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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

BULLETIN 115

Lower Carboniferous Spores from the Bonaparte Gulf Basin, Western Australia and Northern Territory

BY

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EXPLANATION OF TABLE

Table 1. Spore distribution in samples studied. Percentage amounts shown are derived from counts of 250 specimens in each of the core samples that yielded prolific and, in most instances, well-preserved microfloras. 'X' denotes observed presence in a particular sample but not in actual count; C - core sample; Ct - cuttings; P - percussion sample; BC - bagged core sample.

SUMMARY

Well preserved assemblages of plant microfossils have been recovered from Lower Carboniferous sediments — principally or entirely marine in origin and Viséan in age — encountered in four boreholes in the landward Bonaparte Gulf Basin of Western Australia and Northern Territory. The sediments are representative of the following lithostratigraphic units: Bonaparte Beds (upper portion) and overlying Tanmurra Formation (intersected by Bonaparte Nos 1 and 2 Wells, central basinal province of Bonaparte Gulf Basin, Western Australia); Milligans Beds (Spirit Hill No. 1 Well; Spirit Hill and Milligans No. 1 Bores, all located in the southeastern platform region of the basin, Northern Territory) and overlying Burvill Beds (basal portion) of Milligans No. 1 only.

The 55 species of plant microfossils recognized are distributed among 32 genera of trilete *sporae dispersae,* including one new genus, *Exallospora,* which is instituted for the reception of distally annulate cingulate forms having typically verrucate sculptural elevations. Twenty-two species are referable (six tentatively so) to previously established taxa. The palynological flora is dominated by the pan-Australian, Famennian to ?mid-Carboniferous species *Granulatisporites frustulentus* Balme & Hassell (emended herein), which accounts for 44-83 percent of the spore populations. Certain (inevitably subordinate) spore forms, either the same as or closely similar to species known from northern hemisphere Lower Carboniferous sediments, lend confirmation to the Viséan age previously adduced from the contained fauna.

The palynological flora is compared with the few currently known from the Australian Carboniferous System, and with those documented from relatively numerous northern hemisphere sequences of Lower Carboniferous age.

Species newly established are: *Punctatisporites resolutus, P. subvaricosus, Cadiospora abrupta, Anapiculatisporites largus, A. semisentus, Planisporites conspersus, Acanthotriletes intonsus, A. turriculaeformis, Raistrickia inprofusa, R. pinguis, Convolutispora balmei, C. rimulosa, C. subtriquetra, Foveosporites appositus, Reticulatisporites bonapartensis, Acinosporites spiritensis, Exallospora coronata* (type species), *Crassispora invicta, C. scrupulosa, Cristatisporites colliculus, Cirratriradites veeversi, Camptozonotriletes robertsi, Archaeozonotriletes intrastriatus, Grandispora debilis, G. notensis,* and *Velamisporites lacertosus.*

INTRODUCTION

The Bonaparte Gulf Basin of northwestern Australia straddles the northern part of the boundary between Western Australia and the Northern Territory (Fig. 1), covering a land area of about 8000 square miles (20,000 sq. km). It is known to have an even larger northerly extent offshore, beneath the Timor Sea. The basin contains Palaeozoic and (relatively minor) Mesozoic rocks more than 23,000 feet (7000 metres) thick, according to Veevers & Roberts (1968, p. 3), who summarize the known landward sequence thus:

'(a) 16,000 feet of Cambrian to Lower Ordovician and Upper Devonian to Lower Carboniferous shallow-marine quartz sandstone and carbonate rocks, with known equivalent deeper marine grey siltstone in the Upper Devonian and Lower Carboniferous; and

(b) 7000 feet of Upper Carboniferous to Lower Triassic paralic sandstone and shale, capped by a few hundred feet of Lower Cretaceous marine siltstone, sandstone, and conglomerate.'

In overall structural terms, the sediments comprise a broad syncline plunging north (Veevers & Roberts, 1968, fig. 1) and having a faulted eastern boundary (northern part of Halls Creek Mobile Zone of Traves, 1955) with Precambrian rocks. Along the southwestern margin, the basin sediments overlap the Precambrian Kimberley Block. A Precambrian inlier, the Pincombe Range (Fig. 1), occurs in the southern part of the basin.

Traves's (1955) pioneer account of the geology of the region was followed by oil exploration activity (including drilling) and BMR surveys, which collectively have added greatly to knowledge of Bonaparte Gulf Basin geology. Summary accounts, stemming from exploratory work by oil company geologists, have been published by Guillaume (1966) of Australian Aquitaine Petroleum Pty Ltd and Brady, Jauncey, & Stein (1966) of Anacapa Corporation. Thomas (1962, 1965) has presented summarized progress reports on the knowledge of the basin's Carboniferous stratigraphy.

A comprehensive, up-to-date account of the Devonian and Carboniferous geology of the landward Bonaparte Gulf Basin is given by Veevers & Roberts (1968), who conducted intensive field investigations of the basin's southern portion (i.e. south of Queens Channel). Moreover their publication includes latest subsurface data. In a review paper, Veevers (1967b) demonstrated close parallelism between the Phanerozoic geological histories of the Bonaparte Gulf and Canning Basins, which, though separated onshore by the Precambrian Kimberley Block, are regarded as offshoots of an elongate depression (Cartier Furrow of Veevers, 1967a) running parallel to the continental margin (see Veevers, 1967b, pp. 254-7).

A variety of specialized research topics — palaeontological (including the present one), sedimentological, and mineralogical — has arisen from the work of Veevers & Roberts, as cited on page 7 of their 1968 Bulletin. In the current account, miospores extracted from subsurface Viséan sediments of the Bonaparte Gulf Basin are described and their stratigraphic significance discussed. This study

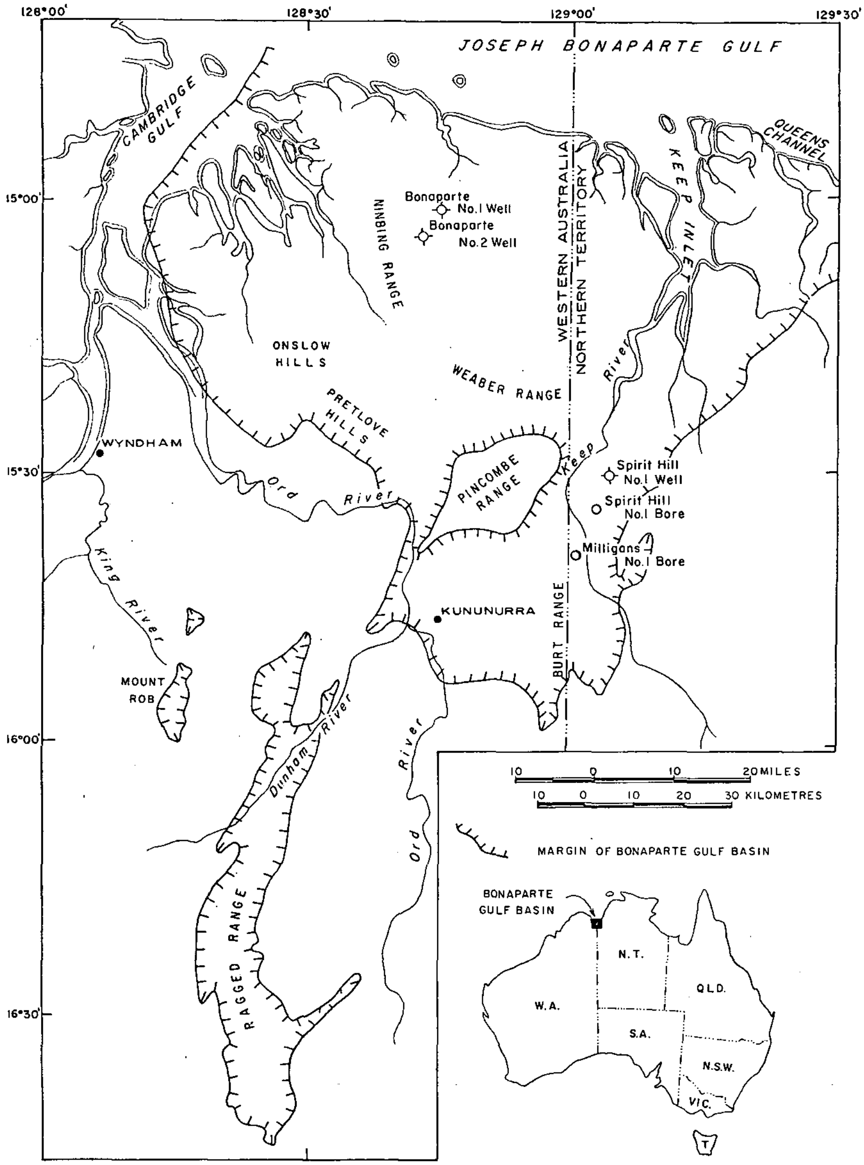

Figure 1: Locality map.

in turn constitutes part of a wider research project, 'Palynological Investigation of Australian Carboniferous Sediments,' being conducted by the writer with the support of the Australian Research Grants Committee.

Previously published palynological literature on the Australian Carboniferous System is not extensive and has been outlined by Playford & Helby (1968) in the introduction to their paper on an Upper Carboniferous spore assemblage from east-central New South Wales. Subsequently Evans (1968) has noted the contents of two spore assemblages, one adduced by him as Famennian, the other as early Tournaisian, from two wells in western New South Wales.

The most relevant papers in relation to the present work are those of Balme (1960, 1964), based on Western Australian material. In the earlier paper — the first to be concerned with Australian Carboniferous palynology—Balme illustrated, designated informally, and described briefly Lower (Tournaisian) and Upper Carboniferous spores he found in the Canning Basin subsurface. Subsequently (1964, pl. 2) he illustrated a variety of Carboniferous spores extracted from borehole material from the Bonaparte Gulf, Canning, and Carnarvon Basins. All the Western Australian assemblages studied by Balme were found to be characterized by a small, morphographically variable, trilete spore, here recorded copiously and assigned to *Granulatisporites frustulentus* Balme & Hassell, 1962 emend. This form was originally described from the Famennian of the Canning Basin by Balme & Hassell (1962), who also noted its extension into the Carboniferous of the Canning and Bonaparte Gulf Basins. Balme (1964, p. 56) referred all the then known Carboniferous assemblages to what he termed the 'Lycosporoid'-microflora, in allusion to the fact that many members of the *G. frustulentus* group are incipiently cingulate and hence comparable to *Lycospora* Schopf, Wilson, & Bentall, 1944. Many of the other types illustrated by Balme (1960, 1964) occur in the Bonaparte Gulf Basin material of the present study and are thus accorded formal taxonomic treatment in later pages of this Bulletin.

Venkatachala (1964) studied spores from a Bonaparte Gulf Basin shale sample which had originally been presented to Dr D. C. Bhardwaj by Dr B. E. Balme as exchange material. Venkatachala gave the locality no more precisely than 'Milligans Bore, Boneparte Gulf Basin of Western Australia.' There are in fact three bores designated Milligans in the Bonaparte Gulf Basin (see Veevers & Roberts, 1968, table 1 and figs 39, 49), and they are all located not in Western Australia but just inside the Northern Territory. Sullivan (1965, p. 549) cited a personal communication from Balme that 'the sample [studied by Venkatachala] was one of a series collected from a depth of 0-400 feet in a sequence of shales and siltstones referred to the Milligans Beds.' From this it transpires that the bore concerned is Milligans No. 1 (total depth, 520 ft) since the other two were considerably shallower (No. 2, 186 ft; No. 3, 90 ft). Further, if the unit represented is indubitably Milligans Beds, the subsurface interval can at least be narrowed down to 146-400 ft (see Fig. 3). The microflora obtained by Venkatachala was poor in terms of quantity of specimens and quality of spore preservation. As a result he was unable to make reliable identifications. The disadvantageous nature of his palynological residue can at least partly be explained by the severity of the oxidative treatment to which the sample was subjected (see Venkatachala, 1964, p. 109). For instance the absence of *Granulatisporites* (i.e. *G. frustulentus* Balme & Hassell, 1962, emend.), found well preserved and in large quantities by the present writer in Milligans Beds of Milligans No. 1, is a probable consequence of extreme overmaceration.

STRATIGRAPHY OF SUBSURFACE SECTIONS STUDIED

Veevers & Roberts (1968) and Veevers (1967b) regard the Upper Devonian and Lower Carboniferous deposits of the Bonaparte Gulf Basin as having accumulated in two main situations within an overall epicontinental shallow-marine environment: (a) shallow (platform) marginal areas that received, typically, limestone (including reefs) and quartzose sandstone; (b) deeper (basinal) areas well away from the shoreline in which were deposited finer (silty, shaly) sediments. In the present paper, the palynological contents of sediments from both situations are documented: the platform province of Milligans Hills/Spirit Hill area (within which are located Oil Dev./Westralian Spirit Hill No. 1 Well and Westralian Spirit Hill No. 1 and Milligans No. 1 Bores); and the basinal province, centrally located in the basin and penetrated by AOD Bonaparte Nos 1 and 2 Wells. The types of samples (i.e. core, cuttings, etc.) and the rock units and depths from which they were taken in each borehole sequence are shown in Figures 2 and 3.

BASINAL PROVINCE

The bulk of material used in this study came from the two Bonaparte wells, both of which penetrated a relatively thick Lower Carboniferous and, in the case of Bonaparte No. 1, Upper Devonian sequence which is laterally equivalent to much of the platform province's sandstone and limestone. Samples were examined from two rock units in each of these wells — Bonaparte Beds and overlying Tanmurra Formation. The following notes on the sequences are taken from Veevers & Roberts (1968, pp. 115-22), to which the reader is referred for a detailed coverage.

Bonaparte Beds

The Bonaparte Beds, typified by the 1630-10,530-foot (494-3193 m) interval in Bonaparte No. 1, consist of varying proportions of dark grey shale and siltstone (often slightly calcareous) with interbeds of siliceous silty sandstone and carbonate rock. In Bonaparte No. 2, the interval between 1577 and 7008 feet (478 and 2124 m) is recognized as Bonaparte Beds.

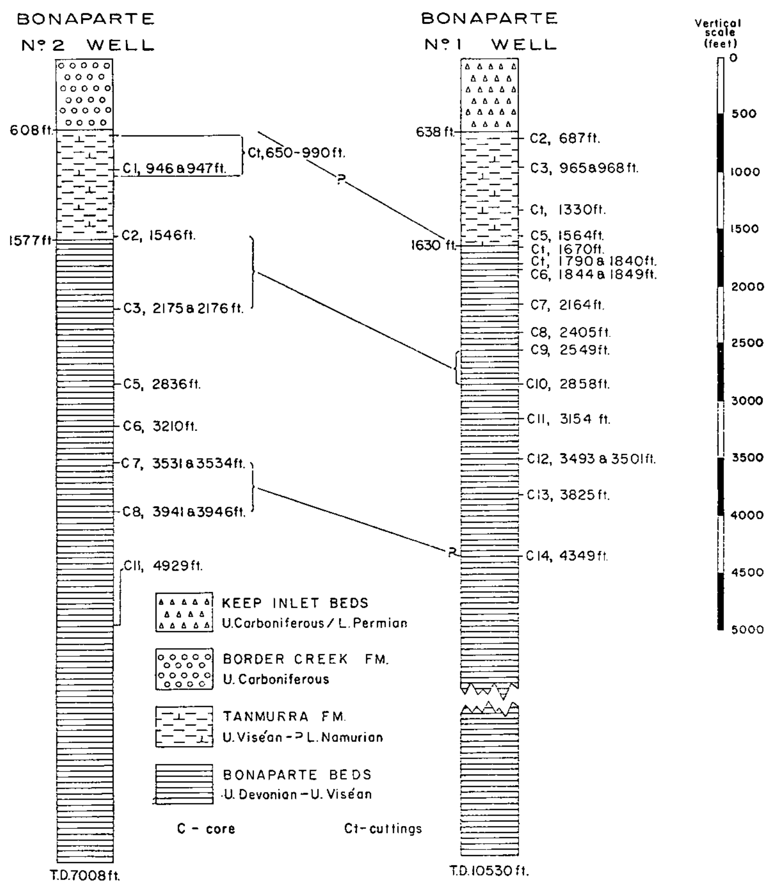

Figure 2: Stratigraphic sequences in AOD Bonaparte Nos 1 and 2 Wells (after Veevers & Roberts, 1968, fig. 65), showing positions of samples studied. Suggested palynological correlations are indicated by (oblique) lines connecting the two sequences.

Dating of the Bonaparte Beds in Bonaparte No. 1 has been adduced from Foraminifera and conodonts, thus: cores 6-8 (1840-2410 ft), late Viséan; core 12 (3500 ft), early Viséan; core 24 (6610 ft), late Tournaisian. Bivalves from core 28 (8310 ft) indicated an Upper Devonian age. Thus the Bonaparte Beds of this well that are documented palynologically here (1670-4349 ft) are probably entirely Viséan in age, though the possibility that cores 13 and 14 (3825-4349 ft) are late Tournaisian cannot entirely be dismissed.

In Bonaparte No. 2, the palynological floras of the Bonaparte Beds between cores 3 (2175-2176 ft) and 11 (4929 ft) are reported; these cores have been been dated as Viséan (from conodonts) and late Viséan (from Foraminifera) respectively.

The Bonaparte Beds, particularly in the upper part of the type section, are known to contain rich faunas of Foraminifera, ostracods, brachiopods, bivalves, and conodonts. The faunal evidence, coupled with clay mineralogical analyses, suggests an almost entirely marine origin for the beds.

Tanmurra Formation

The type section of the Tanmurra Formation comprises the sediments intersected in Bonaparte No. 1 between 638 and 1630 feet (193 and 494 m). These are made up of upper and lower carbonate beds separated by a calcareous or dolomitic sandstone unit 841 feet (255 m) thick. The contact with the underlying Bonaparte Beds is gradational, but with the overlying sandy unit is unconformable; the latter has been attributed to the Keep Inlet Beds (Upper Carboniferous-Lower Permian).

The interval between 608 and 1577 feet (184 and 478 m) in Bonaparte No. 2 comprises sandstone, dolomite, siltstone, and shale; it has been regarded as Tanmurra Formation although the carbonate rock content is lower than in the type section of the latter some five miles distant. The contact with the underlying Bonaparte Beds is abrupt, though not necessarily unconformable. Quartzose sandstone with minor shale interbeds (Border Creek Formation of Upper Carboniferous age) unconformably overlies the Tanmurra Formation in Bonaparte No. 2.

Foraminifera from the upper Tanmurra Formation of Bonaparte No. 1 indicate a late Viséan (? to earliest Namurian) age.

The Tanmurra depositional environment, like that of the Bonaparte Beds, has been envisaged as offshore marine.

PLATFORM PROVINCE, MILLIGANS HILLS/SPIRIT HILL AREA

The area takes in part of the southeast marginal region of the Bonaparte Gulf Basin. The subsurface material from here comes with one exception from the shaly Milligans Beds as intersected by three boreholes; the exception probably represents the Burvill Beds. Stratigraphic and other aspects of the subsurface sequence discussed below have been abstracted from Veevers & Roberts (1968, pp. 87-90, 103-7, 136-7; fig. 38).

Milligans Beds

In their designated type section in Milligans No. 1 Bore (146-520 ft, 44-148 m), the Milligans Beds consist of 'grey-black silty shale which is locally calcareous, gypsiferous, or pyritic.' This was a percussion borehole, as was Spirit Hill No. 1 Bore from which Milligans Beds samples were also examined during this study.

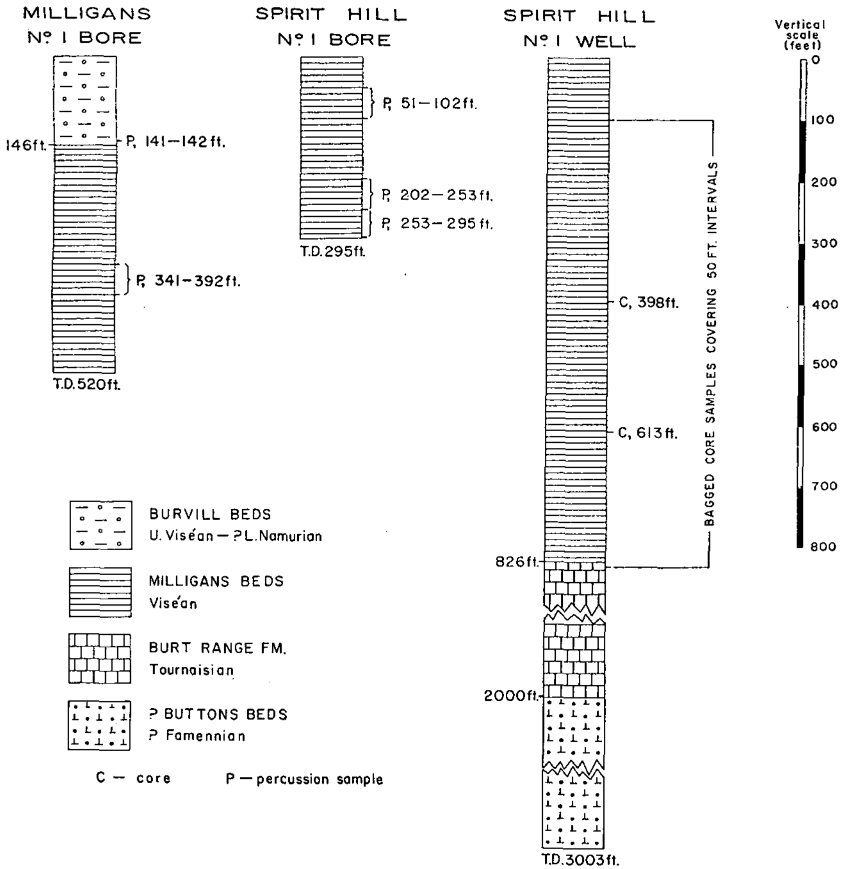

Figure 3: Stratigraphic sequences in Oil Dev./ Westralian Spirit Hill No. 1 Well, Westralian Spirit Hill No. 1 Bore, and Westralian Milligans No. 1 Bore (after Veevers & Roberts, 1968, figs 49, 54), showing positions of samples studied.

The other material came from Spirit Hill No. 1 Well, a continuously cored diamond drillhole which was the only one to pass through the Milligans Beds (826 ft (250 m) thick); it then penetrated an unconformably underlying pre-Viséan sequence [Burt Range Formation (Tournaisian) and ?Buttons Beds (probably Upper Devonian)]. Cores from the Milligans Beds section of the well broke down soon after their surface exposure (J. J. Veevers, pers. comm.), so they were mostly bagged at 50-foot intervals (see Fig. 3).

Numerous groups of marine microfossils and megafossils have been reported from the Milligans Beds; the ostracods and Foraminifera have been regarded as indicative of a Viséan (probably early Viséan) age. Thus the Milligans Beds are currently understood to be equivalent to a small part of the Bonaparte Beds. Indeed, in contrast to the restricted Veevers & Roberts usage followed here, Brady et al. (1966) apply the term Milligans Beds not only to subsurface shales of the Milligans Hills/Spirit Hill area but also to the much thicker offshore shale-siltstone sequence (Bonaparte Beds — Veevers & Roberts) known from the two Bonaparte Wells in the central basinal province. Clay mineralogy of the Milligans Beds is interpreted as indicating nearshore marine conditions, which are also suggested by pebbly conglomerates at the unit's base in Spirit Hill No. 1 Well. The nearshore (platform) shales (Milligans Beds) and offshore (basinal) shales (Bonaparte Beds) are regarded 'as belonging to a single shale body, and the nearshore shales as tongues projecting [i.e. shorewards] from the central mass.' The pronounced thickness of basinal later Viséan shales indicates that subsidence was much greater there than in the marginal regions.

Burvill Beds

The first 146 feet (44 m) of section penetrated by Milligans No. 1 Bore have been regarded as belonging to the Burvill Beds, and a single sample from the basal part (141-142 ft) is documented here. The type section of Burvill Beds, located in the Weaber Range area, is 160 feet (58.5 m) thick and consists of sandstone and shale with interbeds of sandy limestone.

Conodont and foraminiferal evidence from the Burvill Beds in the Weaber Range area indicate a late Viséan (or possibly Namurian) age; correlation with the lower part of the Tanmurra Formation in Bonaparte No. 1 has been suggested.

In Milligans No. 1, the Milligans Beds pass, seemingly transitionally, into overlying sandstone, siltstone, and sandy limestone identified as Burvill Beds. The contact however could not be conformable if one takes account of the apparently considerable age disparity between the two units (Milligans Beds are early Viséan and Burvill Beds late Viséan). The Burvill Beds have been interpreted as beach deposits of a late Viséan sea, which reworked coarse alluvium deposited slightly earlier during a regression along the western and southwestern margins of the basin.

SAMPLES AND THEIR LABORATORY PREPARATION

Appendix 1 gives details concerning the 61 samples documented palynologically in this Bulletin under headings of boreholes and rock units from which they were obtained (see also Figs 2, 3). From the brief megascopic descriptions of the cores it will be evident that the majority of samples are of fine clastic sediments (shale and siltstone) containing appreciable amounts of disseminated carbonaceous material, especially those from the abundantly represented Bonaparte Beds and Milligans Beds. In general the fine sediments yielded prolific assemblages of spores in moderate to excellent states of preservation. There is a progressive decrease in quality of preservation of spore exines with increase in depth in the three wells (Bonaparte Nos 1 and 2, Spirit Hill No. 1). Below core 11 (4929 ft) in Bonaparte No. 2, core 14 (4349 ft) in Bonaparte No. 1, and about 850 ft in Spirit Hill No. 1 Well, plant microfossils were either absent or very poorly preserved, and constituents could not confidently be identified. It is planned to reprepare this material, using somewhat different techniques, and thus, if possible, to obtain palynological data from the older sediments of the wells, particularly the Tournaisian and Upper Devonian sections. Meanwhile the present account is confined to the younger Lower Carboniferous material.

Conventional laboratory techniques were used in the preparatory aspect of the work, which had as its aim the concentration of the acid-resistant microfossils and their mounting for detailed microscopic examination.

Calcareous samples were treated initially in crushed state with 10 percent hydrochloric acid for about two hours and then, after washing with distilled water, were subjected to the normal procedure used for non-calcareous material. This involved standing about 2-5 grams of disaggregated sample in cold 70 percent hydrofluoric acid for at least 24 hours, followed by one hour's boiling in further hydrofluoric acid of the same strength. Gel-like complex fluorides produced by the hydrofluoric acid reaction were removed by means of several treatments with warm 50 percent hydrochloric acid. After thorough washing with distilled water, the residue was assessed by means of test slides as to the likely time required for adequate (wet) Schulze maceration. This was found to vary from 5 to 75 minutes. After the appropriate Schulze treatment, the residue was washed to neutrality with distilled water, immersed very briefly in weak (about one percent) ammonium hydroxide, again washed thoroughly, mixed with a small amount of glycerine-water (1:1) solution containing a few drops of phenol, and then transferred for storage to small stoppered plastic tubes. Adequate natural colour of the microfossils so extracted made staining unnecessary. Three or four strew slides were made (under No. 0 coverslips) of each productive residue. In addition spores were picked individually from water-glycerine smears of residues containing higher concentrations of well preserved spores. In all cases the mountant was glycerine jelly. Slides were thoroughly sealed with gold-size varnish.

Worthy of special mention is the biomicrite of core 2 (687 ft), Bonaparte No. 1. My previous experience has been that such carbonate rocks are almost invariably barren palynologically; hence it was heartening to obtain from this particular sample a palynological flora rich in individuals even though not particularly diverse.

SYSTEMATIC PALAEONTOLOGY

In the ensuing systematic descriptions and supporting plate explanations, all type and other figured spores are documented in the following manner: locality (borehole and depth), preparation/slide number, microscope stage coordinates ('east-west' followed by 'north-south' vernier readings), and registered CPC (Commonwealth Palaeontological Collection) number of the Bureau of Mineral Resources, Geology & Geophysics, Canberra, where the material is deposited. Coordinates cited are those of Leitz Ortholux microscope no. Mx2188 of the Department of Geology & Mineralogy, University of Queensland. A master slide with two clearly marked crosses and their Mx2188 coordinates accompanies the collection.

Spore-morphological terminology used below accords with the glossaries given by Dettmann (1963), Kremp (1965), and Smith & Butterworth (1967). Suprageneric classification of the Anteturma Sporites follows the scheme of Dettmann (1963) with certain revisions and innovations proposed by Smith & Butterworth (1967).

Anteturma SPORITES H. Potonié, 1893

Turma TRILETES Reinsch emend. Dettmann, 1963

Suprasubturma ACAVATITRILETES Dettmann, 1963

Subturma AZONOTRILETES Luber emend. Dettmann, 1963

Infraturma LAEVIGATI Bennie & Kidston emend. R. Potonié, 1956

Genus LEIOTRILETES Naumova emend. R. Potonié & Kremp, 1954

Type species (by subsequent designation of Potonié & Kremp, 1954, p. 120). *Leiotriletes sphaerotriangulus* (Loose) R. Potonié & Kremp, 1955.

LEIOTRILETES sp. A
(Pl. 1, figs 5, 6)

1964 *Leiotriletes* sp. of Balme, pl. 2, fig. 14 [no description].

Description. Spores radial, trilete. Amb subtriangular with convex sides and rounded apices. Laesurae distinct, sinuous or nearly straight, length about two-thirds of spore radius; flanked by conspicuous lips individually 3-4.5μ wide, radially divergent 6-12μ beyond termini of laesurae. Exine laevigate, 3-5μ thick.

Dimensions (4 specimens). Equatorial diameter 78-88μ.

Comparison. The form is morphographically close to two previously described species, *Leiotriletes auritus* Ishchenko, 1956 (p. 23; pl. 2, fig. 22) and *Punctatisporites divaricatus* Felix & Burbridge, 1967 (p. 355; pl. 53, fig. 8), which are from, respectively, the Namurian of the Donetz Basin and the late Mississippian or early Pennsylvanian (Springer Formation) of Oklahoma. Both of these share with the Australian form the terminal divergence of the lips, but in *P. divaricatus* there is also a marked broadening of the lips themselves (range 2-5μ at pole to 5-10μ at termini of laesurae). Close comparison with *L. auritus* is not feasible from Ishchenko's brief description; the drawing he provided suggests a spore intermediate between *P. divaricatus* and the Australian one. Moreover, Felix & Burbridge (1967, p. 358) likened *L. auritus* to their *P. trifidus*.

It seems likely that future discovery of more specimens in the Australian Lower Carboniferous would justify erection of a new species to cover this form.

Previous records. Balme (1964) listed the occurrence of this form in the Lower Carboniferous of Western Australia.

Genus PUNCTATISPORITES Ibrahim emend. R. Potonié & Kremp, 1954

Type species (by original designation). *Punctatisporites punctatus* (Ibrahim) Ibrahim, 1933.

PUNCTATISPORITES RESOLUTUS sp. nov.
(Pl. 1, figs 1-4)

Diagnosis. Spores radial, trilete; originally spherical; off-polar compressions common. Amb circular or subcircular. Laesurae perceptible to distinct, simple; length about two-thirds of spore radius. Exine laevigate; with fine, dense intragranulation; thickness 3-5μ; rare compression folds.

Dimensions (16 specimens). Equatorial diameter 53 (66) 75μ.

Holotype. Preparation B180/19, 43.8 120.8, CPC9934; Plate 1, figure 1. Distal aspect. Amb subcircular, diameter 67μ; laesurae slightly unequal (22, 19, 18μ long); exine 5μ thick, surface smooth, structure intragranulate.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, cuttings, 1840 feet.

Comparison. Despite its simple construction, this form could not satisfactorily be accommodated in any established species. It differs from *Punctatisporites subtritus* Playford & Helby, 1968 (p. 107; pl. 9, figs 11, 12), which was described from the Upper Carboniferous of New South Wales, in being generally much smaller with shorter unlipped laesurae. Two species described by Hacquebard (1957) from the Lower Mississippian of Nova Scotia, *P. planus* and *P. solidus*, are also comparable to *P. resolutus* sp. nov. However, *P. planus* has a thinner, less distinctly structured exine and usually longer laesurae than the Australian form; while *P. solidus* has a subtriangular amb, lipped laesurae, and differently structured exine.

PUNCTATISPORITES SUBVARICOSUS sp. nov.
(Pl. 1, figs 7-12; Pl. 2, figs 13-18)

1964 ?N. gen. and n. sp.; Balme, pl. 2, fig. 19 [no description].

Diagnosis. Spores radial, trilete; amb circular to broadly roundly subtriangular. Laesurae distinct, simple, straight or with small-scale sinuosity, open gaping to produce concave-sided triangular opening; length of laesurae at least two-thirds spore radius. Exine 3-6μ thick; often showing variation (as measured equatorially) on same specimen. Surficial character of exine variable: proximal surface usually finely, irregularly vermiculate overall or in contact areas only, with very fine channels (less than 1μ and 0.5μ deep and broad respectively) that branch and terminate freely without forming a perfect (negative) reticulum; distal surface typically scabrate or very finely, densely granulate; some specimens virtually laevigate or with only a few proximal vermiculae. Equatorial margin entire or finely incised.

Dimensions (70 specimens). Equatorial diameter 46 (60) 74μ.

Holotype. Preparation B19/9, 25.9 121.5, CPC9941; Plate 1, figure 8. Distal aspect. Amb circular, diameter 69μ; laesurae distinct, long, gaping about pole; distal surface very finely, densely granulate — grana not demarked by any obvious negative reticulum; proximal surface incised irregularly by fine shallow vermiculi that are most conspicuous in central interradial areas; vermiculi constitute imperfect negative reticulum; exine slightly crassitudinous, thickness (measured at equator) 3.5-5μ.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, core 11, 3154 feet.

Remarks. The variable morphology (particularly sculpture) of this form has been documented from close examination of the numerous specimens at hand. Minor development of a crassitude was noted in about 10 percent of the specimens and cannot be regarded as diagnostic; Balme's specimen (see synonymy) from the Lower Carboniferous of Western Australia seems to be somewhat crassitudinous.

Comparison. Superficially, *Punctatisporites subvaricosus* sp. nov. resembles *P. heterofiliferus* Felix & Burbridge, 1967 (pp. 356-8; pl. 53, figs 10, 11). The latter species, which was described from the Carboniferous Springer Formation of Oklahoma, differs however in being obervermiculately sculptured. Another American Carboniferous form, *P. vermiculatus* Kosanke, 1950 (p. 19; pl. 2, fig. 4), is distinguishable from *P. subvaricosus* in having much more deeply vermiculate exine on both proximal and distal surfaces.

Previous records. Balme's (1964) record of this species is from the Lower Carboniferous of Western Australia.

Infraturma APICULATI Bennie & Kidston emend. R. Potonié, 1956

Genus APICULIRETUSISPORA Streel emend. Streel, 1967

Type species (by original designation). *Apiculiretusispora brandtii* Streel, 1964.

Discussion. This genus was originally intended (Streel, 1964, p. B7) to accommodate apiculate elements of Naumova's (1953) broad category *Retusotriletes,* which was itself restricted (Streel, 1964, pp. B6-7) to essentially smooth forms (as of the type species *R. simplex* Naumova, 1953). Objections to primary diagnosis of the latter genus on curvaturate development are expressed subsequently in this report (see discussion under *Archaeozonotriletes*); Streel (1967, pp. B28-9, 32), in discussing and emending *Apiculiretusispora,* was evidently aware of the same problem for he placed more emphasis on (essentially distal) sculptural detail ('a very variable ornamentation of grana, coni, and/or spinae or other "biform" ornaments less than one micron in size') than on contact area delimitation.

A few specimens have been found in the Bonaparte Gulf Basin Carboniferous that conform with *Apiculiretusispora;* these are described below but without formal species-designation on account of their insufficient representation.

APICULIRETUSISPORA sp. A
(Pl. 2, figs 9-12)

Description. Spores radial, trilete; amb circular. Laesurae perceptible, simple or with faint, narrow lips, length about one-half spore radius. Contact areas depressed, well defined on account of sculptural differentiation: contact areas virtually smooth, remainder of exine (proximo-equatorial, distal) with fine dense sculpture (coni and grana grading to small verrucae). Sculptural elements closely spaced but discrete; about 0.5-1.5μ in basal diameter and height; a few verrucae and larger coni occasionally each support a minute spina.

Dimensions (7 specimens). Equatorial diameter (excluding projections) 42 (49) 58μ.

Comparison. A Belgian Upper Devonian form, *Retusotriletes verrucosus* Caro-Moniez, 1962 (pp. 111-2; pl. 16, figs 1, 2), shows some similarity to *Apiculiretusispora* sp. A, but differs in being larger (65-70μ) and in having curvaturae perfectae, longer laesurae, and presumably less sculptural diversity. The Australian form could be very close to *Retusotriletes setosus* Kedo, 1963 (pp. 36-7; pl. 2, figs 32, 33), from the Lower Carboniferous of the Pripyat Basin, Byelorussian SSR; but a close comparison is not feasible on the basis of the stylized drawings and brief description provided by Kedo.

