19. DIATOM AND RADIOLARIAN CENOZOIC STRATIGRAPHY, NORWEGIAN BASIN; DSDP LEG 38

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INTRODUCTION

Procedures

The sediment was processed for the investigation of diatoms according to procedures described in the first volume of "Diatomovye vodorosli SSSR" (1974). The processing for radiolarians was that procedure usually applied (Petrushevskaya, 1971). For the abundance of the diatoms and silicoflagellates the following numerical symbols are used: "1" for single or very rare, "2" for rare, "3" for common, "4" for abundant, and "5" for very abundant. For radiolarians, the abundances are denoted by: "r" for rare, "f" for few, "c" for common, and "a" for abundant.

Authorship

R.N. Dzinoridze studied the diatoms, silicoflagellates, and ebridians at Sites 336, 337, 338, 339, 340, 343, and 348 (Plate 20). The diatom units of the Pleistocene, namely the *Thalassiosira zabelinae* unit, *Denticula seminae-D. kamtschatica* unit, *Denticula hustedtii* Zone, *Denticula hustedtii-D. lauta* Zone, and *Denticula lauta* Zone, were isolated.

A.P. Jousé investigated the diatoms, silicoflagellates, and ebridians from Sites 336, 337, and 338 (Plates 12-15) and has established the Miocene-Oligocene strata: the *Denticula lauta* Zone, the unit with *Raphidodiscus marylandicus*, the unit with *Goniothecium decoratum*, the unit with *Pseudotriceratium radiosoreticulatum*, the unit with *Pyxilla caputavis*, and the unit with *Pseudopodosira hyalina*.

G.S. Koroleva-Golikova and G.S. Nagaeva studied diatoms from Sites 342 and 346 (Plates 16-19), and provided the counts per gram of dry sediment.

G.E. Kozlova investigated radiolarians from Sites 336, 337, 338 (Cores 24-40), 339, 340, and 343 (Plates 21-30). The Eocene radiolarian units with *Theocyrtis litos* "Cr," with *Heterosestrum*(?) *tachujenkoi*, with *Lophocorys*(?) *norvegiensis*, with *Phacodiscus testatus* "S," and with *Tripodiscium*(?) *tumulosa* were isolated.

M.G. Petrushevskaya studied the radiolarians of Sites 336, 337, 338 (all cores), 339, 340, 343, 346, 348, 350, and 352 (Plates 32-41). The Miocene-Oligocene radiolarian strata with *Cyrtocapsella tetrapera*, with *Velicucullus*(?) sp. "O," and with *Acanthosphaera* sp. "H" were isolated.

N.I. Strelnikova investigated the diatoms, silicoflagellates, and ebridians at Sites 338 (Cores 24-30), 339, 340, and 343 (Plates 1-11). The Eocene units with *Coscinodiscus* aff. *tenerrimus*, *Cymatosira* sp. B., *Craspedodiscus oblongus*, *Trinacria excavata* f. *tetragona*, and *Pyxilla oligocaenica* were established.

Each author provided the lists of the species (Tables 5-19) and plates. After joint discussions held by the investigators, the common text of this paper was written by M.G. Petrushevskaya.

Methods

The main goal of this study was to follow the evolutionary changes and the succession of diatom and radiolarian species in the Cenozoic in the area of the Norwegian and Greenland seas (Figure 1). Unfortunately, none of the Leg 38 sites contained a complete and uninterrupted Cenozoic sequence. Additionally, assemblages of supposedly one and the same age from different sites are somewhat different, probably because of environmental influences. The hydrological regime is presently very complicated in the area under investigation, and it must have been very complicated and changeable in the past.

In many cases, there is uncertainty about the upper and lower limits of the units isolated, as well as the geographical ranges of some units. Therefore, this is why only units, not zones, are sometimes isolated. However, the defined assemblages of diatoms, silicoflagellates, and radiolarians, and the events in the

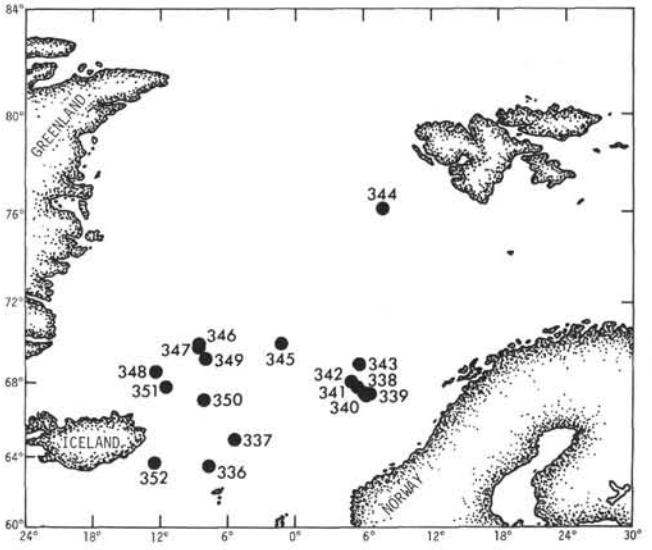

Figure 1. *Location of Leg 38 sites.*

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history of their flora and fauna (Tables 1, 2) provide us with the basis for the definition of 15 or even 16 strata for the Eocene, Oligocene, and Neogene deposits of the Norwegian Basin (Tables 3, 4).

BIOSTRATIGRAPHY

Stratum I (=Diatom unit with Pyxilla oligocaenica, or radiolarian unit with Tripodiscium (?) tumulosa)

Stratum I was isolated in Sample 343-5-6, however, neither upper nor lower limits are known.

The diatom "unit with *Pyxilla oligocaenica*" is characterized by very frequent *Pyxilla oligocaenica* Jousé v. *tenuis* Jousé, *Coscinodiscus decrescens* Grun., *C. decrescens* v. *polaris* Grun., and by frequent *Stephanopyxis edita* Jousé, *Hemiaulus elegans* (Heib.) Grun., *Pterotheca major* Jousé, and *Triceratium basilica* Brun (Table 1).

Among the silicoflagellates, *Distephanus antiquus* Gleser is the most characteristic. *Dictyocha fibula* Ehr. v. *fibula, D. triacantha* Ehr. v. *apiculata* Lemm., *Distephanus crux* (Ehr.) Haeck., *D. speculum* (Ehr.) Haeck., and *Mesocena oamaruensis* Schulz are also encountered.

The radiolarian "unit with *Tripodiscium*(?) *tumulosa*" is characterized by the presence of the *T.*(?) *tumulosa* (Kozlova) group, *Antarctissa*(?) sp. "C," *Antarctissa*(?) sp. "B," *Haliomma* sp. "E," *Phacodiscus* sp. "Q," and by various forms of *Clathrocyclas*(?) *extensa* (Clark and Campbell), namely *tamdiensis, multiplicatus*, and *talwanii* (Table 2).

The question of the age of Stratum I is complicated. The encountered diatom assemblage is rather similar to known middle and even late Eocene assemblages. Thus, the comparison of the list of the diatom species of 343-5-6 with the diatom list dated as early Eocene (viz., Moler Formation, Denmark, and W. Germany [Benda, 1965, 1972], West Siberia [Krotov and Schibkova, 1961; Paramonova, 1964], and near-Volgaland [Diatomovye vodorosli SSSR, 1974]) give us only about 28% of a "Norwegian set" of species in common with early Eocene diatom assemblages of Eurasia. These species are: *Melosira sulcata* (Ehr.) Ktz. v. *sulcata, M. sulcata* (Ehr.) Ktz. v. *crenulata* Grun., *Hemiaulus elegans* (Heib.) Grun., *H. polymorphus* Grun., *Goniothecium odontellum* Ehr., *Odontotropis carinata* Grun., *O. danicus* Debes, *Pseudopyxilla rossica* Pant., *Pseudostictodiscus angulatus* Grun., *Pterotheca carinifera* Grun., *Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *arctica* Grun., v. *cylindrus* Grun. and v. *intermedia* Grun., and *Janishia antiqua* Grun., etc. All of them are, as a rule, species of wide geographical and geological range, thus, they are not stratigraphically reliable.

The comparison with the middle Eocene diatom flora is even more difficult, because middle Eocene diatoms are known (Jousé, 1949; Rudkevich et al., 1957; Strelnikova, 1960; Krotov and Schibkova, 1961) only from West Siberia (the middle Eocene being used is indicated on the scale accepted in the USSR). There are no analogs of that flora outside the USSR. About 38% of the "Norwegian" diatom species in question are common with this middle Eocene flora of West Siberia, but they are mainly the same widely distributed species mentioned above, plus *Stephanopyxis edita* Jousé, *Gyrodiscus vortex* Pant., and *Pterotheca mayor* Jousé.

The diatom assemblage with *Pyxilla oligocaenica* and the silicoflagellate assemblage with *Distephanus antiquus*, encountered in 343-5-6, are most similar to the assemblage with the same name described in the USSR from the late Eocene deposits of the eastern side of the Ural Ridge and the West Siberian lowland (Jousé, 1949; Rudkevich et al., 1957; Strelnikova, 1960; Vozshennikova, 1960; Krotov and Schibkova, 1961; Paramonova, 1964). In addition to widely distributed species, some other diatoms are in common with the "Norwegian" list: *Brightwellia hyperborea* Grun., *Pyxilla oligocaenica* Jousé v. *oligocaenica* et v. *tenuis* Jousé, *Coscinodiscus decrescens* Grun., *C. decrescens* v. *polaris* Grun., *Stephanopyxis grunowii* Gr. et St., *S. megapora* Grun., and *Triceratium basilica* Brun. Common silicoflagellate species are *Distephanus antiquus* Gleser, *Dictyocha fibula* Ehr. v. *fibula, D. triacantha* Ehr. v. *apiculata* Lemm., and *Distephanus speculum* (Ehr.) Haeck.

For the radiolarian assemblage with *Tripodiscium*(?) *tumulosa* encountered in 343-5-6, it is most similar to the radiolarian assemblage known from the same late Eocene West Siberian deposits mentioned above. Twenty-five percent of its species are in common with the "Norwegian" list, among them being *Clathrocyclas*(?) *extensa* (Clark and Campbell) *multiplicatus* (Lipman), *C.*(?) *extensa tamdiensis* (Lipman), *Lophophaena sibirica* (Gorbovetz), *Tripodiscium*(?) *tumulosa* (Kozlova) group, and perhaps *Phacodiscus* sp. Q.

In West Siberia, two radiolarian layers or zones were established (the lower *Ellipsoxiphus chabakovi* Zone and the upper *Heliodiscus lentis* Zone) by Lipman (1956, 1960a, b, 1972) and by Kozlova and Gorbovetz (1966). Unfortunately we failed to correlate the sample from 343-5-6 with any certain part of the West Siberian sequence: the radiolarian species of that sample are widely distributed in both the *Ellipsoxiphus chabakovi* and *Heliodiscus lentis* zones.

The diatom assemblage with *Pyxilla oligocaenica*, the radiolarian assemblage with *Ellipsoxiphus chabakovi*, and the silicoflagellate assemblage with *Distephanus antiquus* are widely distributed all over the eastern side of the Ural Ridge, West Siberia, in Turgai, Kazakhstan, and near Aral. By means of comparison of the sequences, the deposits with the mentioned assemblages are believed to correspond to the upper part of the Bodrak stage (Gleser, 1970, 1974). The latter belongs (Unifizirovannaya skhema ..., 1959; Reschenie ..., 1963) in the upper Eocene. The Bodrak stage of the Paleogene of the south of the European part of the USSR, if compared with the Mediterranean scale (Krasheninnikov, 1971), corresponds to the middle Eocene.

All these speculations indicate that the Stratum I is of middle to late, but not early, Eocene age.

On the other hand, the peculiarities of the radiolarian fauna (the very small number of tropical species

TABLE 1
Stratigraphic Range of Selected Marine Diatoms, Leg 38 DSDP

———— Boundary established.
/ / / / / / Boundary uncertain.

TABLE 1 – *Continued*

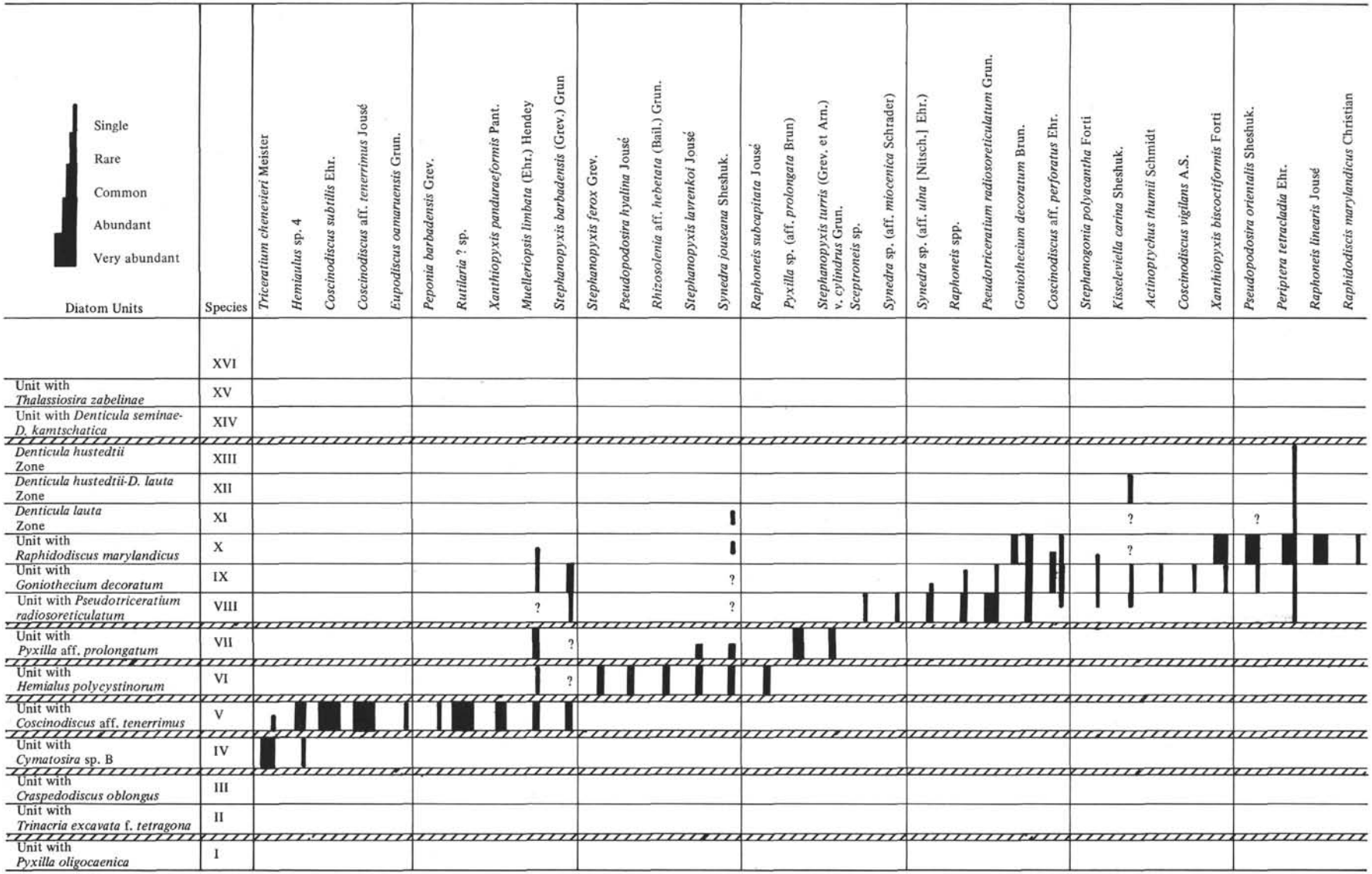
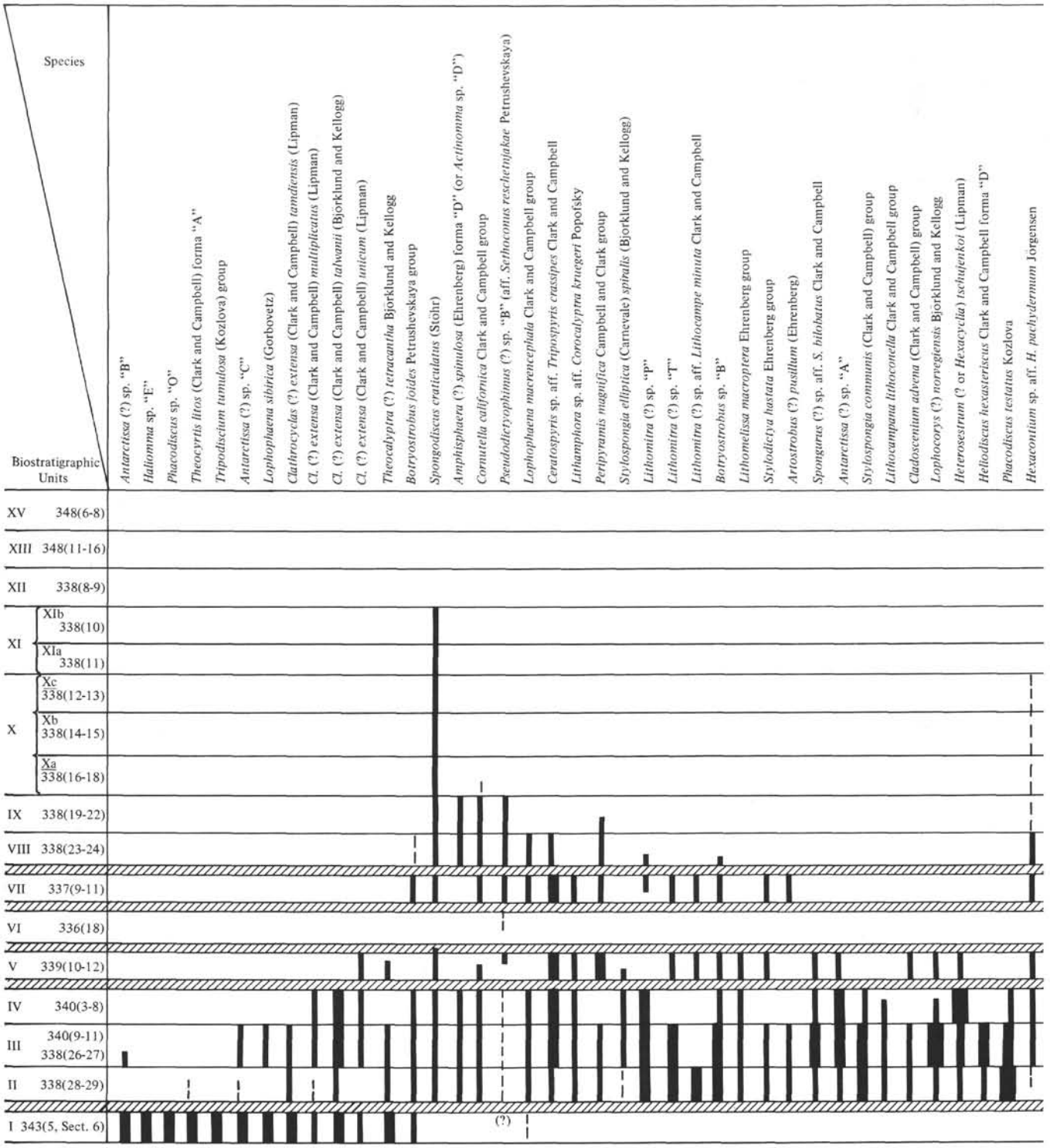


TABLE 1 – *Continued*

Diatom Units	Species	*Stephanopyxis lavrenkoi* Jousé	*Xanthiopyxis* spp.	*Xanthiopyxis diaphana* Forti	*Denticula lauta* Bail.	*Chaetoceros* spp.	*Cymatosira anderssoni* Hanna var.	*Thalassionema nitzschioides* Grun.	*Rouxia peragalloi* Brun et Herib.	*Goniothecium tenue* Brun	*Mediaria splendida* Sheshuk.	*Denticula hustedtii* Simonsen et Kanaya	*Actinocyclus ingens* Rattr.	*Pterotheca reticulata* Sheshuk.	*Thalassiosira* aff. *manifesta* Sheshuk.	*Pterotheca kittoniana* v. *kamtschatica* Gapanov.	*Thalassiosira krypophila* (Grun.) Jörg.	*Thalassiosira oestrupii* (Ostf.) Pr.-Lavr.	*Rhizosolenia barboi* Brun	*Rhizosolenia styliformis* Bright.	*Rhizosolenia hebetata* f. *hiemalis* Gran.	*Denticula kamtschatica* Zabelina	*Denticula seminae* Simonsen et Kanaya	*Thalassiosira zabelinae* Jousé	*Thalassiosira nidulus* (Temp. et Brun) Jousé	*Thalassiosira antiqua* A. Cl.	*Thalassiosira gravida* Cl.	*Actinocyclus oculatus* Jousé	*Actinocyclus ochotensis* Jousé	*Thalassiotrix miocenica* Jousé	Strata	Type Locality Site (Core)
	XVI																														XVI	348 (1-5) 336 (1-6)
Unit with *Thalassiosira zabelinae*	XV																														XV	348 (6-8), 336 (8)
Unit with *Denticula seminae-D. kamtschatica*	XIV																														XIV	336 (9)
Denticula hustedtii Zone	XIII																														XIII	348 (11-16)
Denticula hustedtii-D. lauta Zone	XII																														XII	338 (8-9) 348 (14-16)
Denticula lauta Zone	XI																														XI	338 (10-12)
Unit with *Raphidodiscus marylandicus*	X																														X	338 (13-18)
Unit with *Goniothecium decoratum*	IX																														IX	338 (19-22) 336 (16)
Unit with *Pseudotriceratium radiosoreticulatum*	VIII																														VIII	338 (23-24)
Unit with *Pyxilla* aff. *prolongatum*	VII																														VII	337 (9-11)
Unit with *Hemialus polycystinorum*	VI																														VI	336 (18)
Unit with *Coscinodiscus* aff. *tenerrimus*	V																														V	339 (10, 12)
Unit with *Cymatosira* sp. B	IV																														IV	340 (3-8)
Unit with *Craspedodiscus oblongus*	III																														III	340 (9-11) 338 (26-27)
Unit with *Trinacria excavata* f. *tetragona*	II																														II	338 (28, 29)
Unit with *Pyxilla oligocaenica*	I																														I	343 (Core 5, Section 6)

_____ Boundary established.
////// Boundary uncertain.

TABLE 2
Stratigraphic Range of Selected Radiolarian Species, Leg 38 DSDP

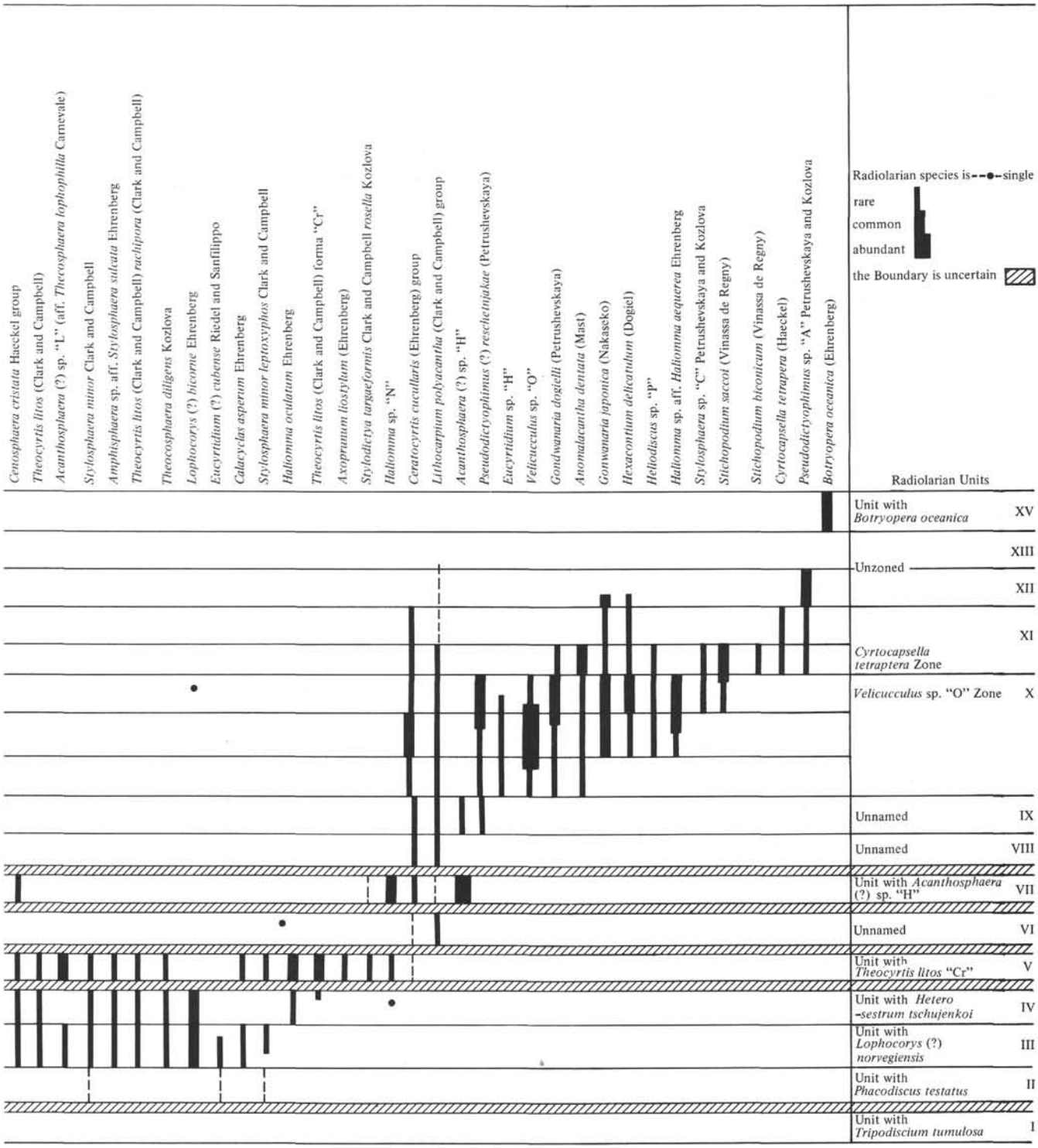


and the very high proportion of boreal ones, the abundance of thick, heavy skeletons, etc.) suggest hydrological isolation and possibly cold-water conditions. It seems possible to believe that the presence of species absent in the other Eocene assemblages of the Norwegian basin is the result of environmental control (perhaps of a cold-water current from or into the West Siberian Sea). In this case, the assemblage of Stratum I may be of the same age as some other strata with different assemblages.

Stratum II (= Diatom unit with Trinacria excavata f. tetragona or the radiolarian unit with Phacodiscus testatus "S")

This stratum was isolated in Site 338, Cores 29 and 28. The lower limit is uncertain.

TABLE 2 – *Continued*



The diatom unit with *Trinacria excavata* f. *tetragona* is characterized by the abundance of that diatom and also of *Coscinodiscus asteromphalus* Ehr. v. *hybrida* Grun., *Hemiaulus polymorphus* Grun., *Pseudopodosira* sp. 3, and *Pterotheca costata* Schibkova. The following species are rare, especially as compared to the higher units—*Craspedodiscus oblongus* (Grev.) Hanna, *Triceratium barbadense* Grev., *Trochosira mirabilis* Kitt., and *T. trochlea* Hanna.

The silicoflagellate species *Corbisema bukry* Jousé, *Dictyocha fibula* Ehr. v. *pentagona* Schulz, *Naviculopsis* sp. I, and *Mesocena oamaruensis* Schulz are characteristic.

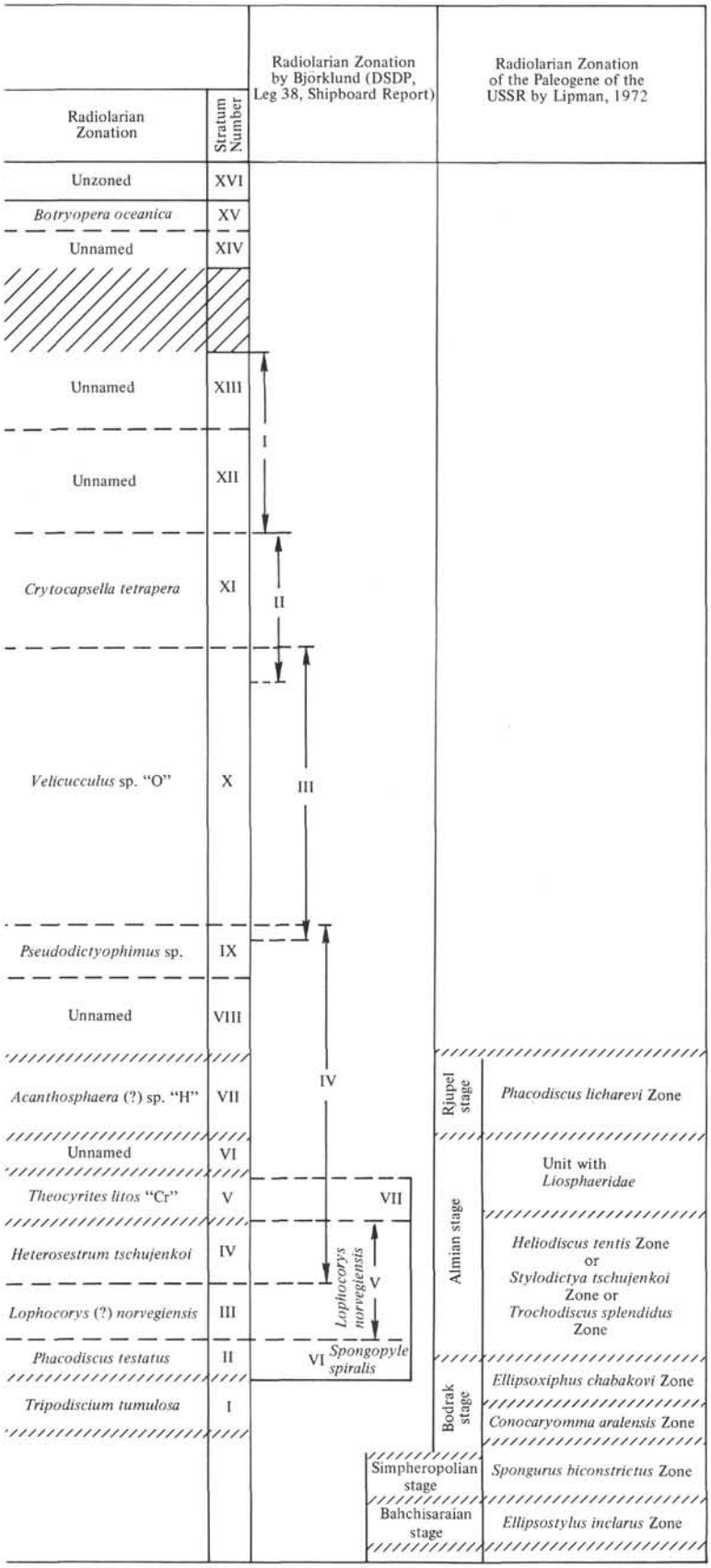
The radiolarian unit with *Phacodiscus testatus* forma "S" is characterized by the abundance of that radiolarian, and also of *Lithomitra*(?) sp. "P" and *Lithomitra*(?) sp. "T." The species *Clathrocyclas*(?) *extensa* (Clark and Campbell) *multiplicatus* (Lipman),

TABLE 3
Biostratigraphy Based on Diatoms, Radiolarians, and Silicoflagellates

Time (m.y.)			Tropical Radiolarian Zonation by Riedel and Sanfilippo, 1970	Tropical Diatom Zonation Burkle, 1972; Jousé, 1974	North Pacific Diatom Zonation by Koizumi, 1973, 1975	Norwegian Basin by the present authors	
						Diatom Zonation	Silicoflagellate and Ebridian Zonation
	PLEIST-OCENE			*Pseudoenotia doliolus*	*Denticula seminae* *Rhizosolenia curvirostris* *Actynocyclus oculatus*		*Distephanus speculum* *D. octonarius*
1.85	PLIOCENE		*Pterocanium prismatium*	*Rhizosolenia praebergonii*	*Thalassiosira zabelinae*	*Thalassiosira zabelinae*	*D. speculum v. cannopiloides* *D. speculum v. septenarius*
			Spongaster pentas	*Thalassiosira convexa* *Nitzschia jousea* *Nitzschia miocenica* *Thalassiosira praeconvexa*	*Denticula seminae-* *D. kamtschatica*	*Denticula seminae* *D. kamtschatica*	*Distephanus speculum*
			Stichocorys peregrina		*Denticula kamtschatica*		
5	MIOCENE	Late	*Ommatartus penultimus*	*Nitzschia porteri*	*Denticula hustedtii*	*Denticula hustedtii*	*Distephanus japonicus* var. *pseudofibula, D. fibula, D. crux, D. speculum, Mesocenaelliptica, Paradictyocha polyactis f. mesocenoidea*
			Ommatartus antepenultimus	*Coscinodiscus jabei*			
10.5		Middle	*Cannartus petterssoni*		*Denticula hustedtii-D. lauta*	*Denticula hustedtii-* *Denticula lauta*	*Dictyocha speculum,* *Mesocena* aff. *apiculata*
			Cannartus laticonus				
			Dorcadospyris alata	*Coscinodiscus marginatus* var.	*Denticula lauta*	*Denticula lauta*	*Distephanus crux longispinus* *Ebriopsis antugua,* *Ammodochium rectangulare*
				and			
14.5		Early	*Calocycletta costata*	*Raphidodiscus marylandicus*			
			Calocycletta virginis (or veneris ?)			*Raphidodiscus marylandicus*	*Naviculopsis navicula,* *Distephanus speculum* var. *pentagonus,* *Dictyocha pseudofibula*
				Bogorovia veniaminii			
22.5			*Lychnocanium bipes*	*Coscinodiscus vigilans*		*Goniothecium decoratum* *Coscinodiscus vigilans*	*Rocella gemma*
	OLIGOCENE		*Dorcadospyris papilio*	*Craspedodiscus coscinodiscus*		*Pseudotriceratium radiosoreticulatum*	*Mesocena apiculata*
				Cestodiscus muhinae			
			Theocyrtis tuberosa	*Cestodiscus pulchellus* *Coscinodiscus excavatus*		*Pyxilla* sp. (*Pyxilla* aff. *prolongata*)	
			Thyrsocyrtis bromia	*Hemiaulus polycystinorum*		*Hemiaulus polycystinorum*	
			Thyrsocyrtis tetracantha			*Coscinodiscus* aff. *tenerrimus*	*Dictyocha hexacantha*
	EOCENE	Late	*Podocyrtis goeteana*			*Cymatosira* sp. B	*Naviculopsis foliacea*
			Podocyrtis chalara			*Craspedodiscus oblongus*	*Dictyocha tricantha v. flexuosa*
			Podocyrtis mitra			*Trinacria excavata* f. *tetragona*	Unnamed
		Middle	*Podocyrtis ampla*			*Pyxilla oligocaenica*	*Distephanus antigua* *Naviculopsis minor*
			Thyrsocyrtis triacantha				
		Early	*Theocampe mongolfieri*				

——— the boundary //////// the boundary is questionable

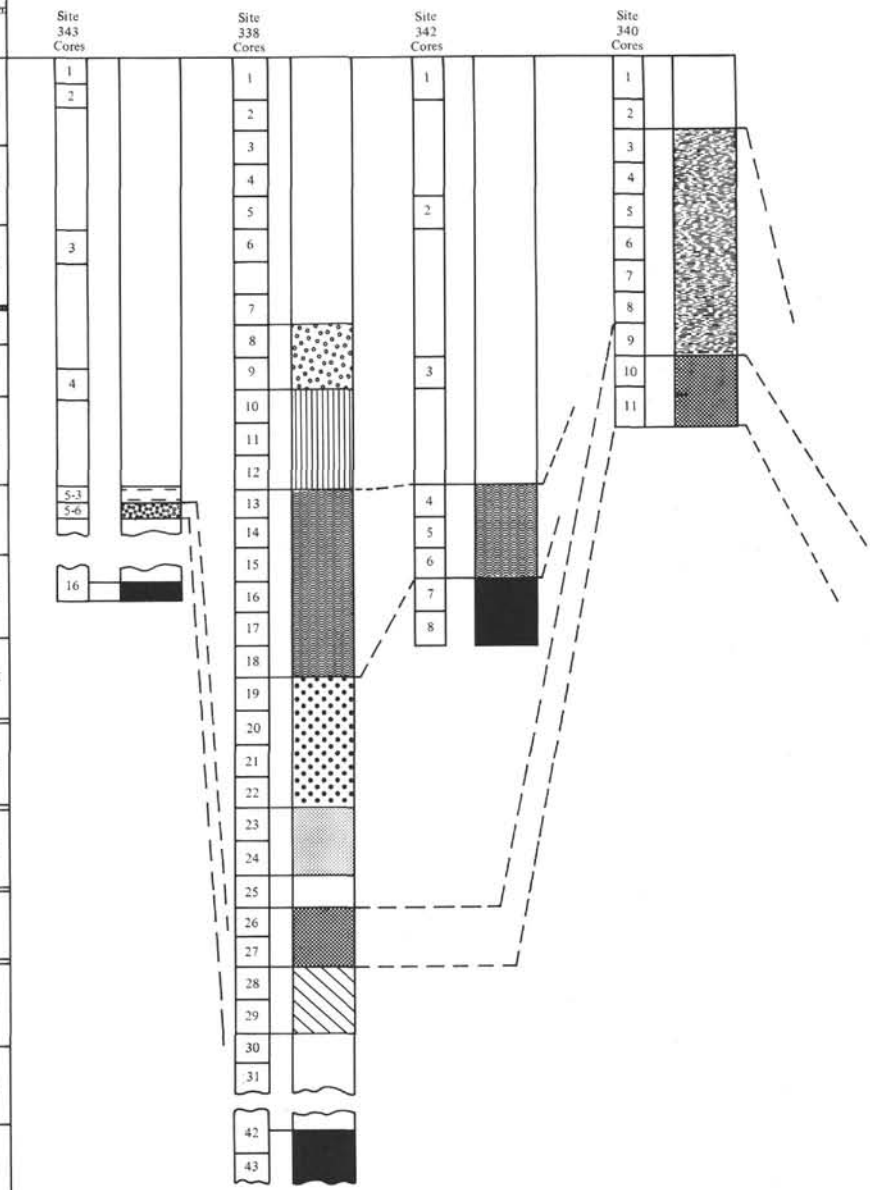
TABLE 3 – *Continued*



— — — the age of the boundary is uncertain

TABLE 4
Correlation of Diatom and Radiolarian Units at Leg 38 Sites

Age	Site (Cores)	Symbol	Diatom Zonation	Radiolarian Zonation	Stratum Number
Pleisto-cene	348 (1-5)		Unzoned	Unzoned	XVI
Pliocene	336(8) 348 (6-8)		Unit with *Thalassiosira zabelinae*	Unit with *Botryopera oceanica*	XV
	336(9)		Unit wtih *Denticula seminae-D. kamtschatica*	Unnamed	XIV
Late Miocene	348 (11-13)		*Denticula hustedtii* Zone	Unnamed	XIII
	338(8,9)		*Denticula hustedtii-D. lauta* Zone	Unnamed	XII
Middle Miocene	338 (10-12)		*Denticula lauta* Zone	Unit with *Cyrtocapsella tetrapera*	XI
Early Miocene	338 (13-18)		Unit with *Raphidodiscus marylandicus*	Unit with *Velicucculus* sp. "O"	X
Oligocene Upper	338 (19-22) 336(16) 346 (6-11)		Unit with *Goniothecium decoratum Coscinodiscus vigilans*	Unit with *Pseudodicty-ophimus* sp.	IX
	338 (23-24)		Unit with *Pseudotriceratium radiosoreticulatium*	Unnamed	VIII
Oligocene Lower	337 (9-11)		Unit with *Pyxilla* sp. *(Pyxilla* aff. *prolongata)*	Unit with *Acanthosphaera* (?) sp. "H"	VII
	336 (18)		Unit with *Hemialus polycyst-linorum*	Unnamed	VI
Middle + Late Eocene	339 (10-12)		Unit with *Coscinodiscus* aff. *tenerrimus*	Unit with *Theocyrtis litos* "Cr"	V
	340 (3-8)		Unit with *Cymatosira* sp. "B"	Unit with *Heterosestrum tschujenkoi*	IV
	338 (26-27) 340 (9-11)		Unit with *Craspedodiscus oblongus*	Unit with *Lophocorys* (?) *norvegiensis*	III
	338 (28,29)		Unit with *Trinacria excavata* f. *tetragona*	Unit with *Phacodiscus testatus* f.S	II
	343 (5, Sec-tion 6)		Unit with *Pyxilla oligocaenica*	Unit with *Tripodiscium* (?) *tumulosa*	I
			Mixture		
			Basalt		

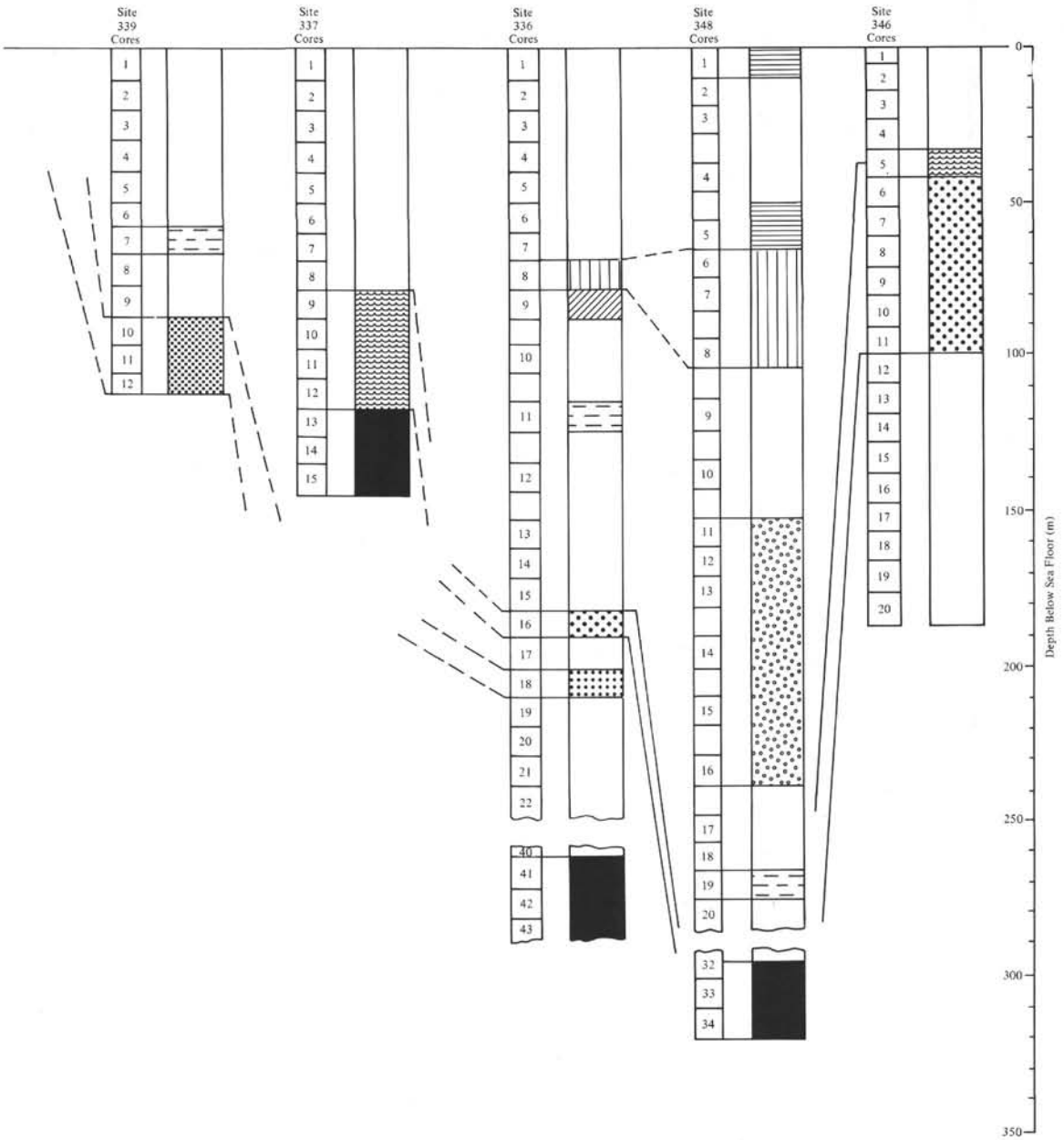


Boundary uncertain.

C.(?) *extensa tamdiensis* (Lipman), common in the supposed lower unit, are rare here. The species *Ceratospyris* sp. aff. *Tripospyris crassipes* (Clark and Campbell), *Spongurus* sp. aff. *S. bilobatus* Clark and Campbell, *Heterosestrum* ? (or *Hexacyclia*) *tschujenkoi* (Lipman), *Lophocorys*(?) *norvegiensis* Bjørklund and Kellogg, and *Spongocyclia ellipticus* (Carnevale) *spiralis* (Bjørklund and Kellogg), common in the upper units, are rare here.

The diatom species *T. excavata* f. *tetragona* was encountered in the Eocene deposits of West Siberia (Strelnikova, 1960; Paramonova, 1964), but with a

TABLE 4 – *Continued*



different set of diatom species. The diatom assemblage with *Trinacria excavata* f. *tetragona*, isolated in Leg 38 material, has no close analogs.

As to the position of the unit with *Trinacria excavata* f. *tetragona* in the stratigraphic sequence, the following species common in the upper units are absent here: *Melosira architecturalis* Brun and *Hemiaulus polycystinorum* Ehr. The species *Craspedodiscus oblongus* (Grev.) Hanna, *Hemiaulus tenuicornis* Grev., and *Triceratium barbadense* Grev., common in the upper "unit with *Craspedodiscus oblongus*," occur in the unit in question, but rather rarely. The species *Melosira architecturalis* Brun, *Hemiaulus polycystinorum* Ehr., etc., are characteristic for the diatom flora described (Gleser, 1970; Gleser and Sheshukova-Poretzkaya, 1969) from deposits overlying the "unit with *Pyxilla oligocaenica*" in the USSR. On this basis, it is possible to place the unit under consideration above the "unit with *Pyxilla oligocaenica*."

The species common to the unit in question and the "unit with *Craspedodiscus oblongus*," and also the uninterrupted sequence of this part of the section at Site 338 provides the basis for placing the "unit with *Trinacria excavata* f. *tetragona*" below the "unit with *Craspedodiscus oblongus*."

The radiolarian assemblage with *Phacodiscus testatus* forma "S" differs strictly from any known radiolarian assemblage. Layers with abundant *Phacodiscus testatus*

(Kozlova) were encountered only in the eastern part of the near Caspian district and in some parts of the south of the Russian platform. These layers belong in the foraminiferal "zone with *Acarinina rotundimarginata*." Stratum II may be of the same age as this foraminiferal zone.

The radiolarian assemblage with *Phacodiscus testatus* forma "S" was isolated in the same interval (338-28 and -29). This was indicated by Bjørklund, in the shipboard Hole Summaries, as the *Spongopyle spiralis* Zone. That zone was isolated by Bjørklund and Kellogg (1972) in the core *Vema* 28-43, taken on the Vøring Plateau. According to Bjørklund and Kellogg, the *Spongopyle spiralis* Zone must have *Sp. spiralis* = *Spongocyclia elliptica* Carnevale) *spiralis* (Bjørklund and Kellogg) and *Theocalyptra*(?) *tetracantha* Bjørklund and Kellogg, and there must be no *Lophocorys*(?) *norvegiensis* Bjørklund and Kellogg. In the samples investigated, the two former species are very rare, and on the contrary *Lophocorys*(?) *norvegiensis* is present. Thus the assemblage of Site 338 (Cores 28, 29) is not typical for the "*Spongopyle spiralis* Zone."

For the radiolarians, as well as the diatoms, there are practically no species restricted to this stratum. Thus, it seems probable that this stratum does not represent by itself a definite zone, but only a subzone of a real zone. The latter must include higher layers also. On the other hand, it is possible that the peculiarities of this stratum are due to local environmental conditions, and not to evolutionary changes.

Stratum III (Diatom unit with Craspedodiscus oblongus or radiolarian unit with Lophocorys(?) norvegiensis)

This stratum was isolated at Site 338 (Cores 26, 27) and at Site 340 (Cores 9-11).

The diatom unit with *Craspedodiscus oblongus* may be characterized by the abundance of that species, and also by the presence of *Hemiaulus polycystinorum* Ehr. v. *polycystinorum* and v. *mesolepta* Grun., *Hemiaulus longicornus* Grev., *H. danicus* Grun., *Hemiaulus* sp. 1, *Hemiaulus* sp. 3, *Dicladia* (sensu Kanaya, 1957), *Melosira architecturalis* Brun, and *Triceratium barbadense* Grev. These species are encountered also in the higher units. The species *Coscinodiscus* aff. *africanus* (W. Sm.) Jan., *Coscinodiscus argus* Ehr. (sensu Kanaya, 1957), *C. oculus iridis* Ehr., *Mesosira ornata* Grun., *Pterotheca spada* Temp. et Brun, and *Trinacria media* Jousé are restricted to the unit.

The silicoflagellate species *Corbisema bukry* Jousé, *Dictyocha frenguelli* Defl., *Dictyocha spinosa* (Defl.) Gleser, *D. triacantha* Ehr. v. *apiculata* Lemm., *D. triacantha* Ehr. v. *flexuosa* (Stradner) Gleser, *D. triacantha* Ehr. v. *inermis* Lemm. are present in the unit, but they are encountered in other units of the Leg 38 material.

The radiolarian zone with *Lophocorys*(?) *norvegiensis* was isolated by Bjørklund and Kellogg (1972) in the core *Vema* 28-43. The base of the zone must be marked, according to Bjørklund and Kellogg, by the disappearance of *Spongopyle spiralis* Bjørklund and Kellogg and *Theocalyptra*(?) *tetracantha* Bjørklund and Kellogg, common below, while *Clathrocyclas*(?) *talwanii* (Bjørklund and Kellogg) and *Stylodictya variabilis* Bjørklund and Kellogg [= *Heterosestrum* ? [or *Hexacyclia*] *tschujenkoi* [Lipman]), also common below, must become less abundant. However, in the samples from Site 338 (Cores 26 and 27) *H.* (?) *tschujenkoi* is most abundant, and *Theocalyptra*(?) *tetracantha* and *Spongocyclia ellipticus spiralis* (Bjørklund and Kellogg) are present here. The index species of the zone, *Lophocorys*(?) *norvegiensis*, is abundant here. *L.*(?) *bicorne* (Ehrenberg), *Calocyclas asperum* (Ehrenberg), and *Thecosphaera diligens* Kozlova seem to appear near the lower limit of the unit. The species *Lithomelissa macroptera* Ehr. group, *Antarctissa*(?) sp. "A," the *Stylospongia communis* (Clark and Campbell) group, and the *Heliodiscus asteriscus* Clark and Campbell group, common below, become more frequent in the unit in question. The lower boundary of the unit is uncertain because in all the sequences investigated it corresponds to a hiatus. The same was true in the core *Vema* 28-43 (320 cm below the sea floor), studied by Bjørklund and Kellogg.

Within the limits of the zone, nearly typical *Theocyrtis litos* (Clark and Campbell), and the form *Th. litos rachipora* (Clark and Campbell) as well as *Hexaconthium* sp. aff. *H. pachydermum* (Jørgensen) and the *Cenosphaera cristata* Haeckel group, become frequent. The upper limit of the zone possibly coincides with the lower boundary of the radiolarian "zone with *Heterosestrum*(?) *tschujenkoi*."

As to correlations, the diatom assemblage with *Craspedodiscus oblongus* has no close analogs among known Paleogene assemblages. And yet about 40% of its species are encountered also in the deposits of the Kiev stage of the Ukraine. These species are *Coscinodiscus argus* Ehr., *Craspedodiscus oblongus* (Grev.) Hanna, *Hemiaulus polycystinorum* Ehr. v. *polycystinorum* and v. *mesolepta* Grun., *Hemiaulus tenuicornis* Grev., *Melosira architecturalis* Brun, *M. goretzkii* Tscherem., *Pseudostictodiscus ovetschkinii* Gleser, *Triceratium barbadense* Grev., *T. condecorum* Bright., etc. According to Gleser (Gleser et al., 1965; Gleser and Sheshukova-Poretzkaya, 1968, 1969; Gleser, 1974) the Ukrainian diatom flora is of latest Eocene age, and belongs in the Almin stage (Table 3).

For the unit in question there are diatom species in common with the equatorial Atlantic described by Gleser and Jousé (1974), and also with Barbados (Greville, 1861-1866), with diatoms of the Kellogg and Sidney formations (Kanaya, 1957), with the Kreyenhagen formation (Hanna, 1927, 1931), and also with the diatom flora of Oamaru (Grove and Sturt, 1886-1887).

The age of the radiolarian zone with *Lophocorys*(?) *norvegiensis* was determined by Bjørklund and Kellogg (1972) as late Eocene on the basis of silicoflagellates and diatoms known from the California Kellogg and Sidney shales.

There are, indeed, some common species, and among the radiolarian assemblage of the "Norwegian" zone in question about 50% are very similar to the species described by Clark and Campbell (1942, 1945) from the

Californian Kreyenhagen formation. These species are the *Heliodiscus heliasteriscus* Clark and Campbell group, *Plectodiscus circularis* (Clark and Campbell), *Stylosphaera minor* Clark and Campbell, the *Porodiscus*(?) *parvus* Clark and Campbell group, the *Stylospongia communis* (Clark and Campbell) group, *Ceratospyris* sp. aff. *Tripospyris crassipes* Clark and Campbell, *Cladoscenium* sp. aff. *Tripilidium advena* (Clark and Campbell), the *Clathrocyclas*(?) *extensa* (Clark and Campbell) group, the *Lithocampana lithoconella* Clark and Campbell group, the *Lophophaena macrencephala* Clark and Campbell group, *Peripyramis magnifica* Clark and Campbell, and the *Theocyrtis litos* (Clark and Campbell) group. Many species names are questionable and only the "species group" may be indicated. All these species are absent in the Caribbean.

At the present time, it is possible to suggest that the "*Lophocorys*(?) *norvegiensis* Zone" is of the same age as the Kreyenhagen formation. However, the age of this formation is questionable. Mallory (1959) suggested the Kreyenhagen formation to be of upper Eocene age, on the basis of benthonic foraminifera. Steineck and Gibson (1972), on the basis of planktonic foraminifera and nannoplankton, believe that formation to be middle Eocene.

It is difficult to correlate the "*Lophocorys*(?) *norvegiensis* Zone" with any radiolarian stratum isolated in the USSR. It is possible that above the "*Lophocorys*(?) *norvegiensis* Zone" is the "zone with *Heterosestrum*(?) *tschujenkoi*." In the USSR the species *H.* (?) *tschujenkoi* (Lipman) is not restricted to the zone with its name, but is also known (V. Zagorodnuk, personal communication) from the underlying Bodrak stage (Table 3). In the Norwegian sequence, this species is present also in the "*Lophocorys*(?) *norvegiensis* Zone".

H.(?) *tschujenkoi* (Lipman) is widely distributed in Kazakhstan, West Siberia, and the Russian Platform. In all these regions, *H.*(?) *tschujenkoi* appears near a certain stratigraphic level, which may be correlated in the southernmost sequences with the foraminiferal zone with *Globigerina turcmenica* (= *Truncorotaloides rohri* Zone). The zone with *H.*(?) *tschujenkoi* was established by Lipman, but its limits (or those of the zone with *Heliodiscus lentis*) were not indicated. In the sequences of Leg 38, the vertical range of the species *Lophocorys*(?) *norvegiensis* and *Heterosestrum*(?) *tschujenkoi* overlap. Thus, the attempt is made to place the boundary between the two zones on the basis of the abundance of these two species and on the basis of some additional species.

Stratum IV (= Diatom unit with Cymatosira sp. B or radiolarian unit with Heterosestrum(?) tschujenkoi)

This stratum was isolated at Site 340, Cores 3-8.

The diatom unit with *Cymatosira* sp. B is characterized by the abundance of the mentioned species and also by the presence of *Asterolampra vulgaris* Grev., *Brightwellia imperfecta* Jousé, and *Hemiaulus* sp. 5. In the upper part of the unit occur *Coscinodiscus bulliens* A.S. and *C. obscurus* A.S.v. *minor* Rattr., *C. senarius* A.S., *Hemiaulus polymorphus* Grun., *Podosira* aff. *maxima* (Ktz.) Grun., *Triceratium barbadense* Grev., *T. chenevieri* Meister, and *Trochosira spinosa* Kitt. These species, encountered also in the other "Norwegian" strata, are most common here (Table 1).

The silicoflagellate species *Naviculopsis foliacea* Defl. and *Naviculopsis* sp. 2 are present in Stratum IV.

The radiolarian zone with *Heterosestrum*(?) *tschujenkoi* has as its lower limit the appearance of *Actinomma californica* (Clark and Campbell). The species *H.*(?) *tschujenkoi* (Lipman), Lithamphora sp. aff. *Corocalyptra kruegeri* Popofsky, *Stylospira dujardinii* (Haeckel) group, and *Lithomelissa macroptera* Ehrenberg become more abundant above that boundary. The *Cladoscenium*(?) *advena* (Clark and Campbell) group and *Heliodiscus hexastericus* Clark and Campbell disappear near this limit. The upper boundary of the zone with *H.*(?) *tschujenkoi* coincides with the lower limit of the "unit with *Theocyrtis litos* '*Cr*' " (Table 2).

The diatom assemblage of the unit with *Cymatosira* sp. B has no equivalents, apart from the fact that about 50% of its species were encountered in the Ukraine (Gleser, 1974), Atlantic (Gleser and Jousé, 1974), Barbados (Greville, 1861-1866; Hanna and Brigger, 1964), California (Hanna, 1927, 1931; Kanaya, 1957), and Tuamotu (Jousé 1968). These species are *Asterolampra marylandica* Ehr., *A. vulgaris* Grev., *Brightwellia imperfecta* Jousé, *Coscinodiscus bulliens* A.S., *C. obscurus* Ehr. v. *minor* Rattr., *Hemiaulus kluschnikovii* Gleser, *Triceratium barbadense* Grev., and some other species mentioned with the assemblage of *Craspedodiscus oblongus* as is common with the regions of the Ukraine, Atlantic, etc.

