33. SPORES AND POLLEN FROM CENOZOIC SEDIMENTS OF THE FALKLAND PLATEAU, SITE 511, DEEP SEA DRILLING PROJECT LEG 71[1]

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ABSTRACT

Cenozoic sediments penetrated by Hole 511 in the southern part of the Atlantic Ocean (Falkland Plateau, Maurice Ewing Bank) were analyzed for palynomorphs. Upper Eocene and lower Oligocene palynoassemblages are characterized and correlated to synchronous palynoassemblages of similar character from South America, Australia, and New Zealand. The lower Oligocene assemblages show a close relationship to those of other Southern Hemisphere continents except Africa. They also contain reworked Permian and Mesozoic species.

The Eocene and early Oligocene climate of the study area was moderately warm and humid, very similar to the southern part of present-day New Zealand; a vertical zonation probably existed.

INTRODUCTION

Samples of Cenozoic sediments from Sites 511 and 512 were analyzed for palynomorphs. At Site 512, all 58 samples of middle Eocene and Miocene carbonate sediments were almost devoid of spores and pollen. In the Cenozoic sediments penetrated by Hole 511, 52 samples were analyzed over the interval from 3 to 185.5 meters. The 10 samples from the uppermost part of the section (Cores 1–3) contained no spores or pollens. In the lower part of the section (Cores 12–21), the spore and pollen content was also insignificant—analysis yielded no more than 50 specimens per sample. Analysis of 17 samples of sediment from the middle part of the section (Cores 4–12) found a relatively large number of spores and pollen, distributed as shown in Table 1.

Preservation of spores and pollen from the Cenozoic sediments at Site 511 is satisfactory, but many specimens are corroded and pitted.

The absence or negligible amounts of spores and pollen in some samples cannot yet be explained. It is clearly not related to lithological composition, which remains the same throughout the interval.

Stratigraphic subdivision of the Cenozoic sediments at Site 511 was accomplished by means of planktonic foraminifers, nannoplankton, radiolarians, and diatoms. The Paleocene–Eocene (Core 21), upper Eocene (Cores 17–20), and lower Oligocene (Cores 2–16) deposits penetrated are composed of diatomaceous oozes and clays.

METHODS

Sediments were treated with 10% HCl to dissolve carbonates, disaggregated by boiling in 10% KOH, elutriated in a pyrophosphate solution ($NO_4P_2O_7$), separated in a heavy liquid (CdF_2) with specific gravity 2.2, and treated by the acetolysis method. Release from silicates was carried out with cold HF. The residue obtained was covered with glycerine. Stable spores and pollen specimens were prepared from a glycerine emulsion on glycerine gel, numbered, and stored in the collection of the Paleofloristic Laboratory of the Geological Institute of the U.S.S.R. Academy of Sciences, No. GIN 3948.

The study and microphotography were carried out using a Mikrofot D-16 biological microscope, magnification 7 × 60. Microphotographs of spores and pollen are presented in Plates 1–17.

CHARACTERISTICS AND COMPARISON OF PALYNOASSEMBLAGES OF THE FALKLAND PLATEAU

Only one specimen—a spore of *Cyathidites* sp. 1—was present in Sample 511-21-1, 40–42 cm (Paleocene–Eocene sediments).

Upper Eocene

Eleven samples were analyzed from upper Eocene sediments (Cores 17–20): 511-20,CC; 511-20-3, 34–36 cm; 511-20-2, 34–36 cm; 511-20-1, 34–36 cm; 511-18,CC; 511-18-2, 34–36 cm; 511-18-1, 34–36 cm; 511-17,CC; 511-17-3, 17–19 cm; 511-17-2, 96–98 cm; 511-17-1, 96–98 cm. The examination showed very small numbers of spores and pollen, from 10 to 40 specimens per sample. Sample 511-18-2, 34–36 cm was the most productive (39 specimens). Despite the small number of isolated microfossils, all samples contain spores of diverse systematic composition: *Leiotriletes microadriennis, Cyathidites minor, Stereisporites antiquasporites, Leptolepidites verrucatus, Gleicheniidites senonicus, Cingutriletes australis, Lygodiidites* sp., *Cyathidites* sp. 1, *Deltoidospora* sp., *Concavissimisporites* sp., *Osmundacidites* sp., *Lycopodiumsporites* sp., *Trilites* sp. 1, and *Form* sp. 1 (item 61 in the list of species). Equal amounts of gymnosperm and angiosperm plant pollen are present within the assemblage. Gymnosperms are represented by three genera (*Podocarpidites marwickii, Dacrydium cupressinum*, and *Phyllocladidites mawsonii*), angiosperms by two (*Nothofagidites asperus, N.* sp. 2, *Tricolpites* sp. 3).

Many species of this palynoassemblage, such as *G. senonicus, Leiotriletes microadriennis, Cingutriletes australis, Podocarpidites marwickii, Phyllocladidites mawsonii, D. cupressinum*, and *N. asperus*, are representative of Eocene deposits in Argentina (Freile, 1972; Archangelsky, 1972, 1973a, b; Archangelsky and Romero, 1974b; Menendes and Caccavari de Filice, 1975;

[1] Ludwig, W. J., Krasheninnikov, V. A., et al., *Init. Repts. DSDP*, 71: Washington (U.S. Govt. Printing Office).

Table 1. Quantitative chart of spores and pollen in lower Oligocene sediment samples from Hole 511.

Spores and Pollen \ Core/Section (interval in cm)	12-1, 25-27	11,CC	11-1, 40-44	9-7, 42-46	9-5, 92-96	9-4, 92-96	9-3, 92-96	9-2, 92-96	6-4, 40-42	6-3, 40-42	6-2, 40-42	5,CC	5-3, 20-22	5-2, 20-22	5-1, 20-22	4-3, 25-27	4-2, 25-27
No. Specimens[a]	156	61	73	214	100	104	78	78	80	122	200	78	107	200	136	87	55
Spores (%)	50.0	33.0	30.0	30.0	23.0	29.0	23.0	33.0	21.0	34.0	37.0	28.0	23.0	28.0	27.0	27.0	40.0
Gymnosperms (%)	35.0	37.0	60.0	55.5	61.0	55.0	53.0	47.0	48.0	44.0	45.0	56.0	58.0	49.5	60.0	67.0	47.0
Angiosperms (%)	15.0	30.0	10.0	14.5	16.0	16.0	24.0	20.0	31.0	22.0	18.0	16.0	19.0	22.5	13.0	6.0	13.0
Spores																	
1. *Leiotriletes microadriennis*	2.0		1	+	1.0					0.5	0.5	2			0.5	1	
2. *L.* sp.	2.5	2	2		1.0						0.5	3		2.0	1.0	2	
3. *Lygodiidites* cf. *balmei*	2.5	2	2	1.0	2.0	3.0	1			2.0	1.5		1.5		1.5		
4. *L.* sp.	1.0			0.5						1.0		1			0.5		
5. cf. *Lygodium*? *labratum*	2.5			0.5						+	1.0			2.5	1.0		
6. *Cyathidites minor*	4.0	4	5	1.5	3.0	4.0	3	2	2	3.0	1.5	3	2.5	3.5	3.0	3	3
7. *C. australis*	1.5			0.5	1.0	3.0		1		1.0	2.0			0.5			
8. *C. patagonicus*	2.5			1.5	1.0	1.0			1		1.0	1		1.5	0.5		
9. *C. punctatus*	1.0			0.5	1.0	1.0	1		1	0.5	1.0			1.5	0.5		1
10. *C.* sp. 1	0.5			0.5		1.0		1					1.0				
11. *C.* sp. 2				0.5	1.0						0.5		1.5		1.5		
12. *C.* sp. 3	1.0			0.5		2.0								0.5			
13. *C.* sp. 4	+				1.0						1.0						
14. *Deltoidospora* cf. *delicata*	1.5		1						1	+	0.5			1.5			1
15. *D.* sp.	0.5	1	2	0.5		1.0	1	1		1.0	1.0		0.5	2.0	1.5	2	
16. *Stereisporites antiquasporites*	3.0			1.0	1.0		2	1		1.0	3.0		2.0				
17. *S. concepcionensis*	0.5		1	+		+					+		+	0.5			
18. *S.* sp.	0.5	2		0.5	3.0			3		+	0.5		1.0		1.0		2
19. *Leptolepidites verrucatus*	3.0	1	2	1.0			2	2		2.0	1.0	1	+	1.0	2.0	2	3
20. *L.* sp.		1		1.0		+				1.0	2.0			0.5			
21. *Concavissimisporites punctatus*	1.0			0.5							1.0						
22. *C. granulatus*	0.5		1	1.0						0.5	0.5		0.5			1	
23. *C.* sp.				1.5				1									
24. *Baculatisporites* sp.	0.5							2			1.0				1.5		
25. *Osmundacidites wellmanii*	+							1			+						
26. *O.* sp.	1.0							2		1.0	+				2.0		
27. *Verrucatosporites transdanubicus*	0.5						1								1.5	1	
28. *V.* sp. 1	1.0	1	1	0.5		2.0	1				1.5	2	+			1	
29. cf. *V.* sp. 2	+			0.5											+		
30. *Concavisporites* sp.			2	1.0								2			0.5		
31. *Foveosporites canalis*	+					1.0				0.5	0.5			1.0			
32. *Lycopodiumsporites* cf. *eminulus*	0.5																1
33. *L. rosewoodensis*	+					1.0					1.5						
34. *L.* sp.	1.5			0.5						0.5	0.5		1.0	+	1.5		
35. *Klukisporites pseudoreticulatus*						1.0			1								
36. *Cicatricosisporites australiensis*	1.0						1		2	1.0	+			1.5			
37. *C.* sp.	0.5			0.5										+			
38. *Gleicheniidites senonicus*	2.0	1		1.5					3	1.0			1.0	+			
39. *G. circinidites*	0.5			0.5						0.5	1.0						
40. *G.* cf. *G. trijugatus*	1.0			1.5		2.0				1.5	0.5		1.5				
41. *Clavifera triplex*				0.5											1.5		
42. *Neoraistrickia* sp.	+			+					1		0.5		2.0				
43. *Trilobosporites purverulentus*						2.0										1	
44. *T.* sp.?	+										+	1					
45. *Trilites* cf. *paravallatus*	0.5							2		1.0	1.0		0.5	2.0			2
46. cf. *T.* sp. 1	1.5					+		1	1	1.0		1			2.0	1	2
47. cf. *T.* sp. 2	0.5					+		2		2.0	1.0		0.5			2	1
48. *Dicksonia* aff. *squarrosa*	1.0			+				2	1	1.0	0.5	2	1.5			2	2
49. *D.* sp.	0.5			0.5				1		1.0	1.5		1.0	1.5			3
50. *Foraminisporis dailyi*						+					+			1.0			
51. *F.* sp.				0.5						+						1	
52. *F. wonthaggiensis*	+									0.5							
53. *Cyatheacidites* sp. 1					1.0					0.5	1.0		0.5		0.5	1	
54. *C.* sp. 2	0.5	1												1.5			
55. *Cingutriletes australis*	0.5			1.5	2.0	+	2		2	1.5	2.0	3		1.5	0.5		1
56. *C. clavus*	+			+			1			1.0							
57. *Polypodiidites speciosus*	+			+													
58. *P.* sp.	3.0	4	1	3.5	2.0	2.0	1		1		+			0.5	1.5		
59. *Aequitricradites* sp.										1.0			+				
60. *Triletes* sp. E				+	2.0	1.0	1								0.5		
61. *Form* sp. 1	+			1.0						0.5	1.0						
62. *Form* sp. 2	0.5			+						1.5						2	
63. *Form* sp. 3	+		1	0.5						0.5			0.5				
64. *Form* sp. 4	+			+						0.5			1.0				
Pollens																	
65. *Tsugaepollenites* sp.									1					0.5			
66. *Pinuspollenites* sp.	3.0			+	3.0						2.0		5.5	6.5			1
67. *Podocarpidites marwickii*	4.5	4	5	10.0	5.0	10.0	10	10	5	7.0	10.0	8	3.5	1.0		3	3
68. *P. elegans*	4.5	1	1	2.5	2.0	2.0	1	3		1.0	3.0		+	2.0		1	1
69. *P. microreticuloidata*	+		4	4.0	4.0		2			+	3.0	1		0.5			
70. *P.* sp.	1.5	5	6	1.5	7.0	7.0	2	3	2	3.0	2.0	6	5.0	4.5		8	2
71. *Dacrydiumites* sp.	2.5	2	5	1.5	2.0	11.0	1	7	2	7.0	2.0	3	5.0	4.5		10	3
72. *Dacrydium cupressinum*	6.0	6	9	9.5	15.0	10	10	5	10	9.0	5.0	8	16.0	10.0		13	5
73. *D.* aff. *cupressinum*	+	2	1	4.5						3.0		2	+	0.5		1	
74. *Phyllocladidites mawsonii*	4.0		3	6.5	15.0	2.0	7	4	10	6.0	11.0	7	10.0	7.0		5	5
75. *P. mawsonii* cf. *verrucosus*	1.5		1	5.5	4.0	4.0	2		5	1.0	2.0	1	0.5	2.0		2	
76. *P.* sp.	2.0	3	8	3.5		5.0	4	5	4	2.0	1.0	3	9.5	8.0		10	4
77. *Microcachrydites antarcticus*	2.5			4.0	4.0		1			3.0		5	2.0	2.0		5	
78. *M. parvus*				0.5		2.0					1.0						
79. *Trisaccites microsacccatus*	1.5			1.0		2.0					2.0						

Note: + indicates that content is <0.5%.

[a] Where total *N* is < 100, column entries specify no. specimens found; for a total N > 100, column entries are percentages.

Table 1. (Continued).

Spores and Pollen \ Core/Section (interval in cm)	12-1, 25-27	11,CC	11-1, 40-44	9-7, 42-46	9-5, 92-96	9-4, 92-96	9-3, 92-96	9-2, 92-96	6-4, 40-42	6-3, 40-42	6-2, 40-42	5,CC	5-3, 20-22	5-2, 20-22	5-1, 20-22	4-3, 25-27	4-2, 25-27
No. Specimens[a]	156	61	73	214	100	104	78	78	80	122	200	78	107	200	136	87	55
Spores (%)	50.0	33.0	30.0	30.0	23.0	29.0	23.0	33.0	21.0	34.0	37.0	28.0	23.0	28.0	27.0	27.0	40.0
Gymnosperms (%)	35.0	37.0	60.0	55.5	61.0	55.0	53.0	47.0	48.0	44.0	45.0	56.0	58.0	49.5	60.0	67.0	47.0
Angiosperms (%)	15.0	30.0	10.0	14.5	16.0	16.0	24.0	20.0	31.0	22.0	18.0	16.0	19.0	22.5	13.0	6.0	13.0
Pollen																	
80. *T.* sp.				0.5												1	
81. *Araucariacites* sp.							1			0.5	0.5						
82. *Ephedra* sp.										+							2
83. *Monosulcites* sp.										0.5	0.5						
84. *Liliacidites* sp.								2									
85. "*Tricolpites*" cf. *gillii*	0.5					1.0	1			+	0.5						
86. *T. alveolatus*				0.5			2				1.0						
87. *T. brevicolpus*	0.5	4		0.5	3.0	1.0	1			1.5	1.0				1.0		
88. *T.* cf. *brevicolpus*									3	1.5	+				+		
89. *T. fissilis*	+			0.5		1.0				+	+						
90. *T. waiparaensis*				0.5					2	1.0	1.0						
91. *T.* sp. 1	0.5							1		1.5				0.5	0.5		
92. *T.* sp. 2		3								0.5					+		
93. *T.* sp. 3	0.5			0.5	2.0				2		0.5		+				1
94. *T.* sp. 4			1							1.0				1.0			
95. *T.* sp. 5	1.0			0.5						0.5	0.5	2					
96. *Tricolporopollenites* sp. 1	+			0.5													
97. *T.* sp. 2				0.5			2				1.0				2.5		
98. *T.* sp. 3				0.5		1.0	2					1					
99. *T.* sp. 4								2		0.5	1.0				0.5		
100. *Tricolporites scabratus*	+			+			2										
101. *Psilatricolporites* sp.	1.0			0.5					3	0.5					2.0		
102. *Rhoipites communis*				0.5			1			+	1.0						
103. *R. baculatus*		2		0.5		2.0			2				2.0	1.0			
104. *R. striatoreticulatus*							2			0.5	1.0						
105. *R.* sp.	0.5	2	2	0.5								2			1.0		
106. *Senipites* cf. *tercrassata*				0.5						0.5		1					
107. *Tetracolporites* sp.							1	1						1.0			
108. *Triorites harrisii*	+							1		0.5							
109. *Casuarinidites cainozoicus*	1.5		2							1.0	1.0		1.0				
110. *C.* sp.	0.5									0.5	1.0	1	2.0		0.5		
111. *Proteacidites minimus*														1.5			
112. *P.* cf. *retiformis*													+		0.5	1	
113. *P. rectomarginis*													0.5				
114. *P.* sp.		2												1.0			
115. *Myrtaceidites* sp.	0.5		2							1.0				1.0			
116. *M. parvus* forma *nesus*									2	0.5	0.5		1.0				
117. *Nothofagidites asperus*	1.0			0.5									0.5	1.5			1
118. *N. deminuta*	1.0			0.5		1.0		5		1.5	2.0	2	3.5	1.5	1.0	2	
119. *N. cranwellae*	2.0			+	3.0					2.0	1.0	2	2.0	3.0	0.5		2
120. *N. spinosus*	0.5			0.5					2	1.0	1.0			1.5	+		
121. *N.* sp. 1										0.5	1.0						
122. *N. brachispinulosa*	1.0	3		2.0				3					1.5	2.0		2	
123. *N. cincta*	0.5		1	1.0	5.0	3.0	3						1.0	0.5			1
124. *N.* sp. 2					1.0				2		0.5		+				
125. *N.* sp. 3	0.5			0.5		1.0			3				0.5	1.0			
126. *N.* sp. 4				0.5		1.0				0.5			2.0	1.0	1.0		2
127. *Parsonsidites* cf. *psilatus*										0.5				1.0	1.5		
128. *P.* cf. *conspicuus*										1.0				1.0			
129. *Ilex* sp.		2												1.0	0.5		
130. *Rhizophora* sp. 1							2						0.5	0.5			
131. *Rhizophora* sp. 2										1.0					1.0		
132. *Alnus* sp.	0.5												+				
133. *Polygonum* sp.						2.0			1								
134. Chenopodiaceae				0.5	2.0							1			0.5		
135. *Form* sp. 1									1	+	0.5						
136. *Form* sp. 2				0.5													
137. *Form* sp. 3						2.0											
138. *Form* sp. 4								1									
139. *Form* sp. 5				0.5					1						+		

