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21. NEOGENE DINOFLAGELLATE DISTRIBUTION IN THE EASTERN INDIAN OCEAN FROM LEG 123, SITE 765[1]

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ABSTRACT

Site 765 contains a sequence of tropical, middle Miocene to Holocene dinoflagellate cysts. These diverse assemblages are characterized by abundant *Polysphaeridium zoharyi* and *Spiniferites bulloideus*. Abundances of *Impagidinium* spp. and *Nematosphaeridium* spp. reflect the shelf-to-slope origin of the assemblages. One new genus, *Blysmatodinium*, and two new species, *Nematosphaeridium(?) wrennii* sp. nov. and *Blysmatodinium argoi*, are described.

INTRODUCTION

Dinoflagellate cysts are not typically abundant in deep-ocean sediments, but are normally associated with estuaries and the continental shelf and slope. The presence of rich assemblages on the Argo Abyssal Plain at Site 765 (Fig. 1) provides a good opportunity for studying outer-shelf and slope assemblages from the tropics.

Comparatively few studies of Neogene dinoflagellate cysts have been done, and most of these are of Northern Hemisphere temperate and boreal assemblages. A summary of previously published Northern Hemisphere Neogene dinoflagellate data is presented in Head et al. (1989c). Published accounts from the Southern Hemisphere are limited to Deflandre and Cookson (1955) and Truswell et al. (1985) from Australia and Gamerro and Archangelsky (1981) from Argentina.

Material from Leg 123 will provide data about poorly known Southern Hemisphere Neogene and tropical assemblages and will contribute to the development of a pan-Australian Neogene dinoflagellate cyst zonation (McMinn, in press, a).

Two sites were drilled during Leg 123 (Sites 765 and 766); however, only Site 765 yielded Neogene dinoflagellate cyst assemblages. Site 765 is located in the eastern Indian Ocean on the Argo Abyssal Plain in a water depth of 5200 m. A 935-m-thick succession of Quaternary to Late Jurassic sediments was intersected; this has been divided into seven lithologic units. Unit I (0–190 m) consists of Quaternary to upper Miocene, redeposited, clayey calcareous sediments of pelagic origin with minor intercalated clays. Unit II (189–474 m) consists predominantly of Miocene, graded, redeposited calcareous sediment of pelagic origin. Unit III (474–591 m) consists of early Miocene to Cenomanian interbedded claystones, graded carbonate sequences, and matrix-supported carbonate conglomerates.

METHODS

Forty-two, approximately 20 cm^3, core samples were taken at approximately 10-m intervals, i.e., approximately one sample per core. Samples were initially disaggregated in HCl and then left in HF for 8 hr. The residue underwent heavy liquid separation in zinc bromide solution (Sp. G. = 2.1) and was then sieved using a 10-μm sieve with the aid of an ultrasonic needle. Residues were then mounted in glycerine jelly and are stored in the Micropalaeontology Collection of the N.S.W. Geological Survey.

All dinoflagellate cysts in a preparation were counted, and these form the basis of the "Count" column in Table 1. Spore and pollen identification and distribution are discussed in McMinn and Martin (this volume). Complete species citations follow Lentin and Williams (1989).

BIOSTRATIGRAPHY

Sediments at Site 765 were initially deposited on the outer continental shelf and slope and have been redeposited at their present location on the Argo Abyssal Plain by density currents. The rapid sedimentation rate caused quick burial and thus preservation of the palynomorphs. Reworked nannoplankton and foraminifers are common (Ludden, Gradstein, et al., 1990), but little evidence exists of reworking of Tertiary dinoflagellates, although reworking from the Middle to Late Jurassic sequence is ubiquitous. Dinoflagellate ranges recorded here are consistent with those reported elsewhere, which suggests that reworking was insignificant.

Rather than propose a formal zonation, which is unwarranted on the basis of a single hole, the sequence of dinoflagellate assemblages is discussed on the basis of age, as determined by comparison with the foraminifers and nannoplankton zonations (Ludden, Gradstein, et al., 1990). The ranges of individual species are then compared with their ranges documented elsewhere.

Middle Miocene

The oldest Tertiary assemblages recovered from Site 765 are of middle Miocene age. Compared with younger assemblages, lowermost middle Miocene samples (123-765C-9R-3, 13–14 cm, and -10R-4, 54–57 cm) are low in dinocyst abundance and diversity. *Batiacasphaera micropapillata* Stover, 1977 is found in both samples, with *Polysphaeridium zoharyi* (Rossignol 1962), *Impagidinium patulum* (Wall, 1967), *Impagidinium paradoxum* (Wall, 1967), *Impagidinium aculeatum* (Wall, 1967), *Systematophora placacantha* (Deflandre and Cookson, 1955), and *Operculodinium janduchenei* Head, 1989 are present in one or another of the samples. The middle Miocene assemblages from Samples 123-765C-8R-2, 61–67 cm, to -2R-3, 69–73 cm, and -39X-1, 46–52 cm, are more abundant and diverse and are typically characterized by abundant *Polysphaeridium zoharyi* and *Spiniferites bulloideus* (Deflandre and Cookson, 1955). Significant first stratigraphic occurrences include *Pyxidinopsis* sp., *Nematosphaeropsis lemniscata* Bujack, 1984, *Dapsilidinium pastielsii* (Davey and Williams, 1966), and *Hystrichokolpoma rigaudiae* (De-

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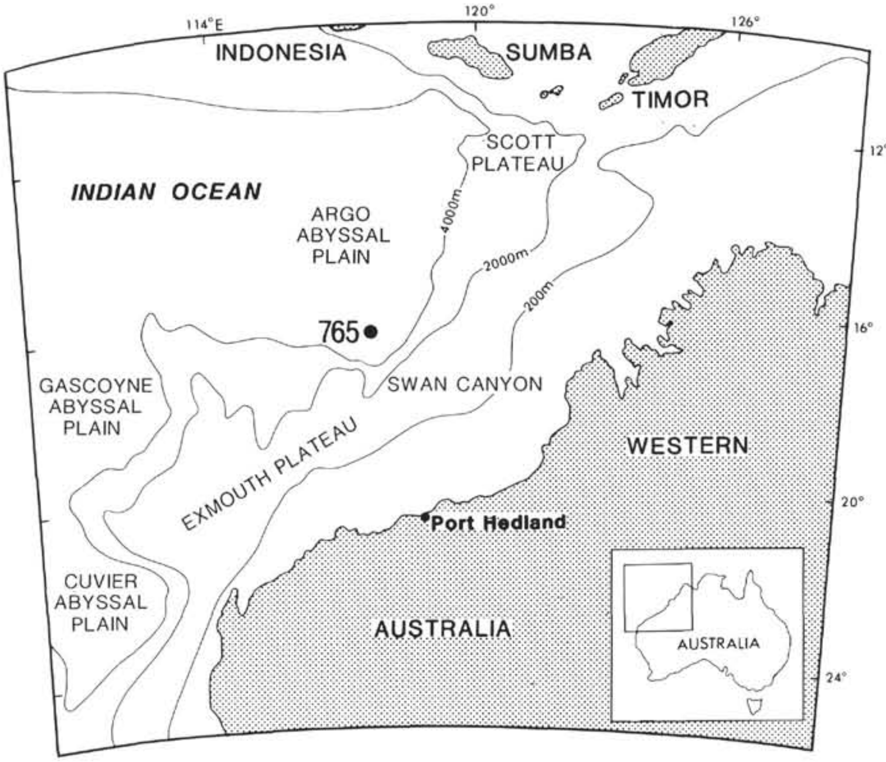

Figure 1. Location of Site 765.

flandre and Cookson, 1955). Significant last stratigraphic occurrences include *Batiacaspaera micropapillata* and *Systematophora placacantha* (Deflandre and Cookson, 1955).

Late Miocene

The late Miocene is represented in Hole 765B by the interval between Samples 123-765B-18H-5, 48–54 cm and 123-765B-38X-1, 35–37 cm. The absence of foraminiferal Zone N18 indicates that the uppermost late Miocene is either absent or represented in an unsampled condensed sequence. Dinoflagellate cysts are abundant, and assemblages are moderately diverse. *Spiniferites bulloideus* and *Polysphaeridium zoharyi* remain the dominant species, but *Impagidinium* spp., *Operculodinium echigoense* Matsuoka, 1983, *Hystrichokolpoma rigaudiae*, and *Operculodinium janduchenei* are common. Significant first stratigraphic occurrences include *Operculodinium longispinigerum* Matsuoka, 1983, *Blysmatodinium argoi* sp. nov., and *Melitasphaeridium choanophorum* (Deflandre and Cookson, 1955), and no significant last appearances occur.