The Norwegian "*Heterosestrum*(?) *tschujenkoi* radiolarian zone" has as assemblage which is rather different from any known Eocene radiolarian assemblage. The species *H.*(?) *tschujenkoi* itself is abundant in Kazakhstan, West Siberia, Turgai, Fergana Valley, near the Aral Sea region, and south of the Russian platform. The beds with *H*(?) *tschujenkoi* belong in the uppermost part of the Kumsk unit of the Bodrak stage and the Beloglinsk unit of the Almin stage.

Lipman, 1972 (Table 3) isolated the zone with *Stylodictya zonata*, and then it was given the new name "*Trochodiscus splendidus* and *Stylodictya tschujenkoi* Zone" (Lipman, 1972). The present authors feel that *Stylodictya zonata* = *S. tschujenkoi* = *Heterosestrum*? (or *Hexacyclia*) *tschujenkoi* = *Stylodictya variabilis* (Bjørklund and Kellogg). The upper and the lower limits of the zone were not indicated by Lipman.

Besides *H.*(?) *tschujenkoi*, there are species in common between the USSR assemblage and Leg 38 assemblage: *Actinommura*(?) *californica* (Clark and Campbell), *Clathrocyclas*(?) *extensa* (Clark and Campbell) *unicum* (Lipman), *Sethocyrtis elegans* Lipman, *Stylospongia communis* (Clark and Campbell), *S. nativa* (Lipman), *Thecosphaera diligens* Kozlova, and *T. leptococcos* Carnevale (after Kozlova, present paper). It is possible that the "Norwegian" unit with *Heterosestrum*(?) *tschujenkoi* is analogous with the zone of Lipman.

Stratum V (= Diatom unit with Coscinodiscus aff. tenerrimus or radiolarian unit with Theocyrtis litos "Cr")

The stratum was isolated at Site 339, Cores 10 and 12. The upper and lower limits of the stratum are not certain.

The diatom assemblage may be characterized by the abundance of *Rutilaria*(?) sp., *Coscinodiscus subtilis* Grev. are characteristic, although they are also found in the higher units (Table 1).

The silicoflagellates *Dictyocha hexacàntha* Schulz and *Pseudorocella barbadensis* Defl. are restricted to the unit. *Dictyocha triacantha* Ehr. v. *triacantha*, *D. triacantha* Ehr. v. *apiculata* Lemm., *D. triacantha* Ehr., v. *flexuosa* (Stradner) Gleser, *D. traicantha* Ehr. v. *hastata* Lemm., as well as, *Naviculopsis biapiculata* (Lemm.) Freng. v. *minor* (Schulz) Gleser, are abundant here.

The radiolarian unit with *Theocyrtis litos* "Cr," may be characterized by the increased contribution of *Haliomma oculatum* Ehrenberg, *Acanthosphaera*(?) sp. "L," *Haliomma* sp. "N," *Cenellipsis bergontianus* Carnevale, and the *Stylodictya stellata* Bailey group. *Heterosestrum* ? (or *Hexacyclia*) *tschujenkoi* (Lipman) and the *Clathrocyclas*(?) *extensa* (Clark and Campbell) group are very rare in the unit, as compared to the lower units. Within the limits of the unit in question appear *Axoprunum liostylum* (Ehrenberg), *Stylodictya targaeformis* Clark and Campbell *rosella* Kozlova, and most characteristically *Theocyrtis litos* (Clark and Campbell) forma "Cr" (Table 2).

The diatom assemblage with *Coscinodiscus* aff. *tenerrimus* has no close analog, and the position of the stratum is not definite. The whole species set of *Stephanopyxis turris* (Grev. et Arn.) Ralfs and its varieties, and the species of the genus *Hemiaulus* which is characteristic for those "Norwegian" strata that are assumed to be lower, are absent here. On the other hand, some species of the unit in question are in common with the mentioned lower units (Table 1), so there is some connection with the lower strata.

The diatom species *Muelleriopsis limbata* (Ehr.) Hendey, *Xanthiopyxis panduraeformis* Pant., and some others known from the Neogene, indicate that Stratum V must be placed above all other Eocene strata.

Stratum VI (= Diatom unit with Pseudopodosira hyalina)

The stratum was isolated at Site 336 (Core 16). The lower and the upper limits of the unit are not certain.

The unit may be characterized by the abundance of *Hemiaulus polycystinorum* Ehr. (which is also present, but not so abundantly, in the supposedly lower unit); *Pseudopodosira hyalina* Jousé, *Trinacria pileolus* Ehr., and *Actinopytychus undulatus* Bail. var. are also abundant here.

The diatom assemblage is a rather peculiar one, but it has something in common with diatom Stratum III (Site 338, Cores 26, 27).

Radiolarians are few in the unit in question. The taxonomy of all encountered Larcoidea, as for example *Lithelius* sp. "E" Petrushevskaya (1975, pl. 3, fig. 2), is so obscure that they are of no value for age determination nor for correlation. Only some specimens, similar to the *Lithocarpium polyacantha* (Clark and Campbell) group, might be indicative of a connection with the upper units. Apart from Larcoidea, practically no Polycystins were encountered.

Stratum VII (= Diatom unit with Pyxilla sp. [Pyxilla aff. prolongata] and Stephanopyxis turris v. cylindrus, or radiolarian unit with Acanthosphaera sp. "H")

The stratum was isolated at Site 337 (Cores 9-11). The lower and the upper limits of the stratum are uncertain.

The diatom unit may be characterized by the abundance of *Pyxilla* aff. *prolongata* Brun, *Stephanopyxis turris* (Grev. et Arn.) Ralfs var. *cylindrus* Grun., *Hemiaulus polymorphus* var. *glacialis* Grunow, *Huttonia norvegica* Schrader, *Navicula udintzevii* Schrader, *Hemiaulus longicornis* Greville, *Liradiscus asperulus* Andrew. Many species of *Sceptroneis* and *Rhaphoneis* are abundant.

The diatom unit under consideration has some species in common with the upper part of the Barbados Oceanic formation. The later diatom assemblage contains *Pyxilla caputavis* and has an age of early Oligocene.

The radiolarian unit with *Acanthosphaera* sp. "H" may be characterized by the presence of various *Lithomitra* species (*Lithomitra*(?) sp. "T," *L.*[?] sp. aff. *Lithocampe minuta* Clark and Campbell, *Lithomitra*[?] sp. aff. *Eucyrtidium elegans* Ehrenberg), by the abundance of *Cornutella californica* Clark and Campbell (or *C β profunda* Ehr.), and by the presence of *Lithamphora* sp. aff. *Corocalyptra kriegeri* Popofsky and *Pseudodictyophimus*(?) sp. aff. *Sethoconus reschetnjakae* Petrushevskaya forma "B." The species of the genus *Lithocarpium* begin to occur at the level of this stratum. Most characteristic for the unit is the species *Acanthosphaera* sp. "H."

The radiolarian unit with *Acanthosphaera* sp. "H" has but few species in common with the Oligocene of Barbados. It has many species in common with the supposedly lower units (especially with V and III), but these species are rare here in Stratum VII.

The species of the genera *Lithomitra*, *Lithamphora*, *Lithocarpium*, and *Cornutella* of this unit have very close analogs in the subantarctic Paleogene, DSDP 29-280, Cores 5-7 (Petrushevskaya, 1975).

The floral and faunal distribution suggests the existence of (approximately) meridional water currents in the Atlantic at the time of Stratum VII.

Stratum VIII (= Diatom unit with Psuedotriceratium radioso-reticulatum)

The stratum was isolated at Site 338, from Core 22 (Section 6) to Core 24. The lower boundary is not certain.

The diatom unit may be characterized by the abundance of *Pseudotriceratium radioso-reticulatum* Grun., *Ps. motabile* Korotrevick, *Ps. chenevieri* Melster, *Synedra* sp. I, II, *Raphoneis* sp. 1, *R.* sp. 2,

Sceptroneis sp., *Pterotheca spada* Temp. et Brun, *Periptera tetracladia* Ehr., and *Rhizosolenia* spp. The silicoflagellate species *Septamesocena apiculata* is characteristic for the unit.

The upper boundary is marked by the mass appearance of various *Stephanopyxis* species. There is no close analog of the flora in question, but the age may be early-middle Oligocene.

For the radiolarians, the last occurrences of the Paleogene species-groups *Botryostrobus joides* Petrushevskaya, *Lophophaena macrencephala* Clark and Campbell, and *Ceratospyris* sp. aff. *Tripospyris crassipes* Clark and Campbell occur in the unit. No characteristic radiolarian species, restricted to the unit, can be indicated.

Stratum IX (= Diatom unit with Goniothecium decoratum, Stephanopyxis marginata)

The unit was isolated at Sites 338 (Cores 19-22, Section 3) and 336 (Core 16).

The unit may be characterized by the abundance of the diatom species *Stephanogonia polyacantha* Forti, *Actinoptychus thunii* A.S., *A. undulatus* (Bail.) Ralfs var., *Coscinodiscus asteromphalus* Ehr. var *hybrida* Grun., *Kisseleviella carina* Sheshuk., and *Xantiopyxis panduraeformis* Forti.

The unit may represent the silicoflagellate zone with *Naviculopsis biapiculata* and *Rocella gemma*.

Two oceanic species *Coscinodiscus vigilans* A.S. and *Amphitetras oligocaenica* Jousé sp. n. are encountered. These two species are very characteristic for late Oligocene strata of the tropical regions (Jousé, 1973, 1974). The presence of these two species in the assemblage "with *Goniothecium decoratum* and *Stephanopyxis marginata*" permits the correlation of the diatom unit in question with the tropical diatom strata of the late Oligocene Zone—*Coscinodiscus vigilans*.

At Site 338, within the limits of the unit, the following radiolarians begin to occur: *Ceratocyrtis* sp. aff. *Helotholus histricosa* Jørgensen, *Lithocarpium* sp. aff. *Ommatodiscus haeckeli* Stöhr, *Pseudodictyophimus*(?) *reschetnjakae* Petrushevskaya) typ., and the *Spongotrochus glacialis* (Popofsky) group. These radiolarians are most characteristic for the upper units of Site 338. *Acanthosphaera*(?) sp. "H," encountered in the unit under consideration, is characteristic for the lower Stratum VII.

Stratum X (= Diatom unit with Raphidodiscus marylandicus and Xanthiopyxis oblonga or radiolarian unit with Velicucullus sp. "O")

The stratum was isolated at Site 338 (Cores 13-17).

The diatom unit may be characterized by the abundance of *Periptera tetracladia* Ehr., *Xanthiopyxis oblonga* Ehr. and *X. globosa* Ehr., *X. panduraeformis* Forti and *X. biscoctiformis* Forti, *X. diaphana* Forti, *X. specticularis, Melosira sulcata* (Ehr.) Ktz. and var. *crenulata* Grun., *Muelleriopsis limbata* (Ehr.) Hendey, *Pseudopodosira orientalis* Sheshuk., *Stephanogonia polygona* Ehr., *Trigonium nancoorensis* Grun. v. *italica* Forti, *Odontella* sp., *Chaetoceros* (sporae), and *Goniothecium odontellum* var. *danica* Grun. *Raphidodiscus marylandicus* Christian is encountered at Site 338, Core 16.

The silicoflagellate zone with *Dictyocha pseudofibula* (Schulz) and *Naviculopsis navicula* may be identified in the unit. *Dictyocha triacantha* and *Mesocena apiculata* occur here, but they are not so abundant as *Naviculopsis navicula*.

The presence of (1) *Raphidodiscus marylandicus* Christian, reported (Andrews, 1973) to be restricted to the uppermost early Miocene or to the lowest middle Miocene; (2) abundance of *Xanthiopyxis* spp. characteristic for Miocene (Hanna and Grant, 1926); and (3) presence of the species *Biddulphia deodora* H.G., *B. penitens* H.G., *Cymatosira andersonii* Hanna var., *Periptera tetracladia* Ehr., and of many *Raphoneis* species, all of them known from Californian Miocene sequences, indicate earliest Miocene rather than latest Oligocene. There is also a good correlation with the early Miocene diatom flora of Site 140, Core 2, Leg 14. On the basis of the diatoms this unit might be correlated with the Upper Maikop strata of the south regions of the USSR.

For the radiolarians, *Velicucullus*(?) sp. "O," *Eucyrtidium* sp. "R," and *Pseudodictyophimus*(?) *reschetnjakae* (Petrushevskaya) are common in the zone. The vertical range of *Velicucullus*(?) sp. "O" seems to coincide with the upper and lower limits of the unit. *Heliodiscus* sp. "P," *Gondwanaria dogieli* (Petrushevskaya), the *G. japonica* (Nakaseko) group, *Stichocorys saccoi* (Vinassa), the *Anomalocantha dentata* Mast group, the *Lithocarpium polyacantha* (Clark and Campbell) group, *Hexacromyum delicatulum* (Dogiel), and the *Ceratocyrtis cucculuris* (Ehr.) group are very characteristic, but are not restricted to the unit.

The radiolarian species *Anomalocantha dentata* Mast, *Hexacromyum delicatulum* (Dogiel), and *Stichocorys saccoi* (Vinassa) (formerly reported by Petrushevskaya and Kozlova [1972, pl. 26, fig. 20] for the Miocene samples DSDP 14-139-7 and 140-2 as *Stichopodium martellii*), and the presence of *Gondwanaria* species, seem to indicate a Miocene age, rather than Oligocene: first, because the listed species are encountered also in the upper layers of Site 338, and second because these species were reported (Petrushevskaya and Kozlova, 1972; Petrushevskaya, 1975) from Neogene deposits. In spite of these known species, the radiolarian assemblage with *Velicucullus*(?) sp. "O" has no analogs in the literature.

Stratum XI (= Diatom zone with Denticula lauta or radiolarian unit with Cyrtocapsella tetrapera)

The stratum was isolated at Site 338 (Cores 10-12).

The lower boundary of the diatom zone of *Denticula lauta* coincides with the upper boundary of the diatom unit with *Raphidodiscus marylandicus*. It is marked by the disappearance of the nominate taxon and also of *Goniothecium decoratum* Brun and *G. odontellum* var. *danica* Grun. The upper limit of the zone is marked by the appearance of *Denticulina hustedtii* Simonsen et Kanaya.

The most characteristic species are *Actinoptychus* aff. *thumii* Schmidt, *Thalassionema nitzschioides* Grun.,

Xanthiopyxis diaphana Forti, *X. specticularis* Hanna, Ehr., *C.* aff. *tenerrimus* Jousé, *Eupodiscus oamaruensis* Grun., *Peponia barbadensis* Grev., and *Hemiaulus* sp. 4. *Muelleriopsis limbata* (Ehr.) Hendey, *Xanthiopyxis panduraeformus* Pant., and *Stephanopyxis barbadensis, Coscinodiscus grossgemii* Gleser, *Cymatosira andersonii* Hanna var., *Periptera tetracladia* Ehr., and *Diploneis crabro* Ehr. The new species *Anaulus antiqua* Jousé occurs here.

The silicoflagellates and ebridians *Distephanus speculum* var. *pentagonis* Lemm., *D. speculum* var. *cannopiloides* Bach., *D. crux* and var. *longispina* Schulz, *Dictyocha pseudofibula* (Schulz), *Ammodochium rectangulare* Schulz, and *Ebriopsis antiqua* (Schulz) Hov. are characteristic for Stratum XI.

The diatom zonation of Koizumi (1973) was very good for the diatom assemblage encountered in the unit in question and for the higher unit. The diatom zone with *Denticula lauta*, indicated here, corresponds well enough to Koizumi's zone of the same name, established for the Miocene deposits of the North Pacific (DSDP Leg 19) and of Japan.

It appeared to be very difficult to correlate the "Norwegian" deposits of Leg 38 with the North Pacific diatom zonation established by Schrader (1973a). Partly this was because some indicator species of his zones were absent in our material and partly because the zonation of Schrader divides sequences into very small parts (Schrader established 25 zones within the limits of the Neogene). The establishment of such zones may be certain only if numerous, detailed sets of samples are investigated. In our case the samples were taken at intervals of 5-9 meters, and the boundaries of the "small" zones of Schrader could easily be missed. The more generalized zones of Koizumi were more easily determined.

For the radiolarians, the lower boundary of the unit is marked by decreasing abundance of *Velicucullus*(?) sp. "O," of the *Pseudodictyophimus* (?) sp. aff. *Sethocomus reschetnjakae* (Petrushevskaya group, of *Schizodiscus disymmetricus* (Dogiel), and *Lithocarpium polyacantha* (Clark and Campbell). In the unit in question, *Stichocorys biconica* (Vinassa) (usually mistakenly named *Eucyrtidium calvertense* Martin), the typical *Pseudodictyophimus gracilipes* (Bailey) group, and *Cryptocapsella tetrapera* (Haeckel) begin to occur. *Stichocorys saccoi* (Vinassa) (= *Stichopodium martellii* conicum) becomes more abundant here than in the lower unit.

The presence of *Cyrtocapsella tetrapera* (Haeckel), *Stylosphaera* sp. "C" Petrushevskaya and Kozlova, and *Gondwanaria japonica* (Nakaseko) recall samples DSDP 14-140-2 and 139-3, CC. The latter belong in the early-middle Miocene radiolarian zones with *Calocycletta virginis* (or *veneris*) and with *C. costata*. The Norwegian unit in question is named the "*Cyrtocapsella tetrapera* Zone" in the sense of Nakaseko and Sugano (1973). These authors have isolated the zone of that name in the middle Miocene beds of Japan, which belong in the foraminiferal zones of Blow N 10 to N 13. It is higher than the "*Cyrtocapsella tetrapera* Zone" sensu Riedel and Sanfilippo.

Stratum XII (= Diatom zone Denticula lauta-D. hustedtii)

The stratum was isolated at Site 338 (Cores 8-9). The lower limit of the zone coincides with the upper boundary of the *Denticula lauta* Zone, and its upper limit is marked by the disappearance of *D. lauta*.

The most characteristic diatom species are: *Denticula hustedtii* Simonsen et Kanaya, *D. lauta* Bail., *Actinocyclus ingens* Rattr., *Chaetoceros* spp., *Mediaria splendida* Sheshuk., *Rouxia peragalloi* Brun et Herib., *Thalassionema nitzschioides* Grun., *Pterotheca reticulata* Sheshuk., *P. kittoniana* var. *kamtschatica* Gaponov, *Rhizosolenia styliformis* Bright., *Mediaria splendida* Sheshuk., *Gymatosira andersoni* Hanna var., *Synedra jouseana* Sheshuk., *Coscinodiscus endoi* Kanaya, and *Cymatosira savtschenkoi* Pr.-Lavr.

Actinocyclus ingens Rattr. and *Denticula hustedtii* Simonsen et Kanaya are very typical (Hajos, 1959; Kanaya, 1959, 1971; Koizumi, 1968, 1973, 1974; Sheshukova-Poretzkaya, 1967; Hanna, 1932; Schrader, 1973a, b.; Mukhina, 1971) for the middle Miocene of boreal, subtropical, and tropical regions: Hungary, Japan, Sakhalin Island, Kamtchatka, California, Experimental Mohole Drilling, the tropical Pacific.

The silicoflagellates and ebridians *Dictyocha fibula* Ehr., *D. pseudofibula* Ehr., *Distephanus crux* (Ehr.) Haeck., *D. speculum* (Ehr.) Haeck. and var. *cannopiloides*, *Mesocena elliptica* (Ehr.) Defl., *Paradictyocha polyactis* var. *Mesocenoideae* (Defl.) Freng., *Ammodochium rectangulare* (Schulz) Hov., *Ebriopsis antiqua* (Schulz) Hov., and *Actiniscus* aff. *sirius* Ehr. are encountered in this unit.

The radiolarians, *Pseudodictyophimus* sp. "A" Petrushevskaya and Kozlova, *Spongodiscus resurgens* Ehr., *Stylodictya stellata* Bailly, *Gondwanaria dogieli* (Petrush.), *Ceratocyrtis* spp., *Spongotrochus glacialis* Popofsky are present here. These species were common in Sample 14-140-2-1, of middle Miocene age.

Stratum XIII (= Diatom zone Denticula hustedtii)

This stratum was isolated at Site 348 (Cores 11-16). The most characteristic species are: the diatoms *Actinocyclus ingens* Rattr., *Chaetoceros* spp., *Ch.* aff. *capreolus* Ehr., *Denticula hustedtii* Simonsen et Kanaya, *Melosira sulcata* (Ehr.) Ktz., *Periptera tetracladia* Ehr., *Rhizosolenia styliformis* Bright., *Stephanopyxis* aff. *barbadensis* (Grev.) Grun., *Thalassionema nitzschioides* Brun, *Xanthiopyxis diaphana* Forti, the silicoflagellate *Distephanus speculum* (Ehr.) Haeck., *D. crux* (Ehr.) Haeck., *D. japonicus, F. pseudofibula* (Schulz) Gleser and the ebridian *Ammodochium rectangulare* (Schulz) Hov.

The lower boundary is marked by the disappearance of *Denticula lauta*, the upper limit by the disappearance of *D. hustedtii*.

Stratum XIV (= Diatom unit with Denticula seminae and D. kamtschatica)

This unit was isolated at Site 336, Core 9. The lower boundary in the "Norwegian" sequence is uncertain. The upper limit is marked by the disappearance of *Denticula kamtschatica*.

The unit may be characterized by the presence of the diatom species *Actinocyclas oculatus* Jousé, *Denticula kamschatica* Zabelina, *D. seminae* Simonsen et Kanaya, *A. ochotensis* Jousé, *Thalassiosira zabelinae* Jousé, *T. nidulus* (Temp. et Brun) Jousé, *T. gravida* Cl. f. *fossilis* Jousé, *Rhizosolenia barboi* Brun, *Melosira sulcata* (Ehr.) Ktz., and *Thalassionema nitzschioides* Grun. Practically no radiolarians can be indicated.

The diatom assemblage discovered here corresponds rather well to the diatom zone with *D. seminae-D. kamtschatica*, established by Koizumi (1973) in the North Pacific. The *D. seminae-D. kamtschatica* Zone belongs in the Pliocene.

Stratum XV (= Diatom unit with Thalassiosira zabelinae or radiolarian unit with Botryopera oceanica)

This stratum was isolated at Sites 348 (Cores 6-8) and 336 (Core 8). The lower boundary of the unit coincides with the upper boundary of the "*Denticula seminae-D. kamtschatica* Zone." The upper boundary of the unit with *Thalassiosira zabelinae* Jousé is marked by the disappearance of this species.

The most characteristic diatoms are: *Rhizosolenia barboi* Brun, *Denticula seminae* Simonsen et Kanaya, *Stephanopyxis turris* (Grev. et Arn.) Ralfs var. *intermedia* Grun. and var. *cylindrus* Grun., *Thalassionema nitzschioides* Grun., *Rhizosolenia hebetata* f. *hiemalis* Grun., and various species of the genus *Thalassiosira*. The species *Thalassiosira punctata* Jousé, *Th. oestruppii* (Ostf.) Pr.-Lavr., *T. manifesta* Sheshuk., and *T. kriophyla* (Grun.) Jorg. become less abundant and even disappear near the limits of the zone. The species *T. antiqua* A. Cl., *T. gravida* Cl. become more abundant near the limits of the zone. In the uppermost part of the zone, *Thalassiothrix miocenica* Schrader was encountered in mass. This phenomenon is characteristic for the North Pacific NPDZ-XX Zone of Schrader (1973a).

The silicoflagellates *Distephanus octonarius* (Ehr.) Defl., *D. speculum* (Ehr.) Haeck., and var. *cannopiloides* and var. *septenarius* (Ehr.) Jørg. are encountered. The ebridian *Ebriopsis antiqua* (Schulz) Hov. was also found.

The radiolarian *Botryopera oceanica* (Ehr.) (Popofsky) is most characteristic for the samples from Site 348 (Cores 6-8).

Stratum XV corresponds to the diatom zone with *Thalassiosira zabelinae*, isolated by Koizumi (1973) in the North Pacific. The zone is known to belong in the upper Pliocene. The upper limit of the zone is the Plio-Pleistocene boundary. At this level *Rhizosolenia barboi* Brun disappears, and this event is believed (Jousé, 1969; Schrader, 1973a) to mark the Plio-Pleistocene boundary.

The samples from Site 348 (Cores 6-8) were isolated by Bjørklund (shipboard Hole Summaries, Leg 38) as the radiolarian zone with *Antarctissa*. The genus was believed (on the basis of some DSDP Leg 28 data) to appear only at the time of the Gilbert paleomagnetic epoch. However, the Recent genus *Antarctissa* appeared in the subantarctic in the Miocene (Petrushevskaya, 1975), and thus this genus cannot be of any use in defining Pliocene boundaries.

Stratum XVI Pleistocene

This stratum was encountered at Site 336 (Cores 1-6) and Site 348 (Cores 1-5). The lower limit coincides with the upper limit of the *Thalassiosira zabelinae* Jousé diatom zone and itself represents the Plio-Pleistocene boundary.

The diatom assemblages discovered in the sequence were rather poor in the species, and no Pleistocene zonation could be indicated.

In this layer, the fresh-water diatoms *Melosira italica* and var. *subarctica* O. Müll., *M. praedistans* f. *seriata* Moiss., *M. praedistans* Jousé, *Tetracyclus lacustris* Ralfs, *Fragilaria construens* (Ehr.) Grun. were encountered. The marine diatoms *Actinocyclus ehrenbergii* Ralfs, *Coscinodiscus lacustris* Grun., *Rhabdonema arcuatum* (Lyngb.) Kutz., *Hyalodiscus scoticus* (Kutz.) Grun, and *Thalassiosira gravida* Cl. are present, but rather rarely.

The upper layers contain the oceanic diatoms *Rhizosolenia hebetata* f. *hiemalis* Gran, *R. styliformis* Bright., *Thalassiosira excentrica* (Ehr.) Cl., *T. oestrupii* (Ostf.) Pr.-Lavr., *T. antiqua* A. Cl., *T. nitzschioides* Grun., *Thalassiothrix longissima* Cl., and *Coscinodiscus marginatus* Ehr. The silicoflagellate *Distephanus speculum* was encountered.

SUMMARY

It would be of importance if the assemblages described above for the strata could be regarded as the stages of evolution of the boreal diatom flora and the boreal radiolarian fauna. This might be possible if the present research could be more complete and if samples from various regions of the North Atlantic, Arctic, and North Pacific would be equally and adequately investigated.

In regions where the water masses have been more or less of the same type during long periods of the Cenozoic—in the tropics, or even in the Antarctic and subantarctic—the necessity for increased numbers of samples is not so urgent as it is for the North Atlantic. That is why tropical and even subantarctic Cenozoic biostratigraphy is so much better developed than boreal Atlantic biostratigraphy.

The system of water currents in the Norwegian Basin in known to be very complicated and changeable. The environmental conditions are very different in the various parts of the basin. In the past, some species of silicoflagellates, diatoms, and radiolarians might have occupied or abandoned certain localities, not because of real evolutionary events, but because of local conditions.

Many of the assemblages described in the present paper were unknown until now, and have no close analogs in other regions. In the Leg 38 materials these assemblages were identified by the authors only two or three times, and some only once in a single hole. Additionally, some of these assemblages (Strata I, V, VI, and VII) were isolated in separate samples, and their stratigraphic position is not quite certain. It is possible that most of their peculiarities may be explained by local conditions, and not by evolution.

As to the other, better defined assemblages, they each represent unequal time periods, if compared with the time scale (Table 3) of the Neogene. For example, the duration of the three zones (*Denticula hustedtii*, *D. hustedtii-D. lauta*, and *D. lauta*) of Strata XI, XII, and XIII seems to be less than the duration of Stratum X (unit with *Raphidodiscus marylandicus* and *Velicucullus* sp. "O").

The steps of the evolution of diatoms and radiolarians seem to coincide in the Norwegian Basin, and yet the diatoms as well as the radiolarians have peculiarities of their own. Thus, the radiolarian faunal composition permits a subdivision of Stratum X into three subunits, and Stratum XI into two subunits (Table 2). However, the diatom flora do not suggest such subdivisions (Table 1). On the other hand, the unit with *Hemiaulus polycystinorum* (VI), the unit with *Pseudotriceratium radiosoreticulatum* (VIII), and the unit with *Goniothecium decoratum* (IX) have practically no characteristic radiolarian species, while each of them have specific diatom flora.

During late Eocene time many diatom and radiolarian species appeared (Tables 1, 2) in the Norwegian Basin. Some of them were restricted to the late Eocene (to the time of Strata II plus III, or even plus IV), and some of them persisted longer, through the whole Oligocene.

Middle Oligocene (Stratum VIII) seems to be the time of appearance of some diatom species. Many of them have existed through the late Oligocene and early Miocene (Strata IX, X). Late Oligocene (Stratum IX) appeared to be the end of the longest living Eocene species of diatoms and radiolarians.

The early Miocene (Stratum X) saw the beginning of the flourishing of many diatom and radiolarian species, most of them restricted to early middle Miocene (Tables 1 and 2). In the middle Miocene (time of Stratum XI) many diatom species appear in the Norwegian Basin. They existed through the late Miocene, Pliocene, and some even through the Pleistocene, but we did not find any appearance of any new or peculiar radiolarian fauna of that age.

The late Miocene and early Pliocene also have been stages of the evolution of the boreal flora of diatoms, but they seem not to be new steps for the boreal Atlantic radiolarian fauna.

Thus not all of the strata are equally characterized by (1) diatoms, (2) radiolarians, and (3) silicoflagellates and ebridians. As a rule, the number of radiolarian and silicoflagellate species restricted to a stratum is less than the number of restricted diatom species.

There may be various explanations of these data.

It is necessary to point out that many of the encountered Neogene diatom species are neritic, while most of the Neogene radiolarian species encountered in the Norwegian Basin seem to be widely distributed oceanic species. The neritic species may be more sensitive to local conditions and become extinct more rapidly than the eurybiotic, widely distributed oceanic species. Differences in radiolarian and diatom physiology may also be involved.

Environmental controls seem to produce somewhat different effects on the diatom flora and on the radiolarian fauna. At times of isolation, and especially when neritic conditions were widespread, most of the radiolarian species and the oceanic diatoms disappeared from the region. The eurybiotic cold water and neritic diatom flora began to flourish, but the neritic radiolarian fauna never has been so rich as the neritic diatom flora.

On the basis of biogeography (the patterns of geographical distribution of diatom and radiolarian species), it is possible to make some suggestions regarding the current systems during the time investigated.

At the time when Stratum I (middle? Eocene) accumulated, the investigated area was connected with the sea, located on the territory of the present Western Siberia (Figure 2).

During the late Eocene (Strata II-IV), the Norwegian-Greenland Basin was connected with the seas of Central Europe, Kazakhstan, and middle Asia, which is obviously due to east-west currents. Characteristic species for the tropical Atlantic were encountered only among diatoms.

Beginning with the early Oligocene (Stratum VII or even earlier) right to the end of the middle or late Miocene (Strata XI-XII) a connection with the subtropical and tropical Atlantic may have existed. It was more or less pronounced in various districts of the Norwegian Basin and at various moments. On the other hand, many peculiar species indicate some isolation or neritic conditions. The late Oligocene flora of the Norwegian Sea and South Mangishlak of the USSR (Middle Majkop-strata) have many common species (*Stephanopyxis marginata* Grun., *Stephanogonia polyacantha* Forti, etc.).

In the middle-late Miocene, the similarity with the Western North Pacific, rather than with the subtropical Atlantic, can be noticed for the areas of Sites 336, 338, and 348. The "North Pacific" species *Diplocyclas ionis* (Haeckel) group, *Hexacontium delicatulum* (Dogiel), *Schizodiscus disymmetricus* (Dogiel) are absent in the

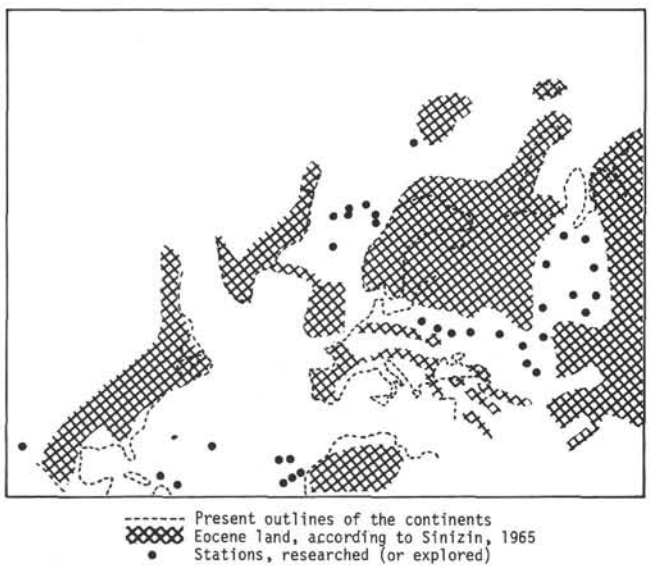


Figure 2. *Approximate distribution of land and sea during Eocene.*

plankton and in the Holocene sediments of the North Atlantic, Norwegian Sea and Arctic (Cleve, 1900a, 1900b; Hülsemann, 1963; Petrushevskaya, 1969), whereas they are still common in the North Pacific recent plankton and sediments (Dogiel and Reschetnjak, 1952; Kruglikova, 1969; Nigrini, 1970).

Unfortunately, the samples of the glacial sediments were too scarce and too poor in flora and fauna to give us any good picture of the climatic fluctuations through the late Pliocene and Pleistocene.

DIATOMS, SILICOFLAGELLATES, AND RADIOLARIANS AT EACH SITE

Site 336

The site was located at 56°21.06'N, 07°47.27'W, with a water depth about 820 meters. The depth of penetration was 515 meters, the last 30.5 meters being in basalt. The hole was drilled on the northern, "Norwegian" flank of the Iceland-Faeroe Ridge which is topographically smooth. Diatoms were studied in Cores 1, 2, 5, 6, 8, 9, 11, 16, 18, and 20, and radiolarians only in Cores 16 and 18 (Tables 5, 6).

At a depth of 64-73.5 meters (Core 8) the diatom zone with *Thalassiosira zabelinae* in the sense of Koizumi (1973), Stratum XV, was encountered in terrigenous clay, sandy mud, and sand. The sediments at a depth of 73-83 meters (Core 9) seem to belong in the diatom unit with *Denticula kamtschatica-D. seminae* in the sense of Koizumi (1973), or in Stratum XIV (see Biostratigraphy. In the Shipboard Hole Summary, the unit 0-168 meters was dated as Pleistocene, mainly on the basis of the foraminifera *Globigerina pachyderma*. We believe that on the basis of the diatoms and silicoflagellates, the layers at about 64-83 meters below the sea floor belong in the Pliocene.

In the terrigenous clay and mud at a depth of 111-121 meters (Core 11), the diatom assemblage is mixed. The presence of *Thalassiosira gravida* and *T. zabelinae* suggests Pliocene, while the occurrence of *Coscinodiscus insignis* and *Kisselleviella carina*, of which the former is known (Koizumi, 1973) to disappear in the late Miocene and the latter in the middle Miocene, indicates Miocene. Thus it is difficult to decide whether Sample 336-11-3 belongs in the Pliocene or in the Miocene.

More detailed sampling might have yielded a nearly uninterrupted Pliocene-Miocene sequence, and then there would be no question of a possible hiatus at a depth of 168.5 meters. This hiatus was suggested in the Shipboard Hole summaries of Leg 38 because only Pleistocene and then (in Core 15) suddenly Rupelian (Oligocene) sediments were identified.

At a depth of 178-187 meters (Core 16) the diatom unit with *Goniothecium decoratum, Stephanogonia polycantha,* and *Coscinodiscus vigilans* (Stratum IX) was identified in the firm mudstone with siliceous biogenic material. The radiolarians *Lithelius* ssp. and *Lithomelissa* sp. "E" Petrushevskaya (1971, pl. 43, fig. IX) were found. About 199-206.5 meters below the sea floor (Core 18) the diatom unit with *Hemiaulus polycistinorum* and *Pseudopodosira hyalina* (Stratum VI) was isolated.

In the shipboard Hole Summaries of Leg 38, possibly endemic (to be exact "unknown") radiolarian species were reported. That indicates endemic (isolated) hydrological conditions. On the contrary, the data of the present authors may be regarded as an indication of oceanic (Atlantic) water currents in the Oligocene in the region of Site 336. Especially in Core 16, many species were encountered which are known from Barbados and from tropical oceanic regions (see Biostratigraphy).

The presence of masses of sponge spicules, and the poverty of the radiolarian assemblages, especially in the lower layers, indicate that in the late Oligocene water depths were not great at the location of Site 336 or nearby. The suggestion, made during the leg (see Site Report Chapter 2, this volume) regarding an increase of the depth during the accumulation of Cores 20-15, seems to be very probable.

Site 352, situated on the opposite, "Atlantic," flank of the Iceland-Faeroe Ridge, is too shallow to contain good diatom and radiolarian assemblages. Thus, no comparison could be made to clarify the history of the ridge.

Site 337

The site was located at 64°52.30'N, 05°20.51'W, in a water depth of about 2640 meters. The depth of penetration was 132.5 meters (Table 7). The hole was drilled on what are believed to be rift mountains just east of the "extinct" spreading axis in the Norway Basin.

The sediments, consisting of indistinctly laminated, mottled clay, mud, terrigenous components, and siliceous fossils at a depth of 75.5-113.5 meters below the sea-floor (Cores 9-12), seem to belong in the diatom unit with *Pyxilla* sp. (*Pyxilla* aff. *prolongata*) or in the radiolarian unit with *Acanthosphaera* sp. "H" (Stratum VII).

The occurrence of many Atlantic species (known from Site 138, Leg 14, lower Oligocene) indicates a connection with the Atlantic Ocean at this time. The more characteristic species for the lower Oligocene flora of Site 337 (Cores 9-11) are: *Pyxilla* sp. (*P.* aff. *prolongata*), *Stephanopyxis turris* v. *cylindrus*, *Hemiaulus polymorphus* var. *glacialis*, *Huttonia* sp. (*Huttonia norvegica* Schrader); many species of *Sceptroneis* and *Raphoneis*, *Liradiscus asperulus* and *Rhizosolenia*. The *Pyxilla*-assemblage has some distinguishing features of the lower Oligocene flora of the Antarctic regions (McCollum, 1975; Hajós, 1976). On the other hand, some peculiarities of the diatom and radiolarian assemblages indicate particular, probably cool-water conditions.

Site 338

The site location was at 67°47.11'N, 05°23.26'E, in a water depth about 1300 meters. The depth of penetration was 437 meters (Tables 8, 9). The hole was drilled on the seaward side of the Vøring plateau.

In the olive-black to olive-gray biogenic siliceous ooze with terrigenous components at a depth of 66-95

TABLE 5
Diatoms at Site 336

Sample (Interval in cm) \ Species	*Actinocyclus divisus* (Grun.) Hust.	*Actinocyclus ehrenbergii* Ralfs	*Actinocyclus ochotensis* Jousé	*Actinocyclus oculatus* Jousé	*Bacterosira fragilis* Gran	*Biddulphia aurita* Bréb et Godey	*Biddulphia tuomey* (Bail.) Roper	*Chaetoceros cinctus* Gran	*Chaetoceros furcellatus* Bail.	*Chaetoceros subsecundus* (Gran) Hust.	*Chaetoceros* spp.	*Cocconeis scutellum* Ehr.	*Cocconeis vitrea* Brun	*Coscinodiscus asteromphalus* Ehr.	*Coscinodiscus convexus* A.S.	*Coscinodiscus curvatulus* Grun.	*Coscinodiscus* group *plicatus* Grun.	*Coscinodiscus marginatus* Ehr.	*Coscinodiscus nodulifer* A. Schmidt	*Coscinodiscus oligocenicus* var. *nodosa* Jousé	*Coscinodiscus symbolophorus* Grun.	*Coscinodiscus vigilans* A.S.	*Cosmiodiscus insignis* Jousé	*Denticula kamtschatica* Zabelina	*Denticula seminae* Simonsen et Kanaya	*Goniothecium decoratum* Brun	*Goniothecium odontellum* Ehr.	*Hemiaulus polycystinorum* Ehr.	*Hyalodiscus obsoletus* Sheshukova	*Mediaria splendida* Sheshukova	*Melosira albicans* Sheshukova	*Melosira sulcata* (Ehr.) Ktz.	*Muelleriopsis limbata* (Ehr.) Hendey	*Kisseleviella carina* Sheshukova
Pleistocene																																	
1-3, 100-102	1																														1		
2-3, 60-62	1	1	1	1									1	1				1													1		
5-3, 10-12																																	
5-6, 90-92																															1		
6-3, 110-112					1																										1		
6-6, 100-102		1	1																												1		
Thalassiosira zabelinae Zone																																	
8-3, 100-102	1	1			1									1	1			1							1						1		
8-6, 40-42	1	1			1									1		1		1							1						1	1	
Denticula kamtschatica-Denticula seminae Zone																																	
9-3, 30-32	1	1	1	1	1			1		1	1	1		1		1	1	2						1	3				1	1	1		
11-3, 120-122	1	1				1		1	1	1		1	1	1	1	1	1	1	1			1	1						1		2		1
Unit with *Goniothecium decoratum*																																	
16-3, 101-103						2														1		3				4	3				3		
16-6, 66-68						4														1		1				5	2				3	1	
18-3, 89-90																												3			3	1	
20, CC																																	

meters below the sea floor, the diatom zone of *Denticula hustedtii-D. lauta* (Stratum XII, upper Miocene) was isolated.

In the distinctive green-colored, dominantly biogenic siliceous ooze at a depth of 97.6-114 meters below the sea floor (Cores 10-12), the middle Miocene diatom zone with *Denticula lauta* (sensu Kiozumi, 1973), and the radiolarian unit with *Cyrtocapsella tetrapera*, were discovered (Stratum XI).

In the sediments of the same lithology, at a depth of 125-180 meters below the sea floor, Stratum X occurred with the diatom unit with *Raphidodiscus marylandicus-Actinoptychus thumii* or the radiolarian unit with *Velicuculus*(?) sp. "O." Neritic conditions are assumed because of the presence of various spores of *Dictyocha pseudofibula*, etc.

In similar sediments, the diatom unit with *Goniothecium decoratum*, *Stephanodiscus marginatus*, *Stephanogonia polycantha* (the analog of the diatom zone with *Coscinodiscus vigilans*), Stratum IX, was isolated at a depth of 180.5-218.5 meters below the sea floor.

The diatom unit with *Pseudotriceratium radiosoreticulatum* and abundant *Synedra* spp. (Stratum VIII? was discovered in the rather calcareous, siliceous ooze of Cores 23 and 24 at a depth of 219-237 meters. In Core 24, the diatom assemblage is poor.

The early Oligocene and late Eocene Strata IV-VII were not discovered at Site 338. At a depth of 237.5-247 meters is a hiatus in sedimentation, especially in the accumulation of siliceous remains.

Below 247 meters, the sediments are calcareous ooze passing down to dominantly biogenic siliceous ooze, locally glauconitic. There is much bioturbation in Cores 28 and 29. The degree of compaction/lithification is high. Here the Eocene Strata III and II (see Biostratigraphy) were discovered at 247-285 meters below the sea floor. In Core 28, the quantity of microfossils is low and the variety of species is poor. In Sample 338-30-3 poorly preserved radiolarian skeletons were found, some of them resembling *Spongodiscus* spp. No diatoms, silicoflagellates, or radiolarians were found below 290 meters.

Site 339

The site was located at 67°12.65'N, 06°17.05'E, in a water depth of about 1262 meters. The depth of penetration was 108 meters. The lithologic record reports biogenic siliceous ooze with 25%-85% diatoms, 2%-20% radiolarians, and 3%-60% sponge spicules and clay minerals. The hole was drilled on the Vøring Plateau (Table 10).

Up to 55.5 meters below the sea floor diatoms and radiolarians are practically absent. At a depth of 55.5-65 meters (Core 7, Section 3), the diatom assemblage as well as the radiolarian set of species seems to be mixed. In Core 7, besides the species common with the lower cores (10-12), some species are present which are absent in these lower cores. It is believed that these species are characteristic of strata even lower than these lowermost

TABLE 5 – *Continued*

Lisitzinia ornata Jousé	*Naviculа distans* W. Sm.	*Nitzchia cylindrus* (Grun.) Hasle	*Nitzschia fossilis* (Freng.) Kanaya	*Nitzschia panduriformis* Grég.	*Nitzschia* sp.	*Podosira maxima* (Ktz.) Grun.	*Podosira glacialis* (Grun.) Jörg.	*Pseudopodosira hyalina* Jousé	*Pseudopodosira wittii* Schulz	*Perotheca aculeifera* Grun.	*Rhizosolenia barboi* Brun	*Rhizosolenia bergonii* Perag.	*Rhizosolenia massiva* Schrader	*Rhizosolenia hebetata* f. *hiemalis* Grun.	*Rhizosolenia* aff. *hebetata* Bail.	*Rhizosolenia styliformis* Brightw.	*Rhizosolenia* sp. (Koizumi, 1973)	*Stephanogonia polygona* Ehr.	*Stephanogonia polyacantha* Forti	*Stephanopyxis barbadensis* (Grev.) Grun.	*Stephanopyxis marginata* Grun.	*Stephanopyxis spinosa* Jousé	*Stephanopyxis turris* var. *cylindrus* Grun.	*Stephanopyxis turris* var. *intermedia* Grun.	*Synedra jouseana* Sheshukova	*Thalassiosira antiqua* A.Cl.	*Thalassiosira convexa* Muchina	*Thalassiosira gravida* Cl. et f. *fossilis* Jousé	*Thalassiosira excentrica* (Ehr.) Cl.	*Thalassiosira hyalina* (Grun.) Gran	*Thalassisira kryophila* (Grun.) Jörg.	*Thalassiosira nidulus* (Temp.et Brun) Jousé	*Thalassiosira nordenskiöldii* Cl.	*Thalassiosira oestrupii* (Östf.) Proschkina-Lavrenko	*Thalassiosira polychorda* (Grun.) Proschkina-Lavrenko	*Thalassiosira zabelinae* Jousé	*Thalassiotrix longissima* Cl. et Grun.	*Thalassionema nitzschioides* Grun.	*Trinacria excavata* Heib.	*Trinacria pileolus* Ehr.	*Xanthiopyxis acrolopha* Forti	*Xanthiopyxis biscoctiformis* Forti	*Xanthiopyxis* aff. *globosa* Ehr.	*Distephanus speculum* (Ehr.) Hack.	Strata
	1			1										1														2	1	1	1			1											XVI
				1										1									1	1				1	1					1											
		1					1				1	1		1													1	1																XV
			1								1			1		1												3	1	1														
		1			1		2				3			1	1	1	1						1				1	1	3	1			2	1	1	1			1					XIV
	1					1	2								1	1	1						3				1	1	3	1			1						1	2				
1								4				3						3	3	3	5	1	2																				
1								4				2						1	2	2	3	2	2																				IX
							2	5	1						3								3																	1	3				
																																									1	1			
																																											3	1	
																																										2	1	

cores (10-12). Thus it is presumed that the assemblage of Core 7 is mixed and reworked (see Site Report Chapter 4, this volume).

At a depth of 84-108 meters (Cores 10 and 12), the diatom unit with *Coscinodiscus* aff. *tenerrimus*, the silicoflagellate unit with *Pseudorocella barbadensis*, and the radiolarian unit with *Theocyrtis litos* "Cr" (Stratum V) were isolated. This stratum seems to belong in the hiatus between Strata III and VIII of Site 338.

In the shipboard Hole Summaries of Leg 38 the suggestion was made, on the basis of the radiolarians, that Cores 10-12 of Site 339 belong to a stratum lower than all the strata at Site 338. Bjørklund designates this stratum of Site 339 as VII. If the flora and fauna of Core 7, Section 3, of Site 339 could be observed as the next younger stage after the assemblages of Cores 10 and 12, then it would be possible to regard the unit with these Cores 10 and 12 as a stratum lower than all the diatom-radiolarian strata isolated at Site 338. However, this does not appear to be the case. Diatom data, studied herein, as well as data obtained during the cruise, suggest that the samples of Core 7 of Site 339 are reworked. Thus, the unit discovered at Site 339 in Cores 10-12 are the uppermost of all the Eocene strata discovered in Leg 38 materials (see Biostratigraphy).

Site 340

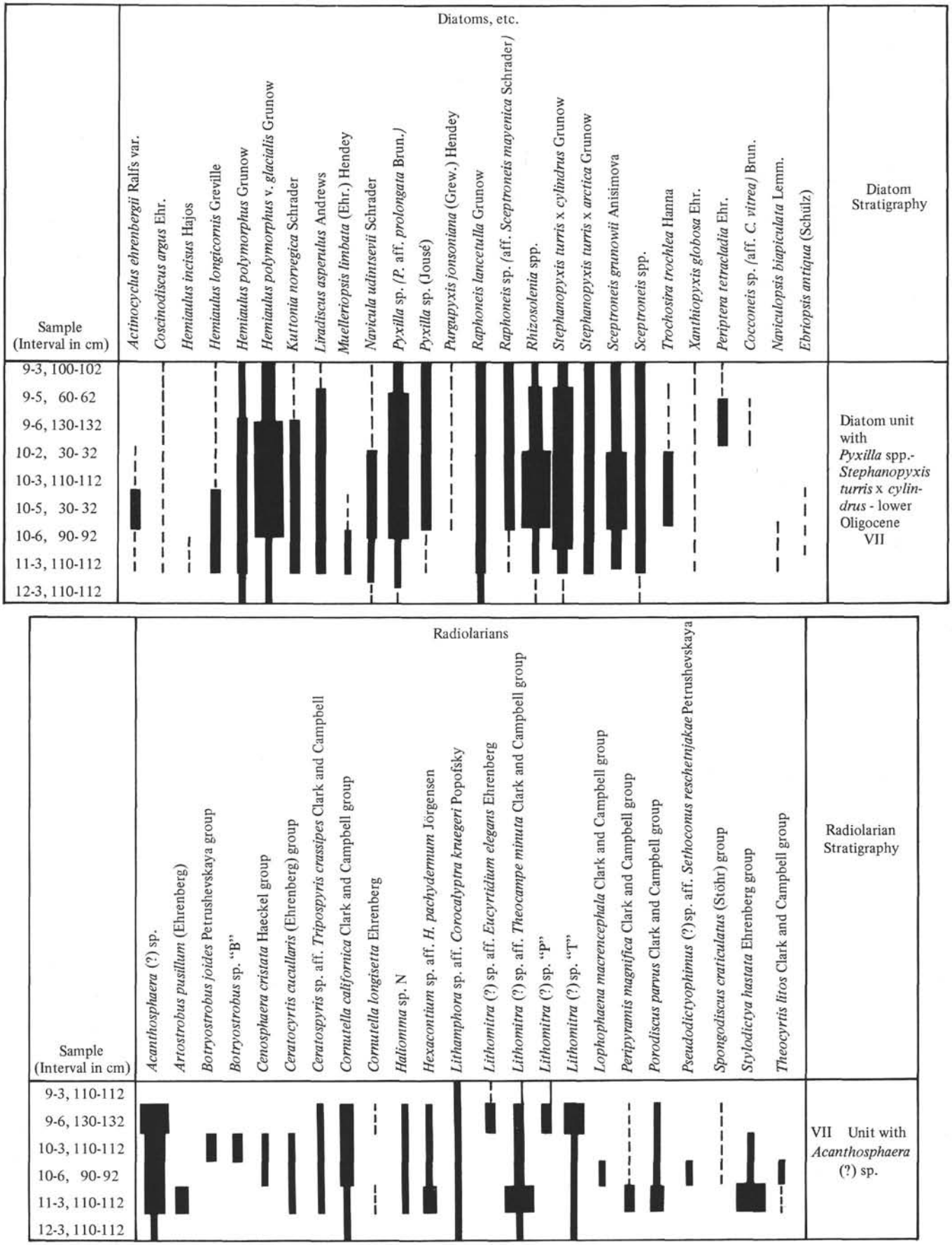
The site was located at 64°12.65′N, 06°18.34′E, in a water depth of about 1217 meters. The depth of the penetration was 104 meters (Tables 11, 12). The hole was drilled on the Vøring Plateau, and the sediment is siliceous biogenic ooze.

Up to 19 meters below the sea floor (Cores 1, 2) no diatoms or radiolarians were found. At a depth of 19-66.5 meters (Cores 3-7), the diatom unit with *Cymatosira* sp. "B," the silicoflagellate unit with *Naviculopsis foliacea*, and the radiolarian unit with *Heterosestrum*(?) *tschujenkoi* (Stratum IV, see Biostratigraphy) were identified.

At a depth of 76-104 meters below the sea floor (Cores 9-11), the diatom assemblage of the unit with *Hemiaulus polycystinorum*, the silicoflagellate assemblage with *Dictyocha triacantha* v. *flexuosa* and the radiolarian assemblage of the *Lophocorys*(?) *norvegiensis* unit (Stratum III) were discovered. This stratum seems to correspond to Cores 26 and 27 of Site 338.

The boundary between the two strata of Site 340 lies at a depth of about 76 meters below the sea floor. It is important to note that this is almost the only boundary which the present authors were able to isolate sufficiently reliably in the Eocene material of Leg 38. The gradual and regular character of the change of the species composition of diatoms and radiolarians is indicative most of all of a normal succession of layers in that interval of the hole. However, this does not permit the present authors to agree with the opinion given in the preliminary report regarding the interfingering of middle Eocene rocks (Cores 4-8) into upper Eocene ones, noting that many species such as radiolarians, as

TABLE 6
Diatoms and Radiolarians at Site 337



well as foraminifera, and possibly also silicoflagellates, have long time ranges, although they are extremely sensitive to changes in environmental conditions. Depending upon ecological conditions, they could either appear or disappear in the area of one and the same station, and accordingly their skeletons will or will not be encountered in the sediments of the core. It is possible that just such "cycles" of occurrence of age indicator species, which were studied during the cruise, led to the assumption of a "disrupted" extent of the zone with *Naviculopsis biapiculata* in the core of Hole 340.

Site 342

Site 342 was located at 67°57.04′N, 04°56.02′E, in a water depth of 1310 meters. The depth of penetration was 170 meters (Tables 13 and 14). The hole was drilled on the Vøring Plateau. The upper layers (to 85 m), of terrigenous-biogenic muds and ooze, contain practically no diatoms.

In the biogenic siliceous ooze of Core 3, especially in Cores 5 and 6 (85-94.5 and 132-151 m below the sea floor), diatoms are very abundant (see Table 14). The diatom assemblage is rather mixed: *Kisseleviella carina* Sheshuk., *Goniothecium decoratum* Brun, *Stephanogonia polycanta*, *Stephanopyxis marginata* v., and *S. turris* var. *cylindrus* Grun. may be regarded as indicators of Strata IX and X. At the same time, the presence of *Periptera tetracladia* Ehr., *Stephanopyxis corona* (Ehr.) Grun., *Xanthiopyxis specticularis* Hanna, and *X. oblonga* Ehr. suggests the diatom unit with *Raphidodiscus marylandicus* (Stratum X). The occurrence of *Actinocyclus ingens* Rattr., *Biddulphia tuomeyi* (Bail.) Ropez., and *Cymatosira savtchenkoi* Pr.-Lavr., may be the indication even of Strata X and XI.

The radiolarians were not studied by the present authors. In the shipboard Hole Summaries of Leg 38, Bjørklund reported *Cyrtocapsella tetrapera* (Haeckel) for Cores 3-5. This radiolarian species is the indicator of the "Norwegian" Stratum XI of the present authors.

Site 343

The site was located at 68°42.91′N, 05°45.75′E, in a water depth of 3131 meters. The penetration was 253 meters. The site is on the east margin of the Lofoten Basin at the base of the Vøring Plateau (Tables 15 and 16).

Diatoms and radiolarians of good preservation were found only in Core 5 (though samples from all 41 cores were studied), at a depth of 145.5-155 meters below the sea floor, in a biogenous siliceous ooze. The assemblage of diatoms from Core 5, Section 3, is mixed: besides species of the *Pyxilla oligocaenica* unit, the species *Stephanopyxis corona* (Ehr.) Grun., *Coscinodiscus marginatus* Ehr., *C. spiniferus* (Gr. et St.) Grun., *Actinocyclus ehrenbergii* Ralfs, *Cymatogonia amblyoceros* (Ehr.) Hanna, etc., known from younger (Neogene) deposits, also occur.

The assemblage of radiolarians in the same sample from Core 5, Section 3, seems to be mixed also. Besides the species common in Section 6, some species are present which are encountered in the unit with *Lophocorys*(?) *norvegiensis* and in the unit with *Heterosestrum*(?) *tschujenkoi*, which we believe to be younger than the sediment in Core 5, Section 6 of Site 343.

In the sample from Core 5, Section 6, the diatom unit with *Pyxilla oligocaenica*, the silicoflagellate unit with *Distephanus antiquus* and the radiolarian unit with *Tripodiscium*(?) *tumulosa* (Stratum I) were isolated. This assemblage was not encountered at any other site of Leg 38. It is believed that this stratum is the lowest of all Eocene strata of Leg 38. We are not sure about the suggestion of a middle Eocene age for this stratum, made on the basis of the silicoflagellates (see Site Report Chapter 4, this volume). The radiolarians of this stratum were noted in the shipboard Hole Summaries as late Eocene or reworked. However, it is believed that they are middle-late Eocene, and in place.

Site 346

Site 346 was located at 69°53.45′N, 08°41.14′W, in a water depth of 732 meters. The penetration depth was 120 meters. The hole was drilled on the Jan Mayen Ridge.

In the "glacial" sediments to 10 meters below the sea floor, neither diatoms nor radiolarians were found. In the volcanic ash, ash-rich sandy mud, and glauconitic sand, diatoms are few (Tables 17, 18) and radiolarians are practically absent to 35 meters below the sea floor.

At a depth of about 35-39 meters (Core 5, Sections 1 and 3), diatoms become abundant (up to 14 million per 1 g of dry sediment), and radiolarians are common. This layer seems to belong in the radiolarian unit with *Velicucullus*(?) sp. "O," Stratum X.

At the time when this stratum was accumulated, the conditions might have been most oceanic. The neritic diatoms *Melosira sulcata* (Ehr.) Ktz. and *Stephanopyxis turris* (Grev.) Ralfs do not play their usual role, and oceanic diatoms are more frequent here (Table 17). The assemblage of radiolarians is somewhat similar to that at Site 338 (Stratum X). All these data may be regarded as indicating a supply of "Norwegian" (or transformed Atlantic?) waters. On the other hand, the presence of the fresh-water diatom *Melosira praegranulata* and the poor preservation of the radiolarian skeletons may be an indication of reworking or of ice transport.

