

#### IV. UPPER EOCENE AND LOWER OLIGOCENE DIATOMACEAE, ARCHAEMONADACEAE, AND SILICOFLAGELLATAE IN SOUTHWESTERN PACIFIC SEDIMENTS, DSDP LEG 29

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#### INTRODUCTION

DSDP Leg 29 began on 2 March 1973 at Lyttleton, New Zealand, and ended on 18 April 1973 at Wellington, New Zealand. During the cruise, 16 holes were drilled in the area south of Australia and New Zealand and in the Tasman Sea (from 40° to 56°S and 143° to 178°E; see Figure 1). The present report is an evaluation of the upper Eocene-lower Oligocene diatom assemblages of 27 samples from 18 cores taken at Sites 280 (in deep water south of the South Tasman Rise), 281 (in shallow water, on the South Tasman Rise), and 283 (Central Tasman Sea).

The diatoms, archaeomonads, and silicoflagellates were studied, and photographs taken, using an Amplival binocular light microscope with 40× and 100× objectives and 10× and 16× oculars. Diatoms are the principal biostratigraphic indicators in the siliceous sediments because of their abundance and good preservation; foraminifers and nannofossils occur in subordinate numbers or are absent. For more precise stratigraphic control and for paleoenvironmental purposes, the entire siliceous microfossil assemblage was studied. The distribution of siliceous microfossils in Leg 29 sediments is shown in Table 1, and the frequency distribution of characteristic species is shown in Figure 2. The following section summarizes the occurrence of siliceous microfossils at all sites drilled during Leg 29.

#### SUMMARIES OF LATE EOCENE-EARLY OLIGOCENE SILICEOUS MICROFOSSIL-BEARING SEDIMENTS IN DSDP LEG 29 SITES

##### Site 277 (Latitude 52°13.43'S, Longitude 116°11.48'E, on the southern Campbell Plateau)

This hole penetrated a calcareous nanno ooze rich in foraminifers. It contains scarce, poorly preserved, and corroded siliceous microfossils. The tests are covered by a siliceous gel which could not be removed in the laboratory without damaging or decomposing the siliceous test.

##### Site 278 (Latitude 56°33.42'S, Longitude 160°04.29'E, in the southern Emerald Basin)

Miocene, Pliocene, and Pleistocene diatom and nanno ooze and nanno-bearing siliceous ooze layers are alternate at this site. Poorly preserved, corroded, fragmentary diatoms occur only from Core 31, Section 1 (295.5 m) to Sample 33, CC (424 m). The sediment is

tentatively regarded as being of middle to upper Oligocene age, but cannot be directly correlated on the basis of the flora with the diatom ooze of Hole 280A and Sites 281 and 283.

##### Site 280, Hole 280A (Latitude 48° 57.44'S, Longitude 147°14.08'E, south of Tasmania and the South Tasman Rise)

The stratigraphic sequence in this hole consists of silty and clayey diatom ooze from Core 1, Section 2 (9-11 cm) to Sample 4, CC (38-91.5 m below the sea floor), and upper Eocene to lower Oligocene greenish-gray diatom ooze and silty clay with diatoms from Core 5, Section 1 (120-122 cm) to Core 8, Section 1 (120-122 cm) (91.5-145 m below the sea floor). Siliceous microfossils in these sediments are well preserved and are very abundant in Cores 1 through 7. In Core 8 they are less abundant and poorly preserved, and lower in the section they are absent; dissolution during deposition or diagenesis is suggested.

Dominant in the assemblages are several species and varieties of the genus *Stephanopyxis* (*Asterolampra schmidti*, *Stictodiscus californicus* var. *nitida*, *Cerataulus pacificus*, *Hemiaulus incisus*, *Kisseleviella carina*, and *Rouxia rouxioides*) which are short ranging and appear only at the lower boundary of the Oligocene (Tables 1 and 2).

##### Site 281 (Latitude 47°59.84'S, Longitude 147°45.85'W, in shallow water, on the southern slope of the South Tasman Rise)

The sandy and silty clay and diatom ooze of Cores 14, 15, and 16 were analyzed in detail. They contain a well-preserved siliceous microfossil assemblage rich in species and individuals. Dominant in the floras are subtropical, neritic-thermophilic planktonic forms with a depth range of 200 to 400 meters (Tables 1 and 2). This assemblage resembles that of the upper Eocene of New Zealand as well as that of the upper Eocene of Site 283 in the Tasman Sea. A significant proportion of the diatoms are through-ranging species, while others disappear in the upper Eocene. Some of the latter are endemic planktonic forms.

##### Site 282 (Latitude 42°14.76'S, Longitude 143°29.18'E, west of Tasmania in the magnetic quiet zone)

All the cores from this site were studied and found to be barren of diatoms as well as any other siliceous microfossils. Only in the core catchers of Cores 5 through 7 were some undeterminable diatom fragments found. Siliceous sponge spicules are commonly of great diversity in Cores 5 through 17 (upper Eocene to upper Oligocene); they are abundant and large and can probably be compared with those observed at Sites 280, 281, and 283 (Eocene and Oligocene).

<sup>1</sup>Publication authorized by Dr. J. Konda, Director of the Hungarian Geological Survey, Budapest.

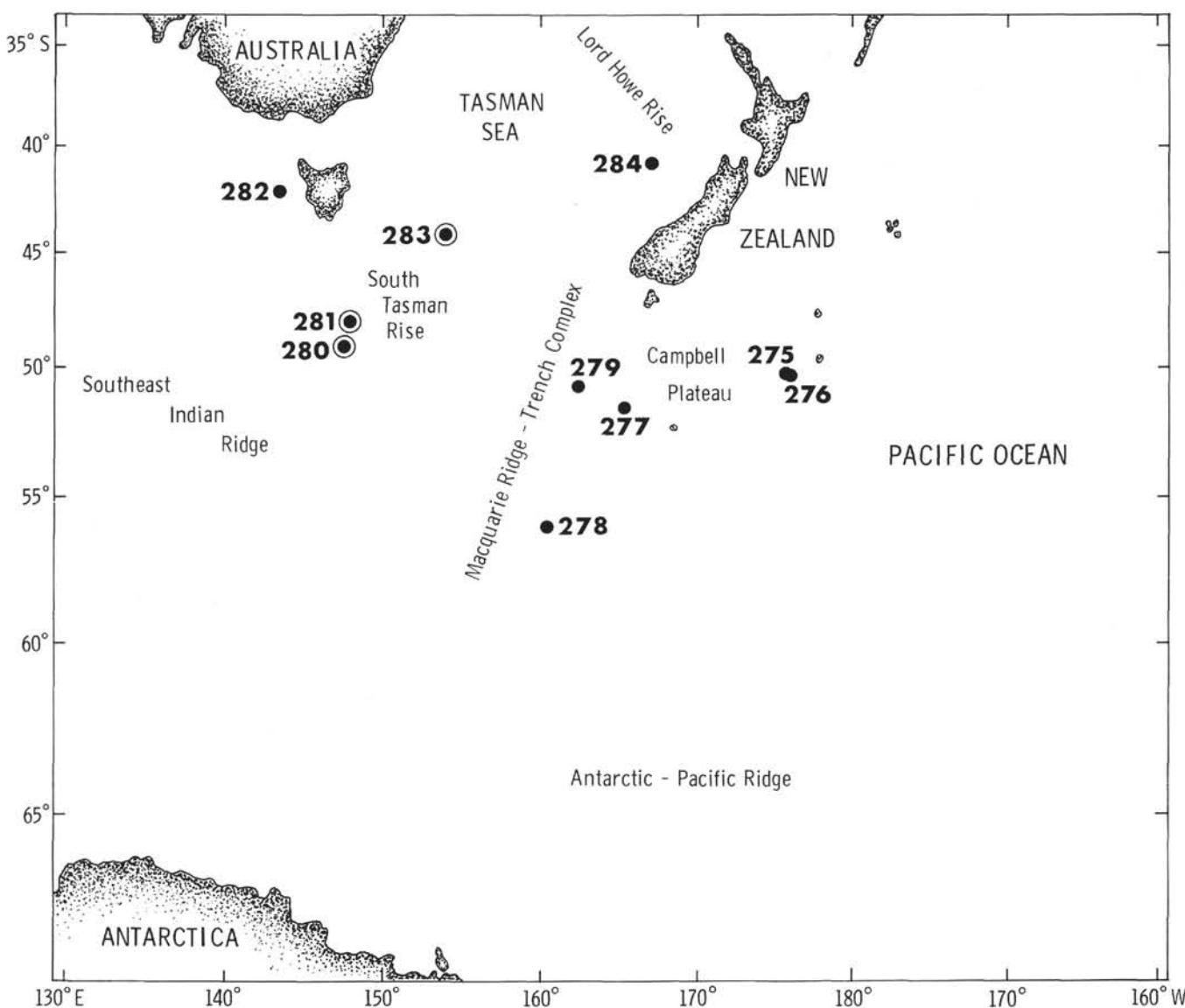


Figure 1. Location of sites cored during Deep Sea Drilling Project Leg 29.

#### Site 283 (Latitude 43°54.60'S, Longitude 154°16.96'E, located in the Central Tasman Sea)

Upper Eocene detrital silty sediments and diatom ooze were recovered in Cores 2 through 7, while silty clay with diatom detritus was recovered in Core 8. From Core 9 down, the sediments were barren of siliceous microfossils. On the basis of species dominance, two units can be differentiated: (a) from 283-2, CC to 6, CC the following species dominate: *Melosira architecturalis*, *Stephanopyxis antiqua*, *S. grunowii*, *S. longispinosa*, *S. superba*, and *Naviculopsis biapiculata* var. *constricta*; (b) from 283-7, CC to 8, CC the number of species is smaller in every sample; the most characteristic species are *Xanthopyxis panduraeformis*, *Pyrgopyxis*, and *Pterotheca*.

#### DISCUSSION

A number of studies based on diatoms deal with the Pliocene through Holocene interval of the Pacific Ocean

(subarctic region, North Pacific, East and Central Pacific, and the equatorial region). These studies indicate that the regional distribution of diatoms is affected mainly by subarctic and North Pacific currents (Kanaya and Koizumi, 1966; Donahue, 1970; Jousé et al., 1969, 1971; in Koizumi, 1973, p. 805, 827-829). In the present case, the diatom assemblages consist mainly of thermophilic, subtropical diatom species. Antarctic or subantarctic species are absent or only doubtfully present. According to the literature (Grunow, 1884; Hustedt, 1927-1930), 11 of the species listed in Table 1 are Recent. However, I have become convinced during the course of my studies that the species described by Grunow (1884) from Franz Joseph Land are extinct, and that their occurrence in Recent sediments must be due to submarine redeposition of Eocene sediments. This admitted, the actual proportion of Recent species is 5%.

The majority of the species studied became extinct at the end of the Eocene or in the Oligocene. Accordingly,

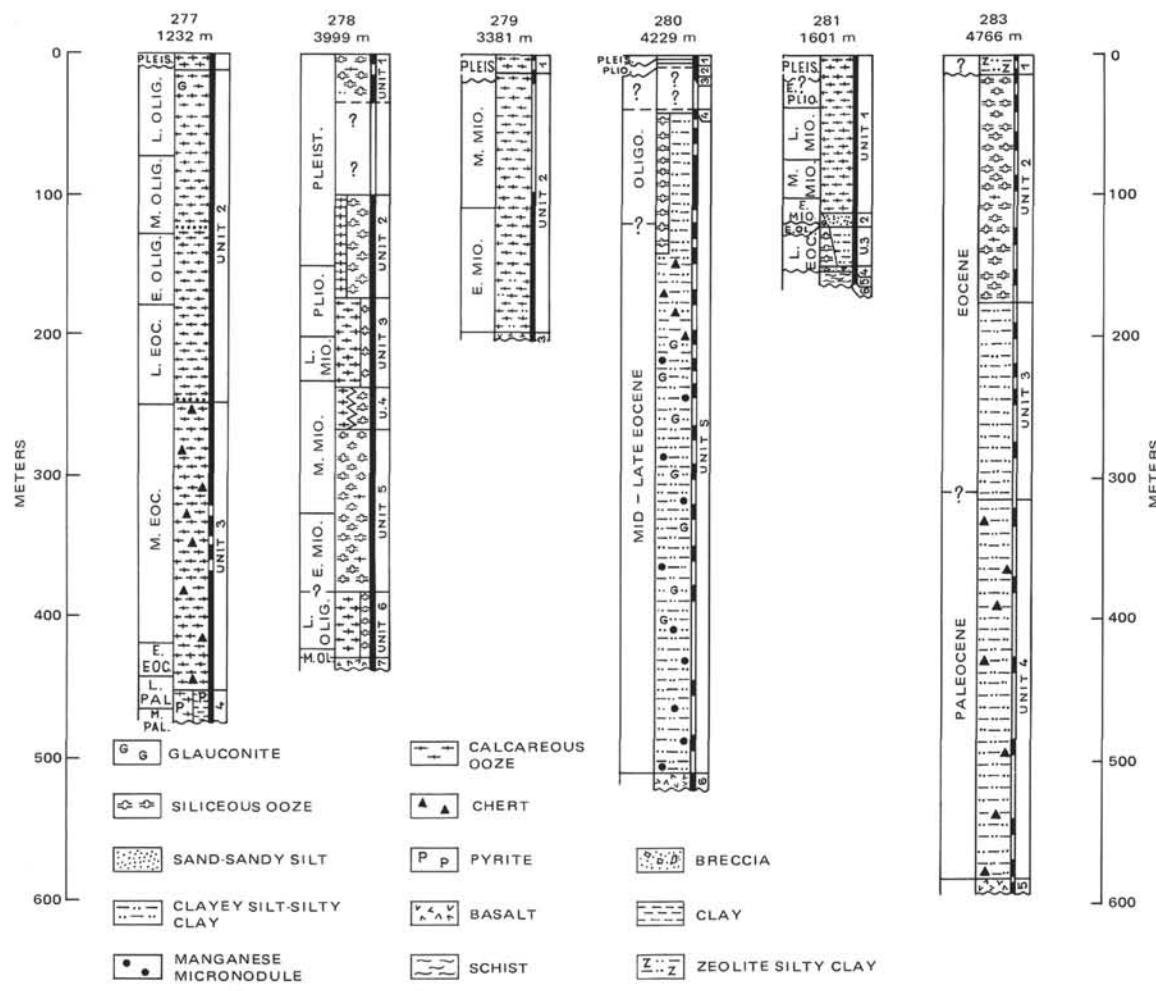


Figure 2. Siliceous microfossil-bearing sediments of drilling sites in the Southwest Pacific Ocean, Leg 29, Deep Sea Drilling Project.

climatological and ecological inferences can be drawn only on the few species still living. It should be stressed, however, that even these are not necessarily unchanged as to their ecology.

The upper Eocene-lower Oligocene assemblages are characterized by a great variety of forms and species, suggesting rather favorable environmental conditions. All the assemblages comprise autochthonous, well-preserved, oceanic planktonic forms; neritic, littoral, brackish, nor fresh-water species were found. Planktonic species of large size indicate the lack of strong currents and favorable conditions of oxygenation. The presence of *Stephanopyxis*, *Trinacria*, *Triceratium*, *Hemiaulus*, *Coscinodiscus symbolophorus*, and *C. radiatus*, indicate a subtropical climate and optimal conditions.

A substantial climatic or physicochemical change is indicated at the Eocene-Oligocene boundary. A significant proportion of the late Eocene species becomes extinct, and a number of new species appear. The size of the species that cross the boundary generally decreases,

although it is highly variable. This may be due to decreasing temperature, oxygen supply, or other ecological factors.

For paleogeographic comparison purposes, the following works were referred to: Greville (1861-1866), Schmidt's Atlas (1874-1959), Grunow (1884), Grove and Sturt (1886-1887), Pantocsek (1886-1905), Reinhold (1937), Jousé (1955), Kanaya (1957), Strelnikova (1960), Paramonova (1964), and Gleser and Posnova (1964). In quantitative terms, the Leg 29 microflora shows close affinities with those of the upper Eocene of Oamaru, New Zealand, Barbados, and Mt. Diablo of California. Several identical species have also been recorded from the Soviet Union (E. Ukraine, W. Kazakhstan, W. Siberia, the Caucasus, and the Urals); however, the number of identical species is lower than in the Eocene.

## SYSTEMATIC PALEONTOLOGY, FLORAL REFERENCE

The diatoms, archaeomonads, and silicoflagellates of Sites 280, 281, and 283 were mainly determined and systematized on the basis of the

TABLE 1  
Distribution of Late Eocene and Early Oligocene Diatomaceae, Archaeomonadaceae, and  
Silicoflagellatae in Samples from DSDP Leg 29, Sites 280A, 281, 283

| Siliceous Microfossils   | 280A-1-2, 9-11<br>280A-1, CC<br>280A-2-2, 45-47<br>280A-2-3, 20-22<br>280A-2, CC<br>280A-3-4, 120-122<br>280A-3, CC<br>280A-4, CC<br>280A-5, CC<br>280A-6-3, 120-122<br>280A-6, CC<br>280A-7-2, 120-122<br>280A-7, CC<br>280A-8-1, 120-122<br>281-14-1, 140-142<br>281-14, CC<br>281-15, CC<br>281-16, CC<br>283-2, CC<br>283-3, CC<br>283-4, CC<br>283-5, CC<br>283-6, CC<br>283-7, CC<br>283-8-1, 44-46<br>283-8, CC |
|--|--|
| BACILLARIOPHYTA<br>Bacillariophyceae (Diatomaceae)                 |  |
| <i>Melosira architecturalis</i> Brun                               | R  |
| <i>M. clavigera</i> Grun.  |  |
| <i>M. oamaruensis</i> Gr. & St.                                    |  |
| <i>Podosira</i> sp.  |  |
| <i>Pseudopodosira corolla</i> (A. Schm.) n. comb.                  |  |
| <i>P. marginata</i> n. sp.   | C  |
| <i>Pseudopodosira</i> sp.  |  |
| <i>Hercotheca inermis</i> Mann                                     | R  |
| <i>Endictya robusta</i> (Grev.) Hanna & Grant                      | C  |
| <i>Stephanopyxis</i> cf. <i>antiqua</i> Pant.                      |  |
| <i>S. barbadensis</i> (Grev.) Grun.                                | R  |
| <i>S. eocaenicus</i> n. sp.  |  |
| <i>S. cf. ferox</i> (Grev.) Ralfs                                  | C C C  |
| <i>S. grunowii</i> Gr. & St.                                       | C C C C C C  |
| <i>S. hyalomarginata</i> n. sp.                                    | C C C C C C  |
| <i>S. inordinata</i> n. sp.  |  |
| <i>S. longispinosa</i> n. sp.                                      | C C C C C C  |
| <i>S. marginata</i> Grun.  |  |
| <i>S. megapora</i> Grun.   |  |
| <i>S. oamaruensis</i> n. sp.                                       | C C C C C C  |
| <i>S. oligocaenica</i> n. sp.                                      | C C C  |
| <i>S. subantarctica</i> n. sp.                                     |  |
| <i>S. superba</i> (Grev.) Grun.                                    |  |
| <i>S. turris</i> (Grev. et Arn.) Ralfs v. <i>arctica</i> Grun. f.? |  |
| <i>Coscinodiscus bulliens</i> A. Schm.                             |  |
| <i>C. denarius</i> A. Schm.  | C C C C  |
| <i>C. marginatus</i> Ehr.  | R  |
| <i>C. cf. moelleri</i> A. Schm. v. <i>macroporus</i> Grun.         |  |
| <i>C. oculusiridis</i> Ehr. v. <i>borealis</i> (Bail.) Cl.         |  |
| <i>C. cf. radiatus</i> Ehr.  |  |
| <i>C. radiatus</i> Ehr. v. <i>nodulifer</i> Reinh.                 | C C C  |
| <i>C. spiralis</i> n. sp.  | C C C C C C  |
| <i>C. symbolophorus</i> Grun.                                      | R R R R R R  |
| <i>C. symbolophorus</i> Grun. var. <i>oamaruensis</i> A. Schm.     | C C C C C C  |
| <i>C. tuberculatus</i> Grev.                                       | R R R R R R  |
| <i>Liradiscus ovalis</i> Grev.                                     |  |
| <i>Liradiscus</i> sp.  | R  |
| <i>Muelleriopsis limbata</i> (Ehr.) Hendey                         | C  |
| <i>Xanthiopyxis acrolopha</i> Forti                                | R R R R R R  |
| <i>X. oblonga</i> Ehr.   |  |
| <i>X. panduraeformis</i> Pant.                                     |  |
| <i>Xanthiopyxis</i> sp.  |  |
| <i>Poretzkia</i> ? sp.   |  |
| <i>Stictodiscus californicus</i> Grev. v. <i>nitida</i> Gr. & St.  | R R R  |
| <i>S. grovei</i> A. Schm.  | C C C C C C  |
| <i>Arachnoidiscus indicus</i> Ehr.                                 |  |
| <i>A. russicus</i> Pant.   |  |
| <i>A. schmidti</i> n. sp.  |  |
| <i>Asterolampra schmidti</i> n. sp.                                | C A C C C C C C C C C C  |
| <i>Actinopytchus splendens</i> (Shadb.) Ralfs                      |  |
| <i>Aulacodiscus rattrayii</i> Gr. & St.                            |  |
| <i>Auliscus gleseri</i> n. sp.                                     |  |
| <i>A. oamaruensis</i> Gr. & St.                                    |  |
| <i>Actinocyclus octonarius</i> Ehr. var.?                          |  |
| <i>Corona magnifica</i> Lef. et Chen.                              |  |
| <i>Rhizosolenia interposita</i> n. sp.                             | C C C C C C C C C C C C  |
| <i>Rhizosolenia</i> sp.  | R  |
| <i>Chaetoceros</i> sp.   |  |
| <i>Triceratium arcticum</i> Brightw.                               |  |
| <i>T. castellatum</i> West v.?                                     | C C C C C C C C C C C C  |
| <i>T. chenevieri</i> Meist.  |  |

TABLE 1 - *Continued*

| Siliceous Microfossils  | 280A-1-2, 9-11<br>280A-1, CC<br>280A-2-2, 45-47<br>280A-2-3, 20-22<br>280A-2, CC | 280A-3-4, 120-122<br>280A-3, CC<br>280A-4, CC<br>280A-5, CC | 280A-6-3, 120-122<br>280A-6, CC | 280A-7-2, 120-122<br>280A-7, CC<br>280A-8-1, 120-122<br>281-14-1, 140-142 | 281-14, CC<br>281-15, CC<br>281-16, CC<br>283-2, CC | 283-3, CC           | 283-4, CC<br>283-5-1, 65-67<br>283-5, CC<br>283-6, CC<br>283-7, CC | 283-8-1, 144-46<br>283-8, CC |
|---|--|---|---------------------------------|---|---|---------------------|--|------------------------------|
| <i>T. crenulatum</i> Gr. & St.<br><i>T. morlandii</i> Gr. & St.<br><i>T. oamaruense</i> Gr. & St.<br><i>T. oamaruense</i> Gr. & St. v. <i>sparsim punctata</i> Gr.<br><i>T. pulvinar</i> A. Schm.   | C C R R C C R C C C C  |   |                                 | R R R R A A C   | C C C C C C C C C C                                 | C C C C C C C C C C | C R C C R R  |                              |
| <i>Biddulphia fimbriata</i> Grev.<br><i>B. rigida</i> A. Schm.<br><i>Cerataulus pacificus</i> n. sp.<br><i>Cerataulina paebergoni</i> n. sp.<br><i>Hemiallus characteristicus</i> n. sp.  | R R R R R C C C C C C  |   |                                 | C C C C C C C C C C   | C C C C C C C C C C                                 | C C C C C C C C C C | C C C C C C C C C C  |                              |
| <i>H. incisus</i> n. sp.<br><i>H. polymorphus</i> Grun. var. ?<br><i>H. polymorphus</i> Grun.<br><i>Trinacria excavata</i> Heib.<br><i>T. simulacrum</i> Gr. & St.  | C C C C C C C C C C  | C C C C C C C C C C   | A R R C C C C C C C             |   | R   |                     |  |                              |
| <i>Pterotheca aculeifera</i> Grun.<br><i>P. danica</i> Grun.<br><i>Pyrgopyxis eocena</i> Hendey<br><i>P. gracilis</i> (Temp. et Forti) Hendey v. <i>buccinalis</i> (Forti) Hendey<br><i>P. gracilis</i> (Temp. et Forti) Hendey v. <i>saratoviana</i> (Pant.) Hendey  | C C C C C C C C C C  | C C C C C C C C C C   | C C C C C C C C C C             | C C C C C C C C C C   | C C C C C C C C C C                                 | C C C C C C C C C C | R R R R R R R R R R  |                              |
| <i>P. johnsoniana</i> (Forti) Hendey<br><i>P. johnsoniana</i> (Forti) Hendey v. <i>intermedia</i> (Temp. et Forti) Hendey<br><i>Acanthodiscus rugosus</i> Pant.<br><i>Goniothecium odontella</i> Ehr.<br><i>Stephanogania</i> cf. <i>polyacantha</i> Forti  | C C C C C C C C C C  | C C C C C C C C C C   | C C C C C C C C C C             | C C C C C C C C C C   | C C C C C C C C C C                                 | C C C C C C C C C C | C C C C C C C C C C  | C C C C C C C C C C          |
| <i>Pseudorutilaria monile</i> Gr. & St.<br><i>Kisseleviella carina</i> Shesh.<br><i>Rouxia rouxioides</i> (Schrader) n. comb.   | R C  | R C   | C C                             | C C   | C C   | C C C C C C C C C C |  |                              |
| <b>CHRYSTOPHYTA</b><br>Archaeomonadaceae  |  |   |                                 |   |   |                     |  |                              |
| <i>Archaeomonas dubia</i> Defl.<br><i>A. oamaruensis</i> Defl.<br><i>A. ovalis</i> Defl.<br><i>A. reticulosa</i> Defl.<br><i>Archaeosphaeridium armatum</i> n. sp.  | R R R R R R R C C C C  | R R C C C C C C C C   | C C C C C C C C C C             | C C C C C C C C C C   | R R R R R R R R R R                                 |                     |  |                              |
| <i>Pararchaeomonas decorata</i> n. sp.<br><i>P. (?) rigaudae</i> Rampi  |  |   |                                 |   |   |                     |  |                              |
| <b>Silicoflagellatae</b>  |  |   |                                 |   |   |                     |  |                              |
| <i>Dictyocha deflandrei</i> Freng.<br><i>D. fibula</i> Ehr.<br><i>D. hexacantha</i> Schulz<br><i>Hannaites quadria</i> Mandra<br><i>Mesocena apiculata</i> (Schulz) Hanna<br><i>M. oamaruensis</i> Schulz<br><i>M. oamaruensis</i> Schulz v. <i>quadrangula</i> Schulz<br><i>Naviculopsis biapiculata</i> (Lemm.) Freng.<br><i>N. biapiculata</i> (Lemm.) Freng. v. <i>constricta</i> (Schulz) Gleser<br><i>N. biapiculata</i> (Lemm.) Freng. v. <i>minor</i> (Schulz) Gleser<br><i>N. trispinosa</i> (Schulz) Gleser | R R C C C C C C C C  | R R C C C C C C C C   | R R R R R R R R R R             | R R R R R R R R R R   | R R R R R R R R R R                                 | R R R R R R R R R R | R R R R R R R R R R  | R R R R R R R R R R          |
| <b>PORIFERA</b><br>Spicules (different)   | R R R R R R R R R R  | R R R R R R R R R R   | R R R R R R R R R R             | C C C C C C C C C C   | C C C C C C C C C C                                 | C C C C C C C C C C | C C C C C C C C C C  | C C C C C C C C C C          |

Note: A = abundant? C = common? R = rare.

works of Proshkina-Lavrenko (1949), Deflandre (1969), and Gleser (1966). Description is given only for those species which could not be defined on the basis of the literature. Within the genera, the new and already known taxa are discussed in alphabetical order. The holotypes of new taxa are in the collection of the author at the Hungarian Geological Survey (Budapest, XIV, Nepstadion ut 14). The paratypes will be deposited in the collection of Dr. Friedrich Hustedt, in the "Institut für Meeresforschung" Bremenhaven, Germany.

