26. ALBIAN TO SENONIAN PALYNOLOGY OF SITE 364, ANGOLA BASIN

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ABSTRACT

Palynological processing of 19 samples from Site 364 yielded 11 good assemblages. The frequent spores and pollen provide better biostratigraphic data than the useful, but rare, dinoflagellates. Cores 42-46 are considered early Albian, Cores 38-40 middle Albian, Cores 29-32 late Albian, Core 27 Vraconian or Cenomanian, and Cores 23-25 late Turonian to Coniacian, with many reworked Cenomanian-Turonian elements.

The site was located a considerable distance from shore during the Cretaceous, or lacked large runoff from major river systems, as most spores and pollen are windborne. The climate may have been tropical but semi-arid; the vegetation was certainly very different from that at Site 361. Although restricted, marine influence in the form of dinoflagellates existed from the south.

INTRODUCTION

This shore based post-leg study was undertaken at the Geological Survey of New South Wales, on samples supplied by Dr. W. Siesser, of the University of Cape Town, and the Lamont-Doherty sample repository. The aim was to improve the age dating of those periods when the basin was restricted and open marine faunas poor. Palynological analysis is largely restricted to sapropelic lithologies, with four exceptions from gray marly shale. Nineteen samples were studied from 15 cores in the Cretaceous part of the section. Four were completely barren, and a further four yielded poor assemblages. Palynomorph distribution is presented in Table 1.

GEOLOGICAL BACKGROUND

Site 364 penetrated a Pleistocene to Albian sequence with a probable Cenomanian-early Turonian hiatus (Chapter 4, this volume). The original target for the hole, late Aptian salts underlying much of the Angola Basin, was not reached and the hole at total depth was in early Albian or possibly late Aptian sediments.

The early and partly middle Albian interbedded dolomite and sapropelic mudstones are interpreted to represent cyclic restrictions of the basin. At this time Africa and South America were adjacent, and the basin was restricted by the Walvis Ridge (Figure 1). The middle Albian to possibly Cenomanian limestones and marly limestones represent a period of continuous shallow open marine conditions. In the Turonian and lower Senonian, lithologies deposited include chalks, marly chalks, and sapropelic mudstones, indicating a second period of cyclic restriction. Middle Senonian to Eocene nanno and marly chalk represent open marine to deep-sea conditions, after the final separation of Africa and South America and perhaps subsidence of the Walvis Ridge. Miocene to Pleistocene lithologies are typical of the deep-sea conditions prevailing to this day at Site 364.

PALYNOLOGICAL BACKGROUND

Although no established zonations exist in the literature for areas immediately surrounding Site 364, a number of zonations from areas to the north have proved useful. Jardine and Magloire (1965) erected 12 spore pollen zones ranging in age from Barremian to Maestrichtian. This zonation was established in Senegal and the Ivory Coast, over 3000 km and 20° of latitude away. Muller (1966) erected five zones of Albian to Senonian age from the Maranhas, Bahia, Sergipe, and Alagoas basins of coastal Brazil. Herngreen (1973, 1975) erected three zones and six subzones in the early Albian to late Cenomanian of the Barreirinhas Basin and discussed the Cenomanian to lower Senonian of the Sergipe Basin, both of coastal Brazil. Before the drifting apart of Africa and South America, the Sergipe Basin was within 1000 km and 5° of latitude of Site 364. In Cenomanian time, separation was about 1500 km and increasing rapidly.

These spore-pollen zonations were expected to be of limited use at Site 364, with vegetation changes associated with latitudinal climatic difference being reflected in the spore pollen floras. The South American zonations were expected to be useful in the Early Cretaceous, but of decreasing relevance in the Late Cretaceous, as the South Atlantic Ocean widened.

A compilation from the zonations cited is presented in Figure 2, with additional data from Jardine (1967), Boltenhagen (1965, 1967, 1975), Jardine et al. (1974), and Brenner (in press). Total known ranges are shown, although some palynomorphs are known to be facies dependent. In particular, *Elaterosporites* spp. and *Cretaceiporites* spp. do not have the maximum known range at Site 364. Some inaccuracy may have been introduced into Figure 2 as spore pollen taxa, some facies controlled, were used to correlate the zonations.

TABLE 1
Palynomorph Distribution Chart

Age (present study)	Age (from Bolli et al., 1975)	Depth (m)	Cores and Samples Examined	Palynology Collection No.	Lithology (after Bolli et al., 1975)
	PLEISTOCENE		1		Calcareous mud and clay
	PLIOCENE		2		
			3		Marly nanno ooze and mud
		100	4		
	MIOCENE OLIGOCENE		5		Pelagic clay and greenish gray rad mud
		200	6		
			7		
	EOCENE	300	8		
			9		
	PALEOCENE		10		
			11		
	MAESTRICHTIAN		12		Nanno chalk and marly chalk
		400	13		
			14		
	CAMPANIAN		15		
		500	16		
			17		
	CONIACIAN		18		
			19		
	SANTONIAN	600	20 / 2, 101-103	2528	Chalks, marly chalks, and mudstones with sapropel
			21 < 3, 144-146	2536	
			4, 115-119	2537	
Late Turonian–Coniacian	TURONIAN		22		
			23 < 3, 128-130	2530	
			4, 123-125	2539	
			24–2, 138-140	2538	
		700	25–3, 67-69	2510	
			26		Limestone and marly limestone
Cenomanian			27–3, 91-92	2580	
			28		
			29–2, 43-44	2511	
		800	30		
			31		
Late Albian	ALBIAN		32–3, 29-31	2585	
			33		
			34–1, 146-148	2582	
		900	35		
			36		
			37		
Middle Albian			38–3, 100-102	2584	
			39–1, 129-130	2534	Dolomite and sapropelic mudstone
		1000	40 < 4, 35-37	2535	
			41 5, 51-53	2509	
	APTIAN		42–5, 32-34	2533	
			43–3, 112-114	2541	
Early Albian			44–4, 36-38	2532	
			45–2, 118-119	2512	
			46		

Palynology Collection No.	*Biretisporites* sp.	*Classopollis maljawkineae*	*Classopollis* aff. *senegalensis*	*Classopollis klausi*	*Incertae sedis* sp. A.	*Ephedripites barghoornii/staplinii* form group	*Ephedripites jansonii*	*Ephedripites* sp. 1	*Ephedripites* sp. 2	*Ephedripites* sp. 4	*Ephedripites* sp. 5	*Ephedripites* sp. 8	*Ephedripites* sp. 10	*Ephedripites* sp. 11	*Steevesipollenites multilineatus*	*Tsugaepollenites dampieri*	*Crybelosporites* c.f. *C. striatus*	*Reticulatasporites jardinus*	*Liliacidites crassatus*	*Retitricolpites* sp. A.	*Striatopollis* sp. A.	*Tricolpites gigantoreticulatus*	*Retitricolpites virgeus*	*Tricolpites parvus*	*Classopollis perplexus*	*Ephedripites* sp. 6	*Ephedripites* sp. 3	*Clavatipollenites dividuus*
2528																												
2536																												
2537																												
2530			•		•	•		•	•										•				•					
2539	•							•	•										•									
2538		•	•	•	•	•			•		•								•				•	•			•	
2510								•	•															•		•	•	
2580		•	•	•		•	•	•	•		•					•		•					•	•		•		
2511		•	•	•	•	•	•		•	•								•	•				•			•	•	
2585		•	•			•			•		•																	
2582						•			•																			
2584		•				•			•	•		•				•		•									•	
2534		•		•		•	•	•			•							•						•			•	
2535		•	•	•		•	•	•	•							•		•	•						•		•	•
2509		•	•			•	•		•	•		•	•			•			•				•			•	•	•
2533		•				MICROFOSSILS EXTREMELY SPARSE																						
2541		•		•																					•			
2532		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				
2512	•																											

As the spore pollen zonations are based on largely non-marine deposits, little attention has been paid to the associated dinoflagellates. Only Herngreen (1975) has discussed upper Senonian dinoflagellates as biostratigraphic markers.

The age of the palynological zones rests on somewhat contradictory evidence, chiefly from microfaunas. Jardine and Magloire (1965) rely on foraminifer and megafaunal evidence which they discuss in detail. Muller (1966) and Herngreen (1973) rely on unpublished foraminifer evidence, but Herngreen (1975) includes discussion of megafaunas and foraminifers. The ages used here are shown on Figure 2, and are only a compilation of the other authors, and should be used with caution. Errors in correlation of the zonations, caused by facies control of the spores and pollen, may also make the ages less precise.

BIOSTRATIGRAPHIC ANALYSIS

Cores 42 to 46 are considered early Albian, Cores 38-40 middle Albian, Cores 29-32 late Albian, Core 27 Vraconian or Cenomanian, and Cores 23-25 late Turonian to Coniacian.

Greatest similarity over the whole section is with the zonation of Jardine and Magloire (1965), and so samples are assigned to those zones Figure 2 shows the correlated zones of the other authors.

Core 46—I did not examine this core, but S. Jardine (personal communication) has observed dinoflagellate species typical of the early Albian (Madiela Series) of the Gabon and Congo basins.

Core 45—Only few nondiagnostic pollen were observed. S. Jardine (personal communication) observed a nondiagnostic assemblage of spores and

TABLE 1 – *Continued*

Spore and Pollen Taxa	1	2	3	4	5	6	7	8	9	10	11	12
	BARREN				SPARSE MICROFOSSILS				SPARSE MICROFOSSILS			
Retimonocolpites sp.												•
Liliacidites textus				•					•		•	•
Liliacidites peroreticulatus		•	•	•		•	•		•	•	•	•
Liliacidites inequalis										•		•
Tsugaepollenites trilobatus						•	•		•	•		•
Podocarpidites ellipticus						•						•
Triletes sp. SCI 124												•
Circulina sp. c.f. SCI 303				•		•		•			•	•
Monosulcites sp. SCI 287		•		•						•	•	•
Cycadopites ovatus											•	•
Elaterosporites protensus									•			
Retitricolpites vulgaris						•	•			•	•	•
Striatopollis dubius							•	•		•	•	•
Tricolporites sp. SCI 260							•				•	•
Trifossapollenites ivoirensis SCI 398			•				•			•	•	•
Tricolpites sp. A.											•	•
Psilatricolpites parvulus				•		•	•	•		•	•	•
Ephedripites sp. 7				•	•		•				•	
Retitricolpites prosimilis					•		•			•	•	
Araucariacites australis						•	•			•	•	
Cyathidites spp.				•	•		•				•	
Gnetaceaepollenites diversus										•		
Matonisporites sp. SCI 56							•			•		
Hexaporotricolpites emelianovi		•	•	•	•	•	•	•				
Cicatricosisporites australiensis							•					
Steevesipollenites binodosus							•					
Tricolpites sp. B.							•					
Tricolpites sp. C.							•					
Tricolpites sp. D.							•					
Tricolpites sp. E.		•	•	•			•					
Elateroplicites africaensis							•	•				
Alisporites grandis							•					
Alisporites similis							•					
Cupuliferoidaepollenites minutus				•	•		•					
Liliacidites reticulatus							•					
Tricolpites sp. c.f. SCI 326		•				•	•					
Tricolpites sp. F.				•	•							
Tricolpites sp. SCI 326	BARREN	•	•	•	•							
Hexaporotricolpites potoniei				•	•							
Hexaporotricolpites coronatus				•								
Cretacaeiporites scabratus		•	•	•								
Cretacaeiporites muellerii				•		•	•					
Classopollis brasiliensis		•		•								
Syncolporites form B. SCI. 146				•								
Cicatricosisporites pseudotripartitus				•								
Rousea georgensis SCI 294				•								
Tricolpites sp. SCI 217			•	•								
Ephedripites sp. A.				•								
Triorites sp. A.				•								
Tricolpites sp. CI 13			•	•								
Cicatricosisporites sp.			•	•								
Retitricolpites operculatus			•	•								
Tricolpites SCI 175 bis		•	•	•								
Tricolporopollenites SCI 100				•								
Tricolpites sp. G.				•								
Tricolpites sp. H.		•	•	•								
Syndemicolpites sp. A.			•									
Cretacaeiporites polygonalis			•									
Ephedripites sp. B.			•									
Tricolpites microstriatus SCI 99			•									
Fraxinoipollenites venustus			•									
Ephedripites sp. C.		•	•									
Tricolpites giganteus SCI 216		•	•									
Ephedripites sp. D.		•										
Tricolpites sp. I.		•										
Tricolpites sp. J.		•										

pollen lacking dinoflagellates. He considered Cores 45 and 46 to represent assemblages known from the post-salt deposits of the Congo and Gabon basins dated as early Albian.

Core 44—Ephedroid and gymnospermous (*Classopollis*) pollen dominate, with rare spores, and monocolpate and tricolpate angiospermous pollen. This assemblage is assigned to the late Aptian and early Albian Zone XI of Jardine and Magloire. The presence of *Crybelosporites* cf. *C. striatus* prevents assignment to Zone XII, and the absence of *Striatopollis dubius* prevents assignment to Zone X.

The angiosperm pollen consists of three monocolpate and five tricolpate species. The oldest records of monocolpate pollen are the Barremian to Aptian of Israel (Brenner, personal communication), and Patagonia (Archangelsky and Gamerro, 1967). The oldest records of tricolpate pollen are the late Aptian to early Albian of Israel (Brenner, personal communication) and the Aptian of Brazil (Muller, 1966). As these areas were at similar latitudes in the Cretaceous, they may be expected to provide relevant age evidence. At these levels, however, tricolpate pollen are simply ornamented, reticulate or scabrate, and so the complexity and diversity of the tricolpate pollen in Core 44 would be unique if the core was Aptian in age. An early Albian age is favored for Core 44, considered in conjunction with the middle Albian age of Cores 38-40. The dinoflagellates are not useful age indicators.

Cores 42, 43—Assemblages are too poor to date, although study of additional material may give representative microfloras.

