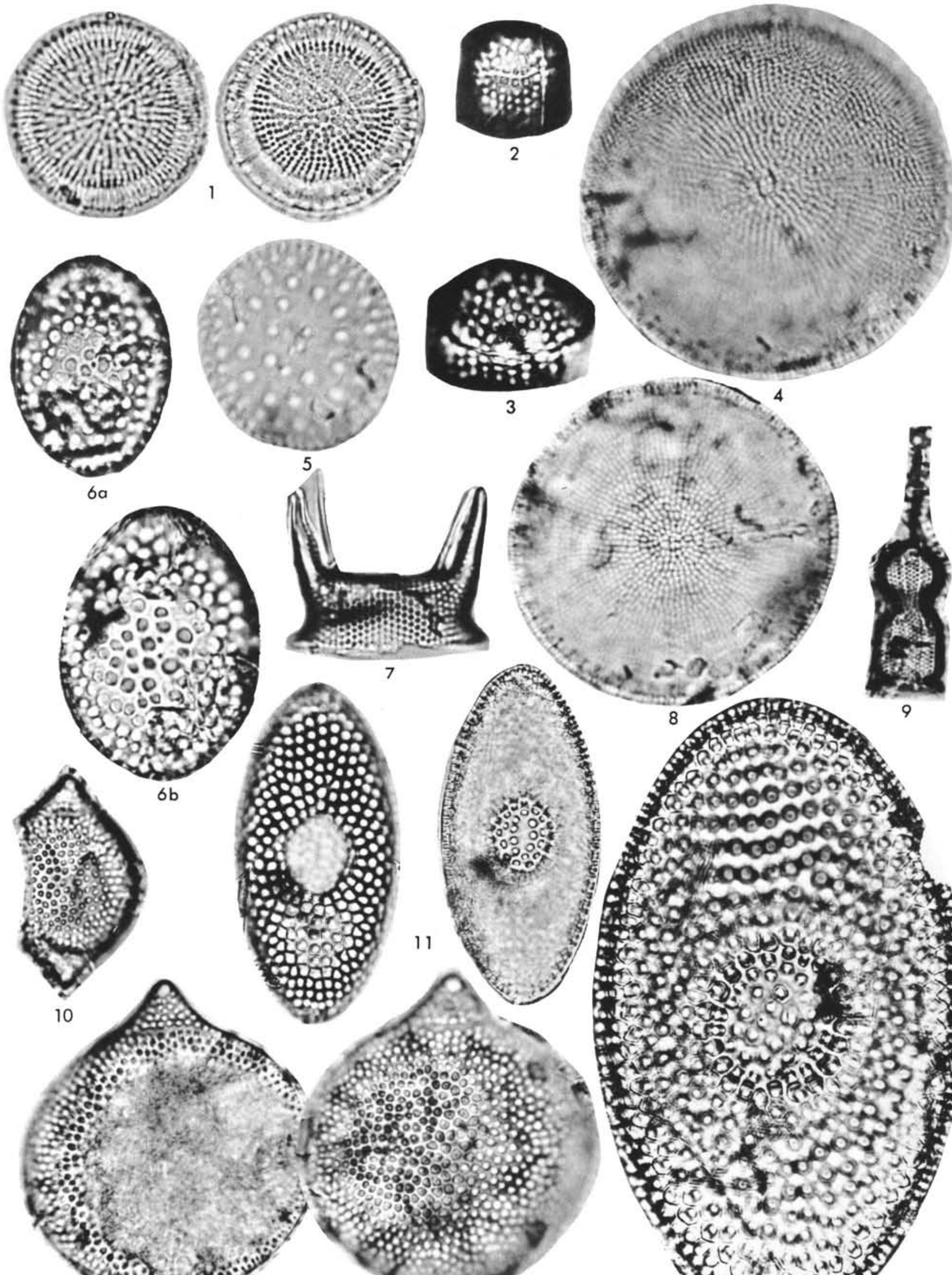


PLATE 37

Magnification 1500×, Figures 1-5, 11-14, 700×.

Figures 1-5	*Goniothecium decoratum* Brun. Sample 346-9-5, 40-42 cm (all figures 700×).
Figure 6	*Goniothecium tenue* Brun var. *structuralis.* Sample 346-11-4, 40-42 cm.
Figure 7	*Goniothecium tenue* Brun. Sample 346-11-4, 40-42 cm.
Figures 8, 9	*Goniothecium tenue* var. *structuralis.* Sample 346-11-4, 40-42 cm.
Figure 10	*Goniothecium tenue.* Sample 346-11-4, 40-42 cm.
Figures 11-14	*Goniothecium decoratum* Brun. Sample 346-9-5, 40-42 cm (all figures 700×). 12, 13. Same individual at different focus in valve view. 14. Same individual at different focus in valve view.
Figure 15	*Rutilaria epsilon* Kitton in litt. Greville (only fragments were observed). Sample 336-18-2, 55-57 cm.
Figure 16	*Rutilaria areolata* Sheshukova. Sample 336-18-2, 55-57 cm.
Figures 17-19	*Stephanopyxis turris.* 17. Sample 338-28-2, 30-32 cm with resting spore of different structure as the vegetative cell. 18. Sample 338-29, CC. 19. Sample 338-27, CC.

