LOWERMOST JURASSIC SPORE-POLLEN ASSEMBLAGE FROM CANADIAN ARCTIC*

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ABSTRACT

An assemblage of pollen and spores from the Upper part of the Heiberg Formation of Arctic Canada is illustrated and discussed. From its stratigraphic position and from the palaeontology of underlying and overlying strata, it is deduced that the assemblage must be older than the Sinemurian Stage of the Lower Jurassic, and younger than the FG subzone of the TK zone of Morbey (1975). The assemblage itself compares closely with that described from the Psilonoten Schichta of Eastern Germany by Schulz (1967). It is therefore postulated that the beds carrying the assemblage are Hettangian in age, correlating with the lower beds of the Blue Lias of Western Europe.

INTRODUCTION

THIS paper is an outline of a study being carried out on the palynology and dating of the lowermost Jurassic strata of the Sverdrup Basin of the Canadian Arctic Archipelago. Once the study is completed it is planned to publish a more detailed and comprehensive paper on these assemblages.

Over the past 15 years Triassic and Jurassic sediments, which form part of the infilling of the Sverdrup Basin of the Canadian Arctic Archipelago, have been extensively studied by officers of the Geological Survey of Canada, the most comprehensive studies being those of Tozer (1956, 1960, 1963a-b, 1967, Frebold (1958, 1960, 1961, 1964a, b, 1970), and Jeletzky (1966, 1971). The Triassic sequence in the region is so well-developed and the fossil sequence so complete that it has been proposed as the standard sequence for international zonation (Tozer, 1967). The Jurassic section is less marine and, particularly in the lower part, ammonite zones are less completely represented. The Jurassic palynology of the Sverdrup Basin of Ellesmere and Axel Heiberg islands has been outlined by Johnson and Hills (1973). Although specifically concerned with microplankton of the Savik Formation, this paper establishes a skeleton dinoflagellate zonation for ammonite dated strata ranging from Toarcian to Kimmeridgian in age. The earliest contribution to the non-marine palynology of the region was that of McGregor (1965), who illustrated selected Triassic, Jurassic and Lower Cretaceous spores and pollen from the area. Pocock (1970, 1972) gave a brief account of Jurassic assemblages from the few Arctic locations available to him at the time. More detailed studies of the palynology of uppermost Jurassic sediments have been published by Brideaux (1975), Brideaux and Fisher (1976) and Pocock (1976).

STRATIGRAPHIC SETTING

Over much of the Canadian Arctic, sandstones of the Heiberg Formation carry megafauna of late Triassic, Norian age. The youngest marine assemblage is typified by *Monotis ochotica*, an Upper Norian species (Thorsteinsson & Tozer, 1970, p. 578). The youngest beds of the Heiberg Formation, overlying beds carrying *Monotis* are non-marine sandstones with a few subsidiary shale stringers and thin coal seams. It has been traditional to place the Triassic-Jurassic boundary at the top of these non-marine sediments, but the boundary could occur within the top of the Heiberg sequence itself (Thorsteinsson & Tozer, 1970, p. 379). Strata of Jurassic age overlie the Heiberg sediments, usually with significant unconformity. The oldest,

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TEXT-FIG. 1

ammonite dated, rocks of Jurassic age in the Sverdrup Basin form the Borden Island Formation. These beds have yielded an ammonite of Sinemurian age at their type locality on Borden Island, and although this was recovered from the taulus at the foot of the cliffs, the record is probably reliable (Tozer, 1963a; Rahamani & Tan, 1978).

At its type locality the grey-green glauconitic sands of the Borden Island Formation overlie the upper non-marine sands of the Heiberg Formation. Borden Island sands are normally overlain, in outcrop by shales at the base of the marine Savik Formation. This formation carries the ammonite *Harpoceras* at its base and is therefore Toarcian in age. Marine Pliensbachian sediments have not been recorded from anywhere in the Canadian Arctic. Thorsteinsson and Tozer (1970, p. 579) suggest that Pliensbachian time may have been a period of gentle uplift and erosion. Lower Jurassic time in the Canadian Arctic was a period of shallow water sedimentation accompanied by much differential earth movement of a relatively gentle nature. This resulted in the development of complex clastic sand-shale sequences, showing rapid facies change in both vertical and lateral directions. One result of this complexity has been that formations vary greatly in age from place to place and any attempt to use lithological markers for time correlation leads to grossly inaccurate results. In fact, correlation from the type sections exposed at the surface into the subsurface is virtually impossible without palaeontological support, and even with such support, much doubt remains regarding correlation in local areas.

PALYNOLOGY

Introduction — While the upper part of the Heiberg Formation is of non-marine origin and therefore lacking in marine megafauna, it does contain thin coal and shale stringers as well as flecks of carbonaceous matter distributed throughout the sand itself. These lithologies appear to be favourable for the preservation of palynological assemblages. Unfortunately, the eastern part of the Sverdrup Basin, where the best and most accessible exposures of the Heiberg sandstone occur, is also an area of Post-Jurassic tectonic activity and

Triassic and Jurassic sediments have often been intruded by sills and dikes which have baked sediment in the vicinity, destroying or severely carbonising included palynomorphs. The effects of such alteration, on a relatively minor scale, can be seen in many of the specimens illustrated in Johnson and Hills (1973) paper. Some locations have, however, escaped thermal alteration and have yielded a rich assemblage of spores and pollen of Jurassic aspect, which is significantly different from that found in the overlying Borden Island Formation. This same assemblage has also been recovered from sediments penetrated by exploratory wells drilled throughout the Sverdrup Basin and forms a valuable marker horizon for purposes of dating and correlation. At Black Top Ridge on Ellesmere Island, the assemblage has been recovered from coaly silts and shales (location F & G in Text-fig. 2). Spores and pollen are excellently preserved and diverse in aspect, and fossil assemblages record from above and below permit bracketing the age within fairly narrow limits.