Pliocene

Foraminiferal Zone N19 and nannoplankton Zone CN10 were not recognized in Hole 765B, indicating that much of the early Pliocene is either absent or represented in an as yet unsampled condensed sequence. The middle and late Pliocene sections were recognized between Samples 123-765B-11H-3, 38–42 cm and 123-765B-17H-4, 111–115 cm. *Spiniferites bulloideus* and *Polysphaeridium zoharyi* continue to dominate, with *Impagidinium patulum*, *Impagidinium paradoxum*, *Operculodinium israelianum* (Rossignol, 1962), *Operculodinium echigoense*, and *Spiniferites mirabilis* (Rossignol, 1964) being common. No significant first occurrences exist within this interval, although rare *Selenopemphix nephroides* Benedeck, 1972 does appear at Sample 123-765B-12H-7, 26–30 cm. The only reliable last stratigraphic occurrences are those of *Blysmatodinium argoi* and *Melitasphaeridium choanophorum*.

Quaternary

The Quaternary section is represented in Hole 765B from the surface, i.e., Cores 123-765A-1H and 765A-1H to 765B-1H to Sample 123-765B-9H-1, 100–107 cm. The presence of reworking in the foraminifers and nannoplankton does not permit the distinction between Holocene and Pleistocene to be determined. However, the boundary between the late Pleistocene N23 and early Pleistocene N22 foraminiferal zones has been placed between Cores 123-765B-2H and -3H.

Spiniferites bulloideus remains dominant throughout the Quaternary, but *Polysphaeridium zoharyi* becomes increasingly less common and disappears in the middle Pleistocene. Other common taxa include *Impagidinium* spp., *Operculodinium israelianum*, *Operculodinium echigoense*, and *Spiniferites mirabilis*. Significant stratigraphic appearances include *Multispinula quantra* Bradford, 1975, *Votadinium calvum* Reid, 1977 and *Stelladinium reidii*. Nine taxa, including *Operculodinium longispinigerum*, *Hystrichokolpoma rigaudiae*, *Dapsilidinium pastielsii*, and *Polysphaeridium zoharyi*, disappear at a horizon within the mid-Pleistocene, but as some of them, e.g., *O. longispinigerum*, are known to become extinct earlier elsewhere (McMinn, in press, a), this horizon possibly represents the termination of reworking.

Many of the taxa documented here have consistent first appearances and extinctions elsewhere.

Operculodinium janduchenei. This species appears in the early late Miocene at Site 765. Other late Miocene appearances include Spain (Jan du Chene, 1977), North Atlantic (Edwards, 1984; Mudie, 1987), Labrador Sea (Head et al., 1989a), Norwegian Sea (Mudie, 1989; Manum et al., 1989), and Gulf of Mexico (Wrenn and Kokinos, 1986). Possible early and middle Miocene occurrences include those of Evans and Hughes (1984) and Powell (1988) from the British Southwest Approaches.

Table 1. Distribution of dinoflagellate cysts at Site 765.

Age			*Batiacasphaera micropapillata*	*Impagidinium aculeatum*	*Polysphaeridium zoharyi*	*Systematophora placacantha*	*Impagidinium paradoxum*	*Impagidinium patulum*	*Operculodinium janduchenei*	*Impagidinium strialatum*	*Operculodinium centrocarpum*	*Operculodinium israelianum*	*Pyxioinopsis* sp.	*Spiniferites bulloideus*	*Spiniferites hyperacanthus*	*Spiniferites ramosus*	*Nematosphaeropsis lemniscata*
Quaternary		1H-2, 142–144	....	3.0	....	....	12.1	9.1	....	....	12.1	9.1	....	33.3	3.0	....	3.0
		1H-3, 80–82	....	....	....	....	50.0	....	....	....	....	....	....	50.0	....	....	....
		3H-6, 37–43	....	....	1.8	....	3.5	3.5	0.9	....	13.2	6.1	....	33.3	6.1	11.4	....
		4H-3, 60–65	....	1.4	0.7	....	2.5	3.5	<0.1	1.8	15.2	3.5	....	39.0	....	0.7	0.4
		5H-6, 63–65	....	3.6	14.9	....	9.2	4.6	1.0	7.2	2.1	3.1	....	28.2	....	0.5	2.1
		6H-1, 69–75	....	3.9	9.0	....	8.1	8.7	0.3	2.4	5.4	4.2	....	35.9	<0.1	0.6	0.9
		7H-6, 56–60	....	....	<0.1	....	<0.1	<0.1	<0.1	....	....	<0.1	....	<0.1	....	<0.1	<0.1
		8H-3, 4–6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		9H-2, 100–107	....	1.2	21.9	....	6.5	16.2	0.8	4.0	3.2	1.2	....	23.5	....	0.4	1.6
Tertiary	Pliocene	10H-1, 123–127	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		11H-3, 38–42	....	3.4	18.6	....	7.2	10.6	2.5	1.7	1.7	7.6	....	28.8	....	....	0.4
		12H-7, 26–30	....	0.9	9.9	....	0.5	1.6	0.2	0.2	1.4	5.9	....	53.4	....	1.6	0.5
		13H-3, 78–83	....	2.7	16.6	....	11.2	6.9	1.5	1.2	0.4	3.1	....	37.1	....	....	0.8
		14R-1, 4–6	....	....	13.0	....	....	....	....	....	13.0	13.0	....	30.4	30.4	....	....
		14H-4, 36–42	....	2.6	13.8	....	7.8	2.6	0.9	2.6	0.9	6.0	....	39.7	....	1.7	....
		15H-6, 28–33	....	1.2	36.9	....	4.4	6.5	2.1	1.8	0.3	3.2	....	33.0	....	2.1	0.3
		16H-1, 70–74	....	3.0	49.5	....	2.0	2.0	1.0	1.0	....	3.0	....	24.8	....	3.0	2.0
		17H-4, 111–115	....	7.4	2.9	....	8.8	7.4	1.5	....	....	2.9	....	48.5	....	....	1.5
	late Miocene	18H-5, 48–54	....	1.4	3.0	....	3.0	0.8	5.7	1.0	....	4.7	....	57.2	....	1.4	0.8
		19X-2, 92–94	....	1.7	3.9	....	1.1	8.8	0.6	1.7	....	3.3	....	54.1	....	1.1	3.9
		20X-3, 131–135	....	....	58.5	....	1.5	18.5	....	....	<0.1	....	....	7.7	1.5	4.6	....
		21X-5, 126–129	....	0.7	4.3	....	0.7	2.2	2.2	0.7	....	7.9	....	43.2	0.4	2.9	<0.1
		22X-1, 108–110	....	<0.1	18.0	....	4.2	3.2	2.3	<0.1	0.3	2.9	<0.1	40.2	<0.1	<0.1	1.6
		23X-1, 120–125	....	....	39.4	....	6.1	3.0	27.3	....	....	3.0	....	9.1	....	....	....
		24X-3, 85–90	....	....	33.6	....	1.2	0.4	....	2.0	....	....	....	41.1	....	1.2	....
		26X-4, 62–68	....	....	14.7	....	2.4	1.2	....	1.2	....	....	....	21.1	0.4	5.2	....
		26X-2, 81–85	....	....	....	....	6.0	2.6	0.9	....	....	2.6	....	53.8	....	4.3	....
		27X-1, 92–96	....	....	23.8	....	....	....	....	....	....	....	....	23.8	....	9.5	....
		28X-2, 10–15	....	....	64.3	....	....	....	....	....	....	....	....	35.7	....	....	....
		29X-1, 120–124	....	....	36.2	....	0.8	....	1.2	1.7	....	10.0	....	32.5	1.2	1.7	<0.1
		30X-1, 75–79	....	....	67.6	....	0.3	0.6	<0.1	....	....	....	....	10.4	....	4.2	0.3
		31X-5, 90–95	....	....	14.4	....	....	0.3	0.3	....	....	....	....	60.4	....	4.0	0.3
		32X-1, 32–37	....	....	42.1	....	....	....	....	....	2.6	....	....	31.6	....	2.6	....
		33X-4, 88–95	....	....	48.3	....	1.0	....	....	....	0.5	6.3	....	33.3	2.4	4.3	0.5
		36X-1, 93–97	....	....	56.7	....	....	3.3	....	....	....	....	....	23.3	3.3	3.3	....
		38X-1, 35–37	....	....	24.3	....	2.7	8.1	....	....	....	13.5	....	37.8	....	5.4	....
	middle Miocene	39X-1, 46–52	....	....	23.9	....	....	....	....	....	2.9	11.2	....	49.3	....	2.9	....
		2R-3, 69–73	....	0.2	14.4	....	0.5	1.1	0.2	....	1.4	6.9	0.5	59.5	0.7	4.8	0.2
		3R-3, 41–45	....	....	19.6	....	....	6.5	....	....	4.3	26.1	....	26.1	....	8.7	2.2
		5R-2, 41–43	25.0	25.0	25.0	....	....	....	25.0	....	....	....	....	....	....	....	....
		7R-3, 62–66	....	....	42.9	....	9.5	4.8	....	....	....	9.5	....	28.6	....	....	4.8
		8R-2, 61–67	....	....	2.6	....	5.1	5.1	....	2.6	5.1	23.1	7.7	28.2	17.9	2.6	....
		9R-3, 13–14	16.7	....	....	....	50.0	16.7	16.7	....	....	....	....	....	....	....	....
		10R-4, 54–57	28.6	14.3	42.9	14.3	....	....	....	....	....	....	....	....	....	....	....

