2. PALYNOLOGICAL BIOSTRATIGRAPHY, DEEP SEA DRILLING PROJECT SITES 367 AND 370

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INTRODUCTION

Samples from Sites 367 and 370, Leg 41 of the Deep Sea Drilling Project (Figure 1), were analyzed for palynological biostratigraphy. The oldest sediments cored and dated from Site 367 are Oxfordian-Kimmeridgian according to the foraminiferal data. They are overlain by Tithonian, Cretaceous, and Tertiary sediments. Palynomorph recovery has been somewhat disappointing from Site 367. Site 370 bottoms in Neocomian sediments. A major hiatus apparently occurs between 673 and 663.5 meters where Paleocene sediments appear to overlie Cenomanian sediments. There is a more or less complete Tertiary sequence. Palynomorphs, and especially dinoflagellates, are abundant throughout Site 370.

BIOSTRATIGRAPHY

Site 367

Site 367 is located in 4748 meters of water in the Cape Verde Basin to the west of Senegal. It was drilled to compare the Mesozoic section in the eastern North Atlantic with that of the western Atlantic, as found in part on the Scotian Shelf and the Grand Banks. The hole bottomed in basalt at 1153 meters. Sequentially overlying the basalt are upper Jurassic through Pleistocene sediments. The dinoflagellates, spores, and pollen present in these sediments are listed in Figure 2 and discussed below.

Jurassic

The interval 1148-1081.5 meters at Site 367 has been dated late Jurassic from the foraminiferal data. Limestones predominate in this interval (Jansa, this volume), probably accounting for the absence of palynomorphs in 7 of the 11 samples examined. However, diagnostic assemblages in Cores 367-38 and 367-35 have been dated as Kimmeridgian. The only spores present are the ubiquitous species *Callialasporites dampieri* (Balme) Dev, *Cicatricosisporites australiensis* (Cookson) Potonié, and *Corollina torosus* (Reissinger) Klaus. The dinocysts include *Epiplosphaera bireticulata* Klement, *Prolixosphaeridium mixtispinosum* (Klement) Davey, *Scriniocassis dictyotum* (Cookson and Eisenack) Beju, *Sirmiodinium grossi* Alberti sensu Gitmez and Sarjeant, 1972, *Systematophora fasciculigera* Klement, and *S. turonica* (Alberti) Downie and Sarjeant (Figure 2). *E. bireticulata*, *P. mixtispinosum*, and *S. grossi* sensu Gitmez and Sarjeant are known only from the Kimmeridgian (Sarjeant, 1975). *S. dictyotum*, which according to Habib (1972) extends into the Valanginian of DSDP Site 105, ranges from Aalenian to Kimmeridgian and questionably into the early Cretaceous according to Sarjeant (1975). This species has not been recorded from Jurassic sediments of the Scotian Shelf. *Systematophora turonica* was originally described from the Turonian by Alberti (1961). In the Scotian Shelf sediments, however, it is not found above the Kimmeridgian. It is probable that Alberti was describing reworked material. The dinocyst assemblage in these cores is assigned a Kimmeridgian age.

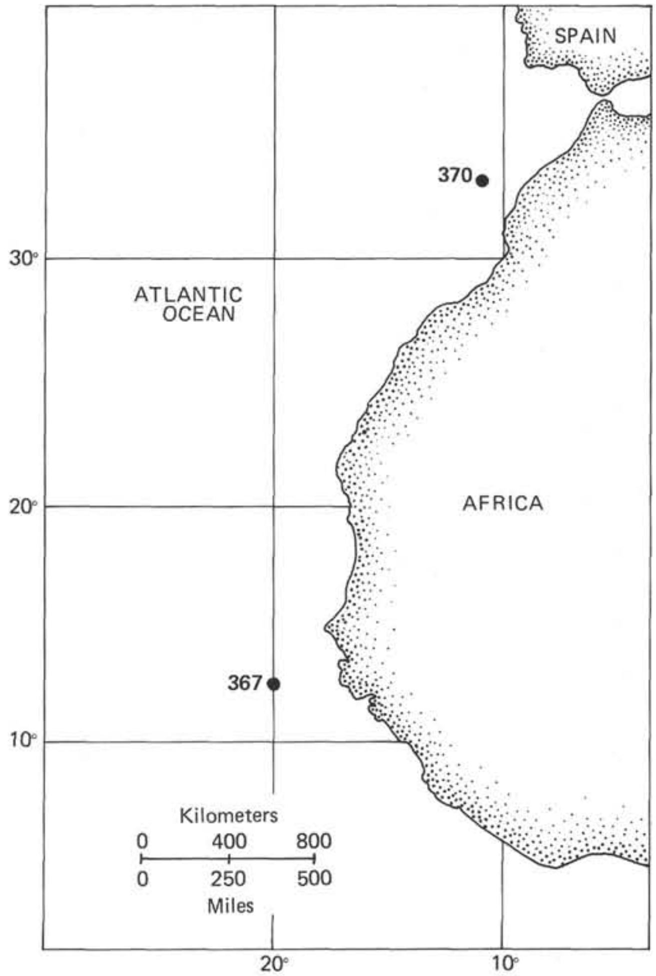

Figure 1. *Location map DSDP Sites 367 and 370.*

The dinocyst species present in Core 367-32 (1091-1081.5 m) include *Ctenidodinium panneum* (Norris) Lentin and Williams. This species is known only from

GEOCHRONOLOGICAL SUBDIVISIONS	ZONE (after Williams, 1975)	DINOCYSTS OCCURRENCE: EARLIEST	DINOCYSTS OCCURRENCE: LATEST
QUAT. / TERTIARY, NEOGENE: PLEISTOCENE-PLIOCENE			Hemicystodinium zoharyi Leptodinium patulum Leptodinium paradoxum Lingulodinium machaerophorum Nematosphaeropsis balcombiana (r) Operculodinium centrocarpum Spiniferites membranaceus (r) Spiniferites scabratus (r) Tuberculodinium vancampoae
		Leptodinium paradoxum Tuberculodinium vancampoae	
		Leptodinium patulum	Operculodinium israelianum
TERTIARY: ?		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
TERTIARY, PALEOGENE: EOCENE, L	Diphyes colligerum	Lingulodinium machaerophorum	Apteodinium australiense (r) Areoligera medusettiformis Diphyes colligerum (r)
EOCENE, ?		BARREN	BARREN
EOCENE, E-M		Areoligera medusettiformis Hemicystodinium zoharyi Operculodinium centrocarpum Operculodinium israelianum	? Adnatosphaeridium patulum (r) Cordosphaeridium inodes (r)
?		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
CRETACEOUS, LATE: CAMPANIAN-CENOMANIAN			Palaeohystrichophora infusorioides
TURONIAN-CENOMANIAN		Palaeohystrichophora infusorioides	
CENOMANIAN	Cleistosphaeridium polypes		Kalyptea aceras Xiphophoridium alatum (r)
CRETACEOUS, EARLY: ALBIAN			
			Oligosphaeridium irregulare sensu Singh, 1964 (r)
APTIAN	Systematophora schindewolfi Subtilisphaera perlucida		Cyclonephelium attadalicum (r)
BARREMIAN			Oligosphaeridium complex (r) Spiniferites dentatus (r) Spiniferites speciosus
			Endoscrinium campanulum Pyxidiella sp. A Habib, 1972
			Kleithriasphaeridium eoinodes Oligosphaeridium cf. complex
			Gonyaulacysta sp. B Habib, 1972 Wallodinium krutzschi
HAUTERIVIAN		Oligosphaeridium cf. complex	
		Spiniferites speciosus	
			Tenua sp. (r)
VALANGINIAN BERRIASIAN		Endoscrinium campanulum Wallodinium krutzschi	Hystrichosphaeridium ? sp. A. Habib, 1972 Tenua verrucosa
		Kleithriasphaeridium eoinodes	Tenua hystrix
			Pareodinia ceratophora (r) Subtilisphaera perlucida (r)
		Gonyaulacysta sp. B Habib, 1972	Gonyaulacysta helicoidea Hystrichodinium ramoides
		Gonyaulacysta helicoidea	Kleithriasphaeridium fasciatum (r)
		Tanyosphaeridium variecalamum	Druggidium deflandrei (r) Systematophora complicata
JURASSIC, LATE: PORTLANDIAN		Hystrichosphaeridium ? sp. A Habib, 1972 Pyxidiella sp. A Habib, 1972 Tenua hystrix	Ctenidodinium panneum (r) Systematophora fasciculigera Systematophora sp. Habib, 1972 (r)
?		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
		BARREN	BARREN
		BARREN	Scriniocassis dictyotum Sirmiodinium grossi sensu Gitmez and Sarjeant, 1972 Systematophora cf. areolata (r)
KIMMERIDGIAN		Scriniocassis dictyotum Sirmiodinium grossi sensu Gitmez and Sarjeant, 1972	Prolixosphaeridium mixtispinosum (r)
		BARREN	BARREN
		BARREN	BARREN
		Systematophora fasciculigera	Epiplosphaera bireticulata (r) Systematophora turonica (r)

(r) PRESENT IN ONE SAMPLE ONLY

Figure 2. *Dinocyst occurrences in DSDP Site 367.*

SPORES AND POLLEN LATEST OCCURRENCE	INTERVAL (cm)	SECTION	CORE	CORE DEPTH (m)
	30-32	6	1	0-8
	80-82	3	2	8-17.5
	86-87	2	3	54-63.5
	52-54	3	4	63.5-73
	118-119	1	5	150-160
	78-79	1	6	236-245.5
	39-40	3	8	302.5-312
Nyssapollenites sp.	40-41			
	74-75	1	9	331-340.5
	142-143	1	12	359.5-369
	146-147			
	103-104	3	13	369-378.5
	20-21	3	14	378.5-388
	75-76	3	15	473.5-483
	116-118	3	16	540-549.5
	95-96	3	17	616-625.5
	101-103	3	19	644.5-654
Corollina torosus	44-45	3	21	692-701.5
	67-68	3	22	720.5-730
	93-94			
Densoisporites perinatus Equisetosporites sp.	62-63	2	23	777.5-787
Alisporites grandis Leptolepidites psarosus	139-140			
	CORE	CATCHER		
Callialasporites dampieri	12-13	3	24	834.5-844
	98-99			
Callialasporites segmentus	20-21	4	25	891.5-901
Callialasporites trilobatus	79-81			
	81-82			
	72-74	3	1	
	31-32	4	26	910.5-920
	52-54			
	79-81	1	27	939-948.5
	107-108	2		
	62-63	1	28	967.5-977
	110-112			
	93-94	3		
	95-96	2	29	996-1005.5
	1-2	3		
Contignisporites cooksonii	13-14	2	30	1024.5-1034
	1-2	2	31	1053-1062.5
	44-45	2	32	1081.5-1091
	106-107	5		
	95-96	2	33	1105.5-1111
	137-138	2	34	1111-1119.5
	23-24	4		
	93-94	1	35	1119.5-1127.5
	37-38	5		
	110-111			
	13-14	3	36	1127.5-1135
	61-62	1	37	1135-1142
	27-29	1	38	1142-1148

GSC

Figure 2. *(Continued).*

the Portlandian of southern England (Norris, 1965) and the Scotian Shelf (Williams, 1975). For this reason Core 367-32 is dated Portlandian.

Cretaceous

Cretaceous sediments extend from 1062.5 to 616 meters (Cores 367-31 to 367-17), of which 1062.5-777.5 meters (Cores 367-31 to 367-23) is lower Cretaceous, and the remainder is upper Cretaceous. Lithologically, there is a limestone-marlstone sequence with some shale from 1062.5 to 891.5 meters (Cores 367-31 to 367-25), successively overlain by a variegated claystone from 844 to 834.5 meters (Core 367-24), a black shale from 787 to 636.0 meters (Cores 367-23 to 367-18), and a multicolored silty clay from 625.5 to 616 meters (Core 367-17) (Jansa, this volume). Palynomorphs are present in all but one sample, from Core 367-24.

Subdivision of the early Cretaceous is difficult, particularly in the Neocomian (here taken to exclude the Barremian), since there is little resemblance to assemblages from known localities. The Berriasian-Valanginian appears to extend from 1053 to 967.5 meters (Cores 367-31 to 367-28). Species present include *Endoscrinium campanulum* (Gocht) Vozzhennikova, *Druggidium deflandrei* (Millioud) Habib, *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant, *Gonyaulacysta* sp. B Habib, 1972, *Hystrichodinium ramoides* Alberti, *Hystrichosphaeridium* sp. A Habib, 1972, *Kleithriasphaeridium eoinodes* (Eisenack) Davey, *K. fasciatum* (Davey and Williams) Davey, *Subtilisphaera perlucida* (Alberti) Jain, and Millepied, *Tenua hystrix* Eisenack, *T. verrucosa* Sarjeant and *Wallodinium krutzschi* (Alberti) Habib. Species not ranging up into the Hauterivian are *Druggidium deflandrei, Gonyaulacysta helicoidea, Hystrichodinium ramoides, Hystrichosphaeridium* sp. A, *Kleithriasphaeridium fasciatum, Subtilisphaera perlucida, Tenua hystrix*, and *T. verrucosa*. *Endoscrinium campanulum*, according to Millioud (1975) has a stratigraphic range of Valanginian-Turonian. This species also first appears in the Valanginian in the Speeton Clay section of northeast England (personal observation). In the Scotian Shelf wells *E. campanulum* occurs, only rarely, above the Barremian. *Druggidium deflandrei* also first appears in the Valanginian (Millioud, 1975), although Habib (1972) recorded it as first appearing in the early Cretaceous, in strata overlain by probable Valanginian sediments. Both Habib (1972) and Millioud (1975) show *Gonyaulacysta helicoidea* as first appearing in the Barremian, and Eisenack and Cookson (1960) recorded it from Neocomian-Aptian, sediments. At Speeton it first appears in the Ryazanian. *Gonyaulacysta* sp. B and *Hystrichosphaeridium* sp. A were described from DSDP Sites 101 and 105 by Habib (1972). The sample from Site 105 containing *Hystrichosphaeridium* sp. A, which is dated late Jurassic-early Cretaceous, also contains *Biorbifera johnewingi* Habib. Although Millioud (1975) extends the range of this species up into the Hauterivian, it has never been found above the Valanginian on the Scotian Shelf (personal observation). Correlation with the Scotian Shelf would therefore suggest a Berriasian-Valanginian age for the association containing *Hystrichosphaeridium* sp. A at Site 105.

The interval from which *Gonyaulacysta* sp. B was recovered at Site 105 is tentatively dated Valanginian by Habib (1972). *Hystrichodinium ramoides* is restricted to the Barremian by Millioud (1975). *Kleithriasphaeridium fasciatum* and *Subtilisphaera perlucida* first appear in the Ryazanian (Berriasian) and Valanginian, respectively, of the Speeton Clay. *K. eoinodes* has a known range of Berriasian-Albian (Millioud, 1975). At Speeton it appears in the Valanginian. *Tenua hystrix* and *T. verrucosa* are predominantly late Jurassic species. Habib (1972) recorded *Wallodinium krutzschi* from the Neocomian of Site 105.