Diatoms are also abundant in Core 7 (about 60 m below the sea floor) and in Cores 9-11 (75.7-101 m) in the biogenic siliceous sediment. These layers seem to belong in the diatom unit with *Goniothecium decoratum* (Stratum IX).

The terrigenous sandy mud in the interval 63 to 73.7 meters below the sea floor is free of diatoms and of radiolarians. This interval might be of latest Oligocene age, and not of Miocene age as is suggested (see Site Report Chapter 7, this volume). The Oligocene age indicated by the present authors would be more consistent with the common picture of the history of the region of the site.

The layers at 16-33 meters at 39.7-63 meters, and about 75.7-101 meters below the sea floor, rich in neritic diatoms and in sponge spicules and poor in radiolarians, might have been accumulated under shallow-water neritic conditions. Below 101 meters in the sequence, siliceous planktonic biogenic remains were not found.

TABLE 7
Diatoms, Silicoflagellates, and Ebridians at Site 338

1 = Single
2 = Rare
3 = Common
4 = Abundant
5 = Very abundant

Diatom Units	Sample (Interval in cm)	Species	BACILLARIOPHYTA	*Actinocyclus* aff. *divisus* (Grun.) Hust.	*A. ehrenbergii* Ralfs var.	*A. ingens* Rattr.	*Actinoptychus thumii* A.S.	*A.* aff. *thumii* A.S.	*A. undulatus* (Bail.) Ralfs	*Anaulus antiqua* Jousé	*Asterolampra insignis* A.S.	*A. marylandica* Ehr.	*A. vulgaris* Grev.	*Biddulphia deodora* H.G.	*B. pinitens* H.G.	*B. rutenica* Witt	*Brightwellia imperfecta* Jousé	*Chaetoceros pliocena* Brun	*C.* aff. *capreolus* Ehr.	*Chaetoceros* spp. (spores)	*Coscinodiscus* aff. *africanus* (W. Sm.) Jan.	*C. argus* Ehr.	*C. argus* (sensu Kanaya, 1957)	*C. asteromphalus* Ehr. v. *hybrida* Grun.	*C. decrescens* Grun.	*C. decrescenoides* Jousé	*C. endoi* Kanaya	*C. grossgeimii* Gleser	*C. lewisianus* Grev.	*C. lineatus* Ehr.	*C. marginatus* Ehr.	*C. monicae* Grun.	*C. payeri* Grun.	*C.* aff. *perforatus* Ehr.	*C. symbolophorus* Grun.
	1-3, 92-94 1, CC 2, CC 3-3, 45-47 3-6, 99-101 3, CC 4, CC 5-6, 101-103 5, CC		No diatoms, silicoflagellates, ebridians																															
Denticula hustedtii-Denticula lauta	8-3, 100-102		1	2	3	2	1										1	2	5							1		1	1	2			1	
	9, CC				5																													
Denticula lauta	10-2, 65-67					4			1						1																			
	11-2, 40-42								1																		1							
	12-2, 40-42								1						1												1							
Raphidodiscus marylandicus	13-2, 40-42								1						3																			
	14-2, 40-42								1						1																			
	15-2, 30-32								1				1	1																				
	16-2, 40-42								1				1																					
	17-3, 20-22							1					1																					
Goniothecium decoratum	19-3, 110-112																																	
	20-3, 120-121							2																										
	21, CC							4																										
	22-3, 113-115																																	
	22-6, 6-8																																	
Pseudotriceratium radiosoreticulatum	23-3, 82-84																																	
	23-6, 80-82																																	
	24-3, 104-106																																	
	24-6, 83-85																																	
Craspedodiscus oblongus	26-3, 52-54								3														5		1								1	
	26, CC								1			1	1								2		5	1	1						1		1	
	27-3, 88-90								2		1	1									1					1					2		1	
	27, CC								5			1			1											1					3		1	
Trinacria excavata f. tetragona	28, CC								1															1									3	
	29-3, 35-37								5						1						3			5	1								1	
	29, CC								5						1	1								5								1	1	
	30-3, 47-49 30, CC 31, CC 32-3, 44-46 32-6, 100-102 32, CC 33-3, 130-132 33-6, 99-101 33, CC 34, CC 35, CC 37, CC 38, CC 39-1, 140-142 39, CC 40, CC 41, CC		No diatoms, silicoflagellates, ebridians																															

TABLE 7 – *Continued*

Craspedodiscus oblongus (Grev.) Hanna	*Cymatosira savtschenkoi* Pr.-Lavr.	*C. andersonii* Hanna var.	*Denticula hustedtii* Simonsen et Kanaya	*D. lauta* Bail.	*Diploneis crabro* Ehr.	*Dicladia* (sensu Kanaya, 1957)	*Goniothecium decoratum* Brun	*G. odontellum* Ehr.	*G. odontellum* Ehr. v. *danicum* Grun.	*Goniothecium* sp. 1	*Gyrodiscus vortex* Witt	*Hemiaulus curvatulus* Streln.	*H. danicus* Grun.	*H. hostilis* Heib.	*H. longicornis* Grev.	*H. polycystinorum* Ehr. v. *polycystinorum*	*H. polycystinorum* Ehr. v. *mesolepta* Grun.	*H. polymorphus* Grun.	*H. tenuicornis* Grev.	*H. unicornutus* Brun	*Hemiaulus* sp. 1	*Hercotheca*? sp. (sensu Kanaya, 1957)	*Kisseleviella carina* Sheshuk.	*Melosira architecturalis* Brun	*M. goretzkii* Tcherem.	*M. sulcata* (Ehr.) Ktz.	*Muelleriopsis limbata* (Ehr.) Hendey	*Navicula directa* W. Sm.	*Odontotropis carinata* Grun.	*Omphalotheca californica* Hanna	*Periptera simplex* Jousé sp. nov.	*P. tetracladia* Ehr.	*Podosira* aff. *maxima* (Ktz.) Grun.	*Pseudopodosira orientalis* Sheshuk.	*P. wittii* Schulz	*Pseudopyxilla americana* (Ehr.) Forti	*P. rossica* Pant.	*P. temperiana* Forti	*Pseudopyxilla* sp. 3	*Pseudostictodiscus angulatus* Grun.	*P. ovetschkinii* Gleser	*Pseudotriceratium radiosoreticulatum* Grun.	*Pterotheca aculeifera* Grun.	*P. alata* Streln.
No diatoms, silicoflagellates, ebridians																																												
	1		4	1				1																		1						3		1		1	1							
		1	4	1																						2																		
		1	1	2	1																					2						1												
		2		1	1																					3						1												
				2	1																					4						4												
					1																					3						2												
											2															3						2												
							1		1		2															5						4												
							2		1		4															5						3												
							4		2		3															5	2				4	5												
							4				4												3			5																		
							3				5												1			4						1										1		
							2				5															3																1		
							2				1															2																2		
							1				1															2																2		
							2				1															1																2		
							1																			2						1										2		
																																1										5		
																																										3		
1						5				1			2		1		3	2	1	1	3	4		1					2									1			1			1
5						5						1	3		1		3	5	5	1	3	2			1	1			5	1									1		1			1
5						1				1				1	1	2	2	2			3	3			1	1			1								1	1	2	1	1			1
5						1				1		2				1		3		1		2						1		1										1	3			
1																		2				1							1											1			1	
1														1				5	1			2			1	1		1	5	2			2				1		5	1			3	1
1																		5				1							1	1			3		1				1	1				
No diatoms, silicoflagellates, ebridians																																												

TABLE 7 – *Continued*

Diatom Units	Sample (Interval in cm)	Species	*P. clavata* Streln.	*P. costata* Schibkova	*P. kittoniana* v. *kamtschatica* Gaponov.	*Pyxilla oligocaenica* Jousé v. *oligocaenica*	*Raphoneis amphiceros* Ehr.	*R. lancettula* Grun.	*R. linearis* Jousé sp. nov.	*R. scalaris* Ehr.	*Raphidodiscus marylandicus* Christian.	*Rhizosolenia manifica* Jousé	*Rylandsia biradiata* Grev.	*Sceletonema utriculosa* Brun.	*Sceptroneis grunowii* Anissimova	*Sceptroneis* sp. Jousé	*Stephanogonia polygona* Ehr.	*Stephanopyxis corona* (Ehr.) Grun.	*S. grunowii* Gr. et St. var.	*S. marginata* Grun.	*S. turris* (Grev. et Arn.) Ralfs var.	*S. turris* (Grev. et Arn.) Ralfs v. *arctica* Grun.	*S. turris* (Grev. et Arn.) Ralfs v. *cylindrus* Grun.	*S. turris* (Grev. et Arn.) Ralfs v. *intermedia* Grun.	*S. schenkii* Kanaya	*Stictodiscus hardmannianus* Grev.	*S. kittonianus* Grev.	*Synedra curvata* Jousé sp. nov.	*S. jouseana* Sheshuk.	*S. punctata* Jousé	*Thalassionema nitzschioides* Grun.	*Triceratium barbadense* Grev.	*T. chenevieri* Meister	*T. condecorum* Bright.	*Trinacria excavata* Heib.	*T. excavata* Heib. f. tetragona A.S.
	1-3, 92-94																																		
	1, CC																																		
	2, CC																																		
	3-3, 45-47																																		
	3-6, 99-101																																		
	3, CC																																		
	4, CC																																		
	5-6, 101-103																																		
	5, CC																																		
																No diatoms, silicoflagellates, ebridians																					
Denticula hustedtii-Denticula lauta	8-3, 100-102			1		1	1									1				1		1	1	1	1			1			5		1		
	9, CC																														5				
Denticula lauta	10-2, 65-67											1																			5				
	11-2, 40-42											1																			5				
	12-2, 40-42						1					1																			2				
Raphidodiscus marylandicus	13-2, 40-42						1		3																				1		1				
	14-2, 40-42						2		3	1						2													2		1				
	15-2, 30-32						2		4	1						3		3											3		1				
	16-2, 40-42								2	2	1					2		4		4																
	17-3, 20-22																4	4		4															
Goniothecium decoratum	19-3, 110-112																4	2		5															
	20-3, 120-122																			5															
	21, CC																			5															
	22-3, 113-115																			4															
	22-6, 6-8																			1															
Pseudotriceratium radiosoreticulatum	23-3, 82-84																			1									5	2	4				
	23-6, 80-82																												5	2	4				
	24-3, 104-106																												5	2	4				
	24-6, 83-85																																		
Craspedodiscus oblongus	26-3, 52-54			1		1																	5	5	5		1								
	26, CC			1		1																1	5	5	5		1					1		2	
	27-3, 88-90			2		2													2			3	5	5	5		3					3	1	1	2	
	27, CC		2												1								5	5	5							2		1	1	
Trinacria excavata f. tetragona	28, CC					1							1	1									3	3	3							1	1		1	1
	29-3, 35-37		1	5											1								5	5	5							1	1		2	5
	29, CC					1									1								5	5	5							5	3		2	3
																No diatoms, silicoflagellates, ebridians																					
	30-3, 47-49																																		
	30, CC																																		
	31, CC																																		
	32-3, 44-46																																		
	32-6, 100-102																																		
	32, CC																																		
	33-3, 130-132																																		
	33-6, 99-101																																		
	33, CC																																		
	34, CC																																		
	35, CC																																		
	37, CC																																		
	38, CC																																		
	39-1, 140-142																																		
	39, CC																																		
	40, CC																																		
	41, CC																																		

TABLE 7 – *Continued*

T. exculpta (Heib.) Hust.	*T. media* Jousé	*T. pileolus* (Ehr.) Heib.	*T. subcoronata* Sheshuk. et Gleser	*Trinacria ventricosa* Gr. et St.	*Trinacria ventricosa* Gr. et St. v. tetragona Streln. v.n.	*Trochosira mirabilis* Kitt.	*T. spinosa* Kitt.	*T. trochlea* Hanna	*Xanthiopyxis diaphana* Forti	*X. globosa* Ehr.	*X. oblonga* Ehr.	*X. specticularis* Hanna	*X. umbonata* Grev.	*Xanthiopyxis* spp.	SILICOFLAGELLATES *Cannopilus haemisphaericus* (Ehr.) Häck.	*Carduifolia lata* Hov.	*Corbisema quadralta* (Hanna) Defl.	*Dictyocha ausonia* Defl.	*D. fibula* Ehr. v. *fibula*	*D. fibula* Ehr. v. *pentagona* Schulz	*D. frenguellii* Defl. v. *frenguellii*	*D. pseudofibula* (Schulz)	*D. triacantha* Ehr. v. *apiculata* Lemm.	*D. triacantha* Ehr. v. *flexuosa* (Stradner) Gleser	*D. triacantha* Ehr. v. *inermis* Lemm.	*D. triacantha* Ehr. v. *triacantha*	*D. spinosa* (Defl.) Gleser	*Distephanus crux* (Ehr.) Häck.	*D. crux* (Ehr.) Häck. v. *longissima* Schulz	*D. speculum* (Ehr.) Häck.	*D. speculum* (Ehr.) Häck. v. *pentagonus* Lemm.	*D. speculum* (Ehr.) Häck. v. *cannopiloides* (Pr.-Lavr.) Gleser	*Mesocena apiculata* (Schulz) Defl.	*M. elliptica* (Ehr.) Defl.	*M. oamaruensis* Schulz	*M. triangula* Ehr.	*Naviculopsis biapiculata* (Lemm.) Freng. v. *biapiculata*	*N. biapiculata* (Lemm.) Freng. v. *minor* (Schulz) Gleser	*N. lata* (Defl.) Freng.	*N. navicula* (Ehr.)	*Paradictyocha polyactis* f. *mesocenoidea* Freng.	EBRIDIANS *Ammodochium rectangulare* Schulz
No diatoms, silicoflagellates, ebridians																																										
									2		1																			1			1	1							1	1
																					1						1				1										2
											1	1						1										4			2	2										2
											1	1									1						3			4											
											1	4														2		2	4		4											
										2	2	4		4					1							1		2			2	3	1							1		
										4	3	4		5					2							1		1			2	1	2	1								
										2	2	4		1								2				1		3			4	2	2							2		1
										1	3	4										1				1		2			1					1			1	1		
										4	3	4										4				1		3	2		4	4										
																						1							1		1	1					1					
																						1						3	1		1	1					1		1			
																			1			1						2									3					
																												1									1					
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																			1																							
		1					1						1		1				1	1	1						1			1												
			1	1	1		1						1		1	1	1		2	1	1		1	1		2	1						1					1				1
	1			1	1	1	1										1		1	1	1		2		1					1			1					1				1
								1									1		1	1	1			1		1								1			1				
								1					1				1						1																			1
1						2		1									1		1				1		1	1								1							1
							1	2											2	1	1					1									1							
No diatoms, silicoflagellates, ebridians																																										

TABLE 7 – *Continued*

Diatom Units	Sample (Interval in cm)	Species: *A. speciosum* Defl.	*Ebriopsis antiqua* (Schulz) Defl.	*E. mesnili* Defl.	*E. valida* Defl.	*Micromarsupium anceps* Defl.	*Parathranium tenuipes* Hovasse	*Pseudoammodochium dictyoides* Hov.	*Rocella gemma* Hanna	ARCHAEOMONADES *Litharchaeocystis costata* Defl.	Strata
	1-3, 92-94 1, CC 2, CC 3-3, 45-47 3-6, 99-101 3, CC 4, CC 5-6, 101-103 5, CC	No diatoms, silicoflagellates, ebridians									?
Denticula hustedtii-Denticula lauta	8-3, 100-102 9, CC		1								XIIa
Denticula lauta	10-2, 65-67 11-2, 40-42 12-2, 40-42		2 3 2				3				XI
Raphidodiscus marylandicus	13-2, 40-42 14-2, 40-42 15-2, 30-32 16-2, 40-42 17-3, 20-22		1 1 1 1								X
Goniothecium decoratum	19-3, 110-112 20-3, 120-121 21, CC 22-3, 113-115 22-6, 6-8								1		IX
Pseudotriceratium radiosoreticulatum	23-3, 82-84 23-6, 80-82 24-3, 104-106 24-6, 83-85										VIII
Craspedodiscus oblongus	26-3, 52-54 26, CC 27-3, 88-90 27, CC	1 1 	 1 2 1	 	 1 1 1	 1 1	 	2 5 3 5	 	 2 2 2	III
Trinacria excavata f. tetragona	28, CC 29-3, 35-37	 1	2 2	 	 	1 1	1 2	1 	 	1 	II
	29, CC		1		1	1		1			?
	30-3, 47-49 30, CC 31, CC 32-3, 44-46 32-6, 100-102 32, CC 33-3, 130-132 33-6, 99-101 33, CC 34, CC 35, CC 37, CC 38, CC 39-1, 140-142 39, CC 40, CC 41, CC	No diatoms, silicoflagellates, ebridians									?

Site 348

The site was located at 63°30.18'N, 12°27.72'W, in a water depth of about 1770 meters. The penetration depth was 544 meters (Table 19). The hole was drilled on the Iceland Plateau.

There are no radiolarians in the "glacial" sediments to 65 meters below the sea floor. Diatoms were found at 0-18 meters (Cores 1, 2), and at 56.5-66 meters below the sea floor (Core 5). In Core 1, an oceanic assemblage of diatoms with *Rhizosolenia hebetata* f. *hiemalis*, *R. styliformis*, *Thalassiosira antiqua*, etc. was encountered. In Core 2, not only marine, but also fresh-water diatoms are present. In Core 5, a marine assemblage with *Thalassiosira graviosa*, *Rhizosolenia hebetata* f. *hiemalis*, *T. oestrupii*, and *T. nidulus* occurs. This is Stratum XVI.

The present authors agree with the Pleistocene age for Cores 1-4, and the absence of the Pliocene species *Thalassiosira zabelinae* and *Rhizosolenia barboi* proves Core 5 to be of the early Pleistocene age. The mentioned Pliocene species occur in Core 6.

Radiolarians are common from 66 to 104 meters below the sea floor in the siliceous-terrigenous mud, especially in Core 8. The variety of polycystine species suggests that conditions were most oceanic at the time when Core 8 (94.5-104 m below the sea floor) accumulated. In the higher layers (Core 7), some polycystine species disappear, while *Botryopera oceanica* (Ehr.) becomes more frequent. This may be an indication of more neritic and colder water conditions. The phaeodarian radiolarian *Protocystis* sp. occurs here. In these layers (66-104 m below the sea floor), a diatom assemblage of the zone with *Thalassiosira zabelinae*, sensu Koizumi (1973) was discovered (Stratum XV). In all samples, the variety of *Thalassiosira* species is characteristic for the unit. In Core 8, *T. nativa* and *T. hyalina* are abundant. In Core 7, *Stephanopyxis turris* and var. *cylindrus* and var. *intermedia* are among the dominant species. *Rhizosolenia barboi* is also frequent here. In Core 6, *Thalassiothrix miocenica* Schrader and *Rhizosolenia hebetata* f. *hiemalis* appear among the dominant species. In Core 6 were encountered the last occurrences of *Thalassiosira zabelinae*, and *Rhizosolenia barboi* was common below. This was the basis to define the upper boundary of the zone with *Thalassiosira zabelinae* and in addition to fix clearly the Plio-Pleistocene boundary.

The silicoflagellates *Distephanus speculum*, *D. speculum* var. *cannopiloides*, and *D. stephanus* var. *septenarius* are common in Cores 6-8. The ebridian *Ebriopsis antiqua* also occurs.

The assemblage of diatoms, silicoflagellates, and radiolarians encountered in the unit in question may be regarded not only as a confirmation of the Pliocene age, but it permits a confident assignment of the unit to the late Pliocene.

At a depth of 161-180 meters below the sea floor, in sediments of nearly the same lithology as the upper unit (biogenic-terrigenous mud), a diatom assemblage of the zone of *Denticula hustedtii* sensu Koizumi (1973), Stratum XIII, occurs. Most abundant is *Thalassionema nitzschioides* and var. *obtusa*. *Chaetoceros* species and *Xanthiopyxis* species are abundant and variable. *Denticula hustedtii*, *Stephanogonia polygona*, and *Stephanopyxis turris* var. *intermedia* are common in Core 12, *Periptera tetracladia* and *Actinoptychus undulatus* are common in Cores 12 and 13; and *Pterotheca kittoniana* var. *kamtschatica* occurs in Core 11. The silicoflagellate species *Mesocena stellata*, *M. apiculata*, *Paradictyocha polyactis* f. *mesocenoides*, *Distephanus speculum*, and *D. crux* were encountered here. The ebridian *Ebriopsis antiqua* occurs. The assemblage of diatoms and silicoflagellates supports the age determination of late Miocene for Cores 11-16. The early Pliocene was not discovered at Site 348.

In Core 11, polycystine radiolarians are abundant. *Artostrobus annulatus* (Bailey), *Cornutella profunda* Ehrenberg, *Spongodiscus osculosus* (Dreyer), and the *Stylospira dujandinii* (Haeckel) group occur. They are widely distributed cool-water subsurface oceanic species. The phaeodarian radiolarian *Cadium* sp. is encountered here.

At a depth of about 265 meters (Core 19, Section 1, 130-132 cm) late Eocene radiolarians of the assemblage of the radiolarian unit with *Heterosestrum*(?) *tschujenkoi* or even of the unit with *Lophocorys*(?) *norvegiensis* (Strata III, IV) were discovered. They occur also at Sites 338 and 340. Because only one single sample was investigated, it is difficult to decide whether or not it was reworked.

Below 265 meters in Cores 19-31, no diatoms were found.

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TABLE 8
Radiolarians at Site 338

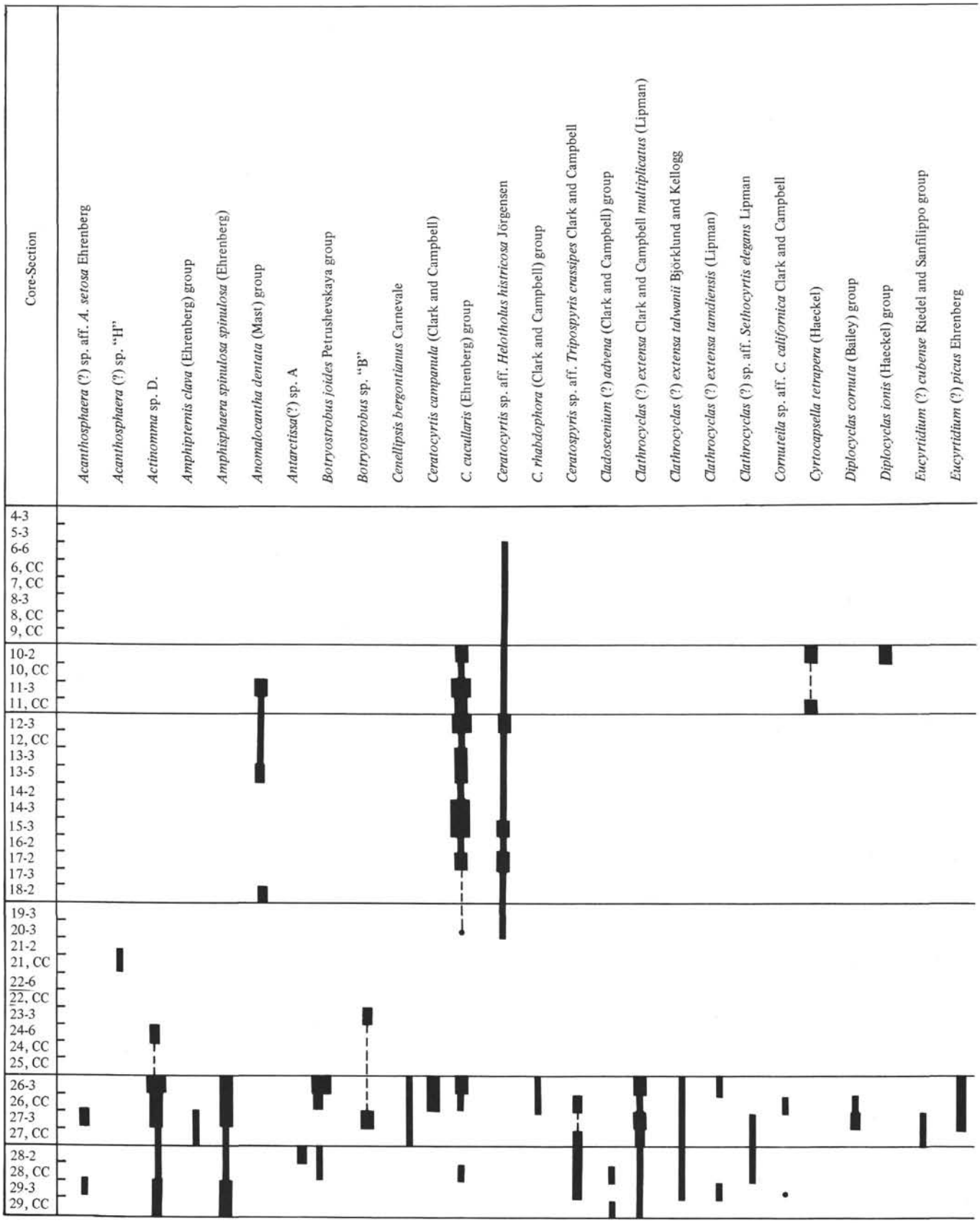

TABLE 8 – *Continued*

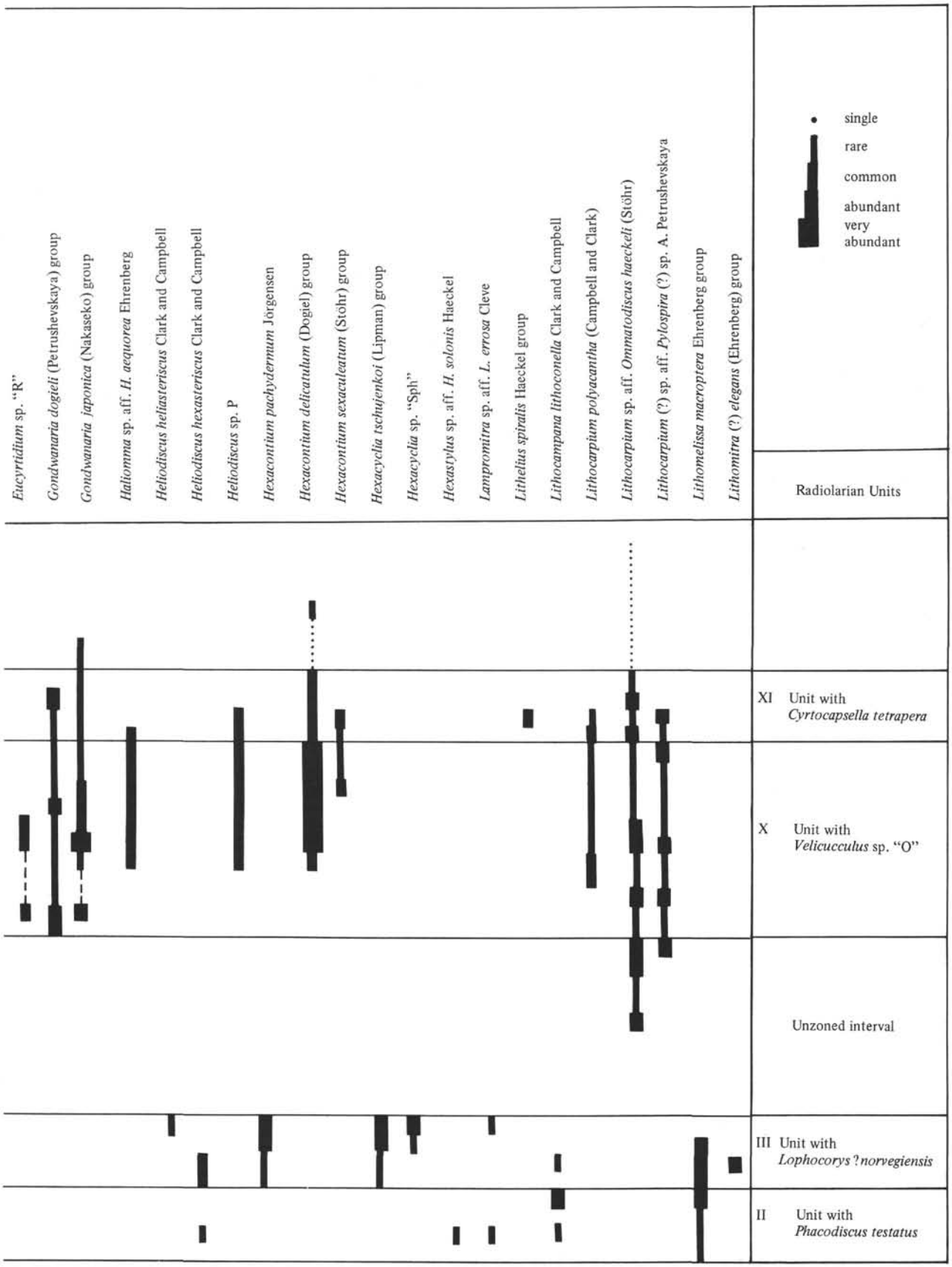

TABLE 8 – *Continued*

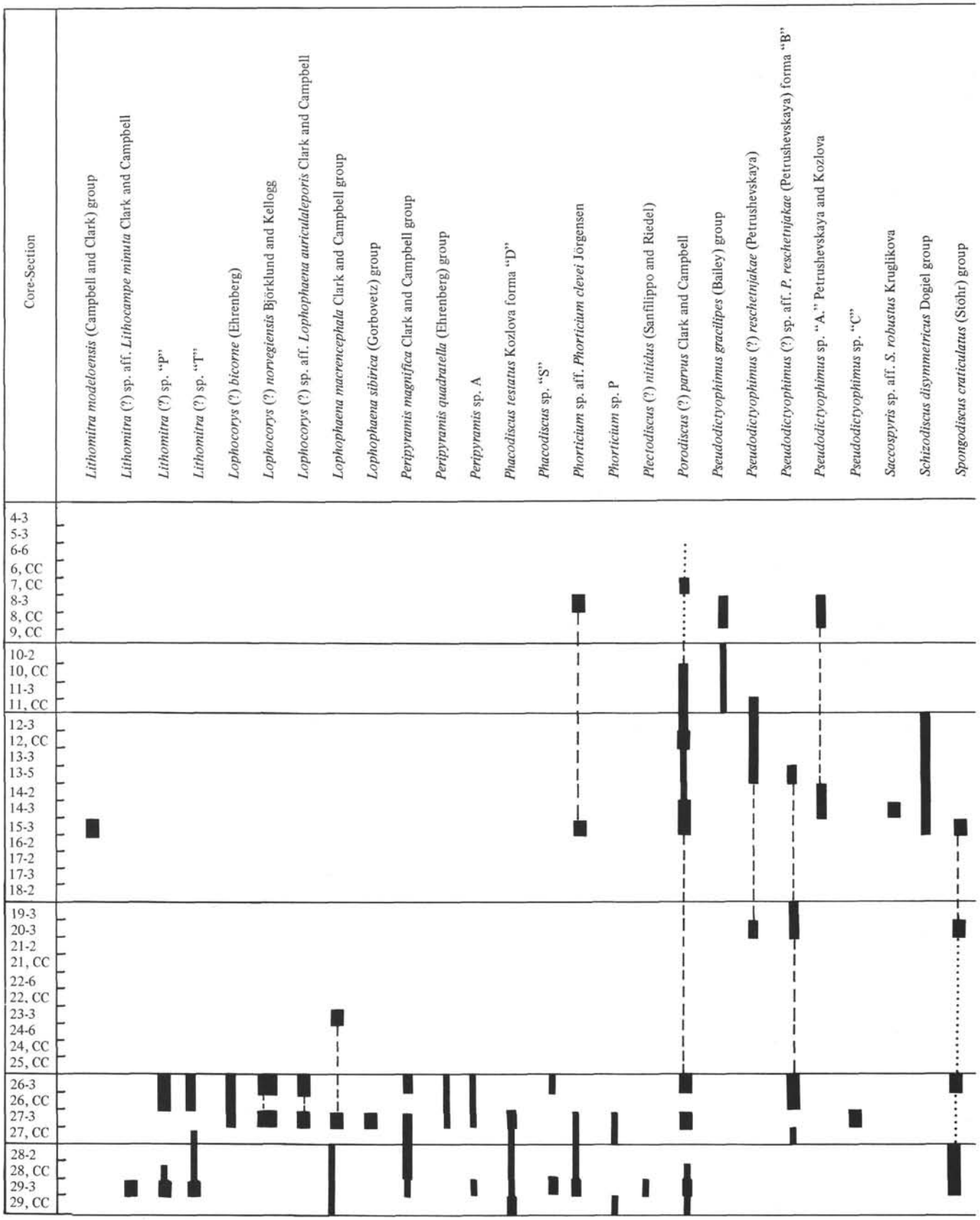

TABLE 8 – *Continued*

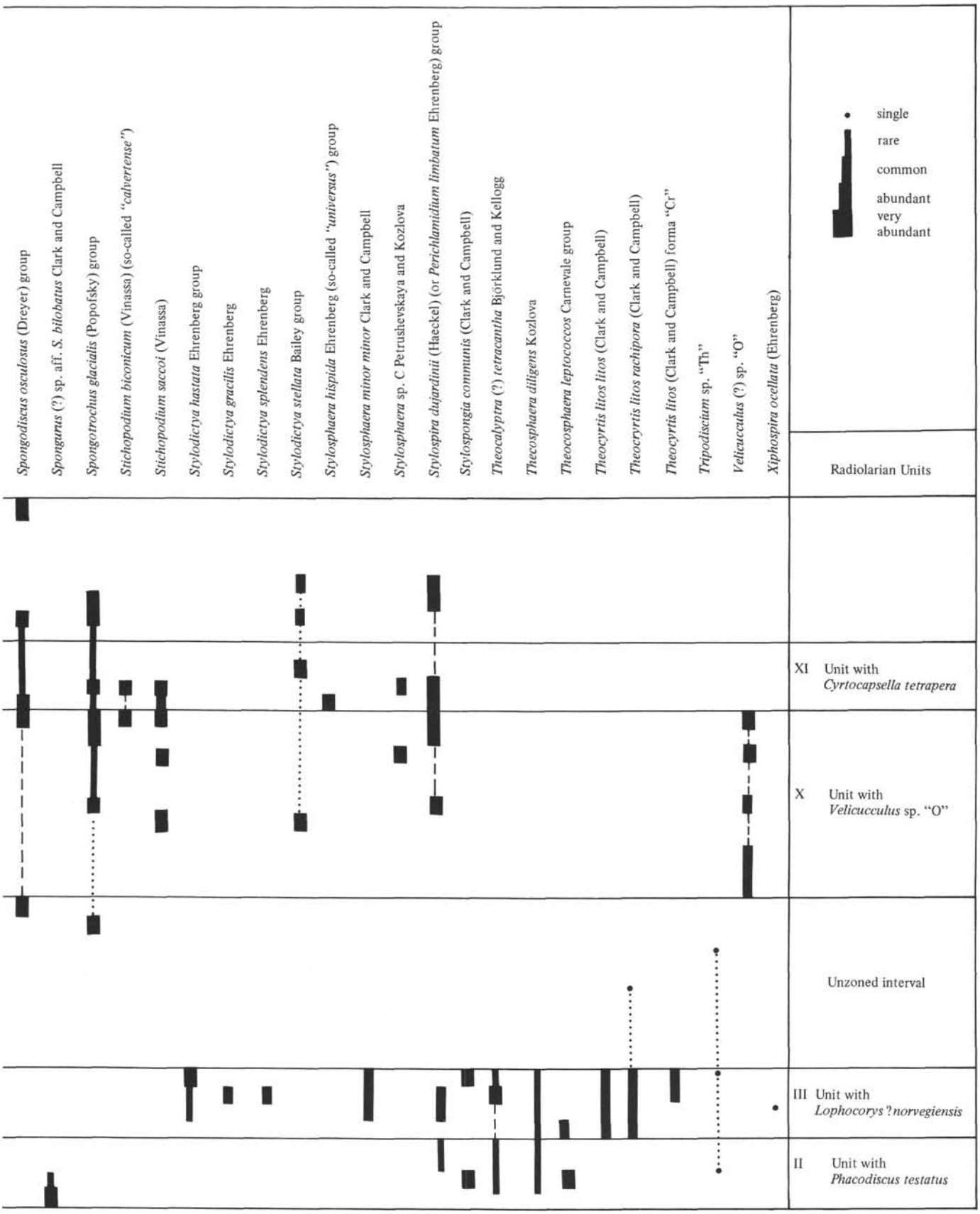

TABLE 9
Diatoms, Silicoflagellates, and Ebridians at Site 339

Diatom Unit	Sample (Interval in cm)	BACILLARIOPHYTA	*Actinoptychus undulatus* (Bail.) Ralfs	*Asterolampra insignis* A.S.	*Biddulphia rutheníca* Witt	*Brightwellia spiralis* Gles.	*Chaetoceros* sp.	*Coscinodiscus argus* Ehr.	*Coscinodiscus bulliens* A.S.	*Coscinodiscus monicae* Grun.	*Coscinodiscus obscurus* A.S. v.*minor* Rattr.	*Coscinodiscus symbolophorus* Grun.	*Coscinodiscus senarius* A.S.	*Coscinodiscus subtilis* Ehr.	*Cosinodiscus* aff. *tenerrimus* Jousé	*Cosinodiscus simbirskianus* A.S.	*Craspedodiscus oblongus* (Grev.) Hanna	*Cymatosira* sp. B	*Eupodiscus oamaruensis* Grun.	*Grunowiella* sp.	*Hemiaulus curvatulus* Streln.	*Hemiaulus hostilis* Heib.	*Hemiaulus polycystinorum* Ehr. v.*polycystinorum*	*Hemiaulus polycystinorum* Ehr. v.*mesolepta* Grun.	*Hemiaulus polymorphus* Grun.	*Hemiaulus tenuicornis* Grev.	*Hemiaulus unicornutus* Brun	*Hemiaulus* sp. 1
	1-3, 97-99 1, CC 2-3, 66-68 3-3, 81-83 3, CC 4-3, 71-72	No diatoms, silicoflagellates, ebridians																										
	7-3, 105-107		5	2		1	1	5	1	1	1	1	2	4	4		1	3			1	2	3	1	5	1	1	
Unit with *Coscinodiscus* aff. *tennerimus*	10-2, 110-112		5	2	1	1		5					5	5	5	1				1		1	1	1	1	1	1	1
	12-3, 100-102		5	2	1			5					5	5	5	1			1	1		1			5	1		2

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TABLE 9 – *Continued*

Hemiaulus sp. 4	*Hemiaulus* sp. 3	*Hemiaulus* sp. 5	*Hercotheca*? sp. (sensu Kanaya, 1957)	*Melosira architecturalis* Brun	*Melosira goretzkii* Tscherem.	*Melosira sulcata* (Ehr. Ktz. v.*crenulata* Grun.	*Muelleriopsis limbata* (Ehr.) Hendey	*Navicula directa* W.Sm.	*Odontotropis carinata* Grun.	*Peponia barbadensis* Grev.	*Periptera tetracladia* Ehr.	*Podosira* aff. *maxima* (Ktz.) Grun.	*Pseudopyxilla temperiana* Forti	*Pseudopyxilla* sp. 3	*Pseudostictodiscus ovetschkinii* Gles.	*Pterotheca aculeifera* Grun.	*Pterotheca clavata* Streln.	*Pterotheca costata* Schibkova	*Raphoneis* sp. 1	*Rhizosolenia* sp. 1	*Rutilaria*? sp.	*Sceletonema* aff. *barbadense* Grev.	*Sceletonema utriculosa* Brun	*Sceptroneis grunowii* Anissimova	*Stephanopyxis barbadensis* Grev.	*Stephanopyxis grunowii* Gr. and St. var.	*Stephanopyxis turris* (Grev. and Arn.) Ralfs v.*arctica* Grun.	*Stephanopyxis turris* (Grev. and Arn.) Ralfs v.*intermedia* Grun.	*Stephanopyxis turris* (Grev. and Arn.) Ralfs v.*cylindrus* Grun.	*Stictodiscus kittonianus* Grev.	*Triceratium barbadense* Grev.	*Triceratium chenevieri* Meister	*Triceratium* sp. 1	*Trinacria excavata* Heib.	*Trinacria excavata* Heib. f.*tetragona* A.S.	*Trinacria subcoronata* Sheshuk. and Gleser	*Trinacria ventricosa* Gr. and St.	*Trinacria ventricosa* Gr. and St. var.	*Trochosira mirabilis* Kitt.	*Trochosira spinosa* Kitt.
1	1	1	4		1	1	3	1	5		2	1	2	4		3	1	1			5	1		1	1	1	5	5	5	2	5	2	4	4	2	1	1		1	2
						1	4		1		1		1		1	1	1	1		1	5	1			2					1				4			1			
2	1		1	1		2	4		1	1			1		1	1		1	1	1	5		1		2	1	1			1		1	1	2			1	1		1

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TABLE 9 – *Continued*

Diatom Unit	Sample (Interval in cm)	*Trochosira trochlea* Hanna	*Xanthiopyxis oblonga* Ehr.	*Xanthiopyxis paduraeformis* Pant.	*Xanthiopyxis umbonata* Grev.	Genus and species indet.	SILICOFLAGELLATAE	*Dictyocha fibula* Ehr. *v.fibula*	*Dictyocha hexacantha* Schulz	*Dictyocha tricantha* Ehr. *v.apiculata* Lemm.	*Dictyocha tricantha* Ehr. *v.apiculata* Lemm. *f.late-radiata* Schulz	*Dictyocha tricantha* Ehr. *v.flexuosa* (Stradner) Gleser	*Dictyocha tricantha* Ehr. *v.hastata* Lemm.	*Dictyocha tricantha* (Ehr.) *v.triacantha*	*Dictyocha spinosa* (Defl.) Gleser	*Distephanus crux* (Ehr.) Hack.	*Mesocena apiculata* (Schulz) Defl.	*Naviculopsis biapiculata* (Lemm.) Freng.var.*minor* (Schulz) Gleser	*Naviculopsis foliacea* Defl.	*Naviculopsis* sp. 1	*Pseudorocella barbadensis* Defl.	EBRIIDEAE	*Ammodochium rectangulare* Schulz	*Ammodochium speciosum* Defl.	*Craniopsis octo* Defl.	*Ebriopsis mesnili* Defl.	*Ebriopsis valida* Defl.	*Micromarsupium anceps* Defl.	*Pseudoammodochium dictyoides* Hov.	PERIDINEAE	*Actiniscus* sp.	Strata
	1-3, 97-99 1, CC 2-3, 66-68 3-3, 81-83 3, CC 4-3, 71-72	No diatoms, silicoflagellates, ebridians																														
	7-3, 105-107	2	1	2	1	1		1		2				1	1	1		1	1	1			1	1	1	1	1	2	3			
Unit with *Coscinodiscus* aff. *tennerimus*	10-2, 110-112	1	2	4	1			2	1	2	1	2	1	1	1		1	2					1	4	4	4	4	4	4			V
	12-3, 100-102	5	2	4	1			2	2	2	1	2	2	4	1		1	1			1		1			2		1	1			

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TABLE 10
Radiolarians at Site 339

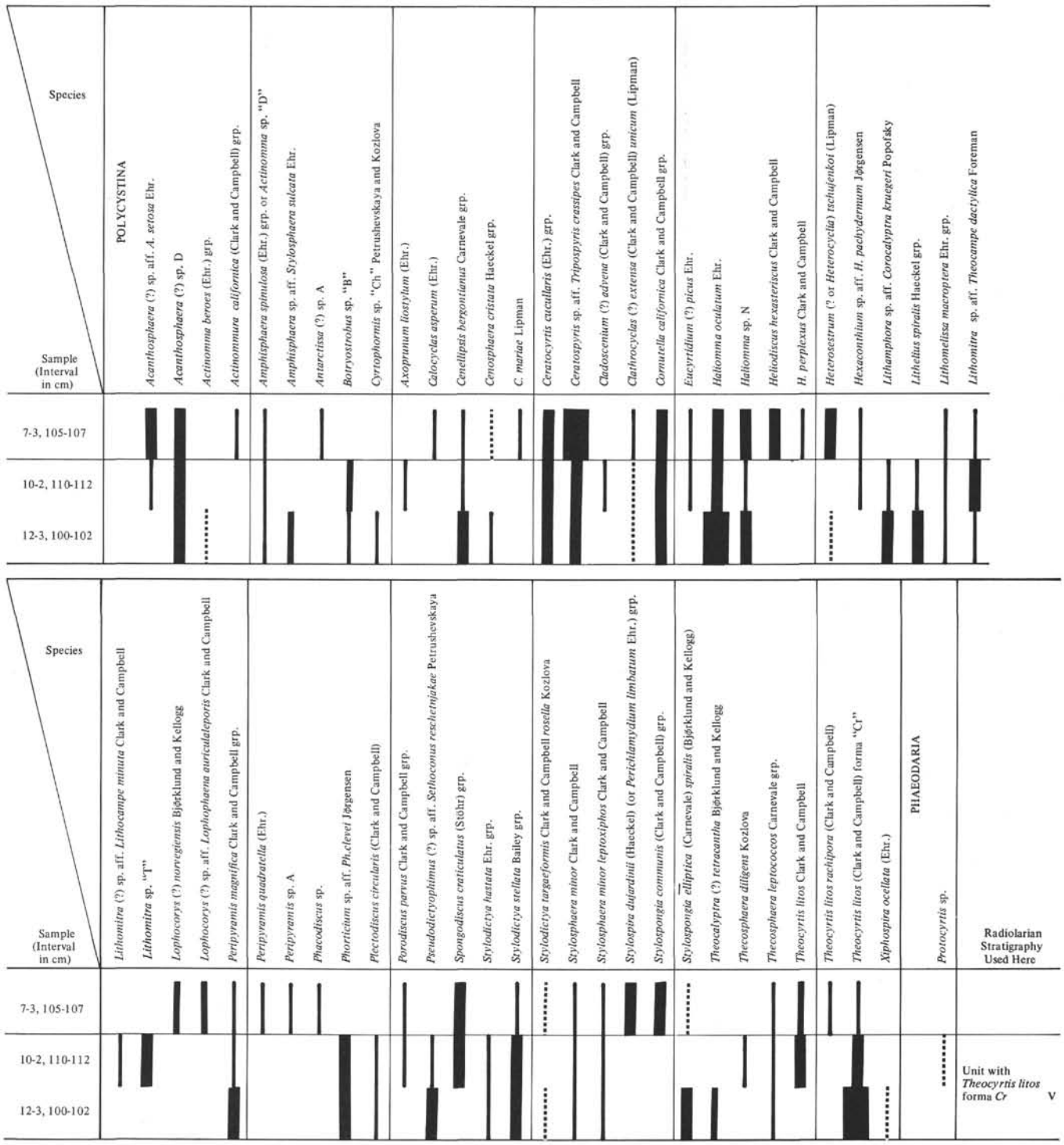

TABLE 11
Diatoms, Silicoflagellates, and Ebridians at Site 340

1 = Single
2 = Rare
3 = Common
4 = Abundant
5 = Very abundant

Diatom Units	Sample (Interval in cm)	Species	BACILLARIOPHYTA	*Actinoptychus undulatus* (Bail.) Ralfs	*Asterolampra insignis* A.S.	*Asterolampra marylandica* Ehr.	*Asterolampra vulgaris* Grev.	*Biddulphia ruthenica* Witt	*Brightwellia* cf. *cornata* (Bright.) Ralfs	*Brightwellia hyperborea* Brun	*Brightwellia imperfecta* Jousé	*Chaetoceros* sp.	*Cladogramma ? cebuense* Grun.	*Coscinodiscus argus* Ehr. (sensu Kanaya, 1957)	*Coscinodiscus asteromphalus* Ehr. v. *hybrida* Grun.	*Coscinodiscus bulliens* A.S.	*Coscinodiscus decrescens* Grun.	*Coscinodiscus decrescenoides* Jousé	*Coscinodiscus debilis* Rattr.	*Coscinodiscus monicae* Grun.	*Coscinodiscus obscurus* A.S. v. *minor* Rattr.	*Coscinodiscus symbolophorus* Grun.	*Coscinodiscus senarius* A.S.	*Coscinodiscus* sp. 1 (aff. *aeginensis* A.S.)	*Craspedodiscus coscinodiscus* Ehr.	*Craspedodiscus oblongus* (Grev.) Hanna	*Cymatosira* sp. B	*Dicladia* (sensu Kanaya, 1957)	*Dicladia* (sensu Kanaya, 1957)	*Endictia oceanica* Ehr.	*Gontothecium odontellum* Ehr.
Unit with *Cymatosira* sp. B	IV	3-3, 110-112		4	1	1	1				1	2	2		2	2	1			1	4	1	4			1	5			1	
		4-3, 30-32		5	1		1								1			1		1	3					1	5				
		4, CC		5	2	1		1			1				4		1			1	1					1	5				
		6-3, 100-102		5	2		1					1			2					1	1					1	5				
		7-6, 120-122		5	1										3			1			1	4	1			1	5				
Unit with *Craspedodiscus oblongus*	III	9-3, 110-112		5	1									1	3			1	1				1	1	1	3		3	1		
		10-3, 130-132		5	1			1						1	3	1	1	1		1				1		2	1		5		
		10, CC		4			1	1				1			5		2	1			2			2		2	1	1			1
		11-3, 110-112		5	1				1						2	1	1	1		1			4	1		2			1		
		11-6, 100-102		5	1					1					2	4	1					1				1			4		1

Diatom Units	Sample (Interval in cm)	Species	*Sceletonema utriculosa* Brun	*Stephanopyxis grunowii* Gr. et St. var.	*Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *arctica* Grun.	*Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *intermedia* Grun.	*Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *cylindrus* Grun.	*Stephanopyxis turris* (Grev. et Arn.) Ralfs var.	*Stictodiscus kittonianus* Grev.	*Triceratium barbadense* Grev.	*Triceratium chenevieri* Meister	*Triceratium condecorum* Bright.	*Trinacria excavata* Heib.	*Trinacria excavata* Heib. f. *tetragona* A.S.	*Trinacria exculpta* (Heib.) Hust.	*Trinacria pileolus* (Ehr.) Heib.	*Trinacria subcoronata* Sheshuk. et Gleser	*Trinacria ventricosa* Gr. et St.	*Trochosira mirabilis* Kitt.	*Trochosira spinosa* Kitt.	*Trochosira trochlea* Hanna	*Xanthiopyxis oblonga* Ehr.	*Xanthiopyxis umbonata* Grev.	Genus et sp. indet.	SILICOFLAGELLATES	*Corbisema quadralta* (Hanna) Defl.	*Dictyocha fibula* Ehr. v. *fibula*	*Dictyocha fibula* Ehr. v. *pentagona* Schulz	*Dictyocha triacantha* Ehr. v. *apiculata* Lemm.	*Dictyocha triacantha* Ehr. v. *inermis* Lemm.	*Dictyocha triacantha* Ehr. v. *apiculata* Lemm. f. *late-radiata* Schulz
Unit with *Cymatosira* sp. B	IV	3-3, 110-112		1	1	5	5		1	5	5		1	1	1				1	5							2		2	1	
		4-3, 30-32		1	1	5	5		1	5	5		1	1						5							1		1		
		4, CC			2	5	5		1		4		2	1	1			1	5		1						1	2	1	1	1
		6-3, 100-102		1	1	5	5		1		2		1	1	1			1		5							1		1	1	1
		7-6, 120-122	1	1	5	5	5		1	5	5		2	1				1		5							1		1	1	
Unit with *Craspedodiscus oblongus*	III	9-3, 110-112	1	2	5	5	5		1			1				1			1			2	1	1		1	1	1			
		10-3, 130-132		1	5	5	5	1	1	2		1	2	1		2			4			2	1			1	1	1			
		10, CC	1		5	5	3		1	1		1	1	5		1		1	4		5	1				1	1	2			
		11-3, 110-112		1	5	5	5		1	1	2	1	1	4		1	1	1	3		1	4	1	2		1	1	1	1		
		11-6, 100-102		2	5	5	5	1	1			1	2	1		1			1	1		4	1				1	1	1		

TABLE 11 – *Continued*

Strata	IV					III				
Goniothecium sp. 1						1	1	1	1	
Goniothecium sp. 2			1			1				
Grunowiella sp.							1	1		
Hemiaulus danicus Grun.	1		1	1	1	1	1	5	1	
Hemiaulus hostilis Heib.			1				1	1		
Hemiaulus klushnikovii Gleser		1	1	1	1					
Hemiaulus longicornis Grev.		1				2	1	1	1	
Hemiaulus polycystinorum Ehr. v. *polycystinorum*		1	1	2		4	1	2		
Hemiaulus polycystinorum Ehr. v. *mesolepta* Grun.	1	1	2	1	1	4	3		2	2
Hemiaulus polymorphus Grun.	5	5	5	5	5	3	1	2	4	1
Hemiaulus tenuicornis Grev.	1	1	1	1	1	1	1	1	1	1
Hemiaulus unicornutus Brun	2	1		1	2	1	1	1	1	
Hemiaulus sp. 1	1	1	1	4	1	5	2	4	4	1
Hemiaulus sp. 4	1	1	2							
Hemiaulus sp. 3	1		1	1	2	1	2	3	1	1
Hemiaulus sp. 5	1	1	1	1						
Hercotheca ? sp. (sensu Kanaya, 1957)	1		1	1		2	4	1	5	5
Janischia antiqua Grun.	1				1					
Melosira architecturalis Brun	1	1	1	1			2	1	1	
Melosira goretzkii Tscherem.						1	1		1	1
Melosira sulcata (Ehr.) Ktz. v. *crenulata* Grun.			1			1	1		1	
Odontotropis carinata Grun.	4	2	4	5	5	3	3		1	4
Omphalotheca californica Hanna	1	1	1			2				
Omphalotheca ? jutlandica Grun.	1					1	1			
Podosira aff. *maxima* (Ktz.) Grun.	4	2	2	2	2		1			
Pseudopodosira wittii (Schulz) Veksch.			1		1			1		1
Pseudopyxilla dubia Grun.										1
Pseudopyxilla rossica Pant.								1	1	
Pseudopyxilla temperiana Forti						2	1		2	1
Pseudopyxilla sp. 3						1	1		1	2
Pseudostictodiscus ovetschkinii Gleser	1	1	1	1	1	1	1		1	1
Pterotheca aculeifera Grun.	3	1	2	1	3	1	4	3	3	
Pterotheca alata Streln.						1	1		1	
Pterotheca carinifera Grun.										1
Pterotheca clavata Streln.					1				1	2
Pterotheca costata Schibkova						1	1		1	
Pterotheca spada Temp. et Brun							1			1
Pterotheca sp. 2	1	1	1	1	1	1	1		1	1
Pyxilla oligocaenica Jousé v. *tenuis* Jousé				1	1		1			1
Pyxilla prolongata Brun				1	1				1	
Rhizosolenia sp. 1	5	5		2	2	2	2		2	2
Sceletonema aff. *barbadense* Grev.	1									
Dictyocha triacantha Ehr. v. *flexuosa* (Stradner) Gleser	1	1			1	1	1	1	1	1
Dictyocha transitoria Defl.		1	1					1		
Dictyocha spinosa (Defl.) Gleser	1		1	1	1	1	1		1	
Distephanus crux (Ehr.) Häck.		1	1	1		1		1	1	
Distephanus speculum (Ehr.) Häck.	1	1		1			1			
Mesocena apiculata (Schulz) Defl.				1	1					
Mesocena oamaruensis Schulz	2	1	2	1	2					1
Naviculopsis foliacea Defl.	3	1	1	1	2	1	1		1	
Naviculopsis sp. 1	2	1	2	1	2	1	1	1	2	1
Naviculopsis sp. 2	2	1	1	1	2					
Naviculopsis biapiculata (Lemm.) Freng. v. *minor* (Schulz) Gleser	1	1	1		1	1		1	1	
EBRIDIANS										
Ammodochium rectangulare Schulz					1		1		1	
Ammodochium speciosum Defl.						1	1			
Ebriopsis mesnili Defl.	2	1		1	1	1	1		1	1
Micromarsupium anceps Defl.					1		1		1	
Pseudoammodochium dictyoides Hov.	1	1		1	1	1	2		1	1
ARCHAEMONADES										
Litharchaeocystis costata Defl.	1					1	1		1	1
PERIDINIANS										
Peridinium sp.	1				1					