Romero, 1977), Chile (Takahashi, 1977), New Zealand (Couper, 1953, 1960), and Australia (Cookson, 1964). The rest of the forms, mainly spores, are widely distributed in both the Mesozoic and the Cenozoic deposits of the Southern Hemisphere. Archangelsky (1973b) showed that in Eocene palynoassemblages from Argentina *Nothofagidites* and gymnosperm pollen (*Podocarpidites, Dacrydiumites*, and *Phyllocladidites*) were predominant. He noted that some Eocene horizons were rich in spores. The Eocene climate in the region of Argentina was moderate and humid. The composition of upper Eocene palynoassemblages at Site 511 testifies to a relatively humid, warm, temperate climate.

Palynological data do not show an abrupt change at the upper Eocene/lower Oligocene boundary, but appreciable change is apparent somewhat higher at 108.5 meters, in lower Oligocene sediments. It is difficult to locate this change precisely, because no samples from 109.5–128.5 meters (Cores 13–14) were available for study (core recovery 3.3% and 0.5%, respectively).

Oligocene

Over the interval from 3 to 147.5 meters (Cores 511-1–16), Hole 511 sediments belong to the lower Oligocene. In this interval, 37 samples were analyzed: 7 proved barren, 13 contained small amounts of pollen

and spores (up to 50 specimens), and 17 had from 50 to 215 specimens.

Four samples (511-16,CC; 511-16-2, 33–35 cm; 511-16-1, 33–35 cm; 511-15-1, 28–30 cm) were analyzed at the base of the lower Oligocene section, from 128.5 to 147.5 meters (Cores 15–16).

The numbers of spores and pollen in the samples were very small; they are most abundant in Sample 511-16-2, 33–35 cm. As in the previous palynoassemblage, spores predominate: *Cyathidites patagonicus, C. minor, Gleicheniidites senonicus, Cingutriletes australis, Stereisporites antiquasporites, Leptolepidites* sp., Osmunda sp., and *Polypodiidites* sp. Gymnosperm pollens were few (*Pinuspollenites, Podocarpus* sp., *Dacrydium cupressinum, Phyllocladidites mawsonii*). Numbers and diversity of angiosperm plants increase somewhat: *Nothofagidites deminuta, N.* sp. 2, *Proteacidites* sp., *Casuarinidites* sp., Chenopodiaceae, *Tricolpites* cf. *brevicolpus, T. fissilis, T.* sp. 3.

In the superjacent sediments, beginning at Sample 511-12-2, 25–27 cm and representing the interval from 6–108.5 meters, the ratio of the major groups in the palynoassemblage (spores, gymnosperms, and angiosperms) changes sharply. Pollens of gymnosperm plants are most abundant (35–60%), spores are second (21–50%), and then pollen of angiosperm plants (10–31%). This ratio remains the same throughout the rest of the lower Oligocene section (see Table 1).

Spores were the most diverse taxonomically, with 27 genera and 64 species identified. These consisted primarily of *Leiotriletes microadriennis*, cf. *Lygodium? labratum, Cyathidites patagonicus, Deltoidospora* cf. *delicata, Stereisporites concepcionensis, Verrucatosporites transdanubicus, Lycopodiumsporites* cf. *eminulus, Neoraistrickia* sp., *Trilites* cf. *paravallatus, Cingutriletes australis,* and *Polypodiidites speciosus*. These have been described from Cenozoic deposits, mostly of Paleogene age, in Argentina (Archangelsky, 1972), Chile (Takahashi, 1977), Western Europe (Krutzsch, 1959; Kedves, 1973), North America (Frederiksen, 1973) and from the Neogene of Africa (Sah, 1967). The spores *Cyathidites minor, C. australis, S. antiquasporites*, and *Leptolepidites verrucatus* are distributed worldwide in Mesozoic and Cenozoic sediments. Some spores, such as *Gleicheniidites senonicus* and *Clavifera triplex*, are present both in Paleogene (Archangelsky, 1972, 1973a) and Cretaceous sediments (Dettmann and Playford, 1969; Burger, 1976). *Dicksonia* aff. *squarrosa* is distributed in New Zealand from Maestrichtian to Recent times (Couper, 1960). The majority of species (*Concavissimisporites punctatus, C. granulatus, Osmundacidites wellmanii, Foveosporites canalis, Klukisporites pseudoreticulatus, Cicatricosisporites australiensis, Gleicheniidites* cf. *G. trijugatus, Foraminisporis wonthaggiensis, F. dailyi, Cingutriletes clavus, Trilobosporites purverulentus,* and *Lycopodiumsporites rosewoodensis*) are characteristic of the Cretaceous of Australia (Dettmann, 1963; Burger, 1974, 1976; Playford et al., 1975; Dettmann and Playford, 1969), New Zealand (Couper, 1960), England (Stover, 1964; Playford, 1971), and Canada (Pocock, 1964; Vagvolgyi and Hills, 1969).

The presence, in the lower Oligocene palynoassemblage, of spores that, judging by the data in the literature, are not peculiar to Cenozoic deposits can be explained in one of two ways: either the plants to which these spores belonged existed in the flora of the Southern Hemisphere longer than previously recognized, or the spores have been reworked from older deposits. In degree of preservation, however, these spores do not differ from the Cenozoic spores. Clearly redeposited forms are present in the palynoassemblage—for instance, striate pollens of conifers, characteristic of Permian and Triassic sediments, and dark brown spores, possibly redeposited from Mesozoic sediments. Microphotographs of some of these are given in Plate 17.

In all samples from these upper cores, the composition of the pollen assemblage derived from gymnosperm plants is very similar and is close to that of the gymnosperm pollen from the underlying Oligocene and upper Eocene sediments. In addition, the palynoassemblage in this upper interval is most diverse taxonomically; it contains 10 genera and 18 species of gymnosperm plant pollen. Predominant are *Podocarpidites marwickii, P. microreticuloidata, Dacrydium cupressinum, D.* aff. *cupressinum, Phyllocladidites mawsonii, P. mawsonii* cf. *verrucosus*, and *Microcachrydites antarcticus.* There are small amounts of *M. parvus, Trisaccites microsaccatus, Pinuspollenites*, and *Ephedra* sp., and single grains of *Tsugaepollenites* and *Araucariacites.* All the above species, except *M. parvus*, are representative of the Cretaceous and Tertiary of the Southern Hemisphere. *M. parvus* is distributed in Oligocene, Neogene, and Pleistocene deposits of New Zealand (Couper, 1960).

The pollen composition of angiosperm plants in the palynoassemblage is relatively diverse—24 genera, 57 species. *Nothofagites* pollens belonging to three groups (*menziesii, brassi,* and *fusca*) are predominant. Among them are: *N. asperus, N. deminuta, N. cranwellae, N. spinosus, N. brachispinulosa, N. cincta.* These are widespread in Cenozoic sediments of New Zealand (Couper, 1960), Australia (Cookson, 1958), Argentina (Archangelsky and Romero, 1974a,b; Menendes and Caccavari de Filice, 1975; Romero, 1977), and the Antarctic (Cranwell, 1964). In the recent flora of New Zealand, Australia, and South America, there are no representatives of the genus *Nothofagidites* of the *menziesii* and *brassi* groups, which are known only in the flora of New Guinea and New Caledonia. The predominance of *Nothofagidites* is peculiar to Tertiary deposits of New Zealand and Australia (Couper, 1960). Almost all samples contain pollen of the genera *Causarinidites, Psilatricolporites, Rhoipites, Tricolporopollenites,* and *Tricolpites.* Pollen of the genera *Proteacidites, Myrtaceidites*, and *Rhizofora* occur in much smaller amounts. Very typical pollens of *Parsonsidites* cf. *psilatus, Ilex, Alnus, Polygonum*, and Chenopodiaceae were observed in some of the samples. Pollens of the angiosperms from the lower Oligocene sediments at Site 511 are, therefore, peculiar to Paleogene deposits of New Zealand (Couper, 1953, 1960), Australia (Cookson, 1958, 1964), and South America (Archangelsky, 1973a, b; Romero, 1977; Takahashi, 1977).

Thus, the lower Oligocene palynoassemblage of Site 511 is very similar to the palynoassemblages from Paleogene deposits of all Southern Hemisphere continents except Africa, and to the palynoassemblage found in Oligocene and lower Miocene sediments penetrated by Hole 270, DSDP Leg 28 (Kemp, 1974).

CONCLUSIONS

The composition of the palynoassemblages suggests that during the accumulation of Paleogene sediments on the Falkland Plateau, the nearest continent (or islands) was covered by forest vegetation similar in composition to the Recent vegetation of New Zealand, and especially of its southern island. In the northern part of this island there are at present subtropical forests consisting of conifers (*Podocarpus, Dacridium*) and broad-leaved plants, and in the southern part subantarctic forests with various types of *Nothofagus* (Campbell, 1948). The wide distribution of *Nothofagus* indicates that the Eocene and Oligocene climate in the area of the Falkland Plateau was moderately warm and humid. It is likely that vertical zonality existed as well.

During the Paleogene, Argentina (Romero, 1977) and Australia (Cranwell, 1964) also supported forest vegetation similar to that existing today in New Zealand.

This study of the composition of the late Eocene–lower Oligocene palynoassemblages of Site 511 in conjunction with the data of other researchers (Cranwell, 1964; Romero, 1977) has enabled us to establish a close relationship among floras of the southern parts of South America, New Zealand, Antarctica, and Australia for the Paleogene period. The connection between South America and New Zealand was made via Antarctica and Australia, which were much closer together at that time. Such a relationship is evidenced by the present-day forests in which *Nothofagus* is present and which cover the southern margins of Argentina, Chile, Australia, and New Zealand. On the Antarctic continent, they have been destroyed by glaciation.

TAXONOMIC LIST

In the numbered list of taxa that follows, the geological distribution of previously defined species is given. The distribution of the taxa is presented in Table 1.

Anteturma SPORITES H. Potonié, 1893
Turma TRILETES Reinsh, 1881, emend. R. Potonié and Kremp, 1954
Subturma AZONOTRILETES Luber, 1935, emend. Dettmann, 1963
Infraturma LAEVIGATI Bennie and Kidstone, 1886, emend., R. Potonié and Kremp, 1954

Genus *LEOTRILETES* Naumova, 1937, emend. R. Potonié and Kremp, 1954

1. *Leiotriletes microadriennis* Krutzsch, 1959 (Plate 1, Fig. 1). Middle Eocene of DDR (Krutzsch, 1959); Eocene of Chile (Takahashi, 1977).
2. Leiotriletes sp. (Plate 1, Fig.4).

Genus *LYGODIIDITES* Pocock, 1964

3. *Lygodiidites* cf. *balmei* Pocock, 1964 (Plate 1, Figs. 2–3). Middle and upper Albian of Canada (Pocock, 1964).
4. *Lygodiidites* sp. (Plate 1, Fig. 5).

Genus *LYGODIUM* Swartz, 1801

5. cf. *Lygodium*? *labratum* Frederiksen, 1973 (Plate 1, Fig. 6). Upper Eocene of Mississippi (Frederiksen, 1973).

Genus *CYATHIDITES* Couper, 1953

6. *Cyathidites minor* Couper, 1953 (Plate 1, Figs. 8–11). Worldwide distribution in Mesozoic and Cenozoic sediments.
7. *Cyathidites australis* Couper, 1953 (Plate 1, Fig. 12). Worldwide distribution in Mesozoic and Cenozoic sediments.
8. *Cyathidites patagonicus* Archangelsky, 1972 (Plate 2, Fig. 1). Eocene of Argentina (Archangelsky, 1972).
9. *Cyathidites punctatus* (Delcourt and Sprumont), Delcourt et al., 1963 (Plate 2, Fig. 2). Lower Cretaceous of Australia (Burger, 1974).
10. *Cyathidites* sp. 1 (Plate 2, Fig. 3).
11. *Cyathidites* sp. 2 (Plate 2, Fig. 4).
12. *Cyathidites* sp. 3 (Plate 2, Figs. 5–6).
13. *Cyathidites* sp. 4 (Plate 2, Fig. 7).

Genus *DELTOIDOSPORA* Miner, 1935, emend. R. Potonié, 1956

14. *Deltoidospora* cf. *delicata* Sah, 1967 (Plate 2, Figs. 8–9). Upper Neogene of Burundi (Sah, 1967).
15. *Deltoidospora* sp. (Plate 2, Fig. 10).

Genus *STEREISPORITES* Pflug, 1953

16. *Stereisporites antiquasporites* (Wilson and Webster), Dettmann, 1963 (Plate 3, Fig. 1). Worldwide distribution in Mesozoic and Cenozoic sediments.
17. *Stereisporites concepcionensis* Takahashi, 1977 (Plate 3, Fig. 2). Eocene of Chile (Takahashi, 1977).
18. *Stereisporites* sp. (Plate 3, Fig. 3).

Infraturma APICULATI Bennie and Kidstone, 1886, emend. R. Potonié, 1956

Genus *LEPTOLEPIDITES* Couper, 1953

19. *Leptolepidites verrucatus* Couper, 1953 (Plate 3, Fig. 4). Worldwide distribution in Mesozoic and Cenozoic sediments.
20. *Leptolepidites* sp. (Plate 3, Fig. 5).

Genus *CONCAVISSIMISPORITES* Delcourt and Sprumont, emend. Delcourt et al., 1963

21. *Concavissimisporites punctatus* (Delcourt and Sprumont), Pocock, 1964 (Plate 3, Fig. 6). Middle and upper Albian of Canada (Pocock, 1964), Cretaceous sediments of England (Stover, 1964); Lower Cretaceous of Canada (Vagvolgyi and Hills, 1969).
22. *Concavissimisporites granulatus* Pocock, 1964 (Plate 3, Fig. 7). Middle and upper Albian of Canada (Pocock, 1964).
23. *Concavissimisporites* sp. (Plate 3, Fig. 8).