PLATE 37

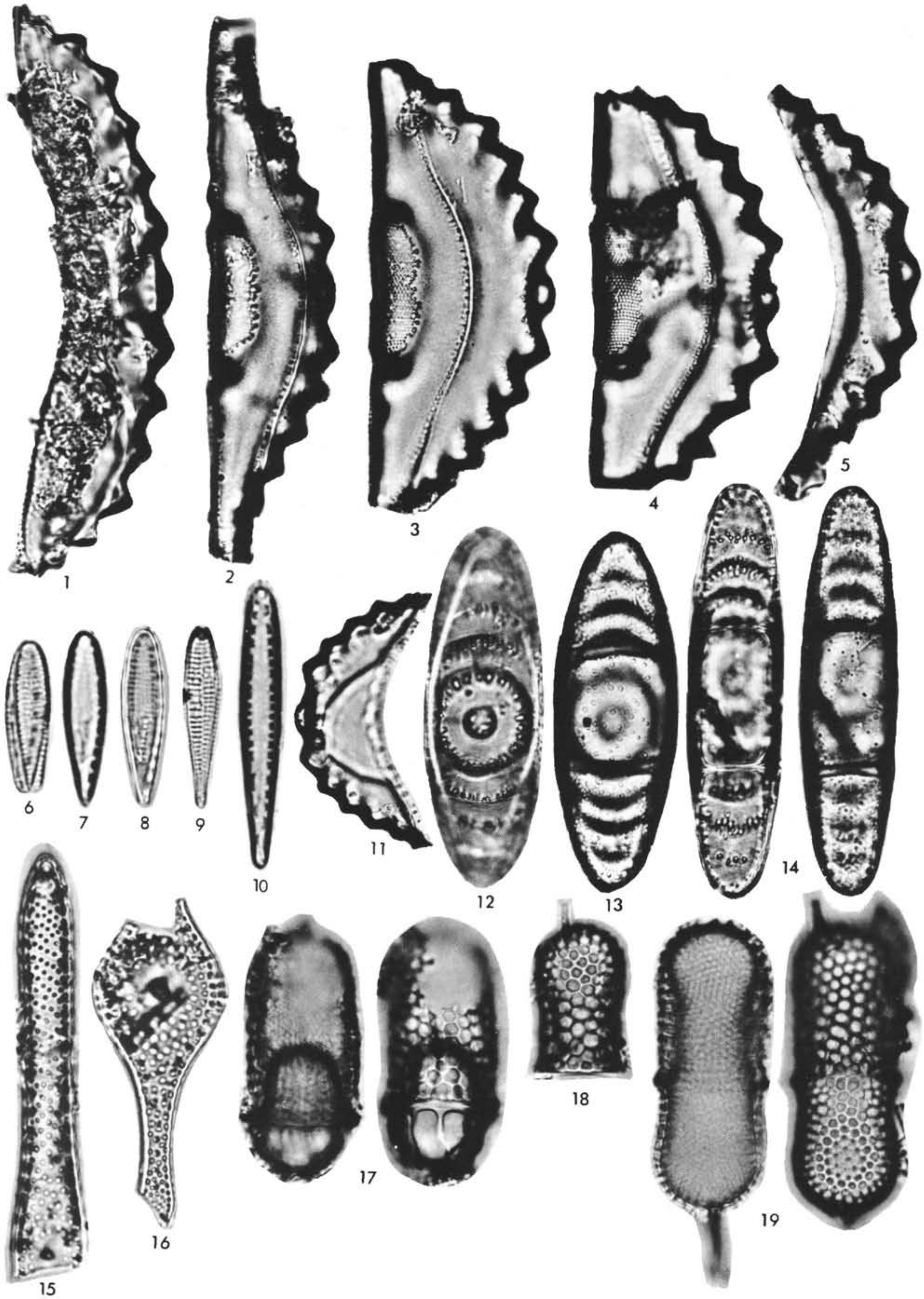


PLATE 38

Magnification 1500×; Figure 5, 1200×.

Figure 1	*Goniothecium loricatum* n. sp. Sample 338-26-5, 63-65 cm (type).
Figure 2	*Chaetoceros* spore. Sample 338-22-2, 65-67 cm.
Figure 3	*Pterotheca* sp. Sample 338-24-2, 86-88 cm.
Figure 4	*Chaetoceros* spore. Sample 338-24-2, 86-88 cm.
Figure 5	*Chaetoceros* sp. (spore). Sample 338-22-2, 65-67 cm (1200×).
Figure 6	*Chaetoceros* sp. (spore). Sample 338-22-2, 65-67 cm.
Figure 7	*Chaetoceros* sp. (spore). Sample 338-24-2, 86-88 cm.
Figure 8	*Chaetoceros* spore. Sample 338-22-5, 51-53 cm.
Figure 9	Resting spore. Sample 338-22-5, 51-53 cm.
Figures 10-12	*Pterotheca reticulata* Sheshukova-Poretzkaya. 10. Sample 338-22-2, 65-67 cm. 11. Sample 338-22-2, 65-67 cm. 12. Sample 338-22-5, 51-53 cm.
Figure 13	*Chaetoceros* spore. Sample 338-22-5, 51-53 cm.
Figures 14-16	*Pterotheca reticulata.* 14. Sample 338-22-2, 65-67 cm. 15. Sample 338-22-2, 65-67 cm. 16. Sample 338-22-2, 65-67 cm.
Figure 17	*Chaetoceros* spore. Sample 338-22-2, 65-67 cm.
Figure 18	*Chaetoceros* spore. Sample 338-22-2, 65-67 cm.
Figure 19	*Chaetoceros* (?)-*Hemiaulus* (?) resting spore. Sample 338-22-2, 65-67 cm.
Figure 20	*Chaetoceros* (?)-*Hemiaulus* (?) resting spore. Sample 338-22-2, 65-67 cm.
Figure 21	*Chaetoceros* (?)-*Hemiaulus* (?) resting spore. Sample 338-22-2, 65-67 cm.
Figure 22	*Chaetoceros* spore. Sample 338-22-5, 51-53 cm.

