41. PALYNOLOGICAL INVESTIGATION OF SAMPLES FROM SITES 259, 261, AND 263, LEG 27, DEEP SEA DRILLING PROJECT

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ABSTRACT

The occurrences of Mesozoic dinoflagellates, pollen, and spores from Sites 259, 261, and 263 are described, and from these descriptions the sediments studied are dated Early Cretaceous. The dinoflagellate stratigraphy is compared with a worldwide range chart compiled for this study; the spore and pollen stratigraphy is compared with previously described zonations. This is a preliminary study and, consequently, includes few taxonomic considerations.

The dinoflagellates were studied by Wiseman and the spores and pollen by Williams.

INTRODUCTION

Twenty-two samples were studied from Site 259, 11 from Site 261, and 24 from Site 263. Most samples yielded varied and well-preserved assemblages of palynomorphs. However, the upper samples from Sites 259 (Cores 10-17) and 261 (Cores 9-12) were barren, and Site 263, Core 3, was also barren. No obvious sedimentological differences were observed which would account for the lack of palynomorphs in these samples.

Virtually all of the samples with palynomorphs had predominantly marine assemblages. Percentages of marine palynomorphs in the total assemblages were counted and the results summarized in Figures 1, 2, and 3.

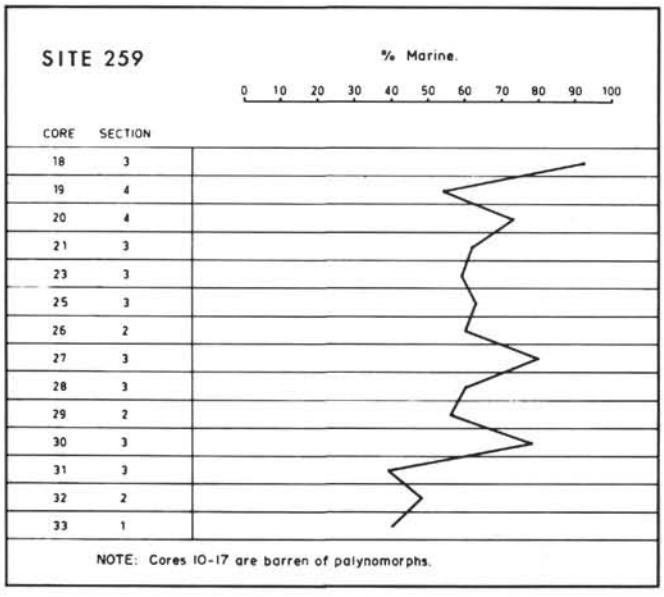


Figure 1. *Percentage of marine (left side of graph) against land-derived (right side of graph) palynomorphs in samples from Site 259.*

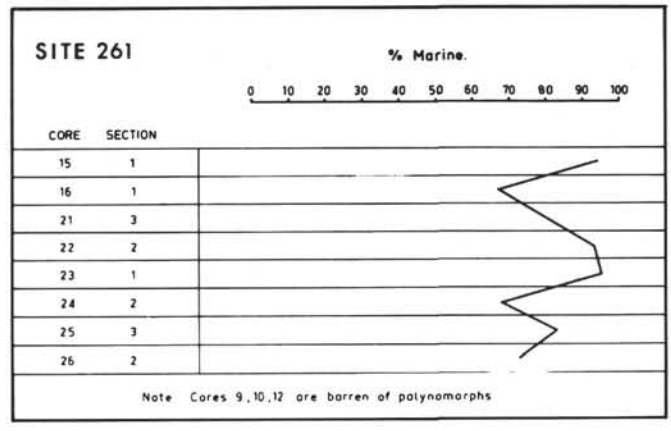


Figure 2. *Percentage of marine (left side of graph) against land-derived (right side of graph) palynomorphs in samples from Site 261.*

DISCUSSION

Dinoflagellates

The previous stratigraphical ranges of the dinoflagellates encountered in this study are summarized in Figure 4. The main sources of reference for this chart were Evans (1966), Eisenack (1967, 1971), Sarjeant (1967), Singh (1971), and Davey and Verdier (1971). The ranges of a number of species have been slightly modified in accordance with unpublished data from studies undertaken at West Australian Petroleum, notably by H. L. Ott, during the drilling of exploratory oil wells in Western Australia.

The ranges of 86 species are shown. The taxonomy employed is that of current usage and, where changes of generic assignments have been made, the author responsible for the reassignment is given together with the original author.

Several species have rather more restricted known stratigraphical ranges in Western Australia than those shown on the worldwide range chart. *Muderongia mcwhaei* Cookson and Eisenack, 1958 is usually

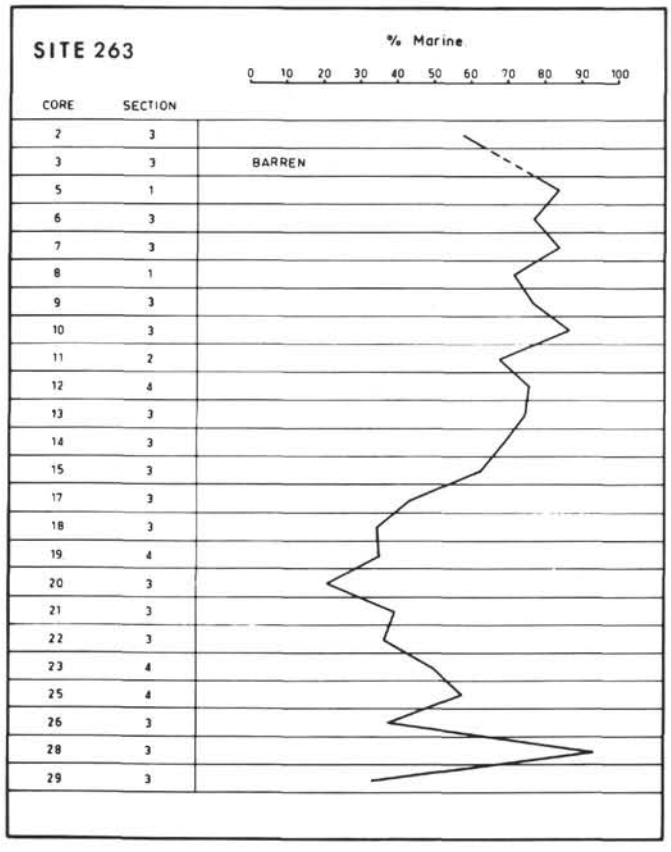


Figure 3. *Percentage of marine (left side of graph) against land-derived (right side of graph) palynomorphs in samples from Site 263.*

restricted to the Aptian. *M. tetracantha* (Gocht, 1957) Alberti, 1961 occurs in the late Aptian. *Muderongia* sp. nov. Evans, 1966 is normally confined to the late Barremian and early Aptian. *?Oligosphaeridium asterigerum* (Gocht, 1959) Davey and Williams, 1969 usually occurs in the early Aptian. *Dingodinium cerviculum* is generally restricted to the Barremian to Albian. *Phoberocysta neocomica* (Gocht, 1957) Millioud, 1967 is confined to the Barremian, whereas *P. neocomica* forma *dedecosa* (Gocht, 1957) usually occurs only in the early Aptian.