Genus *BACULATISPORITES* Thomson and Pflug, 1953

24. *Baculatisporites* sp. (Plate 3, Fig. 9).

Genus *OSMUNDACIDITES* Couper, 1953

25. *Osmundacidites wellmanii* Couper, 1953 (Plate 3, Fig. 10). Triassic to middle Senonian of New Zealand (Couper, 1960).
26. *Osmundacidites* sp. (Plate 3, Fig. 11).

Genus *VERRUCATOSPORITES* Thomson and Pflug, 1953

27. *Verrucatosporites transdanubicus* Kedves, 1973 (Plate 4, Fig. 1). Lower and middle Eocene of Hungary (Kedves, 1973).
28. *Verrucatosporites* sp. 1 (Plate 4, Fig. 2).
29. cf. *Verrucatosporites* sp. 2 (Plate 4, Fig. 4).

Genus *CONCAVISPORITES* (Pflug, 1952), Delcourt and Sprumont, 1955

30. *Concavisporites* sp. (Plate 4, Fig. 5).

Genus *FOVEOSPORITES*

31. *Foveosporites canalis* Balme, 1957 (Plate 4, Fig. 3). Mid-Cretaceous of Australia (Playford et al., 1975).

Infraturma MURORNATI R. Potonié and Kremp, 1954

Genus *LYCOPODIUMSPORITES* Thiergart ex Delcourt and Sprumont, 1955

32. *Lycopodiumsporites* cf. *eminulus* Dettmann, 1963 (Plate 4, Figs. 6–7). Eocene of Argentina (Archangelsky, 1972).
33. *Lycopodiumsporites rosewoodensis* (de Jersey) (Plate 4, Fig. 10). Lower Cretaceous of Australia (Burger, 1974).
34. *Lycopodiumsporites* sp. (Plate 4, Figs. 8–9).

Genus *KLUKISPORITES* Couper, 1958

35. *Klukisporites pseudoreticulatus* Couper, 1958 (Plate 4, Fig. 11). Cretaceous sediments of England (Playford, 1971).

Genus *CICATRICOSISPORITES* Potonié and Gelletich, 1933

36. *Cicatricosisporites australiensis* (Cookson), Potonié, 1956 (Plate 4, Fig. 12). Neocomian?–Cenomanian of Australia (Hill et al., 1968); Cretaceous sediments of Australia (Dettmann and Playford, 1969), and England (Playford, 1971); Neocomian of Australia (Burger, 1973, 1974).
37. *Cicatricosisporites* sp. (Plate 4, Fig. 13).

Infraturma TRICRASSATI Dettmann, 1963

Genus *GLEICHENIIDITES* (Ross ex Delcourt and Sprumont), Dettmann, 1963

38. *Gleicheniidites senonicus* Ross, 1949 (Plate 5, Figs. 1–2). Eocene of Argentina (Archangelsky, 1972); Cretaceous deposits of the eastern to north Atlantic Ocean (Kotova, 1978).
39. *Gleicheniidites circinidites* (Cookson), Burger, 1976 (Plate 5, Fig. 5). Cenomanian of Australia (Burger, 1976).
40. *Gleicheniidites* cf. *G. trijugatus* (Pierce), Burger, 1976 (Plate 5, Figs. 3–4). Cenomanian of Australia (Burger, 1976).

Genus *CLAVIFERA* Bolkhovitina, 1966

41. *Clavifera triplex* (Bolkhovitina), Bolkhovitina, 1966 (Plate 5, Fig. 13). Cretaceous of Australia (Dettmann and Playford, 1969); Paleocene of Argentina (Archangelsky, 1973); Cenomanian of Australia (Burger, 1976).

Genus *NEORAISTRICKIA* Potonié

42. *Neoraistrickia* sp. (Plate 5, Fig. 8). Paleocene of Argentina (Archangelsky, 1973).

Infraturma AURICULATI Schopf, emend. Dettmann, 1963

Genus *TRILOBOSPORITES* Pant ex Potonié, 1956

43. *Trilobosporites purverulentus* (Verbitskaya), Dettmann, 1963 (Plate 5, Fig. 6). Lower Cretaceous of Canada (Playford, 1971).
44. *Trilobosporites* sp.? (Plate 5, Fig. 7).

Genus *TRILITES* Erdtman ex Couper, emend. Dettmann, 1963

45. *Trilites* cf. *paravallatus* W. Kr., 1959 (Plate 5, Figs. 9–10). Paleogene of Hungary (Kedves, 1973).
46. cf. *Trilites* sp. 1 (Plate 5, Figs. 11–12).
47. cf. *Trilites* sp. 2 (Plate 6, Figs. 1–2).

Genus *DICKSONIA* L'Haritier

48. *Dicksonia* aff. *squarrosa* Swartz (Plate 6, Figs. 3–4). Maestrichtian to present-day New Zealand (Couper, 1960); bottom sediments in the western part of the Pacific Ocean (Koreneva, 1964).
49. *Dicksonia* sp. (Plate 6, Figs. 5–6).

Infraturma CINGULATI R. Potonié and Klaus, emend. Dettmann, 1963

Genus *FORAMINISPORIS* Krutzsch, 1959

50. *Foraminisporis dailyi* (Cookson and Dettmann), Dettmann, 1963 (Plate 6, Fig. 7). Cretaceous sediments of Australia (Hill et al., 1968) and Canada (Playford, 1971).
51. *Foraminisporis* sp. (Plate 6, Fig. 9).
52. *Foraminisporis wonthaggiensis* (Cookson and Dettmann), Dettmann, 1963 (Plate 6, Fig. 8). Aptian–Albian of Australia (Dettmann, 1963); Cretaceous sediments of Australia (Hill et al., 1968); Mid-Cretaceous of North America (Norris, 1967; Singh, 1971); Cenomanian of Australia (Burger, 1976).

Genus *CYATHEACIDITES* (Cookson), Potonié, 1956

53. *Cyatheacidites* sp. 1 (Plate 7, Figs. 1–2).
54. *Cyatheacidites* sp. 2 (Plate 7, Figs. 3–4).

Genus *CINGUTRILETES* Pierce, emend. Dettmann, 1963

55. *Cingutriletes australis* (Cookson) Archangelsky, 1972 (Plate 7, Fig. 5). Eocene of Argentina (Archangelsky, 1972).
56. *Cingutriletes clavus* (Balme), Dettmann, 1963 (Plate 7, Fig. 6). Lower Cretaceous of Australia (Burger, 1974) and Canada (Vagvolgyi and Hills, 1969).

Infraturma SCULPTATOMONOLETI

Genus *POLYPODIIDITES* Ross, 1949, emend. Potonié, 1966

57. *Polypodiidites speciosus* (Harris), Archangelsky, 1972 (Plate 7, Fig. 9). Eocene of Argentina (Archangelsky, 1972).
58. *Polypodiidites* sp. (Plate 7, Figs. 7–8).

Turma HILATES Dettmann, 1963

Genus *AEQUITRIRADITES*

59. *Aequitriradites* sp. (Plate 8, Fig. 8).

Incertae sedis

60. *Triletes* sp. E; Koreneva, 1964 (Plate 8, Fig. 1). Bottom sediments in the western part of the Pacific Ocean (Koreneva, 1964).
61. *Form* sp. 1 (Plate 8, Figs. 2–3).
62. *Form* sp. 2 (Plate 8, Figs. 4–5).
63. *Form* sp. 3 (Plate 8, Fig. 6).
64. *Form* sp. 4 (Plate 8, Fig. 7).

Anteturma POLLENITES Potonié, 1931
Infraturma SACCIZONATI Bhardwaj, 1957

Genus *TSUGAEPOLLENITES* Potonié and Venitz, emend. Potonié, 1958

65. *Tsugaepollenites* sp. (Plate 9, Fig. 1).

Subturma DISACCITES Cookson, 1947

Genus PINUSPOLLENITES Raatz, 1937

66. *Pinuspollenites* sp. (Plate 9, Fig. 2).

Genus *PODOCARPIDITES* Cookson ex Couper, 1953

67. *Podocarpidites marwickii* Couper, 1953 (Plate 9, Fig. 3). Lower Cretaceous to lower Oligocene of New Zealand (Couper, 1953); Albian to upper Eocene of New Zealand (Couper, 1960); Maestrichtian–Paleocene of Argentina (Freile, 1972); Upper Cretaceous–Paleocene of Patagonia (Archangelsky and Romero, 1974a); Eocene of Argentina (Romero, 1977).
68. *Podocarpidites elegans* Romero, 1977 (Plate 9, Figs. 4–5). Eocene of Argentina (Romero, 1977); Upper Cretaceous–Paleocene of Patagonia (Archangelsky and Romero, 1974a).
69. *Podocarpidites microreticuloidata* Cookson, 1947 (Plate 9, Fig. 6). Upper Cretaceous–Paleocene of Patagonia (Archangelsky and Romero, 1974a); Eocene of Argentina (Romero, 1977).
70. *Podocarpidites* sp. (Plate 9, Fig. 11).

Genus *DACRYDIUMITES* (Cookson and Pike), Harris, 1965

71. *Dacrydiumites* sp. (Plate 9, Fig. 7).

Genus *DACRYDIUM* Soland.

72. *Dacrydium cupressinum* Soland. ex Forst. (Plate 9, Figs. 8–9). Lower Oligocene to Recent of New Zealand (Couper, 1953); bottom sediments in the western part of the Pacific Ocean (Koreneva, 1964); Maestrichtian–Paleocene–Eocene of Patagonia (Archangelsky and Romero, 1974a, b); Upper Cretaceous–Paleogene of Argentina (Romero, 1977).
73. *Dacrydium* aff. *cupressinum* Soland. ex Forst. (Plate 9, Fig. 10). Maestrichtian to present-day New Zealand (Couper, 1960); bottom sediments in the western Pacific Ocean (Koreneva, 1964).

Genus *PHYLLOCLADIDITES* Cookson, 1947

74. *Phyllocladidites mawsonii* Cookson, 1947 (Plate 10, Fig. 1). Lower Cretaceous–lower Oligocene of New Zealand (Couper, 1953); Cretaceous–Tertiary of Patagonia (Archangelsky and Romero, 1974a, b); Lower Cretaceous–Pliocene of Argentina (Romero, 1977).
75. *Phyllocladidites mawsonii* f. *verrucosus* Cookson, 1947 (Plate 10, Fig. 2). Paleocene–Eocene of Argentina (Romero, 1977).
76. *Phyllocladidites* sp. (Plate 10, Figs. 3–4).

Genus *MICROCACHRYDITES* Cookson, 1947

77. *Microcachrydites antarcticus* Cookson, 1947 (Plate 10, Figs. 5–6). Lower Cretaceous to lower Oligocene of New Zealand (Couper, 1953); Mesozoic and Cenozoic sediments of New Zealand (Couper, 1960); Bajocian–Tertiary of Australia (Balme, 1964; Hill et al., 1968); Cretaceous sediments of Australia (Dettmann and Playford, 1969); Paleocene–Eocene of Patagonia (Archangelsky and Romero, 1974a, b); Eocene of Argentina (Romero, 1977).
78. *Microcachrydites parvus* Couper, 1960 (Plate 10, Fig. 7). Upper Oligocene–lower Pleistocene of New Zealand (Couper, 1960).

Genus *TRISACCITES* (Cookson), Menendez, 1968

79. *Trisaccites microsaccatus* (Couper) Couper, 1960 (Plate 10, Fig. 8). Maestrichtian–Paleocene–Eocene of Patagonia (Archangelsky and Romero, 1974a, b).
80. *Trisaccites* sp. (Plate 10, Fig. 9).

Subturma AZONALETES Luber, emend. R. Potonié and Kremp, 1954

Genus *ARAUCARIACITES* Cookson, 1947

81. Araucariacites sp. (Plate 10, Fig. 10).

Subturma POLYPLICATUS Erdtman, 1952

Genus *EPHEDRA* L.

82. *Ephedra* sp. (Plate 10, Figs. 11–12).

Subturma MONOCOLPATES Iversen and Troels-Smith, 1950

Genus *MONOSULCITES* Cookson ex Couper, 1958

83. *Monosulcites* sp. (Plate 10, Fig. 13).

Genus *LILIACIDITES* Couper, 1953

84. *Liliacidites* sp.

Subturma TRIPTYCHES Naumova, 1939, emend. R. Potonié, 1960

Genus *TRICOLPITES* Cookson ex Couper, 1958, emend. R. Potonié, 1960

85. "*Tricolpites*" cf. *gillii* Cookson, 1957 (Plate 10, Figs. 14–15). Paleocene of Argentina (Archangelsky, 1973).
86. *Tricolpites alveolatus* Couper, 1953 (Plate 10, Fig. 16). Lower Eocene to Miocene of New Zealand (Couper, 1953).
87. *Tricolpites brevicolpus* Couper, 1960 (Plate 11, Figs. 1–2). Maestrichtian of New Zealand (Couper, 1960).
88. *Tricolpites* cf. *brevicolpus* Couper, 1960 (Plate 11, Figs. 3–4).
89. *Tricolpites fissilis* Couper, 1960 (Plate 11, Fig. 5). Upper Senonian of New Zealand (Couper, 1960).
90. *Tricolpites waiparaensis* Couper, 1960 (Plate 11, Figs. 6–8). Upper Cretaceous of New Zealand (Couper, 1960).
91. *Tricolpites* sp. 1 (Plate 11, Figs. 9–10).
92. *Tricolpites* sp. 2 (Plate 11, Figs. 11–12).
93. *Tricolpites* sp. 3 (Plate 11, Figs. 13–16).
94. *Tricolpites* sp. 4 (Plate 11, Fig. 17).
95. *Tricolpites* sp. 5 (Plate 11, Figs. 18–19).

Genus *TRICOLPOROPOLLENITES* Thomson and Pflug, 1953

96. *Tricolporopollenites* sp. 1 (Plate 12, Fig. 1).
97. *Tricolporopollenites* sp. 2 (Plate 12, Fig. 2).
98. *Tricolporopollenites* sp. 3 (Plate 12, Figs. 3–4).
99. *Tricolporopollenites* sp. 4 (Plate 12, Fig. 5).

Genus *TRICOLPORITES*

100. *Tricolporites scabratus* Harris, 1965 (Plate 12, Figs. 6–8). Paleocene–Eocene of Australia (Harris, 1965).

Genus *PSILATRICOLPORITES* (van der Hammen), Pierce, 1961

101. *Psilatricolporites* sp. (Plate 12, Figs. 9–10).

Genus *RHOIPITES* Wodehouse, 1933

102. *Rhoipites communis* Sah, 1967 (Plate 12, Figs. 11–12) Upper Neogene of Burundi (Sah, 1967).
103. *Rhoipites baculatus* Archangelsky, 1973 (Plate 12, Figs. 13–14). Paleocene of Argentina (Archangelsky, 1973).
104. *Rhoipites striatoreticulatus* Sah, 1967 (Plate 12, Figs. 15–16). Upper Neogene of Burundi (Sah, 1967).
105. *Rhoipites* sp. (Plate 12, Figs. 17–18).

Genus *SENIPITES* Srivastava

106. *Senipites* cf. *tercrassata* Archangelsky, 1973 (Plate 12, Figs. 19–21). Paleocene of Argentina (Archangelsky, 1973).

Genus *TETRACOLPORITES* Couper, 1953

107. *Tetracolporites* sp. (Plate 12, Figs. 22–23).

Turma POROSES Naumova, emend. R. Potonié, 1960
Subturma TRIPORINES Naumova, emend. R. Potonié, 1960

Genus *TRIORITES* Cookson ex Couper

108. *Triorites harrisii* Couper, 1953 (Plate 13, Figs. 1–2). Danian to upper Pliocene of New Zealand (Couper, 1960).

Genus *CASUARINIDITES* Cookson

109. *Casuarinidites cainozoicus* Denmark (Plate 13, Figs. 3–4). Eocene–Oligocene of Australia (Cookson, 1964).
110. *Casuarinidites* sp. (Plate 13, Figs. 5–7).