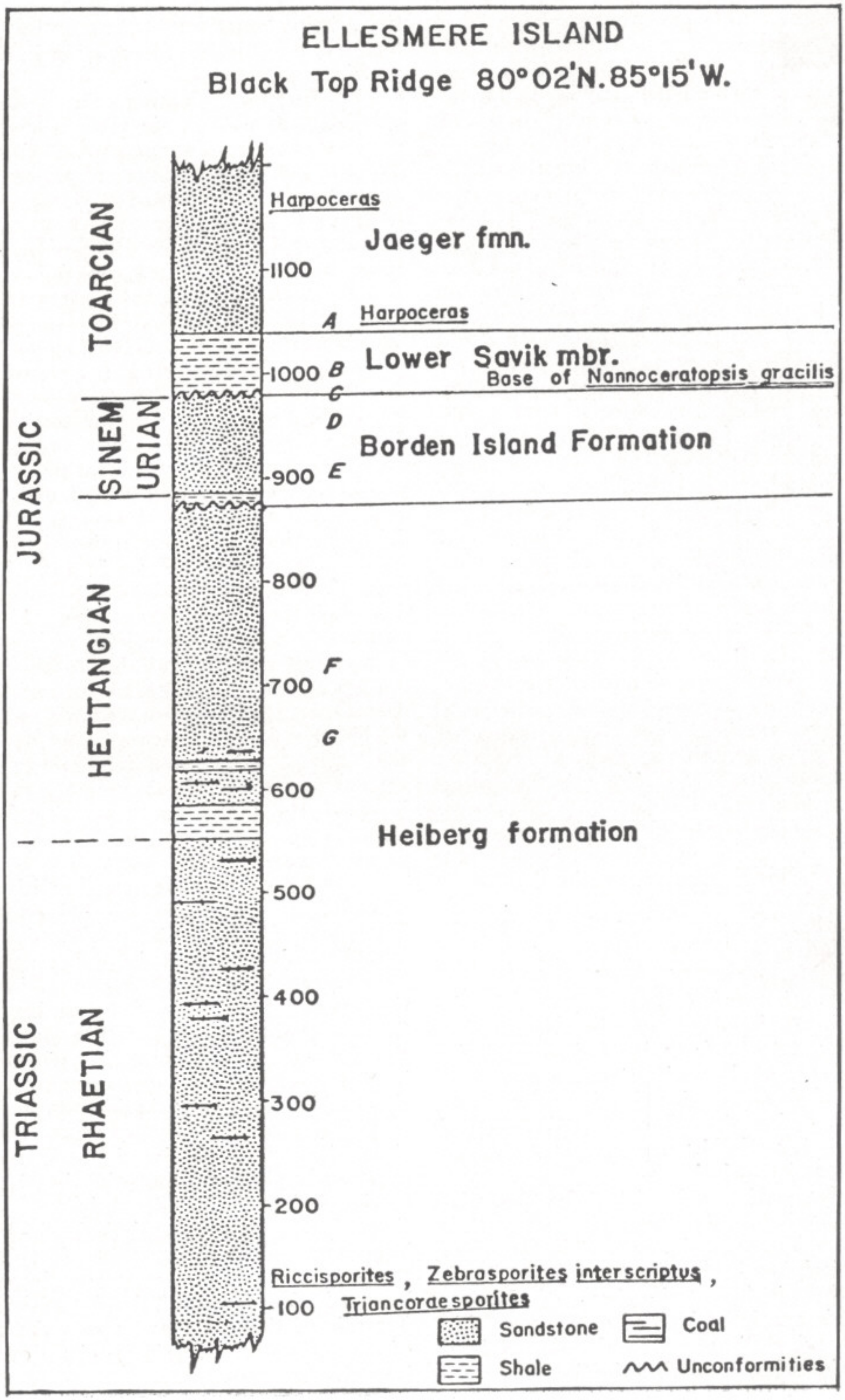
Dating with Reference to Adjacent Fossil Control — About five hundred feet below beds yielding this assemblage, a palynological assemblage has been recovered characterized by the species *Riccisporites tuberculatus* Lundblad, *Zebrasporites interscriptus* (Thierg.) Klaus and *Triancoraesporites ancorae* (Reinh.) Sch. This has been included in the Upper Triassic by McGregor (1965), and placed in the Upper Rhaetian by Schulz (1967), Semenova (1970), Reinhardt (1962) and Mädler (1964). It would fall into the FG subzone of the TK zone of Morbey (1975), making it Uppermost Rhaetian or Lowermost Hettangian in age. Since the base of the Hettangian stage is yet to be formally defined and the assemblage, at least in Canada and over much of Europe, is clearly related to Triassic, rather than Jurassic palynological floras, it is probably best considered to be uppermost Triassic in age.