Site 259

Figure 5 shows the distribution of dinoflagellates in the samples examined from Site 259. It is considered that the assemblages recorded are all typical of the Aptian, since they include *Muderongia simplex* Alberti, 1961; *M. tetracantha* (Gocht, 1957) Alberti, 1961; *M. mcwhaei* Cookson and Eisenack, 1958; *Cyclonephelium ?attadalicum* Cookson and Eisenack, 1962; *Dingodinium cerviculum* Cookson and Eisenack, 1958; *Carpodinium granulatum* Cookson and Eisenack, 1962; *Broomea micropoda* Eisenack and Cookson, 1960; *Gonyaulacysta muderongensis* Cookson and Eisenack, 1958; and *?Oligosphaeridium asterigerum* (Gocht, 1959) Davey and Williams, 1969.

The occurrence of *?Dingodinium albertii* Sarjeant, 1966 in Cores 29-33 and *?Oligosphaeridium asterigerum* in Cores 25-27 would suggest an early Aptian age for these sediments. Also the occurrence of *Hystrichosphaera ramosa* var. *reticulata* Davey and Williams, 1966 in Cores 23-19 is suggestive of a late Aptian age. Therefore, it would appear that Cores 18-33 encompass almost the whole of the Aptian.

The consistent occurrence of *Canningia rotundata* Cookson and Eisenack, 1960 in these samples would indicate that the range of this species should be extended down into the Aptian. (Previous records have shown its range to be Santonian to Turonian.)

Cores 10-17 were found to be barren of palynomorphs. However, they can be inferred to be late Aptian or younger in age.

Site 261

Figure 6 shows the distribution of dinoflagellates in the samples examined from Site 261. Cores 21-26 have typical Aptian assemblages including *Pterodinium cornutum* Cookson and Eisenack, 1962; *Broomea micropoda* Eisenack and Cookson, 1960; *?Oligosphaeridium asterigerum* (Gocht, 1959) Davey and Williams, 1969; *Carpodinium granulatum* Cookson and Eisenack, 1962; *Muderongia simplex* Alberti, 1961; *M. mcwhaei* Cookson and Eisenack, 1958; *Dingodinium cerviculum* Cookson and Eisenack, 1958; *Gonyaulacysta episoma* Sarjeant, 1966; and *G. muderongensis* Cookson and Eisenack, 1958.

Cores 14-16 are rather more problematical with regard to their age. The occurrence of *Odontochitina costata* Alberti, 1961 and *Cleistosphaeridium ancoriferum* Cookson and Eisenack (1960) 1968 in Core 14 would suggest an Albian age, but *Muderongia mcwhaei* Cookson and Eisenack, 1958 in Cores 14 and 15 and *M. tetracantha* (Gocht, 1957) Alberti, 1961 in Core 16 are indicative of an Aptian age. Consequently, these cores may be assigned either a late Aptian or early Albian age.

Cores 9, 10, and 12 from Site 261 were found to be barren of palynomorphs.

Site 263

Figure 7 shows the distribution of dinoflagellates recorded from the samples studied from Site 263. Cores 19-29 are considered to be Barremian because of the occurrence of *?Cordosphaeridium fasciatum* Davey and Williams, 1966; *Senoniasphaera* sp. A (an undescribed species known to occur in the late Neocomian of Western Australia); *Muderongia* sp. nov. Evans, 1966; and *Phoberocysta neocomica* (Gocht, 1957) Millioud, 1967.

Cores 5-18 all have typical Aptian assemblages which include *Muderongia tetracantha* (Gocht, 1957) Alberti, 1961, *M. mcwhaei* Cookson and Eisenack, 1958; *M. simplex* Alberti, 1961; *Gonyaulacysta episoma* Sarjeant, 1966; *G. muderongensis* Cookson and Eisenack, 1958; *Carpodinium granulatum* Cookson and Eisenack, 1962; *Pterodinium cornutum* Cookson and Eisenack, 1962; *P. magnoserratum* Cookson and Eisenack, 1962; *?Oligosphaeridium asterigerum* (Gocht, 1959) Davey and Williams, 1966; and *Broomea micropoda* Eisenack and Cookson, 1960.