The undetermined but significant species were numbered and illustrated and will be published in a following work. From the siliceous sediments of the above-mentioned sites 42 genera, 108 species, and their variants were determined. Nineteen new species and two new combinations are included. The occurrence and frequency of the known taxa are given in Tables 1, 2, and 3.

Synonyms are given only in cases where the valid name of the taxon is changed or where the cited publication leaves it unmentioned.

TABLE 2  
Occurrence Ranges of Late Eocene and Early Oligocene Diatomaceae, Archaeomonadaceae,  
and Silicoflagellatae in Samples from DSDP Leg 29, Holes 280A and 281

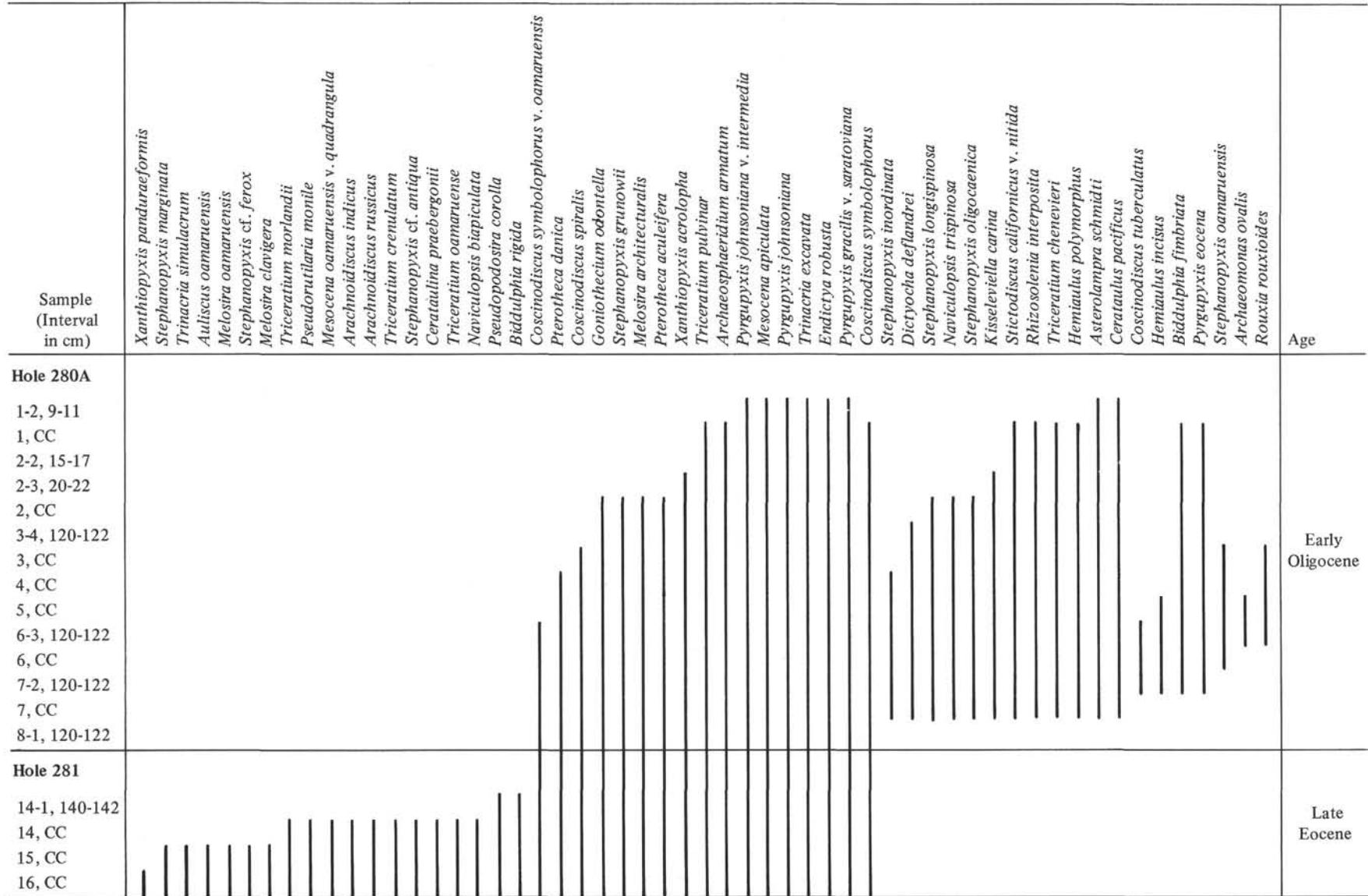


TABLE 3  
Occurrence Ranges of Late Eocene and Early Oligocene Diatomaceae, Archaeomonadaceae,  
and Silicoflagellatae in Samples from DSDP Leg 29, Holes 280A and 283

| Sample<br>(Interval<br>in cm) |  | Age         |
|-------------------------------|--|-------------|
| Hole 280A                     |  |             |
| 1-2, 9-11                     | <i>Dictyocha hexacantha</i>                              |             |
| 1, CC                         | <i>Arachnoidiscus indicus</i>                            |             |
| 2-2, 15-17                    | <i>Stephanopyxis marginata</i>                           |             |
| 2-3, 20-22                    | <i>Trinacria simulacrum</i>                              |             |
| 2, CC                         | <i>Xanthiopyxis panduraeformis</i>                       |             |
| 3-4, 120-122                  | <i>Perotheca danica</i>                                  |             |
| 3, CC                         | <i>Melosira architecturalis</i>                          |             |
| 4, CC                         | <i>Stephanopyxis grunowii</i>                            |             |
| 5, CC                         | <i>Triceratium pulvinar</i>                              |             |
| 6-3, 120-122                  | <i>Xanthiopyxis acrolopha</i>                            |             |
| 6, CC                         | <i>Pyrgopyxis johnsoniana</i> v. <i>intermedia</i>       |             |
| 7-2, 120-122                  | <i>Cerataulina praebergonii</i>                          |             |
| 7, CC                         | <i>Triceratium oamaruense</i>                            |             |
| 8-1, 120-122                  | <i>Naviculopsis biapiculata</i>                          |             |
|                               | <i>Auliscus oamaruensis</i>                              |             |
|                               | <i>Coscinodiscus symbolophorus</i> v. <i>oamaruensis</i> |             |
|                               | <i>Biddulphia rigida</i>                                 |             |
|                               | <i>Triceratium norlandii</i>                             |             |
|                               | <i>Melosira oamaruensis</i>                              |             |
|                               | <i>Stephanopyxis</i> cf. <i>ferox</i>                    |             |
|                               | <i>Melosira clavigera</i>                                |             |
|                               | <i>Archaeosphaeridium armatum</i>                        |             |
|                               | <i>Trinacria excavata</i>                                |             |
|                               | <i>Endictya robusta</i>                                  |             |
|                               | <i>Pseudopodosira corolla</i>                            |             |
|                               | <i>Pseudorutilaria monile</i>                            |             |
|                               | <i>Mesocena oamaruensis</i> v. <i>quadrangula</i>        |             |
|                               | <i>Coscinodiscus spiralis</i>                            |             |
|                               | <i>Pterotheca aculeifera</i>                             |             |
|                               | <i>Pyrgopyxis johnsoniana</i>                            |             |
|                               | <i>Arachnoidiscus russicus</i>                           |             |
|                               | <i>Triceratium crenulatum</i>                            |             |
|                               | <i>Goniothecium odontella</i>                            |             |
|                               | <i>Mesocena apiculata</i>                                |             |
|                               | <i>Coscinodiscus symbolophorus</i>                       |             |
|                               | <i>Stephanopyxis mordinata</i>                           |             |
|                               | <i>Dictyocha deflandrei</i>                              |             |
|                               | <i>Stephanopyxis longispinosa</i>                        |             |
|                               | <i>Naviculopsis trispinosa</i>                           |             |
|                               | <i>Stephanopyxis oligocaenica</i>                        |             |
|                               | <i>Kisseleviella carina</i>                              |             |
|                               | <i>Sitiodiscus californicus</i> v. <i>nitida</i>         |             |
|                               | <i>Rhizosolenia interposita</i>                          |             |
|                               | <i>Triceratium chenevieri</i>                            |             |
|                               | <i>Hemiaulus polymorphus</i>                             |             |
|                               | <i>Asterolampra schmidti</i>                             |             |
|                               | <i>Cerataulius pacificus</i>                             |             |
|                               | <i>Coscinodiscus tuberculatus</i>                        |             |
|                               | <i>Hemiaulus incisus</i>                                 |             |
|                               | <i>Biddulphia fimbriata</i>                              |             |
|                               | <i>Pyrgopyxis eocena</i>                                 |             |
|                               | <i>Stephanopyxis oamaruensis</i>                         |             |
|                               | <i>Archaeomonas ovalis</i>                               |             |
|                               | <i>Rouxia rotundoides</i>                                |             |
| Hole 283                      |  | Late Eocene |
| 2, CC                         |  |             |
| 3, CC                         |  |             |
| 4, CC                         |  |             |
| 5-1, 65-67                    |  |             |
| 5, CC                         |  |             |
| 6, CC                         |  |             |
| 7, CC                         |  |             |
| 8-1, 44-46                    |  |             |
| 8, CC                         |  |             |

Most of the species are of marine planktonic origin. Fresh-water or brackish species were not found.

The taxa—and even the longitudinal forms—may be placed in the orders Centrales Schutt and Mediales Jousé et Proshkina-Lavrenko. The order of Pennales is represented only by the species *Rouxia rouxioides* with a short, rudimentary raphe.

Age in the description of species means occurrence in the examined strata, and not chronostratigraphic range.

The list of microfossils is not complete because of the abundance of species and specimens and the short time available for this study. Only well-preserved taxa of characteristic morphology are described.

#### BACILLARIOPHYCEAE (Diatomaceae)

##### Genus MELOSIRA Agardh, 1824

###### *Melosira architecturalis* Brun, 1892 (Plate 1, Figures 5, 6)

Description: Brun (1892), in Schmidt's Atlas (1874-1959), pl. 177, fig. 49, 50; Gleser (1969), p. 68, pl. 4, fig. 3.

Synonym: *Cyclotella hannaë* Kanaya (1957), p. 82-84, pl. 3, fig. 10-14.

Discussion: Seemingly this species is larger and more common in the late Eocene as it is in early Oligocene sediments.

###### *Melosira clavigera* Grunow, 1882 (Plate 1, Figures 3, 4; Plate 2, Figures 3, 4)

Grunow (1882), in Schmidt's Atlas (1874-1959), pl. 74, fig. 13-15, pl. 175, fig. 21-24; Pantocsek (1886), v. 1, p. 46; Van Heurck (1880-1885), pl. 91, fig. 1, 2.

###### *Melosira oamaruensis* Grove and Sturt, 1887 (Plate 1, Figures 1, 2)

Description: Grove and Sturt (1886-1887), p. 145, pl. 13, fig. 48, 49.  
Occurrence: Only in late Eocene sediments.

##### Genus PODOSIRA Ehrenberg, 1840

###### *Podosira* sp. Hajós

Description: Highly vaulted valves with thick wall, ornate by radiated reticulate pattern.

Dimension: Diameter 60 µm.

Occurrence: DSDP Leg 29, Sample 283-3, CC.

Age: Late Eocene.

Discussion: They look identical to *Podosira* sp. in Paramonova (1964), p. 239, pl. 1, fig. 6 a, b, from W. Siberia, early Eocene-late Eocene.

##### Genus PSEUDOPODOSIRA Jousé, 1949

###### *Pseudopodosira corolla* (A. Schmidt) n. comb. Hajós (Plate 1, Figures 9, 10)

Synonym: *Podosira corolla* A.S. in Schmidt's Atlas (1874-1959), pl. 140, fig. 11, 12 from Oamaru. *Podosira* aff. *corolla* A.S. in Paramonova (1964), p. 239, pl. 1, fig. 5, from W. Siberia.

Discussion: Our specimens look like those described and illustrated by Kanaya (1957), p. 118, pl. 8, fig. 15-17, as *Hercotheca* sp. a; occurrences in samples of Mt. Diablo.

Age: Late Eocene.

###### *Pseudopodosira marginata* n. sp. Hajós (Plate 1, Figures 7, 8; Holotype: Figure 7)

Derivation of name: marginatus (latin) = marginate.

Diagnosis and description: The margin of the valve is hyaline and punctuated in the form of concentric rings with 12-14 small pores per 10 µm arranged in quincunx pattern. The surface of the valve is undulated and vaulted. On the outer side of the projecting part of the valve radial ribs, on the inner side dentiform structures occur every 6 per 10 µm. The central part of the valve is depressed.

Dimension: Diameter 22-25 µm.

Holotype: Prep. 3696/1, HGS.

Type locality: DSDP Leg 29, Sample 281-16, CC.

Type level: Late Eocene.

Occurrence: Identical with the type locality.

###### *Pseudopodosira* sp. Hajós (No illustration)

Description: It seems to be identical with *Pseudopodosira bella* Posnova and Gleser in Gleser and Posnova (1964), p. 61, pl. 1, fig. 2, text-fig. 1, 2, occurring in late Eocene sediments of W. Kazakhstan, USSR.

Age: Late Eocene.

##### Genus HERCOTHECA Ehrenberg, 1844 (1845)

###### *Hercotheca inermis* Mann, 1925 (Plate 25, Figures 3, 4)

Description: Mann (1925), p. 82, 83, pl. 18, fig. 1, 2.  
Age: Early Oligocene.

##### Genus ENDICTYA Ehrenberg, 1844 (1845)

###### *Endictya robusta* (Greville) Hanna and Grant, 1926 (Plate 4, Figures 5-7; Plate 19, Figures 1, 2)

Description: Hanna and Grant (1926), p. 144, pl. 16, fig. 2, 3; Greville (1861-1866), v. 14, p. 3, pl. 1, fig. 8 as *Coscinodiscus robustus*.  
Age: Late Eocene-early Oligocene.

##### Genus STEPHANOPYXIS Ehrenberg, 1844 (1845)

###### *Stephanopyxis cf. antiqua* Pantocsek, 1892, 1905 (Plate 5, Figures 1, 2, 6-8)

Description: Pantocsek (1892), pl. 19, fig. 28 (1905), v. 3, p. 96, from Kusnetzk, USSR.  
Age: Late Eocene.

Stephanopyxis barbadensis (Greville) Grunow, 1884  
(No illustration)

Description: Grunow (1884), p. 91; Greville (1861-1866), v. 13, p. 3, 4, pl. 1, fig. 11, as *Cresswellia barbadensis* from Barbados. Illustrated in Schmidt's Atlas, pl. 130, fig. 6-10, from Oamaru.

Age: Late Eocene-early Oligocene.

###### *Stephanopyxis eocaenica* n. sp. Hajós (Plate 4, Figures 3, 4; Holotype)

Derivation of name: eocaenicus (latin) = of Eocene age.

Diagnosis and description: The valve slightly vaulted with areolae arranged in irregular tangential rows. Towards their margin the areolae appear to decrease in size, 4-5 areolae for each 10 µm near the center. On the surface of the valve, at a distance of about 8-10 µm from the margin a crown of long spines is seen. The spines are strong and long.

Dimension: Diameter 55-66 µm.

Holotype: Prep. 3756/1 HGS.

Type locality: DSDP Leg 29, Sample 283-6, CC, holotype.

Type level: Late Eocene.

Occurrences: DSDP Leg 29, Samples 283-3, CC; 283-6, CC; 283-7, CC.

###### *Stephanopyxis cf. ferox* (Greville) Ralfs, 1861 (Plate 3, Figure 7)

Description: In Pritchard (1861), Infus., p. 826, pl. 5, fig. 75; Grunow (1884), p. 89, 90; Greville (1861-1866), v. 7, pl. 8, fig. 19 as *Cresswellia ferox*.

Age: Late Eocene.

###### *Stephanopyxis grunowii* Grove and Sturt, 1888 (Plate 3, Figures 3, 4; Plate 4, Figures 1, 2)

Description: Schmidt's Atlas (1874-1959), pl. 130, fig. 1-5, from Oamaru.

Age: Late Eocene-early Oligocene.

###### *Stephanopyxis hyalomarginata* n. sp. Hajós (Plate 19, Figures 11, 12; Holotype)

Derivation of name: hyalomarginatus (latin) = after the large hyaline margin of the valve.

Diagnosis and description: Valve with large hyaline margin of 3 µm. The areolae are arranged in quincunx pattern. The inner wall of the valve finely punctuated. On the margin stout spines are seen; their

number changes from about 11 to 18. It is similar to *S. superba*, but its structure is finer, the areolae are denser.

**Dimension:** Diameter 42-45  $\mu\text{m}$ .

**Holotype:** Prep. 3554/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-7-1, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-1, CC, 280A-7, CC; 280A-6-3, 120-122 cm.

#### *Stephanopyxis inordinata* n. sp. Hajós (Plate 20, Figures 4, 5; Holotype)

**Derivation of name:** *inordinatus* (latin) = irregular.

**Diagnosis and description:** On the central part of the valve the areolae are irregularly arranged and of irregular shape, about 2-3 to each 10  $\mu\text{m}$ . Towards the margin smaller areolae are arranged in quincunx pattern, about 4-5 to every 10  $\mu\text{m}$ . The inner part of the wall finely punctuated. The spines are small at the margin, their number is changing.

**Dimension:** Diameter 56-60  $\mu\text{m}$ .

**Holotype:** Prep. 3550/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-6-3, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-4, CC; 280A-7, CC.

**Discussion:** Our species is similar to Schmidt's Atlas, (1874-1959), pl. 123, "Oran, Figure 22, fraglich, ob sp. n.?" Our specimens are better arranged towards the margin.

#### *Stephanopyxis longispinosa* n. sp. Hajós (Plate 20, Figures 1-3; Holotype)

**Derivation of name:** *longispinosus* (latin) = after the long marginal spines.

**Diagnosis and description:** The valve is strongly vaulted with a margin of 1-2.5  $\mu\text{m}$  width. The surface of the valve is decorated by areolae arranged in quincunx pattern. The inner part of the wall is finely punctuated. On the central part of the valve 2-4 areolae are in each 10  $\mu\text{m}$ , the dimension of the areolae is decreasing toward the margin. The marginal spines are stout, 20-25  $\mu\text{m}$  long, their number varies from 7 to 12. In literature such a *Stephanopyxis* species with long spines was not mentioned.

**Dimension:** Diameter 50-55  $\mu\text{m}$ .

**Holotype:** Prep. 3530/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-3-4, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, 280A-2, CC, 280A-7, CC; 280A-6-3, 120-122 cm; 280A-7-2, 120-122 cm.

#### *Stephanopyxis marginata* Grunow, 1884 (Plate 2, Figures 5, 6; Plate 3, Figures 5, 6)

**Description:** Grunow (1884), p. 90, pl. 5, fig. 17.

**Synonym:** *Stephanopyxis grossecellulata* Pantocsek, 1886, v. 1, p. 44, pl. 20, fig. 180, from Hungary, St. Péter.

**Age:** Late Eocene.

#### *Stephanopyxis megapora* Grunow, 1884 (Plate 3, Figures 1, 2)

**Description:** Grunow (1884), p. 89, pl. 5, fig. 24 a, b.

**Age:** Late Eocene.

#### *Stephanopyxis oamaruensis* n. sp. Hajós (Plate 19, Figures 5-8; Holotype, Figures 7, 8)

**Derivation of name:** After the locality of Oamaru, New Zealand.

**Diagnosis and description:** The valve is strongly vaulted, decorated with stout spines. The areolae are arranged in quincunx pattern, their number varies between 6 to 7 in each 10  $\mu\text{m}$ . It is identical with Schmidt's Atlas (1874-1959), Plate 130, Figure 29, "Oamaru," New Zealand.

**Dimension:** Diameter 28-35  $\mu\text{m}$ , the wall is 10-15  $\mu\text{m}$  high.

**Holotype:** Prep. 3530/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-3-4, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-6-3, 120-122 cm; 280A-7-2, 120-122 cm; 280A-3, CC; 280A-4, CC, 280A-5, CC; 280A-6, CC.

#### *Stephanopyxis oligocaenica* n. sp. Hajós (Plate 19, Figures 3, 4; Holotype)

**Derivation of name:** (latin) = of Oligocene age.

**Diagnosis and description:** The form is relatively small, the upper and lower valve are differently vaulted. On the surface of the valve the areolae are arranged in quincunx pattern, 4 in each 10  $\mu\text{m}$ . The spines on the surface of the valves are irregularly arranged and of different length. In literature no similar form was mentioned. For the long spines it is a very characteristic form.

**Dimension:** Diameter 25-30  $\mu\text{m}$ .

**Holotype:** Prep. 3554/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-7-2, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-2, CC; 280A-4, CC; 280A-7, CC.

#### *Stephanopyxis subantarctica* n. sp. Hajós (Plate 5, Figures 6-8; Holotype)

**Derivation of name:** *subantarcticus* (latin) = after the type locality.

**Diagnosis and description:** The cells are large, slightly vaulted, the margin of the valve is 4  $\mu\text{m}$  wide surrounded by a hyalomargin and a ring of 4 to 5 unequal areolae. The areolae of the valve are arranged in quincunx pattern, 2.5-3 in each 10  $\mu\text{m}$ , decreasing toward the margin. The inner part of the wall is finely punctuated.

**Dimension:** Diameter 132-140  $\mu\text{m}$ .

**Holotype:** 3677/1 HGS.

**Type locality:** DSDP Leg 29, Sample 281-15, CC.

**Type level:** Late Eocene.

**Occurrence:** DSDP Leg 29, Sample 281-16, CC.

**Description:** This species, showing a close affinity with *Stephanopyxis turris* var. *antarctica* Grunow, has a flat, slightly constricted valve. The marginal areolae are irregular, constricted, and without strong spines. The cells are, however, larger, more flattened with irregular, constricted marginal areolae.

#### *Stephanopyxis superba* (Greville) Grunow, 1884 (Plate 1, Figures 11-13)

**Synonym:** *Cresswellia superba* Greville (1865), v. 9, pl. 8, fig. 3-5.

**Description:** Grunow (1884), p. 91.

**Age:** Late Eocene.

#### *Stephanopyxis turris* (Greville and Arnott) Ralfs var. *arctica* Grunow, forma? (Plate 3, Figures 8, 9)

**Description:** Grunow (1884), p. 89, pl. 5, fig. 21, as *Stephanopyxis turris* var. *arctica* "ähnlich der var. *intermedia*, aber mit noch grösseren Maschen, und meist nur wenigen Stacheln."

**Age:** Late Eocene.

#### *Stephanopyxis* sp. Hajós (Plate 19, Figures 9, 10)

**Description:** Similar to *Stephanopyxis megapora* except for the hyaline margin and the much smaller areolae around the margin.

**Age:** Early Oligocene.

#### Genus COSCINODISCUS Ehrenberg, 1838

##### *Coscinodiscus bulliens* A. Schmidt, 1878 (Plate 6, Figures 5, 6)

*In* Schmidt's Atlas (1874-1959), pl. 61, fig. 11, 12.

**Age:** Late Eocene.

##### *Coscinodiscus denarius* A. Schmidt, 1878 (Plate 7, Figures 4, 5)

*In* Schmidt's Atlas (1874-1959), pl. 57, figs. 20-21, from Barbados, Springfield. Similar to l.c. pl. 138, fig. 6, Oamaru, sp. n.?

**Description:** Hustedt (1927-1930), v. 1, p. 399-400, fig. 210.

**Age:** Late Eocene.

##### *Coscinodiscus marginatus* Ehrenberg, 1843 (Plate 20, Figures 9, 10)

**Description:** Hustedt (1927-1930), v. 1, p. 416, fig. 223.

**Age:** Early Oligocene.

**Coscinodiscus cf. moelleri A. Schmidt var. macroporus Grunow, 1884**  
(Plate 20, Figures 13, 14)

**Description:** Hustedt (1927-1930), v. 1, p. 395, fig. 206, Grunow (1884), p. 84, pl. 4, fig. 25.

**Discussion:** Specimens are much smaller as by Paramonova (1964), p. 239, pl. 5, fig. 4a, b, published from NW Siberia. Early Oligocene.  
**Age:** Early Oligocene.

**Coscinodiscus oculusiridis Ehrenberg var. borealis (Bailey) Cleve, 1883**  
(Plate 4, Figures 10, 11)

**Description:** Hustedt (1927-1930), v. 1, p. 456, fig. 253.  
**Age:** Late Eocene.

**Coscinodiscus cf. radiatus Ehrenberg, 1839**  
(Plate 4, Figures 12-14; Plate 5, Figures 3-5)

**Description:** Hustedt (1927-1930), v. 1, p. 420-421, fig. 225.

**Discussion:** It is similar to the form published by Kanaya from California (1957), p. 91-93, pl. 5, fig. 4a, b.  
**Age:** Late Eocene.