Infraturma APICULATI Bennie & Kidston emend. R. Potonié, 1956

Subinfraturma GRANULATI Dybová & Jachowicz, 1957

Genus GRANULATISPORITES Ibrahim emend. R. Potonié & Kremp, 1954

Type species (cited by Schopf, Wilson, & Bentall, 1944, p. 33). *Granulatisporites granulatus* Ibrahim, 1933.

GRANULATISPORITES FRUSTULENTUS Balme & Hassell, 1962 emend.
(Pl. 2, figs 1-8)

1960 *Cyclogranisporites* sp. A of Balme, p. 28; pl. 4, fig. 8.
1960 cf. *Lycospora* sp. of Balme, p. 29; pl. 5, fig. 21.
1962 *Granulatisporites frustulentus* Balme & Hassell, pp. 6-7; pl. 1, figs 8, 9.
1964 *Cyclogranisporites* [sic] *frustulentus* Balme & Hassell; Balme, pl. 1, fig. 3 [no description].
1964 cf. *Lycospora* sp. of Balme, pl. 2, fig. 1 [no description].
1964 *Cyclogranisporites* sp. of Balme, pl. 2, fig. 2 [no description].
1964 *Verrucosisporites* sp. of Balme, pl. 2, fig. 4 [no description].
1964 *Lophozonotriletes* n. sp. of Balme, pl. 2, fig. 5 [no description].
1966 *Lycospora suratensis* de Jersey, p. 34; pl. 1, figs 13-15.

Emended diagnosis. Spores radial, trilete; amb broadly rounded subtriangular, occasionally subcircular. Laesurae perceptible to distinct, straight to somewhat curved, simple or with slight, narrow lip development; length at least three-quarters spore radius, frequently extending almost to equatorial margin. Distal-equatorial sculptural elements usually distinct in size/distribution from those of proximal faces. Distal-equatorial elements regularly disposed, often diverse on same specimen, consisting of grana, verrucae, coni, pila, and bacula (in very approximate order of frequency); up to 3μ in height and basal diameter (mean about 1μ); crowded but mainly discrete, rarely as much as 4μ apart. Proximal face (excluding equatorial region) finely and sparsely sculptured with grana. Exine mostly 1-2μ thick; many examples show a variable equatorial modification — crassitudinous, cingulate, or zonate — up to 6μ wide in polar view.

Dimensions (60 specimens). Equatorial diameter, excluding projections, 25 (36) 48μ.

Remarks. Spores included in this specific grouping display considerable morphographical variation, which is documented in the broad specific rediagnosis. At first sight the group would seem to be too broad for a palynomorph species and indeed an attempt at meaningful subdivision was made. However it became clear that the diverse sculptural/structural attributes of the forms in any given assemblage show a continuous mode of variation, which defied any such categorization and could not be put to any obvious biostratigraphic utility. This confirms Balme's (1964, p. 56) finding that the spores are 'taxonomically intractable.'

The choice of an apt form-generic name is not easy because of the way in which the morphological features of the group transgress accepted generic boundaries. The diversity of sculpture conforms to some extent with *Apiculiretusispora* Streel emend. Streel, 1967, but no obvious curvaturae are developed. Further, as Balme (1964, p. 56) has noted, the series includes types that could be attributed to such genera as *Cyclogranisporites, Lophozonotriletes* (including *Tumulispora* Staplin & Jansonius, 1964), and *Lycospora.* At present the species seems best left in *Granulatisporites;* it is applicable to the holotype and probably to most members of the group.

Joint study by Dr N. J. de Jersey and the writer has indicated that the former's (1966) species *Lycospora suratensis* falls within the range of *Granulatisporites frustulentus* Balme & Hassell, 1962, emend.

Previous records. Known, often profusely, from Upper Devonian (Famennian) to Lower and (?) Upper Carboniferous of Western Australia (Balme & Hassell, 1962; Balme, 1960, 1964); and from probable mid-Carboniferous of southern Queensland (de Jersey, 1966).

Genus CADIOSPORA Kosanke emend. Venkatachala & Bhardwaj, 1964

1950 *Cadiospora* Kosanke, p. 50.
1954 *Gravisporites* Bhardwaj, p. 513.
1964 *Cadiospora* Kosanke emend. Venkatachala & Bhardwaj, pp. 166-7.

Type species (by original designation). *Cadiospora magna* Kosanke, 1950 (syn. *C. sphaera* Butterworth & Williams, 1954; see Smith & Butterworth, 1967, pp. 145-6).

CADIOSPORA ABRUPTA sp. nov.
(Pl. 3, figs 7-10)

Diagnosis. Spores radial, trilete, originally spherical; amb circular to subcircular. Laesurae accompanied, and often partly obscured, by very conspicuous lips that are 15-25μ high and 12-20μ in overall width; extending to or nearly to equator. Exine very thick equatorially and distally (9-20μ); slightly thinner (hence of lighter colour) in proximal (contact) areas. Exine with scabrate surface, and fine, dense, spongeous structure.

Dimensions (14 specimens). Equatorial diameter 73 (85) 100μ.

Holotype. Preparation B57/1, 35.5 113.2, CPC9967; Plate 3, figures 7, 8. Proximal aspect. Amb subcircular, diameter 80μ; laesurate lips about 20μ high, length equal to spore radius but projected beyond equator for 6-14μ, through compression; laesurae largely obscured; whole of exine (lips and spore coat) scabrate; exine 10μ thick at equator, thinner in proximal interradial regions.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 6, 3210 feet.

Comparison. This species differs from others attributable to *Cadiospora* in the extremely elevated nature of its laesurate lips.

Subinfraturma VERRUCATI Dybová & Jachowicz, 1957

Genus VERRUCOSISPORITES Ibrahim emend. Smith & Butterworth, 1967

Type species (by original designation). *Verrucosisporites verrucosus* (Ibrahim) Ibrahim, 1933.

VERRUCOSISPORITES NITIDUS Playford, 1964
(Pl. 3, figs 1-6)

1953 *Lophotriletes grumosus* Naumova, p. 57; pl. 7, figs 14, 15.
1956 *Lophotriletes* aff. *grumosus* Ishchenko, p. 40; pl. 7, fig. 74.
1964 *Verrucosisporites nitidus* Playford nom. nov., pp. 13-14; pl. 3, figs 3-6.
1964 *Verrucosisporites grumosus* (Naumova) Sullivan, pp. 1252-3, pl. 1, figs 9-15. [1964a]

Dimensions (42 specimens). Equatorial diameter, including sculpture, 42 (59) 75μ. Size ranges previously quoted for this species: 40-64μ (Naumova, 1953); 30-60μ (Ishchenko, 1956); 28 (41) 55μ (Playford, 1964); 40 (54) 70μ (Sullivan, 1964a).

Remarks and comparison. This species is not altogether satisfactory as it is based initially upon a very brief, generalized statement and two stylized drawings (Naumova, 1953). There is no doubt however that the category, broad as it admittedly is, would not be easy to subdivide taxonomically owing to the continuous variation in sculptural features. Sullivan (1964a) illustrated very adequately such variation, which is clearly evident among Australian examples seen during this study. The specific epithet instituted by Playford (1964) is applicable, owing to the later homonymy (see Playford, 1964, p. 14) induced by *Verrucosisporites grumosus* (Naumova) Sullivan (non *Verrucosisporites grumosus* Ibrahim, 1933).

Bhardwaj & Venkatachala's (1962) species *Convolutispora stigmoidea* probably belongs at least in part to *V. nitidus,* if indeed the sculpture of the former is verrucate rather than pilate. *Lophotriletes mesogrumosus* Kedo, 1963 (p. 51; pl. 4, fig. 82), from the White Russian Tournaisian, is larger (Kedo quotes a single measurement — 86μ).

Previous records. V. nitidus has been recorded previously from the Upper Devonian and Lower Carboniferous of the USSR (Naumova, 1953; Ishchenko, 1956), Lower Mississippian of Canada (Playford, 1964), and Tournaisian of England (Sullivan, 1964a). It probably occurs also in the Lower Carboniferous of Spitsbergen (Bhardwaj & Venkatachala, 1962).

Subinfraturma NODATI Dybová & Jachowicz, 1957

Genus ANAPICULATISPORITES R. Potonié & Kremp, 1954

Type species (by original designation). *Anapiculatisporites isselburgensis* R. Potonié & Kremp, 1954.

Discussion. The circumscription of this genus could well be susceptible to revision or restriction, and Smith & Butterworth (1967, p. 160) have attempted to do this. The emendation propounded by these authors covers structurally simple trilete spores with 'triangular, very occasionally circular' amb together with a granulate, conate, or spinose sculpture that is confined to the distal surface and does not extend to the equatorial interradial regions. This clearly departs significantly from the original diagnosis; and unfortunately there is no indication that Smith & Butterworth studied the type species, *A. isselburgensis* R. Potonié & Kremp, 1954 (p. 133; pl. 20, fig. 97), from either their own (British) material or the German type locality. The holotype (and only figured specimen) of the latter species is preserved in lateral aspect, and does not show the sculptural distribution with respect to radial and interradial portions of the equator. Potonié & Kremp did, however, diagnose *A. isselburgensis* as having ± 25 coni projecting from the equator and made no suggestion that these are absent interradially. It is thus difficult to accept the generic restriction placed by Smith & Butterworth on the extent of the exinal sculpture. The Smith & Butterworth emendation is also unsatisfactory because (1) in a differential diagnostic sense, it involves acceptance of *Anaplanisporites* Jansonius, 1962 (p. 45), which on grounds of typification (designation and selection of type species) remains suspect as a valid generic category (see Potonié, 1966, p. 44); (2) it involves the combination of certain species, previously allocated to *Anapiculatisporites* R. Potonié & Kremp, with the genus *Procoronaspora* Butterworth & Williams emend. Smith & Butterworth, 1967 (pp. 162-3), the type species of which (*P. ambigua* Butterworth & Williams, 1958, p. 384; pl. 4, figs 1-3) appears to be (interradially) tricrassate and assignable to *Rotaspora* Schemel, 1950 (see Sullivan & Marshall, 1966, p. 272). Moreover, *Anaplanisporites* as originally established differs from *Anapiculatisporites* on the slight basis of having 'smaller ornamentation' (see also Potonié, 1966, p. 44). For the present, then, it is considered advisable to continue to apply *Anapiculatisporites* in the sense of Potonié & Kremp (1954).

The genus *Tricidarisporites* Sullivan & Marshall, 1966 (p. 268), is available for most spores conforming with *Procoronaspora sensu* Smith & Butterworth should the latter fall as a result of *P. ambigua* being indubitably a *Rotaspora.*

ANAPICULATISPORITES LARGUS sp. nov.
(Pl. 4, figs 1-6)

1964 *Apiculatisporis* n. sp. of Balme, pl. 2, fig. 16 [no description].

Diagnosis. Spores radial, trilete. Amb circular to subcircular. Laesurae distinct to perceptible, frequently opened to form a subtriangular gape about proximal pole, extending about one-half to two-thirds of the distance to equator. Exine double-layered; 1-2μ in overall thickness, excluding sculptural projections; some specimens display, in places, slight contraction of thin smooth intexine from the thicker (sculptured) exoexine, to the extent of up to 6μ. Proximal hemisphere of spores with virtually laevigate contact areas. Marginal (equatorial) region of proximal hemisphere and whole of distal hemisphere conspicuously sculptured with coni (predominantly), together with subordinate verrucae (some with minute apical spina), spinae, grana, and pila. Sculptural elements 0.5-3μ high and in basal diameter; mostly discrete (up to 6μ apart, average 2μ). Large-scale, arcuate, compression folds are characteristic of exine surface.

Dimensions (50 specimens). Equatorial diameter, excluding projections, 56 (67) 78μ.

Holotype. Preparation B117B/2, 50.0 123.9, CPC9975; Plate 4, figure 6. Proximal aspect. Amb subcircular, diameter 65μ; simple, straight laesurae (two slightly gaping, the other indistinct), length two-thirds spore radius; exine two-layered, about 2μ thick overall; outer layer (exoexine) about 1.5μ thick, virtually smooth in contact areas, conspicuously sculptured elsewhere with coni and very rare spinae (1-1.5μ broad basally, 0.5-2μ high); spacing of elements somewhat variable (0.5-5μ), maximum about distal pole; exoexine finely structured and with several compression folds; intexine slightly separated from exoexine along one segment of equator (maximum separation about 5μ).

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 5, 2836 feet, 4 inches.

Remarks. Balme's informal generic allocation of this form cannot be followed because *Apiculatisporis* R. Potonié & Kremp, 1956, embraces spores with comprehensive conate sculpture. Although the nature and distribution of the sculpture are regarded as conformable with *Anapiculatisporites,* double-layered exines are not, so far as is known, characteristic of that genus. For this reason the generic assignation of this species may be considered as a tentative one. Indeed it might be appropriately accommodated in a (new) generic category within the Subturma Azonolaminatitriletes / Infraturma Tuberculornati Smith & Butterworth, 1967, although the latter grouping has yet to be clearly differentiated from the Pseudosaccitriletes. Allocation to the genus *Spelaeotriletes* Neves & Owens, 1966 (pp. 342-4) was considered in that the species is somewhat diversely sculptured (albeit predominantly conate) and displays smooth contact faces. However, in having a circular-subcircular amb and minor-nonexistent separation of the wall layers, *Anapiculatisporites largus* sp. nov. diverges considerably from Neves & Owens' category.

Comparison. McGregor (1960, p. 30; pl. 11, fig. 12) has described *Apiculatisporis elegans* from probable Upper Devonian of Melville Island, Canada; it differs from *Anapiculatisporites largus* in having a more uniformly and finely sculptured, rarely folded exine.

Previous records. Balme (1964) figured this species from the Lower Carboniferous of Western Australia.

ANAPICULATISPORITES SEMISENTUS sp. nov.
(Pl. 4, figs 7-10; Pl. 5, fig. 18)

Diagnosis. Spores radial, trilete; amb convexly subtriangular to subcircular. Laesurae lipped (2-4μ overall), extending at least three-quarters of the distance to the equator. Exine 2-3μ thick; sculpture consisting of very fine, close-packed coni and very rare spinae, up to 2μ long (average 0.5μ), and 1.5μ in basal diameter (average 0.5μ); sculpture conspicuous and more or less uniform distally and equatorially; elements virtually absent on non-equatorial proximal regions (i.e., on contact areas). Large-scale compression folds of exine common: along laesurae and in equatorial region.

Dimensions (19 specimens). Overall equatorial diameter 70 (85) 100μ.

Holotype. Preparation B54/51, 25.1 116.5, CPC9976; Plate 4, figures 7, 8. Proximal aspect. Amb broadly roundly subtriangular, diameter 82μ; laesurae lipped (up to 4μ wide overall), extending almost to equator; distal-equatorial sculpture of densely and uniformly distributed sharp-pointed conate elements up to 1.5μ long and 1μ broad basally, spacing averages about 0.5μ; proximal surface (apart from extreme equatorial region) laevigate; exine 2μ thick.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Remarks. Sculptural details are visible only under oil immersion, and the elements themselves generally approximate in size to grana. Limited development of curvaturae imperfectae was noted in some specimens (for example on the holotype); even if this were more constant a character, the distal sculpture is too uniform in size and distribution for the species to be considered as belonging to *Apiculiretusispora* Streel emend. Streel, 1967.

Comparison. The late Carboniferous form, *Apiculatisporis triangularis* (Kosanke) R. Potonié & Kremp, 1955 (p. 81; pl. 14, fig. 25) is smaller, unlipped, and comprehensively conate (see also Piérart, 1962, pl. E, fig. 13 and explanation). *Acanthotriletes inferus* Naumova, 1953 (p. 24; pl. 1, figs 13, 14), from the Russian Givetian, differs from *Anapiculatisporites semisentus* sp. nov. at least in its smaller size and laesurate lips.

Genus PLANISPORITES Knox emend. R. Potonié, 1960

Type species (by subsequent designation of Potonié & Kremp, 1954, p. 129). *Planisporites granifer* (Ibrahim) Knox, 1950.

PLANISPORITES CONSPERSUS sp. nov.
(Pl. 4, figs 11-13; Pl. 5, figs 13, 14)

Diagnosis. Spores radial, trilete. Amb subtriangular (rounded apices, convex to nearly straight sides) to subcircular. Laesurae distinct, simple, straight to slightly curved; length at least three-quarters spore radius, frequently extending almost to equatorial margin. Exinal sculpture of finely, rather sparsely distributed coni, 0.5-2.5μ in basal diameter and in height, spaced 0.5-1.5μ apart; developed mainly on distal surface, and in diminished and sparser manner on proximal surface, which in some cases is almost smooth. Equatorial margin smooth or undulant, with as many as 15 coni projecting. Exine between coni 1.5-2.5μ thick.

Dimensions (10 specimens). Equatorial diameter, excluding projections, 50 (60) 75μ.

Holotype. Preparation B54/55, 31.3 120.2, CPC9994; Plate 5, figure 13. Distal aspect. Amb subtriangular, apices rounded, sides convex; diameter 60μ;

laesurae distinct, simple, nearly straight, almost reaching equatorial margin; distal conate sculpture developed sparsely but fairly uniformly (13 elements visible at equator); on proximal surface coni present in central interradial regions; coni 0.5-1μ high, 1-2.5μ broad basally, spaced 0.5-12μ apart; non-conate exine 2.5μ thick.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Comparison. The most closely comparable form to *Planisporites conspersus* sp. nov. appears to be *'Apiculatisporites' erinaceus* (Waltz) R. Potonié & Kremp, 1955, which was originally described (*in* Luber & Waltz, 1938, p. 13; pl. 1, fig. 14; pl. A, fig. 5) from the Russian Lower Carboniferous. No close comparison is possible because Waltz's diagnosis lacks data concerning sculptural dimensions and distribution; but the laesurae of her species are somewhat shorter than in the Australian form and the size range is more restricted.

Genus ACANTHOTRILETES Naumova emend. R. Potonié & Kremp, 1954

Type species (by subsequent designation of Potonié & Kremp, 1954, p. 133). *Acanthotriletes ciliatus* (Knox) R. Potonié & Kremp.

ACANTHOTRILETES INTONSUS sp. nov.
(Pl. 5, figs 1-8)

Diagnosis. Spores radial, trilete. Amb convexly subtriangular with rounded or somewhat pointed apices. Laesurae flanked by distinct lips that taper in overall width equatorially (from 4μ to 2μ approximately) and almost reach margin; lips 3-4μ high at pole. Distal and (narrow) proximo-equatorial regions fairly densely sculptured with discrete, relatively long and narrow spinae that are often recurved. Spinae 1.5-4.5μ long, up to 1μ in basal diameter; spacing 0.5-3μ. Contact faces scabrate or with sparse, much reduced, apiculate sculpture. Exine 1.5-2.5μ thick, excluding projections.

Dimensions (37 specimens). Equatorial diameter 28 (36) 45μ (spinae excluded).

Holotype. Preparation B138/12, 34.0 118.1, CPC9982; Plate 5, figure 1. Proximal aspect. Amb roundly subtriangular, apices rounded to slightly angular; laesurae obscured by dark elevated lips that extend almost to equator; spinae (of distal surface and narrow proximo-equatorial region) 2-4.5μ long, about 1μ broad basally, 0.5-3μ apart; contact areas scabrate, and bearing a few small spinae; about 110 spinae project from equatorial exine which is 1.5μ thick; equatorial diameter, excluding projections, 34μ.

Type locality. Northern Territory, Bonaparte Gulf Basin, Milligans Beds, Viséan; Westralian Oil Spirit Hill No. 1 Bore, percussion sample, 51-102 feet.

Comparison. An Australian Permian form, *Acanthotriletes uncinatus* Balme & Hennelly, 1956 (p. 249; pl. 3, figs 35, 36), is very similar to *A. intonsus* sp. nov. in general appearance but differs in having an essentially straight-sided amb and coarser spinae.

ACANTHOTRILETES TURRICULAEFORMIS Kemp & Playford sp. nov.
(Pl. 6, figs 7-15)

1960 *Apiculatisporites* sp. of Balme, p. 28; pl. 4, figs 10, 11.

Diagnosis. Spores radial, trilete. Amb subcircular to subtriangular (with convex or straight sides), often distorted by exinal folding. Laesurae simple, usually indistinct, extending one-third to two-thirds of the distance to the equator. Contact areas smooth or with minute, simple, scattered spinae/coni (up to 1μ broad basally and 2μ high). Remainder of proximal surface and whole of distal surface conspicuously sculptured with large discrete spinae of distinctive form. Spinae show, overall, a uniform taper from base (subcircular in outline, 1-5μ in diameter) to sharp point; but approximately two-thirds to three-quarters of distance from base of each is a continuous, lateral, circum-spinate expansion, bowl-like in form and concave towards apex, projecting 0.5-2μ outwards from spina and itself appearing *in profile* as two upwardly and outwardly directed coni. Subsidiary expansions/constrictions occur above and below main lateral expansion in some specimens, giving a transversely segmented or nodose appearance to spinae concerned. Length of spinae 7-24μ, spacing 3-14μ. Exine otherwise laevigate, 1-2μ thick.

Dimensions (55 specimens). Equatorial diameter, excluding projections, 40 (68) 100μ.

Holotype. Preparation B180/38, 37.2 120.5, CPC10006; Plate 6, figure 7. Distal aspect. Amb subcircular, 73μ in diameter; simple indistinct laesurae, length about one-half spore radius; majority of proximal exine (contact areas excluded) and whole of distal bearing discrete, robust, spinose projections each of which has a distinctive minaret-like profile due to inverted-cupola-like collar that is impaled centrally by spina from which it projects upwardly and outwardly for a distance of 0.5 to 1μ; spinae ultimately acutely pointed, 3-5μ away from 'collar'; spinae 12-17μ long, 2-3.5μ in basal diameter, spaced 3-9μ apart; exine 1.5μ thick between projections.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, cuttings, 1840 feet.

Remarks. The unusually modified apical region of the projections makes this species a distinctive one among spinose trilete spores recorded to date. The specific diagnosis takes account of considerable size-variation of spinae from one specimen to the next, but, in fact, on a given specimen, the size and spacing of the sculptural projections are fairly uniform. Double-pronged (bifurcating) spinae are very rare; one is present near the distal pole of the specimen figured as Plate 6, figure 9.

The specific institution is credited jointly to Dr Elizabeth M. Kemp and myself. This is an acknowledgment of Dr Kemp's initial recognition and description of the species during B.Sc. Honours research she conducted in 1962, at the University of Western Australia, on Carboniferous sediments of the Canning Basin.

Previous records. Balme (1960) figured and briefly described this spore from the Western Australian Lower Carboniferous.

Genus TRICIDARISPORITES Sullivan & Marshall, 1966

Type species (by original designation). *Tricidarisporites balteolus* Sullivan & Marshall, 1966.

Discussion. Despite the apparent vagueness of Sullivan & Marshall's (1966, p. 268) differential diagnosis, this genus can probably be considered as distinct from *Diatomozonotriletes* Naumova emend. Playford, 1963. Certainly it seems reasonable to regard the type species of each as distinct generically from one another. Possibly the most meaningful distinction that could be made is that in *Tricidarisporites* there is relatively little difference in shape and spacing at least (if not in size as well) between the ornamentation elements of the distal surface and equator (excluding apices). *Diatomozonotriletes,* on the other hand, shows the development of a definite, interradial, equatorial structure (corona), the saetose or spinose elements of which have no parallel in size and/or arrangement on the distal surface. Other than its type *Tricidarisporites* contains only one species, *T. fasciculatus* (Love) Sullivan & Marshall, 1966. Sullivan & Marshall (1966, p. 268) allegedy 'assigned' nine other species to the genus but none of these can be regarded as constituting a validly established combination (see International Code of Botanical Nomenclature, 1966, Article 33). Moreover, *Diatomozonotriletes vesicarius* (Waltz) Playford, 1963 does not conform with *Tricidarisporites* because its non-equatorial (presumably distal) exine is tuberculate in contrast to its coronate equator.

In the event of *Procoronaspora* losing its type species, as seems likely (see discussion under *Anapiculatisporites*), the bulk of its specific contents could go into *Tricidarisporites.* Note again however that *P. ambigua* has yet to be validly combined with *Rotaspora* (cf. Sullivan & Marshall, 1966, p. 272).

TRICIDARISPORITES sp. A
(Pl. 6, fig. 4)

Description. Spore radial, trilete. Amb subtriangular, with almost straight sides. Laesurae distinct, simple, straight; length about four-fifths of spore radius. Proximal exine laevigate, but disrupted by numerous, randomly disposed relic (after pyrite) structures (simple, polygonal-triangular cavities averaging 5μ in diameter). Distal and interradial-equatorial exine fairly densely sculptured with discrete sharp spinae (usually simple, occasionally two-pronged). Spinae $1\text{-}2\mu$ broad basally, $3\text{-}8\mu$ long, bases circular-oval. Sculpture shows gradual diminution around equator from central interradial positions to amb apices where only small coni project. Exine, excluding projections, $2.5\text{-}3\mu$ thick.

Dimensions. Equatorial diameter 64μ (projections excluded); one specimen only.

Comparison. The Spitsbergen Viséan form, *Tricidarisporites serratus* (Playford, 1962, p. 589; pl. 80, figs 16-19; text-fig. 5f) comb. nov., is similar to *T.* sp. A, but differs in being smaller and in having a thinner exine and more closely spaced spinae whose bases are broader and hexagonal in surface view.

Subinfraturma BACULATI Dybová & Jachowicz, 1957

Genus RAISTRICKIA Schopf, Wilson, & Bentall emend. R. Potonié & Kremp, 1954

Type species (by original designation). *Raistrickia grovensis* Schopf *in* Schopf, Wilson, & Bentall, 1944.

RAISTRICKIA INPROFUSA sp. nov.
(Pl. 5, figs 15-17)

Diagnosis. Spores radial, trilete. Amb circular or subcircular. Laesurae evident on well preserved specimens and accompanied by elevated, often slightly roughened lips about 4μ high and in overall width; length about one-half to three-quarters of spore radius. Sculpture of clavae and bacula (in varying proportions) developed on distal surface and on proximo-equatorial region. Projections 1-4μ long, 0.5-1.5μ broad basally, and 0.5-7μ apart. Proximal areas delimited by laesurae bear only sparse projections or are laevigate. Exine 2-3μ thick, excluding projections.

Dimensions (15 specimens). Equatorial diameter 41 (55) 68μ, sculpture excluded.

Holotype. Preparation B19/1, 46.8 122.4, CPC9998; Plate 5, figure 17. Proximal aspect. Amb circular, diameter 53μ; laesurae with somewhat irregular lip development extending two-thirds of distance to equator; dense clavate-baculate sculpture on distal and proximo-equatorial regions; elements about 1.5-3.5μ long, 0.5-1μ in basal diameter, spaced 0.5-4.5μ apart; contact areas virtually laevigate, with only a few small projections; exine otherwise appears very finely structured (?corrosion effect), 3μ thick.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, core 11, 3154 feet.

Comparison. Raistrickia abstrusa Playford, 1964 (p. 24; pl. 6, figs 1-3; fig. 1b), described from the Mississippian Horton Group, Nova Scotia, differs from *R. inprofusa* sp. nov. in having a subtriangular amb, shorter laesurae, and more diverse sculpture. The Australian form could conceivably be the same as *'Schopfites' claviger* Sullivan, 1968 (p. 121; pl. 25, figs 9, 10), an early Carboniferous species from Scotland. However, Sullivan was unable to give a detailed circumscription of his form from material at his disposal; and until such morphological details as apertural characteristics and exine thickness can be specified for the Scottish form, judgment of its possible synonymy with *R. inprofusa* is clearly impracticable.

RAISTRICKIA PINGUIS sp. nov.
(Pl. 5, figs 9-12)

Diagnosis. Spores radial, trilete; amb circular to broadly roundly subtriangular. Laesurae simple, long, nearly reaching equator; usually indistinct (obscured by ornamentation). Dense, comprehensive, exinal sculpture of simple, stout projections, 3-9μ long, 2-8μ broad basally, up to 8μ apart (some basally coalescent). Projections circular, rounded-polygonal, or elongate in basal outline; variable in lateral profile, with straight sides or regular basal or apical expansion; tops flat or rounded-acute. Exine 2-3μ thick (excluding sculptural projections).

Dimensions (17 specimens). Equatorial diameter 33 (43) 52μ, sculpture excluded.

Holotype. Preparation B54/57, 35.3 124.2, CPC9990; Plate 5, figure 9. Proximal aspect. Amb roundly subtriangular, 40μ in diameter; indistinct laesurae about three-quarters of spore radius; sculptural elements variable, but mainly baculate; dimensions of elements: basal diameter 2-7.5μ, length 4-9μ; spacing up to 8μ; exine 3μ in thickness.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Remarks. Projections are fairly diverse in size and form on a given example, being classifiable variously as bacula, clavae, coni, and verrucae; but a dominantly baculate sculpture is characteristic. The sculptural elements are usually slightly larger and more densely distributed on the distal surface than the proximal.

Comparison. From the Upper Carboniferous Italia Road Formation, New South Wales, Playford & Helby (1968, p. 109; pl. 9, figs 13, 14) described *Raistrickia accincta,* which is similar in size and sculptural diversity to *R. pinguis* sp. nov., but differs in being dominantly clavate (not baculate), and in having a consistently circular-subcircular amb and marked proximal diminution of sculpture.

Infraturma MURORNATI R. Potonié & Kremp, 1954

Genus CONVOLUTISPORA Hoffmeister, Staplin, & Malloy, 1955

Type species (by original designation). *Convolutispora florida* Hoffmeister, Staplin, & Malloy, 1955.

CONVOLUTISPORA AMPLA Hoffmeister, Staplin, & Malloy, 1955
(Pl. 6, figs 5, 6)

1955 Convolutispora ampla Hoffmeister, Staplin, & Malloy, p. 384; pl. 38, fig. 12.

Dimensions (14 specimens). Equatorial diameter 55 (63) 74μ.

Remarks. The specimens recovered are very similar to those described originally; in the fine dense rugulate sculpture and relatively short obscure laesurae. The size range, too, is comparable, but falls in the upper portion of the range quoted by Hoffmeister, Staplin, & Malloy (40-75μ).

Previous records. C. ampla has so far been recorded only from the northern hemisphere Carboniferous, as follows: Mississippian of Kentucky (Hoffmeister, Staplin, & Malloy, 1955); Viséan of Scotland (Love, 1960); Namurian of Great Britain (Smith & Butterworth, 1967); Viséan of Northwest Territories, Canada (Barss, 1967).

CONVOLUTISPORA BALMEI sp. nov.
(Pl. 7, figs 1-6)

Diagnosis. Spores radial, trilete; with circular to broadly roundly subtriangular amb. Laesurae distinct to obscure, simple, straight or slightly curved; length one-half to four-fifths of spore radius. Exine distinctly rugulate on both proximal and distal surfaces; contact areas usually show relatively reduced, sparser sculpture and are occasionally virtually smooth. Rugulae smooth, densely distributed, non-overlapping, rounded in cross-section; irregular in form, branching, and disposition; basal width 1-14μ, height up to 3μ (usually about 1-1.5μ). Rugulae typically bordered by sharp narrow channel-like incisions in exine. Subordinate verrucae sometimes present. Spaces between processes vary in width from less than 1μ to as much as 10μ; lumina rarely delimited. Exine 2-3.5μ thick, excluding sculpture; often with large-scale compression folds. Equatorial margin undulate.

Dimensions (15 specimens). Equatorial diameter 91 (117) 146μ.

Holotype. Preparation B75/3, 17.9 124.4, CPC10017; Plate 7, figure 5. Distal aspect. Amb subcircular; diameter 136μ; simple, straight, partly obscured laesurae reach about one-half of distance to equator; coarse comprehensive rugulate sculpture, with processes smaller, more widely spaced in contact areas; rugulae sharply delimited along margins with unthickened exine, width 3-14μ, height up to 3μ, intervening spaces up to 8μ (average 1.5μ). Non-sculptured exine 3.5μ thick.

Type locality. Northern Territory, Bonaparte Gulf Basin, Milligans Beds, Viséan; Oil Dev./Westralian Oil Spirit Hill No. 1 Well, bagged core sample, 400-450 feet.

Remarks and comparison. Rugulae of corroded specimens tend to be irregularly pitted rather than perfectly smooth as in the better preserved examples. This species is a distinctive member of the genus by virtue of its relatively low rugulae, which have irregular courses and very clearly delimited bases, giving overall an irregularly pleated appearance to the exine surface.

'Punctatisporites' grandivermiculatus Peppers, 1964 (pp. 33-4; pl. 4, figs 20, 21), from the Upper Pennsylvanian of Illinois, differs from *Convolutispora balmei* sp. nov. in having a basically vermiculate sculpture, which does not produce a pleated appearance, a thicker exine, and invariably a rounded amb.

CONVOLUTISPORA CRASSA Playford, 1962
(Pl. 8, fig. 6; Pl. 9, fig. 5)

1962 *Convolutispora crassa* Playford, pp. 594-5; pl. 81, figs 10-12.

Dimensions (33 specimens). Equatorial diameter 60 (85) 110μ. This size range coincides almost exactly with the original one cited by Playford (1962, p. 594).

Comparison. *Archaeozonotriletes cerebrum* Byvscheva, 1963 (pp. 41-42; pl. 4, figs 1, 2), from the Viséan of the Volga-Ural region, is remarkably similar to *Convolutispora crassa* Playford, 1962, but appears to be generally much larger (101-187μ, mean 159-162μ).

Previous records. *C. crassa* was first reported from the Lower Carboniferous (Tournaisian-Viséan) of Spitsbergen (Playford, 1962).

CONVOLUTISPORA FLORIDA Hoffmeister, Staplin, & Malloy, 1955
(Pl. 6, fig. 3)

1955 *Convolutispora florida* Hoffmeister, Staplin, & Malloy, p. 384; pl. 38, figs 5, 6.

Description. Spores radial, trilete. Amb subcircular to broadly roundly subtriangular. Conspicuous exinal sculpture consisting dominantly of smooth, sinuous rugulae, with minor interspersed verrucae, on both distal and proximal surfaces; spaces between elements vary in size from less than 1μ to as much as 5μ. Rugulae infrequently branched, rounded in cross-section; variable in basal width (2-7μ) and height (up to 5μ). Laesurae simple, often partly obscured by sculptural elements; length about two-thirds of spore radius. Equatorial margin undulate to lobate, with 9-16 elements projecting. Exine between elements 2-2.5μ thick.

Dimensions (12 specimens). Equatorial diameter 44 (50) 55μ.

Previous records. Initially described from the Upper Mississippian Hardinsburg Formation of Kentucky (Hoffmeister et al., 1955), this species has been reported subsequently in rocks of the following ages and localities: Namurian of Britain (Butterworth & Williams, 1958; Smith & Butterworth, 1967); Viséan of Scotland (Love, 1960); Upper Mississippian or Lower Pennsylvanian of Oklahoma (Felix & Burbridge, 1967); and Namurian A of eastern Canada (Barss, 1967).

CONVOLUTISPORA FROMENSIS Balme & Hassell, 1962

(Pl. 6, figs 1, 2)

1962 *Convolutispora fromensis* Balme & Hassell, p. 8; pl. 1, figs 14-16.

Description. Spores radial, trilete; amb circular to subcircular. Laesurae often indistinct, simple, length averaging two-thirds of spore radius. Exine with comprehensive, dominantly rugulate sculpture. Rugulae irregularly and weakly branched, rounded in lateral view, smooth, rarely over 1μ apart; basal width of rugulae 1.5-4μ, height 1-2μ, length up to about 15μ. Minor discrete verrucae also present (up to 5μ in basal diameter, height similar to that of rugulae). In general, proximal sculpture slightly finer than distal. Exine thickness, between sculptural elements, 2μ. Equatorial margin undulate.

Dimensions (40 specimens). Equatorial diameter 36 (48) 57μ.

Comparison. Balme & Hassell (1962) distinguished the species from *C. florida* Hoffmeister, Staplin, & Malloy, 1955 (which they did not in fact record) on the seemingly slight ground that it has 'finer ornament.' Forms assignable to these two species have been recovered during the present study, and the fact that few morphographic intermediates were found enables me to uphold Balme & Hassell's speciation. It can also be added that the sculptural elements of *C. fromensis* are more uniformly and densely distributed than are those of *C. florida.*

Previous records. Balme & Hassell (1962) described this species from subsurface Upper Devonian sediments of the Canning Basin, Western Australia; and they noted (text-fig. 6) its extension into Lower Carboniferous rocks of the same state.