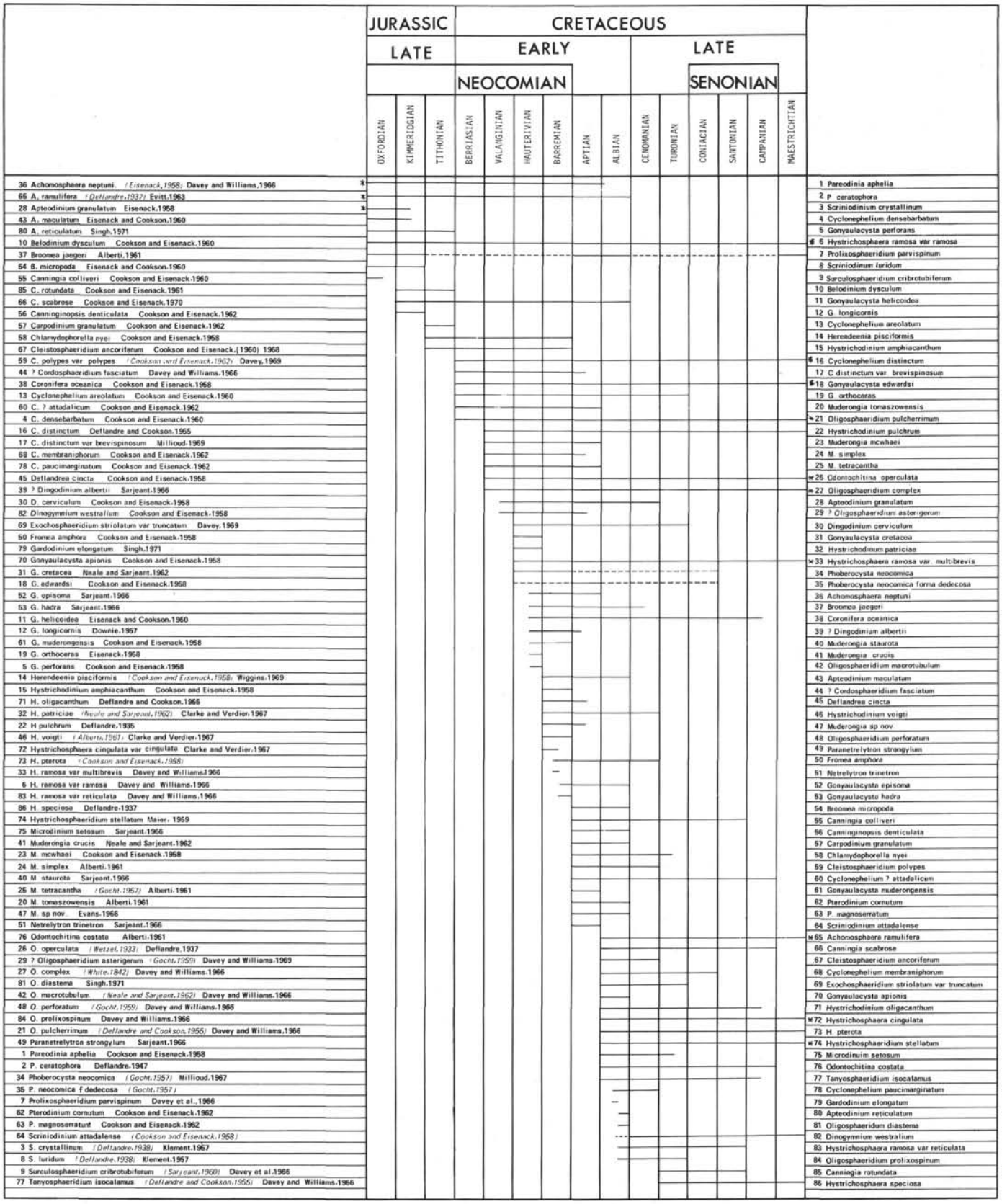
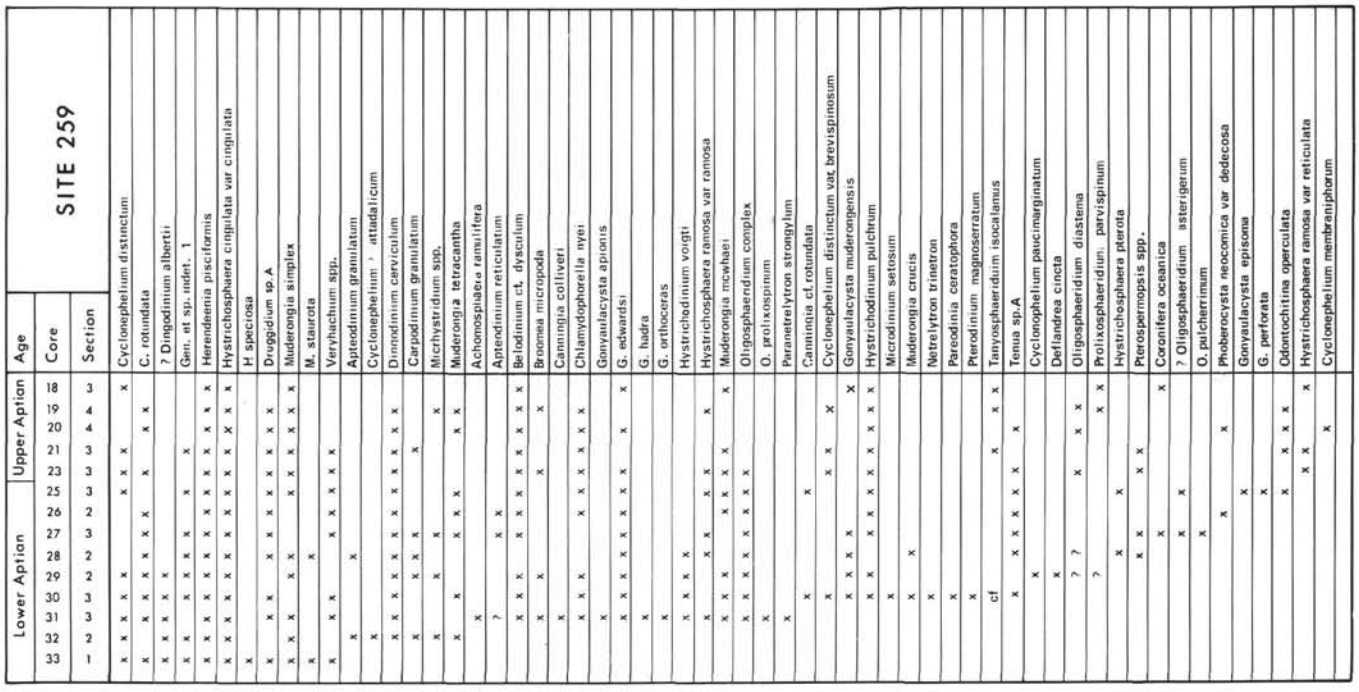
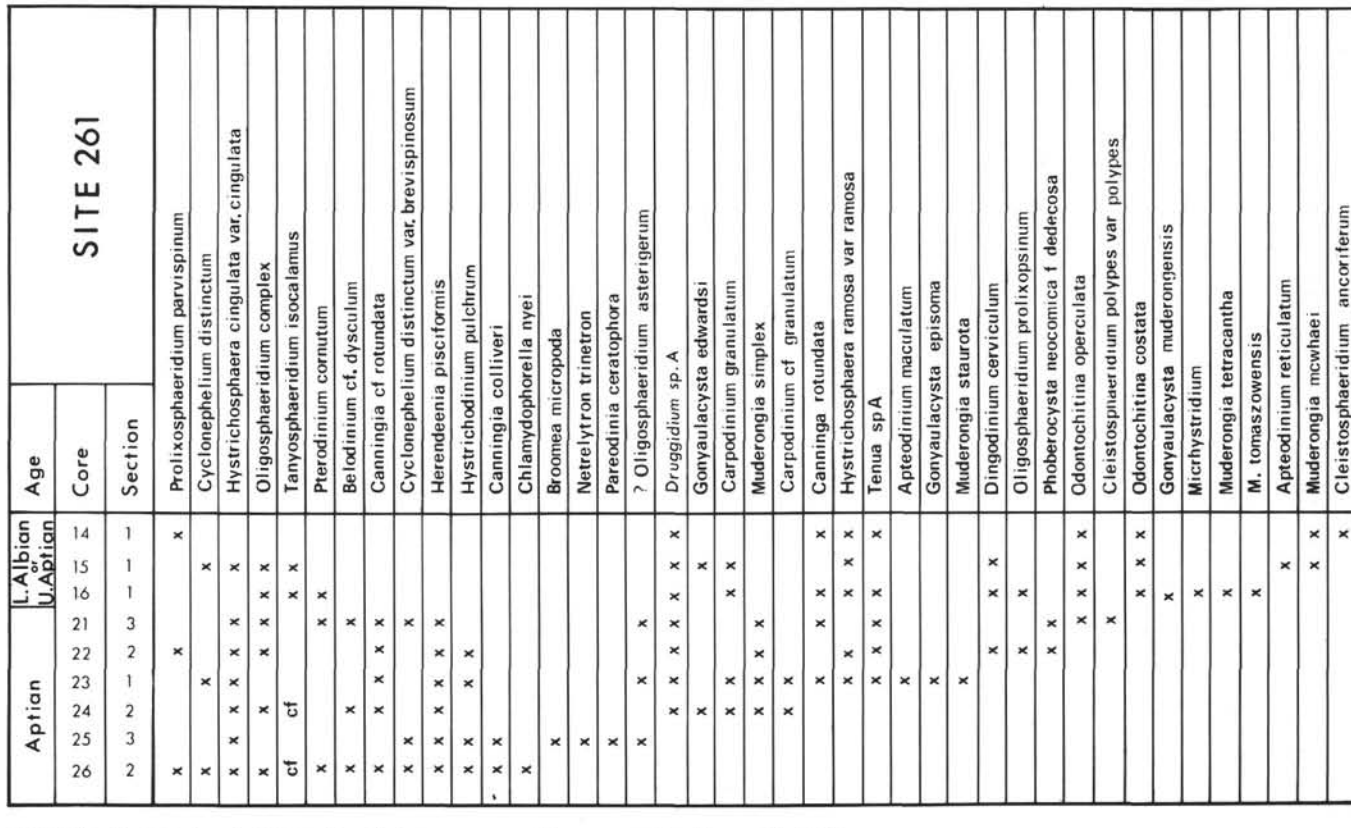