Comparison of the above assemblage from Site 367 with the dinocysts recovered from Site 370, where the Neocomian assemblages show marked similarity to those of the Scotian Shelf and permit subdivision into the Berriasian, Valanginian, and Hauterivian, provides support for a Berriasian-Valanginian age. At Site 370, *Gonyaulacysta helicoidea* and *Hystrichosphaeridium* sp. A are restricted to the Berriasian-Valanginian. The interval 1062.5-967.5 meters at Site 367 is accordingly dated Berriasian-Valanginian.

The Hauterivian is recognized between 948.5 and 910.5 meters at Site 367. Species first appearing are *Oligosphaeridium* cf. *complex* (White) Davey and Williams and *Spiniferites speciosus* (Deflandre) Sarjeant, while *Gonyaulacysta* sp. B Habib, 1972, and *Wallodinium krutzschi* do not range into younger sediments. *W. krutzschi* has a range of Valanginian-Hauterivian at Site 370. The highest occurrence of this species at 920-910.5 meters is therefore taken to mark the top of the Hauterivian at Site 367.

Several species are not present above the Barremian, which extends from 901 to 891.5 meters. These include *Endoscrinium campanulum, Kleithriasphaeridium eoinodes* (Eisenack) Davey, *Pyxidiella* sp. A Habib, 1972, *Oligosphaeridium* cf. *complex, Spiniferites dentatus* (Gocht) Lentin and Williams, and *S. speciosus*. *K. eoinodes*, according to Millioud (1975) has a known range of Berriasian-Albian, although in the Scotian Shelf sediments it is encountered very rarely in the post-Barremian. This species is restricted to the Barremian at Site 370. *Pyxidiella* sp. A was recorded by Habib from the Barremian-Aptian of DSDP Site 101A. *Spiniferites dentatus*, originally described from the late Hauterivian by Gocht (1959), is restricted to the Berriasian-Barremian in the Scotian Shelf sediments. Comparison of the dinocyst assemblages in three samples from Core 367-25 (901-891.5 m) with those in the Barremian of Site 370 and the Scotian Shelf supports the Barremian age determination.

The interval 844-834.5 meters (Core 367-24) is dated Aptian. The index species *Cyclonephelium attadalicum*, common in the type Aptian (recorded as *Cyclonephelium tabulatum* by Davey and Verdier, 1974) and present in the Aptian of several wells on the Scotian Shelf, occurs in large numbers. The spore *Callialasporites dampieri* (Balme) Dev, also present in Core 367-24, is absent from post-Aptian sediments on the Scotian Shelf (Williams, 1975).

The youngest stage in the Early Cretaceous, the Albian, is recognized between 787 and 777.5 meters in Core 367-23. Dinocysts are not abundant with only one diagnostic taxon, *Oligosphaeridium irregulare* (Pocock) Davey and Williams sensu Singh (1964) (as *Hystrichosphaeridium*) being present. Spores species include *Alisporites grandis* (Cookson) Dettmann, *Densoisporites velatus* Weyland and Krieger, *Equisetosporites* sp., and *Leptolepidites psarosus* Norris. *A. grandis* is unknown from post-Albian deposits according to Singh (1971). *L. psarosus* was originally described from the Portlandian. The dinocyst *Oligosphaeridium irregulare* has a known range of Barremian-Albian. Core 367-23 is therefore dated Albian.

Recovery of palynomorphs from the Late Cretaceous black shales is poor, with few dinocysts or pollen. Age determinations are therefore imprecise above 701.5-692 meters (Core 367-21). The interval 730-720.5 meters (Core 367-22) contains the dinocyst species *Kalyptea aceras* Manum and Cookson and *Xiphophoridium alatum* (Cookson and Eisenack) Sarjeant. *X. alatum* has a known range of Aptian-Cenomanian (Davey, 1970). Also present is the pollen species *Corollina torosus* (Reissinger) Klaus, which in the Scotian Shelf-Grand Banks wells has a stratigraphic range of Hettangian-Turonian. The presence of this species in the interval 701.5-692 meters (Core 367-21), together with *Palaeohystrichophora infusorioides* Deflandre, indicates a Cenomanian, possibly Turonian age. *P. infusorioides*, according to Davey (1970), first appears in the Cenomanian. Millioud (1975) and Williams (1975), however, give it a range of late Albian-Campanian, while Davey and Verdier (1973) recorded it from the type Vraconian section of late Albian age.

The interval 654-616 meters (Cores 367-19 and 367-17) can only be dated Cenomanian-Campanian since the only diagnostic palynomorph present is *Palaeohystrichophora infusorioides*. Cores 367-16 through 367-13 (549.5-369 m) do not contain palynomorphs. Lithologically, Cores 367-16 to 367-14 are a multicolored silty clay; Cores 367-14 to 367-13 are zeolitic clays.

Tertiary

Tertiary dinocysts first appear in the interval 369-359.5 meters (Core 367-12) of the zeolitic clay. Species include ?*Adnatosphaeridium patulum* Williams and Downie, *Areoligera medusettiformis* Lejeune-Carpentier, *Cordosphaeridium inodes* (Klumpp) Eisenack, and *Hemicystodinium zoharyi* (Rossignol) Wall. ?*A. patulum*, originally described from the early Eocene, is present in the middle Eocene of Site 370. *A. medusettiformis* appears for the last time in the late Eocene of the Scotian Shelf. *Hemicystodinium zoharyi* has a known range of early Eocene to Recent (Williams, 1975; Wall and Dale, 1969). This interval is therefore dated early to middle Eocene.

Cores 367-9 through 367-1 are lithologically subdivided into zeolitic clay (Core 367-9, 340.5-331 m), diatom-bearing radiolarian clay (Core 367-8, 312-302.5 m), and alternating nanno marls and silty clays (Cores 367-7 to 367-1, 302.5-0 m) (Jansa, this volume). The interval 340.5-331 meters (Core 367-9) is devoid of dinocysts. Core 367-8 (312-302.5 m) however, contains several diagnostic species and can be dated late Eocene. *Apteodinium australiense* (Deflandre and Cookson) comb. nov., is present, together with *Areoligera* *medusettiformis, Diphyes colligerum* (Deflandre and Cookson) Cookson, and *Lingulodinium machaerophorum* (Deflandre and Cookson) Wall. *A. australiense* has a stratigraphic range of late Eocene to early Miocene in DSDP Sites 1 through 6. Williams and Brideaux (1975) who recorded this species as *Apteodinium* sp. Gocht (1969), observed it in late Eocene-late Miocene sediments. *D. colligerum* is used as a late Eocene zonal index species by Williams (1975), who plotted a late Paleocene-late Eocene range for it. The assemblage is therefore regarded as late Eocene.

Cores 367-6 through 367-4 (245.5-63.5 m) are barren. They are overlain by Plio-Pleistocene sediments containing dinocysts and extending from 63.5 to 0 meters (Cores 367-3 through 367-1). Species present include *Leptodinium patulum* Wall, *L. paradoxum* Wall, *Nematosphaeropsis balcombiana* Deflandre and Cookson, *Spiniferites membranaceus* (Rossignol) Sarjeant, *S. scabratus* (Wall) Sarjeant, and *Tuberculodinium vancampoae* (Rossignol) Wall. This assemblage compares favorably with those described from Pleistocene cores in the Caribbean Sea by Wall (1967).

Conclusions

The oldest sediments dated palynologically are Kimmeridgian. These are overlain by Portlandian sediments, the total thickness of the Upper Jurassic being approximately 66 meters. There is a more or less complete Lower Cretaceous section extending from 1062.5 to 777.5 meters. The Upper Cretaceous is imperfectly known because of the absence of palynomorphs in several of the samples. Although recovery is also spasmodic in the Cenozoic, Eocene and Plio-Pleistocene sediments can be differentiated. In the majority of samples the dinocysts predominate. Spores and pollen are most abundant in the Lower Cretaceous, and are sparse or absent in the Upper Cretaceous and Tertiary. Comparison of the assemblages with the Scotian Shelf-Grand Banks shows similarities, particularly in the Lower Cretaceous. It is, however, impossible to draw any conclusions due to the overall sparseness of the assemblages. Throughout, reworked material was minimal.

Site 370

Site 370 is located in 4214 meters of water in the basin off the northwestern Moroccan continental margin. The core hole bottomed in a Lower Cretaceous claystone-marl siltstone sequence at 1176.5 meters. There is a well-developed Lower Cretaceous section, over 400 meters thick, overlain by approximately 65 meters of Cenomanian, which extends from 739.5 to 673 meters. Samples are not available from 673 to 644.5 meters where the sediments are probably of early Eocene age. This is succeeded by middle Eocene, late Eocene, Oligocene, early Miocene, middle Miocene, ?late Miocene, and Plio-Pleistocene sediments, respectively (Figure 3). Dinocysts are abundant throughout, with the assemblages showing a marked similarity to coeval assemblages from the Scotian Shelf. Reworked material is common, particularly in the Tertiary where it sometimes represents up to 30% of the palynomorph count. Spores and pollen are rare.

Cretaceous

The Cretaceous extends from 1167 to 673 meters (Cores 370-50 to 370-20), of which 418 meters are Lower Cretaceous sediments, and 66.5 meters (Cores 370-26 to 370-20) Cenomanian (Figure 3). Jansa (this volume) places this interval in his Unit 5, a sequence of nannofossil-bearing claystones, silty claystones with interbedded siltstone and sandstone, and occasional conglomerates. The oldest sediments, palynologically dated as Berriasian-Valanginian, are present from 1167 to 986.5 meters (Cores 370-50 to 370-41). Species appearing for the first time include *Cribroperidinium muderongense* sensu Habib, 1972, *C. orthoceras* (Eisenack) Davey, *Cyclonephelium distinctum* Deflandre and Cookson, *C. vannophorum* Davey, *Meiourogonyaulax stoveri* Millioud, *Occisucysta* sp. A, *Oligosphaeridium complex* (White) Davey and Williams, *Oligosphaeridium* cf. *complex*, *Oligosphaeridium dividuum* sp. nov., *Pseudoceratium pelliferum* Gocht, *Spiniferites ramosus* (Ehrenberg) Loeblich and Loeblich, and *Wallodinium krutzschi* Alberti) Habib. Species restricted to this interval are *Achomosphaera neptuni* (Eisenack) Davey and Williams, *Endoscrinium campanulum* (Gocht) Vozzhennikova, *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant, *Hystrichosphaeridium* sp. A Habib, 1972, *Lanterna sportula* Dodekova, *Phoberocysta neocomica* (Gocht) Millioud, and *Spiniferites speciosus* (Deflandre) Sarjeant (Figures 3 and 4). *Cribroperidinium orthoceras*, which is present in the bottom Core 370-50, at 1167-1157.5 meters, has a stratigraphic range of Valanginian-Cenomanian (Millioud, 1975). In the Speeton Clay section it first appears in the Valanginian, indicating that the oldest dated sediments at Site 370 are Valanginian, rather than Berriasian. *Cyclonephelium distinctum*, also present in Core 370-50, first occurs in the Valanginian according to Millioud (1975). The range of *C. vannophorum* is imperfectly known, although Williams (1975) recorded it from Hauterivian to Coniacian sediments on the Scotian Shelf. Combining the data from Millioud (1975) and Williams (1975) would result in a Kimmeridgian-Aptian range for *Meiourogonyaulax stoveri*. *Pseudoceratium pelliferum*, a ubiquitous species originally described from the Valanginian-Hauterivian by Gocht (1957), is restricted to the Valanginian-Barremian. This species occurs in large numbers in Core 370-44 (1053-1043.5 m). *Wallodinium krutzschi*, described by Alberti (1961) from the Hauterivian-Barremian, has never been recorded from Jurassic sediments. Perhaps more significant than the above are the presence of *Achomosphaera neptuni* and *Phoberocysta neocomica* in this interval. Williams (1975) defined a *P. neocomica* Zone which he recognized in several wells on the Scotian Shelf and to which he assigned a Berriasian-Valanginian age. Both *P. neocomica* and *A. neptuni* are restricted to this zone. The evidence for dating the interval 1167-986.5 meters (Cores 370-50 to 370-41) at Site 370 Berriasian-Valanginian, and perhaps more correctly Valanginian, is therefore strengthened by comparison with the Scotian Shelf assemblages. The reworked species present in these and subsequent cores will be discussed under a separate heading.

GEOCHRONOLOGICAL SUBDIVISIONS				ZONE (after Williams, 1975)	DINOFLAGELLATES OCCURRENCE EARLIEST	LATEST	COMMON (more than 10)	INTERVAL (cm)	SECTION	CORE	CORE DEPTH (m)
QUAT		PLEISTOCENE PLIOCENE				Hemicystodinium zoharyi Leptodinium patulum Lingulodinium machaerophorum Operculodinium centrocarpum Spiniferites membranaceous Spiniferites pseudofurcatus	Lingulodinium machaerophorum Operculodinium centrocarpum	80-82	3	1	0-8
TERTIARY	NEOGENE	MIOCENE	M-L			Hystrichosphaeropsis obscurum Leptodinium paradoxum Leptodinium patulum Nematosphaeropsis balcombiana Nematosphaeropsis sp. B. Will and Brid (r) Operculodinium giganteum (r) Pterodinium circumsutum (r) Spiniferites hyperacantha (r)	Leptodinium patulum Operculodinium centrocarpum	133-135	1	2	103-112.5
			M		Hystrichosphaeropsis obscurum Leptodinium paradoxum	Apteodinium australiense Maduradinium spatiosum Spiniferites scabratus Systematophora ancyrea Tuberculodinium vancampoae Vozzhennikovia tenella	Apteodinium australiense Hystrichosphaeropsis obscurum Spiniferites scabratus	78-80	2	3	207.5-217
			E			Cyclonephelium semicirculatum (r) Cyclopsiella elliptica (r) Gonyaulacysta giuseppei (r) Hystrichokolpoma rigaudae Palaeocystodinium golzowense		61-63	3	4	217-226.5
	PALEOGENE	OLIGOCENE		Chiropteridium dispersum	Spiniferites scabratus Tuberculodinium vancampoae	Cannosphaeropsis sp. A. Will and Brid. (r) Chiropteridium conispinum (r) Chiropteridium dispersum (r) Cordosphaeridium cantharellum Homotryblium floripes Lejeunia fallax Pentadinium laticinctum (r) Pentadinium laticinctum granulatum Polysphaeridium pastielsi (r)	Chiropteridium conispinum Chiropteridium dispersum Hemicystodinium zoharyi	108-110	1	5	321.5-331
		EOCENE	L	Diphyes colligerum	Leptodinium patulum Nematosphaeropsis balcombiana Pentadinium laticinctum granulatum	Cordosphaeridium gracile Cyclonephelium pastielsi (r) Cyclonephelium retiintextum Deflandrea spinulosa (r) Hystrichosphaeropsis ovum (r) Phthanoperidinium comatum		68-69	1	6	426-435.5
					Systematophora ancyrea	Cordosphaeridium latispinosum Homotryblium aculeatum Schematophora speciosa (r) Thalassiphora pelagica (r)		88-90	2	7	445-454.5
					Apteodinium australiense Homotryblium floripes Maduradinium spatiosum Phthanoperidinium comatum	Diphyes colligerum Hemiplacophora semilunifera (r) Phthanoperidinium echinatum (r) Tubidermodinium sulcatum (r)	Homotryblium aculeatum	60-62	2	8	464-473.5
			M	Adnatosphaeridium reticulense	Cordosphaeridium latispinosum Spiniferites pseudofurcatus Tubidermodinium sulcatum	Adnatosphaeridium patulum Areoligera medusettiformis Areosphaeridium multicornutum (r)	Adnatosphaeridium patulum Diphyes colligerum Homotryblium aculeatum	98-100	2	14	568.5-578
					Cordosphaeridium gracile Cyclonephelium retiintextum Lejeunia fallax Palaeocystodinium golzowense	Adnatosphaeridium multispinosum Cyclonephelium ordinatum Eocladopyxis peniculatum Homotryblium tenuispinosum (r)	Hemicystodinium zoharyi Homotryblium aculeatum	130-132	3	15	587.5-597
			E	Areoligera senonensis	Areoligera medusettiformis Diphyes colligerum Hemicystodinium zoharyi Hystrichokolpoma rigaudae	Hystrichokolpoma unispinum Impletosphaeridium krommelbeini (r) Lanternosphaeridium radiatum (r) Spiniferites septatus Turbiosphaera filosa	Hystrichokolpoma unispinum	98-100	1	17	616-625.5
					Adnatosphaeridium patulum Eocladopyxis peniculatum Homotryblium aculeatum Hystrichokolpoma unispinum Lingulodinium machaerophorum Spiniferites septatus Turbiosphaera filosa	Adnatosphaeridium reticulense (r) Kisselevia coleothrypta (r) Vozzhennikovia elegantula (r) Wetzeliella homomorpha (r)		54-56	2	18	635-644.5