**Coscinodiscus radiatus Ehrenberg var. nodulifer Reinhold, 1937**  
(Plate 4, Figures 8, 9; Plate 6, Figures 3, 4)

**Description:** Reinhold (1937), p. 100-101, pl. 8, fig. 6, from E. Java.  
**Age:** Late Eocene.

**Coscinodiscus spiralis n. sp. Hajós**  
(Plate 7, Figures 1-3; Holotype: Figures 1, 2)

**Derivation of name:** spiralis (latin) = spiral.

**Diagnosis and description:** The disc is flat, the margin is 1.5 µm wide, bending downward, finely striated, 16 striae in each 10 µm. The central area is small, often asymmetrical, not in the midst of the disc. The surface of the disc is finely areolated with 12-13 areolae in each 10 µm. The areolae are arranged in quincunx pattern, in radial and spiral rows. The species is similar to *C. debilis* Grove from Oamaru in Schmidt's Atlas, pl. 163, fig. 4. However in the latter species the radial rows are not spiral.

**Dimension:** Diameter 42-90 µm.

**Holotype:** Prep. 3748/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-4, CC.

**Type level:** Late Eocene.

**Age:** Late Eocene-early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 283-5, CC; 280A-6-3, 120-122 cm; 280A-3, CC; 280A-7, CC.

**Discussion:** In the Oligocene sediments the forms are much smaller.

**Coscinodiscus symbolophorus Grunow, 1884**  
(Plate 20, Figures 11, 12)

**Description:** Grunow (1884), p. 82, pl. 4, fig. 3-6.

**Age:** Early Oligocene.

**Discussion:** Common, but only small specimens with a diameter of 30-50 µm.

**Coscinodiscus symbolophorus Grunow**  
var. *oamaruensis* A. Schmidt, 1888  
(Plate 6, Figures 1, 2; Plate 10, Figure 1; Plate 20, Figure 15)

*In* Schmidt's Atlas (1874-1959), pl. 138, fig. 4, 5.

**Age:** Late Eocene-early Oligocene.

**Coscinodiscus tuberculatus Greville, 1861**  
(Plate 20, Figures 6-8)

**Description:** Greville (1861-1866), n. ser., v. 9, p. 42; pl. 4, fig. 6.

**Type locality:** "Barbados"-Oceanic formation; Kanaya (1957), p. 94, pl. 6, fig. 6-8.

**Age:** Early Oligocene.

## Genus LIRADISCUS Greville, 1865

**Liradiscus ovalis Greville, 1865**  
(Plate 17, Figures 1, 2)

**Description:** Greville (1861-1866), v. 13, p. 5, pl. 1, fig. 15, 16.  
**Age:** Late Eocene.

**Liradiscus sp. Hajós**  
(Plate 21, Figures 3, 4)

**Description:** Valve convex ellipsoidal with remarkable reticulation irregular in shape, and with some short spines. Found only in one sample.

**Age:** Early Oligocene.

## Genus MUELLERIOPSIS Hendey, 1972

**Muelleriopsis limbata (Ehrenberg) Hendey, 1972**  
(Plate 11, Figures 1-4)

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

**Synonym:** *Pyxidicula limbata* Ehrenberg (1844), p. 86; *Pyxidicula*, *Stephanopyxis?* *limbata* Ehrenberg, *Muelleriella limbata* Ehrenberg (1854), pl. 18, fig. 7, Van Heurck (1896), p. 435, fig. 160.

**Age:** Late Eocene-early Oligocene.

## Genus XANTHIOPYXIS Ehrenberg, 1844

**Xanthiopyxis cf. acrolopha Forti, 1912**

(Plate 11, Figure 6; Plate 17, Figures 4, 10, 12; Plate 21, Figure 5)

**Description:** Forti (1912), v. 23, p. 84; Hanna (1927), p. 124, pl. 21, fig. 10, 11.

**Age:** Late Eocene-early Oligocene.

**Xanthiopyxis oblonga Ehrenberg, 1844 (1845)**  
(Plate 17, Figure 11)

**Description:** Kanaya (1957), p. 116, pl. 8, fig. 12 a, b.  
**Age:** Late Eocene

**Xanthiopyxis panduraformis Pantocsek, 1886**  
(Plate 11, Figure 5; Plate 17, Figure 9)

**Description:** Pantocsek (1886), v. 1, p. 43, pl. 29, fig. 297, from Szakal, Hungary.

**Age:** Late Eocene.

**Xanthiopyxis sp. Hajós**  
(No illustration)

**Description:** Oval valve, with stout long spines.  
**Age:** Late Eocene.

## Genus PORETZKIA Jousé, 1949

**Poretzkia? sp.**  
(Plate 17, Figure 3)

**Description:** The valve of this remarkable species is convex, flat, finely punctuated, with a central area; the ornamentation on its margin consists of prominent spines in coronal grouping. Occurrence in one sample only. The genus is doubtful, eventually a new one.

**Age:** Late Eocene.

## Genus STICTODISCUS Greville, 1861

**Stictodiscus californicus Greville var. nitida Grove and Sturt, 1887**  
(Plate 21, Figures 1, 2)

**Description:** Grove and Sturt (1886-1887), v. 3, p. 66, pl. 5, fig. 7.

**Synonym:** *Stictodiscus nitidus* Grove and Sturt (1888) in Schmidt's Atlas (1874-1959), pl. 131, fig. 7, 8; pl. 202, fig. 4, 5; pl. 451, figs. 5-7.

**Age:** Early Oligocene.

**Discussion:** All the l.c. figures are from Oamaru.

**Stictodiscus grovei A. Schmidt, 1890**  
(Plate 10, Figures 4-6)

*In* Schmidt's Atlas (1874-1959), pl. 147, fig. 5-7, from Oamaru.

**Age:** Late Eocene.

**Discussion:** This is a transitional species between the genera *Stictodiscus* and *Arachnoidiscus*.

## Genus ARACHNOIDISCUS Bailey, in Ehrenberg, 1849 (1850)

*Arachnoidiscus indicus* Ehrenberg, 1854  
(Plate 9, Figures 1, 2)

**Description:** Ehrenberg (1854), p. 165 (non vidi); Grove and Sturt (1887), p. 66, from Oamaru.

**Age:** Late Eocene.

*Arachnoidiscus russicus* Pantocsek, 1892  
(Plate 10, Figures 2, 3)

**Description:** Pantocsek (1892), v. 3, pl. 15, fig. 226; (1905), p. 14.

**Age:** Late Eocene.

**Discussion:** Its ornamentation is coarser, the areolae rare, larger, thus it cannot be ranged to the *Arachnoidiscus indicus* species. Identical with the form in Schmidt's Atlas (1874-1959), pl. 147, fig. 9 from Oamaru, "vielleicht zu *Arachnoidiscus indicus* zu rechnen."

*Arachnoidiscus schmidti* n. sp. Hajós  
(Plate 8, Figures 1, 2; Holotype)

**Derivation of name:** Named in honor of A. Schmidt.

**Diagnosis and description:** The disc is flat, its surface is decorated by concentrically arranged dots, while divided by radial lines. These lines do not reach the central part of the disc, and between two long lines one longer and two shorter lines are seen. The radial lines are zig-zagged. The center area is decorated by short ridges. The number of lines and ridges is variable.

**Dimension:** Diameter 110-115  $\mu\text{m}$ .

**Holotype:** Prep. 3748/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-4, CC.

**Type level:** Late Eocene.

**Occurrences:** DSDP Leg 29, Samples 283-5-1, 65-67 cm; 283-5, CC; 283-6, CC.

**Discussion:** The species is identical to Schmidt's Atlas pl. 147, fig. 1, originating from Oamaru, named *Arachnoidiscus ehrenbergii* Bail. var. *oamaruensis*, determined as "uncertain" by Schmidt. Regarding its ornamentation it shows closer affinity with *A. russicus*.

## Genus ASTEROLAMPRA Ehrenberg, 1844 (1845)

*Asterolampra schmidti* n. sp. Hajós  
(Plate 21, Figure 6; Holotype)

**Derivation of name:** Named in honor of A. Schmidt.

**Diagnosis and description:** The disc is flat, heavily decorated. The areolated surface is divided by radial, hyaline areas in several sections whose number varies between 6 and 9. The areas are separated by radial ridges which are terminated in the center part of the disc forming a star-like pattern. The number of the sections is equal to the number of individual parts of the star, i.e., 6 to 9, however, this number may reach 21 by further division. On the areolated part of the sections the areolae are arranged in quincunx pattern with 6-7 areolae in each 10  $\mu\text{m}$ .

**Dimension:** Diameter 65-85  $\mu\text{m}$ .

**Holotype:** Prep. 3550/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-6-3, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-1-2, 9-11 cm; 280A-1, CC.

**Discussion:** This form is extraordinarily variable. It is similar to Schmidt's Atlas, pl. 137, fig. 6, "Oamaru, n. sp.?" and fig. 7, "Barbados, fraglich."

## Genus ACTINOPTYCHUS Ehrenberg, 1839

*Actinoptychus splendens* (Schadboldt) Ralfs, 1861  
(Plate 9, Figure 6)

**Description:** In Pritchard (1861), Infus, p. 840. (non vidi); Hustedt (1927-1930), v. 1, p. 478-79, fig. 265.

**Age:** Late Eocene.

## Genus AULACODISCUS Ehrenberg, 1844 (1845)

*Aulacodiscus rattrayii* Grove and Sturt, 1887  
(Plate 9, Figure 3)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 3, p. 139-140, pl. 11, fig. 29, from Oamaru.

**Age:** Late Eocene.

## Genus AULISCUS Ehrenberg, 1843 (1844)

*Auliscus gleser* n. sp. Hajós  
(Plate 8, Figures 3-5; Holotype)

**Derivation of name:** Named in honor of S.I. Gleser, USSR.

**Diagnosis and description:** The disc is elliptic, flat. The ornamentation is a fine punctuation, arranged nearly cross-shaped, with a light bend at the center. Two protruding round pores are seen near the margin, at the two ends of the longitudinal axis.

**Dimensions:** Length 40  $\mu\text{m}$ , width 32  $\mu\text{m}$ .

**Holotype:** Prep. 3756/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-6, CC.

**Type level:** Late Eocene.

**Discussion:** Nearest from *A. actinoptychoides* Gleser, in Gleser and Posnova (1964), p. 54-56, pl. 3, fig. 1, 2. Gleser described this species from late Eocene and early Oligocene of Ukraine and Kazakhstan, USSR.

*Auliscus oamaruensis* Grove and Sturt, 1887  
(Plate 10, Figure 7)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 2, p. 10, 11, pl. 3., fig. 13, from Oamaru.

**Age:** Late Eocene.

## Genus ACTINOCYCLUS Ehrenberg 1837 (1838)

*Actinocyclus octonarius* Ehrenberg, 1838 var. ?  
(Plate 9, Figure 4)

**Description:** Hustedt (1927-1930), v. 1, p. 525-533, fig. 298.

**Age:** Late Eocene.

**Discussion:** It is not the typical form.

## Genus CORONA Lefébure et Chenevière, 1938

*Corona magnifica* Lefébure et Chenevière, 1938  
(Plate 8, Figures 6, 7)

**Description:** Lefébure et Chenevière (1938), p. 10, pl. 1, fig. 1, from Kamischev, USSR.

**Age:** Late Eocene.

## Genus RHIZOSOLENIA Ehrenberg, 1841 (1843)

*Rhizosolenia interposita* n. sp. Hajós  
(Plate 21, Figure 8; Holotype)

**Derivation of name:** Interpositus (latin) = intermediate.

**Diagnosis and description:** Only apical extensions are found but they are common in all samples of the Oligocene sediments. This species shows close affinity with the *Rhizosolenia curvirostris* Jousé (1968), p. 19, pl. 3, fig. 1-3. The wall of the extension is 3  $\mu\text{m}$  thick, its diameter 11-12  $\mu\text{m}$ . To the end it becomes thinner and at last forms a beak. This beak is asymmetrical, bifurcate, separated in two parts. At Jousé's species the extension does not attenuate to the end and the beak is larger, greater. It is an intermediate form between *R. cretacea* n. sp. Hajós and *R. curvirostris*.

**Dimension:** Diameter 11-12  $\mu\text{m}$ , the process is 100-110  $\mu\text{m}$  long.

**Holotype:** Prep. 3550/1 HGS.

**Type locality:** DSDP Leg 29, 280A-6-3, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Sample 280A-2-3, 20-22 cm; 280A-1, CC; 2, CC; 3, CC; 4, CC; 5, CC; 6, CC; 7, CC.

**Rhizosolenia sp. Hajós**  
(Plate 12, Figure 1)

**Description:** Long, small, apical extension at the base with a large valve, and very short spines. No complete valve has been observed.  
**Age:** Late Eocene.

Genus CHAETOCEROS Ehrenberg, 1844 (1845)

**Chaetoceros sp. Hajós**  
(Plate 9, Figure 5)

**Description:** The cells form a chain. The surface of the valve is flat. From the valve's margin are rising several setae proceeding outwards at right angles to the axis of the chain. Two of the four strong setae start from the lower valve of a cell and intersect two rising ones from the upper valve of another cell.

**Age:** Late Eocene.

Genus TRICERATIUM Ehrenberg, 1839 (1841)

**Triceratium arcticum Brightwell, 1853**

**Description:** Proshkina-Lavrenko (1949-1950), v. 2, p. 168, pl. 94, fig. 5a, b.  
**Age:** Early Oligocene

**Triceratium castellatum West var.?, 1885**  
(Plate 12, Figures 4, 5)

In Schmidt's Atlas (1874-1959), pl. 88, fig. 16, from Barbados.

**Synonym:** *Triceratium fractum* Walker and Chase (1888) in Schmidt's Atlas, pl. 128, fig. 9, 10, Oamaru; *T. castellatum* West var. *fracta* Grunow in Schmidt's Atlas, pl. 167, fig. 7, 8, Oamaru; *T. fractum* Walker and Chase in Schmidt's Atlas, pl. 167, fig. 9, 10, Oamaru.

**Age:** Late Eocene.

**Triceratium chenevieri Meister**  
(Plate 21, Figures 9, 10)

In Strelnikova (1960), pl. 9, fig. 3, from USSR, late Eocene-early Oligocene.

**Age:** Early Oligocene.

**Triceratium crenulatum Grove and Sturt, 1887**  
(Plate 13, Figures 1, 2)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 3, p. 7, pl. 2, fig. 3, 4, Oamaru, in Schmidt's Atlas (1874-1959), pl. 128, fig. 20, 21, Oamaru.

**Age:** Late Eocene.

**Triceratium morlandii Grove and Sturt, 1887**  
(Plate 13, Figures 7, 8)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 3, p. 7, 8, pl. 2, fig. 5, Oamaru, in Schmidt's Atlas (1874-1959), pl. 128, fig. 5, 6, Oamaru, pl. 150, fig. 22, Oamaru.

**Age:** Late Eocene.

**Triceratium oamaruense Grove and Sturt, 1887**  
(Plate 12, Figures 2, 3)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 3, p. 135, pl. 10, fig. 18, from Oamaru, in Schmidt's Atlas (1874-1959), pl. 128, fig. 2, from Oamaru.

**Age:** Late Eocene.

**Triceratium oamaruense Grove and Sturt**  
var. *sparsimpunctata* Grove, 1890  
(Plate 12, Figures 6, 7)

In Schmidt's Atlas (1874-1959), pl. 159, fig. 4.  
**Age:** Late Eocene.

**Triceratium pulvinar A. Schmidt, 1888**  
(Plate 12, Figures 8, 9; Plate 13, Figures 3, 4; Plate 14,  
Figures 1-8; Plate 21, Figures 11, 12)

In Schmidt's Atlas (1874-1957), pl. 126, fig. 8, pl. 168, fig. 7, from Oamaru.

**Age:** Late Eocene-early Oligocene.

**Discussion:** Remarkable and common form of all the samples of late Eocene and early Oligocene.

Genus BIDDULPHIA Gray, 1821

**Biddulphia fimbriata Greville, 1865**  
(Plate 22, Figures 7, 8)

**Description:** Greville (1861-1866), ser. 14, p. 6, pl. 1, fig. 4, from Barbados.

**Age:** Early Oligocene.

**Biddulphia rigida A. Schmidt, 1888**  
(Plate 13, Figures 5, 6)

*In* Schmidt's Atlas (1874-1957), pl. 120, fig. 1, 2, from Oamaru.

**Synonym:** *Biddulphia fistulosa* Pantocsek (1892), v. 3, pl. 18, fig. 273; (1905), p. 21, from Kusnetzk, USSR.

**Age:** Late Eocene.

Genus CERATAULUS Ehrenberg, 1843 (1844)

**Cerataulus pacificus n. sp. Hajós**  
(Plate 22, Figures 1-6; Holotype 1, 2)

**Derivation of name:** After the type locality.

**Diagnosis and description:** The cell is rounded with thick walls and variable ornamentation. The surface of the disc is decorated by areolae of different size and approximately radial arrangement and irregular form. The outward margin of the disc is bent downward, this part is 6-8  $\mu\text{m}$  high. At the two ends of a diagonal line two protruding pores are seen. At the center of the valve are two strong spines. The pores of the areolae show a fine, complex inner structure.

**Dimension:** Diameter 36-85  $\mu\text{m}$ .

**Holotype:** Prep. 3503/1 HGS.

**Type locality:** DSDP Leg 29, 280A-1-1, 9-11 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, Samples 280A-2-3, 20-22 cm; 280A-3-4, 120-122 cm; 280A-6-3, 120-122 cm—280A-7-2, 120-122 cm; 280A-1, CC—280A-7, CC.

**Discussion:** Similar to *Cerataulus marginatus* Grove and Sturt (1886-1887), ser. 2, v. 3, p. 135, pl. 11, fig. 21. This species shows two protruding pores as well, however its ornamentation consists of finer areolae.

Genus CERATAULINA Peragallo, 1892

**Cerataulina paebergonii n. sp. Hajós**

(Plate 14, Figure 13; Plate 15, Figures 5-7; Holotype: Figure 5)

**Derivation of name:** Conform to its similarity with the species *C. bergenii* Peragallo.

**Diagnosis and description:** The cylindric valve with an inner rod-shaped statospore. The surface of the statospore is finely punctuated with scattered spicules. The wall of the valve is terminated in several hyaline filaments.

**Dimension:** Diameter 18  $\mu\text{m}$ , length 55-65  $\mu\text{m}$ , length of filaments 36-60  $\mu\text{m}$ , fragmented.

**Holotype:** Prep. 3756/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-6, CC.

**Type level:** Late Eocene.

**Occurrences:** Leg 29, 281-14, CC; 281-15, CC.

**Discussion:** Very similar to *C. bergenii* Peragallo (1892), v. 1, p. 103, pl. 13, fig. 15, 16, in Hustedt (1927-1930), v. 1, p. 869-871, fig. 517, it is a species of the neritic plankton.

Genus HEMIAULUS Ehrenberg, 1844 (1845)

**Hemiaulus characteristicus n. sp. Hajós**

(Plate 15, Figure 10; Holotype)

**Derivation of name:** *characteristicus* (latin) = characteristic.

**Diagnosis and description:** Found only as a side view. The valve has a relatively long and narrow base of 8  $\mu\text{m}$  width, at both ends extremely long horns with long interior spine. The valve is roughly areolated becoming finer towards the end of the horns.

**Dimensions:** Diameter 85  $\mu\text{m}$ , height of the horns 45  $\mu\text{m}$ , height of the spines 10  $\mu\text{m}$ .

**Holotype:** Prep. 3748/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-4, CC.

**Type level:** Late Eocene.

**Discussion:** Illustrated in Schmidt's Atlas (1874-1959), pl. 142, fig. 12, Mors (Denmark)—“scheint Witt und mir eine neue Spezies zu sein.”

#### **Hemiaulus incisus n. sp. Hajós**

(Plate 23, Figures 4-9; Holotype: Figures 6, 7)

**Derivation of name:** incisus (latin) = incision.

**Diagnosis and description:** Valve lanceolated in outline, in the middle part flatly vaulted, with two long horns at both ends of the valve. At the base of the horns, on the valve incisions are seen. Areolae are coarse and scattered, becoming finer and parallel up to the end of the horns and spines.

**Dimension:** Diameter 22-45 µm, height 17-20 µm, length of the horns from the incision 50 µm, length of the spines 10-15 µm.

**Holotype:** Prep. 3550/1 HGS.

**Type locality:** DSDP Leg 29, Sample 280A-6-3, 120-122 cm.

**Type level:** Early Oligocene.

**Occurrences:** DSDP Leg 29, 280A-7-2, 120-122 cm; 280A-5, CC.

**Discussion:** Similar to *Hemiaulus kittonii* Grunow (1884), p. 61, Schmidt's Atlas, pl. 142, fig. 2-8, 11. Mors.

#### **Hemiaulus polymorphus Grunow, 1884, var.?**

(Plate 15, Figures 11, 12)

**Synonym:** *Hemiaulus polycystinorum* var. *mesolepta* Grunow (1884).

**Description:** Grunow (1884), p. 65, pl. 2, fig. 43, from Barbados.

**Age:** Late Eocene.

**Discussion:** It differs from the characteristic forms, probably *H. polymorphus* n. var. with long horns.

#### **Hemiaulus polymorphus Grunow, 1884**

(Plate 23, Figures 2, 3)

**Description:** Grunow (1884), p. 66, pl. 2, fig. 43; Proshkina-Lavrenko (1949-1950), v. 2, p. 185, pl. 71, fig. 2, 3.

**Age:** Early Oligocene.

#### Genus TRINACRIA Heiberg, 1863

##### **Trinacia excavata Heiberg, 1863**

(Plate 14, Figure 9; Plate 15, Figures 8, 9; Plate 23, Figure 1)

**Description:** Grunow (1884), p. 67. Franz Joseph Land, in Schmidt's Atlas (1874-1959), pl. 96, fig. 6-8; pl. 97, fig. 6-10, from Mors, Denmark.

**Age:** Late Eocene-early Oligocene.

#### **Trinacia simulacrum Grove and Sturt, 1887**

(Plate 15, Figures 1-4)

**Description:** Grove and Sturt (1886-1887), ser. 2, v. 3, p. 144; pl. 13, fig. 46, from Oamaru. Similar to Schmidt's Atlas (1874-1959), pl. 127, fig. 14.

**Age:** Late Eocene.

#### Genus PTEROTHECA Grunow, 1881

##### **Pterotheca aculeifera Grunow in Van Heurck, 1881**

(Plate 16, Figures 6-8)

**Description:** Grunow in Van Heurck (1880-1885), pl. 83, bis. fig. 5, from Mors, Denmark, in Van Heurck (1896), p. 430, fig. 151.

**Age:** Late Eocene.

##### **Pterotheca danica Grunow in Van Heurck, 1881**

(Plate 16, Figures 12-15)

**Description:** Grunow in Van Heurck (1880-1885), pl. 83, bis. fig. 7, 8, as *Stephanogonia/Pterotheca?/danica* from Mors, Denmark.

**Age:** Late Eocene.

#### Genus PYRGUPYXIS Hendey, 1969

##### **Pyrgupyxis eocena Hendey, 1969**

(Plate 24, Figures 3-5, 8, 9)

**Description:** Hendey (1969), p. 3-5, fig. 1-4, from cores of South Atlantic Eocene.

**Age:** Early Oligocene.

##### **Pyrgupyxis gracilis/Tempère and Forti/Hendey var. buccinalis/Forti/Hendey, 1969**

(No illustration)

**Description:** Hendey (1969), p. 5, Forti (1909), p. 26, pl. 2, fig. 6, Oamaru.

**Age:** Late Eocene.

##### **Pyrgupyxis gracilis/Tempère and Forti/Hendey var. saratoviana/Pantocsek/Hendey, 1969**

(Plate 16, Figures 1-5)

**Description:** Hendey (1969), p. 5, from South Atlantic Eocene core.

**Synonym:** *Hemiaulus? saratovianus* Pantocsek (1889), v. 2, p. 83, pl. 13, fig. 235, from Kusnetzk, USSR.

**Age:** Late Eocene-early Oligocene.

##### **Pyrgupyxis johnsoniana (Forti) Hendey**

(Plate 16, Figures 9-11, 16; Plate 24, Figures 6, 7, 10-12)

**Description:** Hendey (1969), p. 5.

**Synonym:** *Pyxilla johnsoniana* Greville in Forti (1909), p. 26, pl. 2, fig. 2, from Oamaru, non *Pyxilla johnsoniana* Greville (1865), v. 13, n. ser., p. 2, pl. 1, fig. 6.

