QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 294

JURASSIC SPORES AND POLLEN GRAINS FROM THE ROSEWOOD COALFIELD

By N. J. de JERSEY, Ph.D., M.Sc., Research Geologist

BRISBANE
By Authority: S. G. Reid, Government Printer
1960

JURASSIC SPORES AND POLLEN GRAINS FROM THE ROSEWOOD COALFIELD

By N. J. de Jersey, Ph.D., M.Sc., Research Geologist

Abstract

Forty species of spores and pollen grains isolated from the coal seams of the Rosewood coalfield have been described and illustrated by photographs. Of these twenty-eight are recorded as new species, the remainder being identified or compared with species previously recorded from Australia, New Zealand and Europe. The new genus Annulispora *is established and its morphology described and illustrated. The microfossil assemblage is discussed in relation to the macro-flora from the same formation and it is concluded that the microflora has provided a more representative record of the fossil vegetation of the coal measures. Comparison with other Jurassic microfloras, particularly those of Western Australia, suggests a Lower Jurassic age for the Walloon Coal Measures in the type area. The investigation will provide a basis for a detailed account of spore distribution in relation to seam correlation in this coalfield.*

1. Introduction

The Rosewood coalfield covers an area of approximately 50 square miles more or less centred around the town of the same name, some 35 miles by rail west from Brisbane. The seams worked form part of the Walloon Coal Measures, a formation named after a town, 5 miles east of Rosewood, near which the first collieries in the district were located. These coal measures are regarded as Jurassic in age on the basis of their contained flora (David 1950, p. 469).

Owing to such factors as lack of outcrops, rarity of reliable marker beds, and marked variation in seam sections, seam correlation, by normal stratigraphic methods, is often a difficult task in this coalfield. Accordingly an investigation of the distribution of spores and pollen grains in the coal seams has been undertaken in order to provide an additional method of correlation. Preliminary reports, giving detailed results from the aspect of correlation, have been published for the areas so far examined (de Jersey 1955a, 1955b, 1957, 1958).

Although some areas of the coalfield still remain to be studied from the aspect of spore distribution, over one hundred samples, from all the principal coal horizons known in the district, have now been examined, and it seems likely that all the more abundant species of spores and pollen have been recognised. Consequently the purpose of this report is to record descriptions of all species known from this coalfield, so as to furnish a general picture of the microflora. It is hoped, in a later report, to describe in detail the vertical and lateral distribution of these species and their use in correlation.

2. Experimental Method

The coal samples studied were derived from two sources—channel samples collected in colliery workings and cores obtained in the diamond drilling programme of the Queensland Mines Department which began in 1952 in this coalfield, and is still in progress. Each sample was first crushed down to approximately quarter-inch screen size and sampled by conventional quartering methods; the coal was then further crushed down to minus-20 mesh and again sampled, dust and finely-divided coal being removed by screening through a 40-mesh sieve. Shale and shaly coal were then removed as the sinks in carbon tetrachloride (specific gravity 1.58), the float fraction consisting of relatively clean coal (average ash approximately 10 per cent.). After air-drying, 4 gm. of this final sample was taken for maceration. A period of 16-17 hours was found suitable for maceration with potassium chlorate and nitric acid, which was carried out by a technique similar to that previously described (de Jersey 1946, p. 2).

Three micro-slides were prepared from the maceration residue for each sample, 500 spores being examined in each case by traversing the slides systematically with the aid of a mechanical stage. Throughout the maceration process, the samples were treated in a standardised manner, so that results from different samples would be strictly comparable.

In spore content the coals proved to be relatively uniform, so that no significant variations could be detected in the total proportions of spores and pollens in the maceration residues, either vertically in the sequence or laterally in individual seams. Samples from the seams examined are all of approximately similar rank (high-volatile bituminous) and consist predominantly of bright coal (clarain) with an average proportion of 50 per cent. fixed carbon (dry, mineral-free basis).

3. Classification of Spores and Pollen Grains

The present position regarding the nomenclature of these microfossils has been well summarised by Balme (1957, pp. 13, 14). The writer is in substantial agreement with Balme's views, the only minor point of difference being that an attempt has been made in the present work to group genera on the basis of natural relationships (as has been done by Couper (1953)) rather than to follow an artificial scheme of supra-generic divisions, such as is advocated by Thomson and Pflug (1953).

In establishing new species the aim has been to base a specific diagnosis on an examination of at least

25 well preserved specimens, in order to study adequately variation in size ranges and other features. Only occasional exceptions have been permitted to this rule, in cases where species are relatively rare but exhibit very distinctive and easily recognisable characteristics. With regard to measurements of dimensions, specimens measured were those preserved in full polar view, the diameter of a triangular form being taken as the maximum median length, and the body diameter of a bisaccate pollen grain as the maximum dimensions of the body, measured in a direction parallel to the length of the furrow. In descriptive terminology the terms employed are largely those used by Balme (1957) and Harris (1955).

The specimens are located on numbered slides in the collection of the Geological Survey of Queensland. To facilitate examination of the type material, stage co-ordinates have been have been recorded for all type and figured specimens, along with the relevant slide numbers. These stage co-ordinates were determined using a Carl Zeiss Binocular Microscope (Model Lg Og, serial No. 322649).

4. Systematic Descriptions

Order SPHAGNALES

Family SPHAGNACEAE

Genus SPHAGNUMSPORITES Raatz

Remarks.—This genus has been discussed by Potonié (1956, p. 17) who listed *Sphagnites* Cookson (1953) as a synonym. This procedure is followed here, so that the species *Sphagnites australis* Cookson and *Sphagnites clavus* Balme are placed in *Sphagnumsporites*.

Sphagnumsporites australis (Cookson) Potonié

Plate 1, Figure 1

Trilites australis Cookson, 1947, B.A.N.Z. Antarctic Research Exped., Rept. A2(8), p. 136, pl. XV, figs, 58–59.

Sphagnites australis Cookson, 1953, Aust. J. Bot. Vol. 1, p. 463, pl. 1, figs. 1–4.

Sphagnumsporites australis (Cookson) Potonié, 1956, Beih. Geol. Jahrb. Part 23, p. 17.

Remarks.—The Rosewood spores referred to this species agree well with Cookson's diagnosis. They are rounded sub-triangular to sub-circular, with diameters from 20 to 45 microns, and laesurae usually extending almost to the periphery. The exine ranges from 2 to 5 microns in thickness. It has not been possible to group the specimens into two formae as has been done by Cookson (1953, p. 464), as there is continuous variation both in diameter and in the thickness of the exine. The species is long-ranged and relatively rare in most of the samples examined.

Figured specimen.—(Plate 1, Figure 1); Slide No. 276; Stage coordinates 7·5; 115·3; diameter 32 microns.

Locality.—Bore N.S. 42, 411 ft. 9½ in. to 413 ft. 2¾ in.

Sphagnumsporites clavus (Balme), new combination

Plate 1, Figure 2

Sphagnites clavus Balme, 1957, C.S.I.R.O. Physical and Chemical Survey of the National Coal Resources, Reference T.C. 25, p. 16, pl. 1, figs. 4–6.

Remarks.—Specimens referred to this species compare closely with those figured and described by Balme. This similarity is shown by the size range (25 to 37 microns), thickness of exine (3 to 4 microns) and the nature of the ornamentation. Its occurrence in the Jurassic extends the stratigraphic range, as the species was recorded in Western Australia from sediments of Lower Cretaceous age.

Figured specimen.—(Plate 1, Figure 2); Slide No. 119; Stage coordinates 8·0, 107·5; diameter 27 microns.

Locality.—Bore N.S. 17, 132 ft. 1 in. to 135 ft. 10 in.

Sphagnumsporites tenuis, new species

Plate 1, Figure 3

Diagnosis.—Amb rounded triangular to subcircular. Trilete, laesurae extending to, or almost to, the periphery. Diameter (based on 33 measured specimens) 20 to 40 microns. Exine smooth, about 1 micron in thickness.

Holotype.—(Plate 1, Figure 3); Slide No. 284; Stage coordinates 14·6 110·0; diameter 33 microns.

Locality.—Bore N.S. 84, 205 ft. 3 in. to 218 ft. 8 in.

Remarks.—This species is distinguished from *S. australis* (Cookson) by its thinner exine; the thickness is appreciably less even than the thinner forms of that species. Study of size distribution indicates a fairly even grouping around an average diameter of about 30 microns. The species resembles the thin-walled spores recorded by Cookson from the Comaum clays (Cookson 1953, p. 469, pl. 2, figs. 25, 26).

Sphagnumsporites adnatus, new species

Plate 1, Figure 4

Diagnosis.—Amb rounded triangular to subcircular. Trilete, laesurae extending about two-thirds the distance to the periphery. Diameter (based on 40 measured specimens) 21 to 37 microns. Contact area marked by a proximal sub-triangular thickening of the exine, normally extending to ends of laesurae. Diameter of contact area 13 to 26 microns. Exine smooth, or with contact area faintly granulate, thickness 1 to 2 microns.

Holotype.—(Plate 1, Figure 4); Slide No. 242; Stage coordinates 16·2, 115·1; diameter 27 microns. Locality.—New Mountain View Colliery (Top section of seam).

Remarks.—*S. adnatus* shows some similarity to a species from the Permian of New South Wales, described as *Calamospora diversiformis* Balme and Hennelly 1956B, p. 246, pl. 2, figs. 14–18). However, the Rosewood specimens are appreciably smaller in average diameter, their contact areas are more distinct and the laesurae are somewhat longer than in the Permian species.

Order LYCOPODIALES
Family LYCOPODIACEAE
Genus LYCOPODIUM Linnaeus

Lycopodium rosewoodensis, new species

Plate 1, Figures 5 and 6

Diagnosis.—Amb sub-circular. Trilete, indistinct laesurae, extending to the periphery. Diameter (based on 81 measured specimens) 25 to 46 microns. Exine about 1 micron thick, ornamented on the distal side by a regular polygonal reticulum, lumina 2 to 8 microns in diameter (average 4 microns), muri 1 micron wide, 1 to 2 microns in height at the spore margin. Equatorial flange absent.

Holotype.—(Plate 1, Figure 5); Slide No. 209; stage coordinates 10.0, 110.4; diameter 37 microns.

Locality.—Bore N.S. 42, 579 ft. 5½ in. to 580 ft. 8¾ in.

Paratype.—(Plate 1, Figure 6); Slide No. 259; stage coordinates 14.1, 107.2; diameter 40 microns.