Figure 3. *Diagnostic species of the dinoflagellate zones in DSDP Site 370.*

CRETACEOUS	LATE	CENOMAN.	L-M	Cleistosphaeridium polypes		Exochosphaeridium bifidum Hystrichosphaeridium tubiferum Kalyptea aceras Odontochitina operculata Palaeohystrichophora infusorioides Spiniferites cingulatus Trichodinium castaneum Xenascus ceratioides Xiphophoridium alatum	Odontochitina operculata	78-80	1	20	673-682.5
						Odontochitina costata Oligosphaeridium complex Tanyosphaeridium variecalamum	Xiphophoridium alatum	68-70	3	20	673-682.5
						Cyclonephelium vannophorum Litosphaeridium siphoniphorum Senoniasphaera rotundata (r)	Cyclonephelium vannophorum Palaeohystrichophora infusorioides Xiphophoridium alatum	28-30	1	21	682.5-692
						Cyclonephelium distinctum Exochosphaeridium sp.	Cyclonephelium vannophorum	68-70	2		
						Cyclonephelium eisenacki Hystrichokolpoma ferox (r) Oodnadattia tuberculata (r) Prolixosphaeridium granulosum	Exochosphaeridium bifidum Odontochitina operculata	79-81	1	22	692-701.5
			E			Canningia reticulata Florentinia laciniata Hystrichosphaeridium bowerbanki Hystrichosphaeridium stellatum Impletosphaeridium whitei	Cyclonephelium vannophorum Xiphophoridium alatum	78-80	3	23	701.5-711
					Xenascus ceratioides	Cleistosphaeridium huguonioti Coronifera oceanica Epelidosphaeridia spinosa Hystrichodinium pulchrum		78-80	3	24	711-720.5
			B		Hystrichosphaeridium stellatum Palaeohystrichophora infusorioides	Cleistosphaeridium polypes subsp. A. Will. Ovoidinium scabrosum (r)	Cleistosphaeridium polypes subsp. A. Ovoidinium scabrosum	78-80	2	26	730-739.5
		ALBIAN		Spinidinium cf. vestitum	Litosphaeridium siphoniphorum	Florentinia radiculata Polysphaeridium laminaspinosum	Oligosphaeridium complex	88-90	1	27	749-758.5
					Odontochitina costata Trichodinium castaneum	Cribroperidinium orthoceras Palaeoperidinium cretaceum	Oligosphaeridium complex	48-50	3		
					Cyclonephelium eisenacki Hystrichosphaeridium bowerbanki Xiphophoridium alatum	Gonyaulacysta cassidata Spinidinium cf. vestitum (r)	Oligosphaeridium complex	68-70	2	28	768-777.5
	EARLY	APTIAN		Systematophora schindewolfi Subtilisphaera perlucida	Canningia reticulata Polysphaeridium laminaspinosum	Cribroperidinium muderongense sensu Habib, 1972 Surculosphaeridium cf. longifurcatum Systematophora schindewolfi (r)	Cribroperidinium muderongense sensu Habib, 1972	58-60	4	30	806-815.5
					Cleistosphaeridium huguonioti Florentinia radiculata Prolixosphaeridium granulosum Spiniferites cingulatus	Canningia colliveri Meiourogonyaulax stoveri Subtilisphaera perlucida	Cribroperidinium muderongense sensu Habib, 1972	68-70	3	31	825-834.5
		BARREMIAN		Tenua anaphrissa	Cleistosphaeridium polypes Coronifera oceanica	Aptea polymorpha (r) Kleithriasphaeridium eoinodes (r) Cyclonephelium attadalicum Gonyaulacysta serrata Oligosphaeridium dividuum	Cyclonephelium attadalicum	115-117	1	32	834.5-844
		HAUTERIVIAN		Ctenidodinium elegantulum	Palaeoperidinium cretaceum	Occisucysta sp. A Pseudoceratium pelliferum	Cyclonephelium attadalicum Meiourogonyaulax stoveri	78-80	3	34	872.5-882
					Odontochitina operculata	Callaiosphaeridium asymmetricum (r) Oligosphaeridium cf. complex	Occisucysta sp. A Cyclonephelium attadalicum Meiourogonyaulax stoveri	91-93	1	35	882-891.5
					Exochosphaeridium bifidum Subtilisphaera perlucida	Tenua hystrix	Oligosphaeridium cf. complex	113-115	4	38	939-948.5
					Cyclonephelium attadalicum Gonyaulacysta serrata	Kleithriasphaeridium fasciatum (r) Dingodinium cerviculum (r) Imbatodinium kondratjevi (r) Muderongia simplex Spiniferites dentatus (r) Wallodinium krutzschi	Oligosphaeridium cf. complex	54-56	2	39	948.5-958
		VALANGINIAN		Phoberocysta neocomica	Cyclonephelium vannophorum Spiniferites ramosus Wallodinium krutzschi	Phoberocysta neocomica Spiniferites speciosus		115-117	1	41	986.5-996
								80-82	1	44	1043.5-1053
					Kalyptea aceras Oligosphaeridium complex Pseudoceratium pelliferum	Endoscrinium campanulum (r)	Pseudoceratium pelliferum	54-56	3		
					Cribroperidinium muderongense sensu Habib, 1972 Meiourogonyaulax stoveri Occisucysta sp. A Oligosphaeridium cf. complex Tanyosphaeridium variecalamum Phoberocysta neocomica	Achomosphaera neptuni Cleistosphaeridium sp. (r) Gonyaulacysta helicoidea Lanterna sportula	Oligosphaeridium dividuum	108-110	1	45	1062.5-1072
					Tenua hystrix			70-72	2	48	1119.5-1129
					Cribroperidinium orthoceras Cyclonephelium distinctum Muderongia simplex Oligosphaeridium dividuum Spiniferites speciosus	Hystrichosphaeridium sp. A. Habib, 1972 (r)		85-87	1	50	1157.5-1167

(r) PRESENT IN ONE SAMPLE ONLY

Figure 3. *(Continued).*

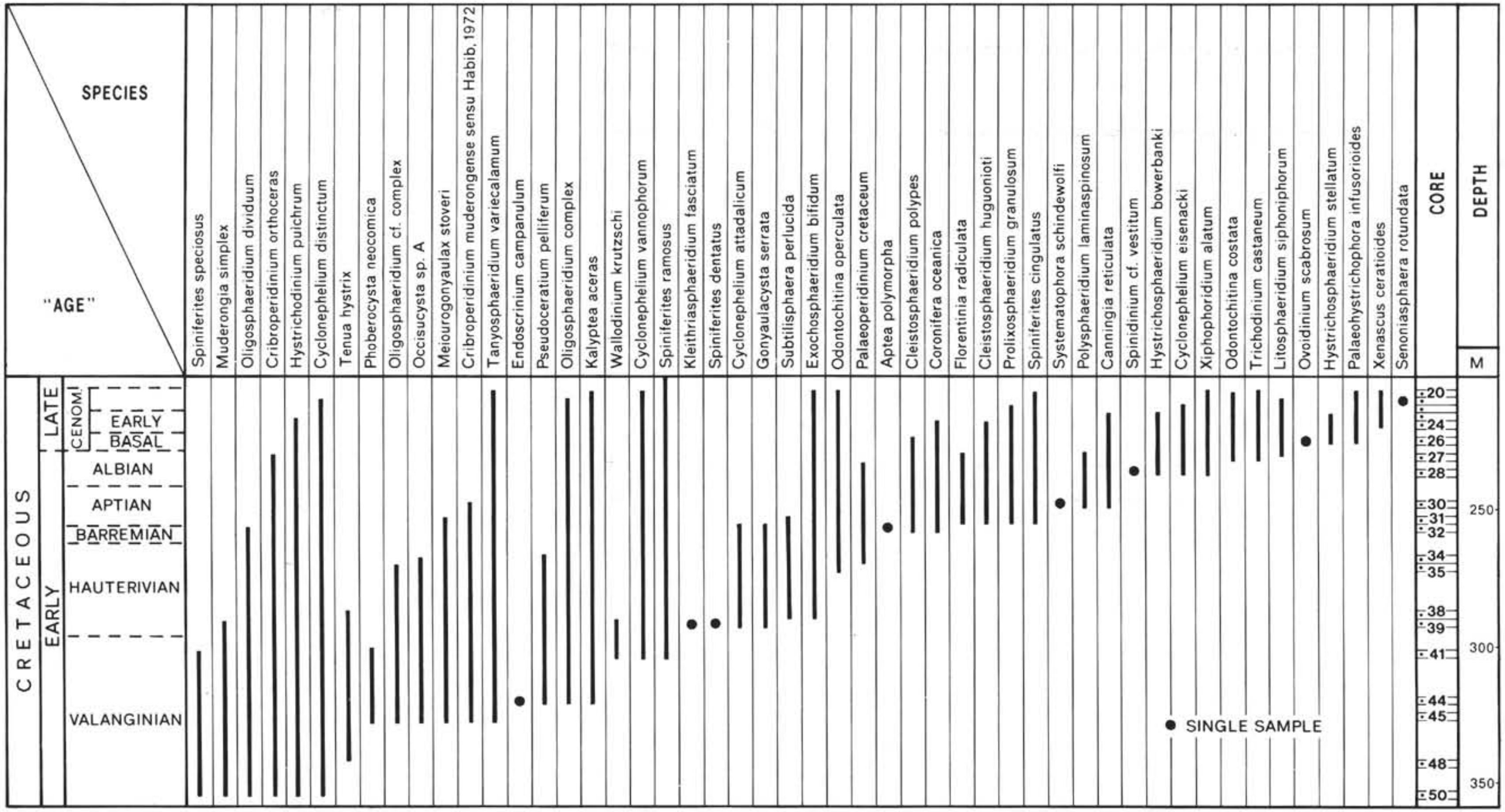

Figure 4. *Stratigraphic ranges of selected dinocysts in the Cretaceous of DSDP Site 370.*

The Hauterivian, as indicated by palynological evidence, extends from 958 to 872.5 meters (Cores 370-39 to 370-34) and contains several dinocyst species which also delineate the Hauterivian of the Scotian Shelf. *Palaeoperidinium cretaceum* Pocock and Davey, *Cyclonephelium attadalicum* Cookson and Eisenack, *Gonyaulacysta serrata* (Cookson and Eisenack) Sarjeant, and *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson are first recorded from this interval. Williams (1975) noted that *C. attadalicum* had a stratigraphic range of Hauterivian-Aptian, and *G. serrata* last appeared in the Hauterivian in the Scotian Shelf sediments. Millioud (1975) recorded the earliest occurrence of *O. operculata* from the Hauterivian.

Confirmation of the Hauterivian age of this interval is provided by the presence of *Dingodinium cerviculum* Cookson and Eisenack, *Imbatodinium kondratjevi* Vozzhennikova, *Kleithriasphaeridium fasciatum* (Davey and Williams) Davey, *Occisucysta* sp. A, *Pseudoceratium pelliferum*, and *Wallodinium krutzschi*, none of which range into younger sediments. *Occisucysta* sp. A is present in the type Hauterivian section and in the Hauterivian of the Scotian Shelf and Grand Banks. *D. cerviculum* and *I. kondratjevi* do not range above the Hauterivian and *K. fasciatum* is Hauterivian-Barremian in the Scotian Shelf sediments. The interval 958-872.5 meters is therefore dated Hauterivian.

Core 370-32 (844-834.4 m) is tentatively dated Barremian because of the presence of *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey, *Kleithriasphaeridium eoinodes* (Eisenack) Davey, *Cyclonephelium attadalicum, Gonyaulacysta serrata*, and *Oligosphaeridium dividuum*. The last named species does not range above the Barremian on the Scotian Shelf. There is a possibility however that Core 370-32 is early Aptian.

The Aptian extends from 834.5 to 806 meters (Cores 370-31 and 370-30). Correlations with coeval Scotian Shelf sediments is excellent. In both Site 370 and the Scotian Shelf wells, *Canningia colliveri* Cookson and Eisenack, *Surculosphaeridium* cf. *longifurcatum* (Firtion) Davey et al., *Subtilisphaera perlucida* (Alberti) Jain and Millepied, and *Systematophora schindewolfi* (Alberti) Downie and Sarjeant do not extend into younger sediments. Species first appearing are *Canningia reticulata* Cookson and Eisenack, *Cleistosphaeridium huguonioti* (Valensi) Davey, *Florentinia radiculata* (Davey and Williams) Davey, and Verdier and *Polysphaeridium laminaspinosum* Davey and Williams. *Cribroperidinium muderongense* sensu Habib (1972) is common in both Cores 370-31 and 370-30. *Oligosphaeridium complex* is common in Core 370-30. *C. muderongense* according to Habib has a range of Barremian-Aptian in Sites 101A and 105.