**Age:** Late Eocene-early Oligocene.

##### **Pyrgupyxis johnsoniana (Forti) Hendey**

var. *intermedia*/Tempère and Forti/Hendey, 1969

(Plate 24, Figures 1, 2)

**Description:** Hendey (1969), p. 5, from South Atlantic core; Forti (1909), p. 26, pl. 2, fig. 3, 4, Barbados.

**Age:** Late Eocene-early Oligocene.

#### Genus ACANTHODISCUS Pantocsek, 1892

##### **Acanthodiscus rugosus Pantocsek, 1892**

(Plate 17, Figures 5, 6)

**Description:** Pantocsek (1892), v. 3, pl. 11, fig. 180; (1905), p. 3, 4, from Kusnetzk, USSR.

**Age:** Late Eocene.

**Discussion:** This form is more plicate and vaulted than the species of Pantocsek. Possibly it is *Xanthiopyxis*.

#### Genus GONIOTHECIUM Ehrenberg, 1844 (1845)

##### **Goniothecium odontella Ehrenberg, 1844**

(Plate 17, Figure 13; Plate 25, Figures 1, 2)

**Description:** Jousé (1951), p. 60, pl. 5, fig. 1-7.

**Age:** Late Eocene-early Oligocene.

#### Genus STEPHANOGONIA Ehrenberg, 1844 (1845)

##### **Stephanogonia cf. polyacantha Forti, 1913**

(Plate 17, Figures 7, 8)

**Description:** in Hanna (1932), p. 218, pl. 16, fig. 8.

**Age:** Late Eocene.

#### Genus PSEUDORUTILARIA Grove and Sturt, 1886

##### **Pseudorutilaria monile Grove and Sturt, 1886**

(Plate 14, Figures 10-12)

**Description:** Grove and Sturt (1886), p. 324, pl. 18, fig. 7, 8, from Oamaru.

**Age:** Late Eocene.

## Genus KISSELEVIELLA Sheshukova, 1962

**Kisseleviella carina** Sheshukova, 1962  
(Plate 25, Figures 5-9, 14)

**Description:** Sheshukova-Poretzkaya (1962), fig. 2a-g; p. 236-237, pl. 40, fig. 6a, b, v; pl. 41, fig. 5a, b, v.

**Age:** Early Oligocene.

## Genus ROUXIA Brun and Héribaud, 1893

**Rouxia rouxioides** (Schrader) n. comb. Hajós  
(Plate 25, Figures 10-13)

**Description:** Schrader (1969), p. 67-68, pl. 15, fig. 11 as *Diploneis rouxioides*, from Oamaru.

**Age:** Early Oligocene.

## ARCHAEOMONADACEAE

## Genus ARCHAEMONAS Deflandre, 1932a

**Archaeomonas dubia** Deflandre, 1933, p. 84, fig. 10  
(Plate 18, Figures 4, 5)

**Age:** Late Eocene.

**Archaeomonas oamaruensis** Deflandre, 1933, p. 85, fig. 15  
(Plate 18, Figures 1-3)

**Age:** Late Eocene.

**Archaeomonas ovalis** Deflandre, 1933, p. 86, fig. 27  
(Plate 25, Figures 15-16)

**Age:** Early Oligocene

**Archaeomonas reticulosa** Deflandre 1932b, p. 350, fig. 20-21  
(Plate 18, Figures 13, 14)

**Age:** Late Eocene.

## Genus ARCHAESPHAERIDIUM Deflandre 1932a

**Archaeosphaeridium armatum** n. sp. Hajós  
(Plate 18, Figures 6-8; Holotype: 6, 7)

**Derivation of name:** armatus (latin) — armed.

**Diagnosis and description:** Globular cyst with large, rounded pore. Round the pore 2.5  $\mu\text{m}$  high thick wall. On the opposite side of the pores of the cyst 1-4 heavy, long spines are present. The surface of the cyst is simple, smooth, hyaline. It is similar to *Archaeosphaeridium pachyceros* Deflandre (1933), p. 88, 89, fig. 40, 41. The difference is that the number of spines, on the species under discussion, is lower; the spines are longer and occur on the opposite side of the cyst's pore.

**Dimension:** Diameter 20-24  $\mu\text{m}$ . Length of the spine = 30-60  $\mu\text{m}$ .

**Holotype:** 3756/1 HGS.

**Type locality:** DSDP Leg 29, Sample 283-6, CC.

**Type level:** Late Eocene.

**Occurrence:** DSDP Leg 29, Sample 280A-2-3, 20-22 cm.

**Age:** Late Eocene-early Oligocene.

## Genus PARARCHAEOMONAS Deflandre, 1932a

**Pararchaeomonas decorata** n. sp. Hajós  
(Plate 18, Figures 9, 10; Holotype)

**Derivation of name:** decoratus (latin) = decorated.

**Diagnosis and description:** Globular cyst with large, rounded, projecting pore. The surface of the cyst is plicated. At the contact of the plicae are spines, similar to *Pararchaeomonas?* *rigaudae* Rampi 1969, in Deflandre (1969), fig. 4400, from Eocene. Kreyenhagen, California, USA, but our forms are ornamented.

**Dimension:** Diameter 25  $\mu\text{m}$ .

**Holotype:** Prep. 3748/1. HGS.

**Type locality:** DSDP Leg 29, Sample 283-4, CC.

**Age:** Late Eocene.

**Pararchaeomonas (?) rigaudae** Rampi, 1969,  
in Deflandre 1969, fig. 4400  
(Plate 18, Figures 11, 12)

**Age:** Late Eocene.

## SILICOFLAGELLATAE

## Genus DICTYOCHA Ehrenberg, 1839

**Dictyochea deflandrei** Frenguelli, 1940, p. 65, fig. 14a, d.  
(non vidi)

*In* Gleser (1966), p. 244, pl. 12, fig. 13, 16; pl. 32, fig. 4.  
(Plate 25, Figure 18)

**Age:** Early Oligocene.

**Dictyochea fibula** Ehrenberg, 1839, p. 129 (non vidi)  
(Plate 18, Figures 15, 16)

*In* Gleser (1966), p. 24, pl. 13, fig. 6-9; pl. 14, fig. 1-9.  
(Plate 25, Figure 18)

**Age:** Late Eocene.

## Genus HANNAITES Mandra, 1969

**Hannaites quadria** Mandra, 1969  
(No illustration)

**Age:** Late Eocene.

## Genus MESOCENA Ehrenberg, 1843

**Mesocena apiculata** (Schulz) Hanna, 1931  
(Plate 18, Figure 18; Plate 25, Figure 17)

**Age:** Late Eocene-early Oligocene.

**Mesocena oamaruensis** Schulz, 1928  
(No illustration)

**Age:** Late Eocene.

**Mesocena oamaruensis** Schulz var. *quadrangula* Schulz, 1928  
(No illustration)

**Age:** Late Eocene.

## Genus NAVICULOPSIS Frenguelli, 1940

**Naviculopsis biapiculata** (Lemmermann) Frenguelli, 1940  
(Plate 18, Figure 20)

*In* Gleser (1966), p. 256, pl. 16, fig. 2-5.

**Age:** Late Eocene.

**Naviculopsis biapiculata** (Lemmermann) Frenguelli  
var. *constricta* (Schulz) Gleser (1966)  
(Plate 18, Figure 21)

**Age:** Late Eocene.

**Naviculopsis biapiculata** (Lemmermann) Frenguelli  
var. *minor* (Schulz) Gleser, 1966  
(No illustration)

**Age:** Late Eocene.

**Naviculopsis trispinosa** (Schulz) Gleser 1966  
(Plate 25, Figure 19)

**Age:** Early Oligocene.

## PORIFERA

**Spicule I**  
(Plate 18, Figure 17)

**Age:** Late Eocene.

**Spicule II**  
(Plate 18, Figure 19)

**Age:** Late Eocene.

## STRATIGRAPHICAL OBSERVATIONS

Paleontological determinations made possible the stratigraphical dating of late Eocene-early Oligocene sediments found in Hole 280A, Site 281, and 283, as well as the correlation of late Eocene sediments found at Sites 281 and 283. To this end, a diagram was constructed (Figure 3). On this curve *a* marks the comparison of the number of species occurring in late Eocene samples of both Sites 281 and 283, and curve *b* designates the percentage of species occurring in late Eocene samples of both Sites 281 and 283, related to the total species numbers, respectively.

Thus it became possible to correlate the diatom sediments of Site 281 of about 30 meters thickness with the diatom sediments of Site 283 of about 200 meters thickness. It may be stated from the diagram that a correlation of samples 281-14, CC with those of 283-3, CC and 4, CC, as well as those of Samples 281-15, CC and 16, CC with Samples 283-5, CC and 6, CC is possible.

The microflora studies have not permitted the determination of standard or local biozones. In this region of the SW Pacific the lack of Oligocene sedimentation makes it impossible to determine the top of early Oligocene species ranges. On the other hand, the determination of the bottom of species ranges in the middle Eocene-early Eocene-Paleocene sediments was impossible because of the complete lack of siliceous microfloras. This disappearance downwards is rather sudden, although the sediment was unchanged clayey silt and silty clay; e.g., 283-8, CC yielded an invaluable amount of diatoms and Silicoflagellata, while 283-9-1 turned out to be barren. This absence of siliceous microfossils is either original, or brought about by dissolution during the sedimentation or during diagenesis.

The distribution of short-range and remarkably dominant species has been compared to that of the Californian diatom assemblage described by Kanaya (1957) which is characteristic of the late Eocene, as well as with the Silicoflagellata (Bukry and Foster, 1974), nannofossil (Edwards 1973), and planktonic foraminifera zones of paleogeographically related areas.

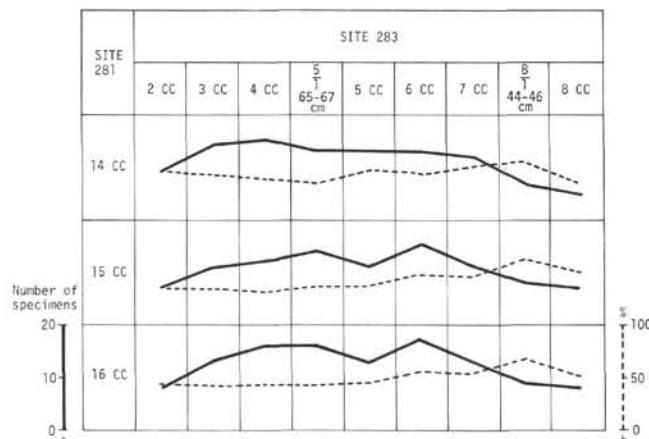


Figure 3. (a) Comparison of the number of species occurring in late Eocene samples of both Sites 281 and 283. (b) Diagram of the percentage of species occurring in late Eocene samples of both Sites 281 and 283, related to the total species numbers, respectively.

The species represented in Tables 1 and 3 as well as the occurrence in our samples of the zone marker species of the authors quoted above have been compared to the standard calcareous nannoplankton zones by Martini (1971, p. 741, 747). It could be stated that samples of Sites 281 and 283 may be correlated with Zones NP-18 and NP-19, while the samples of Hole 280A with Zone NP-22 of Martini (1971) (Figure 4).

## ACKNOWLEDGMENTS

The author thanks the Deep Sea Drilling Project and in particular Dr. Terence Edgar, Chief Scientist, for having given her the opportunity of participating in Leg 29 of the D/V *Glomar Challenger* cruises, from Christchurch to Wellington, New Zealand. The writer thanks for the opportunity President Dr. J. Fülöp, Central Office of Geology, Budapest, Hungary and Director Dr. J. Konda, Hungarian Geological Survey, Budapest, Hungary. Many thanks are due to Professor Dr. M. Kretzoi, Hungarian Geological Survey, Budapest, for his helpful advice in problems of biostratigraphy.

The author thanks Dr. E. Dudich, chief scientist, Hungarian Geological Survey, for the critical review and translation of the manuscript and helpful suggestions.

Thanks are due to Dr. Katharina Perch-Nielsen, Geologisches Institut E.T.H. Sonnegg Str., Zürich, Switzerland, who took and sent me the scanning electron micrography from Sample 29-280A-5-1, 110-112 cm.

Thanks are due to Mrs. Ildikó Mihály, my technician, who prepared most of the microscope slides, assisted in drawing and photographic work, and mounted the plates. Finally, my sincere thanks to G. Chikán, geologist, and also to all other colleagues in the Hungarian Geological Survey, who contributed and helped in this work too.

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| Age         |        | European Stages | New Zealand Stages Based on Edwards, 1973 | Characteristic species of the DSDP Leg 29 Sites 280A, 281, 283   | Characteristic Diatoms of the Mt. Diabolo, Calif. of Kanaya, 1957  | Silicoflagellate Zones, of Buks and Foster, 1974   | Calcareous Nannofossil Zones of Edwards, 1971 | Planktonic Foraminiferal Zones of Jenkins, 1966 |  |  |  |  |  |  |  |  |  |
|-------------|--------|-----------------|---|--|--|--|---|---|--|--|--|--|--|--|--|--|--|
| OLIGOCENE   | Middle | Waitakian       | Chattian                                  | Cerataulus pacificus<br>Rhiosolenia interposita<br>Triceratium chenevieri<br>Kisselvilliella carina<br>Dictyocha deflandrei<br>Naviculopsis trispinosa   | Rocella gemma<br>Discoaster deflandrei<br>Syracosphaera clathrata<br>Cyclococcolithus neogammation<br>Reticulofenestra placomorpha<br>Blackites rectus | Globiquadrina dehicaens (part)   | Globigerina euapertura                        | Globigerina angiporoidea angiporoidea           |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        | Duntroonian     |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             | Early  | Rupelian        | Whaingaroan                               |  |  | Dictyocha deflandrei   |   | Globigerina brevis                              |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        | Lattorfian      |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
| LATE EOCENE | Late   | Runangan        | Priabonian                                | Cyclotella hannaee<br>Syn. of Melosira architectoralis<br>Hemiaulus polymorphus<br>Liradiscus ovalis<br>Pyxilla (Pterotheca) aculeifera<br>Pyxilla (Pterotheca) danica<br>Pyxilla intermedia<br>Syn. of Pyrgopyxis johnsoniana var. intermedia | Dictyocha hexacantha   | Reticulofenestra oamaruensis<br>Discoaster saipanensis<br>Isthmolithus recurvus<br>Chiasmolithus oamaruensis | Globigerina linaperta                         | Globigerina inconspicua inconspicua (part)      |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        | Kaiatan         |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |
|             |        |                 |   |  |  |  |   |   |  |  |  |  |  |  |  |  |  |

Figure 4. Correlation of different microfossil datum levels of the late Eocene to Oligocene interval. Correlation is based on the distribution of characteristic species or zones as listed by the different authors.

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PLATE 1

Magnifications Figures 3-4,  $\times 500$ ; Figures 1, 2, 5-13  $\times 1000$

Figures 1, 2      *Melosira oamaruensis* Gr. et St.  
Sample 281-14, CC.

Figures 3, 4      *Melosira clavigera* Grun.  
Sample 281-15, CC.

Figures 5, 6      *Melosira architecturalis* Brun.  
Sample 281-14-1, 140-142 cm.

Figures 7, 8      *Pseudopodosira marginata* n. sp. (Figure 7,  
Holotype).  
Sample 281-16, CC

Figures 9, 10      *Pseudopodosira corolla* (A. Schm.) n. comb.  
Sample 281-14-1, 140-142 cm.

Figures 11-13      *Stephanopyxis superba* (Grev.) Grun.  
Sample 281-16, CC.

## PLATE 1

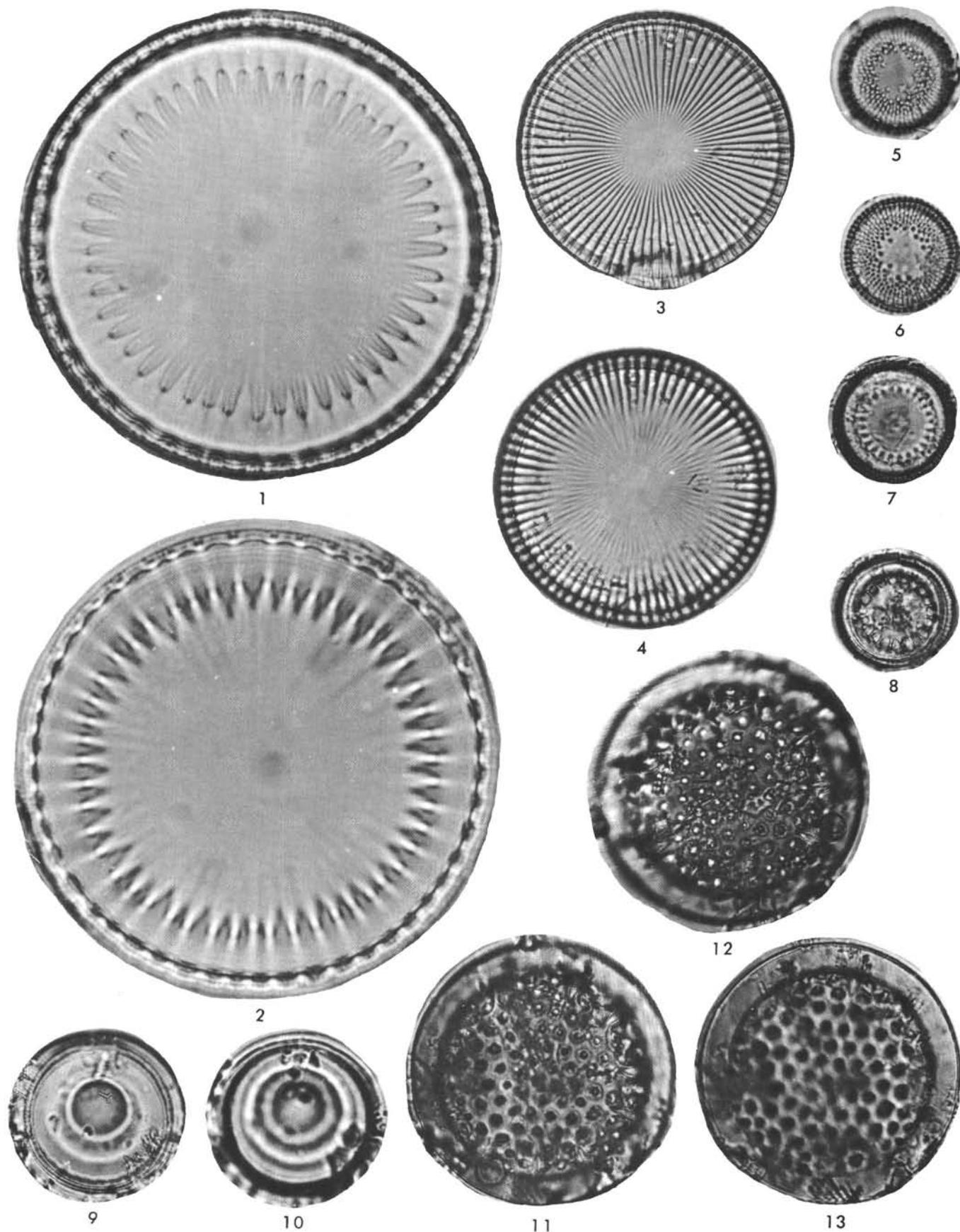


PLATE 2

Magnifications Figures 1-4, 7, 8  $\times 1000$ ; Figures 5, 6  $\times 500$

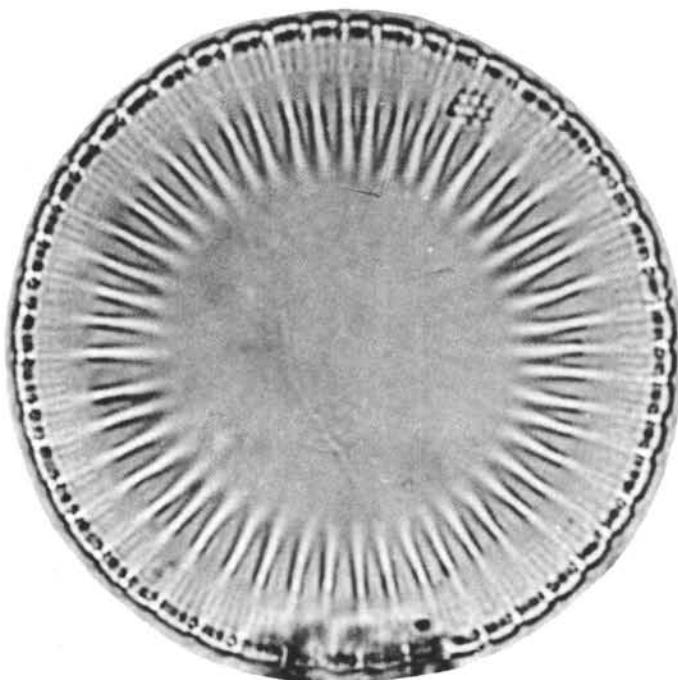
Figures 1, 2      *Melosira oamaruensis* Gr. et St.  
Sample 283-4, CC.

Figures 3, 4      *Melosira clavigera* Grun.  
Sample 283-6, CC.

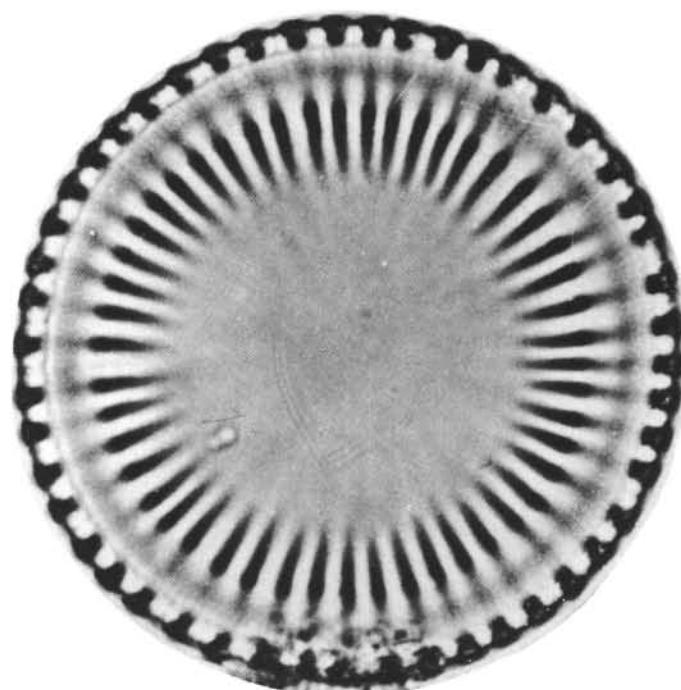
Figures 5, 6      *Stephanopyxis marginata* Grun.  
Sample 283-2, CC.

Figures 7, 8      *Podosira* sp.  
Sample 283-3, CC.

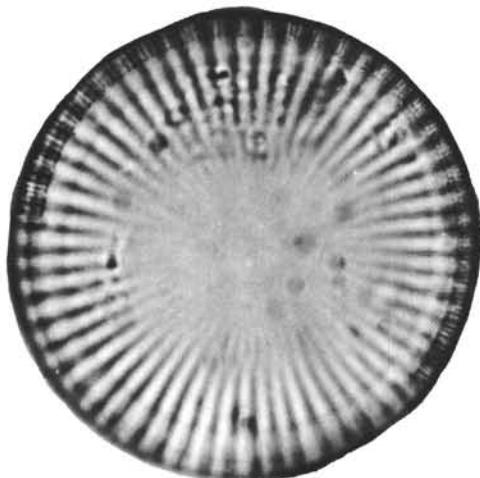
## PLATE 2



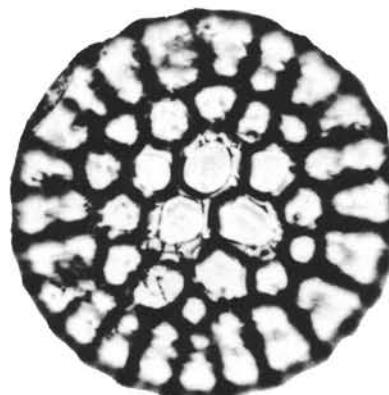
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2



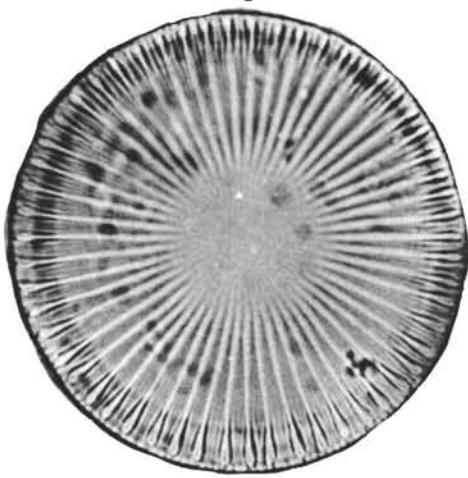
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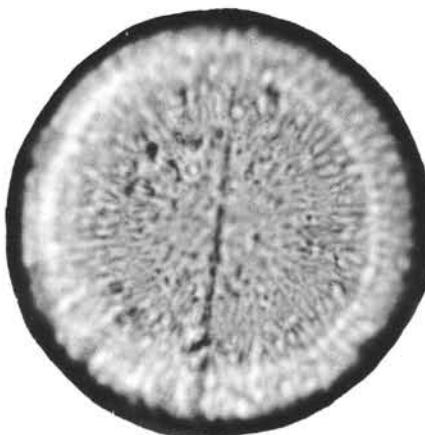
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6



4



7



8

PLATE 3

Magnifications Figures 1-2, 7-9  $\times 1000$ ; Figures 3-6  $\times 500$

Figures 1, 2     *Stephanopyxis megapora* Grun.  
                    Sample 281-16, CC.

Figures 3, 4     *Stephanopyxis grunowii* Gr. et St.  
                    Sample 281-15, CC.

Figures 5, 6     *Stephanopyxis marginata* Grun.  
                    Sample 281-16, CC.

Figure 7         *Stephanopyxis cf. ferox* (Grev.) Ralfs.  
                    Sample 281-16, CC.

Figures 8, 9     *Stephanopyxis turris* (Grev. et Arn.) Ralfs var. *arctica* Grun. f. ?  
                    Sample 281-15, CC.

