

32. PALYNOLOGICAL STUDY OF UPPER JURASSIC AND LOWER CRETACEOUS SEDIMENTS, SITE 511, DEEP SEA DRILLING PROJECT LEG 71 (FALKLAND PLATEAU)¹

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ABSTRACT

Samples from Upper Jurassic and Lower Cretaceous sediments at Site 511 were analyzed for palynomorphs. Three palynological assemblages were identified: Upper Jurassic (presumably Tithonian), Neocomian-Aptian, and lower Albian. These were correlated to synchronous assemblages in Argentina, South Africa, and Australia and were compared with Jurassic palynoassemblages from Hole 330, Leg 36.

INTRODUCTION

At Site 511, on the Falkland Plateau (western part of the Maurice Ewing Bank), Upper Jurassic and Lower Cretaceous sediments were penetrated by Hole 511, drilled to a depth of 632 meters some 10 km from Site 330 (Leg 36). Within the Jurassic-Lower Cretaceous interval, two lithological units (Units 5 and Unit 6) were identified. The upper unit (Unit 5) is composed of calcareous claystones. Their oxidation state did not favor the preservation of organic matter: the sediments contain no spores, pollen, dinoflagellate cysts, or plant detritus.

The lower unit (Unit 6) is composed of black shales containing 1.7–4.1% organic carbon. In this unit, only 47 of all samples taken contained spores, pollen, dinoflagellate cysts, and great amounts of plant detritus.

The samples were treated with hydrochloric acid, potassium sodium hydroxide, hydrofluoric acid, and cadmium liquid.

The results of the palynological analysis are summarized in Table 1, which shows the percentage of spores and pollen. Figure 1 shows the stratigraphic distribution of the most characteristic species and genera. Photographs in Plates 1–15 were made with a Biolam microscope and a MNF-12 microphotographic device.

DISTRIBUTION OF SPORES AND POLLEN IN UPPER JURASSIC AND LOWER CRETACEOUS SEDIMENTS AT SITE 511; AGE OF PALYNOASSEMBLAGES

Organic remains of plant origin in the interval between 498 and 632 meters (Unit 6, Cores 70–56) consisted of plant detritus, spores, pollen, and dinoflagellate cysts. The last were not examined in this study. Plant detritus in Cores 70–59 is in the form of amorphous sapropelic material and fragments of cuticles and tracheids belonging to terrestrial plants. The distribution of pollen and spores in this interval is variable. They are abundant in Cores 70–68 and 63–60 but not numerous in Cores 67–64 and 59. In some samples from the uppermost parts of

this interval (Cores 63, 61, 59), amorphous detritus is coagulated into rounded yellow brown aggregates with an admixture of pyrite. Traces of pyrite are seen on the surfaces of spores and pollen.

The available sapropelic material enables us to assume that black shales in this interval were formed under anaerobic conditions. The uneven distribution of pollen and spores suggests an alternation of anaerobic conditions with slightly oxidizing environments. However, low abundances of spores can be due to unfavorable climatic conditions for ferns on the nearby land. Amorphous sapropelic material disappears at the beginning of Core 58.

In Sample 511-58-3, 53–55 cm, the plant detritus consists of large, bright orange, cuticular remains. The content and diversity of fern spores sharply increase. From Sample 511-58-2, 142–144 cm to Sample 511-56-4, 142–144 cm the plant detritus contains fragments of middle-sized cuticles and tracheids, brown to black in color, with an admixture of crushed micrinitic material. Disappearance of sapropelic material may denote the beginning of oxidizing processes, and the admixture of micrinitic material may suggest a certain remoteness from a source area. Diverse and numerous fern spores lead us to assume that climatic conditions for the existence of ferns were favorable on the nearby land.

The palynological analysis allowed us to distinguish three assemblages within the interval from 495 to 632 meters.

Assemblage I

Assemblage I was identified in the interval from 632 to 555 meters (Cores 70–63). Of 31 samples analyzed, 18 contained spores and pollen.

The assemblage abounds in gymnosperm pollen in which *Classopollis* predominates (45.5–78%) and *Vitreisporites pallidus* (7.5–38%) is abundant. Bisaccate and trisaccate conifer pollen and pollen of the genus *Callialasporites* (*C. dampieri*, *C. trilobatus*, *C. turbatus*, *C. segmentatus*) are always present. Less frequent is monosaccate conifer pollen (*Monosaccites* sp. 1), *Sulcosaccispora* sp., and *Araucariacites australis*. Spores are not numerous (2.0–8%) and are represented mostly by *Antulsporites saevus*, *A. varigranulatus*, *Converrucos-*

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

Table 1. Percentage chart of spores and pollen in Upper Jurassic and Lower Cretaceous sediments, Site 511.

Species	Core/Section (interval in cm)																			
	70-5, 22-24	70-4, 22-24	70-3, 22-24	70-2, 22-24	70-1, 22-24	69-5, 42-44	69-4, 42-44	69-2, 42-44	68-3, 17-19	68-1, 17-19	67-5, 82-84	67-2, 82-84	66-1, 28-30	64-5, 55-59	64-1, 30-34	63, CC	63-3, 133-137	63-1, 130-134	62-5, 40-44	62-4, 120-124
Total Specimens	650	293	427	311	453	282	362	237	430	257	259	236	450	179	240	362	290	347	401	557
Spores	4.5	7.5	6.0	6.0	5.0	5.0	5.0	5.5	5.0	3.5	4.0	7.5	2.0	6.0	4.5	4.0	5.0	8.0	5.0	3.0
Gymnosperms	95.5	92.5	94.0	94.0	95.0	95.0	95.0	94.5	95.0	96.5	96.0	93.0	98.0	94.0	95.5	96.0	95.0	92.0	95.0	97.0
Angiosperms																				
Spores																				
1. <i>Anapiculatisporites dawsonensis</i>	+																0.5			
2. <i>Antulsporites saevus</i>	+	+		+	+	+	+	+	+	+	+		1.5		+	+	0.5	+	+	+
3. <i>A. varigranulatus</i>		+	+		+															
4. <i>Appendicisporites sp.</i>																				
5. <i>Baculatisporites comaumensis</i>	+																			
6. <i>Biretrispores sp.</i>																				
7. <i>Ceratosporites distalgranulatus</i>																				
8. <i>Cibotiumspora sp.</i>																				
9. <i>Cicatricosporites australiensis</i>																				
10. <i>C. hallei</i>																				
11. <i>C. hughesi</i>																				
12. <i>C. ludbrooki</i>																				
13. <i>C. proxiradiatus</i>																				
14. <i>Cicatricosporites sp. 1</i>																				
15. <i>C. sp. 2</i>																				
16. <i>C. sp. 3</i>																				
17. <i>C. sp. 4</i>																				
18. <i>C. sp. 5</i>																				
19. <i>Cinguritrites clavus</i>																				
20. <i>Concavissimisporites variverrucatus</i>	+	+																		
21. <i>C. sp.</i>	+																0.5	+	+	
22. <i>Contignisporites cooksonii</i>	+	+		+																
23. <i>C. forniciatus</i>																				
24. <i>Con verrucosporites utriculosus</i>																				
25. <i>Coronatispora valdensis</i>																				
26. <i>C. perforata</i>																				
27. <i>Crybelosporites aff. striatus</i>																				
28. <i>C. sp. 1</i>																				
29. <i>C. berberioides</i>	+	+			+															
30. <i>Cyatheacidites tectifera</i>																				
31. <i>C. sp. 1</i>																				
32. <i>C. sp. 2</i>																				
33. <i>Cyathidites australis</i>																	0.5	+	+	0.5
34. <i>C. minor</i>	+	0.5	1.0	1.0	1.0	+	+	0.5		1.0	+	0.5	+	1.0		+	0.5	1.5	1.0	+
35. <i>Cyclocystella sp.</i>																				
36. <i>Densisporites velatus</i>																				
37. <i>Dictyophyllidites sp.</i>																				
38. <i>Dictyotosporites complex</i>																				
39. <i>Distaltriangulisporites pelliculus</i>																				
40. <i>Foveosporites moretonensis</i>																				
41. <i>F. subtriangularis</i>																				
42. <i>Gleicheniidites senonicus</i>	+	1.0	0.5	1.5	+	+	+	+	+	1.0	+	+	+	2.0	+	1.0	1.0	+	0.5	0.5
43. <i>G. spp.</i>																				
44. <i>Granulatisporites sp.</i>																				
45. <i>Interulobites algoensis</i>																	0.5	+	+	+
46. <i>I. sinuosus</i>																				
47. <i>I. triangularis</i>																				
48. <i>I. sp.</i>																				
49. <i>Ischyosporites crateris</i>																				
50. <i>I. marburgensis</i>																				
51. <i>I. volkheimeri</i>																				
52. <i>I. sp. 1</i>																				
53. <i>I. sp. 2</i>																				
54. <i>Kuklisporites lacunus</i>																				
55. <i>Kuylisporites lunaris</i>																				
56. <i>Laevigatosporites ovatus</i>																				

Note: + indicates content < 0.5%.

sporites utriculosus, Cyathidites australis, *C. minor*, *Dictyophyllidites* sp., Gleicheniidites senonicus, *Interulobites algoensis*, *I. triangularis*, *I. sinuosus*, *Ischyosporites crateris*, *Marattisporites scaberratus*, and others (Plate 1). Less frequently recognized were *Anapiculatisporites dawsonensis*, *Concavissimisporites variverrucatus*, *Contignisporites cooksonii*, *Dictyotosporites complex*, *Foveosporites subtriangularis*, *Ischyosporites crateris*, *Marattisporites scaberratus*, and others (Plate 1).

The age of Assemblage I is Upper Jurassic. No forms that were observed are peculiar to Lower Cretaceous sediments. The assemblage contains species and genera that are always found in Jurassic sediments of Australia, Argentina, and South Africa: trisaccate conifer pol-

Table 1. (Continued).

len, *Callialasporites* spp., *Contignisporites cooksonii*, *Antulsporites saevus*, *Ischyosporites* spp., *Matonisporites crassiangulatus*, *Dictyotosporites complex*. *Contignisporites cooksonii* appears in Australia and Argentina in Upper Jurassic sediments (Volkheimer and Quattrocchio, 1975; Filatoff, 1975). Most similar in composition to the Jurassic assemblage of Site 511 is an assemblage studied from sediments of the Vaca Muerta Formation

(Neuquén Province, Argentina), the lower-middle Ti-thonian age of which has been established by means of pelecypods, ammonites, fish, and remains of ichthyosaurs (Volkheimer and Quattrocchio, 1975; Malumíán and Báez, 1976). The palynoassemblage of this formation is characterized by abundance of *Classopollis* (up to 64.6%), a small amount of *Araucariacites australis*, trisaccate conifer pollen, the presence of the spores *Con-*

Table 1. (Continued).

Species	Core/Section (interval in cm)																			
	70-5, 22-24	70-4, 22-24	70-3, 22-24	70-2, 22-24	70-1, 22-24	69-5, 42-44	69-4, 42-44	69-2, 42-44	68-3, 17-19	68-1, 17-19	67-5, 82-84	67-2, 82-84	66-1, 28-30	64-5, 55-59	64-1, 30-34	63, CC	63-3, 133-137	63-1, 130-134	62-5, 40-44	62-4, 120-124
57. <i>Leptolepidites verrucatus</i>	+	+	+	+	0.5	+	+	1.0	+	+	+	+	+	+	+	+	+	+	+	
58. <i>L. macroverrucosus</i>																				
59. <i>Lycopodiumsporites</i> sp.	0.5	+	0.5	+	+	+	+	0.5	+	+					1.0	+	+	+	+	
60. <i>Marattisporites scabrinus</i>																				
61. <i>Matonispores crassiangulatus</i>	+	+	+	+	+	+	+		+	+	+	+	+	+		+	+	+	+	
62. <i>Muricungulispores annulatus</i>																				
63. <i>Neoraistrickia</i> sp.																				
64. <i>Nevesisporites</i> sp.	+	+				+	+		+	+	+	+	+	+	+	0.5	0.5			
65. <i>Osmundacitides wellmanii</i>						+	+													
66. <i>Patellaspores</i> sp.																			+	
67. <i>Perostrilites linearis</i>																				
68. <i>Polypodiaceoisporites elegans</i>																			+	
69. <i>Sestrosporites pseudoalveolatus</i>																				
70. <i>Staplinispores caminus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	+	+	+	
71. <i>Stereisporites antiquasporites</i>																				
72. <i>Taucousporites segmentatus</i>																				
73. <i>Todisporites rotundiformis</i>															0.5	+	+	+	+	
74. <i>Trilites</i> sp. 1																				
Gymnosperms																				
75. <i>Alisporites grandis</i>																0.5	0.5	+	+	
76. <i>A. lowoodensis</i>	1.0	1.0	0.5	2.0	+	+	+	1.0	1.0	1.0	+	0.5	+	+	0.5	0.5	0.5	+	+	
77. <i>A. similis</i>	+		+	+			+	+				+			1.0					
78. <i>A. sp.</i>																				
79. <i>Araucariacites australis</i>	0.5																			
80. <i>Bisacado</i> sp. A																				
81. <i>Calialaspores dampieri</i>	1.5	+	+	1.5	2.5	+	5.5	1.0	1.5	1.0	2.5	+	2.0	3.0	9.0	3.5	1.0	4.5	2.5	
82. <i>C. trilobatus</i>	0.5	+			1.0	+	0.5	+	+		1.0	+	+	2.0	1.0	0.5	1.0	2.0	0.5	
83. <i>C. turbatus</i>	0.5						2.0				+					0.5	+			
84. <i>C. segmentatus</i>																				
85. <i>Classopollis</i> spp.	60.0	45.5	47.0	57.0	57.0	52.5	47.0	72.0	67.5	56.0	78.0	60.0	62.0	65.0	57.0	69.0	76.0	52.0	81.0	
86. <i>Cyclusphaera psilata</i>																		0.5	0.5	
87. <i>C. sp. A</i>	6.5	4.0	4.5	4.0	5.0	1.5	7.0	4.0	7.0	4.0	2.0	2.0	6.0	5.0	4.0	1.0	4.0	8.0	2.5	
88. <i>Disaccites</i>											0.5	1.0		0.5	1.0	0.5	+	+	+	
89. <i>Ephedripites</i> sp. 1	0.5																			
90. <i>E. sp. 2</i>																				
91. <i>E. sp. 3</i>																				
92. <i>E. spp.</i>																				
93. <i>E. sp. 5</i>																				
94. <i>Eucommiidites</i> sp.																				
95. <i>Exesipollenites</i> sp.																				
96. <i>Inaperturopollenites limbatus</i>																		1.0	3.0	
97. <i>I. sp.</i>	+	+				1.5			1.0											
98. <i>Microcachryidites antarcticus</i>																				
99. <i>M. sp.</i>																				
100. <i>Monosaccites</i> sp. 1	+	+	+	+	+															
101. <i>M. sp. 2</i>																				
102. <i>Monosulcites</i> spp.	0.5	1.0	+		1.0	+	+		2.0	2.5	2.0	+		1.0		0.5	1.0	+	+	
103. <i>Peromonolites</i> sp.	1.0		+	+							1.5	+								
104. <i>Podocarpidites</i> sp.	1.0		1.0	+	1.5	+	1.0		+	+	+	+	+	1.5		+	0.5	+	+	
105. <i>Podosporites</i> sp.	0.5	0.5	0.5	+	1.5	+	0.5	1.5	0.5	1.0	1.5	+	5.5		2.0	+	1.0	2.5	+	
106. <i>Rugubivesiculosites</i> sp.	+	+																		
107. <i>Sulcosaccispora</i> sp.																				
108. <i>Trisaccites</i> sp.																				
109. <i>Vitreisporites pallidus</i>	20.0	36.0	38.0	25.0	20.0	34.5	30.0	12.5	12.0	21.5	8.0	23.0	15.0	11.0	14.5	18.0	7.5	2.0	5.0	
110. <i>Steevesipollenites</i> sp.																				
Angiosperms																				
111. <i>Clavatipollenites incisus</i>																				
112. <i>C. rotundus</i>																				

Note: + indicates content less than 0.5%.

tignisporites cooksonii, *Interulobites* spp., *Leptolepidites* spp., and some other species. The only difference in the Vaca Muerta Formation is the presence there of two specimens of *Cicatricosisporites* (identified as *Appendicisporites*) in one interlayer. In the samples of Site 511, these spores appear in the Lower Cretaceous assemblage. The Oxfordian-Kimmeridgian assemblages in Argentina are not known. In the Callovian of Argentina (Neuquén Province), a small percentage of *Classopollis* (up

to 10%) was recorded; spores of the genus *Interulobites* are absent (Volkheimer, 1971). Upper Jurassic assemblages of Australia differ from those of Site 511 in their small percentage of *Classopollis* (5–20%) and large amount of *Araucariacites australis* pollen (35–40%) and in the presence of *Murosphaera florida* spores.

Assemblages of similar composition were distinguished from the Kirkwood Formation (except for the upper part) of the Uitenhage Group in South Africa.

Table 1. (Continued).

The Kirkwood Formation is composed of continental deposits, Upper Jurassic-Lower Cretaceous in age, and overlain by the Sundays River Formation, which contains benthic foraminifers, ostracodes, and mollusks that place its age within the Valanginian-Hauterivian (Scott, 1976). The palynological assemblage of the Kirkwood Formation and the Upper Jurassic assemblage of Site 511 are both characterized by a considerable content of *Classopollis* pollen and by the presence of spores of the genus *Interulobites*.

Assemblage II

Assemblage II was identified in the interval from 555 to 518 meters (Cores 62-59). Of 20 samples analyzed, 16 contained spores and pollen.