The dinocyst assemblages of the Albian of the Scotian Shelf are frequently dominated by species of *Oligosphaeridium*. In Site 370, *O. complex* is the most abundant species in the Albian which extends from 777.5 to 749 meters (Cores 370-28 and 370-27). Other species present and which also characterize the Albian of the Scotian Shelf, are *Palaeoperidinium cretaceum, Cyclonephelium eisenacki* Davey, *Cribroperidinium orthoceras, Florentinia radiculata, Litosphaeridium siphoniphorum* (Cookson and Eisenack) Davey and Williams, *Odontochitina costata* Alberti, and *Spinidinium* cf. *vestitum* Brideaux. *P. cretaceum, F. radiculata*, and *L. siphoniphorum* have been recorded from the Albian of France by Davey and Verdier (1971, 1973). *O. costata* first appears in the Vraconian (late Albian) of France and Switzerland according to Davey and Verdier (1973). The *Spinidinium* cf. *vestitum* Zone in the Scotian Shelf sediments has been dated Albian, the taxon not having been recorded outside the Albian.

Species present in the Albian of Site 370, but uncommon in coeval sediments in the Scotian Shelf, are *Gonyaulacysta cassidata* (Eisenack and Cookson) Sarjeant, *Trichodinium castaneum* (Deflandre) Clarke and Verdier and *Xiphophoridium alatum* (Cookson and Eisenack) Sarjeant. All three are present in the Albian of France and Switzerland (Davey and Verdier, 1971, 1973).

Recognizable Upper Cretaceous sediments, all of Cenomanian age, occur between 739.5 and 673 meters (Cores 370-26 to 370-20). Subdivision into basal, early, and middle to late Cenomanian is possible, if the dinocyst assemblages are compared with those of England and, to a lesser extent, the Scotian Shelf. The sample from Core 370-26 (739.5-730 m) is dominated by *Cleistosphaeridium polypes* subsp. A of Williams (1975) and *Ovoidinium scabrosum* (Cookson and Hughes) Davey. *C. polypes* subsp. A is abundant in the Cenomanian of the Scotian Shelf. *O. scabrosum* was originally described from the late Albian-basal Cenomanian of southern England by Cookson and Hughes (1964). Davey (1970) believed that this species marked the base of the Cenomanian. The presence in the same sample of *Palaeohystrichophora infusorioides* strongly indicates a basal Cenomanian age for Core 370-26 (739.5-730 m).

The succeeding Cores 370-24 and 370-23 (720.5-701.5 m) contain *Canningia reticulata* Cookson and Eisenack, *Cleistosphaeridium huguonioti*, and *Epelidosphaeridia spinosa* (Cookson and Hughes) Davey. *C. reticulata* was not found above the early Cenomanian by Clarke and Verdier (1967). *E. spinosa*, according to Clarke and Verdier (1967) and Davey (1970), last appears in the middle Cenomanian. In the Scotian Shelf wells it also "tops" in the Cenomanian. The last occurrence of *C. reticulata* is taken as the top of the early Cenomanian at Site 367.

The interval 701.5-673 meters (Cores 370-22 to 370-20) is middle to late Cenomanian. No new taxa appear but all the Cretaceous species disappear. These include *Cyclonephelium vannophorum, Litosphaeridium siphoniphorum, Odontochitina costata, O. operculata, Palaeohystrichophora infusorioides, Trichodinium castaneum, Xenascus ceratioides*, and *Xiphophoridium alatum*. The presence of the last named species in the topmost sample indicates that Core 370-20 is Cenomanian, since *X. alatum* has not been found in post Cenomanian sediments (Clarke and Verdier, 1967).

Cenozoic

Cenozoic sediments have been recognized between Cores 370-18 and 370-1 (644.5-0 m). The oldest dated sediments are Eocene (644.5-426 m). These are succeeded by Oligocene (331-321.5 m), Miocene (226.5-103 m), and Plio-Pleistocene (8-0 m). Unfortunately the individual cores are well spaced so that precise delineation of the boundaries is not possible. Lithologically, 644.5-208.5 meters (Cores 370-18 to 370-3) are nanno-bearing calcareous silty clays, porcellanite and chert with silt, sand and gravel beds, clayey nanno ooze, and silty marl (208.3-?0 m) and nannofossil-foraminiferal bearing clay at the top (Jansa, this volume).

Within the Eocene, Cores 370-18 and 370-17 (644.5-616 m) contain an early Eocene dinocyst assemblage. There is a marked influx of new species including ?*Adnatosphaeridium patulum* Williams and Downie, *Areoligera medusettiformis* (O. Wetzel) Lejeune-Carpentier, *Diphyes colligerum* (Deflandre and Cookson) Cookson, *Hemicystodinium zoharyi* (Rossignol) Wall, *Homotryblium aculeatum* sp. nov., *Hystrichokolpoma unispinum* Williams and Downie, and *Spiniferites septatus* (Cookson and Eisenack) McLean (Figure 5). The last two species, together with *Wetzeliella homomorpha*, are restricted to this horizon. ?*A. patulum*, originally described from the early Eocene of southern England ranges into the middle Eocene on the Scotian Shelf. *Areoligera medusettiformis* has been recorded from Eocene sediments by Gocht (1969). Williams (1975) noted that *D. colligerum* ranged from the late Paleocene to late Eocene, while *Spiniferites septatus* appeared for the last time and *Hemicystodinium zoharyi* for the first time in the early Eocene. *Hystrichokolpoma unispinum* is restricted to the early Eocene (Williams and Downie, 1966). The interval 644.5-616 meters (Cores 370-18 and 370-17) is therefore dated early Eocene.

Cores 370-15 and 370-14 (597-568.5 m) are assigned to the middle Eocene because of the presence of (?)*Adnatosphaeridium patulum*, *A. multispinosum* Williams and Downie, *Areosphaeridium multicornutum* Eaton, *Eocladopyxis peniculatum*, and *Tubidermodinium sulcatum* Morgenroth. *Areosphaeridium multicornutum* described by Eaton (1971) from the middle Eocene of southern England, extends into the early Oligocene on the Grand Banks, as does *Eocladopyxis peniculatum*, originally described from the early Eocene by Morgenroth (1966a). *Tubidermodinium sulcatum*, although described from the early Eocene by Morgenroth, first appears in the middle Eocene on the Scotian Shelf, and extends into the late Oligocene. ?*A.*

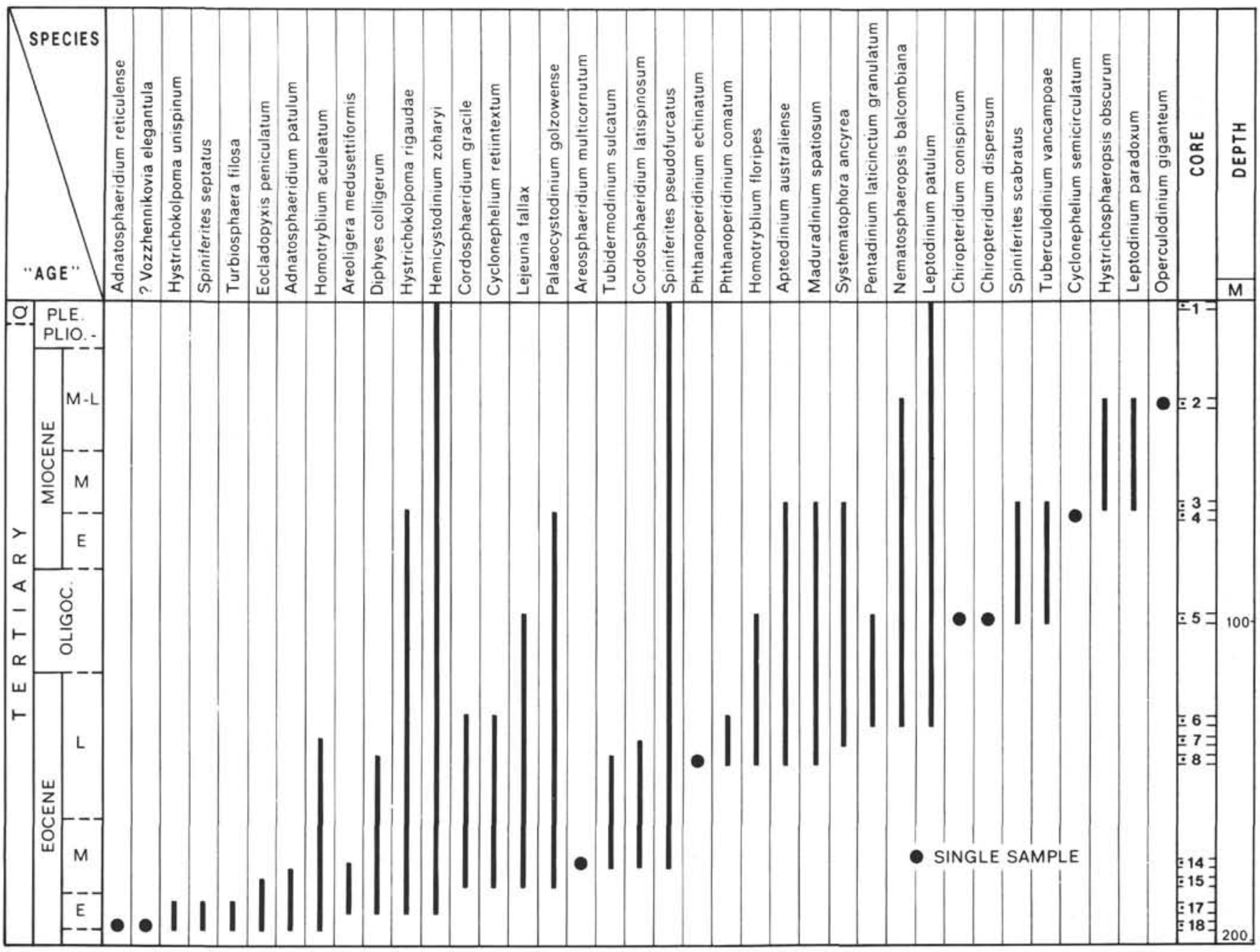

Figure 5. *Stratigraphic ranges of selected dinocysts in the Cenozoic of DSDP Site 370.*

patulum and *A. multicornutum* have overlapping ranges only in the middle Eocene. This confirms the middle Eocene age for Cores 370-15 and 370-14.

The late Eocene sediments in Cores 370-8 through 370-6 (473.5-426 m) correlate with the coeval sediments in the DSDP Sites 1-6 and to the Scotian Shelf and Grand Banks. Species restricted to this horizon are *Deflandrea spinulosa* Alberti, *Hemiplacophora semilunifera* Cookson and Eisenack, *Hystrichosphaeropsis ovum* Deflandre, *Phthanoperidinium comatum* (Morgenroth) Eisenack and Kjellström, *P. echinatum* Eaton, and *Schematophora speciosa* Deflandre and Cookson. Species appearing for the first time are *Apteodinium australiense* (Deflandre and Cookson) comb. nov., *Homotryblium floripes* (Deflandre and Cookson) Stover, *Lejeunia spatiosa* Morgenroth, *Nematosphaeropsis balcombiana* Deflandre and Cookson, *Pentadinium laticinctum granulatum* Gocht, and *Systematophora ancyrea* Cookson and Eisenack. Species last occurring include *Cordosphaeridium gracile* (Eisenack) Davey and Williams, *Diphyes colligerum*, and *Homotryblium aculeatum* sp. nov.

Deflandrea spinulosa has a range of late Eocene to Oligocene on the Scotian Shelf-Grand Banks. *Hemiplacophora semilunifera* and *Schematophora speciosa* are restricted to the late Eocene in Sites 1 through 6, offshore Florida. In these same holes, *Homotryblium floripes* and *Apteodinium australiense* are first recorded from the late Eocene (personal observation). *Diphyes colligerum* is the late Eocene zonal index species in the Scotian Shelf-Grand Banks wells, last appearing at the same time as *Cordosphaeridium gracile*. The presence of the above species in the same samples is strong evidence for a late Eocene age.

The Oligocene assemblage in Core 370-5 (331-321.5 m) continues to show affinities to the Oligocene assemblages in DSDP Sites 1-6 and the Scotian Shelf-Grand Banks wells. The middle to late Oligocene zonal species in the Scotian Shelf-Grand Banks wells, *Chiropteridium dispersum* Gocht is common in the single sample from Core 370-5. Also present are *Chiropteridium conispinum* sp. nov., *Pentadinium laticinctum* Gerlach, and *Tuberculodinium vancampoae*. These species overlap in the Oligocene only, in DSDP Sites 1 through 6 and the Scotian Shelf-Grand Banks wells. Several species last appearing in Core 370-5 of 367 meters range into the Miocene elsewhere. These include *Cannosphaeropsis* sp. A Williams and Brideaux (1975), *Cordosphaeridium cantharellum* (Brosius) Gocht, *Lejeunia fallax* Morgenroth, *Pentadinium laticinctum* and *Polysphaeridium pastielsi* Davey and Williams.

The Neogene dinocyst assemblages from Site 370 exhibit marked differences to the coeval sediments in the Scotian Shelf-Grand Banks wells, especially in the Plio-Pleistocene. Comparable assemblages are however present in DSDP Sites 1 through 6 and the Pleistocene cores recovered from the Caribbean and described by Wall (1967). Provincialism of dinocyst assemblages seems to be increasingly prevalent within the Neogene.

Early Miocene sediments are recognized between 226.5-217 meters (Core 370-4). Species appearing for the last time include *Cyclonephelium semicirculatum* Morgenroth, *Cyclopsiella elliptica* Drugg and Loeblich and *Gonyaulacysta giuseppei* (Morgenroth) Sarjeant. *C. semicirculatum* and *C. elliptica* were both originally described from the Oligocene by Morgenroth (1966b), and Drugg and Loeblich (1967) respectively. *G. giuseppei* has a known range of early Eocene-early Miocene. The postulated early Miocene age for this sample is confirmed by the foraminiferal data (this report).

The dinocyst assemblages in Core 370-3 (217-207.5 m) show marked similarities to those in DSDP Sites 1 through 6 and the Scotian Shelf-Grand Banks wells. *Apteodinium australiense*, *Lejeunia spatiosa*, and *Systematophora ancyrea* are present for the last time, while *Hystrichosphaeropsis obscurum* Habib and *Leptodinium paradoxum* Wall appear. Williams and Brideaux (1975) extend *Apteodinium australiense* (as *Apteodinium* sp. Gocht, 1969) into the late Miocene. Williams (1975) restricted *H. obscurum* to the middle to late Miocene and recorded *Systematophora ancyrea* for the last time from the middle Miocene. The presence of these two species in the same sample is taken to indicate a middle Miocene age.

The interval 112.5-103 meters (Core 370-2) contains *Hystrichosphaeropsis obscurum* together with *Leptodinium paradoxum*, *L. patulum* Wall, and *Pterodinium circumsutum* Morgenroth. *P. circumsutum* according to Drugg and Stover (1975) has a known stratigraphic range of Oligocene to late Miocene. In DSDP Sites 1 through 6, however, it ranges into the Pliocene. The presence of *Hystrichosphaeropsis obscurum* is the basis for the middle to late Miocene age determination.