Cores 38, 39, 40—*Classopollis* dominates, with secondary abundances of *Ephedripites*, tricolpates, *Trifossapollenites*, and monocolpates. Spores are absent. Except for this feature, a Zone X assignment is

TABLE 1 – *Continued*

Age (present study)	Age (from Bolli et al., 1975)	Depth (m)	Cores and Samples Examined	Palynology Collection No.	Lithology (after Bolli et al., 1975)	Fungal spores	*Striate bisaccates* (P-TR. Reworking)	*Subtilisphaera* c.f. *perlucida*	*Leptodinium* sp. A.	*Micrhystridium* spp.	*Apteodinium conjunctum*	*Cymatiosphaera* spp.	*Leptodinium* spp.	*Oligosphaeridium complex*	*Spiniferites ramosus*	*Diconodinium arcticum*	*Veryhachium* spp.	*Exochosphaeridium phragmites*	*Hystrichosphaeridium arundum*	*Dioxya villosa*	*Cribroperidinium edwardsii*	*Cornonifera oceanica*	*Aptea polymorpha*	*Dinopterygium cladoides*	*Gonyaulacysta cassidata*	*Gonyaulacysta helicoidea*	*Odontochitina operculata*	*Psaligonyaulax deflandrei*	*Tanyosphaeridium variecalamum*	*Trichodinium intermedium*	*Litosphaeridium conispinum*	*Pterospermella australiensis*	*Astrocysta cretacea*
	PLEISTOCENE		1		Calcareous mud and clay																												
	PLIOCENE		2																														
			3		Marly nanno ooze and mud																												
		100	4																														
	MIOCENE OLIGOCENE		5																														
		200	6		Pelagic clay and greenish gray rad mud																												
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			15																														
		500	16																														
			17																														
	CONIACIAN		18																														
			19																														
	SANTONIAN	600	20																														
	TURONIAN		21–2, 101-103	2528	Chalks, marly chalks, and mudstones with sapropel																												
			21–3, 144-146	2536																													
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			23–3, 128-130	2530						•	•	•			•	•																	
			23–4, 123-125	2539																													
			24–2, 138-140	2538						•					•																		
		700	25–3, 67-69	2510						•																						•	
			26																														
Cenomanian			27–3, 91-92	2580							•				•						•	•					•			•	•		•
			28																														
			29–2, 43-44	2511						•	•	•	•		•			•				•									•	•	
		800	30																														
Late Albian			31		Limestone and marly limestone																												
	ALBIAN		32–3, 29-31	2585											•				•				•	•	•	•	•	•	•	•	•		
			33																														
			34–1, 146-148	2582											•																		
		900	35																														
			36																														
			37																														
Middle Albian			38–3, 100-102	2584											•																		
			39–1, 129-130	2534						•					•							•											
			40–4, 35-37	2535						•					•		•	•	•		•												
		1000	41–5, 51-53	2509	Dolomite and sapropelic mudstone										•		•	•	•	•													
			42–5, 32-34	2533																													
			43–3, 112-114	2541				•								•																	
Early Albian	APTIAN		44–4, 36-38	2532				•	•	•				•	•																		
			45–2, 118-119	2512		•	•	•	•	•	•	•	•																				
			46																														

suggested. The presence of *Striatopollis dubius* (Cores 39, 40), *Tricolporites* S. Cl. 260 (Cores 39, 40), and *Elaterosporites protensus* (Core 38) indicate a middle Albian Zone X or younger assignment. Jardine (1967) dates the oldest occurrence of *S. dubius* as within the middle Albian on foraminifer evidence.

Dinoflagellates from Cores 39, 40 include *Hystrichosphaeridium arundum*, recorded from the early to late Albian (pre-Vraconian) in Europe and elsewhere (Verdier, 1975) and *Dioxya villosa*, recorded from Australia in the middle and late Albian (unpublished information). Thus both spore-pollen and dinoflagellate evidence support a middle Albian age.

Core 34—The assemblage is too poor to date.

Cores 29, 32—*Classopollis* and *Ephedripites* dominate, with secondary abundances of tricolplates and *Trifossapollenites*. Spores and bisaccate pollen are rare. Except for the scarcity of spores, the assemblage is similar to Zones VIII, IX, and X. The presence of *S. dubius* (Cores 29, 32) indicates assignment to the lower Zone VIII or older zones. The presence of *Hexaporotricolpites emelianovi* (Cores 29, 32), *Elateroplicites africaensis* forma B (Core 32), *Elateroplicites africaensis* forma A (Core 29), and *Cretaceiporites muellerii* (Cores 29, 32) indicate assignment to the lower Zone VIII or younger zone. Thus these cores are assigned to the late Albian lower Zone VIII of Jardine and Magloire.

Dinoflagellates include *H. arundum* (Core 32—late Albian and older), *L. conispinum* (Cores 29, 32—late Albian and younger), and *P. deflandrei* (Core 32—late Albian and younger). The ranges are detailed by Verdier (1975), and indicate a late Albian age, in agreement with the spore-pollen data.

Core 27—*Classopollis* and *Ephedripites* dominate, with secondary abundance of tricolpates and

TABLE 1 – *Continued*

Hexagonifera chlamydata	*Hystrichodinium pulchrum*	*Florentinia deanei*	*Cassiculosphaera reticulata*	*Palaeohystrichophora infusorioides*	*Ascodinium acrophorum*	*Ascodinium* c.f. *A. serratum*	*Cymatiosphaera* sp. A.	*Crassosphaera concinna*	*Dinogymnium euclaensis*	*Pterospermella* sp.	*Cyclonephelium distinctum*	*Litosphaeridium siphoniphorum*	*Achomosphaera sagena*	*Deflandrea acuminata*	*Dinogymnium acuminatum*	*Spiniferites* sp.
				•					•	•					•	•
				•					•	•				•	•	
				•					•		•	•	•			
				•	•	•	•	•	•	•						
•	•	•	•	•												

Trifossapollenites. Spores are rare. Except for this, the assemblage is similar to Zones VIII, IX, and X. The presence of *Reticulatasporites jardinus* suggests a Zone VIII or older assignment. The presence of *H. emelianovi* suggests a Zone VIII or younger assignment. The absence of *S. dubius* may suggest that an early Cenomanian upper Zone VIII assignment is more likely.

Dinoflagellates include *P. infusorioides*, recorded from Vraconian and younger sediments (Verdier, 1975).

Thus spore pollen data and dinoflagellate data indicate a Vraconian or early Cenomanian age, with the Cenomanian age favored by negative evidence.

Cores 23, 24, 25—Poorly ornamented small and giant tricolpate pollen dominate, with secondary abundance of *Ephedripites*, *Cretaceiporites*, and *Hexaporo tricolpites*. This assemblage resembles the Turonian to early Senoian (Zone VII of Jardine and Magloire. Problems exist, however, in the mutual occurrence of species recorded in the literature as mutually exclusive. The younger elements which are considered to be in situ include:

Coniacian-Maestrichtian—*Tricolpites* S.CI. 326 (Cores 23, 24, 25)
Coniacian-Santonian—*Syncolporites* S.CI. 146 (Core 24)
Turonian-Coniacian—*Rousea* S.CI. 294 (Core 24)
Turonian-Coniacian—*Tricolpites* S.CI. 217 (Cores 23, 24)
Turonian-Coniacian—*Tricolpites* S.CI. 13 (Cores 23, 24)
Turonian-Coniacian—*Tricolpites* S.CI. 100 (Core 24)
Turonian-Coniacian—*Tricolpites giganteus* (Core 23)
Turonian—*Tricolpites* S.CI. 99 (Core 23)

This group suggests a Turonian-Coniacian age as probable. Older elements considered to be reworked include:

Cenomanian—*Hexaporotricolpites potoniei* (Cores 24, 25)
Jurassic to late Cenomanian—*Classopollis* spp. (Cores 23, 24)
Early to late Cenomanian—*Classopollis brasiliensis* (Core 23)
Late Cenomanian—*Tricolpites* S.CI. 175 bis (Core 24)

This group suggests that Cenomanian sediments were present in the area, and have been reworked during the Turonian-Coniacian.

Dinoflagellates from these samples show similar mixing suggesting Coniacian or younger sediments, with Cenomanian-Turonian reworking. Significant species include *Dinogymnium euclaensis* (Cores 23, 24, 25, Senonian to Maestrichtian, worldwide), *Dinogymnium acuminatum* (Core 23, Senonian to Maestrichtian, worldwide), *Deflandrea acuminata* (Core 23, Cenomanian to Turonian, worldwide), and *Ascodinium acrophorum* (Core 25, Cenomanian, Australia). The first two or possibly three species are considered in situ, and the last one or possibly two reworked.

In the Northern Hemisphere, the *Dinogymnium* species listed are considered to be Santonian-Maestrichtian indicators, although the genus has been recorded sporadically from the Turonian, and rarely from the Cenomanian. S. Jardine (personal communication) has found these *Dinogymnium* species in African sediments older than Santonian. The dinoflagellates thus suggest an early Senonian or younger age with Cenomanian-Turonian reworking.

In synthesis, the combined spore-pollen and dinoflagellate evidence favor a Turonian-Coniacian age, with Cenomanian and Turonian reworking.

PALEOENVIRONMENT

Environmental conclusions from the present study are automatically limited because only sapropelic lithologies provided good assemblages. In a cyclicly restricted environment such as this, palynology can thus only provide insight to the most restricted phases.

General features of the organic content of these cores suggest a very low energy environment of deposition, at

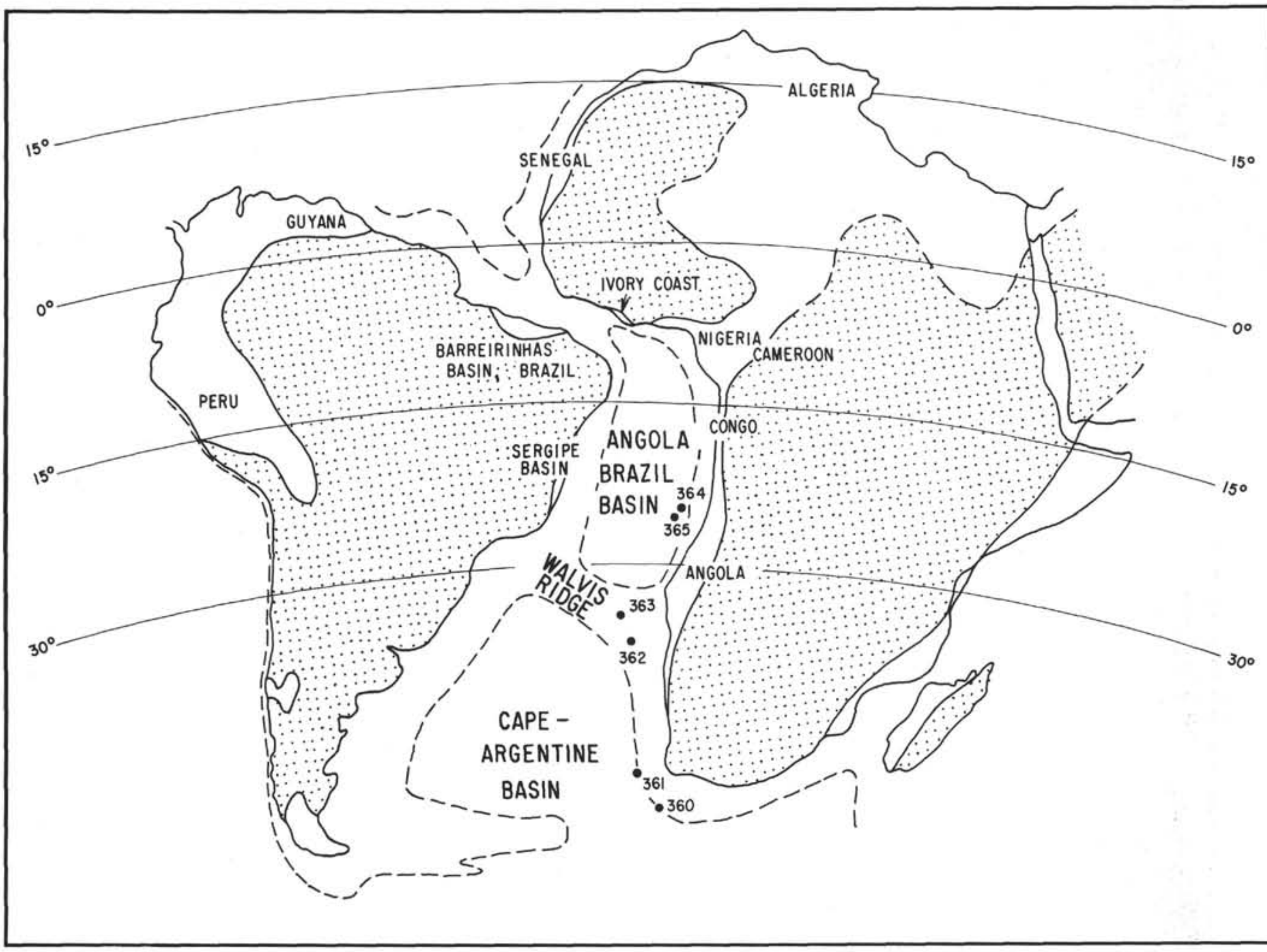

Figure 1. *Locality map in middle cretaceous time (after Jardine et al. 1974) onshore sedimentation largely non-marine.*

some distance from shore, with dominant wind transport of spores and pollen. Organic detritus, other than spores and pollen, is 1-2 μm in size, reflecting the very low energy of the environment, sufficient to allow settling of these particles. The energy is so low that the spores and pollen cannot easily have been transported into the site by water currents, especially as organic debris intermediate in size between the pollen and the fine matter is absent. Some samples have abundant fine matter, but are barren of spores and pollen, while others have diverse microfloras as well as abundant fine matter. This is interpreted as reflecting fluctuating wind patterns, alternately denying and supplying spores and pollen to Site 364. The absence of cuticle and wood tracheid fragments also suggests distance from shore, away from the influence of major river systems and water borne detritus. The only exception is in Core 45, where Permian or Triassic pollen, presumably reworked by eroding rivers from the hinterland, are found.

The average spore-pollen diversity of about 30 species suggests a stable and homogeneous plant community, possibly living under harsh conditions. Under more favorable conditions, diversity might average 50 species, but the observed diversity may be biased against large and heavy spores and pollen incapable of transport to Site 364 by wind currents.