PLATE 38

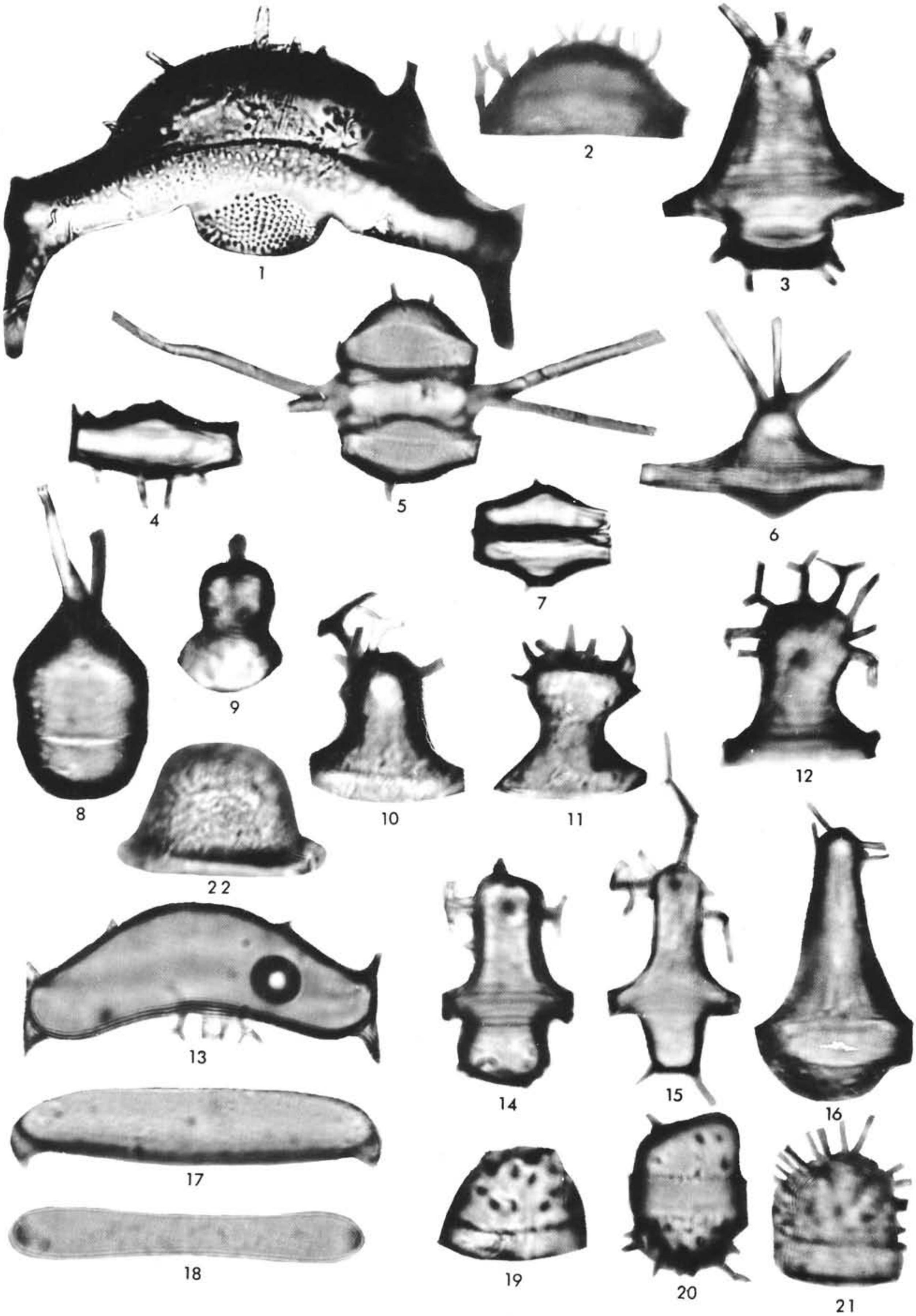


PLATE 39

Magnification 1500×; Figure 4, 500×.

Figures 1, 2	*Stephanogonia* sp. 1. 1. Sample 338-28-2, 48-50 cm. 2. Sample 338-22-5, 51-53 cm.
Figures 3a, b	Genus and species indet. (*Archaeomonadaceae*). Sample 338-26-5, 63-65 cm (same specimen).
Figure 4	*Stephanogonia* sp. Sample 338-22-2, 65-67 cm (500×).
Figures 5, 6	*Pteriptera tetracladia* Ehrenberg. 5. Sample 338-22-2, 65-67 cm. 6. Sample 338-24-2, 86-88 cm.
Figure 7	*Pteriptera* sp. 1. Sample 338-22-2, 65-67 cm.
Figure 8	*Stephanogonia* sp. Sample 338-22-2, 65-67 cm.
Figures 9, 10	*Xanthiopyxis oblonga* Ehrenberg. Sample 338-22-2, 65-67 cm.
Figure 11	Genus and species indet. (*Archaeomonadaceae*). Sample 338-28-2, 48-50 cm.

PLATE 39

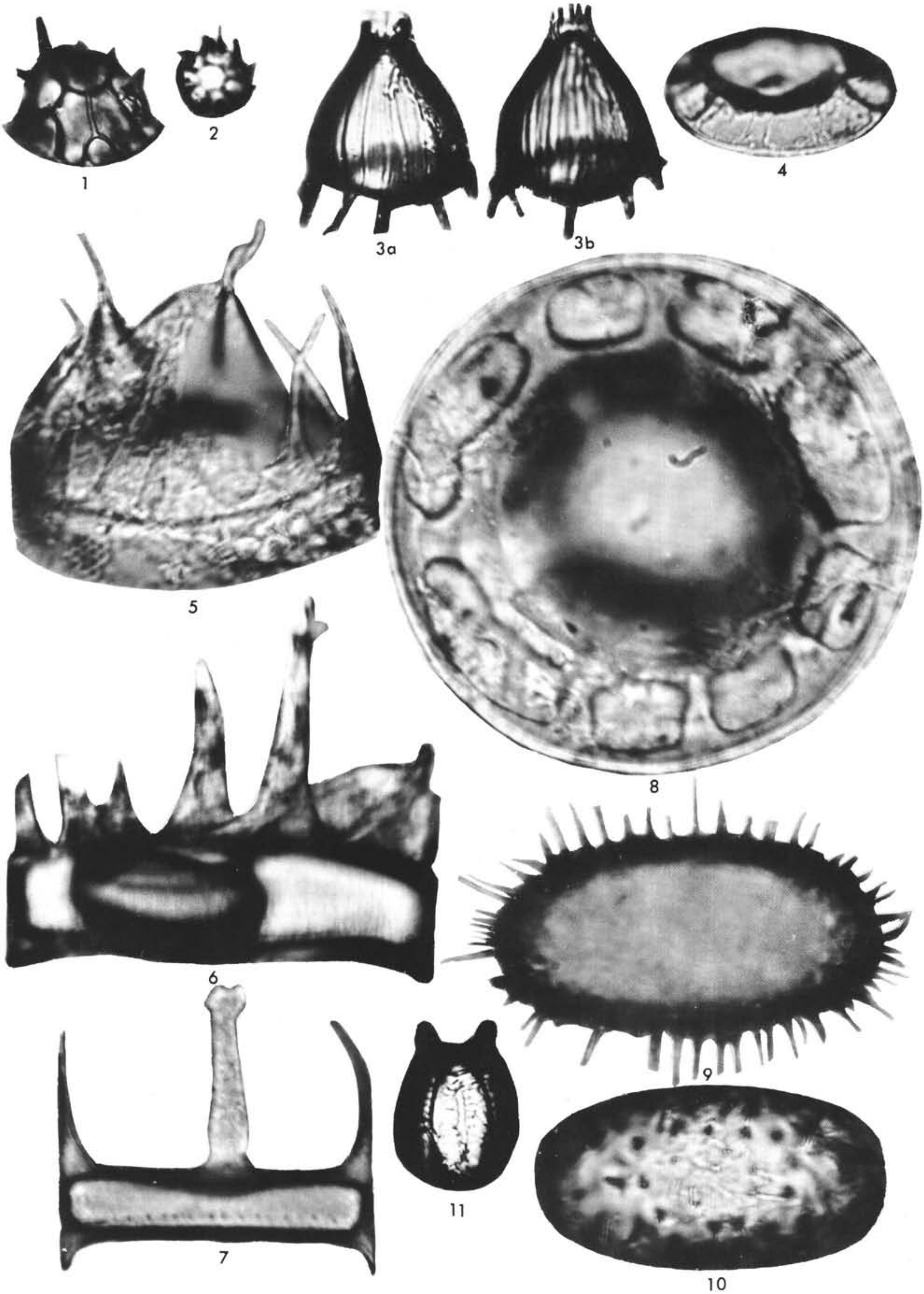


PLATE 40

Magnification 1500×; Figures 3, 1200×; 2a, b, 18, 1000×.