Genus *PROTEACIDITES* Cookson ex Couper 1954

111. *Proteacidites minimus* Couper, 1954 (Plate 13, Figs. 8–9). Upper Oligocene to lower Pleistocene of New Zealand (Couper, 1960).
112. *Proteacidites* cf. *retiformis* Couper, 1960 (Plate 13, Figs. 10–11). Upper Senonian of New Zealand (Couper, 1960).
113. *Proteacidites rectomarginis* Cookson, 1950 (Plate 13, Figs. 14–15). Tertiary sediments of Australia (Cookson, 1950); middle Eocene of New Zealand (Couper, 1960).
114. *Proteacidites* sp. (Plate 13, Figs. 12–13).

Genus *MYRTACEIDITES* Cookson and Pike, 1954, ex R. Potonié, 1960

115. *Myrtaceidites* sp. (Plate 13, Figs. 16–17).
116. *Myrtaceidites parvus* forma *nesus* Cookson and Pike, 1954 (Plate 13, Figs. 18–20). Eocene to Pliocene of Australia (Cookson and Pike, 1954); Eocene of Chile (Takahashi, 1977).

Genus *NOTHOFAGIDITES* R. Potonié, 1960
Type *Menziesii*

117. *Nothofagidites asperus* (Cookson), Romero, 1973 (Plate 14, Figs. 1–2). Paleocene, Eocene, Oligocene of Argentina (Menendez and Caccavari de Filice, 1975); Eocene of Argentina (Romero, 1977).

Type *Brassi*

118. *Nothofagidites deminuta* (Cookson), Romero, 1977 (Plate 14, Figs. 3–4). Eocene–Miocene of Australia (Cookson, 1958); Paleogene of Patagonia (Archangelsky and Romero, 1974a, b); Eocene of Argentina (Romero, 1977).
119. *Nothofagidites cranwellae* (Couper), Fasola, 1969 (Plate 14, Fig. 5). Middle Oligocene–upper Pliocene of New Zealand (Couper, 1960); Paleogene of Argentina (Mendendez and Caccavari de Filice, 1975); Eocene–Oligocene of Patagonia (Archangelsky and Romero, 1974b); Eocene of Argentina (Romero, 1977).
120. *Nothofagidites spinosus* Couper, 1960 (Plate 14, Figs. 6–8). Upper Oligocene–middle Miocene (Couper, 1960).
121. *Nothofagidites* sp. 1 (Plate 14, Fig. 11).

Type *Fusca*

122. *Nothofagidites brachispinulosa* (Cookson), Harris, 1965 (Plate 14, Figs. 9–10). Eocene–Miocene of Australia (Cookson, 1958); Eocene–Oligocene of Patagonia (Archangelsky and Romero, 1974b); Eocene of Argentina (Romero, 1977).
123. *Nothofagidites cincta* (Cookson), Fasola, 1969 (Plate 14, Figs. 15–16). Eocene–Miocene of Australia (Cookson, 1958); Eocene–Oligocene of Patagonia (Archangelsky and Romero, 1974); Eocene of Argentina (Romero, 1977).
124. *Nothofagidites* sp. 2 (Plate 14, Figs. 12–14).
125. *Nothofagidites* sp. 3 (Plate 14, Figs. 17–19).
126. *Nothofagidites* sp. 4 (Plate 14, Figs. 20–21).

Genus *PARSONSIDITES* Couper, 1960

127. *Parsonsidites* cf. *psilatus* Couper, 1960 (Plate 15, Figs. 1–5). Tertiary sediments of New Zealand (Couper, 1960).
128. *Parsonsidites* cf. *conspicuus* Frederiksen, 1973 (Plate 15, Figs. 6–7). Middle, upper Eocene–lower Oligocene of Mississippi and Alabama (Frederiksen, 1973).

Genus *ILEX* L.

129. *Ilex* sp. (Plate 15, Fig. 13).

Genus *RHIZOPHORA* L.

130. *Rhizophora* sp. 1 (Plate 15, Figs. 8–9).
131. *Rhizophora* sp. 2 (Plate 15, Figs. 10–11).

Genus *ALNUS* L.

132. *Alnus* sp. (Plate 15, Fig. 12).

Genus *POLYGONUM* L.

133. *Polygonum* sp. (Plate 15, Figs. 17–18).
134. Chenopodiaceae (Plate 15, Figs. 14–16).

Incertae sedis

135. *Form* sp. 1 (Plate 16, Figs. 1–3).
136. *Form* sp. 2 (Plate 16, Figs. 4–5).
137. *Form* sp. 3 (Plate 16, Fig. 6).
138. *Form* sp. 4 (Plate 16, Figs. 7–8).
139. *Form* sp. 5 (Plate 16, Fig. 9).

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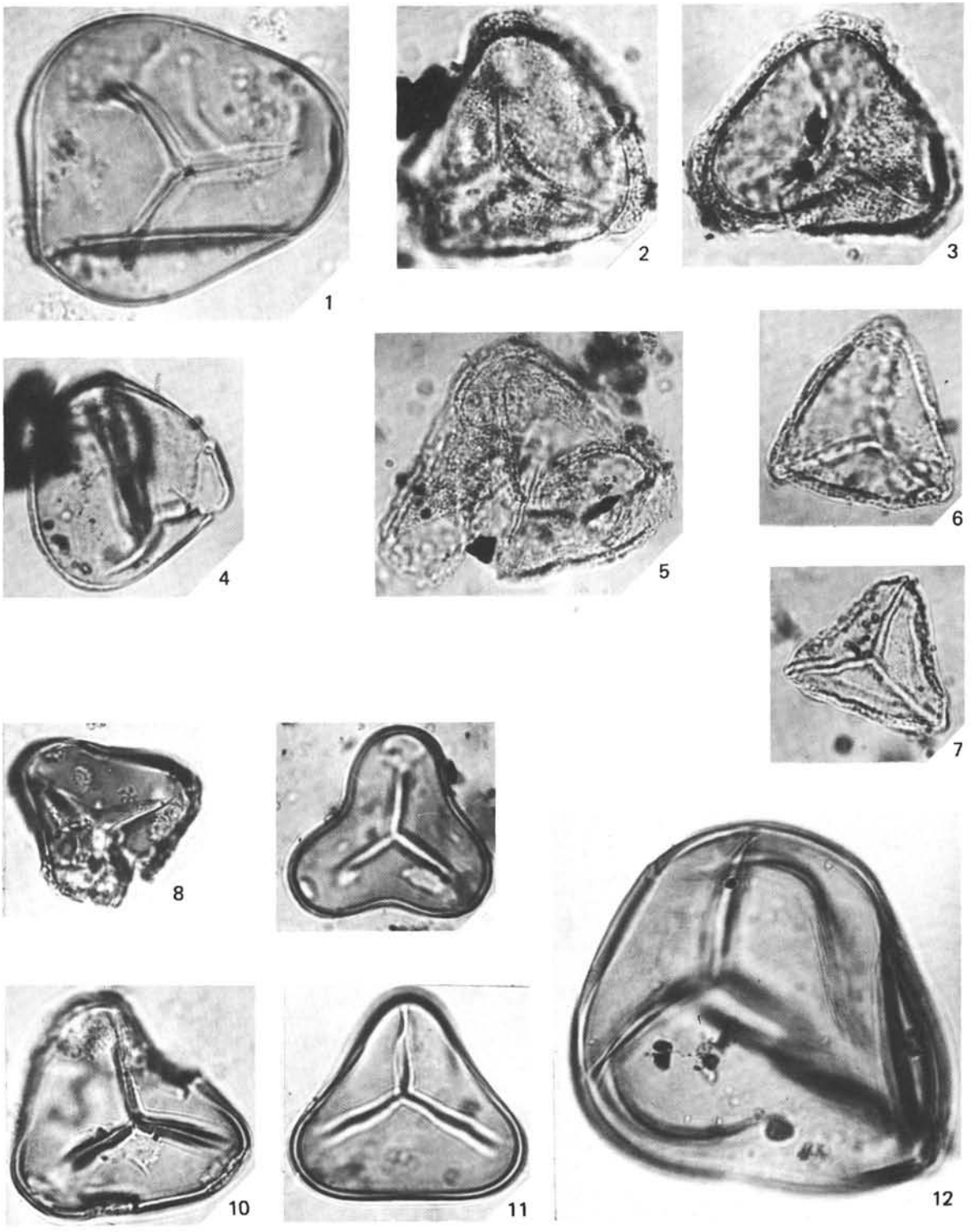


Plate 1. (All specimens magnified ×1000.) 1. *Leiotriletes microadriennis* Krutzsch, 1959, Sample 511-18-1, 34–36 cm. 2–3. *Lygodiidites* cf. *balmei* Pocock, 1964 (2) Sample 511-6-2, 40–42 cm. (3) Sample 511-9-3, 96–92 cm. 4. *Leiotriletes* sp., Sample 511-5-2, 20–22 cm. 5. *Lygodiidites* sp., Sample 511-11-3, 40–44 cm. 6–7. cf. *Lygodium*? *labratum* Frederiksen, 1973 (6) Sample 511-6-2, 40–42 cm (7) Sample 511-5-2, 20–22 cm. 8–11. *Cyathidites minor* Couper, 1953 (8) Sample 511-9-3, 92–96 cm (9) Sample 511-5-4, 20–22 cm (10) Sample 511-12-1, 25–27 cm (11) Sample 511-6-1, 40–42 cm. 12. *Cyathidites australis* Couper, 1953, Sample 511-12-1, 25–27 cm.

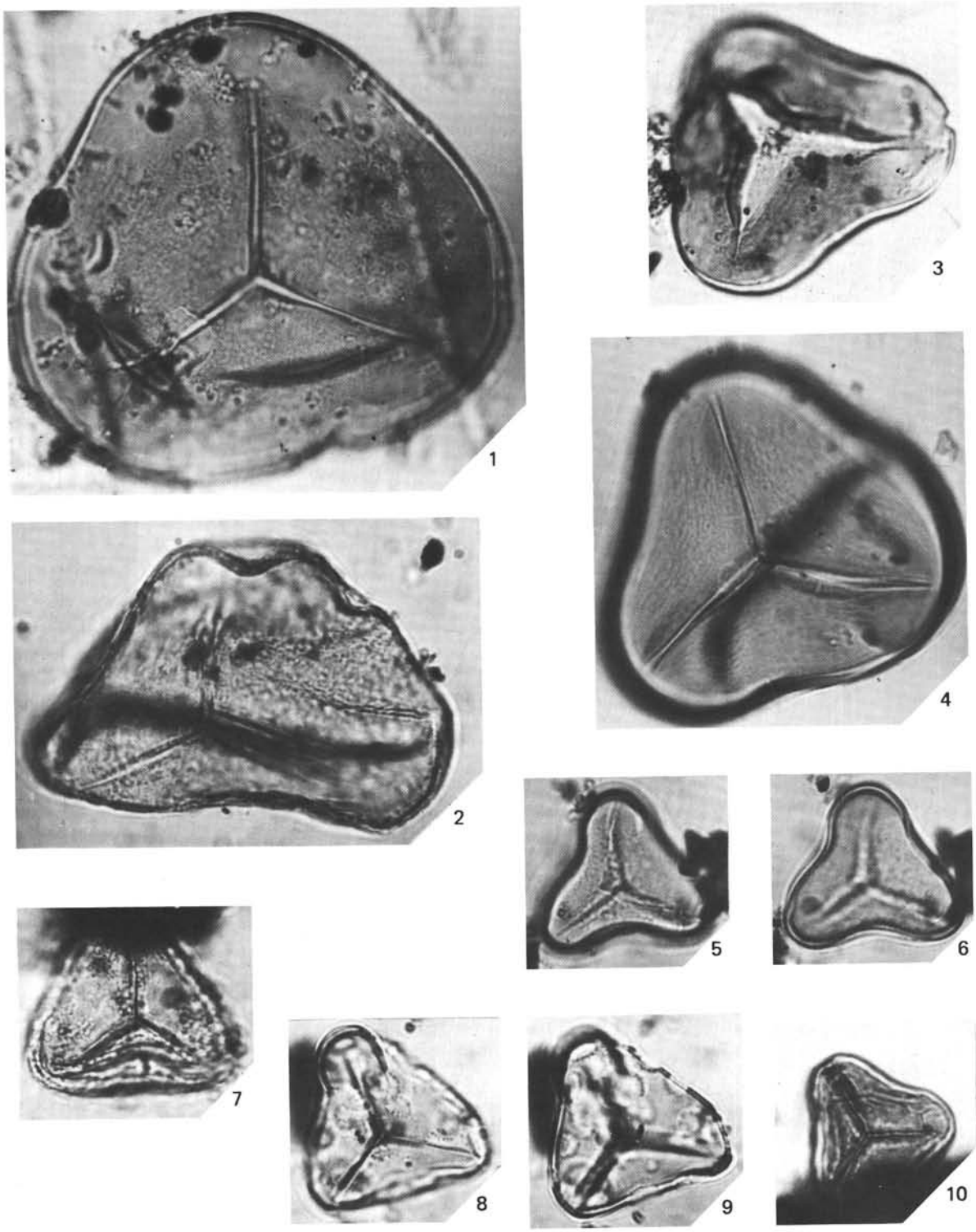


Plate 2. (All specimens magnified ×1000.) 1. *Cyathidites patagonicus* Archangelsky, 1972, Sample 511-16-2, 33–35 cm. 2. *Cyathidites punctatus* (Delcourt and Sprumont), Delcourt et al., 1963, Sample 511-5-2, 20–22 cm. 3. *Cyathidites* sp. 1, Sample 511-12-1, 25–27 cm. 4. *Cyathidites* sp. 2, Sample 511-9-7, 42–46 cm. 5–6. *Cyathidites* sp. 3, Sample 511-9-7, 42–46 cm. 7. *Cyathidites* sp. 4, Sample 511-12-1, 25–27 cm. 8–9. *Deltoidospora* cf. *delicata* Sah, 1967, Sample 511-5-2, 20–22 cm. 10. *Deltoidospora* sp., Sample 511-12-1, 25–27 cm.