At Site 765, *Operculodinium janduchenei* last occurs in the early Pliocene. Elsewhere, it last occurs in the early Pliocene of the Norwegian and Labrador seas (Mudie, 1989) and late Pliocene of the North Atlantic (Mudie, 1987; Head et al., 1989a).

Melitasphaeridium choanophorum. At Site 765 *Melitasphaeridium choanophorum* has a range between late Miocene and late Pliocene. In eastern Australia, it disappears in the early Pliocene (McMinn, in press, a). Elsewhere, it has a range between the late Miocene and early Pleistocene in the northwest Pacific (Bujak and Matsuoka, 1986) and offshore Japan (Matsuoka et al., 1987) and late Miocene to early Pliocene in the Bay of Biscay (Harland, 1979). It has also been recorded from the late Pliocene of the Gulf of Mexico (Wrenn and Kokinos, 1986), middle Miocene of South Carolina (Edwards, 1986), early to Miocene of Italy (Powell, 1986), the Norwegian Sea (Mudie, 1989), and offshore Louisiana (Duffield and Stein, 1986).

Operculodinium longispinigerum. At Site 765, *Operculodinium longispinigerum* has a range between early late Miocene and early Pleistocene. It was initially documented from central Japan (Matsuoka, 1983), where it had a middle Miocene to early Pleistocene range and has since been recorded from the west coast of northern Japan as having a similar range (Matsuoka et al., 1987), the late Miocene to late Pliocene of the North Atlantic Ocean and Labrador Sea (Mudie, 1987; Head et al., 1989a; de Vernal and Mudie, 1989), and the early Pliocene to early Pleistocene of southeastern Australia (McMinn, in press, a).

Table 1 (continued).

Age		Sample	*Tectatodinium* sp.	*Achomosphaera* sp.	*Impletosphaeridium* spp.	*Spiniferites mirabilis*	*Dapsilidinium pasteilsii*	*Hystrichokolpoma rigaudiae*	*Operculodinium echigoense*	*Spiniferites rubinus*	*Lingulodinium machaerophorum*	*Operculodinium longispinigerum*	*Melitasphaeridium choanophorum*	*Tuberculodinium vancampoae*	*Spiniferites membranaceus*	*Impagidinium sphaericum*	*Blysmatodinium argoi*
Quaternary		1H-2, 142–144	....	3.0	6.1	....	....	....	....	....	....	....	....	6.1	....	....	....
		1H-3, 80–82	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		3H-6, 37–43	....	....	5.3	2.6	0.9	0.9	0.9	....	0.9	3.5	....	0.9	3.5	....	....
		4H-3, 60–65	....	<0.1	7.8	7.4	....	....	....	....	0.7	2.8	....	6.7	1.1	0.4	....
		5H-6, 63–65	....	0.5	....	3.1	....	1.0	7.7	....	1.0	2.6	....	5.6	1.5	....	....
		6H-1, 69–75	....	0.9	....	5.1	....	0.3	6.9	....	1.5	2.1	....	1.2	1.2	1.5	....
		7H-6, 56–60	....	....	....	....	....	....	<0.1	....	<0.1	....	....	....	....	....	....
		8H-3, 4–6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		9H-2, 100–107	....	....	1.2	2.0	....	1.2	10.1	....	....	1.6	....	1.2	2.0	....	....
Tertiary	Pliocene	10H-1, 123–127	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		11H-3, 38–42	....	0.4	....	3.0	0.4	0.8	5.5	....	2.1	....	....	2.1	....	2.1	0.8
		12H-7, 26–30	....	0.5	....	1.1	1.6	2.3	14.2	....	1.1	1.8	0.5	0.2	0.7	....	....
		13H-3, 78–83	....	0.4	0.4	2.7	1.9	1.2	6.2	....	0.8	1.5	0.4	0.8	1.5	0.8	....
		14R-1, 4–6	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		14H-4, 36–42	....	0.9	2.6	8.6	0.9	<0.1	2.6	....	0.9	3.4	0.9	....	....	....	0.9
		15H-6, 28–33	....	0.3	0.3	2.9	0.3	0.6	0.3	....	<0.1	1.5	....	0.3	1.5	0.3	....
		16H-1, 70–74	....	....	....	....	....	3.0	1.0	....	<0.1	5.0	....	....	....	....	....
		17H-4, 111–115	....	....	2.9	14.7	....	....	....	....	1.5	....	....	....	....	....	....
	late Miocene	18H-5, 48–54	....	0.2	2.0	4.3	0.8	1.2	2.6	....	0.8	5.7	0.2	<0.1	2.2	....	0.8
		19X-2, 92–94	....	....	....	4.4	....	0.6	3.3	....	2.8	8.3	....	....	0.6	....	....
		20X-3, 131–135	....	....	....	1.5	....	3.1	1.5	....	1.5	....	....	....	....	....	....
		21X-5, 126–129	....	0.4	....	2.9	0.4	1.1	24.8	....	2.2	1.8	....	....	0.4	....	<0.1
		22X-1, 108–110	....	<0.1	....	<0.1	<0.1	1.6	22.5	<0.1	0.3	1.3	0.3	<0.1	<0.1	1.0	<0.1
		23X-1, 120–125	....	....	....	3.0	....	3.0	6.1	....	....	....	....	....	....	....	....
		24X-3, 85–90	....	....	0.4	3.6	<0.1	2.4	9.1	....	0.8	3.6	....	0.4	....	0.4	....
		26X-4, 62–68	0.8	0.8	1.2	6.4	....	16.3	19.9	....	....	5.6	....	0.8	1.6	<0.1	0.4
		26X-2, 81–85	4.3	....	....	5.1	....	3.4	7.7	....	1.7	7.7	....	....	....	....	....
		27X-1, 92–96	4.8	....	....	14.3	....	....	14.3	....	....	4.8	....	....	....	4.8	....
		28X-2, 10–15	....	....	....	....	....	....	....	....	<0.1	....	....	....	....	....	....
		29X-1, 120–124	<0.1	0.8	1.2	3.7	....	2.5	....	....	0.8	3.7	....	1.2	0.4	....	....
		30X-1, 75–79	....	0.6	....	<0.1	<0.1	2.0	11.5	0.3	0.3	0.8	<0.1	0.8	0.3	....	....
		31X-5, 90–95	....	....	1.3	1.6	0.3	0.8	12.3	....	0.5	0.8	2.4	0.3	....	....	....
		32X-1, 32–37	....	....	2.6	....	....	....	18.4	....	....	....	....	....	....	....	....
		33X-4, 88–95	....	<0.1	....	2.9	....	<0.1	<0.1	....	<0.1	0.5	....	....	....	....	....
		36X-1, 93–97	....	....	....	3.3	....	....	6.7	....	....	....	....	....	....	....	....
		38X-1, 35–37	....	....	....	5.4	....	....	....	....	2.7	....	....	....	....	....	....
	middle Miocene	39X-1, 46–52	....	....	....	5.9	....	1.5	1.5	....	1.0	....	....	....	....	....	....
		2R-3, 69–73	....	0.2	....	4.8	0.2	0.7	2.5	1.1	....	....	....	....	....	....	....
		3R-3, 41–45	....	2.2	2.2	2.2	....	....	....	....	....	....	....	....	....	....	....
		5R-2, 41–43	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		7R-3, 62–66	<0.1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		8R-2, 61–67	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		9R-3, 13–14	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
		10R-4, 54–57	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Systematophora placacantha. The diachronous last occurrence of *S. placacantha*, between the middle and late Miocene, is discussed by Head et al. (1989a). It is a rare species at Site 765 and was recorded only from the middle Miocene.