Locality.—Bore N.S. 80, 110 ft. 7¼ in. to 117 ft. 11½ in. (United No. 8 Bottom Seam).

Remarks.—*L. rosewoodensis* shows a general similarity to spores of the *Lycopodium fastigiatum-volubile* group (see Harris 1955, pp. 53–55), but is distinct from any of the living species. It differs from *L. austroclavatidites* Cookson in having smaller lumina, and also narrower and lower muri. The species is also distinct from *L. austroclavatidities tenuis* Balme, which is appreciably smaller and exhibits a thin equatorial flange not observed in the Queensland specimens.

Lycopodium triangularis, new species

Plate 1, Figure 7

Diagnosis.—Amb triangular, sides straight or slightly convex, apices rounded. Trilete, indistinct laesurae, extending to the periphery. Diameter (based on 116 measured specimens) 20 to 50 microns. Exine about 1 micron thick, ornamented on the distal side by a regular polygonal reticulum, lumina 2 to 7 microns in diameter (average 4 microns), muri 1 micron wide, 1 to 2 microns in height at the spore margin. Equatorial flange absent.

Holotype.—(Plate 1, Figure 7); Slide No. 232; Stage coordinates 15.0, 114.2; diameter 36 microns.

Locality.—Bore N.S. 34, 49 ft. 5 in. to 57 ft. 1 in.

Remarks.—The ornamentation of this species is similar to that of *L. rosewoodensis.* However *L. triangularis* has a sharply triangular outline, and has been separated from that species because forms of intermediate shape have not been observed.

Order FILICALES
Family OSMUNDACEAE
Genus OSMUNDACIDITES Couper

Osmundacidites cf. *O. wellmanii* Couper

Plate 1, Figure 8

Description.—Amb rounded sub-triangular to sub-circular. Trilete, well-defined laesurae, extending to, or almost to, the periphery. Lips of tetrad-scar often slightly thickened. Diameter (based on 97 measured specimens) 33 to 61 microns. Exine about 1.5 micron thick, frequently folded, with folds of an arcuate nature. Ornamentation granular-papillate, varying from granular in the apical region, to slightly papillate at the periphery.

Figured Specimen.—(Plate 1, Figure 8); Slide No. 221; Stage coordinates 13.4, 114.0; diameter 43 microns.

Locality.—Bore N.S. 48, 116 ft. 0½ in. to 118 ft. 4 in.

Remarks.—This species is close to *O. wellmanii* Couper but differs slightly in having more prominent lips to the tetrad-scar. It differs from *O. comaumensis* (Cookson) in the smaller size of the projections constituting the ornament.

Family GLEICHENIACEAE
Genus GLEICHENIA Smith

Gleichenia cf. *G. circinidites* Cookson

Plate 1, Figure 9

Description.—Amb triangular, margins slightly concave or convex, apices rounded. Trilete, well-defined laesurae, extending to the periphery. Diameter (based on 18 measured specimens) 25 to 45 microns. Exine smooth, 1 micron or less in thickness at apices, thickening between apices (up to 3.5 microns).

Figured Specimen.—(Plate 1, Figure 9); Slide No. 179; Stage coordinates 11.6, 111.0; diameter 33 microns.

Locality.—Bore N.S. 42, 213 ft. 2½ in. to 214 ft. 11½ in.

Remarks.—Under this heading are recorded spores similar to Cookson's species in shape and dimensions, which have narrower laesurae than that species. In size the Rosewood specimens are somewhat larger and are also thinner-walled than those described by Balme (1957, p. 23) as *G.* cf. *circinidites* from the Upper Jurassic and Lower Cretaceous. Specimens which can be definitely placed in *G. circinidites* have been observed by the writer in macerations of the Cretaceous Burrum coals, and these Cretaceous spores have wider laesurae and are darker in appearance than the Rosewood specimens.

PTERIDOPHYTA-INCERTAE SEDIS
Genus CYATHIDITES Couper

Cyathidites parvus, new species

Plate 1, Figure 10

Diagnosis.—Amb triangular, sides concave, apices sharply rounded. Trilete, laesurae faintly marked, extending also to the periphery. Diameter (based on 65 measured specimens) 20 to 35 microns. Exine smooth, relatively thin (less than 1 micron), often folded.

Holotype.—(Plate 1, Figure 10); Slide No. 300; Stage coordinates 7.5, 110.2; diameter 23 microns.

Locality.—Bore N.S. 42, 465 ft. 9½ in. to 468 ft. 8¾ in.

Remarks.—This species is distinguished from *C. minor* Couper by its smaller size, the majority of specimens examined being below the size range quoted for the New Zealand species. In addition the exine is somewhat thinner in *C. parvus*. With regard to the affinities of *Cyathidites*, Balme states (1957, p. 21) "There is little justification for regarding *Cyathidites* as more than a purely morphographic form genus, for although spores of this type occur among the Cyatheaceae, similar types are found in the Dicksoniaceae and Polypodiaceae."

Genus LEPTOLEPIDITES Couper

Leptolepidites verrucatus Couper

Plate 1, Figure 11

Remarks.—Specimens of this distinctive species agree closely with Couper's diagnosis. The size range (based on 30 measured specimens) is from 30 to 46 microns. The species is characterised by its large, irregularly shaped verrucate projections, averaging about 5 microns in diameter. The larger size range as compared with that of the New Zealand spores (31 to 35 microns) is probably due to the larger number of specimens measured, as the size range in the original description was based on 7 specimens only. Inevitably when further specimens are studied the size ranges are extended, and the separation of larger forms as another species (*L. major*) by Couper (Couper 1958, p. 141) may require confirmation by means of size-frequency distribution studies.

Couper (1953, p. 28) has discussed the resemblance to spores of the living fern *Leptolepia novae-zealandiae*, a number of the Dennstaediaceae. In addition Potonié (1956, p. 27) suggests comparison with *Alsophila cooperi*, in the family Cyatheaceae.

Figured Specimen.—(Plate 1, Figure 11); Slide No. 252; stage coordinates 15·0 110·2; diameter 43 microns.

Locality.—Bore N.S. 80, 154 ft. 8¼ in. to 162 ft. 2½ in.

Genus LEIOTRILETES (Naumova) Potonié and Kremp

Leiotriletes directus Balme and Hennelly

Plate 1, Figures 12 and 13

Remarks.—Under this species are recorded small, trilete, triangular forms indistinguishable from the Permian spores described by Balme and Hennelly (1956B, p. 244). As stated by those authors, *L. directus* is a very broad category embracing the spores of many plants. Thus an extended range, through several geological periods, is not unexpected for such a simple, generalised type of spore.

In the Rosewood specimens the diameter (based on 58 measured specimens) ranges from 17 to 37 microns; the exine is thin, smooth and frequently folded (see Plate 1, Figure 13).

Figured Specimen.—(Plate 1, Figure 12); Slide No. 276; stage coordinates 8·5, 110·5; diameter 30 microns.

Locality.—Bore N.S. 42, 411 ft. 9¼ in. to 413 ft. 2¾ in.

Figured Specimen.—(Plate 1, Figure 13); Slide No. 301; stage coordinates 11·0, 107·0; diameter 33 microns.

Locality.—Bore N.S. 42, 465 ft. 9½ in. to 468 ft. 8¾ in.

Leiotriletes magnus, new species

Plate 1, Figure 14

Diagnosis.—Amb triangular, sides straight or slightly convex in polar view. Trilete, laesurae well defined, extending to, or almost to, the periphery, with lips slightly developed. Diameter (based on 25 measured specimens) 41 to 65 microns. Exine thin (about 1 micron), smooth, subject to folding during compression.

Holotype.—(Plate 1, Figure 14); Slide No. 297; Stage coordinates 12·1, 105·8; diameter 57 microns.

Locality.—Bore N.S. 42, 512 ft. 9½ in. to 514 ft. 2 in.

Remarks.—*L. magnus* is larger than almost all of the unornamented species of *Leiotriletes*. The one exception is *L. grandis* (Kosanke) Bhardwaj, from the Carboniferous, which has a size range of 60 to 80 microns. However the latter species has a much more rounded outline, shorter laesurae, and a thicker exine.

Leiotriletes mortoni, new species

Plate 1, Figure 15

Diagnosis.—Amb triangular, sides slightly convex or concave in polar view. Trilete, tetrad scar prominent, laesurae extending to the periphery. Lips of tetrad scar thickened and slightly raised, width of scar (inclusive of lips) 3 to 8 microns. Diameter (based on 35 measured specimens) 20 to 40 microns. Exine smooth, relatively thin (about 1 micron).

Holotype.—(Plate 1, Figure 15); Slide No. 300; stage coordinates 7·9, 111·2; diameter 27 microns.

Locality.—Bore N.S. 42, 465 ft. 9½ in. to 468 ft. 8¾ in.

Remarks.—Two Carboniferous species, *L adnatoides* Potonié and Kremp and L. *subadnatoides* Bhardwaj also have thickened lips to the laesurae, but in each case the exine is finely ornamented. The species is named after the late Mr. C. C. Morton, former Chief Geologist, Geological Survey of Queensland, under whose direction this investigation was initiated.