Plio-Pleistocene sediments are recognized in Core 370-1 (8-0 m). The dinocyst assemblage compares closely with that described by Wall (1967) from the Caribbean. All the species present were also noted by Wall. These include *Hemicystodinium zoharyi* which is not present in post middle Miocene sediments in the Scotian Shelf-Grand Banks wells and *Operculodinium centrocarpum* (Deflandre and Cookson) Wall which is common in the Tertiary of the Scotian Shelf-Grand Banks wells, but does not extend above the Miocene. The Core 370-1 assemblage also shows a marked similarity to that in DSDP Sites 1-6. Provincialism is presumably responsible for the differences between the Scotian Shelf-Grand Banks on the one hand and the DSDP Sites 1-6, 267, and the Caribbean on the other hand in the Plio-Pleistocene.

Conclusions

Lower Cretaceous and Tertiary sediments predominate at Site 370. The oldest, dated palynologically, are Valanginian. These are overlain by a more or less complete Hauterivian-Cenomanian sequence. The total observed thickness of the lower Cretaceous is 418 meters, overlain by approximately 85 meters of Cenomanian sediments. There is a gap between the highest Cenomanian sample at 673 meters and the lowest lower Eocene sample at 644.5 meters. Foraminiferal control indicates that the Cenomanian is immediately overlain by lower Paleocene, although there is a distance of 10 meters between the dated sediments. Palynological control within the Tertiary is good, but the boundaries are speculative because of the infrequent coring. Eocene through Plio-Pleistocene sediments have been recognized and compared with coeval assemblages from elsewhere. As in the Cretaceous, the Paleogene assemblages can be satisfactorily correlated with the Scotian Shelf-Grand Banks zones as formally proposed by Williams (1975). Increasing provincialism in the Neogene necessitates comparison with the more closely similar assemblages from DSDP Sites 1 through 6, offshore Florida. Recovery of dinocysts from all samples has been excellent; spores and pollen have been rare. The high degree of reworked material is discussed in the following section.

Reworked Dinocysts in the Samples from Site 370

Reworked dinocyst species have been recognized in 18 of the samples examined from Site 370 and attain a peak in the Eocene. Their distribution and age are shown in Figure 6. The differentiation of reworked and indigenous material can pose severe problems if they are either long-ranging species or if they are not far removed stratigraphically. Fortunately the present investigation was greatly facilitated by the ability of reworked and indigenous species to take stain differentially. This technique, which has been presented in detail by Stanley (1965, 1966), is not a foolproof method, but can be instrumental in separating indigenous and reworked material, as at Site 370.

The reworked species fall into distinct categories. The Valanginian-Hauterivian samples, Cores 370-50 to 370-34 extending from 1167-872.5 meters, contain reworked species which have a known range of Callovian to Portlandian. The differential staining technique does not work with these samples. The percentage of reworked specimens is below 10%. Reworking in the Barremian-Cenomanian, from Cores 370-32 to 370-20 or 844-673 meters is minimal with only a few specimens of late Jurassic-early Cretaceous age apparently being reworked. There is, however, considerable difficulty in interpreting what is reworked since most of the species, indigenous or reworked, do not stain.

Recognition of reworked specimens is greatly simplified in the Eocene which extends from Cores 370-18 to 370-6 or 644.5-426 meters. The indigenous species readily accept the stain Safranin "O"; the reworked species do not stain and therefore retain their body color which may vary from almost colorless to dark brown. Although some of the reworked species present in the Eocene range throughout the Cretaceous, collation of the data indicates that the source was Campanian to Paleocene. Species with a Maestrichtian-Paleocene range are particularly abundant in the lower cores. The percentage of reworked specimens in the total dinocyst count may be as high as 25% to 30%. The source area may lie to the east or be local and represent sediments deposited and subsequently removed in post Cenomanian-pre Paleocene time. This second possibility, however, is not supported by the reworked species, most of which tend to be concentrated in inner neritic environments. Jansa (this volume) includes this interval in his Unit 3, a nannofossil-radiolarian bearing calcareous silty clay sequence, with porcellanite and chert, and silt, sand, and gravel beds. Turbidites and slump deposits occur in Cores 370-18 through 370-12 (644.5-540 m).

The reworked late Cretaceous species are also present in the Oligocene (Core 370-5, 331-321.5 m) and early Miocene (Core 370-4, 226.5-217 m). One species of Barremian-Cenomanian age is reworked into the late Miocene (112.5-103 m).

The age of the reworked material shows a marked change in the single Pleistocene Core 370-1, from 8-0 meters. Only Tertiary species are present, ranging in age from early Eocene to middle Miocene. There is also a marked drop in the percentage of reworked material which is approximately 10%.

Three reworked zones are therefore recognizable. The oldest, restricted to the early Cretaceous, includes several species which are restricted to the Jurassic. These do not stain differentially to the indigenous species so that it is possible that several longer ranging species which are also reworked in the Early Cretaceous, have been overlooked. The second zone, present in the Eocene to Miocene sediments is composed of species whose overlapping ranges suggest a Senonian-Paleocene age. These do not stain whereas the indigenous Tertiary species stain pink to red. Differentiation of the two categories is therefore relatively simple. Zone three is restricted to the single Pleistocene sample and contains only species of an original Tertiary age. The reworked species of Zone 3 show a variable acceptance to stain so that differentiation by this method alone is very difficult. The absence of pre Tertiary species in the Pleistocene contrasts with their high relative abundances in the Eocene.

SYSTEMATIC DESCRIPTIONS

Division PYRRHOPHYTA Pascher, 1914

Class DINOPHYCEAE Fritsch, 1929

Order PERIDINIALES Haeckel, 1894

Apteodinium Eisenack, 1958

Apteodinium australiense (Deflandre and Cookson, 1955) comb. nov., pl. 1, fig. 3.

1955 *Gymnodinium australiense* Deflandre and Cookson, p. 248, pl. 5, fig. 1.

1967 *Scriniodinium australiense* (Deflandre and Cookson) Eisenack, p. 195.

1969 *Apteodinium* sp. Gocht, p. 30, pl. 6, fig. 6.

Remarks: This species is abundant in samples from Site 367 and the Miocene of the Scotian Shelf and Grand Banks. It has a precingular archeopyle resulting from the loss of the third precingular paraplate and a distinct paracingulum. Further evidence of paratabulation is usually lacking. The morphology of this species, which is proximate, forbids its retention in *Scriniodinium* Klement.

Genus CHIROPTERIDIUM Gocht, 1960

Chiropteridium conispinum sp. nov.
(Plate 2, Figures 1-6)

Diagnosis: Chorate cyst with subcircular ambitus. Phragma microreticulate, lumina very irregular in size and shape. On the

GEOCHRONOLOGICAL SUBDIVISIONS				ZONE (after Williams, 1975)	REWORKED SPECIES	KNOWN STRATIGRAPHIC RANGE	INTERVAL (cm)	SECTION	CORE	DEPTH CORE (m)
Q	NEOGENE	PLEISTOCENE PLIOCENE			Lejunia fallax Selenopemphix nephroides Vozzhennikovia elegangula Tanyosphaeridium sp. A.Will. and Brid.	M. Eocene-M. Miocene Oligocene Early Eocene L. Eocene-M. Miocene	80-82	3	1	0-8
TERTIARY	NEOGENE	MIOCENE	L-M		Cleistosphaeridium polypes	Barremian-Cenomanian	133-135	1	2	103-112.5
TERTIARY	NEOGENE	MIOCENE	M				78-80	2	3	207.5-217
TERTIARY	NEOGENE	MIOCENE	E		Isabelia cooksoniae Oligosphaeridium complex	Santonian-E. Paleocene Valanginian-E. Paleocene	61-63	3	4	217-226.5
TERTIARY	PALEOGENE	OLIGO		Chiropteridium dispersum	Cordosphaeridium gracile Isabelia cretacea	Danian-L. Eocene Maastrichtian-E. Paleocene	108-110	1	5	321.5-331
TERTIARY	PALEOGENE	EOCENE	L	Diphyes colligerum			68-69	1	6	426-435.5
TERTIARY	PALEOGENE	EOCENE	L	Diphyes colligerum	Odontochitina costata	Albian-Campanian	88-90	2	7	445-454.5
TERTIARY	PALEOGENE	EOCENE	L	Diphyes colligerum	Isabelia belfastensis Isabelia cooksoniae	Santonian-Maastrichtian Santonian-E. Paleocene	60-62	2	8	464-473.5
TERTIARY	PALEOGENE	EOCENE	M	Adnatosphaeridium reticulense	Cyclonephelium distinctum Deflandrea speciosa Isabelia cooksoniae Odontochitina costata Palaeohystrichophora infusorioides Trichodinium castaneum	Berriasian-Campanian Paleocene Santonian-E. Paleocene Albian-Campanian L. Albian-Campanian Hauterivian-Campanian	98-100	2	14	568.5-578
TERTIARY	PALEOGENE	EOCENE	M	Adnatosphaeridium reticulense	Deflandrea speciosa Isabelia belfastensis Isabelia cooksoniae Isabelia cretacea Odontochitina operculata Palaeoperidinium pyrophorum	Paleocene Santonian-Maastrichtian Santonian-E. Paleocene Maastrichtian-E.Paleocene? Hauterivian-Campanian Maastrichtian-E. Paleocene	130-132	3	15	587.5-597
TERTIARY	PALEOGENE	EOCENE	E	Areoligera senonensis	Isabelia cooksoniae Isabelia cretacea Palaeocystodinium benjaminii Tanyosphaeridium magdalium	Santonian-E. Paleocene Maastrichtian-E. Paleocene? Maastrichtian-L. Paleocene Maastrichtian-E. Paleocene	98-100	1	17	616-625.5
TERTIARY	PALEOGENE	EOCENE	E	Areoligera senonensis	Deflandrea diebeli Dinogymnium acuminatum Isabelia cretacea Oligosphaeridium complex	Maastrichtian-E. Paleocene ?Coniacian-Maastrichtian Maastrichtian-E. Paleocene Valanginian-E. Paleocene	54-56	2	18	635-644.5

Figure 6. *Dinocyst species identified as reworked in DSDP Site 370.*

CRETACEOUS	LATE	CENOMANIAN		Cleistosphaeridium polyes			78-80	1	20	673-682.5
							68-70	3		
							28-30	1	21	682.5-692
							68-70	2		
					Tenua hystrix	Kimmeridgian-Aptian	79-81	1	22	692-701.5
			E				78-80	3	23	701.5-711
					Tenua hystrix	Kimmeridgian-Aptian	78-80	3	24	711-720.5
			B				78-80	2	26	730-739.5
		ALBIAN		Spinidinium cf. vestitum			88-90	1	27	749-758.5
							48-50	3		
							68-70	2	28	768-777.5
		APTIAN		Systematophora schindewolfi Subtilisphaera perlucida			58-60	4	30	806-815.5
					Spiniferites "duplifurcatus"	Berriasian-Valanginian	68-70	3	31	825-834.5
		BARREMIAN		Tenua anaphrissa			115-117	1	32	834.5-844
	EARLY	HAUTERIVIAN		Ctenidodinium elegantulum			78-80	3	34	872.5-882
					Gonyaulacysta ambigua	Oxfordian-Kimmeridgian	91-93	1	35	882-891.5
							113-115	4	38	939-948.5
					Ctenidodinium culmulum Gen. et sp. 2 Gocht	L.Kimmeridgian-Portlandian Bathonian-Oxfordian	54-56	2	39	948.5-958
		VALANGINIAN		Phoberocysta neocomica			115-117	1	41	986.5-996
					Gonyaulacysta jurassica	Callovian-E. Kimmeridgian	80-82	1	44	1043.5-1053
							54-56	3		
					Gonyaulacysta jurassica	Callovian- E. Kimmeridgian	108-110	1	45	1062.5-1072
							70-72	2	48	1119.5-1129
					Systematophora fasciculigera	Oxfordian-Tithonian	85-87	1	50	1157.5-1167

Figure 6. *(Continued).*

ventral surface linear membranes originating on the first and fifth precingular paraplates, respectively, run towards the antapex.

Membranous processes, generally restricted to the dorsal surface, are proximally conical or subconical and distally may branch into slender tubules. The processes are nontabular. Archeopyle apical, tetratabular. Parasulcal notch visible. Paratabulation indeterminate other than 1 pra, 4′, 6″.

Dimensions: Cyst width, 64-81 μm, length (less operculum) 59-70 μm. Processes up to 20 μm, linear membrane rarely exceeding 10 μm in height. Number of specimens measured, 6.

Holotype: GSC No. 47855; P8177-01, 3.4 × 102.4. Diameter width 87 μm, length 64 μm. Processes up to 20 μm. Oligocene, Site 370.

Description: The ventral surface of the cyst always bears two membranes with their entire margins running apically antapically. These originate on the apical paraplates in one specimen. In specimens lacking an operculum, they always originate towards the midline on paraplates 1″ and 5″, respectively, and extend to the antapex, where they form two distinct antapical projections. These membranes may have a single process along their length, at which point there is a change in direction, and antapically. Occasionally a third membrane runs laterally across the dorsal surface in the vicinity of the postcingular antapical paraplate boundaries. The processes, generally restricted to the operculum and the dorsal surface are membranous, proximally conical to subconical and sometimes open on one side, in effect forming a soleate structure. In some specimens they are ribbed. The processes rarely exceed 12 in number and apparently do not relate to paratabulation. In the vicinity of the archeopyle margin they appear to be located on the parasutures between adjacent precingular paraplates. Distally the processes may be acuminate closed, or produced into slender tubules up to 12 μm in length. One operculum possesses five such processes, united to each other by membranes. Four of these processes are peripherally located on paraplates 1′ through 4′. The fifth is centrally located and is presumably a preapical. Of the precingulars, 6″ is always devoid of processes. The other precingulars, excluding 1″ and 5″, appear to bear processes suturally. Some specimens show lateral process alignment in what is presumably the vicinity of the paracingulum.

Remarks: Only one species of *Chiropteridium*, *C. aspinatum* (Gerlach) Brosius, bears a superficial resemblance to *C. conispinum*. *C. aspinatum* does not, however, possess processes and the apically-antapically aligned membranes when examined under the scanning electron microscope are seen to form closed structures with one wall on the lateral dorsal surface, and one on the lateral ventral surface.

Genus HOMOTRYBLIUM Davey and Williams, 1966b

Homotryblium aculeatum sp. nov.
(Plate 4, Figures 5, 6, 8, 9)

Diagnosis: Chorate cyst with spherical to slightly ellipsoidal shape. Phragma composed of thin laevigate endophragm and thin scabrate periphragm, from which arise the processes. There is one intratabular process per paraplate, apart from a single, slender, solid acuminate or bifid process, whose location is variable on the hypocyst. Processes are tubiform, slender open distally with an aculeate or secate margin. Aculei and secae may be simple or branched and are commonly recurved. Process formula 4′, 6″, 6c, 5″′, 1p, 1″″, 2s. Paracingulum delineated by six processes, parasulcus indicated by anterior sulcal paraplate and two processes. Archeopyle epicystal formed from the loss of the four apicals and six precingulars.

Dimensions: Cyst diameter 40-53 μm. Processes, length 19-25 μm, width 1 to 3 μm. Aculei and secae up to 5 μm in length. Number of specimens measured, 8.