The assemblage abounds in gymnosperm pollens with in which, as in the previous assemblage, *Classopolis* (42-81%) and *Vitreisporites pallidus* (3-26%) are predominant. An important difference from the previous assemblage is the appearance of *Inaperturopollenites*

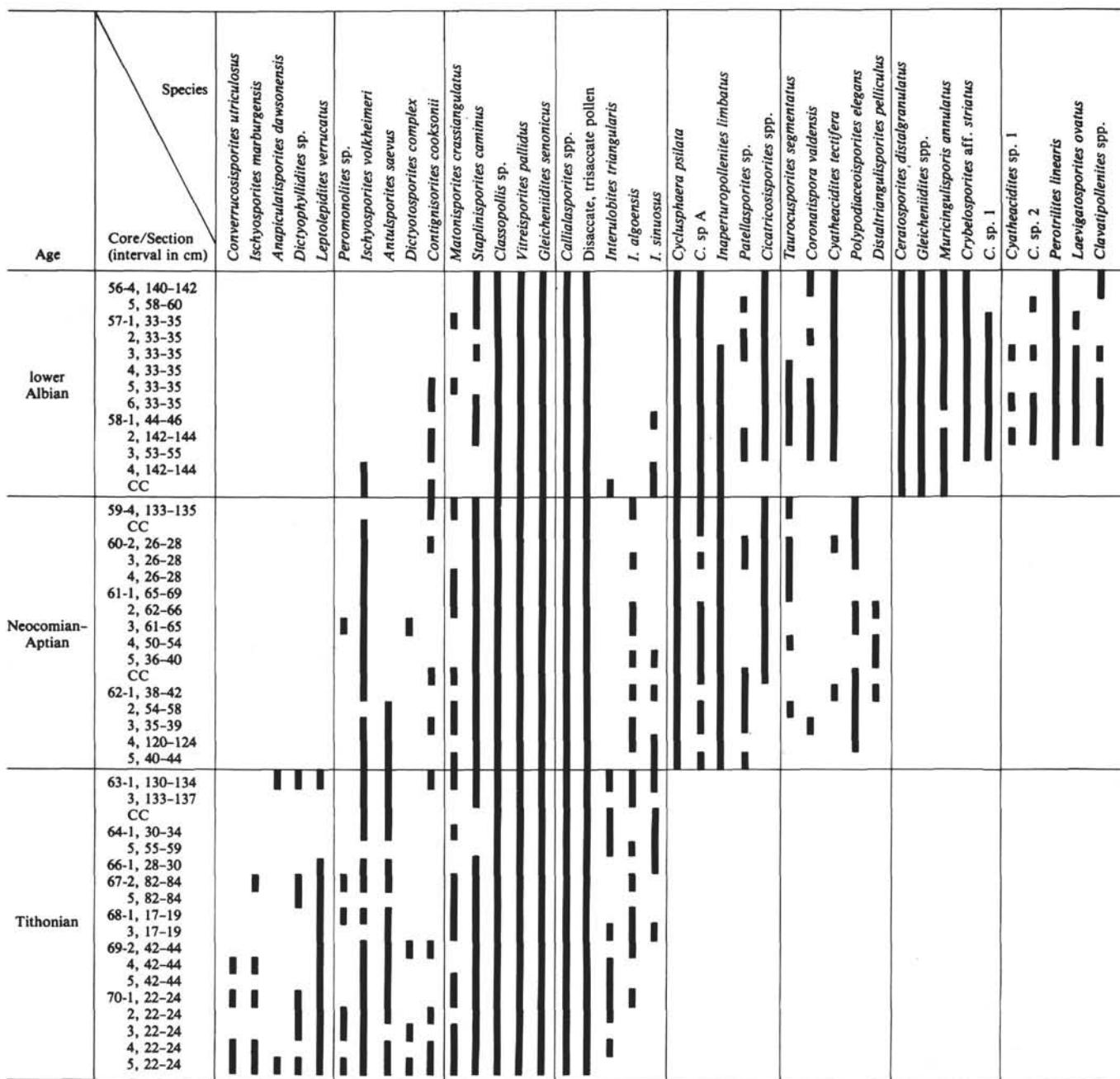


Figure 1. Pollen diagram of some species in Upper Jurassic and Lower Cretaceous sediments, Hole 511.

limbatus and *Cyclusphaera psilata*. Both forms are representative of the Lower Cretaceous only. *I. limbatus* is found in the Lower Cretaceous in Australia, South America, and Argentina; *C. psilata* has not been known in Australia, but is characteristic of Lower Cretaceous assemblages of South Africa and Argentina. Again, as in Assemblage I, spores are not numerous (3-9%) and their composition is generally similar to that assemblage. A number of species, however, disappear. These are *Anapiculatisporites dawsonensis*, *Dictyophyllidites* sp., *Ischyosporites marburgensis*, *Klukisporites lacunus*, and *Leptolepidites verrucatus*. Rare spores of *Cicatricosporites*, *Cyattheacidites tectifera*, *Trilites* sp. 1, *limbatus* and *Cyclusphaera psilata*. Both forms are representative of the Lower Cretaceous only. *I. limbatus* is found in the Lower Cretaceous in Australia, South America, and Argentina; *C. psilata* has not been known in Australia, but is characteristic of Lower Cretaceous assemblages of South Africa and Argentina. Again, as in Assemblage I, spores are not numerous (3-9%) and their composition is generally similar to that assemblage. A number of species, however, disappear. These are *Anapiculatisporites dawsonensis*, *Dictyophyllidites* sp., *Ischyosporites marburgensis*, *Klukisporites lacunus*, and *Leptolepidites verrucatus*. Rare spores of *Cicatricosporites*, *Cyattheacidites tectifera*, *Trilites* sp. 1,

Polypodiaceoisporites elegans, *Taurocuspores segmentatus*, and *Distaltriangulisporites pelliculus* appear. Beginning from Sample 511-60-3, 26-28 cm, pollen of *Bisaccado* sp. A appears.

It is impossible to date precisely the age of Assemblage II, as there are no detailed descriptions of spore-pollen assemblages of some of the Lower Cretaceous stages in the Southern Hemisphere. We can, however, determine an approximate age. First, *P. elegans* and *C. tectifera*, which appear in this interval, have been described from Barremian-Aptian continental deposits of the Baqueró Formation, Santa Cruz Province, Argentina (Archangelsky and Gamarro, 1965, 1966, 1967). *D.*

pelliculus was described from Lower Cretaceous sediments of the Sundays River Formation in South Africa (Scott, 1976) and its age was tentatively determined as Valanginian-Hauterivian by means of ostracodes, benthic foraminifers, and mollusks. Many species observed in Assemblage II of Site 511 also appear in sediments from the upper part of the Kirkwood and Sundays River formations. There are *Interulobites algoensis*, *I. sinuosus*, rare *Cicatricosisporites*, *Cyclusphaera* sp. A (described as *Inaperturopollenites* sp. VI), and *Inaperturopollenites limbatus* (described as *Inaperturopollenites* sp. 1). Assemblages similar in composition were distinguished in the Ortiz and Agrio formations in Neuquén Province, Argentina (Volkheimer and Sepúlveda, 1976; Volkheimer et al., 1977). The Agrio Formation is composed of marine sediments with corals, ammonites, pelecypods, and gastropods that allow one to determine its age as Hauterivian-early Barremian (Volkheimer and Sepúlveda, 1976; Malumán and Báez, 1976). The Ortiz Formation is of continental origin and can be correlated by spores and pollens with the Agrio Formation. Assemblages from the Ortiz and Agrio formations also abound in *Classopolis* pollen; *Cyclusphaera psilata*, *Inaperturopollenites limbatus*, and *Bisacado* sp. A are present as well. Spores are not numerous. *Taurocuspites* cf. *segmentatus* and *Trilites* sp. 1 (determined as *Leptolepidites* sp.) were recognized.

At Site 327, drilled during Leg 36 on the Falkland Plateau (Hedlund and Beju, 1977), two spore-pollen assemblages were distinguished; the lower one is Neocomian-Aptian in age (interval 396-463 m) and is similar to Assemblage II of Site 511 in its abundance of *Classopolis*, presence of *Cyclusphaera psilata* (determined as *Coptospora* sp.), and rare *Cicatricosisporites*. A similar assemblage was identified in the Cape Basin near the coasts of South Africa at Site 361 (Cores 27-49). Some researchers have estimated its age as Aptian-Albian (McLachlan and Pieterse, 1978), others as Aptian (Davay, 1978). Predominant in this assemblage also is *Classopolis* pollen; *I. limbatus*, *Cyclusphaera psilata* (identified as *I. sp. VII*), and rare *Cyatheacidites tectifera*, *Cicatricosisporites*, and *Gleicheniidites* are present as well. This assemblage differs from that of Site 511 in the presence of very rare specimens on monocolpate angiosperm pollen (*Liliacidites*, *Clavatipollenites*).

So Assemblage II of Site 511 is similar to a spore-pollen assemblage from the Agrio and Ortiz formations of Hauterivian-Barremian age; to one from the Baqueró Formation of Barremian-Aptian age; to one from Site 327 of Neocomian-Aptian age; to one from Site 361 of Aptian age (Cores 27-49) and to one from the Sundays River Formation of Valanginian-Hauterivian age.

The age of Assemblage II could have been determined as pre-Barremian, since we found no monocolpate pollen of *Clavatipollenites* angiosperms, which appear in many regions of the world in the Barremian. Yet some species (*Polypodiaceoisporites elegans* and *Cyatheacidites tectifera*) described from Barremian-Aptian continental deposits of the Baqueró Formation are present in the assemblage, although their vertical distribution is not known. Therefore, the age of the deposits, including

Assemblage II, can be established, for the time being, within a wider range, for instance, Neocomian-Aptian.

Assemblage III

Assemblage III was distinguished within the interval 518-495 meters (Cores 56-58). All of the 13 samples analyzed except the two lower ones (Samples 511-58, CC and 511-58-4, 142-144 cm) contain great amounts of spores and pollen. The spore/pollen ratio varies. In general, the amount of spores becomes greater (18.5-54.0%), mainly through an increase in specimens of the spores *Gleicheniidites* (6-39%) and *Cyathidites minor* (1.5-10%); spores of *Cicatricosisporites* become more diverse. Some new species of spores appear; *Biretisporites* sp., *Ceratosporites distalgranulatus*, *Cingutriletes clavus*, *Crybelosporites* aff. *striatus*, *Crybelosporites* sp. 1, *Densoisporites velatus*, *Laevigatosporites ovatus*, *Muricingulisporis annulatus*, *Perotrilites linearis*, and *Cyatheacidites tectifera* are constant. Pollen of the genus *Classopolis* prevails as before, through its percentage is less than in the previous assemblage (17.5-55%). Only in Sample 511-58-3, 53-55 cm does it amount to as much as 72%. *Cyclusphaera psilata* and bisaccate, trisaccate, and monosaccate conifer pollens are present. The monosaccate pollens are represented by small forms (*Monosaccites* sp. 2). The amount of *Vitreisporites pallidus* pollen diminishes. Only in the lowermost sample (511-58, CC) does it amount to 28%; in the remaining samples it ranges between 1 and 9%. In this assemblage, monocolpate angiosperm pollen appears, represented by the genus *Clavatipollenites*.

Assemblage III is determined to be Albian. Some of the species just listed were described or mentioned in the assemblage of the Barremian-Aptian Baqueró Formation, (Archangelsky and Gamarro, 1965, 1966, 1967): *Cyatheacidites tectifera*, *Muricingulisporis annulatus*, *Monosulcites* sp. 2 (as a monosaccate specimen), *Clavatipollenites rotundus* (as *C. hughesii*), and *Cyclusphaera psilata* (as *Inaperturopollenites* sp.). However, such characteristic species of Assemblage III as *Ceratosporites distalgranulatus*, *Crybelosporites* aff. *striatus*, *C. sp. 1*, and large forms of *Gleicheniidites*, *Perotrilites linearis*, and *Laevigatosporites ovatus* were not observed in the Baqueró Formation. *Ceratosporites distalgranulatus* was described from Aptian-Albian deposits in England (Kemp, 1970); *Crybelosporites* aff. *striatus* is similar to *C. striatus*, a peculiar lower Albian species from Australia (Burger, 1980). *L. ovatus* also appears from the lower Albian of Australia (Burger, 1980). The same assemblage was distinguished in Hole 327 (Falkland Plateau, Leg 36) from the interval 341-368 meters. Its age was determined to be Albian (Hedlund and Beju, 1977). The assemblage of planktonic foraminifers in Cores 57-55 confirms the lower Albian age of these sediments, including Assemblage III (the *Ticinella roberti* Zone).

CORRELATION OF UPPER JURASSIC SEDIMENTS AT SITES 511 AND 330

Because of drilling restrictions, Site 511 did not reach the crystalline basement. Site 330 of Leg 36, drilled on

the Falkland Plateau 10 km from Site 511, did penetrate Jurassic sediments and crystalline rock. Harris (1977), using the data on microplankton, spores, and pollen at Site 330, determined the age of the sediments in the interval from 300 to 550 meters (Cores 5-15) as Oxfordian-Kimmeridgian, when compared to those on the Australian continent. Other researchers (Hedlund and Beju, 1977) identified two assemblages in this interval; one, in the interval 315-440 meters (Cores 6-11), was determined to be Oxfordian-Kimmeridgian, the other, at a depth of 525 meters (Core 14), to be Middle Jurassic. As these authors used mostly dinoflagellate cysts to determine the age of Jurassic sediments at Site 330, it is worthwhile to correlate palynoassemblages from Sites 330 and 511, since Site 330 penetrated older sediments.

The preliminary study of spores and pollen from samples of Site 330 in the interval 315-525 meters (Cores 6-14) enabled us to distinguish three assemblages. The results of the palynological analysis are summarized in Table 2. The assemblage identified in the interval from 315 to 440 meters (Cores 6-11) proved similar to Assemblage I of Site 511. It abounds in pollen of *Classopollis* (23.0-58.5%) and *Vitreisporites pallidus* (16.5-47.0%). Bisaccate and trisaccate conifer pollen and pollen of *Callialasporites trilobatus*, *C. dampieri*, and *C. segmentatus* are present throughout the assemblage. Very rare specimens of *Ephedripites* sp. 1, *E.* sp. 3, *Sulcosaccospora* sp., and *Monosaccites* sp. 1 were found. Spores are not numerous (5.0-15.0%), and are represented by *Antulsporites saevus*, *A. varigranulatus*, *Contignisporites cooksonii*, *Dictyophyllidites* sp., *Dictyotosporites complex*, *Ischyosporites marburgensis*, *I. volkheimeri*, *Klukisporites lacunus*, *Marattisporites scabratus*, *Matosporites crassiangularis*, *Interulobites algoensis*, *I. sinuosus*, and *I.* sp. A. In Sample 330-6-1, 43-47 cm, very rare spores of *Cicatricosisporites* sp. were observed.

All of the species listed are characteristic of the Upper Jurassic assemblage of Site 511. The similarity lies in the presence of common species of spores and pollen, including spores of *I. algoensis* and *I. sinuosus*, *E.* sp. 1, and *E.* sp. 3. These species are not representative of the Oxfordian-Kimmeridgian of Australia but can be observed in the uppermost parts of the Upper Jurassic of Argentina and South Africa. The presence of very rare specimens of spores of the genus *Cicatricosisporites* in Sample 330-6-1, 43-47 cm also suggests the uppermost Jurassic. Rare specimens of these spores have been found in the uppermost parts of the Upper Jurassic but have never been observed in assemblages from Oxfordian-Kimmeridgian deposits.

The composition of the assemblage from Samples 330-12-2, 86-87 cm to 330-13-4, 116-120 cm remains approximately the same as the Tithonian assemblage just described. Nevertheless, no spores of *I. algoensis* and *I. sinuosus* or pollen of *E.* sp. 1 and *E.* sp. 3 were observed here. This assemblage is characterized by presence of spores of *I.* sp. A., *Verrucosisporites* sp. E., *V.* sp. 1, *Trilites* sp. 2, and a large trisaccate pollen of *Podosporites* sp. 1. *I.* sp. A. and *V.* sp. E. have been described by Volkheimer and Quattrochio (1975) from the Tithonian of Argentina. However, their complete stratigraphic

distribution is not known: the Oxfordian-Kimmeridgian palynoassemblages in Argentina and South Africa have not been studied, and these spores may occur in pre-Tithonian deposits. The exact dating of this assemblage is not possible at present.

The assemblage from Samples 330-14-4, 70-74 cm, 330-14-3, 92-96 cm, and 330-14-2, 18-31 cm is rather clearly characterized by a higher content of *Gleicheniidites* spores (up to 16%), and the presence of the spores *Polycingulatisporites striatus*, *Polypodiaceoisporites neuquenensis*, and *Ischyosporites crateris*. This assemblage may be transitional between the Middle and Late Jurassic: *P. neuquenensis* has been described from the Middle Jurassic of Argentina (Volkheimer, 1968) and *Polycingulatisporites striatus* from Middle-Upper Jurassic deposits of Australia (Filatoff, 1975). *I. crateris* has been found in Upper Jurassic sediments of Australia, the Lower and Middle Jurassic of France, and the Middle Jurassic of Sweden (Filatoff, 1975).

Thus, correlation of sediments from Sites 330 and 511 leads to the following preliminary conclusions:

1) Five successive palynoassemblages in a section of Jurassic and Lower Cretaceous sediments have been distinguished (from bottom to top):

- Middle-Upper Jurassic (Site 330)
- Upper Jurassic, pre-Tithonian (Site 330)
- Tithonian (Sites 330 and 511)
- Neocomian-Aptian (Site 511)
- lower Albian (Site 511).

It is quite possible, however, that between the Upper Jurassic and Lower Cretaceous there is a hiatus and that the lowest parts of the Cretaceous or uppermost parts of the Jurassic are absent from the section. That hiatus may exist between deposits dated by us as Neocomian-Aptian and early Albian. Thus we must determine the age of these Mesozoic sediments more exactly, through correlation with surface sections containing marine faunas and thoroughly studied palynoassemblages.

2) The presence of sediments transitional between the Middle and Upper Jurassic at Site 330 shows that the subsidence of the Falkland Plateau began at the boundary of Middle and Late Jurassic time.