Figure 4. *Compilation of previously described stratigraphical ranges in the Late Jurassic and Cretaceous of dinoflagellates recorded in this study. (*denotes a range beyond the limits of chart.)*



Lower Aptian										Upper Aptian									Age	SITE 259
32	31	30	29	28	27	26	25	23	21	20	19	18							Core	
1	3	3	2	2	3	2	3	3	3	4	4	3							Section	
x	x	x	x	x			x	x	x			x							Cyclonephelium distinctum	
x		x	x	x	x	x			x		x	x							C. rotundata	
x	x	x	x	x															? Dingodinium albertii	
x	x		x	x	x		x		x										Gen. et sp. indet. 1	
x	x	x	x	x	x	x	x	x	x	x	x	x							Herendeenia pisciformis	
x	x	x	x	x	x	x	x	x	x	x	x	x							Hystrichosphaera cingulata var cingulata	
x																			H speciosa	
x		x	x	x	x	x	x	x	x	x	x	x							Druggidium sp. A	
x	x	x	x	x			x	x	x	x	x	x							Muderongia simplex	
x			x				x												M. staurota	
x		x	x	x	x	x	x												Verychachium spp.	
	x		x																Apteodinium granulatum	
	x																		Cyclonephelium ? attadalicum	
x	x	x	x	x	x	x	x	x	x	x	x								Dinodinium cervicului	
	x		x	x	x				x										Carpodinium granulatum	
x		x		x								x							Micrhystridium spp.	
x		x			x	x	x			x	x								Muderongia tetracantha	
	x																		Achomosphaera ramulifera	
	?			x	x														Apteodinium reticulatum	
x	x	x	x	x	x	x	x	x	x	x	x	x							Belodinium cf. dysculum	
	x	x					x		x			x							Broomea micropoda	
	x																		Canningia colliveri	
x	x	x	x	x	x	x	x	x	x	x	x								Chlamydophorella nyei	
	x																		Gonyaulacysta apionis	
x	x	x	x	x	x	x	x	x	x	x	x	x							G. edwardsi	
	x																		G. hadra	
	x																		G. orthoceras	
x	x	x	x	x															Hystrichodinium voigti	
	x		x	x	x	x	x	x	x	x	x	x							Hystrichosphaera ramosa var ramosa	
	x		x	x	x	x	x	x	x	x	x	x							Muderongia mcwhaei	
	x		x	x	x	x	x												Oligosphaeridium complex	
	x																		O. prolixospinum	
	x																		Paranetrelytron strongylum	
	x					x													Canningia cf. rotundata	
	x						x	x	x										Cyclonephelium distinctum var. brevispinosum	
x	x	x	x	x	x	x	x	x	x	x	x	x							Gonyaulacysta muderongensis	
	x																		Hystrichodinium pulchrum	
	x																		Microdinium setosum	
	x		x																Muderongia crucis	
	x																		Netrelytron trinetron	
	x																		Pareodinia ceratophora	
	x																		Pterodinium magnoserratum	
	cf								x		x	x							Tanyosphaeridium isocalamus	
	x		x	x	x	x	x	x	x	x									Tenua sp. A	
			x																Cyclonophelium paucimarginatum	
			x																Deflandrea cincta	
			?	?		x		x	x	x									Oligosphaeridium diastema	
			?				x			x	x								Prolixosphaeridium parvispinum	
				x		x													Hystrichosphaera pterota	
			x	x		x	x	x											Pterospermopsis spp.	
				x								x							Coronifera oceanica	
				x		x													? Oligosphaeridium asterigerum	
				x															O. pulcherrimum	
						x				x									Phoberocysta neocomica var dedecosa	
							x												Gonyaulacysta episoma	
							x												G. perforata	
							x	x	x	x									Odontochitina operculata	
									x										Hystrichosphaera ramosa var reticulata	
										x									Cyclonephelium membraniphorum	

Figure 5. *Range chart of dinoflagellates recovered from samples from Site 259.*



Aptian	L. Albian or U. Aptian	Age	SITE 261
26	16	Core	
2	1	Section	
x	x		Prolixosphaeridium parvispinum
x	x		Cyclonephelium distinctum
x x x x x	x		Hystrichosphaera cingulata var. cingulata
x x x x x	x		Oligosphaeridium complex
cf cf	x x		Tanyosphaeridium isocalamus
x x x x x	x x		Pterodinium cornutum
x x x	x		Belodinium cf. dysculum
x x x x x			Canningia cf rotundata
x x x	x		Cyclonephelium distinctum var. brevispinosum
x			Herendeenia pisciformis
x x x			Hystrichodinium pulchrum
x			Canningia colliveri
x			Chlamydophorella nyei
x			Broomea micropoda
x			Netrelytron trinetron
x			Pareodinia ceratophora
x x x	x		? Oligosphaeridium asterigerum
x x x x x x x	x		*Druggidium sp. A*
x			Gonyaulacysta edwardsi
x x x	x		Carpodinium granulatum
x x x x	x		Muderongia simplex
x x	x		Carpodinium cf granulatum
x x x	x		Canninga rotundata
x x x x	x		Hystrichosphaera ramosa var ramosa
x x x x	x		Tenua spA
x			Apteodinium maculatum
x			Gonyaulacysta episoma
x			Muderongia staurota
x x x			Dingodinium cerviculum
x x			Oligosphaeridium prolixopsinum
x x			Phoberocysta neocomica f dedecosa
x x x x	x		Odontochitina operculata
x			Cleistosphaeridium polypes var polypes
x x x			Odontochitina costata
x			Gonyaulacysta muderongensis
x			Micrhystridium
x			Muderongia tetracantha
x			M. tomaszowensis
x			Apteodinium reticulatum
x x			Muderongia mcwhaei
x			Cleistosphaeridium ancoriferum