CONVOLUTISPORA HARLANDII Playford, 1962

(Pl. 8, figs 1-3)

1962 *Convolutispora harlandii* Playford, pp. 593-4; pl. 81, figs 6-9; text-figs 5h, j.

Dimensions (38 specimens). Equatorial diameter 68 (84) 111μ.

Remarks. Spitsbergen forms originally diagnosed (Playford, 1962) had a size range of 73 (106) 140μ. The Australian examples, like the originals, sometimes display a subequatorial murus that may simulate a cingulum.

Previous records. Playford (1962) described the species from the Spitsbergen Lower Carboniferous.

CONVOLUTISPORA JUGOSA Smith & Butterworth, 1967

(Pl. 8, figs 4, 5)

1958 *Convolutispora mellita* Hoffmeister, Staplin, & Malloy; Butterworth & Williams, pl. 2, fig. 26.

1958 *Convolutispora* cf. *mellita* Hoffmeister, Staplin, & Malloy; Butterworth & Williams, p. 372; pl. 2, figs 20, 21.

1967 *Convolutispora jugosa* Smith & Butterworth, pp. 186-7; pl. 10, figs 1-3.

Dimensions (20 specimens). Equatorial diameter 79 (91) 116μ.

Remarks and previous records. The Australian specimens fall into the fairly broad category established by Smith & Butterworth (1967), although some few are borderline cases between *C. jugosa* and *C. varicosa* Butterworth & Williams, 1958 (recorded below). Smith & Butterworth (1967) regarded the latter two as specifically distinct, but they conceded the presence in their (British Namurian) material of 'occasional' morphological intermediates.

CONVOLUTISPORA RIMULOSA sp. nov.

(Pl. 9, figs 10, 11)

Diagnosis. Spores radial, trilete. Amb circular, subcircular, or oval. Laesurae usually distinct, simple or accompanied by narrow lips; length one-third to one-half spore radius; sometimes unequal on same specimen. Predominantly rugulate sculpture on distal surface and proximal surface outside contact areas. Rugulae close-spaced, irregular, non-overlapping, smooth, freely terminating; irregularly but infrequently branching, rarely exceeding 20μ in length; subordinate verrucae also present. Sculptural elements 2-5.5μ broad basally, 1-2.5μ high; separated by fine channels 0.5-2μ wide, rare lumina up to 4μ wide. Exine of contact areas with comparatively minor sculpture — usually sparse verrucae and/or rugulae only. Equatorial margin undulating to notched; with 50-70 elements projecting. Exine thin (1.5-2μ, excluding sculpture); usually with one or more large-scale folds.

Dimensions (29 specimens). Equatorial diameter 93 (122) 150μ.

Holotype. Preparation B17A/8, 35.0 118.8, CPC10033; Plate 9, figure 10. Proximal aspect. Amb oval, diameter 136μ; laesurae extending about one-half of distance to equator; lipped half way from pole to termini (lips 4μ wide overall at pole, tapering equatorially); exine outside contact areas distinctly rugulate and with minor verrucae; contact areas with greatly reduced sculpture (sparse grana and verrucae); 54 projections from equator; non-sculptured exine 2μ thick, with one major fold.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, core 8, 2405 feet.

Comparison. The most closely comparable species described to date appears to be *Tuberculatisporites permagnus* Dybová & Jachowicz, 1957 (p. 113; pl. 25, figs 1-4) from the Upper Silesian Coal Measures (Upper Carboniferous). The Polish form differs, however, in having longer laesurae and apparently truly comprehensive sculpture.

CONVOLUTISPORA SUBTRIQUETRA sp. nov.
(Pl. 9, figs 2-4)

Diagnosis. Spores radial, trilete. Amb roundly subtriangular. Laesurae distinct, straight or sinuous, extending at least three-quarters of the distance to the equator; flanked by lips individually 3-5.5μ broad. Contact areas virtually smooth or supporting low scattered rugulae and verrucae. Remainder of exine (proximal-equatorial and distal) sculptured with somewhat irregular rugulae interspersed with minor verrucae. Rugulae closely spaced, smooth, rounded, not frequently branched, freely terminating, rarely delimiting lumina (up to about 4μ wide). Sculptural elements 2-6μ broad at base, 1-3.5μ high, 0.5-4μ apart. Exine 1.5-2μ thick where unsculptured; with occasional compression folds. Equatorial margin undulating to notched, supporting about 30-50 sculptural projections.

Dimensions (12 specimens). Equatorial diameter 62 (74) 90μ.

Holotype. Preparation P370B/2, 34.8 128.1, CPC10025; Plate 9, figure 2. Distal aspect. Amb subtriangular with convex sides and rounded apices; sinuous, lipped laesurae, length three-quarters spore radius; sinuous, occasionally forking rugulae densely distributed, with some verrucae, over distal and proximo-equatorial surfaces; rugulae up to about 25μ long, 2-3μ wide, 1-2.5μ high, not overlapping, 0.5-4μ apart; diminished sculpture on contact areas; exine between ridges 2μ thick; about 46 projections are equatorially based.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, core 14, 4349 feet.

Comparison. C. subtriquetra differs from other species previously assigned to the genus in having the following combination of features: reduced sculpture in contact areas, subtriangular amb, and lipped laesurae.

CONVOLUTISPORA VARICOSA Butterworth & Williams, 1958
(Pl. 9, fig. 9)

1958 *Convolutispora varicosa* Butterworth & Williams, pp. 372-3; pl. 2, figs 22, 23.

Dimensions (20 specimens). Equatorial diameter 69 (83) 100μ.

Previous records. This species has been reported previously from the British Namurian A (Butterworth & Williams, 1958; Smith & Butterworth, 1967); the Scottish Viséan (Love, 1960); and the Spanish Upper Carboniferous (Neves, 1964b). A form probably conformable with it was figured by Barss (1967, pl. 12, fig. 40) from Namurian A of eastern Canada.

CONVOLUTISPORA VERMIFORMIS Hughes & Playford, 1961
(Pl. 9, fig. 1)

1957 *Convolutispora flexuosa* forma *minor* Hacquebard, p. 312; pl. 2, fig. 10.
1961 *Convolutispora vermiformis* Hughes & Playford, p. 30; pl. 1, figs 2-4.

Dimensions (7 specimens). Equatorial diameter 63 (68) 75μ.

Previous records. The species was originally reported from Lower Mississippian strata of eastern Canada (Hacquebard, 1957; later Playford, 1964, and Barss, 1967). It occurs also in the Upper Devonian of Melville Island, Canadian Arctic (McGregor, 1960); Lower Carboniferous of Spitsbergen (Hughes & Playford, 1961; Playford, 1962); and Upper Mississippian or Lower Pennsylvanian of Oklahoma (Felix & Burbridge, 1967). The Spitsbergen Givetian example figured by Allen (1965, pl. 96, fig. 8) as *Convolutispora vermiformis* is probably of a different species.

CONVOLUTISPORA sp. A
(Pl. 9, fig. 6)

Description. Spores radial, trilete, with convexly subtriangular to subcircular amb. Laesurae simple, indistinct to perceptible; length at least two-thirds spore radius. Comprehensive sculpture of close-spaced, non-overlapping, sinuous rugulae, that are rounded in lateral aspect, 0.5-3.5μ broad, and 1-2.5μ high. Rugulae branch occasionally, often form wave- or chevron-like pattern on exine surface, continuous (unbranched) for as much as 20μ; separated by well defined channels usually less than 0.5μ wide, in places widening to form distinct, somewhat irregular lumina up to 5μ broad. Exine about 3μ thick, including sculpture; peripherally folded in some examples.

Dimensions (7 specimens). Equatorial diameter 70 (76) 84μ.

Comparison and remarks. This form appears closest to *Convolutispora ampla* Hoffmeister, Staplin, & Malloy, 1955 (see p. 23 above), but differs mainly in having a tendency towards a subtriangular amb, and in the nature and distribution of its sculptural elements. Insufficient examples have been recovered so far for a new species to be erected.

Genus FOVEOSPORITES Balme, 1957

Type species (by original designation). *Foveosporites canalis* Balme, 1957.

FOVEOSPORITES APPOSITUS sp. nov.
(Pl. 10, figs 1-8)

Diagnosis. Spores radial, trilete. Amb circular, subcircular, or convexly subtriangular. Laesurae distinct or indistinct, straight to slightly sinuous, simple; length about two-thirds to four-fifths of spore radius. Comprehensive vermiculate or vermiculate-foveolate sculpture of straight or sinuous, narrow, usually mostly unbranched vermiculi (channels) and, usually subordinately, small foveolae; exine incised by sculptural elements to depth of 0.5-2μ. Vermiculi up to 12μ long (usually about 1.5-3μ), and varying in width from less than 0.5μ to as much as 2μ. Foveolae circular to oval in surface view, up to 2μ in diameter. Sculptural elements about 1-7μ apart (average 2-3μ). Non-sculptured exine 1.5-3.5μ thick.

Dimensions (25 specimens). Equatorial diameter 37 (46) 56μ.

Holotype. Preparation B117B/14, 38.2 118.9, CPC10035; Plate 10, figures 1, 2. Proximal aspect. Amb circular, diameter 46μ; laesurae simple, length about two-thirds of spore radius; exine 2μ thick, comprehensively, finely sculptured with vermiculi and foveolae, mainly less than 0.5μ in width, averaging about 2μ apart and 1μ deep.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 5, 2836 feet.

Remarks. The density and precise nature of the negative sculptural elements are fairly variable (and continuously so) within this specific category, but are relatively uniform on both hemispheres of a given specimen. The predominant elements are usually vermiculi.

Comparison. *Foveosporites appositus* sp. nov. differs from the Australian Upper Carboniferous species *F. pellucidus* Playford & Helby, 1968 (p. 111; pl. 10, figs 2-6) in being smaller and sculptured proximally as well as distally; moreover the latter species is more typically foveolate. *F. insculptus* Playford var. *minor* Doubinger & Rauscher, 1966 (p. 388; pl. 7, figs 3-5) probably belongs to *F. appositus.*

Previous records. The species probably occurs in the Viséan of Bourbach-le-Haut, France (Doubinger & Rauscher, 1966).

Genus DICTYOTRILETES Naumova emend. R. Potonié & Kremp, 1954

Type species (by subsequent designation of Potonié & Kremp, 1955, pp. 106, 107). *Dictyotriletes bireticulatus* (Ibrahim) R. Potonié & Kremp, 1955.

DICTYOTRILETES sp. cf. D. DENSORETICULATUS R. Potonié & Kremp, 1955
(Pl. 10, figs 13, 14)

Cf. 1955 *Dictyotriletes densoreticulatus* R. Potonié & Kremp, p. 109; pl. 16, fig. 313.

Remarks. A relatively small number of comprehensively reticulate specimens has been found; these appear to be morphographically closer to *Dictyotriletes densoreticulatus* R. Potonié & Kremp, 1955, than to any other described species. They differ from Potonié & Kremp's form (as described particularly by Smith & Butterworth, 1967, p. 196; pl. 11, fig. 19) in that the muri are more variable in width (1-4μ) and height (1-2.5μ). A comparable number of murate projections (average 20) is visible equatorially and a similar size range (68-83μ, 6 specimens) was measured.

D. densoreticulatus has been described from European Upper Carboniferous sediments (Potonié & Kremp, 1955; Dybová & Jachowicz, 1957; Smith & Butterworth, 1967). The Russian Lower Carboniferous record by Kedo (1966, p. 61; pl. 2, fig. 53) cannot be upheld because it involves smaller specimens (55-60μ) with short laesurae and relatively fine sculpture (many more projections at equator).

Genus MICRORETICULATISPORITES Knox emend. R. Potonié & Kremp, 1954

Type species (by subsequent designation of Potonié & Kremp, 1954, p. 143). *Microreticulatisporites lacunosus* (Ibrahim) Knox, 1950.

MICRORETICULATISPORITES sp. A
(Pl. 10, fig. 9)

Description. Spores radial, trilete; amb circular to subcircular. Laesurae simple, straight, length about two-thirds spore radius. Exine comprehensively reticulate: lumina circular to roundly elongate, 1-5μ in longest diameter; muri smooth, with rounded tops, and breadth of 3-11μ. Exine of lumina 2.5-3.5μ thick; margin with ± regular undulations.

Dimensions (4 specimens). Equatorial diameter 96-110μ.

Comparison. Microreticulatisporites irregularis (Kosanke, 1950, p. 26; pl. 5, fig. 1) R. Potonié & Kremp, 1955, has a less regular reticulum (i.e. more variable lumina) and its apertural characteristics have not been reported.

Genus Reticulatisporites Ibrahim emend. R. Potonié & Kremp, 1954

Type species (by original designation). *Reticulatisporites reticulatus* (Ibrahim) Ibrahim, 1933.

Discussion. Objections to Neves' (1964a) diagnosis and suprageneric attribution of *Reticulatisporites* have already been raised (e.g. Potonié, 1966, p. 49; Playford & Helby, 1968, p. 110). Smith & Butterworth (1967, pl. 14, fig. 15) showed a laterally compressed example of the type species and considered it to be cingulate. However, although the exinal thickening concerned may be at least subequatorially placed, it shows no apparent difference from the murornate sculptural elements of the distal hemisphere.

Reticulatisporites bonapartensis sp. nov.
(Pl. 10, fig. 10; Pl. 11, figs 1-3)

Diagnosis. Spores radial, trilete. Amb circular, subcircular, or (rarely) convexly subtriangular. Laesurae perceptible, simple, often gaping, extending about two-thirds of distance to equator. Proximal hemisphere laevigate. Distal hemisphere coarsely reticulate: muri smooth or pitted (corrosion effect), 2-7μ broad, approximately 10-20μ high, enclosing polygonal to subcircular lumina 10-22μ in longest diameter. Equatorial margin undulating. Exine thickness, excluding muri, often difficult to gauge — usually about 5μ.

Dimensions (40 specimens). Equatorial diameter 86 (111) 146μ.

Holotype. Preparation P382A/2, 27.8 128.6, CPC10042; Plate 10, figure 10. Distal aspect. Amb subcircular, diameter 116μ overall; laesurae fairly distinct, simple, length about two-thirds spore radius; muri and lumina of distal reticulum scabrate to pitted (through corrosion); width of muri 2-4μ, height about 10-14μ; irregularly polygonal lumina 7-14μ broad; exine of lumina about 5μ in thickness.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 1 Well, core 9, 2549 feet.

Remarks. Most of the examples seen are strongly compressed proximo-distally, so that the muri about the equator have the appearance of constituting a wide, independent, flange-like, equatorial extension; this is the case particularly in specimens oriented with proximal faces upwards, in which the height of the distal muri is not so readily observable as being comparable to those of equatorial regions. The several lateral compressions and tetrads examined do, however, show that the equator is neither cingulate nor zonate but that it often serves as a base for the proximal, poleward limit of the reticulum.

The spore cavity is often emphasized by a dark peripheral zone due to overlapping of the compressed muri arising near the equator. A few examples show partial slight detachment of intexine from exoexine (separation of no more than 8μ) but most display no sign of exine differentiation. Exine of contact areas appears thinner than elsewhere and this, coupled with a lack of any stabilizing muri, makes them subject to compression-folding.

Comparison. A number of large, coarsely reticulate, Carboniferous species from the northern hemisphere is comparable with the Australian form. *Reticulatisporites muricatus* Kosanke, 1950 (p. 27, pl. 4, fig. 7; see also Smith & Butterworth, 1967, pp. 197-8, pl. 11, figs 25, 26), known from the Upper Carboniferous of Britain and the United States, has a lower size range, distinct laesurae, thinner, more twisted muri, and a partly reticulate proximal surface. From Viséan coal of the Northwest Territories, Canada, Hacquebard & Barss (1957, p. 18; pl. 2, fig. 17) described *R. speciosus,* which like *R. bonapartensis* sp. nov. has a coarse distal reticulum but differs in having well displayed, lipped laesurae as well as generally larger lumina. *R. fimbriatus* Knox, 1950 (p. 323; fig. 257), a Scottish, presumably Carboniferous form, could be very close to *R. bonapartensis,* but more morphological data and illustrations of it are needed before an accurate comparison can be made.

RETICULATISPORITES PAPILLATUS (Naumova) comb. nov., emend.
(Pl. 10, figs 11, 12)

1938 *Aptera papillata* Naumova, p. 27; pl. 3, fig. 2.
1962 *Reticulatisporites peltatus* Playford, pp. 599-600; pl. 84, figs 1-4.
1963 *Dictyotriletes papillatus* (Naumova) Byvscheva, p. 39; pl. 2, figs 3-5.

Emended diagnosis (Playford, 1962, p. 599). 'Spores radial, trilete; originally spherical; amb circular to subcircular. Laesurae simple, straight, length almost equal to body radius; often obscured by sculpture. Exinal sculpture coarsely reticulate with smooth, rounded muri (2-5.5μ wide and 2-3μ high) enclosing irregularly polygonal lumina 6-46μ in longest diameter (average 14μ). Numerous, conspicuous, peltate (mushroom-like) processes are developed on, and characteristically at junctions of, the muri; processes 6-15μ long (average 8μ), 4-6.5μ broad at base, (expanded) apices 5-13μ in diameter; profile clearly evident at equator. Exine (exclusive of sculpture) 3.5-4.5μ thick.'

Dimensions (11 specimens, present study). Equatorial diameter (excluding projections) 56 (70) 86μ.

Neotype. As designated by Byvscheva (1963, p. 39), from the Viséan of the Volga-Ural region, USSR.

Remarks. Illustrations and descriptions given by Naumova (1938) and Byvscheva (1963) leave no doubt that synonymy exists between spores originally designated as *Aptera papillata* Naum. and those of the species *Reticulatisporites peltatus* Playford, 1962. Although Naumova gave the Russian spores the rank of 'forma' (within her 'subgroup' *Aptera*), the binomial name was clearly compounded according to Linnean procedures, and is regarded as legitimately established for purposes of priority.

Previous records. Byvscheva (1963) reported the form in Viséan microfloras of the Volga-Ural region and Naumova's (1938) initial record of it was from the early Carboniferous of the Moscow Basin. Playford (1962), in describing the species, noted its restriction in Spitsbergen to the Aurita Assemblage of Viséan-? Namurian age. Karczewska (1967, table 2) listed the occurrence of *Reticulatisporites papillatus* (Naumova) comb. nov. (as *R. peltatus*) in subsurface Polish material which she dated as Viséan-Namurian A. In North America, the species has been recorded from probable Viséan of Arctic Canada (Playford & Barss, 1963; Sullivan, 1965; Barss, 1967); and from the late Mississippian (possibly to earliest Pennsylvanian) of Oklahoma and Nevada (Felix & Burbridge, 1967).

Genus ACINOSPORITES Richardson, 1965

Type species (by original designation). *Acinosporites acanthomammilatus* Richardson, 1965.

ACINOSPORITES SPIRITENSIS sp. nov.
(Pl. 11, figs 4-6)

Diagnosis. Spores radial, trilete, with circular or subcircular amb. Laesurae distinct or indistinct, simple, straight; length about two-thirds spore radius. Proximal exine, at least of contact areas, smooth or almost so. Remainder of exine (i.e. distal and equatorial regions) bearing composite sculpture consisting of coarse reticulum, the mural crests of which support very long, slender (often complexly bent) spinae. Muri sharp-crested, 7-20μ high; lumina subcircular to polygonal, longest diameter about 15-30μ. Spinae 14-63μ in length; tapering abruptly near base (diameter 3-12μ) then gradually to sharp point; spinae sometimes with slightly noded appearance in profile. Spinae typically borne individually at mural junctions, hence not densely distributed. Equatorial region 'pseudoflanged' on account of high muri. Exine 4-7μ thick without reticulum/spinae.

Dimensions (12 specimens). Equatorial diameter, excluding spinae, 85 (102) 120μ.

Holotype. Preparation B78/1, 31.0 113.4, CPC10050; Plate 11, figure 4. Distal aspect. Amb oval, diameter 118μ; laesurae not clearly visible; distal-equatorial regions with irregularly roughened muri (7-12μ high) forming a coarse-meshed reticulum; spinae, mainly at mural junctions, 22-63μ long, 4-7μ broad basally; tops of some spinae eroded; 13 spinae based equatorially; exine 6μ thick excluding sculpture.

Type locality. Northern Territory, Bonaparte Gulf Basin, Milligans Beds, Viséan; Oil Dev./Westralian Spirit Hill No. 1 Well, bagged core sample, 550-600 feet.

Remarks. In its current broadly defined form, the genus *Acinosporites* Richardson, 1965 (p. 577) can reasonably accommodate the species described above. Although the basic ornamentation of the genus is typically rugulate (*A. acanthomammilatus* Richardson, 1965), some of the spores assigned by Richardson to the genus (i.e. of or compared with *A. macrospinosus* Richardson, 1965) are partly reticulate.

Comparison. Richardson (1965) has described several species of the genus from the middle Old Red Sandstone of Scotland. Reticulate examples of one of these (*A. macrospinosus* Richardson, 1965, pp. 578-9; pl. 91, figs 3-6; also *A.* cf. *macrospinosus,* pl. 91, fig. 7) differ from *A. spiritensis* sp. nov. in having a finer meshed reticulum and elevated lips associated with the laesurae.

Subturma ZONOTRILETES Waltz, 1935

Infraturma AURICULATI Schopf emend. Dettmann, 1963

Genus MOOREISPORITES Neves, 1958

Type species (by original designation). *Mooreisporites fustis* Neves, 1958.

MOOREISPORITES sp. A
(Pl. 9, fig. 7)

Description. Spore radial, trilete. Amb subtriangular, sides concave, apices broadly rounded. Laesurae simple, straight, extending almost to auriculate region. Interradial equatorial exine 1.5-2μ thick. Exine at equatorial radial regions conspicuously modified with relatively large, close-spaced (basally fused in part) processes that are mainly based equatorially but encroach as much as 15μ on to distal surface. Processes variable in form (bacula, coni, blunt spinae, clavae); basal diameter 2-10μ, length 3-12μ. Remainder of exine scabrate — irregularly pitted, probably due to corrosion.

Dimensions. Equatorial diameter (excluding projections) 45μ (one specimen only).

Remarks and comparison. Although represented by only one specimen, this form is worth recording as the only member of the Auriculati so far found in the present study. Its morphology accords well with the diagnostic provisions for the genus (Neves, 1958, pp. 7-8), but not with any previously described species.

Infraturma TRICRASSATI Dettmann, 1963

Genus DIATOMOZONOTRILETES Naumova emend. Playford, 1963

Type species (by subsequent designation of Playford, 1963, p. 646). *Diatomozonotriletes saetosus* (Hacquebard & Barss) Hughes & Playford, 1961.

Discussion. Discrimination between this genus and *Tricidarisporites* Sullivan & Marshall, 1966, has already been discussed (p. 21).

DIATOMOZONOTRILETES sp. A
(Pl. 9, fig. 8)

Description. Spore radial, trilete. Amb subtriangular, sides almost straight. Laesurae distinct, simple, almost straight, extending almost to smooth amb apices; one laesura obscured by exinal fold. Corona consisting of fourteen close-spaced but discrete bacula/spinae projecting radially from each interradial margin of equator; coronal projections 1.5-9μ long, 1.5-4μ in basal diameter, largest at centres of amb sides, reduced to small coni near apices of amb. Exine smooth on proximal face; conate distally — coni scattered (1.5-6μ apart), broad-based (average 2μ), 1.5-3μ long. Exine, excluding projections, 1.5μ thick.

Dimensions. Equatorial diameter, excluding corona, 51μ (one specimen only).

Comparison and remarks. Diatomozonotriletes hughesii Playford, 1963 (p. 648; pl. 93, figs 8-11; text-fig. 11f) is smaller with coronal projections attaining a larger size and with spinose distal sculpture. The form is noteworthy in being the only tricrassate type found so far in the Bonaparte Gulf Basin material.

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

Genus KNOXISPORITES R. Potonié & Kremp emend. Neves, 1961

Type species (by original designation). *Knoxisporites hageni* R. Potonié & Kremp, 1954.

KNOXISPORITES HEDERATUS (Ishchenko) Playford, 1963
(Pl. 13, figs 1, 2)

1956 *Euryzonotriletes hederatus* Ishchenko, pp. 58-9; pl. 10, fig. 121.
1963 *Knoxisporites hederatus* (Ishchenko) Playford, pp. 634-5; pl. 90, figs 9-12; text-fig. 10a.

Dimensions (14 specimens). Overall equatorial diameter 74 (86) 106μ.

Remarks. Specimens referable to *Knoxisporites hederatus* (Ishchenko) Playford, 1963, are present but never common in the Bonaparte Gulf Basin material. They compare closely with the morphology of the Russian and Spitsbergen specimens, showing variably and asymmetrically disposed distal muri ranging in breadth from 4.5 to 15μ.

Previous records. This form has been reported widely from early Carboniferous sediments, of USSR (Ishchenko, 1956, 1958), Spitsbergen (Playford, 1963), Poland (Karczewska, 1967), and Canada (Barss, 1967); and also from late Mississippian or early Pennsylvanian of Oklahoma (Felix & Burbridge, 1967).

KNOXISPORITES LITERATUS (Waltz) Playford, 1963

1938 *Zonotriletes literatus* Waltz *in* Luber & Waltz, p. 18; pl. 2, fig. 21, and pl. A, fig. 11.
1956 *Euryzonotriletes literatus* (Waltz) Ishchenko, pp. 52-3; pl. 9, fig. 108.
1956 *Anulatisporites literatus* (Waltz) R. Potonié & Kremp, p. 111.
1957 *Cincturasporites literatus* (Waltz) Hacquebard & Barss, pp. 23-4; pl. 3, figs 2-5.
1962 *Labiadensites literatus* (Waltz; Hacquebard & Barss) Bhardwaj & Venkatachala, p. 38; pl. 8, figs 128-130.
1963 *Knoxisporites literatus* (Waltz) Playford, p. 634; pl. 90, figs 7, 8.
1963 *Archaeozonotriletes literatus* (Waltz) Kedo, pp. 75-6; pl. 8, figs 188-190.
1966 *Knoxisporites literatus* (Waltz) Luber *in* Pokrovskaya, vol. 1, pp. 183-4; vol. 3, pl. 41, fig. 2, and pl. 45, fig. 10.

Remarks. A few specimens were observed in the Bonaparte Gulf Basin material, but none was well enough preserved for adequate illustration.

Previous records. As the above synonymy list shows, this species has been reported widely from USSR, whence Luber (*in* Pokrovskaya, 1966) summarizes its distribution as Tournaisian-Viséan. Other northern hemisphere records are also from within that interval (e.g. Canada—Hacquebard & Barss, 1957, Playford & Barss, 1963, Sullivan, 1965, Barss, 1967; Poland—Zakowa & Jachowicz, 1963, Karczewska, 1967; Spitsbergen — Bhardwaj & Venkatachala, 1962, Playford, 1963; England — Sullivan, 1964a). Balme & Hassell (1962) have described forms comparable to *Knoxisporites literatus* from the Upper Devonian of the Canning Basin, Western Australia, and their text-figure 6 indicates vertical extension of the species into the Carboniferous of the same state.

KNOXISPORITES sp. cf. K. RUHLANDI Doubinger & Rauscher, 1966
(Pl. 12, figs 1-11)

1964 cf. *Cincturasporites* n. sp. of Balme, p. 61; pl. 2, fig. 7 [no description].
Cf. 1966 *Knoxisporites ruhlandi* Doubinger & Rauscher, pp. 384, 386; pl. 6, figs 4-7; pl. 7, figs 1, 2; text-fig. 3.

Description. Spores radial, trilete. Amb subtriangular with rounded apices and slightly convex, straight, or (very rarely) slightly concave sides. Laesurae distinct to perceptible, straight, extending about two-thirds to four-fifths of distance to equatorial margin; simple or (rarely) flanked by narrow lips, individually up to 2.5μ wide. Cingulum 3-15μ wide; width fairly uniform on same specimen. Distal surface bearing well defined, usually continuous ridge that is circular or subcircular in polar view and encloses a (distal) polar area, 10-28μ in diameter. Centre of latter area (i.e. distal pole) itself usually marked by a subcircular, thickened, boss-like structure, 7-15μ in maximum diameter. In a few cases the circumpolar ridge has up to four radially directed off-shoots which may extend to the cingulum; such ridge-extensions show no constant symmetrical arrangement. Thickened and unthickened exine laevigate.

Dimensions (55 specimens). Overall equatorial diameter 31 (51) 74μ.

Remarks and comparison. The considerable morphographical variation among specimens included in the above category will be evident from the description and supporting plate illustrations. Felix & Burbridge (1967, p. 395; pl. 60, figs 10-14) documented a comparable variation among Carboniferous spores from Oklahoma which they allocated to *Knoxisporites stephanephorus* Love, 1960. Doubinger & Rauscher (1966) distinguished their *K. ruhlandi* from Love's species principally on the ground of the former's consistently triangular (or subtriangular) amb. None of the specimens incorporated in the foregoing description is circular or oval in polar view; however, positive assignment to *K. ruhlandi* must be withheld since the laesurate lips and distal radial thickenings, which appear to be diagnostic of the latter, were only observed in a few of the Australian examples.

Previous records. Balme's record (1964, see above synonymy) of this form is from the Western Australian Lower Carboniferous. The closely comparable specimens of Doubinger & Rauscher (1966) were described from marine Viséan strata of the southern Vosges, France.

Genus EXALLOSPORA nov.

Type species (here chosen). *Exallospora coronata* sp. nov.

Diagnosis. Microspores radial, trilete; acavate, cingulate, and with a ring-like distal circumpolar projection. Amb subtriangular to circular. Laesurae extending at least half distance to equatorial margin. Cingulum of more or less uniform thickness throughout its width, which is itself fairly constant on individual

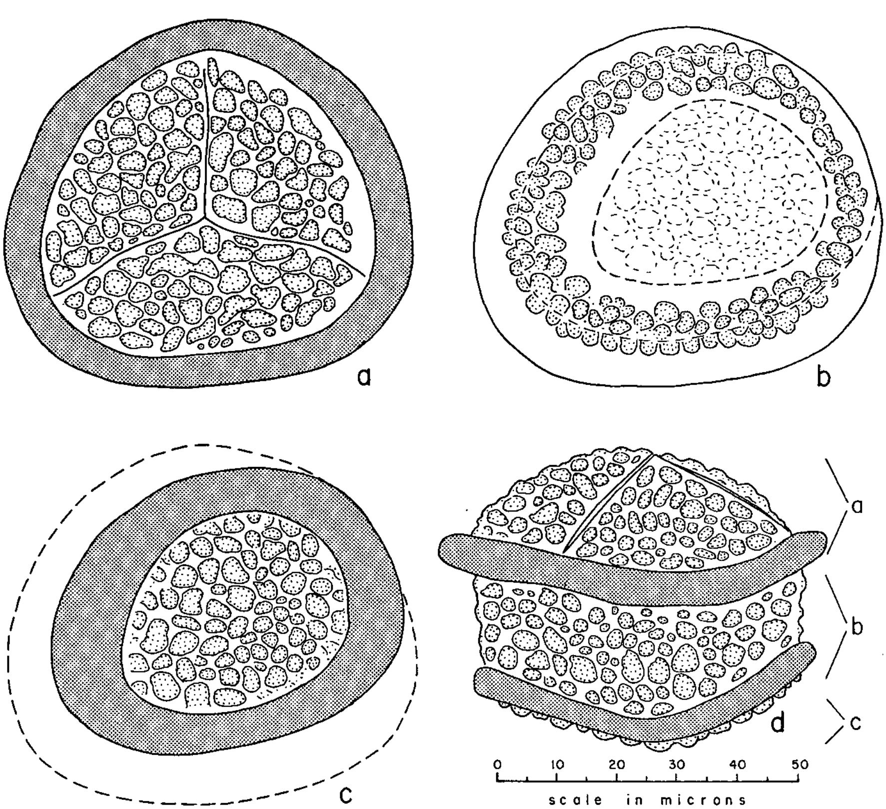

Figure 4: Drawings from photographs of *Exallospora coronata* gen. et sp. nov. a,b,c, holotype (distal aspect)—proximal surface, distal surface (low focus), distal surface (high focus), respectively. d, lateral view; AOD Bonaparte No. 1, 2164 ft; preparation B16B/3, 39.2 119.5, CPC 10066.

specimens. Cingulum and distal ring-projection laevigate. Remainder of exine with wart-like (predominantly verrucate) sculptural elevations.

Comparison. The most closely similar form described to date appears to be *Nexuosisporites* Felix & Burbridge, 1967 (pp. 395-6), which comes from the Springer Formation (Mississippian or earliest Pennsylvanian) of Oklahoma. It differs from *Exallospora* gen. nov., however, in having 'tightly packed convolutions' confined to the distal central area. Distal surfaces of spores assigned to *Knoxisporites* R. Potonié & Kremp emend. Neves, 1961 (pp. 264-6) have 'radial and/or concentric bands of thickening,' but there is no additional sculpture like convoluted muri (as in *Nexuosisporites*) or verrucate elements (as in *Exallospora*).

EXALLOSPORA CORONATA sp. nov.
(Pl. 12, figs 12-17; text-figs 4a-d)

Diagnosis. Spores radial, trilete. Amb subtriangular (with rounded apices and convex to slightly concave sides) to subcircular. Plano-convex or biconvex; distal surface steeply arched. Laesurae perceptible to distinct, straight or almost so, simple; extending about three-quarters to four-fifths of distance to equator (to about inner margin of cingulum). Cingulum laevigate; of more or less uniform width on same specimen. Distal central area (i.e. portion bounded by cingulum) bearing smooth elevated circular or subcircular ridge which in compressed state forms a continuous sometimes irregular band 5-18μ wide, enclosing distal polar area about 40-50μ in diameter. Apart from cingulum and distal ridge, exine of both surfaces 3-4μ thick, densely verrucate and in places rugulate; elements closely spaced (<0.5-3μ apart, often delimited by fine negative reticulum), with rounded-elongate bases (1.5-14μ in maximum dimension), and height of 1.5-2.5μ. Equatorial margin smooth to gently undulating.

Dimensions (22 specimens). Overall equatorial diameter 58 (70) 88μ; cingulum width 5 (8) 12μ.

Holotype. Preparation B181/1, 42.9 126.3, CPC10062; Plate 12, figures 12-14. Distal aspect. Subtriangular amb, 68μ in diameter; cingulum averages 6μ in width; laesurae about four-fifths spore radius; subcircular elevated (about 12μ high) distal band enclosing polar area 42μ in diameter, slightly oblique compression causing slight apparent overlap with cingulum; close-spaced (not exceeding 3μ apart) smooth irregular verrucae and subordinate rugulae borne on proximal and distal central areas with negative reticulum between; elements 2-11μ in longest basal diameter, 2.5μ or less in height; equatorial margin gently undulating.

Type locality. Western Australia, Bonaparte Gulf Basin, ?Tanmurra Formation, ?Viséan; AOD Bonaparte No. 2 Well, cuttings, 650-660 feet.

Remarks. Some specimens show a fairly regular sculptural variation; in these, relatively coarse verrucae-rugulae occur about the poles, and towards the equator there is a progressive sculptural diminution with elements approaching grana borne near inner margin of cingulum. Slightly oblique compressions are encountered frequently, presumably as a result of the strong convexity of the distal surface, and are manifest in apparently asymmetrical disposition of the distal ring-projection.

Suprasubturma LAMINATITRILETES Smith & Butterworth, 1967

Subturma ZONOLAMINATITRILETES Smith & Butterworth, 1967

Infraturma CRASSITI Bhardwaj & Venkatachala emend. Smith & Butterworth, 1967

Genus CRASSISPORA Bhardwaj emend. Sullivan, 1964

Type species (by original designation). *Crassispora ovalis* Bhardwaj, 1956. According to Smith & Butterworth (1967, p. 237), *C. ovalis* is a junior synonym of *C. kosankei* (R. Potonié & Kremp) Bhardwaj, 1957.

CRASSISPORA INVICTA sp. nov.
(Pl. 13, fig. 6; Pl. 14, figs 9, 10)

Diagnosis. Spores radial, trilete. Amb convexly subtriangular to subcircular. Laesurae usually indistinct; simple or obscured by sinuous elevated lips (2-8μ in overall width); extending at least three-quarters of distance to equator. Exine crassitudinous equatorially. Crassitude never sharply defined, being result of fairly gradual increase in exine thickness from poles (4-10μ) to equator (7-17μ). Exine with distinct, dense intrapunctation; liable to corrosion; ornamented with stout resistant spinae on distal and relatively narrow proximo-equatorial region. Spinae sharp-pointed, tapering regularly from broad bases; length 5-18μ, basal diameter 2-5μ, spaced 2-22μ apart. Contact faces laevigate, sometimes partly curvaturate.