## PLATE 3

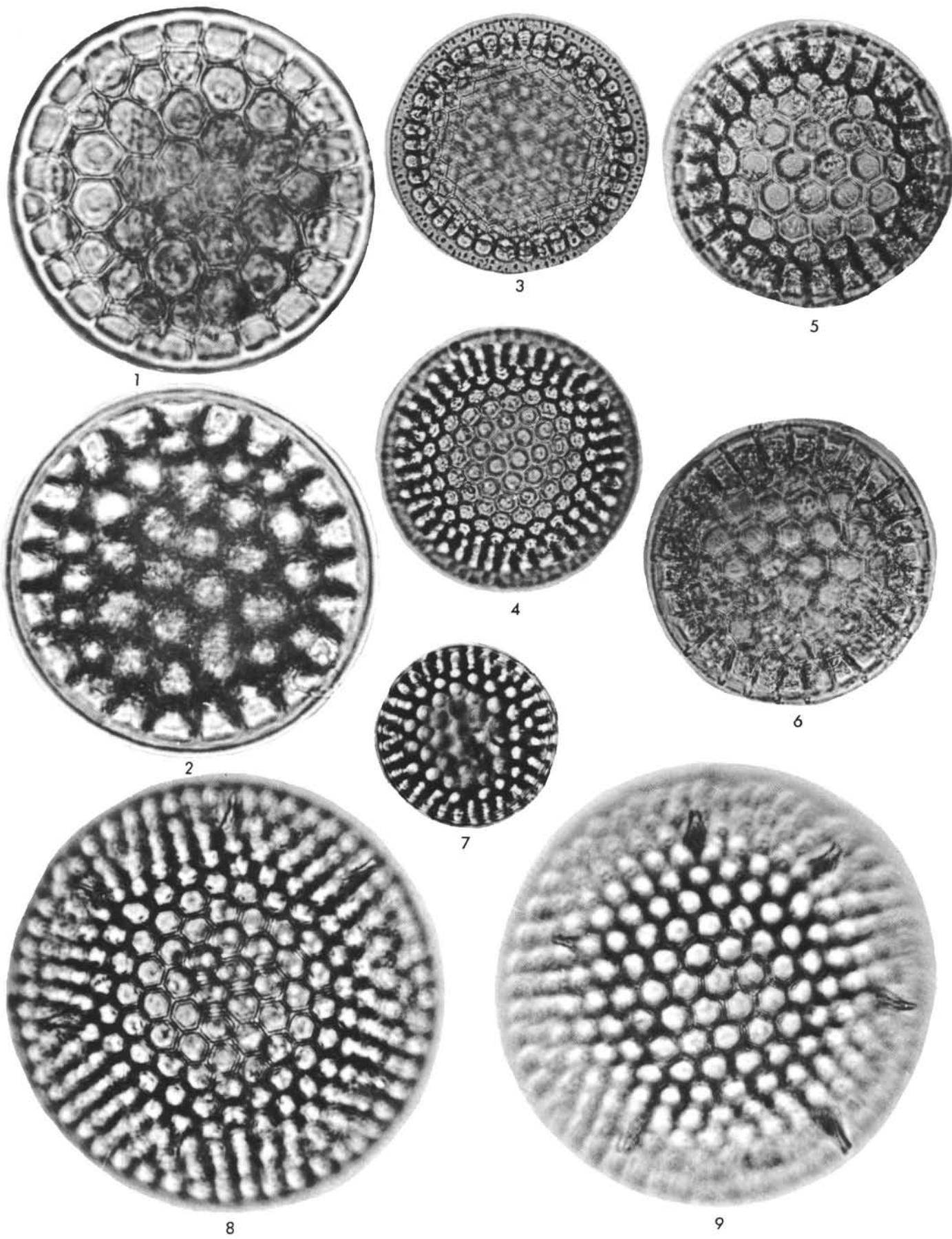


PLATE 4  
Magnifications  $\times 500$

- Figures 1, 2      *Stephanopyxis grunowii* Gr. et St.  
                      Sample 283-6, CC.
- Figures 3, 4      *Stephanopyxis eocaenicus* n. sp. Holotype.  
                      Sample 283-6, CC.
- Figures 5-7      *Endictya robusta* (Grev.) Hanna et Grant.  
                      Sample 283-6, CC.
- Figures 8, 9      *Coscinodiscus radiatus* Ehr. var. *nodulifer* Reinhard.  
                      Sample 283-6, CC.
- Figures 10, 11     *Coscinodiscus oculusiridis* Ehr. var. *borealis* (Bail.)  
                      Cl.  
                      Sample 283-2, CC.
- Figures 12-14     *Coscinodiscus cf. radiatus* Ehr.  
                      Sample 283-6, CC.

## PLATE 4

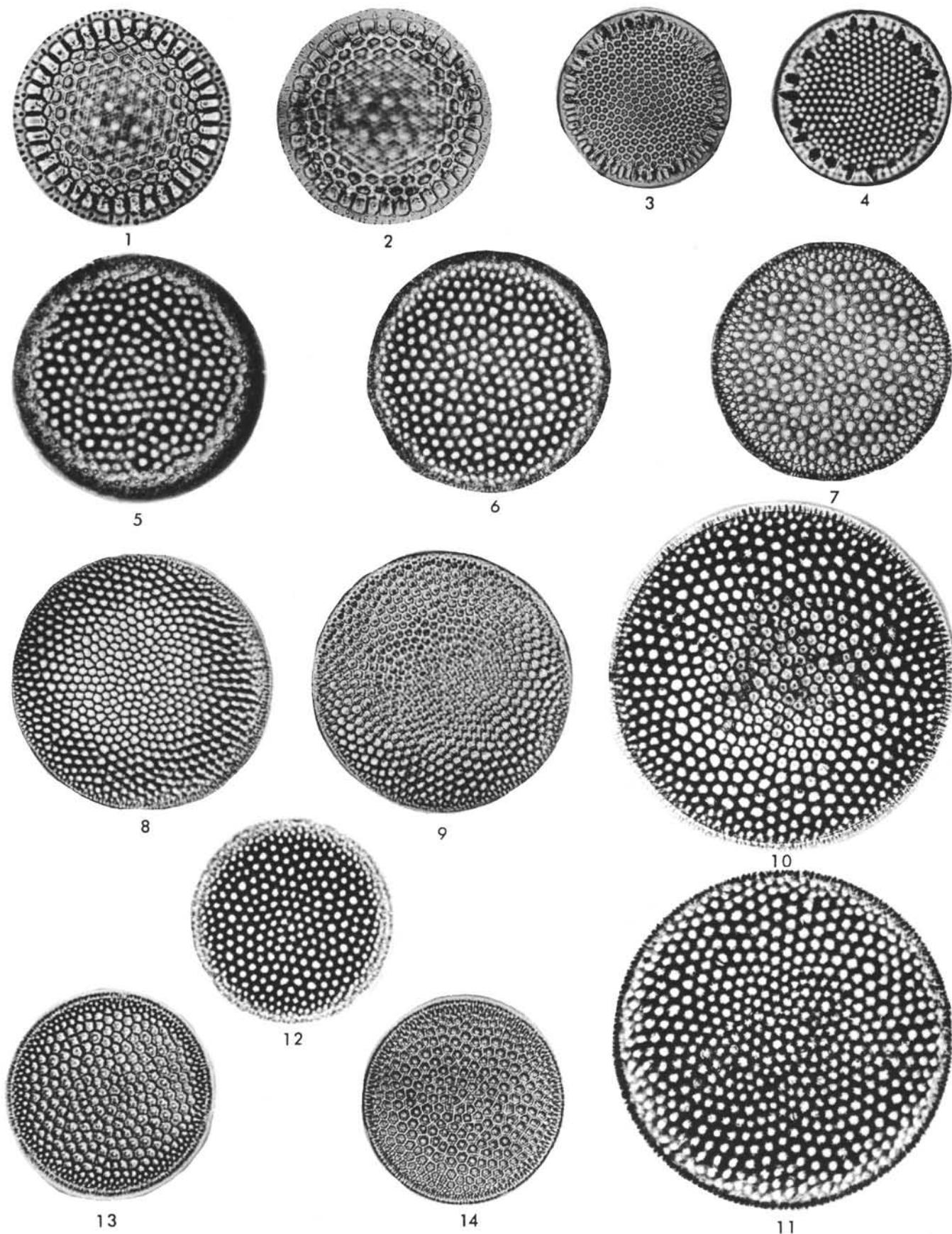


PLATE 5

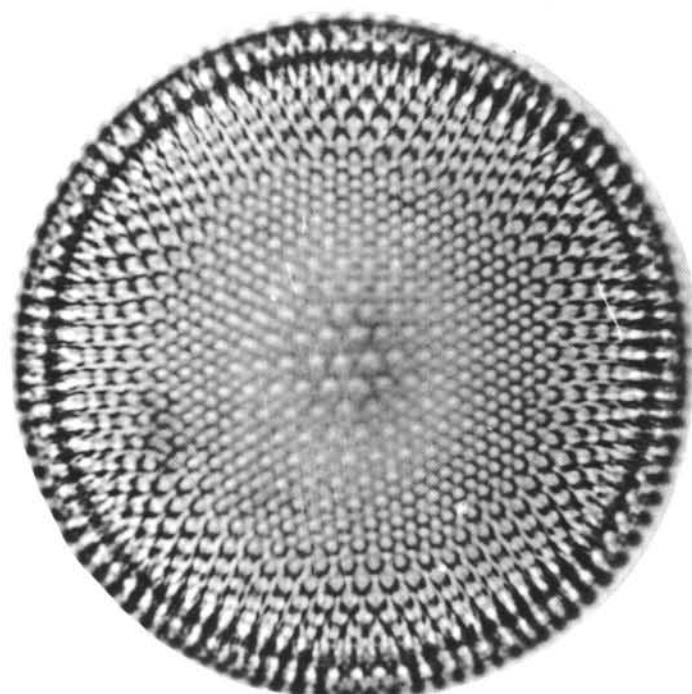
Magnifications Figures 1, 2  $\times 1000$ ; Figures 3-8  $\times 500$

Figures 1, 2      *Stephanopyxis cf. antiqua* Pant.  
                      Sample 281-14, CC.

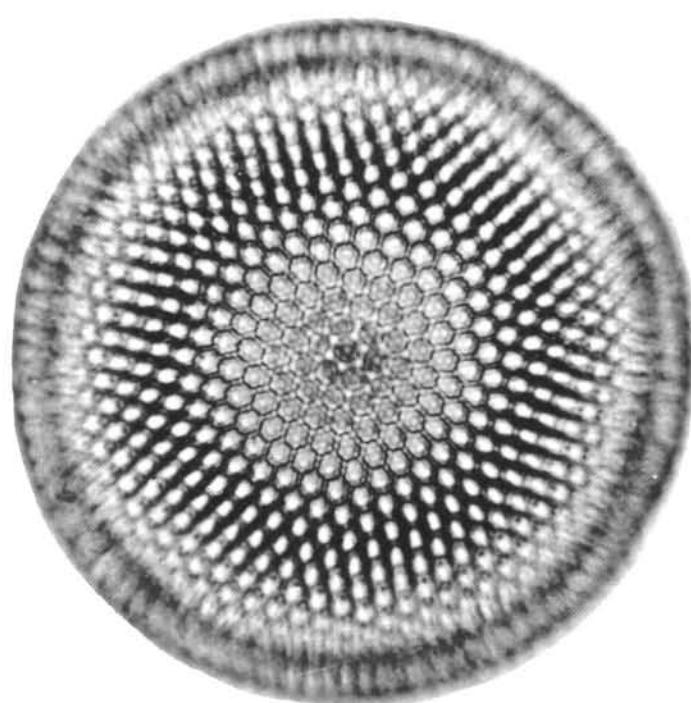
Figures 3-5      *Coscinodiscus cf. radiatus* Ehr.  
                      Sample 281-15, CC.

Figures 6-8      *Stephanopyxis cf. antiqua* Pant.  
                      Sample 281-15, CC.

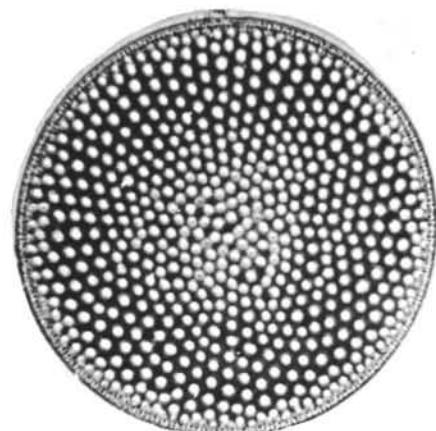
## PLATE 5



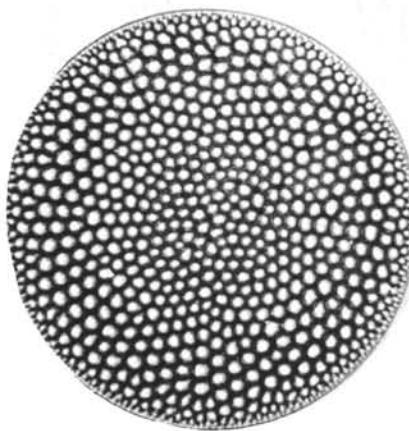
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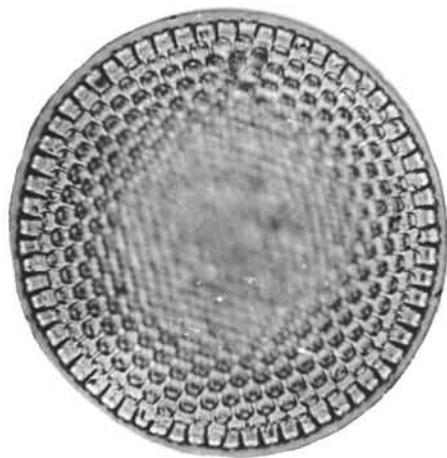
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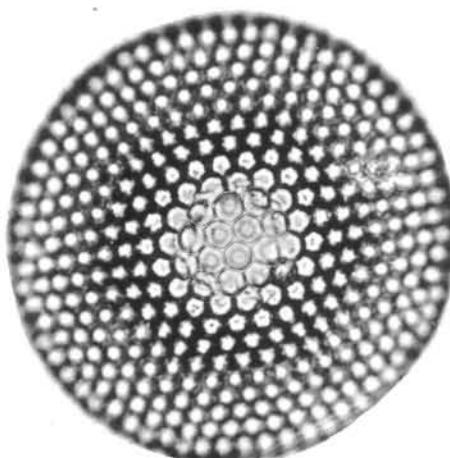
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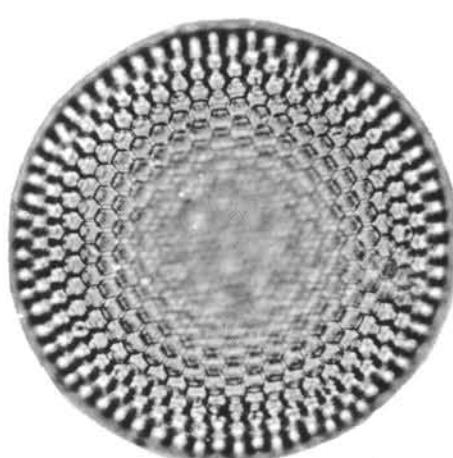
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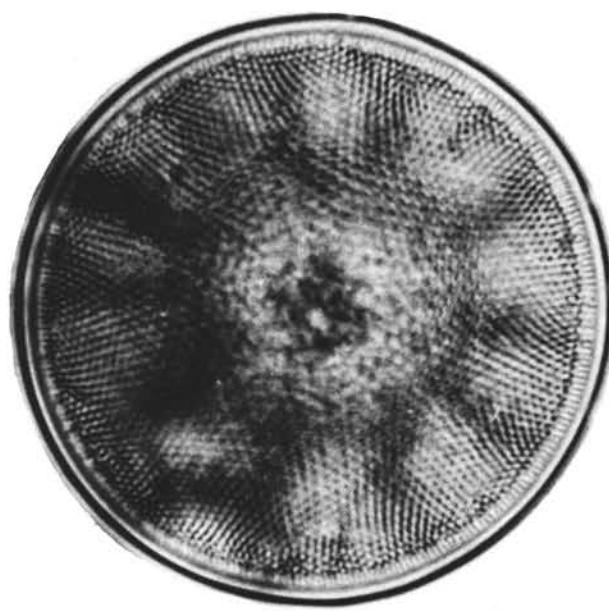


8

PLATE 6  
Magnifications  $\times 1000$

- Figures 1, 2      *Coscinodiscus symbolophorus* Grun. var.  
*oamaruensis* A. Schm.  
Sample 283-4, CC.
- Figures 3, 4      *Coscinodiscus radiatus* Ehr. var. *nodulifer*  
Reinhard.  
Sample 283-4, CC.
- Figures 5, 6      *Coscinodiscus bulliens* A. Schm.  
Sample 283-3, CC.

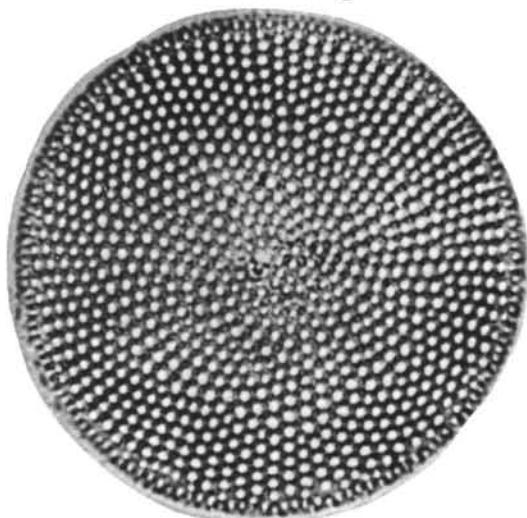
PLATE 6



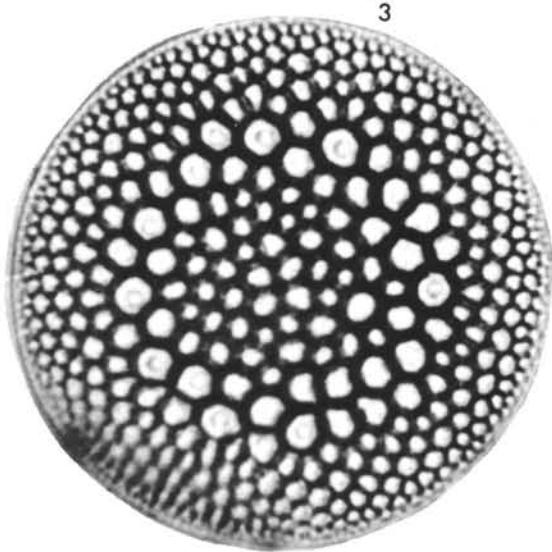
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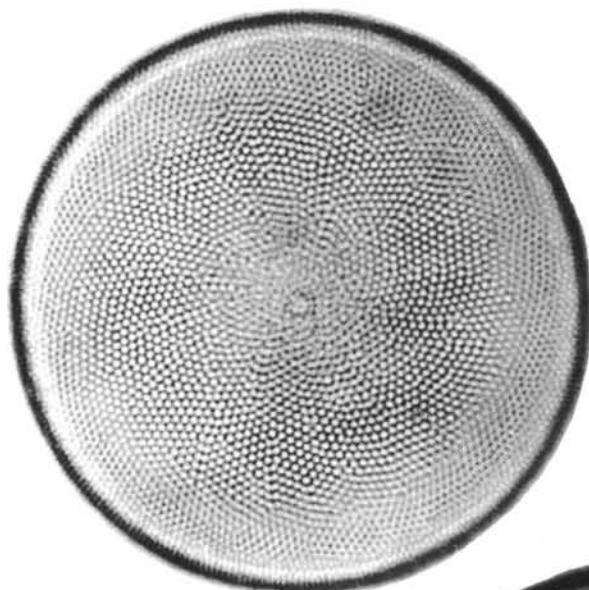
6

PLATE 7  
Magnifications  $\times 1000$

Figures 1-3      *Coscinodiscus spiralis* n. sp.  
                      Sample 283-4, CC.  
                      1, 2. Holotype.

Figures 4, 5      *Coscinodiscus denarius* A. Schm.  
                      Sample 283-4, CC.

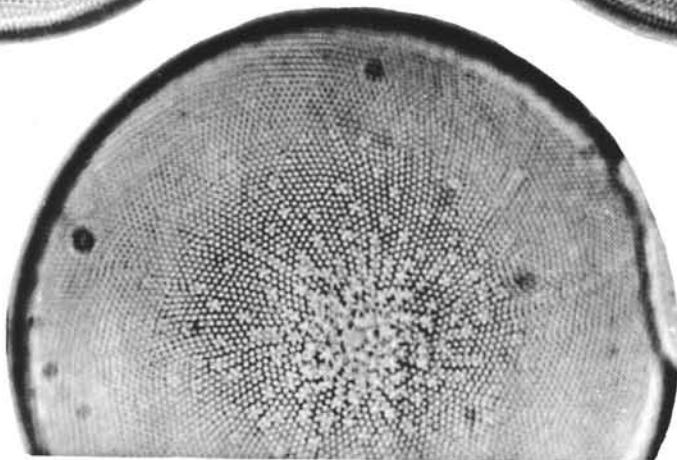
PLATE 7



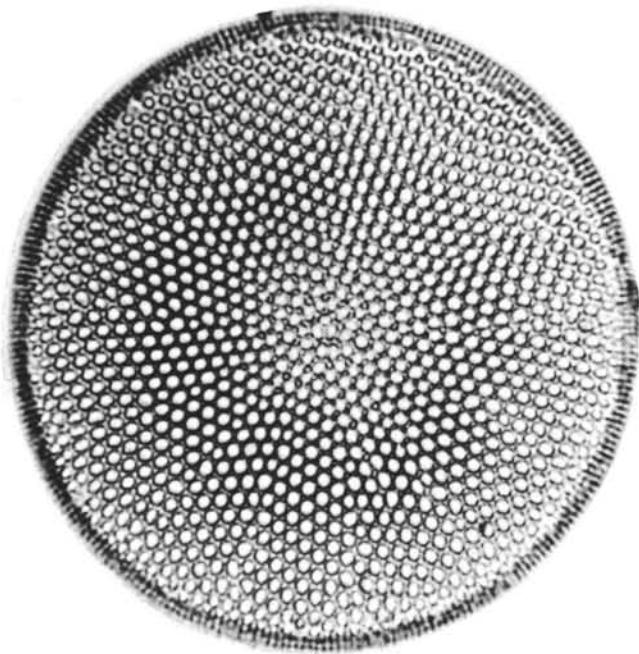
1



2



3



4



5

PLATE 8

Magnifications Figures 1, 2, 6, 7  $\times 1000$ ; Figures 3-5  $\times 500$

Figures 1, 2      *Arachnoidiscus schmidti* n. sp. Holotype.  
Sample 283-4, CC.

Figures 3-5      *Auliscus gleseri* n. sp. Holotype.  
Sample 283-6, CC.

Figures 6, 7      *Corona magnifica* Lef. et Chen.  
Sample 283-3, CC.

## PLATE 8

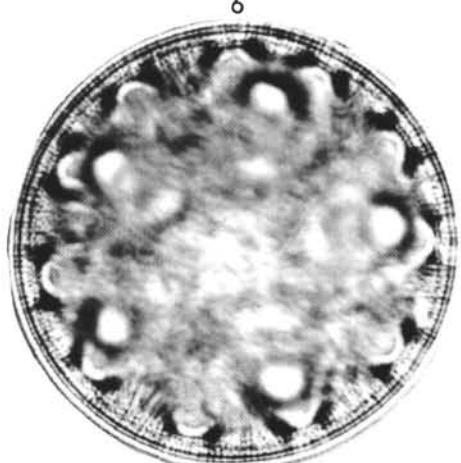
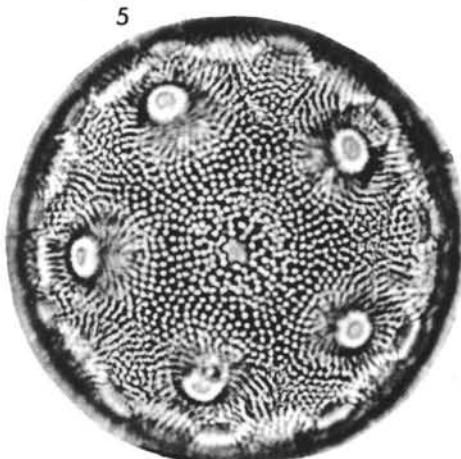
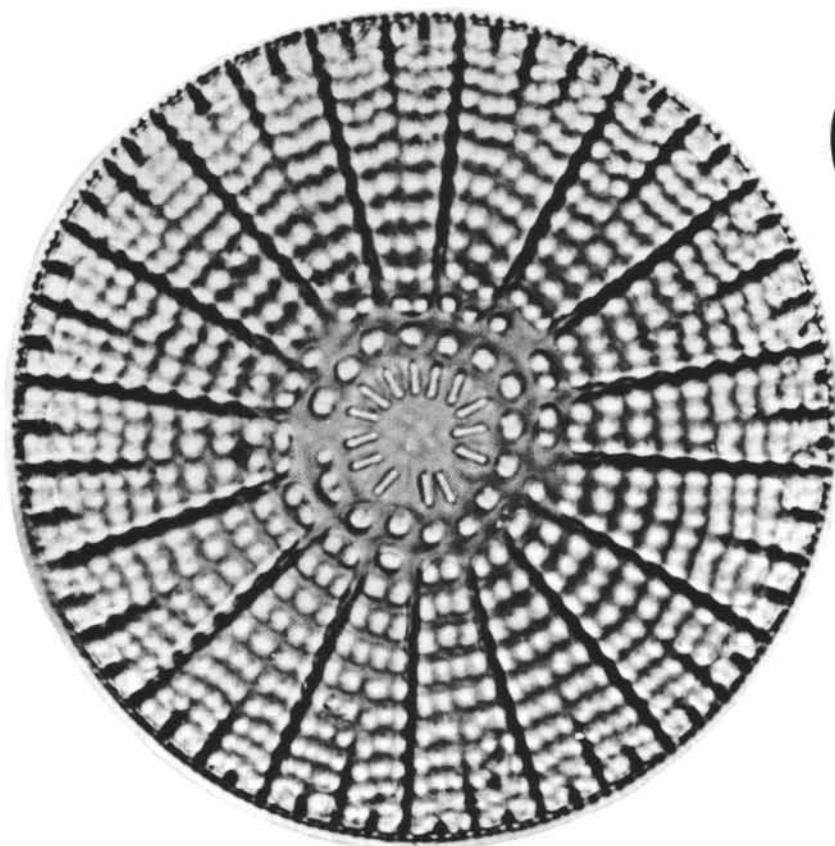


PLATE 9

Magnifications Figures 1-3  $\times 1000$ ; Figures 4-6  $\times 500$

Figures 1, 2      *Arachnoidiscus indicus* Ehr.  
Sample 283-4, CC.

Figure 3      *Aulacodiscus rattrayii* Gr. et St.  
Sample 283-3, CC.

Figure 4      *Actinocyclus octonarius* Ehr. var.?.  
Sample 283-3, CC.

Figure 5      *Chaetoceros* sp.  
Sample 283-6, CC.

Figure 6      *Actinoptychus splendens* (Shadb.) Ralfs.  
Sample 283-3, CC.