COMPARISON OF UPPER JURASSIC AND LOWER CRETACEOUS PALYNOASSEMBLAGES OF THE FALKLAND PLATEAU, SOUTH AMERICA, WEST AND SOUTH AFRICA, AND AUSTRALIA

According to palynological data, a pronounced climatic zonation existed within the Atlantic realm in Late Jurassic and Early Cretaceous times. In the south, the assemblages most similar to those at Sites 511 and 330 are spore and pollen assemblages from Argentina and South Africa. Upper Jurassic assemblages of these countries are characterized by abundance of *Classopollis* pollen, very rare *Ephedripites*, the presence of bisaccate and trisaccate conifers, and spores of the genus *Interulobites*. Pollen of *Cyclusphaera psilata* and spores of *Cyatheacidites tectifera*, *Muricungulisporis annulatus*, and *Polypodiaceoisporites elegans* are representative only of Lower Cretaceous deposits of these regions.

Table 2. Percentage of spores and pollen in Jurassic sediments, Hole 330.

Species	Core/section (interval in cm)																								
	14-4, 70-74	14-3, 92-96	14-2, 18-21	13-4, 116-120	13-3, 112-116	13-2, 69-73	12-6, 111-115	12-5, 72-76	12-3, 70-74	12-2, 81-87	11-6, 90-93	11-5, 120-124	11-4, 112-116	11-3, 83-87	9-2, 92-95	8-4, 114-117	7-5, 90-94	7-4, 87-91	7-3, 82-86	6-5, 90-94	6-4, 120-124	6-3, 102-105	6-2, 65-68	6-1, 43-47	
Total no. specimens	396	423	416	437	461	461	369	310	372	302	376	322	268	369	201	262	470	205	647	300	294	333	111	238	
Spores	30.5	22.5	16.5	19.0	12.5	14.0	20.5	11.0	11.5	5.0	15.0	9.0	8.0	8.5	9.0	6.0	6.0	5.0	6.5	6.5	5.5	5.0	4.5	9.0	
Gymnosperms	69.5	77.5	83.5	81.0	87.5	86.0	79.5	89.0	88.5	95.0	85.0	91.0	92.0	91.5	91.0	94.0	94.0	95.0	93.5	93.5	94.5	95.0	95.5	91.0	
Spores																									
1. <i>Anapiculatisporites dawsonensis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	+	1.5	+	+	+	0.5	+	+	+	
2. <i>Antulispores saevus</i>																									
3. <i>A. varigranulatus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
113. <i>Auritulinaspores intrastriatus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
5. <i>Baculatisporites comauensis</i>	+	+	0.5	+	+	0.5	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
8. <i>Cibotiumspora</i> sp.	2.0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
114. <i>Cicatricosporites</i> sp.																									
115. <i>Clavatisporites</i> sp.																									
116. <i>Concavatilaspores</i> sp.																									
20. <i>Concavissimisporites variterrucatus</i>																									
21. <i>C. sp.</i>																									
22. <i>Contignisporites cooksonii</i>	+	+	+	+	0.5	+	+	+	+	+	+	+	+	0.5	+	+	+	+	+	+					
117. <i>C. sp.</i>																									
24. <i>Converrucosporites utriculosus</i>																									
26. <i>Coronatisporites perforata</i>																									
29. <i>Cyberlosporites berberoides</i>																									
33. <i>Cyathidites australis</i>	+	1.5	+	0.5	+	2.0	4.0	7.0	+	3.0	+	1.0	1.0	0.5	+	+	+	+	0.5	0.5	0.5	+	1.0	1.0	
34. <i>C. minor</i>	2.0	1.5	0.5	4.0	2.0	4.0	7.0	+	3.0	+	2.0	0.5	1.5	1.0	1.0	1.5	0.5	0.5	0.5	0.5	+	1.0	1.0	1.0	
35. <i>Cyclocrystella</i> sp.																									
36. <i>Densospores velatus</i>																									
37. <i>Dictyophyllidites</i> sp.																									
38. <i>Dictyotisporites complex</i>																									
40. <i>Foveosporites aff. moretonensis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
41. <i>F. subtriangularis</i>																									
42. <i>Gleicheniales</i> spp.	16.0	13.0	5.0	3.0	+	0.5	+	+	1.0	0.5	+	0.5	+	1.5	1.0	+	2.0	1.0	1.5	0.5	1.0				
44. <i>Granulatisporites</i> sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	0.5	1.0	+	+	+	1.0		
45. <i>Interulobites algensis</i>																									
46. <i>I. sinuosus</i>																									
47. <i>I. triangularis</i>																									
118. <i>I. sp. A</i>																									
48. <i>I. sp.</i>																									
49. <i>Ischyrosporites crateris</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
50. <i>I. marburgensis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					
119. <i>I. sp.</i>	+	+	+	0.5	+	0.5	+	+	+	+	+	+	+	+	+	+	+	0.5	+	+					
51. <i>I. volkheimeri</i>	1.0	+	+	3.0	3.0	0.5	3.0	+	1.0	+	3.0	1.5	+	+	1.5		0.5	0.5	1.0	+	0.5	+	+	+	
54. <i>Kluksporites lacunus</i>																									
55. <i>Kuylsporites aff. lunaris</i>																									
120. <i>Laevigatosporites</i> sp.																									
58. <i>Leptolepidites macroverrucosus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	0.5	1.0	0.5	0.5	1.0	1.5		
121. <i>L. sp. 1</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	0.5	1.0	0.5	0.5	1.0	1.0		
57. <i>L. verrucosus</i>																									
59. <i>Lycopodiumspores</i> sp.	1.0	+	+	+	+	+	+	+	+	+	+	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	+	+	+	
60. <i>Marattisporites scabrinatus</i>	2.0	1.5	3.0	+	+	0.5	+	+	1.0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
61. <i>Matonisporites crassiangularis</i>																									
122. <i>Neoraistrickia suratensis</i>	0.5	+	0.5	0.5	+	0.5	+	+	+	+	+	+	+	+	+	+	+	0.5	+	+	+	+	+	+	
63. <i>N. sp.</i>																									
64. <i>Nevesisporites</i> sp.																									
65. <i>Osmundacidites wellmannii</i>																									
123. <i>Polycingulatisporites</i> sp.																									
124. <i>P. crenulatus</i>																									
125. <i>P. striatus</i>																									
126. <i>Polyodiaceoisporites neuquensis</i>																									
127. <i>Retitriteles</i> sp.																									
70. <i>Staphlinisporites caminus</i>	+	+	+	+	+	+	+	+	+	+	0.5	+	+	+	+	+	0.5	+	+	+	+	+	+	+	
71. <i>Stereolites antiquasporites</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
73. <i>Todisporites rotundiformis</i>																									
128. <i>Trilites</i> sp. 2	+	+	+	0.5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.5	+	+	+	+	+	
129. <i>Trilobisporites antiquus</i>																									
130. <i>Tripartina variabilis</i>	+	+	0.5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
131. <i>Verrucosporites</i> sp. E																									
132. <i>V. sp. 1</i>																									
Gymnosperms																									
75. <i>Alisporites grandis</i>	0.5	0.5	+	0.5	+	0.5	+	+	+	+	1.0	1.5	2.5	1.0	1.5	1.0	3.5	1.0	+	3.0	1.0	+	1.5		
76. <i>A. lowoodensis</i>	0.5	0.5	1.0	+	1.5	+	+	1.0	2.0	+	1.0	2.0	2.0	2.5	0.5	2.0	0.5	1.0	0.5	1.0	2.5	+	1.0		
77. <i>A. similis</i>	+	0.5																							
79. <i>Araucariacites australis</i>																									
81. <i>Calliallasporites dampieri</i>	3.0	1.5	4.0	3.0	7.0	3.0	3.0	2.0	2.0	0.5	1.5	0.5	2.5	1.0	6.0	1.0	1.5	3.0	6.0	2.0	5.5	3.0	+	2.0	
84. <i>C. segmentatus</i>	+	0.5	7.5																						

The lower Albian is also characterized by a rather high content of *Classopollis* pollen, by the appearance of *Crybelosporites* aff. *striatus*, C. sp. 1, *Laevigatosporites ovatus*, *Cyatheacidites* sp. 1, considerable numbers of *Gleicheniidites* spores, and very rare specimens of the angiosperm pollen *Clavatipollenites*.

In Australia the palynoassemblages of the uppermost Jurassic and Neocomian are characterized by the small amount of *Classopollis* pollen and the presence of *Murosphaera florida*. In addition, there are a number of species peculiar to the Neocomian of Australia, and not observed in Argentina and South Africa: *Cyclosporites hunghesii*, *Crybelosporites stylosus*, and *Dictyotosporites speciosus*. The lower Albian of Australia is characterized by the small number of *Classopollis* and *Gleicheniidites* specimens. Some species from the lower Albian of Australia are also observed at Site 511: *L. ovatus*, *Crybelosporites striatus*, *Clavatipollenites* sp.

So, despite a number of endemic species characteristic only of Argentina and South Africa on the one hand, and Australia on the other, there is a certain similarity among assemblages in these territories. This similarity is seen in the presence of common species of bisaccate and trisaccate conifer pollen, very rare findings of *Ephedripites*, and some common species of spores.

Assemblages from the more northerly regions of the South Atlantic (Brazil, Western Africa) are significantly different from those of the Falkland Plateau, Argentina, and South Africa. Palynoassemblages from Upper Jurassic sediments of these regions are not known.

In Neocomian assemblages, as well as in those of the South Atlantic, *Classopollis* pollens are dominant, bisaccate conifer pollens occur as very rare specimens, and trisaccate pollens are totally absent. *Ephedripites* pollen is representative and diverse. Fern spores from a great number of species are present; *Cicatricosisporites* spores are especially diverse. A typical form for these regions is pollen of *Dicheiropollis etruscus*, which was recognized in Neocomian sediments of the coastal regions of Brazil and West Africa (Angola, Congo, Gabon) and at DSDP Sites 370 and 416 in the Morocco Basin but which is absent in Western Europe and the South Atlantic. The lower Albian of Brazil and West Africa is characterized by the presence of tricolporate grains of angiosperms, a great diversity of *Ephedripites* pollen, and rare spores with no representatives of species common in the lower Albian of Argentina.

The abundance of pollen of the genus *Classopollis* is thus typical of the Lower Cretaceous of Brazil, West Africa, Argentina, and South Africa. Data indicate that plants producing this pollen grew on seashores. Some researchers believe that these plants were of the same type as modern mangroves and formed brushwoods in the river deltas (Hughes, 1973); others believe they grew both on the near-shore slopes and on the elevations themselves (Vakhrameev, 1970, 1980).

In Brazil and West Africa a great amount of *Classopollis* is associated with a diversity of *Ephedripites* pollen and fern spores, pollen of other conifers being almost totally absent. In South Africa and Argentina the abundance of *Classopollis* is related to the presence

of pollen of bisaccate and trisaccate conifers, a few spores of ferns, and very rare pollen of *Ephedripites*. Judging from the data of Jardiné et al. (1974), who observed the distribution of *D. etruscus* pollen in the regions adjacent to the Atlantic Ocean, a latitudinal belt covering West Africa and Brazil existed during the Neocomian. There was an abundance of *Classopollis*, diverse *Ephedripites*, and an almost complete absence of conifers. Deposition of salts in the Early Cretaceous within this belt testifies to a hot, dry climate.

This belt existed during the Albian as well, as shown by a peculiar angiosperm palynoflora found in Brazil and in West Africa up to the Angola Basin. At that time, West Africa and Brazil were situated near one another, and the southern boundary of the belt distinguished by Jardiné et al. (1974) may have passed between the Angola and Cape basins—a theory confirmed by DSDP data obtained in those basins. The assemblages from Albian sediments at Site 364 in the Angola Basin (Morgan, 1978) resemble synchronous assemblages from Senegal and the Ivory Coast (Jardiné and Magloire, 1965) and to Albian assemblages from Brazil (Herngreen, 1973). Aptian-Albian or Aptian assemblages in the Cape Basin at Site 361 tend to resemble Lower Cretaceous ones from Argentina and South Africa (McLachlan and Pieterse, 1978). The climate in Argentina and South Africa during the Neocomian-Aptian appears to have been dry but more moderate; this is evidenced by the scarcity of ferns and the numerous coniferous pollen with saccates. Data obtained from Sites 511 and 327, which show that the number of spores and ferns in the lower Albian increased sharply, testify to a more humid climate at that time.

TAXONOMIC LIST

Spores

1. *Anapiculatisporites dawsonensis* Reiser and Williams, 1969 (Plate 3, Fig. 21). Lower–Upper Jurassic of Australia (Filatoff, 1975).
2. *Antulsporites saevus* (Balme) Archangelsky and Gamerro, 1966 (Plate 2, Figs. 11–15). Lower–Upper Jurassic of Australia (Balme, 1957; Filatoff, 1975); Jurassic–Lower Cretaceous of Argentina (Archangelsky and Gamerro, 1966; Volkheimer, 1968).
3. *Antulsporites varigranulatus* (Levet-Carette) Reiser and Williams, 1969 (Plate 2, Figs. 16–18). Lower Jurassic of France (Levet-Carette, 1963); Lower–Upper Jurassic of Australia (Filatoff, 1975).
4. *Appendicisporites* sp. (Plate 7, Fig. 8).
5. *Baculatisporites comaumensis* (Cookson) Potonié, 1956. (Plate 3, Fig. 27). Worldwide distribution in Mesozoic sediments.
6. *Biretrisporites* sp. (Plate 5, Figs. 12–13).
7. *Ceratosporites distalgranulatus* (Couper) Kemp, 1970 (Plate 5, Figs. 4–6). Upper Aptian–upper Albian of England (Kemp, 1970).
8. *Cibotiumspora* sp.
9. *Cicatricosisporites australiensis* (Cookson) Potonié, 1956 (Plate 7, Figs. 12–14). Worldwide distribution in Cretaceous sediments; Tithonian–Berriasian of West Europe (Dornhofer and Norris, 1977).
10. *Cicatricosisporites haliei* Delcourt and Sprumont, 1955 (Plate 7, Figs. 16–18). Worldwide distribution in Lower Cretaceous.
11. *Cicatricosisporites hughesi* Dettmann, 1963 (Plate 7, Fig. 15). Lower–upper Cretaceous of Australia (Dettmann, 1963; Burger, 1968, 1973, 1975, 1980); upper Cretaceous of North America (Drugg, 1967; Groot et al., 1961).
12. *Cicatricosisporites ludbrookii* Dettmann, 1963 (Plate 7, Figs. 9–11). Lower Cretaceous of Australia (Dettmann, 1963; Burger,