TABLE 12
Radiolarians at Site 340

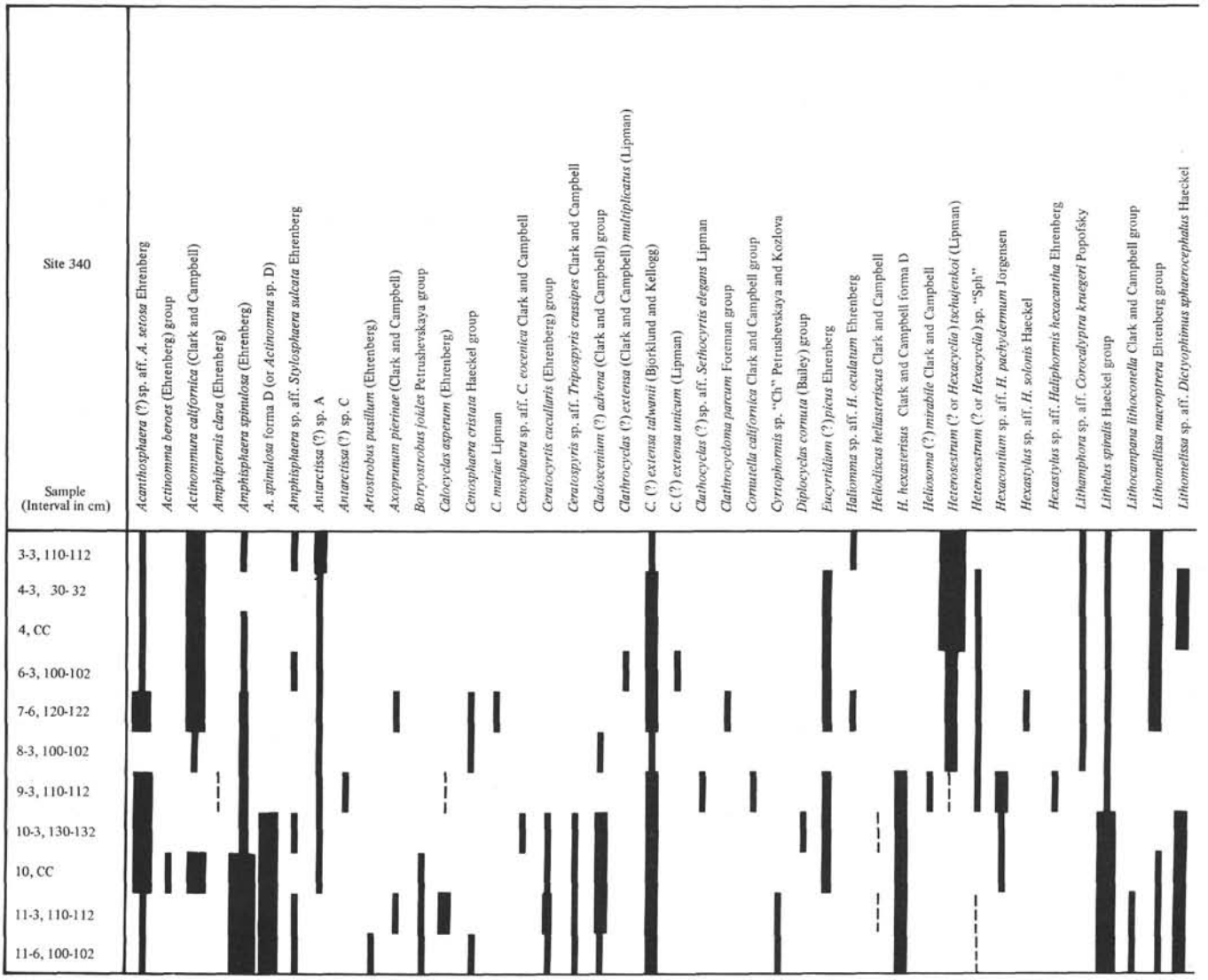

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TABLE 12 – *Continued*

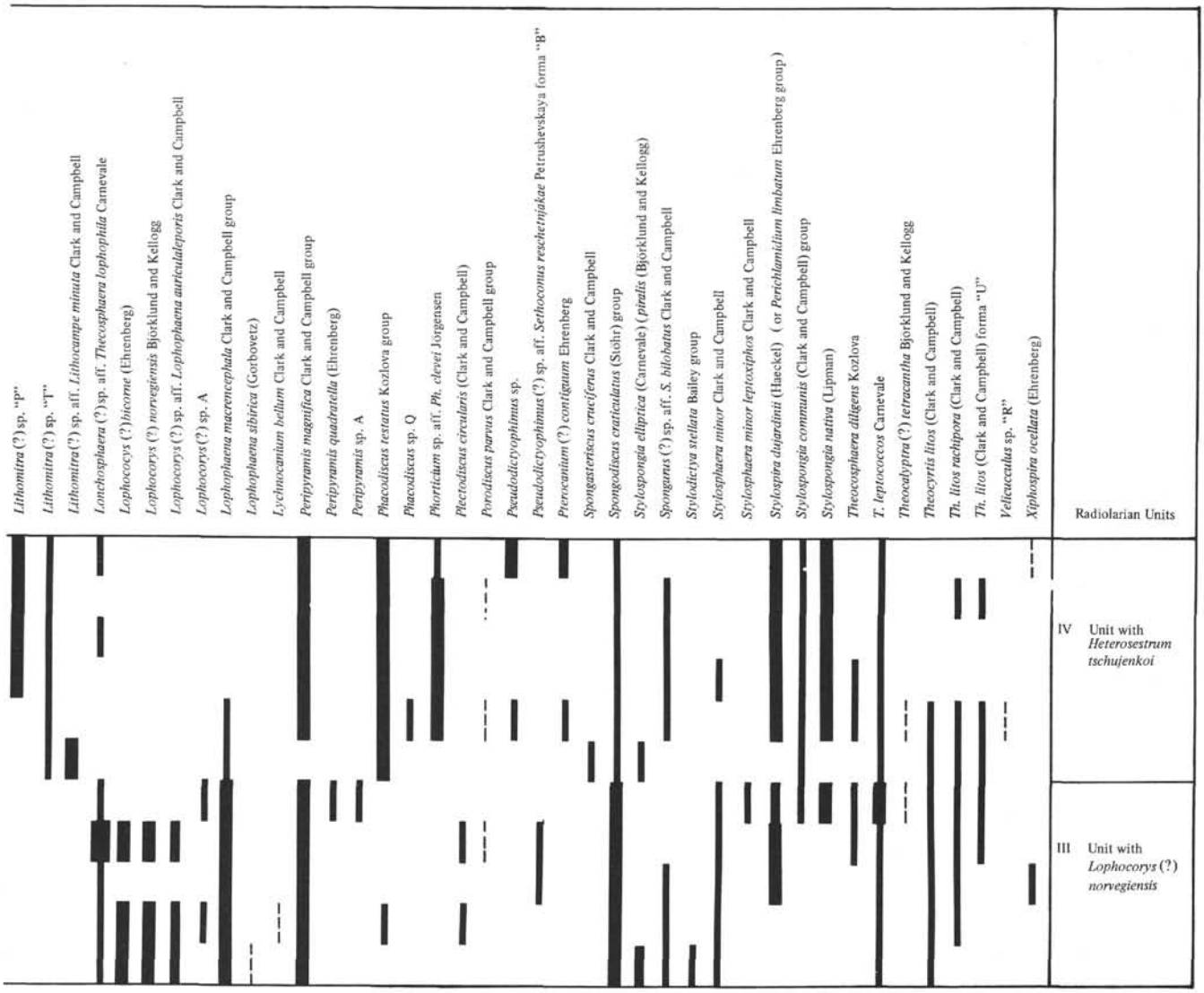

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TABLE 13
Diatoms at Site 342

Sample (Interval in cm)	Diatoms: *Actinocyclus divisus* (Grunow) Hustedt	*A. ehrenbergii* var. *tenellus* (Breb.) Hustedt	*A. ingens* Rattr.	*Biddulphia aurita* (Lyngb.) Breb. and Godey	*B. tuomeyi* (Bail.) Roper	*Chaetoceros cinctus* Gran	*Ch. furcellatus* Bail.	*Ch. pliocenus* Brun.	*Coscinodiscus* aff. *asteromphalus* Ehr.	*C. marginatus* Ehr.	*C. nitidus* Gregory	*C. obscurus* A.S.	*C. oculus-iridis* Ehr.	*C. symbolophorus* Grun.	*C. lewisianus* Grev.	*Cymatosira savtchenkoi* Pr.-Lavr.	*Goniothecium decoratum* Brun	*Grunoviella* sp.	*Hemiaulus polymorphus* Grun.	*Kisseleviella carina* Sheshuk.	*Melosira ornata* Grun.	*Peripteria tetracladia* Ehr.	*Pseudopodosira hyalina* Jousé	*P. westii* (W. Sm.) Sheshuk.	*P. wittii* (Schulz) Vekshina	*Pseudopyxilla americana* (Ehr.) Forti	*Pterotheca aculeifera* (Ehr.) Forti	*Rhaphoneis amphiceros* Ehr.	*Stephanogonia polyacantha* Forti	*Stephanopyxis* sp.	*S. corona* (Ehr.) Grun.	*S. marginata* Grun.	*Stephanopyxis turris* (Grev. and Arn.) Ralfs	*S. turris* var. *arctica* Grun.	*S. turris* var. *cylindrus* Grun.	*Thalassionema nitzschioides* Grun. var. *nitzschioides*	*Th. nitzschioides* var. *parva* Heid. and Kolbe	*Trinacria excavata* Heib.	*Xanthiopyxis* sp.	*X. specticularis* Hanna	*X. oblonga* Ehr.	Stratigraphy Used Here
1-3, 70-77																																										
1-6, 88-90																																1					1			1			
2-3, 100-102																																											
3-3, 100-102	2		1				2			2	2			1				1	2	1	1	1	2	2		2	1		2	1	1	2	3	2		3	2	1				?
5-3, 110-112	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3				3			3	3	3	3	3	3			3	3	5	5			3	3	IX-XI
5-6, 80-82	3	3	3	3			3	3	3	3		3	3	3	3	3	3	3							3				3	3				3	3	5	5	3				
6-3, 70-72		2	2				2		2	2			2		2		2					3	2	3		2		2	3	3	3	2			3					2	3	

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TABLE 14
Total Number of Diatoms per 1g of Dry Sediments and Percentage of the Selected Species at Site 342

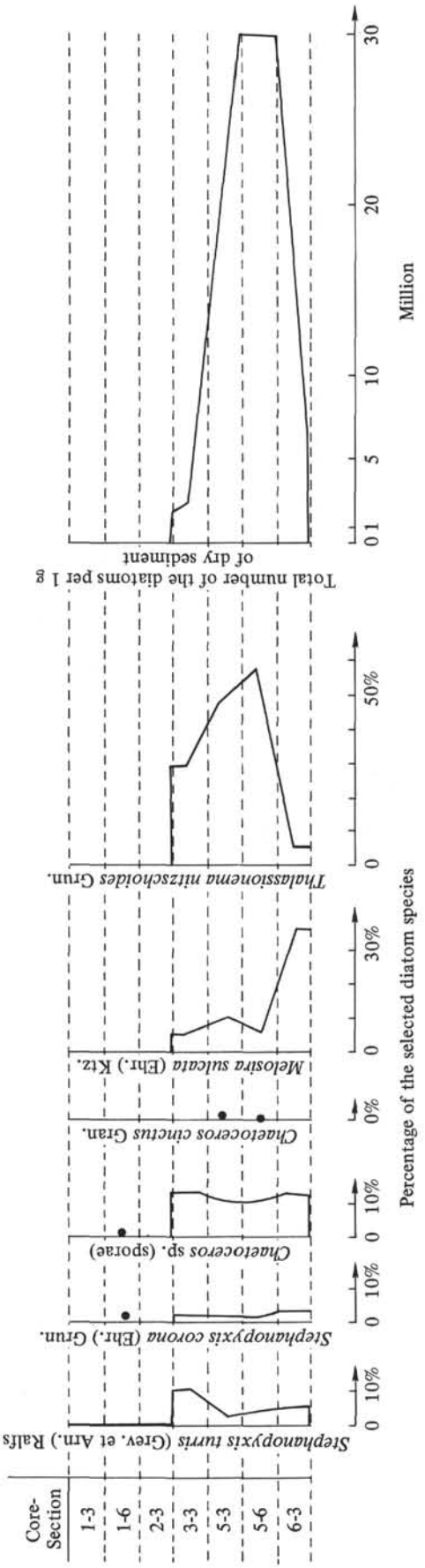

TABLE 15
Diatoms, Silicoflagellates, and Ebridians at Site 343

1 = Single
2 = Rare
3 = Common
4 = Abundant
5 = Very abundant

Diatom Units		Sample (Interval in cm)	Species	BACILLARIOPHYTA	*Actinoptychus undulatus* (Bail.) Ralfs	*Actinocyclus ehrenbergii* Ralfs v. *intermedia* Grun.	*Brightwellia hyperborea* Grun.	*Chaetoceros* sp.	*Coscinodiscus* aff. *asteroides* Truan et Witt	*Coscinodiscus decrescens* Grun.	*Coscinodiscus decrescens* Grun. v. *polaris* Grun.	*Coscinodiscus marginatus* Ehr.	*Coscinodiscus monicae* Grun.	*Coscinodiscus obscurus* A.S. v. *minor* Rattr.	*Coscinodiscus princeps* Jousé	*Coscinodiscus spiniferus* (Gr.et St.) Grun.	*Craspedodiscus oblongus* (Grev.) Hanna	*Cymatogonia amblyocerus* (Ehr.) Hanna	*Cymatosira* sp. B	*Dicladia pylea* Hanna et Grant	*Dicladia* (sensu Kanaya, 1957)	*Epithelion lanigerum* Meister	*Goniothecium odontellum* Ehr.	*Gyrodiscus vortex* Pant.	*Hemiaulus elegans* (Heib.) Grun.	*Hemiaulus polycystinorum* Ehr. v. *polycystinorum*	*Hemiaulus polymorphus* Grun.	*Hemiaulus* sp. 3	*Hercotheca ?* sp. (sensu Kanaya, 1957)	*Janischia antiqua* Grun.	*Melosira architecturalis* Brun	*Melosira goretzkii* Tscherem.
		1-3, 97-99 2-3, 39-41 3-3, 108-110 3-6, 105-110 4-3, 90-92		No diatoms, silicoflagellates, ebridians																										
		5-3, 50-52			1	1						1	1	1	1	1	2	1	1	1	1	1	1		1	1	3	1		1	1
Unit with *Pyxilla oligocaenica*	I	5-6, 90-92					1	1	3	4	4		1								2	4	1	1			1	4	1		1
		7-3, 40-42 8-3, 105-107 15-1, 105-107		No diatoms, silicoflagellates, ebridians																										

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TABLE 15 – *Continued*

Diatom Units	Sample (Interval in cm)	*Melosira sulcata* (Ehr.) Ktz. v. *sulcata*	*Melosira sulcata* (Ehr.) Ktz. v. *crenulata* Grun.	*Odontotropis carinata* Grun.	*Odontotropis danicus* Debes	*Pantocsekia clivosa* Grun.	*Periptera tetracladia* Ehr.	*Pseudopyxilla dubia* Grun.	*Pseudopyxilla temperiana* Forti	*Pseudostictodiscus angulatus* Grun.	*Pseudostictodiscus ovetschkinii* Gles.
	1-3, 97-99 2-3, 39-41 3-3, 108-110 3-6, 105-110 4-3, 90-92	No diatoms, silicoflagellates, ebridians									
	5-3, 50-52	1				1		1			
Unit with *Pyxilla oligocaenica* I	5-6, 90-92	1	1	5	1		1	1	1	1	1
	7-3, 40-42 8-3, 105-107 15-1, 105-107	No diatoms, silicoflagellates, ebridians									

Sample (Interval in cm)	*Pterotheca alata* Streln.	*Pterotheca carinifera* Grun.	*Pterotheca costata* Schibkova	*Pterotheca mayor* Jousé	*Pyxilla oligocaenica* Jousé v. *oligocaenica*	*Pyxilla oligocaenica* Jousé v. *tenuis* Jousé	*Rhizosolenia* sp. 1	*Rhizosolenia calcaravis* M. Schultze	*Sceletonema utriculosa* Brun	*Stephanopyxis corona* (Ehr.) Grun.
5-3, 50-52		1	1			2	1	1	1	1
5-6, 90-92	1	2	1	4	4	4				

Sample (Interval in cm)	*Stephanopyxis edita* Jousé	*Stephanopyxis grunowii* Gr.et St.	*Stephanopyxis megapora* Grun.	*Stephanopyxis permarginata* Grove	*Stephanopyxis* aff. *pediastriformis* Forti	*Stephanopyxis turris* (Grev.et Arn.) Ralfs v. *arctica* Grun.	*Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *intermedia* Grun.	*Stephanopixis turris* (Grev.et Arn.) Ralfs v. *cylindrus* Grun.	*Triceratium barbadense* Grev.	*Triceratium basilica* Brun	*Triceratium chenevieri* Meister	*Triceratium* sp. 1	*Trinacria excavata* Heib.	*Trinacria subcoronata* Sheshuk. et Gleser	*Xanthiopyxis oblonga* Ehr.
5-3, 50-52	1	2	1	1	4		5	5	1		1	2	1		1
5-6, 90-92	3	5	1		3	5	5	5		1	1			5	

Sample (Interval in cm)	SILICOFLAGELLATES: *Dictyocha frenguellii* Defl. v. *frenguellii*	*Dictyocha fibula* Ehr. v. *fibula*	*Dictyocha spinosa* (Defl.) Gles.	*Dictyocha triacantha* Ehr. v. *apiculata* Lemm.	*Distephanus antiquus* Gles.	*Distephanus crux* (Ehr.) Häck.	*Distephanus speculum* (Ehr.) Häck.	*Mesocena oamaruensis* Schulz	*Naviculopsis biapiculata* (Lemm.) Freng. v. *biapiculata*	*Naviculopsis biapiculata* (Lemm.) Freng. v. *minor* (Schulz) Gles.
5-3, 50-52	1	1			1	1	1	1	1	1
5-6, 90-92		1	1	1	2	1	2	1		1

Diatom Units	Sample (Interval in cm)	EBRIDIANS: *Ammodochium speciosum* Defl.	*Ebriopsis mesnili* Defl.	*Pseudoammodochium dictyoides* Hov.	*Pseudoammodochium sphaericum* Hov.	ARCHAEMONADES: *Litharchaeocystis costata* Delf.	PERIDINIANS: *Actiniscus* sp.	Strata
	1-3, 97-99 2-3, 39-41 3-3, 108-110 3-6, 105-110 4-3, 90-92							
	5-3, 50-52		1	1	1		1	?
Unit with *Pyxilla oligocaenica* I	5-6, 90-92	2	3	2	1	1		I
	7-3, 40-42 8-3, 105-107 15-1, 105-107							?

TABLE 16
Radiolarians at Site 343

Species / Sample (Interval in cm)	5-3, 56-57	5-6, 90-92
Actinommura (?) *californica* (Clark and Campbell)	■	
Amphisphaera (?) sp. aff. *Crommyodruppocarpus esterae* Campbell and Clark	■	■
Amphisphaera spinulosa (Ehr.) grp.	■	
Antarctissa (?) sp. B	■	■
Antarctissa (?) sp. C	■	■
Artostrobus (?) *pusillum* (Ehr.)	■	
Axoprunum liostylum (Ehr.)	■	
Botryostrobus joides Petrushevskaya grp.	■	
Cenosphaera mariae Lipman	■	
Ceratocyrtis cucullaris (Ehr.) grp.	■	
Ceratospyris sp. aff. *Tripospyris crassipes* Clark and Campbell	■	
Cladoscenium(?) *advena* (Clark and Campbell)	■	■
Clathrocyclast(?) *extensa* (Clark and Campbell) *multiplicatus* (Lipman)	■	■
Clathrocyclas (?) *extensa* (Clark and Campbell) *talwanii* (Bjørklund and Kellogg)	■	
Clathrocyclas (?) *extensa* (Clark and Campbell) *tamdiensis* Lipman	■	■
Clathrocyclas (?) *extensa* (Clark and Campbell) *unicum* Lipman		■
Clathrocycloma parcum Foreman grp.	■	■
Cornutella californica Clark and Campbell grp.	■	
Eucyrtidium (?) *cubense* Riedel and Sanfilippo grp.	■	
Eucyrtidium picus Ehr.	■	■
Haliomma(?) sp. E		■
Heliodiscus heliastericus Clark and Campbell	■	
Heliodiscus perplexus Clark and Campbell	■	
Heterosestrum (? or *Hexacyclia*) *tschujenkoi* (Lipman)	■	
Hexaconthium sp. aff. *H. pachydermum* Jørgensen	■	
Lithamphora sp. aff. *Corocalyptra kruegeri* Popofsky	■	
Lithelius spiralis Haeckel grp.	■	
Lithocampana lithoconella Clark and Campbell grp.	■	
Lithomelissa macroptera Ehrenberg grp.	■	

TABLE 16 – *Continued*

Species / Sample (Interval in cm)	5-3, 56-57	5-6, 90-92
Lithomitra (?) sp. aff. *Lithocampe minuta* Clark and Campbell	■	
Lithomitra (?) sp. P	■	
Lithomitra (?) sp. T	■	
Lophocorys (?) *norvegiensis* Bjørklund and Kellogg	■	
Lophophaena macrencephala Clark and Campbell grp.	▮	▮
Lophophaena sibirica (Gorbovetz)	▮	■
Peripyramis quadratella (Ehr.)	▮	
Peripyramis sp. A	▮	
Phacodiscus sp. Q	▮	■
Plectodiscus circularis (Clark and Campbell)	▮	
Plectodiscus(?) *nitidus* (Sanfilippo and Riedel)	▮	
Porodiscus concentricus (Ehr.)	▮	
Pseudodictyophimus (?) sp. aff. *Sethoconus reschetnjakae* Petrushevskaya	▮	
Spongodiscus craticulatus (Stöhr)	▮	
Spongocyclia ellipticus (Carnevale) *spiralis* Bjørklund and Kellogg	▮	
Spongotrochus sp. aff. *paciferum* (Lipman)	▮	
Spongurus sp. aff. *S. bilobatus* Clark and Campbell	▮	
Stylosphaera minor Clark and Campbell	▮	
Stylosphaera minor leptoxiphos Clark and Campbell	▮	
Theocalyptra(?) *tetracantha* Bjørklund and Kellogg	▮	▮
Thecosphaera diligens Kozlova	▮	
Thecosphaera leptococcos Carnevale	▮	
Theocyrtis lithos (Clark and Campbell) forma A	▮	▮
Tripodiscium (?) sp. aff. T. *tumulosa* (Kozlova)	■	■
Xiphospira ocellata (Ehr.)	■	■
Radiolarian Stratigraphy	? ?	I Unit with *Tripodiscium* (?) *tumulosa*

TABLE 17
Diatoms at Site 346

Sample (Interval in cm)	Bacillariophyta: *Actinocyclus ehrenbergii* var. *tenellus* (Bréb) Hust.	*Actinoptychus undulatus* Ralfs	*Biddulphia tuomey* (Bail.) Roper	*Chaetoceros* sp. (spores)	*Chaetoceros cinctus* Gran	*Chaetoceros furcellatus* Bail.	*Cocconeis interrupta* Grun.	*Cocconeis scutellum* Ehr.	*Coscinodiscus marginatus* Ehr.	*Coscinodiscus symbolophorus* Grun.	*Coscinodiscus subtilis* Ehr.	*Cosmiodiscus insignis* Jousé	*Cyclotella comta* var. *paucipunctata* Grun.	*Diploneis elliptica* (Ktz.) Cl.	*Eunotia* sp.	*Goniothecium tenue* Brun	*Goniothecium decoratum* Brun	*Grammatophora oceanica* (Ehr.) Grun.	*Grunowiella* sp.	*Hemiaulus plicatus* Sheshukova	*Hemiaulus polymorphus* Grun.	*Hyalodiscus* sp.	*Kisseleviella carina* Sheshukova	*Melosira albicans* Sheshukova	*Melosira polaris* Grun.	*Melosira sulcata* (Ehr.) Ktz.	*Melosira sulcata* var. *crenulata* Grun.	*Melosira sulcata* var. *siberica* Grun.	*Melosira praegranulata* Jousé	*Navicula distans* W. Sm.	*Navicula lyra* var. *ehrenbergii* Cl.	*Nitzschia cocconeiformis* Grun.	*Opephora marina* (Greg.) Petit	*Pseudopodosira wittii* (Schulz) Vekschina	*Pseudopodosira westii* (W. Sm.) Sheshukova and Gleser	*Pseudotriceratium radioso-reticulatum* Grun.	*Pseudopyxilla americana* (Ehr.) Forti
1-4, 105-107	No diatoms																																				
1-5, 120-122																																					
2-1, 65-67																			1			1					1	1									
3-1, 120-122																																					
3-4, 140-142				1						1		1							1			1		1			1	2		1			1				
4-2, 120-122			1	1						1									1		1	1				1	1	1									
4-4, 130-132				2					1	2		1	1						1		1					2		2									
5-1, 85-87	1			3					1			1							1								1	2		1	1		1	1			2
5-3, 85-87		1		5				1									1		2						1		2	2	3				4				
6-2, 120-122				3		2				2						2	2	1	1		1	1	1		1			2					3				
6-4, 110-112				2			1									1	1		1			1						1				1	1	1	1		
7-3, 30-32	2	1		3		2											2					1	1					3	2				1		1		
7-3, 120-122			1	3			1			1					1		1	1	2	1	1	2		1			2	3	2				1	1	2	1	1
8-2, 95-97																			1							1		1					1				
8-5, 20-22																																					
9-2, 120-122					2																																
9-5, 120-122		1	1	3		2	1	1		1					1		2	2	1	1			2		1			2	1					1			2
10-1, 110-112				4	3	2							2				3		1				3					3	3				3				
10-3, 35-37				3	2					1		1					3						1	1		1		1					2				
11-2, 120-122				4	2	2					1					2	3	2					3	2			1	2					2				
11-4, 90-92				2			1										2	1			1		1	1				2	1				2	1			
12-1, 90-92			1	2									1	1				1	1		1	1		1		1							1		1		
12-3, 95-97																										1								1	1		
13-1, 110-112	No diatoms																																				
14-2, 72-74																																					
14-3, 62-64																																					
15-3, 139-141																																					
16-2, 133-135																																					
17-3, 106-108																																					
18-1, 75-77																																					
19-2, 41-43																																					
20-1, 97-99																																					
20-2, 45-47																																					

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TABLE 17 – *Continued*

Pterotheca spada Tempere and Brun	*Pterotheca aculeifera* Grun.	*Pterotheca uralica* Jousé	*Raphoneis amphiceros* Ehr.	*Raphoneis lancettula* Grun.	*Rhizosolenia* sp.	*Rhizosolenia* sp. (Schrader, 1973)	*Stephanopyxis marginata* Grun.	*Stephanopyxis barbadensis* Grev.	*Stephanopyxis lavrenkoi* Jousé	*Stephanopyxis turris* (Grev. and Arn.) Ralfs	*Stephanopyxis turris* var. *arctica* Grun.	*Stephanopyxis turris* var. *cylindrus* Grun.	*Thalassionema nitzschioides* Grun.	*Xanthiopyxis panduraeformis* Forti	*Xanthiopyxis* sp.	*Xanthiopyxis oblonga* Ehr.	Polycystine Radiolarians	Strata
																		?
				1		1				1			1				Practically no radiolarians	
						1				1	1		1					? XI
	1				1				2	2	1		1	1	1	1		
	2	1			1	1	1				2	2	1		1	2	f c r c c f c c f f f c r	X *Velicucculus*
	2					3						3	1	2		2	c c c r	sp. O Unit
	1					1	1	2							2	2		
	1							2	1		1				1	1		
1	1					2		3			2			1	1			
	1		1	1				2		1		2	2		1	1		
													1					
																	Practically no radiolarians	IX *Goniothecium decoratum*
	2	2		1	2		3						2	2	1	2		
	2				3	1	1						2	2		3		
	2						3			1								
	2			1	3		2				2			2				
	1			1	1		3					1	1			1		
	1						2						1			1		?
							1									1	No radiolarians	
																		?

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TABLE 18
Total Number of Diatoms per 1g of Dry Sediment and Percentage of the Selected Diatom Species

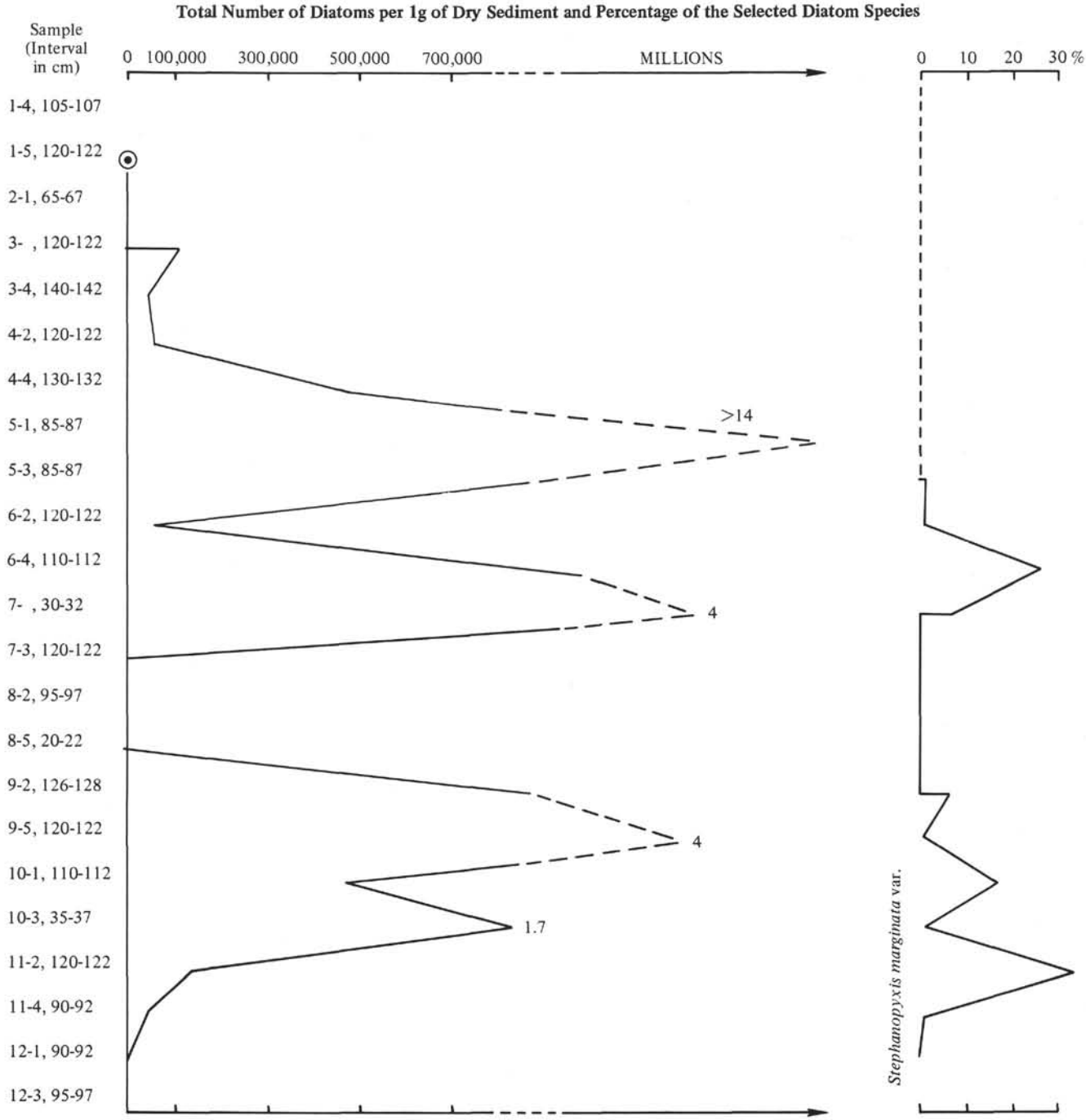

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TABLE 18 – *Continued*

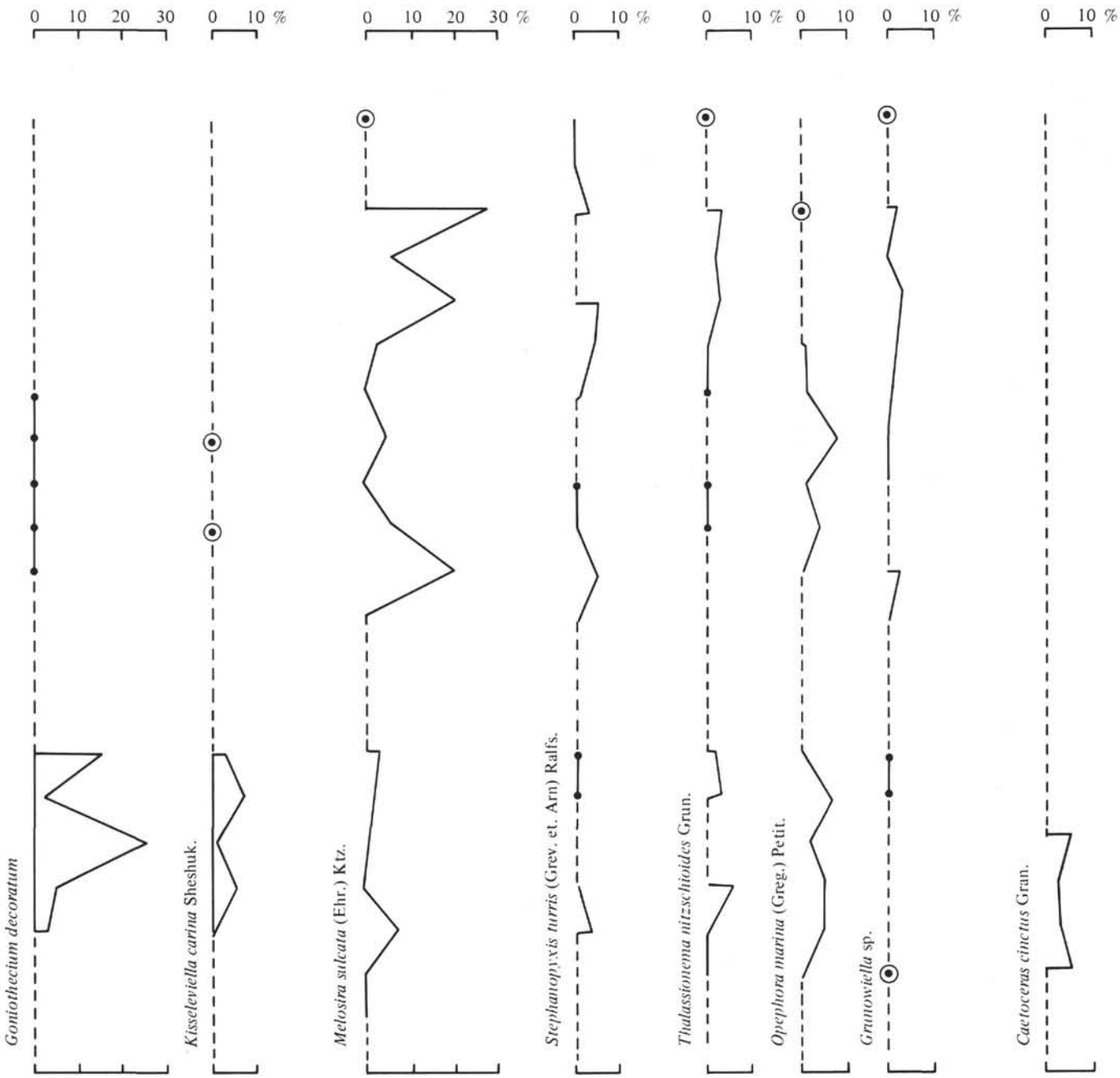

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TABLE 19A
Diatoms, Silicoflagellates, and Ebridians at Site 348

MARINE DIATOMS

BACILLARIOPHITAE

Diatom Units	Sample (Interval in cm)	*Actinocyclus divisus* (Grun.) Hust.	*A. ehrenbergii* Ralfs.	*A. ellipticus* Grun.	*A. ingens* Rattr.	*A. oculatus* Jousé	*Actynoptychus undulatus* (Bail.) Ralfs	*A. vulgaris* Schum.	*Asteromphalus robustus* Castr.	*Aulicus coelatus* Bail.	*Bacterosira fragilis* Gran	*Biddulphia aurita* (Lyngb.) Bréb. and Godey	*Chaetoceros affinis* Laud.	*Ch. cinctus* Gran	*Ch. furcellatus* Bail.	*Ch. capreolus* Ehr.	*Ch. subsecundus* (Grun.) Hust.	*Chaetoceros* sp. 1	*Chaetoceros* spp.	*Cladogramma ellipticum* Lohman	*C. dubium* Lohman	*Cocconeis formosa* Brun.	*C. scutellum* Ehr.	*C. vitrea* Brun.
Pleistocene	1-1, 115-117								1															
	2-1, 135-137		1				1						1										1	
	5-3, 60-62	1																	1					
Unit with *Thalassiosira zabelinae*	6-1, 140-142	1					1				1		1											
	7-1, 130-132	2			1	1		1				1				1	1							
	8-3, 128-130		1										1		1			1						
Denticula hustedtii Zone	11-1, 120-122	1	1				1		1	1		1	4	1	1	3	1	2	6			1	1	
	12-3, 135-137	1	1	1	1		2					1	1	1		3	1	3	6		1	1	1	
	13-2, 130-132		1				2						1	1		3	1	2	4		1		1	1
	14-3, 125-127		1		1		2						1	1	1		1	1	3	1				
	15-3, 105-107		1		1		2		1			1	1	2		2	2	5	5					
	16-1, 70-72				1		1										4	1	5					
	19, CC																							

Diatom Units	Sample (Interval in cm)	*Coscinodiscus asteromphalus* Ehr.	*C. convexus* Greg.	*C. curvatulus* Grun.	*C. denarius* A.S.	*C. endoi* Kanaya	*C. lacustris* Ehr.	*C. plicatus* Grun. group	*C. lineatus* Ehr.	*C. marginatus* Ehr.	*C. marginatus* f. *fossilis* Jousé	*C. obscurus* A.S.	*C. oculus-iridi* Ehr.	*C. rhothii* (Ehr.) Grun.	*C. rhotii* var. *planus* Sheshukova	*C. radiatus* Ehr.	*C. paleaceus* (Grun.) Rattr.	*C. perforatus* Ehr.	*C. symbolophorus* Grun.	*Cymatosira savtchenkoi* Pr.-Lavr.	*Cosmiodiscus insignis* Jousé	*C. intersectus* (Brun.) Jousé	*Denticula hustedtii* Simonsen and Kanaya	*D. punctata* Schrader
Pleistocene	1-1, 115-117			1	1					2						2								
	2-1, 135-137						1					1				1								
	5-3, 60-62	1								1														
Unit with *Thalassiosira zabelinae*	6-1, 140-142						1				2				1							1		
	7-1, 130-132			1	1					2				1					1					
	8-3, 128-130									2						1								
Denticula hustedtii Zone	11-1, 120-122			1				2	1	1					1								3	
	12-3, 135-137	1					1	2		1							1			1			3	
	13-2, 130-132	1		1	1	1		2	1	1				1		1			1	1			3	
	14-3, 125-127		1					1	1	1	1											1	3	
	15-3, 105-107		1					2	1	1		1	1		1	1		1	1	1			3	
	16-1, 70-72														1	1							3	1
	19, CC																							

TABLE 19A – *Continued*

Diatom Units	Sample (Interval in cm)	*D. seminae* Simonsen and Kanaya	*Goniotecium odontella* Ehr.	*G. tenue* Brun.	*Grammatophora angulosa* Ehr.	*G. arcuata* Ehr.	*G. robusta* Ehr.	*Grunowiella gemmata* (Grun.) V. H.	*Hemiaulus* aff. *polymorphus* Grun.	*Hemidiscus cuneiformis* Wall.	*Hyalodiscus dentatus* O.Korotk.	*H. obsoletus* Sheshukova	*H. frenguellii* Hanna	*H. scoticus* (Kütz.) Grun.	*Kisseleviella carina* Sheshukova	*Lyradiscus bipolaris* Lohman	*Mediaria splendida* Sheshukova	*Melosira abbiacans* Sheshukova	*M. polaris* Grun.	*M. sulcata* (Ehr.) Kütz.	*Muelleriopsis limbata* (Ehr.) V.H.	*Navicula hennedyi* var. *luxuosa* A.Cl.	*Nitzschia extincta* Kozyrenko et Sheshukova	*N. fossilis* (Freng.) Kanaya
Pleistocene	1-1, 115-117																			1				
	2-1, 135-137																							
	5-3, 60-62																			1				
Unit with *Thalassiosira zabelinae*	6-1, 140-142	1									1									2				
	7-1, 130-132											1								2				
	8-3, 128-130	1																		1				
Denticula hustedtii Zone	11-1, 120-122			1	1	1		1	1	1		1	1	1			1	1	1	2			3	1
	12-3, 135-137			1	1	1			1			1		1					1	1			1	
	13-2, 130-132			1			1					1				1				2			1	
	14-3, 125-127			3				1	1								1			1			3	
	15-3, 105-107		1	3	1				1						1		1	1		1		1	2	1
	16-1, 70-72			4	1																		1	1
	19, CC																							

Diatom Units	Sample (Interval in cm)	*N. porteri* Freng.	*Nitzschia* sp. 1	*Periptera tetracladia* Ehr.	*Porosira glacialis* (Grun.) Jörg.	*Pseudopodosira elegans* Sheshukova	*P. hyalina* Sheshukova	*P. simplex* (Jousé) Strelnikova	*Pseudopyxilla americana* (Ehr.) Forti	*P. rossica* (Pant.) Forti	*Pterotheca kittoniana* var. *kamtschatica* Gaponow	*P. reticulata* Sheshukova	*Raphoneis amphiceros* Ehr.	*R. amphiceros* var. *gemmifera* f. *hasta* A.Cl.	*R. angustata* Pant.	*R. margaritalimbata* Mertz.	*R. meotica* (Milovanova)	*Raphoneis* sp. 1	*Raphoneis* sp. 2	*Rhabdonema arcuatum* (Lyngb.) Kütz.	*Rhizosolenia alata* Brightw.	*Rh. barboi* Brun.	*Rh. hebetata* f. *hiemalis* Gran.	*Rh. miocenica* Schrader
Pleistocene	1-1, 115-117					1																	1	
	2-1, 135-137																			1				
	5-3, 60-62				1																1		1	
Unit with *Thalassiosira zabelinae*	6-1, 140-142		1								1				1							1	4	
	7-1, 130-132		2		3						1		1	1							1	4	4	1
	8-3, 128-130				1						1		1									1	1	
Denticula hustedtii Zone	11-1, 120-122						1		1	1	3	1		1	1					1				
	12-3, 135-137	1		1		1		2	1	1	2	1	1		1	2			1					
	13-2, 130-132	1		2			1	2	1	1	2	1			1						1	1	2	
	14-3, 125-127			1		1					1	2		1			1			1	1	1	1	
	15-3, 105-107	1		1	1			1	1	1	1	3					1	1	1			1	1	1
	16-1, 70-72			1					1		2	4						1				1	1	
	19, CC																							

TABLE 19A – *Continued*

Diatom Units	Sample (Interval in cm)	*Rh. setigera* Brightw.	*Rh. styliformis* Brightw.	*Rhizosolenia* sp. 1	*Roperia tesselata* (Roper) Grun.	*Rouxia pergalloi* var. *californica* (Perag.) Sheshukova	*Stephanogonia polygona* Ehr.	*Stephanopyxis inermis* Jousé	*S. schenkii* Kanaya	*S. turris* (Grev. and Arn.) Ralfs	*S. turris* var. *cylindrus* Grun.	*S.* aff. *barbadensis* (Grev.) Grun.	*Synedra jouseana* Sheshukova	*S. jouseana* f. *linearis* Sheshukova	*Thalassionema-nitzschioides* Grun.	*T. nitzschioides* var. *obtusum* Grun.	*Thalassiosira antiqua* A.Cl.	*Th. decipiens* (Grun.) Jörg.	*Th. excentrica* (Ehr.) Cl.	*Th. gravida* Cl.	*Th. gravida* f. *fossilis* Jousé	*Th. hyalina* (Grun.) Gran.	*Th. kryophila* (Grun.) Jörg.	*Th. nativa* Sheshukova	*Th. nidulus* (Temp. and Brun) Jousé	*Th. nordenskiöldii* Cl.	*Th. oestrupii* (Ostf.) Proschkina-Lavrenko	*Th. polychorda* (Gran) Proschkina-Lavrenko	*Th. punctata* Jousé	*Th. usatschevii* Jousé	*Th. zabelinae* Jousé	*Th.* aff. *manifesta* Sheshukova	*Thalassiosira* (?) sp.	*Thalassiotrix longissima* Cl. and Grun.	*Th. miocenica* Schrader	*Xanthiopyxis diaphana* Forti	*X. oblonga* Ehr.	*X. ovalis* Lohman	*X. umbonata* Grev.	*X. lacera* Forti	*Xanthiopyxis* sp. A Wornadt	*Xanthiopyxis* sp. B Wornardt	*Xanthiopyxis* sp. D Wornardt	*Amphora ovalis* Kütz	*Anomoeoneis serians* (Bréb.) Cl.	*Cymbella cistula* (Hemp.) Grun.	*Eunotia bidentula* W. Sm.
		DIATOMS																																													
		MARINE																																										FRESH WATER			
Pleistocene	1-1, 115-117	2	1		1					1					4		3	2	3	2							4	1						2													
	2-1, 135-137														1		1			2			1																					1	1	1	1
	5-3, 60-62		2							1	1				1		1	1	1	1		1			1		1																				
Unit with *Thalassiosira zabelinae*	6-1, 140-142		3							4	4				1		3	1	2	1			1	1	1		4		2		1	1			4												
	7-1, 130-132		3												3	2	2	1	2			1	3	1			4		2	1	1			1	1												
	8-3, 128-130														1		1		1		3	3	1	1		1	3		1			1		1	1												
Denticula hustedtii Zone	11-1, 120-122		2	1			1	1		1		1			4	4			1		1		1			1			2			3	1			2	2	1									
	12-3, 135-137						1			2		2			5	2			1							1						2				3			1	1	1	1	1				
	13-2, 130-132		3							1		1	1	1	5	2					1					1						2				2	1			1			1				
	14-3, 125-127		3			1	1	1	1			1	1		6	4					1											1	1			1											
	15-3, 105-107		3			1		1	1	1		1	1		4	1																1	1			1			1								
	16-1, 70-72		2				1		1	1		1	1		4	2																1	1			2											
	19, CC	No diatoms																																										No diatoms			

TABLE 19A – *Continued*

Diatom Units	Sample (Interval in cm)	FRESH-WATER DIATOMS: *Fragilaria construens* (Ehr.) Grun.	*Melosira distans* (Ehr.) Kütz.	*M. italica* (Ehr.) Kütz.	*M. italica* var. *subarctica* O.Müll.	*M. praegranulata* Jousé	*M. praeislandica* f. *seriata* Moiss.	*Navicula* sp.	*Tetracyclus lacustris* Ralfs.	SILICOFLAGELLATES: *Dictyocha fibula* Ehr.	*Distephanus crux* (Ehr.) Haeckel	*D. japonicus* f. *pseudofibula* (Schulz) Gleser	*D. octonarius* (Ehr.) Defl.	*D. speculum* (Ehr.) Haeckel.	*D. speculum* var. *cannopiloides* (Pr.-Lavr.) Gleser	*D. speculum* var. *pentagonus*	*D. speculum* var. *septenarius* (Ehr.) Jörg.	*Cannopilus hemisphaericus* (Ehr.) Haeckel	*Mesocena elliptica* Ehr. emend. Defl.	*M. stellata* Haeckel	*M.* aff. *apiculata* (Schulz) Defl.	*Paradictyocha polyactis* f. *mesocenoidea* (Defl.) Freng.	*Ebria* sp.	*Ammodochium rectangulare* (Schulz) Hov.	RADIOLARIANS: POLYCYCSTINA: *Artostrobus annulatus* (Bailey)	*Botryopera oceanica* (Ehr.)	*Cenosphaera cristata* Haeckel group	*Ceratocyrtis cucullaris* (Ehrenberg) group	*Clathrocyclas* (?) *extensa* Clark and Campbell *talwanii* (Björklund and Kellogg)	*Cornutella* B *profunda* Ehrenberg	*Hexacyclia tschunjenkoi* (Lipman) forma Sph	*Hexacontium delicatulum* (Dogiel)	*Lithocarpium polyacantha* (Campbell and Clark)	*Lithocarpium* sp. aff. *Pylospira* sp. "A" Petrushevskaya	*Lithomelissa macroptera* Ehrenberg group	*Lithomitra nodosaria* Haeckel group	*Lithomitra* (?) sp. "P"	*Perichlamidium* sp.	*Porodiscus parvus* Clark and Campbell group	*Spongodiscus craticulatus* (Stöhr) group	*S. osculosus* (Dreyer) group	*Spongotrochus glacialis* (Popofsky) group	*Stylodictya stellata* Bailey group	*Stylodictya dujardinii* (Haeckel) group	PHAEODARIA: *Cadium* sp.	*Protocyrtis* sp.	Unit No.
Pleistocene	1-1, 115-117			1																																							
	2-1, 135-137	1	1	3	2	1	1	1	1					1																														XVI
	5-3, 60-62		1				1						1	1																													
Unit with *Thalassiosira zabelinae*	6-1, 140-142	1	1										1	1	1		1						1				c														f		c	
	7-1, 130-132													2	2		1						1	2	a							c										c	XV
	8-3, 128-130													2	1		1						1		f		f			c				a								c	
Denticula hustedtii Zone	11-1, 120-122										1			2	1				1	1		3	1	2	f				r													r		
	12-3, 135-137									1				1		1						1		2							c	a				f						c		
	13-2, 130-132									1	1			1					1			1		1																				
	14-3, 125-127						1				1			1										1							c													
	15-3, 105-107								1	1	2	1		1				1			1			1														c						XIII
	16-1, 70-72										1	1		1		1		2	1		1			1					r								c						
	19, CC	No Silicoflagellates																							f		r			r	r												

TABLE 19B
Radiolarians at Site 348

Species / Core-Section	RADIOLARIA																				PHAEODARIA		Strata
	Actinomma tetrapyle (Hays)	*Artostrobus annulatus* (Bailey)	*Antarctissa* (?) sp. aff. *A. capitata* (Popofsky)	*Cenosphaera cristata* Haeckel grp.	*Ceratocyrtis cucullaris* (Ehr.) grp.	*Clathrocyclas* (?) *extensa* Clark and Campbell *talwanii* Bjørklund and Kellogg	*Cornutella B profunda* Ehr.	*Hexacyclia tschuenkoi* (Lipman) grp. forma Sph.	*Hexacromyum* sp. aff. *Hexaconthium pachydermum* Jørgensen	*Hexacromyum delicatulum* (Dogiel)	*Lithocarpium polycantha* (Campbell and Clark) grp.	*Lithocarpium* sp. aff. *Pylospira* sp. A Petrushevskaya	*Lithomelissa macroptera* Ehr. grp.	*Lithomitra arachnea* (Ehr.) grp.	*Lithomitra nodosaria* Haeckel grp.	*Lithomitra* (?) sp. P	*Perichlamidium* sp.	*Porodiscus parvus* Clark and Campbell grp.	*Spongodiscus craticulatus* (Stöhr) grp.	*Spongodiscus osculosus* (Dreyer) grp.	*Spongotrochus glacialis* (Popofsky) grp.	*Stylodictya stellata* Bailey grp.	*Stylospira dujardinii* (Haeckel) (? or *Perichlamidium limbatum* Ehr.) grp.	*Cadium* sp.	*Protocyrtis* spp.	
1-3 2-1 3-3 4-3 5-3	No radiolarians																						XV
6-3	f									c								f				c	XIV
7-3			a											c								c	
8-1			f		f					c						a				c			
11-3	f	f					r											f			r	r	XII
12-3											c	a		c			f				c		
13-2	No radiolarians																						
14-1			f										c	c									
15-1																		c					
16-3																		c			r		
19-1				r		f		c	f		c					f		f	c		c		III?
20-1 32-2	No radiolarians																						?

Reschenie postoyannoi stratigraficheskoi komissii Mezhvedomstvennogo stratigraficheskogo komiteta po paleogenu SSSR. 1963: Sow. Geol., v. 4, p. 145-154.

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PLATE 1

Middle-late Eocene diatoms. All figures ×1000.

Figures 1-4 *Stephanopyxis turris* (Grev. et Arn.) Ralfs. v. *arctica* Grun: 338-29-3, 35-37 cm.

Figures 5-7 *Stephanopyxis turris* (Grev. et Arn.) Ralfs v. *intermedia* Grun.
5, 7. 338-29-3, 35-37 cm.
6. 338-27, CC.

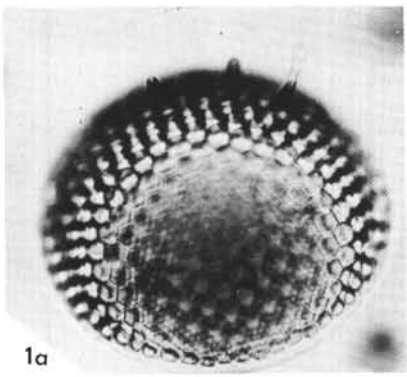
Figure 8 *Stephanopyxis turris* (Grev. et Arn.) Ralfs v. cylindrus Grun: 340-10-3, 130-132 cm.

Figure 9 *Stephanopyxis grunowii* Gr. et St. var: 338-26, CC.

Figures 10, 11 *Melosira architecturalis* Brun: 338-29, CC.

Figures 12, 13a, 13b Sceletonema utriculosum Brun 338-16, CC.

PLATE 1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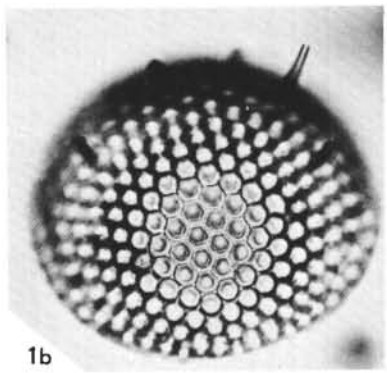
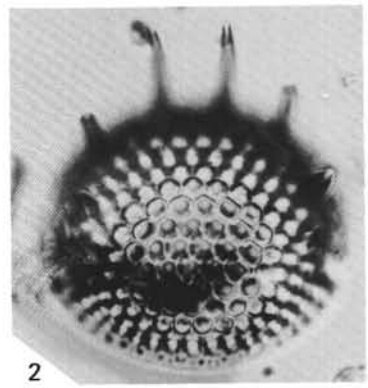

1b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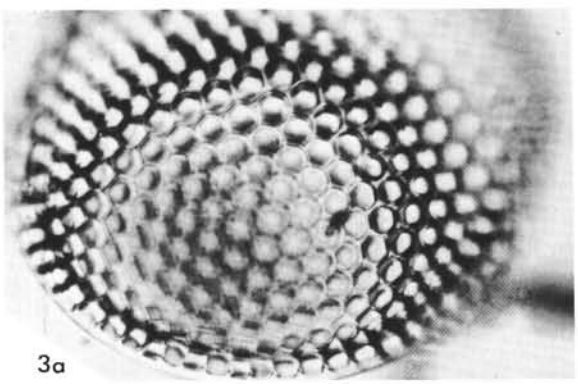
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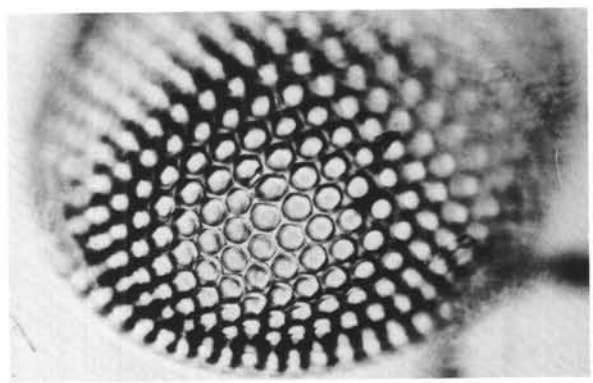
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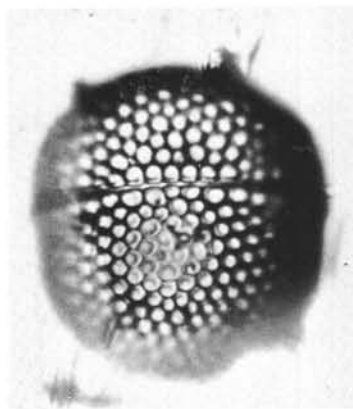
4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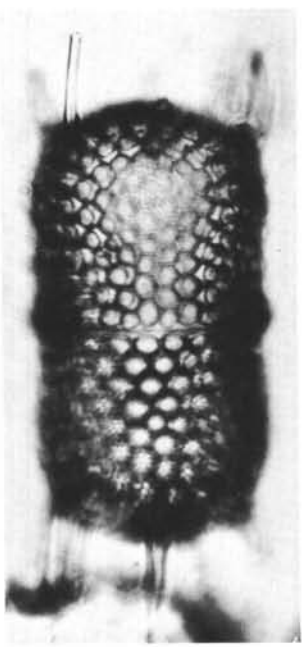
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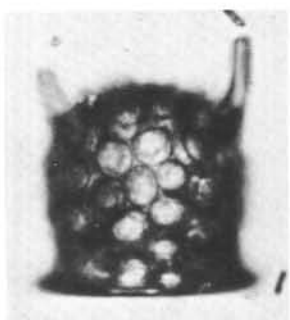
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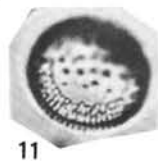
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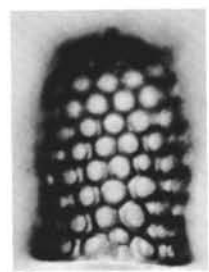
12


8a


8b


13a


13b

PLATE 2

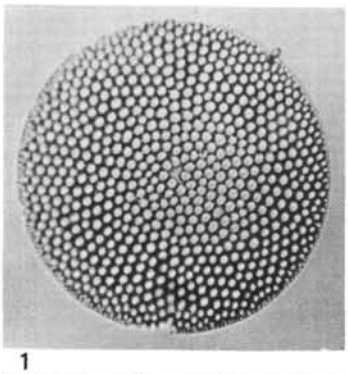
Middle-late Eocene diatoms. Figures 1-3, 5b, 6b, 8b, 9 ×1000; Figure 2 ×1800; Figures 4, 5a, 6a, 7 ×600; Figure 8a ×200

Figures 1-4 *Coscinodiscus argus* Ehr. (sensu Kanaya, 1957): 338-26, CC.

Figures 5-7 *Coscinodiscus monicae* Grun.
5a, 5b, 7. 338-27, CC.
6a, 6b. 338-26, CC.

Figures 8, 9 *Coscinodiscus asteromphalus* Ehr. v. *hybrida* Grun: 338-29-3, 35-37 cm.