The taxonomic composition suggests a tropical, possibly hot and semiarid climate, away from deltaic influence. The overall nature of the assemblages, as well as the occurrence of many zonal indicators, shows close affinity with the paleo-equatorial microfloras of Jardine and Magloire. Sufficient differences indicate that the floras, separated by 20° of palaeolatitude, are not, however, identical. A tropical influence is further suggested by the presence of early Albian tricolpate angiosperms, which do not appear in temperate regions until the middle or late Albian. The dominance of ephedroid, cycadophyte, angiosperm, and *Classopollis* pollen, with rare pteridophyte and very rare bisaccate pollen implies hot semi-arid conditions. These features and the presence of certain exotic spores and pollen suggest affinity with the tropical Northern Gondwana Province of Brenner (in press), rather than the temperate Southern Gondwana Province, which is characterized by persistent bisaccate and minor ephedroid pollen, as seen at Site 361 by McLachlan and Pieterse (this volume). The Northern Gondwana Province of Brenner (in press) is essentially the same as the African-South American microfloral belt of

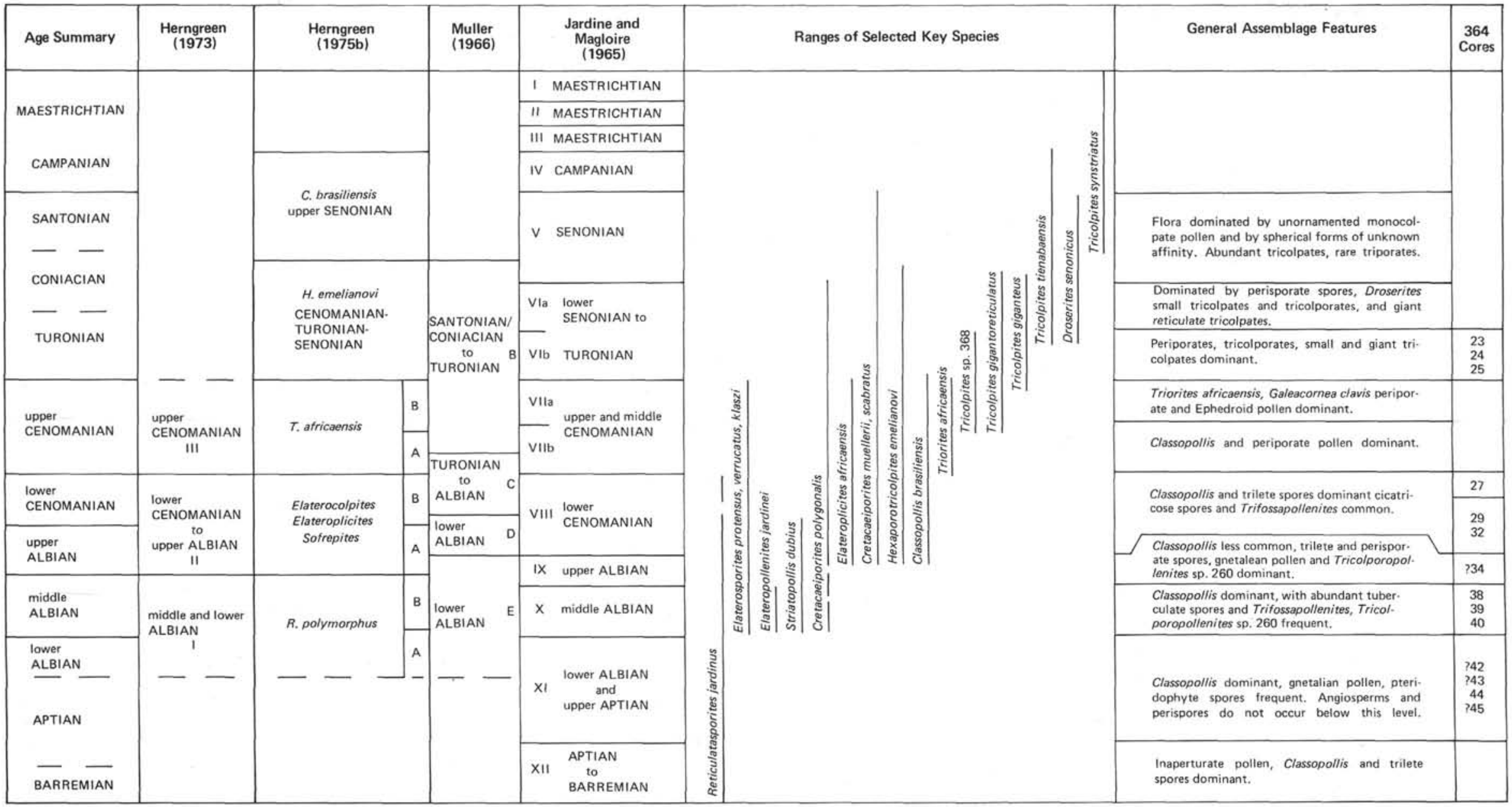

Figure 2. *Compilation of relevant biostratigraphic data.*

Herngreen (1975), which occupies a band of approximate 15° of latitude both sides of the paleo-equator. The virtual absence of the large and exotic spores and pollen common in deltas suggests the absence of these depositional features, or their distant presence.

The microplankton suggest restricted marine deposition with possible southern (Austral) influence. Low diversity of dinoflagellate assemblages (an average of 10 species), and frequent common acritarchs indicate a restricted marine influence. Of the dinoflagellates observed and previously described, all occur in sediments of similar age in Australia, although many occur worldwide. Tropical dinoflagellate assemblages in the Lower Cretaceous are poorly known, but none of the Aptian species described by Jain and Millepied from Senegal were observed. *Dioxya villosa*, in the Albian, and *Ascodinium acrophorum* reworked into the Turonian-Coniacian, are recorded here for the first time outside Australia, and may indicate a southern (Austral) influence.

TAXONOMIC LIST

The following list is a key to the taxonomy used. Reference to the original author is made to those forms adequately described in the literature. There are inconsistencies in the taxonomy of the spores and pollen at the generic level because of the use of the published informal names of Jardine and Magloire (1965). For future recognition, previously unrecorded species are informally designated, briefly described, and illustrated.

Spores

Biretisporites sp. small smooth-walled rounded triangular amb.
Cicatricosisporites australiensis Cookson, 1953
Cicatricosisporites pseudotripartitus (Bolkhovitina, 1961) Dettman, 1963 (pl. 1, fig. 1)
Cicatricosisporites sp. -3 (or rarely 4) distal muri, about 5 μm wide, with lumina 1 μm wide, in each series; strong membranous lips (3-4 μm high); contact area smooth.
Crybelosporites cf. *C. striatus* (Cookson and Dettman, 1958) Dettmann, 1963—this spore differs from *C. striatus* by being irregularly rugulate instead of being regularly reticulate.
Cyathidites sp. psilate forms with concave triangular amb.
Elaterosporites protensus (Stover) Jardine, 1967
Matonisporites sp. S.CI. 56 Jardine and Magloire, 1965.

Inaperturate Forms

Araucariacites australis Cookson, 1953.
Circulina? sp. S.CI. 303 Jardine and Magloire, 1965 (pl. 1, fig. 2, 3).
Classopollis maljawkineae Boltenhagen, 1973 (pl. 1, fig. 4).
Classopollis aff. *senegalensis* Reyre, et al., 1970, *in* Boltenhagen, 1973 (pl. 1, fig. 6, 7).
Classopollis klausi Boltenhagen, 1973 (pl. 1, fig. 8).
Classopollis perplexus Boltenhagen, 1973 (pl. 1, fig. 5).
Classopollis brasiliensis Herngreen, 1975—includes *Classopollis* sp. S.CI. 310 Jardine and Magloire, 1965 (pl. 1, fig. 9).
Cycadopites ovatus Rouse, 1959 (pl. 1, fig. 10).
Monosulcites sp. S.CI. 287 Jardine and Magloire, 1965 (pl. 1, fig. 13).
Tsugaepollenites dampieri (Balme) (pl. 1, fig. 12).
Tsugaepollenites trilobatus (Balme) (pl. 1, fig. 11).

Polyplicate Pollen

Elateroplicites africaensis Herngreen, 1973 (pl. 2, fig. 1, 2).
Ephedripites barghoornii/staplinii form-group (Pocock, 1964) (pl. 2, fig. 3).
Ephedripites jansonii (Pocock, 1964), Muller, 1968 (pl. 2, fig. 4).
Ephedripites sp. 1 Herngreen, 1973—larger than 50 μm, with many narrow ridges; similar to *Ephedripites* sp. S.CI. 284 Jardine and Magloire, 1965. (pl. 2, fig. 5, 8).
Ephedripites sp. 2 Herngreen, 1973—20-50 μm long with many narrow ridges (pl. 2, fig. 7, 9).
Ephedripites sp. 3 Herngreen, 1973—less than 20 μm long with many narrow ridges (pl. 3, fig. 2, 7).
Ephedripites sp. 4 Herngreen, 1973—larger than 50 μm with fewer broad ridges; very large specimens are similar to *Ephedripites* sp. S.CI. 391 Jardine and Magloire, 1965.
Ephedripites sp. 5 Herngreen, 1973—20-50 μm long with broad ridges (pl. 2, fig. 6).
Ephedripites sp. 6 Herngreen, 1973—smaller than 20 μm, with broad ridges.
Ephedripites sp. 7 Herngreen, 1973—larger than 50 μm with numerous ridges of narrow to moderate width; exine thick and solid at the poles; similar to specimen figured by Stover (1964, pl. 2, fig. 10).
Ephedripites sp. 8 Herngreen, 1973—larger than 50 μm; about six very broad spiral ridges.
Ephedripites sp. 10 Herngreen, 1973—20-50 μm long; about six or seven very broad weakly spiral ridges; similar to pl. 3 fig. 16, 17 of Jardine and Magloire (1965) as *Cicatricosisporites* S.CI. 164B.
Ephedripites sp. 11 Herngreen, 1973—larger than 50 μm, about 8-10 broad weakly spiral ridges which are separated except at the poles.
Gnetaceaepollenites diversus Stover, 1964 (pl. 3, fig. 1).
Steevesipollenites binodosus Stover, 1964 (pl. 3, fig. 3).
Steevesipollenites multilineatus Stover, 1964—over 50 μm long; (pl. 3, fig. 4) many (30-40) narrow ridges; distinctive polar "granular caps."
Ephedripites sp. A—less than 20 μm long; small solid thickening at poles; about 10 broad straight margined ridges with about 12 cross-striations on each ridge.
Ephedripites sp. B—20-50 μm long, with solid polar thickenings and with 8-10 broad wavy edged ridges (pl. 3, fig. 6, 8).
Ephedripites sp. C—20-50 μm long with 6-8 broad wavy edged spiral ridges (pl. 3, fig. 5).

Bisaccate Pollen

Alisporites grandis (Cookson, 1953) Dettman, 1963.
Alisporites similis (Balme, 1957) Dettman, 1963.
Podocarpidites ellipticus Cookson, 1947.

Tricolpate Pollen

Cupuliferoidaepollenites minutus (Brenner, 1963) Norris, 1967 (pl. 4, fig. 1).
Fraxinoipollenites venustus Singh, 1971 (pl. 4, fig. 2).
Psilatricolpites parvulus (Groot and Penny, 1960) Norris, 1967 (pl. 4, fig. 3-5).
Retitricolpites sp. A—prolate, equatorial diameter 26 μm; exine distinctly thickened at poles; fine 0.5 μm, even reticulation does not cover poles; colpi long (pl. 4, fig. 6).
Retitricolpites operculatus Herngreen (pl. 4, fig. 7).
Retitricolpites prosimilis Norris, 1967.
Retitricolpites virgeus (Groot, et al., 1961) Brenner, 1963 (pl. 4, fig. 8-10).
Retitricolpites vulgaris Pierce; 1961 (pl. 4, fig. 11-13).
Rousea georgensis (Brenner, 1963) Dettman, 1973.
Striatopollis sp. A—prolate, equatorial diameter 32 μm fine low surface muri in fine discontinuous striate and reticulate pattern; densely infrabaculate (pl. 4, fig. 14, 15).
Striatopollis dubius Jardine and Magloire 1965—here restricted to specimens illustrated in pl. 10 fig. 50-51 of Jardine and Magloire, showing equatorial, not longitudinal, striation at the equator. (pl. 5, fig. 1, 2).
Tricolpites giganteus Jardine and Magloire 1965.
Tricolpites gigantoreticulatus Jardine and Magloire 1965 (pl. 5, fig. 3).
Tricolpites microstriatus Jardine and Magloire 1965.
Tricolpites parvus Stanley 1965 (pl. 5, fig. 4, 5, 12).
Tricolpites sp. S.CI. 175 bis Jardine and Magloire 1965—subspherical, subcircular amb; equatorial diameter 35-40 microns; colpi long, exine thin, finely granulate and very finely infrabaculate; differs from *Tricolpites* sp. F by having a thinner wall and longer colpi. (pl. 5, fig. 8).
Tricolpites sp. S.CI. 260 Jardine and Magloire 1965 (pl. 5, fig. 10, 11).
Tricolpites sp. CI. 13 Jardine and Magloire 1965 (pl. 5, fig. 7).

Tricolpites sp. S.CI. 217 Jardine and Magloire 1965.

Tricolpites sp. cf. *T.* sp. S.CI. 326 Jardine and Magloire 1965—oblate, convex triangular amb; equatorial diameter 17 microns; colpi long, exine thin, covered with low verrucae 0.6-1.0 microns in diameter; differs from *T.* sp. 326 by having longer colpi, less pronounced ornament, and by being smaller. (pl. 5, fig. 6).

Tricolpites sp. S.CI. 326 Jardine and Magloire 1965—subspherical, equatorial diameter 28 microns; colpi short to moderate length; exine 1 micron thick, densely covered with verrucae 1 micron in diameter. (pl. 5, figs. 13, 14).

Tricolpites sp. C. —oblate triangular amb; equatorial diameter 17 μm; colpi extend three quarters of the way to the poles; exine 1.0 μm, with verrucae 0.5-1.0 μm in diameter; triangular amb, verrucate ornament, andlon colpiare diagnostic (pl. 6, fig. 3,4).

Tricolpites sp. B—oblate, rounded triangular to sub-circular amb; equatorial diameter 20 microns; exine thin, smooth, layering not observed; colpi extend almost to the poles, *Tricolpites* CI. 13 is similar, but the colpi do not extend as close to the poles; subcircular amb and very long colpi are diagnostic (pl. 6, fig. 7).