Figure 1 — *Xanthiopyxis ovalis* Lohmann.
Sample 338-22-2, 65-67 cm.

Figures 2a, b — *Xanthiopyxis* sp. A Wornardt.
Sample 338-22-2, 65-67 cm (1000×).

Figure 3 — *Xanthiopyxis* sp. 1 Hajós.
Sample 338-22-5, 51-53 cm (1200×).

Figure 4 — *Xanthiopyxis papillosus* Hajós.
Sample 338-24-2, 86-88 cm.

Figure 5 — *Xanthiopyxis oblonga* Ehrenberg.
Sample 338-24-2, 86-88 cm.

Figure 6 — *Xanthiopyxis* sp.
Sample 338-22-5, 51-53 cm.

Figure 7 — *Xanthiopyxis* sp. 1 Hajós.
Sample 338-22-5, 51-53 cm.

Figure 8 — *Xanthiopyxis* sp.
Sample 338-22-5, 51-53 cm.

Figure 9 — *Chaetoceros* spore.
Sample 338-24-2, 86-88 cm.

Figure 10 — *Liradiscus ovalis* Greville.
Sample 338-22-5, 51-53 cm.

Figures 11, 12 — *Xanthiopyxis papillosus* Hajós.
11. Sample 338-22-5, 51-53 cm.
12. Sample 338-22-2, 65-67 cm.

Figure 13 — *Xanthiopyxis* sp.
Sample 338-22-2, 65-67 cm.

Figure 14 — *Xanthiopyxis* sp.
Sample 338-22-5, 51-53 cm.

Figure 15 — *Xanthiopyxis globosa* Ehrenberg.
Sample 338-22-2, 65-67 cm.

Figure 16 — *Chaetoceros* (?)-*Hemiaulus* (?) resting spore.
Sample 338-22-2, 65-67 cm.

Figure 17 — *Xanthiopyxis globosa.*
Sample 338-22-2, 65-67 cm.

Figures 18, 19 — *Hyalodiscus* aff. *szurdokpuespo<ckiensis* Hajós.
Sample 338-24-2, 86-88 cm (1000×).

PLATE 40

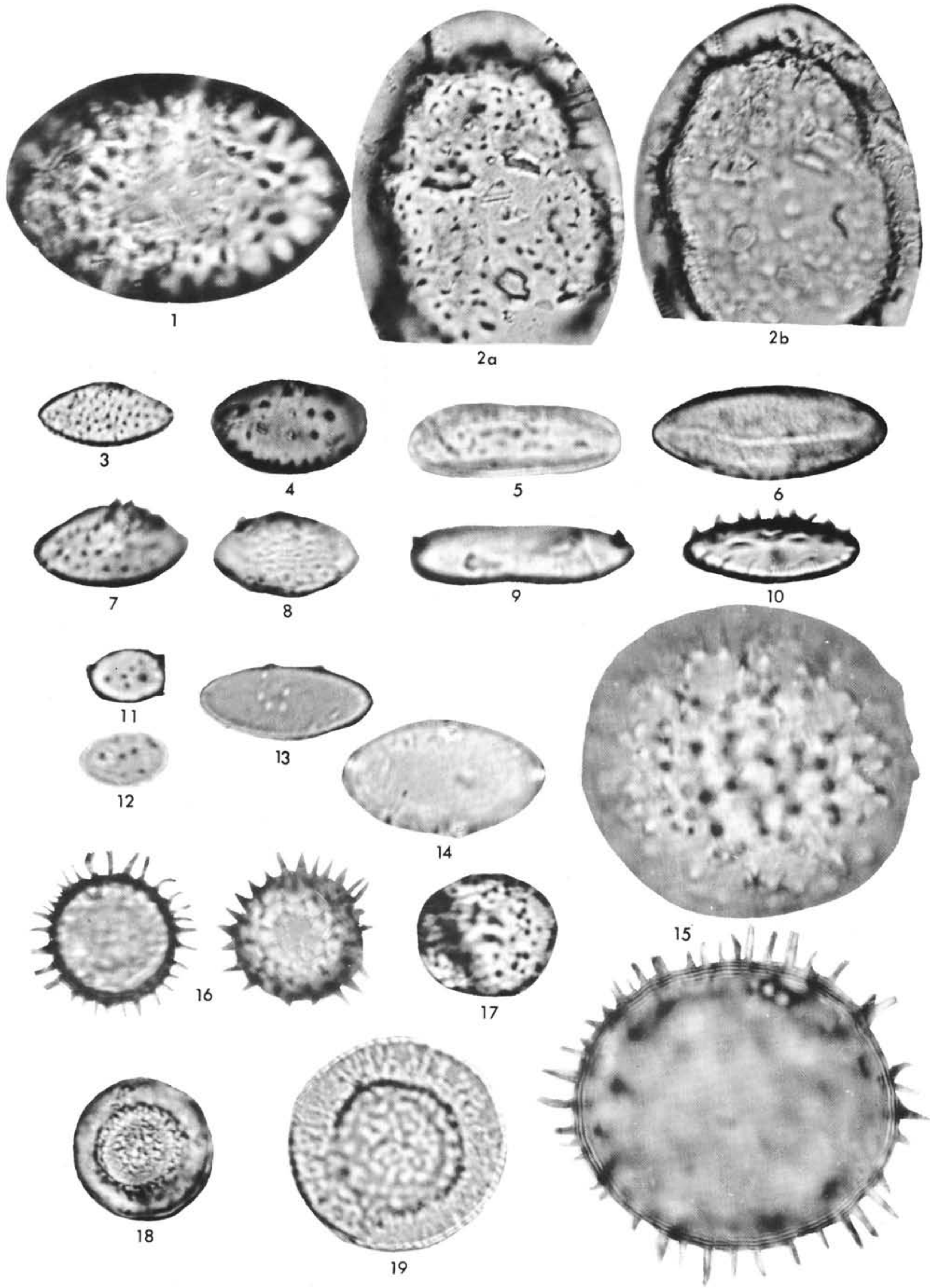


PLATE 41

Magnification 1500×; Figures 1, 2, 4, 6, 7, 9, 12, 19, 700×.