Leiotriletes crassus, new species

Plate 1, Figure 16

Diagnosis.—Amb triangular, sides slightly convex or concave in polar view. Trilete, laesurae indistinct, reaching the periphery. Diameter (based on 17

All the photographs are at a magnification of 830 diameters

Plate 1

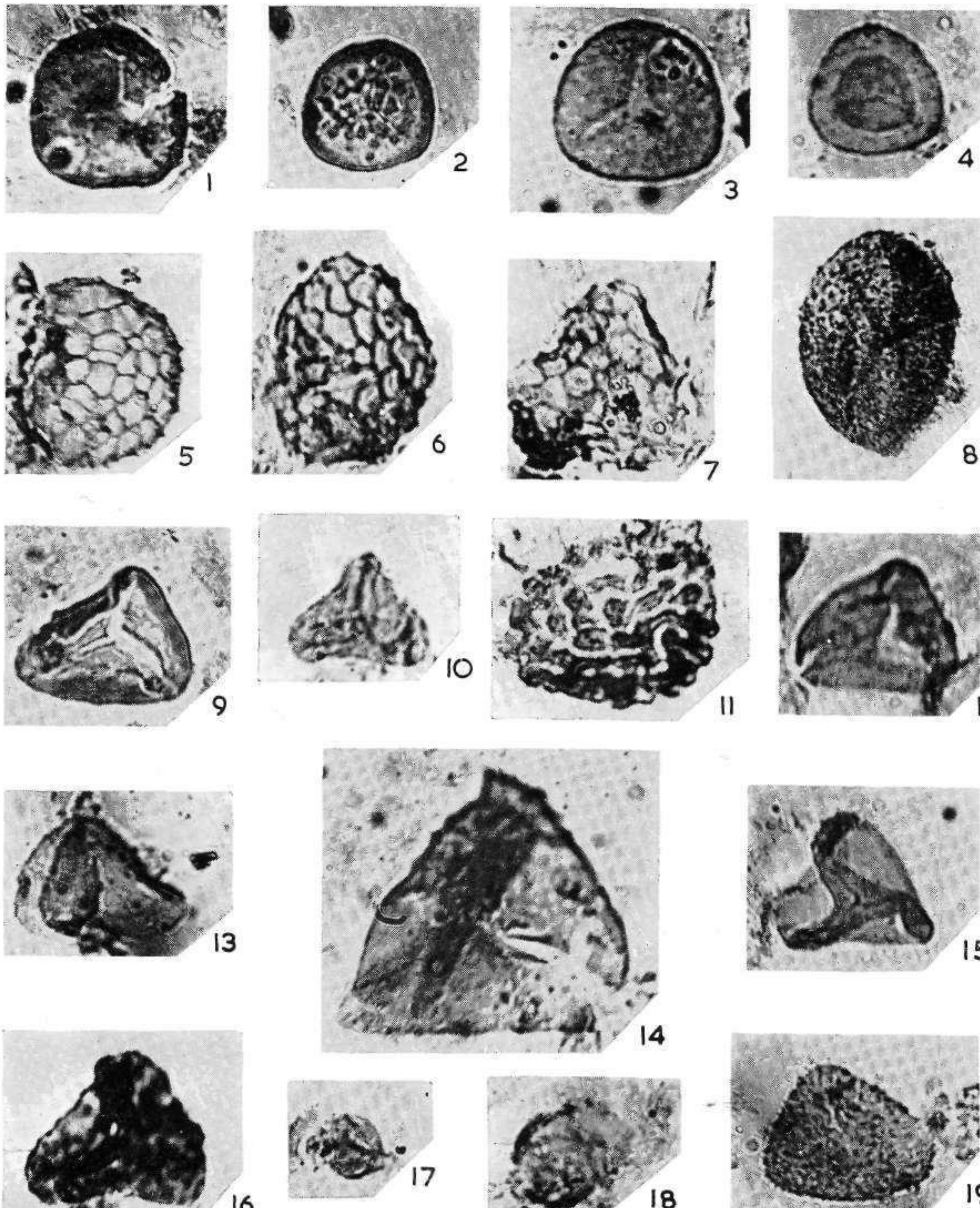

Fig. 1.—*Sphagnumsporites australis* (Cookson) Potonié.
Fig. 2.—*Sphagnumsporites clavus* (Balme), n. comb.
Fig. 3.—*Sphagnumsporites tenuis* n. sp. Holotype.
Fig. 4.—*Sphagnumsporites adnatus* n. sp. Holotype.
Fig. 5.—*Lycopodium rosewoodensis* n. sp. Holotype.
Fig. 6.—*Lycopodium rosewoodensis* n. sp. Paratype.
Fig. 7.—*Lycopodium triangularis* n. sp. Holotype.
Fig. 8.—*Osmundacidites* cf *wellmanii* Couper.
Fig. 9.—*Gleichenia* cf *circinidites* Cookson.
Fig. 10.—*Cyathidites parvus*, n. sp. Holotype.
Fig. 11.—*Leptolepidites verrucatus* Couper.
Fig. 12.—*Leiotriletes directus* Balme & Hennelly, Proximal view.
Fig. 13.—*Leiotriletes directus* Balme & Hennelly. Folded specimen (laterally compressed).
Fig. 14.—*Leiotriletes magnus* n. sp. Holotype.
Fig. 15.—*Leiotriletes mortoni* n. sp. Holotype.
Fig. 16.—*Leiotriletes crassus* n. sp. Holotype.
Fig. 17.—*Punctatisporites minimus* n. sp. Holotype.
Fig. 18.—*Cyclogranisporites breviradiata* n. sp. Holotype.
Fig. 19.—*Granulatisporites minor* n. sp. Holotype.

measured specimens) 20 to 37 microns. Exine smooth, relatively thick (about 3 microns) appearing dark brown in transmitted light.

Holotype.—(Plate 1, Figure 16); Slide No. 102; Stage coordinates 12·1, 110·3; diameter 36 microns.

Locality.—Bore N.S. 17, 356 ft. 1½ in. to 358 ft. 6 in.

Remarks.—The thick exine and dark colour of this species are characteristic. Somewhat similar spores occur in the living species. *Dicksonia fibrosa* (see Harris 1955, p. 86), which is, however, appreciably larger (size range 43 to 53 microns).

Genus GRANULATISPORITES (Ibrahim) Potonié and Kremp

Granulatisporites minor, new species

Plate 1, Figure 19

Diagnosis.—Amb. triangular, sides straight or slightly convex in polar view. Trilete, laesurae indistinct, extending to the periphery. Diameter (based on 35 measured specimens) 20 to 35 microns. Exine about 1 micron thick, ornamented with small, closely packed granulations (diameter 1 micron or less), becoming slightly papillate at the periphery.

Holotype.—(Plate 1, Figure 19); Slide No. 139; Stage coordinates 14·4, 103·6; diameter 32 microns.

Locality.—Bore N.S. 40, 238 ft. to 240 ft. 6½ in.

Remarks.—The ornamentation of this species is rather similar to that of *Osmundacidites wellmanii* Couper, and thus may suggest affinity with the Osmundaceae. However, other families, notably the Hymenophyllaceae also exhibit this granulate-papillate type of ornament. The species is readily distinguished by its size and ornamentation, from previously described species of *Granulatisporites*.

Genus CYCLOGRANISPORITES Potonié and Kremp

Remarks.—*Cyclogranisporites* constitutes a convenient form-genus for the reception of species of unknown affinity, characterised by their circular shape and granulate sculpture, such as *C. breviradiata* described below.

Cyclogranisporites breviradiata new species

Plate 1, Figure 18

Diagnosis.—Amb circular or well-rounded triangular. Diameter (based on 105 measured specimens) 20 to 55 microns. Exine relatively thin (about 1 micron), with occasional folds, granulate with closely packed projections up to 1 micron in diameter.

Holotype.—(Plate 1, Figure 18); Slide No. 139; Stage coordinates 9·4, 114·8; diameter 21 microns.

Locality.—Bore N.S. 40, 238 ft. to 240 ft. 6½ in.

Remarks.—*C. breviradiata* is distinguished from previously described species of the genus by its smaller size and short laesurae.

Genus PUNCTATISPORITES (Ibrahim) Potonié and Kremp

Punctatisporites crassiradiata, new species

Plate 2, Figure 1

Diagnosis.—Amb circular or sub-circular. Trilete, prominent laesurae extending to, or almost to, the periphery. Lips thickened, total width of rays 4 to 10 microns. Diameter (based on 27 measured specimens) 50 to 95 microns. Exine smooth, 1 to 2 microns thick, frequently folded, folds often of an arcuate nature.

Holotype.—(Plate 2, Figure 1); Slide No. 148; Stage coordinates 14.6, 104.1; diameter 93 microns.

Locality.—Bore N.S. 40, 206 ft. 0½ in. to 207 ft. 5¼ in.

Remarks.—This species can be compared with *P. gretensis* Balme and Hennelly from the Permian, from which it differs in having a thinner exine, longer laesurae, and a smaller size range. There is also a general similarity to certain species of *Calamospora*, but in that genus the laesurae are distinctly shorter.

Punctatisporites minimus, new species

Plate 1, Figure 17

Diagnosis.—Amb circular or sub-circular. Trilete, laesurae extending almost to the periphery. Diameter (based on 48 measured specimens, 10 to 21 microns. Exine smooth, relatively thin (less than 1 micron).

Holotype.—(Plate 1, Figure 17); Slide No. 217; Stage coordinates 16·5, 108·7; diameter 15 microns.

Locality.—Bore N.S. 48, 187 ft. 4½ in. to 191 ft. 9 in.

Remarks.—The small size of this species is distinctive and readily enables separation from other described species of *Punctatisporites*.

Genus VERRUCOSISPORITES (Ibrahim 1932) Emend.

In view of the occurrence of a species (*V. triangularis*) in the Rosewood coals which has ornamentation typical of *Verrucosisporites*, but differs from previously described species of the genus in its triangular outline, Bhardwaj's (1955) emended diagnosis is emended as follows:—Trilete iso-or microspores of triangular to sub-triangular or circular outline and without other differentiation than the warty exoexine, its warts being closely set and often bigger than the *grana* of *Granulatisporites*, but not so uniform in size. The base of wart is broader than its bluntly conical or flat apex.

Verrucosisporites walloonensis, new species

Plate 2, Figure 8

Diagnosis.—Amb rounded sub-triangular or sub-circular. Trilete, laesurae indistinct; when observed relatively inconspicuous. Diameter (based on 65 measured specimens) 27 to 45 microns. Exine thin, ornamented with rounded sub-hemispherical to bluntly conical projections 2 to 3 microns in diameter and 1 to 3 microns apart.

Holotype.—(Plate 2, Figure 8); Slide No. 148; Stage coordinates 15·0, 108·5; diameter 35 microns.

Locality.—Bore N.S. 40, 206 ft. 0½ in. to 207 ft. 5¼ in.

Remarks.—*V. walloonensis* differs from most of the Permian species described by Balme and Hennelly (1956, pp. 250, 251) in its smaller size; the dimensions are roughly similar to those of *V. parmatus* Balme and Hennelly but the latter species has a clearly defined contact area. It also differs from *Baculatisporites truncatus* (Cookson) Balme in having smaller, more rounded projections and less distinct laesurae.

Verrucosisporites triangularis, new species

Plate 2, Figure 9

Diagnosis.—Amb triangular, sides straight or slightly convex. Trilete, laesurae indistinct, where observed extending to the periphery. Diameter (based on 48 measured specimens) 22 to 45 microns. Exine thin, ornamented with rounded (sub-hemispherical) projections 2 to 3 microns in diameter, and 1 to 4 microns apart.

Holotype.—(Plate 2, Figure 9); Slide No. 157; stage coordinates 6·6, 112·6; diameter 30 microns.

Locality.—Bore N.S. 40, 176 ft. 7¾ in. to 177 ft. 11¾ in.