The Jaeger Formation (Text-fig. 2) carries the ammonite *Harpoceras* at its base and is therefore Toarcian in age. The base of the underlying lower member of the Savik Formation includes the base of *Nannoceratopsis gracilis* which also occurs within the Toarcian Stage. The Borden Island Formation which underlies the Savik Formation, being separated from it by unconformity, is probably Sinemurian in age (see p. 364).

The interval yielding the assemblage discussed in this paper must therefore be as young as, or younger than, uppermost Triassic (i.e. Upper Rhaetian) and as old as, or older than, Sinemurian in age. Since it is very different in aspect from those below and significantly different from that from the Borden Island Formation above, it is not unreasonable to assign it a tentative Hettangian, or lowermost Jurassic, dating.

Composition of the Assemblage — The assemblage was recovered from samples F and G (the 650 to 730 ft intervals), as shown in Text-fig. 2. In the initial study, 53 taxa of spores and pollen have been photographed and identified. Microplankton, including both dinoflagellates and acritarchs, was also recovered, but its determination and description is reserved for a future work. Of the 53 taxa illustrated, 42 could be assigned to previously described taxa, the remaining 11 being either new species or species not described in literature readily available to the author. All species were assignable to previously described genera. With regard to ranges (Table 1), 6 species range upward from the Triassic, 2 extending upwards into younger strata; 13 are confined to the interval itself; and the remaining 34 have their bases within the interval and range upwards into younger beds.

These ranges accord well with those recorded on the charts of Schulz (1967), Semenova (1970), Mädler (1964), Klaus (1960) and Briche, Danzé-Corsin and Levene (1963). Morbey (1975), however, indicates that many of the species terminating in Canada at the base of the Jurassic extend a significant distance into the Rhaetian at its type section. It appears probable, to the author, that the Rhaetian type section may be stratigraphically more complete than the other sections investigated, the apparently shorter ranges in the Canadian section being the result of loss of section through unconformity at the Triassic-Jurassic boundary. It is also possible that detailed studies, currently underway, on the palynology of the Upper Triassic and Lower Jurassic of Canada may extend the ranges of some Lower Jurassic species downward into the Triassic.


ELLESMERE ISLAND
Black Top Ridge 80°02'N. 85°15'W.
JURASSIC
TRIASSIC
TOARCIAN
SINEMURIAN
HETTANGIAN
RHAETIAN
Harpoceras
Jaeger fmn.
1100
A Harpoceras
Lower Savik mbr.
1000 B
Base of Nannoceratopsis gracilis
C
D
Borden Island Formation
900 E
800
F
700
G
600
Heiberg formation
500
400
300
200
Riccisporites, Zebrasporites interscriptus,
100 Triancoraesporites
Sandstone
Coal
Shale
Unconformities

TEXT-FIG. 2

TABLE 1

Ranges of species mentioned in this paper

Species	Upper Triassic	Hettangian	Lower Jurassic	Middle Jurassic	Upper Jurassic	Cretaceous
Alisporites opii	x	x				
Aratrisporites saturnii	x	x				
Calamospora keuperiana	x	x				
Calamospora tener	x	x	x	x		
Vitreisporites latus	x	x				
Vitreisporites pallidus	x	x	x	x	x	x
Alisporites giganteus	x	x				
Aratrisporites minimus	x	x				
Aratrisporites sp. A	x	x				
Aratrisporites sp. B	x	x				
Cycadopites sp. A	x	x				
Cyclotriletes sp. A	x	x				
Chordasporites sp. A	x	x				
Chordasporites sp. B	x	x				
Chordasporites sp. C	x	x				
Enzonalasporites sp. A	x	x				
Enzonalasporites sp. B	x	x				
Podosporites sp. A	x	x				
Trilobosporites sp. A	x	x				
Rogalskoisporites bujargiensis	x	x	x			
Rogalskoisporites cicatricosus	x	x	x			
Rogalskoisporites incertus	x	x	x			
Concavissimisporites subgravulosus	x	x	x	x		
Dictyotriletes arkellii	x	x	x	x		
Bennettiteaepollenites lucifer	x	x	x	x		
Gleicheniidites nilssonii	x	x	x	x		
Murospora bicollateralis	x	x	x	x		
Pityosporites dividuus	x	x	x	x		
Podocarpidites multicinus	x	x	x	x		
Protoconiferus funarius	x	x	x	x		
Psophosphaera nimius	x	x	x	x		
Auritulinasporis intrastriatus	x	x	x	x		
Cycadopites parvus	x	x	x	x		
Deltoidospora nana	x	x	x	x		
Densoisporites crassus	x	x	x	x		
Microreticulatisporites pseudoalveolatus	x	x	x	x		
Cerebropollenites macroverrucosus	x	x	x	x	x	
Matonisporites crassigranulatus	x	x	x	x	x	
Protopicea exilioides	x	x	x	x	x	
Vitreisporites craigii	x	x	x	x	x	
Clavatipollenites hughesii	x	x	x	x	x	
Eucomiidites troedssonii	x	x	x	x	x	
Obtusiporis juncta	x	x	x	x	x	
Ovalipollis enigmatica	x	x	x	x	x	
Perinopollenites elatoides	x	x	x	x	x	
Retitriletes austroclavatidites	x	x	x	x	x	
Retitriletes clavatoides	x	x	x	x	x	
Schizosporis sinuosus	x	x	x	x	x	
Stereisporites congregatus	x	x	x	x	x	
Gleicheniidites senonicus	x	x	x	x	x	x
Psophosphaera clausa	x	x	x	x	x	x
Schizosporis spriggii	x	x	x	x	x	x
Stereisporites clavus	x	x	x	x	x	x

The overall makeup of this assemblage is Jurassic in aspect, but there are a number of features which make it of particular interest.