Figure 1	*Riedelia* sp. 1. Sample 338-29, CC (700×).
Figures 2, 3	*Pyrgupyxis oligocaenica* (Jousé) n. comb. 2. Sample 338-28, CC (fragment basal part missing) (700×). 3. Sample 338-28, CC (blowup of top of Figure 2).
Figures 4, 5	*Pterotheca spada* Temp. and Brun. 4. Sample 338-28-2, 133-134 cm (700×). 5. Sample 338-28-2, 133-134 cm.
Figures 6-8	*Riedelia claviger* (A. Schmidt) n. comb. 6. Sample 338-29, CC (700×). 7. Sample 340-8-5, 60-62 cm (700×). 8. Sample 338-28-2, 133-134 cm.
Figure 9	*Riedelia claviger* (A. Schmidt) n. comb. Sample 338-28-2, 133-134 cm (700×).
Figure 10	*Melosira goretzkii* Tschenem. Sample 338-28-2, 30-32 cm (type).
Figure 11	*Rhizosolenia palliola* n. sp. Sample 338-28-2, 133-134 cm (type).
Figures 12, 13	*Pterotheca spada* Temp. and Brun. 12. Sample 338-28-2, 133-134 cm (700×). 13. Sample 338-28-2, 133-134 cm.
Figure 14	*Rhizosolenia bergonii* Peragallo. Sample 336-6-2, 30-32 cm.
Figures 15, 16	*Monobrachia* n. gen. *simplex* n. sp. 15. Sample 338-26, CC. 16. Sample 338-29, CC (genero type).
Figure 17	*Rhizosolenia* aff. *minima* Schrader. Sample 346-11-4, 40-42 cm.
Figure 18	*Monobrachia simplex* n. sp. Sample 338-29, CC.
Figure 19	*Rhizosolenia massiva* n. sp. Sample 336-18-2, 55-56 cm (type) (700×).
Figure 20	*Monobrachia simplex* n. sp. Sample 340-8-5, 60-62 cm (type).

PLATE 41

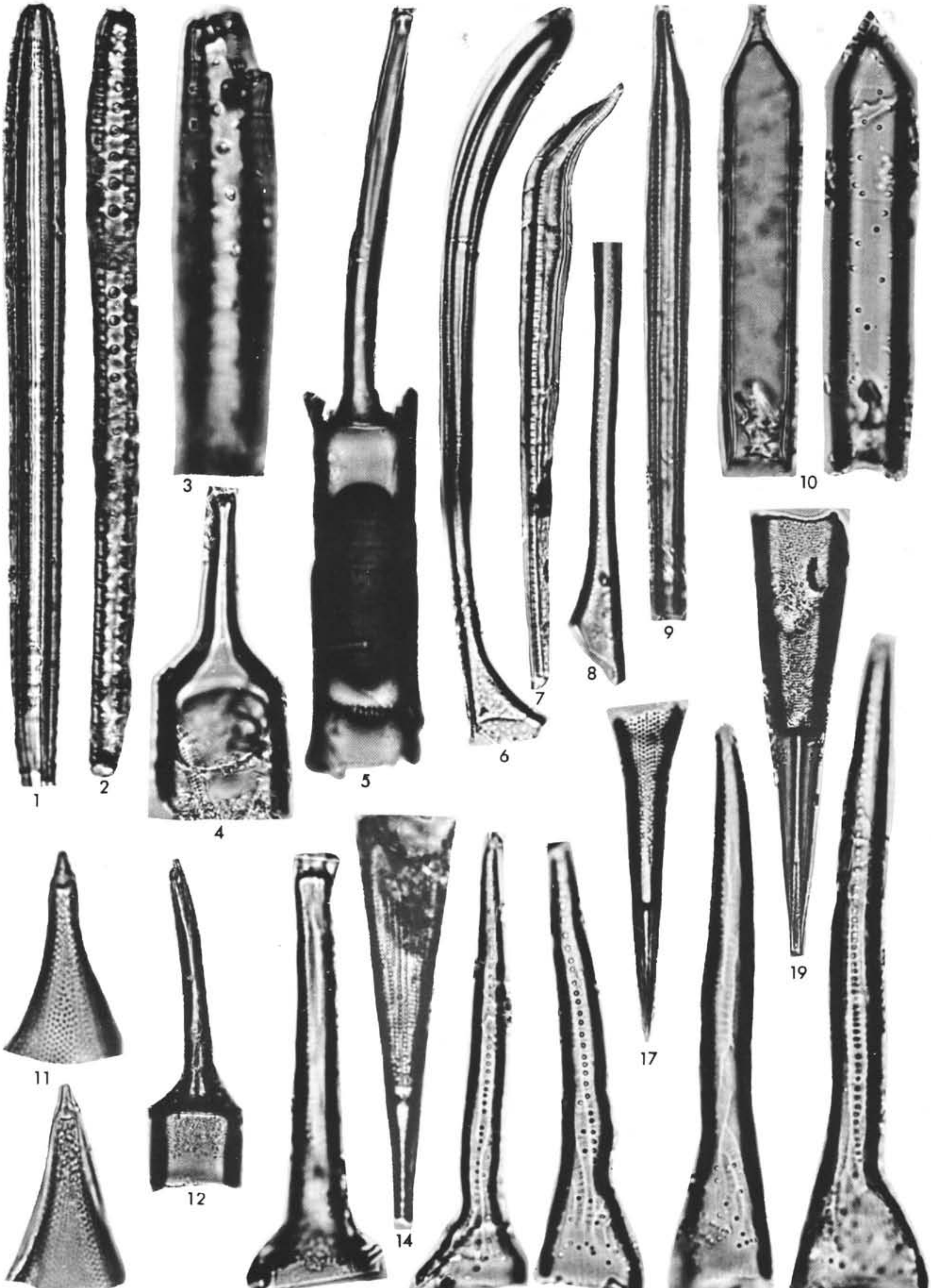


PLATE 42

Magnification 1500×, Figures 1, 3, 11, 13, 14, 700×; 7-9, 1000×; 6, 1200×.