Dimensions (40 specimens). Equatorial diameter 88 (124) 188μ (excluding projections).

Holotype. Preparation B54/16, 39.6 123.5, CPC10080; Plate 14, figure 10. Distal aspect. Amb subcircular; diameter 121μ; indistinct laesurae extend *ca.* three-quarters of distance to equator; contact areas smooth, partly curvaturate borders; distal face and narrow proximo-equatorial region bearing discrete, coarse, sharp-pointed, often bent spinae ranging in length from 6 to 10μ, in basal diameter from 2 to 3.5μ, in spacing from 2 to 18μ; exine finely, densely intrapunctate between spinae; one contact area showing corrosive effects in places; crassitude not clearly defined.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Remarks. Some specimens show slight separation of exoexine and intexine, but in most the layers appear to be adpressed. Tetrad associations (e.g. Pl. 13, fig. 6) are common. In specimens with an apparently biform apiculate sculpture, the finer grade elements (much finer than the large spinose projections) derive from surficial corrosion of the structured exine.

Comparison. Spinozonotriletes conspicuus Playford, 1964 (pp. 22-3; pl. 5, figs 3, 4) has a definitely cavate exine, a relatively narrow size range (76-110μ) and generally considerably larger spinae which in places coalesce basally. On these grounds, this species (from the early Carboniferous of eastern Canada) is distinct from *Crassispora invicta* sp. nov.

CRASSISPORA SCRUPULOSA sp. nov.
(Pl. 13, figs 3-5)

Diagnosis. Spores radial, trilete; biconvex, the distal surface strongly arched. Amb subtriangular with convex to almost straight sides and rounded apices. Laesurae accompanied by elevated lips (2-4μ in height and in overall width); length about three-quarters of spore radius. Exine crassitudinous equatorially, where it reaches thickness of about 8-12μ; crassitude not clearly defined; polar exine about 3μ thick. Proximal surface laevigate or with comparatively minor sculpture. Distal surface and equator with biform sculpture consisting of broad, low, rounded elevations (verrucae), each supporting one, two, or several minute coni or spinae. Verrucae 2-10μ broad, 1-3μ high, basal outlines polygonal; usually densely distributed with fine negative reticulum developed (channel width about 0.5μ). Length of coni-spinae ranges from about 0.5μ to 3μ; basal diameter about 0.5-1.5μ.

Dimensions (28 specimens). Equatorial diameter 84 (100) 112μ.

Holotype. Preparation B117B/1, 42.5 111.2, CPC10069; Plate 13, figure 3. Distal aspect. Amb subtriangular with rounded apices and convex to almost straight sides; diameter 87μ; conspicuously lipped laesurae extend about three-quarters of distance to equator, two terminating at curvaturae imperfectae; distal and equatorial verrucae up to 3μ high, very closely spaced, defined by fine negative reticulum with channels about 0.5μ wide (rarely as much as 2μ); bases of verrucae polygonal in surface view, 2-9μ in maximum diameter; verrucae form bases for fine conate/spinose elements (up to 1.5μ in basal diameter, 2μ high); proximal surface features difficult to discern in detail, sculpture absent or at least greatly reduced.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 5, 2836 feet 4 inches.

Remarks. Intexine is often vaguely recognizable as crumpled body filling most of spore cavity. Supra-verrucate spines-cones seem to be readily eroded, as ill preserved examples appear to be normally verrucate. One or two imperfect curvaturae partly delineate contact faces in some examples (e.g. holotype), but are not to be regarded as essential to the species definition. The nature of the sculpture makes this form distinct from previously described species assignable to *Crassispora.*

Infraturma CINGULICAVATI Smith & Butterworth, 1967

Genus DENSOSPORITES Berry emend. Butterworth, Jansonius, Smith, & Staplin, 1964

Type species (by original designation). *Densosporites covensis* Berry, 1937.

DENSOSPORITES sp. cf. D. ACULEATUS Playford, 1963
(Pl. 14, figs 3-8)

Cf. 1963 *Densosporites aculeatus* Playford, p. 631; pl. 88, figs 16, 17; text-fig. 10e.

Description. Spores radial, trilete. Amb subtriangular with rounded apices and convex to almost straight sides. Laesurae straight or slightly sinuous; accompanied and frequently masked by narrow, smooth, elevated lips, 1-2.5μ in overall breadth; extending to inner margin of cingulum with which lips frequently merge with slight divergence. Exoexine distinctly, uniformly cingulate (cingulum about 5-8μ wide); distal surface (central area and cingulum) with conate to spinose sculpture. Coni/spinae discrete, evident at equator; bases circular-subcircular, often somewhat mammoid, 0.5-5μ in diameter, up to 10μ apart; length 0.5-8μ. Apart from apiculate elements, exoexine (including whole of proximal surface) smooth to scabrate (corroded specimens). Intexine smooth, up to 1.5μ thick, showing partial detachment from exoexine to extent of 1-4μ (distinct intexinal body not delimited).

Dimensions (25 specimens). Overall equatorial diameter (excluding sculptural projections) 43 (52) 63μ.

Remarks and comparison. The description records considerable diversity in size of the apiculate elements; such variation is between specimens (constituting an apparently continuous gradation) rather than on a given example of the form. Distribution of the elements is also variable even on a particular specimen, where relative crowding may occur in disto-equatorial regions.

The spores are obviously very close to those described by Playford (1963) as *Densosporites aculeatus*. Assignment to the latter category could not, however, be made with absolute conviction, because the original and subsequently examined topotypic (Spitsbergen) examples of *D. aculeatus* lack a distinct trilete mark, have a different (and generally lower) dimensional range, and show less conspicuous exine-differentiation than do the Australian spores. Nonetheless, the distinct possibility remains that disparities between the similar spores of the two areas could at least partly be a matter of differences in preservation. Indeed, Felix & Burbridge (1967, p. 389; pl. 59, fig. 6) assigned to *D. aculeatus* spores which when well preserved show comparable lip development to many of those reported here; moreover in the present study several rather poorly preserved examples (e.g. Pl. 14, fig. 5) have only very inconspicuous lips represented. However, it must be pointed out that the original *D. aculeatus* material shows little or no sign of corrosive or other ill effects, and hence one would expect the laesurate features to be faithfully represented in it.

Previous records. The similar spores described by Playford (1963) and Felix & Burbridge (1967) are from, respectively, Viséan of Spitsbergen and Upper Mississippian (-?lowermost Pennsylvanian) of Oklahoma.

Genus CRISTATISPORITES R. Potonié & Kremp emend. Butterworth et al., 1964

1954 *Cristatisporites* R. Potonié & Kremp, p. 142.

1964 *Cristatisporites* R. Potonié & Kremp emend. Butterworth et al. *in* Staplin & Jansonius, p. 108.

1965 *Samarisporites* Richardson, pp. 581-2.

Type species (by original designation). *Cristatisporites indignabundus* (Loose) R. Potonié & Kremp, 1954.

Discussion. In 1960 Richardson described three species of *Cristatisporites* from the middle Old Red Sandstone of Scotland. In 1965 he regarded them as belonging to a distinct generic category, *Samarisporites* Richardson, 1965, on the understanding that the sculpture of *Cristatisporites* is truly comprehensive. However, on account of the reinterpretation and consequent rediagnosis of *Cristatisporites* (see Staplin & Jansonius, 1964, p. 108), it is difficult to justify the maintenance of *Samarisporites*.

CRISTATISPORITES COLLICULUS sp. nov.
(Pl. 14, figs 1, 2; Pl. 15, figs 1-6)

Diagnosis. Spores radial, trilete; biconvex, the distal surface strongly arched. Amb roundly subtriangular, rarely subcircular. Lipped laesurae extend at least to inner margin of cingulum; lips usually sinuous, 1.5-4μ in overall breadth. Cingulum inner margin clearly or ill defined; width of cingulum (polar view) about one-third of spore radius, more or less constant on same specimen. Intexine and exoexine often recognizable as distinct layers, only slightly separated from each other. Distal sculpture consisting of cristae and coni (relative proportions variable from one specimen to another) of somewhat irregular distribution. Cristate ridges sinuous, usually relatively short, irregularly branching, infrequently anastomosing, rarely forming complete reticulum (lumina highly irregular, up to 12μ in longest diameter). Crests of ridges pointed (conate appearance in transverse lateral aspect), somewhat variable in height (undulant appearance in longitudinal lateral aspect), sometimes with fine accessory conate/saetose projections. Coni discrete or more usually connected by low ridges. Distal sculptural elements about 1.5-4.5μ broad and high. Proximal exine smooth-scabrate, occasionally marginally cristate where elements encroach proximally on to cingulum. Equatorial margin dentate.

Dimensions (28 specimens). Overall equatorial diameter 63 (75) 88μ.

Holotype. Preparation B70/5, 43.8 118.4, CPC10081; Plate 15, figures 1-3. Proximal aspect. Amb roundly subtriangular, diameter 79μ overall; cingulum averages 12μ in width; sinuous elevated lips of laesurae 2-3μ high and wide overall, merging into cingulum; proximal surface essentially unsculptured; distal surface with irregularly distributed sharp-pointed cristate/conate sculptural elements 0.5-6μ apart, 2-3μ high and broad, no reticulum delimited; intexine uniformly contracted from exoexine to comprise clearly defined, thin-walled, inner body (triangular in polar view, diameter 45μ).

Type locality. Northern Territory, Bonaparte Gulf Basin, Milligans Beds, Viséan; Oil Dev./Westralian Spirit Hill No. 1 Well, bagged core sample, 100-150 feet.

Remarks. The distal sculpture is sometimes more strongly developed in the equatorial region (i.e. on cingulum) than elsewhere. Badly corroded specimens (omitted from consideration for diagnosis) usually show sculpturally only a few low sinuous ridges.

Comparison. A species from the Canadian Mississippian, *Dictyotriletes submarginatus* Playford, 1964 (pp. 29-30; pl. 8, figs 9-13) is reminiscent of *Cristatisporites colliculus* sp. nov. but is apparently not two-layered and has a lower size range and rugulate-reticulate sculpture. *Samarisporites hesperus* Allen, 1965 (pp. 715-6; pl. 98, figs 12-16), from the Devonian of Spitsbergen, has evenly developed distal sculpture and its exine is one-layered.

Previous records. 'Zonales n. gen. and n. sp.,' figured by Balme (1964, pl. 2, fig. 13) from the Western Australian Lower Carboniferous, is probably a corroded example of this species.

Genus CIRRATRIRADITES Wilson & Coe, 1940

Type species (by subsequent designation of Schopf, Wilson, & Bentall, 1944, p. 43). *Cirratriradites maculatus* Wilson & Coe, 1940.

CIRRATRIRADITES VEEVERSI sp. nov.
(Pl. 16, figs 1, 2)

Diagnosis. Spores radial, trilete. Amb subtriangular with convex sides and rounded to slightly pointed apices. Laesurae distinct, straight; accompanied by conspicuous elevated lips, individually about 2.5-6μ wide, extending to inner margin of zona or just beyond. Zona with undulate outer margin in well preserved specimens (ragged in corroded examples) and close-spaced radial ribs. Non-zonate exoexine (i.e. of 'body') finely, densely, somewhat irregularly pitted-channelled to scabrate; relatively thick distally, non-foveolate. Intexine thin (about 1μ), smooth, and non-structured; usually recognizable and detached slightly, in part, from exoexine (maximum separation 2-4μ).

Dimensions (17 specimens). Overall equatorial diameter 70 (93) 110μ; width of zona 5 (9) 14μ.

Holotype. Preparation B117B/3, 46.3 129.2, CPC10090; Plate 16, figure 2. Proximal aspect. Amb subtriangular, diameter 99μ; laesurate lips about 6μ wide overall; exoexine, surrounded by zona, irregularly vermiculate-pitted; zona 12μ wide, radial ribs about 1μ wide; intexine not clearly defined, only slightly detached in part (cavity up to 3μ wide developed).

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 5, 2836 feet 4 inches.

Remarks. In polar view the zona in some specimens appears to have a distinctly thick inner part ('cingulizonate'), but this is in reality an optical section of the thick distal exoexine [cf. *Cirratriradites elegans* (Waltz) R. Potonié & Kremp, 1956 (in Hughes, Dettmann, & Playford, 1962, p. 251; pl. 38, figs 5-7)].

Comparison. The most closely comparable species appears to be *Hymenozonotriletes radialis* Juschko & Byvscheva (*in* Byvscheva, 1963, p. 49; pl. 17, figs 1-6) from the Viséan of the Volga-Ural region. However, the Russian form is clearly distinct from *C. veeversi* sp. nov. in possessing a broader zona and longer laesurae. *C. elegans*, as described by Playford (1963, pp. 644-5; pl. 92, figs 6, 7) from the Spitsbergen Viséan, also has a generally wider zona which lacks regular radial plications.

Genus CAMPTOZONOTRILETES Staplin, 1960

Type species (by original designation). *Camptozonotriletes vermiculatus* Staplin, 1960.

CAMPTOZONOTRILETES ROBERTSI sp. nov.
(Pl. 15, figs 7-10)

Diagnosis. Spores radial, trilete. Amb roundly subtriangular to subcircular. Laesurae usually distinct, straight or slightly sinuous, length three-fifths to three-quarters of spore radius; simple or accompanied by narrow lips (1-1.5μ in overall width). Equatorial flange 6-14μ broad, thickness and width (polar view) fairly uniform on same specimen; laevigate, apart from occasional marginal encroachment of distal sculptural elements. Distal exine encompassed by flange bearing conspicuous rugulate, and often subordinately verrucate, sculpture of open, non-reticulate pattern; elements smooth, rounded, non-overlapping, sinuous, branching and freely terminating, 3-10μ wide, 1-15μ apart, 2-6μ high. Proximal exine virtually laevigate or with much reduced sculpture (very low, broad, ill defined elevations). Equatorial margin entire to gently undulating.

Dimensions (14 specimens). Overall equatorial diameter 60 (75) 91μ.

Holotype. Preparation B54/63, 30.6 111.5, CPC10084; Plate 15, figure 7. Proximal aspect. Amb broadly roundly subtriangular, diameter 75μ; laesurae with narrow sinuous lips extending to margin of central area, which is finely, irregularly pitted (slight corrosion effect); distal surface with strong, loosely, irregularly distributed rugulae, 3-8μ broad, 1-6μ apart, branching and terminating freely; one or two verrucae present; flange 13μ wide.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Comparison. The (Canadian Mississippian) type species, *Camptozonotriletes vermiculatus* Staplin, 1960 (p. 21; pl. 4, fig. 25), is distinct from *C. robertsi* sp. nov. in having proximal as well as distal rugulate sculpture and a flange that thins equatorially. *Camptozonotriletes velatus* (Waltz) Playford, 1963 (p. 645; pl. 93, figs 1-3), which was described from the Lower Carboniferous of USSR and Spitsbergen, is very similar to the Australian species, but differs in that its laesurate lips, where present, are much more distinct and terminally divergent; its flange is lighter in colour than the central area; verrucae are absent; its rugulae are less conspicuous, often divided longitudinally into two equal halves, and sometimes form a coarse reticulum. Perhaps the most obvious distinction between *C. velatus* and *C. robertsi* is that the distal ridges of the latter are more sinuous and variable in width (on a given specimen) and terminate more freely on the central area.

Infraturma PATINATI Butterworth & Williams emend. Smith & Butterworth, 1967

Genus ARCHAEOZONOTRILETES Naumova emend. Allen, 1965

Type species (by subsequent designation of Potonié, 1958, p. 28). *Archaeozonotriletes variabilis* Naumova, 1953.

Discussion. As originally described, *Archaeozonotriletes* Naumova, 1953 (p. 30) could scarcely be considered useful as it encompassed such a sculpturally and structurally diverse group of trilete spores. In typifying the genus with *A. variabilis* Naumova, 1953, Potonié (1958, p. 28) presented an emended generic diagnosis based on an interpretation of Naumova's brief description and several line drawings of the species. Essentially, Potonié restricted the genus to smooth trilete spores with a cingulum which in polar aspect showed variation in width. Allen (1965, p. 721) treated *Archaeozonotriletes* as a patinate (not cingulate) genus with a one- or two-layered, laevigate or punctate exine; his rediagnosis was based upon detailed studies of *A. variabilis* (from the Givetian of Spitsbergen) and must therefore be regarded as more securely founded than Potonié's. Allen recognized overlap between *Archaeozonotriletes* and *Tholisporites* Butterworth & Williams, 1958 (p. 381), but suggested that the two genera could be maintained separately, *Tholisporites* having a patina that is thickest equatorially and an abrupt demarcation of the patina from the rest of the (proximal) exine. Clearly, also, *Retusotriletes* Naumova, 1953 (p. 29) must be regarded as a related genus, though Allen did not allude to it. *Retusotriletes* is in fact rather a loose category, which despite several revisionary efforts (e.g. Richardson, 1965, pp. 563-4; Streel, 1967, p. B23-7) has not proved satisfactory in its application. The main difficulty is that it is founded upon a criterion — development of curvaturae — which should hardly be regarded as a primary diagnostic character in taxonomic discrimination taking precedence over, for instance, exine structures. Moreover, representatives of some species show considerable variation in demarcation of contact areas; for example, some representatives of the species described below possess perfect curvaturae, others have imperfect curvaturae, and still others have virtually none.

Regarding suprageneric classification, Allen (1965) logically allocated *Archaeozonotriletes* to the Infraturma Patinati Butterworth & Williams, 1958. The latter has, however, since been emended by Smith & Butterworth (1967, p. 263) to embrace trilete patinate spores of their Subturma Zonolaminatitriletes (two-layered, cavate, with only minor separation of exinal layers). This is followed here, but with the reservation that the exine stratification of *Archaeozonotriletes* at least is variable (Allen specifies it to be one- or two-layered and acavate, although this could imply a partly cavate condition in the broader usage of Smith & Butterworth, 1967, p. 114). Similar dilemmas arise when considering suprageneric allocation, in the Smith & Butterworth scheme, of some of the contents of certain other genera. For example, neither *Densosporites gracilis* Smith & Butterworth, 1967, nor *Lycospora noctuina* Butterworth & Williams, 1958, has been demonstrated to be, or described as, cavate species, yet they belong to genera assigned to the Zonolaminatitriletes.

ARCHAEOZONOTRILETES INTRASTRIATUS sp. nov.

(Pl. 15, figs 11, 12; Pl. 16, figs 5-7)

Diagnosis. Spores radial, trilete, acavate, probably one-layered. Amb circular to roundly subtriangular. Laesurae usually obscured by sinuous elevated (1-2μ high) lips, that are 2-6μ broad overall (usually broadest at radial termini) and extend at least two-thirds of the distance to equator. Distal and equatorial exine relatively thick (5-9μ); laevigate; finely, densely intrapunctate-granulate. Proximal exine of contact areas relatively thin; laevigate, but distinctly intrarugulate with elements usually displaying distinct radial alignment (as radial intrastriae). Contact areas depressed, well or poorly defined (i.e. curvaturae perfectae or imperfectae may or may not be evident). Periphery entire in non-corroded specimens.

Dimensions (20 specimens). Equatorial diameter 73 (93) 126μ.

Holotype. Preparation B54/48, 31.2 117.0, CPC10093; Plate 16, figure 6. Distal aspect. Amb subcircular-subtriangular, diameter 91μ; laesurae obscured by somewhat sinuous lips about 2μ broad at pole, broadening to 4μ at radial termini (three-quarters of distance to equator); contact areas poorly defined (very imperfect curvaturae), relatively thin; contact areas intrarugulate (about pole) to radially intrastriate (outer margins); remainder of exine intrapunctate, 6.5-9μ, thick with smooth equatorial margin.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Comparison. Allen's (1965, p. 724; pl. 100, figs 13, 14) *Archaeozonotriletes meandricus* from the Spitsbergen Devonian differs from the Australian form in that its proximal exine lacks intrastriate-rugulate structure and is distinctly curvaturate. *Hymenozonotriletes actinomorphus,* described by Byvscheva (1963, pp. 47-8; pl. 15, figs 1-3) from the Viséan of Tatar ASSR, appears similar to *A. intrastriatus* but lacks a differentially thickened exine and the exine (?intra) striae are much more distinct.

Suprasubturma PSEUDOSACCITRILETES Richardson, 1965

Infraturma MONOPSEUDOSACCITI Smith & Butterworth, 1967

Genus GRANDISPORA Hoffmeister, Staplin, & Malloy emend. Neves & Owens, 1966

1955 *Grandispora* Hoffmeister, Staplin, & Malloy, p. 388.
1957 *Spinozonotriletes* Hacquebard, p. 315.
1960 *Cosmosporites* (pars.) Richardson, p. 52.
1962 *Calyptosporites* (pars.) Richardson, p. 192 [nom. nov. pro *Cosmosporites* Richardson].

Restated diagnosis. Spores radial, trilete, cavate. Outline (polar view) of intexine and exoexine mostly conformable in same specimen; but varying between specimens from circular to convexly subtriangular. Laesurae simple or lipped, frequently reaching intexine margin; lips commonly extend to or almost to equator, and are usually irregularly folded in compressed examples. Exine distinctly two-layered, the intexine and exoexine being separated by a cavity except in region of tetrad mark, where they were probably in close contact; degree of separation (i.e. size of cavity) variable. Relative thicknesses of intexine and exoexine also variable; often the two layers are subequal in thickness. Intexine virtually smooth. Exoexine bearing prominent distal sculpture of simple (non-bifurcating) spinose and/or conate elements; sculpture reduced or absent proximally.

Discussion. During an attempt to find a suitable generic repository for the two species described below, comparisons were inevitably drawn among *Grandispora* Hoffmeister, Staplin, & Malloy, 1955, *Spinozonotriletes* Hacquebard, 1957, and *Calyptosporites* Richardson, 1962. The conclusion ultimately reached is that no meaningful separation of the three can consistently be maintained; and accordingly the two species concerned are assigned to *Grandispora,* the senior synonym. Neves & Owens (1966) presented an emended diagnosis of *Grandispora* which is accepted here in the above slightly modified form. Although Neves & Owens still recognized *Spinozonotriletes* and *Calyptosporites* as distinct from one another and from *Grandispora,* the reasons they advance for doing so are unconvincing. According to them (p. 348), *Spinozonotriletes* and *Grandispora* show differences in associations and relative thicknesses of intexine and exoexine; but microtome sections of spores assigned to both these genera and to *Calyptosporites* (see Dettmann & Playford, 1963; Allen, 1965) fail to confirm differences that can be used for such generic discrimination. Further, the supposed differences cited by Neves & Owens in compressional folding cannot be regarded as providing a way to distinguish *Spinozonotriletes* from *Grandispora.* Thus I concur with Potonié's (1960, p. 42) intimation that if *Spinozonotriletes* contains a 'central body' (i.e. is pseudosaccate, as is now confirmed) it must be regarded as congeneric with *Grandispora.*

Richardson's (1960) diagnosis of *Cosmosporites* [which he later renamed *Calyptosporites,* because of Nilsson's prior (1958) usage of the former name] indicates that the main differences between his category and *Grandispora* relate to (1) equatorial outline (subcircular in *Grandispora,* subtriangular in *Calyptosporites*); (2) sculptural features (some spores of *Calyptosporites* have spinae with bifurcate termini); and (3) size (*Calyptosporites* being said to be larger). With regard to equatorial outline, the body of *Calyptosporites* is stated to be round, and numerous described species of spinose pseudosaccate spores show amb variation from subcircular to roundly subtriangular. Size, too, cannot stand as a valid criterion, particularly in view of the considerable size overlap between the type species of the two genera. No realistic sculptural difference can be invoked as a means of distinction because the type species of *Calyptosporites* possesses non-bifurcating coni. The other species instituted by Richardson, *C. microspinosus,* is said to include spinae with bifurcate tips, and could probably be accommodated in *Ancyrospora* Richardson, 1960. Allen (1965, p. 735), however, records (but does not figure) examples of *C. microspinosus* lacking bifurcate elements.

Until the wall construction of *Ibrahimispores* Artüz, 1957 (in particular of the type, *I. microhorridus* Artüz) is clarified no decision concerning possible synonymy between that genus and *Grandispora* can be made. Artüz (1957, 1959) and Potonié (1960) regarded *Ibrahimispores* as being acavate, although the latter suggested (p. 41) that, if one attaches no taxonomic significance to a mesospore, *Ibrahimispores* and *Grandispora* (with mesospore) should be merged. In the Dettmann (1963) — Smith & Butterworth (1967) classificatory scheme, taxonomic significance is of course so attached, so the question hinges on whether *Ibrahimispores* is pseudosaccate or not. Sullivan & Marshall's (1966, p. 280; pl. 3, figs 19, 20) specimens of *Ibrahimispores brevispinosus* Neves, 1961, are clearly pseudosaccate, but Neves gives no indication that the holotype is. Presumably Sullivan & Marshall would have had access to Neves's type material, at the University of Sheffield, so a possible question of misidentity could be discounted. Hence it seems likely that, of the contents of *Ibrahimispores,* at least *I. brevispinosus* is a *Grandispora.*

Type species (by original designation). *Grandispora spinosa* Hoffmeister, Staplin, & Malloy, 1955. Occurrence: USA, Upper Mississippian-?Lower Pennsylvanian (Hoffmeister, Staplin, & Malloy, 1955; Felix & Burbridge, 1967); Great Britain, Viséan and Namurian A (Neves, 1961; Sullivan & Marshall, 1966; Neves & Owens, 1966).

Other Carboniferous species

1. *Grandispora balteata* (Playford) comb. nov.
   Synonymy: *Spinozonotriletes balteatus* Playford, 1963, pp. 657-8; pl. 95, figs 4-6; text-fig. 11b. Occurrence: Spitsbergen, Viséan (Playford, 1963); England, Tournaisian (Sullivan, 1964a).
2. *Grandispora circumspinosa* Menendez, 1965, p. 56; pl. 2, fig. 8. Occurrence: Argentina, Carboniferous.
3. *Grandispora conspicua* (Playford) comb. nov.
   Synonymy: *Spinozonotriletes conspicuus* Playford, 1964, pp. 22-3; pl. 5, figs 3, 4. Occurrence: Nova Scotia (Canada), Lower Mississippian.
4. *Grandispora debilis* sp. nov. (described below).
5. *Grandispora echinata* Hacquebard, 1957, p. 317; pl. 3, fig. 17. Occurrence: Nova Scotia (Canada), Lower Mississippian (Hacquebard, 1957; Playford, 1964); Oklahoma (USA), Upper Mississippian or Lower Pennsylvanian (Felix & Burbridge, 1967); Great Britain, Tournaisian-Namurian (Sullivan & Marshall, 1966; Neves & Owens, 1966; Sullivan, 1968).
6. *Grandispora maculosa* Playford & Helby, 1968, p. 113; pl. 11, figs 4, 5. Occurrence: New South Wales, Upper Carboniferous.
7. *Grandispora notensis* sp. nov. (described below).
8. *Grandispora procincta* (Felix & Burbridge) comb. nov.
   Synonymy: *Spinozonotriletes procinctus* Felix & Burbridge, 1967, pp. 368-9;

pl. 55, figs 9-12. Occurrence: Oklahoma (USA), Upper Mississippian or Lower Pennsylvanian.

9. *Grandispora tenuispinosa* (Hacquebard) comb. nov.
Synonymy: *Spinozonotriletes tenuispinus* Hacquebard, 1957, p. 316; pl. 3, figs 6, 7. Occurrence: Nova Scotia (Canada), Lower Mississippian (Hacquebard, 1957; Playford, 1964).

10. *Grandispora tuberculata* (Neves & Owens) comb. nov.
Synonymy: *Spinozonotriletes tuberculatus* Neves & Owens, 1966, pp. 356-7; pl. 3, figs 4, 5. Occurrence: England, Namurian A. Note: This species is very close to, possibly identical with, *G. procincta*.

11. *Grandispora uncata* (Hacquebard, 1957) comb. nov. (see below).

12. *Grandispora vinchenensis* Menendez, 1965, pp. 56-7; pl. 2, fig. 7. Occurrence: Argentina, Carboniferous.

Devonian species. It is beyond the scope of this paper to list, and formally combine where warranted, the various Devonian pseudosaccate species attributable to *Grandispora.* However, it is relevant here to assign formally to *Grandispora* the type species of its synonym *Calyptosporites.*

Grandispora velata (Eisenack) comb. nov.

Synonymy: *Triletes velatus* Eisenack, 1944, p. 108 (pars); pl. 1, figs 1-3 (*fide* Richardson, 1960, p. 52). Occurrence: Middle Devonian of Europe and Canada (Richardson, 1960; McGregor & Owens, 1966).

GRANDISPORA DEBILIS sp. nov.
(Pl. 17, figs 7, 8)

1964 *Grandispora* sp. of Balme, p. 61; pl. 2, fig. 12.

Diagnosis. Spores radial, trilete, with roundly subtriangular to subcircular amb. Laesurae straight or slightly sinuous, length about equal to radius of intexinal body; usually accompanied and largely obscured by narrow, smooth, elevated lips that simulate exinal folds and often almost attain equatorial margin. Exoexine 1-1.5μ thick often with large-scale folds, sculptured distally and equatorially with minute, scattered, discrete coni (and less commonly spinae), about 0.5-2μ long, 0.5-1μ in basal diameter, and spaced up to 4μ apart; elements may encroach on equatorial regions of proximal surface which is otherwise virtually smooth. About 20-50 elements project equatorially. Intexine about 1μ or less in thickness, smooth; outline (polar view) convexly subtriangular, hence more or less conformable with amb.

Dimensions (25 specimens). Overall equatorial diameter, excluding sculptural elements, 42 (50) 60μ; central body (intexine) diameter 28 (35) 42μ.

Holotype. Preparation B138/11, 36.2 118.2, CPC10100; Plate 17, figures 7, 8. Proximal aspect. Amb convexly subtriangular (intexine outline conformable); overall diameter 46μ, intexine 29μ; laesurae largely masked by narrow (1.5-2μ overall), elevated lips which almost attain equator and are folded through compression; exoexine about 1μ thick, proximal surface practically smooth apart from a few coni-spinae developed in equatorial region, distal surface supporting scattered, more or less uniformly distributed coni and rare spinae; sculptural elements up to 1μ in basal diameter and 1.5μ high, 48 elements project equatorially; smooth intexine about 1μ thick.

Type locality. Northern Territory, Bonaparte Gulf Basin, Milligans Beds, Viséan; Westralian Spirit Hill No. 1 Bore, percussion sample, 51-102 feet.

Remarks. Laesurate features, including lips, are usually poorly developed on ill preserved specimens.

Comparison. Of previously described forms, the one showing closest resemblance to *Grandispora debilis* sp. nov. appears to be *G. inculta,* which was described by Allen (1965, p. 373; pl. 103, figs 7-9) from the Givetian of Spitsbergen. Allen's species differs, however, in being of generally larger spores (mean 70μ), with a thicker intragranulate intexine (1.5-3μ) and possibly also a rather denser, exclusively conate, exoexinal sculpture. Also meriting comparison with *G. debilis* are *G. echinata* Hacquebard, 1957 (p. 317; pl. 3, fig. 17), from the Lower Mississippian of eastern Canada (see also Playford, 1964, p. 22; pl. 5, fig. 2); and *G. maculosa* Playford & Helby, 1968 (p. 113; pl. 11, figs 4, 5), from the Upper Carboniferous of New South Wales. *G. echinata* differs from *G. debilis* principally in being larger overall [59 (73) 96μ], with larger intexinal body [42 (58) 76μ] and somewhat coarser sculpture; *G. maculosa* also has a different size range [36 (52) 78μ overall], a much denser spinose-conate sculpture of the exoexine, and a typically more prominent intexinal body beyond which the laesurae and attendant lips do not extend.

Previous records. Balme's (1964) record is from the Western Australian Carboniferous.

GRANDISPORA NOTENSIS sp. nov.
(Pl. 16, figs 3, 4; Pl. 17, fig. 16)

1960 *Grandispora* cf. *G. spinosa* of Balme, p. 29; pl. 5, figs 32-34.
1964 *Grandispora* sp. of Balme, pl. 2, fig. 15 [no description].

Diagnosis. Spores radial, trilete; amb subtriangular with convex to almost straight sides and rounded apices. Laesurae accompanied (and usually masked) by elevated, smooth, membranous lips, sinuous and folded through compression, extending at least as far as body margin and often near to equatorial margin. Central body (intexine) relatively dark in colour, approximately 1-2μ thick, featureless; margin (polar view) conforms with amb. Distal-equatorial sculpture of exoexine consisting of fairly uniformly distributed, discrete coni-spinae (coni usually predominating); elements about 0.5μ to as much as 2.5μ in basal diameter, 0.5-3.5μ high, spaced 0.5-10μ apart. Remaining exoexine (including whole of proximal surface) laevigate, approximately 2.5-3μ thick. 25 to 50 coni-spinae project equatorially.

Dimensions (16 specimens). Overall equatorial diameter (excluding sculptural projections) 71 (86) 106μ; diameter of central body (intexine) 43 (55) 67μ.

Holotype. Preparation B181/1, 50.2 115.1, CPC10091; Plate 16, figures 3, 4. Distal aspect. Amb subtriangular with rounded apices and convex sides, diameter 91μ; membranous laesurate lips extending almost to equatorial margin; intexine diameter 60μ; exoexine smooth proximally, conate-spinose elsewhere, elements up to 2μ broad basally, 3.5μ high, and 5μ apart (average 2μ); about 50 elements based equatorially.

Type locality. Western Australia, Bonaparte Gulf Basin, ?Tanmurra Formation, ?Viséan; AOD Bonaparte No. 2 Well, cuttings, 650-660 feet.

Remarks. In listing morphological characters of this species, Balme (1960, fig. 1, p. 29) noted a 'size range' of 41-50μ; clearly this must be an error, or else it applies only to the central body, for his illustrated specimens (at X600 magnification) fall within the limits of the size range of the specimens described above.

Comparison. From the Donetz Basin Namurian, Ishchenko (1956, p. 87; pl. 16, fig. 201) has described *Acanthozonotriletes bellus* which may be close to *Grandispora notensis* sp. nov. Although the diagram and description of *A. bellus* are inadequate for comparative purposes, it seems that it has a smaller intexinal body, no marked lip development, and a thinner folded exoexine. A Russian Famennian spore figured in Pokrovskaya (1966, pl. XV, fig. 1) as *Archaeozonotriletes micromanifestus* Naumova is possibly identical with *G. notensis*. However, the original illustrations of the former (Naumova, 1953, pl. 2, figs 18, 19) and others (including some varieties) produced subsequently from the Russian Upper Devonian — Lower Carboniferous (e.g. by Chibrikova, 1959, 1962; Kedo, 1963; Pokrovskaya, 1966, pl. 36, fig. 9, pl. 39, fig. 8) do not accord with *G. notensis* in terms of sculpture and/or apertural characteristics.

Previous records. Balme (1960, 1964) recorded this species generally from the Western Australian Lower Carboniferous and in the later paper he also indicated possible extension into the Upper Carboniferous.

GRANDISPORA sp. cf. G. UNCATA (Hacquebard, 1957) comb. nov.

Cf. 1957 *Spinozonotriletes uncatus* Hacquebard, p. 316; pl. 3, figs 8-10.

Remarks. A few rather poorly preserved specimens closely comparable with the forms described by Hacquebard (1957) occur in the present material. Size range of these (i.e. overall equatorial diameter, excluding spinae) is 81-114μ.

Previous records. *Grandispora uncata* (Hacquebard) comb. nov. has been reported from the Tournaisian of eastern Canada (Hacquebard, 1957; Playford, 1964; Barss, 1967), Spitsbergen (Playford, 1963), and England (Sullivan, 1964a). Neves & Owens (1966) mentioned infrequent occurrence of the species in the English Namurian A.

Genus AURORASPORA Hoffmeister, Staplin, & Malloy, 1955

Type species (by original designation). *Auroraspora solisortus* Hoffmeister, Staplin, & Malloy, 1955.

AURORASPORA MACRA Sullivan, 1968
(Pl. 17, figs 1-6)

1968 *Auroraspora macra* Sullivan, pp. 124-5; pl. 27, figs 6-10.

Description. Spores radial, trilete. Amb subcircular, occasionally roundly subtriangular. Laesurae distinct, simple, straight; length at least two-thirds of central body (intexine) radius, sometimes equal to body radius. Exoexine laevigate to scabrate; usually with very fine, sinuous irregularly arranged folds; thickness not determinable. Intexine attached proximally to exoexine; virtually laevigate; shape in polar view conformable with amb; well defined; 1-2μ thick. Equatorial margin entire to gently undulating.

Dimensions (38 specimens). Overall equatorial diameter 38 (55) 70μ; diameter of central body (intexine) 30 (44) 62μ.