1. *Aratrisporites*, a typically Triassic genus, shows a final burst of variation before disappearing at the top of the Heiberg Formation.

2. *Enzonalasporites*, ranges from the Triassic through the Hettangian. It also disappears at the top of this unit.

3. *Chordasporites* represents, with the possible exception of *Vittatina cretacea*, the last of the proximally striate-bisaccate genera which are characteristic of Permian and Triassic palynological assemblages. It first appears in the Upper Triassic (Klaus, 1960), exhibits a burst of variation in this, Hettangian, assemblage and persists upwards, although always rare, into the Bajocian (Pocock, 1970). It is a characteristic of the Jurassic proximally striate-saccates that the striations (Chordae, Taeneae, etc.) are always faint and the grains are of a 'floppy' aspect with finely infrareticulate sacci, characteristic of the pollen of some of the Jurassic Pteridosperms.

4. *Cerebropollenites, Clavatipollenites* and *Bennettiteaepollenites* first appear in this assemblage and their ranges nowhere appear to extend into the Triassic. *Psophosphaera nimius, P. clausa, Schizosporis spriggii* and *S. sinuosus* also appear to be good Jurassic indicators.

5. The other taxa whose ranges begin in the Hettangian of northern Canada possibly range downwards into the Rhaetian in some other areas, although their abundance and association in an assemblage is normally a reliable indicator of Jurassic age.

CONCLUSIONS

The assemblage described in this paper, from the upper part of the Heiberg Formation of the Canadian Arctic was recovered from beds stratigraphically lower than those dated by means of ammonites as Sinemurian. Strata stratigraphically lower in the Heiberg Formation have yielded palynological floras that appear to correlate with the FG subzone of the TK zone of Morbey (1975). This subzone correlates with part of the Pre-Planorbis beds of Europe which are either Upper Rhaetian or Lower Hettangian in age, the boundary between the stages having yet to be defined. The assemblage itself is significantly different from those recovered from strata above and below, and compares most closely with that described from the Psilonoten-Schichten, jlαl of Eastern Germany, by Schulz (1967). This would indicate an Hettangian age for the assemblage, correlating with the Lower beds (*Psiloceras*) of the Blue Lias of Western Europe, an age consistent with all other available fossil evidence.

It must be emphasized again that this study is of a preliminary nature and the conclusions are necessarily tentative. Since this is a preliminary study, the paper is not intended as a vehicle for discussions of nomenclature and taxonomy. Names of taxa employed are derived directly from the literature and their use by the author does not imply his approval of their usage.

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EXPLANATION OF PLATES

PLATE 1

1. *Rogalskoisporites incertus* (Bolch.) Pocock.
2. *Rogalskoisporites bujargiensis* (Bolch.) Pocock = *Stereisporites cicatricosus* Rog.
3. *Stereisporites* (*Converrucosisporites*) *congregatus* (Bolch.) Pocock.
4. *Stereisporites clavus* (Balme) Pocock.

5-6. *Microreticulatisporites* sp. cf. *M. pseudoalveolatus* (Couper) Vignradova: proximal (Fig. 5) and distal (Fig. 6) aspects of the same specimen.

7. cf. *Gleicheniidites senonicus* Ross: in Vigran & Thusu, 1975, pl. 2, fig. 14.
8. *Obtusisporis juncta* (Kara-Murza) Pocock.

9. *Auritulinasporis intrastriatus* Nilsson.
10. *Calamospora tener* (Leschik) Mädler = *Calamospora mesozoica* Couper.
11. *Calamospora* sp. cf. *C. keuperiana* Mädler.
12. *Cyclotriletes* sp. A.
13. *Deltoidospora nana* Burger.
14. Spore sp. A.
15. Spore sp. B.
16. *Murospora bicollateralis* (Rog.) Pocock.
17. cf. *Densoisporites crassus* Tralau.
18. *Retitriletes austroclavatidites* (Cooks.) Dor., W. Kr., Mai & Schulz.

PLATE 2

19. *Gleicheniidites* (*Matonisporites*) *nilssoni* Pocock.
20. *Dictyotriletes arkellii* Pocock.
21. *Matonisporites crassigranulatus* (Balme) Lavette-Carette = *Deltoidospora neddeni* var. *torus* Pflug.
22. *Trilobosporites* sp. A.
23. *Concavissimisporites* sp. cf. *C. subgranulosus* (Couper) Pocock.
24. *Enzonalasporites* sp. A.
25. *Enzonalasporites* sp. B.
26. *Retitriletes clavatoides* (Couper) Schulz.
27. *Aratrisporites* sp. A.
28. *Aratrisporites* sp. cf. *A. minimus* Schulz.
29. *Aratrisporites saturni* (Thierg.) Mädler.
30. *Aratrisporites* sp. B.

PLATE 3

31. *Psophosphaera clausa* Bolch.
32. *Schizosporis spriggii* Cooks. & Dett.
33. *Psophosphaera* (*Podozamites*) *nimius* Bolch.
34. *Schizosporis sinuosus* (Bolch.) Pocock.
35. *Psophosphaera* sp. indet.