Remarks.—This species differs from *V. walloonensis* described above in having a distinctly triangular outline and longer laesurae, extending to the periphery.

Genus ACANTHOTRILETES (Naumova) Potonié and Kremp

Acanthotriletes pallidus, new species

Plate 2, Figure 10

Diagnosis.—Amb rounded triangular to circular. Trilete, laesurae indistinct, where observed extending almost to the periphery. Diameter (based on 35 measured specimens) 30 to 53 microns. Exine about 1 micron thick, ornamented on the distal side by scattered, acicular processes, about 2 to 3 microns long and 1·5 microns in basal diameter. Ornament reduced or absent on proximal face.

Holotype.—(Plate 2, Figure 10); Slide No. 196; Stage coordinates 16·2, 110·4; diameter 32 microns.

Locality.—Bore N.S. 42, 484 ft. 1 in. to 487 ft. 0¼ in.

Remarks.—The ornamentation of this species is of the same general type as in *A. levidensis* Balme from the Cretaceous of Western Australia, from which species *A. pallidus* differs in being appreciably larger and in having poorly defined laesurae. The following remarks regarding the affinities of *A. levidensis* by Balme (1957, p. 18) could apply equally well to the Queensland species:—"Although spinose ornament of this type is not often found among the spores of present-day ferns, it occurs occasionally among other pteridophyte groups, notably the Selaginellaceae. Perhaps the closest modern resemblance is to be found in the spores of the *Selaginella subarborescens* group as this was delimited by Knox (1950)".

Genus RUGULATISPORITES Pflug

Remarks.—The species *R. ramosus* described below fits well the generic diagnosis quoted by Potonié (1956, p. 38). The genotype is of Tertiary age and has suggested affinities with the Osmundaceae.

Rugulatisporites ramosus, new species

Plate 2, Figures 5 and 6

Diagnosis.—Amb circular. Laesurae ill-defined, often obscured by ornamentation, where observed reaching almost to periphery. Diameter (based on 45 measured specimens) 30 to 43 microns. Exine about 1·5 micron thick, ornamented with sinuous ridges, often branching, averaging 2·5 microns in width and 1 micron in height, and 2 to 3 microns apart.

Holotype.—(Plate 2, Figure 5); Slide No. 146; Stage coordinates 10·0, 105·9; diameter 41 microns.

Locality.—Bore N.S. 40, 221 ft. 6¼ in. to 222 ft. 11¼ in.

Paratype.—(Plate 2, Figure 6); Slide No. 209; Stage coordinates 14·1, 114·0; diameter 37 microns.

Locality.—Bore N.S. 42, 579 ft. 5½ in. to 580 ft. 8¾ in.

Remarks.—*R. ramosus* differs from the genotype *R. quintus* Thomson and Pflug in its smaller size, and in having less closely-spaced ridges.

Genus CINGULATISPORITES Thomson

Cingulatisporites granulatus, new species

Plate 2, Figure 7

Diagnosis.—Amb rounded triangular to subcircular. Spore complex, consisting of a central body surrounded equatorially by a hyaline cingulum 3 to 6 microns wide. Trilete, laesurae extending to the junction of the central body and cingulum. Total diameter (based on 10 measured specimens) 33 to 50 microns; diameter of body 27 to 37 microns. Exine 1 to 2 microns thick, proximal side smooth, distal face granulate-echinate, ornamented by close-packed granulate to bluntly spinose projections 1 to 3 microns in length and 1 to 2 microns in basal diameter. Cingulum smooth.

Holotype.—(Plate 2, Figure 7); Slide No. 199; Stage coordinates 7·5, 107·1; diameter 35 microns.

Locality.—Bore N.S. 42, 515 ft. 7¼ in. to 522 ft. 1½ in.

Remarks.—This species can be compared with *C. saevus* Balme from the Upper Jurassic, from which it is distinguished by the finer ornamentation of the central body and the slightly narrower cingulum. Regarding the affinities of the latter species, Balme states (1957, p. 26) "Perhaps the closest morphological omalogies are to be found in the spores of the *Selaginella scandens*—group (see Knox 1950, p. 254)."

All the photographs are at a magnification of 840 diameters

Plate 2

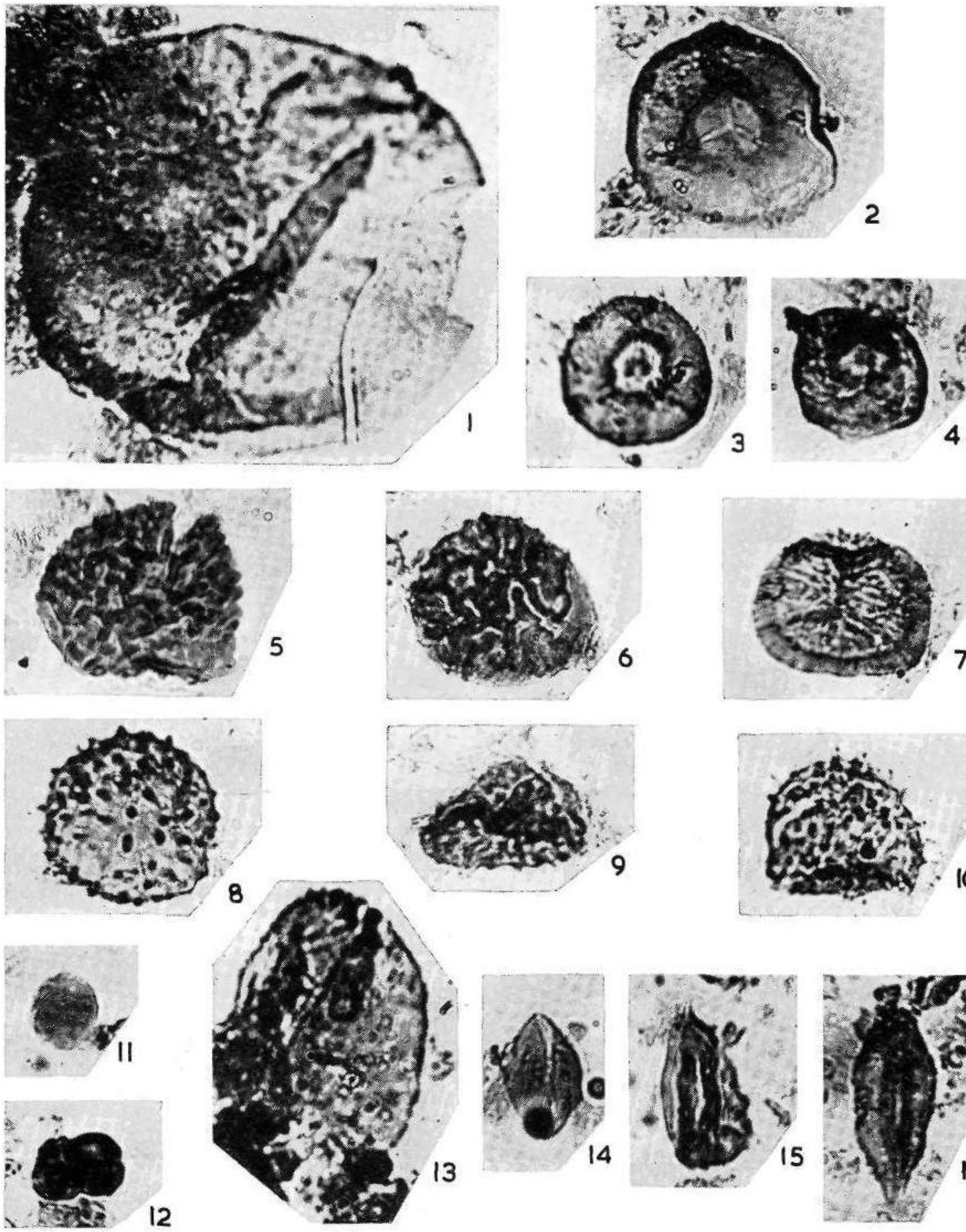

Fig. 1.—*Punctatisporites crassiradiata* new species. Holotype.
Fig. 2.—*Annulispora folliculosa* (Rogalska) n. comb.
Fig. 3.—*Annulispora densata* n. sp. Holotype (specimen compressed proximo-distally).
Fig. 4.—*Annulispora densata* n. sp. Paratype (specimen compressed laterally).
Fig. 5.—*Rugulatisporites ramosus* n. sp. Holotype.
Fig. 6.—*Rugulatisporites ramosus* n. sp. Paratype.
Fig. 7.—*Cingulatisporites granulatus* n. sp. Holotype.
Fig. 8.—*Verrucosisporites walloonensis* n. sp. Holotype.
Fig. 9.—*Verrucosisporites triangularis* n. sp. Holotype.
Fig. 10.—*Acanthotriletes pallidus* n. sp. Holotype.
Fig. 11.—*Pilasporites minutus* n. sp. Holotype.
Fig. 12.—*Pilasporites crassus* n. sp. Holotype (specimen on right)
Fig. 13.—*Marsupipollenites psilatus* n. sp. Holotype.
Fig. 14.—*Entylissa nitidus* Balme
Fig. 15.—*Entylissa crassimarginis* n. sp. Paratype.
Fig. 16.—*Entylissa crassimarginis* n. sp. Holotype.

SPORES—INCERTAE SEDIS

Genus ANNULISPORA, new genus

The generic name *Annulispora* is proposed for isolated fossil spores of unknown affinities having the following characters:

Amb circular or rounded triangular. Trilete, laesurae distinct, of variable length (average length about two-thirds of the spore radius). Exine smooth or faintly roughened, about 2 to 3 microns thick. The distal portion of the spore wall exhibits a thickened sub-circular ring, about 2 to 5 microns in width, with a sharp inner boundary, and a more gradual demarcation from the outer portion of the spore body.

Type species (here designated).—*Annulispora folliculosa* (Rogalska) new combination (Rogalska 1954, pp. 26, 44, pl. 12, fig. 8).

Remarks.—The type species was originally described as *Sporites folliculosus* Rogalska. Regarding the name *"Sporites"* Schopf, Wilson, and Bentall state (1944, p. 60) "The names *Sporites* (H. Potonié, 1892), *Pollenites* and *Sporonites* (R. Potonié, 1931) cannot be regarded as having systematic value. Forms listed in these groups have no essential biological features in common, no type species are recognised, and no systematic treatment is feasible on this basis." Consequently the species has been transferred to the new genus *Annulispora* now established.