Hystrichokolpoma rigaudiae. The top range of *H. rigaudiae* has been reported variously as late Neogene to Pleistocene. Pliocene extinctions have been reported from the Bering Sea (Matsuoka and Bujak, 2988). Pleistocene extinctions have been reported from the Gulf of Mexico (Wrenn and Kokinos, 1986), the northwestern Pacific Ocean (Bujak and Matsuoka, 1986), and Japan (Matsuoka et al., 1987). Earlier extinctions have been reported by Williams and Bujak (1977) from the late Miocene of offshore eastern Canada, the central North Atlantic Ocean (Mudie, 1987), and the Norwegian Sea (Mudie, 1989).

TROPICAL NEOGENE PALYNOLOGY

The ocean crust on which Site 765 is located has been moving north throughout the Tertiary. Site 765 moved into the tropics at the end of the early Miocene and has continued to move north to its present position at a latitude of 15°97.86′S. Most of the dinoflagellate cysts were brought to the site from the outer continental slope by density currents. Benthic foraminiferal assemblages imply that original deposition was at middle to upper bathyal depths, i.e., 600–2000 m (Ludden, Gradstein, et al., 1990).

Table 1 (continued).

Age			*Nematosphaeropsis? wrennii*	*Selenopemphix nephroides*	*Impagidinium* sp. A	*Multispinula quanta*	*Stelladinium reidii*	*Votadinium calvum*	Count
Quaternary		1H-2, 142–144	....	....	....	....	....	....	33
		1H-3, 80–82	....	....	....	....	....	....	2
		3H-6, 37–43	....	....	0.9	<0.1	....	....	117
		4H-3, 60–65	....	....	2.5	0.4	1.1	0.4	750
		5H-6, 63–65	....	....	<0.1	0.5	....	....	196
		6H-1, 69–75	....	....	....	....	....	....	340
		7H-6, 56–60	....	....	....	....	....	....	—
		8H-3, 4–6	....	....	....	....	....	....	—
		9H-2, 100–107	....	....	....	....	....	....	247
Tertiary	Pliocene	10H-1, 123–127	....	....	....	....	....	....	—
		11H-3, 38–42	....	....	....	....	....	....	237
		12H-7, 26–30	....	0.2	....	....	....	....	447
		13H-3, 78–83	....	....	....	....	....	....	261
		14R-1, 4–6	....	....	....	....	....	....	25
		14H-4, 36–42	....	....	....	....	....	....	117
		15H-6, 28–33	....	....	....	....	....	....	339
		16H-1, 70–74	....	....	....	....	....	....	103
		17H-4, 111–115	....	....	....	....	....	....	68
	late Miocene	18H-5, 48–54	....	....	....	....	....	....	489
		19X-2, 92–94	....	....	....	....	....	....	181
		20X-3, 131–135	....	....	....	....	....	....	68
		21X-5, 126–129	1.1	....	....	....	....	....	273
		22X-1, 108–110	0.3	....	....	....	....	....	324
		23X-1, 120–125	....	....	....	....	....	....	33
		24X-3, 85–90	....	....	....	....	....	....	258
		26X-4, 62–68	....	....	....	....	....	....	255
		26X-2, 81–85	....	....	....	....	....	....	124
		27X-1, 92–96	....	....	....	....	....	....	22
		28X-2, 10–15	....	....	....	....	....	....	16
		29X-1, 120–124	....	....	....	....	....	....	242
		30X-1, 75–79	....	....	....	....	....	....	356
		31X-5, 90–95	....	....	....	....	....	....	373
		32X-1, 32–37	....	....	....	....	....	....	42
		33X-4, 88–95	....	....	....	....	....	....	207
		36X-1, 93–97	....	....	....	....	....	....	30
		38X-1, 35–37	....	....	....	....	....	....	37
	middle Miocene	39X-1, 46–52	....	....	....	....	....	....	205
		2R-3, 69–73	....	....	....	....	....	....	436
		3R-3, 41–45	....	....	....	....	....	....	47
		5R-2, 41–43	....	....	....	....	....	....	3
		7R-3, 62–66	....	....	....	....	....	....	23
		8R-2, 61–67	....	....	....	....	....	....	42
		9R-3, 13–14	....	....	....	....	....	....	7
		10R-4, 54–57	....	....	....	....	....	....	7

Assemblages from purely pelagic sediments are dominated by *Impagidinium* spp., as they are in the equatorial Pacific Ocean (Jarvis and Tocher, 1985).

Tropical Neogene dinoflagellate cysts are virtually unrecorded. One of the only reports is from Jarvis and Tocher (1985), who described Neogene and Quaternary assemblages from the equatorial Pacific Ocean. These have a low diversity and are dominated by long-ranging oceanic forms such as *Impagidinium* spp. and *Nematosphaeropsis* spp. These Pacific Ocean assemblages are similar to several from Site 765, but particularly to those derived from the pelagic deposits of Site 761 on the Exmouth Plateau (McMinn, unpubl. data). No Neogene dinoflagellate assemblages from the continental shelf or slope have been reported. However, many reports of modern tropical dinoflagellate cysts do exist. These include McMinn (1990; in press, b) and Bint (1988) from northern Australia; Morzadec-Kerfourn (1988) from the West African (Guinean) margin; Wall et al. (1977) included assemblages from Jamaica, Puerto Rico, Trinidad, and Belize in the Caribbean Sea; Ivory Coast near Abidjan in western equatorial Africa; and from off the coast of Peru in the eastern equatorial Pacific; Bradford and Wall (1984) included those from the Persian Gulf.

The Australian assemblages from the inner continental shelf of the Gulf of Carpentaria and Trinity Bay (McMinn, 1990; in press, b) are characterized by abundant *Operculodinium centrocarpum* (Deflandre and Cookson, 1955), *Operculodinium israelianum*, and *Spiniferites bulloideus*. Those of Bint (1988) from the littoral zone of northwestern Australia are dominated by peridineacean cysts. The assemblages from the inner continental shelf of the Caribbean Sea are characterized by *Polysphaeridium zoharyi*, which is often dominant; *Spiniferites bulloideus*; *Lingulodinium machaerophorum* (Deflandre and Cookson, 1955); *Operculodinium centrocarpum*; and *Operculodinium israelianum*. The Ivory Coast assemblages are dominated by *Spiniferites bulloideus* and *Spiniferites ramosus* (Deflandre and Cookson, 1955); the Peruvian assemblages by *Protoperidinium* cysts inshore and *Operculodinium centrocarpum* and *Spiniferites bulloideus* offshore. The assemblages from the Persian Gulf (Bradford and Wall, 1984) are characterized by abundant *Polysphaeridium zoharyi*, with common *Operculodinium* spp., *Spiniferites* spp., and *Lingulodinium machaerophorum*. The Pleistocene assemblages from the West African coast (Morzadec-Kerfourn, 1988) are characterized by abundant *O. israelianum*, *O. centrocarpum*, *Lingulodinium machaerophorum*, *S. ramosus*, *Spiniferites bentori*, and *Spiniferites mirabilis*; *Impagidinium* spp. and *Tuberculodinium vancampoae* also are common.

The Neogene assemblages from Site 765 are most similar to those of the West African (Guinean) coast, the Persian Gulf, and the Caribbean Sea in having common *Polysphaeridium zoharyi*, *Operculodinium* spp., and *Spiniferites* spp. The main difference between the assemblages of the latter two areas and Site 765 (Table 2) is the addition of the oceanic component of *Impagidinium* spp. and *Nematosphaeropsis* spp., which is accounted for by the presumed outer shelf and slope origin for these cysts. This component is present in the Pleistocene assemblages of West Africa. The modern assemblages from the southwest coast of Africa and west coast of South America, both of which experience major upwelling, differ by being dominated by *Operculodinium centrocarpum* and *Spiniferites bulloideus*.

Duffield and Stein (1986), Lenoir and Hart (1986) and Wrenn and Kokinos (1986) reported Neogene assemblages from the continental shelf off the United States in the Gulf of Mexico (latitudes 28°–30°N). The assemblages reported by Wrenn and Kokinos (1986) are dominated by *Lingulodinium machaerophorum*, *Spiniferites mirabilis*, *Polysphaeridium zoharyi*, and *Impagidinium patulum*; those Neogene assemblages, therefore, are the closest in composition to those from Site 765.