Figure 6. *Range chart of dinoflagellates recovered from samples from Site 261.*

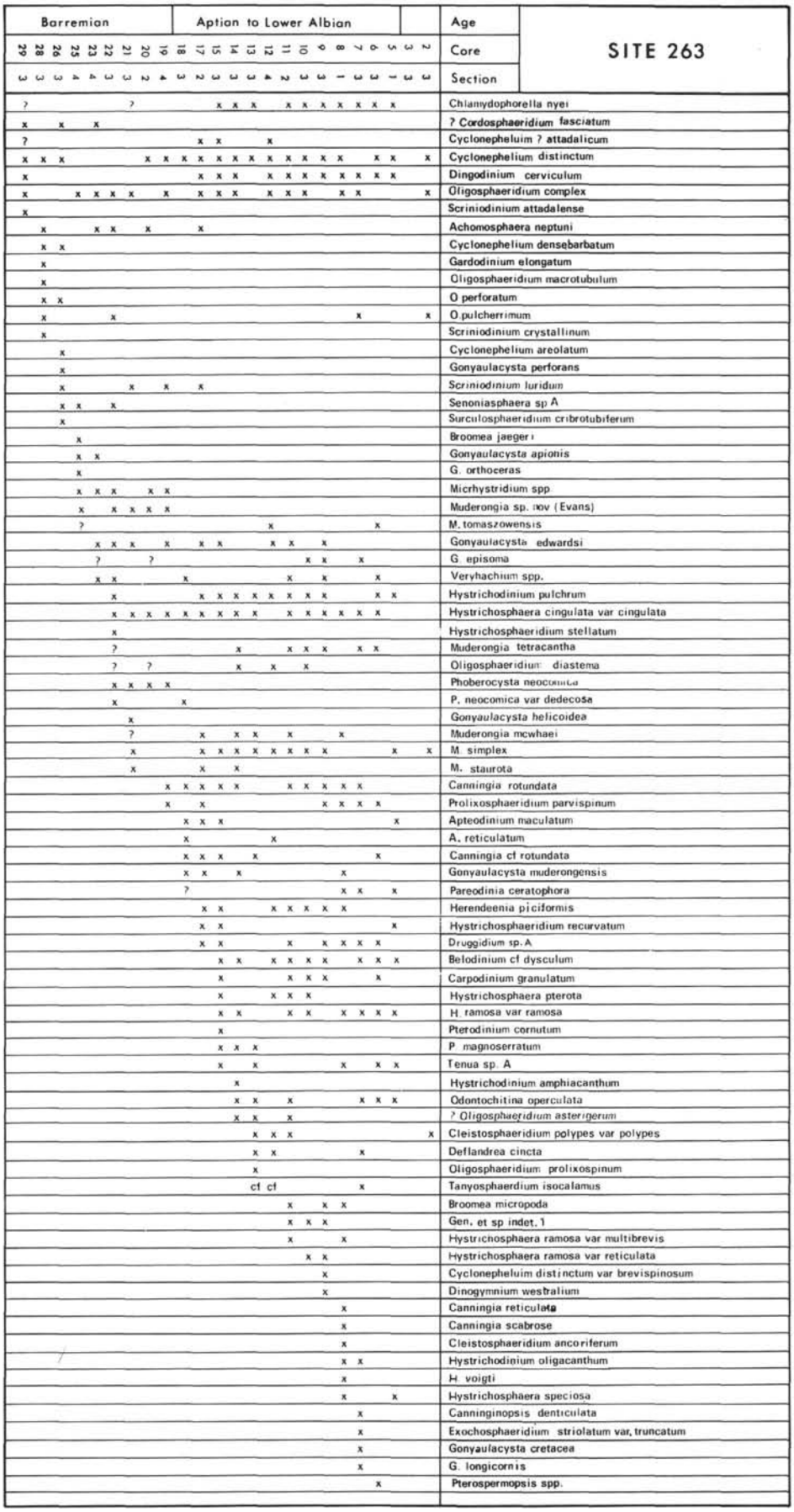


Figure 7. *Range chart of dinoflagellates recovered from samples from Site 263.*

These samples probably range into the late Aptian to early Albian. This is suggested by the occurrence in Cores 8 and 5 of *Cleistosphaeridium ancoriferum* Cookson and Eisenack, (1960) 1968; *Hystrichodinium oligacanthum* Deflandre and Cookson, 1955; *Hystrichosphaera speciosa* Deflandre, 1937; and *Exochosphaeridium striolatum* var. *truncatum* Davey, 1969.

Core 3 was barren of palynomorphs. Core 2 contained a poorly preserved, restricted assemblage of dinoflagellates of Early Cretaceous aspect. These are considered to be reworked and not indicative of the age of these sediments.

A number of reworked dinoflagellates were recognized in the Aptian assemblages. These include *Cyclonephelium densebarbatum* Cookson and Eisenack, 1960 (Oxfordian to Kimmeridgian) in Cores 28 and 26; *Scriniodinium crystallinum* (Deflandre, 1938) Klement, 1957 (Callovian to Kimmeridgian) in Core 28; *Cyclonephelium areolatum* Cookson and Eisenack, 1960 (Tithonian), *Gonyaulacysta perforans* Cookson and Eisenack, 1958 (Oxfordian to Tithonian), and *Surculosphaeridium cribrotubigerum* (Sarjeant, 1960) Davey et al., 1966 (Kimmeridgian to Tithonian) in Core 26; and *Gonyaulacysta cretacea* Neale and Sarjeant, 1962 (Hauterivian) and *G. longicornis* Downie, 1957 (Tithonian) in Core 7.

Spores and Pollen

Range charts of spores and pollen for Sites 259, 261, and 263 are given in Figures 8-10. Overall, spores and pollen comprise a minor part of the microfloral asemblages (see Figures 1-3), particularly in the samples studied from Site 261 and the upper part of Site 263. There is a rough correlation between a greater diversity of species recorded and samples with relatively high percentages of spores and pollen (e.g., at Site 259, contrast the assemblages recovered from Core 26 with Core 27, and Core 29 with Core 30); this is probably a function of the availability of spores and pollen, and their transport and sorting, partly by air but largely by water (Muller, 1959), into the marine environment indicated by the microplankton.