Figure 1	*Riedelia tenuicornis* (Greville), n. comb. Sample 339-6-2, 60-62 cm (700×).
Figure 2	*Monobrachia simplex* (teratological form). Sample 340-11-5, 70-72 cm.
Figure 3	*Riedelia claviger* (A. Schmidt) n. comb. Sample 339-7-2, 70-72 cm (700×).
Figure 4	*Riedelia claviger* (A. Schmidt) n. comb. Sample 338-26-2, 109-110 cm.
Figure 5	*Riedelia* sp. Sample 340-11-5, 70-72 cm.
Figure 6	*Chaetoceros* species bristle. Sample 338-27-3, 59-60 cm (1200×).
Figure 7	*Riedelia claviger* (A. Schmidt) n. comb. Sample 338-26-4, 130-131 cm (1000×).
Figures 8, 9	*Riedelia* sp. Sample 338-26-4, 130-131 cm (1000×).
Figures 10, 11	*Riedelia claviger* (A. Schmidt) n. comb. 10. Sample 339-6-6, 60-62 cm. 11. Sample 339-10-2, 60-62 cm (700×).
Figure 12	*Riedelia claviger* (A. Schmidt) n. comb. Sample 338-27-3, 59-60 cm.
Figures 13, 14	*Monobrachia unicornitus* (Brun) n. comb. Sample 339-10-2, 80-82 cm (700×).
Figure 15	*Riedelia claviger* (A. Schmidt) n. comb. Sample 340-11-5, 70-72 cm.

PLATE 42

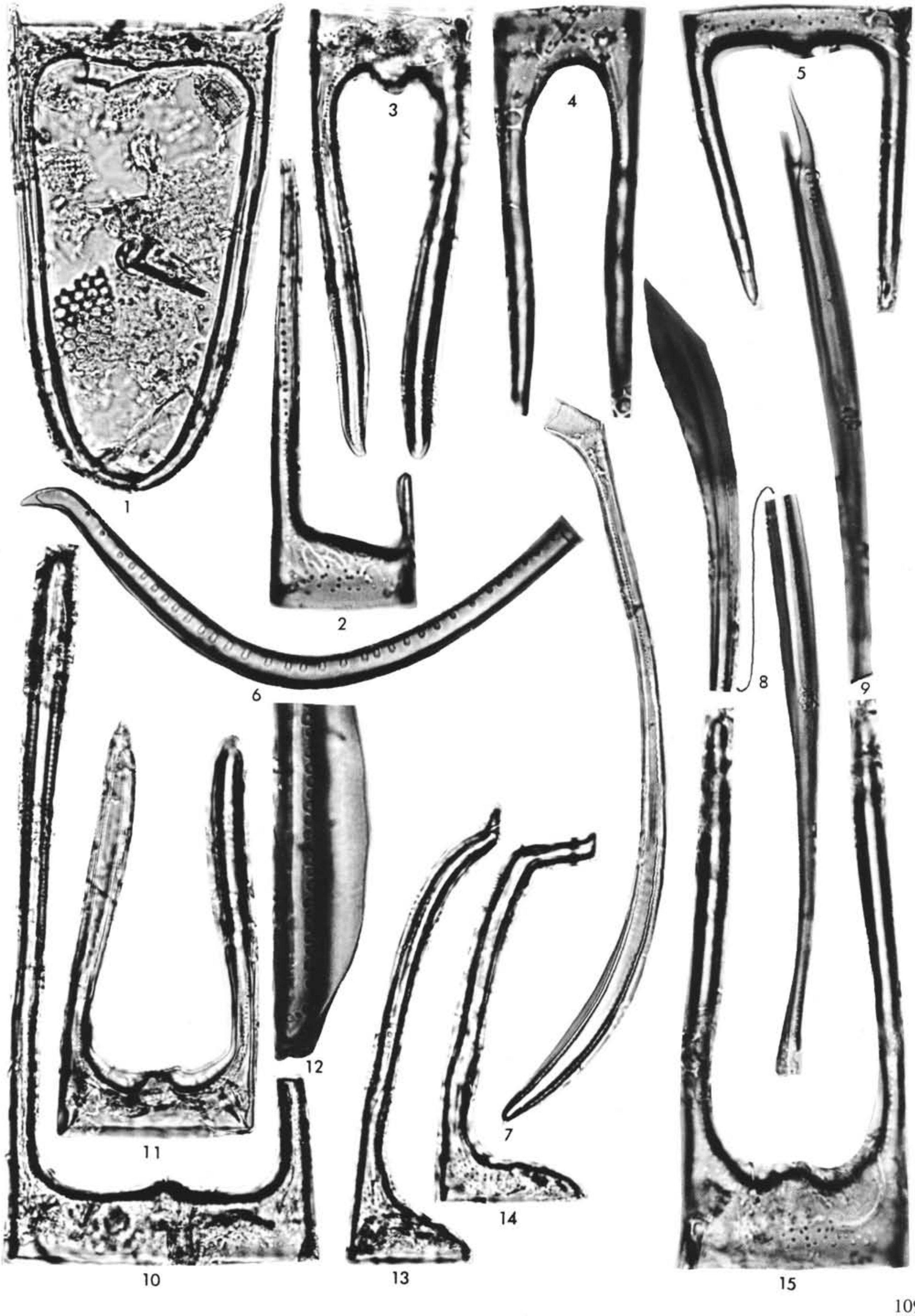


PLATE 43

Magnification 1500×; Figures 18, 500×; 19, 20, 21, 700×.