The composition of tropical Neogene dinoflagellate cyst assemblages from Site 765, therefore, is consistent with Quaternary tropical assemblages and warm-temperate Neogene assemblages from the Northern Hemisphere. These assemblages are characterized by abundant *Polysphaeridium zoharyi*, *Spiniferites bulloideus*, and *Operculodinium* spp. The outer shelf to slope origin of the assemblages is attested to by the presence of common *Impagidinium* spp. and *Nematosphaeropsis lemniscata*.

SYSTEMATIC PALYNOLOGY

Thirty-six dinoflagellate cyst species, all of which are listed below, were identified at Site 765. Illustrated specimens have been registered with the Micropalaeontological Collection of the N.S.W. Geological Survey and have been designated with an MMMC number.

Division *PYRROPHYTA* Pascher, 1914
Class *DINOPHYCEAE* Fritsch, 1935
Order *PERIDINIALES* Haeckel, 1894
Genus *ACHOMOSPHAERA* Evitt, 1963
Achomosphaera sp.
(Plate 1, Fig. 2)

Genus *BATIACASPHAERA* Drugg, 1970
Batiacasphaera micropapillata Stover, 1977
(Plate 3, Figs. 14–16)

Genus *BLYSMATODINIUM* gen. nov.

Type species. *Blysmatodinium argoi*.

Diagnosis. Cyst composed of an endophragm and periphragm. Periphragm is characterized by numerous nontabular blisters. Archeopyle is apical; operculum is detached.

Comments. The pattern of blisters on *Blysmatodinium* does not reflect a typical gonyaulacacean paratabulation pattern. However, the blisters do show evidence of alignment parallel to a paracingulum and thus could reflect a nongonyaulacacean paratabulation.

Blysmatodinium is differentiated from *Ataxiodinium* by having an apical archeopyle and in having distinct blisters in the periphragm, rather than "funnel-shaped depressions" (Reid, 1974).

It is differentiated from *Polykrikos* Butschli, 1873, a nongonyaulacacean genus, by lacking both a reticulum and fibrous periphragm.

Derivation of name. From blysmatos (Greek) meaning bubble.

Blysmatodinium argoi sp. nov.
(Plate 3, Figs. 1–4)

Diagnosis. Small cavate cyst composed of an endophragm and periphragm. Periphragm forms into numerous nontabular blisters.

Description. Small cyst composed of a 1-μm-thick, smooth endophragm and a <1-μm-thick periphragm. Periphragm is formed into numerous, apparently nontabular, low blisters up to 4 μm high. On the dorsal surface, these are possibly aligned parallel to a paracingulum. Archeopyle is apical, type tA; operculum is detached.

Type material. Holotype MMMC1856, Sample 123-765B-18H-5, 48–54 cm, Pl. 3, Figs. 1–3. Paratype MMMC1857, Sample 123-765B-11X-3, 38–42 cm, Pl. 3, Fig. 4.

Size. Length 26(28)30 μm, length 24(26)28 μm; five specimens were measured.

Derivation of name. From Argo Abyssal Plain, location of Site 765.

Genus *DAPSILIDINIUM* Bujak et al., 1980
Dapsilidinium pastielsii (Davey and Williams, 1966) Bujak et al., 1980
(Plate 3, Figs. 12, 13)

Size. Diameter 29(35)46 μm, process length 15(16)17 μm; five specimens were measured.

Genus *HYSTRICHOKOLPOMA* Klumpp, 1953
Hystrichokolpoma rigaudiae Deflandre and Cookson, 1955
(Plate 4, Figs. 10, 11)

Genus *IMPAGIDINIUM* Stover and Evitt, 1978
Impagidinium aculeatum (Wall, 1967) Lentin and Williams, 1981

Size. Length 27(29)33 μm, width 21(25)29 μm, septa height 5(7)9 μm; five specimens were measured.

Impagidinium paradoxum (Wall, 1967) Stover and Evitt, 1978
(Plate 1, Figs. 9–12)

Size. Length 28(30)36 μm, width 20(25)33 μm, septa height 3(4)5 μm; 10 specimens were measured.

Impagidinium patulum (Wall, 1967) Stover and Evitt, 1978
(Plate 1, Figs. 14–17)

Size. Length 45(50)57 μm, width 41(45)52 μm, septa height 3(4)6 μm.

Impagidinium sphaericum (Wall, 1967) Lentin and Williams, 1981
(Plate 1, Fig. 1)

Impagidinium strialatum (Wall, 1967) Stover and Evitt, 1978
(Plate 1, Figs. 5–8)

Size. Length 27(31)34 μm, width 20(24)26 μm, septa height 5(8)12 μm; 10 specimens were measured.

Genus *LINGULODINIUM* Wall, 1967
Lingulodinium machaerophorum (Deflandre and Cookson, 1955) Wall, 1967
(Plate 4, Fig. 5)

Genus *IMPLETOSPHAERIDIUM* Morgenroth, 1966
Impletosphaeridium spp.

Comments. Included in this category are the small (i.e., <20 µm diameter), thin-walled cysts with numerous, short, nontabular acuminate to capitate processes. It was not possible to determine the mode of archeopyle formation.

Genus *LINGULODINIUM* Wall, 1967
Lingulodinium machaerophorum (Deflandre and Cookson, 1955) Wall, 1967
(Plate 4, Fig. 5)

Genus *MELITASPHAERIDIUM* Harland and Hill, 1979
Melitasphaeridium choanophorum (Deflandre and Cookson, 1955) Harland and Hill, 1979
(Plate 3, Figs. 7–9)

Genus *MULTISPINULA* Bradford, 1975
Multispinula quanta Bradford, 1975
(Plate 4, Fig. 4)

Genus *NEMATOSPHAEROPSIS* Deflandre and Cookson, 1955
Nematosphaeropsis lemniscata Bujak, 1984
(Plate 4, Fig. 6)

Size. Diameter 21(25)31 µm, process length 7(11)15 µm; five specimens were measured.

Nematosphaeropsis(?) wrennii n. sp.
(Plate 3, Figs. 17–20)

Diagnosis. Spiniferate cyst with gonal processes and low proximal connecting septa. Opposite paracingular processes are connected across the paracingulum by fine trabeculae.

Description. Small, egg-shaped cyst composed of a thin, <1 µm, smooth, autophragm, which is produced into gonal processes and basal connecting septa. Opposite paracingular processes are joined across the paracingulum by fine trabeculae. Paracingular processes are larger and are associated with higher basal septa. Paratabulation is standard gonyaulacacean, i.e., 4', 6'', 6c, 6''', 1p, 1''''; the archeopyle is precingular, type 1P; and operculum is detached.

Comments. *Nematosphaeropsis(?) wrennii* differs from other species of *Nematosphaeropsis* in having only trabeculae connecting paracingular process across the paracingulum and in having well-developed basal connecting septa. In these regards, *N. wrennii* is intermediate in morphology between *Spiniferites* and *Nematosphaeropsis*.

Type material. Holotype MMMC1865, Sample 123-765B-21X-5, 126–129 cm, Pl. 3, Figs. 19–20. Paratype MMMC1864, Sample 123-765B-21X-5, 126–129 cm, Pl. 3, Figs. 17–18.

Size. Length 25(28)33 µm, width 22(25)28 µm, process length 9(10)11 µm; 10 specimens were measured.

Derivation of name. After J. H. Wrenn, Amoco Production Company, who has been responsible for a major revision of *Nematosphaeropsis*.

Genus *OPERCULODINIUM* Wall, 1967
Operculodinium centrocarpum (Deflandre and Cookson, 1955) Wall, 1967
Operculodinium israelianum (Rossignol, 1962) Wall, 1967
(Plate 2, Figs. 10–13)

Size. Diameter 46(51)54 µm, process length 7(10)16 µm; five specimens were measured.

Operculodinium janduchenei Head et al., 1989a
(Plate 2, Figs. 1, 4, 7)

Description. Small, egg-shaped cyst composed of a 1- to 2-µm-thick, smooth endophragm and a thinner, smooth periphragm. The periphragm is produced into numerous small, conical, hollow, nontabular processes. The processes are either closed or open, although this feature is usually uniform on any specimen. The archeopyle is precingular, type 1P, and no other paratabulation is indicated.

Comments. Specimens examined from Site 765 are similar to the type specimens described by Head et al. (1989a); the main difference between them is the absence of grana on the former.

Size. Length 27(30)35 µm, width 23(25)27 µm, process length 2(2)3 µm; seven specimens were measured.

Operculodinium longispinigerum Matsuoka, 1983
(Plate 2, Figs. 3, 6, 8, 9)

Description. Small, smooth-walled cyst having slender, solid, nontabular, acuminate processes. Wall consists of an autophragm only and is smooth between processes. Archeopyle is precingular, type 1P with a free operculum, and no other paratabulation is indicated.