## PLATE 9

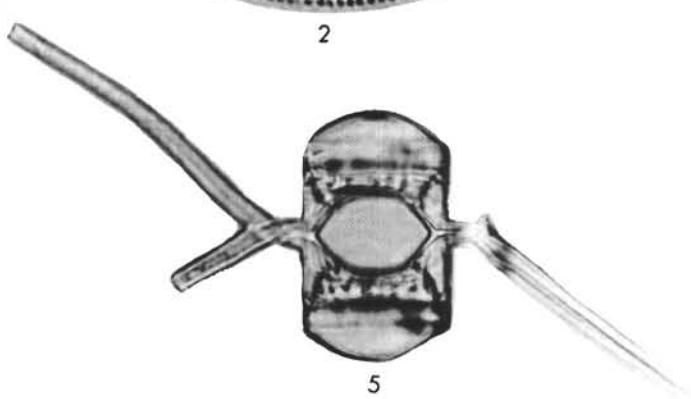
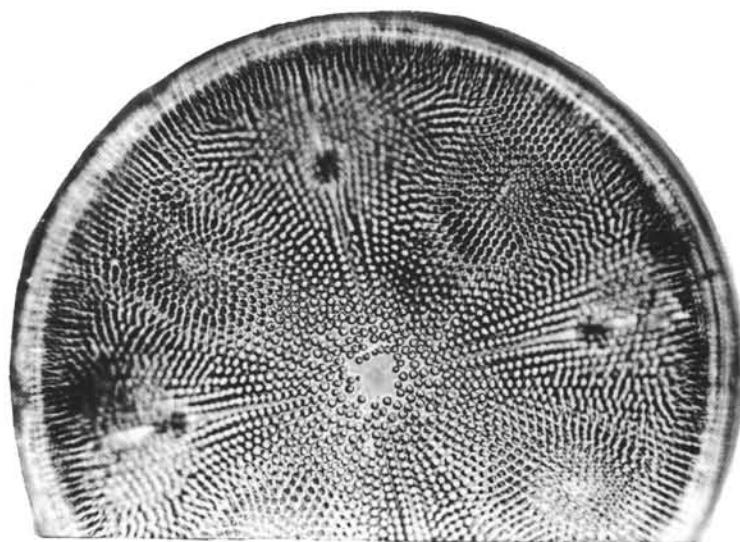
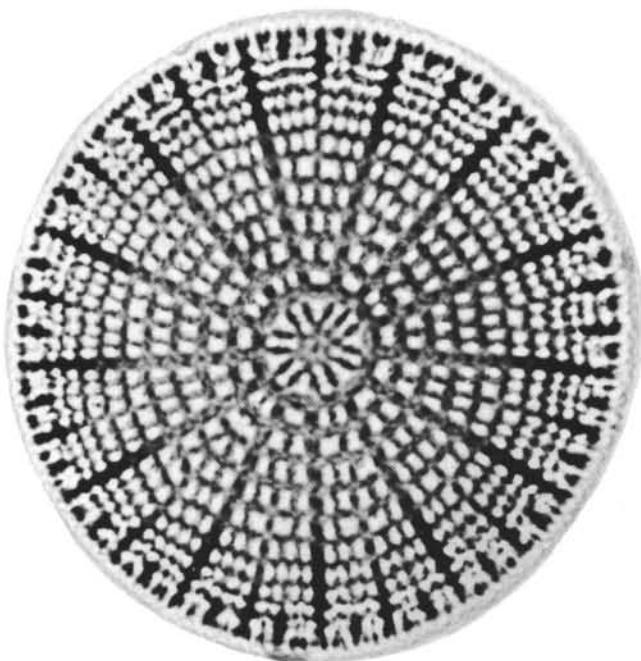


PLATE 10

Magnifications Figures 1-3, 7  $\times 1000$ ; Figures 4-6,  $\times 500$

- Figure 1      *Coscinodiscus symbolophorus* Grun. var. *oamaruensis* A. Schm.  
Sample 281-14, CC.
- Figures 2, 3    *Arachnoidiscus russicus* Pant.  
Sample 281-16, CC.
- Figures 4-6    *Stictodiscus grovei* A. Schm.  
Sample 281-15, CC.
- Figure 7       *Auliscus oamaruensis* Gr. et St.  
Sample 281-15, CC.

## PLATE 10

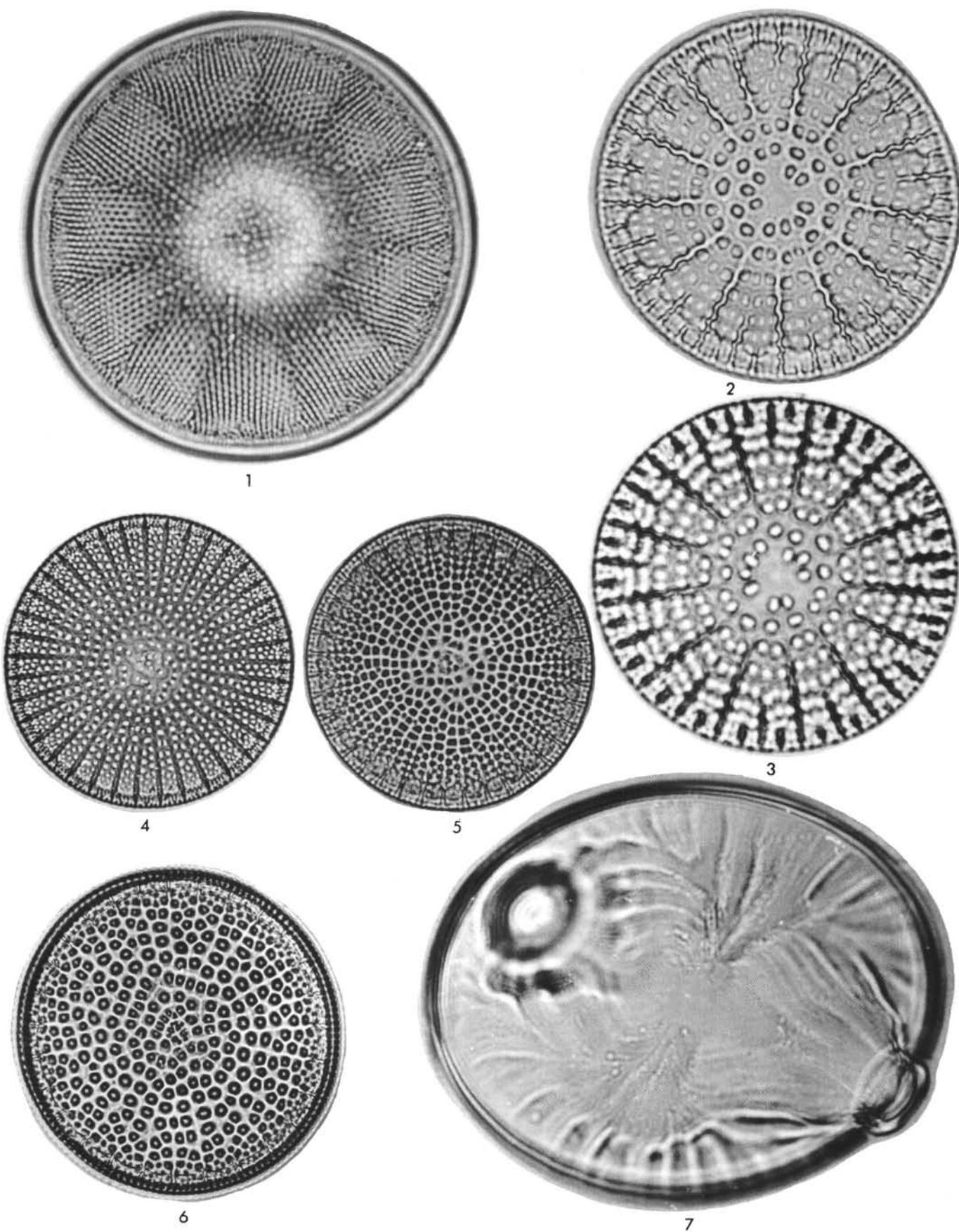
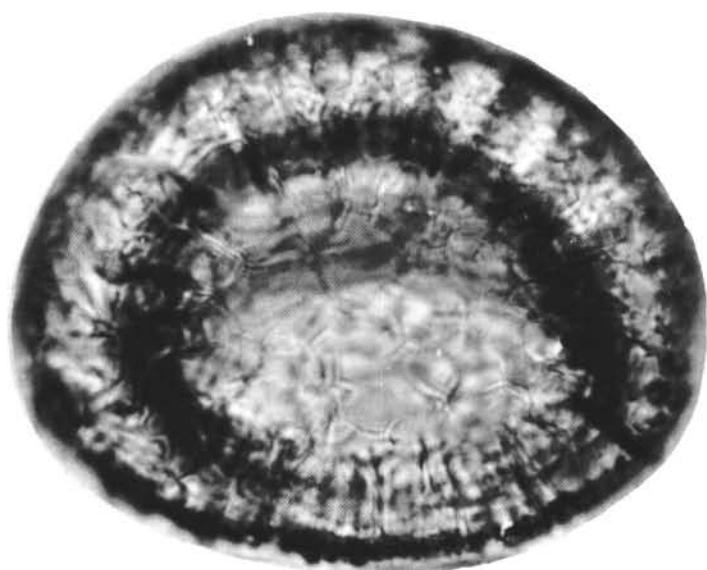


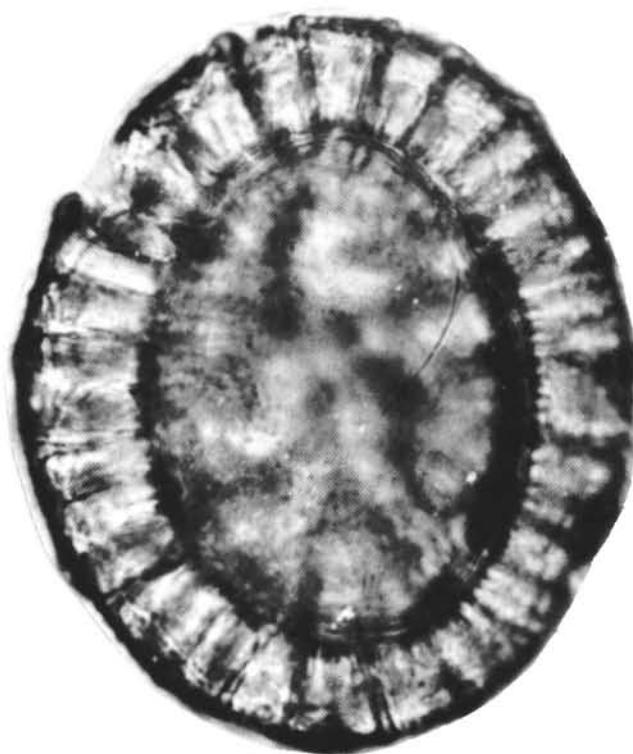
PLATE 11  
Magnifications  $\times 1000$

- Figures 1-3      *Muelleriopsis limbata* (Ehr.) Hendey.  
                    Sample 281-15, CC.
- Figure 4        *Muelleriopsis limbata* (Ehr.) Hendey.  
                    Sample 281-14, CC.
- Figure 5        *Xanthiopyxis panduraeformis* Pant.  
                    Sample 281-16, CC.
- Figure 6        *Xanthiopyxis* cf. *acrolopha* Forti.  
                    Sample 281-16, CC.

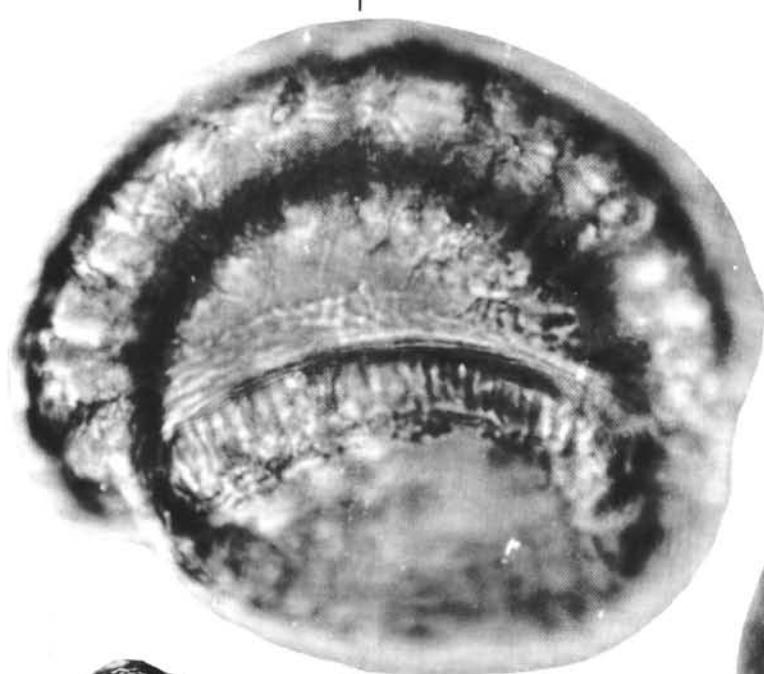
## PLATE 11



1



2



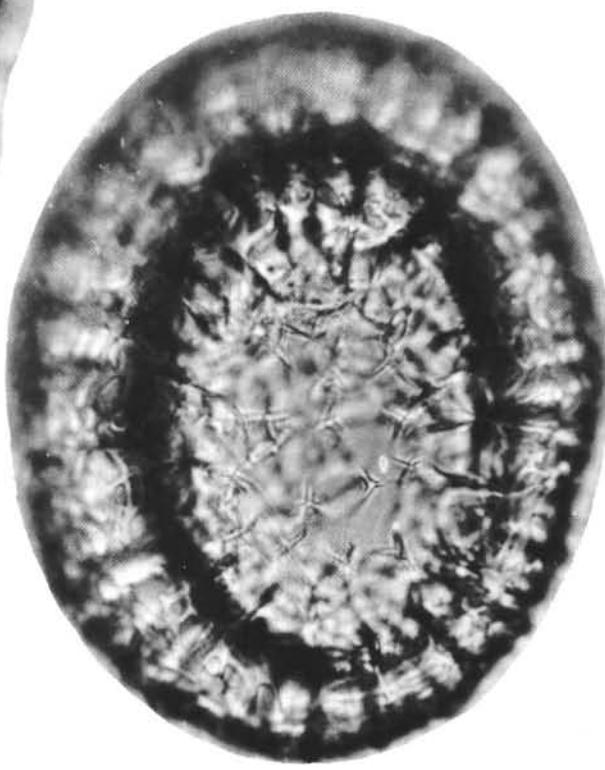
3



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6



4

PLATE 12  
Magnifications  $\times 500$

- Figure 1      *Rhizosolenia* sp.  
                  Sample 281-15, CC.
- Figures 2, 3    *Triceratium oamaruense* Gr. et St.  
                  Sample 281-14, CC.
- Figures 4, 5    *Triceratium castellatum* West var.?.  
                  Sample 281-15, CC.
- Figures 6, 7    *Triceratium oamaruense* Gr. et St. var. *sparsim punctata* Gr.  
                  Sample 281-14, CC.
- Figures 8, 9    *Triceratium pulvinar* A. Schm.  
                  Sample 281-14, CC.

## PLATE 12

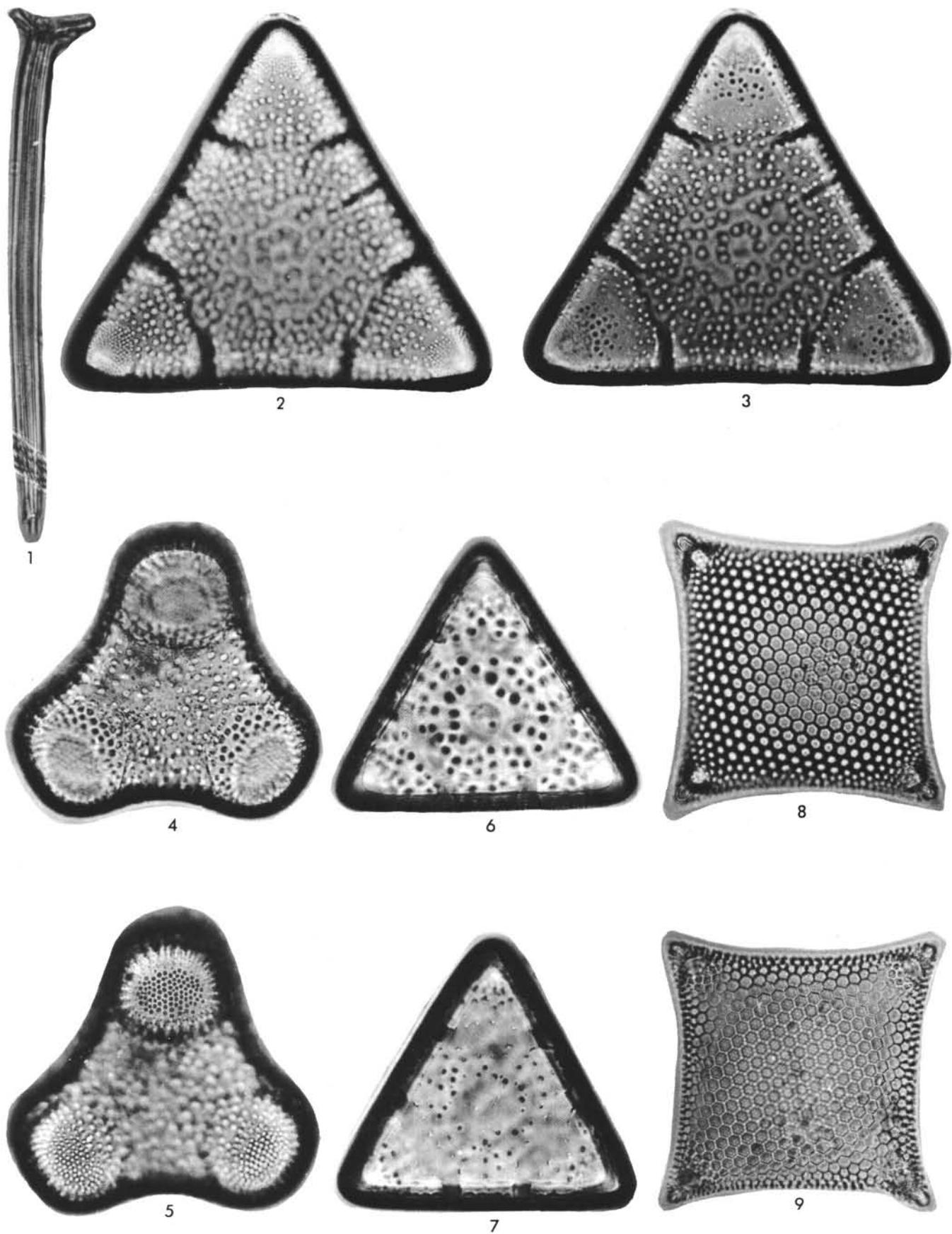


PLATE 13

Magnifications Figures 1, 2  $\times 1000$ ; Figures 3-8  $\times 500$

Figures 1, 2      *Triceratium crenulatum* Gr. et St.  
Sample 283-4, CC.

Figures 3, 4      *Triceratium pulvinar* A. Schm.  
Sample 283-6, CC.

Figures 5, 6      *Biddulphia rigida* A. Schm.  
Sample 283-3, CC.

Figures 7, 8      *Triceratium morlandii* Gr. et St.  
Sample 283-6, CC.

## PLATE 13

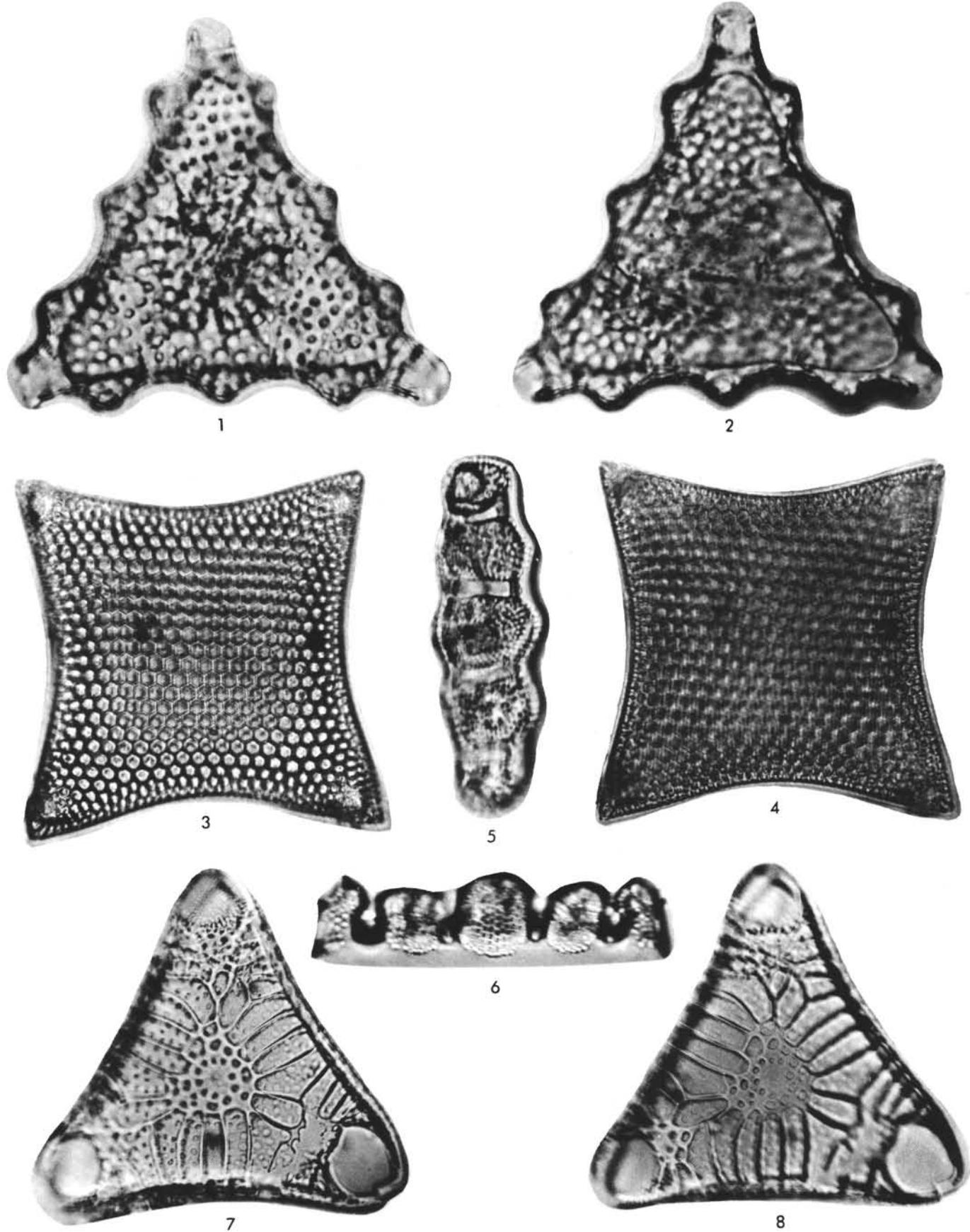


PLATE 14

Magnifications Figures 1-3, 7-13  $\times 500$ ; Figures 4-6  $\times 1000$

- Figures 1-3      *Triceratium pulvinar* A. Schm.  
Sample 281-15, CC.
- Figures 4-6      *Triceratium pulvinar* A. Schm. Detail of the structure of the valve mantle. Sample 281-15, CC.
- Figures 7, 8      *Triceratium pulvinar* A. Schm.  
Sample 281-14, CC.
- Figure 9      *Trinacria excavata* Heib.  
Sample 281-15, CC.
- Figures 10-12      *Pseudorutilaria monile* Gr. et St.  
Sample 281-16, CC.
- Figure 13      *Cerataulina paebergoni* n. sp.  
Sample 281-15, CC.

## PLATE 14

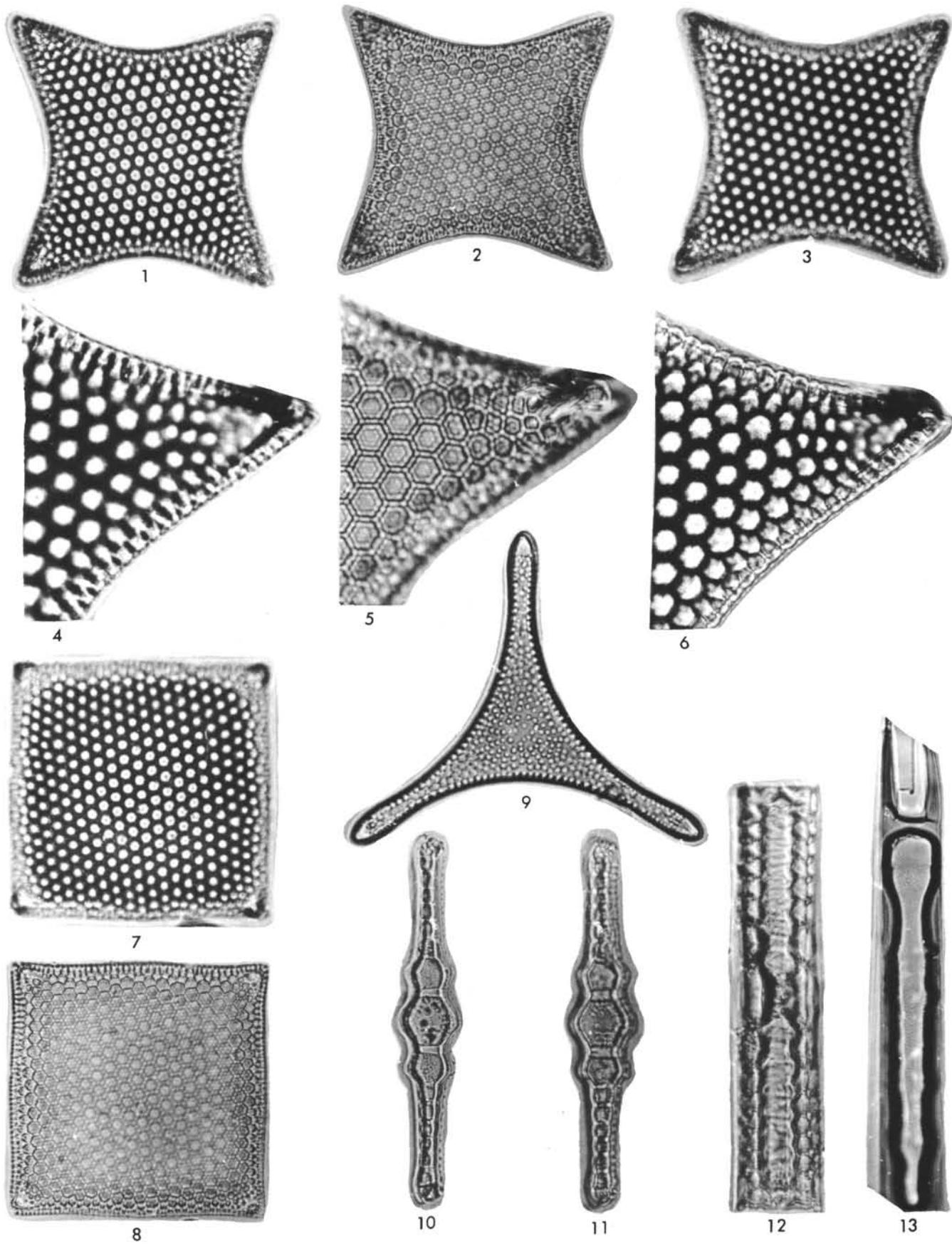


PLATE 15

Magnifications Figures 1-9  $\times 500$ ; Figures 10, 11  $\times 1000$

- Figures 1, 2      *Trinacria simulacrum* Gr. et St.  
Sample 283-6, CC.
- Figures 3, 4      *Trinacria simulacrum* Gr. et St.  
Sample 283-6, CC.
- Figures 5-7      *Cerataulina praebergoni* n. sp.  
Sample 283-6, CC.
- Figures 8, 9      5. Holotype.  
*Trinacria excavata* Heib.  
Sample 283-6, CC.
- Figure 10      *Hemiaulus characteristicus* n. sp. Holotype.  
Sample 283-4, CC.
- Figure 11      *Hemiaulus polymorphus* Grun. var.?  
Sample 283-5, CC.
- Figure 12      *Hemiaulus polymorphus* Grun. var.?  
Stereoscan micrograph  $\times 2200$ . Sample 283-5, CC.