PLATE 4

36. *Vitreisporites* (*Caytonipollenites*) *latus* (Mädler) n. comb.
37. *Vitreisporites pallidus* (Reiss.) Nilsson.
38. *Vitreisporites craigii* Pocock.
39. *Podosporites* sp.
40. *Bennettiteaepollenites lucifer* Thierg.
41. *Eucommiidites* sp. A.
42-43. *Eucommiidites troedssonii* Erdtman.
44. *Cycadopites parvus* (Bolch.) Pocock.
45. *Cycadopites* sp. A.
46. *Labiipollis* sp. A.
47. *Clavatipollenites hughesii* Couper.
48. *Concentrisporites sulcatus* (Rog.) Pocock.
49. *Perinopollenites elatoides* Couper.
50. *Cycadopites* sp. B: Pocock 1970, pl. 26, fig. 20.
51. *Cerebropollenites macroverrucosus* (Thierg.) Schulz.

PLATE 5

52, 55. *Alisporites* (*Alipollenites*) *giganteus* Briche. Danzé-Corsin & Laveine: two aspects of the same species.
53, 56. cf. *Protoconiferus funarius* (Bolch.) Pocock: two aspects of the same species.
54. *Alisporites opii* Daugherty.
57. *Podocarpidites multicinus* (Bolch.) Pocock.
58. *Pityosporites dividuus* (Bolch.) Pocock.
59. *Chordasporites* sp. A.
60. *Chordasporites* sp. B.
61, 65. *Chordasporites* sp. C: two aspects of the same species.
62. *Taeneaesporites* sp.
63. *Ovalipollis enigmaticus* (Couper) Pocock & Jansonius = *Quadreculina anellaeformis* Mal.
64. *Protopicea exilioides* (Bolch.) Pocock.