Tricolpites sp.C—oblate triangular amb; equatorial diameter 17 μm; colpi extend three quarters of the way to the poles; exine 1.0 μm thick, with verrucae 0.5-1.0 μm in diameter; triangular amb, verrucate ornament, and long colpi are diagnostic (pl. 6, fig. 8).

Tricolpites sp. D—subspherical to slightly prolate; equatorial diameter 25-30 μm; colpi long; exine reticulate with bimodal lumina (0.5-1.0 and 2.5 μm diameter), large lumina in interradial equatorial area; bimodal reticulum is diagnostic (pl. 6, fig. 3, 4).

Tricolpites sp. E—oblate, convexly triangular amb; equatorial diameter 2 μm; colpi short, exine finely granuloscabrate; convex triangular amb and short colpi are diagnostic (pl. 6, fig. 5, 6).

Tricolpites sp. F—oblate, convex triangular amb; equatorial diameter about 45 μm; colpi moderately long, exine 1.0-1.5 μm thick, faintly scabro-verrucate, and very finely infrabaculate; large size, tectate exine and moderate colpi are diagnostic; very similar to *Tricolpites* sp. 175 bis, from which it differs by having shorter colpi, and a thicker wall (pl. 6, fig. 10, 11).

Tricolpites sp. G—subspherical, equatorial diameter 26 μm; colpi long, exine 1.5-2.0 μm thick; densely foveolate very finely at poles grading to 0.5 μm in diameter at equator; long colpi and graded reticulum diagnostic (pl. 6, fig. 9).

Tricolpites sp. H—subspherical to slightly oblate, equatorial diameter 35-45 μm; colpi moderately long; exine about 1 μm thick; moderate to dense cover of low verrucae 1-2 μm in diameter; strongly and densely infrabaculate (baculae 0.3-0.5 μm in diameter); large size and "spotted" appearance diagnostic (pl. 7, fig. 1).

Tricolpites sp. I—oblate, subcircular amb; equatorial diameter 28-35 μm; colpi short; end-exine thin; ectexine has very dense pila 1.0-1.5 μm long forming distal fine reticulum, lumina irregular 0.5-1.0 μm in diameter; muri thin, supported by a single row of pila; large size, short colpi, and strong tegillum are diagnostic; *T. giganto-reticulatus* is larger, and has long colpi (pl. 7, fig. 2, 3).

Tricolpites sp. J—subspherical; equatorial diameter 45-48 μm; colpi long; exine about 2 μm thick, no layering visible, covered densely with low verrucae 2-3 μm in diameter; long colpi, large verrucae and nontegillate exine are diagnostic and distinguish it from *Tricolpites* sp. F (pl. 7, fig. 4).

Trifossapollenites ivoirensis Jardine and Magloire, 1965, S.CI 398 (pl. 7, fig. 9).

Monocolpate Pollen

Liliacidites crassatus Singh, 1971.

Liliacidites dividuus (Pierce, 1961), Brenner, 1963 (pl. 7, fig. 6).

Liliacidites inaequalis Singh, 1971 (pl. 7, fig. 8).

Liliacidites peroreticulatus (Brenner, 1963) Singh, 1971.

Liliacidites reticulatus (Brenner, 1963) Singh, 1971.

Liliacidites textus Norris, 1967 (pl. 7, fig. 7).

Retimonocolpites sp. Herngreen, 1973—differs from *L. dividuus* by having a much finer reticulum, and much shorter pila, so as to appear almost single layered.

Porate Pollen

Cretacaeiporites muellerii Herngreen, 1973 (pl. 8, fig. 4).

Cretacaeiporites polygonalis (Jardine and Magloire, 1965) Herngreen, 1973 (pl. 8, fig. 3).

Cretacaeiporites scabratus Herngreen, 1973—the criteria suggested by Boltenhagen (1975) to distinguish *C. scabratus* have not proved workable, so all specimens of this type have been assigned to *C. scabratus* (pl. 8, fig. 1, 2, 6).

Triorites sp. A—oblate subcircular to convexly triangular amb; equatorial diameter 16 μm; exine 1 μm thick, very finely reticulate (pl. 8, fig. 5).

Complex Aperturate Pollen

Hexaporotricolpites coronatus Jardine, 1972 (pl. 8, fig. 9).

Hexaporotricolpites emelianovi Boltenhagen, 1967 (pl. 8, fig. 7, 8).

Hexaporotricolpites potoniei Boltenhagen, 1969 (pl. 9, fig. 1).

Syncolporites form B S.CI. 146 Jardine and Magloire, 1965 (pl. 9, fig. 2, 3).

Syndemicolpites sp. A—oblate; amb rounded isosceles triangular with straight to slightly concave sides; short equatorial diameter about 27 μm, long diameter about 33 μm; three radial colpi extend from close to pole to close to equator on both sides of grain; exine 1.5-2 μm thick, thickest at radial extremities, finely scabrate; tyecies *Syndemicolpites typicus* Van Hoeken—Klinkenberg, 1962, from the Nigerian Maestrichtian is reticulate (pl. 9, fig. 4, 5).

Tricolporopolleites sp. S.CI. 260 Jardine and Magloire, 1965, slightly oblate, 22 μm equatorial diameter, distinctly tricolporate; endexine 1-2 μm thick, homogeneous; extexine 0.5-1 μm thick, foveoreticulate, very fine at colpal margin and poles, coarse and irregular (lumina about 2 μm across) elsewhere; may occur in tetrads.

Tricolporopollenites sp. CI. 100 Jardine and Maglore, 1965.

Incertae Sedis

Incertae Sedis sp. A—Inaperturate sphere about 30 μm in diameter with a sparse and patchy cover of short gemmae about 1μm long. This taxon may be an inaperturate pollen (pl. 9, fig. 8).

Reticulatasporites jardinus Brenner, 1968 (pl. 9, fig. 9).

Dinoflagellates

All dinoflaggellate references not to be found in the bibliography are available in Lentin and Williams (1973).

Achomosphaera sagena Davey and Williams, 1966a.

Aptea polymorpha Eisenack, 1958.

Apteodinium conjunctum Eisenack and Cookson, 1960.

Ascodinium acrophorum Cookson and Eisenack, 1960; specimens from the Angola Basin differ from Australian *Ascodinium* specimens by being more elongate, with the wall layers closer together at the cingulum (pl. 10, fig. 1, 2).

Ascolinium cf. *A. serratum* Cookson and Eisenack, 1960—specimens are not as strongly serrated on the antapex as the holotype of *A. serratum*.

Coronifera oceanica Cookson and Eisenack, 1958.

Cribroperidinium edwardsii (Cookson and Eisenack, 1958) Davey, 1969a.

Cyclonephelium distinctum Deflandre and Cookson, 1955 (pl. 10, fig. 3).

Deflandrea acuminata Cookson and Eisenack, 1958 (pl. 10, fig. 4).

Diconodinium arcticum Manum and Cookson, 1964—all speciments of *Diconodium* with sparse granulation are included in this species.

Dinogymnium acuminatum Evitt et al., 1967 (pl 10, fig. 7, 8).

Dinogymium euclaensis Cookson and Eisenack, 1970 (pl. 10, fig. 5, 6).

Dinopterygium cladoides Deflandre, 1935.

Dioxya villosa Eisenack and Cookson, 1960 (pl. 11, fig. 1).

Exochosphaeridium phragmites Davey et al. (1966).

Florentinia deanei (Davey and Williams, 1966) Davey and Verdier, 1973.

Gonyaulacysta cassidata (Eisenack and Cookson, 1960) Sarjeant, 1966.

Gonyaulacysta helicoidea (Eisenack and Cookson, 1960) Sarjeant, 1966.

Hexagonifera chlamydata Cookson and Eisenack, 1962.

Hystrichodinium pulchrum Deflandre, 1935.

Hystrichosphaeridium arundum Eisenack and Cookson, 1960 (pl. 11, fig. 2).

Leptodinium sp. A—cysts (65-75 μm long and 60-65 μm broad; sutural crests 4-5 μm high, fibrous and highly perforate, lumina up to 3-4 μm in diameter, distal extremity of crests bear numerous short spines 1-2 μm long along their length; endophragm finely and evenly granular, or finely reticulate; precingular archeopyle (pl. 11, fig. 3,4).

Leptodinium spp.—simple smooth-walled forms with simple psilate sutural crests (pl. 11, fig. 5).

Litosphaeridium conispinum Davey and Verdier, 1973 (pl. 11, fig. 6).

Litosphaeridium siphoniphorum (Cookson and Eisenack, 1958) Davey and Williams, 1966 (pl. 11, fig. 7).

Odontochitina operculata (O. Wetzel, 1933) Deflandre and Cookson, 1955.

Oligosphaeridium complex (White, 1842) Davey and Williams, 1966 (pl. 12, fig. 1).

Palaeohystrichophora infusiorioides Deflandre, 1935 (pl. 12, fig. 2).
Psaligonyaulax deflandrei Sarjeant, 1966.
Spiniferites ramosus (Ehrenberg, 1838) Loeblich and Loeblich, 1966.
Spiniferites sp.—cysts about 70 × 62 μm, exclusive of ornament; low sutural crests about 1 μm high bear numerous hollow 5-6 μm long bifurcation spines; after 3-4 μm, a second bifurcation occurs, the final elements being 1-2 μm long; spines gonal and scattered along suture; 15-20 spines outline each reflected plate area; both wall layers smooth; precingular archeopyle (pl. 12, fig. 3).
Subtilisphaera cf. *S. perlucida* (Alberti, 1959) Jain and Millepied, 1973—specimens differ from *S. perlucida* by having a fine even cover of granules or short spines to 0.5 μm long; suggestion on some specimens of a archeopyle involving loss of plate 2a and detachment of plate 3 everywhere except along the cingulum, present on some specimens (pl. 12, fig. 4, 5).
Tanyosphaeridium variecalamum Davey and Williams, 1966b.
Trichodinium intermedium Eisenack and Cookson, 1960.

Acritarchs

Crassosphaera concinna Cookson and Manum, 1960 (pl. 12, fig. 10).
Cymatiosphaera spp.—various simple species.
Cymatiosphaera sp. A—small spherical form about 16 μm in diameter exclusive of ledges; ledges 2-3 μm high, smooth, outlining 15-20 pentagonal or hexagonal fields 6-7 μm in diameter; at three point junctions, a central hollow tube 0.5 μm exists, giving a characteristic pattern (pl. 12, fig. 9).
Micrhystridium spp.—various simple forms (pl. 12, fig. 7, 8).
Pterospermella australensis (Deflandre and Cookson, 1955) Cookson and Eisenack, 1974.
Pterospermella spp. various simple forms (pl. 12, fig. 6).
Veryhachium spp. various simple forms.

CONCLUSIONS

Site 364, in the south eastern Angola Basin, bottomed in early Albian sediments representing a cyclicly restricted basin with minor marine influence. The basin was bounded to the east and north by Africa, to the west by South America, and to the south by the Walvis Ridge. Marine influence, apparently over the Walvis Ridge was cyclic but very slight in the early Albian. The middle and late Albian were times of more open marine circulation, but the basin again became cyclicly restricted in the late Albian and probably the Cenomanian. Deposition was probably continuous through the Cenomanian and Turonian, but most of this interval is now absent from Site 364. Possibly, Cenomanian and Turonian sediments were eroded during the period of changing currents accompanying the Turonian separation to the north of Africa and South America. By the late Turonian or Coniacian, sedimentation resumed at Site 364 in the still restricted basin, with contemporaneous erosion of Cenomanian and Turonian rocks in the area, resulting in significant reworking into Site 364. The lithological expression of this hiatus has not yet been recognized in the consecutive Cores 25, 26, and 27. Within the Senonian, Site 364 became progressively more open marine as part of the deep sea basin of the present South Atlantic Ocean.

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APPENDIX
Key to Illustrated Specimens

Plate	Figure	Palyn. No.	M.M.M.C. No.	Co-ordinates
1	1	2538/b	2049	105/0923
1	2	2538/a	2048	188/0950
1	3	2511/a	2039	062/0970
1	4	2538/a	2048	040/0948
1	5	2511/a	2039	080/0928
1	6	2538/a	2048	078/1080
1	7	2511/a	2039	180/1065
1	8	2538/a	2048	042/0885
1	9	2538/a	2048	023/0918
1	10	2535/a	2047	050/1125
1	11	2511/a	2039	205/0974
1	12	2532/c	2045	063/1051
1	13	2509/a	2036	022/1060
2	1	2511/b	2040	030/1080
2	2	2511/a	2039	152/0993
2	3	2532/a	2043	123/0936
2	4	2532/a	2043	052/1068
2	5	2511/a	2039	058/1128
2	6	2509/a	2036	045/0952
2	7	2511/a	2039	200/0883
2	8	2538/a	2048	060/0880
2	9	2510/a	2037	152/0820
3	1	2534/a	2046	205/0910
3	2	2535/a	2047	105/0970
3	3	2511/a	2039	082/1090
3	4	2532/a	2043	123/0851
3	5	2539/a	2050	105/1008
3	6	2539/a	2050	087/1014
3	7	2511/a	2039	206/0938
3	8	2539/a	2050	038/1053
4	1	2511/a	2039	092/0910
4	2	2539/a	2050	202/1120
4	3	2511/a	2039	104/1050
4	4	2511/a	2039	158/0962
4	5	2538/b	2049	230/1122
4	6	2532/c	2045	063/1145
4	7	2538/a	2048	153/0862
4	8	2539/a	2050	160/1175
4	9	2532/a	2043	092/1038
4	10	2530/a	2042	170/1230
4	11	2534/a	2046	025/0998
4	12	2511/a	2039	142/1152
4	13	2534/a	2046	025/0998
4	14	2532/c	2045	040/0970
4	15	2532/c	2045	100/0855
5	1	2511/a	2039	202/1052
5	2	2511/a	2039	113/0885
5	3	2532/c	2045	188/0904
5	4	2538/b	2049	153/0903
5	5	2532/a	2043	183/0967
5	6	2511/b	2040	155/1188
5	7	2538/a	2048	062/0835
5	8	2538/a	2048	180/0890
5	9	2509/a	2036	157/0890
5	10	2509/a	2036	108/0982
5	11	2535/a	2047	197/1222
5	12	2509/a	2036	176/1100
5	13	2538/a	2048	122/1055
5	14	2538/a	2048	020/0762
6	1	2535/a	2047	184/1060
6	2	2509/a	2036	050/1180