## PLATE 15

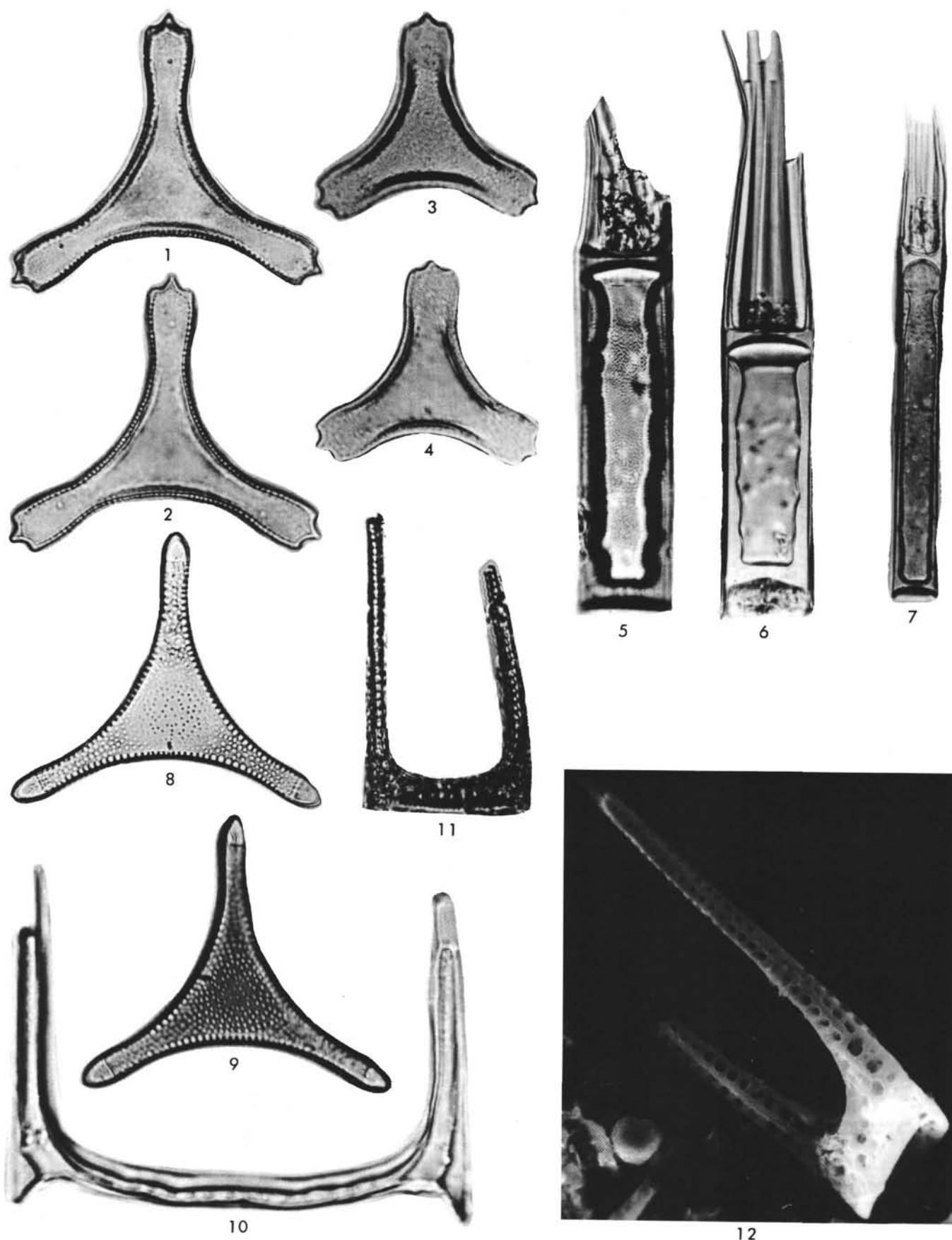


PLATE 16

Magnifications Figures 1-3, 12-15  $\times 500$ ; Figures 4-7, 9-11  $\times 1000$

- Figures 1-5      *Pyrgupyxis gracilis* (Temp. et Forti) Hendey var.  
*saratoviana* (Pant.) Hendey  
Sample 283-4, CC.
- Figures 6, 7      *Pterotheca aculeifera* Grun.  
Sample 283-5-1, 65-67 cm.
- Figure 8      *Pterotheca aculeifera* Grun.  
Stereoscan micrograph  $\times 2860$ . Sample 283-5, CC.
- Figures 9-11      *Pyrgupyxis johnsoniana* (Forti) Hendey.  
Sample 283-5, CC.
- Figures 12, 13      *Pterotheca danica* Grun.  
Sample 283-6, CC.
- Figures 14, 15      *Pterotheca danica* Grun.  
Sample 283-6, CC.
- Figure 16      *Pyrgupyxis johnsoniana* (Forti) Hendey.  
Stereoscan micrograph  $\times 2200$ . Sample 283-5, CC.

## PLATE 16

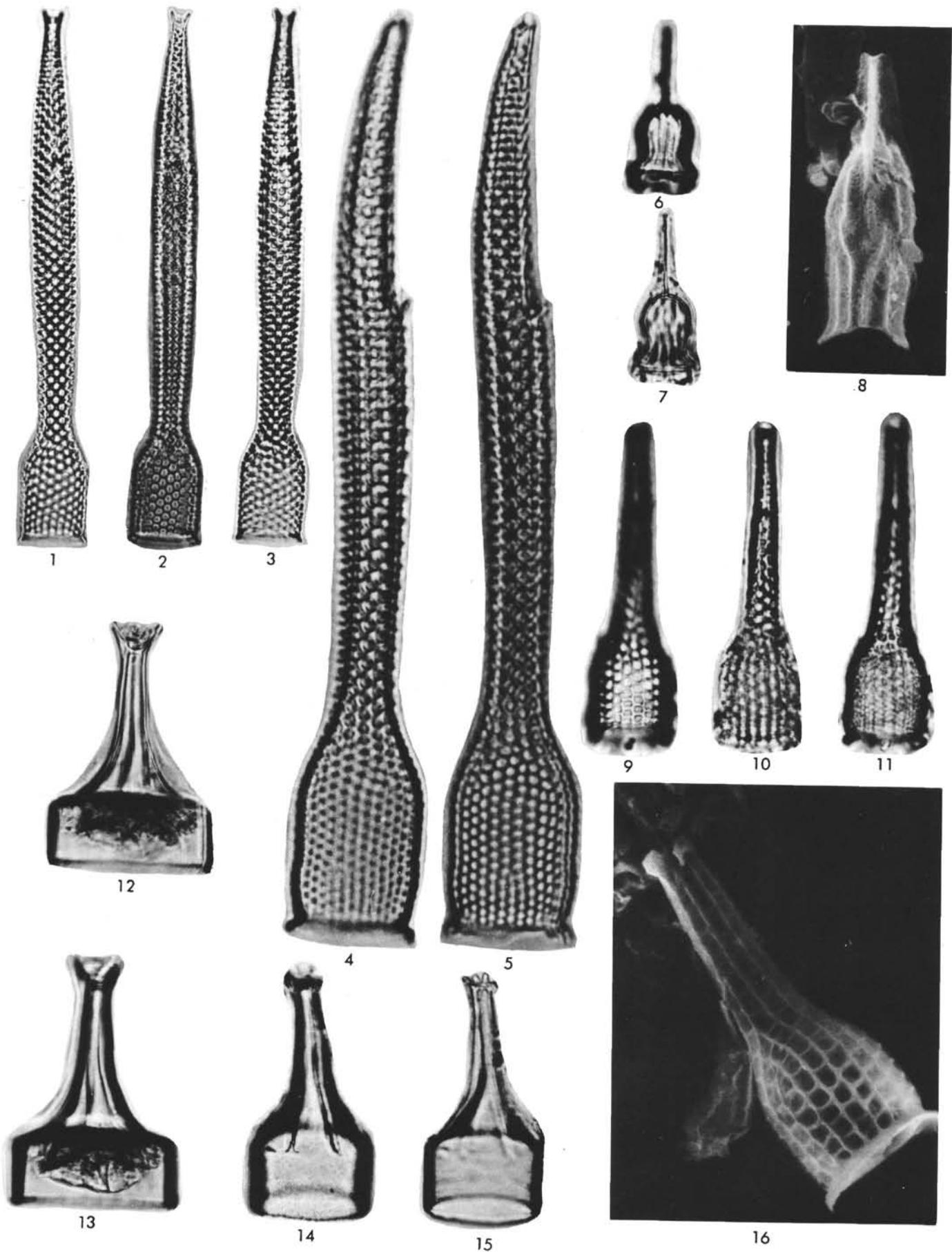


PLATE 17

Magnifications Figures 1, 2, 4, 7-13  $\times 1000$ ; Figures 3, 5-6  $\times 500$

Figures 1, 2      *Liradiscus ovalis* Grev.  
Sample 283-8, CC.

Figure 3      *Poretzkia?* sp.  
Sample 283-3, CC.

Figure 4      *Xanthiopyxis acrolopha* Forti.  
Sample 283-4, CC.

Figures 5, 6      *Acanthodiscus rugosus* Pant.  
Sample 283-3, CC.

Figures 7, 8      *Stephanogonia* cf. *polyacantha* Forti.  
Sample 283-2, CC.

Figure 9      *Xanthiopyxis panduraeformis* Pant.  
Sample 283-8, CC.

Figures 10, 12      *Xanthiopyxis* cf. *acrolopha* Forti.  
Sample 283-5-1, 65-67 cm.

Figure 11      *Xanthiopyxis oblonga* Ehr.  
Sample 283-4, CC.

Figure 13      *Goniothecium odontella* Ehr.  
Sample 283-4, CC.

PLATE 17

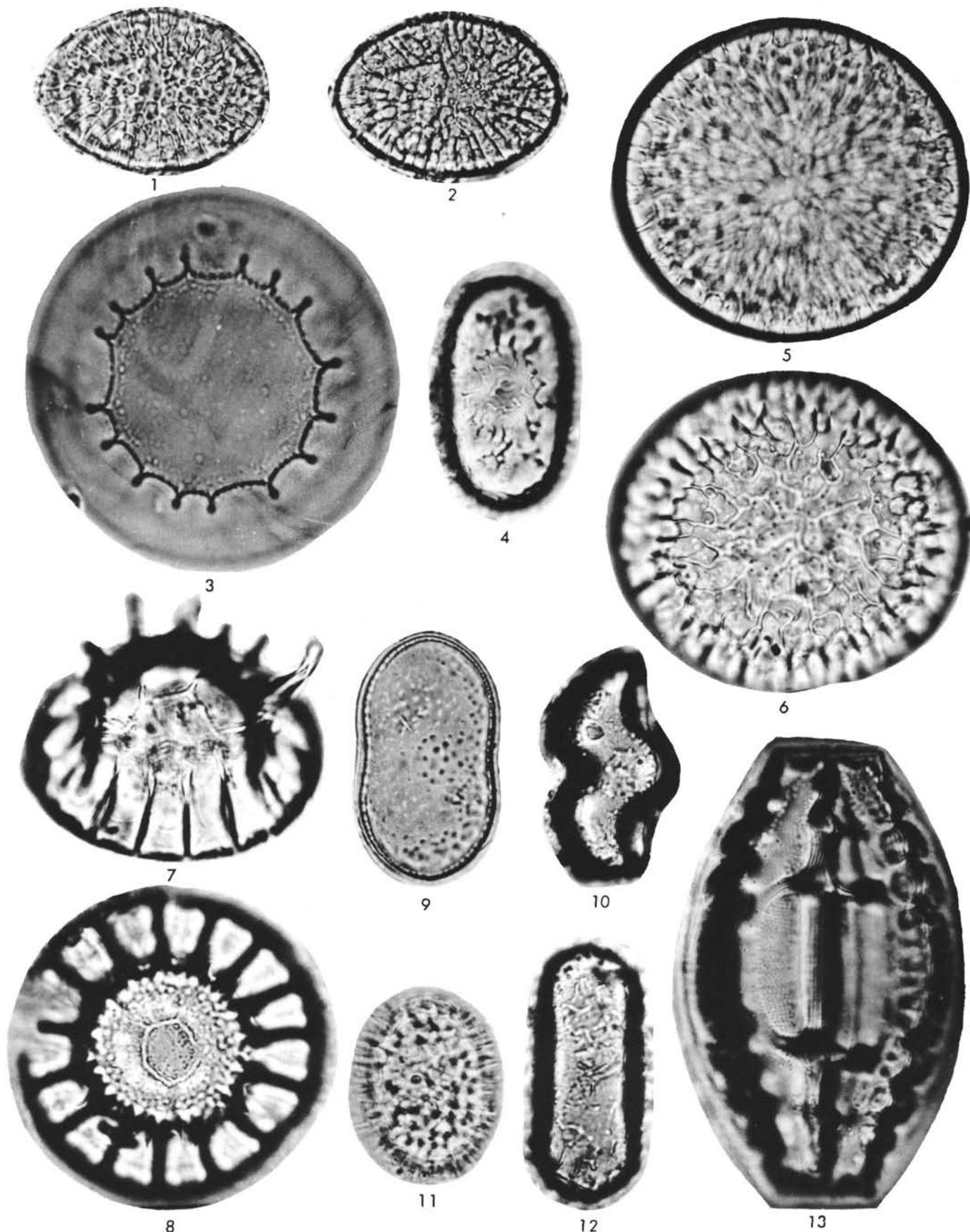


PLATE 18

Magnifications Figures 1-16, 18, 20-21  $\times 1000$ ; Figures 17, 19  $\times 500$

- Figures 1-3      *Archaeomonas oamaruensis* Defl.  
Sample 283-6, CC.
- Figures 4, 5      *Archaeomonas dubia* Defl.  
Sample 283-6, CC.
- Figures 6-8      *Archaeosphaeridium armatum* n. sp.  
Sample 283-6, CC.  
6-7. Holotype
- Figures 9, 10      *Pararchaeomonas decorata* n. sp. Holotype.  
Sample 283-4, CC.
- Figures 11, 12      *Pararchaeomonas? rigaudae* Rampi.  
Sample 283-4, CC.
- Figures 13, 14      *Archaeomonas reticulosa* Defl.  
Sample 283-4, CC.
- Figure 15      *Dictyocha fibula* Ehr.  
Sample 283-2, CC.
- Figure 16      *Dictyocha fibula* Ehr.  
Sample 283-3, CC.
- Figures 17, 19      *Porifera* spicules  
Sample 283-6, CC.
- Figure 18      *Mesocena apiculata* (Schulz) Hanna.  
Sample 283-6, CC.
- Figure 20      *Naviculopsis biapiculata* (Lemm.) Freng. Sample  
283-2, CC.
- Figure 21      *Naviculopsis biapiculata* (Lemm.) Freng. var. *con-*  
*stricta* (Schulz) Glezer.  
Sample 283-4, CC.

## PLATE 18

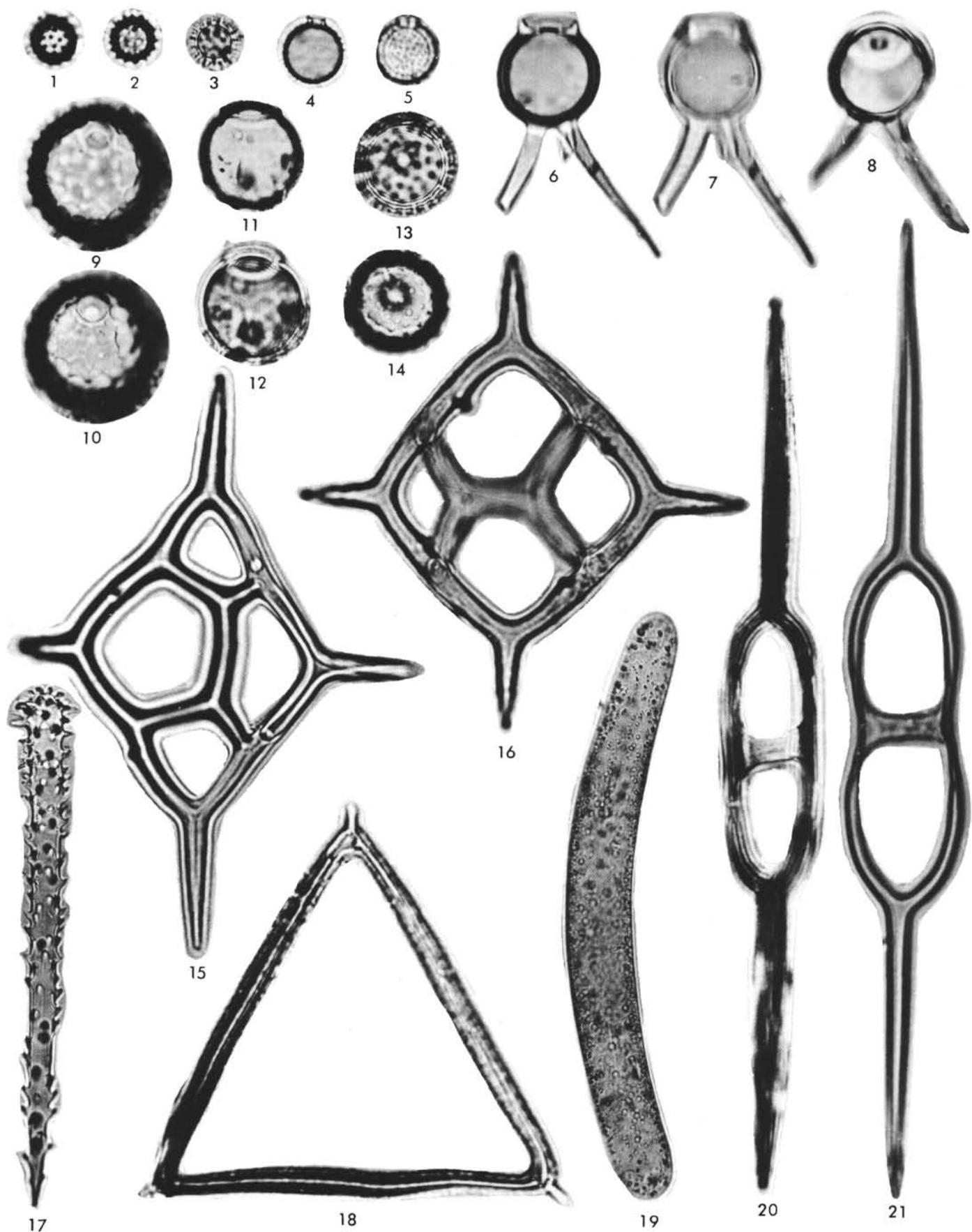


PLATE 19

Magnifications  $\times 1000$

- Figures 1, 2     *Endictya robusta* (Grev.) Hanna et Grant.  
Sample 280A-6-3, 120-122 cm.
- Figures 3, 4     *Stephanopyxis oligocaenica* n. sp. Holotype.  
Sample 280A-7-2, 120-122 cm.
- Figures 5, 6     *Stephanopyxis oamaruensis* n. sp.  
Sample 280A-7-2, 120-122 cm.
- Figures 7, 8     *Stephanopyxis oamaruensis* n. sp. Holotype.  
Sample 280A-3-4, 120-122 cm.
- Figures 9, 10    *Stephanopyxis* sp.  
Sample 280A-3-4, 120-122 cm.
- Figures 11, 12   *Stephanopyxis hyalomarginata* n. sp. Holotype.  
Sample 280A-7-2, 120-122 cm.

## PLATE 19

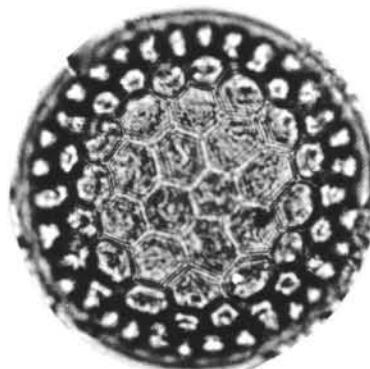
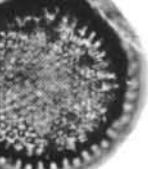
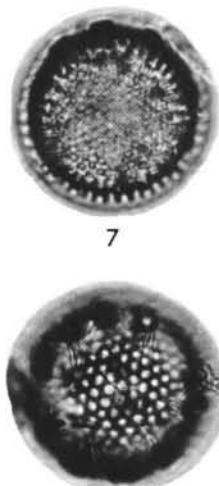
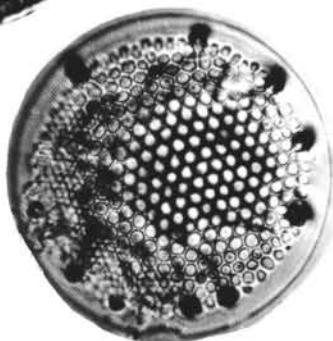
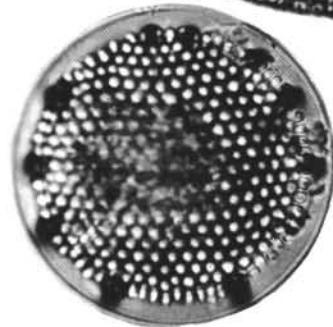
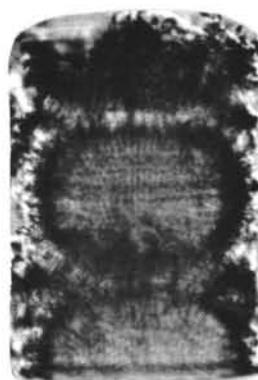
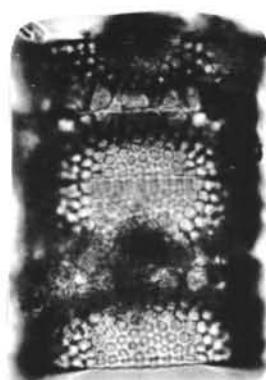
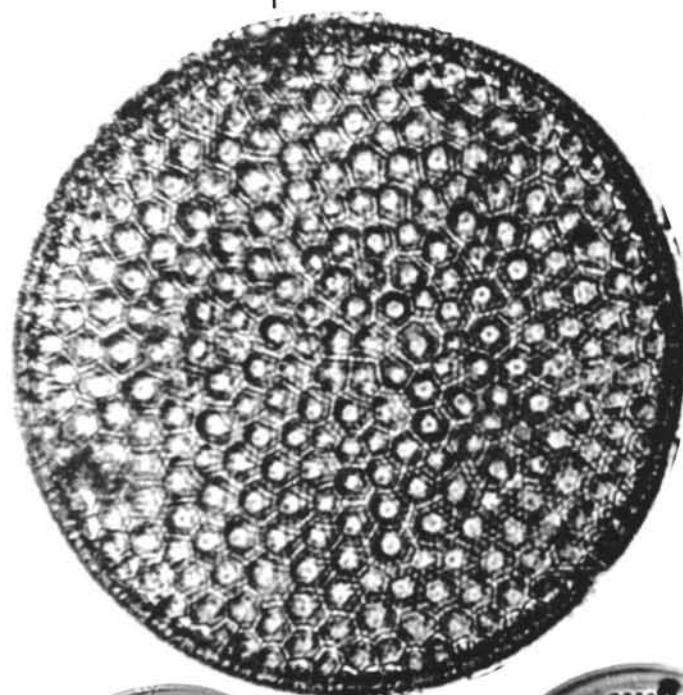
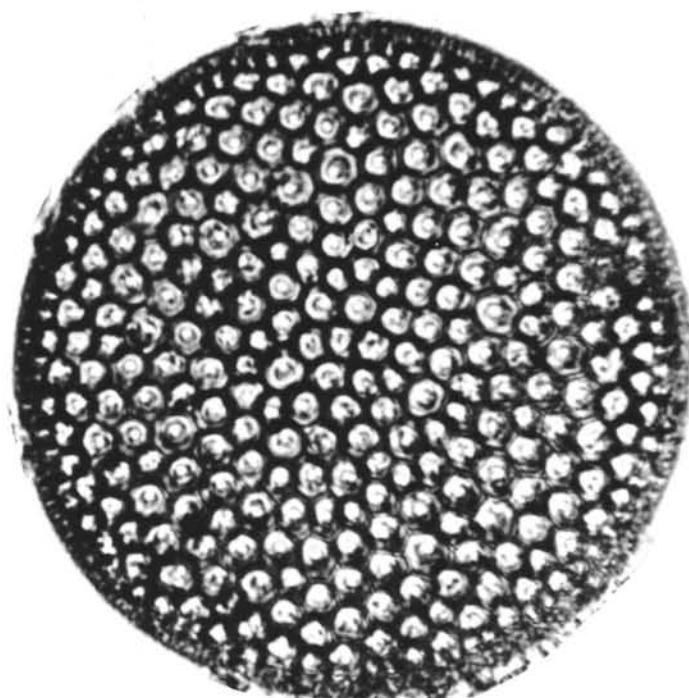


PLATE 20  
Magnifications  $\times 1000$

- Figures 1-3     *Stephanopyxis longispinosa* n. sp. Holotype.  
Sample 280A-3-4, 120-122 cm.
- Figures 4, 5     *Stephanopyxis inordinata* n. sp. Holotype.  
Sample 280A-3-4, 120-122 cm.
- Figures 6-8     *Coscinodiscus tuberculatus* Grev.  
Sample 280A-6-3, 120-122 cm.
- Figures 9, 10     *Coscinodiscus marginatus* Ehr.  
Sample 280A-6-3, 120-122 cm.
- Figures 11, 12     *Coscinodiscus symbolophorus* Grun.  
Sample 280A-8-1, 120-122 cm.
- Figures 13, 14     *Coscinodiscus cf. moelleri* A. Schm. var. *macroporus* Grun.  
Sample 280A-3-4, 120-122 cm.
- Figure 15     *Coscinodiscus symbolophorus* Grun. var. *oamaruensis* A. Schm.  
Sample 280A-6-3, 120-122 cm.