PLATE 2



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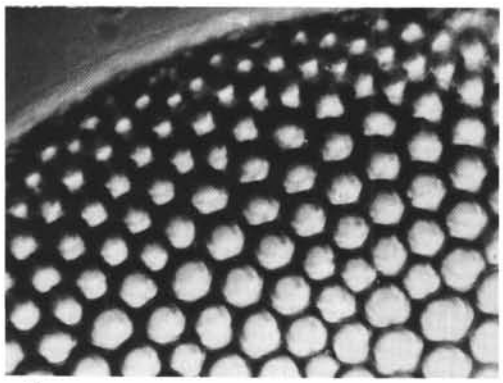

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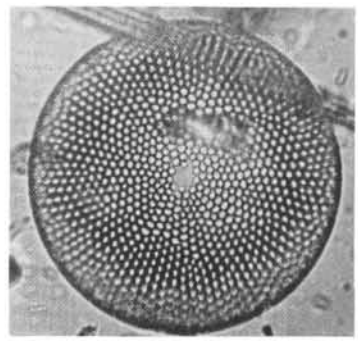

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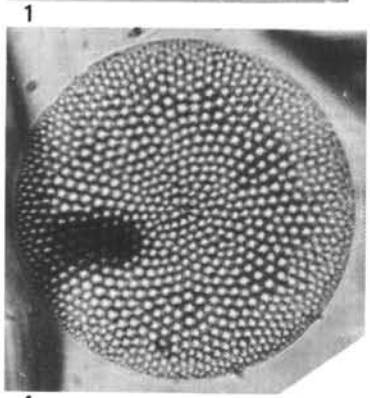

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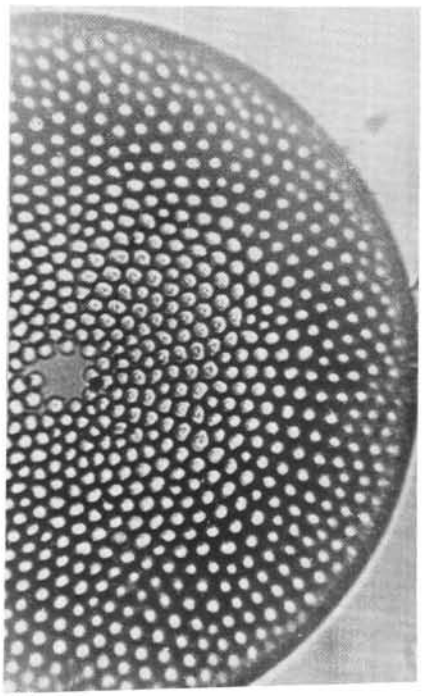
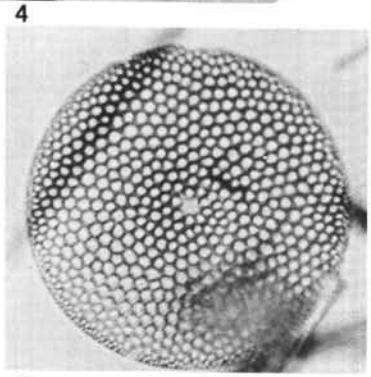
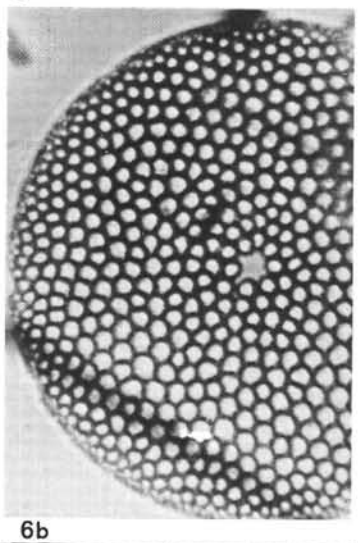


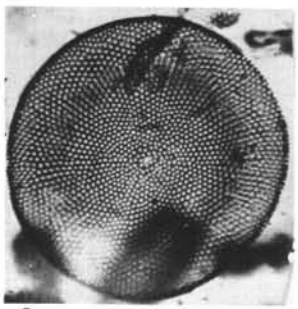
5b



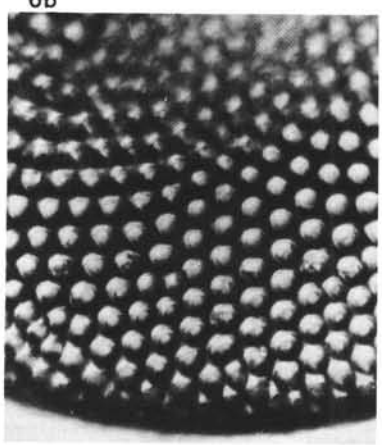
6a



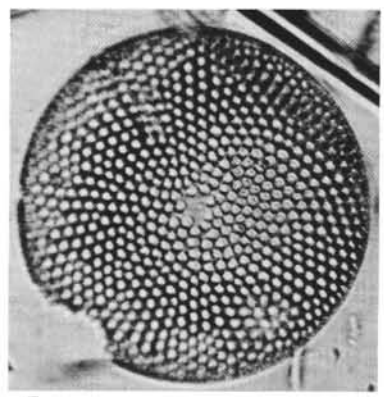
6b



8a



8b



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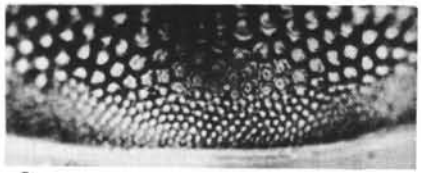


9

PLATE 3

Middle-late Eocene diatoms. Figures 1, 3, 4b, 5, 7, 8, 10 ×1000; Figures 2, 4a, 6, 9 ×600.

Figures 1, 2 — *Coscinodiscus debilis* Rattr.
1. 340-10, CC.
2. 340-10-3, 130-132 cm.

Figure 3 — *Coscinodiscus decrescens* Grun: 338-26, CC.

Figure 4 — *Coscinodiscus* aff. *tenerrimus* Jousé: 340-9-3, 110-112 cm.

Figure 5 — *Coscinodiscus obscurus* A.S. v. *minor* Rattr. 340-11-3, 110-112 cm.

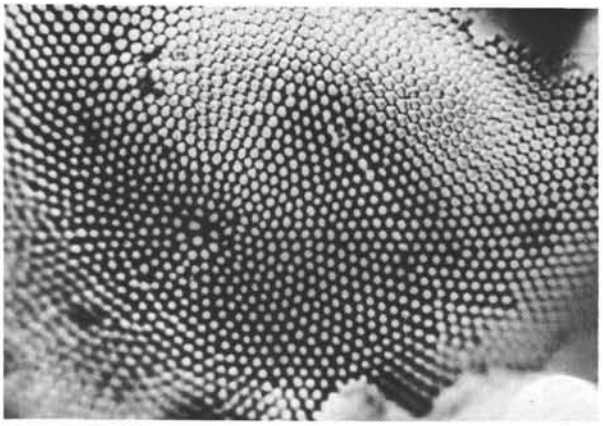
Figures 6, 7 — *Coscinodiscus decrescenoides* Jousé.
6. 338-7, CC.
7. 340-9-3, 110-112 cm.

Figure 8 — *Coscinodiscus symbolophorus* Grun: 338-29, CC.

Figure 9 — *Coscinodiscus bulliens* A.S.: 340-3-3, 110-112 cm.

Figure 10 — *Coscinodiscus* aff. *africanus* (W.Sm.) Jan: 338-27-3, 88-90 cm.

PLATE 3



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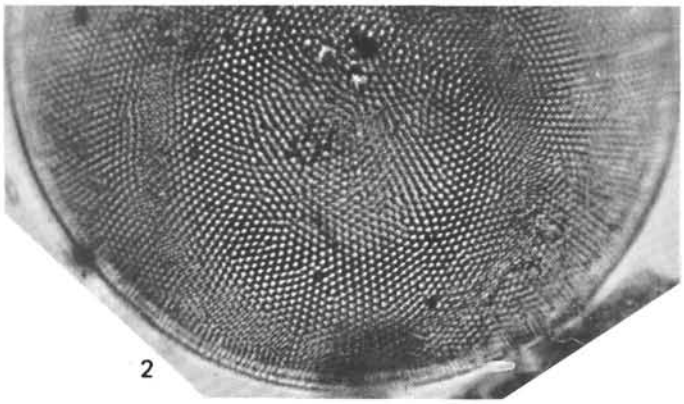

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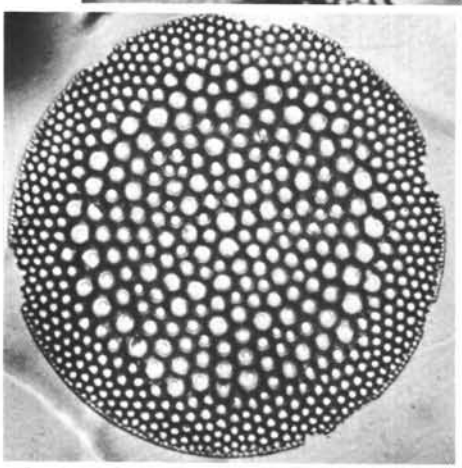

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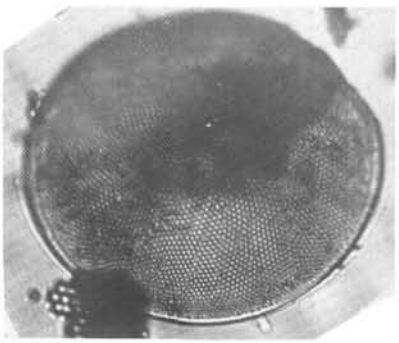

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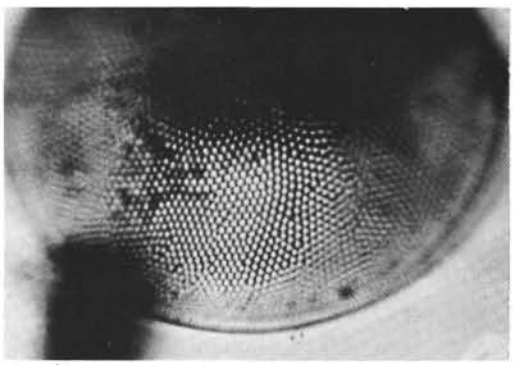

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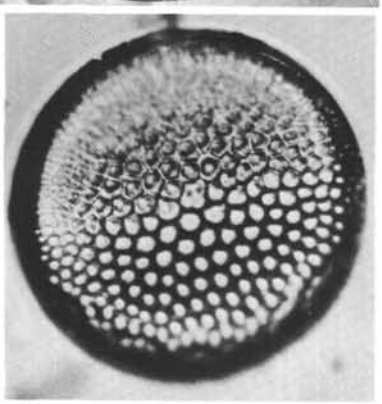

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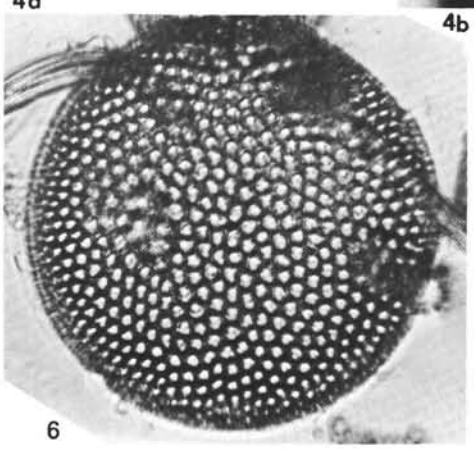

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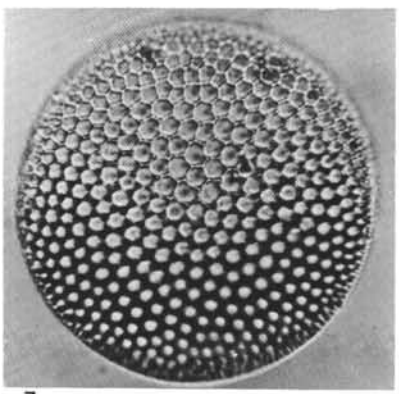

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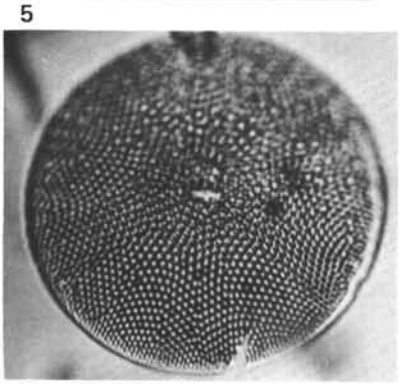

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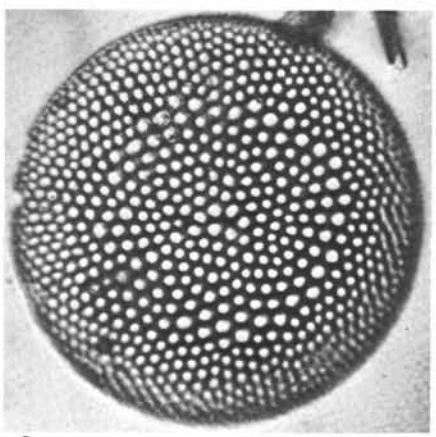

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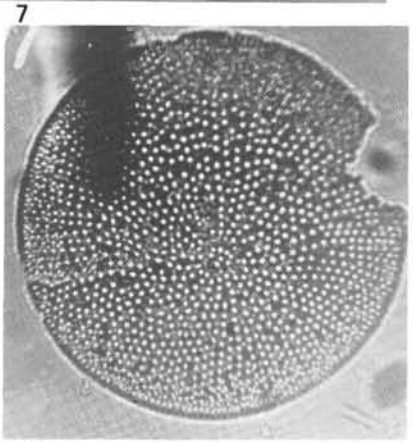


10

PLATE 4

Middle-late Eocene diatoms. All figures ×1000.

Figures 1-5 *Coscinodiscus senarius* A.S.
1. 338-29, CC.
2a, 2b, 5. 340-7-6, 120-122 cm.
3, 4. 340-11-3, 110-112 cm.

Figures 6, 7 *Podosira* aff. *maxima* (Ktz.) Grun: 338-29, CC.

Figures 8, 9 *Coscinodiscus simbirskianus* Grun.
8. 340-9-3, 110-112 cm.
9. 338-27, CC.

Figure 10 *Stictodiscus kittonianus* Grev: 338-27, CC.

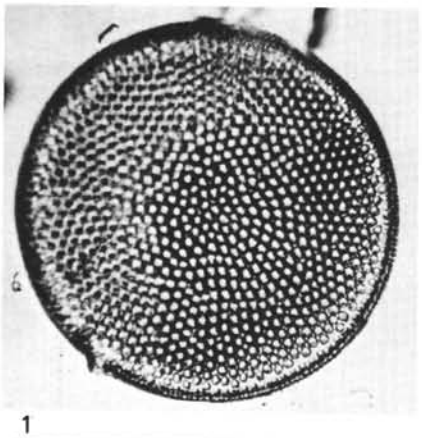
Figure 11 *Pseudostictodiscus ovetschkinii* Gleser: 340-10, CC.

Figures 12, 13 *Trochosira trochlea* Hanna.
12. 340-10, CC.
13. 340-6-3, 100-102 cm.

Figure 14 *Trochosira mirabilis* Kitt: 340-10, CC.

Figure 15 *Trochosira spinosa* Kitt: 340-7-6, 120-122 cm.

PLATE 4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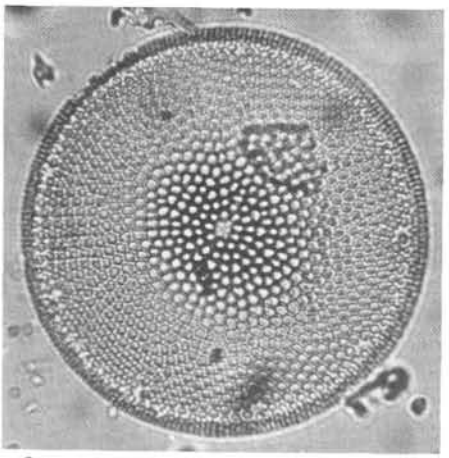
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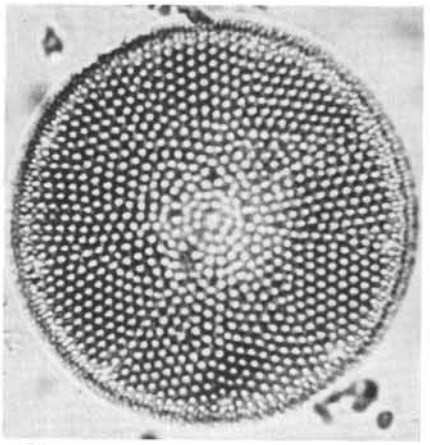
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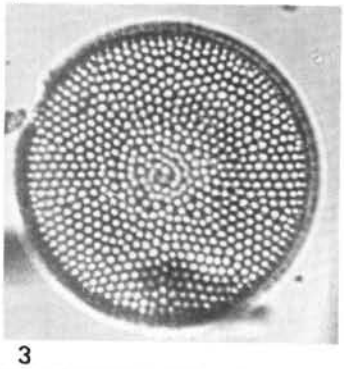
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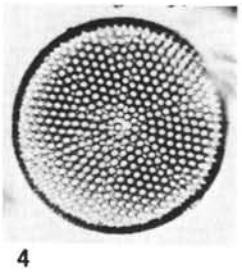
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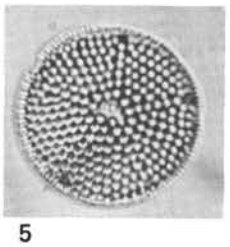
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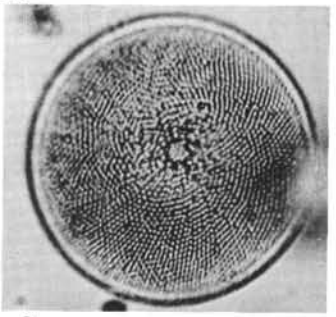
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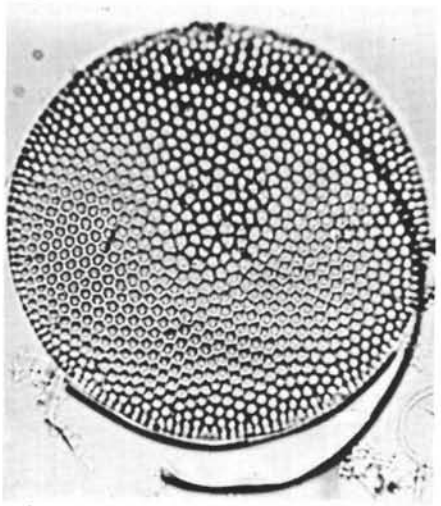
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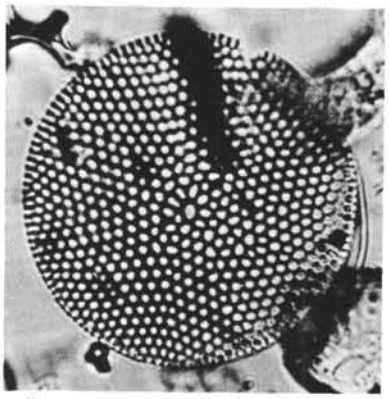
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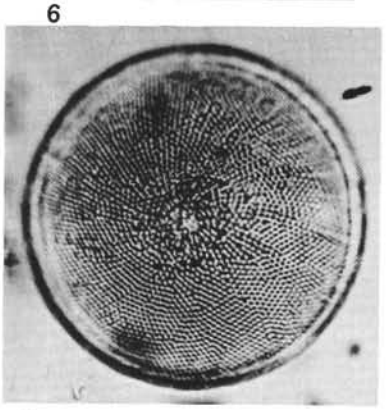
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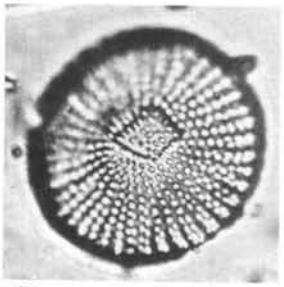
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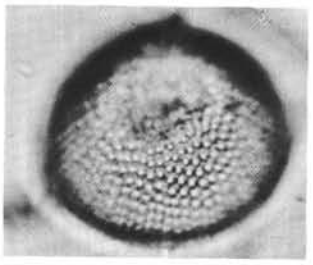
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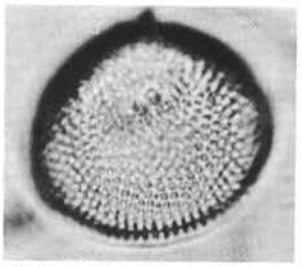
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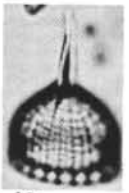
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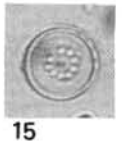
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PLATE 5

Middle-late Eocene diatoms. Figures 1b, 1c, 2b, 2c, 4b, 4c ×1000; Figures 4a, 5 ×600; Figures 2a, 3, 4a, ×200; Figure 6 ×100.

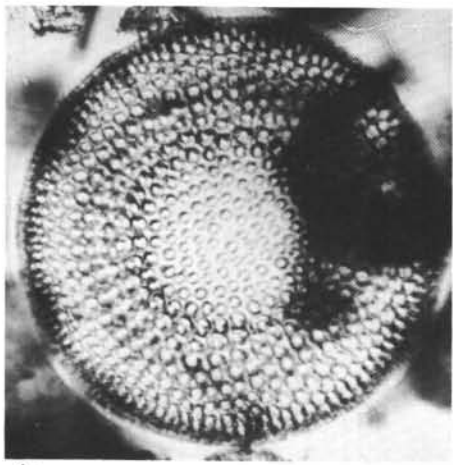
Figure 1 — *Craspedodiscus coscinodiscus* Ehr: 340-10-3, 130-132 cm.

Figures 2, 3 — *Pyxilla oligocaenica* Jousé v. *tenuis* Jousé.
2a, 2b, 2c. 338-29-3, 35-37 cm.
3. 338-26, CC.

Figures 4, 6 — *Rhizosolenia* sp. 1.
4a, 4b, 4c. 340-7-6, 120-122 cm.
6. 340-6-3, 100-102 cm.

Figure 5 — *Craspedodiscus oblongus* (Grev.) Hanna: 338-26, CC.

PLATE 5



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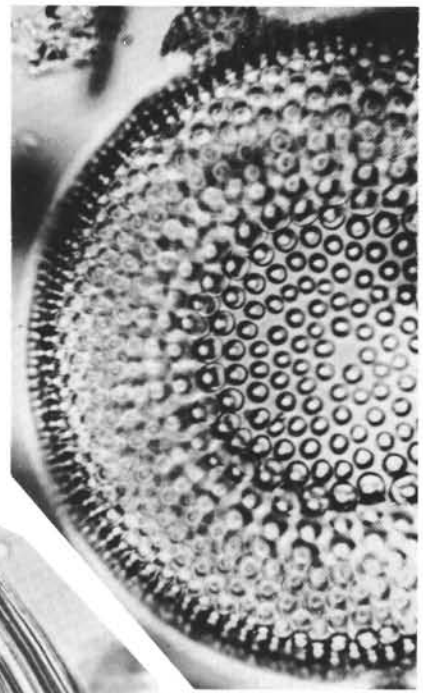

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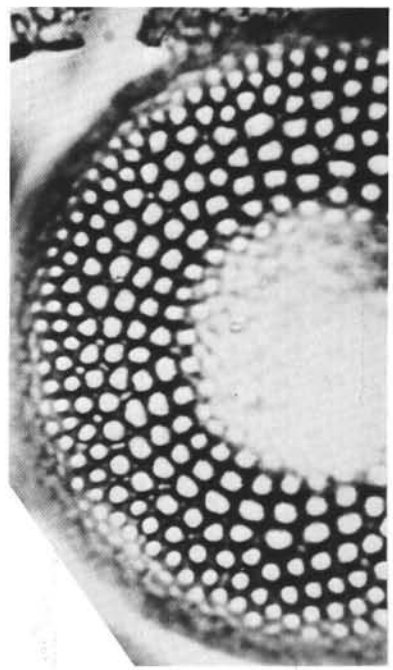
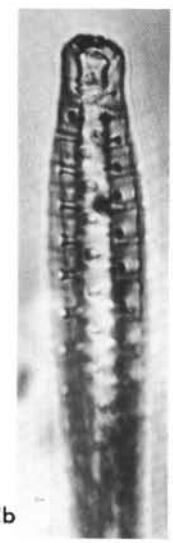


1c

2a



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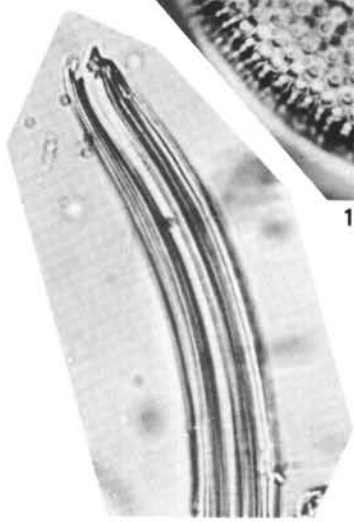

4b

4a

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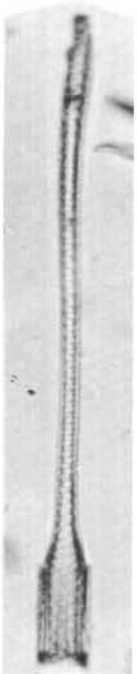

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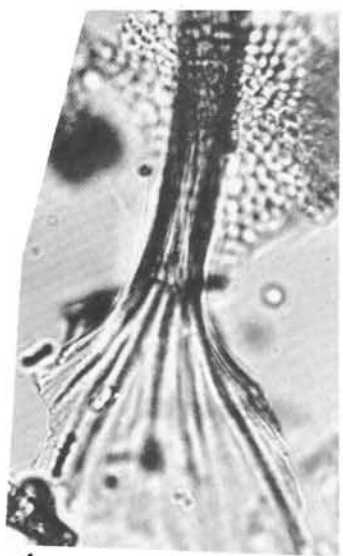
2c



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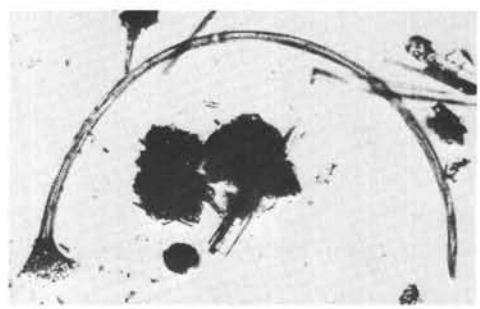


6

PLATE 6

Middle-late Eocene diatoms. Figures 1a, 1b, 5, 7-12 ×1000; Figure 6 ×200.

Figures 1-5 *Actinoptychus undulatus* (Bail.) Ralfs.
1a, 1b. 338-29, CC.
2a, 2b. 340-11-6, 100-102 cm.
3. 338-27, CC.
4, 5. 340-11-3, 110-112 cm.

Figures 6, 7 *Brightwellia imperfecta* Jousé.
6. 340-11-3, 110-112 cm.
7. 338-29-3, 35-37 cm.

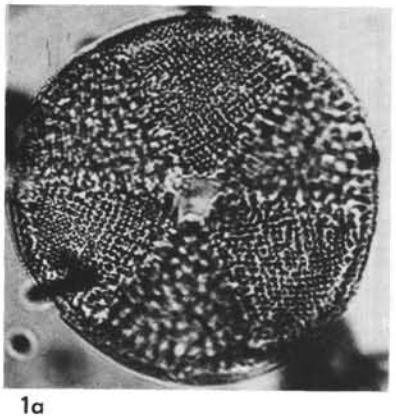
Figures 8, 9 *Asterolampra vulgaris* Grev.: 338-26, CC.

Figure 10 *Asterolampra marylandica* Ehr.: 338-27, CC.

Figure 11 *Rylandsia biradiata* Grev.: 338-29-3, 35-37 cm.

Figure 12 *Asterolampra insignis* A.S.: 338-27, CC.

PLATE 6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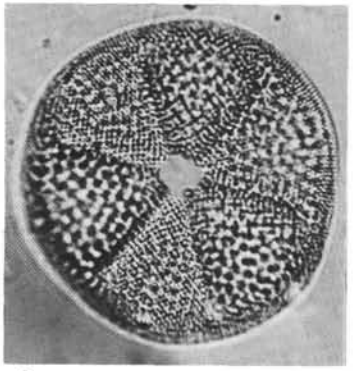
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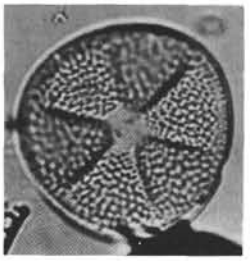
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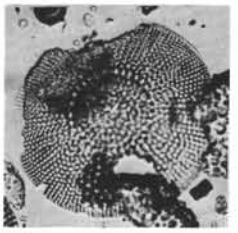
4


5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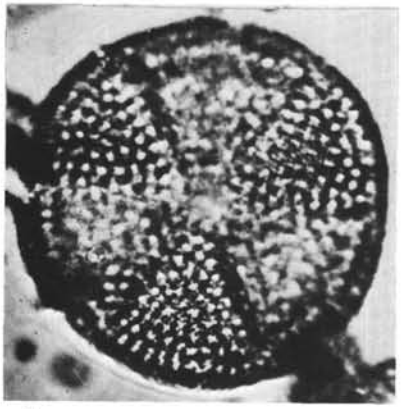
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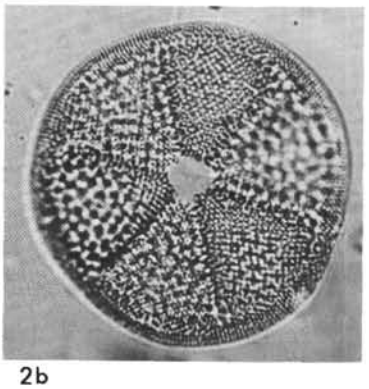
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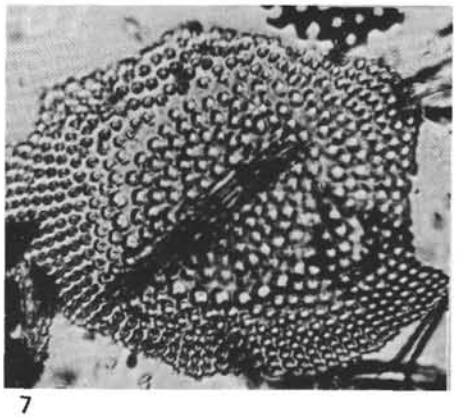
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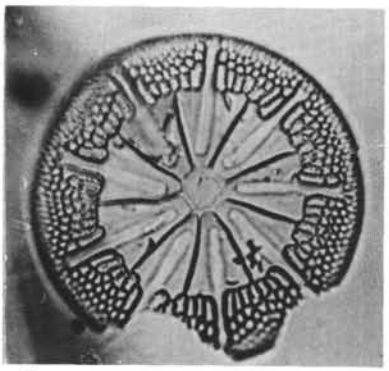
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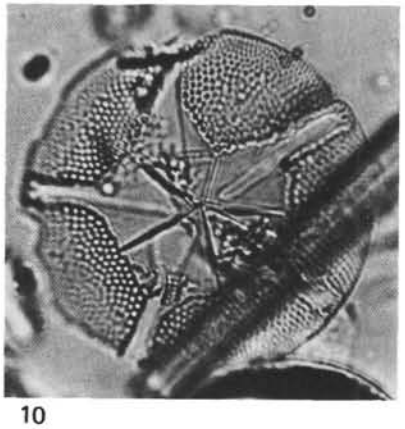
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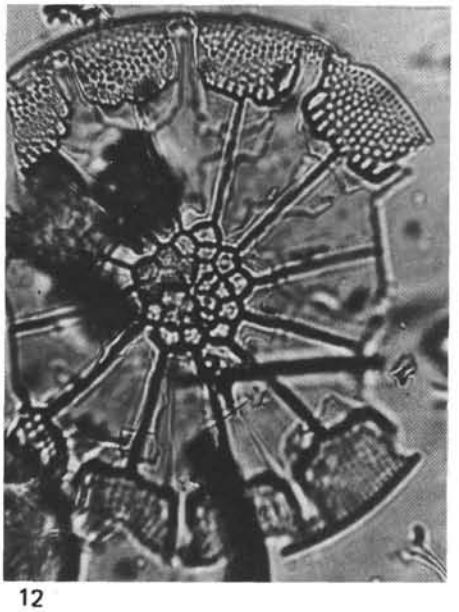
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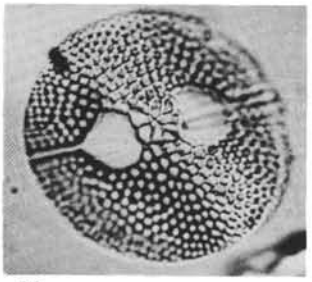

11

PLATE 7

Middle-late Eocene diatoms. All figures ×1000.

Figures 1-9 *Hemiaulus polymorphus* Grun.
1. 340-10, CC.
2-4, 6. 338-26, CC.
5, 7, 8. 338-29, CC.
9. 340-7-6, 120-122 cm.

Figures 10-13 *Hemiaulus* sp. 1.
10. 340-9-3, 110-112 cm.
11. 340-10-3, 130-132 cm.
12. 338-26, CC.
13a, 13b. 340-10, CC.

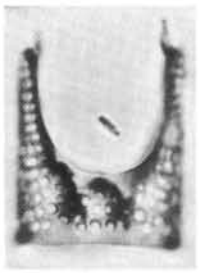
Figures 14-17 *Hemiaulus danicus* Grun.: 338-26, CC.

PLATE 7


1


2


3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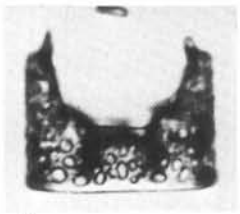
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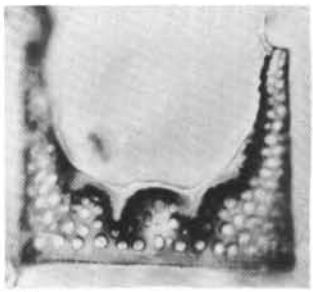
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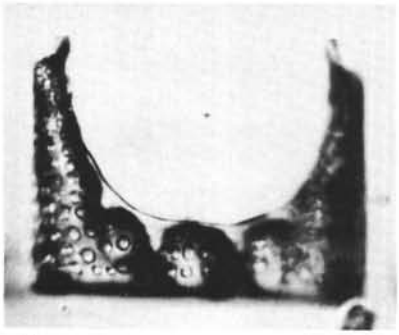
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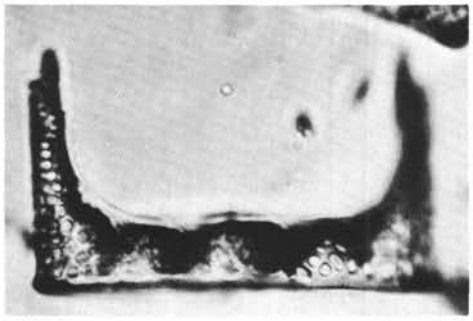
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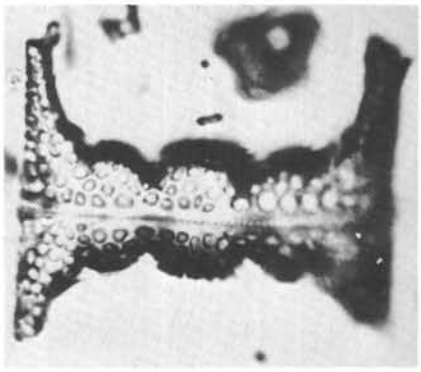
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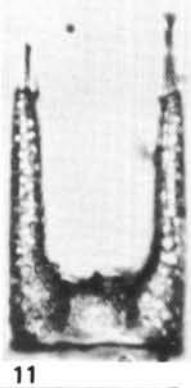
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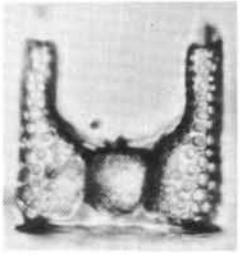
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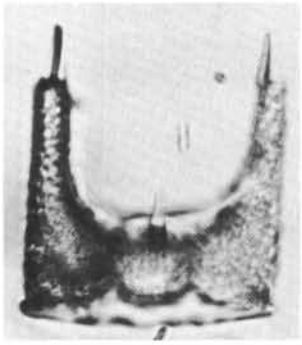
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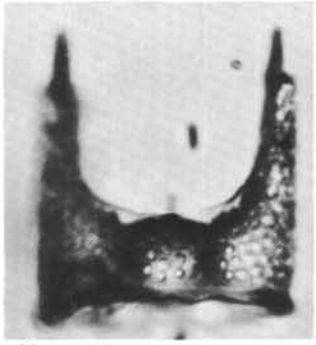
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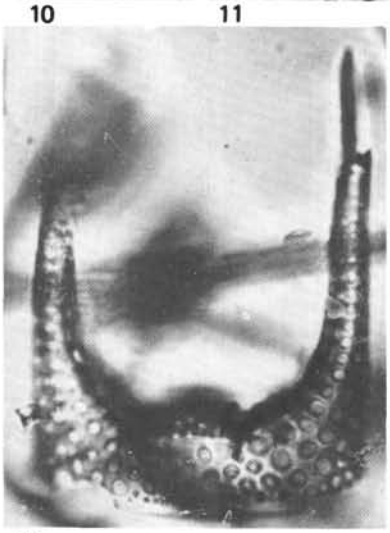
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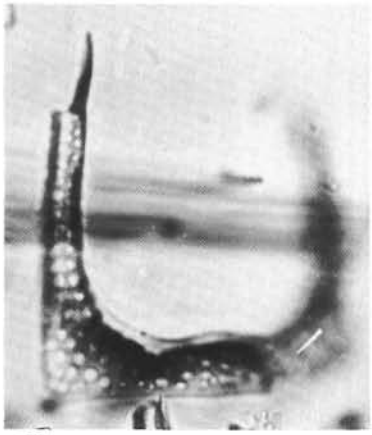
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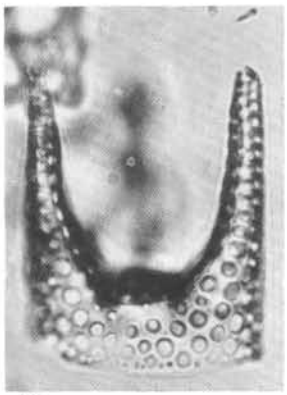
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17

PLATE 8

Middle-late Eocene diatoms. All figures ×1000.

Figure 1 — *Hemiaulus polycystinorum* Ehr. v. *polycystinorum*: 340-9-3, 110-112 cm.

Figure 2 — *Hemiaulus polycystinorum* Ehr.: v. *mesolepta* Grun., 340-10-3, 130-132 cm.

Figure 3 — *Biddulphia ruthenica* Witt: 338-29-3, 35-37 cm.

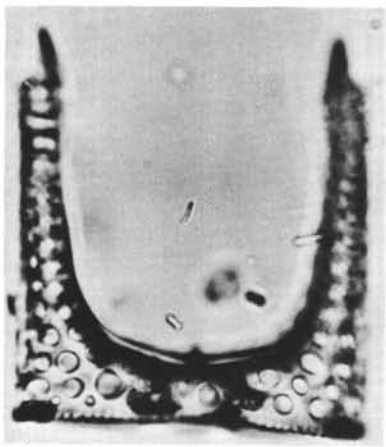
Figure 4 — *Hemiaulus* sp. 3: 338-26, CC.

Figure 5 — *Hemiaulus* sp. 4: 340-6-3, 100-102 cm.

Figures 6, 7 — *Hemiaulus longicornis* Grev.
6. 340-9-3, 110-112 cm.
7. 338-27, CC.

Figures 8, 9 — *Hemiaulus klushnikovii* Gleser: 340-6-3, 100-102 cm.

PLATE 8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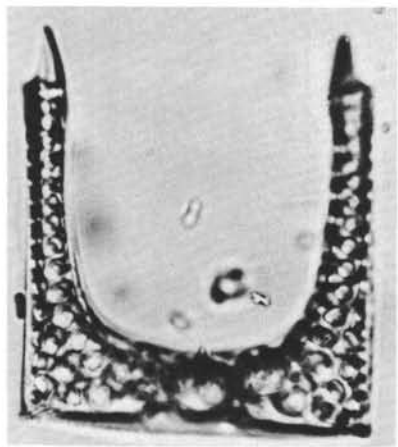
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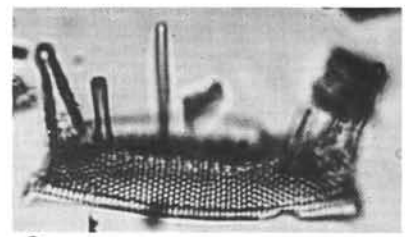
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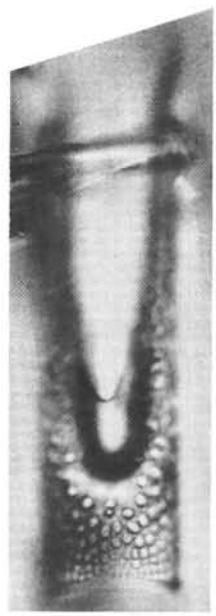
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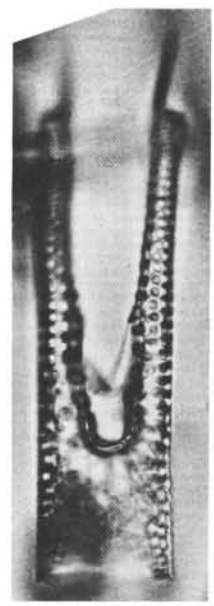
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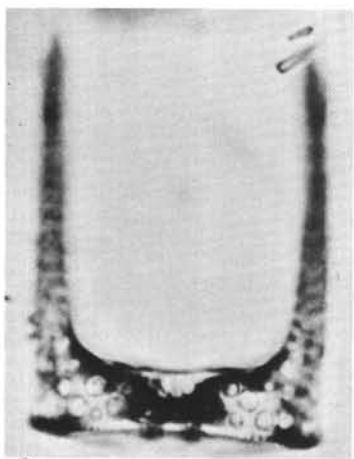
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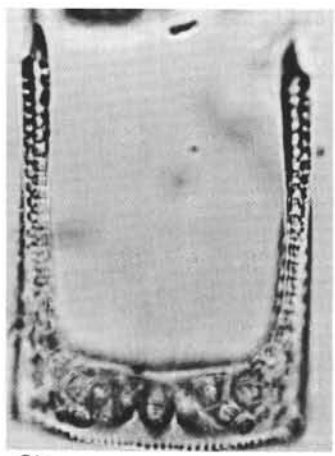
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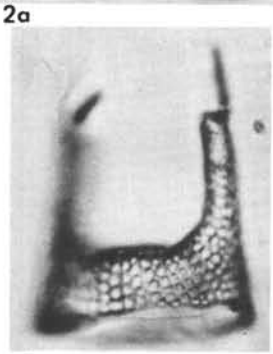
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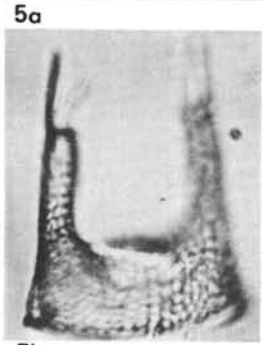
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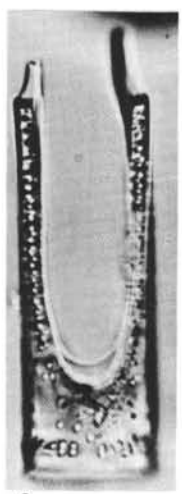
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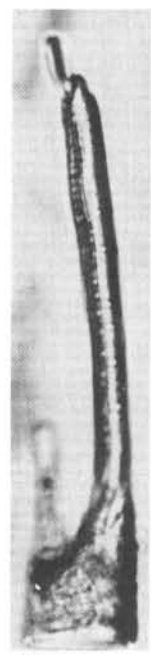

9a


9b

PLATE 9

Middle-late Eocene diatoms. All figures ×1000.

Figures 1-3 *Hemiaulus* sp. 5.
1-3. 340-6-3, 100-102 cm.

Figure 4 *Hemiaulus unicornutus* Brun: 338-29-3, 35-37 cm.

Figure 5 *Pterotheca clavata* Streln.: 338-29-3, 35-37 cm.

Figure 6 *Pterotheca aculeifera* Grun.: 340-3-3, 110-112 cm.

Figure 7 *Pterotheca spada* Temp. et Brun: 338-29-3, 35-37 cm.

Figures 8, 9 *Pseudopyxilla* sp. 3: 338-29-3, 35-37 cm.

Figure 10 *Pseudopyxilla* sp. 2: 340-9-3, 110-112 cm.

Figures 11, 12 *Dicladia* (sensu Kanaya, 1957).
11. 338-29-3, 35-37 cm.
12a, 12b. 340-9-3, 110-112 cm.

Figures 13-15 *Chaetoceros* sp.: 338-29-3, 35-37 cm.

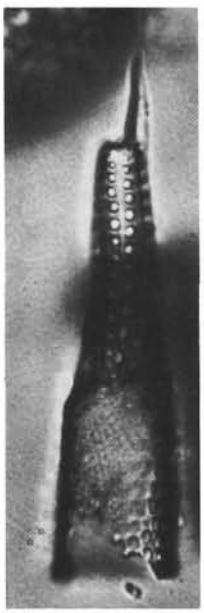
Figure 16 *Dicladia* (sensu Kanaya, 1957): 338-26, CC.

Figures 17, 18 *Hercotheca*? sp. (sensu Kanaya, 1957).
17. 338-29, CC.
18. 338-29-3, 35-37 cm.

Figures 19-23 *Pterotheca costata* Schibkova: 338-29-3, 35-37 cm.

PLATE 9


1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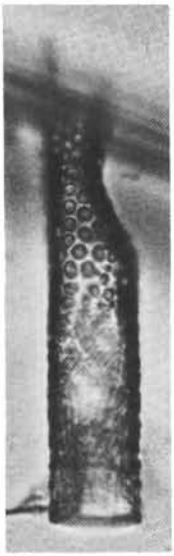
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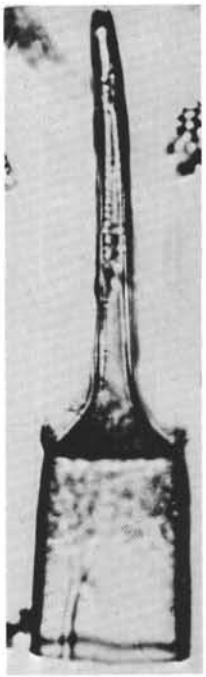
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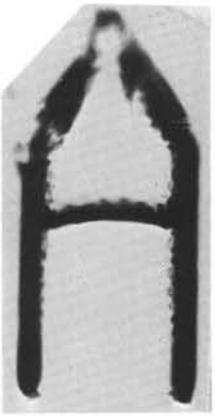
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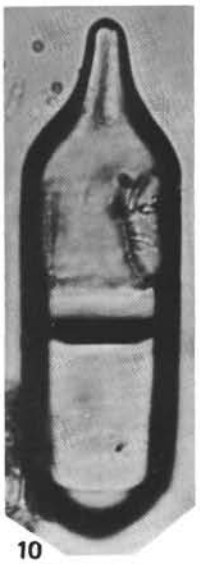
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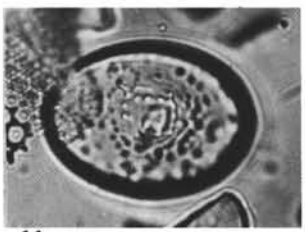
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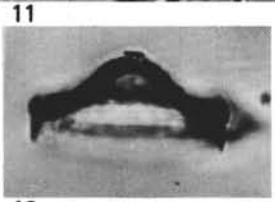
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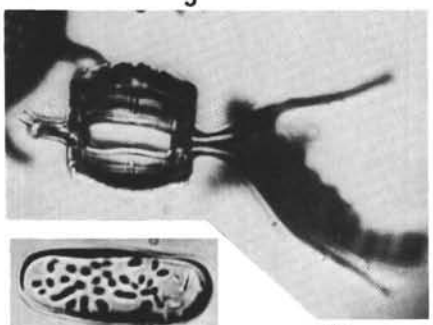
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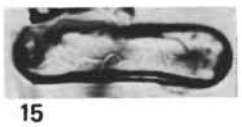
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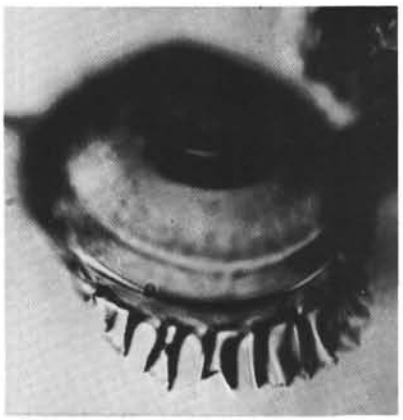
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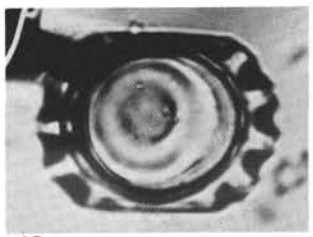
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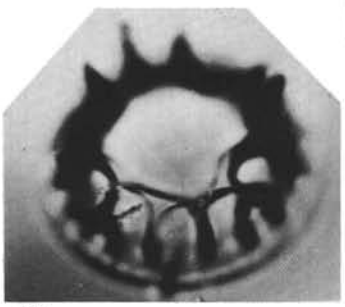
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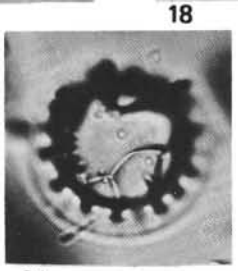
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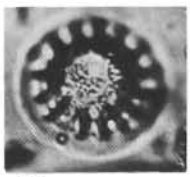
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23

PLATE 10

Middle-late Eocene diatoms. Figures 1, 2, 4a, 4b, 5, 8a, 8b-20 ×1000; Figures 3, 7 ×600; Figure 6 ×200.

Figure 1 — *Triceratium barbadense* Grev.: 338-29, CC.

Figure 2 — *Pseudotriceratium chenevieri* (Meister) Gleser 340-7-6, 120-122 cm.

Figures 3, 4 — *Trinacria excavata* Heib.: 338-29-3, 35-37 cm.

Figure 5 — *Trinacria excavata* Heib. f. *tetragona* A.S.: 338-29-3, 35-37 cm.

Figure 6 — *Trinacria ventricosa* Gr. et St.: 340-3-3, 110-112 cm.

Figure 7 — *Trinacria subcoronata* Sheshuk. et Gleser: 340-11-3, 110-112 cm.

Figures 8, 9 — *Xanthiopyxis oblonga* Ehr.
8a, 8b. 340-10, CC.
9a, 9b. 340-10-3, 130-132 cm.

Figures 10-13 — *Xanthiopyxis umbonata* Grev.
10. 338-29-3, 35-37 cm.
11. 340-10, CC.
12. 340-11-6, 100-102 cm.
13. 340-10, CC.

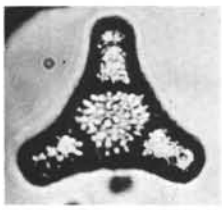
Figures 14-17 — *Cymatosira* sp. B.
14, 15, 17. 340-7-6, 120-122 cm.
16. 340-6-3, 100-102 cm.

Figure 18 — *Sceptroneis grunowii* Anissimova: 340-7-6, 120-122 cm.

Figure 19 — *Grunowiella* sp.: 338-29-3, 35-37 cm.

Figure 20 — *Navicula directa* W. Sm.: 338-29-3, 35-37 cm.

PLATE 10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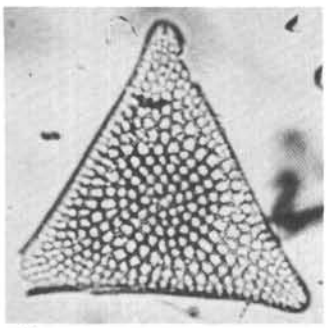
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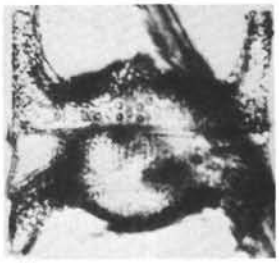
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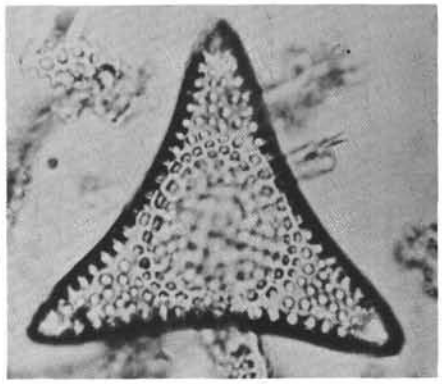
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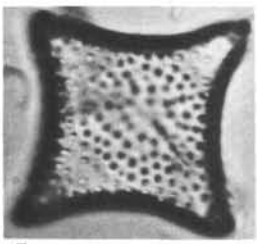
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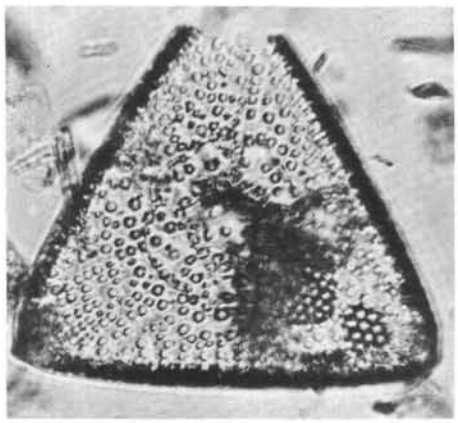
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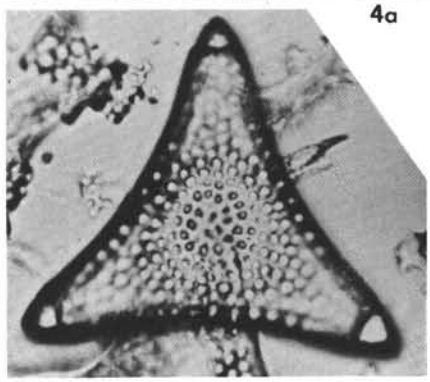
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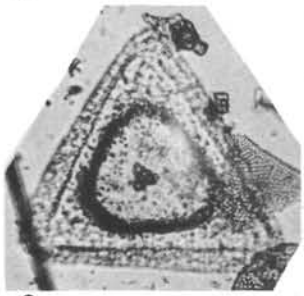
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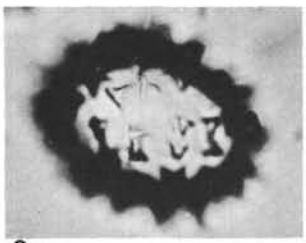
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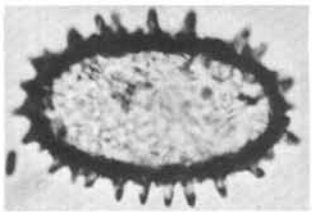
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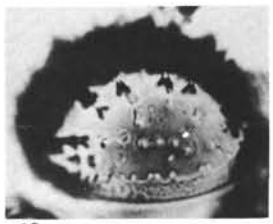
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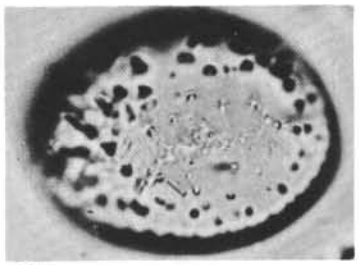
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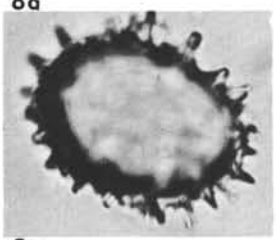
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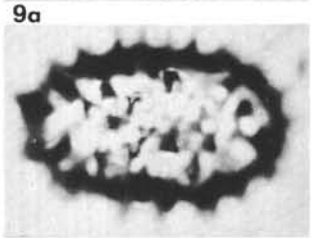
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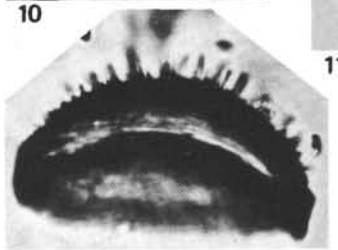
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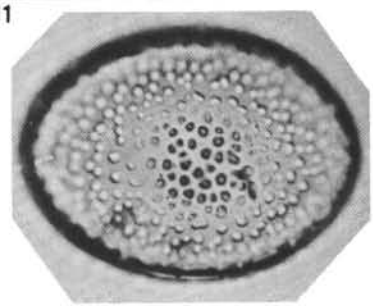
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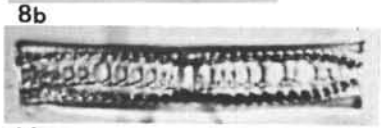
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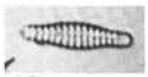
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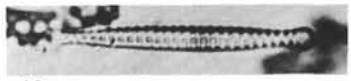
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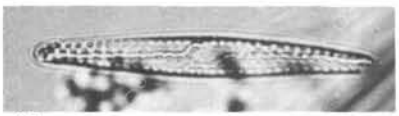
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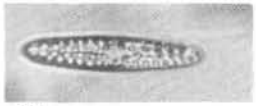
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PLATE 11

Middle-late Eocene diatoms. Figures 3, 4, 6-9, 14-16 ×1000; Figures 1, 2, 5, 11-13 ×600; Figure 10 ×400.

Figure 1 — *Naviculopsis foliacea* Defl.: 340-10-3, 130-132 cm.

Figures 2, 3 — *Naviculopsis* sp. 1.
2. 340-10-3, 130-132 cm.
3. 340-10, CC.

Figure 4 — *Mesocena oamaruensis* Schulz: 340-7-6, 130-132 cm.

Figure 5 — *Mesocena apiculata* (Schulz) Defl.: 338-26, CC.

Figure 6 — *Dictyocha hexacantha* Schulz: 340-7-6, 120-122 cm.

Figures 7-9 — *Dictyocha triacantha* Ehr. v. *apiculata* Lemm.
7, 9. 338-26, CC.
8. 338-29-3, 35-37 cm.

Figures 10, 11 — *Corbisema bukry* (Jousé)
10. 340-9-3, 110-112 cm.
11. 338-29-3, 35-37 cm.

Figure 12 — *Distephanus crux* (Ehr.) Häck.: 340-6-3, 100-102 cm.

Figure 13 — *Dictyocha fibula* Ehr. v. *fibula*: 338-29-3, 36-37 cm.

Figure 14 — *Pseudoammodochium dictyoides* Hov.: 338-26, CC.

Figures 15, 16 — *Ebriopsis mesnili* Defl.
15. 340-10-3, 130-132 cm.
16. 340-10, CC.