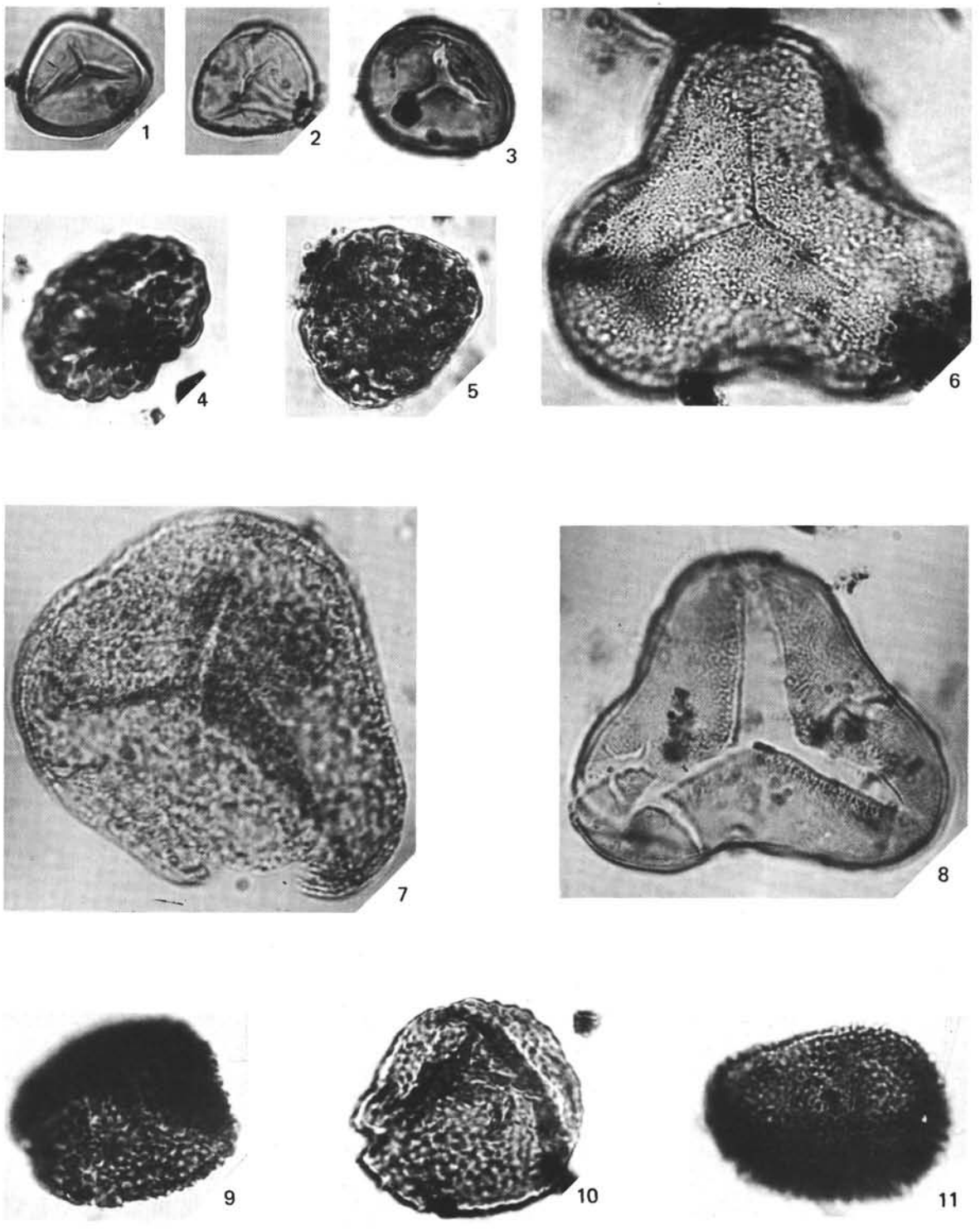


Plate 3. (All specimens magnified ×1000.) 1. *Stereisporites antiquasporites* (Wilson and Webster), Dettmann, 1963, Sample 511-11-3, 40–44 cm. 2. *Stereisporites concepcionensis* Takahashi, 1977, Sample 511-5-2, 20–22 cm. 3. *Stereisporites* sp., Sample 511-6-2, 40–42 cm. 4. *Leptolepidites verrucatus* Couper, 1953, Sample 511-9-7, 42–46 cm. 5. *Leptolepidites* sp., Sample 511-11-3, 40–44 cm. 6. *Concavissimisporites punctatus* (Delcourt and Sprumont), Pocock, 1964, Sample 511-6-2, 40–42 cm. 7. *Concavissimisporites granulatus* Pocock, 1964, Sample 511-9-7, 42–46 cm. 8. *Concavissimisporites* sp., Sample 511-9-7, 42–46 cm. 9. *Baculatisporites* sp.?, Sample 511-12-1, 25–27 cm. 10. *Osmundacidites wellmanii* Couper, 1953, Sample 511-12-1, 25–27 cm. 11. *Osmundacidites* sp., Sample 511-9-2, 92–96 cm.

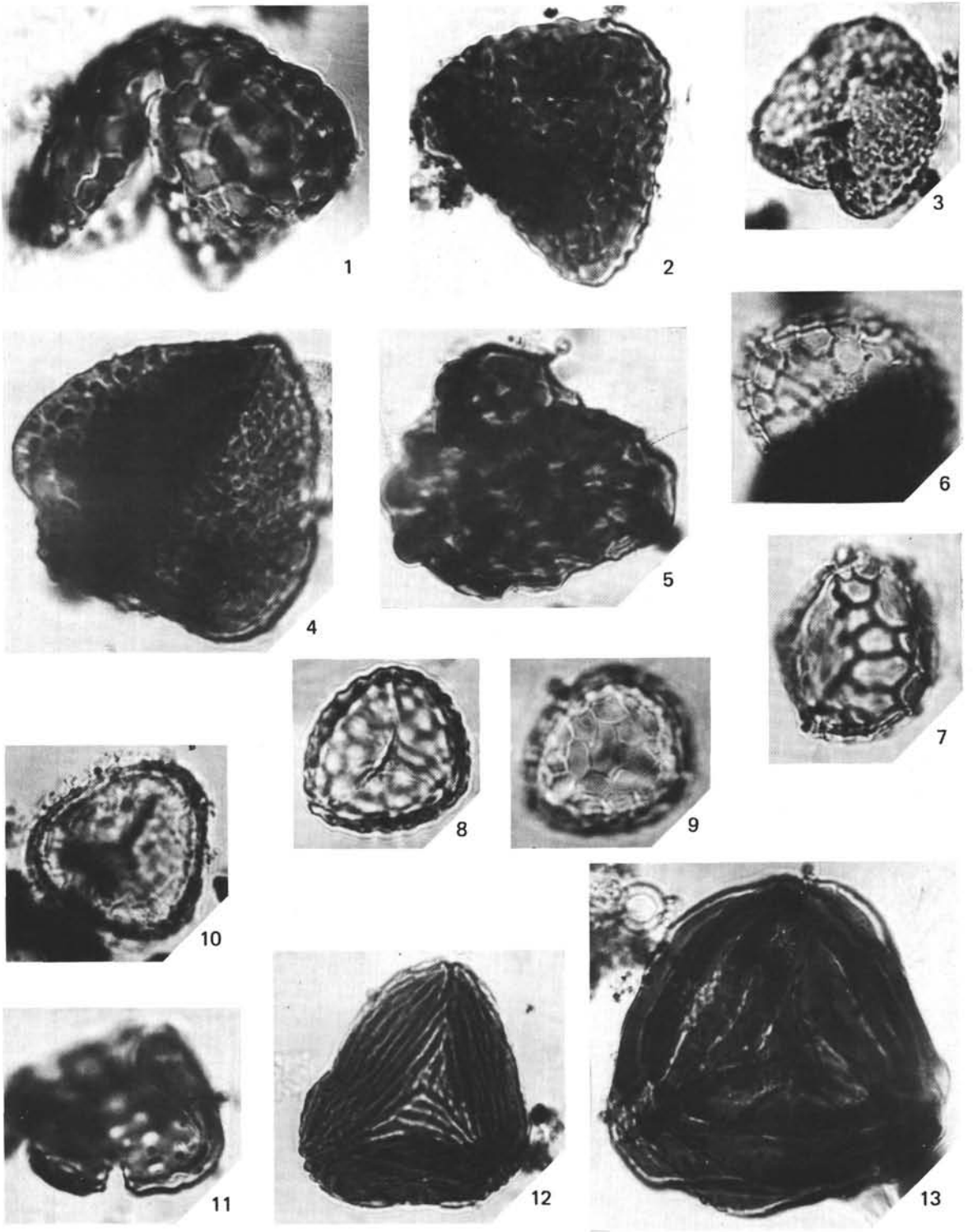


Plate 4. (All specimens magnified ×1000.) 1. *Verrucatosporites transdanubicus* Kedves, 1973, Sample 511-5-1, 20–22 cm. 2. *Verrucatosporites* sp. 1, Sample 511-9-4, 92–96 cm. 3. *Foveosporites canalis* Balme, 1957, Sample 511-5-2, 20–22 cm. 4. cf. *Verrucatosporites* sp. 2, Sample 511-9-7, 42–46 cm. 5. *Concavisporites* sp., Sample 511-9-7, 42–46 cm. 6–7. *Lycopodiumsporites* cf. *eminulus* Dettmann, 1963 (6) Sample 511-12-1, 25–27 cm, (7) Sample 511-11-3, 40–44 cm. 8–9. *Lycopodiumsporites* sp., Sample 511-12-1, 25–27 cm. 10. *Lycopodiumsporites rosewoodensis* (de Jersey), Sample 511-12-1, 25–27 cm. 11. *Klukisporites pseudoreticulatus* Couper, 1958, Sample 511-9-4, 92–96 cm. 12. *Cicatricosisporites australiensis* (Cookson), Potonié, 1956, Sample 511-5-2, 20–22 cm. 13. *Cicatricosisporites* sp., Sample 511-12-1, 25–27 cm.

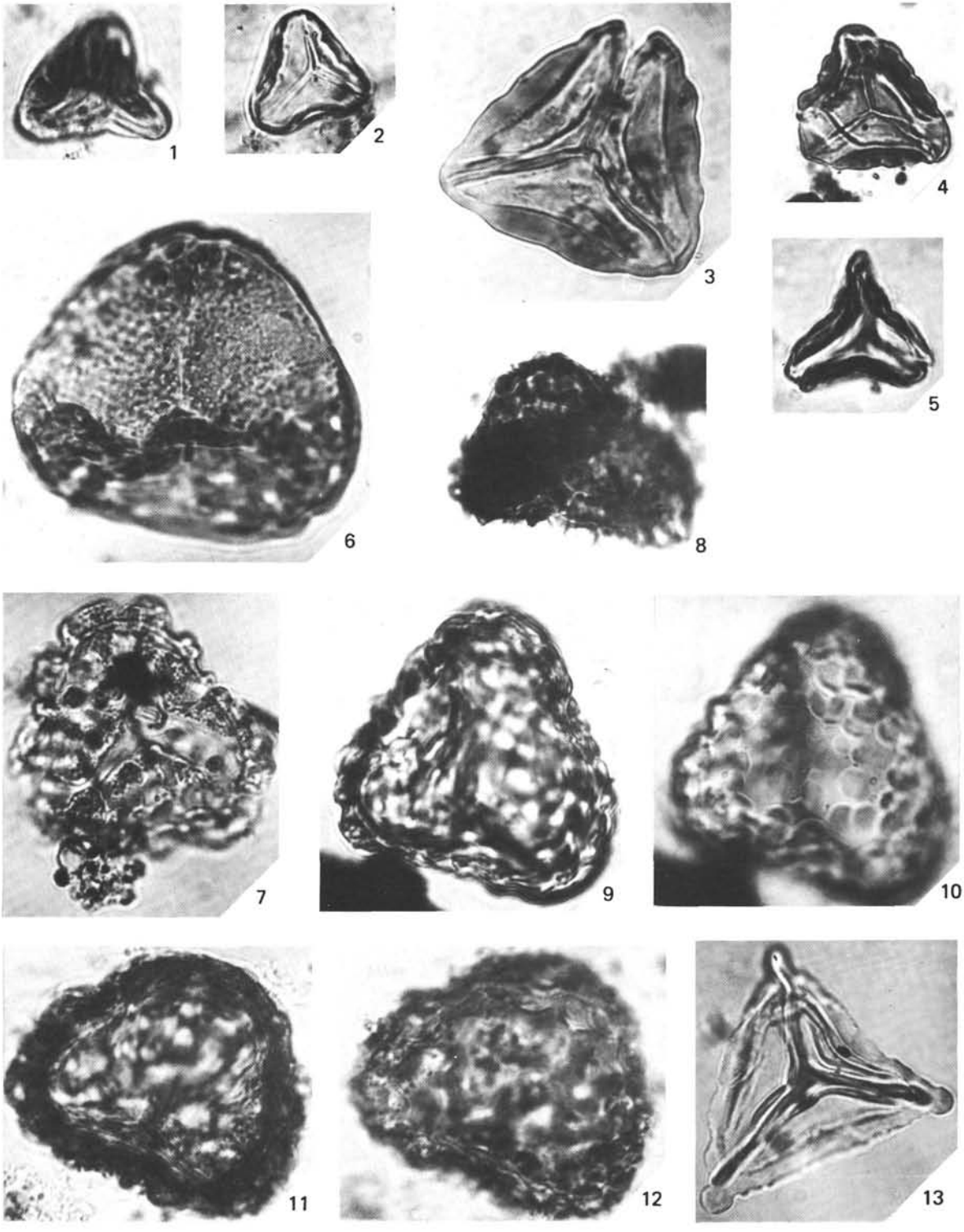


Plate 5. (All specimens magnified ×1000.) 1–2. *Gleicheniidites senonicus* Ross, 1949 (1) Sample 511-6-3, 40–42 cm (2) Sample 511-16-1, 33–35 cm. 3–4. *Gleicheniidites* cf. *G. trijugatus* (Pierce), Burger, 1976 (3) Sample 511-6-2, 40–42 cm, (4) Sample 511-5-3, 20–22 cm. 5. *Gleicheniidites circinidites* (Cookson), Burger, 1976, Sample 511-6-2, 40–42 cm. 6. *Trilobosporites purverulentus* (Verbitskaya), Dettmann, 1963, Sample 511-9-4, 92–96 cm. 7. *Trilobosporites* sp.?, Sample 511-12-1, 25–27 cm. 8. *Neoraistrickia* sp., Sample 511-5-3, 20–22 cm. 9–10. *Trilites* cf. *paravallatus* W. Kr., 1959, Sample 511-4-2, 25–27 cm. 11–12. cf. *Trilites* sp. 1, Sample 511-6-3, 40–42 cm. 13. *Clavifera triplex* (Bolkhovitina), Bolkhovitina, 1966, Sample 511-5-1, 20–22 cm.

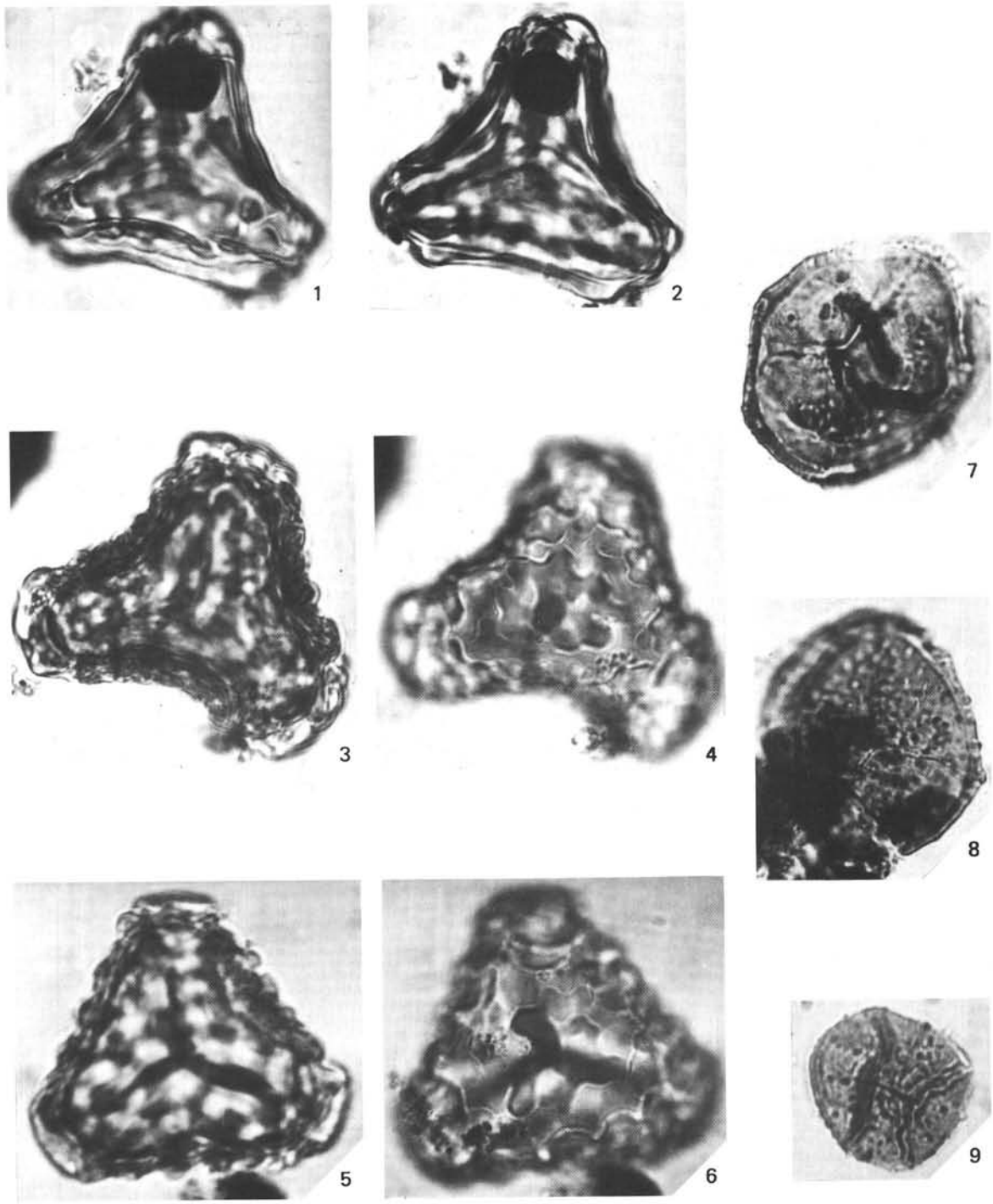
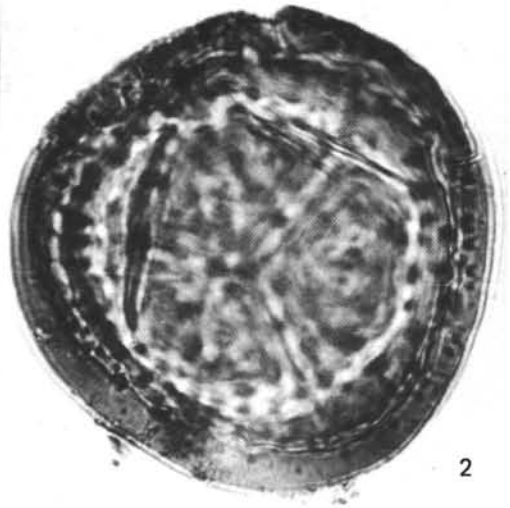
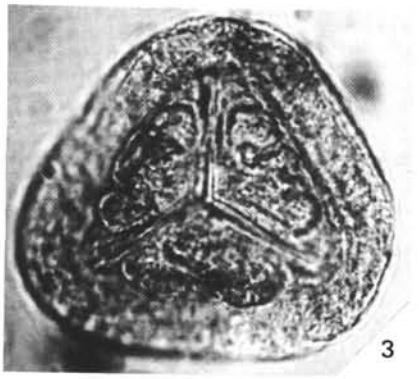
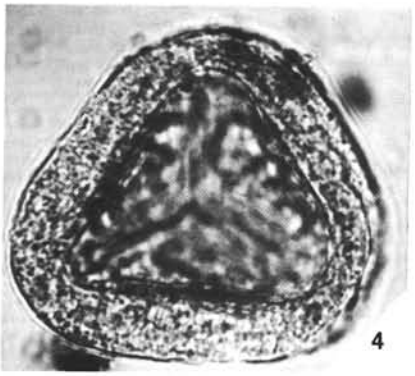
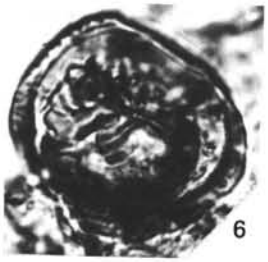