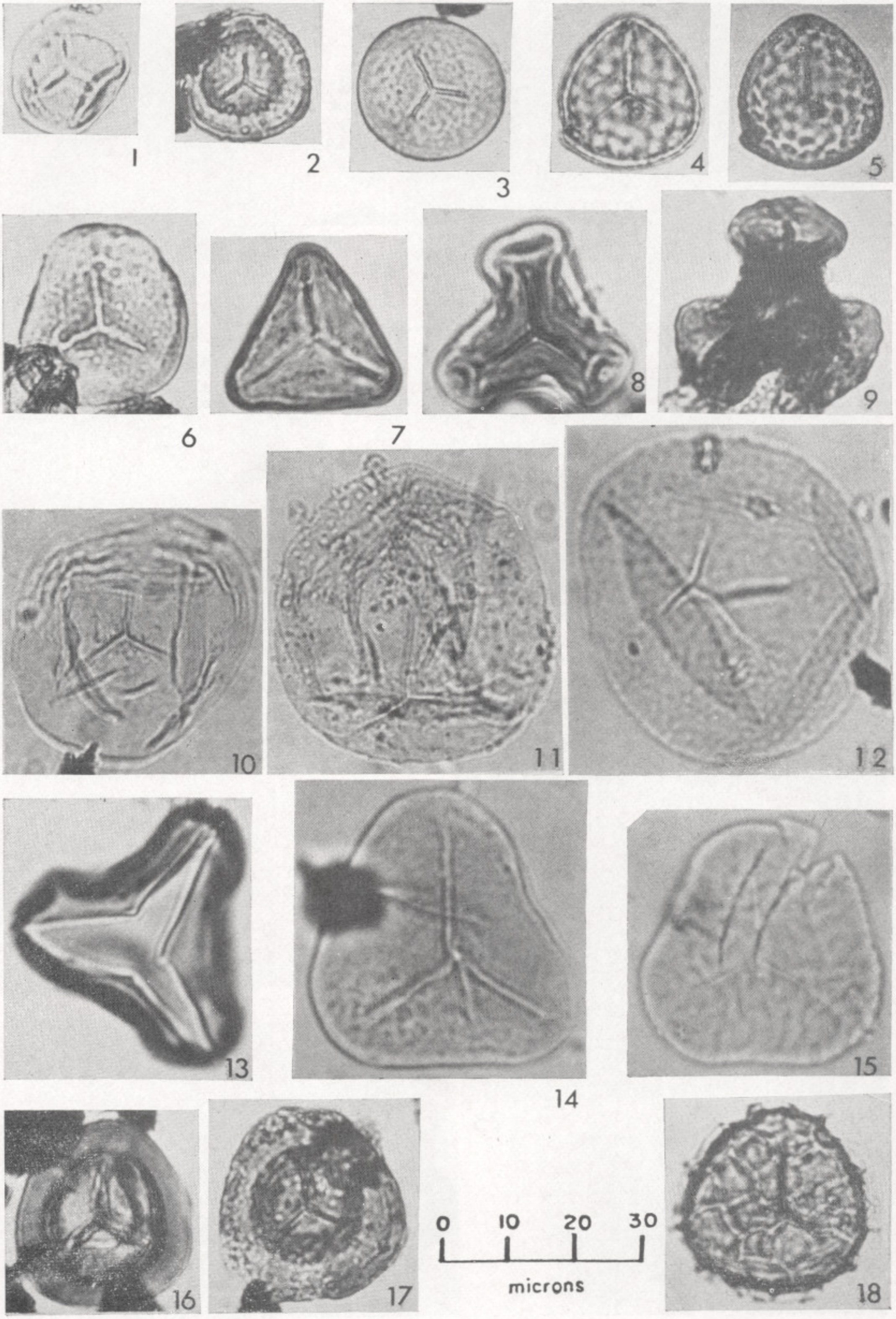
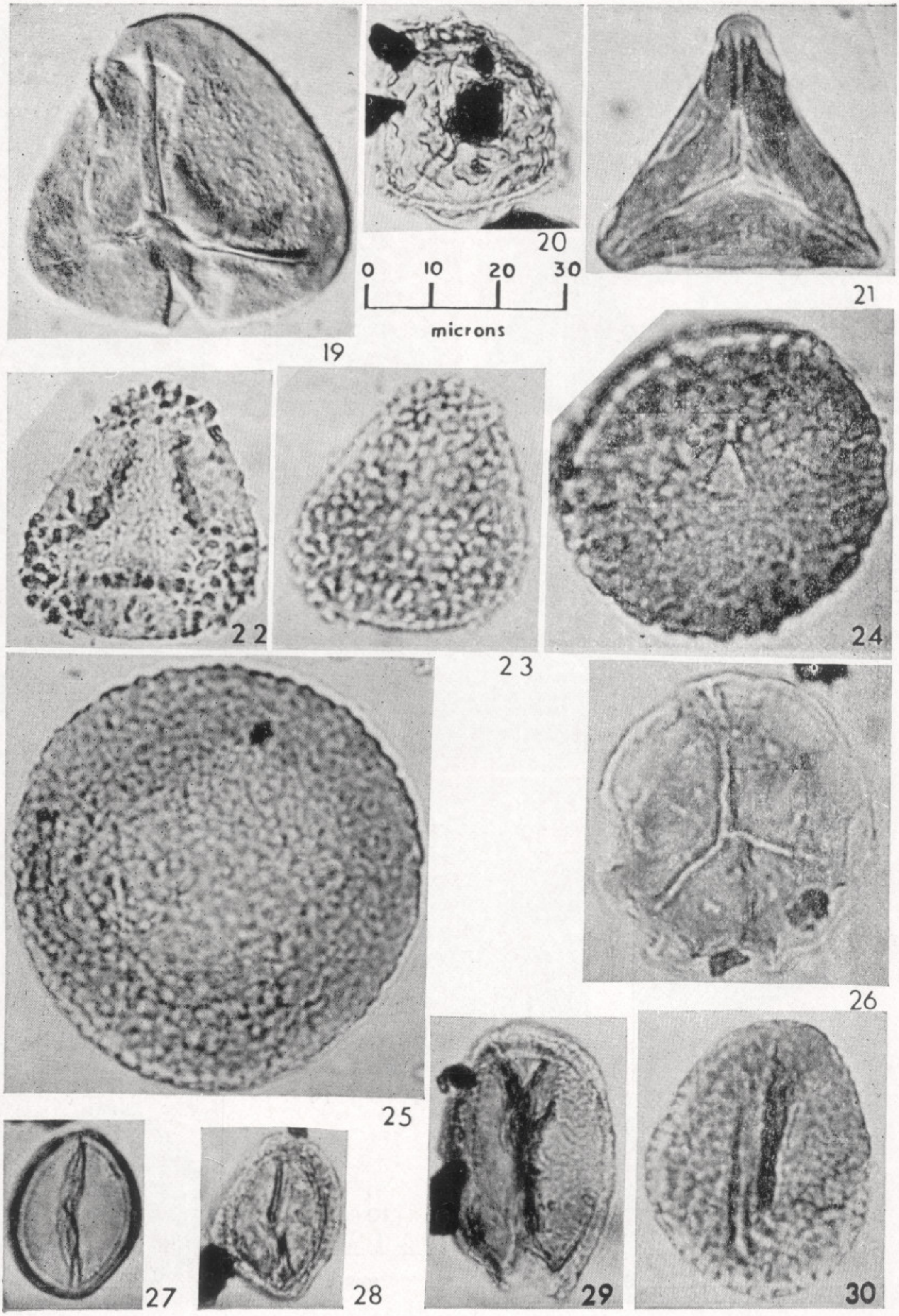