Remarks. Spores described and figured by Doubinger & Rauscher (1966, p. 306; pl. 9, figs 4, 5) and Byvscheva (1967, p. 24; pl. 3, figs 8-10) as *Cirratriradites granulatipunctatus* Hoffmeister, Staplin, & Malloy, 1955 and *Hymenozonotriletes granulatipunctatus* (Hoffmeister, Staplin, & Malloy) Byvscheva comb. nov., respectively, are probably representative of *Auroraspora macra* Sullivan.

It is possible that Balme & Hassell (1962, p. 22) mistook this species for their *Diaphanospora riciniata* when they stated that the latter 'occurs fairly commonly in Lower Carboniferous sediments from the Canning and Bonaparte Basins.' In fact no parallels to *D. riciniata,* with its lipped laesurae, very thin, laevigate, outer membrane and relatively thick ('cingulate') intexine margin (as seen in polar view), were encountered during the present study.

Previous records. Sullivan (1968) described *A. macra* from Scottish Tournaisian strata; and the same species is probably present in the Viséan of southern Vosges, France (Doubinger & Rauscher, 1966) and the Lower Carboniferous of USSR (Byvscheva, 1967).

AURORASPORA SOLISORTUS Hoffmeister, Staplin, & Malloy, 1955

(Pl. 17, figs 18, 19)

1955 *Auroraspora solisortus* Hoffmeister, Staplin, & Malloy, p. 381; pl. 37, fig. 3.

Description. Spores radial, trilete. Amb subcircular or subtriangular with convex sides; central (intexinal) body outline more or less conformable in polar view. Laesurae long, often extending to the central body margin; simple or with slight lip development. Wall of central body (i.e. intexine) 1-1.5μ thick, virtually smooth; body relatively dark in colour, well defined. Outer enveloping layer (exoexine) very thin, densely granulate-scabrate; often with relatively large-scale folds emanating radially from polar regions. Equatorial margin entire to irregularly undulating or embayed.

Dimensions (12 specimens). Overall equatorial diameter 51 (66) 83μ; diameter of central body (intexine) 33 (41) 55μ.

Previous records. Described originally from the Upper Mississippian of Kentucky (Hoffmeister, Staplin, & Malloy, 1955), this species was subsequently reported from the Scottish Namurian A (Butterworth & Williams, 1958), and English Viséan (Sullivan, 1964b), and the Upper Mississippian-?Lower Pennsylvanian of Oklahoma (Felix & Burbridge, 1967). Staplin's (1960, pl. 7, fig. 15) spore labelled *A. solisortus?* is almost certainly a bona fide example of the species (from the Upper Mississippian of Alberta).

Genus HYMENOSPORA Neves, 1961

Type species (by original designation). *Hymenospora palliolata* Neves, 1961.

HYMENOSPORA cf. H. CAPERATA Felix & Burbridge, 1967
(Pl. 17, figs 9-15)

Cf. 1967 *Hymenospora caperata* Felix & Burbridge, pp. 405-6; pl. 62, fig. 12.

Description. Spores radial, trilete; amb circular to broadly roundly subtriangular. Laesurae indistinct to distinct; extending to, or at least two-thirds of distance to, the margin of the intexine; often flanked by low lips, individually up to 4.5μ broad and with sinuous margins. Intexinal body conformable in outline with amb; relatively dark in colour; apparently laevigate; margin not well defined because of (plicated) exoexine cover. Exoexine 0.5-1.5μ thick, with finely wrinkled surface; wrinkles low, up to 1μ broad, often assuming radial alignment towards equator. Exoexine projects beyond intexine as a flange-like structure, 3-11μ wide, with irregularly undulating or embayed margin.

Dimensions (33 specimens). Overall equatorial diameter 44 (54) 64μ.

Comparison and remarks. Numerous examples of this form have been studied, for it is abundant in many of the Bonaparte Gulf Basin samples. Decisive allocation to Felix & Burbridge's species could not be made because the Australian spores do not show the finely pitted intexine said to be characteristic of *Hymenospora caperata*; moreover their often conspicuous laesurate lips may not be in accord with *H. caperata.* However, the single specimen (holotype) figured by Felix & Burbridge is without doubt very similar to the spores under consideration. The original generic attribution is retained for the present, although with some diffidence because Neves' genus is not regarded as adequately differentiated from other related cavate genera with smooth or nearly smooth exoexines; e.g. *Endosporites* Wilson & Coe, 1940, *Auroraspora* Hoffmeister, Staplin, & Malloy, 1955.

Cirratriradites granulatipunctatus Hoffmeister, Staplin, & Malloy, 1955 (pp. 382-3; pl. 37, fig. 2) may possibly prove to be synonymous with *H. caperata.*

Previous records. H. caperata is described as ubiquitous in the late Mississippian-?early Pennsylvanian Springer Formation of Oklahoma (Felix & Burbridge, 1967); the same authors noted its additional occurrence in the Upper Mississippian Goddard Formation of Oklahoma and in the Kanawha Formation (Pennsylvanian) of Kentucky. The similar spores of *C. granulatipunctatus* are known from the Upper Mississippian of Illinois and Kentucky (Hoffmeister, Staplin, & Malloy, 1955) and Namurian A of Scotland (Butterworth & Williams, 1958). French and Russian Lower Carboniferous spores referred to *C. granulatipunctatus* by Doubinger & Rauscher (1966) and Byvscheva (1967), respectively, probably do not belong to that category (see *Auroraspora macra* Sullivan, p. above).

Genus ENDOSPORITES Wilson & Coe, 1940

Type species (by subsequent designation of Schopf, Wilson, & Bentall, 1944, p. 45). *Endosporites ornatus* Wilson & Coe, 1940.

ENDOSPORITES MICROMANIFESTUS Hacquebard, 1957
(Pl. 17, fig. 17)

1956 *Hymenozonotriletes* aff. *variabilis* Naumova; Ishchenko, p. 62; pl. 11, figs 129, 130.
1957 *Endosporites micromanifestus* Hacquebard, p. 317; pl. 3, fig. 16.
1960 *Auroraspora micromanifestus* (Hacquebard) Richardson, p. 51.

Dimensions (25 specimens). Overall equatorial diameter 45 (60) 83μ; diameter of intexinal body (polar view) 31 (46) 67μ.

Previous records. This species has been reported widely from northern hemisphere deposits of Lower Carboniferous age (e.g. Hacquebard, 1957; Playford, 1963, 1964; Sullivan & Marshall, 1966; Doubinger & Rauscher, 1966; Felix & Burbridge, 1967), and lately (Evans, 1968) from probable Tournaisian beds in western New South Wales.

Genus VELAMISPORITES Bhardwaj & Venkatachala, 1962

Type species (by original designation). *Velamisporites rugosus* Bhardwaj & Venkatachala, 1962.

Discussion. Bhardwaj & Venkatachala (1962, p. 24) diagnosed the genus as follows: 'trilete spores with a thick, laevigate exine, enveloped uniformly all over by a perisporial covering.' They noted the latter structure as being 'wrinkled on the surface giving a corrugated and pseudoreticulate appearance.' They conceded that the genus *Perotrilites* as diagnosed by Couper (1953), and typified with *P. granulatus* Couper, could accommodate their (Lower Carboniferous, Spitsbergen) spores; but preferred to regard the latter as generically distinct because of the age disparity in that Couper's material was from considerably younger (New Zealand Mesozoic) sediments. Balme & Hassell (1962, p. 20) argued in the same way, in support of their *Diaphanospora.* Other workers (e.g. Hughes & Playford, 1961) have applied *Perotrilites* in Couper's sense to pre-Mesozoic dispersed spores, maintaining that morphological (rather than stratigraphic) criteria are relevant to form-generic assignments. However, recent work suggests that Couper's interpretation of the morphology of *Perotrilites* is in error. A detailed study by Dr P. R. Evans (pers. comm.) reveals that the holotype of *P. granulatus* is equatorially modified (zonate, not perinate); for this reason *Perotrilites* cannot continue to be applied to spores wholly enveloped by a thin outer layer. This in effect narrows the field to *Diaphanospora* and *Velamisporites.* The type species of the former, *D. riciniata* Balme & Hassell, 1962 (p. 22; pl. 4, figs 1-4; text-fig. 5), is said to have an equatorially thickened inner layer. Because no such thickening is evident in the two forms described here, they are assigned to *Velamisporites.* It is also necessary to allocate to the same genus two other early Carboniferous species previously combined with *Perotrilites.* Both were described originally (Hughes & Playford, 1961) from the Billefjorden Sandstones of Spitsbergen:

Velamisporites perinatus (Hughes & Playford) comb. nov. Synonymy: *Perotrilites perinatus* Hughes & Playford, 1961, p. 33; pl. 2, figs 7-10.

Velamisporites magnus (Hughes & Playford) comb. nov. Synonymy: *Perotrilites magnus* Hughes & Playford, 1961, p. 33, pl. 2, figs 5, 6.

Rugospora Neves & Owens, 1966 appears to be morphologically close to *Velamisporites,* although the holotype illustration (Neves & Owens, pl. 2, fig. 4) is not clear enough to establish synonymy.

VELAMISPORITES LACERTOSUS sp. nov.
(Pl. 18, figs 1-4)

Diagnosis. Spores radial, trilete. Amb, and outline of inner sclerine (polar view), subtriangular with convex or (rarely) almost straight sides. Outer sclerine about 1-2μ thick, intact in well preserved specimens; densely wrinkled (rugulae up to 2.5μ wide, often overlapping, but not forming a reticulate pattern), otherwise laevigate to finely granulate or scabrate. Inner sclerine smooth, 2.5-4μ thick. Laesurae usually distinct, straight to sinuous, accompanied by elevated lips individually 3-5μ wide on inner sclerine, and extending to or almost to equatorial margin of inner sclerine. Laesurae and lips reflected on outer sclerine by broad triradiate elevations, themselves densely rugulate and up to 15μ wide, 9μ high, often extending to equator.

Dimensions (23 specimens). Overall equatorial diameter (i.e. of outer sclerine) 93 (118) 156μ; diameter of inner sclerine 59 (80) 113μ.

Holotype. Preparation B54/1, 40.2 109.9, CPC10114; Plate 18, figure 3. Proximal aspect. Subtriangular amb with convex sides, diameter 136μ; conformable with inner sclerine outline, 104μ in diameter; laesurae straight, extending to margin of inner sclerine, almost obscured by conspicuous superimposed triradiate elevation of outer sclerine, 7-9μ high, 12-15μ wide; outer sclerine about 2μ thick with very close-spaced sinuous wrinkles overall; inner sclerine about 3.5μ thick.

Type locality. Western Australia, Bonaparte Gulf Basin, Bonaparte Beds, Viséan; AOD Bonaparte No. 2 Well, core 3, 2176 feet.

Comparison. The most closely comparable species described to date appears to be *Hymenozonotriletes antis* instituted by Ishchenko (*in* Brazhnikova et al., 1956, p. 276; pl. 3, fig. 37) from the Viséan of USSR. It differs from *Velamisporites lacertosus* sp. nov. in that its outer layer is coarsely reticulate, not finely wrinkled.

VELAMISPORITES sp. cf. V. RUGOSUS Bhardwaj & Venkatachala, 1962
(Pl. 18, figs 5, 6)

Cf. 1962 *Velamisporites rugosus* Bhardwaj & Venkatachala, p. 25; pl. 4, figs 52-54.
1964 *Velamisporites rugosus* Bhard. & Venk.; Venkatachala, p. 111; pl. 2, figs 14-16.

Description. Spores radial, trilete; amb circular to broadly roundly subtriangular. Laesurae evident only on inner sclerine, where they extend from about one-half to three-quarters of distance to margin; slight lips usually present, individually up to 4μ broad. Inner sclerine smooth, 2-3.5μ thick. Outer sclerine thin (probably 0.5-1μ in thickness), finely granulate to almost laevigate, with numerous fine, randomly dispersed, sinuous wrinkles; often at least partly eroded from inner layer.

Dimensions (34 specimens). Overall equatorial diameter (i.e. of outer sclerine) 93 (151) 264μ; diameter of inner sclerine 84 (118) 170μ.

Comparison and previous records. Velamisporites magnus (Hughes & Playford) comb. nov., from the Lower Carboniferous of Spitsbergen, is similar in size and apertural features but differs (by direct comparison) in having a more diaphanous, less conspicuously wrinkled, closer fitting, outer sclerinous covering, and its, often thinner, inner sclerine is characteristically subject to marked compressional folding. The present form is possibly identical with *V. rugosus* which is also known from

Spitsbergen Lower Carboniferous sediments. However, the original illustrations of the latter (Bhardwaj & Venkatachala, 1962, pl. 4, figs 52-54) lack sufficient clarity for a positive assignment to be made. The spores assigned by Venkatachala (1964) to *V. rugosus* came from Milligans Bore (No. 1) in the Bonaparte Gulf Basin and are certainly the same as the specimens described above. Evans (1968) has listed, without illustration, the occurrence of *V. rugosus* in probable Tournaisian beds of western New South Wales. Scottish Viséan spores figured by Sullivan & Marshall (1966, pl. 4, figs 7, 9, 11) as *V. rugosus* differ from the Australian spores at least, in having a more strongly rugulate outer layer.

DISCUSSION OF THE PALYNOLOGICAL FLORA

GENERAL FEATURES

The 55 spore species documented in the systematic section include 26 new species and 7 types that are each given a simple letter designation ('sp. A') because their representation is insufficient for formal taxonomic treatment. The remaining 22 species are referable (6 tentatively so) to previously established taxa.

Table 1 shows the distribution in the palynologically productive material (61 samples) from the various subsurface sections. Counting was undertaken in the case of cored horizons that yielded sufficiently abundant and, in most instances, well preserved spores. Included for completeness in the percentage estimates are rather nondescript categories of morphographically simple trilete spores (e.g. *Leiotriletes* spp., *Calamospora* spp.); the taxonomy of these is in general confused, hence their omission from the formal systematics and from the non-counted sample columns in the table.

The overwhelmingly dominant element in all but one of the samples studied is the possibly lycopodiaceous form *Granulatisporites frustulentus* Balme & Hassell, 1962 emend., which where quantitatively determined accounts for between 44 and 83 percent of the total spore populations. The only sample in which it was not observed (Bonaparte No. 1, core 2, 687 feet) differs from the others lithologically (it is a biomicrite) as well as palynologically (in terms of relatively low species representation). Such differences would seem to reflect a distinct offshore depositional environment rather than a distinct temporal disparity.

Almost as widespread through the microfloras, if markedly less abundant, are *Punctatisporites subvaricosus* sp. nov., *Verrucosisporites nitidus* Playford, 1964, *Anapiculatisporites largus* sp. nov., *Hymenospora* cf. *caperata* Felix & Burbridge, 1967, and *Velamisporites* cf. *rugosus* Bhardwaj & Venkatachala, 1962. Of the various suprageneric groups, the Murornati are diversely represented, in particular by the genus *Convolutispora* (at least a dozen species).

Simple spinose acritarchs of the *Micrhystridium*-type occur only very spasmodically in the material, which is somewhat surprising in view of the undoubted marine character of at least the greater part of the Viséan sequence. In particular, the Bonaparte Beds (of Bonaparte Nos 1 and 2 Wells) are interpreted (Veevers & Roberts, 1968) as having accumulated in a relatively deep offshore basinal situation, which is difficult to reconcile with Muller's (1959) and Staplin's (1961) findings that such a situation would tend to favour a high acritarch population especially if the turbidity was low.

Plant microfossils occur more consistently than do any of the other fossil groups (e.g. Foraminifera, ostracods, conodonts) hitherto recorded in the subsurface sequences. Hence their significance in local correlation is enhanced by the fact that, within limits imposed by sample intervals and quality of preservation, vertical ranges of spore species can be established through the sequence.

Enormous quantities of the virtually ubiquitous *Granulatisporites frustulentus* obviously tend to overshadow the occurrence of many other species in the palynological assemblages, and may partly explain the apparently inconsistent representation of some of the very rare types. As noted previously, *G. frustulentus* occurs in all of the samples except the biomicrite of core 2 (687 feet), Bonaparte No. 1. Distribution of all the species recognized is documented in Table 1.

Bonaparte Nos 1 and 2 Wells

These two wells, of the basinal region, cover the greatest thickness of Lower Carboniferous sediments treated in the present work. Figures 5 and 6 show in each of the two sections the distribution of species selected on account of their apparently more consistent pattern of occurrence. Species which are confined to the Bonaparte Beds of both wells include *Cristatisporites colliculus* sp. nov., *Knoxisporites* sp. cf. *K. ruhlandi* Doubinger & Rauscher, 1966, *Anapiculatisporites semisentus* sp. nov., *Acanthotriletes intonsus* sp. nov., and *Cadiospora abrupta* sp. nov. Several other forms are restricted to the type Bonaparte Beds (Bonaparte No. 1), but in Bonaparte No. 2 extend upwards into the (presumed) Tanmurra Formation; these include the new species *Reticulatisporites bonapartensis, Crassispora invicta,* and *Archaeozonotriletes intrastriatus.* All species recorded from the type Tanmurra Formation (Bonaparte No. 1) are also found in the underlying Bonaparte Beds (with the exception of one specimen, *Tricidarisporites* sp. A). Several species extend no higher in Bonaparte No. 1 than the basal Tanmurra core (1564 feet), viz. *Acanthotriletes turriculaeformis* sp. nov., *Anapiculatisporites largus,* and *Exallospora coronata* gen. et sp. nov. In Bonaparte No. 2 the first two named extend from Bonaparte Beds to, or nearly to, the top of the sampled Tanmurra Formation; *E. coronata* is, in the same well, confined to upper horizons of the latter unit. *Auroraspora macra* Sullivan, 1968, occurs in Bonaparte No. 1 in the Tanmurra Formation and the upper 1000 feet of Bonaparte Beds (down to core 9: 2549 feet), whereas in Bonaparte No. 2 it is confined to the presumed Tanmurra Formation.

The following appear from present knowledge to be significant aspects of the microfloral sequence in the two wells:

(1) Association of *Cristatisporites colliculus* and *Knoxisporites* sp. cf. *K. ruhlandi*: Bonaparte No. 2, core 11 (4929 feet).

(2) Introduction of *Anapiculatisporites semisentus, Reticulatisporites bonapartensis, Crassispora invicta, Acanthotriletes intonsus,* and *Cadiospora abrupta*: Bonaparte No. 2, cores 7-8 (3531-3946 feet); Bonaparte No. 1, core 14 (4349 feet) or below.

(3) Last appearance of *Anapiculatisporites semisentus, R. bonapartensis, Crassispora invicta, Acanthotriletes intonsus,* and *Cadiospora abrupta;* and introduction of *Auroraspora macra*: Bonaparte No. 2, cores 2-3 (1546-2176 feet); Bonaparte No. 1, cores 9-10 (2549-2858 feet).

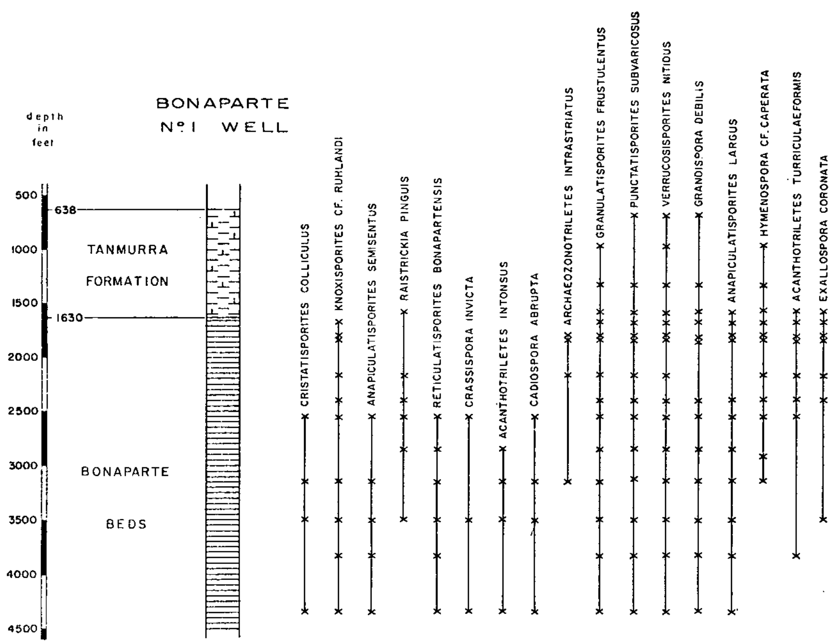

Figure 5: Distribution of selected species, AOD Bonaparte No. 1 Well.

(4) Last appearance of *Anapiculatisporites largus, Acanthotriletes turriculaeformis,* and *Exallospora coronata*: Bonaparte No. 1, core 5 (1564 feet).

Correlations implied by these data are indicated in Figure 2. They cannot be reconciled with the view of Veevers & Roberts (1968, p. 118; fig. 65), based on foraminiferal and ostracod occurrences, that 'the interval between cores 6 and 8 (1840-2410 feet) in Bonaparte No. 1 is equivalent to core 11 (4920 feet) in Bonaparte No. 2'. Moreover it seems likely from the palynological data that the postulated Tanmurra Formation of Bonaparte No. 2 is older than the type Tanmurra (Bonaparte No. 1), which in turn could be expressed by the unconformity at the base of the Border Creek Formation in Bonaparte No. 2.

In general the type Tanmurra and its presumed equivalent in Bonaparte No. 2, being sandy and calcareous, yielded sparser and less diverse microfloras than the underlying, silty-shaly, carbonaceous strata of the Bonaparte Beds. Nevertheless associations 3-4 were in presumed Tanmurra equivalent (Bonaparte No. 2) on the one hand and in type Bonaparte Beds (Bonaparte No. 1) on the other, and hence their distribution is not considered to be facies-controlled.

Spirit Hill No. 1 Well; Spirit Hill No. 1 and Milligans No. 1 Bores

Apart from the upper sample from Milligans No. 1 Bore all the material from these boreholes comes from the Milligans Beds. At a depth of 141-142 feet, the exception represents either the base of the Burvill Beds or the transition zone between the latter and the (type) Milligans Beds.

The following species occur in all the samples studied from these boreholes: *Granulatisporites frustulentus* (dominant), *Punctatisporites subvaricosus, Verrucosisporites nitidus, Anapiculatisporites largus, Knoxisporites* sp. cf. *K. ruhlandi, Grandispora debilis* sp. nov., and *Hymenospora* cf. *caperata.*

	BONAPARTE NO. 2 WELL																								BONAPARTE NO. 1 WELL																			MILLIGANS NO. 1 BORE		SPIRIT HILL NO. 1 BORE			SPIRIT HILL NO. 1 WELL												
	Ct, 650-660 ft.	Ct, 680-690 ft.	Ct, 710-720 ft.	Ct, 740-750 ft.	Ct, 770-780 ft.	Ct, 810-820 ft.	Ct, 850-860 ft.	Ct, 870-880 ft.	Ct, 900-910 ft.	Ct, 920-930 ft.	C1, 946 ft.	C1, 947 ft.	Ct, 960-970 ft.	Ct, 980-990 ft.	C2, 1546 ft.	C3, 2175 ft.	C3, 2176 ft.	C5, 2836 ft.	C6, 3210 ft.	C7, 3531 ft.	C7, 3534 ft.	C8, 3941 ft.	C8, 3946 ft.	C11, 4929 ft.	C2, 687 ft.	C3, 965 ft.	C3, 968 ft.	Ct, 1330 ft.	C5, 1564 ft.	Ct, 1670 ft.	Ct, 1790 ft.	Ct, 1840 ft.	C6, 1844 ft.	C6, 1849 ft.	C7, 2164 ft.	C8, 2405 ft.	C9, 2549 ft.	C10, 2858 ft.	C11, 3154 ft.	C12, 3493 ft.	C12, 3501 ft.	C13, 3825 ft.	C14, 4349 ft.	P, 141-142 ft.	P, 341-392 ft.	P, 51-102 ft.	P, 202-253 ft.	P, 253-295 ft.	BC, 100-150 ft.	BC, 150-200 ft.	BC, 200-250 ft.	BC, 250-300 ft.	BC, 350-400 ft.	C, 398 ft.	BC, 400-450 ft.	BC, 450-500 ft.	BC, 500-550 ft.	BC, 550-600 ft.	C, 613 ft.	BC, 700-750 ft.	BC, 800-850 ft.
LEIOTRILETES SP. A																	X																																												
LEIOTRILETES SPP.												0.4							0.4	0.4		1.2							0.4									0.8	0.8	0.8	0.8																		0.8		
PUNCTATISPORITES RESOLUTUS																		X	0.4											X		X			0.8	0.8		X	X					X	X														0.4		
PUNCTATISPORITES SUBVARICOSUS	X	X	X	X	X	X	X	X	X	X	X	7.6	X	X	X	X	2.4	7.2	5.6	11.2	X	4.0	X	X	X			X	4.4	X	X	X	7.2	X	4.8	7.2	8.8	16.0	4.0	5.2	8.4	X	7.6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	5.6	X	X
PUNCTATISPORITES SPP.												0.8					2.4	2.0	2.4	2.4		3.6							0.8				0.4		2.0	1.6	2.4	2.8	1.6	1.2	2.0		1.2																2.4		
CALAMOSPORA SPP.												1.6					1.6	1.2	2.8	2.0		0.8							2.8				0.8			0.4	1.2	1.2	0.8	1.6			0.4																1.6		
APICULIRETUSISPORA SP. A											X							X																					X												X										
GRANULATISPORITES FRUSTULENTUS	X	X	X	X	X	X	X	X	X	X	X	77.2	X	X	X	X	57.6	56.8	56.0	61.2	X	60.0	X	X		X	X	X	76.0	X	X	X	81.2	X	82.8	80.4	74.0	62.0	62.4	50.0	49.2	X	60.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	44.4	X	X
CADIOSPORA ABRUPTA																X	X	X	X	X	X																X		X		0.4		0.4																		
VERRUCOSISPORITES NITIDUS	X	X	X	X	X		X	X	X	X		0.4	X	X	X	X	X	0.4	0.4	0.8	X	X	X	X	X	X	X	X	0.8	X	X	X	0.8	X	0.4	2.4	X	2.4	1.2	0.4	0.4	X	1.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1.2	X	X
ANAPICULATISPORITES LARGUS				X			X	X		X	X	1.2	X	X	X	X	1.6	0.8	11.6	1.2	X	3.6	X	X					1.6	X	X	X	0.8	X	X	X	3.2	1.2	10.0	1.6	3.6	X	2.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	9.2	X	X
ANAPICULATISPORITES SEMISENTUS																X	0.4	X	X	X			X														X		X	X	X	X	X		X		X									X					
PLANISPORITES CONSPERSUS													X		X	X	1.2		1.2	X																		0.4	0.4		X	X	0.4					X													
ACANTHOTRILETES INTONSUS																X	4.8	6.0	X	1.6	X																	X	1.6		0.4		1.2	X	X	X	X	X		X	X	X	X	X	X				2.4		
ACANTHOTRILETES TURRICULAEFORMIS								X				X										X	X						X	X	X	X	X	X	X	X	X					X		X			X	X	X	X			X		X	X	X				
TRICIDARISPORITES SP. A					X																																																								
RAISTRICKIA IMPROFUSA		X		X		X	X	X										X																					X							X			X										0.4		
RAISTRICKIA PINGUIS																X	X						X						X						X	X	X	0.4		X	0.4			X			X	X		X		X		X	X			X			
CONVOLUTISPORA AMPLA	X	X	X		X			X														X	X									X															X		X				X		X		X	X			
CONVOLUTISPORA BALMEI												X						X	0.4	0.4	X	X	X						X			X			X	X									X				X						X				X		
CONVOLUTISPORA CRASSA	X				X			X	X			X		X		X	X	X		1.2	X	X	X						X	X	X	X	X	X	X	X				0.4				X					X	X		X		X							
CONVOLUTISPORA FLORIDA				X												X	X					0.4	X														X				0.4					X	X			X	X		X			X					
CONVOLUTISPORA FROMENSIS								X								X	0.4	0.4	X	0.4	X	0.8	X	X					0.8						X	X	X	0.4	0.4	X	0.4	X		X	X				X			X	X			X		X			X
CONVOLUTISPORA HARLANDII	X		X	X	X		X	X								X	0.4	0.4		X	X							X	X	X	X	X	X	X	X	X	0.4	0.4			X			X			X	X		X	X								X		
CONVOLUTISPORA JUGOSA			X	X	X			X				X					X		X				X						0.4						X	X		0.4					X		X		X		X	X		X	X		X		X	X			
CONVOLUTISPORA RIMULOSA												X				X	X	X	X	X	X	0.8	X						X	X	X				X	X		X		X		X	X					X	X		X		X	X			X				
CONVOLUTISPORA SUBTRIQUETRA		X																	X													X					X	X	X				X																		
CONVOLUTISPORA VARICOSA		X		X								X								0.8			X	X					0.4						X	X	X						X	X		X							X		X	X			X		
CONVOLUTISPORA VERMIFORMIS					X																	0.4									X		X					X				X																	X		
CONVOLUTISPORA SP. A																	X																				X																							X	
CONVOLUTISPORA SPP.												0.8										2.4															0.4		0.4																				1.6		
FOVEOSPORITES APPOSITUS	X		X									X				X	0.4	X	X	0.4	X	0.4	X	X				X	0.4	X			0.8	X			X			0.4	X		X	X			X	X	X	X				X	X	X			0.4		X
DICTYOTRILETES CF. DENSORETICULATUS	X												X							X									X		X	X			X		X																		X						
MICRORETICULATISPORITES SP. A																				X	X															X							X																		
RETICULATISPORITES BONAPARTENSIS															X	X	X	X	X	X	X	X	X														X	X	X	X	X	X	X					X	X		X	X				X	X		X		
RETICULATISPORITES PAPILLATUS																																				X	X					X		X								X							X		
ACINOSPORITES SPIRITENSIS																				X	X	0.4	X																												X	X				X		X	X	X	
MOOREISPORITES SP. A																																																				X									
DIATOMOZONOTRILETES SP. A																	X																																												
KNOXISPORITES HEDERATUS																X	X	X	X			X								X		X			X		X			X				X		X	X									X			X		
KNOXISPORITES LITERATUS												X					0.4	X	X	X												X												X	X		X														
KNOXISPORITES CF. RUHLANDI																X	0.8	1.2	0.4	0.4	X	0.4	X	X						X	X	X	X		X	X	X		0.4	0.8	X	X	0.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1.2	X	X
EXALLOSPORA CORONATA	X		X								X	X																	X	X	X	X			X	X					X																				
CRASSISPORA INVICTA															X	X	X	0.8	0.4	0.8	X	X	X														X			0.8	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	0.4	X	X
CRASSISPORA SCRUPULOSA		X	X	X	X											X	0.4	X	0.4														X	X	X	X			X																	X	X				
DENSOSPORITES CF. ACULEATUS																X	X																				X		X				0.4		X			X	X	X	X	X	X	X	X	X	X	X	0.4		X
CRISTATISPORITES COLLICULUS																		X		0.4	X	0.4	X	X													X		X		0.8		0.4	X	X		X		X	X		X	X		X	X	X	X	X		
CIRRATRIRADITES VEEVERSI																X	X	X	X																								X									X									X
CAMPTOZONOTRILETES ROBERTSI		X				X	X						X				X															X	X	X	X	X	0.4										X												X		
ARCHAEOZONOTRILETES INTRASTRIATUS															X		0.4			X											X	X			X				X					X													X				
GRANDISPORA DEBILIS												0.8			X	X	14.0	13.2	8.4	2.8	X	2.8	X	X	X			X	1.2	X	X	X	0.4			X	0.4	1.6	6.4	26.4	26.0	X	12.4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1.2	X	X
GRANDISPORA NOTENSIS	X	X													X				X									X	X			X			X									X																	
GRANDISPORA CF. UNCATA																				X			X														X				X																				
AURORASPORA MACRA					X		X			X	X	X	X	X	X										X		X	X			X						X											X					X								
AURORASPORA SOLISORTUS																									X	X								X																											
HYMENOSPORA CF. CAPERATA	X	X	X	X	X	X	X	X	X	X	X	X	X											X		X	X	X	1.2	X	X	X	1.2	X	0.8	X	X		0.4					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	6.4	X	X
ENDOSPORITES MICROMANIFESTUS					X										X	X	X	X	0.4	0.4	X	X	X			X			X				X		X		X		0.4	0.4				X	X	X	X		X	X		X	X	X	X				0.8		X
VELAMISPORITES LACERTOSUS			X			X					X	X	X			X	X			X	X		X						0.4	X	X	X			X		X		X	X	X	X		X												X			X		X
VELAMISPORITES CF. RUGOSUS	X		X	X	X			X		X	X	X	X	X	X	X	0.4	X	1.2	1.2	X	2.0	X						1.2						2.8	X	X		0.8	0.4	0.4	X	0.4	X	X	X	X	X		X		X	X	X	X	X	X	X	1.6	X	X
INDETERMINATE												9.2					10.4	9.6	7.6	10.0		15.6							7.2				6.4		5.6	7.2	8.8	10.0	8.0	9.6	6.4		10.0																17.6		

TABLE 1

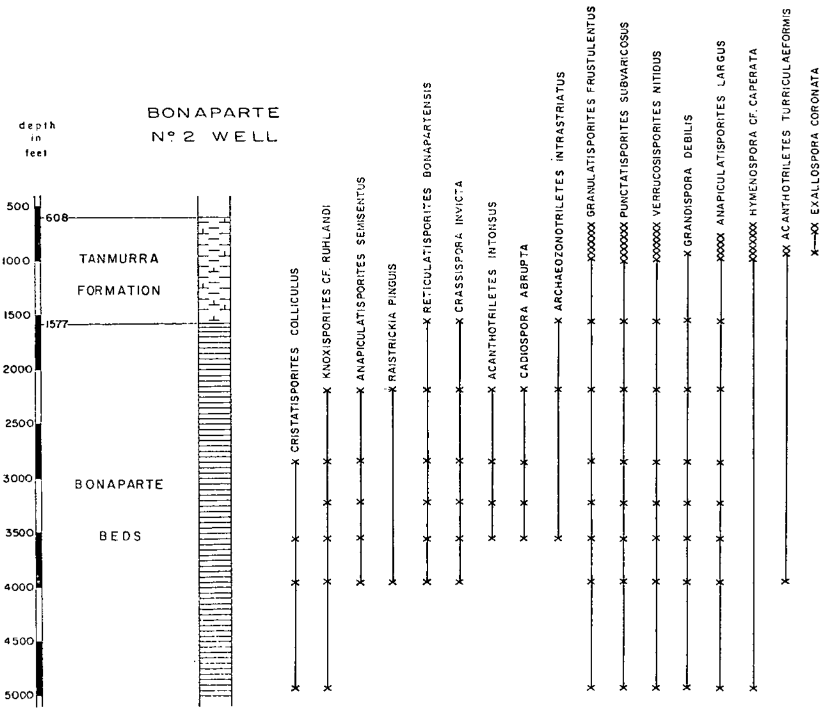

Figure 6: Distribution of selected species, AOD Bonaparte No. 2 Well.

The bagged-core section of Spirit Hill No. 1 Well contains *Anapiculatisporites semisentus* (450-500 feet), *Acanthotriletes intonsus* (150-613 feet), *A. turriculaeformis* (100-550 feet), *Reticulatisporites bonapartensis* (100-613 feet), *Cristatisporites colliculus* (100-613 feet), and *Auroraspora macra* (350-400 feet). This assemblage correlates with that of cores 9-10 (2549-2858 feet) of Bonaparte No. 1 and cores 2-3 (1546-2176 feet) of Bonaparte No. 2. Note that the apparent absence of some of the more significant spores in the lower two samples of the Spirit Hill Well section (700-850 feet) may be explained by the fact that they yielded sparse and not well preserved microfloras.

Species observed within the sampled interval (51-295 feet: three percussion samples) of Spirit Hill No. 1 Bore include: *Anapiculatisporites semisentus* (202-253 feet), *Acanthotriletes turriculaeformis* (202-295 feet), *Reticulatisporites bonapartensis* (253-295 feet), *Crassispora invicta* (202-295 feet), *Cristatisporites colliculus* (202-253 feet), and *Auroraspora macra* (253-295 feet). The assemblage conforms with that of Spirit Hill No. 1 Well (100-*ca.* 850 feet), Bonaparte No. 1 (cores 9-10; 2549-2858 feet), and Bonaparte No. 2 (cores 2-3; 1546-2176 feet).

From Milligans No. 1 Bore, the upper (141-142 feet) and lower (341-392 feet) percussion samples represent (probable) lowermost Burvill Beds and Milligans Beds respectively. Species identified include *Anapiculatisporites semisentus* (341-392 feet), *Acanthotriletes intonsus* (both samples), *A. turriculaeformis* (141-142 feet), *Crassispora invicta* (both samples), and *Archaeozonotriletes intrastriatus* (141-142 feet). Presence of these and absence of *A. macra* may suggest a correlation with Bonaparte No. 1, core 10 (2858 feet) or below, and Bonaparte No. 2, cores 3-8 (2175-3946 feet) or below. The microfloral evidence of the upper sample does not support the admittedly indirect correlation of the Burvill Beds, at least their basal portion, with the (type) Tanmurra Formation (lower portion) of Bonaparte No. 1.