Plate 6. (All specimens magnified ×1000.) 1–2. cf. *Trilites* sp. 2, Sample 511-12-1, 25–27 cm. 3–4. *Dicksonia* aff. *squarrosa* Swartz, Sample 511-12-1, 25–27 cm. 5–6. *Dicksonia* sp., Sample 511-6-3, 40–42 cm. 7. *Foraminisporis dailyi* (Cookson and Dettmann), Dettmann, 1963, Sample 511-5-2, 20–22 cm. 8. *Foraminisporis wonthaggiensis* (Cookson and Dettmann), Dettmann, 1963, Sample 511-12-1, 25–27 cm. 9. *Foraminisporis* sp., Sample 511-9-7, 42–46.









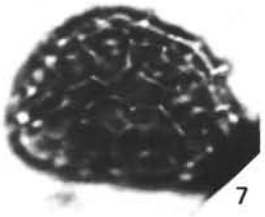
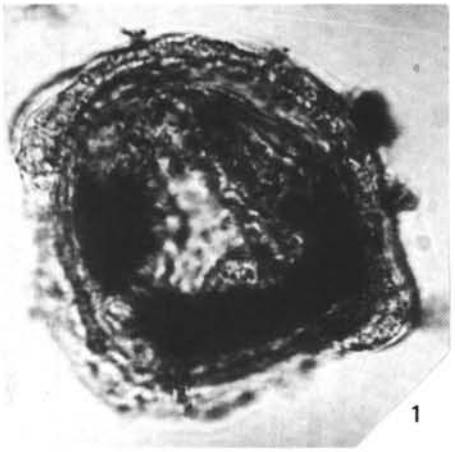
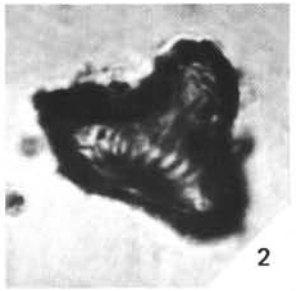
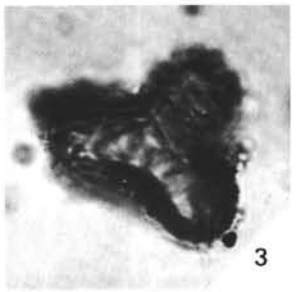
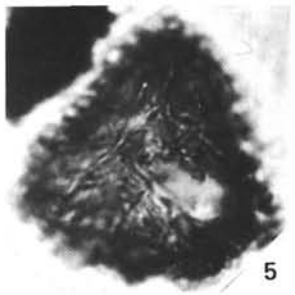


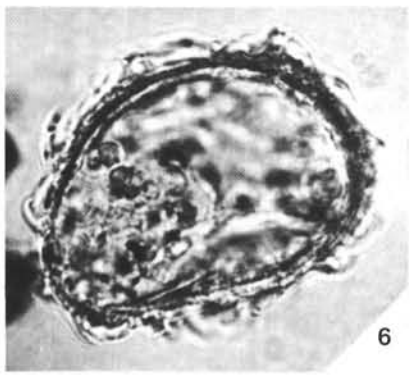
Plate 7. (All specimens magnified ×1000.) 1–2. *Cyatheacidites* sp. 1, Sample 511-6-2, 40–42 cm. 3–4. *Cyatheacidites* sp. 2, Sample 511-4-3, 25–27 cm. 5. *Cingutriletes australis* (Cookson), Archangelsky, 1972, Sample 511-12-1, 25–27 cm. 6. *Cingutriletes clavus* (Balme), Dettmann, 1963, Sample 511-12-1, 25–27 cm. 7–8. *Polypodiidites* sp., Sample 511-5-1, 20–22 cm. 9. *Polypodiites speciosus* (Harris), Archangelsky, 1972, Sample 511-12-1, 25–27 cm.











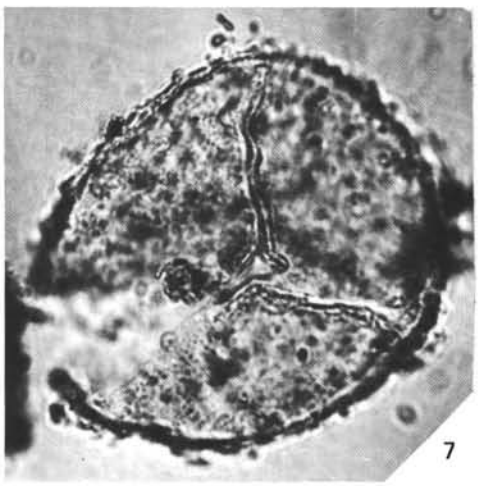


Plate 8. (All specimens magnified ×1000.) 1. *Triletes* sp. E; Koreneva, 1964, Sample 511-9-4, 92–96 cm. 2–3. *Form* sp. 1, Sample 511-6-2, 40–42 cm. 4–5. *Form* sp. 2, Sample 511-5-3, 20–22 cm. 6. *Form* sp. 3, Sample 511-5-3, 20–22 cm. 7. *Form* sp. 4, Sample 511-5-3, 20–22 cm. 8. *Aequitriradites* sp., Sample 511-6-3, 40–42 cm.

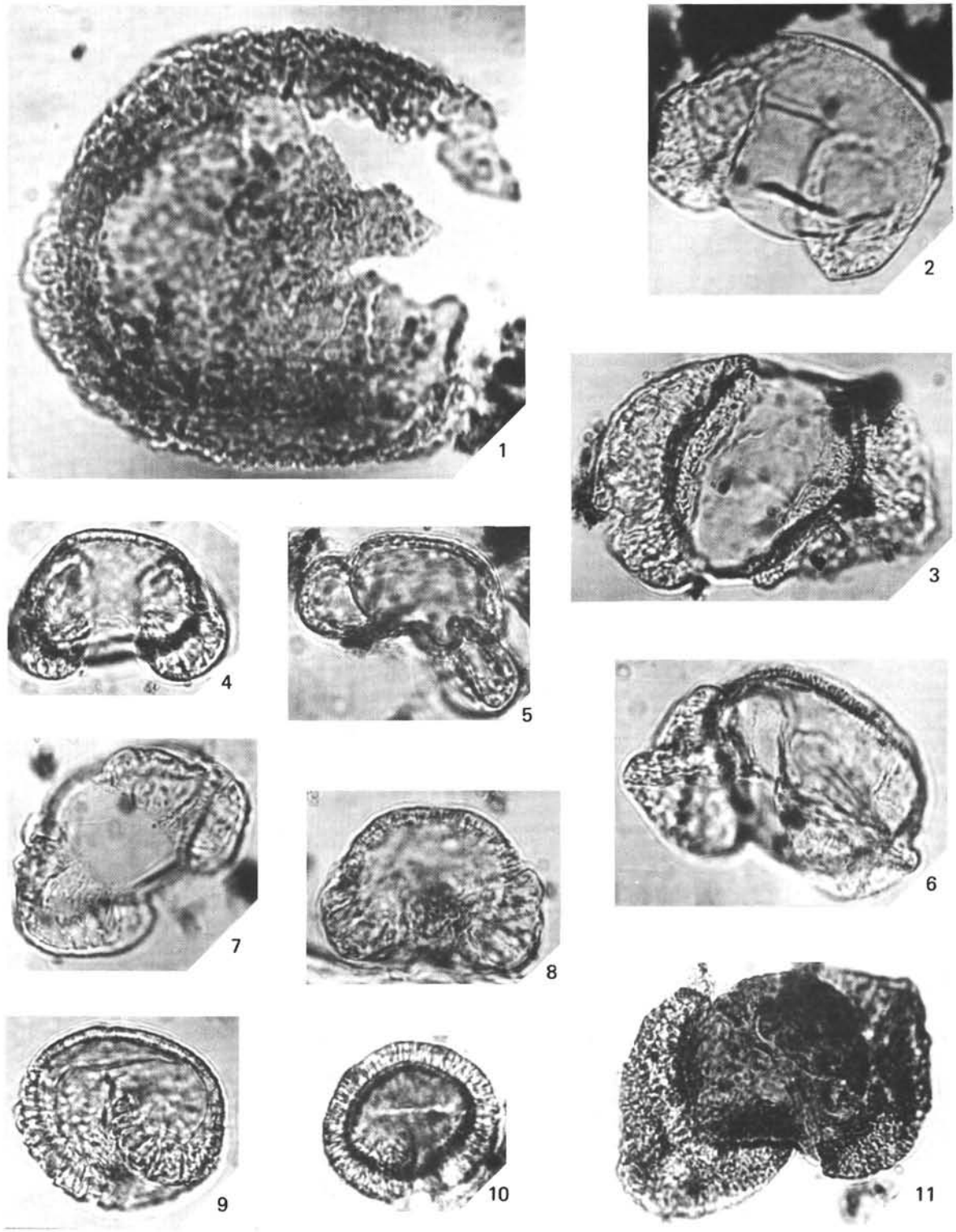


Plate 9. (All specimens magnified ×1000.) 1. *Tsugaepollenites* sp., Sample 511-5-2, 20–22 cm. 2. *Pinuspollenites* sp., Sample 511-6-2, 40–42 cm. 3. *Podocarpidites marwickii* Couper, 1953, Sample 511-6-2, 40–42 cm. 4–5. *Podocarpidites elegans* Romero, 1977 Sample 511-6-2, 40–42 cm. 6. *Podocarpidites microreticuloidata* Cookson, 1947, Sample 511-6-2, 40–42 cm. 7. *Dacrydiumites* sp., Sample 511-5-2, 20–22 cm. 8–9. *Dacrydium cupressinum* Soland. ex Forst. (8) Sample 511-6-2, 40–42 cm, (9) Sample 511-5-4, 20–22 cm. 10. *Dacrydium* aff. *cupressinum* Soland. ex Forst., Sample 511-9-7, 42–46 cm. 11. *Podocarpidites* sp., Sample 511-4-2, 25–27 cm.

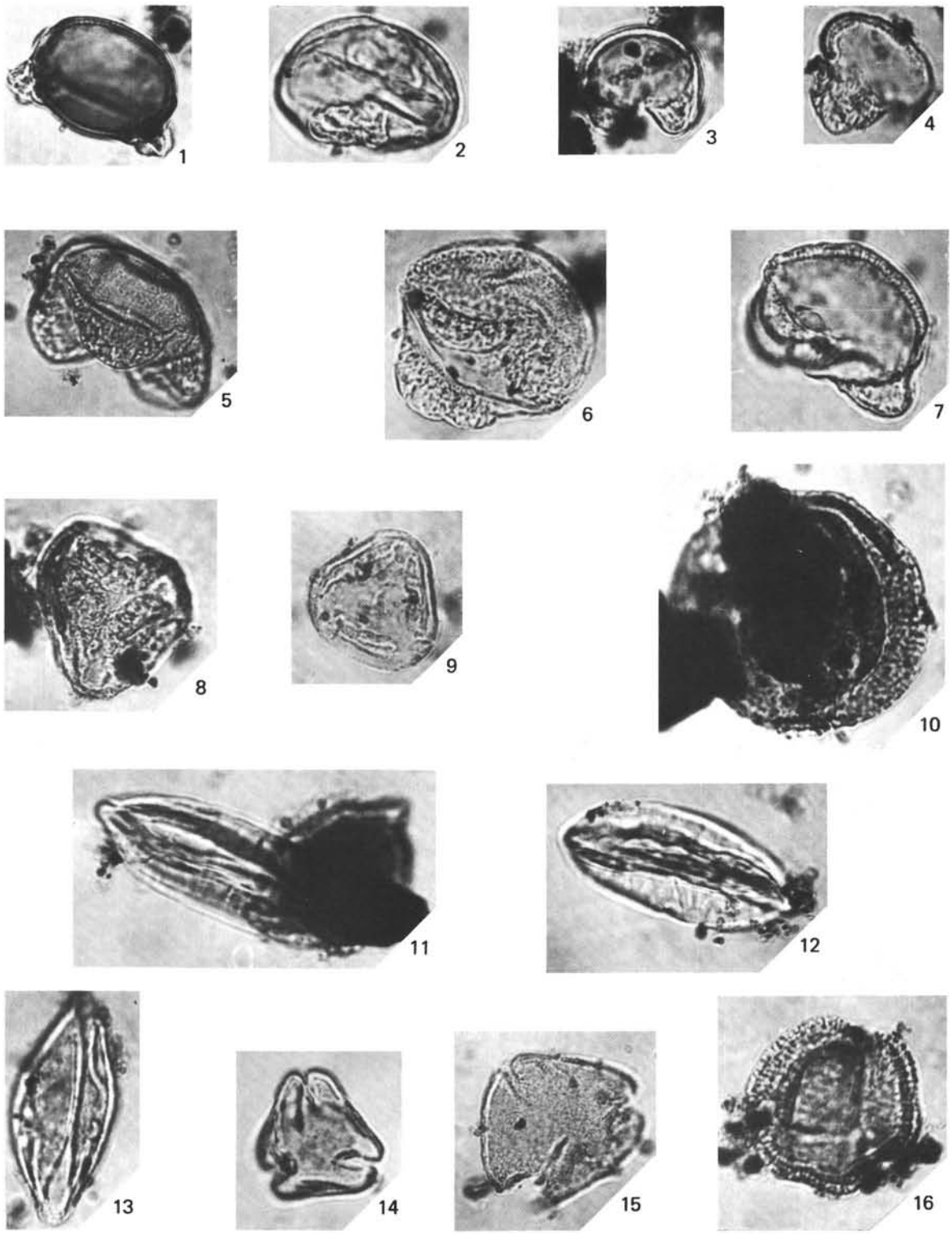


Plate 10. (All specimens magnified ×1000.) 1. *Phyllocladidites mawsonii* Cookson, 1947, Sample 511-16-1, 33–35 cm. 2. *Phyllocladidites mawsonii* cf. *verrucosus* Cookson, 1947, Sample 511-6-2, 40–42 cm. 3–4. *Phyllocladidites* sp. (3) Sample 511-4-3, 25–27 cm, (4) Sample 511-6-2, 40–42 cm. 5–6. *Microcachrydites antarcticus* Cookson, 1947 (5) Sample 511-11-3, 40–44 cm, (6) Sample 511-5-2, 20–22 cm. 7. *Microcachrydites parvus* Couper, 1960, Sample 511-6-2, 40–42 cm. 8. *Trisaccites microsaccatus* (Couper), Couper, 1960, Sample 511-6-2, 40–42 cm. 9. *Trisaccites* sp., Sample 511-5-2, 20–22 cm. 10. *Araucariacites* sp., Sample 511-6-2, 40–42 cm. 11–12. *Ephedra* sp. (11) Sample 511-3-1, 74–76 cm, (12) Sample 511-4-2, 25–27 cm. 13. *Monosulcites* sp., Sample 511-6-2, 40–42 cm. 14–15. "*Tricolpites*" cf. *gillii* Cookson, 1957 (14) Sample 511-12-1, 25–27 cm, (15) Sample 511-9-3, 92–96 cm. 16. *Tricolpites alveolatus* Couper, 1953, Sample 511-6-2, 40–42 cm.