PLATE 1



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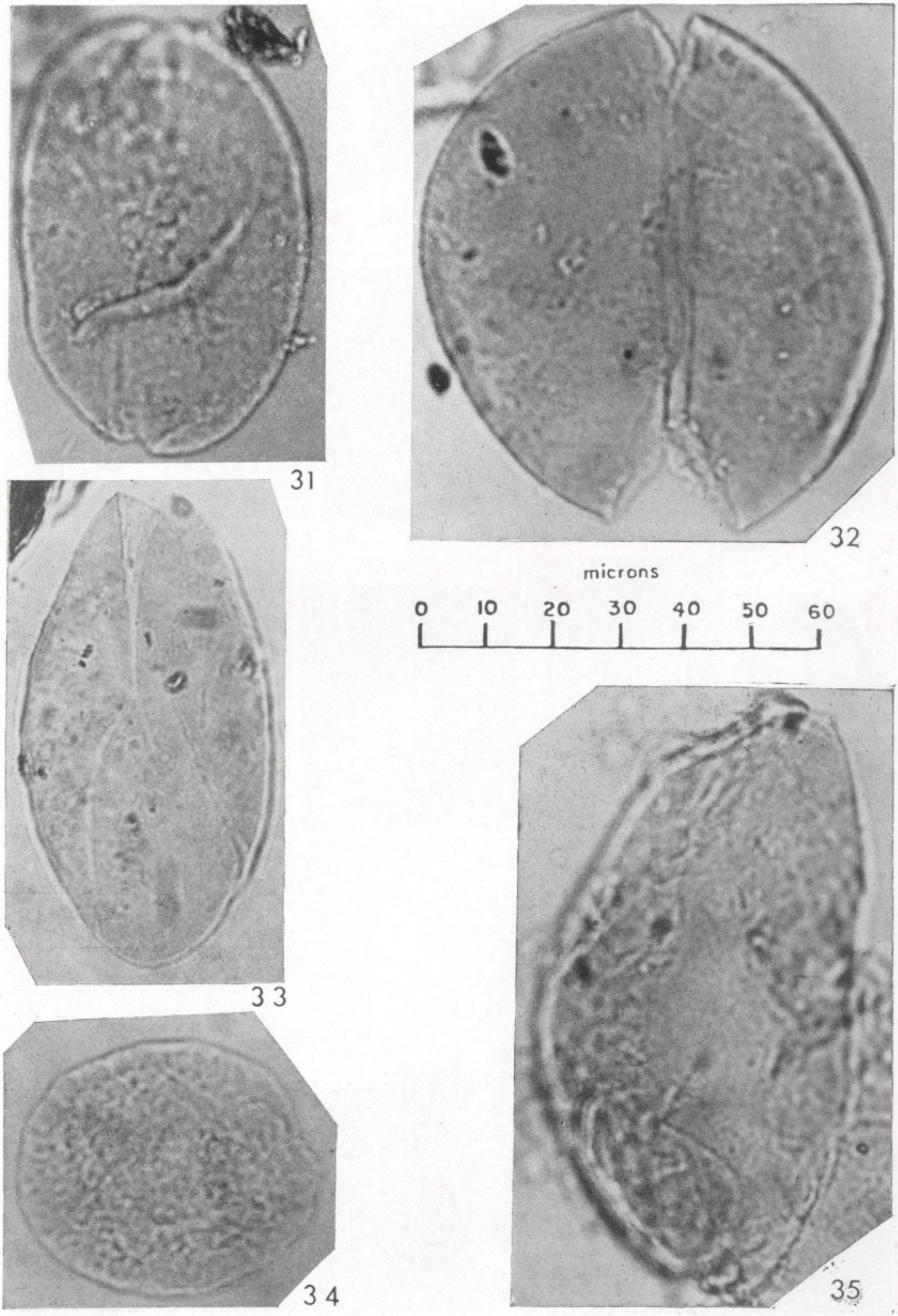

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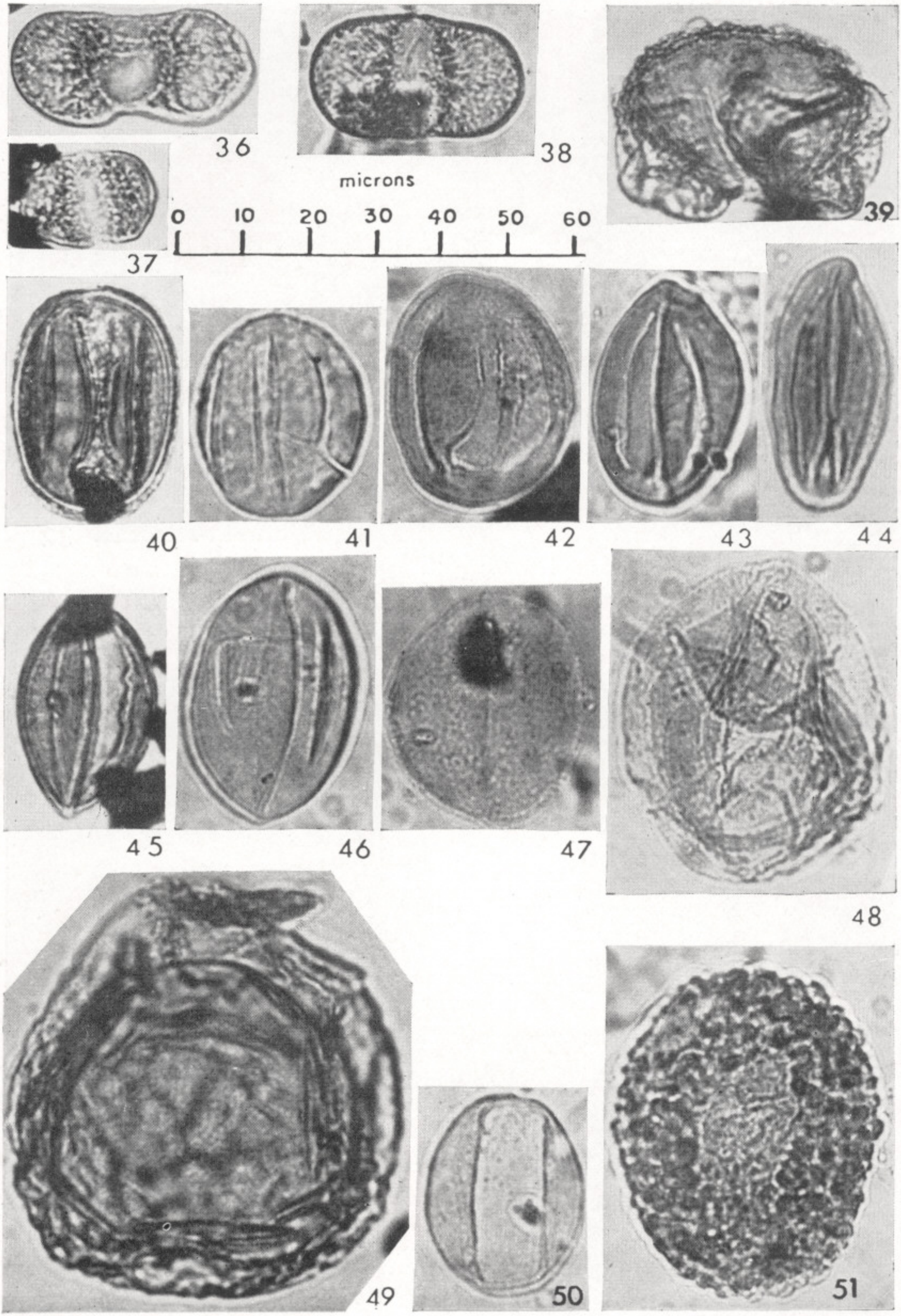
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PLATE 4