A microfaunal (foraminiferal) correlation has been suggested (Veevers & Roberts, 1968, p. 118) between the upper part of Milligans Beds of Milligans No. 2 Bore (not examined in the current work) and core 9 of Bonaparte No. 1.

COMPARISON WITH OTHER AUSTRALIAN CARBONIFEROUS ASSEMBLAGES

Of previously published works on Australian Carboniferous palynology, one would have anticipated that Venkatachala's (1964) assemblage would be demonstrably the same as at least part of the currently described microflora since it came from one of the sections studied herein (Milligans No. 1 Bore). However, as discussed earlier, the palynological residue extracted by Venkatachala contained only a low concentration of poorly preserved spores which he had difficulty in identifying; in particular its apparent lack of *Granulatisporites frustulentus* presumably resulted from overmaceration during laboratory preparation. Spores likened to *Velamisporites rugosus* occur in Venkatachala's residue, but the others he figured are in no condition to be compared adequately with forms described here.

Balme's (1960) Lower Carboniferous (probable Tournaisian) microflora from the 'Laurel Beds' (now upper Fairfield Formation—see Playford & Lowry, 1966), northern Canning Basin, Western Australia, was not studied exhaustively by him, but there are certain elements common to it and the Bonaparte Gulf Basin Viséan: e.g. the forms designated here as *Granulatisporites frustulentus, Acanthotriletes turriculaeformis,* and *Grandispora notensis* sp. nov. In the same paper Balme recorded the microflora from an Anderson Formation sample of probable Upper Carboniferous (certainly pre-Permian) age. Again, it contains *Granulatisporites frustulentus* in large quantities, but that is apparently where the resemblance with the Lower Carboniferous material of this study ends.

In his admirable summary (to 1961) of Australian pre-Tertiary palynological floras, Balme (1964) included a plate of Carboniferous spore photographs, but apart from reiterating his 1960 findings did not delineate any specific assemblages within the areas from which his data came (Canning, Carnarvon, and Bonaparte Gulf Basins). He introduced the term 'Lycosporoid-Microflora' to embrace the then known Carboniferous assemblages extending from the Tournaisian into the Upper Carboniferous. No specific locality details were given by Balme (1964) for the Carboniferous spores he illustrated and named informally. Some of these spores occur in the material of the present study, in which they are given formal specific designations; viz. *Granulatisporites frustulentus, Knoxisporites* sp. cf. *K. ruhlandi, Grandispora debilis, G. notensis, Anapiculatisporites largus,* and *Punctatisporites subvaricosus.*

The Carboniferous assemblage from southern Queensland described by de Jersey (1966) shares with the present material a pronounced abundance of *Granulatisporites frustulentus* (=*Lycospora suratensis* de Jersey), which de Jersey noted (p. 40) 'probably constitutes over 50 per cent of all the specimens observed'; but there are no other obvious similarities. De Jersey (1966) adduced a mid-Carboniferous (probably Namurian) age for his material, but lately (verbal communication) inclines more toward a Viséan dating.

The younger of the two Mulga Downs assemblages listed by Evans (1968) from western New South Wales was dated by him as Lower Carboniferous, no younger than Tournaisian. It contains the following elements that are identical with or closely related to forms of the Bonaparte Gulf Basin's Viséan sequence: *Endosporites micromanifestus* Hacquebard, 1957, *Velamisporites rugosus,* and cf. *Knoxisporites hederatus* (Ishchenko) Playford, 1963. The genera *Deltoidospora* (=*Leiotriletes*), *Punctatisporites,* and *Granulatisporites* (?including *G. frustulentus*) were recorded as abundant constituents. A stratigraphically significant form in both of Evans's assemblages was *Hymenozonotriletes lepidophytus* Kedo, 1957 (=*Leiozonotriletes naumovae* Balme & Hassell, 1962) which as discussed by

Owens & Streel (1967) is ubiquitous in Famennian and lowermost Tournaisian strata. This species does not occur in sediments of this study, but I have detected it in the Upper Devonian (and ?basal Tournaisian) sector of the Bonaparte Beds of Bonaparte No. 1.

The New South Wales assemblage from the Upper Carboniferous Italia Road Formation (Playford & Helby, 1968) bears no resemblance to the currently described palynological flora, which is scarcely surprising in view of the considerable age-disparity between the two. As suggested by Playford & Helby, their assemblage is probably younger than that from the Anderson Formation of Western Australia (Balme, 1960, 1964).

COMPARISON WITH EXTRA-AUSTRALIAN LOWER CARBONIFEROUS ASSEMBLAGES

Outside Australia no definite Lower Carboniferous spore assemblages have been reported from the southern hemisphere, so the comments below are concerned with the reasonably well known Lower Carboniferous assemblages of the northern hemisphere and their relationship to the Bonaparte Gulf Basin microflora.

Insofar as the assemblage studied here is dominated by the morphographically variable pan-Australian species *Granulatisporites frustulentus* it diverges markedly from coeval extra-Australian microfloras. Amongst the other, strictly subordinate elements, however, some similarities can be detected in the way of forms that are either identical with or closely related to certain northern hemisphere species of Lower Carboniferous-early Namurian age. Such affiliations with various extra-Australian assemblages are discussed below.

Several spore species of the Lower Mississippian (Tournaisian) Horton Group of eastern Canada (Hacquebard, 1957; Playford, 1964) have been found in the Bonaparte Gulf Basin, viz. *Verrucosisporites nitidus, Convolutispora vermiformis* Hughes & Playford, 1961, and probably *Grandispora uncata* (Hacquebard) comb. nov.

In the mid-Continent region of the United States, the late Mississippian to possibly early Pennsylvanian (Viséan-Namurian) microfloras (Hoffmeister, Staplin, & Malloy, 1955; Felix & Burbridge, 1967) include a number of species that are either identical with or very close to types recorded here as: *Convolutispora ampla* Hoffmeister, Staplin, & Malloy, 1955, *C. florida* Hoffmeister, Staplin, & Malloy, 1955, *C. vermiformis, Reticulatisporites papillatus* (Naumova) comb. nov., emend. (=*R. peltatus* Playford, 1962), *Knoxisporites hederatus, Densosporites* sp. cf. *D. aculeatus* Playford, 1963, *Auroraspora solisortus* Hoffmeister, Staplin, & Malloy, 1955, and *Hymenospora* cf. *caperata.* Hoffmeister et al. (1955, p. 378) note the peak of development in Chester (Viséan) time in the area of their study of the genus *Convolutispora* Hoffmeister, Staplin, & Malloy, 1955, which in turn shows considerable diversity in the Bonaparte Gulf Basin material.

British Tournaisian microfloras described by Sullivan (1964a, 1968) have in common with the Australian one *Verrucosisporites nitidus, Knoxisporites literatus* (Waltz) Playford, 1963, *Auroraspora macra,* and possibly *Grandispora uncata.* Other forms of the present microflora which are known from younger (Viséan-Namurian A) assemblages of Britain (Butterworth & Williams, 1958; Love, 1960; Sullivan, 1964b; Sullivan & Marshall, 1966; Neves & Owens, 1966; Smith & Butterworth, 1967) include *Convolutispora ampla, C. florida, C. jugosa* Smith & Butterworth, 1967, *C. varicosa* Butterworth & Williams, 1958, *?Grandispora uncata,* and *Auroraspora solisortus.* A form like *Hymenospora* cf. *caperata* occurs in the Scottish Namurian A.

From marine Viséan sediments of northeast France, Doubinger & Rauscher (1966) described a diverse microflora including spores which they assigned to

Knoxisporites ruhlandi, Foveosporites insculptus Playford var. *minor* Doubinger & Rauscher, 1966, and *Cirratriradites granulatipunctatus* Hoffmeister, Staplin, & Malloy, 1955. These are at least very close to forms found in the Bonaparte Gulf Basin, as discussed in the systematic section.

A number of species known from the Lower Carboniferous of western USSR (e.g. Luber & Waltz, 1938, 1941; Ishchenko, 1956, 1958) and Spitsbergen (Bhardwaj & Venkatachala, 1962; Playford, 1962, 1963) and from the Upper Mississippian (Viséan) of northern and western Canada (Hacquebard & Barss, 1957; Staplin, 1960; Playford & Barss, 1963), occurs as either identical or closely related forms in the Australian material of this study: e.g. *Verrucosisporites nitidus, Convolutispora ampla, C. crassa* Playford, 1962, *C. harlandii* Playford, 1962, *C. vermiformis, Reticulatisporites papillatus, Knoxisporites literatus, K. hederatus, Densosporites aculeatus, Auroraspora solisortus, A. macra, Velamisporites rugosus,* and *Grandispora uncata.* The Viséan palynological assemblages from these northerly regions of the northern hemisphere display marked similarities, as has already been noticed by Hacquebard & Barss (1957, p. 46), Playford & Barss (1963, p. 4), Playford (1964, p. 42) and, particularly, Sullivan (1965, 1967). In his discussions of regional variation among Mississippian spore floras, Sullivan referred to the palynological contents of the postulated northerly Viséan-Namurian A floral province as the *Monilospora* suite. The older palynological flora of Russia and Spitsbergen was named by him the *Lophozonotriletes* suite (Tournaisian). On the basis of Venkatachala's (1964) findings, Sullivan (1965, 1967) attributed, albeit somewhat tentatively, the Viséan Milligans Beds microflora to the *Monilospora* suite. However, it is now clear that none of that suite's 'typical elements' (Sullivan, 1967, p. 188) occurs in the Australian microflora, although two of its apparently less diagnostic components, *Reticulatisporites papillatus* (syn. *R. peltatus*) and *Knoxisporites literatus* (listed by Sullivan, 1965, p. 554), are represented. Likewise no characteristic components of the coexisting *Grandispora* suite (see Sullivan, 1967, p. 187) are recorded herein, except for one form, *Convolutispora florida,* shown in the list of Sullivan (1965, p. 555). Of the 8 'ubiquitous species' listed by Sullivan on the same page, only one, *Endosporites micromanifestus,* is represented in the Bonaparte Gulf Basin. Thus at present it seems clear that the palynological flora studied here does not match any of Sullivan's associations, because in the first place, the enormous quantities, let alone actual presence, of *Granulatisporites frustulentus* are unparalleled in any of them. Further work on the much wider range of material now available is expected to help to illuminate phytogeographic relationships in the Australian Carboniferous.

As discussed previously, faunal evidence from the strata under consideration [Bonaparte Beds (upper portion), Milligans Beds, Tanmurra Formation, Burvill Beds] indicates a Viséan age (with possible extension into the lowest Namurian in the case of the last two named units). This age assessment is strengthened by the palynological information when one collates the known extra-Australian ranges of previously established species discussed above. Probably the most significant of these in terms of international correlation are the following, whose known ranges are given in parentheses and whose names are preceded by 'cf.' where identity with a Bonaparte Gulf Basin species is not yet proven (see systematic section for sources of data).

Verrucosisporites nitidus (Upper Devonian-Viséan)
Convolutispora ampla (Viséan-Namurian)
Convolutispora crassa (Tournaisian-Viséan)
Convolutispora florida (Viséan-Namurian)
Convolutispora harlandii (Tournaisian-Viséan)
(cf.) *Foveosporites insculptus* var. *minor* (Viséan)
Reticulatisporites papillatus (Viséan-?Namurian)
Knoxisporites literatus (Tournaisian-Viséan)

(cf.) *Knoxisporites ruhlandi* (Viséan)
Auroraspora macra (Tournaisian-?Viséan)
Auroraspora solisortus (Viséan-Namurian)
(cf.) *Hymenospora caperata* (Viséan?-Namurian)
(cf.) *Velamisporites rugosus* (Viséan)

From the distribution of individual members of this association in the sediments studied (see Table 1) together with the known extra-Australian range of each species, the conclusion reached is that the sediments are entirely, or at least dominantly, Viséan in age. Moreover diversity of *Convolutispora* and occurrence, however minor, of *Tricidarisporites* Sullivan & Marshall, 1966 and *Diatomozonotriletes* Naumova emend. Playford, 1963 also indicate, at generic level, a Viséan age.

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APPENDIX 1

DATA ON SAMPLES STUDIED

Samples are listed under headings of boreholes and rock units from which they were taken. The palynological preparation number or numbers (prefixed 'B', 'K', or 'P') of each sample are cited; and core samples are given brief megascopic descriptions.

AOD BONAPARTE NO. 2 WELL

Tanmurra Formation

Cuttings: 650-660 ft (B181); 680-690 ft (B183); 710-720 ft (B184); 740-750 ft (B185); 770-780 ft (B186); 810-820 ft (B187); 850-860 ft (B188); 870-880 ft (B189); 900-910 ft (B190); 920-930 ft (B191).

Core 1: 946 ft (B50), sandstone, pale grey, fine to medium-grained, quartzose; 947 ft (B51, K177), sandstone, pale grey, fine-grained, quartzose, with grey shaly bands.

Cuttings: 960-970 ft (B192); 980-990 ft (B193).

Core 2: 1546 ft (K178), sandstone, pale grey, medium to coarse-grained, quartzose.

Bonaparte Beds

Core 3: 2175 ft (B53), shale, grey, carbonaceous; 2176 ft (B54), shale, grey, carbonaceous.

Core 5: 2836 ft (B56, B117), shale, dark grey, carbonaceous.

Core 6: 3210 ft (B57), shale, grey, silty, carbonaceous.

Core 7: 3531 ft (B59), shale, dark grey, silty, carbonaceous, micaceous; 3534 ft (B60), sandstone, pale grey, indurated, fine-grained, quartzose, with indeterminate plant fragments.

Core 8: 3941 ft (B62), shale, dark grey, silty, carbonaceous; 3946 ft (B63, B170), shale, dark grey, silty, carbonaceous.

Core 11: 4929 ft (B65, K179), shale, dark grey, silty, carbonaceous.

AOD BONAPARTE NO. 1 WELL

Tanmurra Formation

Core 2: 687 ft (B8, B30), limestone (biomicrite), pale grey.

Core 3: 965 ft (B9, K173), sandstone, very pale grey, fine-grained, silty, calcareous; 968 ft (B10, K174), sandstone, pale grey, fine-grained, silty, calcareous, with fine, carbonaceous lenticles and flecks.

Cuttings: 1330 ft (B174).

Core 5: 1564 ft (B12, K176), siltstone, grey, shaly, carbonaceous.

Bonaparte Beds

Cuttings: 1670 ft (B176), 1790 ft (B179), 1840 ft (B180).

Core 6: 1844 ft (B14, B46), siltstone, grey, shaly, carbonaceous, calcareous, fossiliferous; 1849 ft (B15, B47), siltstone, grey, shaly, carbonaceous, calcareous, fossiliferous.

Core 7: 2164 ft (B16), siltstone, grey, shaly, carbonaceous.

Core 8: 2405 ft (B17), siltstone, grey, shaly, carbonaceous, micaceous.

Core 9: 2549 ft (P382, B18A and B), siltstone, pale grey, shaly, carbonaceous, calcareous.

Core 10: 2858 ft (P383, B18C), siltstone, grey, shaly, carbonaceous, calcareous, fossiliferous.

Core 11: 3154 ft (B19), shale, grey, silty, carbonaceous.

Core 12: 3493 ft (B20), shale, dark grey, silty, carbonaceous, calcareous; 3501 ft (B21), siltstone, dark grey, carbonaceous.

Core 13: 3825 ft (B22), siltstone, grey, shaly, carbonaceous.

Core 14: 4349 ft (P370, B23), siltstone, dark grey, shaly, carbonaceous.

WESTRALIAN MILLIGANS NO. 1 BORE

Burvill Beds

Percussion sample: 141-142 ft (B214).

Milligans Beds

Percussion sample: 341-392 ft (B215).

WESTRALIAN SPIRIT HILL NO. 1 BORE

Milligans Beds

Percussion samples: 51-102 ft (P314, B138); 202-253 ft (B139); 253-295 ft (B140).

OIL DEV./WESTRALIAN SPIRIT HILL NO. 1 WELL

Milligans Beds

Bagged core samples: 100-150 ft (B70, B95); 150-200 ft (B71); 200-250 ft (B72); 250-300 ft (B73); 350-400 ft (B74).

Core: 398 ft (B141), siltstone, grey, indurated, shaly, sandy, carbonaceous.

Bagged core samples: 400-450 ft (B75); 450-500 ft (B76); 500-550 ft (B77); 550-600 ft (B78).

Core: 613 ft (B142), siltstone, grey, indurated, shaly, carbonaceous.

Bagged core samples: 700-750 ft (B80, B81); 800-850 ft (B91).

APPENDIX 2

DERIVATION OF NEW NAMES

abrupta (Cadiospora): Lat., *abruptus,* precipitous.
appositus (Foveosporites): Lat., *appositus,* appropriate.
balmei (Convolutispora): After Dr B. E. Balme (see Acknowledgments).
bonapartensis (Reticulatisporites): After Bonaparte Gulf Basin.
colliculus (Cristatisporites): Lat., *collis,* hill, high ground.
conspersus (Planisporites): Lat., *conspersus,* sprinkled.
coronata (Exallospora): Lat., *coronatus,* wreathed, garlanded.
debilis (Grandispora): Lat., *debilis,* weak.
Exallospora: Gk., *exallos,* quite different.
inprofusa (Raistrickia): Lat., *in-,* not; and Lat., *profusus,* abundant.
intonsus (Acanthotriletes): Lat., *intonsus,* unshorn.
intrastriatus (Archaeozonotriletes): Lat., *intra-,* within; and Lat., *striatus,* striated.
invicta (Crassispora): Lat., *invictus,* strong.
lacertosus (Velamisporites): Lat., *lacertosus,* muscular, strong.
largus (Anapiculatisporites): Lat., *largus,* copious, abundant.
notensis (Grandispora): Lat., *notensis,* southerly.
pinguis (Raistrickia): Lat., *pinguis,* fat.
resolutus (Punctatisporites): Lat., *resolutus,* firm.
rimulosa (Convolutispora): Lat., *rimula,* small fissure.
robertsi (Camptozonotriletes): After Dr J. Roberts (see Acknowledgments).
scrupulosa (Crassispora): Lat., *scrupulosus,* rough.
semisentus (Anapiculatisporites): Lat., *semi-,* half; and Lat., *sentus,* rough.
spiritensis (Acinosporites): After Spirit Hill.
subtriquetra (Convolutispora): Lat., *sub-,* somewhat; and Lat., *triquetrus,* triangular.
subvaricosus (Punctatisporites): Lat., *sub-,* somewhat; and Lat., *varicosus,* varicose.
turriculaeformis (Acanthotriletes): Lat., *turricula,* minaret; and Lat., *forma,* shape.
veeversi (Cirratriradites): After Dr J. J. Veevers (see Acknowledgments).

PLATE 1

All figures X500, and from unretouched negatives

Figures 1-4.—*Punctatisporites resolutus* sp. nov. Page 11

1. **Holotype,** proximal focus; Bonaparte No. 1 Well, 1840 ft; preparation B180/19, 43.8 120.8; CPC9934.
2. Proximal focus; Bonaparte No. 1 Well, 2164 ft; preparation B16A/16, 32.3 118.4, CPC9935.
3. Proximal focus; Bonaparte No. 1 Well, 2405 ft; preparation B17A/4, 22.8 123.0, CPC9936.
4. Proximo-lateral view; Bonaparte No. 1 Well, 3154 ft; preparation B19/1, 17.2 119.1, CPC9937.

Figures 5, 6.—*Leiotriletes* sp. A. . . . . Page 10

5. Proximal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/3, 27.9 110.9, CPC9938.
6. Proximal focus; same loc. as fig. 5; preparation B54/10, 36.4 123.8, CPC9939.

Figures 7-12.—*Punctatisporites subvaricosus* sp. nov. . . . . Page 12

7. Proximal focus; Bonaparte No. 2 Well, 2836 ft; preparation B117B/9, 37.1 117.2, CPC9940.
8. **Holotype,** proximal focus; same loc. as fig. 4; preparation B19/9, 25.9 121.5, CPC9941.
9. Distal focus; same loc. as fig. 7; preparation B117B/17, 35.5 118.9, CPC9942.
10. Median focus; Bonaparte No. 1 Well, 1790 ft; preparation B179/4, 35.9 116.7, CPC9943.
11. Proximal focus; Bonaparte No. 2 Well, 2175 ft; preparation B53A/1, 31.3 121.9, CPC9944.
12. Median focus; same loc. as fig. 7; preparation B117B/12, 36.2 120.2, CPC9945.

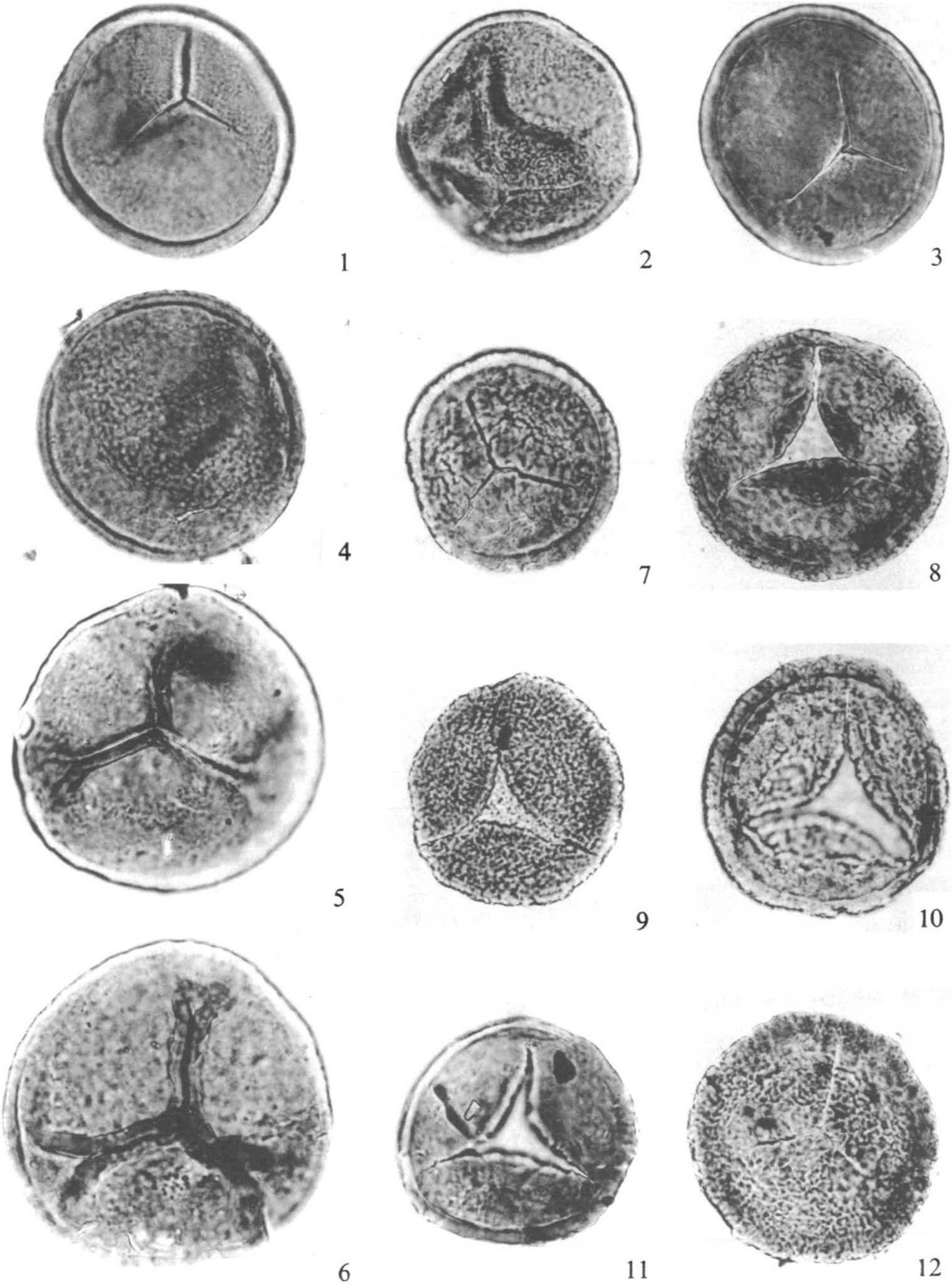
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PLATE 2

All figures X500, and from unretcuched negatives

Figures 1-8. — *Granulatisporites frustulentus* Balme & Hassell, 1962, emend. .. Page 13

1. Proximo-lateral view; Bonaparte No. 2 Well, 2175 ft; preparation B53A/1, 17.8 114.6, CPC9946.
2. Median focus; Spirit Hill No. 1 Well, 150-200 ft; preparation B71B/3, 35.6 114.6, CPC9947.

3, 4. Proximal and distal foci; Bonaparte No. 2 Well, 2836 ft; preparation B117B/3, 28.2 121.4, CPC9948.

5. Tetrad; Bonaparte No. 1 Well, 3154 ft; preparation B19/8, 31.6 121.3, CPC9949.
6. Tetrad; Bonaparte No. 1 Well, 2549 ft; preparation P382B/1, 18.9 114.2, CPC9950.
7. Distal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/13, 42.9 119.2, CPC9951.
8. Median focus; same loc. as fig. 1; preparation B53A/1, 21.9 109.2, CPC9952.

Figures 9-12. — *Apiculiretusispora* sp. A. .. .. Page 13

9, 10. Proximal and distal foci; same loc. as fig. 5; preparation B19/1, 32.2 114.7, CPC9953.

11, 12. Proximal and distal foci; same loc. as fig. 5; preparation B19/3, 40.2 115.3, CPC9954.

Figures 13-18. — *Punctatisporites subvaricosus* sp. nov. .. .. Page 12

13. Median focus; Bonaparte No. 1 Well, 3501 ft; preparation B21/1, 33.9 112.3, CPC9955.
14. Proximal focus; same loc. as fig. 13; preparation B21/1, 14.0 113.6, CPC9956.
15. Proximal focus; same loc. as fig. 6; preparation P382A/2, 16.9 127.2, CPC9957.
16. Proximal focus; same loc. as fig. 7; preparation B54/38, 41.5 119.2, CPC9958.
17. Proximal focus; same loc. at figs 3, 4; preparation B117B/1, 29.6 123.5, CPC9959.
18. Proximal focus; same loc. as fig. 7; preparation B54/69, 34.5 119.6, CPC9960.

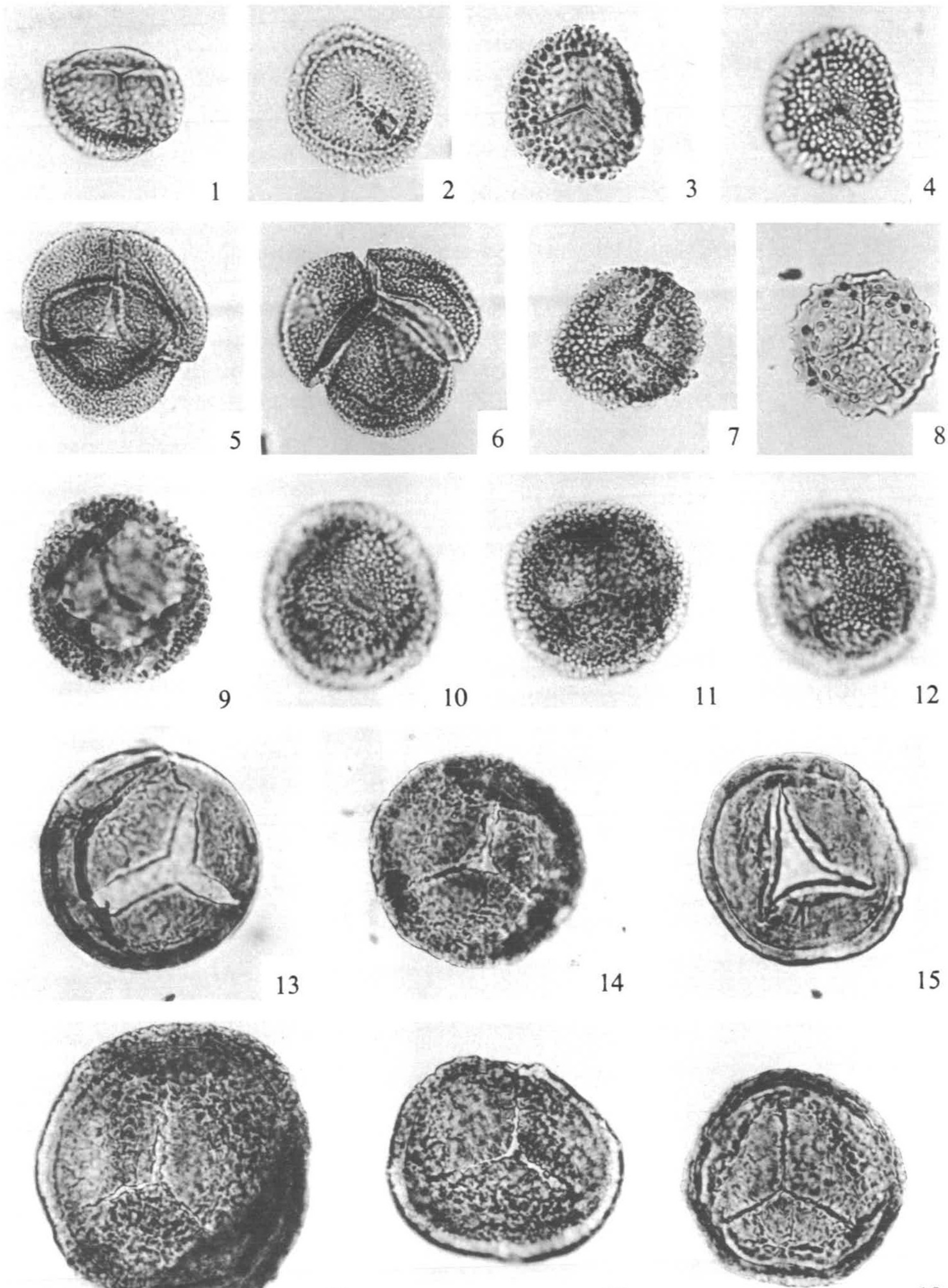
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PLATE 3

All figures X500, and from unretouched negatives

Figures 1-6. — *Verrucosisporites nitidus* Playford, 1964 . . . . Page 15

1. Distal focus; Spirit Hill No. 1 Well, 400-450 ft; preparation B75/2, 29.0 128.6, CPC9961.
2. Proximal focus; Bonaparte No. 2 Well, 980-990 ft; preparation B193/1, 43.8 111.5, CPC9962.
3. Median focus; Bonaparte No. 1 Well, 3154 ft; preparation B19/1, 39.9 112.2, CPC9963.
4. Median focus; Bonaparte No. 1 Well, 2549 ft; preparation P382A/1, 24.8 120.1, CPC9964.
5. Proximal focus; Bonaparte No. 2 Well, 850-860 ft; preparation B188/1, 29.4 114.2, CPC9965.
6. Lateral view; Bonaparte No. 1 Well, 2164 ft; preparation B16B/1, 46.6 112.7, CPC9966.

Figures 7-10. — *Cadiospora abrupta* sp. nov. . . . . Page 14

7, 8. **Holotype,** high proximal and median foci; Bonaparte No. 2 Well, 3210 ft; preparation B57/1, 35.5 113.2, CPC9967.

9. High proximal focus; same loc. as fig. 3; preparation B19/17, 43.7 124.1, CPC9968.

10. Median focus; same loc. as fig. 4; preparation P382B/1, 30.7 126.9, CPC9969.

Plate 3

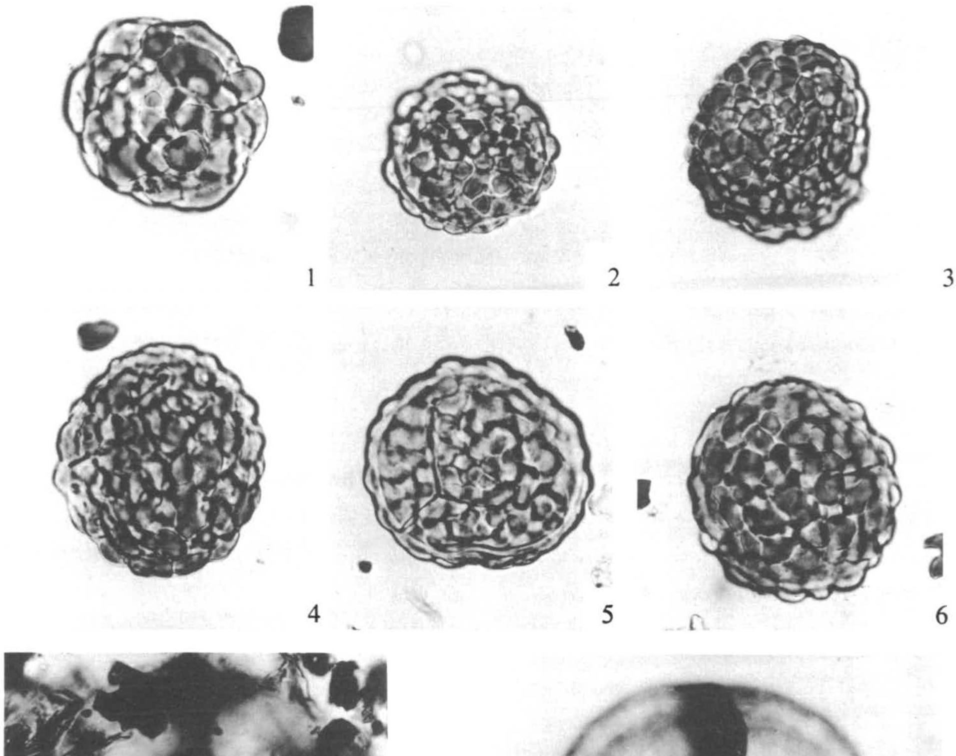

PLATE 4

All figures X500, and from unretouched negatives

Figures 1-6. — *Anapiculatisporites largus* sp. nov. . . . . Page 16

1. Median focus; Bonaparte No. 2 Well, 2836 ft; preparation B117B/22, 40.9 119.3, CPC9970.
2. Distal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/3, 20.5 111.4, CPC9971.
3. Median focus; same loc. as fig. 2; preparation B54/44, 35.8 124.4, CPC9972.
4. Distal focus; same loc. as fig. 1; preparation B117B/6, 36.4 117.6, CPC9973.
5. Proximal focus; same loc. as fig. 1; preparation B117B/3, 40.9 118.0, CPC9974.
6. **Holotype,** median focus; same loc. as fig. 1; preparation B117B/2, 50.0 123.9, CPC9975.

Figures 7-10. — *Anapiculatisporites semisentus* sp. nov. . . . . Page 17

7, 8. **Holotype,** proximal and distal foci; same loc. as fig. 2; preparation B54/51, 25.1 116.5, CPC9976.

9. Distal focus; Bonaparte No. 1 Well, 4349 ft; preparation P370B/1, 44.2 121.9, CPC9977.
10. Median focus; same loc. as fig. 2; preparation B54/2, 46.6 120.5, CPC9978.

Figures 11-13. — *Planisporites conspersus* sp. nov. . . . . Page 18

11. Median focus; same loc. as fig. 2; preparation B54/41, 32.0 120.2, CPC9979.
12. Distal focus; same loc. as fig. 2; preparation B54/3, 43.0 116.8, CPC9980.
13. Proximal focus; same loc. as fig. 2; preparation B54/2, 24.4 109.0, CPC9981.