Plate	Figure	Palyn. No.	M.M.M.C. No.	Co-ordinates
6	3	2511/a	2039	099/0930
6	4	2511/a	2039	060/1146
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6	6	2538/b	2049	138/1008
6	7	2511/a	2039	078/0854
6	8	2511/b	2040	113/1120
6	9	2538/a	2048	163/0970
6	10	2539/a	2050	177/1073
6	11	2510/b	2038	148/0902
7	1	2539/a	2050	032/1162
7	2	2539/a	2050	218/1048
7	3	2539/a	2050	090/1162
7	4	2539/a	2050	220/0892
7	5	2511/a	2039	138/1128
7	6	2509/a	2036	202/1138
7	7	2511/a	2039	156/0980
7	8	2509/a	2036	030/1208
7	9	2535/a	2047	070/1146
8	1	2538/b	2049	051/0990
8	2	2539/a	2050	032/0946
8	3	2539/a	2050	215/0881
8	4	2538/b	2049	192/1018
8	5	2538/a	2048	070/0825
8	6	2539/a	2050	227/0982
8	7	2538/a	2048	158/0930
8	8	2511/a	2039	120/0910
8	9	2538/b	2049	035/1016
9	1	2538/b	2049	102/0978
9	2	2538/b	2049	218/1085
9	3	2538/a	2048	195/0922
9	4	2530/a	2042	022/1030
9	5	2539/a	2050	130/1156
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10	7	2539/a	2050	013/0970
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11	3	2532/a	2043	043/1040
11	4	2532/c	2045	032/1040
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12	2	2538/b	2049	184/1104
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12	8	2538/a	2048	028/0920
12	9	2510/a	2037	196/1040
12	10	2510/a	2037	012/0850

PLATE 1
All ×1000 unless otherwise indicated

Figure 1a, b	*Cicatricosisporites pseudotripartitus*, ×400. Sample 24-2, 138-140 cm.
Figure 2	*Circulina*? sp. S.CI. 303. Sample 24-2, 138-140 cm.
Figure 3	*Circulina*? sp. S.CI. 303. Sample 29-2, 43-44 cm.
Figure 4	*Classopollis maljawkineae*. Sample 24-2, 138-140 cm.
Figure 5	*Classopollis perplexus*. Sample 29-2, 43-44 cm.
Figure 6	*Classopollis* aff. *C. senegalensis*. Sample 24-2, 138-140 cm.
Figure 7	*Classopollis* aff. *C. senegalensis*. Sample 29-2, 43-44 cm.
Figure 8	*Classopollis klausi*. Sample 24-2, 138-140 cm.
Figure 9a, b	*Classopollis jardinei*. Sample 24-2, 138-140 cm.
Figure 10	*Cycadopites ovatus*. Samples 40-4, 35-37 cm.
Figure 11	*Tsugaepollenites trilobatus*. Sample 29-2, 43-44 cm.
Figure 12	*Tsugaepollenites dampieri*, ×400. Sample 44-4, 36-38 cm.
Figure 13	*Monosulcites* sp. S.CI. 287. Sample 40-5, 51-53 cm.

PLATE 1

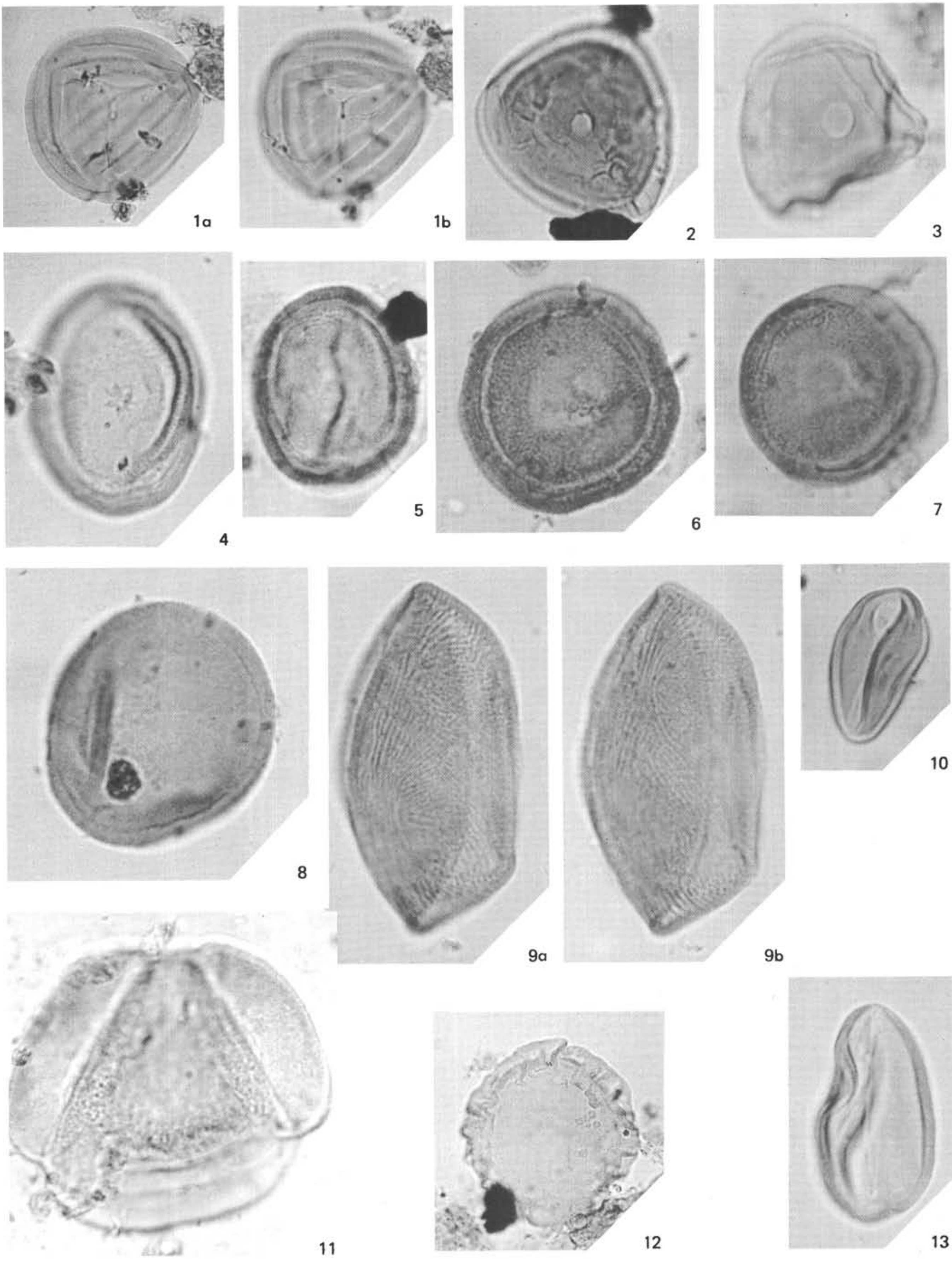


PLATE 2

All ×1000 unless otherwise indicated

Figure 1a, b	*Elateroplicites africaensis*. Sample 29-2, 43-44 cm.
Figure 2a, b	*Elateroplicites africaensis*. Sample 29-2, 43-44 cm.
Figure 3a, b	*Ephedripites barghoornii/staplinii*. Sample 44-4, 36-38 cm.
Figure 4a, b	*Ephedripites jansonii*. Sample 44-4, 36-38 cm.
Figure 5	*Ephedripites* sp. 1. Sample 29-2, 43-44 cm.
Figure 6	*Ephedripites* sp. 5. Sample 40-5, 51-53 cm.
Figure 7	*Ephedripites* sp. 2. Sample 29-2, 43-44 cm.
Figure 8a, b	*Ephedripites* sp. 1. Sample 24-2, 138-140 cm.
Figure 9a-c	*Ephedripites* sp. 2. Sample 25-3, 67-69 cm.

PLATE 2

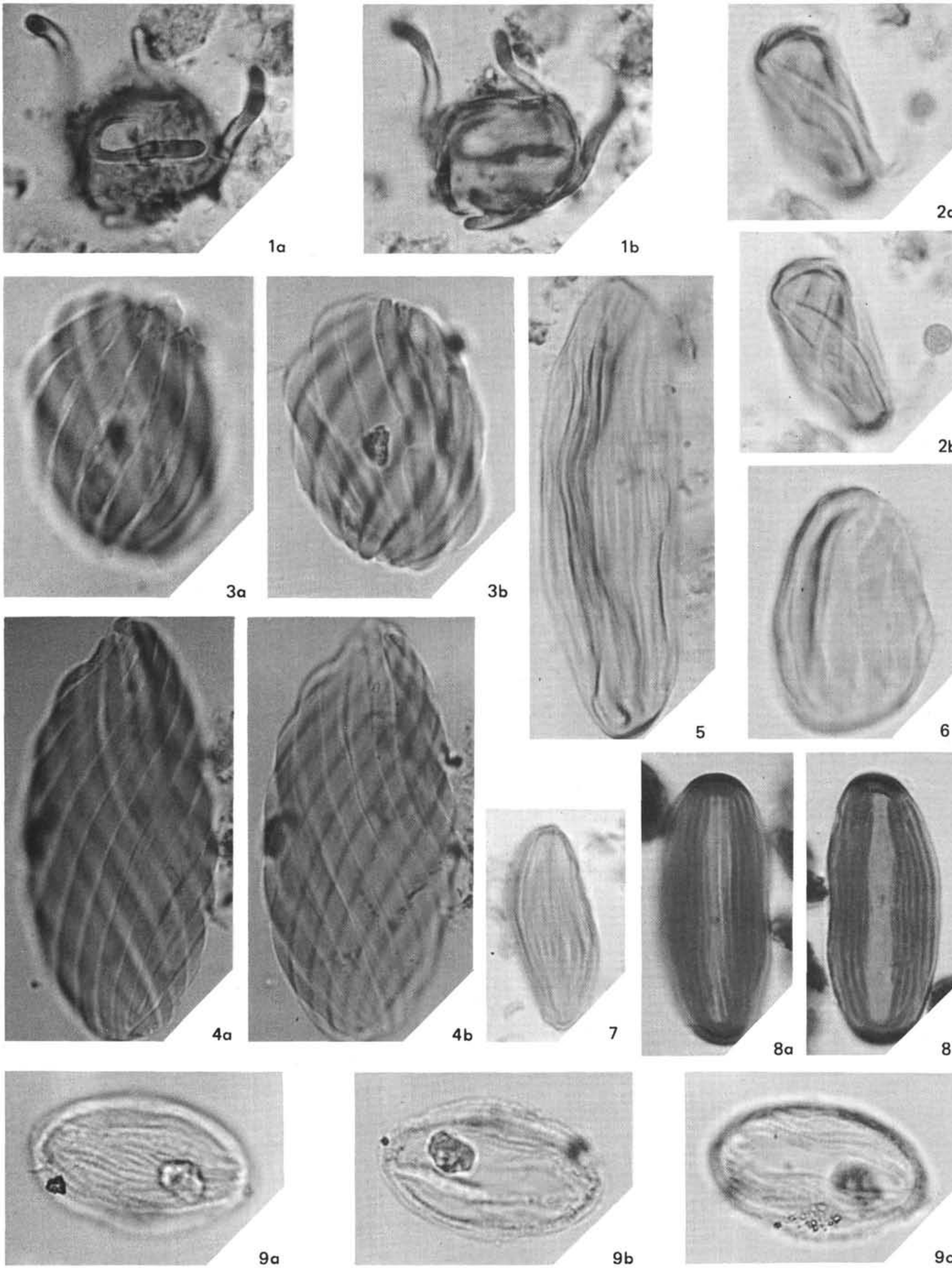


PLATE 3
All $\times 1000$ unless otherwise indicated

Figure 1a, b	*Gnetaceaepollenites diversus*. Sample 39-1, 129-130 cm.
Figure 2a, b	*Ephedripites* sp. 3. Sample 40-4, 35-37 cm.
Figure 3a-c	*Steevesipollenites binodosus*. Sample 29-2, 43-44 cm.
Figure 4	*Steevesipollenites multilineatus*. Sample 44-4, 36-38 cm.
Figure 5a, b	*Ephedripites* sp. C. Sample 23-4, 123-125 cm.
Figure 6a, b	*Ephedripites* sp. B. Sample 23-4, 123-125 cm.
Figure 7a-c	*Ephedripites* sp. 3. Sample 29-2, 43-44 cm.
Figure 8a, b	*Ephedripites* sp B. Sample 23-4, 123-125 cm.