Examination of the figure of a second species described as *Sporites lunaris Rogalska* (Rogalska 1954, pp. 26, 45; pl. 12, fig. 9) suggests that it represents a specimen of *Annulispora folliculosa* flattened laterally, so that it is observed in oblique equatorial view, and the distal ring is superimposed on one of the laesurae of the triradiate tetrad scar. In the other photograph (plate 12, fig. 8) the same species is observed in polar view, flattened in good proximal-distal orientation, so that the distal ring is superimposed symmetrically on the trilete tetrad-scar.

Similar variations in appearance due to flattening in different positions have been observed in specimens of the same species from the Rosewood coalfield. Consequently *Sporites lunaris* Rogalska is regarded as a synonym of *Annulispora folliculosa* (Rogalska) new combination.

Annulispora folliculosa (Rogalska) new combination

Plate 2, Figure 2

Sporites folliculosus Rogalska 1954. Inst. Geol. Bull. 89 (Warsaw), pp. 26, 44, pl. XII, fig. 8.

Sporites lunaris Rogalska 1954. Inst. Geol. Bull. 89 (Warsaw), pp. 26, 45, pl. XII, fig 9.

Emended diagnosis.—Amb circular or rounded triangular. Trilete, laesurae distinct, of variable length (average length about two-thirds of the spore radius). Diameter (based on 103 measured specimens) 23 to 48 microns. Exine smooth, or faintly roughened, about 2 to 3 microns thick. The distal portion of the spore wall exhibits a thickened sub-circular ring of exine, about 2 to 5 microns in windth, with a sharp inner boundary, and a more gradual demarcration from the outer portion of the spore body. Internal diameter of ring 7 to 17 microns.

Figured specimen.—(Plate 2, Figure 2); Slide No. 196; stage coordinates 7·5, 111·8; diameter 42 microns.

Locality.—Bore N.S. 42, 484 ft. 1 in. to 487 ft. 0¼ in.

Remarks.—The type material was derived from the Blanowice coal in Upper Silesia, Poland, the age of which is regarded as Liassic (Rogalska 1954, pp. 41–43). The species is also present in small proportions in most samples of the Rosewood coals which have been examined.

The only spore type recorded among Recent ferns to which *Annulispora* shows any resemblance is that of the species *Saccoloma inequale,* a member of the Dicksoniaceae. In this species (see Knox 1938, pp. 454) "the wall is locally banded to form a thickened circular area from which extensions may pass to the margin of the spore, the corners of which are also conspicuously thickened." *Annulispora* resembles this species in having a thickened circular area of the exine, but differs in lacking the extensions of the thickening to the spore margin and apices.

The only fossil form to which it can be compared is *Exesipollenites tumulus* Balme, from the Lower Jurassic of Western Australia (Balme 1957, p. 39). The latter species also exhibits a ring-shaped thickened portion surrounding a circular depression formed by thinner exine. However, no tetrad markings are visible in *Exesipollenites,* which genus Balme considers to represent pollen grains of unknown affinities. In addition the distal (?) circular depression is somewhat smaller than in *Annulispora.* Of the two genera *Annulispora* appears to have a longer range as it has been observed by the writer in some of the seams of the Ipswich Coal measures, of Triassic age, as well as in the Walloon Coal measures at Rosewood. In Western Australia *Exesipollenites* is confined to the Lower Jurassic (Balme 1957, Table 3).

Annulispora densata, new species

Plate 2, Figures 3 and 4

Diagnosis.—Amb circular or rounded triangular. Trilete, laesurae distinct, of variable length (average length about two-thirds of the spore radius). Diameter (based on 20 measured specimens) 26 to 42 microns. Exine smooth, about 2 to 3 microns thick. The distal portion of the spore wall exhibits a thickened sub-circular ring of exine, about 2 to 5 microns in width, with a sharp inner boundary, and a more gradual demarcation from the outer portion of the spore body. Internal diameter of the ring about 8 to 10 microns. Spore body characterised by a dark brown thickened portion 3 to 5 microns in diameter located centrally on its distal surface.

Holotype.—(Plate 2, Figure 3) (flattened proximo-distally); Slide No. 142; Stage coordinates 9·5 112·5; diameter 30 microns.

Locality.—Bore N.S. 40, 230 ft. 8¼in to 232 ft. 11¼ in.

Paratype.—(Plate 2, Figure 4) (flattened laterally); Slide No. 206; Stage coordinates 16·0, 106·8; diameter 27 microns.

Locality.—Bore N.S. 42, 546 ft. 8 in to 547 ft. 1¾ in.

Remarks.—This species is distinguished from *A. folliculosa,* described above, principally by the occurrence of a thickened portion of exine located centrally on the distal surface.

Genus PILASPORITES Balme and Hennelly

Remarks.—Balme and Hennelly (1956A, p. 64) have proposed this genus for alete spores of unknown affinities and have pointed out the difficulties of classifying spores in the absence of germinal apparatus.

Pilasporites minutus, new species

Plate 2, Figure 11

Diagnosis.—Outline circular or sub-circular. No germinal mechanism visible. Diameter (based on 89 measured specimens) 7 to 17 microns. Exine smooth, one micron or less in thickness.

Holotype.—(Plate 2, Figure 11); Slide No. 294; Stage coordinates 16·1, 105·5; diameter 15 microns.

Locality.—Bore N.S. 84, 235 ft. 0¼ in. to 238 ft. 2½ in.

Remarks.—The affinities of alete spores of this type are unknown.

Pilasporites crassus, new species

Plate 2, Figure 12

Diagnosis.—Outline circular or sub-circular. No germinal mechanism visible. Diameter (based on 53 measured specimens 9 to 17 microns. Exine smooth, relatively thick, appearing dark brown in transmitted light.

Holotype.—(Plate 2, Figure 12, specimen on right); Slide No. 197; Stage coordinates 9·0, 113·8; diameter 12 microns.

Locality.—Bore N.S. 42, 484 ft. 1 in to 487 ft. 0¼ in.

Remarks.—The affinities of alete spores of this type are unknown.

GYMNOSPERMAE

The pollen grains described under this heading include some forms which show affinity with certain families, e.g. the Podocarpaceae, but in view of the difficulties involved in classifying many of the pollen genera from the early Mesozoic, no supra-generic classification has been attempted here.

Genus MARSUPIPOLLENITES Balme and Hennelly

Marsupipollenites psilatus, new species

Plate 2, Figure 13

Diagnosis.—Amb of unexpanded grain oval. Distal furrow bordered by two longitudinal overfolds extending almost the full length of the grain. Small trilete tetrad scar on proximal face, rays of scar about 4 microns long. Length of longitudinal axis (based on 25 measured specimens) 65 to 95 microns, transverse axis 37 to 67 microns. Exine 1 to 2 microns in thickness, smooth, light yellow in transmitted light.

Holotype.—(Plate 2, Figure 13); Slide No 302; Stage coordinates 13·4, 107·4; dimensions 65 x 43 microns.

Locality.—Bore N.S. 46, 88 ft. 10 in to 95 ft.

Remarks.—*M. psilatus* is similar in many respects to *M. triradiatus* Balme and Hennelly from the Permian, but differs in having a smooth exine. It is also distinct from the forms described as *Marsupipollenites sp.* from the Lower Jurassic of Western Australia (Balme 1957, p. 29) which were characterised by their long triradiate markings, subtriangular shape and rugose ornamentation. The affinities of *Marsupipollenites* are probably with the Pteridospermae (see Balme and Hennelly 1956A, p. 60).

Genus ENTYLISSA Naumova ex Potonié and Kremp

Entylissa nitidus, Balme

Plate 2, Figure 14

Description.—Amb elongated oval, extremities rounded to sharply pointed. Monocolpate, furrow extending full length of the distal surface. Length (based on 63 measured specimens) 20 to 45 microns, width 11 to 25 microns. Exine 1 micron or less thick, smooth or faintly granulate.

Figured specimen.—(Plate 2, Figure 14); Slide No. 304; Stage coordinates 15·0, 111·5; length 25 microns, width 15 microns.

Locality.—Bore N.S. 46, 88 ft. 10 in. to 95 ft.

Remarks.—The differences between the Rosewood specimens and the Western Australian species *E. nitidus* Balme are relatively slight so that the pollen grains described here have been recorded under that species. The Rosewood specimens have a larger size range, and also exhibit some variation in shape, the extremities ranging from well rounded to sharply pointed. However detailed study has shown that there is continuous variation, both in size and shape of the extremities, and that no grouping of the forms is possible.

Regarding distribution and affinities Balme states (1957, p. 30) "*Entylissa nitidus* occurred in almost all the upper Jurassic and Lower Cretaceous samples and was sometimes very common. It almost certainly includes the pollen of many Mesozoic plants of

Cycadalean or Bennettitalean affinities." In addition pollen grains of similar type have been recorded from the Pteridosperm *Lepidopteris ottonis* (see Lundblad 1949, p. 5).

Entylissa crassimarginis, new species

Plate 2, Figures 15 and 16

Diagnosis.—Amb elongated oval. Monocolpate, furrow extending full length of the distal surface, each furrow margin thickened for an average width of about 3 microns. Length (based on 63 measured specimens) 20 to 45 microns, width 10 to 31 microns. Exine smooth, 1 micron or less in thickness.

Holotype.—(Plate 2, Figure 16); Slide No. 91; Stage coordinates 13·1, 107·7; length 40 microns, width 17 microns.

Locality.—Bore N.S. 11, 301 ft. 7½ in. to 302 ft. 11 in.

Paratype.—(Plate 2, Figure 15); Slide No. 238; Stage coordinates 9·6, 114·7; length 33 microns, width 17 microns.

Locality.—Bore N.S. 56, 840 ft. 3¼ in. to 840 ft. 6¼ in.

Remarks.—*E. crassimarginis* has a similar size range and shape to the specimens referred to *E. nitidus* Balme, being distinguished by the conspicuous thickening of the furrow margins.

Entylissa magna, new species

Plate 3, Figure 1

Diagnosis.—Amb elongated oval, Monocolpate, furrow extending full length of distal face without conspicuous development of furrow margins. Length (based on 38 measured specimens) 60 to 110 microns, width 27 to 66 microns. Exine smooth, 1 to 2 microns in thickness.

Holotype.—(Plate 3, Figure 1); Slide No. 238; Stage coordinates 14·5, 115·5; length 87 microns, width 47 microns.

Locality.—Bore N.S. 56, 840 ft. 3¼ in. to 840 ft. 6¼ in.

Remarks.—This species has been separated from the specimens described above under *E. nitidus* Balme on the basis of its larger size, less prominent furrow, and slightly thicker exine. Its affinities are considered to be with the Bennettitales or Cycadales.