Figures 1, 2	*Pterotheca aculeifera* Grunow. Sample 338-28-2, 48-50 cm.
Figure 3	*Pterotheca aculeifera* Grunow. Sample 338-28-2, 48-50 cm.
Figure 4	*Pterotheca aculeifera* Grunow. Sample 338-28-2, 48-50 cm.
Figure 5	*Pterotheca* sp. (*simplex*). Sample 338-27-2, 40-41 cm.
Figure 6	*Pterotheca* sp. (*simplex*). Sample 338-27-2, 134-135 cm.
Figure 7	*Pterotheca* sp. (*simplex*). Sample 338-27-4, 57-58 cm.
Figure 8	*Pterotheca* sp. (*simplex*). Sample 338-27-2, 40-41 cm.
Figure 9	*Hemiaulus pungens* Grunow. Sample 338-26-2, 109-110 cm.
Figures 10, 11	*Hemiaulus curvatulus* Strelnikova. 10. Sample 338-28-2, 30-31 cm. 11. Sample 338-26-4, 130-131 cm.
Figure 12	*Pseudopyxilla carinifera* (Grunow) Forti. Sample 338-22-2, 65-67 cm.
Figure 13	*Pterotheca* sp. Sample 338-22-2, 65-67 cm.
Figure 14	*Pterotheca* sp. Sample 338-22-1, 89-90 cm.
Figure 15	*Hemiaulus* sp. Sample 340-10-6, 60-62 cm.
Figure 16	*Chasea ornata* Hajós and Stradner. Sample 338-22-2, 65-67 cm.
Figures 17-19	*Pyrgupyxis oligocaenica* (Jousé) n. comb. 17. Sample 338-23-4, 92-93 cm. 18. Sample 338-27-3, 59-60 cm (500×). 19. Sample 343-5-4, 25-27 cm (700×).
Figures 20, 21	*Pyrgupyxis oligocaenica* (Jousé) n. comb. Sample 343-5-3, 100-102 cm (700×).
Figure 22	*Pyrgupyxis oligocaenica* (Jousé) n. comb. Sample 340-11-5, 70-72 cm.
Figure 23	*Pyrgupyxis* aff. *gracilis* (Temp. and Forti) Hendey. Sample 340-11-2, 60-62 cm.

PLATE 43

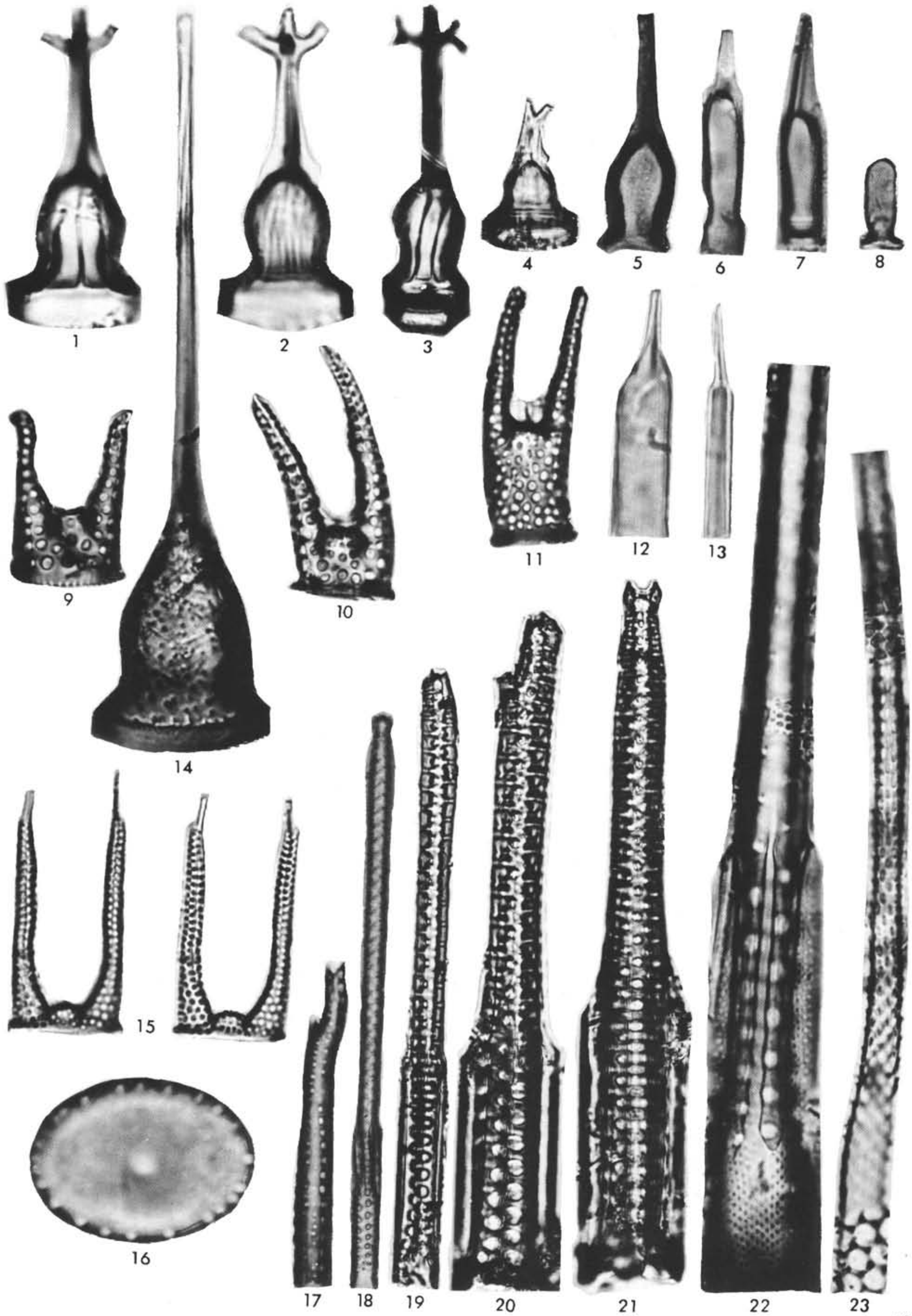


PLATE 44

Magnification 1500×; Figures 13, 1000×; 9, 750×.

Figure 1	*Melosira goretzkii* Tscherem. Sample 338-27-3, 137-138 cm.
Figure 2	*Pseudopyxilla rossica* (Pant.) Forti. Sample 338-24-1, 34-35 cm.
Figure 3	*Pseudopyxilla baltica* (Grunow) Forti. Sample 338-26-5, 63-65 cm.
Figure 4	*Pseudopyxilla rossica.* Sample 338-23-3, 116-117 cm.
Figure 5	*Pseudopyxilla rossica* (?). Sample 338-27-4, 57-58 cm.
Figure 6	*Pseudopyxilla baltica.* Sample 338-22-2, 65-67 cm.
Figure 7	*Goniothecium coronatum* n. sp. Sample 338-24-1, 34-35 cm.
Figure 8	*Pseudopyxilla* sp. Sample 338-27-3, 59-60 cm.
Figure 9	*Pseudopyxilla baltica* (Grunow) Forti (1909). Sample 338-26-5, 63-65 cm (750×).
Figures 10, 11	*Goniothecium odontella* var. *danicum* Grunow. Sample 343-5-3, 100-102 cm.
Figure 12	*Pseudopyxilla directa* (Pantocsek) Forti. Sample 338-22-2, 65-67 cm.
Figures 13, 14	*Pseudopyxilla dubia* (Grunow) Forti. 13. Sample 338-28-2, 48-50 cm (1000×) 14. Sample 338-28-2, 48-50 cm.