Size. Diameter 24(27)31 µm, process length 7(9)10 µm; six specimens were measured.

Operculodinium echigoense Matsuoka, 1983
(Plate 2, Figs. 14–21)

Description. Large, ovoid cyst composed of a 2- to 3-µm-thick endophragm and a 1-µm-thick periphragm. Endophragm is smooth; periphragm is microreticulate and formed into nontabular processes. Process morphology is variable; most specimens have long, slender, acuminate to bifid processes, but other specimens have shorter processes with ragged distal terminations; intermediate forms are also present. Archeopyle is precingular, predominantly 1P, although a few specimens having 2P archeopyles also have been observed; no other tabulation is indicated.

Comments. *Operculodinium echigoense* is similar to *Operculodinium israelianum*, but is differentiated by longer, more variable processes and by a larger size.

Size. Diameter 64(85)110 µm, process length 12(24)37 µm, 10 specimens were measured.

Operculodinium sp. cf *O. janduchenei* Head et al., 1989a
(Plate 2, Figs. 2, 5)

Description. Small, egg-shaped cyst composed of a 1- to 2-µm-thick, smooth endophragm and a <1-µm-thick, smooth periphragm. The periphragm is formed into many nontabular, acuminate processes. The archeopyle is precingular, type 1P, and no other tabulation is indicated.

Comments. This taxa differs from *Operculodinium janduchenei* in having longer, acuminate processes. The two taxa look similar, but a clear differentiation in process length exists.

Size. Length 25(31)34 µm, width 25(28)31 µm, process length 7(9)10 µm; five specimens were measured.

Genus *PENTADINIUM* Gerlach, 1961
Pentadinium sp.
(Plate 3, Figs. 5, 6)

Size. Pericyst; length 31 µm, width 34 µm; endocyst, length 25 µm, width 23 µm; only one specimen was measured.

Genus *POLYSPHAERIDIUM* Davey and Williams, 1966
Polysphaeridium zoharyi (Rossignol, 1962) Bujak et al., 1980
(Plate 4, Figs. 7, 8)

Comments. Ecological constraints on the geographical distribution of *P. zoharyi* have apparently changed since the early Neogene. *Polysphaeridium zoharyi* is common in sediments of deep-water origin throughout most of the Neogene, but in the Pleistocene, it becomes rare in this environment and eventually disappears (at Site 765). In modern sediments, it is common only in tropical, estuarine environments. The presence of *P. zoharyi* in the early Miocene at a paleolatitude of approximately 45°S (Truswell et al., 1985) suggests that it probably also had a much greater temperature tolerance than at present.

Size. Diameter 46(59)70 µm, process length 14(18)26 µm, 10 specimens were measured.

Genus *PYXIDINOPSIS* Habib, 1976
Pyxidinopsis sp.
(Plate 3, Figs. 10, 11)

Genus *SELENOPEMPHIX* Benedek, 1972
Selenopemphix nephroides Benedek, 1972
(Plate 4, Fig. 3)

Genus *SPINIFERITES* Mantell, 1850
Spiniferites bulloideus (Deflandre and Cookson, 1955) Sarjeant, 1970

Spiniferites hyperacanthus (Deflandre and Cookson, 1955) Cookson and Eisenack, 1974

Spiniferites membranaceus (Rossignol, 1964) Sarjeant, 1970
(Plate 1, Fig. 4)

Spiniferites mirabilis (Rossignol, 1964) Sarjeant, 1970
(Plate 1, Fig. 13)

Spiniferites ramosus (Ehrenberg, 1838) Loeblich and Loeblich, 1966
(Plate 1, Fig. 3)

Spiniferites rubinus (Rossignol, 1964) Sarjeant, 1970

Genus *STELLADINIUM* Bradford, 1975
Stelladinium reidii Bradford, 1975
(Plate 4, Figs. 1, 2)

Genus *SYSTEMATOPHORA* Klement, 1960
Systematophora placacantha (Deflandre and Cookson, 1955) Davey et al., 1969

Genus *TUBERCULODINIUM* Wall, 1967
Tuberculodinium vancampoae Wall, 1967
(Plate 4, Fig. 9)

Genus *VOTADINIUM* Reid, 1977
Votadinium calvum Reid, 1977

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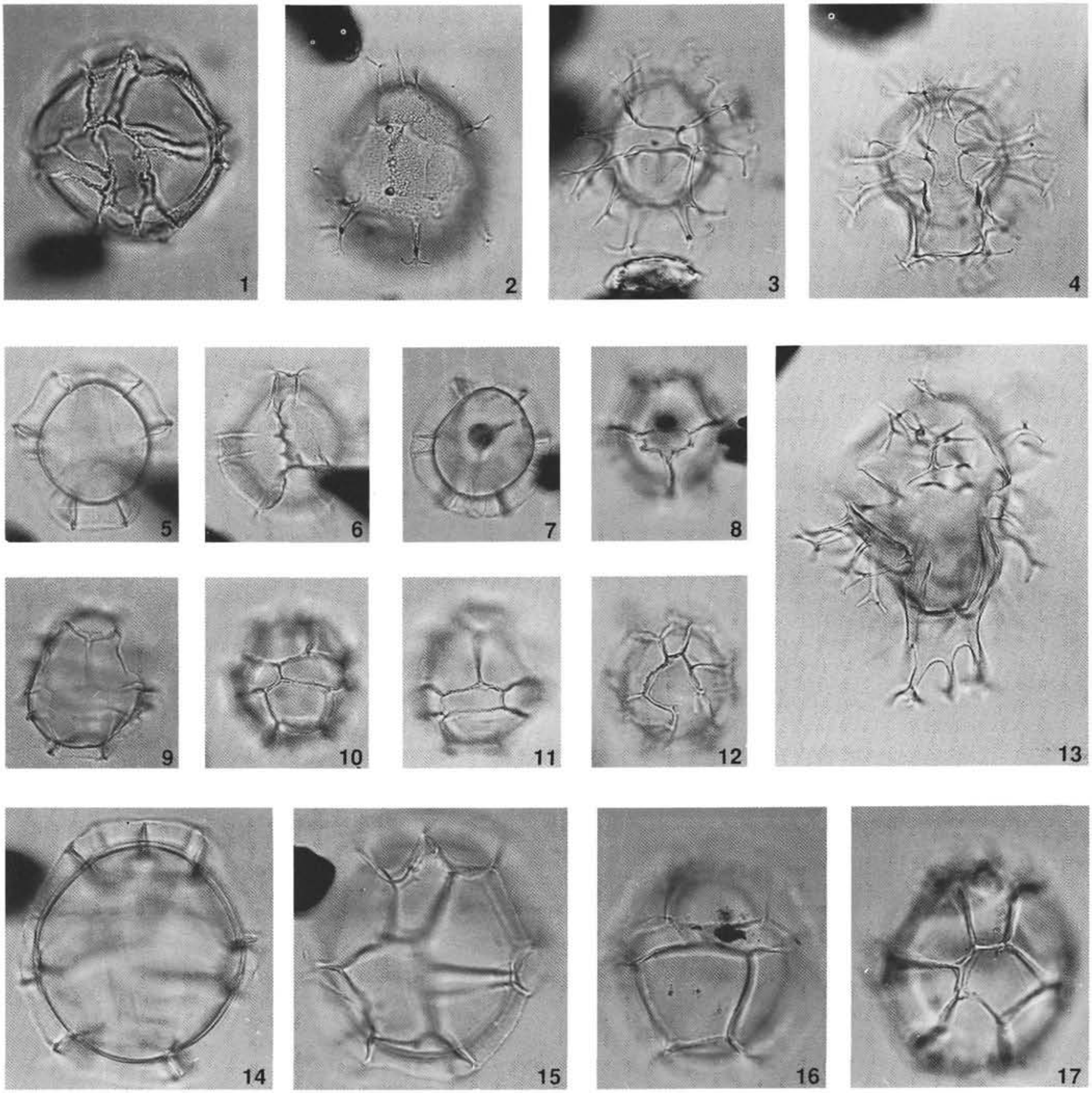