Holotype: GSC No. 47873; P8182-01, 6.0 × 109.4. Diameter 44 by 50 μm. Process length 19-22 μm. Middle Eocene, Site 370.

Description: The process formula of *Homotryblium aculeatum* indicates its gonyaulacacean affinities although it does not reveal the presence of a sixth postcingular paraplate. The paraplates of the eipicyst may remain attached or there may be separation of the apicals from the precingulars or within the precingulars. The hypocystal paraplates never show separation. the processes are slender, particularly the anterior sulcal and 6″. Some processes proximally exhibit the floral pattern as seen in *Homotryblium floripes* (Deflandre and Cookson) Stover. Distally the recurved aculei or secae, which can number up to 13 on an individual process, may be simple or bifurcate. Occasionally they exhibit first- and second-order bifurcations as in *Spiniferites ramosus* (Ehrenberg) Loeblich and Loeblich. The small adventitious process located on the hypocyst is solid, distally acuminate or bifid. The number of processes appears to be constant, there being 10 on the epicyst and 15 on the hypocyst.

Remarks: Six species of *Homotryblium* have been described in the literature. These are *H. bifurcatum* Caro, *H. floripes* (Deflandre and Cookson) Stover, *H. pallidum* Davey and Williams, *H. plectilum* Drugg and Loeblich, *H. tasmaniense* Cookson and Eisenack, and *H. tenuispinosum* Davey and Williams. Only *H. pallidum*, *H. tasmaniense*, and *H. tenuispinosum* have simple tubiform processes, open distally. None of these, however, possess the long, recurved, branched aculei or secae as found in *H. aculeatum*.

Genus OLIGOSPHAERIDIUM Davey and Williams, 1966b

Oligosphaeridium dividuum sp. nov.
(Plate 5, Figure 8)

Diagnosis: Chorate cyst with subspherical, or ellipsoidal shape. Phragma laevigate, scabrate, or finely rugulate. Processes formed from the periphragm which may be up to 1 μm thick in the process walls. Processes intratabular, commonly one per paraplate, sometimes two or three showing some variation in size according to location. Processes are buccinate sometimes simple but commonly branched. They are generally open distally with simple or branched aculei or secae up to 25 μm in length. Aculei and secae may be patulate, orthogonal, or recurved. They are sometimes united along their length. Process formula 4″, 6″ 5″′, 1p, 1″″, 1s. Paracingulum devoid of processes. Parasulcus containing one slender process. Archeopyle apical tetratabular. Operculum free.

Dimensions: Cyst diameter 40-60 μm. Processes, length 23-43 μm, width 1-7 μm. Number of specimens measured, 6.

Holotype: GSC No. 47891; P8205-01, 5.6 × 117.0. Diameter 40 by 46 μm. Process length 27-43 μm. Valanginian, Site 370.

Description: All specimens of *Oligosphaeridium dividuum* possess simple and branched processes distally produced into aculei or secae. The branching can occur anywhere along the process length: occasionally it occurs proximally so that an individual paraplate bears two or three processes. The aculei and secae may be simple or branched, occasionally united along their length or remain free. Distally they may be further branched acuminate, commonly bulbous, or bifid. Some processes have very short stems with the aculei extending almost to the base of the process. The aculei are sometimes recurved but may be orthogonal or patulate. There are up to six aculei per process. Occasional processes appear solid. Several are closed distally. The posterior intercalary and sulcal processes tend to be smaller than the others. The archeopyle frequently has accessory sutures separating the precingular paraplates.

Remarks: Two species of *Oligosphaeridium*, *O. asterigerum* (Gocht) Davey and Williams, and *O. complex* (White) Davey and Williams bear a superficial resemblance to *O. dividuum*. Neither of these species possess branched processes or more than one process per paraplate however. The aculei in *O. asterigerum* and *O. complex* are simple or occasionally bifid, but never attain the relative length of the aculei and secae in *O. dividuum*.

Oligosphaeridium cf. complex
(Plate 5, Figures 7, 10, 11)

Description: *Oligosphaeridium* cf. *complex* has tubiform to buccinate processes produced distally into very long aculei or secae. The processes are intratabular, one per paraplate. The aculei are generally bulbous distally. The secae are bifid or oblate. Both may be up to 20 μm in length. Each process may possess up to 12 aculei which are usually patulate but may be orthogonal. The processes are very rarely branched. The process formula is 4′, 6″, 5″′, 1p, 1″″, 1s. The posterior intercalary and sulcal processes are smaller than the others.

Dimensions: Cyst diameter 43-61 μm. Processes, length 15-51 μm, width up to 7 μm. Number of specimens measured, 6.

Genus VOZZHENNIKOVIA Lentin and Williams, 1976

?Vozzhennikovia elegantula sp. nov.
(Plate 7, Figures 7, 9)

Diagnosis: The pericyst ambitus is ovoidal to pentagonal, widest in precingular region. Apex occasionally rounded, more commonly produced into a short apical horn which distally may be acuminate or oblate. Antapex flattened or with slight asymmetry, there being a weak left antapical lobe. Epipericyst and hypopericyst more or less equal in size. Length:breadth ratio about 1. Compression very slight.

An endocyst has not been observed. Periphragm laevigate with parasutural processes which are simple, slender, distally oblate or bulbous. The processes may be isolated or united proximally by a membrane. The paratabulation is presumably peridinioid since there is a hexa 2a intercalary paraplate. Pericingulum helicoidal, hepta-pentapartite with parasutural processes. Perisulcus indented, largely restricted to the hypocyst and widening antapically. Archeopyle hexa, intercalary, resulting from the partial or complete detachment of the second anterior intercalary paraplate 2a. Operculum often remains attached along parasuture H4.

Dimensions: Pericyst length 50-52 μm, breadth 45-56 μm. Processes, length 2-10 μm. In apical view lateral width 45-50 μm. Number of specimens measured, 6.

Holotype: GSC No. 47910, P8182-01. 10.2 × 101.7. Pericyst length 51 μm, breadth 56 μm. Process length 2-7 μm. Middle Eocene, Site 370.

Description: ?*Vozzhennikovia elegantula* has a distinctly peridinioid ambitus, but lacks the prominent antapical horns which characterize several peridinioid genera. The parasutural processes are hollow throughout or for half to two-thirds of their length, terminating in a slender solid tip. The cingular processes tend to be shorter than the others. Delineation of the paratabulation is difficult when the processes are not united proximally. The archeopyle is hexa with the operculum often remaining attached proximally.

Remarks: The genus *Vozzhennikovia* was erected by Lentin and Williams (1976)°to include peridinioid taxa with processes which are nontabular. Six species were included in the genus *Vozzhennikovia* by these authors. Only two, ?*V. extensa* (Stover) Lentin and Williams and ?*V. filigrana* (Benedek) Lentin and Williams, are known to possess a broad hexa 2a archeopyle, but both have nontabular processes. *V. elegantula* is questionably placed in *Vozzhennikovia* because of its parasutural processes. It cannot be included in the genus *Wilsonidium* Lentin and Williams which has parasutural ornamentation because of the possession by that genus of a quadra 2a archeopyle. The only other comparable genus, *Sumatradinium* Lentin and Williams, lacks an apical horn.

The coordinates given are those for a Zeiss Photomicroscope II. The vertical reading precedes the horizontal. The repository for all type material is the Geological Survey of Canada, Ottawa.

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PLATE 1

Figure 1	*Veryhachium* sp. Oligocene, Site 370. ×1000; GSC No. 47845.
Figure 2	*Veryhachium* sp. Oligocene, Site 370. ×800; GSC No. 47846.
Figure 3	*Apteodinium australiense* (Deflandre and Cookson) comb. nov., late Eocene, Site 370. ×500; GSC No. 47847.
Figure 4	*Aptea polymorpha* Eisenack, Aptian, Site 370. ×800; GSC No. 47848.
Figure 5	*Aptea polymorpha* Eisenack, Barremian, Site 370. ×800; GSC No. 47849.
Figure 6	*Areoligera medusettiformis* (O. Wetzel) Lejeune-Carpentier, early Eocene, Site 370. ×500; 47850.
Figure 7	*Cannosphaeropsis* sp. A Williams and Brideaux, 1975, Oligocene, Site 370. ×800; GSC No. 47851.
Figure 8	?*Adnatosphaeridium patulum* Williams and Downie, middle Eocene, Site 370. ×500; GSC No. 47852.
Figure 9	*Concentricystes rubinus* Rossignol, Plio-Pleistocene, Site 367. ×800; GSC No. 4853.
Figure 10	*Ovoidinium scabrosum* (Cookson and Hughes) Davey, basal Cenomanian, Site 370. ×800; GSC No. 47854.

PLATE 1

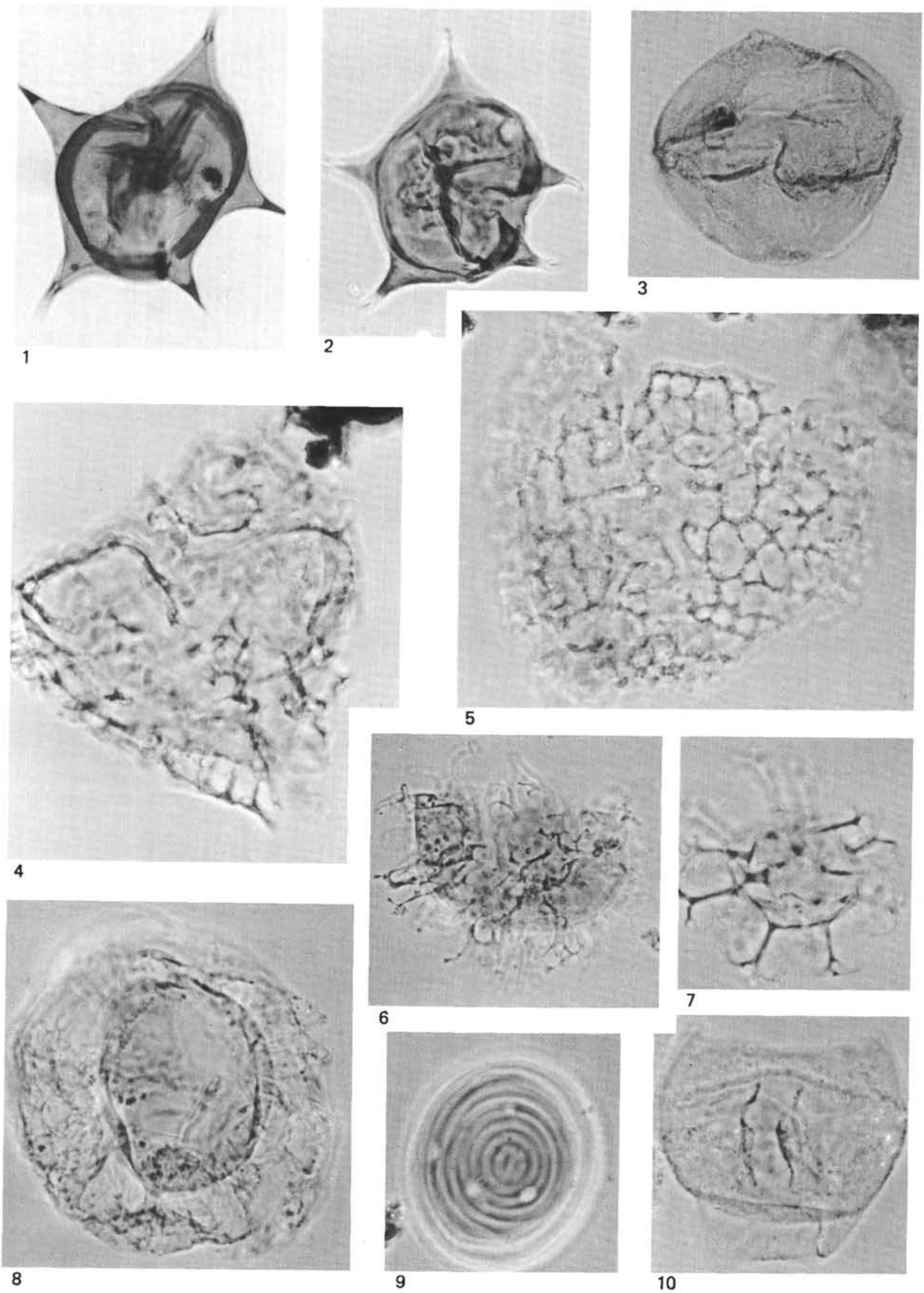

PLATE 2

Figure 1	*Chiropteridium conispinum* sp. nov., holotype, dorsal surface, Oligocene, Site 370. ×500; GSC No. 47855.
Figure 2	*Chiropteridium conispinum* sp. nov., holotype, ventral surface, Oligocene, Site 370. ×500.
Figure 3	*Chiropteridium conispinum* sp. nov., paratype, dorsal surface, Oligocene, Site 370. ×500; GSC No. 47856.
Figure 4	*Chiropteridium conispinum* sp. nov., paratype, dorsal surface, Oligocene, Site 370. ×500; GSC No. 47857.
Figure 5	*Chiropteridium conispinum* sp. nov., paratype, ventral surface, Oligocene, Site 370. ×500.
Figure 6	*Chiropteridium conispinum* sp. nov., paratype, ventral surface, Oligocene, Site 370. ×500.
Figure 7	*Chiropteridium dispersum* Gocht, Oligocene, Site 370. ×500; GSC No. 47858.
Figure 8	*Cleistosphaeridium* sp., Valanginian, Site 370. ×800; GSC No. 47859.
Figure 9	*Cleistosphaeridium huguonioti* (Valensi) Davey, early Cenomanian, Site 370. ×1300; GSC No. 47860.
Figure 10	*Cribroperidinium muderongense* (Cookson and Eisenack) Davey, Aptian, Site 370. ×500; GSC No. 47861.
Figure 11	*Cribroperidinium muderongense* (Cookson and Eisenack) Davey, Aptian, Site 370. ×500; GSC No. 47862.