- 1972); Aptian-Albian of Canada (Brideaux and McIntyre, 1975).
13. *Cicatricosporites proxiradiatus* Kemp, 1970 (Plate 7, Figs. 19-20). Aptian-Albian of England (Kemp, 1970).
 - 14-18. *Cicatricosporites* sp. 1-5 (Plate 8, Figs. 1-13).
 19. *Cingutriletes clavus* (Balme) Dettmann, 1963 (Plate 5, Fig. 14). Worldwide distribution in Cretaceous sediments.
 20. *Concavissimisporites variverrucatus* (Couper) Brenner, 1963 (Plate 1, Fig. 11). Worldwide distribution in upper Mesozoic sediments.
 21. *Concavissimisporites* sp. (Plate 1, Fig. 10).
 22. *Contignisporites cooksonii* (Balme) Dettmann, 1963 (Plate 2, Figs. 21-23). Worldwide distribution in Upper Jurassic and Lower Cretaceous.
 23. *Contignisporites fornicatus* Dettmann, 1963 (Plate 2, Figs. 19-20). Cretaceous of Australia (Dettmann, 1963; Burger, 1973, 1980).
 24. *Converrucosporites utriculosus* (Krasnova) Pocock, 1970 (Plate 3, Figs. 22-23). Upper Jurassic of Canada (Pocock, 1970), Middle Jurassic of Sweden (Guy-Olsson, 1976).
 25. *Coronatispora valdensis* (Couper) Dettmann, 1963 (Plate 4, Figs. 1-2). Lower Cretaceous of England (Couper, 1958; Kemp, 1970); Aptian-Albian of Canada (Brideaux and McIntyre, 1975).
 26. *Coronatispora perforata* Dettmann, 1963 (Plate 4, Fig. 3). Upper Jurassic-Lower Cretaceous of Australia (Dettmann, 1963; Filatoff, 1975).
 27. *Crybelosporites aff. striatus* (Cookson and Dettmann) Dettmann, 1963 (Plate 6, Figs. 1-9). Lower Cretaceous of Australia (Dettmann, 1963; Burger, 1980).
 28. *Crybelosporites* sp. 1 (Plate 6, Figs. 10-17). Cavate forms with very thin reticulate exine. Found only in lower Albian assemblages.
 29. *Crybelosporites berberioides* Burger, 1976 (Plate 4, Figs. 19-21). Lower Cretaceous of Australia (Burger, 1976, 1980).
 30. *Cyatheacidites tectifera* Archangelsky and Gamerro, 1966 (Plate 7, Figs. 1-2). Lower Cretaceous of Argentina (Archangelsky and Gamerro, 1967); Lower Cretaceous of Cape Basin (McLachlan and Pieterse, 1978).
 31. *Cyatheacidites* sp. 1 (Plate 7, Figs. 3-4) Forms differ from *C. tectifera*; perforate distally.
 32. *Cyatheacidites* sp. 2 (Plate 7, Figs. 5-7). Forms differ from *C. tectifera*; verrucate distally.
 33. *Cyathidites australis* Couper, 1953 (Plate 1, Figs. 1-2). Worldwide distribution in Mesozoic sediments.
 34. *Cyathidites minor* Couper, 1953 (Plate 1, Figs. 3-4). Worldwide distribution in Mesozoic sediments.
 35. *Cyclocrystella* sp. (Plate 2, Fig. 24). A single specimen only was found in Sample 511-63-1, 130-134.
 36. *Densoisporites velatus* Weyland and Krieger, 1953 (Plate 4, Fig. 4). Worldwide distribution in upper Mesozoic sediments.
 37. *Dictyophyllidites* sp. (Plate 1, Figs. 5-6).
 38. *Dictyotosporites complex* Cookson and Dettmann, 1958 (Plate 3, Figs. 25-26). Wide distribution in Mesozoic sediments of Australia.
 39. *Distaltriangulisporites pelliculus* Scott, 1976 (Plate 4, Figs. 11-12). Upper Valanginian-lower Hauterivian of the Algoa Basin, South Africa (Scott, 1976).
 40. *Foveosporites moretonensis* de Jersey, 1964 (Plate 2, Fig. 10). Wide distribution in upper Mesozoic of Australia.
 41. *Foveosporites subtriangularis* (Brenner) Doring, 1966 (Plate 2, Figs. 8-9). Worldwide distribution in upper Mesozoic sediments.
 42. *Gleicheniidites senonicus* Ross, 1949 (Plate 1, Fig. 13). Worldwide distribution in Mesozoic sediments.
 43. *Gleicheniidites* spp. (Plate 5, Figs. 7-10). Large forms; there may be more than one species of *Gleicheniidites*. Found only in the lower Albian Assemblage III.
 44. *Granulatisporites* sp. (Plate 1, Fig. 12).
 45. *Interulobites algoensis* Scott, 1976 (Plate 3, Figs. 12-13). Upper Jurassic-Lower Cretaceous of the Algoa Basin in South Africa (Scott, 1976).
 46. *Interulobites sinuosus* Scott, 1976 (Plate 3, Figs. 14-17). Lower Cretaceous of the Algoa Basin in South Africa (Scott, 1976); Lower Cretaceous of the Cape Basin (McLachlan and Pieterse, 1978).
 47. *Interulobites triangularis* (Brenner) Paden et al., 1971 (Plate 3, Figs. 10-11). Lower Cretaceous of U.S.A. (Paden et al., 1971); Upper Jurassic-Lower Cretaceous of the Algoa Basin in South Africa (Scott, 1976).
 48. *Interulobites* sp. (Plate 3, Figs. 18-20).
 49. *Ischyosporites crateris* Balme, 1957. Upper Mesozoic of Australia (Balme, 1957; Filatoff, 1975); Middle Jurassic of Argentina (Volkheimer, 1974).
 50. *Ischyosporites marburgensis* de Jersey, 1963 (Plate 1, Figs. 20-21). Lower-Middle Jurassic of Australia (Filatoff, 1975); Middle Jurassic of Argentina (Volkheimer, 1974).
 51. *Ischyosporites volkheimeri* Filatoff, 1975 (Plate 3, Figs. 1-6). Lower-Upper Jurassic of Australia (Filatoff, 1975); Callovian of Argentina (Volkheimer, 1972).
 52. *Ischyosporites* sp. 1 (Plate 5, Figs. 16-18).
 53. *Ischyosporites* sp. 2 (Plate 5, Figs. 19-20).
 54. *Klukisporites lacunus* Filatoff, 1975 (Plate 1, Fig. 22). Middle-Upper Jurassic of Australia (Filatoff, 1975).
 55. *Kuylisporites lunaris* Cookson and Dettmann (Plate 5, Figs. 1-3). Worldwide distribution in Lower Cretaceous sediments.
 56. *Laevigatosporites ovatus* Wilson and Webster, 1946 (Plate 5, Fig. 11). Albian-Cenomanian of Australia (Dettmann, 1963); Cenomanian of U.S.A. (Hedlund, 1966).
 57. *Leptolepidites verrucatus* Couper, 1953 (Plate 2, Figs. 1-5). Worldwide distribution in Jurassic and Lower Cretaceous sediments.
 58. *Leptolepidites macroverrucosus* Schulz, 1967 (Plate 2, Figs. 6-7). Lower Jurassic of Germany (Schulz, 1967), Tithonian-Lower Cretaceous of Argentina (Volkheimer and Quattrochio, 1975).
 59. *Lycopodiumsporites* sp. (Plate 1, Figs. 16-17).
 60. *Marattisporites scabrus* Couper, 1958 (Plate 1, Fig. 15). Worldwide distribution in upper Mesozoic sediments.
 61. *Matonisporites crassiangulatus* (Balme) Dettmann, 1963 (Plate 1, Figs. 7-9). Worldwide distribution in upper Mesozoic sediments.
 62. *Muricungulispores annulatus* Archangelsky and Gamerro, 1966 (Plate 6, Figs. 18-21). Lower Cretaceous of Argentina (Archangelsky and Gamerro, 1966).
 63. *Neoraistrickia* sp. (Plate 3, Fig. 24).
 64. *Nevesisporites* sp. (Plate 3, Figs. 7-9).
 65. *Osmundacitides wellmanii* Couper, 1953 (Plate 3, Fig. 28). Worldwide distribution in Mesozoic sediments.
 66. *Patellasporites* sp. (Plate 4, Fig. 18).
 67. *Perotrilites linearis* (Cookson and Dettmann) Evans, 1970 (Plate 5, Figs. 21-24). Cretaceous of Australia (Dettmann, 1963; Burger, 1975).
 68. *Polypodiaceoisporites elegans* Archangelsky and Gamerro, 1966 (Plate 4, Figs. 5-9). Lower Cretaceous of Argentina (Archangelsky and Gamerro, 1967).
 69. *Sestosporites pseudoalveolatus* (Couper) Dettmann, 1963 (Plate 4, Fig. 10). Worldwide distribution in upper Mesozoic sediments.
 70. *Staplinisporites caminus* (Balme) Pocock, 1962 (Plate 1, Figs. 18-19).
 71. *Stereisporites antiquasporites* (Wilson and Webster) Dettmann, 1963 (Plate 5, Fig. 15). Worldwide in upper Mesozoic sediments.
 72. *Taurocuspores segmentatus* Stower, 1962 (Plate 4, Figs. 13-14). Worldwide distribution in Lower Cretaceous sediments.
 73. *Todisporites rotundiformis* (Maljavin) Pocock, 1970 (Plate 1, Fig. 14). Lower-Middle Jurassic of Canada.
 74. *Tritites* sp. 1. (Plate 4, Figs. 15-17).

Gymnosperm Pollen

75. *Alisporites grandis* (Cookson) Dettmann, 1963 (Plate 10, Figs. 14-15). Worldwide distribution in upper Mesozoic sediments.
76. *Alisporites lowoodensis* de Jersey, 1963 (Plate 10, Figs. 10-11). Triassic-Jurassic of Australia (Hill et al., 1966; Filatoff, 1975).
77. *Alisporites similis* (Balme) Dettmann, 1963 (Plate 10, Fig. 12). Lower Jurassic-Lower Cretaceous of Australia (Balme, 1957; Dettmann, 1963; de Jersey, 1971; McKellar, 1974).

78. *Alisporites* sp. (Plate 10, Fig. 13).
 79. *Araucariacites australis* (Cookson) Couper, 1953 (Plate 12, Fig. 3). Worldwide distribution in upper Mesozoic sediments.
 80. *Bisacado* sp. A (Plate 9, Figs. 23–26). Lower Cretaceous of Argentina (Volkheimer et al., 1977).
 81. *Callialasporites dampieri* (Balme) Dev, 1961 (Plate 11, Fig. 7). Worldwide distribution in Mesozoic sediments.
 82. *Callialasporites trilobatus* (Balme) Dev, 1961 (Plate 11, Figs. 8–9). Worldwide distribution in Mesozoic sediments.
 83. *Callialasporites turbatus* (Balme) Schulz, 1967 (Plate 11, Figs. 10–11). Worldwide distribution in Mesozoic sediments.
 84. *Callialasporites segmentatus* (Balme) Srivastava, 1963 (Plate 11, Fig. 12).
 85. *Classopollis* spp. (Plate 12, Figs. 4–7).
 86. *Cyclusphaera psilata* Volkheimer and Sepúlveda, 1976 (Plate 12, Figs. 8–11). Hauterivian–lower Albian of Argentina (Volkheimer and Sepúlveda, 1976; Volkheimer et al., 1977).
 87. *Cyclusphaera* sp. A (Plate 12, Figs. 12–15). Hauterivian–Barremian of Argentina (Volkheimer et al., 1977).
 88. *Disaccites* (Plate 10, Figs. 18–19; Plate 11, Figs. 1–6).
 89. *Ephedripites* sp. 1 (Plate 8, Figs. 23–25).
 90. *Ephedripites* sp. 2 (Plate 8, Figs. 17–19).
 91. *Ephedripites* sp. 3 (Plate 8, Figs. 20–22).
 92. *Ephedripites* spp. (Plate 9, Figs. 3–8).
 93. *Ephedripites* sp. 5 (Plate 9, Figs. 1–2).
 94. *Eucommiidites* sp.
 95. *Exesipollenites* sp. (Plate 11, Fig. 13).
 96. *Inaperturopollenites limbatus* Balme, 1957 (Plate 12, Fig. 1). Lower Cretaceous of Australia, Argentina, Cape Basin (Balme, 1957; Archangelsky and Gamoero, 1967; Volkheimer et al., 1977; McLachlan and Pieterse, 1978).
 97. *Inaperturopollenites* sp. (Plate 12, Fig. 2).
 98. *Microcachryidites antarcticus* Cookson, 1947 (Plate 10, Figs. 2–4). Jurassic–Lower Cretaceous of Australia, Argentina (Balme, 1957; Dettmann, 1963; Burger, 1972; Archangelsky and Gamoero, 1967; Volkheimer, 1968).
 99. *Microcachryidites* sp. (Plate 10, Fig. 5).
 100. *Monosaccites* sp. 1 (Plate 9, Figs. 13–14).
 101. *Monosaccites* sp. 2 (Plate 9, Figs. 11–12).
 102. *Monosulcites* sp. (Plate 8, Figs. 14–16).
 103. *Peromonolites* sp. (Plate 11, Figs. 14–15).
 104. *Podocarpidites* sp. (Plate 10, Figs. 16–17).
 105. *Podosporites* sp. (Plate 10, Figs. 6–9).
 106. *Rugubivesiculites* sp. (Plate 9, Figs. 17–20).
 107. *Sulcosaccispora* sp. (Plate 9, Figs. 15–16).
 108. *Trisaccites* sp. (Plate 10, Fig. 1).
 109. *Vitreisporites pallidus* (Reissinger) Nilsson, 1958 (Plate 9, Figs. 21–22). Worldwide distribution in Mesozoic sediments.
 110. *Steevesipollenites* sp. (Plate 9, Figs. 9, 10).

Angiosperm Pollen

111. *Clavatipollenites incisus* Chlonova, 1977 (Plate 12, Figs. 18–19). Albian–Cenomanian of West Siberia (Chlonova, 1977).
 112. *Clavatipollenites rotundus* Kemp, 1968 (Plate 12, Figs. 16–17). Worldwide distribution in Albian sediments.

Additional Taxons from Site 330

113. *Auritulinaspores intrastriatus* Nilsson, 1958 (Plate 13, Figs. 1–2). Lower and Middle Jurassic of Sweden (Tralau and Artursson, 1971).
 114. *Cicatricosporites* sp. (Plate 15, Fig. 12).
 115. *Clavatisporites* sp. (Plate 13, Figs. 6–7).
 116. *Conbaculatisporites* sp. (Plate 14, Figs. 14–17).
 117. *Contignisporites* sp. (Plate 14, Figs. 9–10).
 118. *Interulobites* sp. A Volkheimer and Quattrochio, 1975 (Plate 13, Figs. 10–13). Tithonian of Argentina (Volkheimer and Quattrochio, 1975).
 119. *Ischyosporites* sp. (Plate 14, Fig. 21).
 120. *Laevigatosporites* sp. (Plate 15, Fig. 2).
 121. *Leptolepidites* sp. 1 (Plate 13, Figs. 18–21).
 122. *Neoraistrickia suratensis* McKellar, 1974 (Plate 14, Figs. 5–7). Lower Jurassic of Australia (McKellar, 1974); Middle–Upper Jurassic of Australia (Filatoff, 1975).
 123. *Polycingulatisporites* sp. (Plate 14, Fig. 13).
 124. *Polycingulatisporites crenulatus* Playford and Dettmann, 1965 (Plate 14, Fig. 11). Worldwide distribution in upper Triassic and Jurassic sediments.
 125. *Polycingulatisporites striatus* Filatoff, 1975 (Plate 14, Fig. 12). Middle–Upper Jurassic of Australia (Filatoff, 1975).
 126. *Polypodiaceoisporites neuquensis* Volkheimer, 1969 (Plate 13, Figs. 3–4). Middle Jurassic of Argentina.
 127. *Retitriteles* sp. (Plate 13, Figs. 8–9).
 128. *Triletes* sp. 2 (Plate 13, Fig. 5).
 129. *Trilobospores antiquus* Reiser and Williams, 1969 (Plate 15, Fig. 11). Jurassic of Australia.
 130. *Tripartina variabilis*. Worldwide distribution in Mesozoic sediments.
 131. *Verrucosisporites* sp. E Volkheimer and Quattrochio, 1975 (Plate 14, Figs. 1–3). Tithonian of Argentina (Volkheimer and Quattrochio, 1975).
 132. *Verrucosisporites* sp. 1 (Plate 14, Fig. 4).
 133. *Callialasporites* sp. (Plate 15, Fig. 22).
 134. *Indusispora* sp. (Plate 15, Fig. 18).
 135. *Podosporites* sp. 1. (Plate 15, Figs. 20–21).

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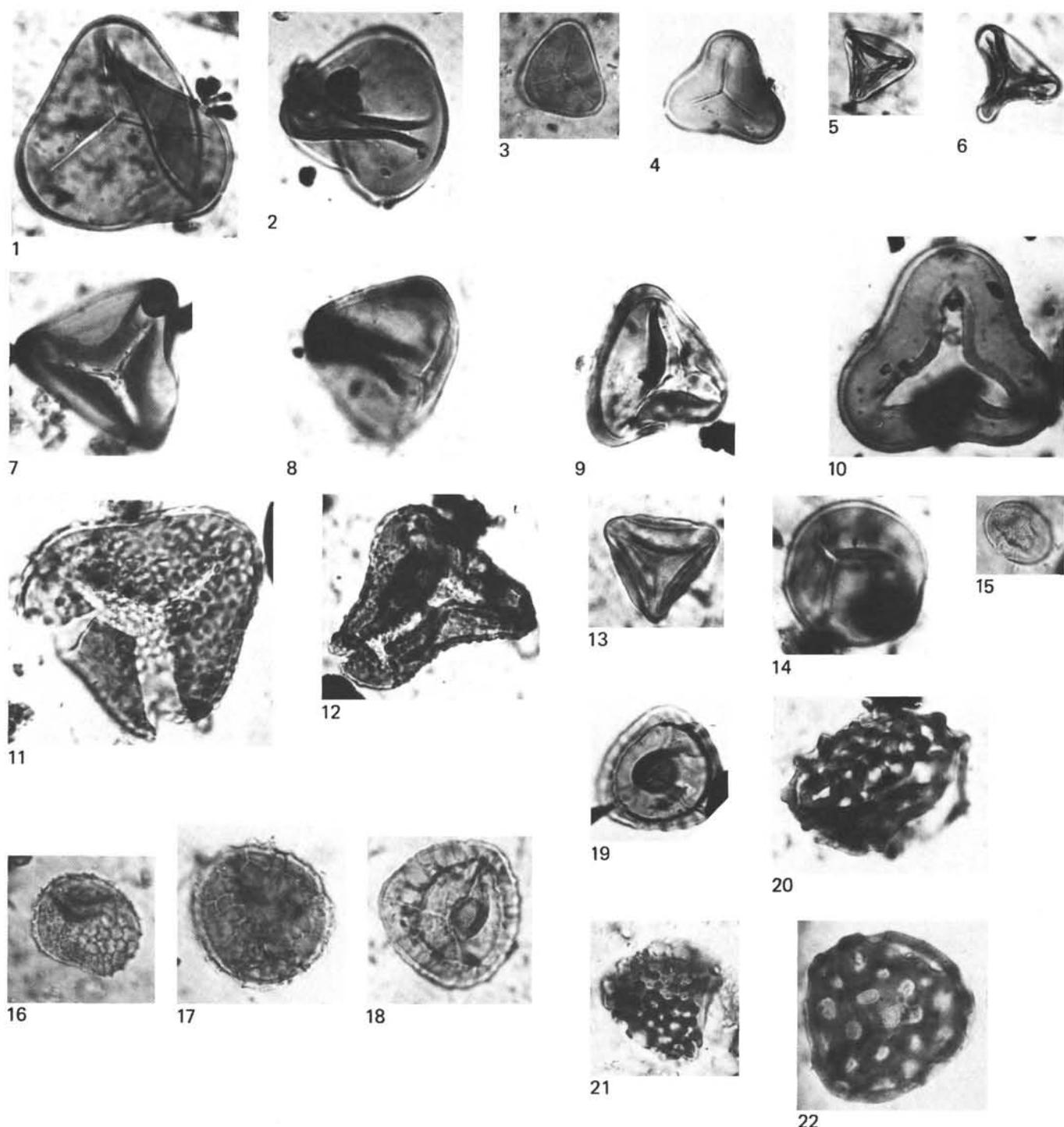


Plate 1. (All specimens magnified $\times 600$.) 1-2. *Cyathidites australis* Couper (1) Sample 511-57-3, 33-35 cm (2) Sample 511-60-4, 26-28 cm. 3-4. *Cyathidites minor* Couper (3) Sample 511-70-5, 22-24 cm (4) Sample 511-57-2, 33-35 cm. 5-6. *Dictyophyllidites* sp. (5) Sample 511-70-1, 22-24 cm (6) Sample 511-69-2, 42-44 cm. 7-9. *Matonisporites crassiangulatus* (Balme) Dettmann (7) Sample 511-61-2, 62-66 cm (8) Sample 511-70-1, 22-24 cm (9) Sample 511-67-2, 82-84 cm. 10. *Concavissimisporites* sp. Sample 511-58,CC. 11. *Concavissimisporites variverrucatus* (Couper) Brenner, Sample 511-61-4, 50-54 cm. 12. *Granulatisporites* sp., Sample 511-69-2, 42-44 cm. 13. *Gleichenioides senonicus* Ross, Sample 511-57-3, 33-35 cm. 14. *Todisporites rotundiformis* (Mal.) Pocock, Sample 511-57-3, 33-35 cm. 15. *Marattisporites scabrinatus* Couper, Sample 511-70-1, 22-24 cm. 16-17. *Lycopodiumsporites* sp. (16) Sample 511-70-1, 22-24 cm (17) Sample 511-57-2, 33-35 cm. 18-19. *Staplinisporites caminus* (Balme) Pocock (18) Sample 511-70-1, 22-24 cm (19) Sample 511-61-2, 62-66 cm. 20-21. *Ischyosporites marburgensis* de Jersey (20) Sample 511-70-5, 22-24 cm (21) Sample 511-70-3, 22-24 cm. 22. *Klukisporites lacunus* Filatoff, Sample 511-70-5, 22-24 cm.