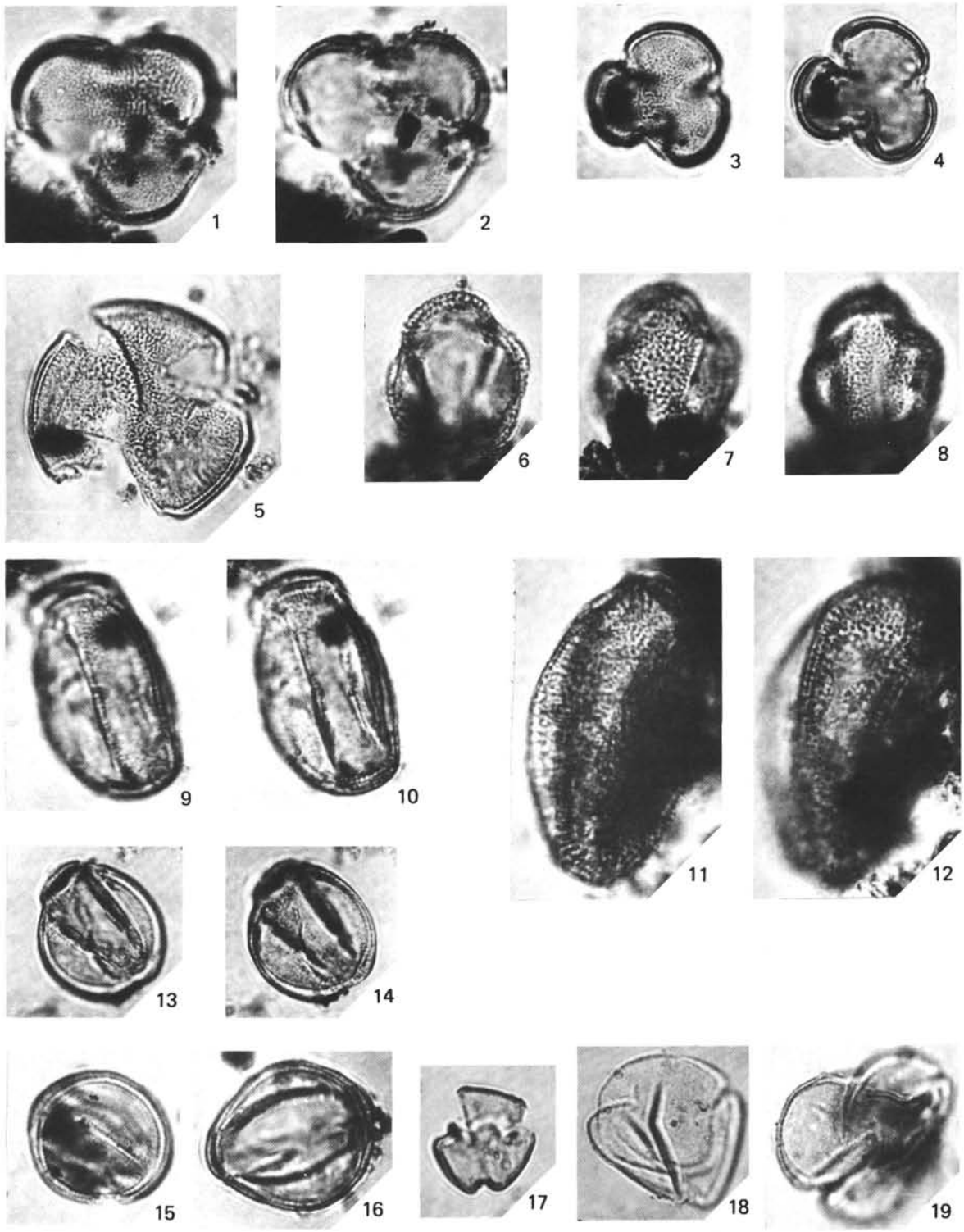


Plate 11. (All specimens magnified ×1000.) 1–2. *Tricolpites brevicolpus* Couper, 1960, Sample 511-12-1, 25–27 cm. 3–4. *Tricolpites* cf. *brevicolpus* Couper, 1960, Sample 511-16-1, 33–35 cm. 5. *Tricolpites fissilis* Couper, 1960, Sample 511-16-1, 33–35 cm. 6–8. *Tricolpites waiparaensis* Couper, 1960, Sample 511-6-1, 40–42 cm. 9–10. *Tricolpites* sp. 1, Sample 511-6-3, 40–42 cm. 11–12. *Tricolpites* sp. 2, Sample 511-6-3, 40–42 cm. 13–14. *Tricolpites* sp. 3, Sample 511-16-1, 33–35 cm. 15–16. *Tricolpites* sp. 3 (15) Sample 511-6-4, 40–42 cm, (16) Sample 511-6-2, 40–42 cm. 17. *Tricolpites* sp. 4, Sample 511-5-2, 20–22 cm. 18–19. *Tricolpites* sp. 5 (18) Sample 511-9-7, 42–46 cm, (19) Sample 511-5,CC.

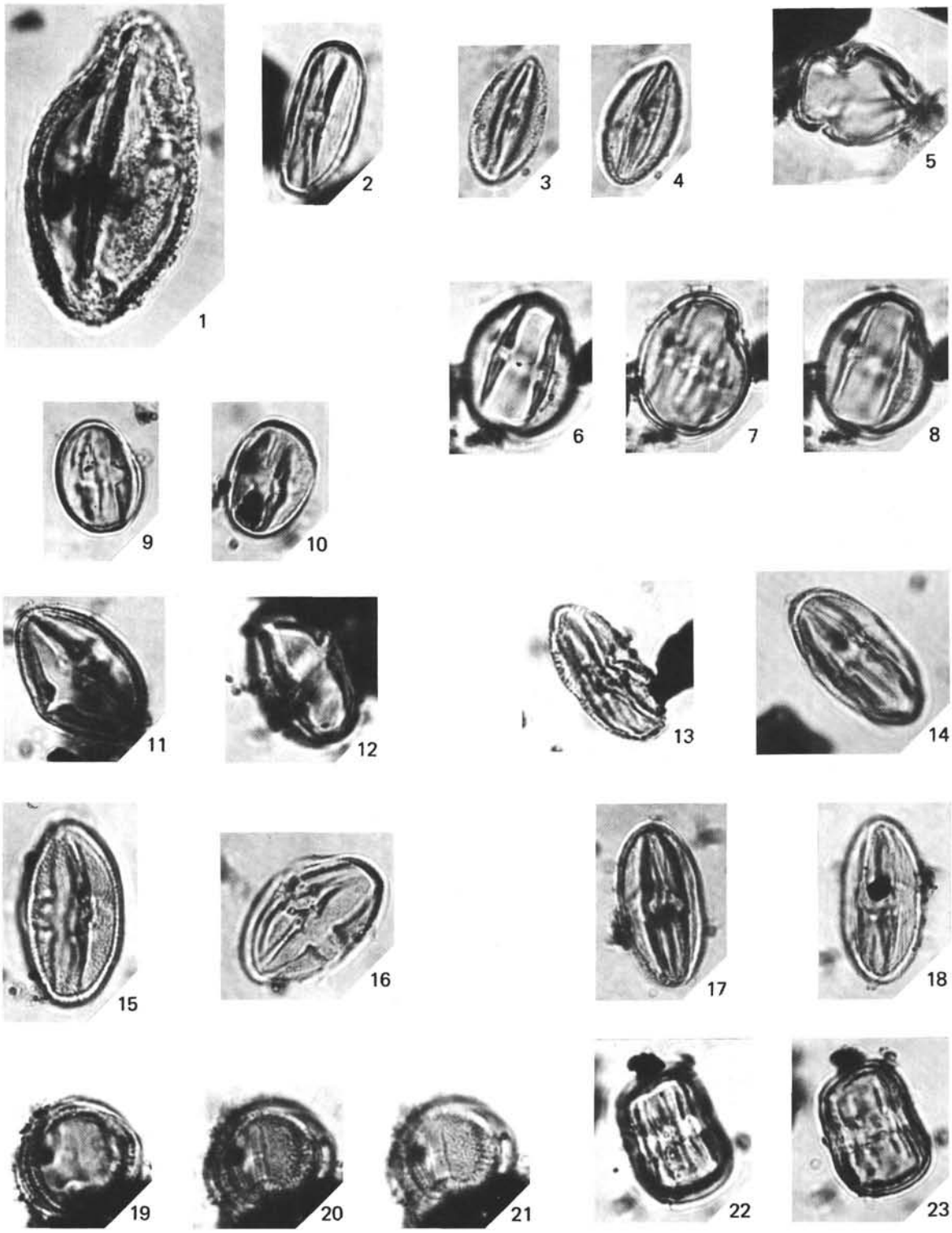


Plate 12. (All specimens magnified ×1000.) 1. *Tricolporopollenites* sp. 1, Sample 511-12-1, 25–27 cm. 2. *Tricolporopollenites* sp. 2, Sample 511-6-2, 40–42 cm. 3–4. *Tricolporopollenites* sp. 3, Sample 511-9-3, 92–96 cm. 5. *Tricolporopollenites* sp. 4, Sample 511-6-2, 40–42 cm. 6–8. *Tricolporites scabratus* Harris, 1965, Sample 511-9-3, 92–96 cm. 9–10. *Psilatricolporites* sp. (9) Sample 511-6-2, 40–42 cm, (10) Sample 511-6-4, 40–42 cm. 11–12,. *Rhoipites communis* Sah, 1967 (11) Sample 511-6-2, 40–42 cm, (12) Sample 511-6-2, 40–42 cm. 13–14. *Rhoipites baculatus* Archangelsky, 1973 (13) Sample 511-5-2, 20–22 cm, (14) Sample 511-9-4, 92–96 cm. 15–16. *Rhoipites striatoreticulatus* Sah, 1967 (15) Sample 511-6-2, 40–42 cm, (16) Sample 511-5-2, 20–22 cm. 17–18. *Rhoipites* sp., Sample 511-6-2, 40–42 cm. 19–21. *Senipites* cf. *tercrassata* Archangelsky, 1973, Sample 5,CC. 22–23. *Tetracolporites* sp., Sample 511-5-2, 20–22 cm.

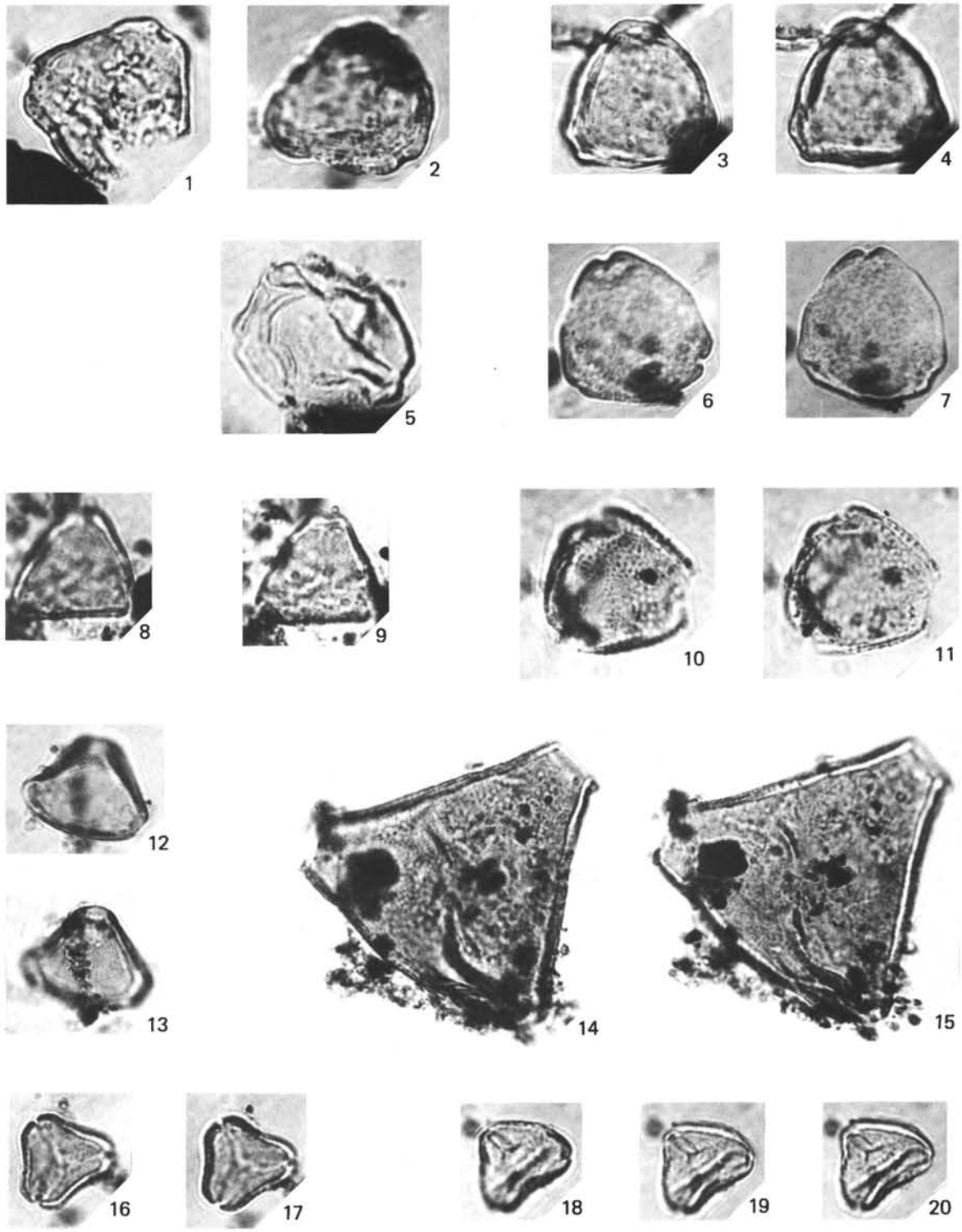


Plate 13. (All specimens magnified ×1000.) 1–2. *Triorites harrisii* Couper, 1953 (1) Sample 511-12-1, 25–27 cm, (2) Sample 511-12-2, 25–27 cm. 3–4. *Casuarinidites cainozoicus* Denmark, Sample 511-6-2, 40–42 cm. 5–7. *Casuarinidites* sp. (5) Sample 5,CC, (6–7) Sample 511-6-2, 40–42 cm. 8–9. *Proteacidites minimus* Couper, 1954, Sample 511-5-2, 20–22 cm. 10–11. *Proteacidites* cf. *retiformis* Couper, 1960, Sample 511-4-3, 25–27 cm. 12–13. *Proteacidites* sp., Sample 511-5-1, 20–22 cm. 14–15. *Proteacidites rectomarginis* Cookson, 1950, Sample 511-6-1, 40–42 cm. 16–17. *Myrtaceidites* sp., Sample 511-5-2, 20–22 cm. 18–20. *Myrtaceidites parvus* forma *nesus* Cookson and Pike, 1954, Sample 511-5-3, 20–22 cm.