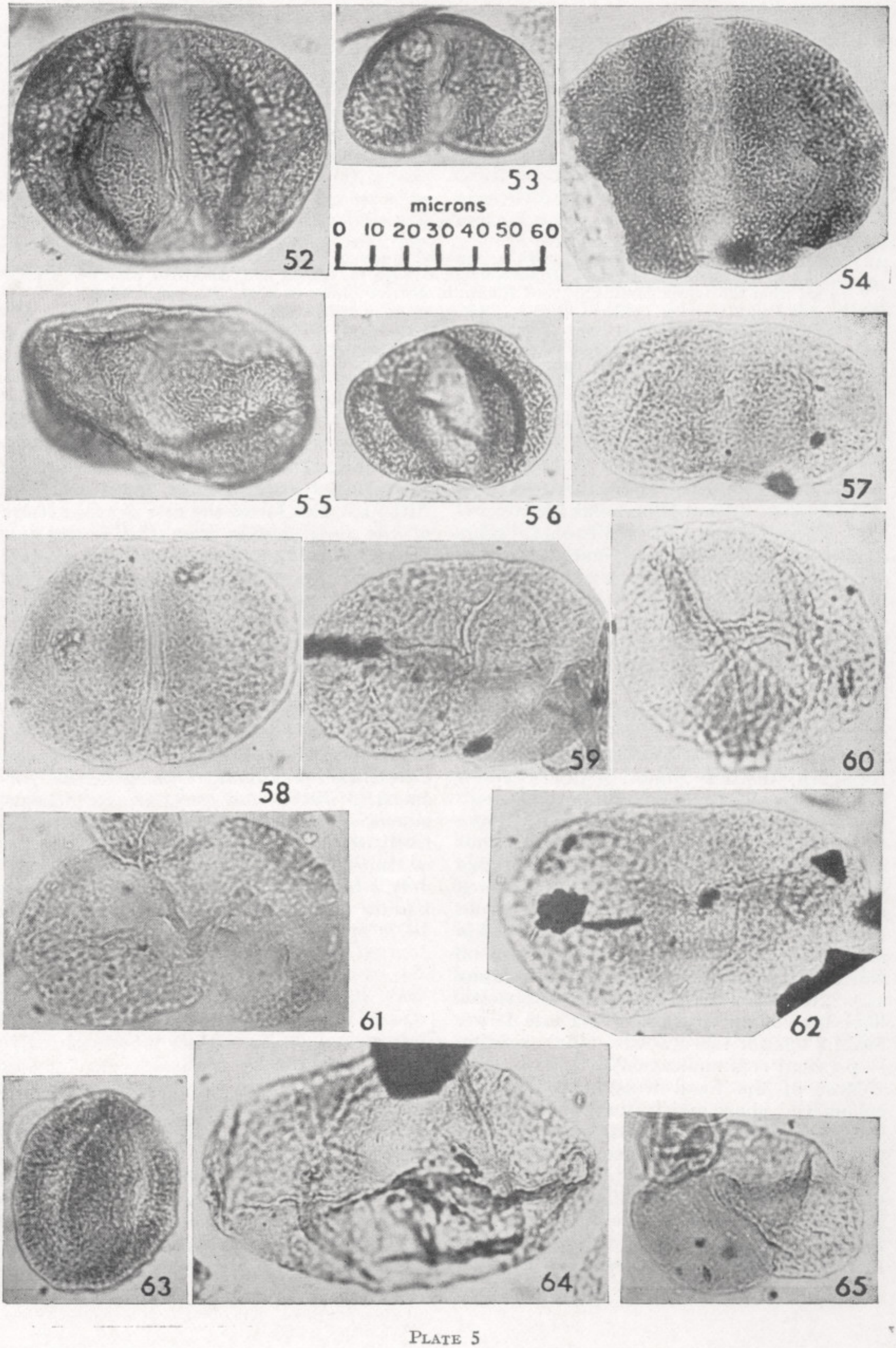

PLATE 5