## PLATE 20

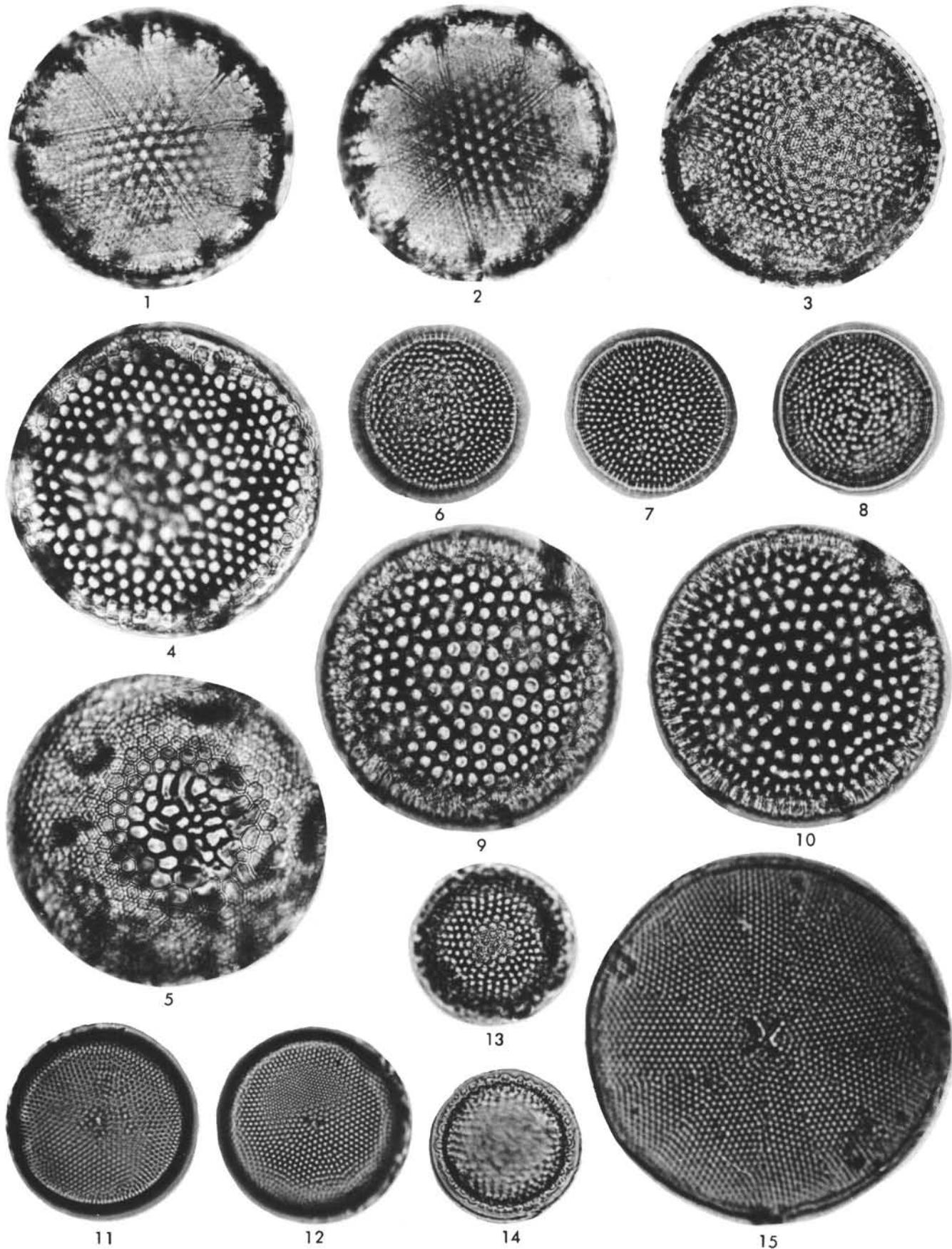


PLATE 21

Magnifications  $\times 1000$

- Figures 1, 2      *Stictodiscus nitidus* Gr. et St.  
Sample 280A-3-4, 120-122 cm.
- Figures 3, 4      *Liradiscus* sp.  
Sample 280A-3-4, 120-122 cm.
- Figure 5      *Xanthiopyxis* cf. *acrolopha* Forti.  
Sample 280A-6-3, 120-122 cm.
- Figure 6      *Asterolampra schmidti* n. sp. Holotype.  
Sample 280A-6-3, 120-122 cm.
- Figure 7      *Triceratium arcticum* Brightw.  
Sample 280A-2-3, 20-22 cm.
- Figure 8      *Rhizosolenia interposita* n. sp. Holotype.  
Sample 280A-6-3, 120-122 cm.
- Figures 9, 10      *Triceratium chenevieri* Meist.  
Sample 280A-6-3, 120-122 cm.
- Figures 11, 12      *Triceratium pulvinar* A. Schm.  
Sample 280A-6-3, 120-122 cm.

## PLATE 21

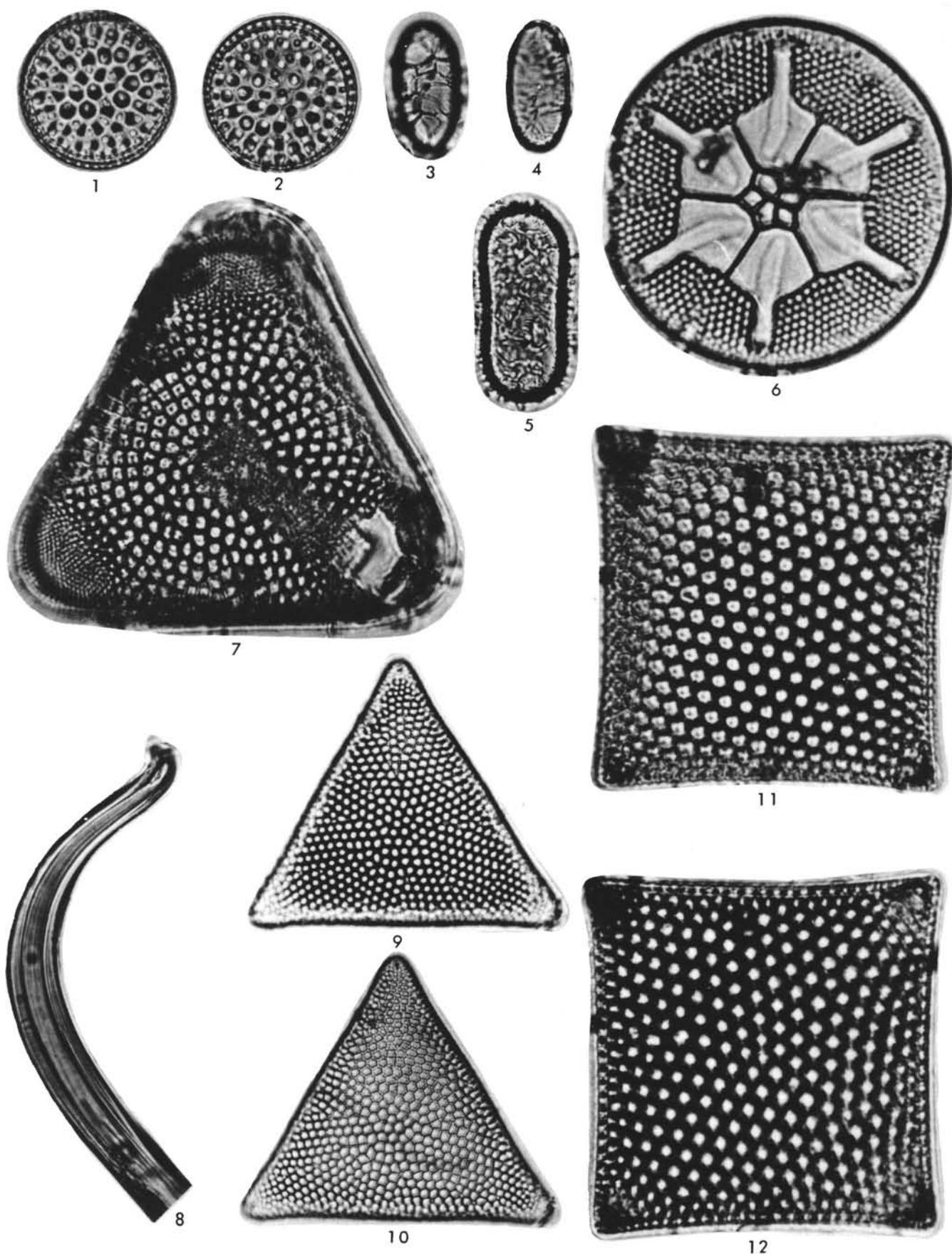
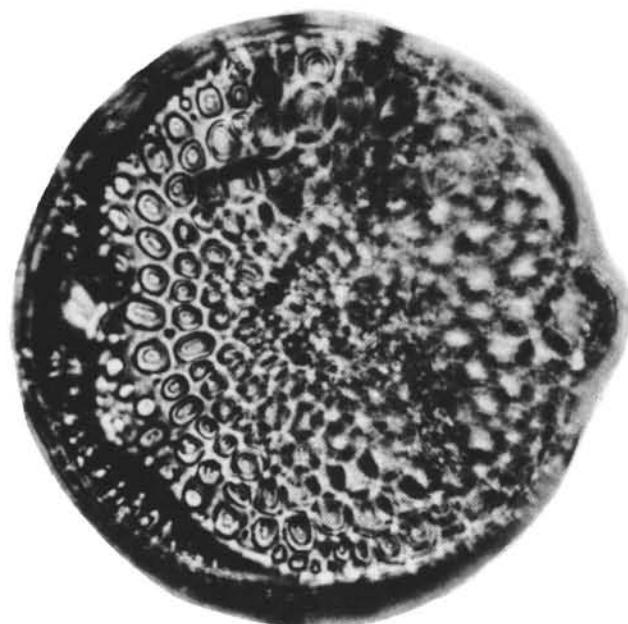


PLATE 22

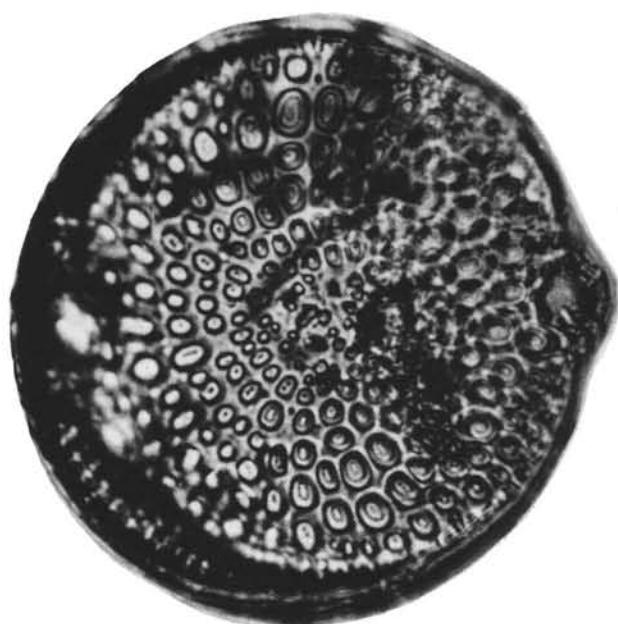
Magnifications  $\times 1000$

- Figures 1, 2      *Cerataulus pacificus* n. sp. Holotype.  
                      Sample 280A-1-2, 9-11 cm.
- Figures 3, 4      *Cerataulus pacificus* n. sp.  
                      Sample 280A-6-3, 120-122 cm.
- Figure 5            *Cerataulus pacificus* n. sp.  
                      Sample 280A-2-2, 20-22 cm.
- Figure 6            *Cerataulus pacificus* n. sp.  
                      Sample 280A-1-2, 9-11 cm.
- Figure 7            *Biddulphia fimbriata* Grev.  
                      Sample 280A-6-3, 120-122 cm.
- Figure 8            *Biddulphia fimbriata* Grev.  
                      Sample 280A-7-2, 120-122 cm.

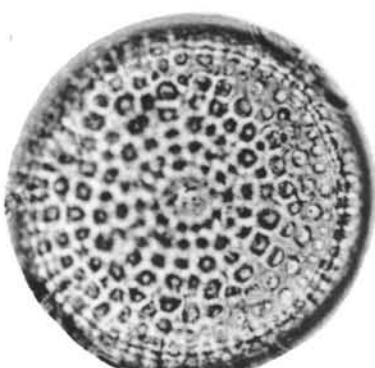
## PLATE 22



1



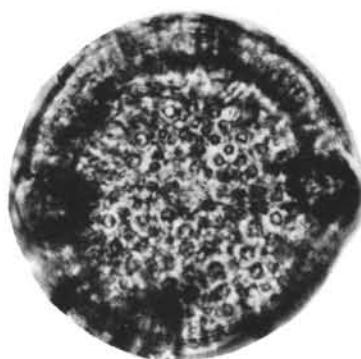
2



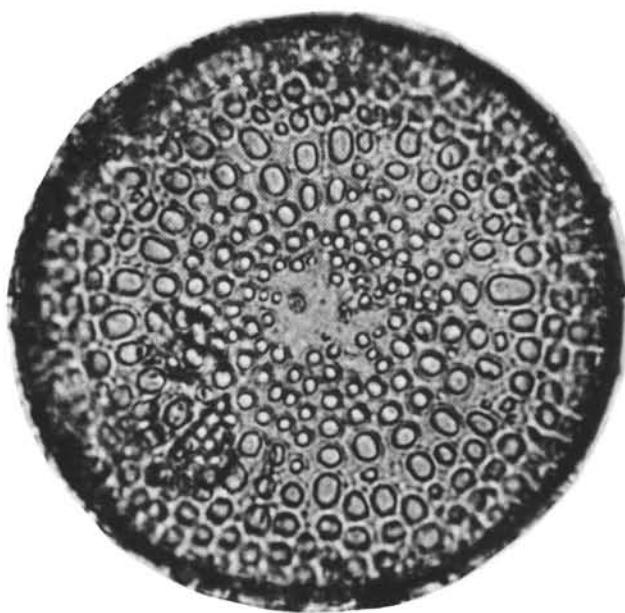
3



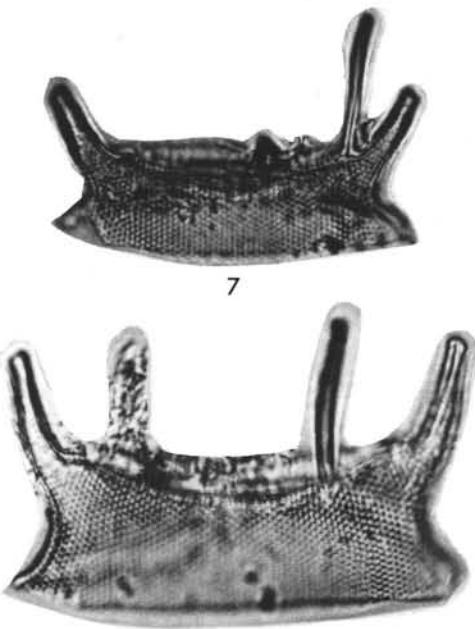
4



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7

8

PLATE 23  
Magnifications  $\times 1000$

- Figure 1      *Trinacria excavata* Heib.  
                  Sample 280A-6-3, 120-122 cm.
- Figures 2, 3    *Hemiaulus polymorphus* Grun.  
                  Sample 280A-6-3, 120-122 cm.
- Figures 4, 5    *Hemiaulus incisus* n. sp.  
                  Sample 280A-6-3, 120-122 cm.
- Figures 6, 7    *Hemiaulus incisus* n. sp. Holotype.  
                  Sample 280A-6-3, 120-122 cm.
- Figure 8        *Hemiaulus incisus* n. sp.  
                  Stereoscan micrograph  $\times 1600$ .  
                  Sample 280A-5-1, 110-112 cm.
- Figure 9        *Hemiaulus incisus* n. sp.  
                  Stereoscan micrograph  $\times 8000$ .  
                  Detail of the structure of the valve mantle. Sample  
                  280A-5-1, 110-112 cm.

## PLATE 23

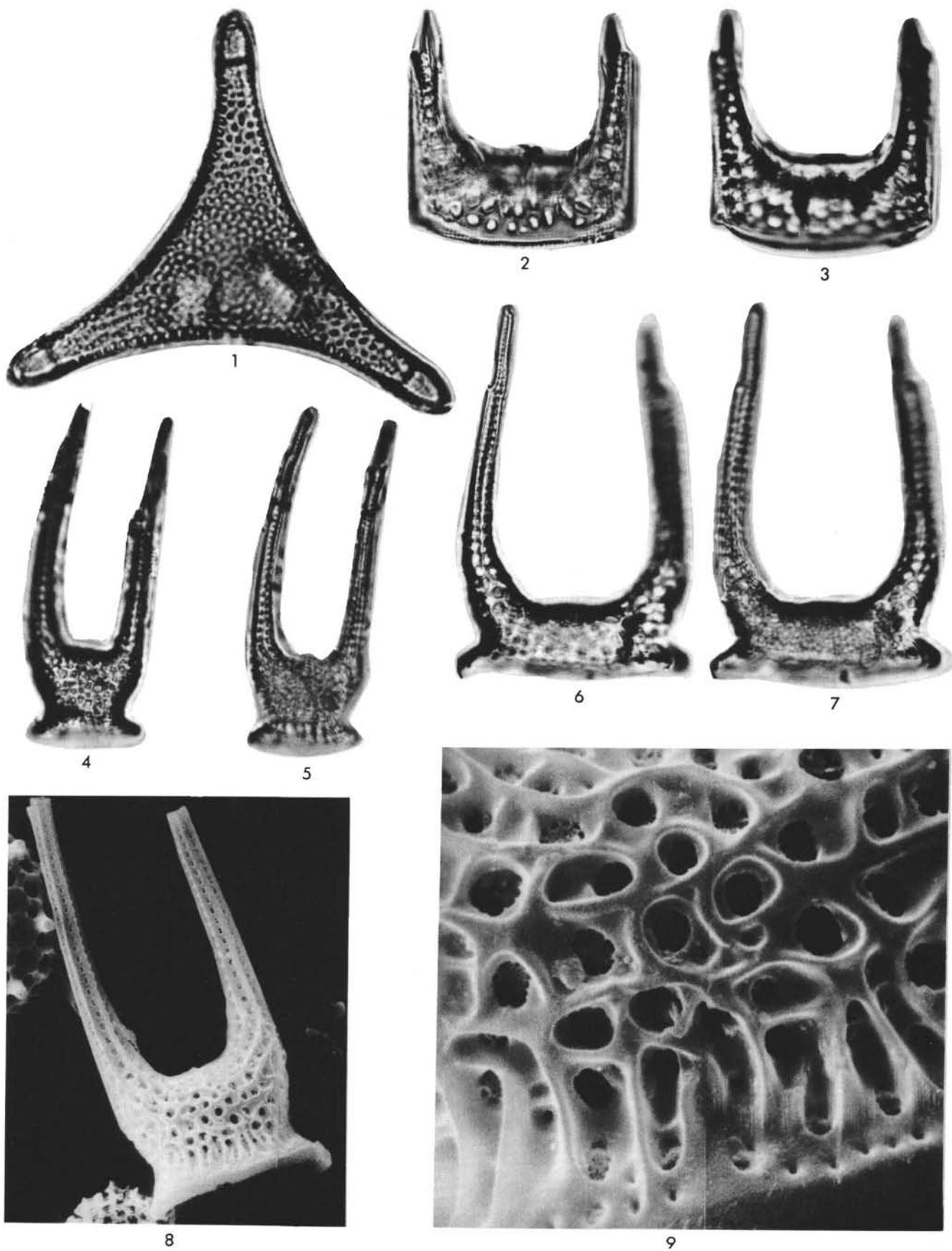


PLATE 24  
Magnifications  $\times 1000$

- Figures 1, 2      *Pyrgopyxis johnsoniana* (Forti) Hendey var. *intermedia* (Temp. et Forti) Hendey. Sample 280A-6-3, 120-122 cm.
- Figures 3-5      *Pyrgopyxis eocena* Hendey.  
Sample 280A-6-3, 120-122 cm.
- Figures 6, 7      *Pyrgopyxis johnsoniana* (Forti) Hendey.  
Sample 280A-6-3, 120-122 cm.
- Figures 8, 9      *Pyrgopyxis eocena* Hendey.  
Sample 280A-6-3, 120-122 cm.
- Figures 10, 11    *Pyrgopyxis johnsoniana* (Forti) Hendey.  
Sample 280A-6-3, 120-122 cm.
- Figure 12        *Pyrgopyxis johnsoniana* (Forti) Hendey.  
Stereoscan micrograph  $\times 1600$ .  
Sample 280A-5-1, 110-112 cm.

## PLATE 24

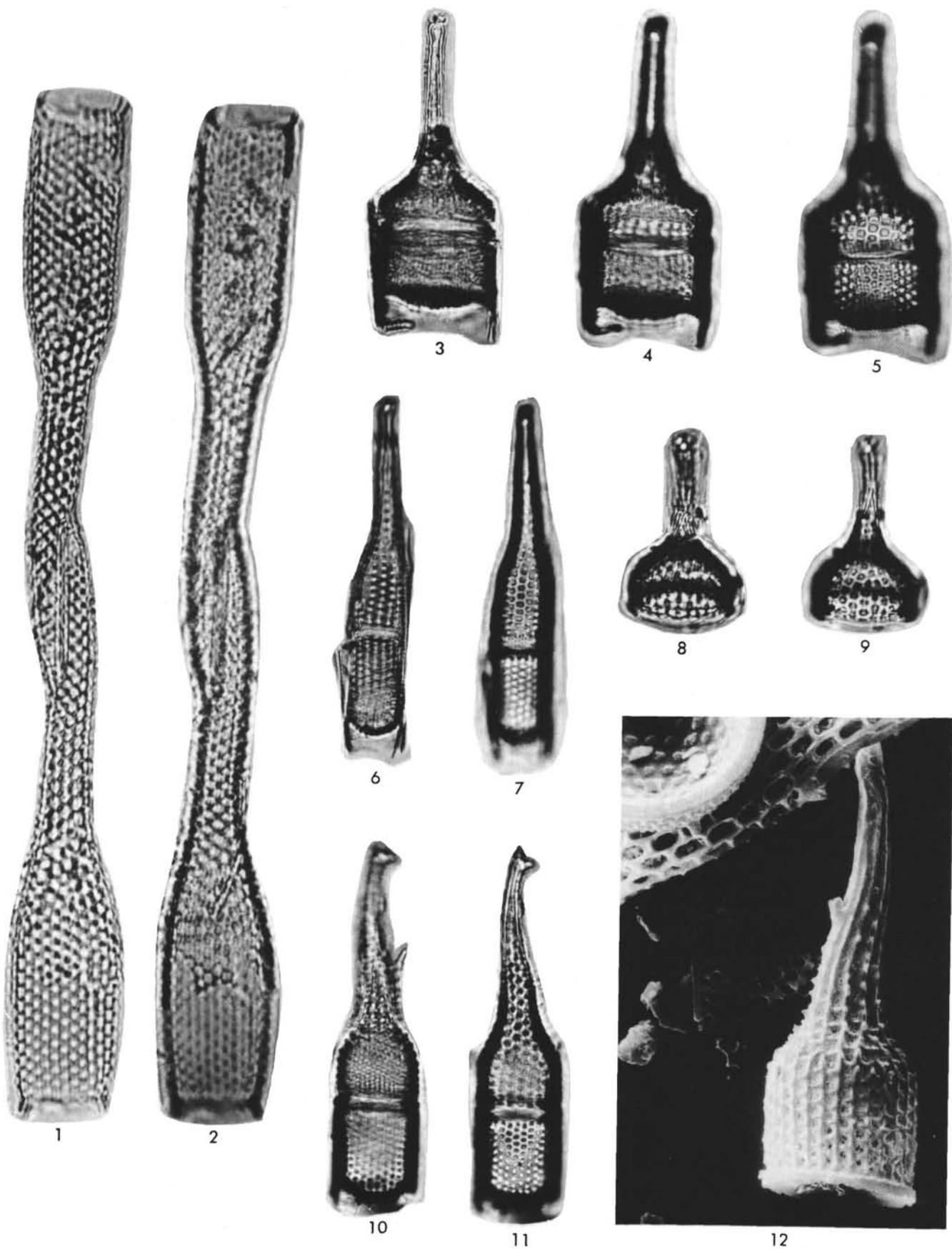


PLATE 25  
Magnifications  $\times 1000$

- Figures 1, 2     *Goniothecium odontella* Ehr.  
Sample 280A-3-4, 120-122 cm.
- Figures 3, 4     ?*Hercotheca inermis* Mann.  
Sample 280A-2-2, 15-17 cm.
- Figures 5, 6     *Kisseleviella carina* Shesh.  
Sample 280A-2-3, 20-22 cm.
- Figures 7-9     *Kisseleviella carina* Shesh.  
Sample 280A-7-2, 120-122 cm.
- Figures 10, 11    *Rouxia rouxioides* (Schrader) n. comb.  
Sample 280A-6-3, 120-122 cm.
- Figures 12, 13    *Rouxia rouxioides* (Schrader) n. comb.  
Sample 280A-6-3, 120-122 cm.
- Figure 14        *Kisseleviella carina* Shesh.  
Stereoscan micrograph  $\times 3200$ . Sample 280A-5-1,  
110-112 cm.
- Figures 15, 16    *Archaeomonas ovalis* Defl.  
Sample 280A-6-3, 120-122 cm.
- Figure 17        *Mesocena apiculata* (Schulz) Hanna.  
Sample 280A-1-2, 9-11 cm.
- Figure 18        *Dictyocha deflandrei* Freng.  
Sample 280A-3-4, 120-122 cm.
- Figure 19        *Naviculopsis trispinosa* (Schulz) Gleser.  
Sample 280A-3-4, 120-122 cm.

## PLATE 25