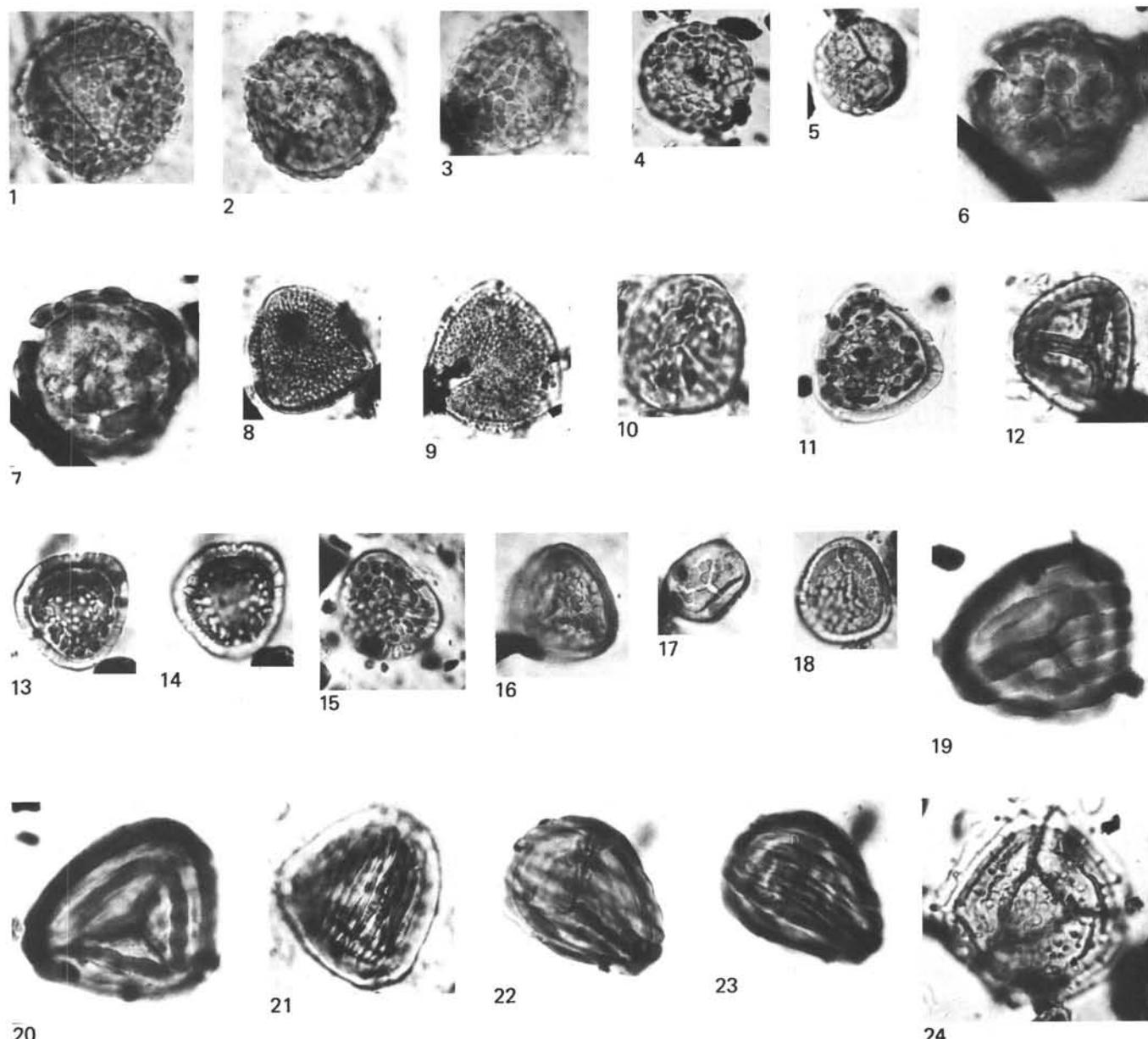


Plate 2. (All specimens magnified $\times 600$.) 1-5. *Leptolepidites verrucatus* Couper (1-3) Sample 511-70-1, 22-24 cm (4) Sample 511-60-2, 26-28 cm (5) Sample 511-70-4, 22-24 cm. 6-7. *Leptolepidites macroverrucosus* Schulz, Sample 511-69-2, 42-44 cm. 8-9. *Foveosporites subtriangularis* (Brenner) Döring (8) Sample 511-70-5, 22-24 cm (9) Sample 511-64-1, 30-34 cm. 10. *Foveosporites moretonensis* de Jersey, Sample 511-57-3, 33-35 cm. 11-15. *Antulsporites saevus* (Balme) Archangelsky and Gamerro (11-12) Sample 511-70-5, 22-24 cm (13-15) Sample 511-64-1, 30-34 cm. 16-18. *Antulsporites varigranulatus* (Levet-Carette) Reiser and Williams (16) Sample 511-70-1, 22-24 cm (17) Sample 511-62-5, 40-44 cm (18) Sample 511-61-2, 62-66 cm. 19-20. *Contignisporites fornicatus* Dettmann, Sample 511-63-1, 130-134 cm. 21-23. *Contignisporites cooksonii* (Balme) Dettmann (21) Sample 511-61-3, 61-65 cm (22-23) Sample 511-60-4, 26-28 cm. 24. *Cyclocrystella* sp. Sample 511-63-1, 130-134 cm.

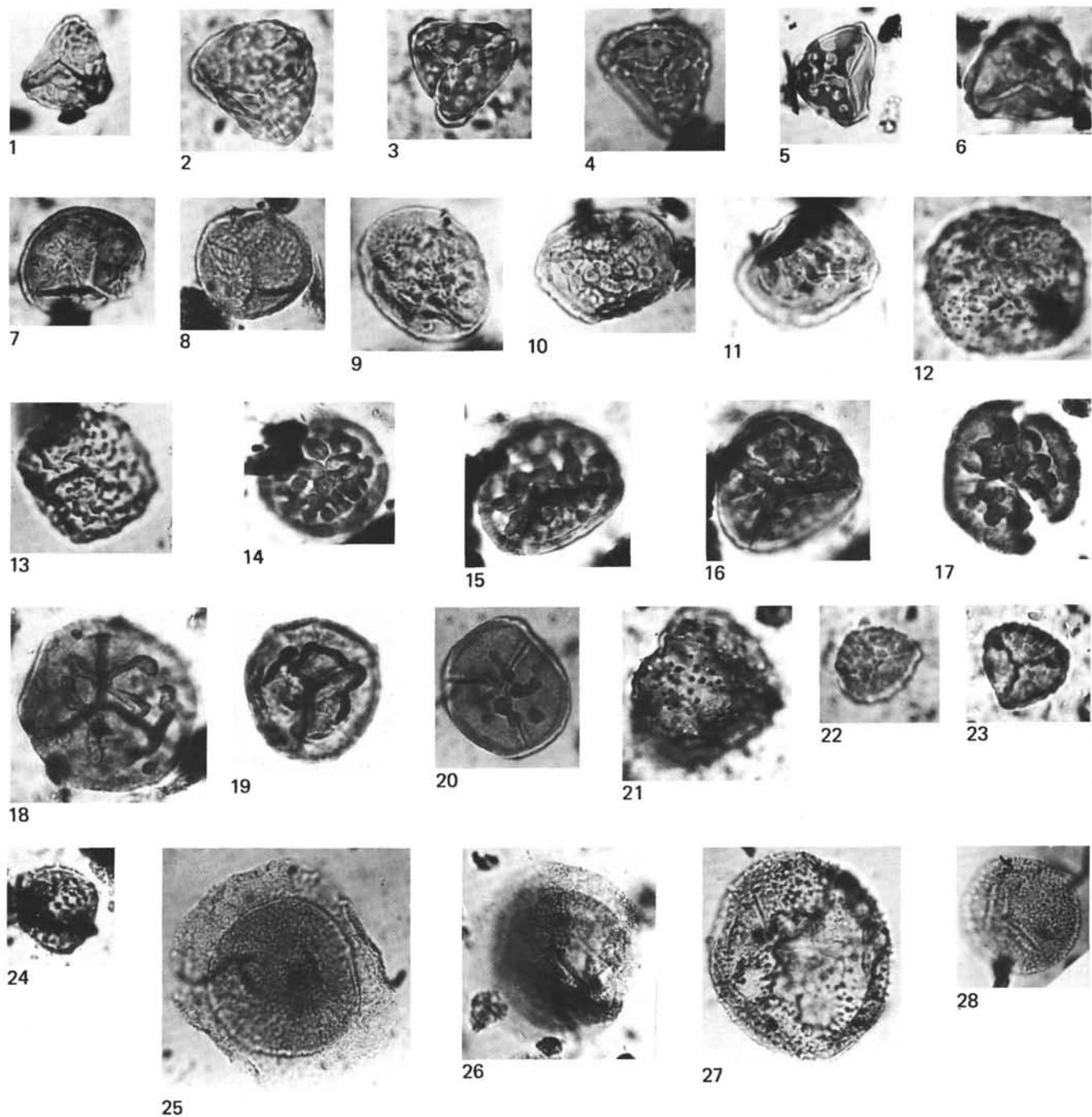


Plate 3. (All specimens magnified $\times 600$.) 1-6. *Ischyosporites volkheimeri* Filatoff (1) Sample 511-70-4, 22-24 cm (2-3) Sample 511-70-1, 22-24 cm (4-5) Sample 511-63, CC (6) Sample 511-61-5, 36-40 cm. 7-9. *Nevesisporites* sp. (7-8) Sample 511-70-1, 22-24 cm (9) Sample 511-59-4, 133-135 cm. 10-11. *Interulobites triangularis* (Brenner) Paden et al. (10) Sample 511-60-4, 26-28 cm (11) Sample 511-64-1, 30-34 cm. 12-13. *Interulobites algoensis* Scott (12) Sample 511-70-1, 22-24 cm (13) Sample 511-59-4, 133-135 cm. 14-17. *Interulobites sinuosus* Scott (14) Sample 511-64-1, 30-34 cm (15-17) Sample 511-63-1, 130-134 cm. 18-20. *Interulobites* sp. (18) Sample 511-63-1, 130-134 cm; (19) Sample 511-64-1, 30-34 cm (20) Sample 511-60-4, 26-28 cm. 21. *Anapiculatisporites dawsonensis* Reiser and Williams, Sample 511-63-1, 130-134 cm. 22-23. *Converrucosporites utriculosus* (Krasn.) Pocock, Sample 511-70-5, 22-24 cm. 24. *Neoraistrickia* sp., Sample 511-59, CC. 25-26. *Dicytotosporites complex* Cookson and Dettmann (25) Sample 511-70-5, 22-24 cm (26) Sample 511-61-3, 61-65 cm. 27. *Baculatisporites com-aumensis* (Cookson) Potonić, Sample 511-67-5, 82-84 cm. 28. *Osmundacidites wellmanii* Couper, Sample 511-70-4, 22-24 cm.

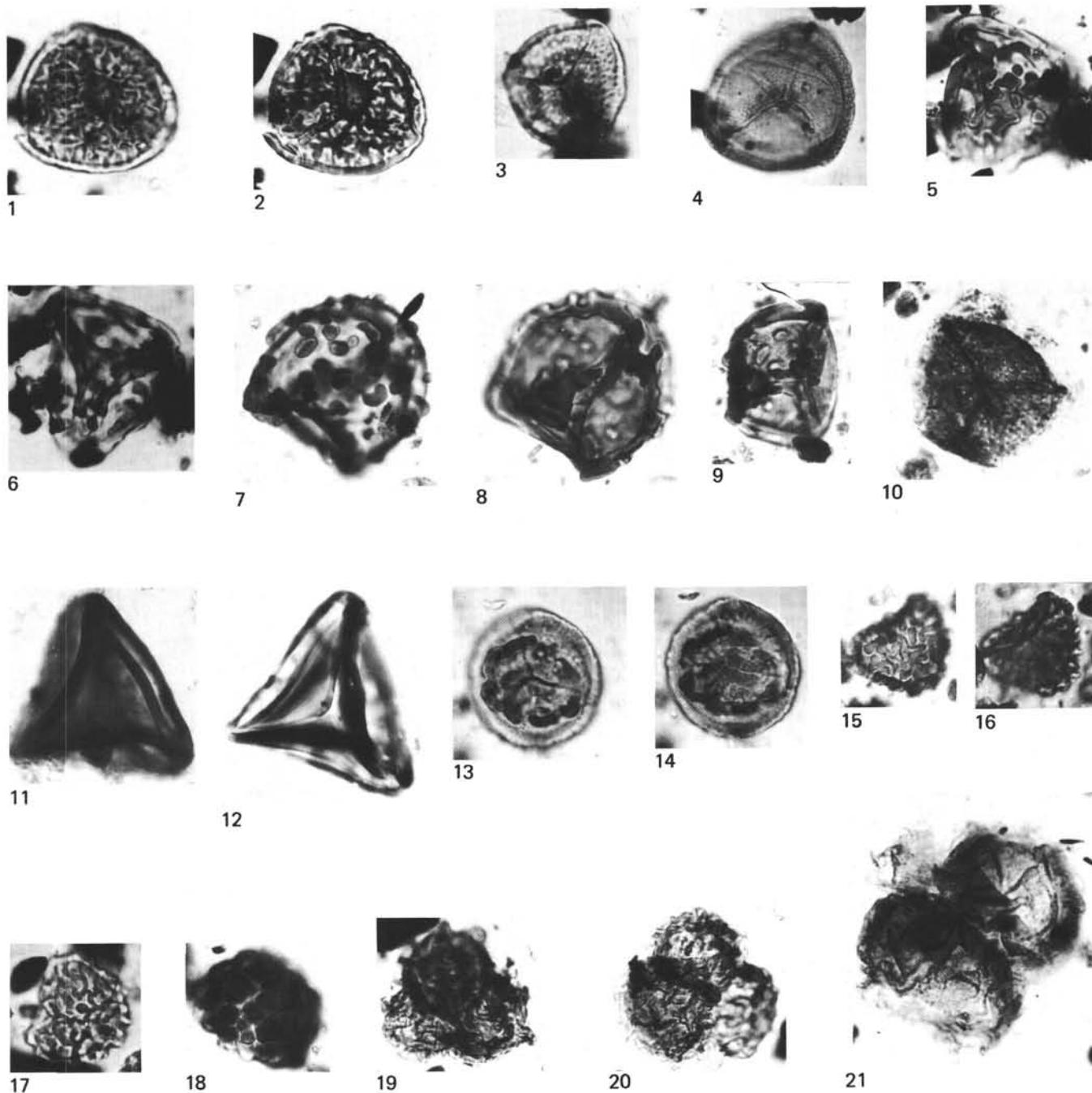


Plate 4. (All specimens magnified $\times 600$.) 1-2. *Coronatispora valdensis* (Couper) Dettmann, Sample 511-58-1, 44-46 cm. 3. *Coronatispora perforata* Dettmann, Sample 511-60-2, 26-28 cm. 4. *Densoisporites velatus* Weyland and Krieger, Sample 511-58-2, 142-144 cm. 5-9. *Polypodiaceoisporites elegans* Archangelsky and Gamerro (5-6) Sample 511-60-3, 26-28 cm (7-8) Sample 511-61, CC (9) Sample 511-62-4, 120-124 cm. 10. *Sestosporites pseudoalveolatus* (Couper) Dettmann, Sample 511-57-3, 33-35 cm. 11-12. *Distaltriangulisporites pelliculus* Scott, Sample 511-62-1, 38-42 cm. 13-14. *Taurocuspites segmentatus* Stover, Sample 511-57-5, 33-35 cm. 15-17. *Trilites* sp. 1 (15-16) Sample 511-62-3, 35-39 cm (17) Sample 511-60-2, 26-28 cm. 18. *Patellasporites* sp., Sample 511-62-5, 40-44 cm. 19-21. *Crybelosporites berberioides* Burger (19-20) Sample 511-63-1, 130-134 cm (21) Sample 511-70-4, 22-24 cm.