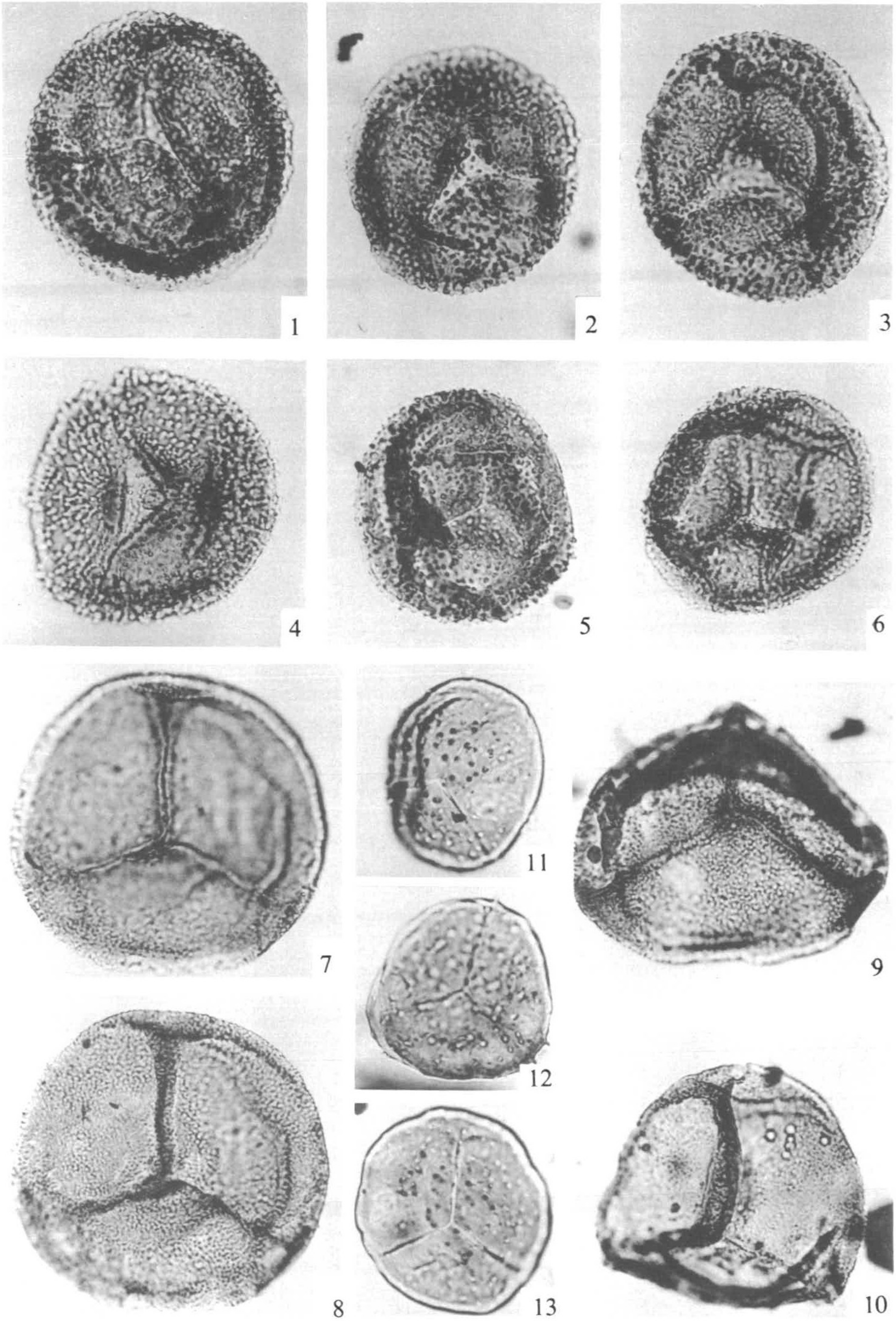
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PLATE 5

All figures X500, and from unretouched negatives

Figures 1-8. — *Acanthotriletes intonsus* sp. nov. . . . . Page 19

1. **Holotype,** median focus; Spirit Hill No. 1 Bore, 51-102 ft; preparation B138/12, 34.0 118.1, CPC9982.
2. Proximal focus; Bonaparte No. 1 Well, 3154 ft; preparation B19/2, 33.8 127.1, CPC9983.
3. Median focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/24, 35.2 119.0, CPC9984.
4. Distal focus; same loc. as fig. 1; preparation B138/13, 31.5 117.6, CPC9985.
5. Distal focus; same loc. as fig. 1; preparation B138/1, 59.2 125.3, CPC9986.
6. Proximo-lateral view; same loc. as fig. 2; preparation B19/5, 38.6 117.7, CPC9987.
7. Median focus; same loc. as fig. 1; preparation B138/2, 18.8 111.4, CPC9988.
8. Proximal focus; Bonaparte No. 2 Well, 2836 ft; preparation B56A/1, 26.9 125.0, CPC9989.

Figures 9-12. — *Raistrickia pinguis* sp. nov. . . . . Page 22

9. **Holotype,** distal focus; same loc. as fig. 3; preparation B54/57, 35.3 124.2, CPC9990.
10. Proximal focus; same loc. as fig. 3; preparation B54/5, 31.8 118.9, CPC9991.
11. Distal focus; same loc. as fig. 3; preparation B54/1, 27.5 107.5, CPC9992.
12. Proximal focus; Spirit Hill No. 1 Well, 550-600 ft; preparation B78/2, 36.6 115.0, CPC9993.

Figures 13, 14. — *Planisporites conspersus* sp. nov. . . . . Page 18

13. **Holotype,** median focus; same loc. as fig. 3; preparation B54/55, 31.3 120.2, CPC9994.
14. Distal focus; same loc. as fig. 3; preparation B54/56, 33.8 121.4, CPC9995.

Plates 15-17. — *Raistrickia inprofusa* sp. nov. . . . . Page 22

15. Lateral view; Spirit Hill No. 1 Well, 100-150 ft; preparation B70/2, 33.7 111.2, CPC9996.
16. Lateral view; Bonaparte No. 2 Well, 740-750 ft; preparation B185/2, 45.2 125.8, CPC9997.
17. **Holotype,** median focus; same loc. as fig. 2; preparation B19/1, 46.8 122.4, CPC9998.

Figure 18. — *Anapiculatisporites semisentus* sp. nov. . . . . Page 17
Distal focus, same loc. as fig. 3; preparation B54/2, 23.4 122.0, CPC9999.

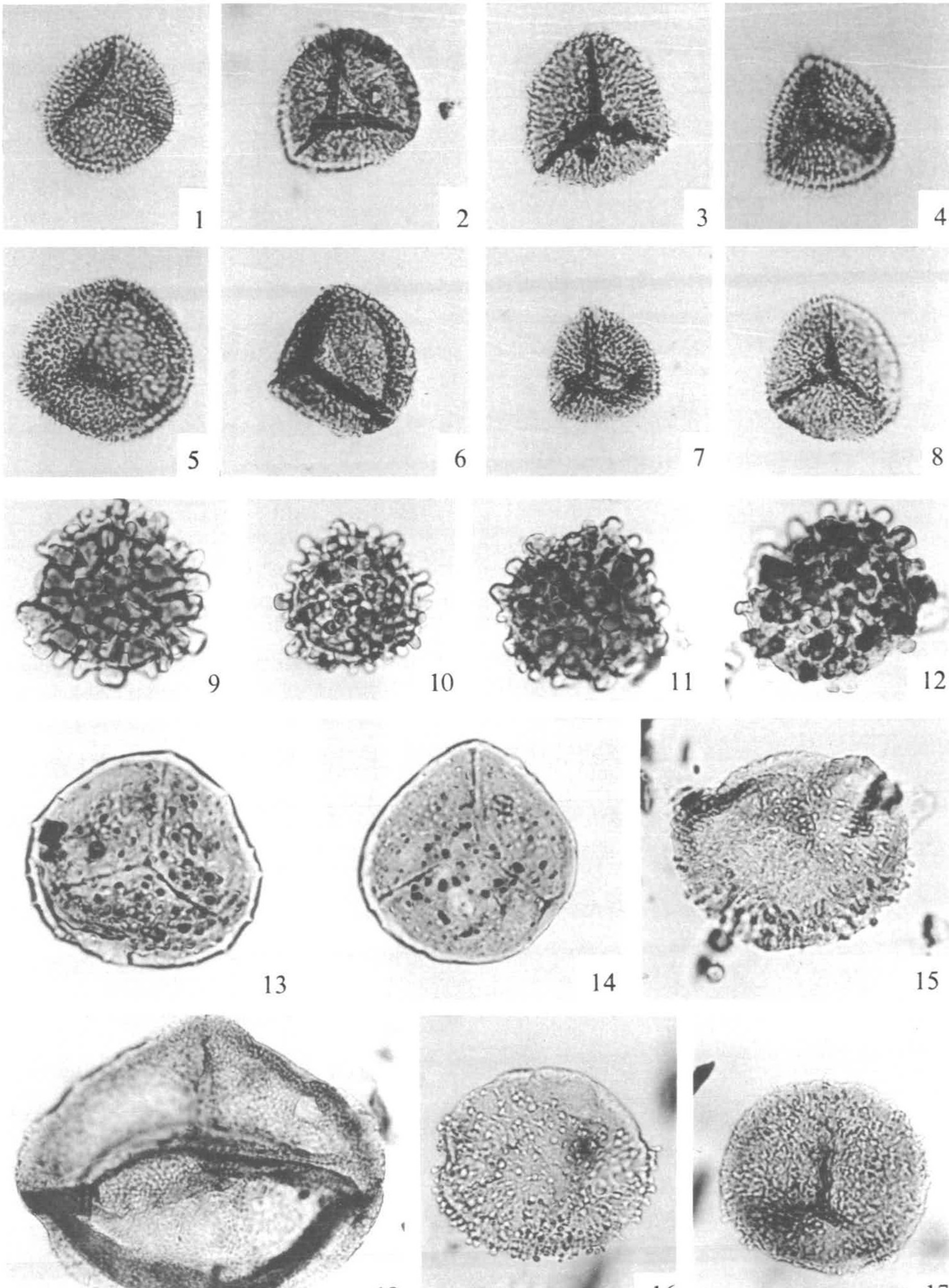
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PLATE 6

All figures X500 unless stated otherwise, from unretouched negatives

Figures 1, 2. — *Convolutispora fromensis* Balme & Hassell, 1962 . . . . Page 25

1. Distal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/1, 18.6 126.6, CPC10000.
2. Distal focus; same loc. as fig. 1; preparation B54/3, 24.8 115.9, CPC10001.

Figure 3. — *Convolutispora florida* Hoffmeister, Staplin, & Malloy, 1955 . . . . . . Page 24

Proximal focus; Spirit Hill No. 1 Bore, 51-102 ft; preparation B138/8, 39.6 118.8, CPC10002.

Figure 4. — *Tricidarisporites* sp. A . . . . Page 21

Low proximal focus; Bonaparte No. 2 Well, 770-780 ft; preparation B186/2, 38.2 124.0, CPC10003.

Figures 5, 6. — *Convolutispora ampla* Hoffmeister, Staplin, & Malloy, 1955 . . Page 23

5. Median focus; Bonaparte No. 1 Well, 1840 ft; preparation B180/24, 33.8 117.7, CPC10004.
6. Proximal focus; Bonaparte No. 2 Well, 710-720 ft; preparation B184/1, 48.5 116.9, CPC10005.

Figures 7-15. — *Acanthotriletes turriculaeformis* Kemp & Playford sp. nov. . . . . Page 20

7. **Holotype,** distal focus; same loc. as fig. 5; preparation B180/38, 37.2 120.5, CPC10006.
8. Distal focus; same loc. as fig. 5; preparation B180/2, 39.5 110.3, CPC10007.
9. Proximal focus; Bonaparte No. 1 Well, 1790 ft; preparation B179/10, 36.0 109.1, CPC10008.

10, 11. Distal focus and sculptural detail (X1000); same loc. as fig. 5; preparation B180/39, 35.4 116.0, CPC10009.

12. Proximal focus; Spirit Hill No. 1 Bore 253-295 ft; preparation B140/1, 24.8 123.2, CPC10010.
13. Distal focus; Bonaparte No. 1 Well, 2405 ft; preparation B17A/6, 34.8 119.1, CPC10011.
14. Sculptural detail (X1000); same loc. as fig. 5; preparation B180/2, 38.0 111.3, CPC10012.
15. Distal focus; same loc. as fig. 5; preparation B180/6, 31.0 117.9, CPC10013.

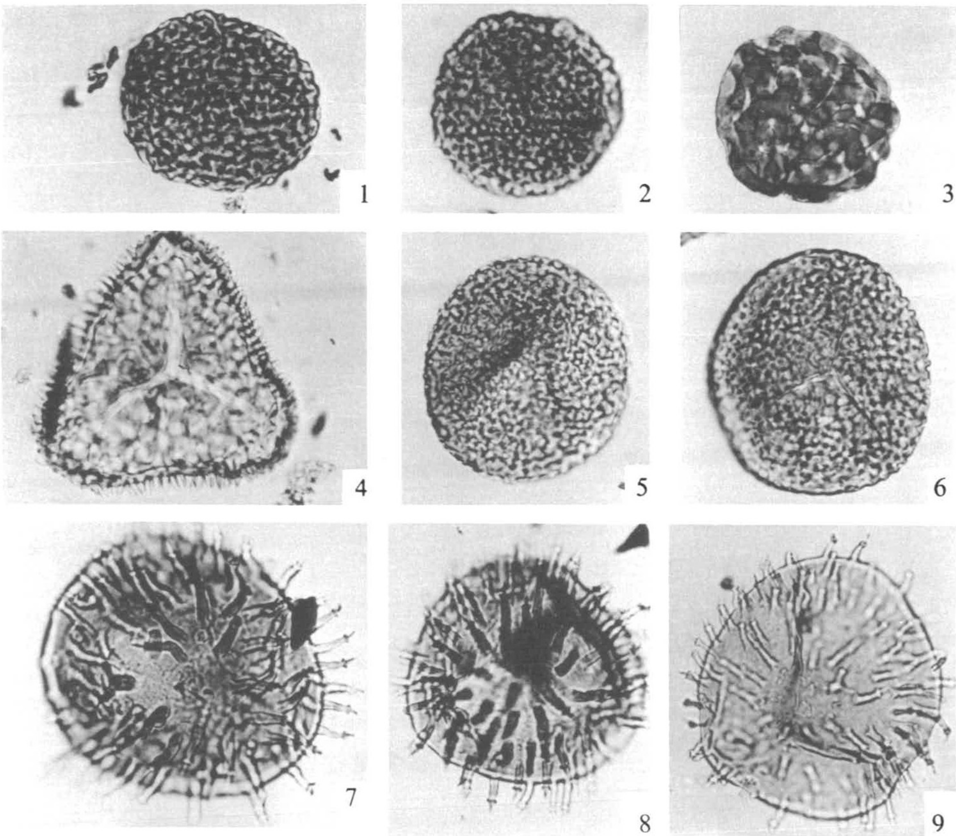
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PLATE 7

All figures X500 unless stated otherwise, from unretouched negatives

Figures 1-6. — *Convolutispora balmei* sp. nov. .. .. Page 23

1, 2. Distal and proximal foci; Bonaparte No. 1 Well, 2405 ft; preparation B17A/12, 37.5 118.5, CPC10014.

3. Proximal focus; same loc. as fig. 1; preparation B17A/3, 39.6 122.6, CPC10015.

4. Proximal focus; Bonaparte No. 2 Well, 3531 ft; preparation B59/5, 32.0 119.9, CPC10016.

5. **Holotype,** median focus; Spirit Hill No. 1 Well, 400-450 ft; preparation B75/3, 17.9 124.4, CPC10017.

6. Sculptural detail (X1000); Bonaparte No. 1 Well, 2164 ft; preparation B16B/1, 35.9 111.0, CPC10018.

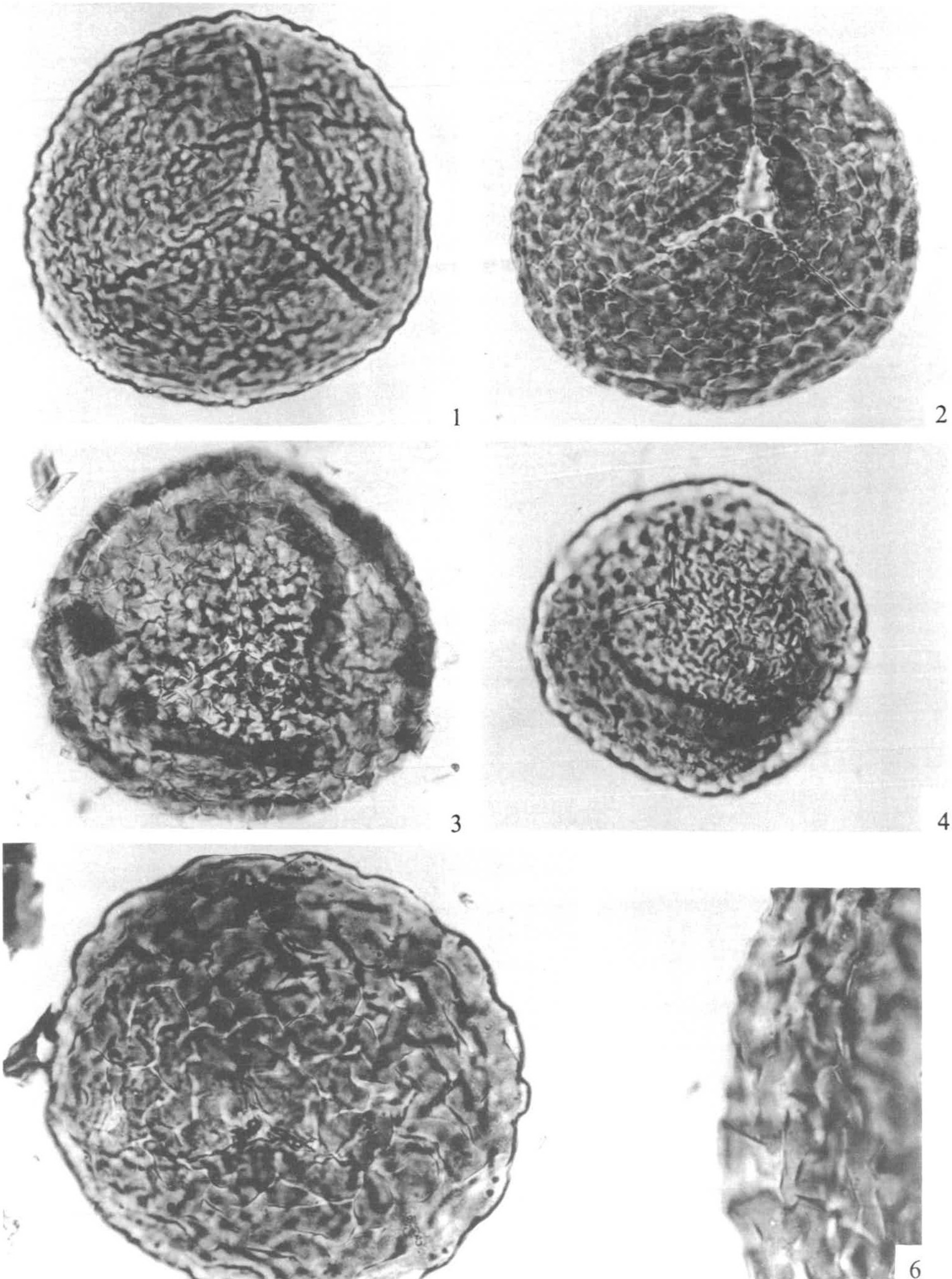
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PLATE 8

All figures X500, and from unretouched negatives

Figures 1-3. — *Convolutispora harlandii* Playford, 1962 . . . . Page 25

1, 2. Proximal and distal foci; Bonaparte No. 1 Well, 2405 ft; preparation B17A/3, 26.9 124.5, CPC10019.

3. Lateral view; Bonaparte No. 2 Well, 2836 ft; preparation B117B/30, 33.4 118.7, CPC10020.

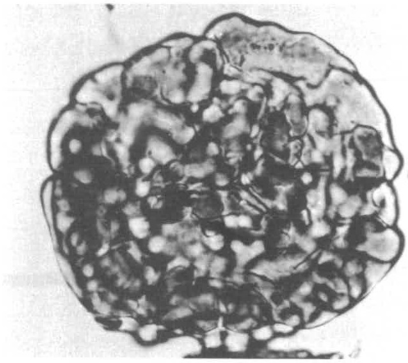
Figures 4, 5. — *Convolutispora jugosa* Smith & Butterworth, 1967 . . . . Page 26

4. Distal focus; Bonaparte No. 2 Well, 770-780 ft; preparation B186/2, 16.6 122.5, CPC10021.

5. Lateral view; same loc. as figs 1, 2; preparation B17A/2, 54.0 115.4, CPC10022.

Figure 6. — *Convolutispora crassa* Playford, 1962 . . . . Page 24

Median focus; Bonaparte No. 1 Well, 1849 ft; preparation B15C/3, 46.8 124.3, CPC10023.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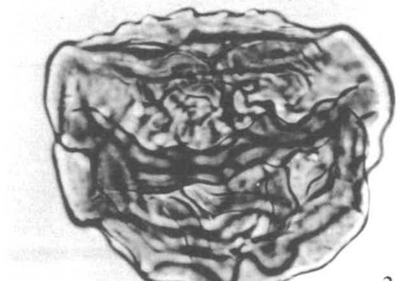
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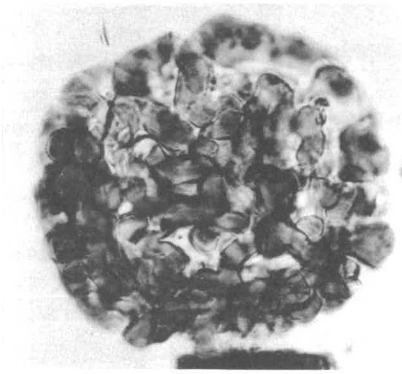
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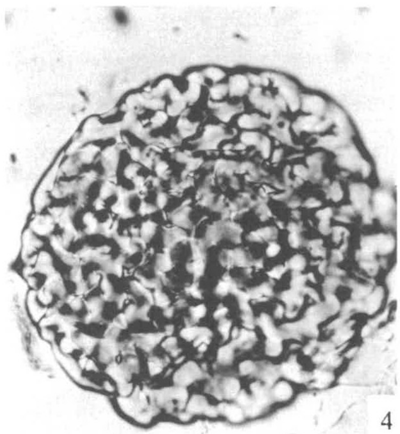
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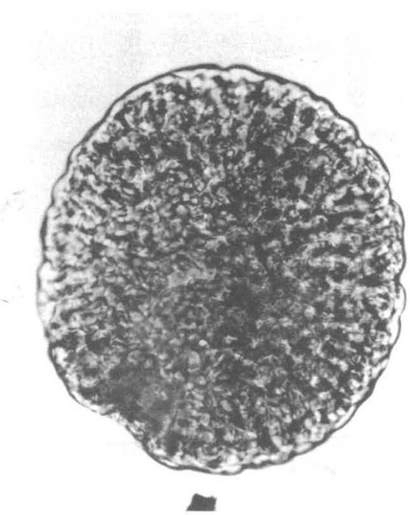
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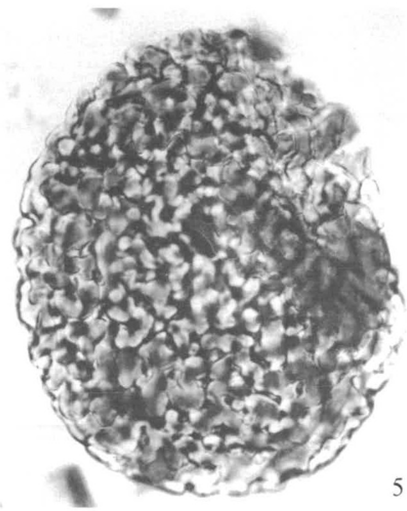
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PLATE 9

All figures X500, and from unretouched negatives

Figure 1. — *Convolutispora vermiformis* Hughes & Playford, 1961 . . . . Page 27

Proximal focus; Bonaparte No. 2 Well, 3941 ft; preparation B62/1, 54.8 110.3, CPC10024.

Figures 2-4. — *Convolutispora subtriquetra* sp. nov. . . . . Page 27

2. **Holotype,** distal focus; Bonaparte No. 1 Well, 4349 ft; preparation P370B/2, 34.8 128.1, CPC10025.
3. Proximal focus; Bonaparte No. 1 Well, 1840 ft; preparation B180/16, 36.5 120.9, CPC10026.
4. Distal focus; Bonaparte No. 1 Well, 2549 ft; preparation B18B/1, 32.9 115.7, CPC10027.

Figure 5. — *Convolutispora crassa* Playford, 1962 . . . . Page 24

Distal focus; Bonaparte No. 2 Well, 650-660 ft; preparation B181/1, 52.8 124.5, CPC10028.

Figure 6. — *Convolutispora* sp. A . . . . Page 28

Median focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/3, 44.9 123.0, CPC10029.

Figure 7. — *Mooreisporites* sp. A . . . . Page 33

Median focus; Spirit Hill No. 1 Well, 250-300 ft; preparation B73A/1, 20.2 115.8, CPC10030.

Figure 8. — *Diatomozonotriletes* sp. A . . . . Page 33

Median focus; same loc. as fig. 6; preparation B54/2, 32.3 125.2, CPC10031.

Figure 9. — *Convolutispora varicosa* Butterworth & Williams, 1958 . . . . Page 27

Distal focus; same loc. as fig. 4; preparation P382A/1, 26.9 115.3, CPC10032.

Figures 10, 11. — *Convolutispora rimulosa* sp. nov. Page 26

10. **Holotype,** proximal focus; Bonaparte No. 1 Well, 2405 ft; preparation B17A/8, 35.0 118.8, CPC10033.
11. Proximal focus; same loc. as fig. 6; preparation B54/3, 37.7 113.0, CPC10034.

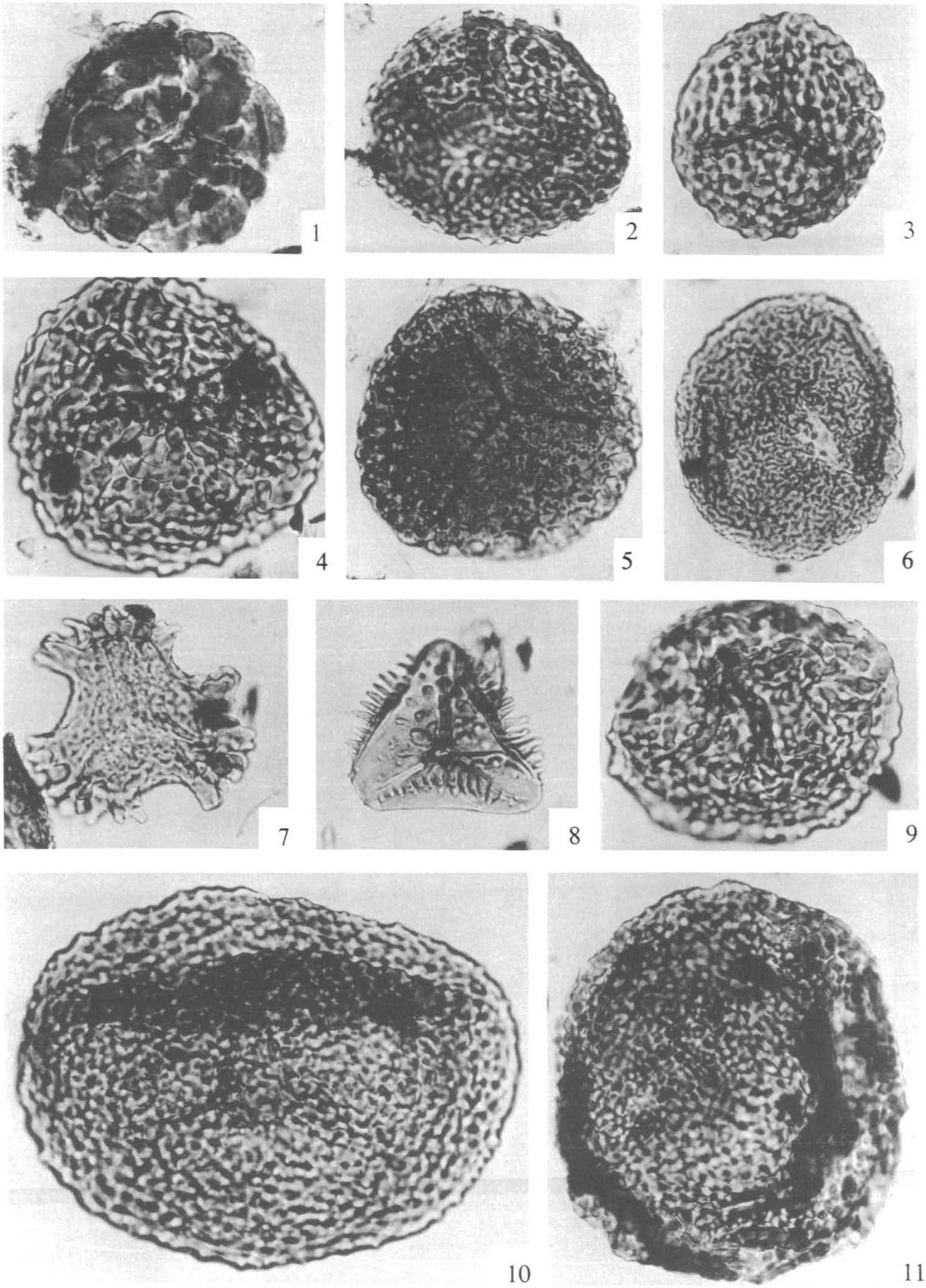
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PLATE 10

All figures X500, and from unretouched negatives

Figures 1-8. — *Foveosporites appositus* sp. nov. .. .. Page 28

1, 2. **Holotype,** distal and proximal foci; Bonaparte No. 2 Well, 2836 ft; preparation B117B/14, 38.2 118.9, CPC10035.

3, 4. Proximal and distal foci; Bonaparte No. 2 Well, 2176 ft; preparation B54/59, 38.2 122.8, CPC10036.

5. Distal focus; Spirit Hill No. 1 Well, 150-200 ft; preparation B71B/1, 43.8 115.9, CPC10037.

6. Disto-lateral view; Bonaparte No. 1 Well, 1844 ft; preparation B46/3, 43.2 114.5, CPC10038.

7. Distal focus; Bonaparte No. 2 Well, 2175 ft; preparation B53A/1, 19.9 124.8, CPC10039.

8. Lateral view; Bonaparte No. 2 Well, 650-660 ft; preparation B181/2, 45.2 114.1, CPC10040.

Figure 9. — *Microreticulatisporites* sp. A .. .. Page 29

Distal focus; Bonaparte No. 1 Well, 2405 ft; preparation B17B/1, 28.8 127.5, CPC10041.

Figure 10. — *Reticulatisporites bonapartensis* sp. nov. .. .. Page 30

Holotype, median focus; Bonaparte No. 1 Well, 2549 ft; preparation P382A/2, 27.8 128.6, CPC10042.

Figures 11, 12. — *Reticulatisporites papillatus* (Naumova) comb. nov., emend. .. Page 31

11. Distal focus; same loc. as fig. 9; preparation B17B/2, 45.5 114.2, CPC10043.

12. Distorted specimen; same loc. as fig. 9; preparation B17B/1, 24.5 120.5, CPC10044.

Figures 13, 14. — *Dictyotriletes* sp. cf. *D. densoreticulatus* R. Pontonié & Kremp, 1955Page 29

13. Proximal focus; Bonaparte No. 2 Well, 3531 ft; preparation B59/2, 20.4 124.6, CPC10045.

14. Disto-lateral view; Bonaparte No. 1 Well, 1790 ft; preparation B179/8, 41.0 120.6, CPC10046.

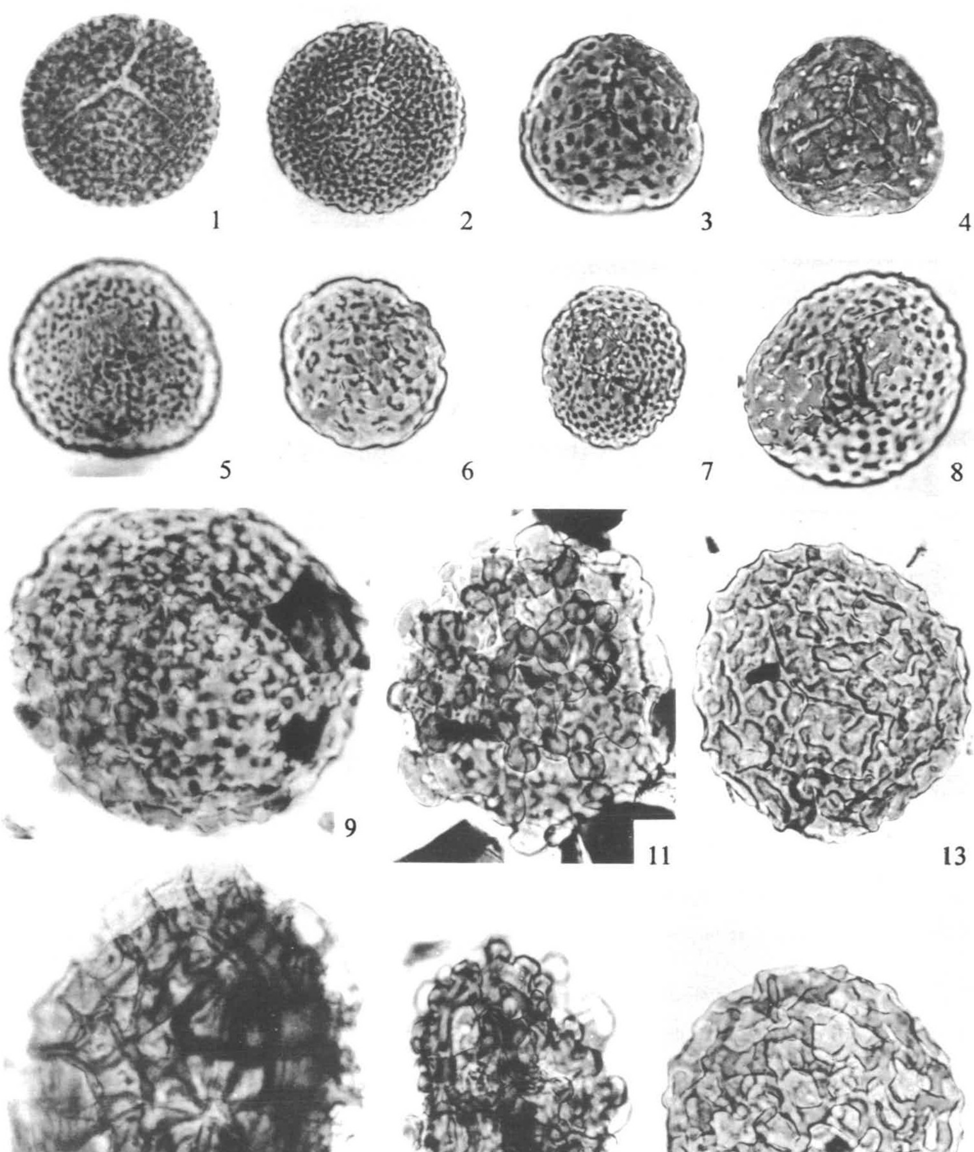


PLATE 11

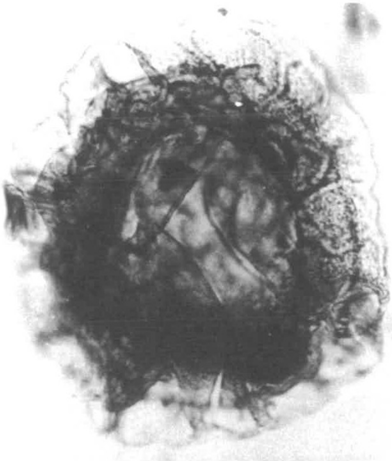
All figures X500, and from unretouched negatives

Figures 1-3. — *Reticulatisporites bonapartensis* sp. nov. . . . . Page 30

1. Proximal focus; Bonaparte No. 1 Well, 2549 ft; preparation P382B/1, 25.2 122.7, CPC10047.
2. Proximal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/1, 27.4 109.5, CPC10048.
3. Distal focus; Bonaparte No. 2 Well, 3531 ft; preparation B59/1, 36.8 111.2, CPC10049.