Plate 1. **1.** *Impagidinium sphaericum* (Wall, 1967) Lentin and Williams, 1981 (800X), Sample 123-765B-5H-6, 63–65 cm, MMMC1834. **2.** *Achomosphaera* sp. (800X), Sample 123-765B-12H-7, 26–30 cm, MMMC1835. **3.** *Spiniferites ramosus* (Ehrenberg, 1838) Loeblich and Loeblich, 1966 (800X), Sample 123-765B-21X-5, 126–129 cm, MMMC1836. **4.** *Spiniferites membranaceus* (Rossignol, 1964) Sarjeant, 1970 (800X), Sample 123-765B-18H-5, 48–54 cm, MMMC1837. **5,6.** *Impagidinium strialatum* (Wall, 1967) Stover and Evitt, 1978 (800X), Sample 123-765B-4H-3, 60–65 cm, MMMC1838. **7,8.** *Impagidinium strialatum* (800X), Sample 123-765B-12X-7, 26–30 cm, MMMC1839. **9–11.** *Impagidinium paradoxum* (Wall, 1967) Stover and Evitt, 1978 (800X), Sample 123-765B-22X-1, 108–110 cm, MMMC1840. **12.** *Impagidinium paradoxum* (800X), Sample 123-765B-24X-3, 85–90 cm, MMMC1841. **13.** *Spiniferites mirabilis* (Rossignol, 1964) Sarjeant, 1970 (800X), Sample 123-765B-22X-1, 108–110 cm, MMMC1842. **14,15.** *Impagidinium patulum* (Wall, 1967) Stover and Evitt, 1978 (800X), Sample 123-765B-22X-1, 108–110 cm, MMMC1843. **16,17.** *Impagidinium patulum* (800X), Sample 123-765B-2H-3, 97–100 cm, MMMC1844.

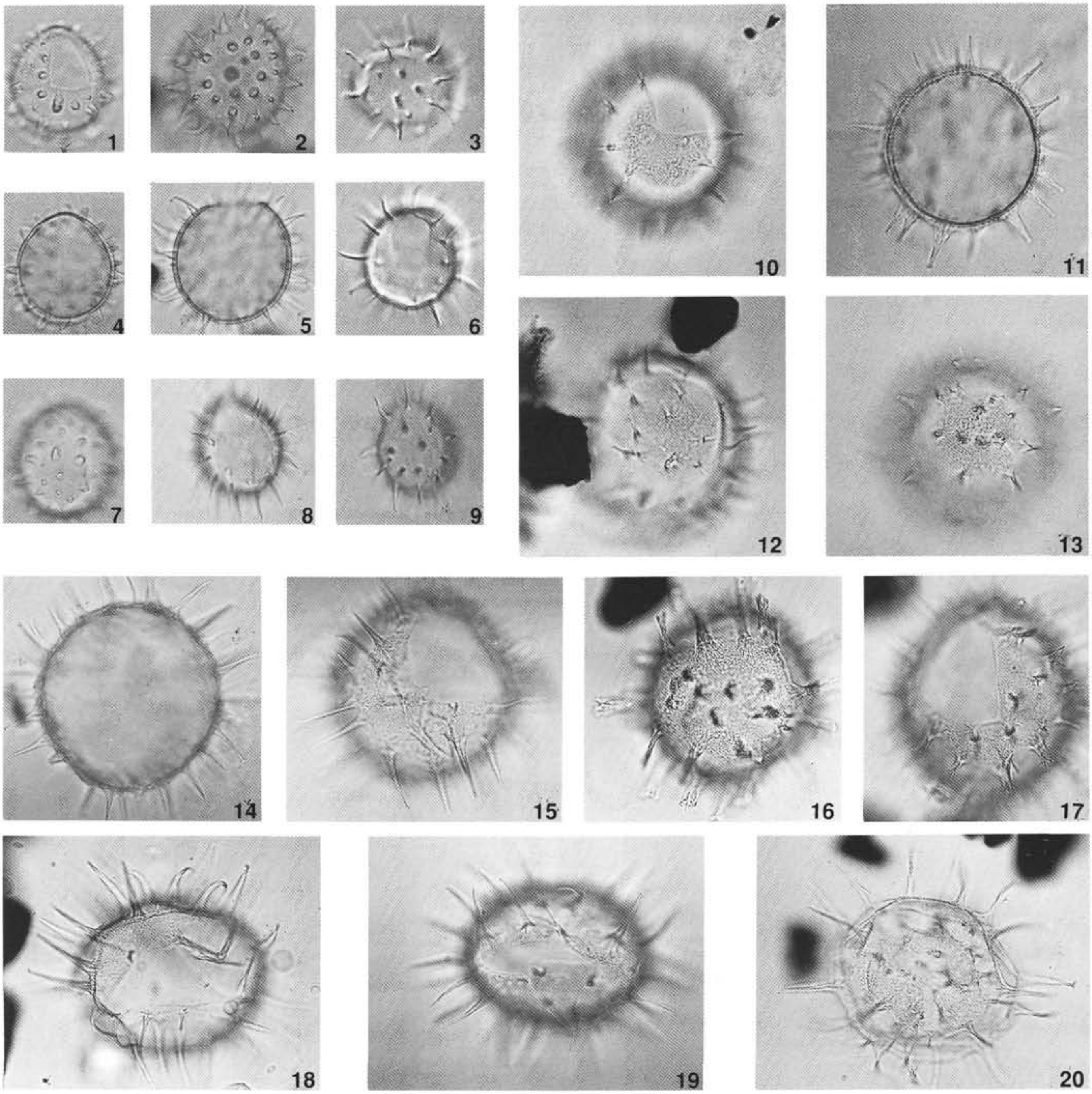

Plate 2. **1–3.** *Operculodinium janduchenei* Head et al., 1989a (800X), Sample 123-765B-22X-1, 108–110 cm, MMMC1845. **4, 5.** *Operculodinium* sp. cd. *janduchenei* (800X), Sample 123-765B-18H-5, 48–54 cm, MMMC1846. **6, 9.** *Operculodinium longispinigerum* Matsuoka, 1983 (800X), Sample 123-765B-22X-1, 108–110 cm, MMMC1847. **7, 8.** *Operculodinium longispinigerum* (800X), Sample 123-765B-22X-1, 108–110 cm. **10, 11, 13.** *Operculodinium israelianum* (Rossignol, 1962) Wall, 1967 (800X), Sample 123-765B-6H-1, 69–75 cm, MMMC1849. **12.** *Operculodinium israelianum* (800X), Sample 123-765fB-22X-1, 108–110 cm, MMMC1850. **14, 15.** *Operculodinium echigoense* Matsuoka, 1983 (400X), MMMC1851. **16, 17.** *Operculodinium echigoense* (400X), Sample 123-765B-12H-7, 26–30 cm, MMMC1852. **18.** *Operculodinium echigoense* (400X), Sample 123-765B-22X-1, 108–110 cm, MMMC1853. **19.** *Operculodinium echigoense* (400X), MMMC1854. **20.** *Operculodinium echigoense* (400X), Sample 123-765B-22X-1, 108–110 cm, MMMC1856.