PLATE 11


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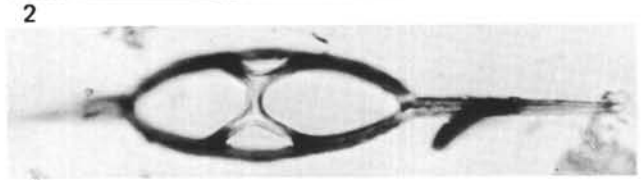
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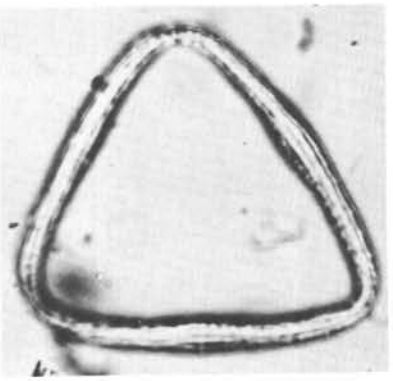
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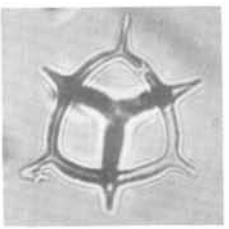
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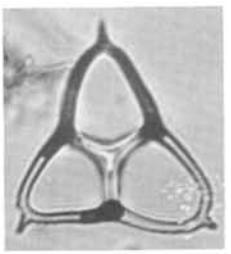
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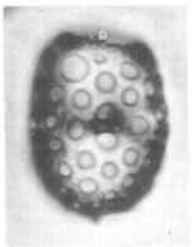
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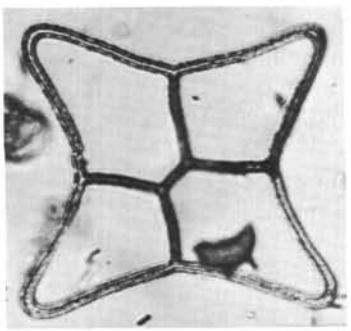
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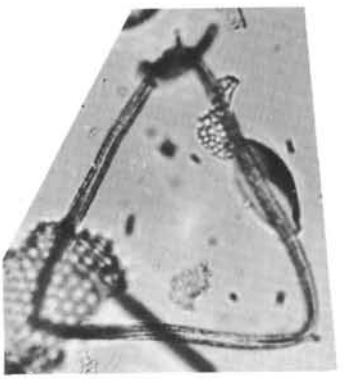
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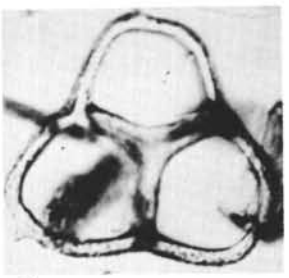
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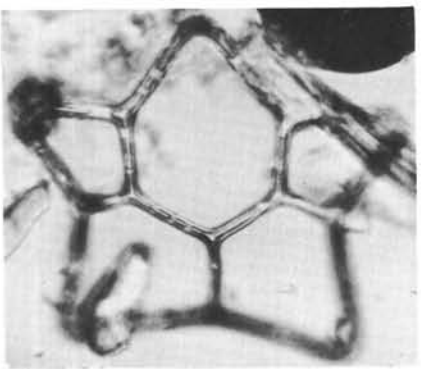
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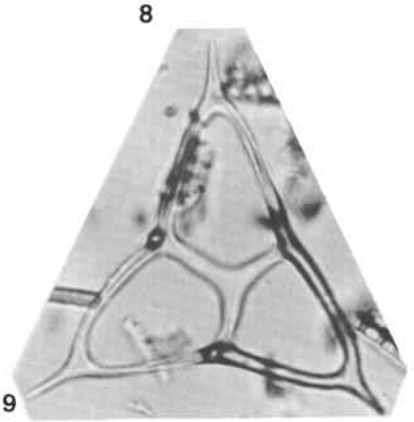
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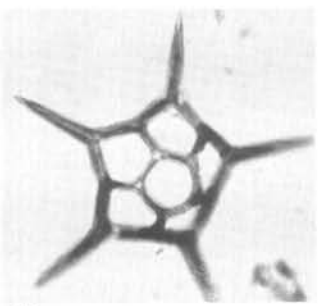
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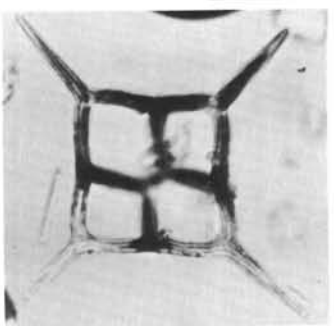
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PLATE 12

Late Oligocene-Miocene diatoms. All Figures ×1000

Figure 1 — *Actinoptychus thumii* Schmidt: 338-20-3, 120-121 cm.

Figure 2 — *Actinoptychus thumii* Schmidt: 338-21-3, 120-121 cm.

Figure 3 — *Actinoptychus thumii* Schmidt: 338-21, CC.

Figure 4 — *Actinoptychus undulatus* Bail. Ralfs: 338-20-3, 120-121 cm.

Figure 5 — *Stephanopyxis turris* (Grev. et Arn.) Ralfs var.: 338-20-3, 120-121 cm.

Figure 6 — *Rhizosolenia* sp. 2 (Jousé): 338-17-3, 20-22 cm.

Figure 7 — *Stictodiscus enlensteinii* (Grun.) Castr.: 338-16-2, 40-42 cm.

Figure 8 — *Biddulphia deodora* Hanna: 338-17-3, 20-22 cm.

Figure 9 — *Actinocyclus ingens* Rattray: 338-9, CC.

Figure 10 — Genus indet.: 338-22-3, 20-22 cm.

Figure 11 — *Actinocyclus* sp.: 338-22-3, 113-115 cm.

Figure 12 — *Stictodiscus kittonianus* Grev.: 338-22-3, 113-115 cm.

Figure 13 — *Raphidodiscus marylandicus* Christian: 338-16-2, 40-42 cm.

Figures 14, 15 — *Hyalodiscus oculatus* Jousé sp. n.

PLATE 12

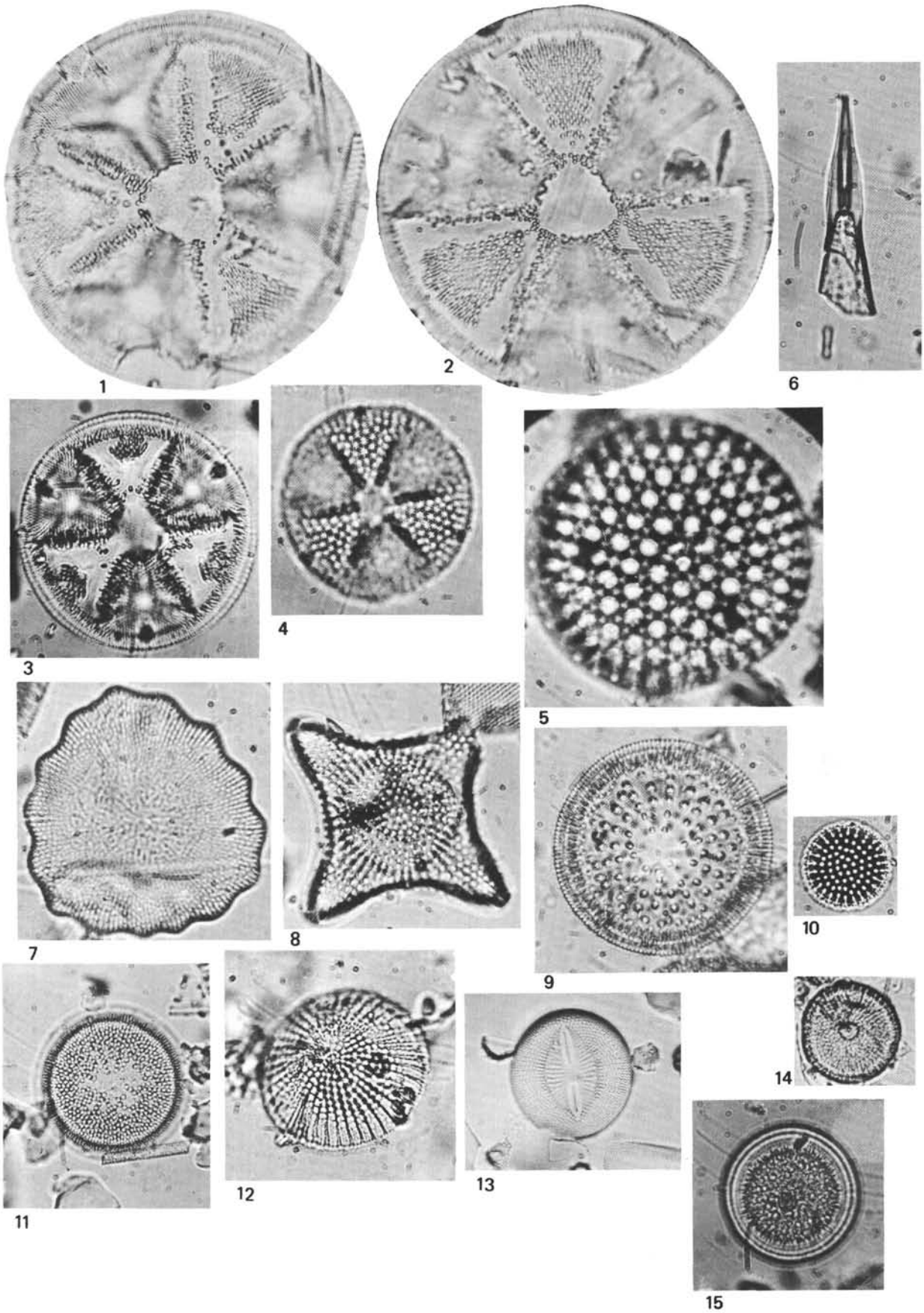


PLATE 13

Late Oligocene-Miocene diatoms. All Figures ×1000.

Figure 1 — *Coscinodiscus* aff. *asteromphalus* Ehr.: 338-20-3, 120-121 cm.

Figures 2, 3 — *Coscinodiscus kurzii* Grun.
2. 338-16, CC.
3. 338-19-3, 110-112 cm.

Figure 4 — *Coscinodiscus decrescenoides* Jousé: 336-18-3, 89-90 cm.

Figure 5-6 — *Coscinodiscus stellaris* Roper: 338-19-3, 110-112 cm.

Figures 7, 9 — *Raphoneis* sp.: 338-17-3, 20-22 cm.

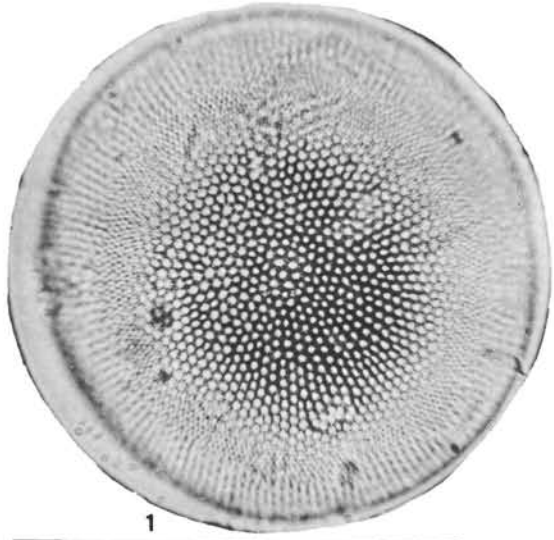
Figure 8 — *Raphoneis gemmifera* Ehr.: 338-17-3.

Figure 10 — *Raphoneis amphiceros* var. *angularis* (Lohman) Wornardt Perag.: 338-19-3, 110-112 cm.

Figure 11, 12 — *Chaetoceros pliocenum* Brun: 338-17-3, 20-22 cm.

Figure 13 — *Synedra jouseana* Sheshuk. *F. linearis* Sheshuk.: 338-16, CC.

PLATE 13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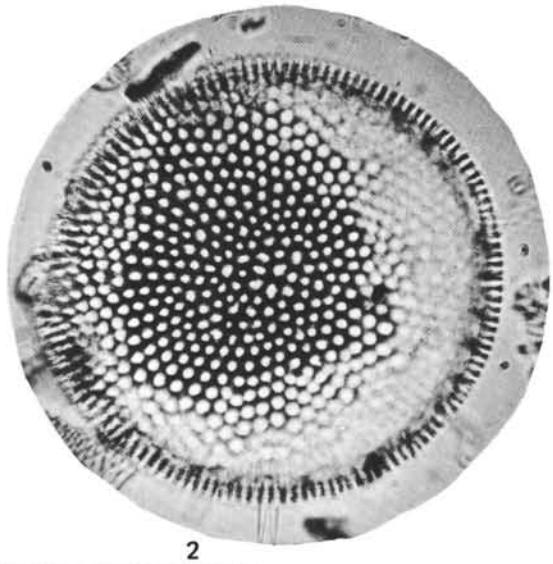
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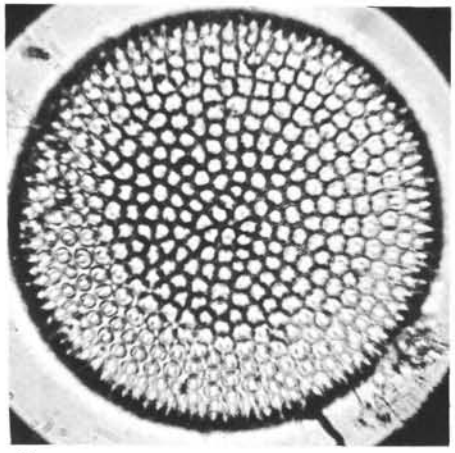
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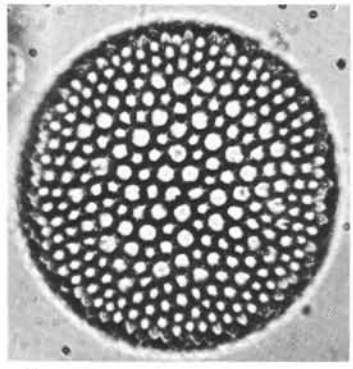
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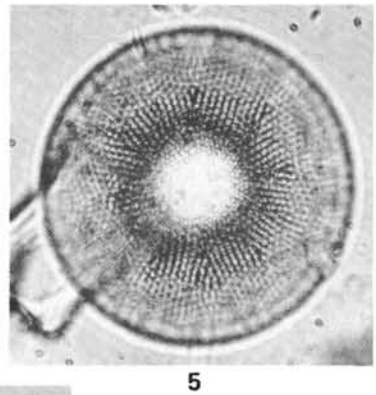
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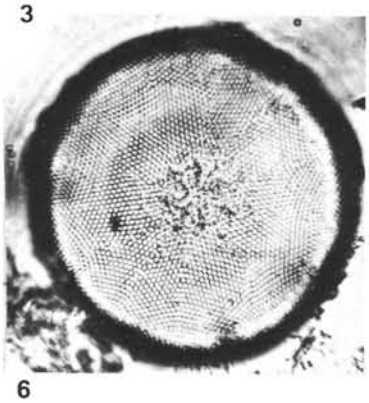
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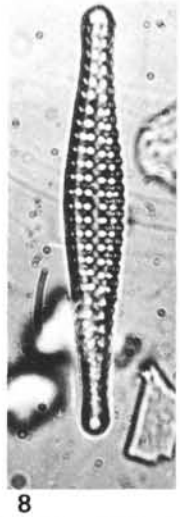
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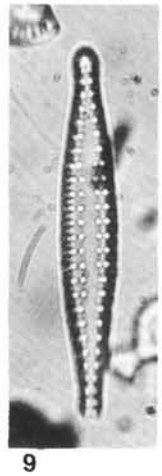
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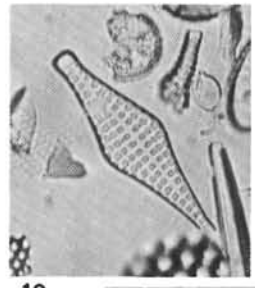
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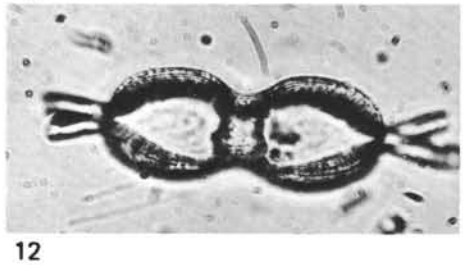
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PLATE 14

Late Oligocene diatoms. All Figures ×1000.

Figure 1 — *Stephanopyxis corona* (Ehr.) Grun.: 336-16-6, 66-68 cm.

Figure 2 — *Stephanopyxis corona* (Ehr.) Grun.: 336-16-6, 66-68 cm.

Figures 3, 4 — *Stephanopyxis marginata* Grun.: 338-20-3, 120-121 cm.

Figures 5, 6 — *Stephanopyxis marginata* Grun.: 338-20-3, 120-121 cm.

Figure 7 — *Stephanopyxis spinossima* Grun.: 338-20-3, 120-121 cm.

Figure 8 — *Pseudotriceratium notabile* (O. Korotkevich) Gleser: 338-23-6, 80-82 cm.

Figure 9 — *Biddulphia thuomey* Bail.: 336-16-3, 101-103 cm.

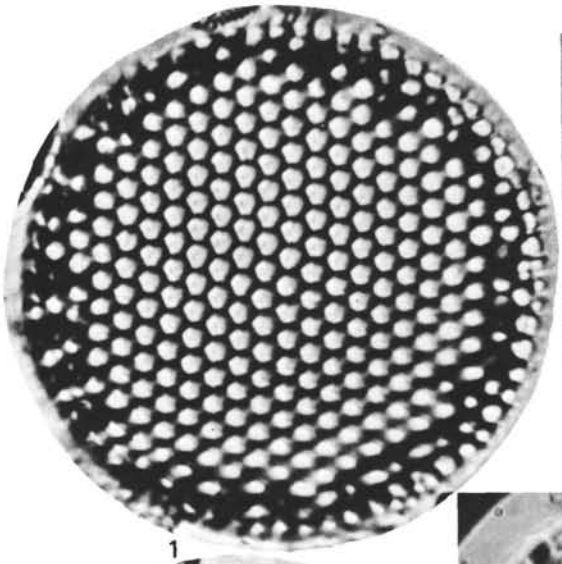
Figure 10 — *Cocconeis vitrea* Brun: 336-16-6, 66-68 cm.

Figure 11 — *Distephanus crux* Ehr.: 338-22-3, 113-115 cm.

Figure 12 — *Dictyocha pseudofibula* (Schulz): 338-17-3, 20-22 cm.

Figure 13 — *Mesocena apiculata* (Schulz) Defl.: 336-16-3, 101-103 cm.

PLATE 14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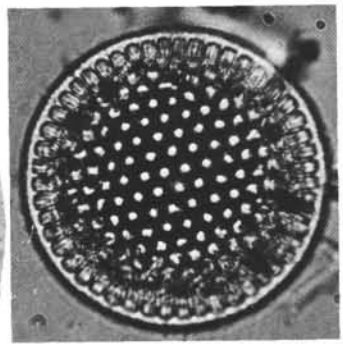
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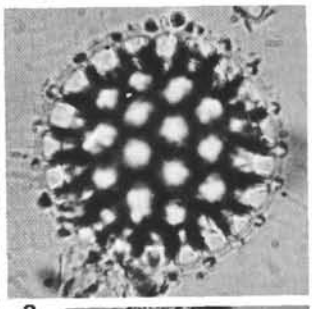
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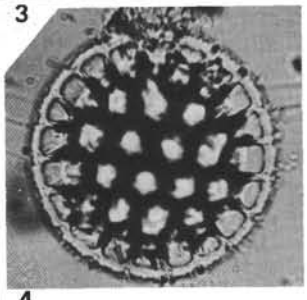
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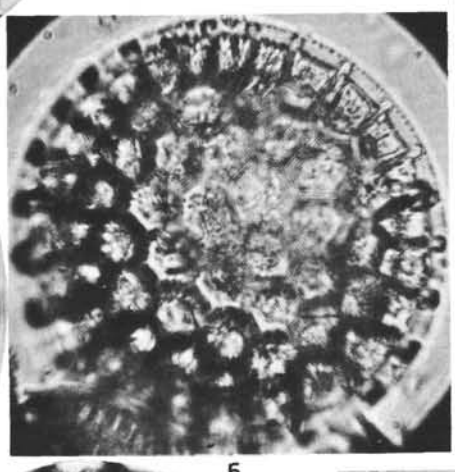
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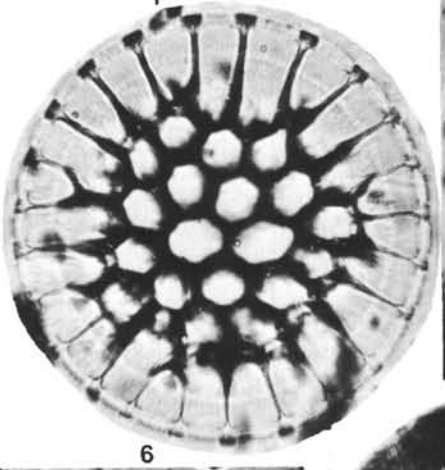
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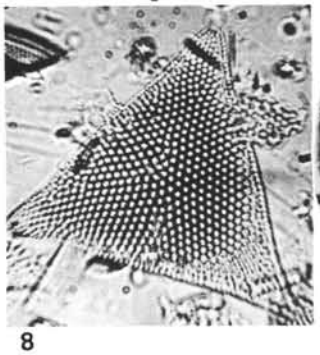
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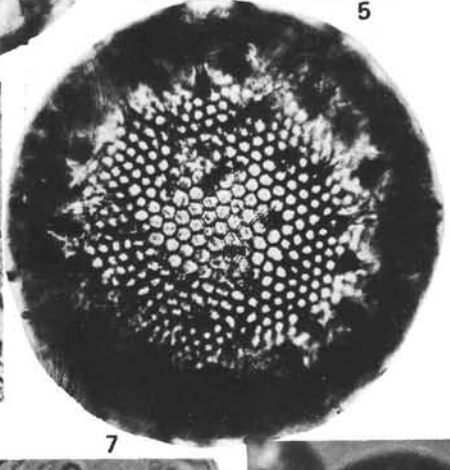
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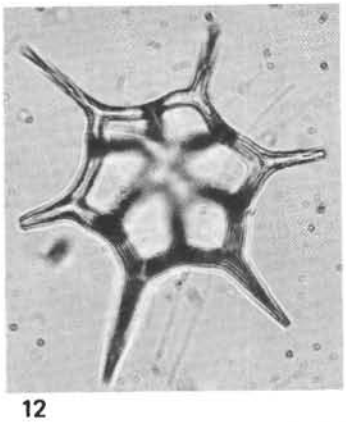
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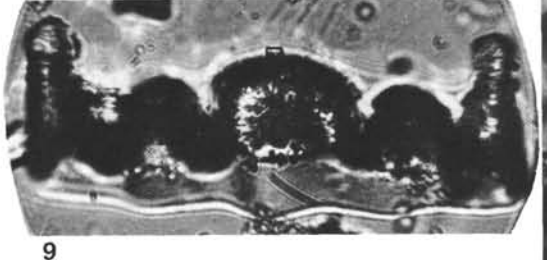
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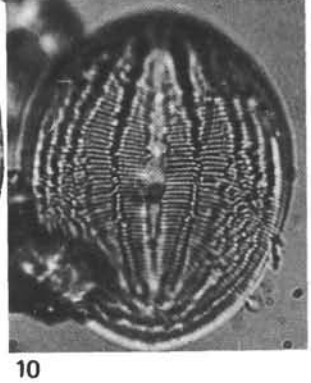
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PLATE 15

Late Oligocene diatoms. Figures 1-9 ×900; Figures 10-20 ×1200.

Figure 1 — *Goniothecium decoratum* Brun: 336-16-6, 66-68 cm.

Figure 2 — *Goniothecium decoratum* Brun: 336-16-6, 66-68 cm.

Figure 3 — *Goniothecium decoratum* Brun: 336-16-6, 66-68 cm.

Figure 4 — *Goniothecium decoratum* Brun: 338-19-3, 110-112 cm.

Figure 5 — *Goniothecium decoratum* Brun: 336-16-6, 66 cm.

Figure 6 — *Goniothecium odontella* var. *danica* Grun.: 338-19-3, 20-22 cm.

Figure 7 — *Muelleriopsis limbata* (Ehr.) Hendey: 338-20-3, 120-121 cm.

Figures 8, 9 — *Stephanogonia polyacantha* Forti: 338-20-3, 120-121 cm.

Figure 10 — *Cladogramma ellipticum* Lohman: 336-16-3, 101-103 cm.

Figure 11 — *Cladogramma dubium* Lohman: 338-16, CC.

Figure 12 — *Stephanogonia hanzawae* Kanaya: 338-21, CC.

Figure 13 — *Actinocyclus cholnokyi* Van Landingen: 338-21, CC.

Figure 14 — *Actinocyclus cholnokyi* Van Landingen: 338-23-6, 80-82 cm.

Figure 15 — *Paralia sulcata* (Ehr.) Kütz.: 338-16, CC.

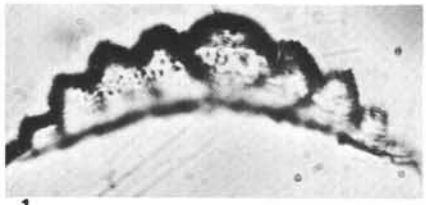
Figures 16, 17 — *Pseudopodosira wittii* (Schulz) Vershima: 336-16-3, 101-102 cm.

Figure 18 — Spora: 336-22-3, 113-115 cm.

Figure 19 — *Triceratium* sp.: 336-18-3, 89-90 cm.

Figure 20 — *Biddulphia thuomey* Bail.: 336-16-3, 101-103 cm.

PLATE 15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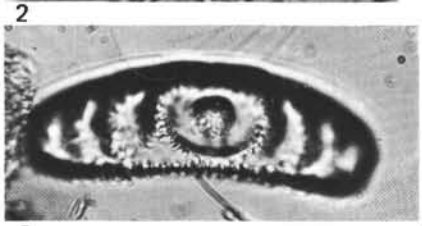
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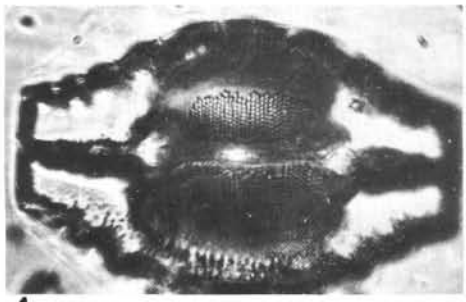
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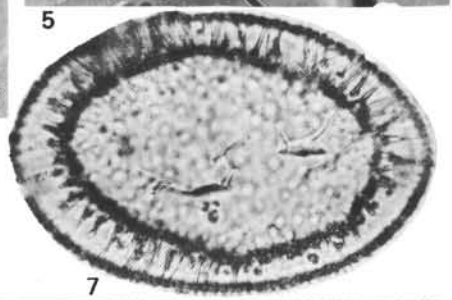
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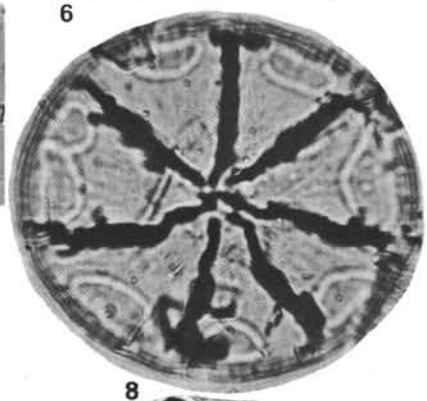
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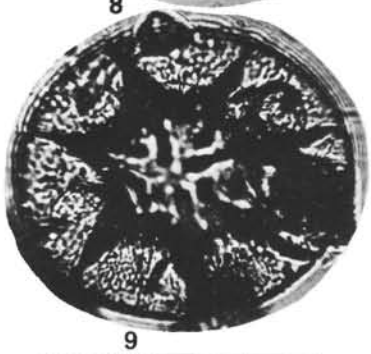
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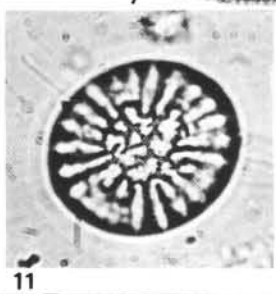
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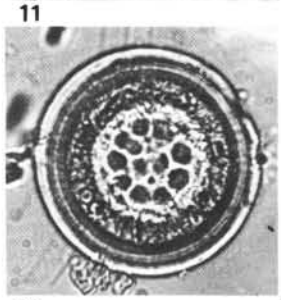
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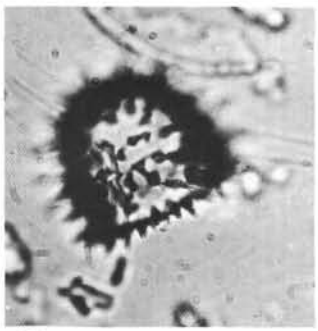
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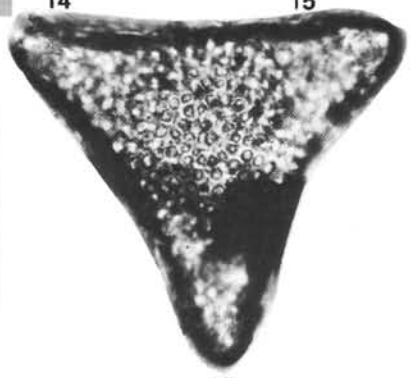
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PLATE 16

Figures 1-3 ×1000; Figures 4-12 ×600 SEM.

Figures 1-3 *Melosira sulcata* (Ehr.) Kutz: 337-9, 10-11 cm.

Figures 4, 5 *Stephanopyxis turris* (Grev. et Arnolt) Ralfs var. *cylindrus* Grun.: 337-10.

Figures 6-8 *Stephanopyxis turris* (Grev. et Arnolt) Ralfs var. *intermedia* Grun.: 337-9, 10

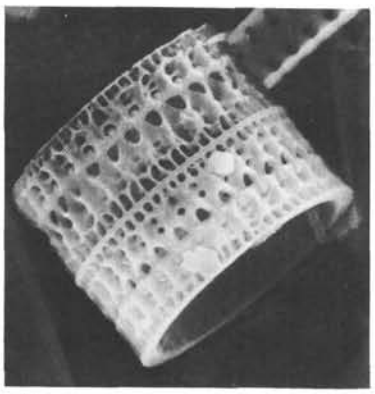
Figure 9 *Hemiaulus kittonii* Grun.: 337-11.

Figure 10 *Hemiaulus* aff. *subacatus* Grun.: 337-11.

Figure 11 *Coscinodiscus* sp. (with labiate process): 337-9.

Figure 12 *Stephanopyxis turris* (Grev. et Arnolt) Ralfs var. *intermedia* Grun.: 337-10.

PLATE 16



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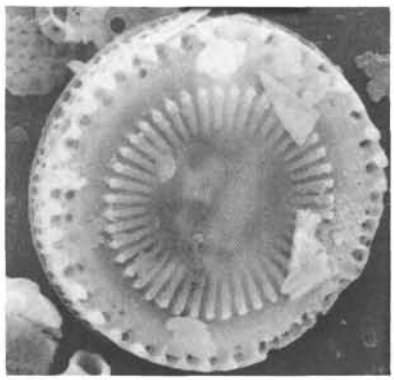

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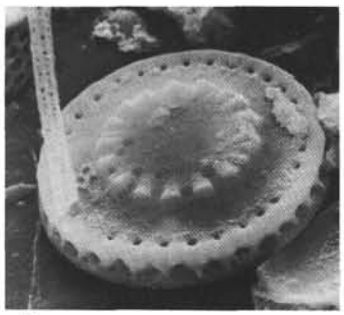

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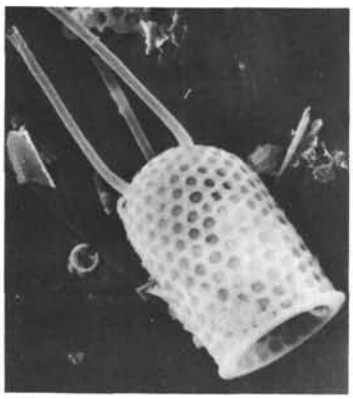

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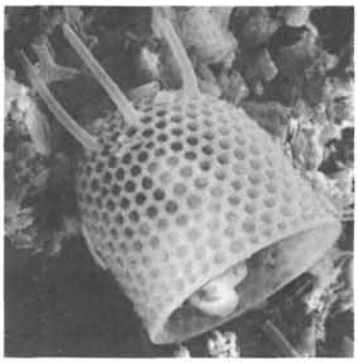

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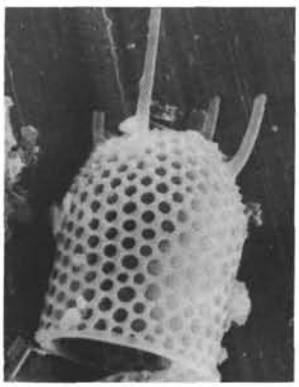

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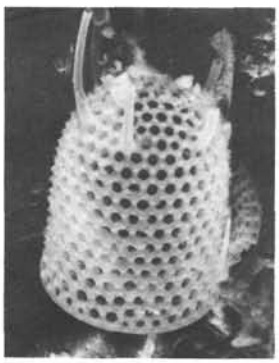

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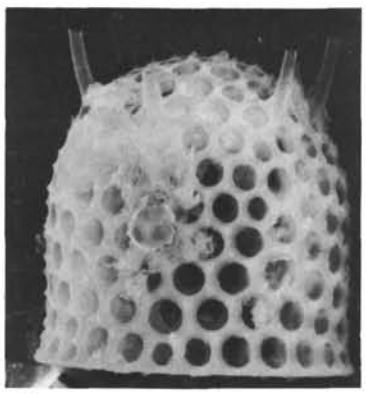

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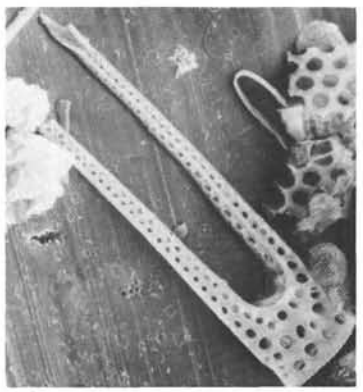

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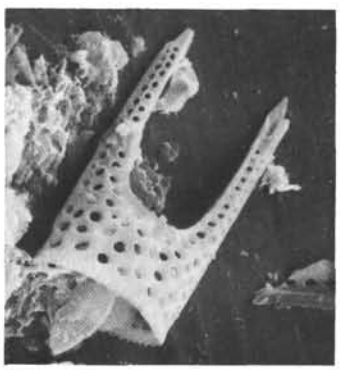

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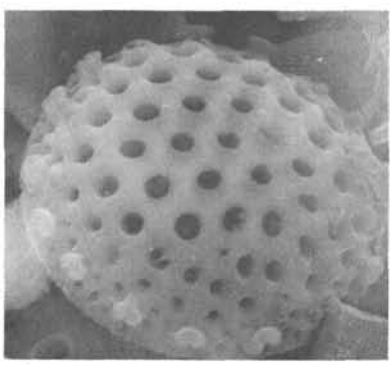

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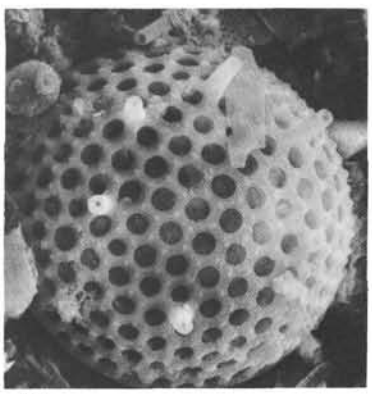

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PLATE 17

Figures 1-7 ×1000; Figures 8-10 ×600; Figures 11-15 ×1000.

Figure 1 *Xanthiopyxis ovalis* Lohm.? (resting spore): 337-10.

Figure 2 *Xanthiopyxis globosa* Ehr.: 337-10.

Figures 3-6 *Archaeomonas* sp. sp.: 337-9.

Figure 7 *Periptera* sp. (Jousé): 337-10.

Figure 8 *Periptera tetracladia* Ehr.: 338-10, CC.

Figure 9 *Xanthiopyxis biscoctiformis* Forti: 338-10, CC.

Figure 10 *Stephanogonia hanzawae* Kanaya: 338-10, CC.

Figure 11 *Periptera* sp. 2 (Jousé): 338-6.

Figure 12 *Xanthiopyxis* sp. (*X. globosa*?): 338-20, CC.

Figure 13 *Xanthiopyxis acrolopha* Forti: 338-10, CC.

Figure 14 *Stephanogonia poligona* Ehr.: 338-10, CC.

Figure 15 Genus indet. (resting spore): 337-11.

PLATE 17


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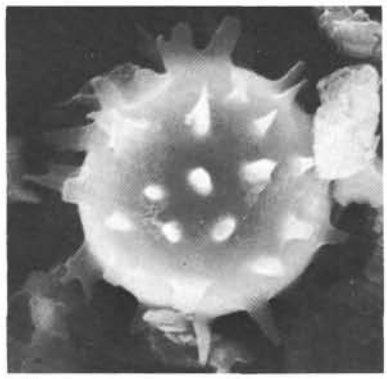
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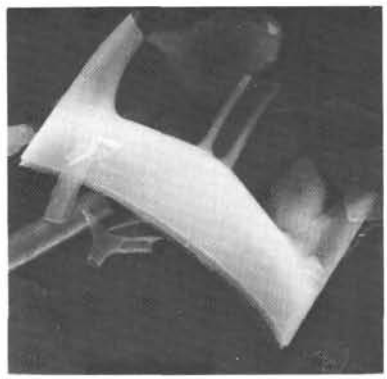
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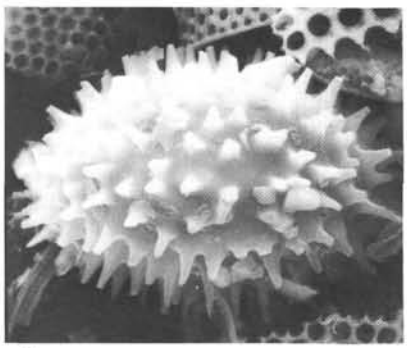
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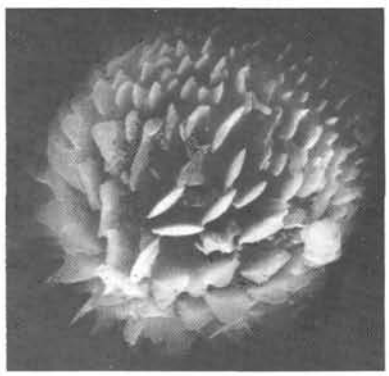
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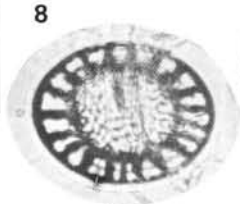
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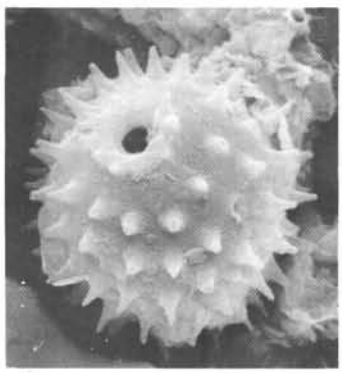
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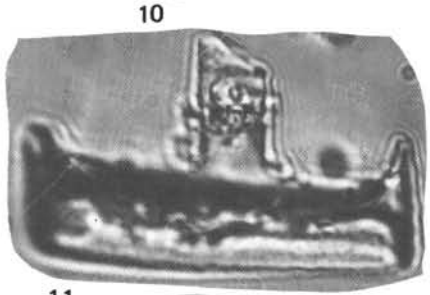
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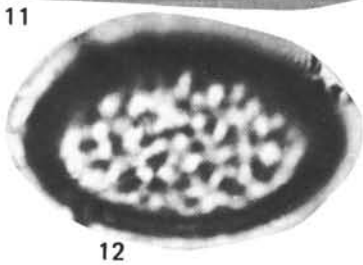
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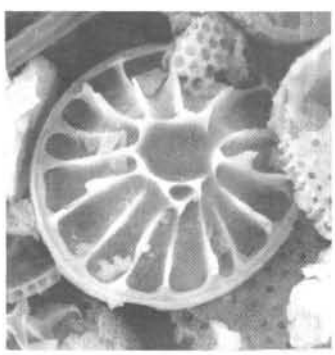
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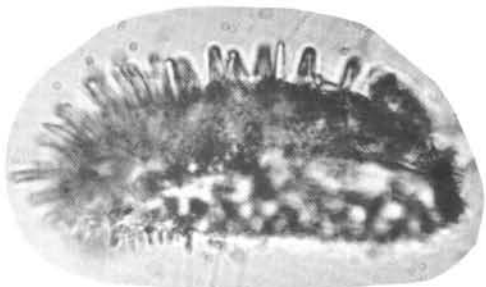
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PLATE 18

Figures 1-7, 9, 15 ×750; Figures 8, 10, 13-14, 16 ×1250; Figures 11, 12 ×500.

Figures 1, 4 *Raphoneis lancettula* Grun.: 337-11.

Figure 2 *Raphoneis* sp. 1 (Jousé): 337-9.

Figure 3 *Raphoneis lancettula* Grun.: 338-16-6.

Figure 5 *Gyrodiscus vortex* Witt: 337-9.

Figure 6 *Stephanopyxis marginata* Grun: 338-22.

Figure 7 *Stephanopyxis* sp.: 338-10, CC.

Figure 8 *Pseudotriceratium radiosoreticulatum* Grun.: 338-22.

Figure 9 *Triceratium* sp.: 338-10, CC.

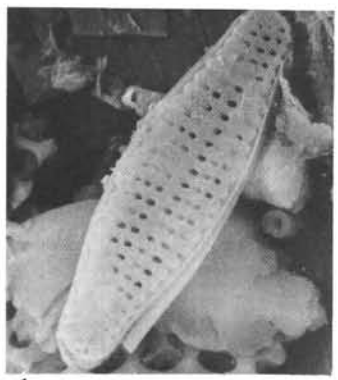
Figure 10 *Muelleriopsis limbata* (Van Heurck) Hendey: 337-11.

Figures 11-14 *Pyxilla caputavis* Brun: 337-9-6.

Figure 15 *Rhizosolenia manifica* Jousé sp. n.: 337-9-6.

Figure 16 *Pseudopyxilla directa* (Pant.) Forti: 336-16-6.

PLATE 18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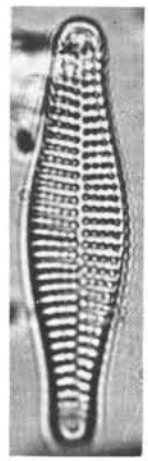
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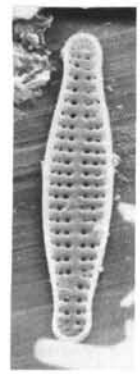
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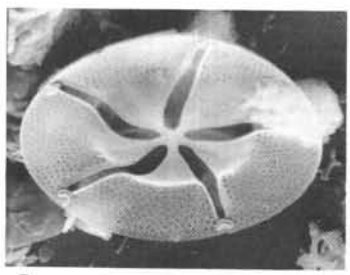
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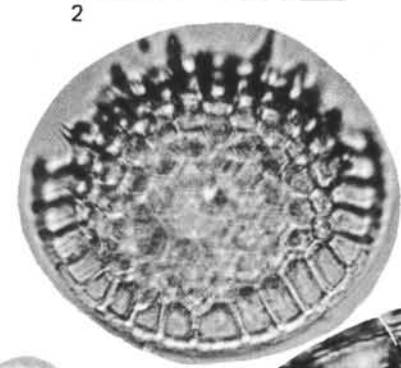
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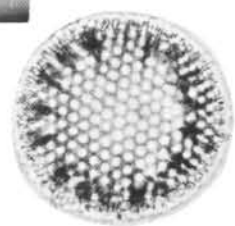
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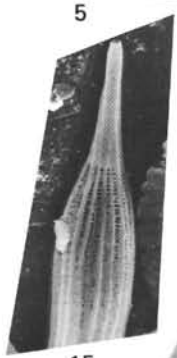
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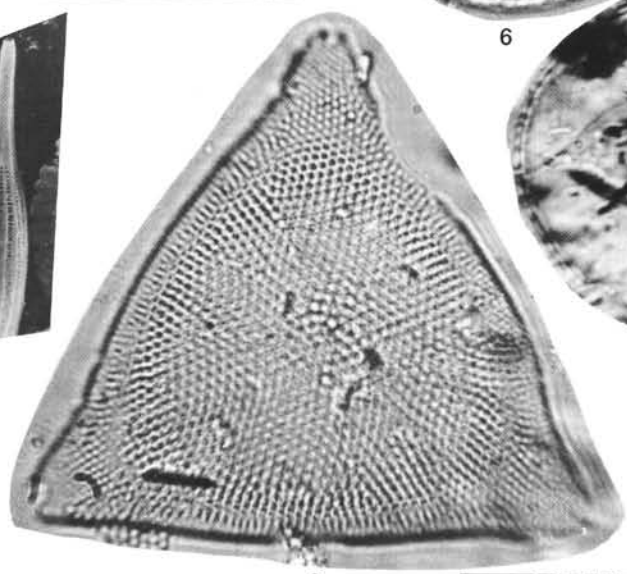
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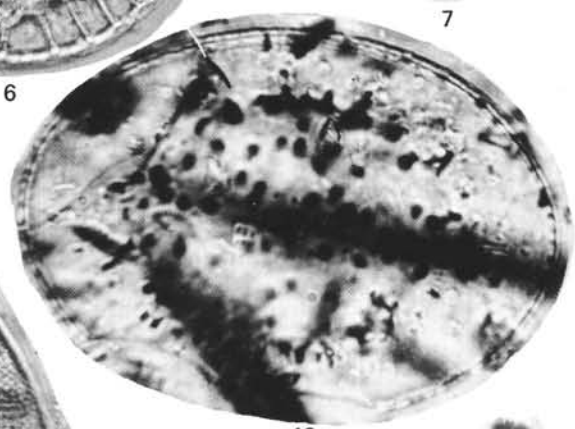
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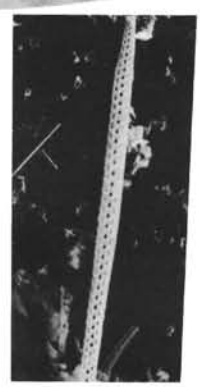
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PLATE 19

Miocene-Pleistocene diatoms. All Figures ×1000.

Figure 1 — *Actinocyclus oculatus* Jousé: 336-9-3, 30-32 cm.

Figure 2 — *Coscinodiscus endoi* Kanaya: 338-8-3, 100-102 cm.

Figures 3, 4 — *Thalassiosira zabelinae* Jousé.
3. 336-8-6, 40-42 cm.
4. 336-9-3, 30-32 cm.

Figures 5, 6 — *Thalassiosira* sp.: 348-11-1, 120-122 cm.

Figures 7-10 — *Thalassiosira* aff. *manifesta* Sheshukova.
7, 8, 10. 348-11-1, 120-122 cm.
9. 348-13-2, 130-132 cm.

Figure 11 — *Rhizosolenia miocenica* Schrader: 348-15-3, 105-107 cm.

PLATE 19

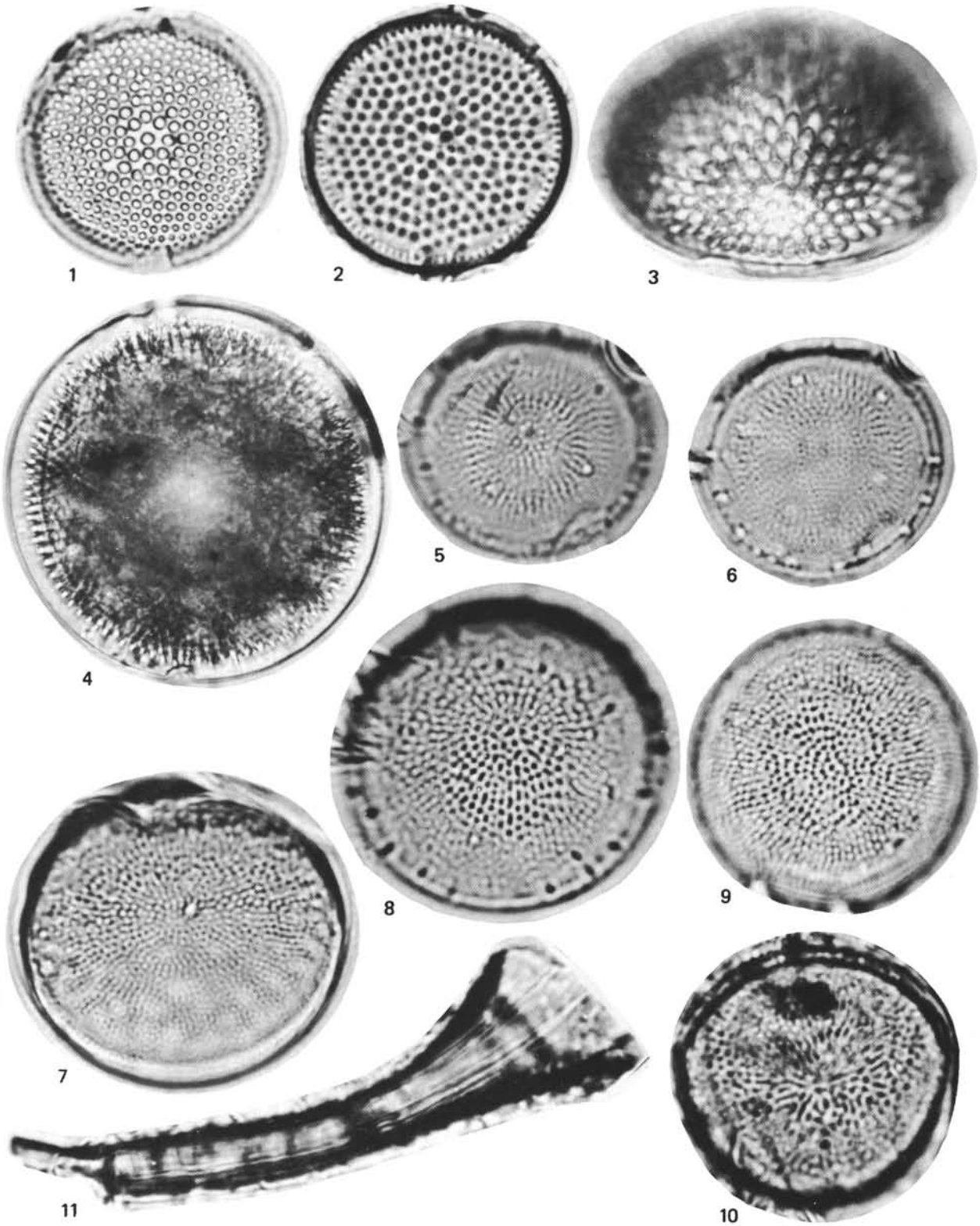

PLATE 20

Upper Miocene-Pleistocene diatoms. Figures 1-10, 17-23, 25, 27-30 ×1700. Figures 11-16, 24, 26 ×1000.

Figures 1, 2, 11	*Denticula hustedtii* Simonsen et Kanaya. 1, 2. 348-14-3, 125-127 cm. 11. 338-8-3, 100-102 cm.
Figures 3, 4	*Denticula punctata* Schrader: 348-12-3, 135-137 cm.
Figures 5, 6, 12-14	*Denticula seminae* Simonsen et Kanaya: 336-9-3, 30-32 cm.
Figure 7	*Denticula kamtschatica* Zabelina: 336-9-3, 30-32 cm.
Figures 8-10	*Denticula lauta* Bailey: 338-8-3, 100-102 cm.
Figure 15	*Pterotheca reticulata* Sheshukova: 348-13-2, 130-132 cm.
Figure 16	*Thalassiosira nidulus* (Temp. et Brun): 348-6-1, 140-142 cm.
Figure 17	*Raphoneis* sp. 1: 348-15-3, 105-107 cm.
Figure 18	*Raphoneis* sp. 2: 348-12-3, 135-137 cm.
Figure 19	*Nitzschia* sp. 1: 348-7-3, 128-130 cm.
Figure 20	*Nitzschia* sp. 2: 348-8-3, 100-102 cm.
Figure 21	*Nitzschia* aff. *extincta* Kozyrenko et Sheshukova: 348-14-3, 125-127 cm.
Figures 22, 23	*Thalassiosira oestrupii* (Ostf.) Pr.-Lavr.: 348-8-3, 128-130 cm.
Figure 24	*Thalassiosira decipiens* (Grun.) Jörg.: 348-6-1, 140-142 cm.
Figure 25	*Thalassiosira nativa* Sheshukova: 348-8-3, 128-130 cm.
Figure 26	*Rhizosolenia barboi* Brun: 348-7-1, 130-132 cm.
Figure 27, 28	*Thalassiosira gravida f. fossilis* Jousé: 336-9-3, 120-122 cm.
Figures 29, 30	*Thalassiosira hyalina* (Grun.) Gran: 348-8-3, 128-130 cm.

PLATE 20

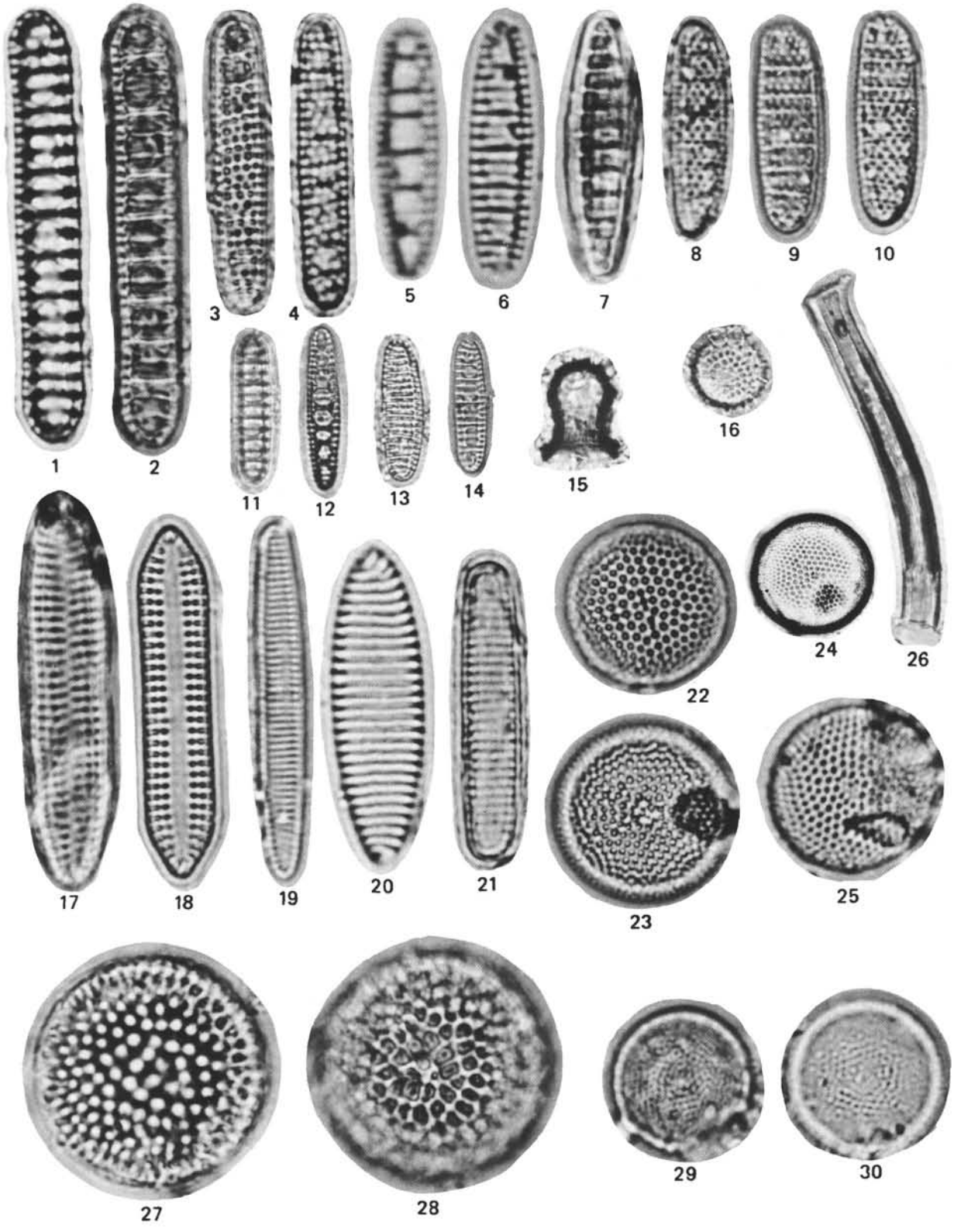
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PLATE 21

Eocene radiolarians, Figure 1 ×140; all others ×200.

Figure 1 — *Acanthosphaera* sp. H: 337-10-3, 110-112 cm.

Figure 2 — *Thecosphaerella glebulenta* Sanfilippo and Riedel: 337-10-3, 110-112 cm.

Figure 3 — *Haliomma* sp. N: 339-12-3, 100-102 cm.

Figure 4 — *Acanthosphaera* (?) sp. L: 339-12-3, 100-102 cm.

Figure 5 — *Haliomma* (?) *sp.* aff. *Cenosphaera eocenica* Clark and Campbell: 340-10-3, 130-132 cm.

Figure 6 — *Cenosphaera cristata* Haeckel grp.: 339-12-3, 100-102 cm.

Figure 7 — *Actinommura* (?) *californica* (Clark and Campbell): 340-7-6, 120-122 cm.

Figure 8 — *Haliomma* sp. aff. *H. oculatum* Ehr.: 339-12-3, 100-102 cm.

Figure 9 — *Hexastylus* sp. aff. *H. solonis* Haeckel: 338-26, CC.

Figure 10 — *Cenosphaera* (?) *mariae* Lipman: 343-5-3, 50-52 cm.

Figures 11 — *Haliomma* (?) sp. E: 343-5-6, 90-92 cm.

Figure 12 — *Hexastylus* sp. aff. *Haliphormis hexacantha* Ehr.: 340-9-3, 110-112 cm.

Figure 13 — *Thecosphaera leptococcos* Carnevalle: 339-12-3, 100-102 cm.

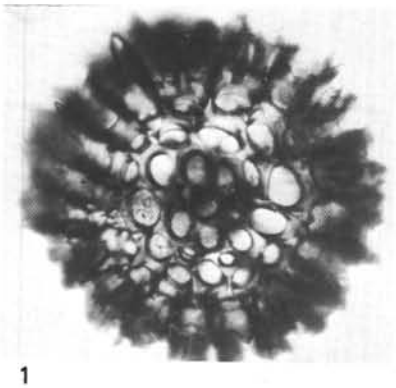
Figure 14 — *Heliosoma* (?) *mirabile* Clark and Campbell: 340-9-3, 110-112 cm.