PLATE 44

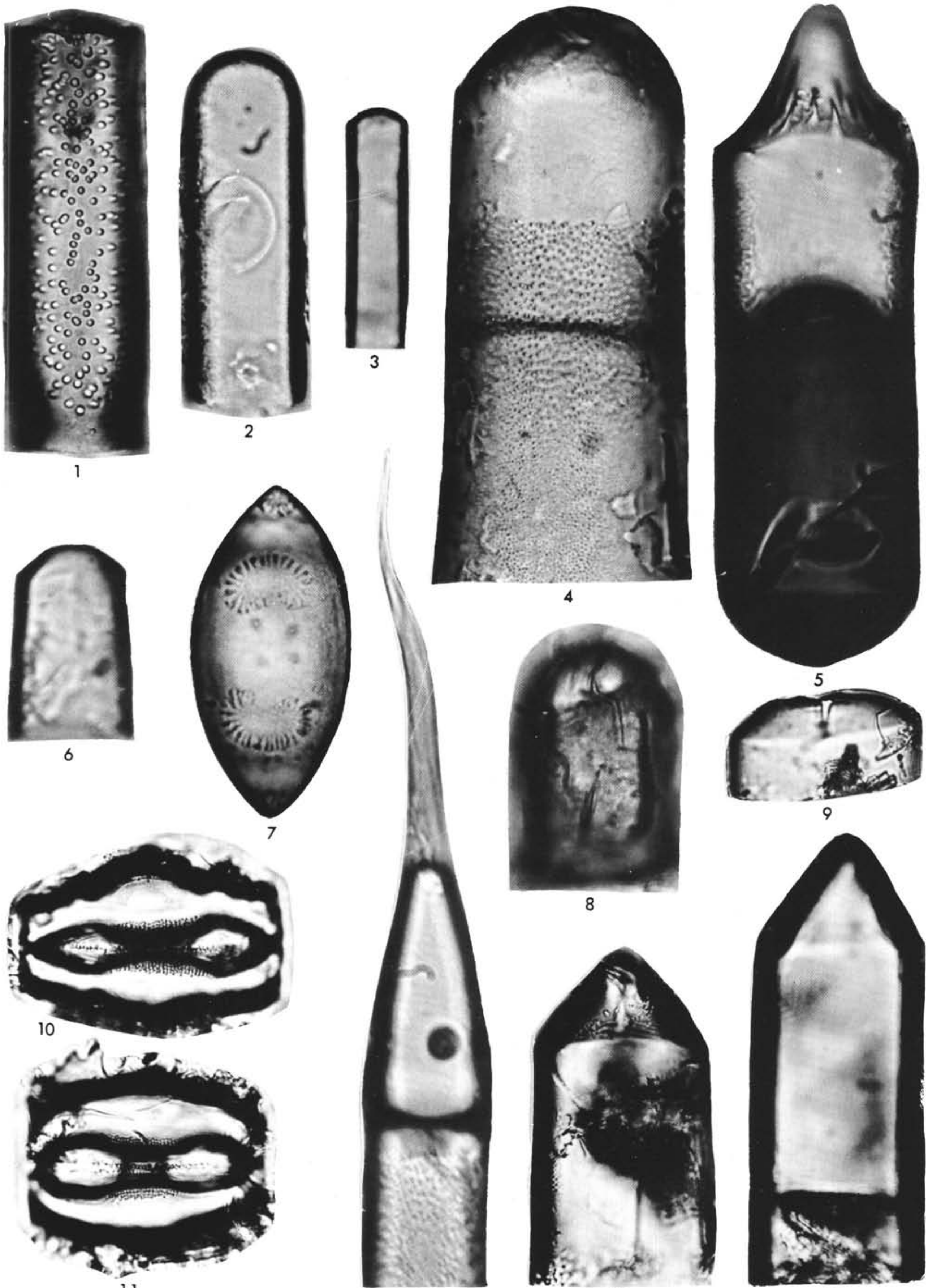


PLATE 45

Magnification 1500×; Figures 2, 3, 750×;
5, 18, 1000×; 19, 21, 1200×.

Figure 1	Genus and species indet. 7. Sample 338-26-5, 112-113 cm.
Figures 2, 3	*Stephanogonia* sp. 2. Sample 338-22-0, 35-36 cm (750×). 3. Sample 338-22-2, 85-87 cm (750×).
Figure 4	*Hemiaulus hostilus* Heiberg. Sample 339-10-2, 80-82 cm.
Figure 5	Genus and species indet. 6. Sample 338-28-2, 48-50 cm (1000×).
Figure 6	*Pterotheca reticulata* Sheshuk.-Poretzk. Sample 338-22-3, 22-23 cm.
Figure 7	*Xanthiopyxis panduraeformis* Pantocsek. Sample 338-22-1, 89-90 cm.
Figure 8	*Xanthiopyxis* sp. Sample 338-23-6, 17-18 cm.
Figure 9	*Xanthiopyxis* sp. Sample 338-26-3, 127-128 cm.
Figure 10	*Xanthiopyxis* sp. Sample 338-23-0, 9-10 cm.
Figure 11	Genus and species indet. 6. Sample 338-27-2, 40-41 cm.
Figure 12	*Chaetoceros* (?)-*Hemiaulus* (?) resting spore. Sample 338-24-1, 34-35 cm.
Figure 13	*Chaetoceros* (?)-*Hemiaulus* (?) resting spore. Sample 338-23-5, 49-50 cm.
Figure 14	Genus and species indet. 6. Sample 338-28-2, 48-50 cm.
Figure 15	Resting spore. Sample 338-26-5, 30-31 cm.
Figure 16	Resting spore. Sample 338-26-4, 130-131 cm.
Figure 17	*Xanthiopyxis* sp. Sample 338-26-5, 112-113 cm.
Figure 18	*Synedra* aff. *ulna* (Nitzsch) Ehrenberg. Sample 338-22-5, 51-53 cm (1000×).
Figures 19-21	*Synedra miocenica* Schrader. 19. Sample 338-22-2, 65-67 cm (1200×). 20. Sample 338-22-5, 51-53 cm. 21. Sample 338-22-5, 51-53 cm (1200×).

PLATE 45