Genus CAYTONIPOLLENITES (Couper 1958) Emend.

Remarks.—The recent definition of this genus (Couper, 1958, p. 149) provides an appropriate designation for small, disaccate pollen grains resembling the pollen of *Caytonanthus* Harris, a genus of the Caytoniales. The genus is distinguished from winged conifer pollen grains by its small size, elongated body and very thin exine. The specimens from the Rosewood coals described below agree with Couper's generic diagnosis in all particulars except that the bladders in the Queensland pollens are smooth to very faintly ornamented. Accordingly the generic diagnosis is amended as follows:—"Pollen grains, very small, usually less than 35 mircons overall; disaccate or rarely trisaccate, body of grain oval in polar view, longer than broad; exine of body very thin and finely scabrate to smooth; bladders large in relation to body, smooth or sculptured with fine thickenings, forming an obscure reticulum." The occurrence of species with smooth bladders in this genus has an analogy in *Caytonanthus kochi Harris,* in which species the bladder surface is nearly smooth, showing only the most indistinct thickenings and pits.

Caytonipollenites contectus, new species

Plate 3, Figures 2 and 3

Diagnosis.—Pollen grain disaccate. Central body oval in polar view; longer than broad; exine smooth, very thin (less than 1 micron). Total span of grain (based on 25 measured specimens) 25 to 45 microns; length of body 15 to 30 microns; breadth of body 13 to 25 microns; average ratio of length to breadth of body 1·5. Bladders large in relation to size of body, attached with a slight distal inclination. Bladders covering body except for a narrow median longitudinal portion, 1 to 2 microns in width, extending complete length of body. Bladders smooth or very faintly granulate (?), less than 1 micron in thickness.

Holotype.—(Plate 3, Figure 2); Slide No. 79; Stage coordinates 16·0, 109·9; total span 33 microns.

Locality.—Bore N.S. 11, 361 ft. 8 in. to 363 ft. 6 in.

Paratype.—(Plate 3, Figure 3); Slide No. 85; Stage coordinates 12·0, 113·6; total span 25 microns.

Locality.—Bore N.S. 11, 331 ft. to 332 ft. 6 in.

Remarks.—This species is distinguished from the only previously described species *C. pallidus* (Reissinger) Couper, by the lack of well-defined bladder ornamentation and also by the extreme overlap of the bladders, covering most of the body surface. Like that species, its affinities are probably with the Caytoniales.

Caytonipollenites subtilis, new species

Plate 3, Figure 4

Diagnosis.—Pollen grain disaccate. Central body oval in polar view; longer than broad; exine smooth, very thin (less than 1 micron). Total span of grain (based on 54 measured specimens) 23 to 50 microns; length of body 14 to 28 microns; breadth of body of 12 to 25 microns; average ratio of length to breadth of body 1·5. Bladders large in relation to size of body, attached with slight distal inclination. Bladders overlapping body except for a median portion 5 to 10 microns in width, extending length of body. Bladders smooth or faintly granulate (?), less than 1 micron in thickness. Length of bladders equal to, or slightly greater than, length of body.

Holotype.—(Plate 3, Figure 4); Slide No. 113; Stage coordinates 9.0; 105-7; total span 37 microns.

Locality.—Bore N.S. 17, 200 ft. 9 in. to 205 ft. 4¾ in.

Remarks.—*C. subtilis* differs from *C. contectus*, described above, in having a much greater proportion of the body surface exposed due to the lesser overlap of the bladders. It is distinguished from *C. pallidus* (Reissinger) Couper in lacking the distinct bladder ornamentation of that species and its bladders also appear to be slightly longer and more inclined distally. Like the species mentioned, its affinities are probably with the Caytoniales.

Genus ARAUCARIACITES Cookson

Araucariacites cf. *A. australis* Cookson

Plate 3, Figure 9

Description.—Outline circular or sub-circular, frequently distorted by folding. No germinal mechanism or tetrad markings visible. Diameter (based on 325 measured specimens) 31 to 98 microns (average 55 microns). Exine thin, granulate, with granulations of varying size (up to 1 micron), closely spaced to distinctly separated.

Figured specimens.—(Plate 3, Figure 9); Slide No. 205; Stage coordinates 14·1, 107·4; diameter 55 microns.

Locality.—Bore N.S. 42, 546 ft. 8 in. to 547 ft. 1¾ in.

Remarks.—The Rosewood specimens show considerable variation, both in diameter and in the size and closeness of the granulations. In size range they compare closely with that given by Cookson (1947, p. 130) (39 to 93 microns) but some of the Rosewood specimens, such as that figured (Plate 3, Figure 9) have somewhat larger granulations, which are further apart than in Cookson's figures (1947, Pl. XIII, Figs. 1–4), and consequently the specimens are only compared with *A. australis*. Study of a large number of specimens has shown that there is continuous variation, both in size range and in the nature of the ornamentation, so that no closer grouping of the Rosewood pollens has been possible.

Genus INAPERTUROPOLLENITES Thomson and Pflug

Inaperturopollenites reidi, new species

Plate 3, Figure 7

Diagnosis.—Outline circular or sub-circular, frequently distorted by folding. No germinal mechanism or tetrad markings visible. Diameter (based on 156 measured specimens) 60 to 112 microns (average about 82 microns). Exine smooth, thin (about 1 micron in thickness), frequently folded, light brownish yellow to almost colourless.

Holotype.—(Plate 3, Figure 7); Slide No. 290; Stage coordinates 13·6, 111·9; diameter 110 microns.

Locality.—Bore N.S. 84, 231 ft. 8 in. to 232 ft. 7½ in.

Remarks.—This species is distinguished from *I. limbatus and I. turbatus* described by Balme (1957, p. 31) by its lack of ornamentation, and also by the absence of differential thickening. It also differs from *Araucariacites australis* Cookson in having a smooth exine. There is a general resemblance to the latter species in size range and in the lack of germinal openings which suggests affinity with the Araucariaceae.

Inaperturopollenites reidi is named after the late Mr. J. H. Reid, former District Geologist, Geological Survey of Queensland, who made the first detailed geological survey of the Rosewood coalfield.

Inaperturopollenites sp.

Plate 3, Figure 5

Description.—Outline circular or subcircular, frequently distorted by folding. No germinal mechanism or tetrad markings visible. Diameter (based on 81 measured specimens) 20 to 55 microns (average about 32 microns). Exine smooth, thin (about 1 micron in thickness), frequently folded.

Figured specimen.—(Plate 3, Figure 5); Slide No. 154; Stage coordinates 11·5; 109·1; diameter 30 microns.

Locality.—New Malabar Colliery (1954 tunnel).

Remarks.—Forms described here have been separated from *I. reidi* on the basis of size frequency distribution. The large size range suggests that the description may include more than one species, and consequently no specific name has been given to the specimens. The affinities of these forms are also doubtful; some of the larger specimens resemble pollens of the Araucariaceae, while some of the smaller forms can be compared with the spores of *Equisetum*, as was done by Balme (1957, p. 28) in the case of *Pilasporites marcidus*, a somewhat similar species from Western Australia. In view of the continuous size range and lack of ornamentation and germinal characters to provide a basis for classification, no closer grouping of the Rosewood specimens can be attempted.

Genus ZONALAPOLLENITES Pflug

Zonalapollenites dampieri Balme

Plate 3, Figure 8

Zonapollenites dampieri Balme, 1957, C.S.I.R.O. Physical and Chemical Survey of the National Coal Resources, Ref. T.C. 25, p. 32, pl. 8, figs. 88-90.

Figured Specimen.—(Plate 3, Figure 8); Slide No. 142; Stage coordinates 16·1, 108·6; diameter 65 microns.

Locality.—Bore N.S. 40, 230 ft. 8¼ in. to 232 ft. 11¼ in.