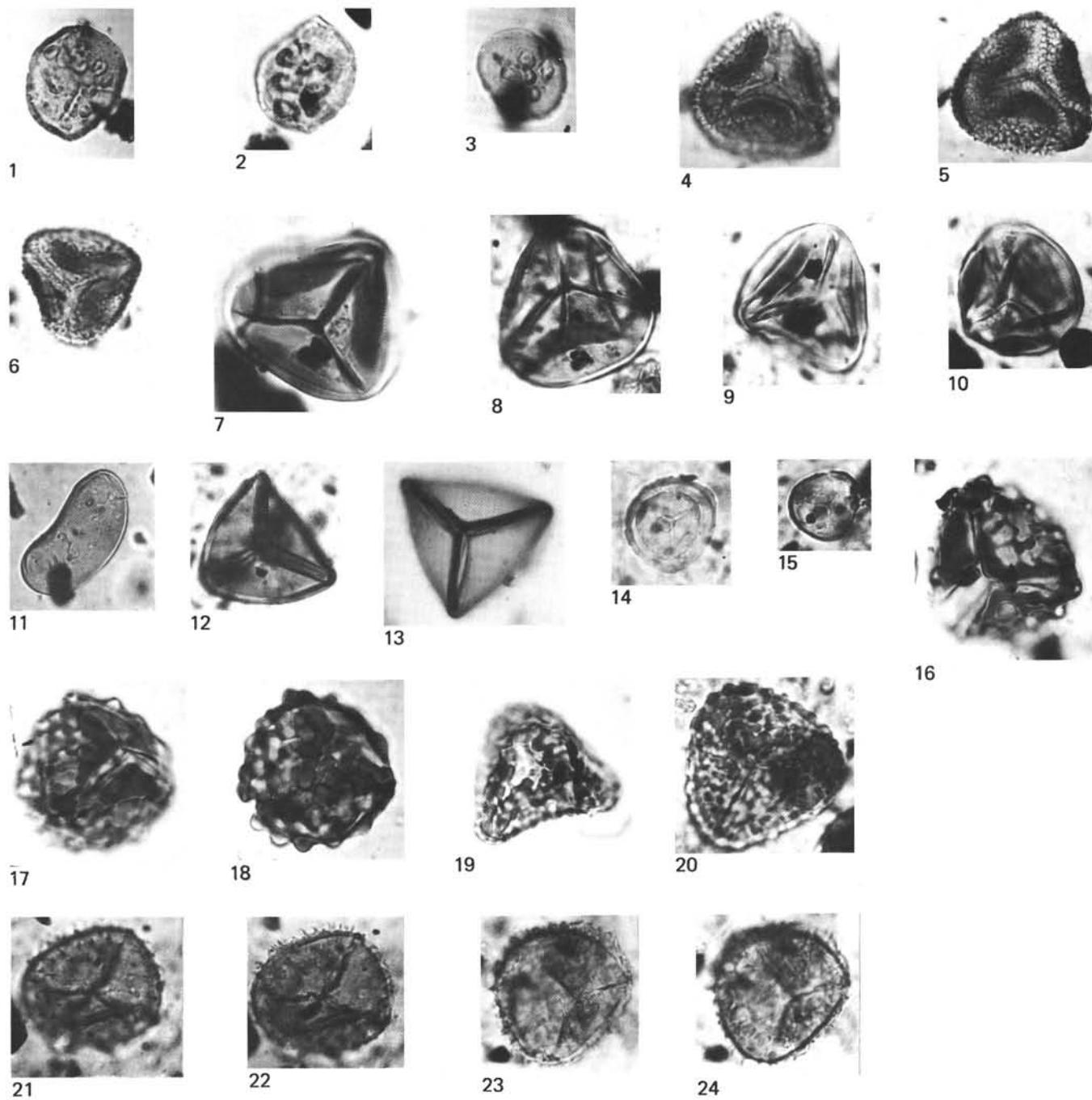


Plate 5. (All specimens magnified $\times 600$.) 1-3. *Kuylisporites lunaris* Cookson and Dettmann (1) Sample 511-60-3, 26-28 cm (2) Sample 511-62-3, 35-39 cm (3) Sample 511-58,CC. 4-6. *Ceratosporites distalgranulatus* (Couper) Kemp, Sample 511-57-5, 33-35 cm. 7-10. *Gleicheniidites* spp. (7) Sample 511-57-5, 33-35 cm (8-9) Sample 511-57-3, 33-35 cm (10) Sample 511-56-5, 58-60 cm. 11. *Laevigatosporites ovatus* Wilson and Webster, Sample 511-58-1, 44-46 cm. 12-13. *Biretisporites* sp. (12) Sample 511-57-3, 33-35 cm (13) Sample 511-58-2, 142-144 cm. 14. *Cingulitrites clavus* (Balme) Dettmann, Sample 511-57-3, 33-35 cm. 15. *Stereisporites antiquasporites* (Wilson and Webster) Dettmann, Sample 511-57-1, 33-35 cm. 16-18. *Ischyosporites* sp. 1 (16) Sample 511-57-4, 33-35 cm. (17-18) Sample 511-58-2, 142-144 cm. 19-20. *Ischyosporites* sp. 2 (19) Sample 511-57-4, 33-35 cm (20) Sample 511-62-1, 38-42 cm. 21-24. *Perotrilites linearis* (Cookson and Dettmann) Evans, Sample 511-57-3, 33-35 cm.

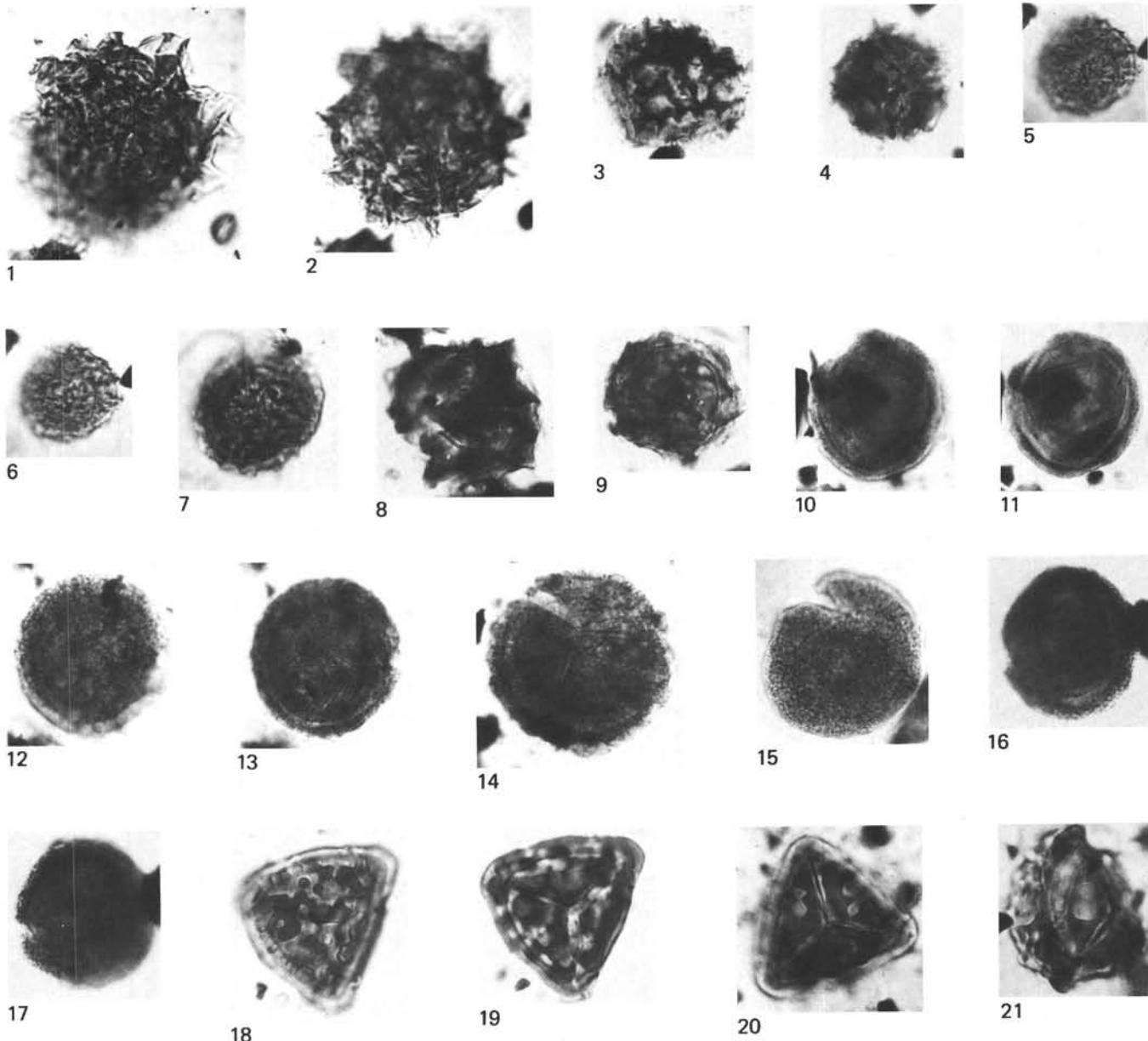


Plate 6. (All specimens magnified $\times 600$.) 1-9. *Crybelosporites* aff. *striatus* (Cookson and Dettmann) Dettmann (1, 2, 5, 6) Sample 511-58-2, 142-144 cm (3, 4, 7, 8) Sample 511-57-3, 33-35 cm (9) Sample 511-57-6, 33-35 cm. 10-17. *Crybelosporites* sp. 1 (10-11) Sample 511-57-6, 33-35 cm (12-14) Sample 511-57-3, 33-35 cm (15) Sample 511-58-3, 53-55 cm (16-17) Sample 511-57-2, 33-35 cm. 18-21. *Muricingulipollenites annulatus* Archangelsky and Gamarro (18-19) Sample 511-57-5, 33-35 cm (20-21) Sample 511-57-3, 33-35 cm.

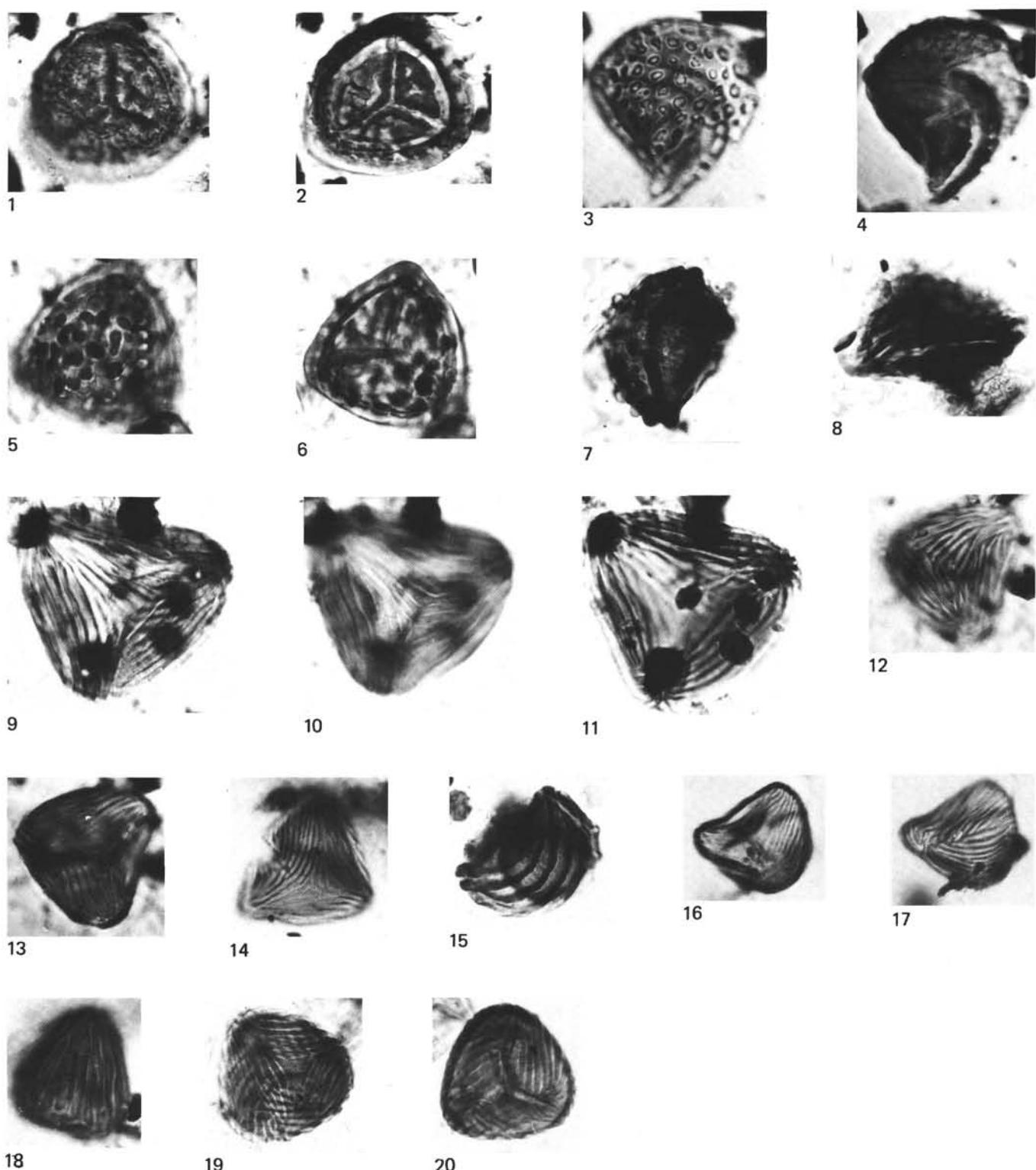


Plate 7. (All specimens magnified $\times 600$.) 1-2. *Cyatheacidites tectifera* Archangelsky and Gamerro, Sample 511-57-6, 33-35 cm. 3-4. *Cyatheacidites* sp. 1, Sample 511-58-2, 142-144 cm. 5-7. *Cyatheacidites* sp. 2 (5-6) Sample 511-58-2, 142-144 cm (7) Sample 511-56-5, 58-60 cm. 8. *Appendicisporites* sp., Sample 511-56-5, 58-60 cm. 9-11. *Cicatricosisporites ludbrooki* Dettmann (Sample 511-61-4, 50-54 cm. 12-14. *Cicatricosisporites australiensis* (Cookson) Potonié (12-13) Sample 511-57-3, 33-35 cm (14) Sample 511-58-2, 142-144 cm. 15. *Cicatricosisporites hughesi* Dettmann, Sample 511-61-3, 61-65. 16-18. *Cicatricosisporites hallei* Delcourt and Sprumont, Sample 511-57-4, 33-35 cm. 19-20. *Cicatricosisporites proxiradiatus* Kemp, Sample 511-57-3, 33-35 cm.

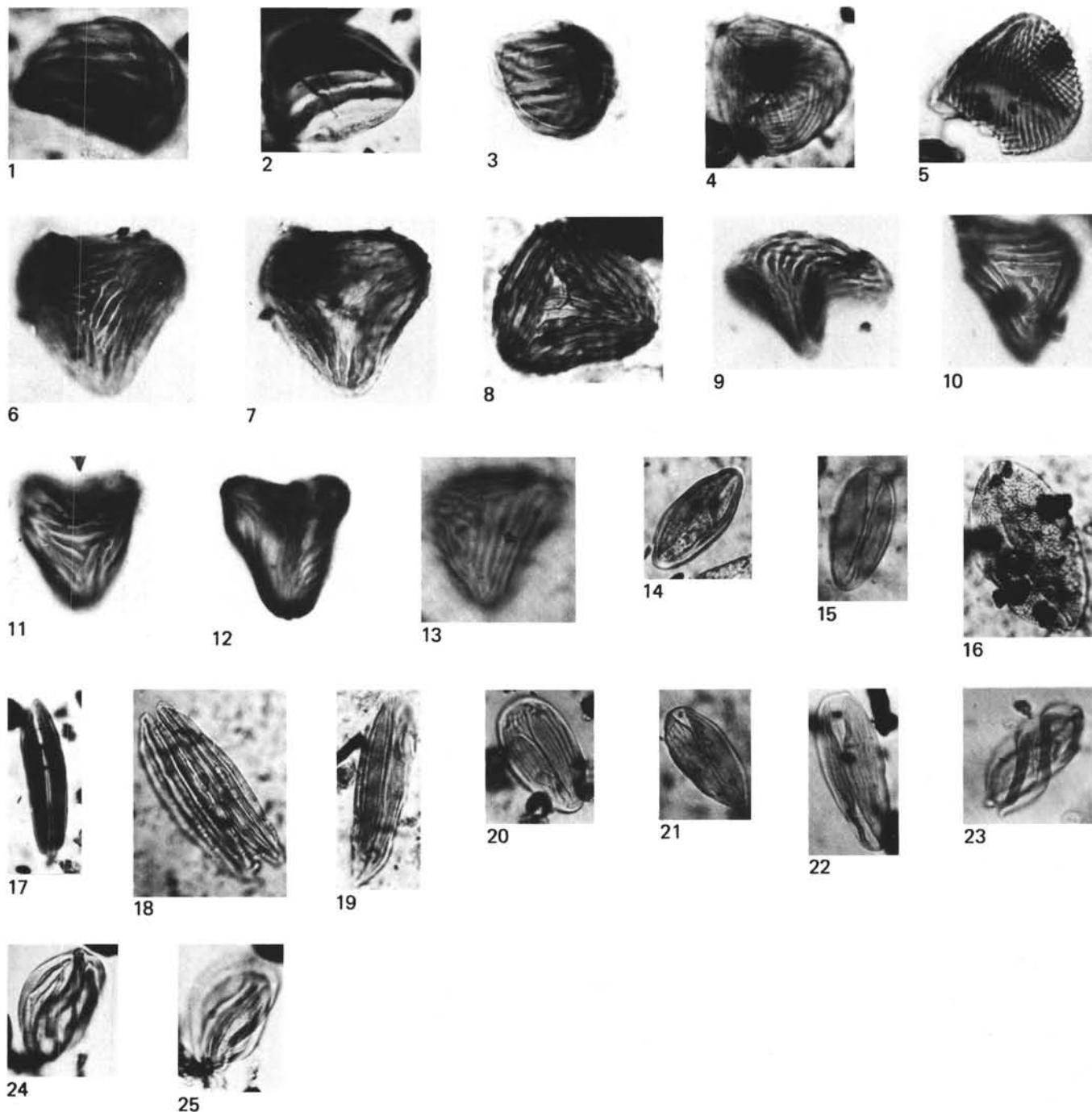


Plate 8. (All specimens magnified $\times 600$.) 1-2. *Cicatricosisporites* sp. (1) Sample 511-60-4, 26-28 cm (2) Sample 511-59, CC. 3. *Cicatricosisporites* sp. 4. Sample 511-57-6, 33-35 cm. 4-5. *Cicatricosisporites* sp. 2 (4) Sample 511-57-3, 33-35 cm (5) Sample 511-57-4, 33-35 cm. 6-9. *Cicatricosisporites* sp. 3 (6, 7, 9) Sample 511-57-2, 33-35 cm (8) Sample 511-57-3, 33-35 cm. 10-13. *Cicatricosisporites* sp. 5 (10) Sample 511-57-4, 33-35 cm 11-12. Sample 511-57-6, 33-35 cm (13) Sample 511-57-3, 33-35 cm. 14-16. *Monosulcites* spp. (14) Sample 511-69-2, 42-44 cm; (15) Sample 511-59, CC (16) Sample 511-60-2, 26-28 cm. 17-19. *Ephedripites* sp. 2 (17) Sample 511-70-5, 22-24 cm (18-19) Sample 511-70-1, 22-24 cm. 20-22. *Ephedripites* sp. 3 (20) Sample 511-61-3, 61-65 cm (21) Sample 511-63-1, 130-134 cm. 23-25. *Ephedripites* sp. 1 (23) Sample 511-61, CC (24-25) Sample 511-61-3, 61-65 cm.