Figure 15 — *Acanthosphaera* (?) aff. *A. setosa* Ehr.: 340-9-3, 110-112 cm.

Figure 16 — *Thecosphaera diligens* Kozlova: 340-9-3, 110-112 cm.

Figure 17 — *Thecosphaera diligens* Kozlova: 340-9-3, 110-112 cm.

PLATE 21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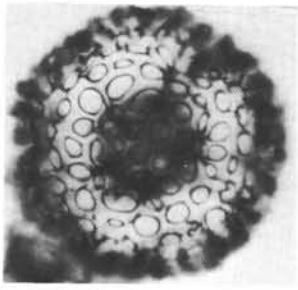
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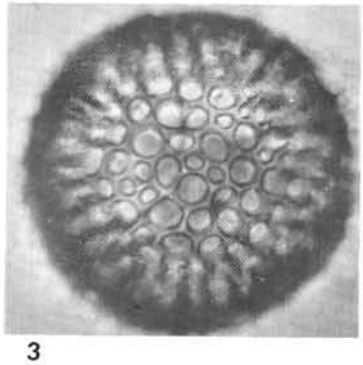
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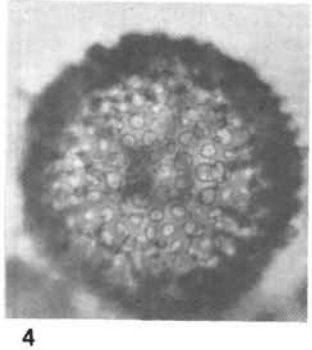
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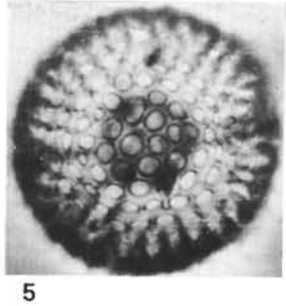
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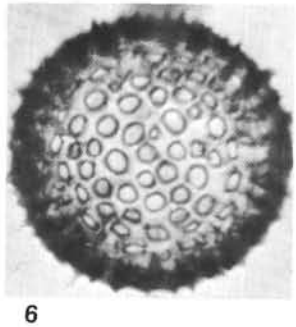
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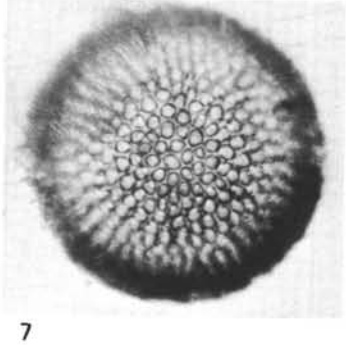
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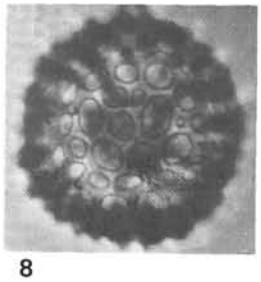
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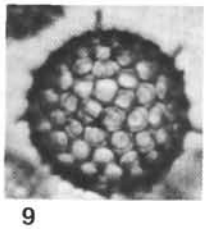
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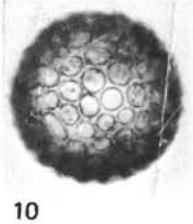
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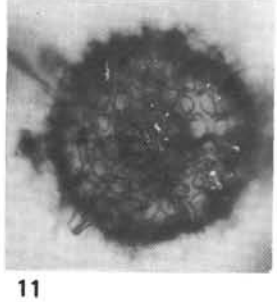
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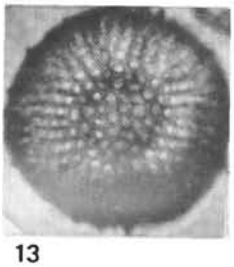
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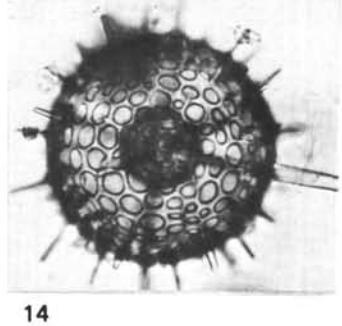
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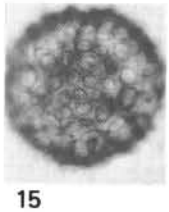
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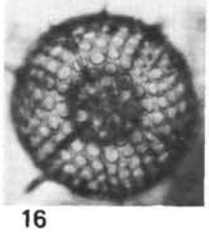
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PLATE 22

Eocene radiolarians. All figures ×200.

Figures 1, 2 — *Stylosphaera* (?) sp. aff. *Cromyodruppacarpus esterae* Clark and Campbell: 343-5-6, 90-92 cm.

Figures 3, 4 — *Amphisphaera spinulosa* Ehr.
3. 338-27-3, 88-90 cm.
4. 339-7-3, 105-107 cm.

Figure 5 — *Amphisphaera* sp. aff. *Stylosphaera sulcata* Ehr.: 340-10-3, 130-132 cm.

Figure 6 — *Hexaconthium* sp. aff. *H. pachydermum* Jørgensen: 338-26-3, 52-54 cm.

Figure 7 — *Actinomma beroes* (Ehr.) grp.: 340-10-3, 130-132 cm.

Figures 8, 9 — *Amphisphaera* (?) *spinulosa* Ehr. f. D: 338-26-3, 52-54 cm.

Figure 10 — *Cenellipsis bergontianus* Carnevale grp.: 339-12-3, 100-102 cm.

Figure 11 — *Amphistylus* (?) sp. aff. *A. ensiger* Kozlova: 343-5-3, 50-52 cm.

Figures 12, 13 — *Stylosphaera minor* Clark and Campbell.
12. 340-9-3, 110-112 cm.
13. 339-12-3, 100-102 cm.

Figure 14 — *Stylosphaera minor leptoxiphos* Clark and Campbell: 343-5-6, 90-92 cm.

Figure 15 — *Amphistylus* (?) *ensiger* Kozlova: Western Siberian, River N. Soswa, Hole 1, 23-27 m.

Figure 16 — *Axoprunum* sp. aff. *Stylacontarium bispiculum* Popofsky. 339-10-2, 110-112 cm.

Figure 17 — *Axoprunum liostylum* (Ehr.): 339-7-3, 105-107 cm.

Figure 18 — *Axoprunum visendus* (Kozlova): Western Siberian, Kurgan, Hole 1-OK, 72.5 m.

Figure 19 — *Axoprunum pierinae* (Clark and Campbell): 340-4, CC.

PLATE 22


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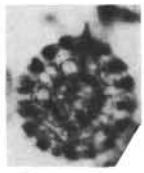
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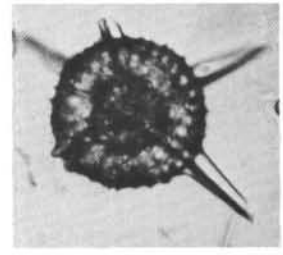
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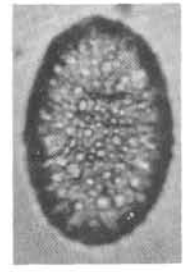
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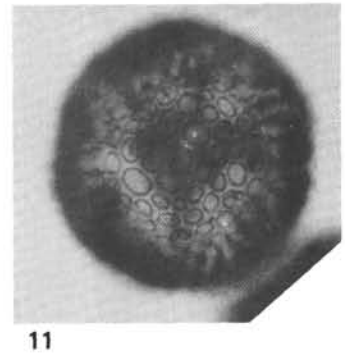
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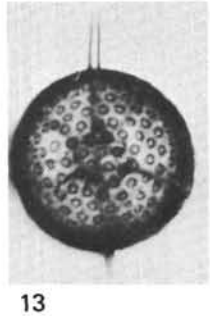
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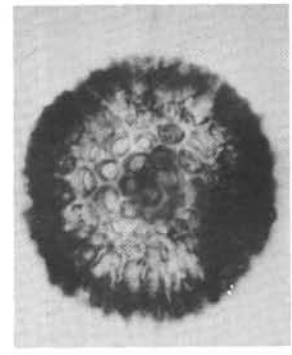
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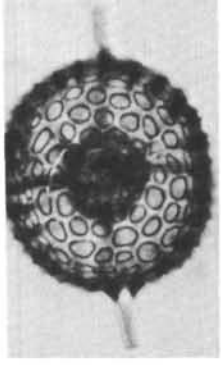
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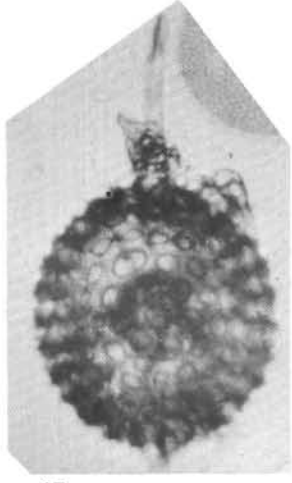
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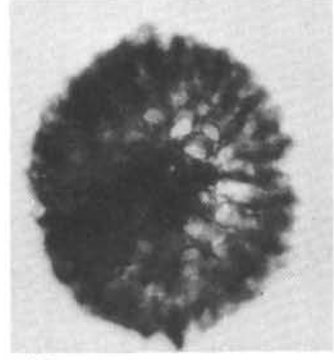
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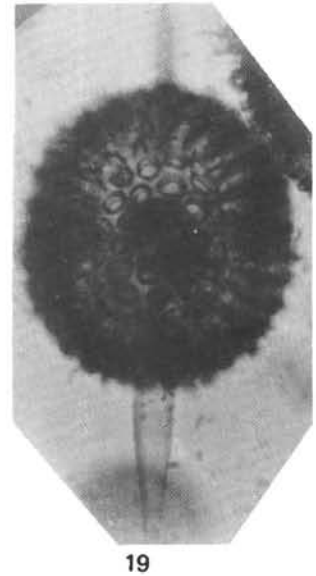
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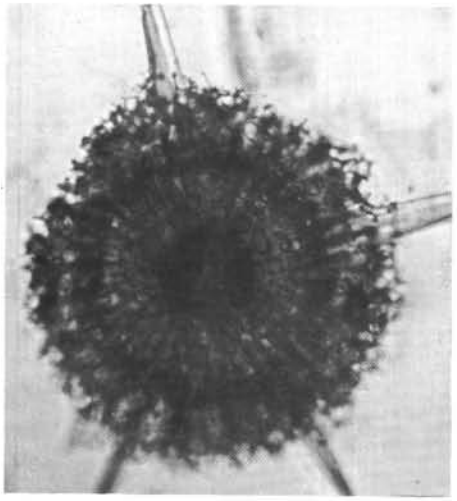
PLATE 23

Eocene radiolarians. Figures 1, 9 ×140; all others ×200.

Figures 1, 5	*Heliodiscus hexasteriscus* Clark and Campbell f. D.: 340-10-3, 130-132 cm.
Figures 2, 3	*Phacodiscus* sp. D: 340-7-6, 120-122 cm.
Figure 4	*Heterosestrum* (?) *tschujenkoi* (Lipman): 338-27-3, 88-90 cm.
Figure 6	*Heliodiscus hexasteriscus* Clark and Campbell: 338-28, CC.
Figure 7	*Phacodiscus testatus* Kozlova: Kasachstan, Chelkar, Hole 330, 192-195 m.
Figure 8	*Phacodiscus testatus* Kozlova f. D: 338-28, CC.
Figures 9-11	*Phacodiscus* sp. Q: 343-5-6, 90-92 cm.
Figure 12	*Phacodiscus testatus* Kozlova f. S: 338-29, CC.

PLATE 23



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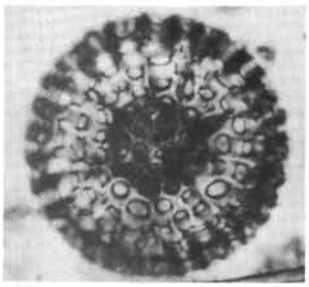

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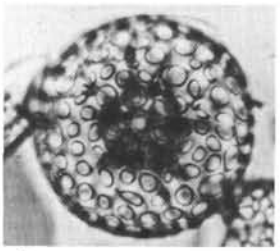

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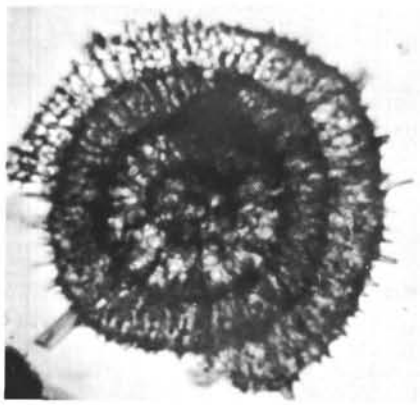

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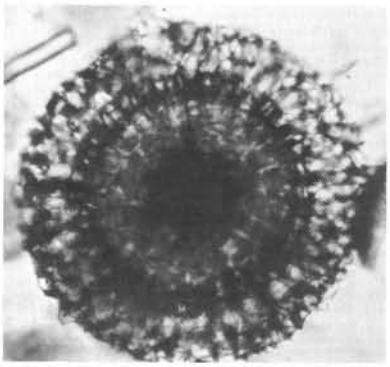

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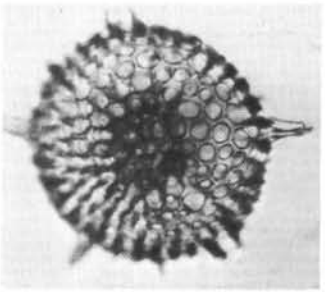

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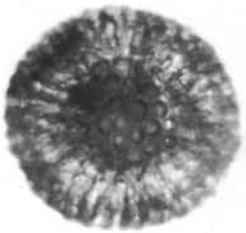

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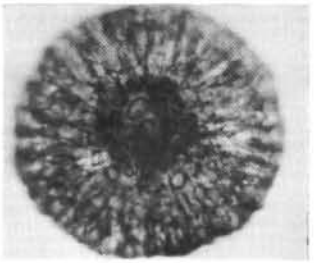

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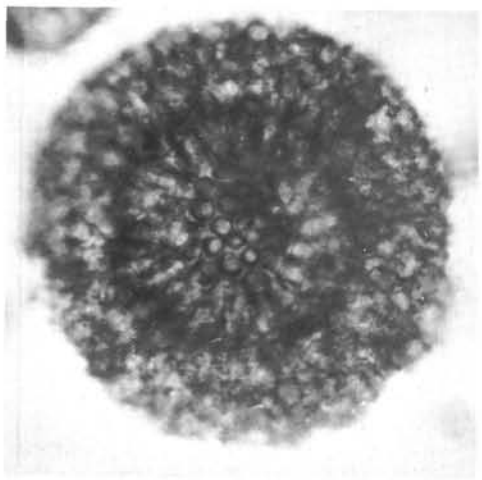

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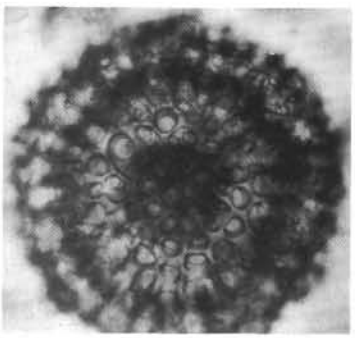

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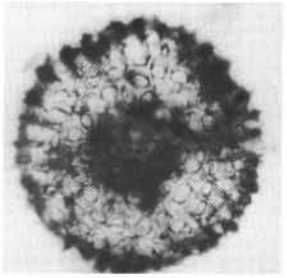

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PLATE 24

Eocene radiolarians. Figures 4, 5 ×140; all others ×200.

Figures 1-5 — *Heterosestrum tschujenkio* (Lipman) grp. Fig. 5 vertical optical section.
1, 2. 338-27-3, 88-90 cm.
4. 338-27, CC.
3, 5. 340-4, CC.

Figure 6 — *Heterosestrum* (?) sp. "sph.": 340-4, CC.

Figure 7 — *Staurodictya* (?) *densa* Kozlova. Western Siberia, Ljawdinka, Hole 28, 316-320 m.

Figure 8 — *Heliodiscus perplexus* Clark and Campbell: 343-5-3, 50-52 cm.

Figure 9 — *Heliodiscus heliasteriscus* Clark and Campbell: 340-9-3, 110-112 cm.

Figure 10 — *Plectodiscus* (?) *mitidus* (Riedel and Sanfilippo): 343-5-3, 50-52 cm.

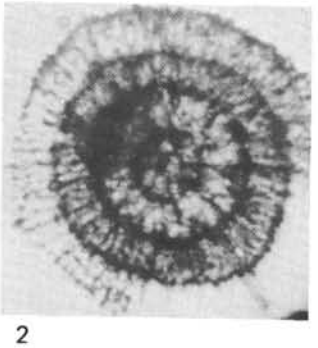
Figure 11 — *Plectodiscus circularis* (Clark and Campbell): 343-5-3, 50-52 cm.

Figure 12 — *Lithelius* sp. aff. *L. spiralis* Haeckel: 340-7-6, 120-122 cm.

Figure 13 — *Lithelius* sp. aff. *L. alveolina* Haeckel: 338-28, CC.

PLATE 24


1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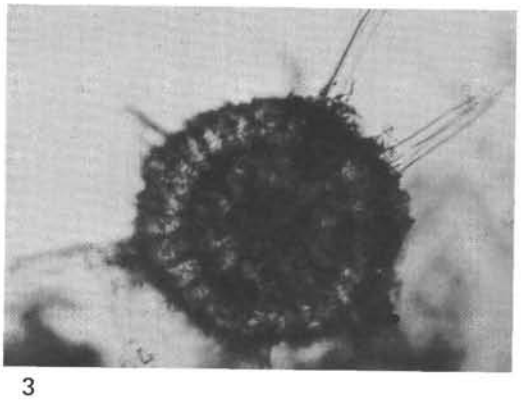
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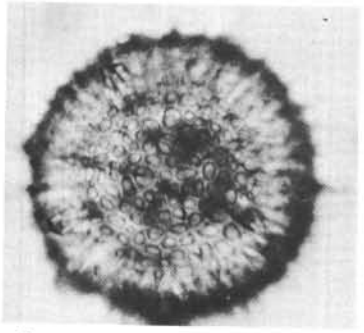
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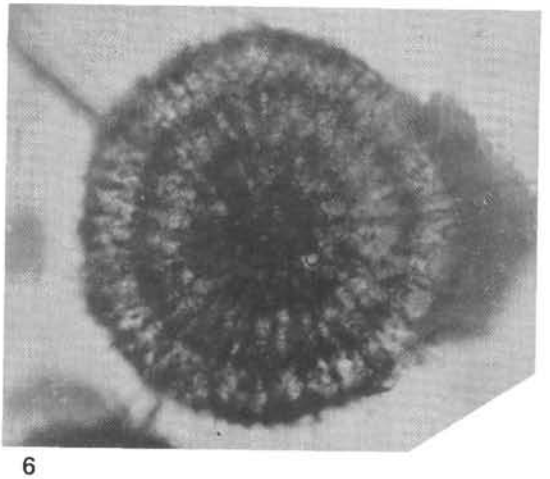
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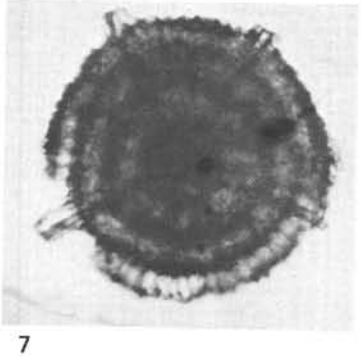
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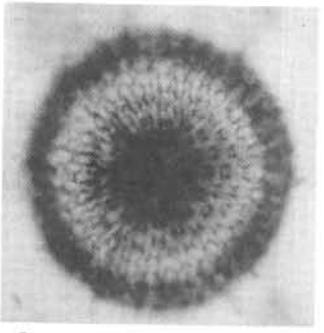
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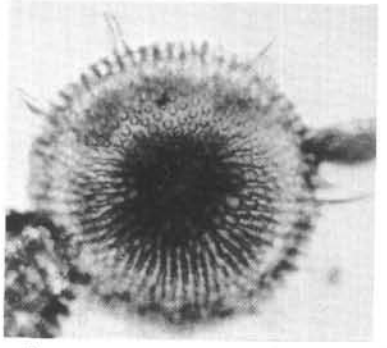
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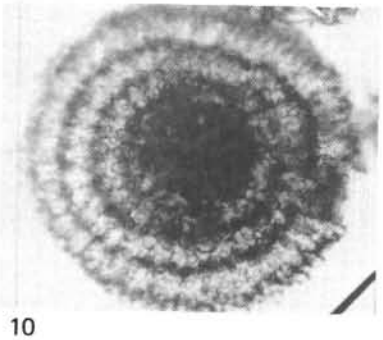
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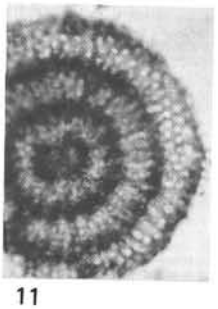
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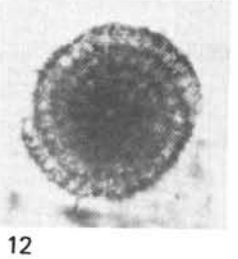
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PLATE 25

Eocene radiolarians. All figures ×140.

Figure 1 — *Stylodictya stellata* Bailey grp.: 339-12-3, 100-102 cm.

Figure 2 — *Stylodictya hastata* Ehr.: 338-26, CC.

Figure 3 — *Stylodictya targaeformis* Clark and Campbell subsp. *rosella* Kozlova: 339-7-3, 105-107 cm.

Figure 4 — *Stylospira dujardinii* (Haeckel) (or *Perichlamydium limbatum* Ehr.) grp.: 340-10-3, 130-132 cm.

Figure 5 — *Stylodictya centrospira* Haeckel: 338-27-3, 88-90 cm.

Figures 6, 8, 9 — *Stylospongia communis* (Clark and Campbell).
6. 338-26, CC.
8, 9. 338-27-3, 88-90 cm.

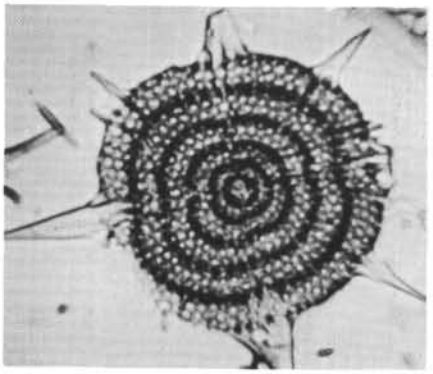
Figures 7, 10 — *Stylospongia elliptica* (Carnevale) subsp. *spiralis* Bjørklund and Kellogg: 339-12-3, 100-102 cm.

Figure 11 — *Spongodiscus* sp.: 339-12-3, 100-102 cm.

Figure 12 — *Spongodiscus craticulatus* (Stöhr) grp.: 338-29, CC.

PLATE 25


1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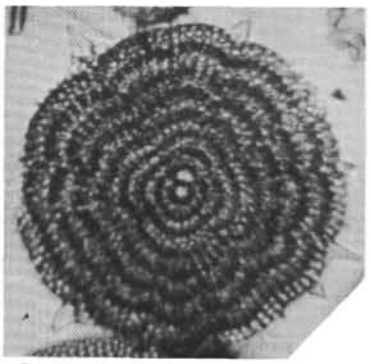
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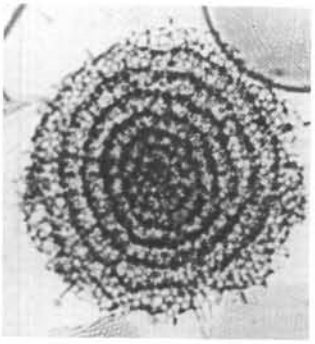
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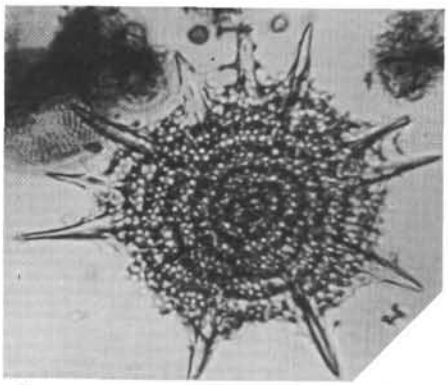
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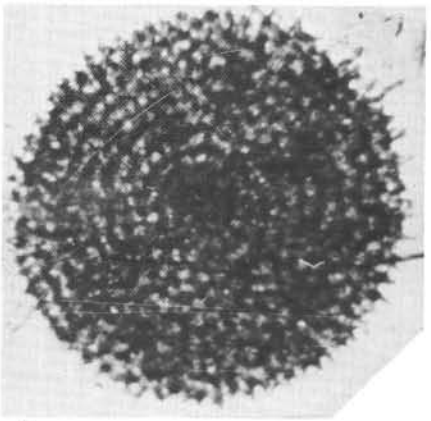
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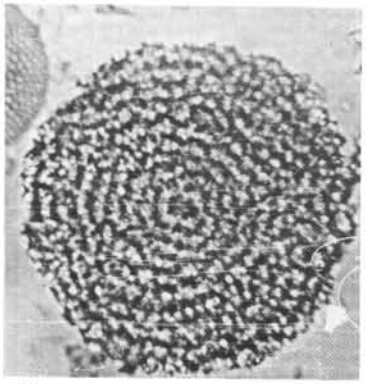
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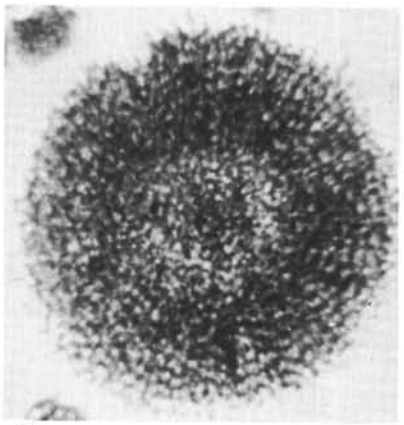
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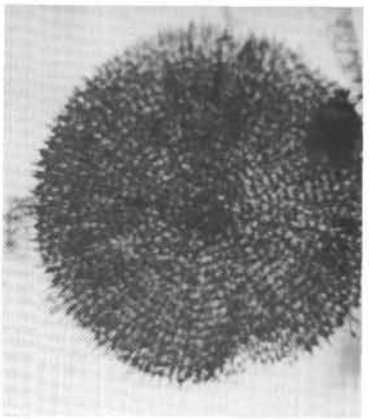
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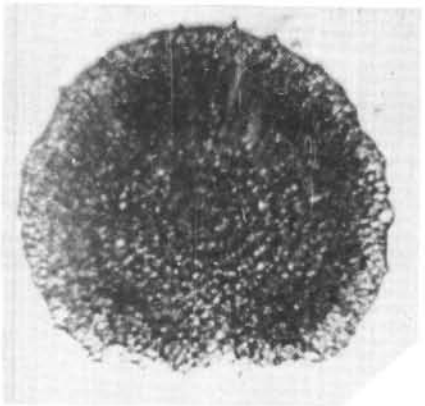
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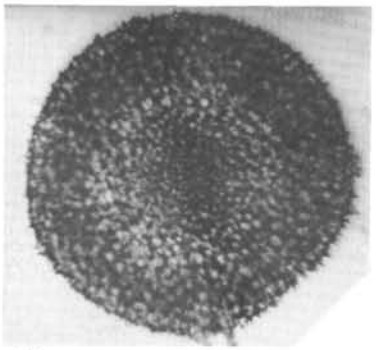
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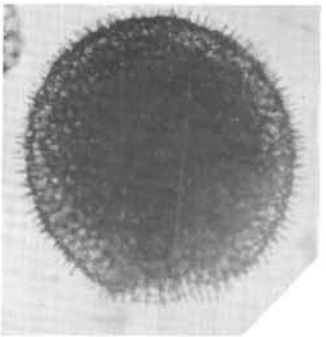
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PLATE 26

Eocene radiolarians. Figures 1, 2 ×140; Figure 16 ×125; all others ×200.

Figure 1 — *Peripyramis* sp. aff. *P. magnifica* (Clark and Campbell) grp.: 339-12-3, 100-102 cm.

Figure 2 — *Peripyramis* sp. A: 338-27-3, 88-90 cm.

Figure 3 — *Peripyramis quadratella* (Ehr.): 340-9-3, 110-112 cm.

Figure 4 — *Peripyramis victory* (Lipman): Western Siberia, Ljawdinka, Hole 28, 316-320 m.

Figure 5 — *Clathrocycloma parcum* Foreman: 343-5-6, 50-52 cm.

Figure 6 — *Pteropilium* (?) sp.: 340-7-6, 120-122 cm.

Figure 7 — *Clathrocyclas* (?) sp.: 340-7-6, 120-122 cm.

Figure 8 — *Cornutella clathrata profunda* B. Ehr.: 339-12-3, 100-102 cm.

Figure 9 — *Theocalyptra* (?) *tetracantha* Bjørklund and Kellogg: 338-26-3, 52-54 cm.

Figure 10 — *Diplocyclas cornuta* (Baily) grp.: 338-27-3, 88-90 cm.

Figure 11 — *Dictyophimus* sp. aff. *D. histricosus* Jørgensen: 340-9-3, 110-112 cm.

Figure 12 — *Ceratocyrtis cuccularis* (Ehr.) grp.: 339-12-3, 100-102 cm.

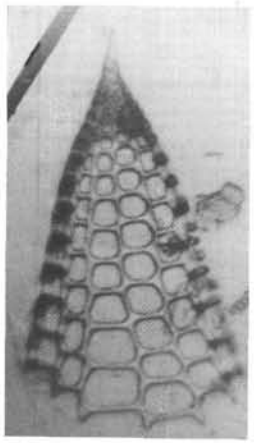
Figure 13 — *Ceratocyrtis* (?) *campanula* (Clark and Campbell): 338-26, CC.

Figure 14 — *Lampromitra* (?) sp. aff. *L. erosa* Cleve: 338-26-3, 52-54 cm.

Figure 15 — *Bathrocalpis* (?) *rhabdophora* Clark and Campbell grp.: 338-26, CC.

Figure 16 — *Velicucullus* sp. R: 340-7-6, 120-122 cm.

PLATE 26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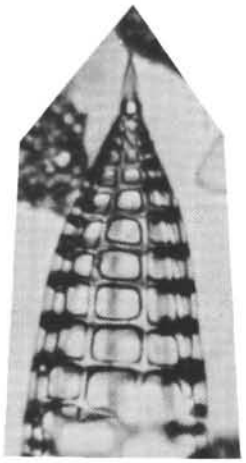
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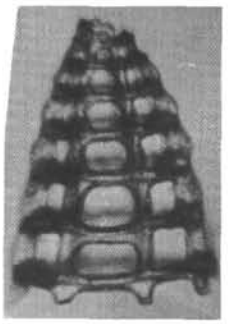
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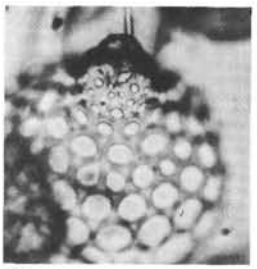
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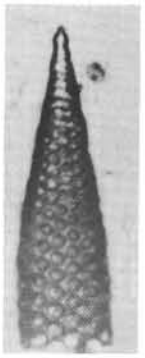
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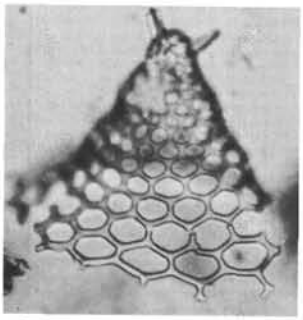
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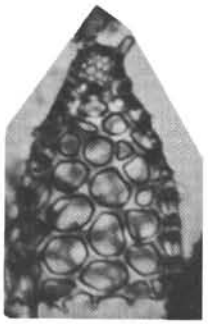
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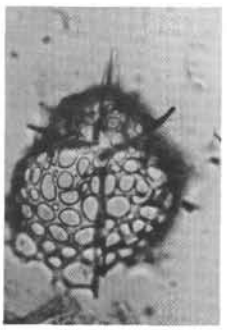
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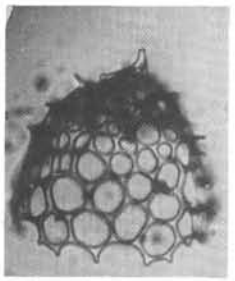
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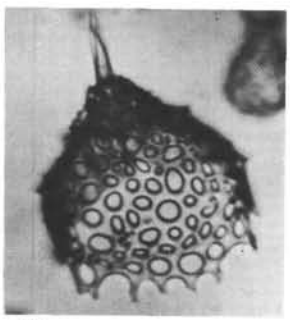
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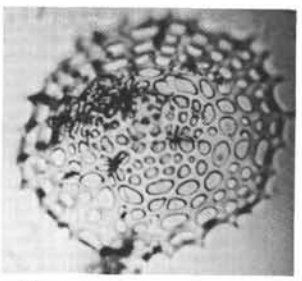
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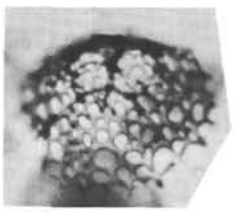
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PLATE 27

Eocene radiolarians. Figures 1, 2, 3 ×140; all others ×200.

Figures 1, 2 — *Clathrocyclas* (?) *extensa* (Clark and Campbell) *talwanii* (Bjørklund and Kellogg).
1. 338-27, CC.
2. 340-7-6, 120-122 cm.

Figures 3, 4 — *Clathrocyclas* (?) sp. sp.
3. 343-5-6, 90-92 cm.
4. 338-27-3, 88-90 cm.

Figures 5-7 — *Clathrocyclas* (?) *extensa* (Clark and Campbell) *unicum* Lipman.
5. 343-5-6, 90-92 cm.
6-8. Western Siberia, River Oliku-By-Tarca.

Figure 8 — *Clathrocyclas* sp. Western Siberia, River Oliku-Bai-Tarca.

Figures 9, 10 — *Clathrocyclas* (?) sp. aff. *Clathrocyclas* (?) *extensa unicum* (Lipman).
9. 343-5-3, 50-52 cm.
10. Western Siberia, Kurgan, Hole 1-OK, 71.5 m.

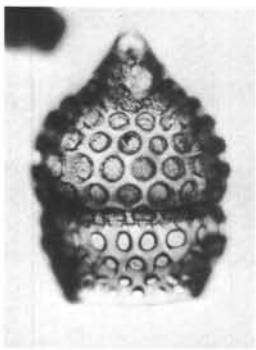
Figures 11, 12 — *Clathrocyclas*? *extensa* (Clark and Campbell) *multiplicatus* Lipman.
11. 343-5-3, 50-52 cm.
12. Western Siberia, Petuchovo, Hole 4, 150-156 m.

Figures 13, 14 — *Clathrocyclas* (?) *extensa* (Clark and Campbell) *tamdiensis* Lipman.
13. 343-5-3, 50-52 cm.
14. Western Siberia, River Oliku-By-Tarca.

Figure 15 — *Clathrocyclas* (?) sp. aff. *Sethocyrtis elegans* Lipman 338-27, CC.

Figure 16 — *Sethocyrtis* (?) *elegans* Lipman: Western Siberia, Petuchovo, Hole 4, 173-181 m.

PLATE 27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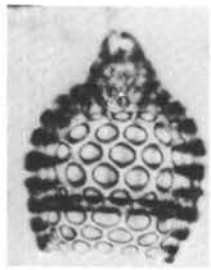
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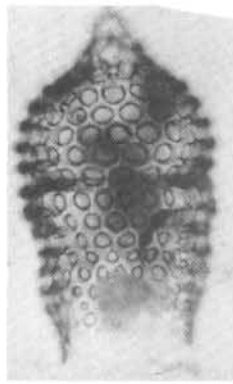
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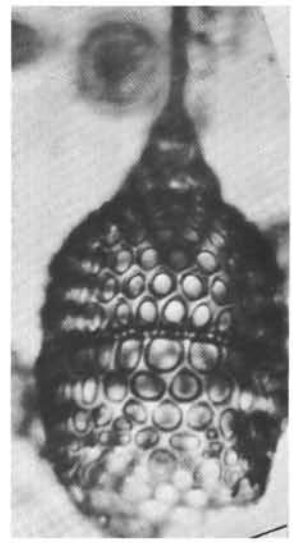
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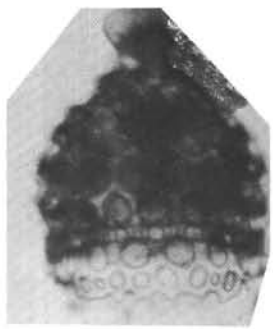
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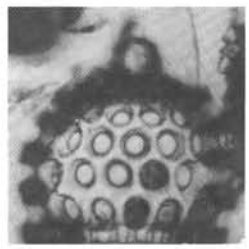
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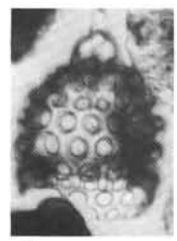
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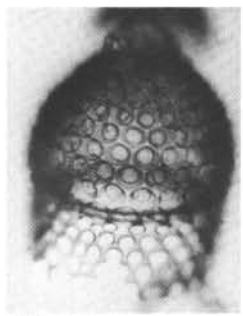
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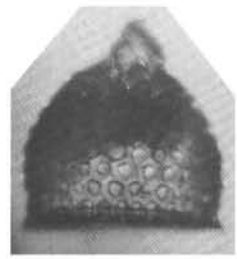
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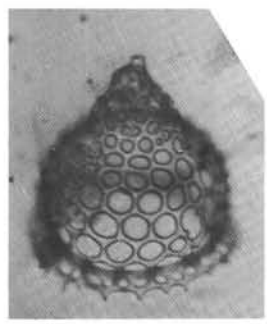
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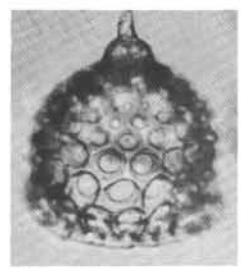
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PLATE 28

Eocene radiolarians. All figures ×200.

Figure 1 — *Theocyrtis litos* (Clark and Campbell) *forma* Cr.: 339-12-3, 100-102 cm.

Figure 2 — *Theocyrtis litos* (Clark and Campbell) *forma* U: 340-7-6, 120-122 cm.

Figure 3 — *Cyrtophormis* sp. Ch Petrushevskaya and Kozlova: 339-12-3, 100-102 cm.

Figures 4, 5 — *Cyrtophormis* (?) sp. aff. *Eucyrtidium cubense* Riedel and Sanfilippo: 338-27, CC.

Figure 6 — *Theocyrtis litos* (Clark and Campbell): 338-27, CC.

Figure 7 — *Theocyrtis* sp.: 340-9-3, 110-112 cm.

Figures 8, 9 — *Theocyrtis litos rachipora* (Clark and Campbell)
8. 340-9-3, 110-112 cm.
9. 338-27, CC.

Figure 10 — *Theocyrtis litos* (Clark and Campbell) forma A: 343-5-6, 90-92 cm.

Figure 11 — *Theocyrtis litos* (Clark and Campbell) forma U (?): 340-10-3, 130-132 cm.

Figure 12 — *Lophocorvs* (?) *bicorne* (Ehr.): 338-28, CC.

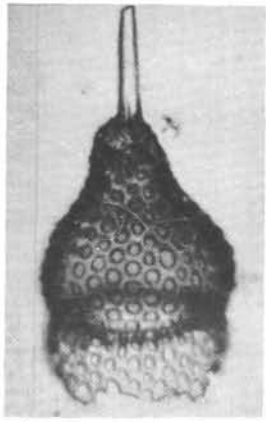
Figures 13, 14 — *Lophocorys* sp.
13. 338-26, CC.
14. 338-27-3, 88-90 cm.

Figure 15 — *Calocyclas asperum* (Ehr.): 340-11-3, 110-112 cm.

Figure 16 — *Lophocorys* (?) sp. aff. *Lophocorys auriculaleporis* (Clark and Campbell).

Figures 17, 18 — *Lophocorys* (?) *norvegiensis* Bjørklund and Kellogg: 338-26, CC.

PLATE 28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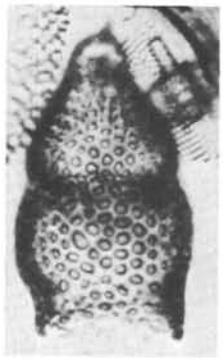
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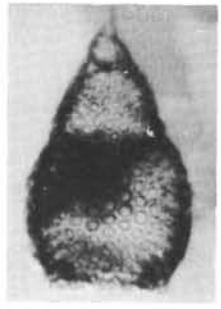
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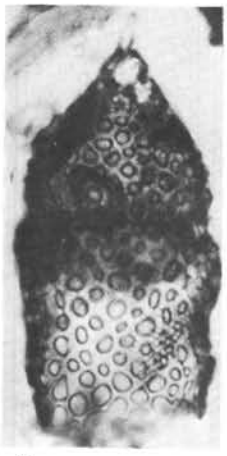
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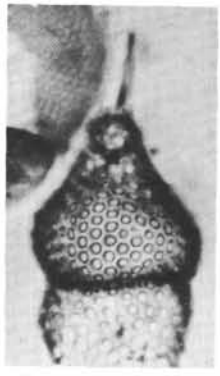
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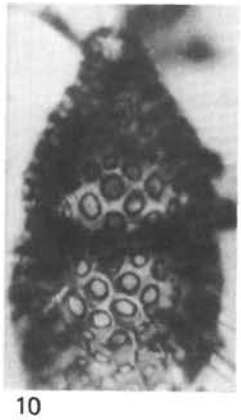
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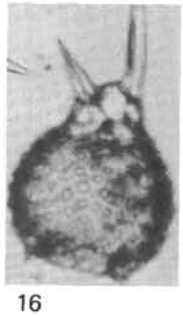
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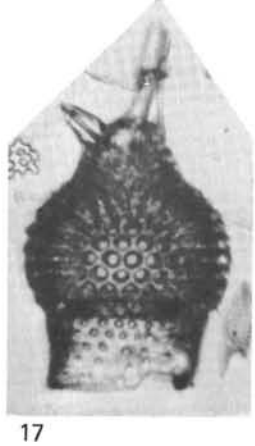
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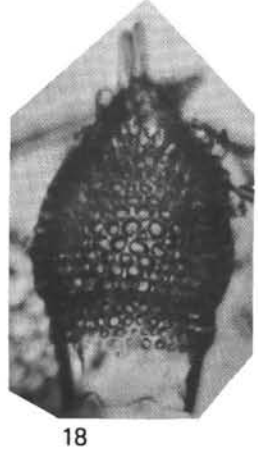
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PLATE 29

Eocene radiolarians.

Figure 1 — *Lithamphora* sp. aff. *L. quadrata* Petrushevskaya and Kozlova: 340-7-6, 120-122 cm.

Figure 2 — *Lithomitra* (?) sp. "T": 339-12-3, 100-102 cm.

Figures 3, 4 — *Lithomitra* (?) sp. P: 338-28, CC.

Figure 5 — *Lithomitra* (?) sp: 339-10-2, 110-112 cm.

Figure 6 — *Lithomitra* (?) sp. aff. *Lithocampe minuta* Clark and Campbell: 338-28, CC.

Figure 7 — *Lithomitra imbricata* (Ehr.) grp.: 339-7-3, 105-107 cm.

Figure 8 — *Bothryostrobus joides* Petrushevskaya grp.: 338-28, CC.

Figure 9 — *Eucyrtidium* (?) *picus* Ehr.: 338-27, CC.

Figure 10 — *Lithamphora* sp.: 340-27, CC.

Figure 11 — *Amphiptermis clava* (Ehr.): 338-27, CC.

Figure 12 — *Ceratospyris* sp. aff. *Tripospyris crassipes* (Clark and Campbell): 340-10-3, 130-132 cm.

Figure 13 — *Cladoscenium* sp. aff. *Tripilidium advena* Clark and Campbell: 339-12-3, 100-102 cm.

Figures 14, 15 — *Lithomelissa macroptera* Ehr.: 340-7-6, 120-122 cm.

Figure 16 — *Lithomelissa* sp. aff. *Dictyophimus sphaerocephalus* Haeckel: 338-27-3, 88-90 cm.

Figure 17 — *Tripodiscium* (?) sp.: 343-5-6, 90-92 cm.

Figure 18 — *Lophophaenidae* gen. sp. 343-5-6, 90-92 cm.

Figure 19 — *Lophophaena sibirica* (Gorbovetz): 343-5-6, 90-92 cm.

Figure 20 — *Lophophaena macrencephala* Clark and Campbell grp.: 340-7-6, 120-122 cm.

Figure 21 — *Spongomelissa* sp.: 339-12-3, 100-102 cm.

Figures 22, 23 — *Tripodiscium* (?) sp. sp. Western Siberia.
22. River Oliku-By-Tarca.
23. River N. Soswa, Hole 1, 27-37 m.

Figures 24, 25 — *Lophophaena sibirica* (Gorbovetz). Western Siberia.
24. Ljawdinka, Hole 28, 316-320 m.
25. River Oliku-By-Tarca.

PLATE 29


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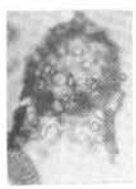
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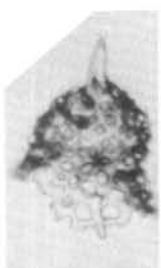
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PLATE 30

Eocene radiolarians.

Figure 1 — *Antarctissa* (?) sp. A: 340-7-6, 120-122 cm.

Figure 2 — *Antarctissa* (?) sp.: 340-9-3, 110-112 cm.

Figures 3, 4 — *Antarctissa* (?) sp. B: 343-5-6, 90-92 cm.

Figure 5 — *Antarctissa* (?) sp.: 343-5-6, 90-92 cm.

Figures 6-10 — *Tripodiscium* (?) *tumulosa* (Kozlova) grp.: 343-5-6, 90-92 cm.

Figure 11 — *Tripodiscium* (?) sp. Western Siberia, River Oliku-By-Tarca.

Figures 12-14 — *Tripodiscium* (?) *tumulosa* (Kozlova) grp. Western Siberia.
12, 13. Ljawdinka, Hole 28, 316-320 m.
14. Kurgan, Hole 1-ok, 72.5 m.

Figure 15 — *Clathromitridae* (?) gen. sp.: 343-4-6, 90-92 cm.

Figures 16, 20 — *Pseudodictyophimus* (?) sp. aff. *Sethoconus* (?) *reschetnjakae* (Petrushevskaya) forma A: 339-12-3, 100-102 cm.

Figure 17 — *Tripodiscium* (?) sp.: 340-9-3, 110-112 cm.

Figure 18 — *Tripodiscium* (?) *vanus* (Kozlova). Western Siberia, River Oliku-By-Tarca.

Figure 19 — *Lampromitridae* (?) gen. sp.: 343-5-6, 90-92 cm.

Figure 21 — *Pseudodictyophimus* (?) sp. aff. *Sethoconus*(?) *reschetnjakae* (Petrushevskaya) forma B: 338-27, CC.

Figures 22, 23 — *Pseudodictyophimus* (?) sp. C.
22. 337-11-3, 110-112 cm.
23. Western Siberia, Petuchovo, Hole 4, 150-156 m.

PLATE 30


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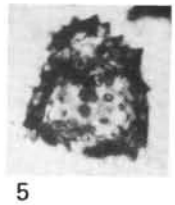
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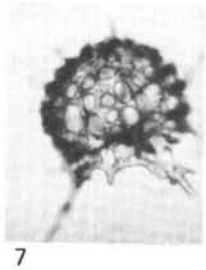
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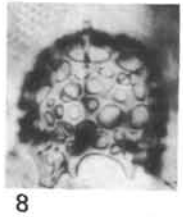
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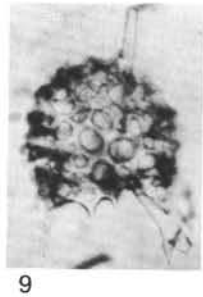
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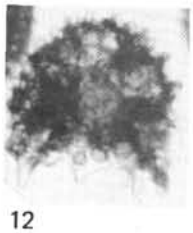
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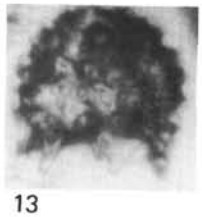
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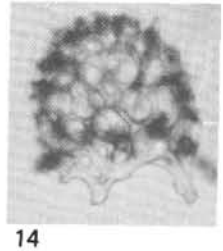
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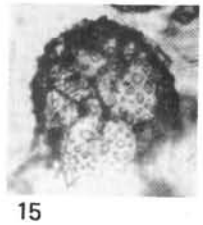
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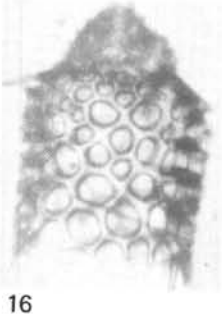
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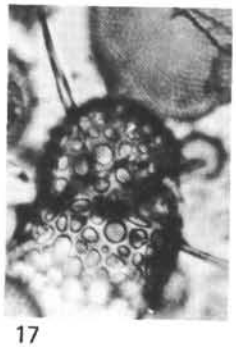
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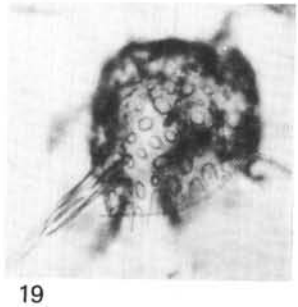
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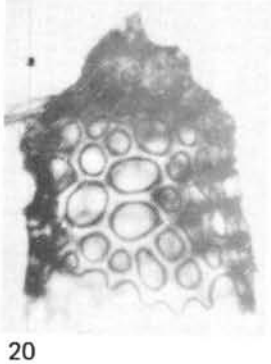
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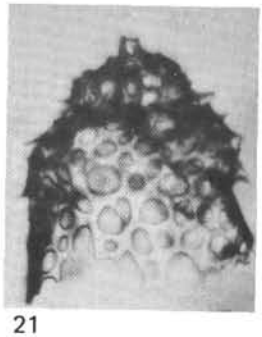
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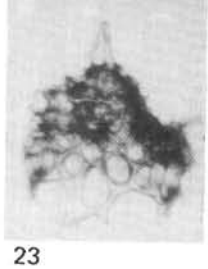
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PLATE 31

Eocene radiolarians.

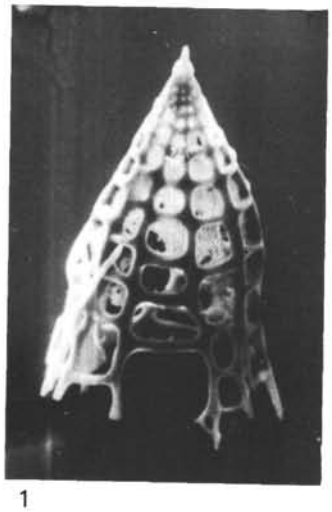
Figures 1-3 — *Peripyramis* sp. aff. *P. magnifica* Clark and Campbell grp.: 340-8-3.
1, 2. ×250.
3. ×290.

Figure 4 — *Peripyramis circumtexta* Haeckel grp., Eocene; 29-280A-3-4; ×285.

Figure 5 — *Ceratospyris* sp. aff. *Tripospyris crassipes* Clark and Campbell: 340-11-3; ×420.

Figures 6-9 — *Spongurus* (?) sp. aff. *S. bilobatus* Clark and Campbell.
6, 7. 340-6-3; ×290.
8. 340-8-3, ×200.
9. 340-8-3, ×500.

PLATE 31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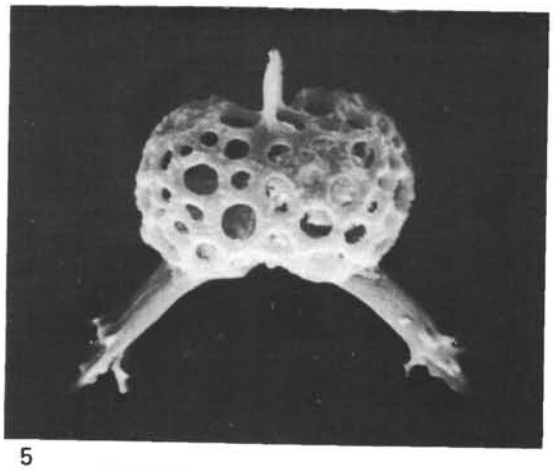
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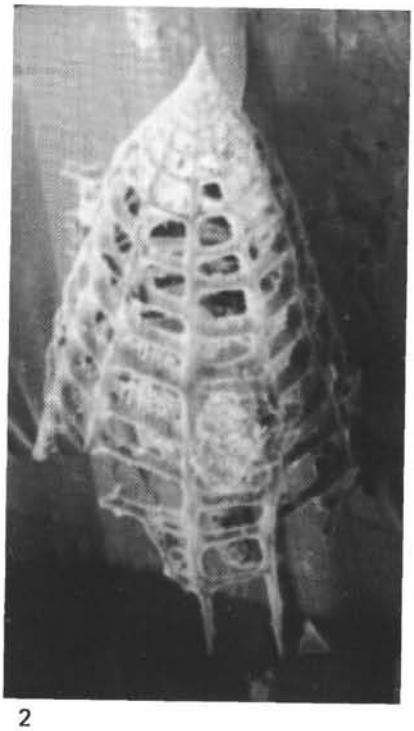
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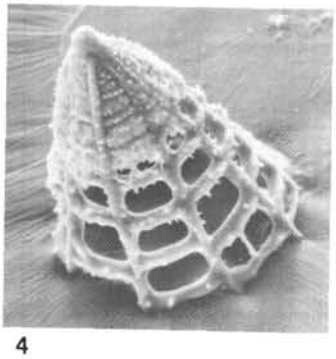
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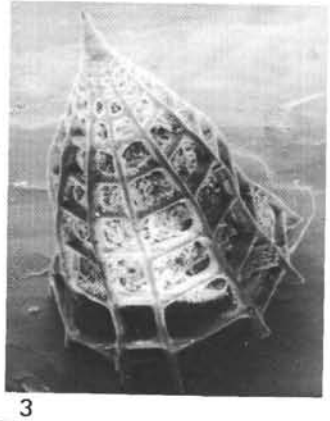
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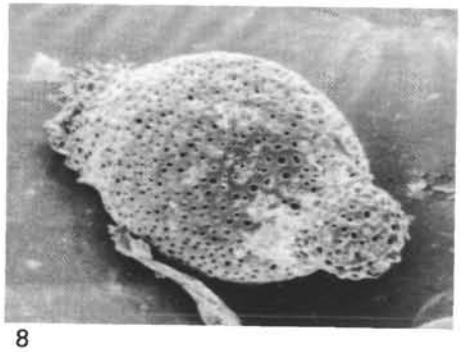
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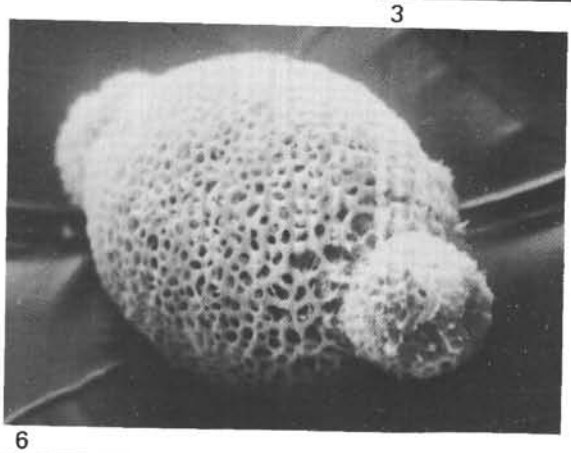
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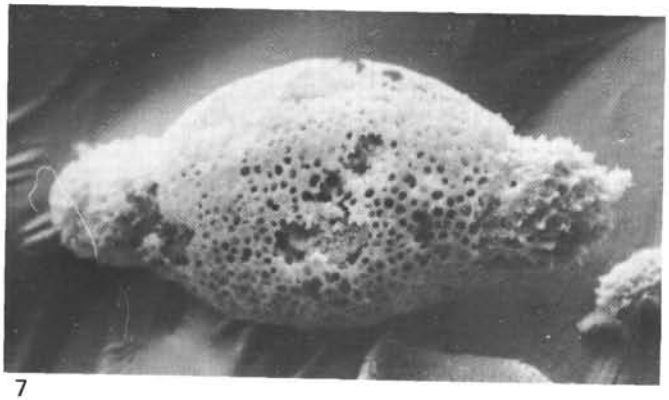
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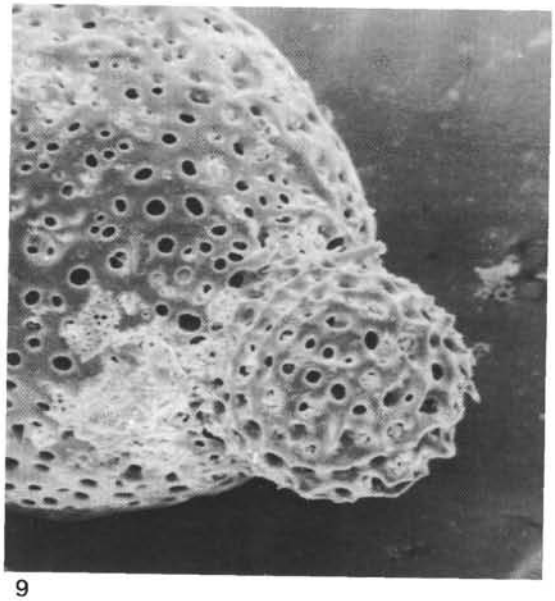
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PLATE 32

Paleogene radiolarians. All figures have the same magnification.

Figure 1 — *Lithomitra* (?) sp. aff. *Theocampe dactylica* Foreman: 339-10-3.

Figures 2-7 — *Lithomitra*(?) sp. "P."
2. 340-6-3.
3. 340-2-3.
4. Barbados TR 39F.
5-7. 340-8-3.

Figure 8 — *Eucyrtidium* (?) *biauritum* Ehr., Barbados S 39 1076.

Figure 9 — *Artostrobus*(?) *pusillum* (Ehr.): 29-275-1, CC.

Figures 10, 11 — *Lithomitra*(?) sp. "T."
10. Barbados S 39 1076.
11. 340-2-3.