All the photographs are at a magnification of 830 diameters

Plate 3

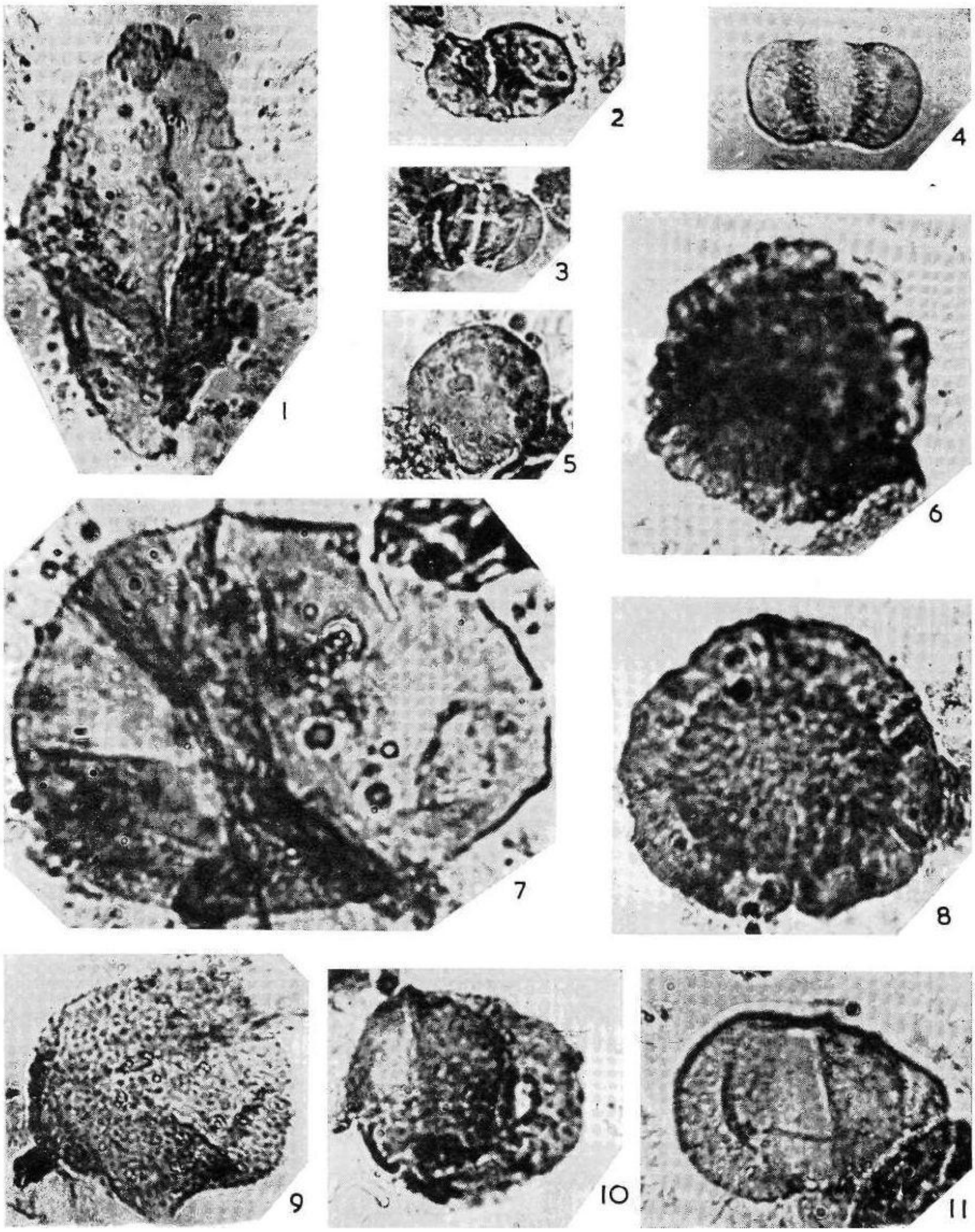

Fig. 1.—*Entylissa magna* n. sp. Holotype.
Fig. 2.—*Caytonipollenites contectus* n. sp. Holotype.
Fig. 3.—*Caytonipollenites contectus* n. sp. Paratype.
Fig. 4.—*Caytonipollenites subtilis* n. sp. Holotype.
Fig. 5.—*Inaperturopollenites sp.*
Fig. 6.—*Zonalapollenites segmentatus* Balme.
Fig. 7.—*Inaperturopollenites reidi* n. sp. Holotype.
Fig. 8.—*Zonalapollenites dampieri* Balme.
Fig. 9.—*Araucariacites* cf. *australis* Cookson.
Fig. 10.—*Pityosporites parvisaccatus* n. sp. Holotype.
Fig. 11.—*Pityosporites psilatus* n. sp. Holotype.

Remarks.—The pollen grains recorded here agree closely with Balme's description, the only additional observation being that in many of the Rosewood specimens the bladders are smooth walled, rather than very finely granulate as in the type material. In preliminary work on the Rosewood specimens they were tentatively classified under the genus *Perotrilites* Couper; however further study has shown that the triradiate markings observed are of a vestigial nature, as in *Zonalapollenites,* rather than functional, as in *Perotrilites.*

Regarding the affinities of this species Balme states (1957, p. 32): "The species is morphologically similar to the pollen grains of certain species of *Tsuga* but is most unlikely to have derived from this, or any closely related, genus. Its frequent occurrence and widespread distribution suggest that it is a tree pollen, perhaps of coniferalean affinities."

Zonalapollenites segmentatus Balme

Plate 3, Figure 6

Zonalapollenites segmentatus Balme, 1957, C.S.I.R.O. Physical and Chemical Survey of the National Coal Resources, Ref. T.C. 25, p. 33, pl. 9, figs. 93-94.

Figured specimen.—(Plate 3, Figure 6); Slide No. 149; Stage coordinates 8·5, 110·9; diameter 57 microns.

Locality.—Bore N.S. 40, 206 ft. 0½ in. to 207 ft. 5¼ in.

Remarks.—Under this species are recorded specimens which agree closely with Balme's diagnosis. Regarding its distribution and relation to Z. *dampieri* Balme states (1957, p. 33): "This species differs from *Zonalapollenites dampieri* in its smaller size, thicker exine, and narrower, more intensely folded bladder. It was fairly common in the Hill River—Jurien Bay sediments, but very rare elsewhere."

Genus PITYOSPORITES Seward

Remarks.—The writer has followed Balme (1957, p. 35) in placing in this form-genus bisaccate pollen grains, lacking characters which clearly differentiate them from Abietineous pollens. Balme considers that the likely affinities of such forms in the Australian Mesozoic and Tertiary are with the Podocarpaceae or Pteridospermae.

Specimens of *Pityosporites* isolated from the Rosewood coals are frequently unexpanded, crumpled or unfavourably exposed, and in addition the genus is not very abundant in any of the samples studied. Consequently it has only been possible to define two species, *P. parvisaccatus* and *P. psilatus* which are described below.

Pityosporites parvisaccatus, new species

Plate 3, Figure 10

Diagnosis.—Pollen grains bilateral, bisaccate. Body of grain broadly elliptical in polar view, length 43 to 80 microns, width 32 to 62 microns (based on 56 measured specimens). Exine of cap smooth to faintly granular, relatively thin (1 to 1·5 microns) no marginal ridge. Sulcus (furrow) psilate to finely granular, without a thickened furrow-rim. Two small air-bladders, sometimes inequal in size, usually shorter than length of grain and with a fine indistinct reticulum. Size range of bladders 33 to 65 microns (length) and 15 to 33 microns (width).

Holotype.—(Plate 3, Figure 10); Slide No. 136; Stage coordinates 11·5, 101·4; length of body 45 microns; width of body 35 microns.

Locality.—Bore N.S. 21, 219 ft. 4 in. to 220 ft. 4¼ in.

Remarks.—The ellipsoidal body, with its thin exine, and the small narrow bladders, distinguish this species from previously described species of *Pityosporites.* There is some resemblance to a specimen figured, but not described, by Cookson (Cookson 1953, plate 2, fig. 42) from the Cretaceous Comaum clays of Victoria, but in the latter specimen the bladders appear to be wider than is normal in *P. parvisaccatus.*

Pityosporites psilatus, new species

Plate 3, Figure 11

Diagnosis.—Pollen grain bisaccate. Total span (based on 29 measured specimens) 50 to 73 microns. Central body circular or sub-circular, proximal cap smooth and relatively thin (less than 1 micron). Diameter of central body 33 to 43 microns. Bladders symmetrically disposed on either side of the furrow (width 10 to 17 microns), extending along its full length, distal inclination slight. Bladders with a fine indistinct internal reticulum (mesh about 1 micron).

Holotype.—(Plate 3, Figure 11); Slide No. 202; Stage coordinates 15·6, 107·8; Total span 57 microns; diameter of body 36 microns.

Locality.—Bore N.S. 42, 528 ft. 6¼ in. to 530 ft. 6¼ in.

Remarks.—This species is somewhat similar to *P. similis* Balme from the Upper Jurassic and Lower Cretaceous of Western Australia, but the exine of the body is smooth, not ornamented as in that species, and the shape and ornamentation of the bladders are also different.

5. Comparison with the Macro-Flora of the Rosewood Coalfield

Although David (1950, p. 465) gives a list of 25 species of fossil plants identified in the Walloon Coal measures and equivalent formations, the majority of these species were collected from localities away from the type area in the Rosewood coalfield. As direct comparison with the microflora must be based on material collected within the area of the coalfield, such comparison is restricted to the following list, compiled largely from Walkom (1917A, p. 24; 1917B, p. 25) and Reid (1922, p. 19):—

Cladophlebis australis (Morris)
Taeniopteris spatulata (McClelland)
Phyllopteris feistmanteli (Eth. Jr.)
Sphenopteris sp. (?)
Brachyphyllum crassum, Tenison-Woods
?*Thinnfeldia acuta* Walkom
Coniopteris sp.

In the course of the present drilling programme carried out by the Mines Department, shale cores from various horizons in the coal measures have been searched for plant fossils, but well-preserved specimens have proved to be relatively rare. Only one species not already recorded by Reid and Walkom was found in these bore cores; this was a form identified by the writer as *Coniopteris* sp.

Of the above species, *Cladophlebis australis* is considered to have affinities with the Osmundaceae (Walkom 1917A, p. 2). Of the spore species described here, the only one with definite Osmundaceous affinities is *Osmundacidites cf. wellmanii* Couper. This suggests that the spores recorded under this name are either the spores of *Cladophlebis australis* or of some closely related species.

Taeniopteris spatulata is a leaf type known in Queensland from impressions only. Although the evidence of cuticular structure is thus lacking, it seems likely that this species is a member of the Cycadophyta. Pollen grains with probable Cycadophyte affinities are represented by three species of *Entylissa* – *E. nitidus* Balme and the two new species, *E. magna* and *E. crassimarginis*. One of these species may thus include the pollen of *T. spatulata*.

The genus *Brachyphyllum* comprises conifer stems and foliage, which on the basis of cuticular structure and associated cones, were considered by Kendall (1947) to have Araucarian affinities. On the other hand Bose (1952, p. 294) has shown that the secondary wood of one species (*B. spiroxylum* Bose) resembles that of the Taxineae. In the microflora three species—*Araucariacites* cf. *australis, Inaperturopollenites reidi* and *Inaperturopollenites sp.,* have possible Araucarian affinities, while none of the pollen species have been related to the Taxineae. Thus it seems likely that one of these pollen types may represent the pollen of *Brachyphyllum crassum*.

On the evidence of the fertile fronds the genus *Coniopteris* is now placed in the Dicksoniaceae (Medwell 1954, p. 85). In the microflora there are several species which resemble spores of the Dicksoniaceae and may thus be the spores of the frond type recorded as *Coniopteris sp.* They are: *Cyathidites parvus, Leiotriletes directus, L. magnus, L. mortoni, L. crassus, Granulatisporites minor, Verrucosisporites triangularis* and *V. walloonensis*.

The remaining three species of the macro-flora—*Phyllopteris feistmanteli, ?Thinnfeldia acuta* and *Sphenopteris* sp.—are either doubtful records or forms of which the affinities are uncertain and consequently do not furnish any further evidence on the relationships of the micro – and macro-floras. A comparison of the floras has thus suggested relationships of certain species of spores and pollen to four species based on leaf characters—namely *Cladophlebis australis, Taeniopteris spatulata, Brachyphyllum crassum* and *Coniopteris* sp.

From the preceding account, it is evident that the fossil spores and pollen grains have provided a much more detailed and representative record of the vegetation of the Walloon Coal Measures in the type area than is furnished by the larger plant fossils. This could be expected as a consequence of the abundance of microfossils in the coal seams and the relative rarity of plant impressions in the accompanying sediments.