PLATE 3

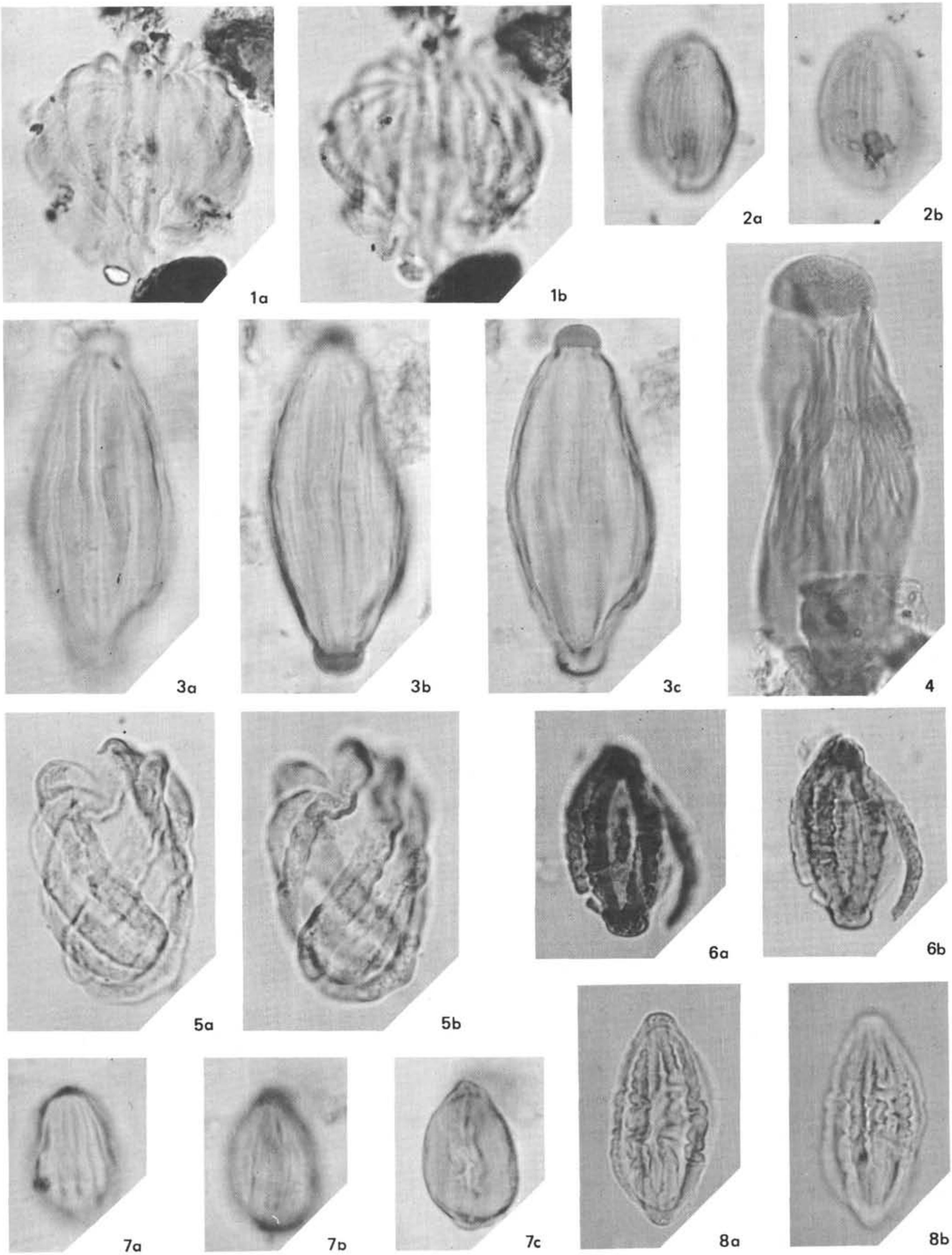
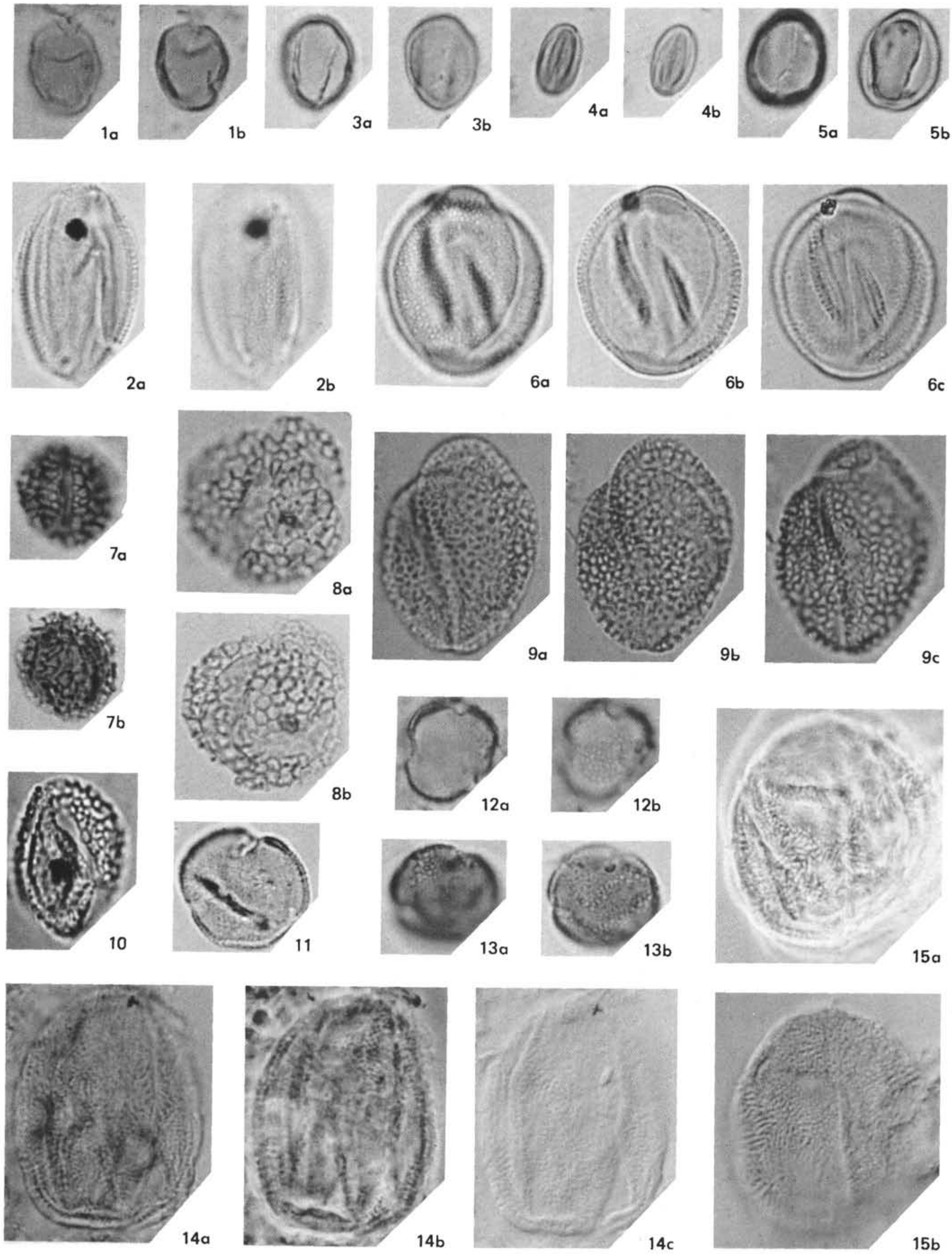


PLATE 4

All ×1000 unless otherwise indicated

Figure 1a, b	*Cupuliferoidaepollenites minutus*. Sample 29-2, 43-44 cm.
Figure 2a, b	*Fraxinoipollenites venustus*. Sample 23-4, 123-125 cm.
Figure 3a, b	*Psilatricolpites parvulus*. Sample 29-2, 43-44 cm.
Figure 4a, b	*Psilatricolpites parvulus*. Sample 29-2, 43-44 cm.
Figure 5a, b	*Psilatricolpites parvulus*. Sample 24-2, 138-140 cm.
Figure 6a-c	*Retitricolpites* sp. A. Sample 44-4, 36-38 cm.
Figure 7a, b	*Retitricolpites operculatus*. Sample 24-2, 138-140 cm.
Figure 8a, b	*Retitricolpites virgeus*. Sample 23-4, 123-125 cm.
Figure 9a-c	*Retitricolpites virgeus*. Sample 44-4, 36-38 cm.
Figure 10	*Retitricolpites virgeus*. Sample 23-3, 128-130 cm.
Figure 11	*Retitricolpites vulgaris*. Sample 39-1, 129-130 cm.
Figure 12a, b	*Retitricolpites vulgaris*. Sample 29-2, 43-44 cm.
Figure 13a, b.	*Retitricolpites vulgaris*. Sample 39-1, 129-130 cm.
Figure 14a-c	*Striatopollis* sp. A. Sample 44-4, 36-38 cm.
Figure 15a, b	*Striatopollis* sp. A. Sample 44-4, 36-38 cm.

PLATE 4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8b
12a
12b
15a
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11
13a
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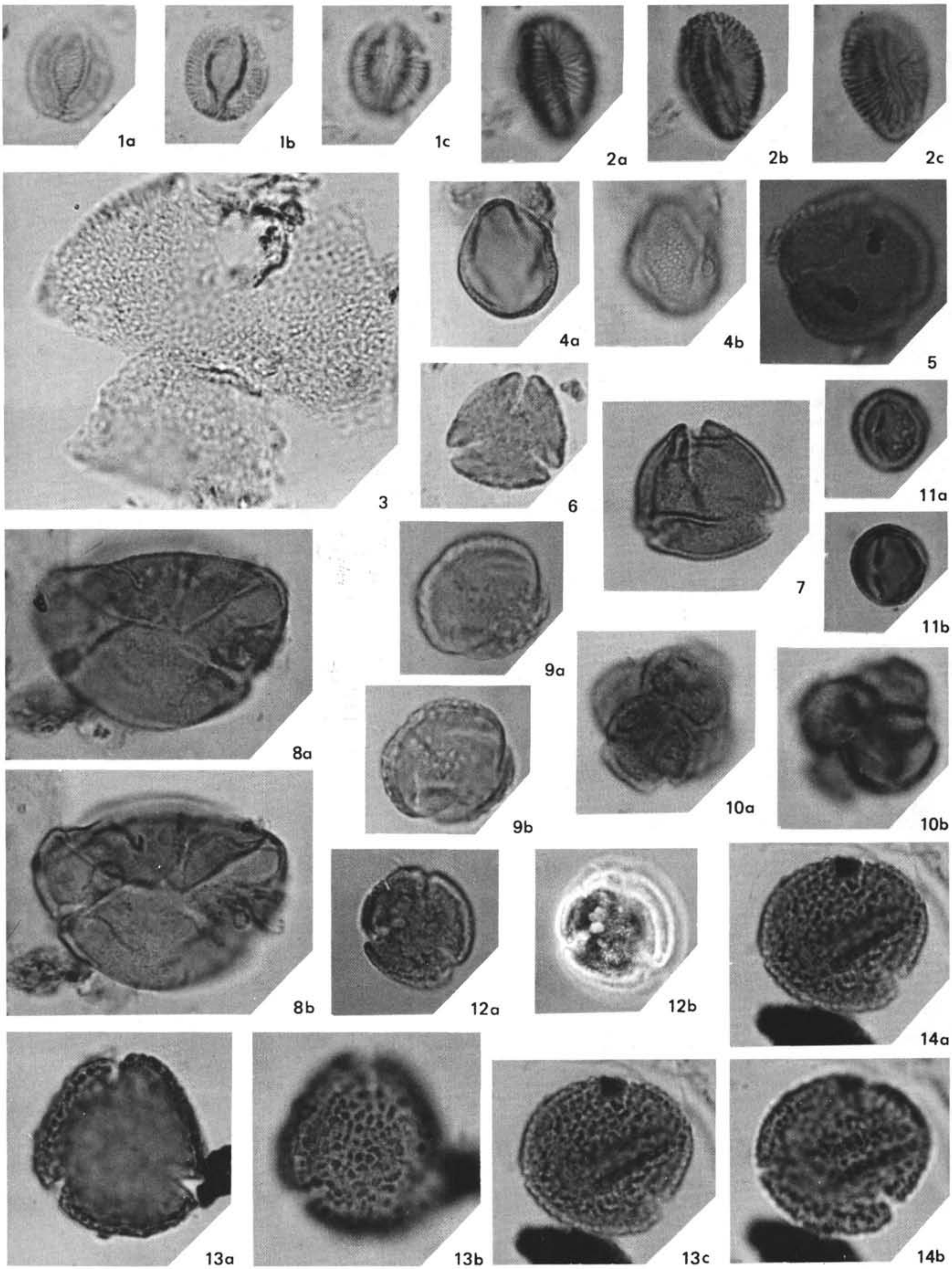
14a
14b
14c
15b

PLATE 5
All ×1000 unless otherwise indicated

Figure 1a-c	*Striatopollis dubius*. Sample 29-1, 43-44 cm.
Figure 2a-c	*Striatopollis dubius*. Sample 29-2, 43-44 cm.
Figure 3	*Tricolpites gigantoreticulatus*. Sample 44-4, 36-38 cm.
Figure 4	*Tricolpites parvus*. Sample 24-2, 138-140 cm.
Figure 5	*Tricolpites parvus*. Sample 44-4, 36-38 cm.
Figure 6	*Tricolpites* sp. cf. *T*. 326. Sample 29-2, 43-44 cm.
Figure 7	*Tricolpites* sp. CI. 13. Sample 24-2, 138-140 cm.
Figure 8a, b	*Tricolpites* sp. S. CI. 175 bis. Sample 24-2, 138-140 cm.
Figure 9a, b	*Tricolpites* sp. cf. *T*. 260. Sample 40-5, 51-53 cm.
Figure 10a, b	Tetrad of *Tricolpites* sp. S. CI. 260. Sample 40-5, 51-53 cm.
Figure 11a, b	*Tricolpites* sp. S. CI. 260 with suggestion of tricolporate structure. Sample 40-4, 35-37 cm.
Figure 12a, b	*Tricolpites parvus*. Sample 40-5, 51-53 cm.
Figure 13a-c	*Tricolpites* sp. S. CI. 326. Sample 24-2, 135-140 cm.
Figure 14a, b	*Tricolpites* sp. S. CI. 326. Sample 24-2, 138-140 cm.

PLATE 5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9b
10a
10b
8b
12a
12b
14a
13a
13b
13c
14b

PLATE 6
All ×1000 unless otherwise indicated

Figure 1a, b	*Tricolpites* sp. A. Sample 40-4, 35-37 cm.
Figure 2a, b	*Tricolpites* sp. A. Sample 40-5, 51-53 cm.
Figure 3	*Tricolpites* sp. D. Sample 29-2, 43-44 cm.
Figure 4a-d	*Tricolpites* sp. D. Sample 29-2, 43-44 cm.
Figure 5a-c	*Tricolpites* sp. E. Sample 24-2, 138-140 cm.
Figure 6	*Tricolpites* sp. E. Sample 24-2, 138-140 cm.
Figure 7	*Tricolpites* sp. B. Sample 29-2, 43-44 cm.
Figure 8a, b	*Tricolpites* sp. C. Sample 29-2, 43-44 cm.
Figure 9a, b	*Tricolpites* sp. G. Sample 24-2, 138-140 cm.
Figure 10	*Tricolpites* sp. F. Sample 23-4, 123-125 cm.
Figure 11a, b	*Tricolpites* sp. F. Sample 25-3, 67-69 cm.