Figures 12-15 — *Lithamphora* sp. aff. *Corocalyptra kruegeri* Popofsky.
12, 13. 339-12-3.
14. 340-4-3.
15. 28-280A-1-4.

Figures 16, 17 — *Lithomitra* (?) sp. aff. *Lithocampe minuta* Clark and Campbell.
16. 278-33-2.
17. 29-280A-4, CC.

Figures 18-20 — *Lithomitra* (?) *elegans* (Ehr.) grp.: Barbados S 39 1076.

Figure 21 — *Lithomitra* (?) sp. aff. *Eucyrtidium elegans* Ehr.: 29-280 A-4, CC.

Figures 22-24 — *Lithomitra* (?) *minuta* (Clark and Campbell).
22, 23. Californian Eocene, 1785.
24. 28-278-34-1.

Figures 25, 26 — *Lithocampana litoconella* Clark and Campbell grp.
25. Californian Eocene, 1785.
26. 340-11-3.

Figure 27 — *Ceratospyris* sp. aff. *Tripospyris crassipes* Clark and Campbell: 339-10-3.

Figures 28, 29 — *Botryostrobus* sp. "B": 340-11-6.

Figure 30 — *Cornutella* sp. aff. *C. californica* Clark and Campbell: 339-10-3.

Figure 31 — *Cornutella longisetta* Ehr.: 339-10-3.

Figure 32 — *Spongurus* (?) sp. aff. *Spongurus bilobatus* Clark and Campbell: 340-4-3

Figures 33-35 — *Lophophaena sibirica* (Gorbovetz) grp.
33. 340-8-3.
34, 35. West Sibiria, Ladvinka, 296-300 m.

Figure 36 — *Lophophaena macrencephala* Clark and Campbell grp. Kiev-Charkov layers, Hole 264, 74 m, S. Totchilina collection.

Figure 37 — *Botryoid* gen. sp.: 340-2-3.

PLATE 32

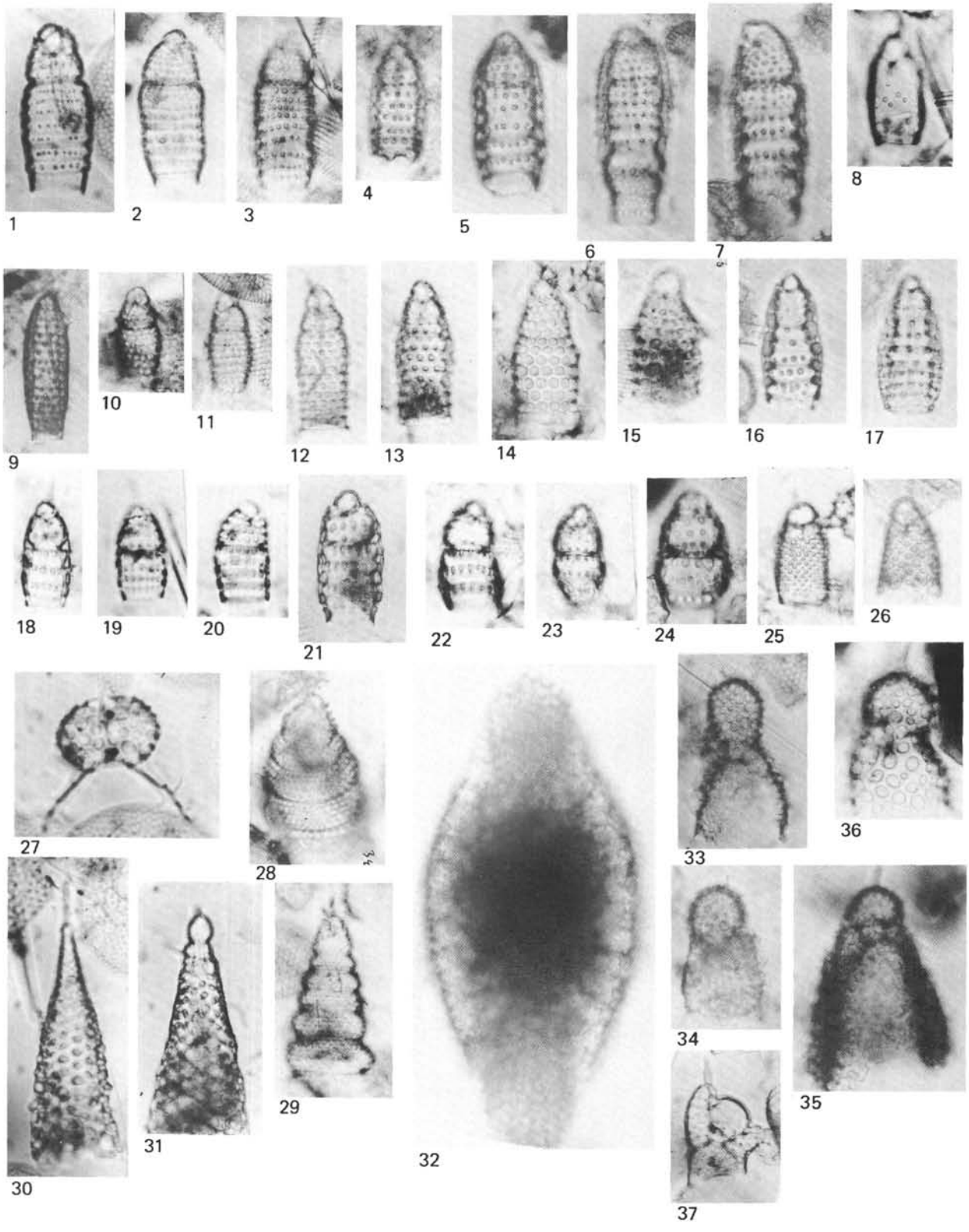
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PLATE 33

Eocene radiolarians.

Figure 1 — *Lithamphora* sp. aff. *Corocalyptra kruegeri* Popofsky): 340-7-6; ×410.

Figures 2-4 — *Lithomitra* (?) sp. "P."
2, 3. 340-6-3; 2. ×275; 3. ×425.
4. 340-8-3; ×475.

Figure 5 — *Lithomitra* (?) sp. "T": 340-6-3; ×275.

Figure 6 — *Lithomitra* (?) sp.: 340-11-3; ×450.

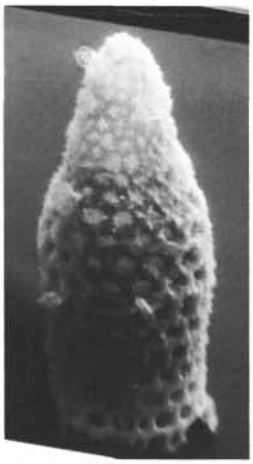
Figure 7 — *Stylospongia communis* Clark and Campbell grp.: 338-26-3; ×180.

Figure 8 — *Stomatosphaera* (?) sp.: 340-11-3; ×215.

Figure 9 — *Porodiscus* (?) *parvus* Clark and Campbell grp.: 340-7-6; ×170.

Figure 10 — *Lampromitra* (?) sp.: 340-8-3; ×250.

PLATE 33



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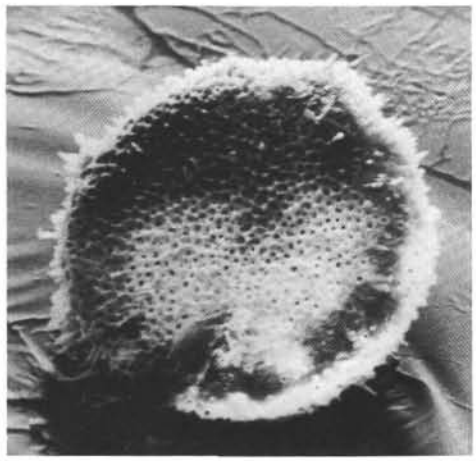

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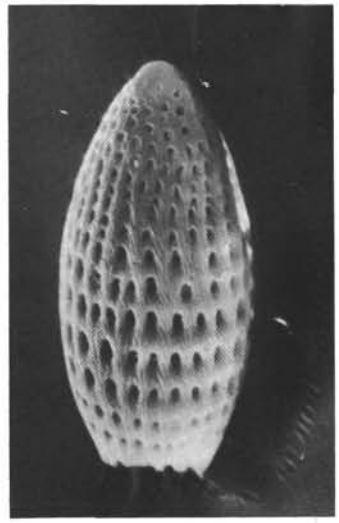

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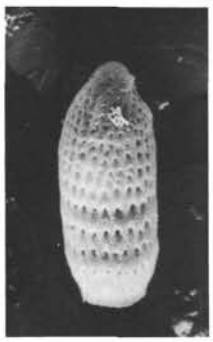

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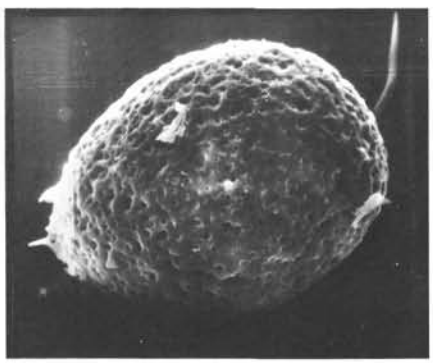

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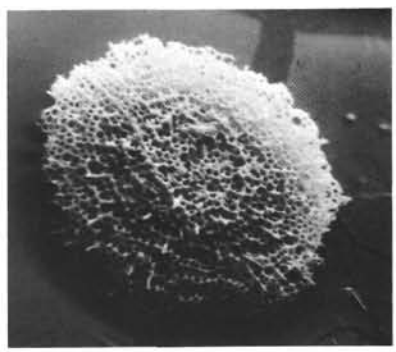

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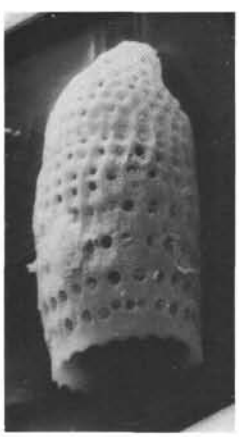

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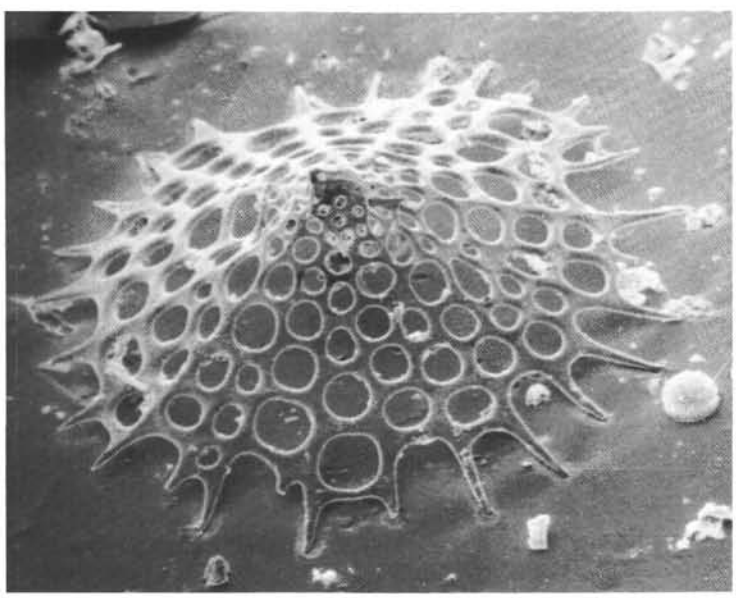

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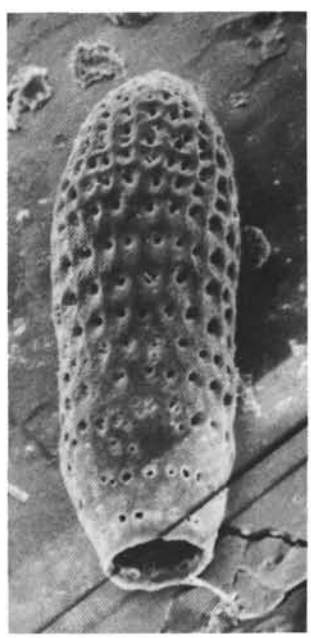

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PLATE 34

Eocene radiolarians.

Figure 1 — *Theocyrtis litos* (Clark and Campbell) grp.: 340; ×215.

Figures 2, 3 — *Lophocorys* (?) *norwegiensis* Bjørklund and Kellogg: 340-11-3.
2. ×265.
3. ×275.

Figure 4 — *Lophocorys*(?) *bicorne* (Ehr.); 21-208-27, CC, ×280.

Figure 5 — *Calocyclas asperum* Ehr.: 340-11-3; ×225.

Figure 6 — *Stylosphaera* sp. aff. *S. minor* Clark and Campbell: 340-8-3, ×220.

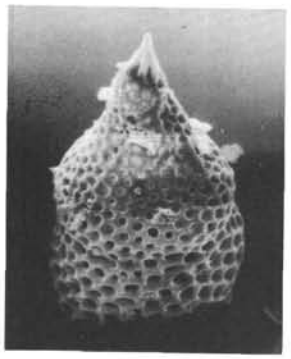
Figure 7 — *Stylosphaera* sp. aff. *S. minor* Clark and Campbell: 340-9-3, ×260.

Figures 8-10 — *Clathrocyclas* (?) *extensa talwanii* (Bjørklund and Kellogg): 340-8-3.
8. ×160.
9. ×200.
10. ×300.

Figure 11 — *Clathrocyclas* (?) *extensa multiplicatus* (Lipman): 340-8-3; ×270.

Figure 12 — *Clathrocyclas* (?) sp. aff. *Sethocyrtis elegans* Lipman. Kiev-Charkov-layers, Core 209, 43 m, S. Totchilina collection, ×250.

PLATE 34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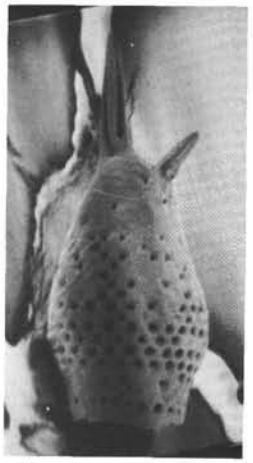
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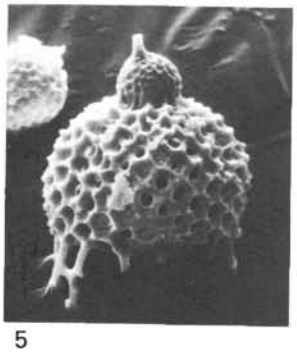
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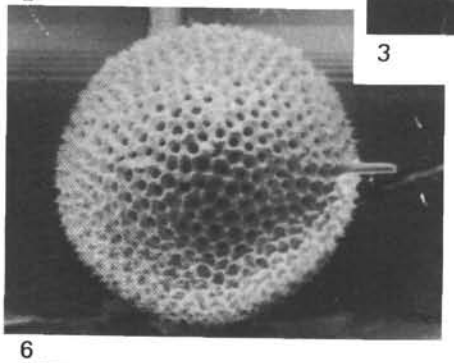
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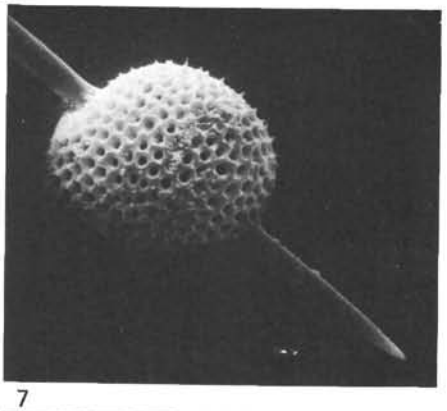
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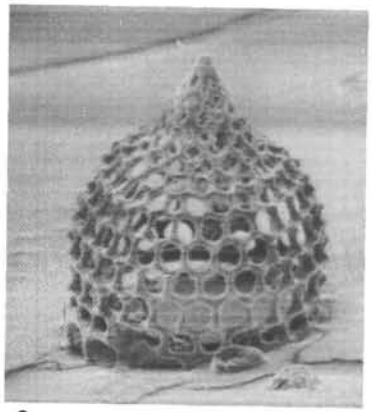
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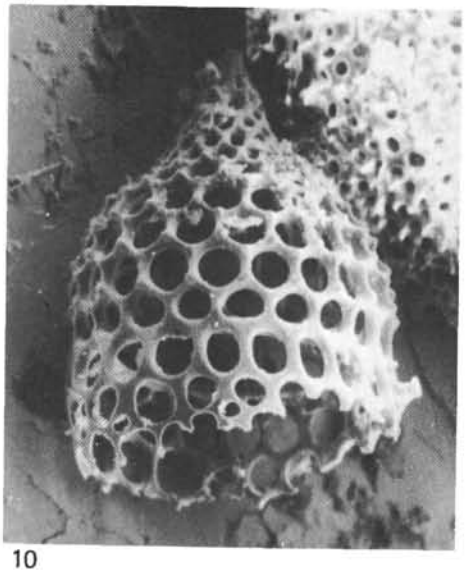
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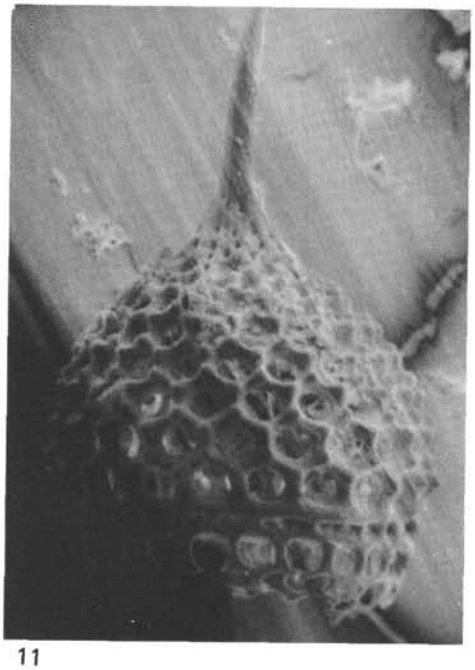
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PLATE 35

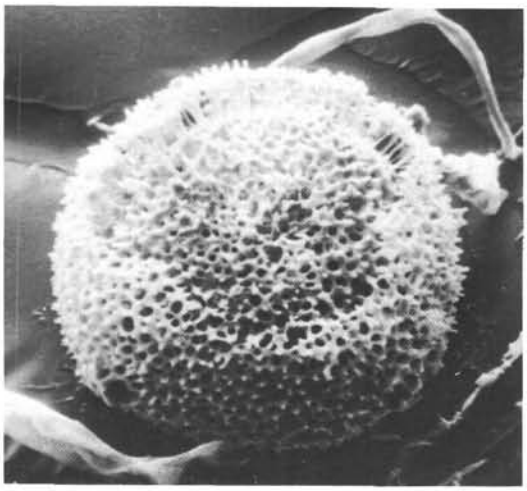
Eocene radiolarians.

Figures 1, 2 *Hexacyclia* (?) sp. "T," 340-8-3.
1. ×175.
2. ×220, side view.

Figures 3, 4 *Heterosestrum tschujenkoi* (Lipman).
3. Kiev-Charkov-layers, Core 209, 43.5 m, S. Totchilina collection, ×200.
4. 340-8-3, ×260.

Figures 5, 6 *Hexacyclia* (?) sp. "Sph," 340-8-3.
5. ×570.
6. ×230.

PLATE 35



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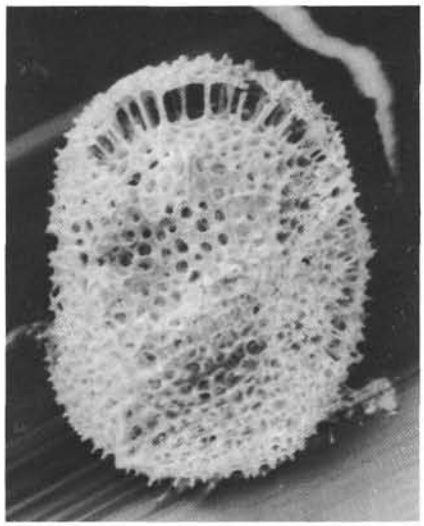

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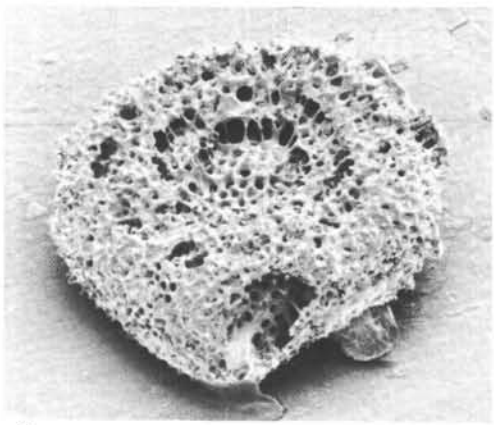

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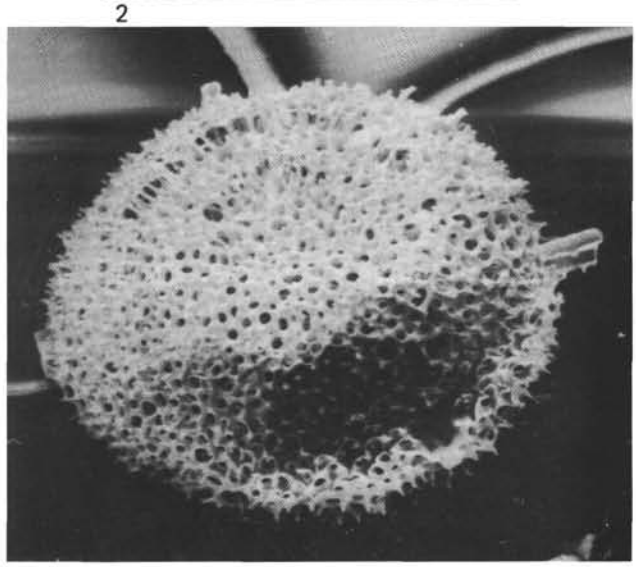

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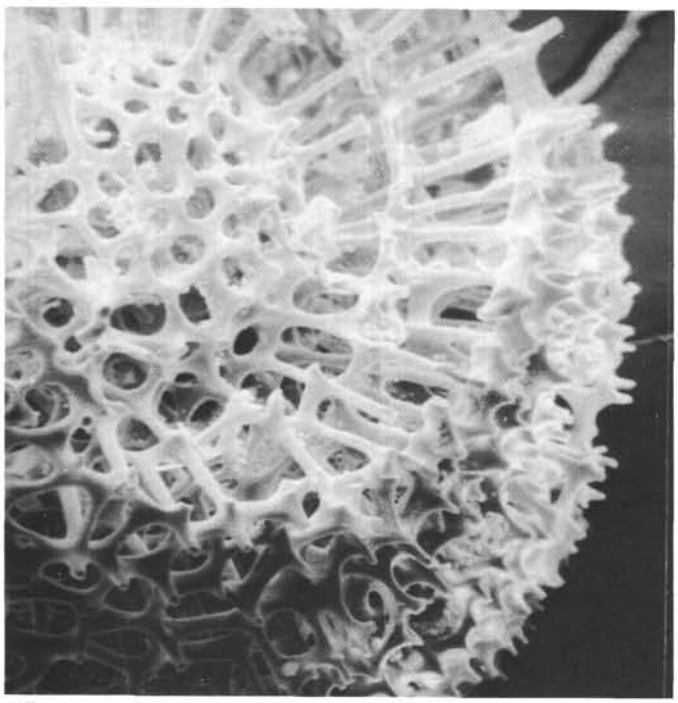

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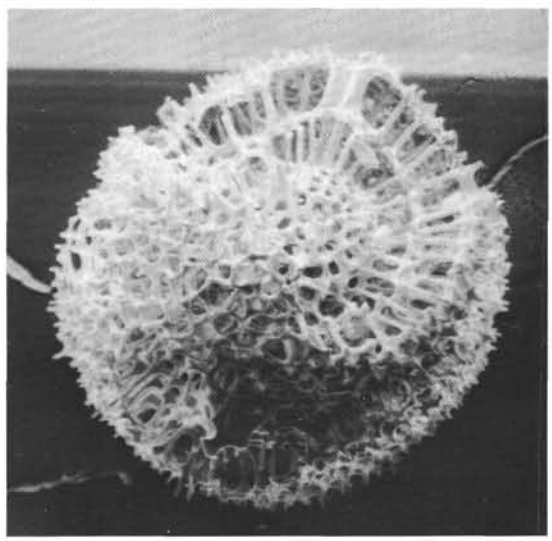

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PLATE 36

Cenozoic radiolarians Discoidea. All figures have the same magnification.

Figures 1-4 *Stylodictya stellata* Bailey grp.
1. 339-12-3.
2. Californian Eocene, 1785.
3. 339-10-3.
4. 38-339-12-3.

Figure 5 *Stylodictya hastata* Ehr. *targaeformis* Clark and Campbell: 339-12-3.

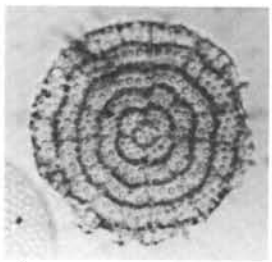
Figure 6 *Xiphospira ocellata* (Ehr.): 339-12-3.

Figures 7-14 *Porodiscus* (?) *parvus* Clark and Campbell grp.
7. Californian Eocene, 1785.
8. 340-3-4.
9. 338-11-3.
10. Kiev-Charkov-Eocene: Hole 209-C, S. Totchilina collection.
11. 338-6-6.
12. 38-338-11-2.
13. 340-3-4.
14. 338-13-3.

Figures 15, 16 *Stylospira dujardini* (Haeckel): 338-13-3.

Figure 17 *Stylodictya* sp. Kiev-Charkov-Eocene, Hole 264, S. Totchilina collection.

PLATE 36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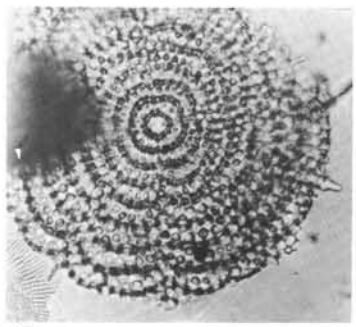
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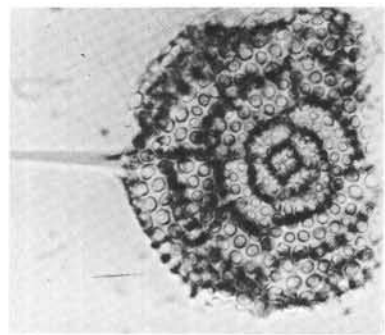
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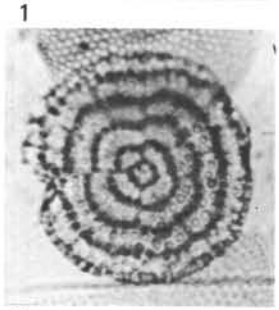
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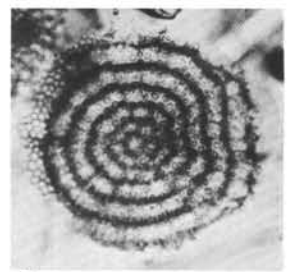
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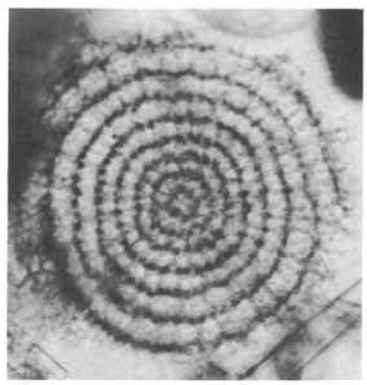
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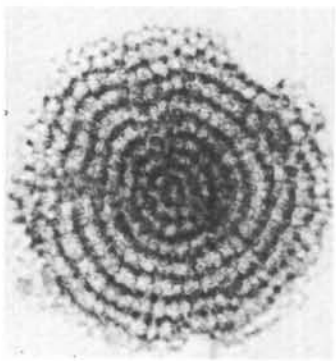
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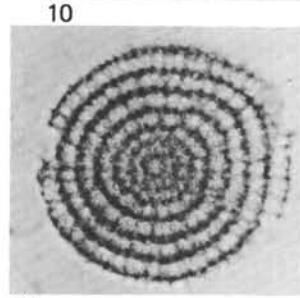
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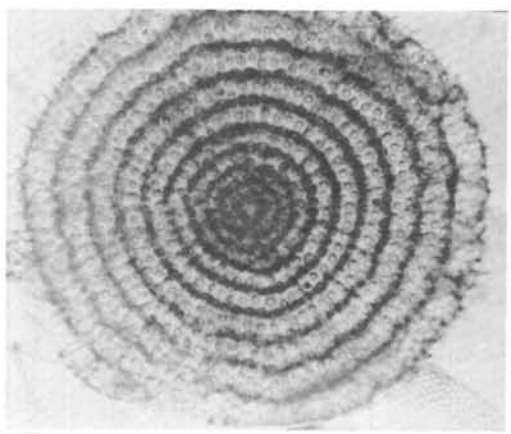
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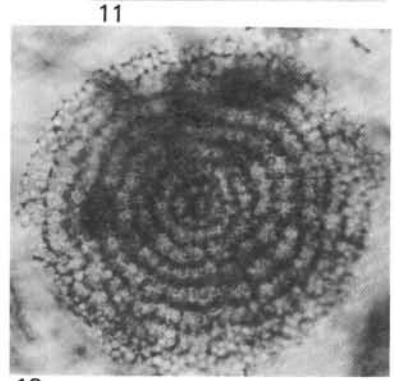
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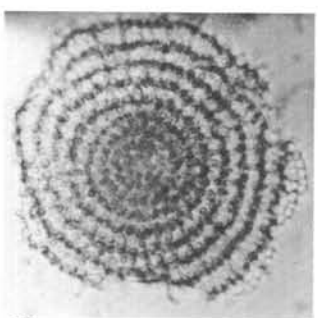
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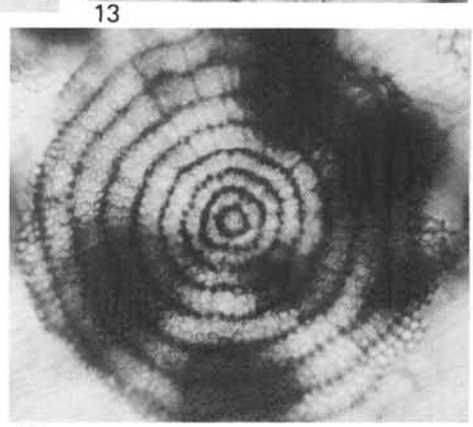

17

PLATE 37

Figures 1-7 Oligocene-Miocene radiolarians;
Figures 8-12 Eocene radiolarians.

Figure 1 — *Hexacromyum sexaculeatum* (Stöhr) grp.: 338-14-3; ×237.

Figure 2 — *Stichocorys saccoi* (Vinassa): 338-14-3; ×245.

Figure 3 — *Heliodiscus* sp. P.: 338-14-3; ×230.

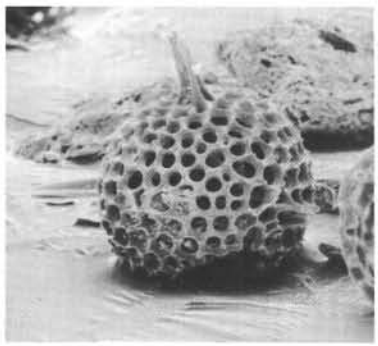
Figures 4-6 — *Ceratocyrtis cucullaris* (Ehr.): grp.: 338-14-3.
4. ×325.
5. ×230.
6. ×240.

Figure 7 — *Stylosphaera* sp. "C" Petrushevskaya and Kozlova: 338-19-2.

Figure 8 — *Tripodiscium* (?) sp. "G": 340-8-3; ×475.

Figures 9-12 — *Lithomelissa macroptera* Ehr. grp.
9. S. Totchilina collection, Core 59, Kiev-Charkov units; ×250.
10. 29-280 A-6, CC; ×350.
11. 340-9-3; ×255.
12. 340-6-3; ×250.

PLATE 37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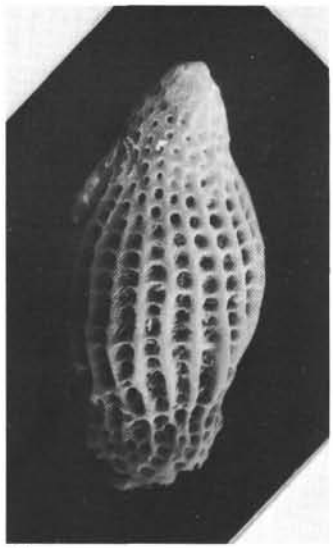
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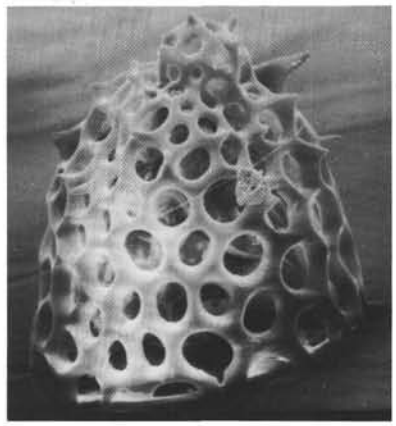
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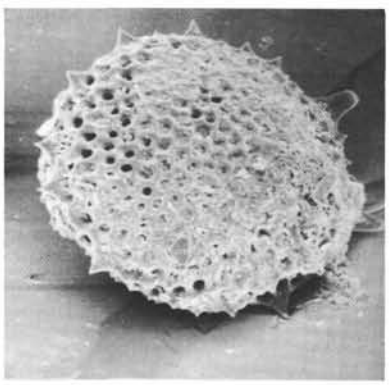
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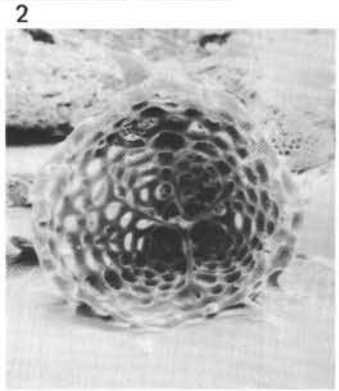
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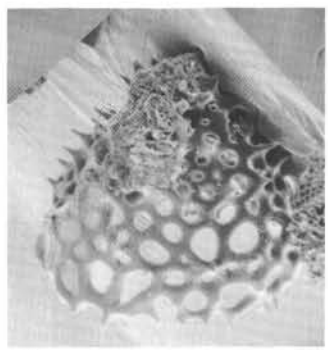
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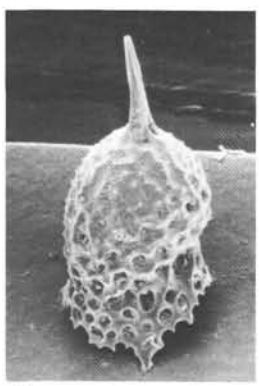
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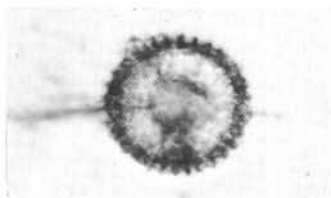
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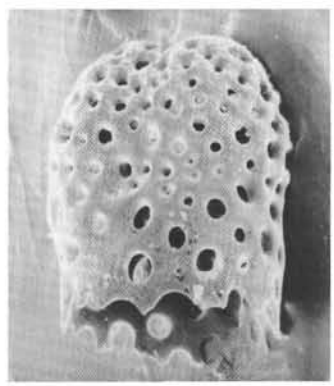
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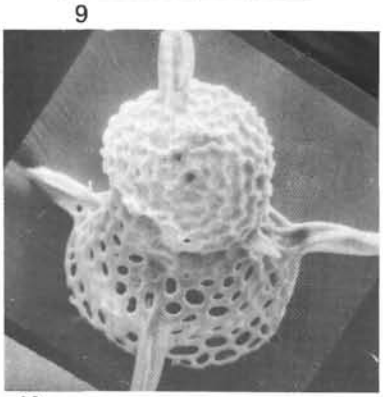
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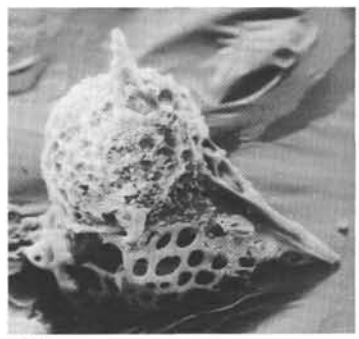
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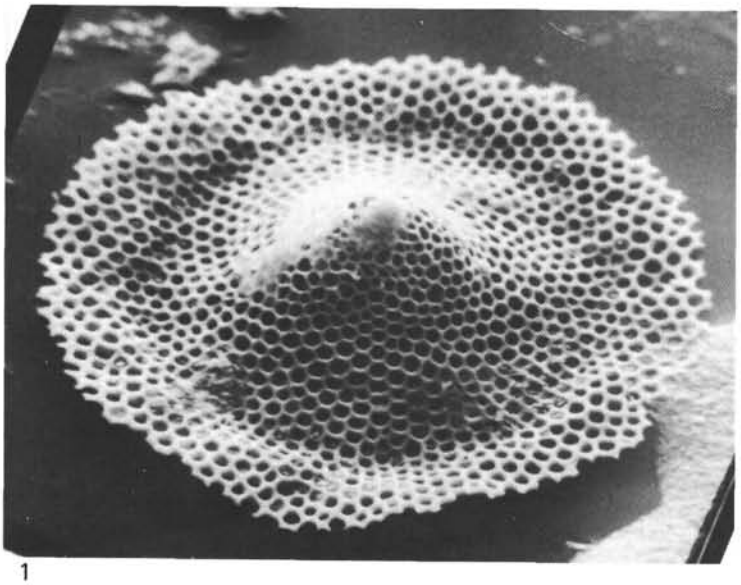
PLATE 38

Oligocene-Miocene radiolarians.

Figures 1-3 *Velicucullus* sp. "O," 340-14-3.
1. Seen from above, ×187.
2. Another specimen, lateral view; ×150.
3. Another specimen, seen from below; ×175.

Figures 4-6 *Gondwanaria dogieli* (Petrushevskaya) forma "C": 338-14-3.
4. Two specimens; ×220.
5. The first; ×280.
6. Two other specimens; ×220.

PLATE 38



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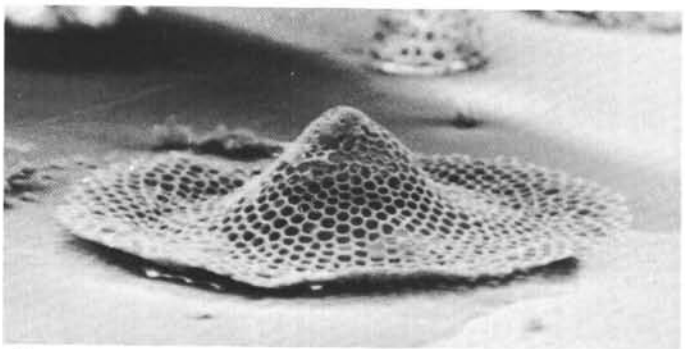

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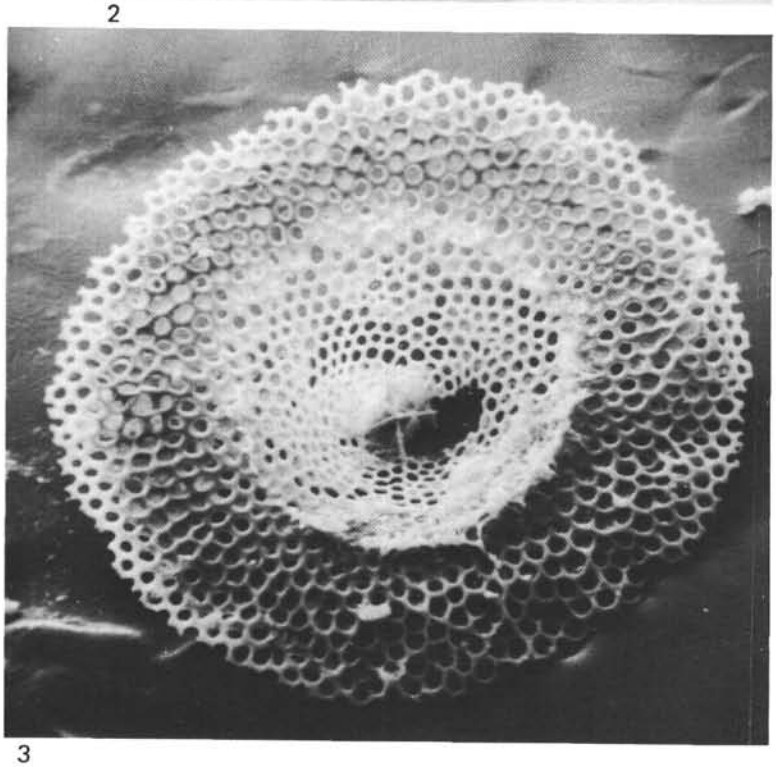

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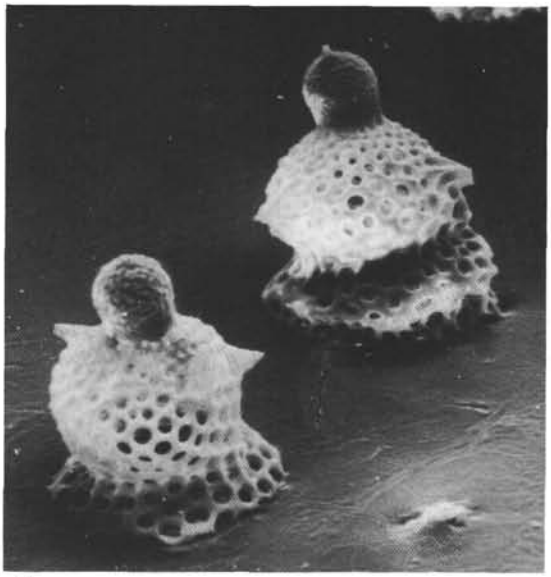

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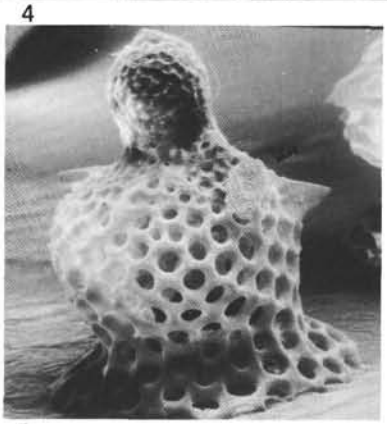

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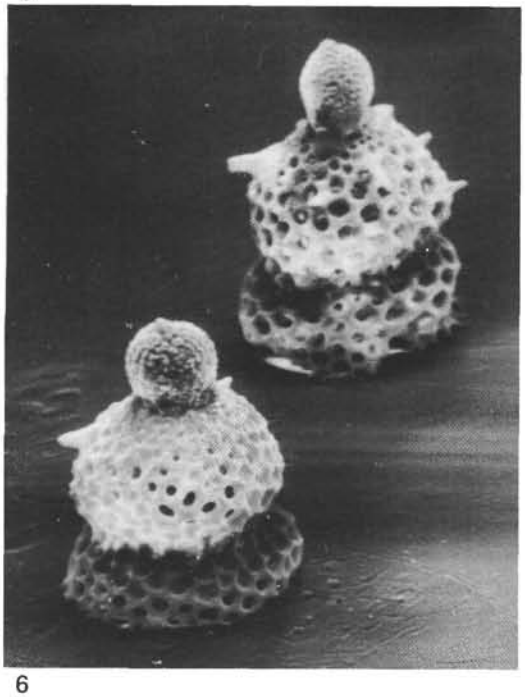


6

PLATE 39

Oligocene-Miocene radiolarians.
All figures have same magnification.

Figures 1-3 *Stichocorys saccoi* (Vinassa): 338-11-3.

Figures 4, 5 *Porodiscus parvus* Clark and Campbell grp.
4. 338-14-3.
5. 38-338-5-6.

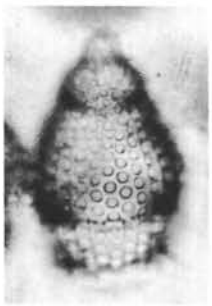
Figure 6 *Stylospira dujardini* (Haeckel): 338-13-3.

Figures 7, 8 *Stichocorys biconica* (Vinassa): 338-11-3.

Figures 10-13 *Spongotrochus glacialis* (Popofsky) grp.
10. 338-11-3.
11-13. 338-8-3.

Figure 14 *Spongodiscus osculosus* (Dreyer): 338-13-3.

PLATE 39



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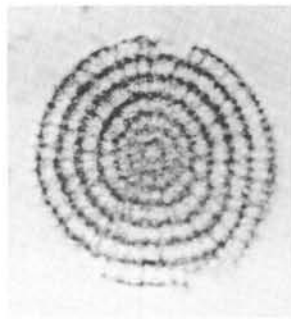

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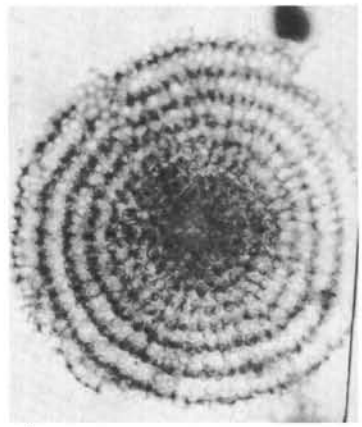

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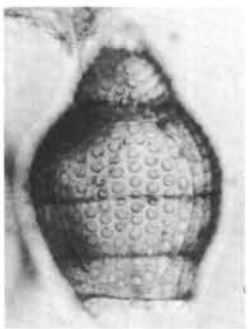

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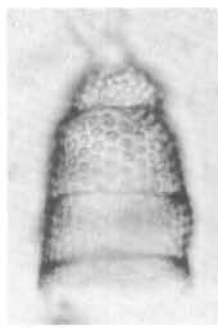

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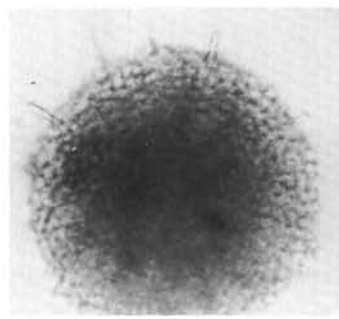

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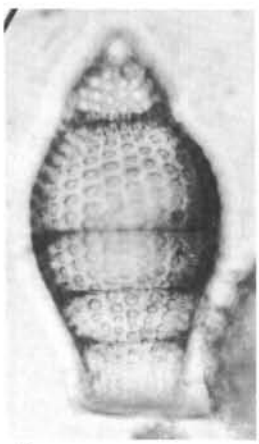

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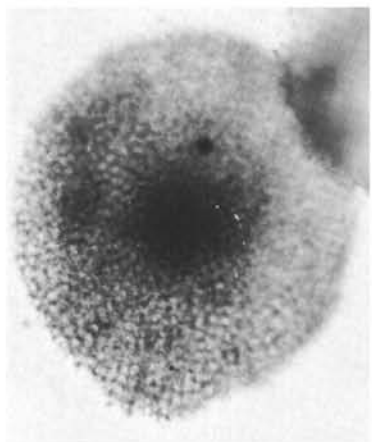

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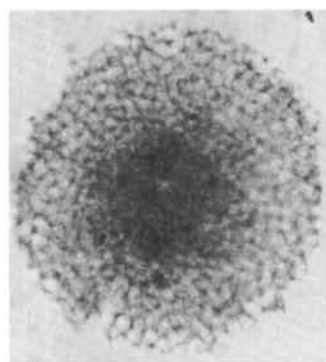

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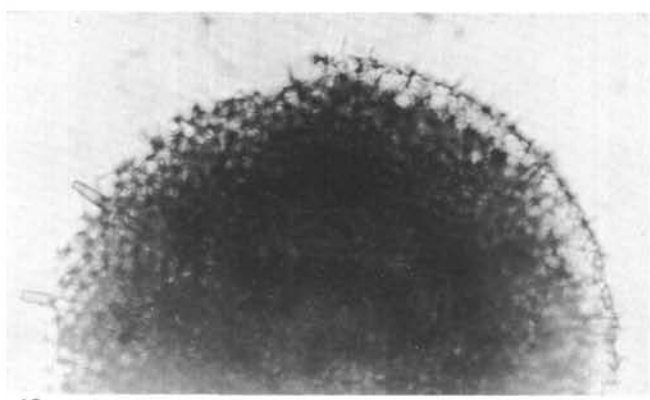

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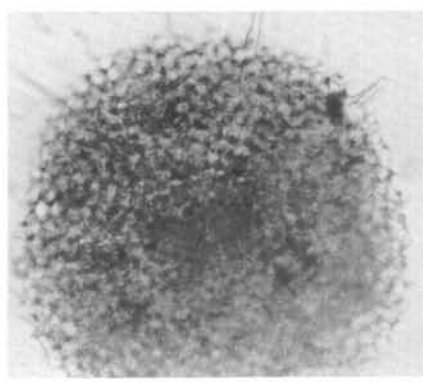


13

PLATE 40

Oligocene-Miocene radiolarians.
All figures have the same magnification.

Figure 1 — *Hexacromyum sexaculeatum* (Stöhr) grp.: 338-11-3.

Figures 2, 3 5 — *Hexacromyum* sp. aff. *Hexaconthium pachydermum* Jørgensen: 338-11-3; the same specimen.

Figures 4, 6 — *Haliomma* sp. aff. *H. aequorea* Ehr.: The same specimen, 338-11-3.

Figure 7 — *Lithomitra modeloensis* (Campbell and Clark) grp.: 338-14-3.

Figure 8 — *Heliodiscus* sp. "P": 338-13-3.

Figure 9 — *Anomalocantha dentata* Mast: 338-11-3.

Figure 10 — *Ectonocorys* (?) sp.: 338-13-3.

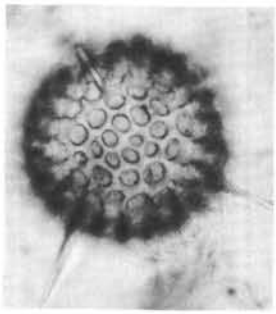
Figure 11 — *Velicucculus* (?) sp. "O": 338-14-3.

Figures 12, 13 — *Lithocarpium polyacantha* (Campbell and Clark) grp.
12. 338-13-3
13. 338-20-3.

Figures 14, 15 — *Lithocarpium* sp. aff. *Ommatodiscus haeckeli* Stöhr: 338-13-3.

Figures 16, 17 — *Lithocarpium* (?) sp. aff. *Pylospyra* (?) sp. "A" Petrushevskaya.
16. 338-14-3.
17. 338-19-3.

PLATE 40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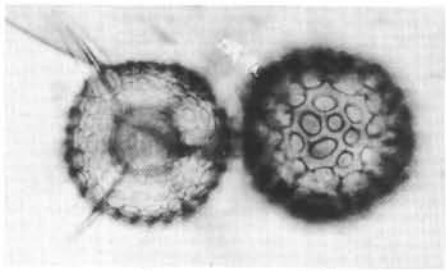
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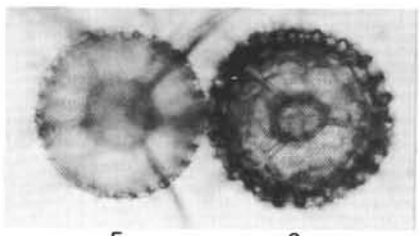
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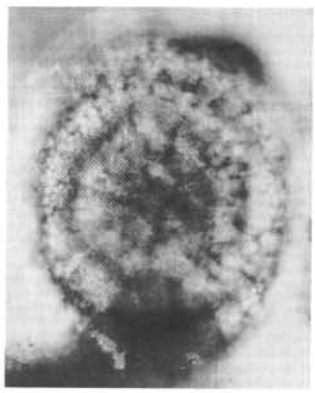
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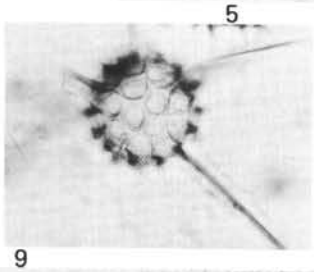
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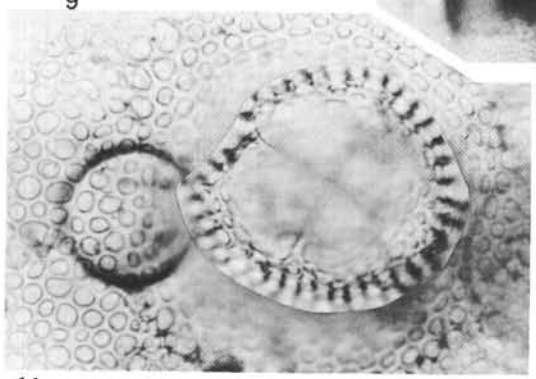
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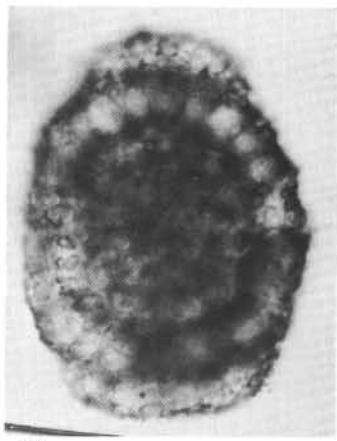
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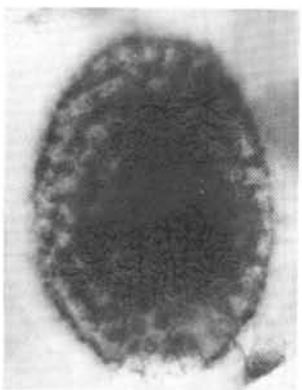
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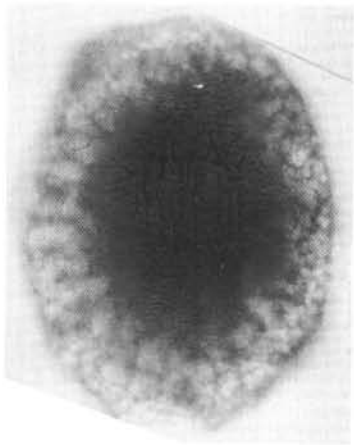
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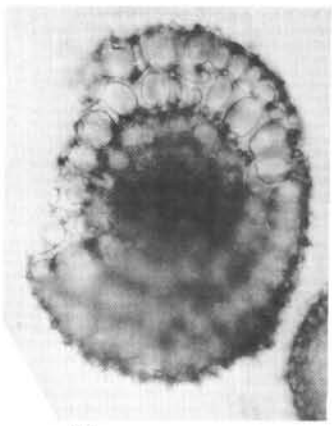

15

PLATE 41

Oligocene-Miocene radiolarians.
All figures have the same magnification.

Figures 1-3 *Gondwanaria dogieli* (Petrushevskaya) grp.
1. 38-339-11-3.
2. 338-13-3.
3. 338-14-3.

Figures 4, 5 *Gondwanaria japonica* (Nakaseko) grp.: 338-14-3.

Figures 6, 7 *Pseudodictyophimus* (?) *reschetnjakae* (Petrushevskaya) 338-13-3.

Figures 8, 9 *Gondwanaria* sp. aff. *G. japonica* (Nakaseko)
8. 338-13-3.
9. 338-14-3.

Figure 10 *Gondwanaria japonica* (Nakaseko) grp.: 338-13-3.

Figure 11 *Clathrocorona* sp.: 338-14-3.

Figure 12 *Pseudodictyophimus* sp. "G": 338-14-3.

Figure 13 *Ceratocyrtis* sp. aff. *Helotholus histricosa* Jørgensen. 338-11-3.

Figures 14-16 *Ceratocyrtis cucullaris* (Ehr.) grp.
14. 338-13-3.
15. 29-280A-4, CC.
16. 338-15-2.

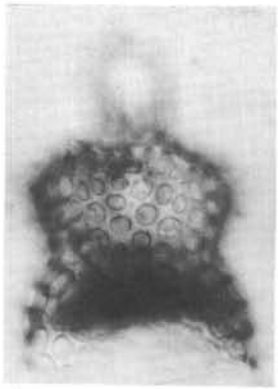
Figure 17 *Pseudodictyophimus gracilipes* (Bailey) grp.: 338-20-3.

Figures 18, 19 *Pseudodictyophimus* sp. "A," Petrushevskaya and Kozlova 338-14-3.

Figure 20 *Ceratocyrtis* sp.: 338-14-3.

Figure 21 *Ceratocyrtis* sp. aff. *C. cucullaris* (Ehr.): 338-19-3.

PLATE 41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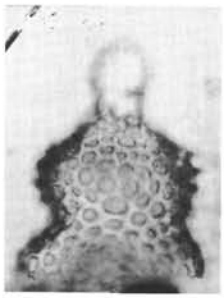
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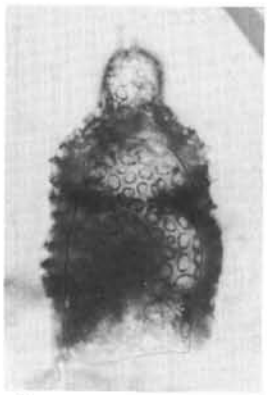
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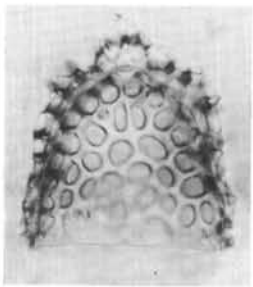
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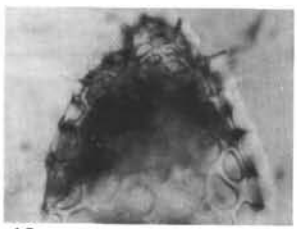
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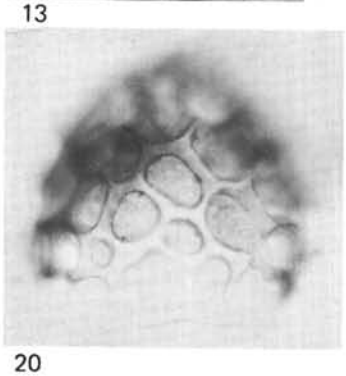
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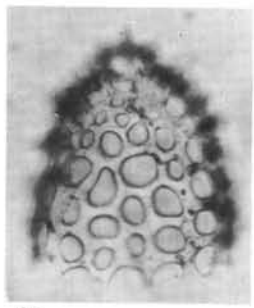
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