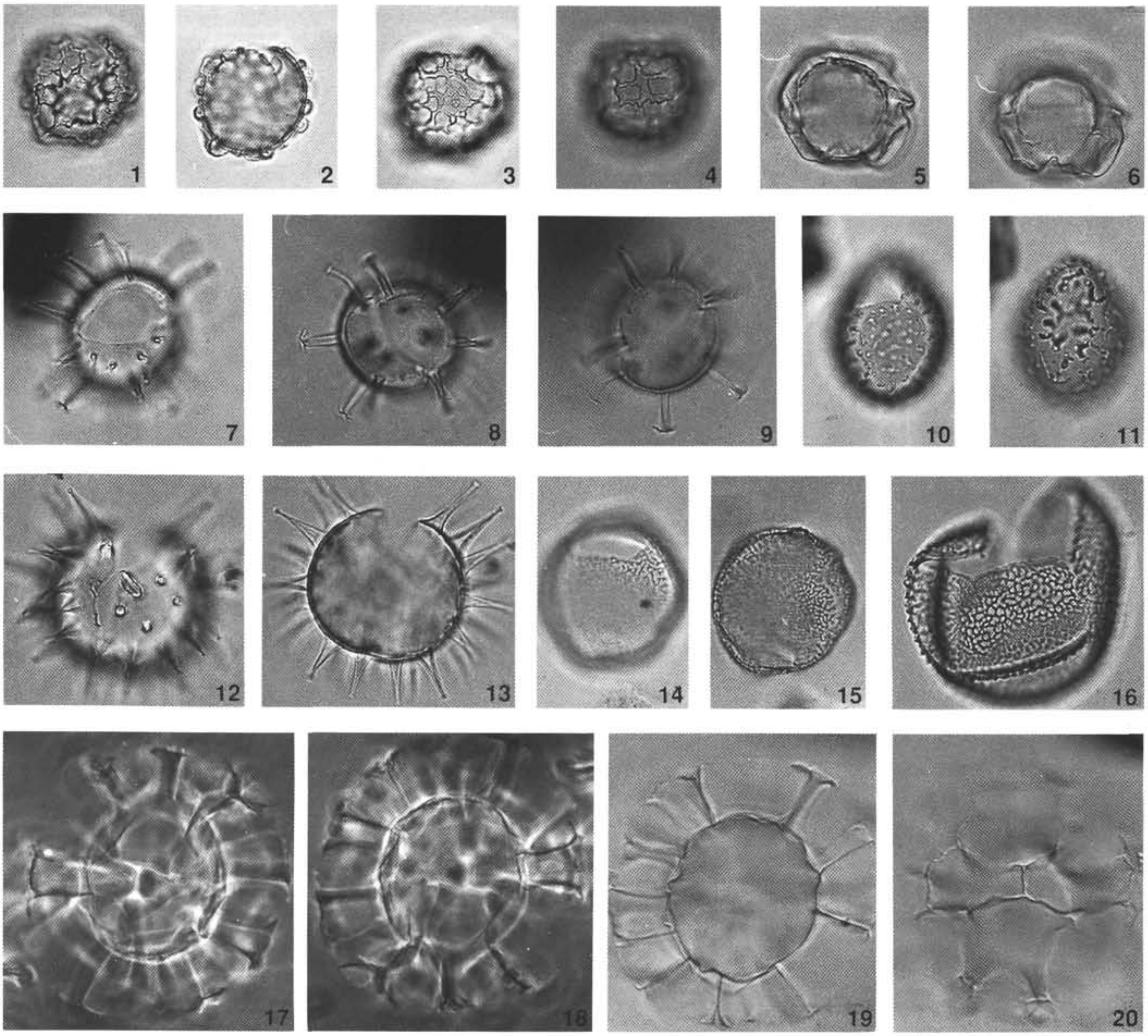

Plate 3. **1–3.** *Blysmatodinium argoi* gen. et sp. nov. (800X), Holotype, Sample 123-765B-18H-5, 48–54 cm, MMMC1856. **4.** *Blysmatodinium argoi* (800X), Paratype, Sample 123-765B-11X-3, 38–42 cm, MMMC1857. **5,6.** *Pentadinium* sp. (800X), Sample 123-765B-13H-3, 78–83 cm, MMMC1858. **7–9.** *Melitasphaeridium choanophorum* (Deflandre and Cookson, 1955) Harland and Hill, 1979 (800X), Sample 123-765B-12H-7, 26–30 cm, MMMC1859. **10,11.** *Pyxidinopsis* sp. (800X), Sample 123-765C-2R-3, 69–73 cm. **12,13.** MMMC1860. *Dapsilidinium pastielsii* (Davey and Williams, 1966) Bujak et al., 1980 (800X), Sample 123-765B-13H-3, 78–83 cm, MMMC1861. **14,15.** *Batiacasphaera micopapillata* Stover, 1977 (800X), Sample 123-765B-27X-1, 92–96 cm, MMMC1862. **16.** *Batiacasphaera micropapillata* (800X), Sample 123-765C-10R-4, 54–57 cm, MMMC1863. **17,18.** *Nematosphaeropsis wrennii* n. sp. Paratype (1000X), Sample 123-765B-21X-5, 126–129 cm, MMMC1864. **19,20.** *Nematosphaeropsis wrennii* Holotype (800X), Sample 123-765B-21X-5, 126–129 cm, MMMC1865.

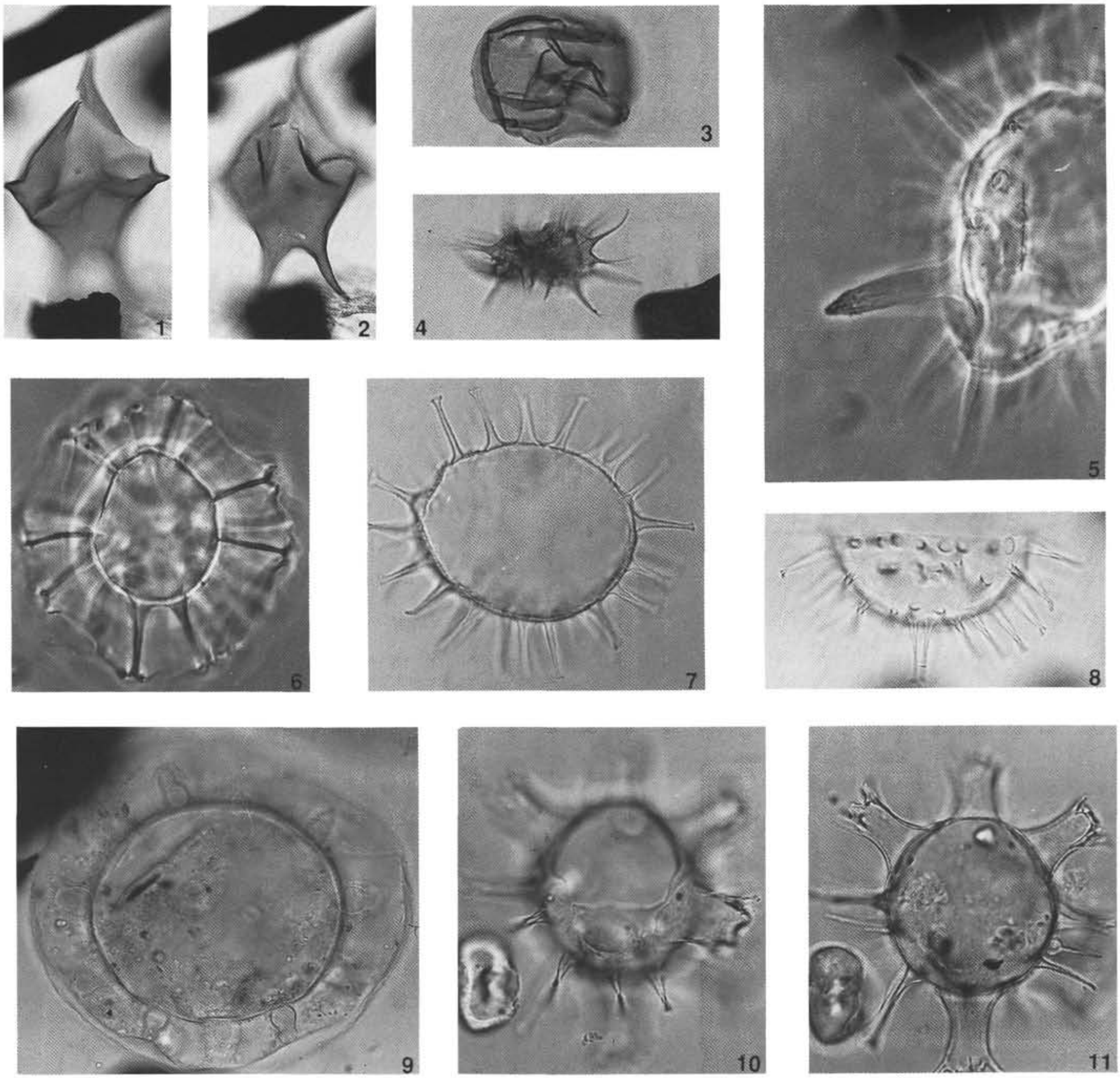

Plate 4. **1,2.** *Stelladinium reidii* Bradford, 1975 (400X), Sample 123-765B-4H-3, 60–65 cm, MMMC1866. **3.** *Selenopemphix nephroides* Benedek, 1972 (800X), Sample 123-765B-12H-7, 26–30 cm, MMMC1867. **4.** *Multispinula quantra* Bradford, 1975 (800X), Sample 123-765B-5H-6, 63–65 cm, MMMC1868. **5.** *Lingulodinium machaerophorum* (1000X), Sample 123-765B-22X-1, 108–110 cm, MMMC1869. **6.** *Nematosphaeropsis lemniscata* Bujak, 1984 (800X), Sample 123-765B-13H-3, 78–83 cm, MMMC1870. **7.** *Polysphaeridium zoharyi* (Rossignol, 1962) Bujak et al., 1980 (800X), Sample 123-765B-22X-1, 108-110 cm, MMMC1871. **8.** *Polysphaeridium zoharyi* (800X), Core 765B-22X-1, 108-110 cm, MMMC1872. **9.** *Tuberculodinium vancampoae* Wall 1967 (400X), Core 765A-1H, CC, MMMC1873. **10-11.** *Hystrichokolpoma rigaudiae* Deflandre & Cookson 1955 (800X), Sample 123-765B-39X-1, 46–52 cm, MMMC1874.