PLATE 6

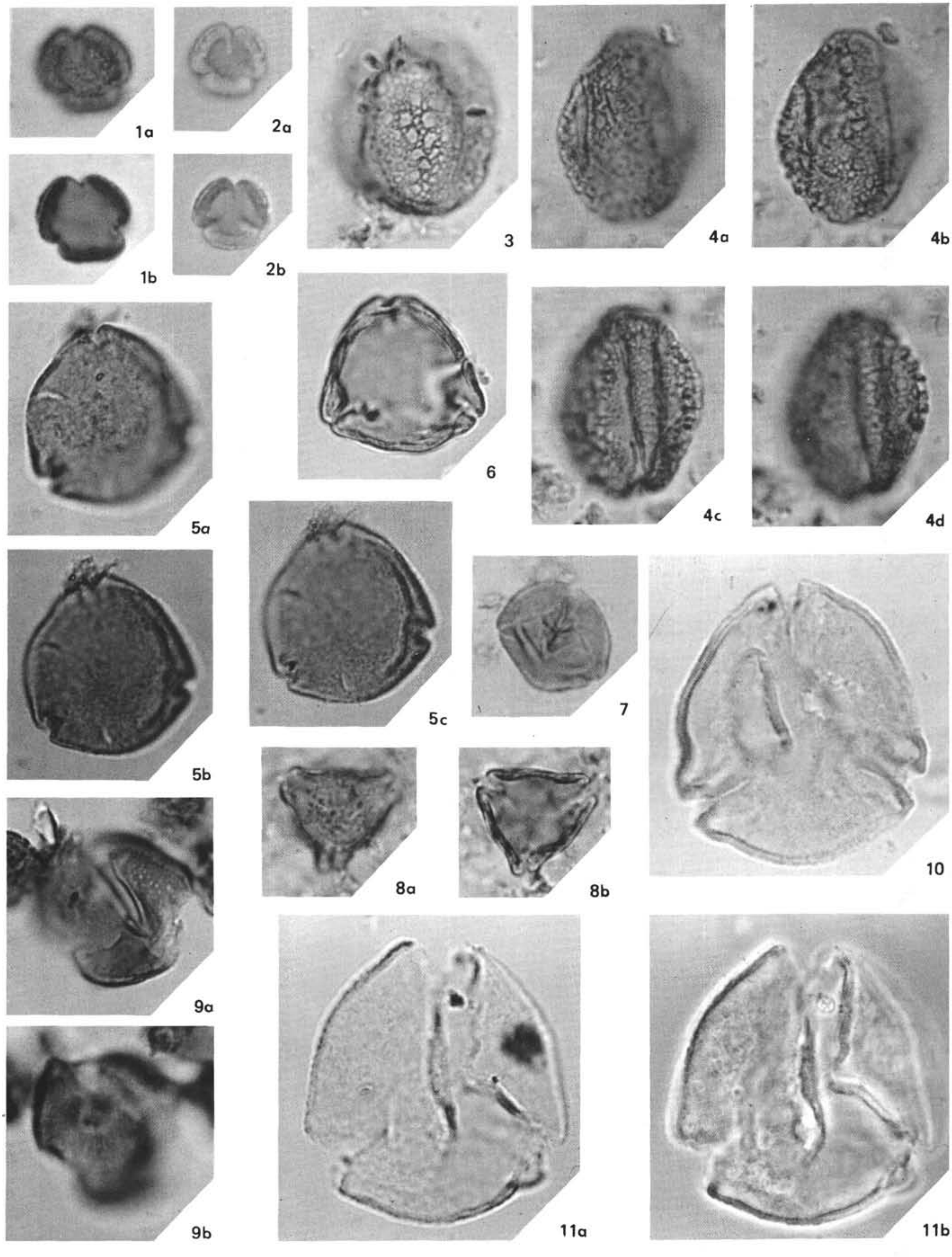

PLATE 7
All ×1000 unless otherwise indicated

Figure 1a, b	*Tricolpites* sp. H. Sample 23-4, 123-125 cm.
Figure 2a-c	*Tricolpites* sp. I. Sample 23-4, 123-125 cm.
Figure 3	*Tricolpites* sp. I. Sample 23-4, 123-125 cm.
Figure 4a, b	*Tricolpites* sp. J. Sample 23-4, 123-125 cm.
Figure 5a-c	*Liliacidites* sp. Sample 29-2, 43-44 cm.
Figure 6	*Liliacidites dividuus*. Sample 40-5, 51-53 cm.
Figure 7a, b	*Liliacidites textus*. Sample 29-3, 43-44 cm.
Figure 8a, b	*Liliacidites inaequalis*. Sample 40-5, 51-53 cm.
Figure 9a, b	*Trifossapollenites ivoirensis*. Sample 40-4, 35-37 cm.

PLATE 7

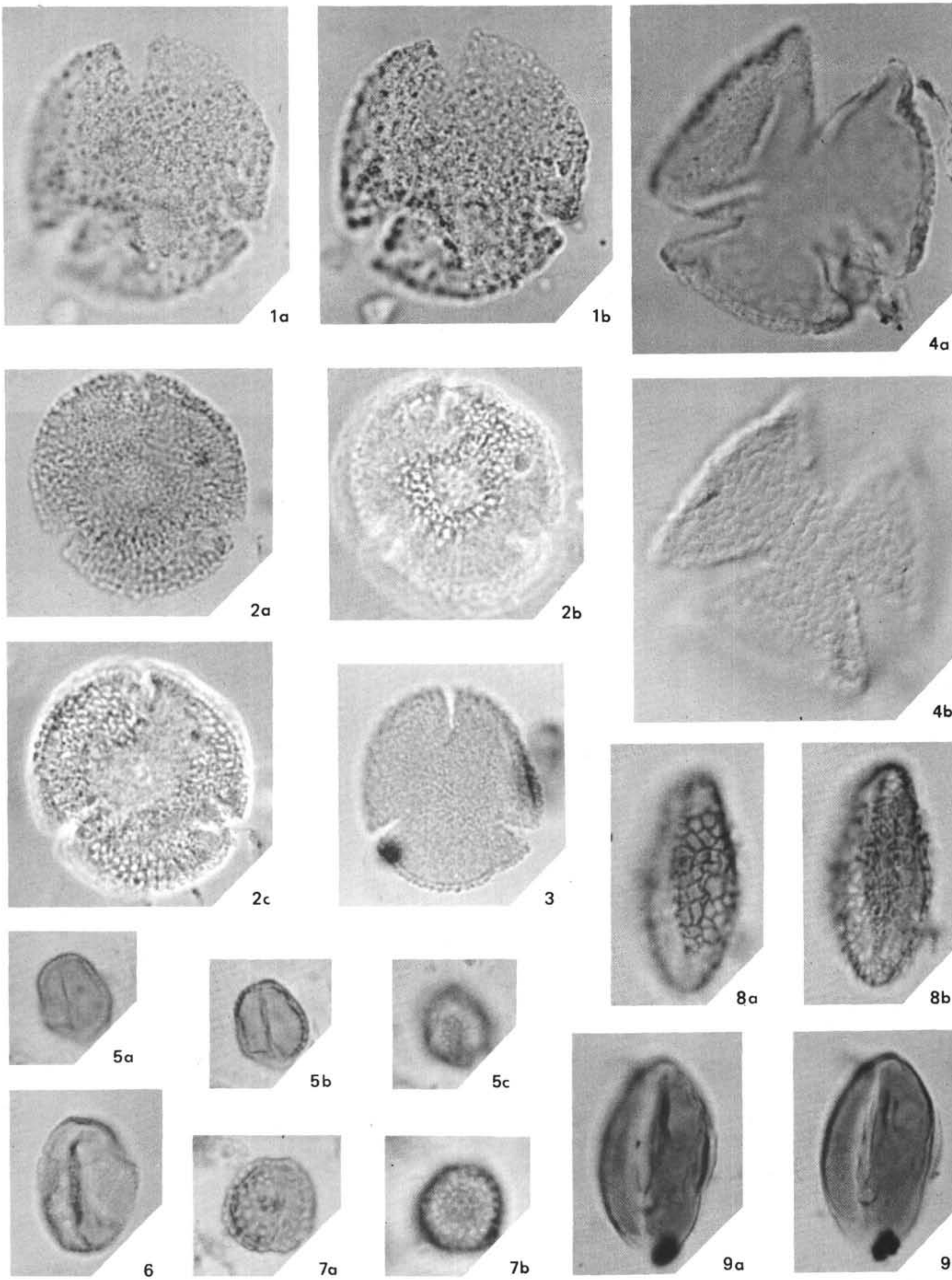

PLATE 8
All ×1000 unless otherwise indicated

Figure 1	*Cretacaeiporites scabratus*. Sample 24-2, 138-140 cm.
Figure 2a, b	*Cretacaeiporites* aff. *scabratus*. Sample 23-4, 123-125 cm.
Figure 3a, b	*Cretacaeiporites polygonalis*. Sample 23-4, 123-125 cm.
Figure 4	*Cretacaeiporites mulleri*. Sample 24-2, 138-140 cm.
Figure 5a-c	*Triorites* sp. A. Sample 24-2, 138-140 cm.
Figure 6a, b	*Cretacaeiporites* aff. *scabratus*. Sample 23-4, 123-125 cm.
Figure 7a, b	*Hexaporotricolpites emelianovi*. Sample 24-2, 138-140 cm.
Figure 8a, b	*Hexaporotricolpites emelianovi*. Sample 29-2, 43-44 cm.
Figure 9a, b	*Hexaporotricolpites coronatus*. Sample 24-2, 138-140 cm.

PLATE 8

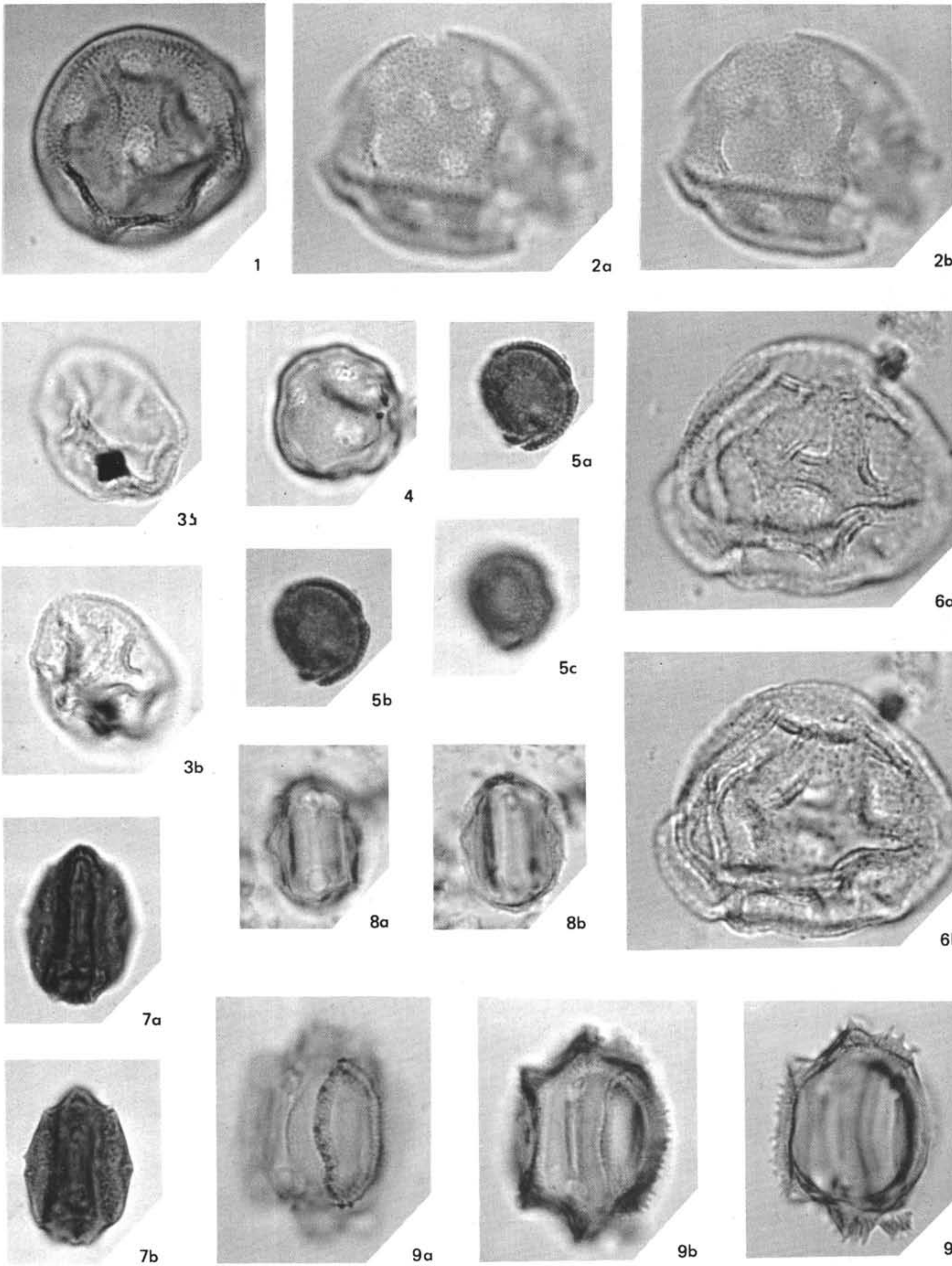

PLATE 9
All ×1000 unless otherwise indicated

Figure 1a-c	*Hexaporotricolpites potoniei*. Sample 24-2, 138-140 cm.
Figure 2a, b	*Syncolporites* form B S.CI. 146. Sample 24-2, 138-140 cm.
Figure 3a, b	*Syncolporites* form B S.CI. 146. Sample 24-2, 138-140 cm.
Figure 4a, b	*Syndemicolpites* sp. A. Sample 23-3, 128-130 cm.
Figure 5	*Syndemicolpites* sp. A. Sample 23-4, 123-125 cm.
Figure 6	*Bulbopollis* sp. Sample 23-4, 123-125 cm.
Figure 7	Fungal Spore. Sample 44-4, 36-38 cm
Figure 8	Incertae Sedis sp. A. Sample 29-2, 43-44 cm.
Figure 9a, b	*Reticulatasporites jardinus*. Sample 44-4, 36-38 cm.