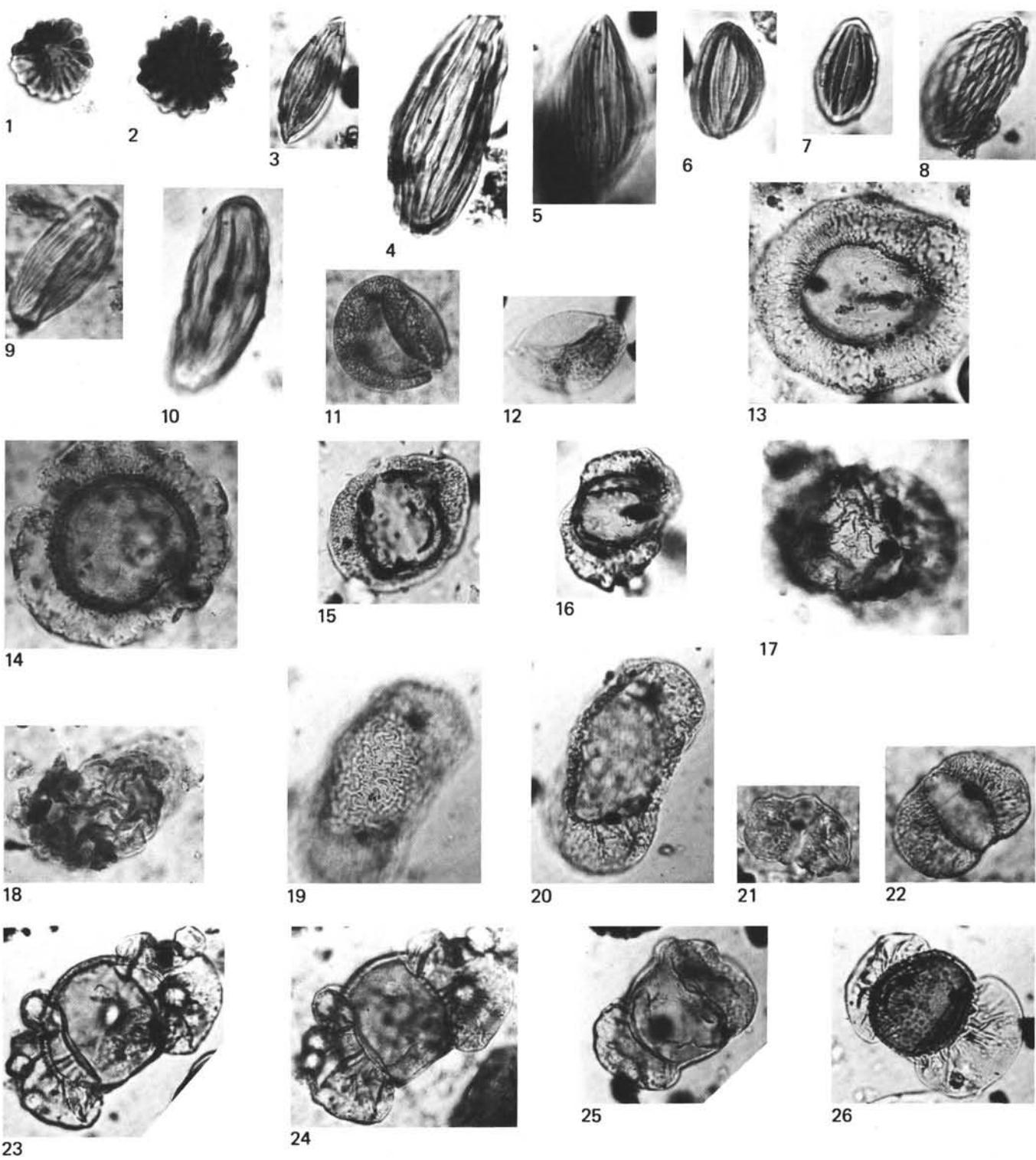


Plate 9. (All specimens magnified $\times 600$) 1-2. *Ephedripites* sp. 5, Sample 511-57-5, 33-35 cm. 3-8. *Ephedripites* spp. (3) Sample 511-70-1, 22-24 cm (4) Sample 511-62-2, 54-58 cm (5) Sample 511-58-2, 142-144 cm (6) Sample 511-70-2, 22-24 cm (7) Sample 511-58-1, 44-46 cm (8) Sample 511-60-3, 26-28 cm. 9-10. *Steevesipollenites* sp. (9) Sample 511-62-1, 38-42 cm (10) Sample 511-58-2, 142-144 cm. 11-12. *Monosaccites* sp. 2, Sample 511-57-2, 33-35 cm. 13-14. *Monosaccites* sp. 1 (13) Sample 511-70-5, 22-24 cm (14) Sample 511-62-2, 54-58 cm. 15-16. *Sulcosaccispora* sp. (15) Sample 511-69-2, 42-44 cm; (16) Sample 511-70-4, 22-24 cm. 17-20. *Rugubivesculites* sp. (17) Sample 511-70-5, 22-24 cm (18) Sample 511-70-1, 22-24 cm (19-20) Sample 511-58-2, 142-144 cm. 21-22. *Vitreisporites pallidus* (Reissinger) Nilsson (21) Sample 511-70-5, 22-24 cm (22) Sample 511-69-2, 42-44 cm. 23-26. *Bisacado* sp. A (23-24) Sample 511-57-3, 33-35 cm (25-26) Sample 511-58-1, 44-46 cm.

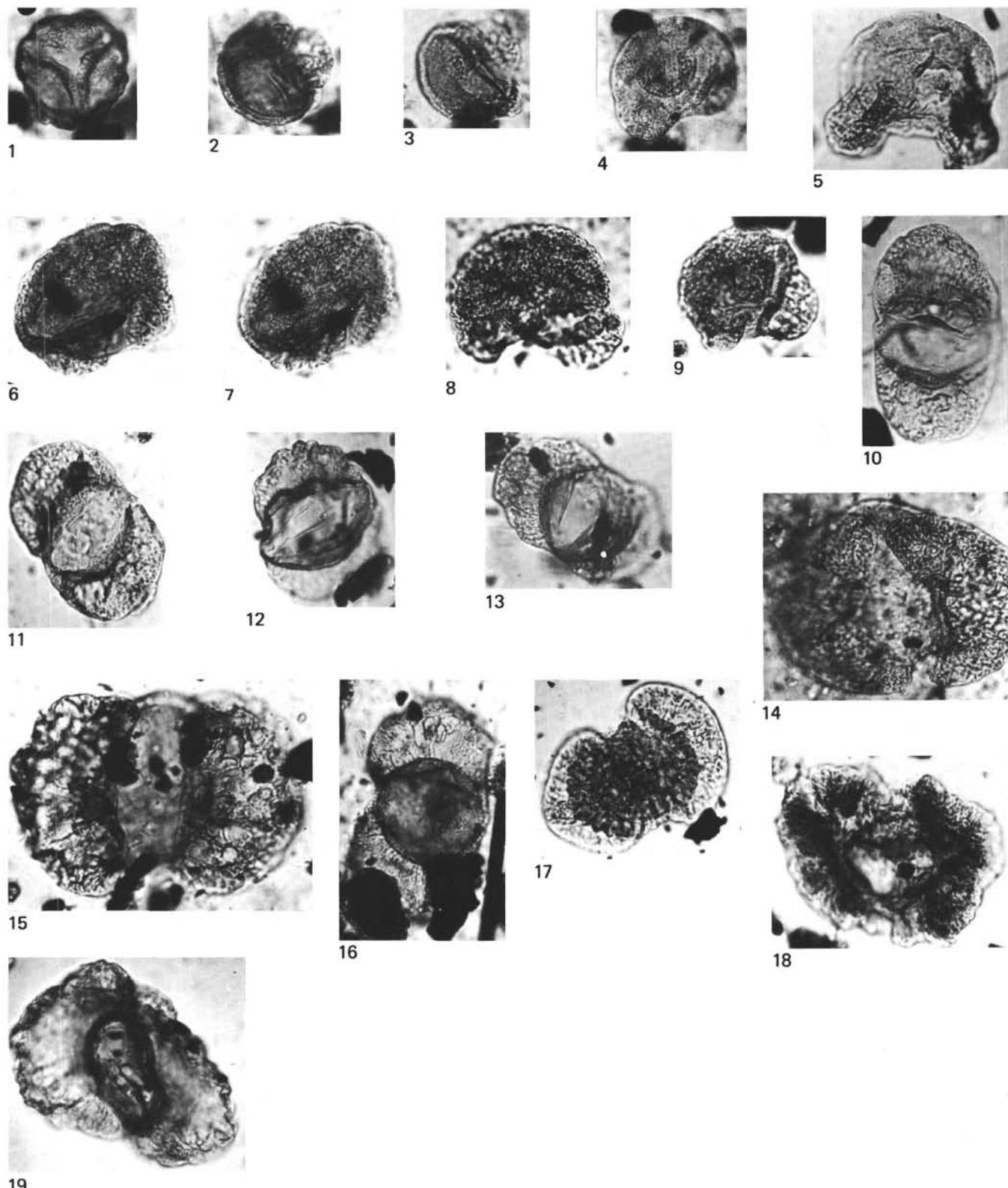


Plate 10. (All specimens magnified $\times 600$.) 1. *Trisaccites* sp., Sample 511-63-1, 130-134 cm. 2-4. *Microcachryidites antarcticus* Cookson (2) Sample 511-66-1, 28-30 cm (3) Sample 511-59, CC (4) Sample 511-57-1, 33-35 cm. 5. *Microcachryidites* sp., Sample 511-70-4, 22-24 cm. 6-9. *Podosporites* sp. (6-7) Sample 511-70-5, 22-24 cm (8) Sample 511-64-1, 30-34 cm (9) Sample 511-70-4, 22-24 cm. 10-11. *Alisporites lowwoodensis* de Jersey, Sample 511-69-5, 42-44 cm. 12. *Alisporites similis* (Balme) Dettmann, Sample 511-70-2, 22-24 cm. 13. *Alisporites* sp., Sample 511-70-5, 22-24 cm. 14-15. *Alisporites grandis* (Cookson) Dettmann (14) Sample 511-56-5, 58-60 cm (15) Sample 511-69-2, 42-44 cm. 16-17. *Podocarpidites* sp. (16) Sample 511-70-3, 22-24 cm (17) Sample 511-58-2, 142-144 cm. 18-19. *Disaccites* (18) Sample 511-69-2, 42-44 cm (19) Sample 511-70-4, 22-24 cm.

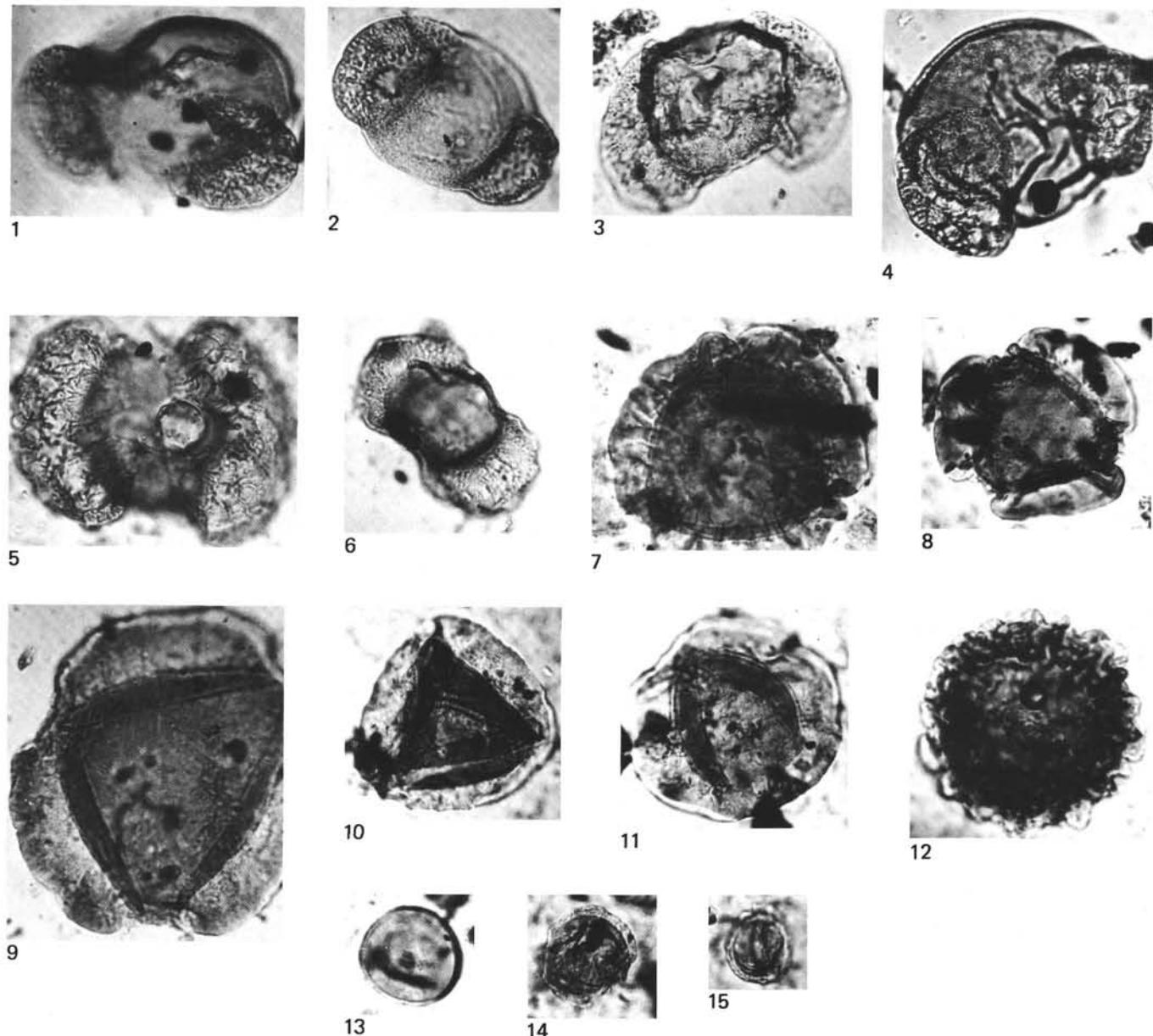


Plate 11. (All specimens magnified $\times 600$.) 1-6. *Disaccites* (1) Sample 511-57-5, 33-35 cm (2,6) Sample 511-70-4, 22-24 cm (3) Sample 511-57-4, 33-35 cm (5) Sample 511-69-2, 42-44 cm. 7. *Callialasporites dampieri* (Balme) Sukh Dev, Sample 511-70-5, 22-24 cm. 8-9. *Callialasporites trilobatus* (Balme) Sukh Dev (8) Sample 511-63-1, 130-134 cm (9) Sample 511-69-2, 42-44 cm. 10-11. *Callialasporites turbatus* (Balme) Schulz (10) Sample 511-69-2, 42-44 cm (11) Sample 511-70-1, 22-24 cm. 12. *Callialasporites segmentatus* (Balme) Srivastava, Sample 511-70-1, 22-24 cm. 13. *Exesipollenites* sp., Sample 511-70-3, 22-24 cm. 14-15. *Peromonolites* sp. (14) Sample 511-64-4, 79-83 cm (15) Sample 511-67-2, 82-84 cm.

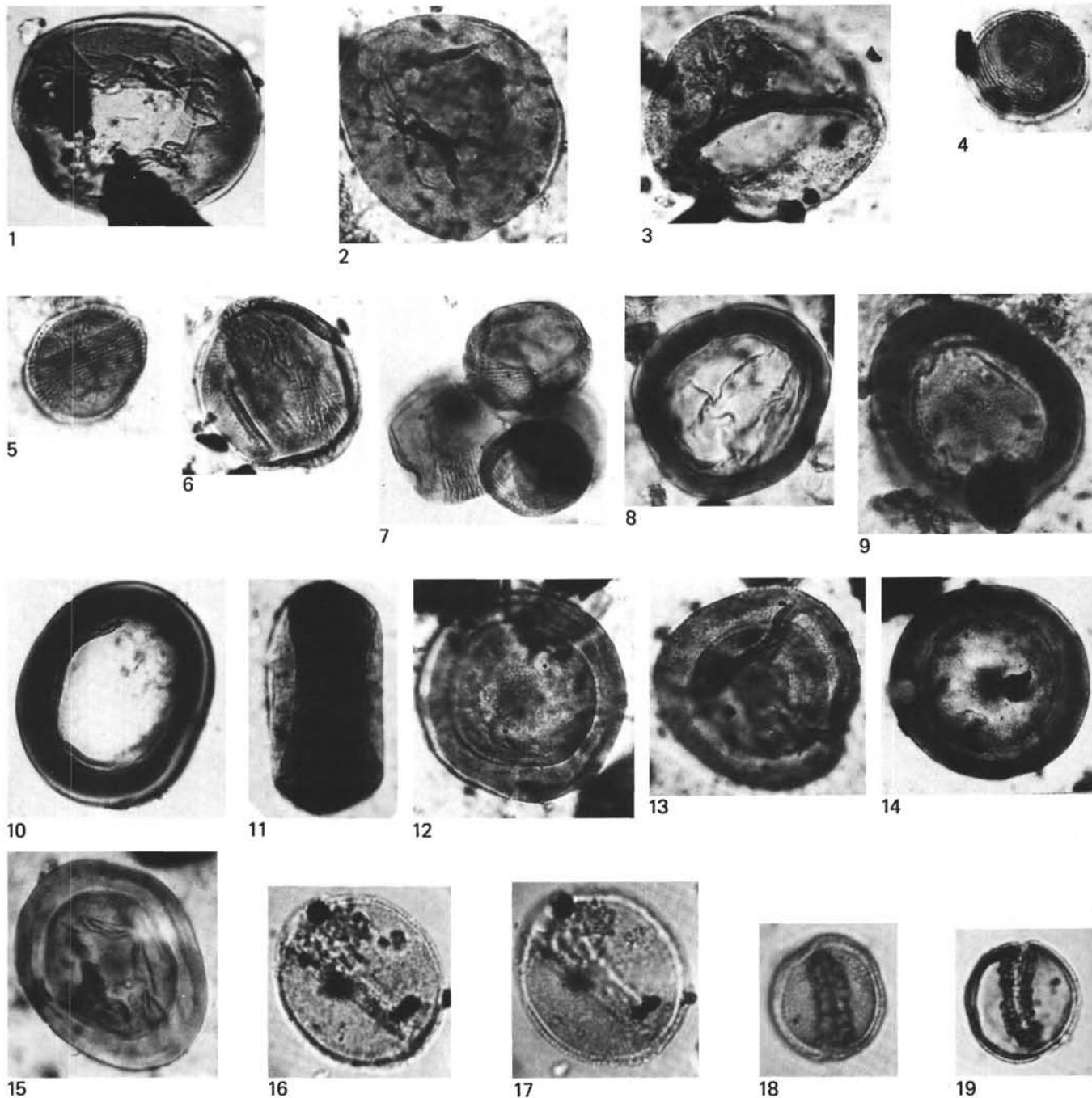


Plate 12. (Figs. 1-15 $\times 600$; Figs. 16-19 $\times 1000$.) 1. *Inaperturopollenites limbatus* Balme, Sample 511-57-6, 33-35 cm. 2. *Inaperturopollenites* sp., Sample 511-70-3, 22-24 cm. 3. *Araucariacites australis* (Cookson) Couper, Sample 511-69-2, 42-44 cm. 4-7. *Classopollis* spp. (4-6) Sample 511-70-5, 22-24 cm (7) Sample 511-69-2, 42-44 cm. 8-11. *Cyclusphaera psilata* Volkheimer and Sepulveda (8-9) Sample 511-62-1, 38-42 cm (10) Sample 511-57-2, 33-35 cm (11) Sample 511-56-5, 58-60 cm. 12-15. *Cyclusphaera* sp. A (12-13) Sample 511-57-3, 33-35 cm (14) Sample 511-57-1, 33-35 cm (15) Sample 511-58-2, 142-144 cm. 16-17. *Clavatipollenites rotundus* Kemp, Sample 511-57-6, 33-35 cm. 18-19. *Clavatipollenites incisus* Chlonova, Sample 511-58-2, 142-144 cm.