Figures 4-6. — *Acinosporites spiritensis* sp. nov. . . . . Page 32

4. **Holotype,** distal focus; Spirit Hill No. 1 Well, 550-600 ft; preparation B78/1, 51.0 113.4, CPC10050.
5. Median focus; Spirit Hill No. 1 Well, 613 ft; preparation B142/2, 50.9 124.8, CPC10051.
6. Proximal focus; Spirit Hill No. 1 Well, 250-300 ft; preparation B73A/1, 13.2 118.2, CPC10052.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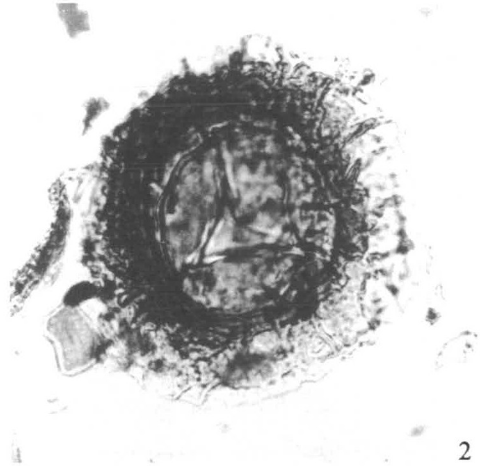
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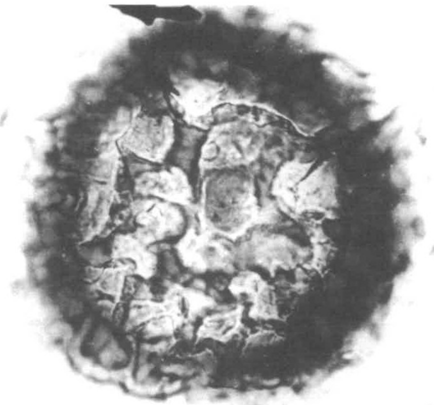
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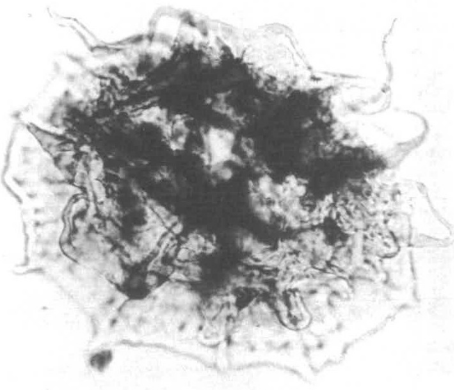
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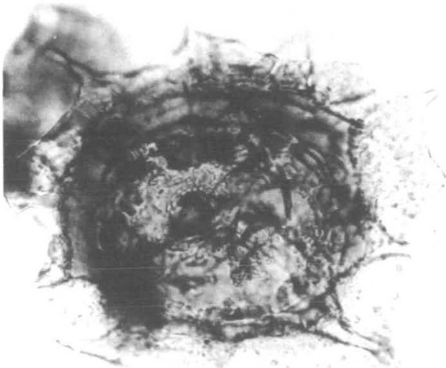
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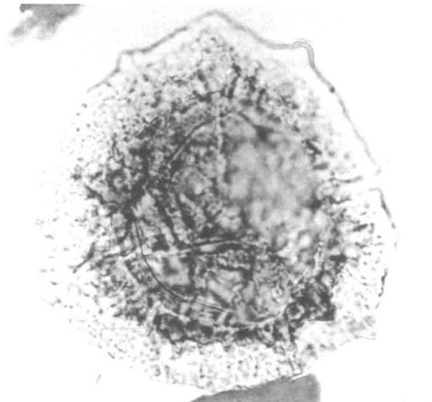
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PLATE 12

All figures X500, and from unretouched negatives

Figures 1-11. — *Knoxisporites* sp. cf. *K. ruhlandi* Doubinger & Rauscher, 1966 .. Page 35

1. Proximal focus; Bonaparte No. 2 Well, 2836 ft; preparation B117B/36, 38.9 119.2, CPC10053.

2, 3. Proximal and distal foci; Bonaparte No. 1 Well, 3493 ft; preparation B20/2, 30.6 112.7, CPC10054.

4. Median focus; same loc. as fig. 1; preparation B117B/4, 39.0 120.4, CPC10055.

5. Median focus; Spirit Hill No. 1 Well, 550-600 ft; preparation B78/1, 21.2 117.2, CPC10056.

6. Median focus; Bonaparte No. 1 Well, 2164 ft; preparation B16B/4, 41.1 115.8, CPC10057.

7. Median focus; same loc. as fig. 1; preparation B117B/3, 19.1 124.3, CPC10058.

8. Distal focuc; Bonaparte No. 1 Well, 2549 ft; preparation B18A/1, 33.5 109.9, CPC10059.

9. Proximal focus; Spirit Hill No. 1 Bore, 51-102 ft; preparation B138/10, 28.3 115.9, CPC10060.

10, 11. Proximal and distal foci; Bonaparte No. 1 Well, 2405 ft; preparation B17A/23, 40.2 123.2, CPC10061.

Figures 12-17. — *Exallospora coronata* gen. et sp. nov. .. .. Page 36

12-14. **Holotype;** proximal, distal, and extreme distal foci respectively; Bonaparte No. 2 Well, 650-660 ft; preparation B181/1, 42.9 126.3, CPC10062.

15. Proximal focus; Bonaparte No. 1 Well, 1790 ft; preparation B179/1, 26.2 122.3, CPC10063.

16. Proximal focus; same loc. as fig. 15; preparation B179/3, 43.7 121.3, CPC10064.

17. Distal focus; Bonaparte No. 1 Well, 2164 ft; preparation B16B/1, 22.9 123.9, CPC10065.

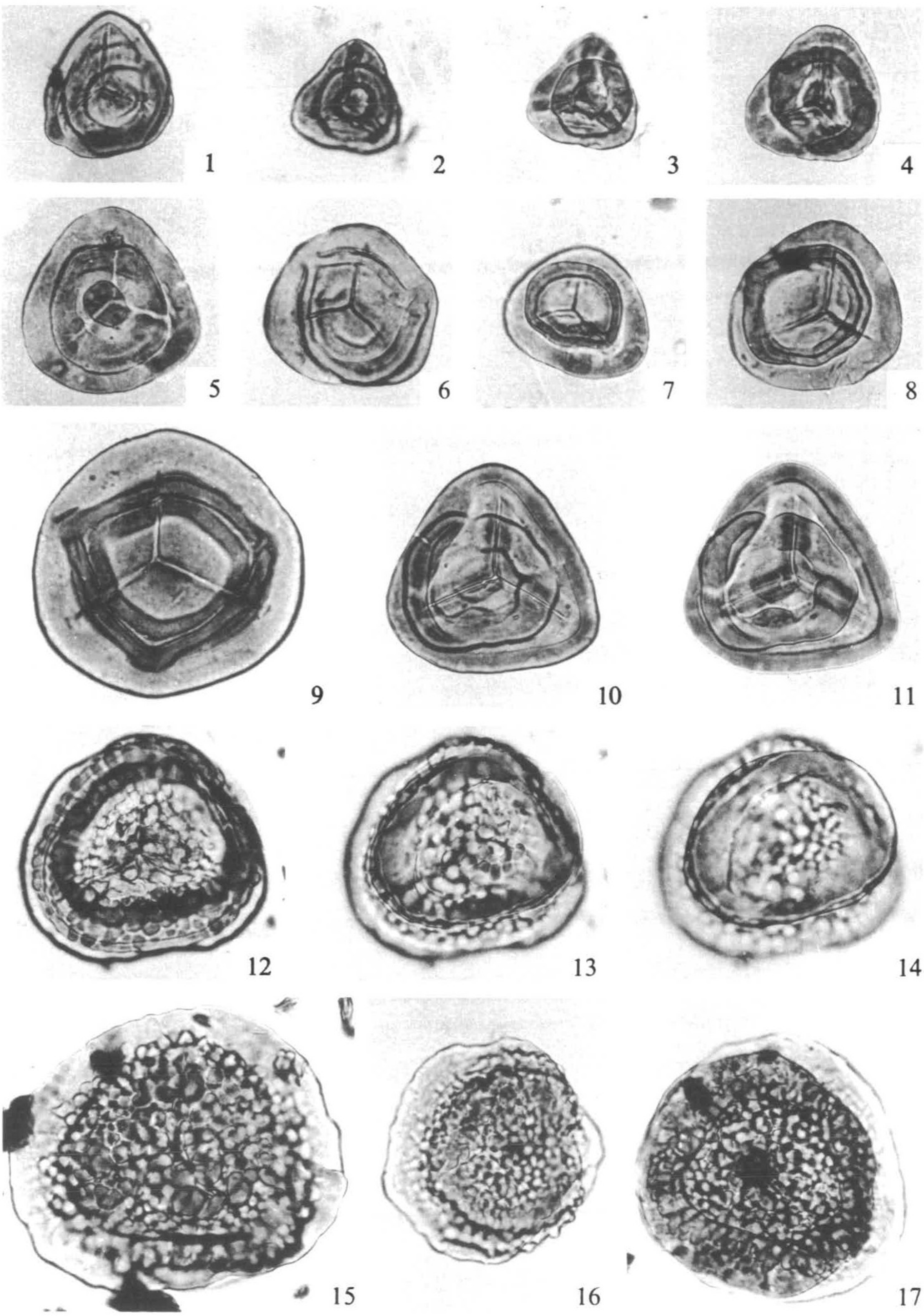
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PLATE 13

All figures X500, and from unretouched negatives

Figures 1, 2. — *Knoxisporites hederatus* (Ishchenko) Playford, 1963 . . . . Page 34

1. Median focus; Bonaparte No. 2 Well, 2836 ft; preparation B117B/23, 35.9 118.2, CPC10067.

2. Proximal focus; same loc. as fig. 1; preparation B117B/31, 38.0 120.4, CPC10068.

Figures 3-5. — *Crassispora scrupulosa* sp. nov. . . . . Page 38

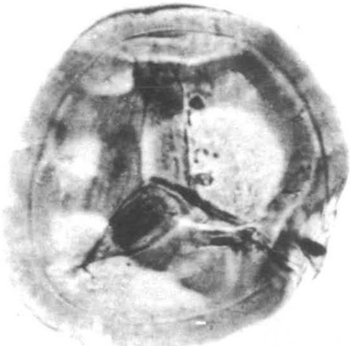
3. **Holotype,** proximal focus; same loc. as fig. 1; preparation B117B/1, 42.5 111.2, CPC10069.

4. Median focus; Spirit Hill No. 1 Well, 500-550 ft; preparation B77/2, 57.5 116.0, CPC10070.

5. Distal focus; same loc. as fig. 1; preparation B117B/29, 39.6 119.1, CPC10071.

Figure 6. — *Crassispora invicta* sp. nov. . . . . Page 37

Portion of tetrad; Bonaparte No. 2 Well, 2176 ft; preparation B54/54, 31.2 116.7, CPC10072.



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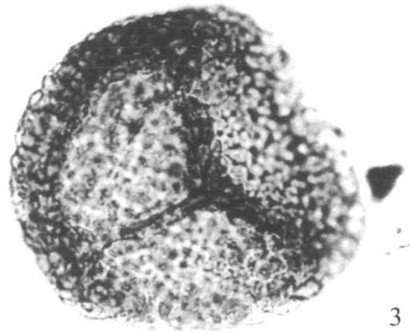

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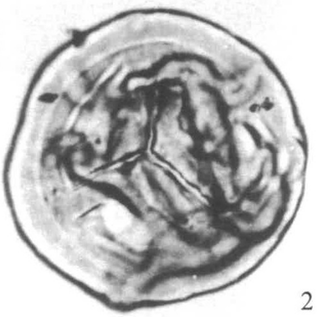

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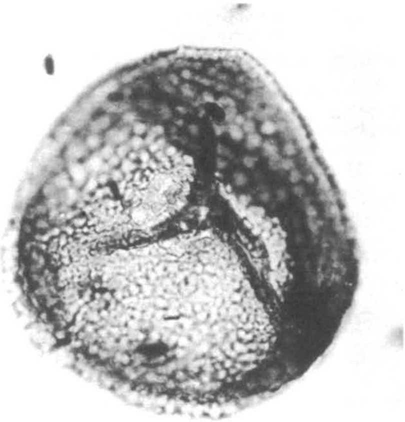

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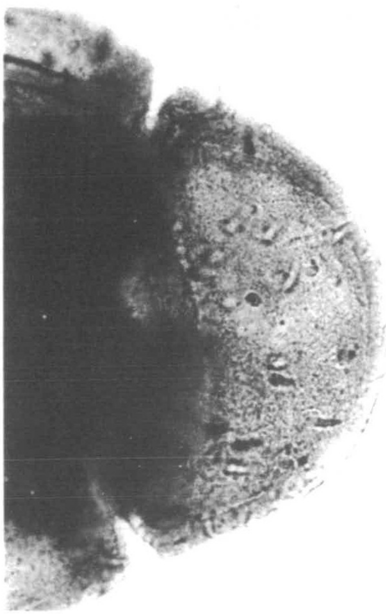

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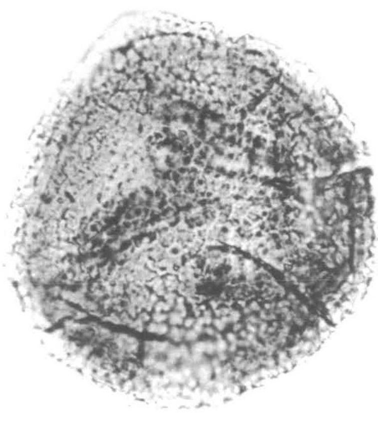

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PLATE 14

All figures X500, and from unretouched negatives

Figures 1, 2. — *Cristatisporites colliculus* sp. nov. Page 40

Proximal and distal foci; Bonaparte No. 2 Well, 2176 ft; preparation B54/1, 46.9 127.8, CPC10073.

Figures 3-8. — *Densosporites* sp. cf. *D. aculeatus* Playford, 1963 . . . . Page 39

3. Median focus; Spirit Hill No. 1 Well, 100-150 ft; preparation B70/3, 34.4 123.1, CPC10074.
4. Proximal focus; same loc. as fig. 1; preparation B54/3, 58.3 109.8, CPC10075.
5. Median focus; Bonaparte No. 1 Well, 3154 ft; preparation B19/12, 37.6 119.8, CPC10076.
6, 7. Proximal and distal foci; Spirit Hill No. 1 Well, 150-200 ft; preparation B71B/3, 31.3 120.0, CPC10077.
8. Tetrad; Spirit Hill No. 1 Well, 550-600 ft; preparation B78/1, 50.7 114.0, CPC10078.

Figures 9, 10. — *Crassispora invicta* sp. nov. . . . . Page 37

9. Distal focus; same loc. as fig. 3; preparation B70/2, 29.3 119.0, CPC10079.
10. **Holotype,** median focus; same loc. as figs 1, 2; preparation B54/16, 39.6 123.5, CPC10080.

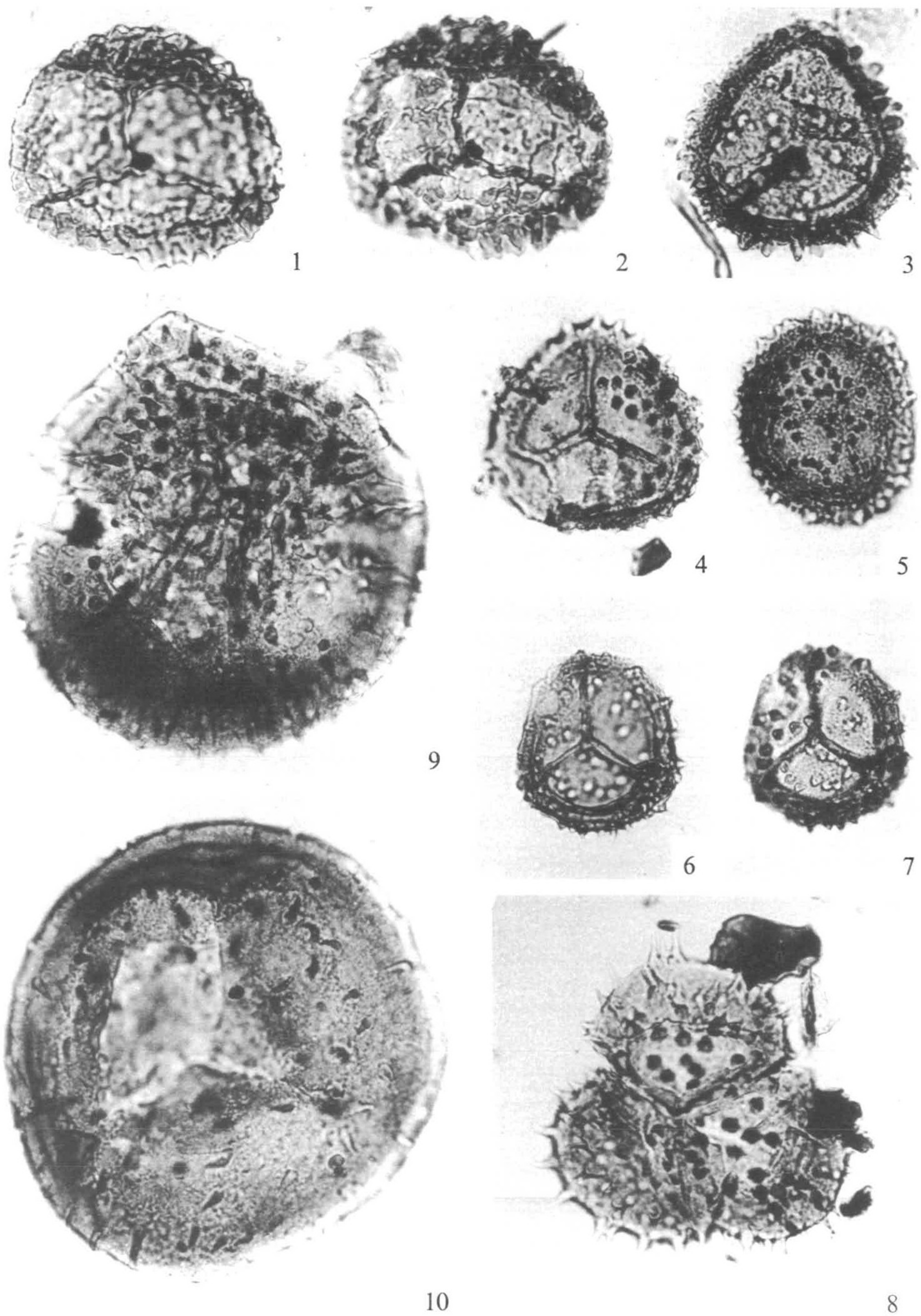
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PLATE 15

All figures X500, and from unretouched negatives

Figures 1-6. — *Cristatisporites colliculus* sp. nov. . . . . Page 40

1-3. **Holotype;** proximal, median, and distal foci respectively; Spirit Hill No. 1 Well, 100-150 ft; preparation B70/5, 43.8 118.4, CPC10081.

4, 5. Proximal and distal foci; Bonaparte No. 2 Well, 2176 ft; preparation B54/71, 37.2 118.2, CPC10082.

6. Distal focus; Spirit Hill No. 1 Well, 500-550 ft; preparation B77/2, 60.0 120.4, CPC10083.

Figures 7-10. — *Camptozonotriletes robertsi* sp. nov. . . . . Page 42

7. **Holotype,** median focus; same loc. as figs 4, 5; preparation B54/63, 30.6 111.5, CPC10084.

8, 9. Proximal and distal foci; same loc. as figs 4, 5; preparation B54/1, 31.5 118.6, CPC10085.

10. Distal focus; Bonaparte No. 1 Well, 1849 ft; preparation B15C/1, 28.9 120.0, CPC10086.

Figures 11, 12. — *Archaeozonotriletes intrastriatus* sp. nov. . . . . Page 44

11. Median focus; same loc. as figs 4, 5; preparation B54/36, 41.3 124.4, CPC10087.

12. Proximal focus; same loc. as figs 4, 5; preparation B54/25, 35.8 121.0, CPC10088.

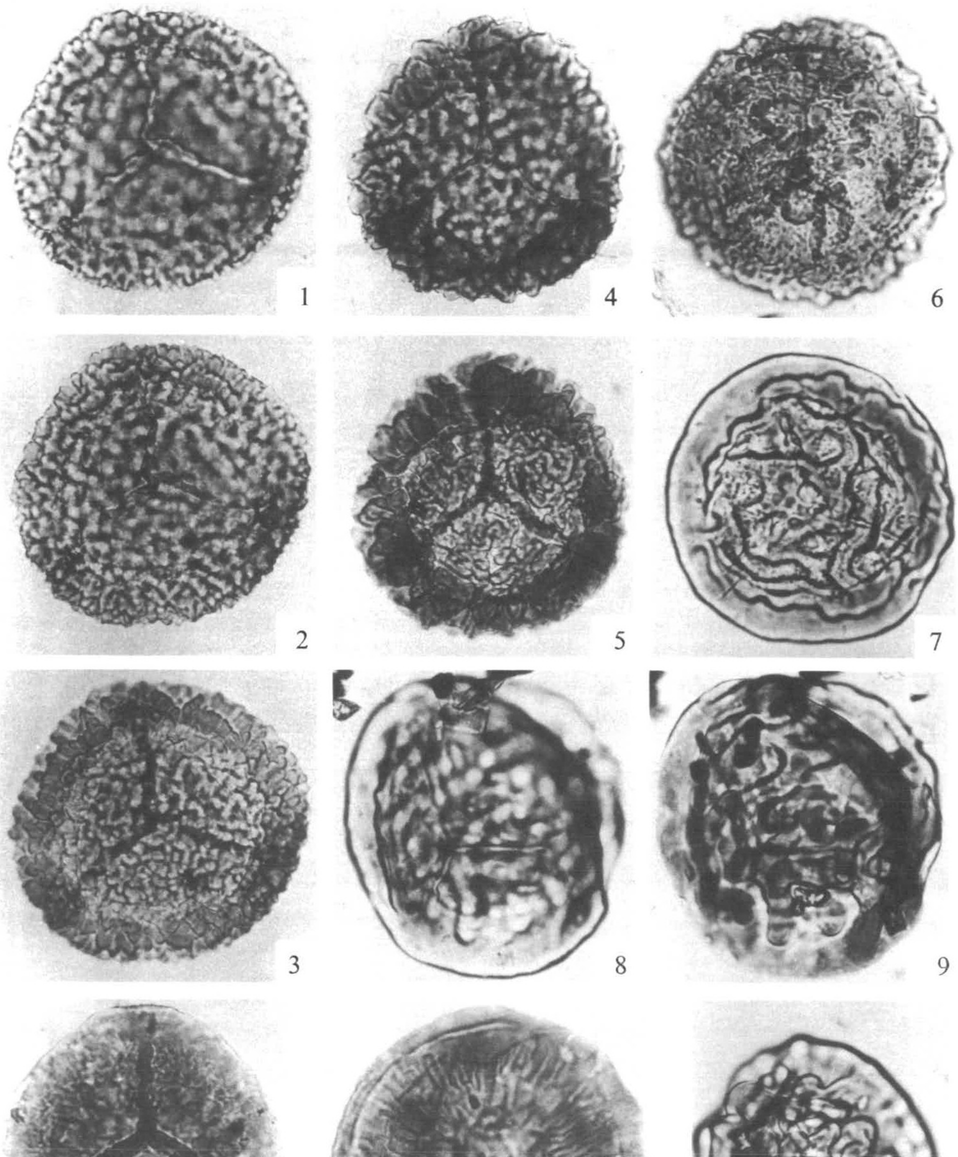
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PLATE 16

All figures X500, and from unretouched negatives

Figures 1, 2. — *Cirratriradites veeversi* sp. nov. .. .. Page 41

1. Median focus; Bonaparte No. 2 Well, 2836 ft; preparation B56/1, 18.7 118.0, CPC10089.
2. **Holotype,** proximal focus; same loc. as fig. 1; preparation B117B/3, 46.3 129.2, CPC10090.

Figures 3, 4. — *Grandispora notensis* sp. nov. .. .. Page 48

Holotype, proximal and distal foci; Bonaparte No. 2 Well, 650-660 ft; preparation B181/1, 50.2 115.1, CPC10091.

Figures 5-7. — *Archaeozonotriletes intrastriatus* sp. nov. .. .. Page 44

5. Median focus; Bonaparte No. 2 Well, 3531 ft; preparation B59/8, 36.5 125.5, CPC10092.
6. **Holotype,** proximal focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/48, 31.2 117.0, CPC10093.
7. Proximal focus; same loc. as fig. 6; preparation B54/7, 38.9 113.3, CPC10094.


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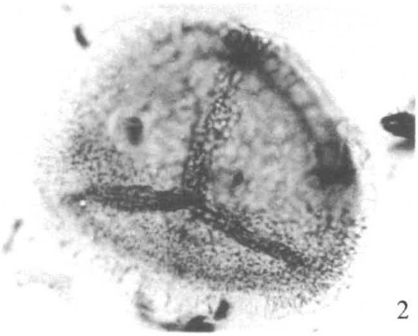
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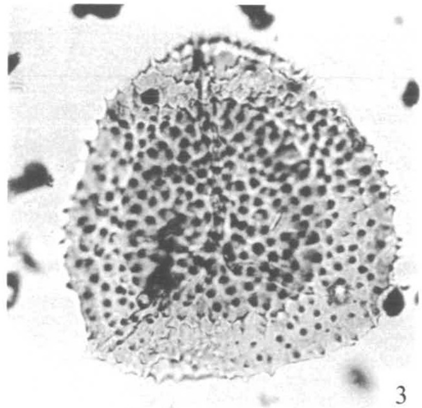
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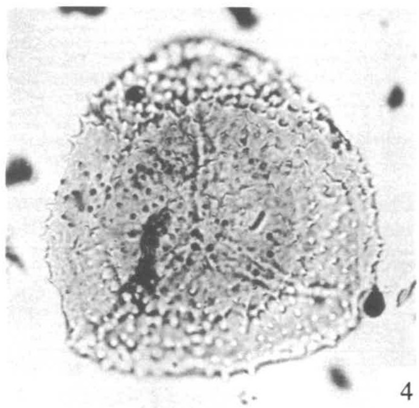
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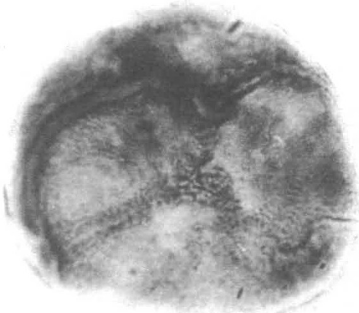
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PLATE 17

All figures X500, and from unretouched negatives

Figures 1-6. — *Auroraspora macra* Sullivan, 1968 .. .. Page 49

1. Median focus; Bonaparte No. 1 Well, 687 ft; preparation B8/4, 36.2 122.3, CPC10095.
2. Distal focus; same loc. as fig. 1; preparation B30B/1, 48.2 109.8, CPC10096.
3. , 4. Proximal and distal foci; same loc. as fig. 1; preparation B30B/1, 39.6 109.2, CPC10097.
5. Proximal focus; same loc. as fig. 1; preparation B30B/1, 19.8 127.9, CPC10098.
6. Distal focus; Spirit Hill No. 1 Well, 350-400 ft; preparation B74/1, 53.3 113.3, CPC10099.

Figures 7, 8. — *Grandispora debilis* sp. nov. .. .. Page 47

Holotype, proximal and distal foci; Spirit Hill No. 1 Bore, 51-102 ft; preparation B138/11, 36.2 118.2, CPC10100.

Figures 9-15. — *Hymenospora* cf. *H. caperata* Felix & Burbridge, 1967 .. .. Page 51

9. Median focus; Bonaparte No. 1 Well, 1840 ft; preparation B180/31, 35.1 116.3, CPC10101.
10. Proximal focus; same loc. as figs 17, 18; preparation B138/5, 46.5 119.7, CPC10102.
11. Median focus; same loc. as figs 17, 18; preparation B138/21, 34.2 113.4, CPC10103.
12. Proximal focus; same loc. as fig. 9; preparation B180/22, 39.7 123.4, CPC10104.
13. Proximal focus; same loc. as fig. 9; preparation B180/35, 39.6 121.0, CPC10105.
14. Median focus; Bonaparte No. 1 Well, 3154 ft; preparation B19/13, 33.9 120.6, CPC10106.
15. Proximal focus; same loc. as fig. 9; preparation B180/11, 31.5 111.2, CPC10107.

Figure 16. — *Grandispora notensis* sp. nov. .. .. Page 48

Proximal focus; Bonaparte No. 1 Well, 2164 ft; preparation B16A/1, 47.3 111.5, CPC10108.

Figure 17. — *Endosporites micromanifestus* Hacquebard, 1957 .. .. Page 52

Proximal focus; Bonaparte No. 2 Well, 2836 ft; preparation B56A/1, 19.7 122.0, CPC10109.

Figures 18, 19. — *Auroraspora solisortus* Hoffmeister, Staplin, & Malloy, 1955 .. Page 50

18. Distal focus; specimen lacking portion of exoexine; same loc. as fig. 1; preparation B8/6, 34.5 121.2, CPC10110.
19. Proximal focus; same loc. as fig. 1; preparation B8/5, 38.2 123.3, CPC10111.

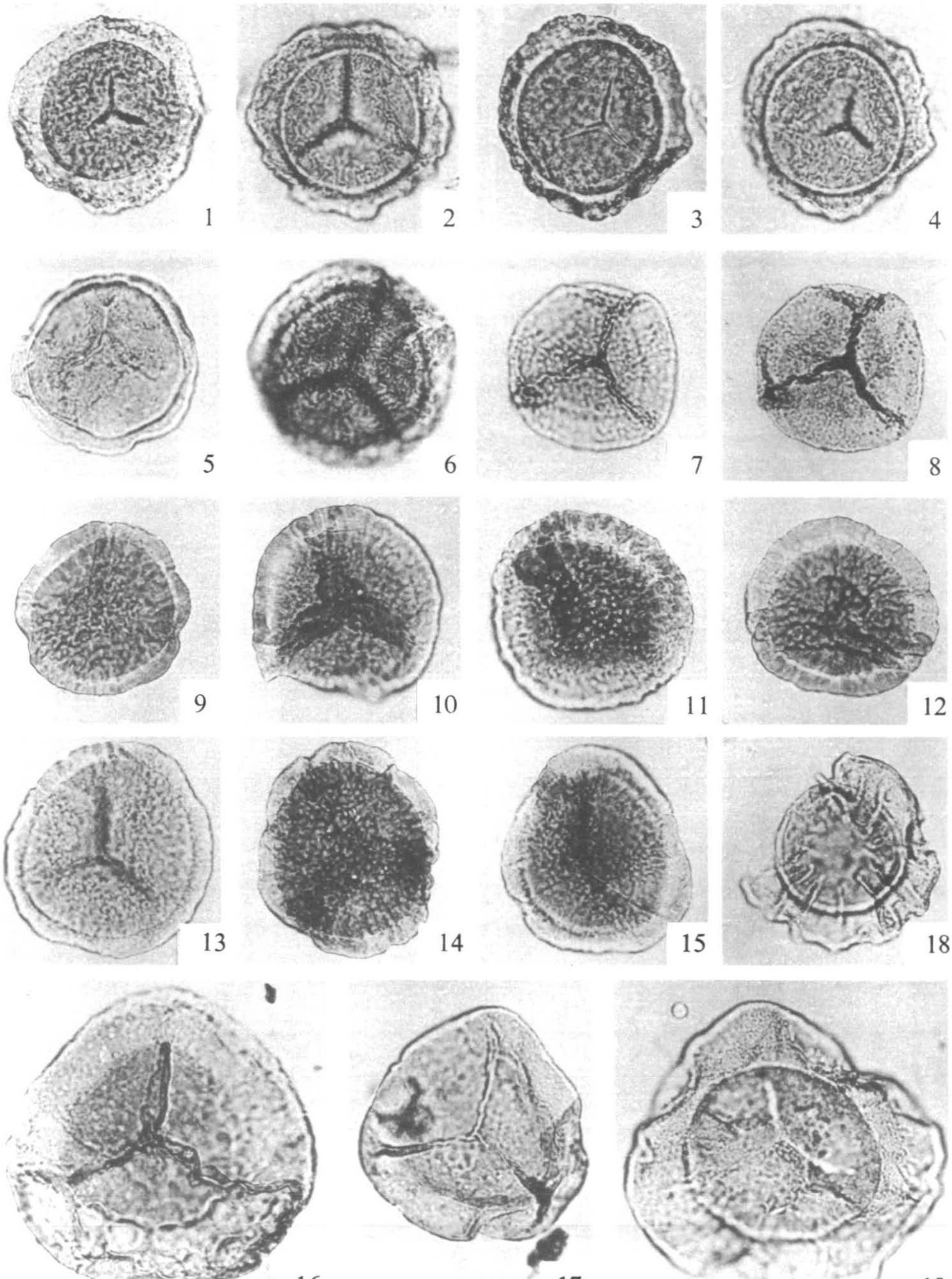
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PLATE 18

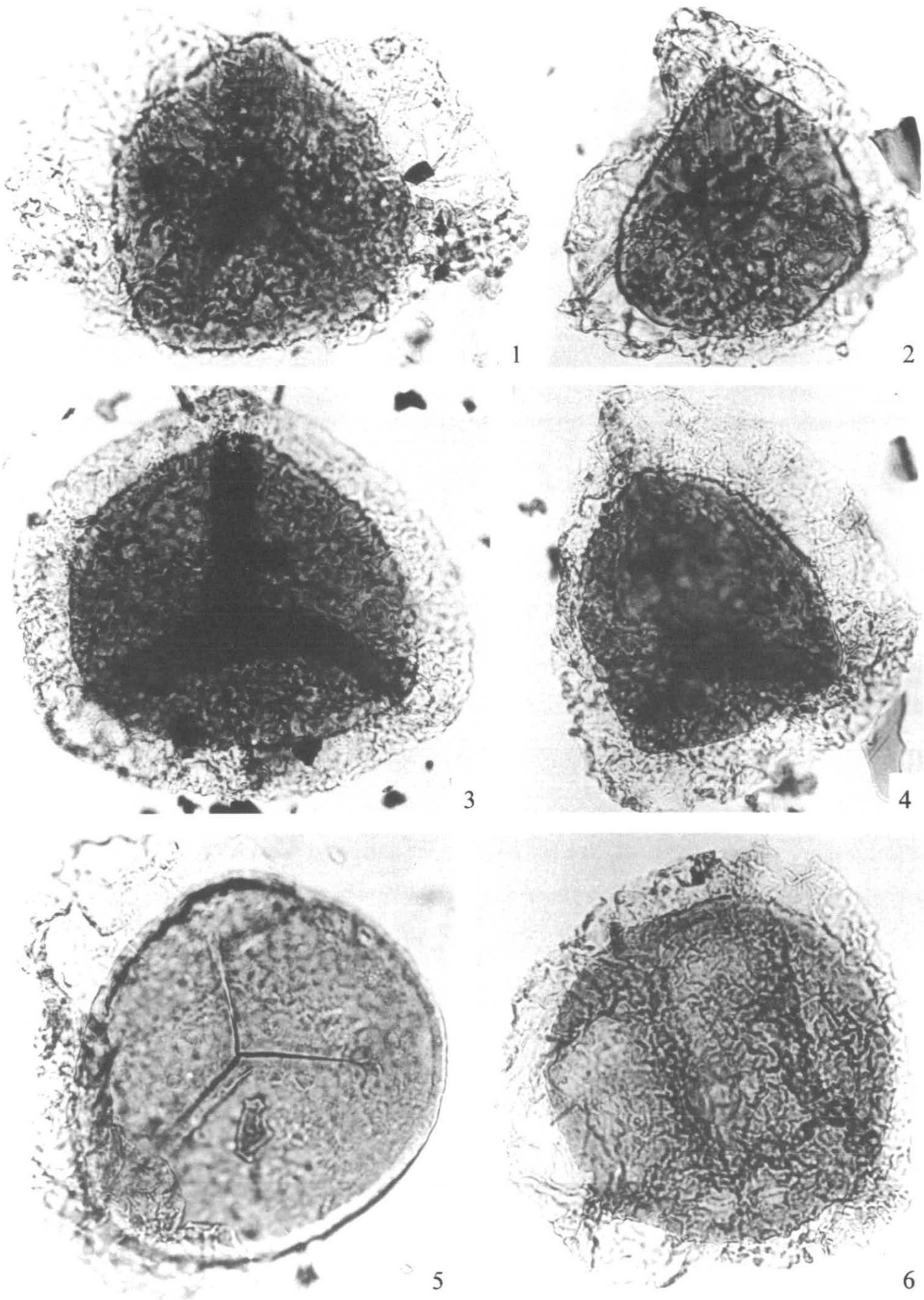
All figures X500, and from unretouched negatives

Figures 1-4. — *Velamisporites lacertosus* sp. nov. . . . . Page 53

1. Median focus; Bonaparte No. 1 Well, 1564 ft; preparation B12B/1, 49.9 116.3, CPC10112.
2. Proximal focus; Bonaparte No. 1 Well, 1670 ft; preparation B176/2, 51.5 125.8, CPC10113.
3. **Holotype,** median focus; Bonaparte No. 2 Well, 2176 ft; preparation B54/1, 40.2 109.9, CPC10114.
4. Median focus; Bonaparte No. 1 Well, 2164 ft; preparation B16B/1, 31.5 113.4, CPC10115.

Figures 5, 6. — *Velamisporites* sp. cf. *V. rugosus* Bhardwaj & Venkatachala, 1962 Page 53

5. Proximal focus; exoexine absent from much of specimen; Bonaparte No. 2 Well, 980-990 ft; preparation B193/2, 17.2 122.9, CPC10116.
6. Oblique proximal view; Bonaparte No. 1 Well, 2405 ft; preparation B17A/22, 38.2 114.0, CPC10117.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