Balme's papers (1957, 1964) remain the main works on Early Cretaceous spores and pollen of Western Australia. Dettmann and Playford (1969) have reviewed the palynology of the Lower Cretaceous in Australia and compared it with extra-Australian records. The assemblages recorded here are of Late Jurassic to Early Cretaceous aspect, containing many bryophytic, pteridophytic, and gymnospermous elements reported previously from sediments of this age, (Dettmann and Playford, 1969) especially from Australia, India, and South America; no angiosperm pollen was recorded.

The zone ranges of the key species of Dettmann and Playford (1969) are not well verified in Western Australia, and some species (e.g., *C. stylosus*) are rarely recorded. The *C. stylosus* and *D. speciosus* zones are not precisely dated (Dettmann and Playford, 1969, p. 186-190), but probably fall, respectively, within the limits of Late Jurassic to Early Neocomian, and Late Neocomian to Late Aptian. The datings from spores and pollen are considered together with microplankton datings (see Conclusions).

At Site 259 the occurrence of *Microcachryidites antarcticus* Cookson, *Podocarpidites ellipticus* Cookson, and *Inaperturopollenites limbatus* Balme, frequently in some numbers, and *Cicatricosisporites* spp., *Acanthotriletes levidensis* Balme, and *Concavisporites infirmus* Balme, indicate a correlation with Balme's (1964) *Microcachryidites* Assemblage (Neocomian to Aptian), at least up to Core 20. Although the occurrence of *Crybelosporites stylosus* Dettmann in Core 31 suggests that the lower part of the interval examined may be assigned to the *C. stylosus* Zone of Dettmann and Playford (1969), in the light of evidence from the dinoflagellates, this probably represents reworking of older sediments. The upper limit of *Contignisporites cooksonii* (Balme) and the presence of *Dictyotosporites filosus* Dettmann indicate that most of the interval, at least up to Core 20, is in the *Dictyotosporites speciosus* Zone (Dettmann and Playford, 1969).

The samples up to Core 11 at Site 263 are assigned to the *Microcachryidites* Assemblage; they yielded the same species as listed for the *Microcachryidites* Assemblage at Site 259 together with *Murospora florida* (Balme) and *Reticuloidosporites arcus* (Balme). The occurrence of *Aequitriradites hispidus* Dettmann and Playford implies assignment to the *C. stylosus* Zone for the assemblage from Core 29. However, in view of the Barremian age determined from the dinoflagellates present, this probably represents reworking. The occurrences of *Murospora florida* and *Krauselisporites linearis* (Cookson and Dettmann) and the top of the range of *Contignisporites cooksonii* indicate that the assemblages up to Core 12 correlate with the lower part of the *D. speciosus* Zone, and the occurrence of *D. speciosus* Cookson and Dettmann (*D. speciosus* Zone) in Core 11 is the highest occurrence of a key species.

Recovery of spores and pollen was low from the samples from Site 261. The assemblages are consistent with an Early Cretaceous age.

Reworked palynomorphs were recorded from some samples. They may give some clue to sediment source and are included on the range charts, together with their age ranges.

SYSTEMATIC PALEONTOLOGY

The taxa described are only those which differ markedly from previously described forms, either in morphologic or stratigraphic occurrence. New species are herein given informal designations.

Genus BELODINIUM Cookson and Eisenack, 1960

Belodinium sp. cf. B. dysculum

Remarks: This is most likely a separate species from *B. dysculum* Cookson and Eisenack, 1960, since there is a wide stratigraphic separation between the occurrence of the two forms, Cookson and Eisenack's species being restricted to the Late Jurassic. However, the only distinguishing morphological feature recognized is that *B.* cf. *dysculum* has a longer apical horn than *B. dysculum* s.s. In most observed specimens, this horn has been lost during archeopyle formation and is, therefore, not generally useful in distinguishing a separate species. Until other morphological differences are observed, it is considered unwise to erect a separate species for the Early Cretaceous forms.

Occurrence: Site 259, Cores 18, 19, 20, 21, 23, 25, 26, 27, 29, 30, 31. Site 261, Cores 21, 24, 26. Site 263, Cores 5, 6, 7, 9, 10, 11, 12, 14, 15.

Inferred age: Aptian.

Neocom	Aptian to Neocomian		AGE	SITE 259
33	32	31	CORE	
1	2	3	SECTION	
				Microcachryidites antarcticus *Cookson*
				Inaperturopollenites limbatus *Balme*
				Lycopodiumsporites austroclavatidites *(Cookson)*
aff.				Lycopodiumsporites reticulumsporites *(Rouse)*
				Podocarpidites ellipticus *Cookson*
				Alisporites grandis *(Cookson)*
				Zonalapollenites dampieri *Balme*
				Classopollis classoides *(Pflug)*
				Alisporites cf. bilateralis *Rouse*
				Duplexisporites mortoni *(De Jersey)*
				Zonalapollenites segmentatus *Balme*
				Cicatricosisporites australiensis *(Cookson)*
				Gleicheniidites senonicus *Ross*
				Osmundacidites wellmanii *Couper*
				Ceratosporites equalis *Cookson & Dettmann*
				Vitreisporites pallidus *(Leschick)*
		cf.		Cyathidites minor *Couper*
				Contignisporites cooksonii *(Balme)*
				Duplexisporites gyratus *Playford & Dettmann* (? T.-J. Reworking)
				Gleicheniidites sp.1.
				Podocarpidites multesimus *(Bolkhovitina)*
				Cingutriletes clavus *(Balme)*
				Araucariacites sp.
				Araucariacites australis *Cookson*
				Acanthotriletes levidensis *Balme*
				Lycopodiumsporites aff. glebulentus *Kemp*
				Alisporites similis *(Balme)*
				Zonalapollenites trilobatus *Balme*
				Baculatisporites comaumensis *(Cookson)*
				Contignisporites multimuratus *Dettmann*
				Lycopodiumsporites eminulus *Dettmann*
				Lycopodiumsporites circolumenus *Cookson & Dettmann*
				Dictyotosporites complex *Cookson & Dettmann*
				Neoraistrickia truncata *(Cookson)*
				Podocarpidites sp.
				Crybelosporites stylosus *Dettmann*
				Triletes cf. tuberculatus *Cookson (as in Dettmann, 1963)*
				Samarosporites speciosus *Goubin* (T. Reworking)
				Alisporites australis *De Jersey* (P – T. Reworking)
				Trisaccites microsaccatus *(Couper)*
				Protohaploxypinus sp. (? P. – T. Reworking)
				Striatopodocarpites fusus *(Balme & Hennelly)* (P – T. Reworking)
				?Cedrepites sp.
				Podocarpidites sp.1.
				Trisaccites variabilis *(Dev)*
				Protohaploxypinus amplus *(Balme & Hennelly)* (P. Reworking)
				Acanthotriletes dentatus *Balme & Hennelly* (P. Reworking)
				Cyathidites australis *Couper*
				Cicatricosisporites ludbrooki *Dettmann*
				Coronatispora telata *(Balme)*
				?Tigrisporites sp.
				Matonisporites crassiangulatus *(Balme)*
				Ischyosporites punctatus *Cookson & Dettmann*
				Podocarpidites exiguus *Harris*
				Concavisporites infirmus *Balme*
				Velosporites triquetrus *(Lantz)*
				Lycopodiacidites asperatus *Dettmann*
				Biretisporites cf. potoniaei *Delcourt & Sprumont*
				Dictyotosporites filosus *Dettmann*
				Protohaploxypinus limpidus *(Balme & Hennelly)* (?P. Reworking)
				Monosulcites sp.
				Lycopodiumsporites nodosus *Dettmann*