6. Age and Relationships of the Microflora

Although the Walloon Coal Measures have for many years been regarded as Jurassic in age, there has been insufficient evidence for closer age determination. Drilling in recent years has shown that the productive portion of the coal measures, containing all the workable seams, is only about 500 feet in thickness in the vicinity of Rosewood. Thus it seems highly improbable that such a thin sequence of fresh-water sediments, without any major disconformities, could have required a large part of the Jurassic period for its deposition. Accordingly it was hoped that the investigation of the spore and pollen content of the coals would supply additional evidence on their geological age, and thus enable the formation to be placed within one of the divisions of the Jurassic. Although it cannot be expected that these plant microfossils will ever rival certain marine invertebrates, such as Foraminifera or Ammonites, for accuracy as index fossils, their value in correlating fresh-water sediments is now well established, and they have already provided further evidence on the age of these coal measures, which is summarised below.

A study of recent papers describing the stratigraphical applications of plant microfossils, for example, those of Couper (1953) and Balme (1957) indicates that many spore and pollen genera have ranges extending through one or more geological periods, and that species, rather than genera, are the Key fossils for correlation purposes. Of the forty species distinguished in the present investigation, twenty-eight are new, and thus of little value in correlation, while the remaining twelve have been identified or compared with species recorded from Mesozoic formations in Western Australia, New Zealand and Poland.

The most useful reference succession for correlation is provided by the microfloras described by Balme (1957, pp. 40-44) from the Mesozoic of Western Australia. These microfloras are accurately dated from the evidence of marine fossils in sediments interbedded with the strata containing the plant micro-fossils and their sequence extends from Lower Jurassic to Aptian. The species which also occur in the Walloon Coal Measures have the following distribution in this sequence:—

(1) *Zonalapollenites segmentatus* has been recorded from the Lower Jurassic, with doubtful specimens from the Bajocian, Oxfordian and Kimeridgian.

(2) *Zonalapollenites dampieri* ranges from Bajocian to Aptian, with doubtful specimens from the Lower Jurassic.

(3) The species *Sphagnumsporites australis, Entylissa nitidus* and *Araucariacites australis* range throughout the Western Australian sequence.

(4) *Sphagnumsporites clavus* is restricted to the Neocomian and Aptian. However Balme suggests (1957, pp. 15, 43) that such Bryophyte spores may be markedly affected in their distribution by facies changes, so that relatively little importance should be attached to the presence or relative abundance of this species, which may ultimately prove to be as long-ranged as *Sphagnumsporites australis.*

The distribution of these species, particularly the occurrence of the distinctive *Zonalapollenites segmentatus,* favours a Lower Jurassic age for the Walloon Coal Measures in the type area. This correlation is supported by the presence of the genus *Annulispora,* which in certain morphological features resembles *Exesipollenites* Balme, a genus restricted to and characteristic of the Lower Jurassic in Western Australia. Certain differences observed between the Western Australia and Queensland assemblages may reflect facies differences, as investigation of the Walloon Coal Measures has so far been confined to the coal seams, while a wider range of lithological types has been examined in Western Australia. Further work in both States may thus indicate a closer relationship between the microfloras.

A comparison with the microfloras of the Hawks Crag Breccia and Ohika Beds of New Zealand (see Couper 1953, pp. 9, 10) does not assist further in age determination, as these formations have not been definitely placed in any of the divisions of the Jurassic. One of the New Zealand species—*Leptolepidites verrucatus* Couper—has been identified in the Rosewood coals, while the following comparisons have been made:—*Araucariacites cf. australis* Cookson, *Entylissa nitidus* Balme, *Osmundacidites cf. wellmanii* Couper, *Sphagnumsporites australis* (Cookson), all from the Walloon Coal Measures, resemble respectively in many features *Araucariacites cf. australis* Cookson, *Monosulcites aff. minimus* Cookson, *Osmundacidites wellmanii* Couper and *Sphagnum sp.* Couper from the New Zealand formations. Distinctive Lower Jurassic forms such as *Zonalapollenites segmentatus* and *Exesipollenites* appear to be missing from the New Zealand microfloras and this suggests that the latter may be somewhat younger (Middle or Upper Jurassic).

The principal feature the Walloon microflora has in common with the Liassic assemblage from Poland described by Rogalska (1954) is the occurrence of the species *Annulispora folliculosa* (Rogalska). The discovery of this distinctive spore in the Queensland samples is further evidence for a Lower Jurassic age.

The present position regarding the age of the Walloon Coal Measures in the type area is thus that the available evidence from the spore and pollen assemblage favours a Lower Jurassic age. Insufficient information is at present available to determine the age of the underlying Marburg Sandstone, as only one sample from it has so far been examined, but from the absence of a major time break between it and the coal measures this formation is likely to be either Lower Jurassic or Upper Triassic.

7. Acknowledgements

The writer wishes to thank Dr. Isabel Cookson, of the University of Melbourne, for her interest and encouragement, as well as assistance with the literature. The assistance of Professor W. H. Bryan and the staff of the Geology Department, University of Queensland, in providing facilities for the preparation of the photo micrographs is also gratefully acknowledged. Mr. I. G. Sanker, Assistant Geologist, Geological Survey of Queensland, assisted throughout in the preparation of the photomicrographs and plates.

8. Bibliography

BALME, B. E., 1957. Spores and Pollen Grains from the Mesozoic of Western Australia. *C.S.I.R.O. Physical and Chemical Survey of the National Coal Resources, Ref. T.C. 25, December, 1957.*

BALME, B. E. & HENNELLY, J. P. F., 1956 (A). Monolete, monocolpate and alete sporomorphs from Australian Permian sediments. *Aust. J. Bot.,* 4, (1), 54-67.

————, 1956 (B). Trilete sporomorphs from Australian Permian sediments. *Aust. J. Bot.,* 4 (3), 240-260.

BHARDWAJ, D. C., 1955. The spore genera from the upper Carboniferous coals of the Saar and their value in stratigraphical studies. *The Palaeobotanist,* 4, 119-149.

BOSE, M. N., 1952. *Brachyphyllum spiroxylum* sp. nov. from the Rajmahal Hills, India. *Jour. Ind. Bot. Soc.,* XXI,(4), 287-296.

COOKSON, I. C., 1947. Plant microfossils from the lignites of Kerguelen Archipelago. *B.A.N.Z. Antarct. Res. Exped.* 2, pt. 8, 129-142.

————, 1953. Difference in microspore composition of some samples from a bore at Comaum, South Australia. *Aust. J. Bot.,* 1(3), 462-473.

COUPER, R. A., 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *N.Z. Geol. Surv., Palaeont. Bull.* No. 22.

———, 1958. British Mesozoic microspores and pollen grains. A systematic and stratigraphic study. *Palaeontographica B,* 103, 75-179.

DAVID, T. W. E., 1950. The Geology of the Commonwealth of Australia. Vol. 1 747 pp.

DE JERSEY, N. J., 1946. Microspore types in some Queensland Permian Coals. *Univ. Qld. Dep. Geol. Pap.* 3 (5).

———, 1955 (a). Spore distribution and correlation—Rosewood coalfield, Pt. 1; Roughrigg and Malabar mine areas. *Qld. Gov. Min. J.,* LVI, 55-59.

———, 1955 (b). Spore distribution and correlation—Rosewood coalfield, Pt. 2; Lanefield Mine Area. *Qld. Gov. Min. J.,* LXI, 617-621.

———, 1957. Spore distribution and correlation—Rosewood coalfield; Glencoe, Oakleigh and Normanton No. 1 Mine Areas. *Qld. Gov. Min. J.,* LVIII, 190-197.

———, 1958. Spore distribution and correlation—Rosewood Coalfield; Smithfield No. 3 Mine Area. Unpublished report to Chief Government Geologist.

HARRIS, T. M., 1941. *Caytonanthus,* the microsporophyll of *Caytonia. Annals of Botany, N.S.,* 5, (17), 47-58.

HARRIS W. F., 1955. A manual of the spores of New Zealand pteridophyta. *New Zealand, D.S.I.R.,* Bull. 116.

KENDALL, N. W., 1947.—On the five species of *Brachyphyllum* from the Jurassic of Yorkshire and Wiltshire. *Annals Mag. Nat. Hist.* 11 (14); 225-251.

KNOX, E. M., 1938. The spores of Pteridophyta, with observations of microspores in coals of Carboniferous age. *Trans. & Proc. Bot. Soc. Edin.,* 32 (3), 438-466.

———, 1950. The spores of *Lycopodium, Phylloglossum, Selaginella,* and *Isoetes,* and their value in the study of microfossils of Palaeozoic age. *Trans. & Proc. Bot. Soc. Edin.,* 35, 211-357.

LUNDBLAD, B., 1949. On the presence of *Lepidopteris* in cores from "Hollviken 11." *Sveriges Geologiska Undersokning.* Arsbok 43 (5).

MEDWELL, L. M., 1954. A Review and Revision of the flora of the Victorian Lower Jurassic. *Proc. Roy. Soc. Vict., N.S.* 65, Pt. 2, 70-111.

POTONIÉ, H., 1893. Die Flora des Rothleigenden von Thuringen : *d.k. Preuss. geol. Landesanstalt. Abh. new Folge.* 9, (2), 185.

POTONIÉ, R., 1931. Zur. Mikroskopie der Braunkohle. Tertiare Blutenstaubformen (l'ste mitteilung): *Braunkohle,* 30, (16), 325-333.

———, 1956. Synopsis der Gattungen der Sporae dispersae—1. Teil: Sporites. *Beih. Geol. Jahrb.,* 23.

REID, J. H., 1922. Geology of the Walloon-Rosewood Coalfield. *Q'ld Geol. Surv. Publ.* 272.

ROGALSKA, M., 1954. Spore and pollen analysis of the region of the so-called Blanowice Coal in Upper Silesia. (Polish with English Summary). *Inst. Geol. Bull.* 89 (Warsaw).

SCHOPF, J. M., WILSON, L. R. & BENTALL, R., 1944. An Annotated Synopsis of Palaeozic Fossil Spores and the Definition of generic groups. *Ill. Geol. Surv. Rep. Inv.,* 91.

THOMSON, P. W. & PFLUG, H., 1953. Pollen und Sporen des "mitteleuropaischen Tertiars." *Palaeontographica,* 95B., 1-138.

WALKOM, A. B., 1917 (a). Mesozoic Floras of Queensland. Pt. 1—contd.; The Flora of the Ipswich and Walloon Series (c) Filicales, etc. *Qld. Geol. Surv. Publ.* 257.

———, 1917 (b). Mesozoic Floras of Queensland. Pt. 1—concluded; The Flora of the Ipswich and Walloon Series (d) Ginkgoales (e) Cycadophyta (f) Coniferales. *Qld. Geol. Surv. Publ.* 259.

By Authority: S. G. REID, Government Printer, Brisbane.