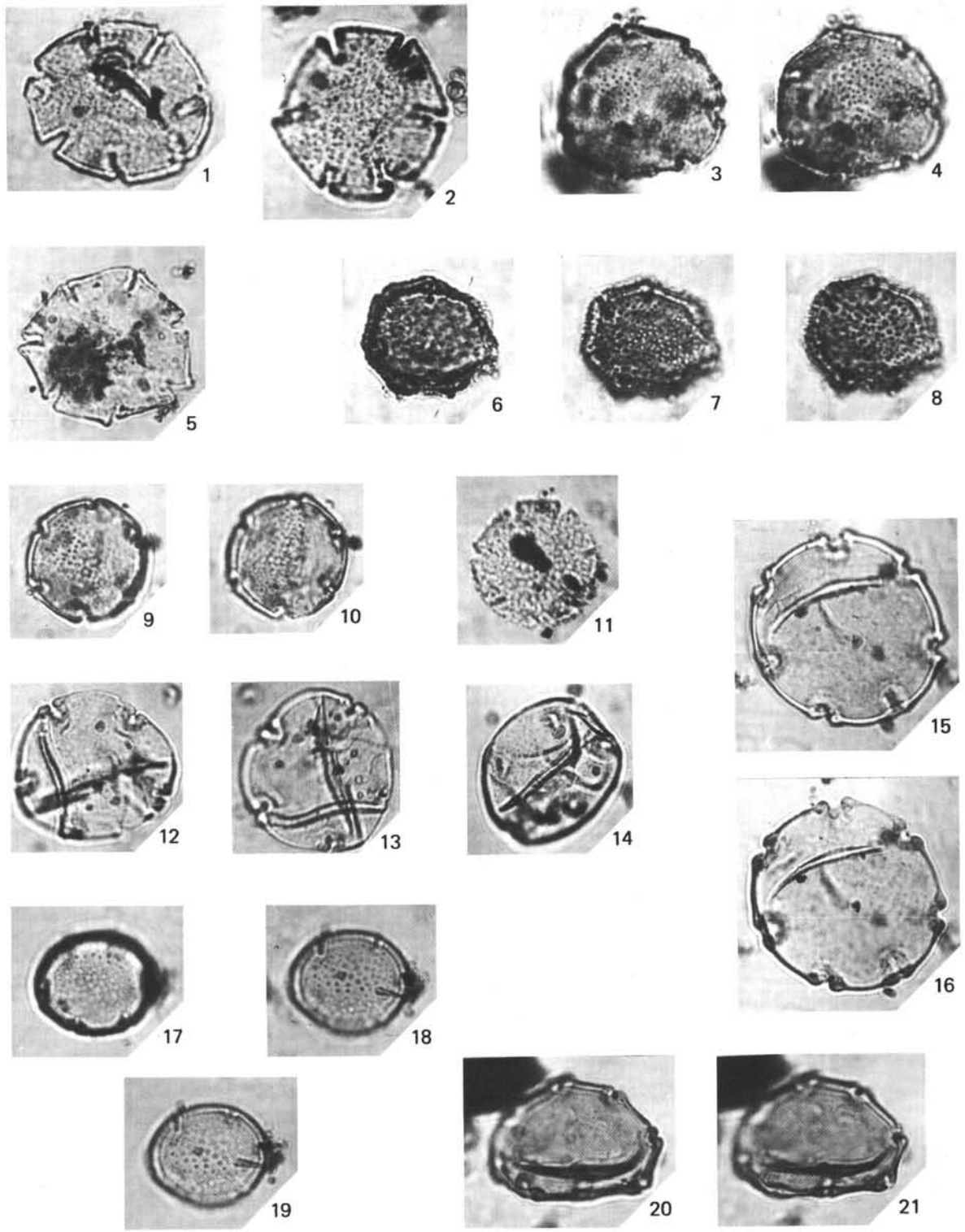


Plate 14. (All specimens magnified ×1000.) 1–2. *Nothofagidites asperus* (Cookson), Romero, 1973 (1) Sample 511-12-2, 25–27 cm, (2) Sample 511-5-2, 20–22 cm. 3–4. *Nothofagidites deminuta* (Cookson), Romero, 1977, Sample 511-5-1, 20–22 cm. 5. *Nothofagidites cranwellae* (Couper), Fasola, 1969, Sample 511-6-2, 40–42 cm. 6–8. *Nothofagidites spinosus* Couper, 1960, Sample 511-6-2, 40–42 cm. 9–10. *Nothofagidites brachispinulosa* (Cookson), Harris, 1965, Sample 511-5-2, 20–22 cm. 11. *Nothofagidites* sp. 1, Sample 511-6-2, 40–42 cm. 12–14. *Nothofagidites* sp. 2 (12–13) Sample 6-2, 40–42 cm, (14) Sample 511-16-1, 33–35 cm. 15–16. *Nothofagidites cincta* (Cookson), Fasola, 1969, Sample 511-9-3, 93–96 cm. 17–19. *Nothofagidites* sp. 3, Sample 511-5-2, 20–22 cm. 20–21. *Nothofagidites* sp. 4, Sample 511-5-2, 20–22 cm.

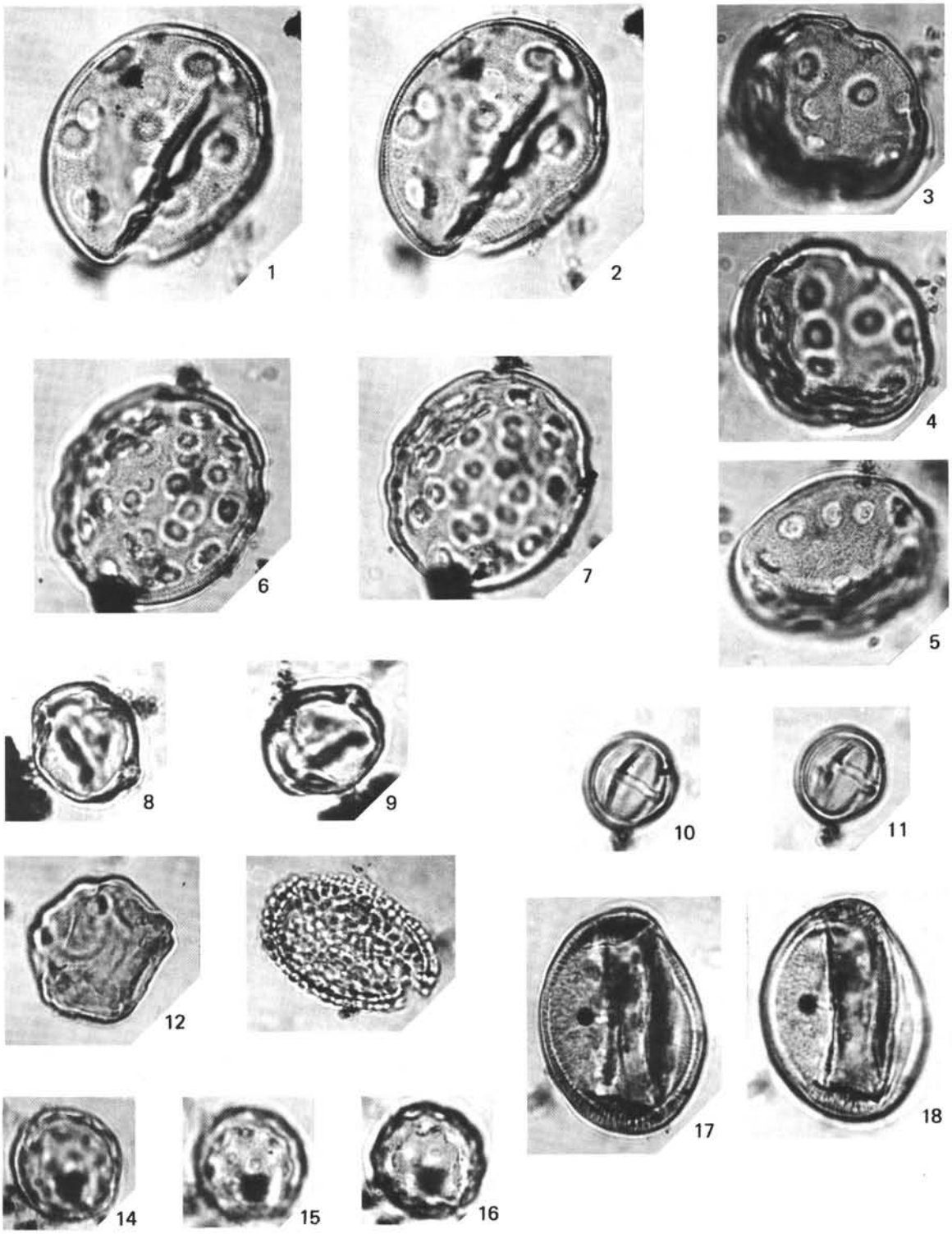
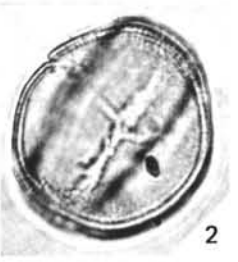
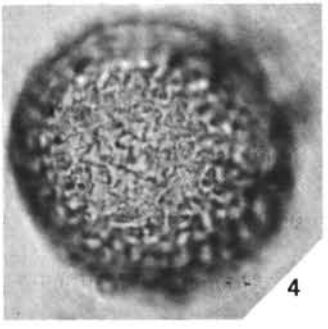
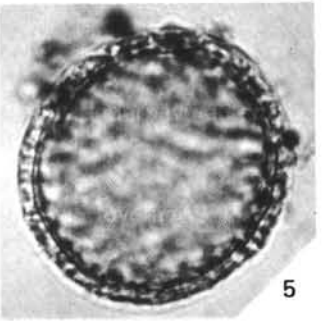
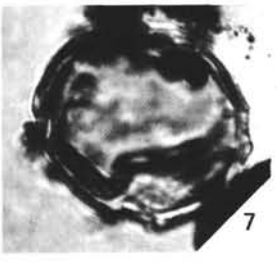


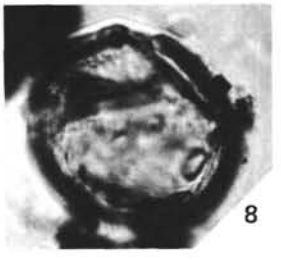
Plate 15. (All specimens magnified ×1000.) 1–5. *Parsonsidites* cf. *psilatus* Couper, 1960 (1–2) Sample 511-5-1, 20–22 cm. (3–5) Sample 511-6-3, 40–42 cm. 6–7. *Parsonsidites* cf. *conspicuus* Frederiksen, 1973, Sample 511-5-2, 20–22 cm. 8–9. *Rhizophora* sp. 1, Sample 511-9-3, 92–96 cm. 10–11. *Rhizophora* sp. 2, Sample 511-5-1, 20–22 cm. 12. *Alnus* sp., Sample 511-12-1, 25–27 cm. 13. *Ilex* sp., Sample 511-5-1, 20–22 cm. 14–16. Chenopodiaceae, Sample 511-5,CC. 17–18. *Polygonum* sp., Sample 511-9-4, 92–96 cm.











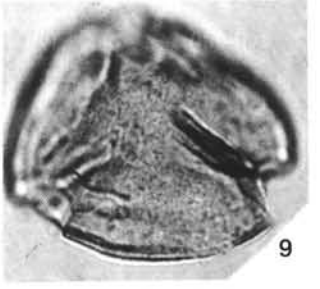


Plate 16. (All specimens magnified ×1000.) 1–3. *Form* sp. 1, Sample 511-6-2, 40–42 cm. 4–5. *Form* sp. 2, Sample 511-9-7, 42–46 cm. 6. *Form* sp. 3, Sample 511-9-4, 92–96 cm. 7–8. *Form* sp. 4, Sample 511-5-4, 20–22 cm. 9. *Form* sp. 5, Sample 511-9-7, 42–46 cm.

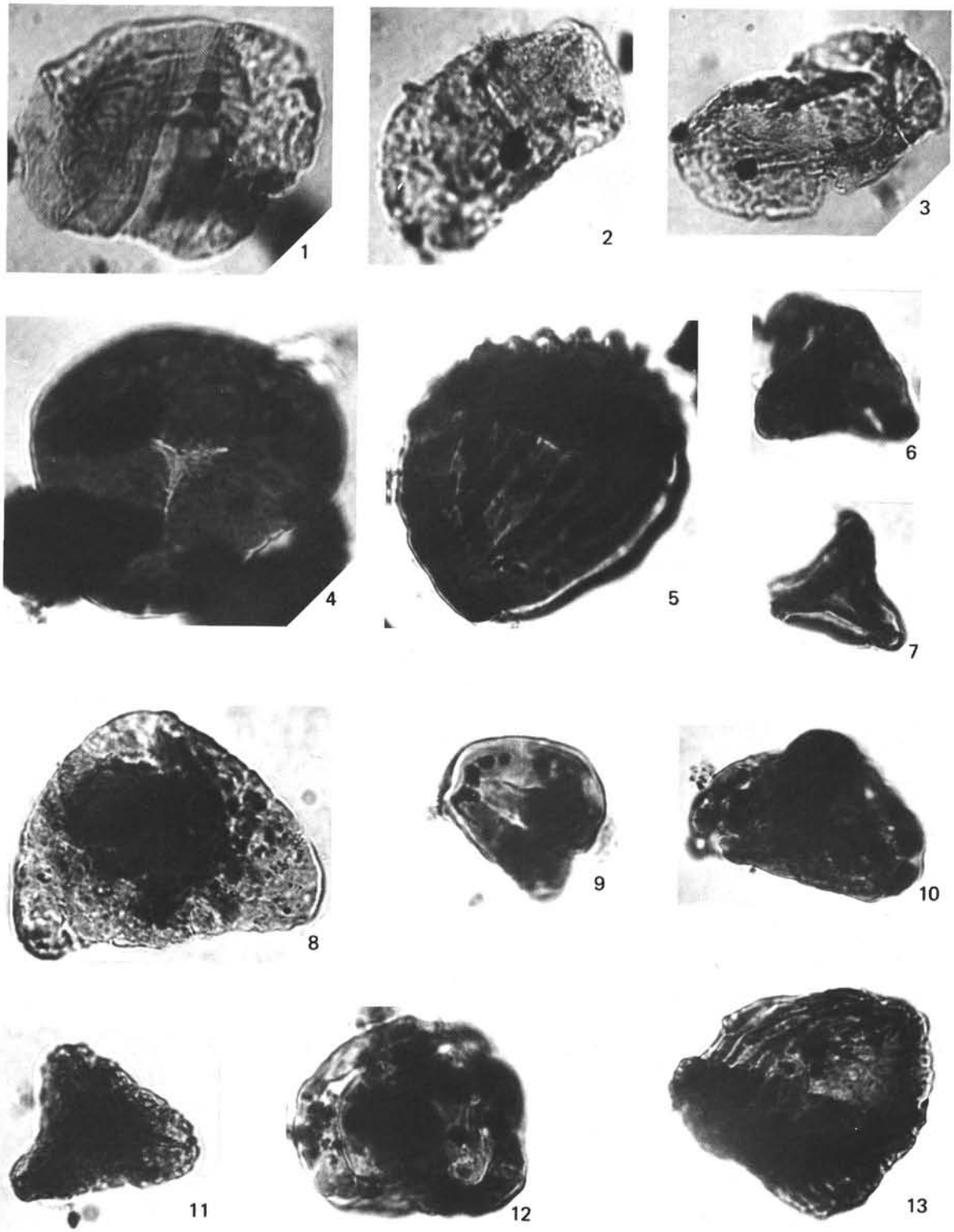


Plate 17. (All specimens magnified ×1000.) 1–3. Striate pollen (1) Sample 511-4-2, 25–27 cm, (2) Sample 511-5-4, 20–22 cm, (3) Sample 511-4-3, 25–27 cm. 4. *Leiotriletes*?, Sample 511-5-2, 20–22 cm. 5. *Cicatricosisporites* sp., Sample 511-6-2, 40–42 cm. 6–7. *Gleicheniidites*? (6) Sample 511-6-2, 40–42 cm, (7) Sample 511-5-4, 20–22 cm. 8–12. Spore? (8) Sample 511-5,CC, (9) Sample 511-9-3, 92–96 cm, (10) Sample 511-11-3, 40–44 cm, (11) Sample 511-9-2, 92–96 cm, (12) Sample 511-6-1, 40–42 cm. 13. *Cicatricosisporites* sp., Sample 511-6-2, 40–42 cm.