Figure 8. *Range chart of spores and pollen recovered from samples from Site 259.*

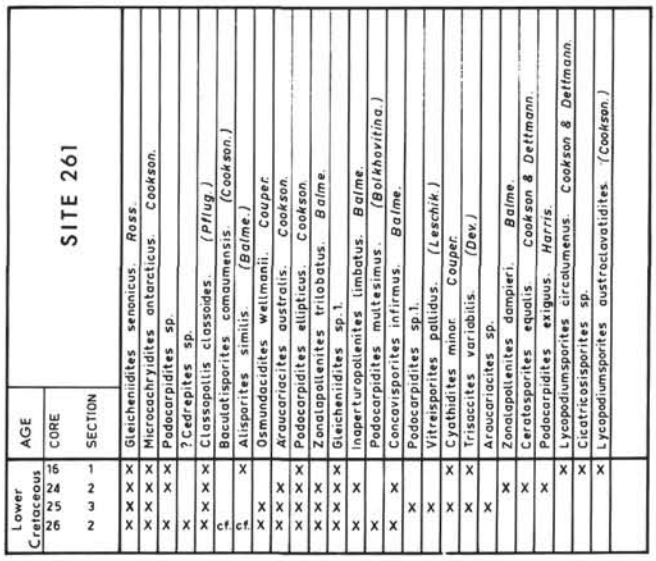


Figure 9. *Range chart of spores and pollen recovered from samples from Site 261.*

Genus CANNINGIA Cookson and Eisenack 1960

Canningia sp. cf. C. rotundata Cookson and Eisenack, 1961

Remarks: *C.* cf. *rotundata* is reserved for those specimens of *C. rotundata* with thick walls (~5μ) and a strongly vermiculate or reticulate ornamentation. These forms were included in Cookson and Eisenack's original description of the species but are readily distinguishable from the more typical thin-walled and indistinctly ornamented specimens.

Occurrence: Site 259, Cores 25, 30. Site 261, Cores 21, 22, 23, 24, 26. Site 263, Cores 6, 13, 15, 17, 18.

Inferred age: Aptian.

Genus DRUGGIDIUM Habib, 1973

Druggidium sp. A.

Description: Small, oval to spherical, proximate cysts with a tabulation of 4', 6", 6g, 6‴, lp, 1⁗. Plates smooth, bordered by low, simple ridges. Archeopyle precingular, formed by loss of plates 2" and 3".

Sizes of observed specimens range between 35 and 46 meters.

Remarks: This species most closely resembles *D. apicopaucicum* Habib 1973, described from Leg 11, Hole 105 (Valanginian-Tithonian). It differs in that the septa marking the plate boundaries are smooth, straight, and not crenulated. It differs from *D. rhabdoreticulatum* Habib, 1973 in that it does not possess the raised membrane described for that species.

are smooth, straight, and not crenulated. It differs from *D. rhabdoreticulatum* Habib, 1973 in that it does not possess the raised membrane described for that species.

Occurrence: Site 259, Cores 19, 20, 21, 23, 25, 26, 27, 38, 30, 31, 33. Site 261, Cores 14, 15, 16, 21, 22, 23, 24. Site 263, Cores 6, 7, 8, 9, 11, 15, 17.

Inferred age: Aptian.

Genus SENONIASPHAERA Clarke and Verdier, 1967

Senoniasphaera sp. A.

Description: A species of *Senoniasphaera* with pronounced antapical horns and lateral horns, the inner body protruding into the antapical horns. Apical horn not observed due to archeopyle formation.

Remarks: This species closely resembles *S. protrusa* Clarke and Verdier, 1967, described from the Senonian of the Isle of Wight. The antapical horns in *Senoniasphaera* sp. A are equal in length and more pronounced.

The size range observed is 93-125μ for the overall length and 67-86μ for the overall width.

Occurrence: Site 263, Cores 22, 25, 26.

Genus TANYOSPHAERIDIUM Davey and Williams, 1966

Tanyosphaeridium sp. cf. T. isocalamus

Remarks: The specimens observed are very similar to *Tanyosphaeridium* sp. Singh, 1971 from the Albian of the Peace River Area, Alberta, in that they vary from *T. isocalamus* s.s. in having slightly buccinate extremities to the processes.

Occurrence: Site 259, Core 30. Site 261, Cores 24, 26. Site 263, Cores 12, 13.

Inferred age: Early Aptian.

Genus TENUA (Eisenack 1958) Sarjeant, 1968

Tenua sp. A.

Description: Relatively small, ovoidal species of *Tenua* with no indication of tabulation. The wall is thick (~5μ) and possesses strong vermiculate ornamentation.

Remarks: *Tenua* sp. A is probably closely related to *Canningia* sp. cf. C. *rotundata* Cookson and Eisenack, 1961. However, the two species do occur in different samples, although they are not mutually exclusive and have similar stratigraphic ranges.

Occurrence: Site 259, Cores 20, 23, 25, 26, 27, 28, 30. Site 261, Cores 14, 16, 21, 22. Site 263, Cores 5, 6, 8, 13, 15.

Inferred age: Aptian to ?early Albian.

Genus et species indet. 1

Remarks: This genus is probably closely related to *Dichadogonyaulax* Sarjeant, 1966 since it is tabulate and has an epitractal archeopyle. It will be formally described at a latter date.

CONCLUSIONS

The ages obtained from study of the dinoflagellates from Sites 259, 261, and 263 agree well with the ages indicated by the pollen and spores present.

Site 259, Cores 18-33 are all considered to be Aptian and probably range from early to late Aptian. The age of Cores 10-17 could not be determined by palynological means.

Site 261, Cores 14-26 range from early Aptian to late Aptian or early Albian in age. The age of Cores 9-12 could not be determined by palynological means.

Site 263, Cores 5-29 range from Barremian to late Aptian or early Albian in age. The ages of Cores 2 and 3 are indeterminable by palynological means.