PLATE 2

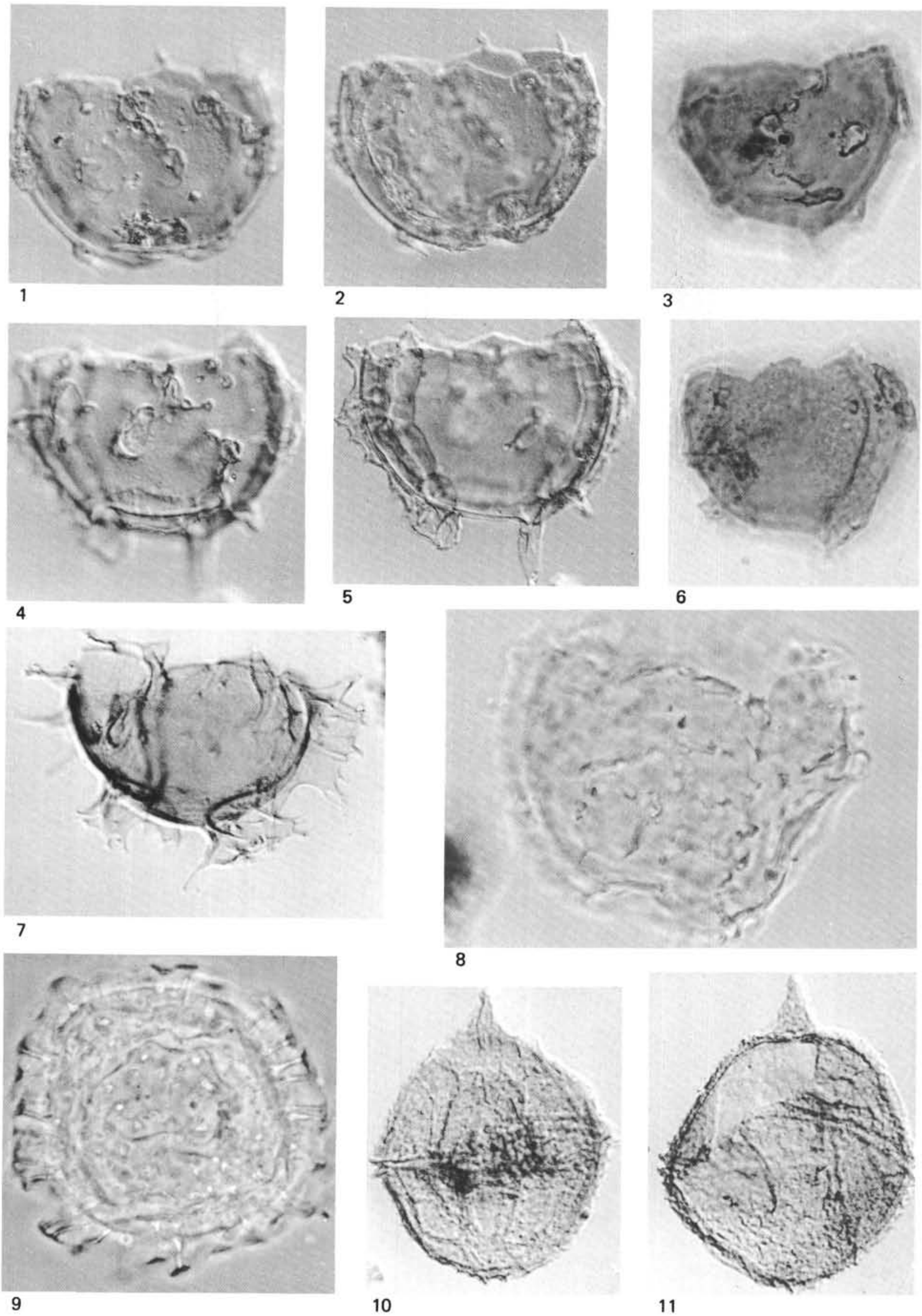

PLATE 3

Figure 1	*Cleistosphaeridium* sp. Valanginian, Site 370. ×800; GSC No. 47863.
Figure 2	*Cleistosphaeridium* sp. Valanginian, Site 370. ×800; GSC No. 47864.
Figure 3	*Cribroperidinium orthoceras* (Eisenack) Davey, Aptian, Site 370. ×500; GSC No. 47865.
Figure 4	*Cleistosphaeridium* sp. Valanginian, Site 370. ×800; GSC No. 47866.
Figure 5	*Cyclonephelium attadalicum* Cookson and Eisenack, Hauterivian, Site 370. ×800; GSC No. 47867.
Figure 6	*Chlamydophorella* sp. Kimmeridgian, Site 367. ×1300; GSC No. 47868.

PLATE 3

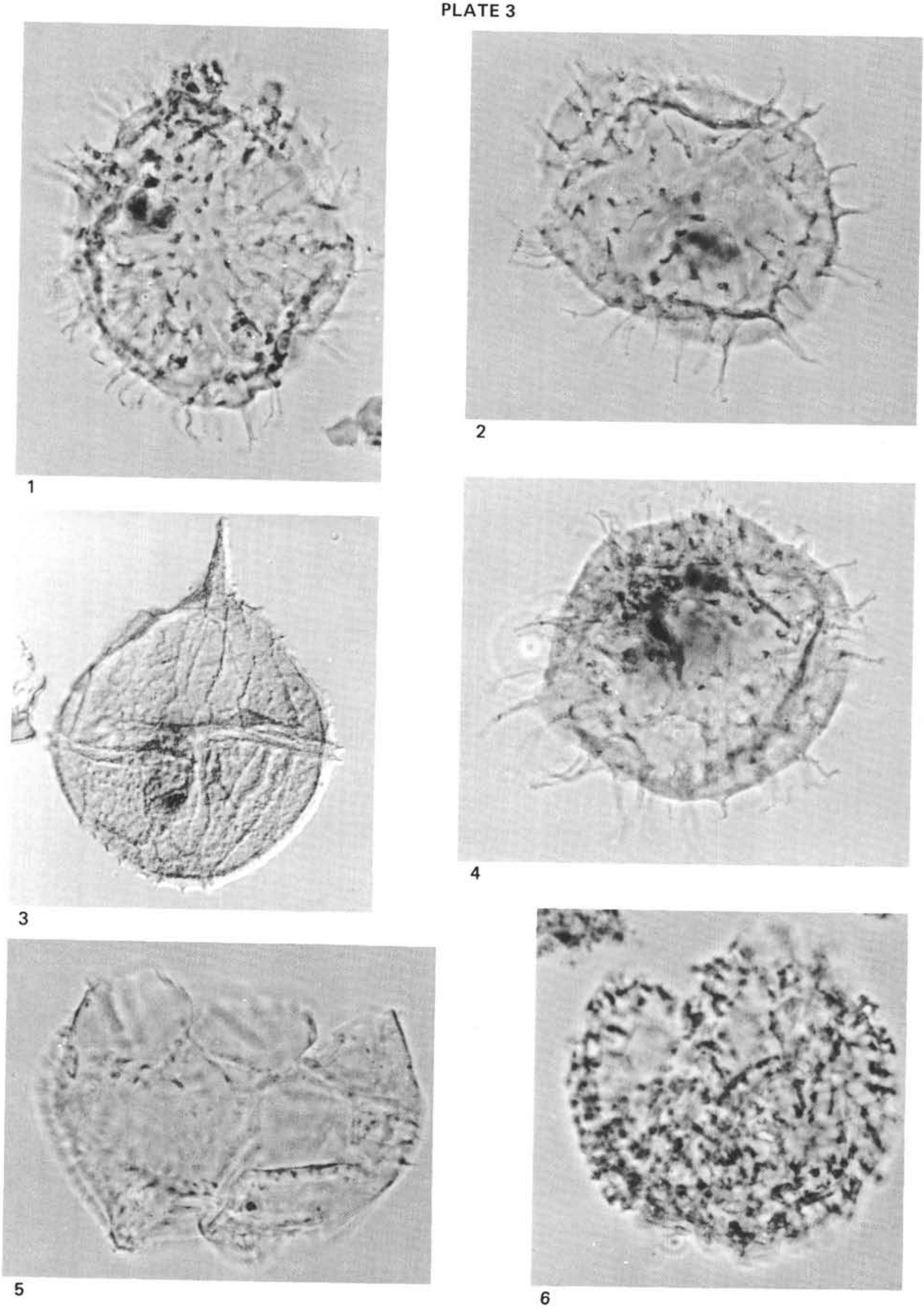

PLATE 4

Figure 1	*Cyclonephelium eisenacki* Davey, Albian, Site 370. ×800; GSC No. 47869.
Figure 2	*Cyclonephelium vannophorum* Davey, middle-late Cenomanian, Site 370. ×500; GSC No. 47870.
Figure 3	*Cyclonephelium retiintextum* Cookson, middle Eocene, Site 370. ×500; GSC No. 47871.
Figure 4	*Cyclopsiella* cf. *elliptica* Drugg and Loeblich, late Eocene, Site 370. ×800; GSC No. 47872.
Figure 5	*Homotryblium aculeatum* sp. nov., paratype, late Eocene, Site 370. ×500; GSC No. 47874.
Figure 6	*Homotryblium aculeatum* sp. nov., paratype, middle Eocene, Site 370. ×500; GSC No. 47875.
Figure 7	*Hystrichodinium pulchrum* Deflandre, Valanginian, Site 370. ×500; GSC No. 47877.
Figure 8	*Homotryblium aculeatum* sp. nov., paratype, middle Eocene, Site 370. ×500; GSC No. 47876.
Figure 9	*Homotryblium aculeatum* sp. nov., holotype, middle Eocene, Site 370. ×500; GSC No. 47873.
Figure 10	*Hystrichokolpoma eisenacki* Williams and Downie, Oligocene, Site 370. ×500; GSC No. 47878.
Figure 11	*Litosphaeridium siphoniphorum* (Cookson and Eisenack) Davey and Williams, basal Cenomanian, Site 370. ×800; GSC No. 47879.
Figure 12	*Lanternosphaeridium radiatum* Morgenroth, middle Eocene, Site 370. ×500; GSC No. 47880.

PLATE 4

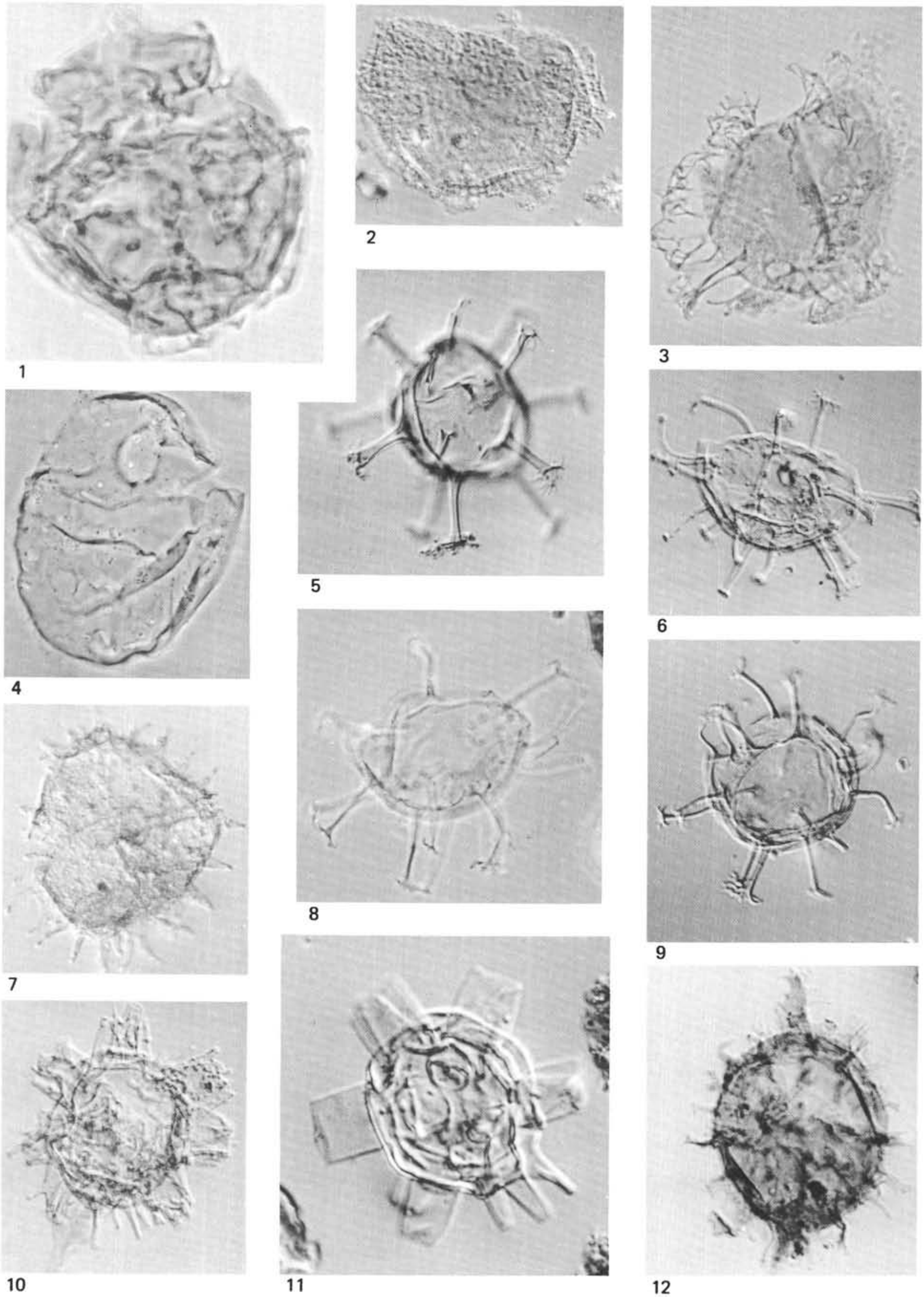

PLATE 5

Figure 1	*Hystrichosphaeridium* sp. A Habib, 1972, Portlandian, Site 367. ×1300; GSC No. 47881.
Figure 2	*Meiourogonyaulax stoveri* Millioud, Hauterivian, Site 370. ×800; GSC No. 47882.
Figure 3	*Leptodinium* sp. Barremian, Site 367. ×800; GSC No. 47884.
Figure 4	*Occisucysta* sp. A, Hauterivian, Site 370. ×500; GSC No. 47885.
Figure 5	*Meiourogonyaulax stoveri* Millioud, Hauterivian, Site 370. ×800; GSC No. 47883.
Figure 6	*Meiourogonyaulax* sp. Aptian, Site 370. ×500; GSC No. 47886.
Figure 7	*Oligosphaeridium* cf. *complex* (White) Davey and Williams, Hauterivian, Site 370. ×500; GSC No. 47887.
Figure 8	*Oligosphaeridium dividuum* sp. nov., holotype, Valanginian, Site 370. ×500; GSC No. 47891.
Figure 9	*Oligosphaeridium complex* (White) Davey and Williams, Albian, Site 370. ×500; GSC No. 47888.
Figure 10	*Oligosphaeridium* cf. *complex* (White) Davey and Williams, Hauterivian, Site 370. ×500; GSC No. 47889.
Figure 11	*Oligosphaeridium* cf. *complex* (White) Davey and Williams, Hauterivian, Site 370. ×500; GSC No. 47890.