PLATE 9

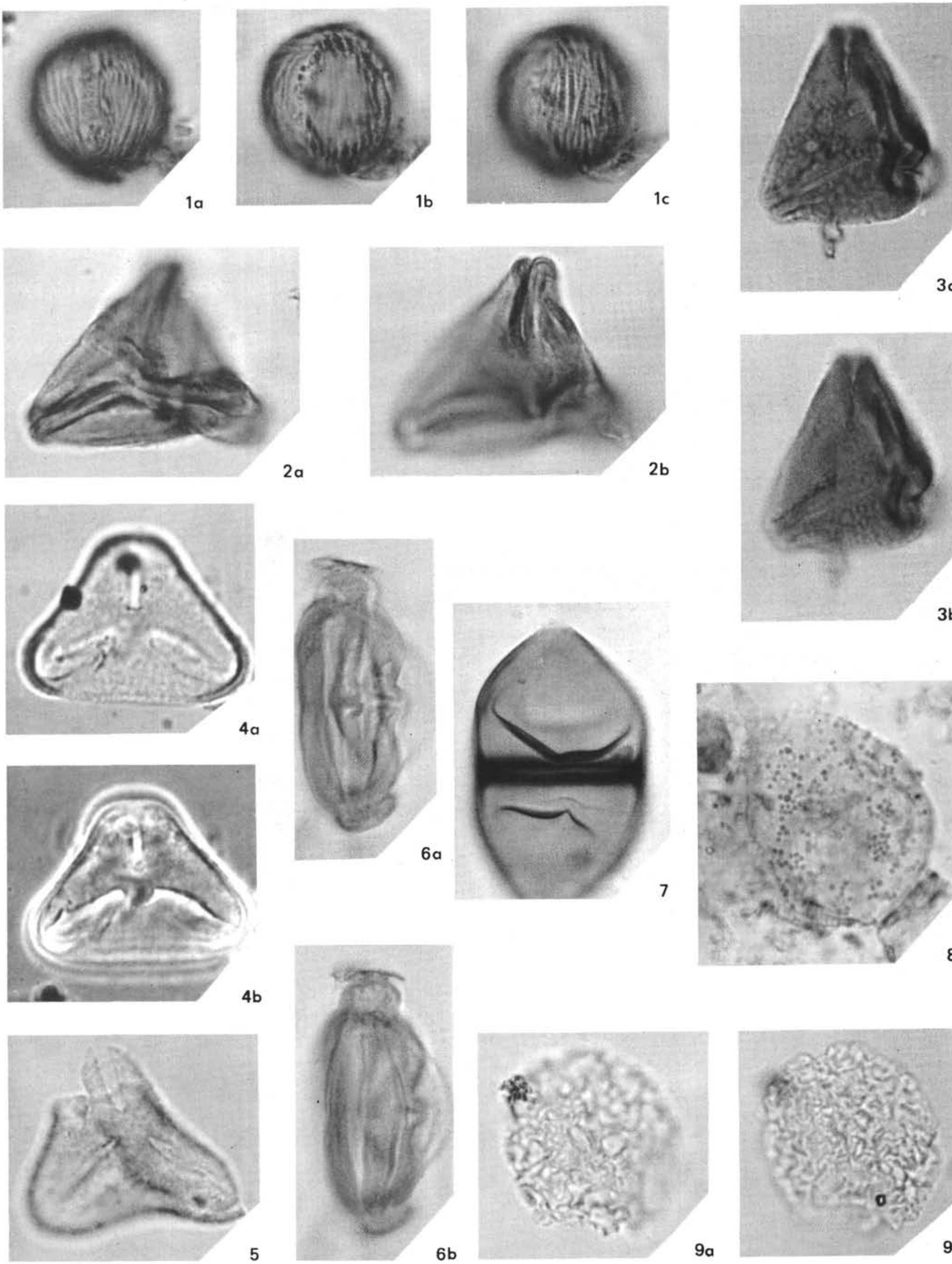

PLATE 10
All ×1000 unless otherwise indicated

Figure 1a, b	*Ascodinium acrophorum.* Sample 25-3, 67-69 cm.
Figure 2	*Ascodinium acrophorum.* Sample 25-3, 67-69 cm.
Figure 3	*Cyclonephelium distinctum.* Sample 24-2, 138-140 cm.
Figure 4a, b	*Deflandrea acuminatum.* Sample 23-4, 123-125 cm.
Figure 5	*Dinogymnium euclaensis.* Sample 23-3, 128-130 cm.
Figure 6a, b	*Dinogymnium euclaensis.* Sample 23-4, 123-125 cm.
Figure 7a, b	*Dinogymnium acuminatum.* Sample 23-4, 123-125 cm.
Figure 8a, b	*Dinogymnium acuminatum.* Sample 23-4, 123-125 cm.

PLATE 10

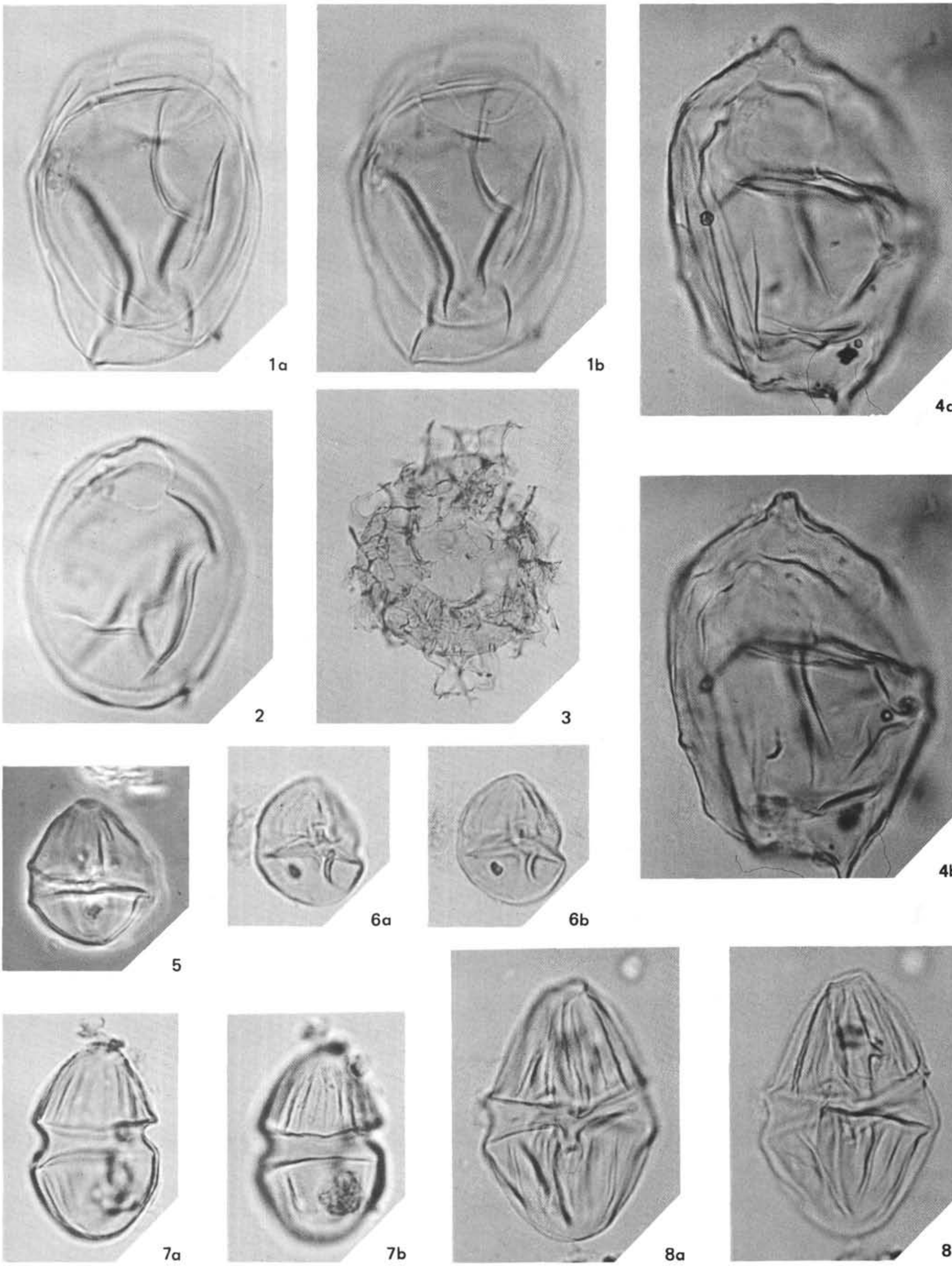

PLATE 11

All ×1000 unless otherwise indicated.

Figure 1	*Dioxya villosa*. Sample 40-5, 51-53 cm.
Figure 2a, b	*Hystrichosphaeridium arundum*. Sample 40-4, 35-37 cm.
Figure 3a-c	*Leptodinium* sp. A. ×400. Sample 44-4, 36-38 cm.
Figure 4a-c	*Leptodinium* sp. A. ×400. Sample 44-4, 36-38 cm.
Figure 5a, b	*Leptodinium* sp. Sample 44-4, 36-38 cm.
Figure 6a, b	*Litosphaeridium conispinum*. Sample 29-2, 43-44 cm.
Figure 7	*Litosphaeridium siphoniphorum*. Sample 24-2, 138-140 cm.

PLATE 11

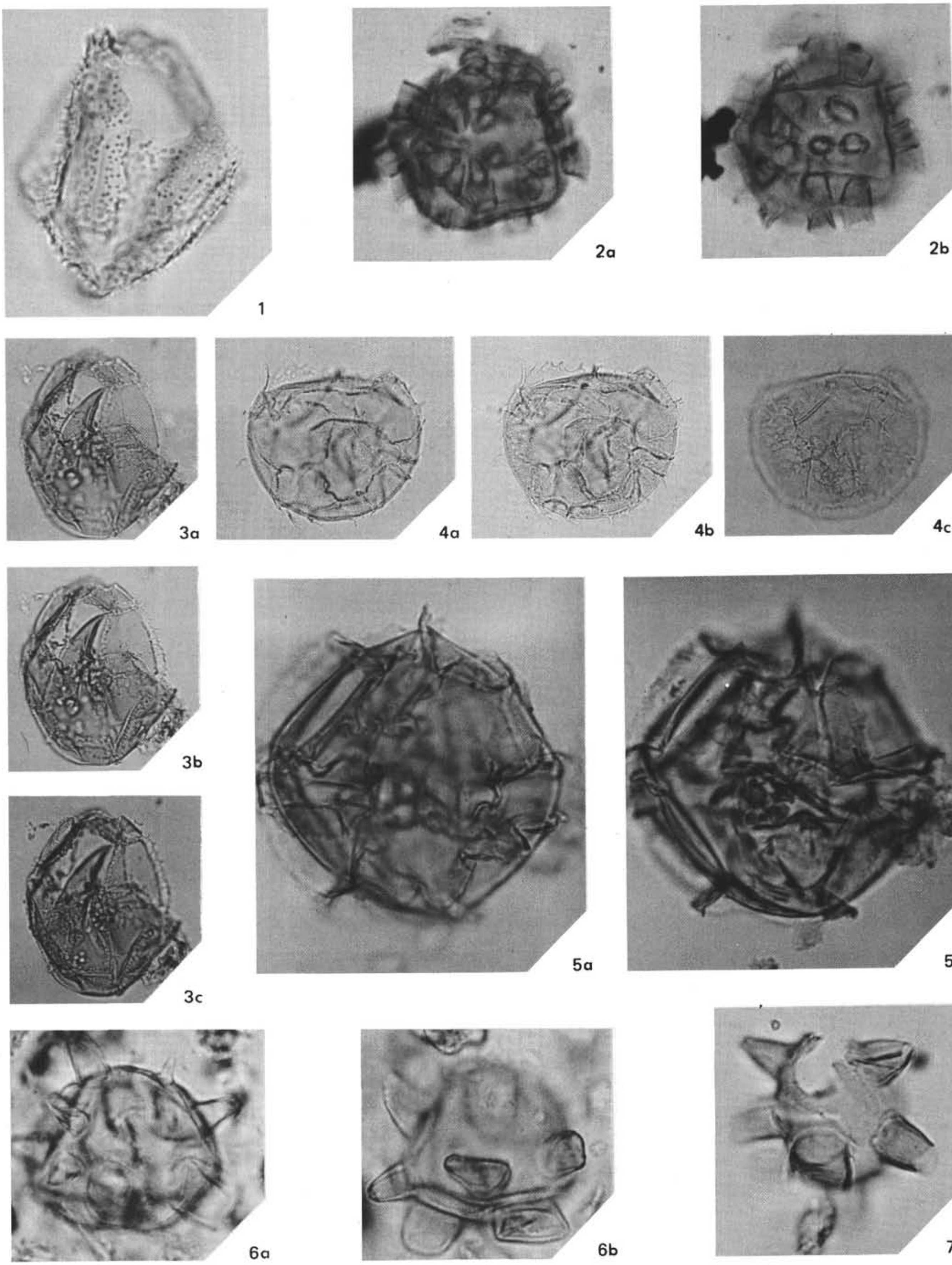

PLATE 12
All ×1000 unless otherwise indicated

Figure 1	*Oligosphaeridium complex*, ×400. Sample 44-4, 36-38 cm.
Figure 2	*Palaeohystrichophora infusorioides*. Sample 24-2, 138-140 cm.
Figure 3a, b	*Spiniferites* sp. Sample 23-4, 123-125 cm.
Figure 4a, b	*Subtilisphaera* cf. *S. perlucida*. Sample 45-2, 118-119 cm.
Figure 5a, b	*Subtilisphaera* cf. *S. perlucida*. Sample 45-2, 118-119 cm.
Figure 6	*Pterospermella* sp. Sample 25-3, 67-69 cm.
Figure 7	*Micrhystridium* sp. Sample 40-4, 35-37 cm.
Figure 8	*Micrhystridium* sp. Sample 24-2, 138-140 cm.
Figure 9a, b	*Cymatiosphaera* sp. A. Sample 25-3, 67-69 cm.
Figure 10a, b	*Crassosphaera concinna*. Sample 25-3, 67-69 cm.

PLATE 12