ACKNOWLEDGMENTS

The authors thank B. E. Balme (University of Western Australia), B. S. Ingram (Burmah Oil Australia), M. H. Johnstone, P. G. Quilty, and P. W. Nygreen, West Australian Petroleum Pty. (WAPET) for their constructive help and criticisms. Thanks is also extended to the staff of WAPET who provided assistance in the preparation of this paper, particularly J. J. McKenny who did much of the drafting and specimen counts, C. A. Howard, V. E. Slater, G. Beacher, and W. Canters who prepared the samples, and M. Sullivan who drafted the range charts.

J. J. Veevers and H. Bolli provided much helpful information.

Finally the authors acknowledge with gratitude the time and facilities made freely available by West Australian Petroleum for this work.

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Neoc	Upper Aptian to Upper Neocomian	AGE	SITE 263
29	29 26 23 21 20 19 18 17 14 12 11 9 7 5	CORE	
4	3 3 4 3 3 4 3 3 2 3 4 2 3 3 1	SECTION	
	× × × × × × × × × × × × × × ×		Zonalapollenites trilobatus *Balme*
	× × × × × × × × × × × × × × ×		*Araucariacites australis Cookson*
	× × × × × × × × × × × × × ×		Podocarpidites ellipticus *Cookson*
	×		Inaperturopollenites turbatus *Balme*
	× × × ×		Zonalapollenites segmentatus *Balme*
	× × × × × × × × × × × × × × × ×		Alisporites similis *(Balme)*
	× × × × × × × × × × × × × × × ×		Classopollis classoides *(Pflug)*
	× × × × ×		Zonalapollenites dampieri *Balme*
	× × × × × × × × × × × × × × ×		Inaperturopollenites limbatus *Balme*
cf.	cf. ×		Leptolepidites major. *Couper*
	× × × × × × × × ×		Contignisporites cooksonii *(Balme)*
	× × × × × × × × × × ×		Cyathidites minor. *Couper*
	× × × × × × cf. ×		Contignisporites multimuratus. *Dettmann*
?	× × × ×		Podocarpidites multesimus *(Bolkhovitina)*
	× × × ×		Triletes cf. tuberculatus *Cookson (as in Dettmann, 1963)*
	× × × ×		Cicatricosisporites hughesi *Dettmann*
	× × × × × × × × × ×		Gleicheniidites senonicus *Ross*
cf.			Foraminisporis asymmetricus *(Cookson & Dettmann)*
	× × × × × × × × × × ×		Lycopodiumsporites austroclavatidites *(Cookson)*
	× × × × × × × × × × × × ×		Alisporites grandis *(Cookson)*
	×		Aequitriradites hispidus *Dettmann & Playford*
	× × × × × × cf. × ×		Neoraistrickia truncata *(Cookson)*
	× × × × × × × × × ×		Vitreisporites pallidus *(Leschik)*
	× × cf. × × × × × × × × ×		Lycopodiumsporites circolumenus *Cookson & Dettmann*
	× × × × × × × × × × × × × ×		Microcachryidites antarcticus *Cookson*
	× ×		Plicatipollenites gondwanensis *(Balme & Hennelly)* (P Reworking)
cf.			Dictyophyllidites crenatus *Dettmann*
	× × × × ×		Laevigatosporites sp. *(as in Ingram, 1967, pl. 37, fig. 7)*
	× × × × × × ×		Osmundacidites wellmanii *Couper*
	×		Zonalapollenite sp.
	×		Araucariacites sp.
	× × × × ×		Coronatispora perforata *Dettmann*
	×		Ornamentifera sp.
	× ×		Staplinisporites caminus *(Balme)*
	×		Foveosporites canalis *Balme*
	×		Velosporites triquetrus *(Lantz)*
	× × ×		Cicatricosisporites ludbrooki *Dettmann*
	× × ×		Ischyosporites punctatus *Cookson & Dettmann*
	× × × ×		Polypodiidites sp.
	× × × × × × ×		Dictyophyllidites mortoni *(De Jersey)*
	× × × ×		Foramisporis dailyi *(Cookson & Dettmann)*
?	×		Murospora florida *(Balme)*
	×		Aequitriradites spinulosus *(Cookson & Dettmann)*
	× ×		Araucariacites sp.
	×		Dulhuntyspora parvithola *(Balme & Hennelly)* (P Reworking)
	× × ×		Matonisporites crassiangulatus *(Balme)*
	× ×		Leptolepidites verrucatus *Couper*
	×		Contignisporites fornicatus *Dettmann*
	× × × ×		Densoisporites velatus *Weyland & Kreiger*
	× × × × × × × × × × × × × ×		Ceratosporites equalis *Cookson & Dettmann*
	× ×		Cyathidites australis *Couper*
	×		Reticuloidosporites arcus *(Balme)*
	× × × ×		Aequitriradites verrucosus *(Cookson & Dettmann)*
	cf.		Trilobosporites tribotrys *Dettmann*
	×		Kuylisporites lunaris *Cookson & Dettmann*
	× × ×		Cyathidites punctatus *(Delcourt & Sprumont)*
	× × ×		Klukisporites scaberis *(Cookson & Dettmann)*
	? cf.		Contignisporites glebulentus *(Dettmann)*
	cf. × × ×		Concavissimisporites variverrucatus *(Couper)*
	×		Cicatricosisporites australiensis *(Cookson)*
	× × × × × ×		Alisporites cf. bilateralis *Rouse*
	× × × × × × × × ×		Gleicheniidites sp.1.
	× × × × × × ×		Baculatisporites comaumensis *(Cookson)*
	× × ×		Lycopodiumsporites eminulus *Dettmann*
	×		Foveotriletes parviretus *(Balme)*
	×		Polycingulatisporites reduncus *(Bolkhovitina)*
	×		Concavisporites infirmus *Balme*
	×		Alisporites australis *De Jersey* (P – Tr. Reworking)
	×		Coronatispora telata *(Balme)*
	×		Cyathidites concavus. *(Bolkhovitina)*
	×		Krauselisporites linearis *(Cookson & Dettmann)*
	× × ×		Lycopodiumsporites reticulumsporites *(Rouse)*
	× × ?		Podocarpidites sp.1.
	×		Trisaccites variabilis *(Dev)*
	× ×		Cingutriletes clavus *(Balme)*
	× × ×		Dictyotosporites complex *Cookson & Dettmann*
	×		Acanthotriletes levidensis *Balme*
	×		Dictyotosporites speciosus *Cookson & Dettmann*
	×		Guthoerlisporites cancellosus *Playford & Dettmann* (P – Tr. Reworking)
	×		? Tigrisporites sp.
	×		Podocarpidites exiguus *Harris*
	cf.		Polycingulatisporites densatus *(De Jersey)*

Figure 10. *Range chart of spores and pollen recovered from samples from Site 263.*

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