PLATE 5

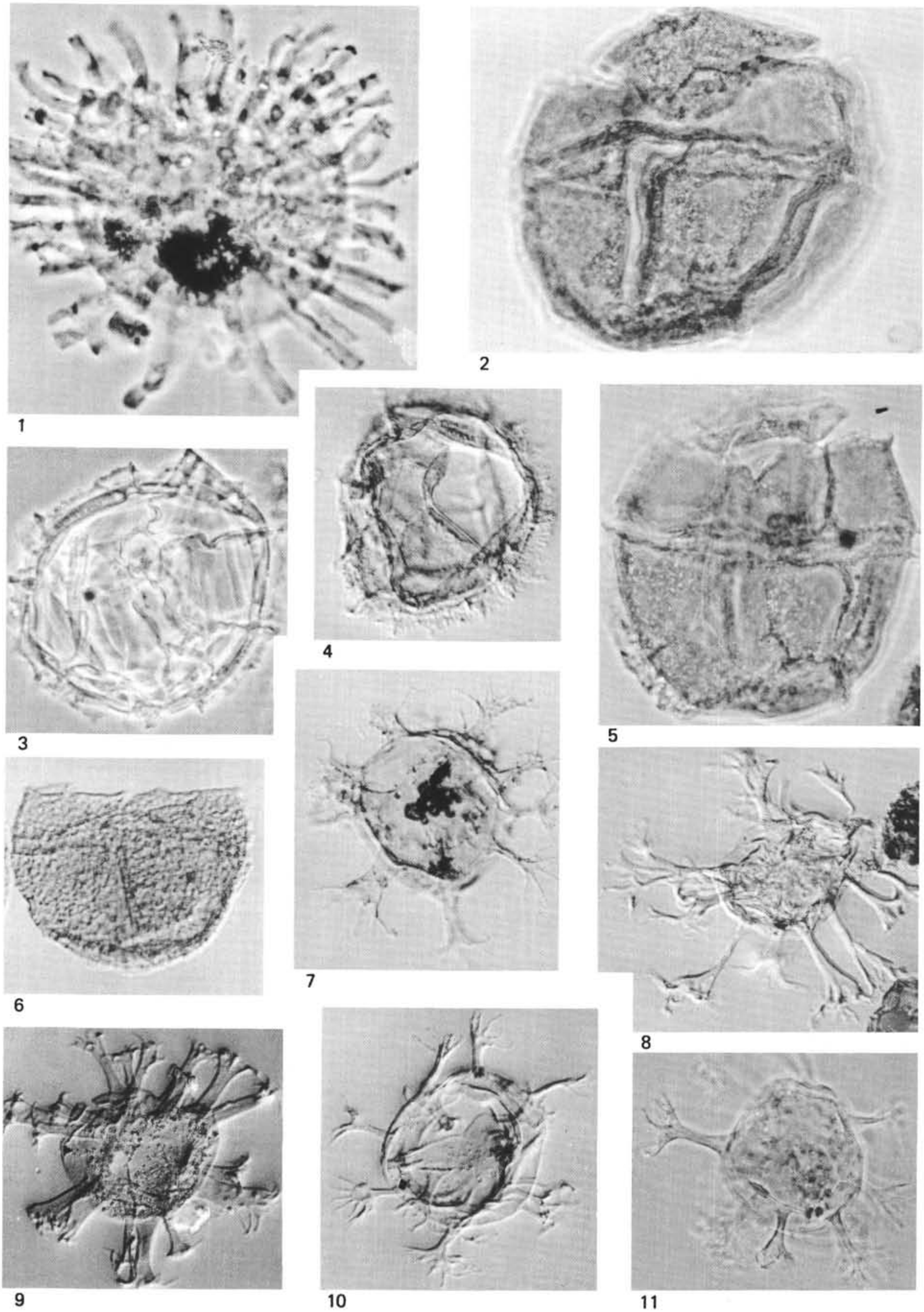

PLATE 6

Figure 1	*Oodnadattia tuberculata* Eisenack and Cookson, 1960, middle-late Cenomanian, Site 370. ×800; GSC No. 47892.
Figure 2	*Ovoidinium scabrosum* (Cookson and Hughes) Davey, basal Cenomanian, Site 370. ×800; GSC No. 47893.
Figure 3	Fungal Spore, middle-late Cenomanian, Site 370. ×800; GSC No. 47894.
Figure 4	*Scriniocassis dictyotum* (Cookson and Eisenack) Beju, Kimmeridgian, Site 367. ×500; GSC No. 47895.
Figure 5	*Prolixosphaeridium granulosum* (Deflandre) Davey et al., Aptian, Site 370. ×800; GSC No. 47896.
Figure 6	*Schematophora speciosa* Deflandre and Cookson, late Eocene, Site 370. ×800; GSC No. 47897.
Figure 7	*Pentadinium laticinctum* Gerlach, Oligocene, Site 370. ×500; GSC No. 47898.
Figure 8	*Scriniocassis dictyotum* (Cookson and Eisenack) Beju, Kimmeridgian, Site 367. ×500; GSC No. 47899.
Figure 9	*Pseudoceratium* sp. basal Cenomanian, Site 370. ×500; GSC No. 47900.
Figure 10	*Pyxidiella* sp. A Habib, 1972, Barremian, Site 367. ×800; GSC No. 47901.
Figure 11	*Pyxidiella* sp. A Habib, 1972, Kimmeridgian, Site 367. ×800; GSC No. 47902.

PLATE 6

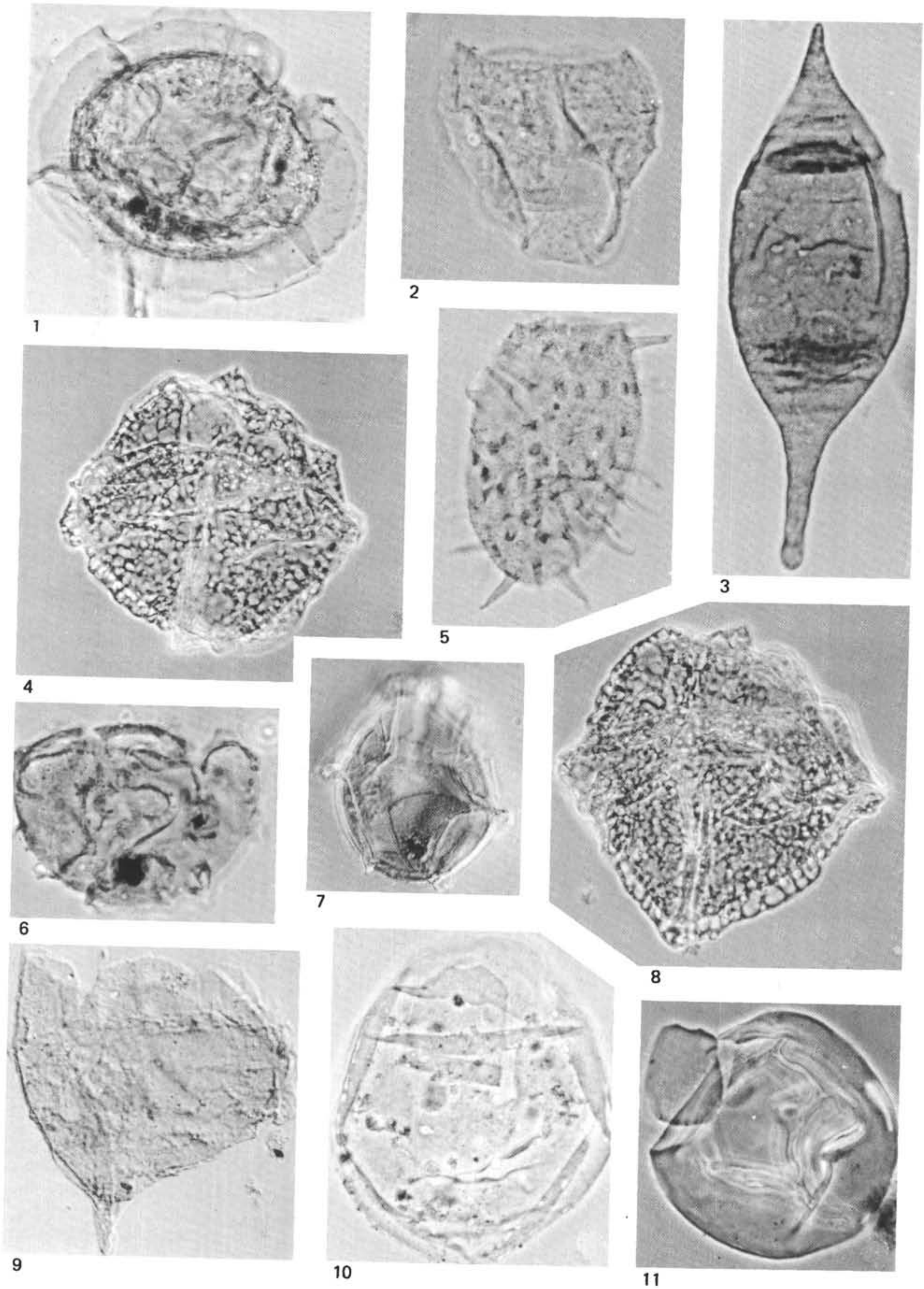

PLATE 7

Figure 1	*Subtilisphaera* cf. *perlucida* (Alberti) Jain and Millepied, Aptian, Site 370. ×800; GSC No. 47903.
Figure 2	*Palaeohystrichophora* sp., middle-late Cenomanian, Site 370. ×800; GSC No. 47904.
Figure 3	*Selenopemphix nephroides* Benedek, Plio-Pleistocene, reworked, Site 370. ×1300; GSC No. 47905.
Figure 4	?*Vozzhennikovia elegantula* sp. nov., early Eocene, Site 370. ×800; GSC No. 47906.
Figure 5	*Sirmiodinium grossi* Alberti sensu Gitmez and Sarjeant, 1972, Kimmeridgian, Site 367. ×800; GSC No. 47907.
Figure 6	*Sirmiodinium grossi* Alberti sensu Gitmez and Sarjeant, 1972, Kimmeridgian, Site 367. ×800; GSC No. 47908.
Figure 7	?*Vozzhennikovia elegantula* sp. nov., early Eocene, Site 370. ×800; GSC No. 47909.
Figure 8	?*Vozzhennikovia elegantula* sp. nov., holotype, early Eocene, Site 370. ×500; GSC No. 47910.
Figure 9	?*Vozzhennikovia elegantula* sp. nov., early Eocene, Site 370. ×800, GSC No. 47911.
Figure 10	*Vozzhennikovia tenella* (Morgenroth) Lentin and Williams sensu Morgenroth, 1966b, pl. 1, fig. 9, Oligocene, Site 370. ×650; GSC No. 47912.
Figure 11	*Sumatradinium* sp., Plio-Pleistocene, Site 370. ×500; GSC No. 47913.
Figure 12	*Eisenackia* sp., early Cenomanian, Site 370. ×800; GSC No. 47914.

PLATE 7

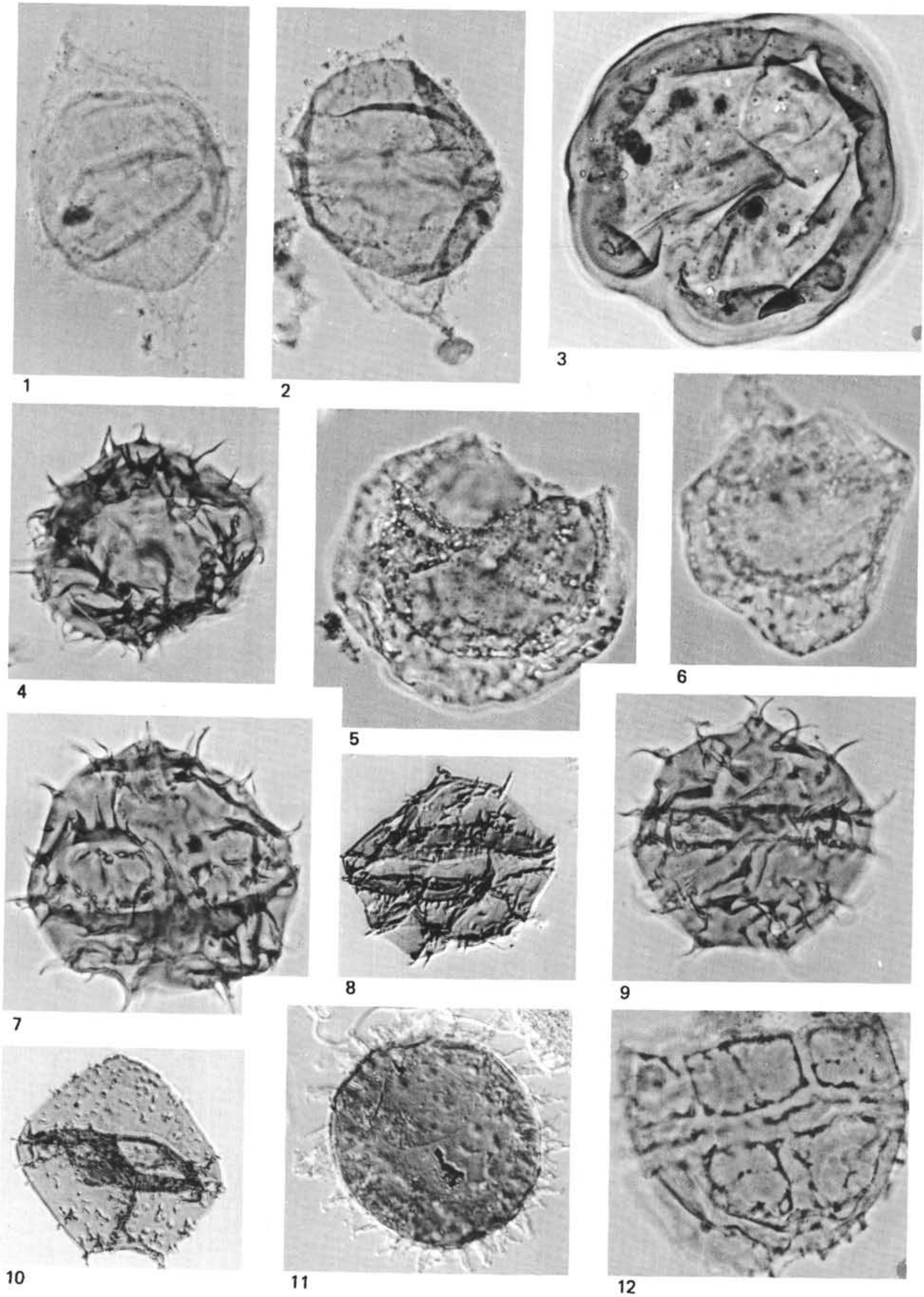

PLATE 8

Figure 1	*Tenua* sp. Hauterivian, Site 367. ×800; GSC No. 47915.
Figure 2	*Spinidinium densispinatum* Stanley sensu Benedek, 1972, Oligocene, Site 370. ×500; GSC No. 47916.
Figure 3	*Tenua verrucosa* Sarjeant, Barremian, Site 367. ×800; GSC No. 47917.
Figure 4	*Wallodinium krutzschi* (Alberti) Habib, Hauterivian, Site 367. ×800; GSC No. 47918.
Figure 5	*Endoscrinium campanulum* (Gocht) Vozzhennikova, Barremian, Site 367. ×800; GSC No. 47919.
Figure 6	*Vozzhennikovia tenella* (Morgenroth) Lentin and Williams, Oligocene, Site 370. ×800; GSC No. 47920.
Figure 7	*Spinidinium densispinatum* Stanley sensu Benedek, 1972, Oligocene, Site 370. ×500; GSC No. 47921.
Figure 8	*Xiphophoridium alatum* (Cookson & Eisenack) Sarjeant, middle-late Cenomanian, Site 370. ×800; GSC No. 47922.
Figure 9	*Galeacornea* sp., basal Cenomanian, Site 370. ×800; GSC No. 47923.

PLATE 8