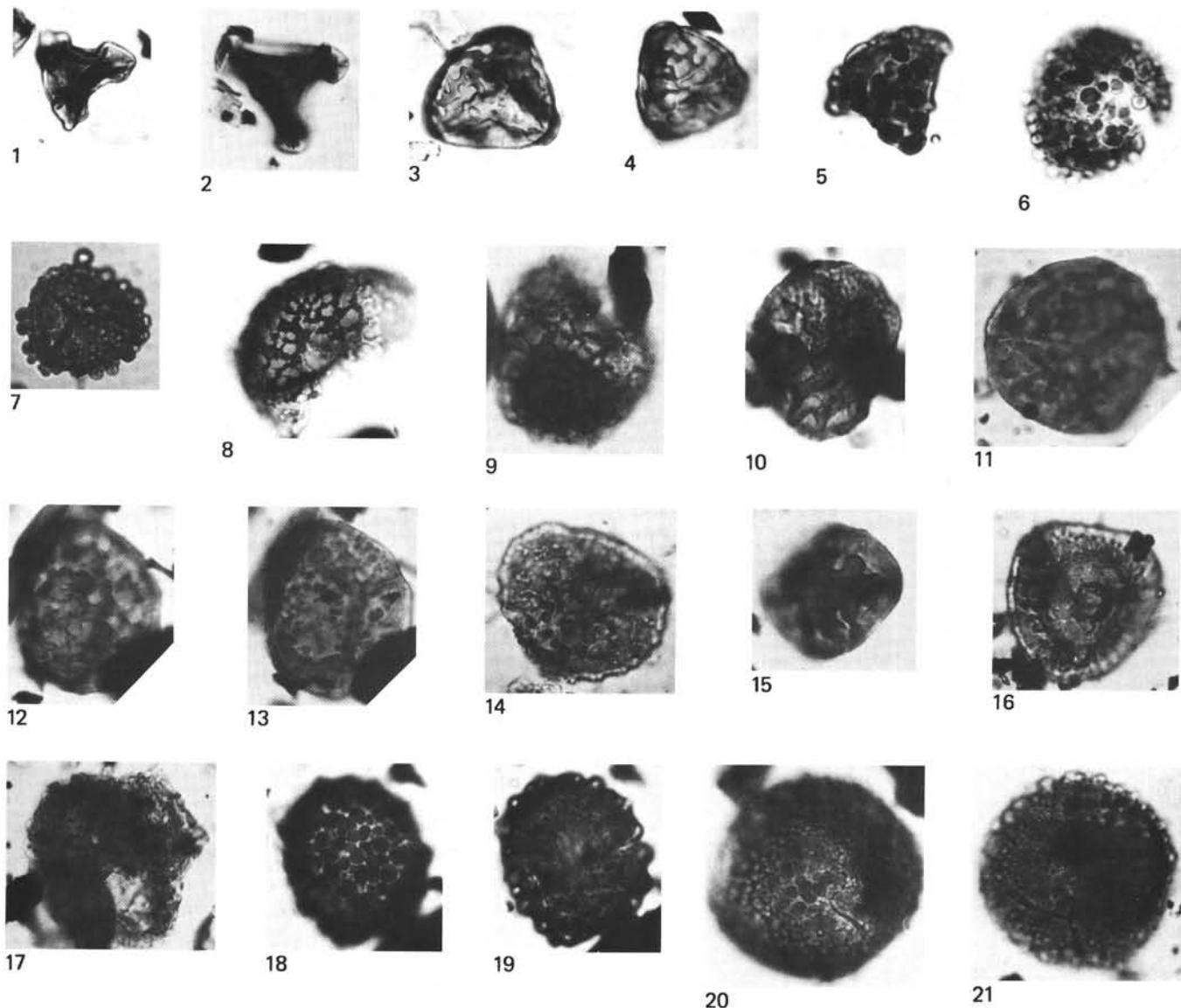


Plate 13. (All specimens magnified $\times 600$.) 1-2. *Auritulinaspores intrastriatus* Nilsson (1) Sample 330-14-4, 70-74 cm (2) Sample 330-14-2, 18-21 cm. 3-4. *Polypodiaceoisporites neuquensis* Volkheimer, Sample 330-14-4, 70-74 cm. 5. *Trilites* sp. 2, Sample 330-13-3, 112-116 cm. 6-7. *Clavatisporites* sp., Sample 330-13-3, 112-116 cm. 8-9. *Retitriletes* sp., Sample 330-13-3, 112-116 cm. 10-13. *Interulobites* sp. A (10) Sample 330-14-4, 70 cm (11-13) Sample 330-12-5, 72-76 cm. 14. *Interulobites algoensis* Scott, Sample 330-11-5, 120-124 cm. 15. *Interulobites sinuosus* Scott, Sample 330-6-5, 90-94 cm. 16. *Coronatispora perforata* Dettmann, Sample 330-11-6, 90-93 cm. 17. *Crybelosporites* aff. *berberioides* Burger, Sample 330-8-4, 114-117 cm. 18-21. *Leptolepidites* sp. 1 (18-20) Sample 330-13-4, 116-120 cm (21) Sample 330-13-2, 69-73 cm.

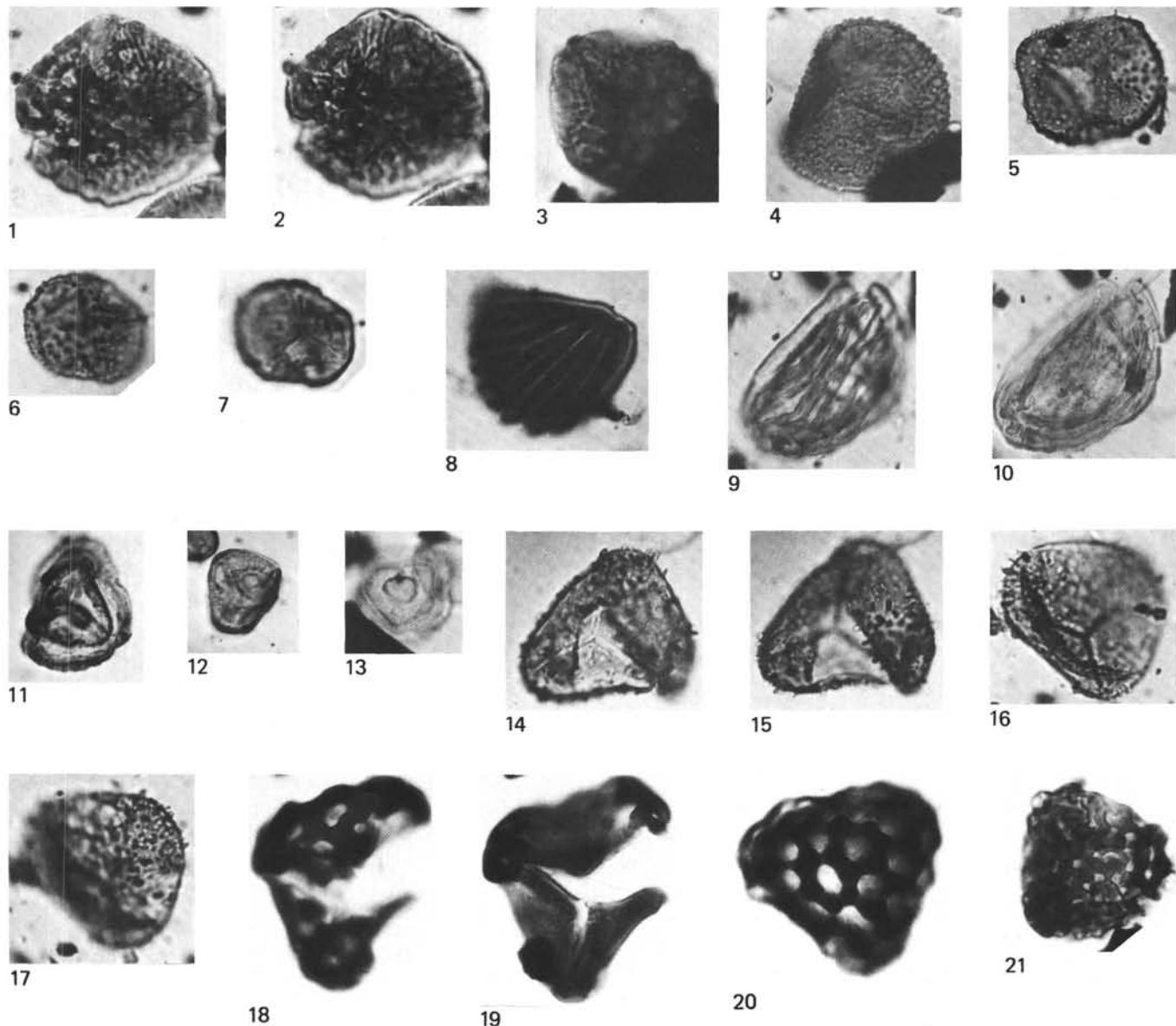


Plate 14. (All specimens magnified $\times 600$.) 1-3. *Verrucosisporites* sp. E (1-2) Sample 330-13-2, 69-73 cm (3) Sample 330-12-6, 111-115 cm. 4. *Verrucosisporites* sp. 1, Sample 330-12-3, 70-74 cm. 5-7. *Neoraistrickia suratensis* McKellar (5) Sample 330-13-4, 116-120 cm (6-7) Sample 330-13-2, 69-73 cm. 8. *Contignisporites cooksonii* (Balme) Dettmann, Sample 330-13-3, 112-116 cm. 9-10. *Contignisporites* sp., Sample 330-12-3, 70-74 cm. 11. *Polycingulatisporites crenulatus* Playford and Dettmann, Sample 330-7-3, 82-86 cm. 12. *Polycingulatisporites striatus* Filatoff, Sample 330-14-3, 92-96 cm. 13. *Polycingulatisporites* sp., Sample 330-12-6, 111-115 cm. 14-17. *Conbaculatisporites* sp. (14-15) Sample 330-14-2, 18-21 cm (16-17) Sample 330-13-2, 69-73 cm. 18-20. *Ischyosporites crateris* Balme (18-19) Sample 330-14-3, 92-96 cm (20) Sample 330-13-3, 112-116 cm. 21. *Ischyosporites* sp., Sample 330-13-2, 69-73 cm.

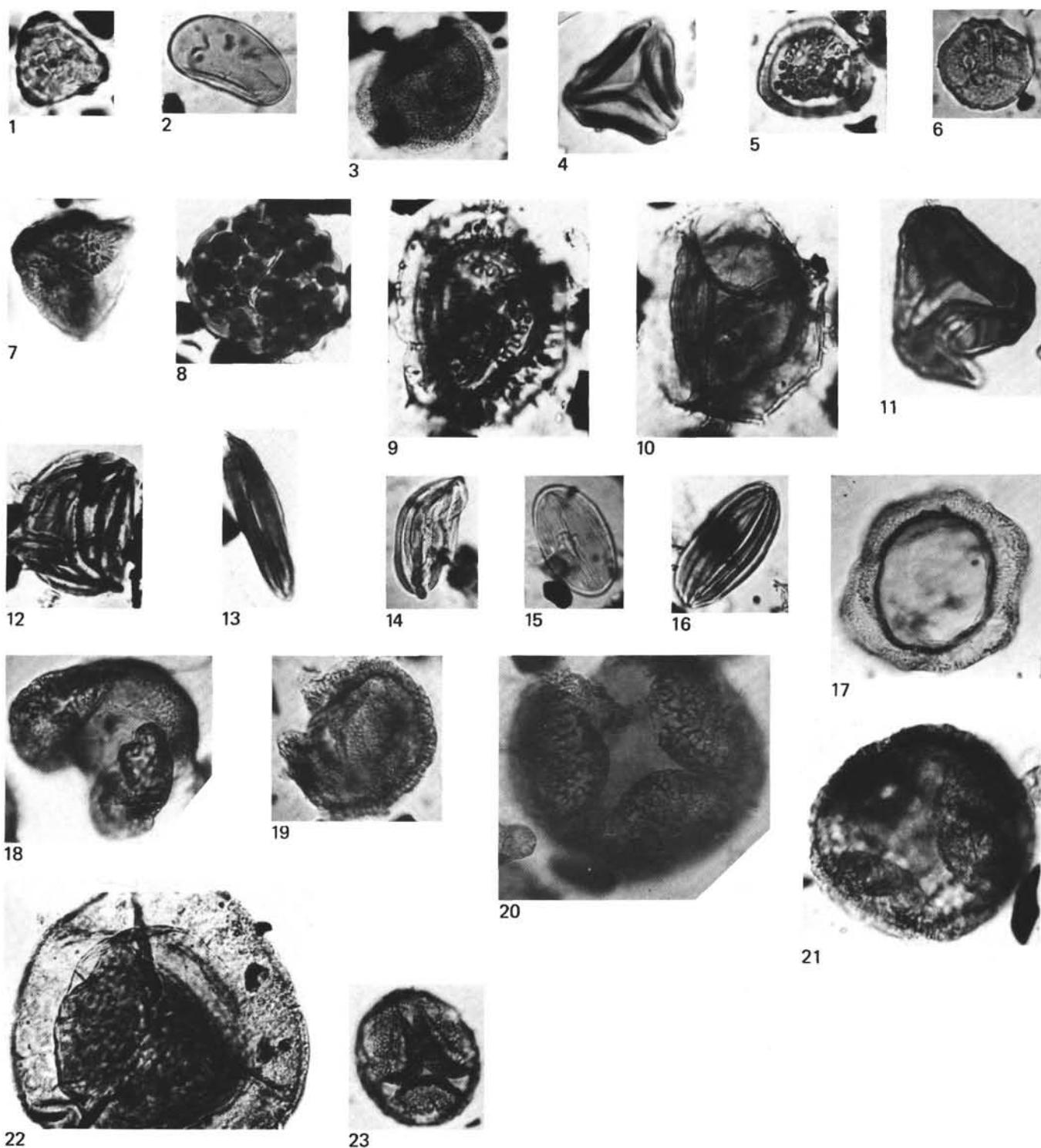


Plate 15. (All specimens magnified $\times 600$.) 1. *Ischiosporites volkheimeri* Filatoff, Sample 330-11-5, 120–124 cm. 2. *Laevigatosporites* sp., Sample 330-13-3, 112–116 cm. 3. *Dictyotosporites complex* Cookson and Dettmann, Sample 330-14-4, 70–74 cm. 4. *Gleicheniidites* sp., Sample 330-14-2, 18–21 cm. 5. *Antulsporites saevus* (Balme) Archangelsky and Gamerro, Sample 330-7-5, 90–94 cm. 6. *Kuylisporites lunaris* Cookson and Dettmann, Sample 330-7-5, 90–94 cm. 7. *Nevesisporites* sp., Sample 330-6-5, 90–94 cm. 8. *Leptolepidites macroverrucosus* Schulz, Sample 330-11-3, 83–87 cm. 9,10. *Cyclocystella* sp., Sample 330-8-4, 114–117 cm. 11. *Trilobosporites antiquus* Reiser and Williams, Sample 330-13-3, 112–116 cm. 12. *Cicatricosporites* sp., Sample 330-6-1, 43–47 cm. 13. *Ephedripites* sp. 2, Sample 330-14-2, 18–21 cm. 14. *Ephedripites* sp. 1, Sample 330-6-1, 43–47 cm. 15. *Ephedripites* sp. 3, Sample 330-6-3, 102–105 cm. 16. *Ephedripites* sp., Sample 330-9-2, 92–95 cm. 17. *Monosaccites* sp. 1, Sample 330-13-2, 69–73 cm. 18. *Indusispora* sp., Sample 330-14-2, 18–21 cm. 19. *Podosporites* sp., Sample 330-7-3, 82–86 cm. 20–21. *Podosporites* sp. 1 (20) Sample 330-12-3, 70–74 cm (21) Sample 330-13-4, 116–120 cm. 22. *Callialasporites* sp., Sample 330-14-4, 70–74 cm. 23. *Trisaccites* sp., Sample 330-13-3, 112–116 cm.