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SOME TRILETE SPORES FROM UPPER MESOZOIC DEPOSITS IN THE EASTERN AUSTRALIAN REGION

By Isabel C. Cookson* and Mary E. Dettmann*

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Abstract

Twenty-nine trilete microspore species are recorded; twenty-one of these are new types. New occurrences for four megaspores species are noted.

Evidence indicating a Lower Cretaceous (Albian) age for several Victorian deposits, three of which have previously been referred to the Lower Jurassic, is brought forward.

A correlation is established between the lower section of the Robe Bore and the Wonthaggi Coal Measures. It is suggested that the age of both deposits is Lower Cretaceous (Neocomian-Aptian).

Introduction

This paper is the outcome of early work on a long-term project which has for its ultimate aim the dating of the freshwater Mesozoic deposits of south-eastern Australia and Tasmania by palynological means. It is concerned partly with the identification and description of some of the more distinctive types of trilete microspores that occur in certain eastern Australian Upper Mesozoic sediments and partly with the stratigraphical implications to which they have given rise.

Until comparatively recently a Jurassic age has been accepted for all the freshwater Mesozoic deposits occurring in Victoria (the Triassic beds of the Bacchus Marsh area excepted) and the adjoining area of south-eastern South Australia. This age determination was originally based on the macroscopic plant remains which are frequently abundant in such Victorian deposits. In 1904, Seward compared the flora of the coal measures of these deposits with that of the Rajmahal Hills in India, while Medwell (1954a) after a re-examination of the flora as a whole came to the conclusion that it was of Lower Jurassic age.

The first intimation of the occurrence of Cretaceous deposits in Victoria was made by Kenley (1954) following the discovery of fragmentary dicotyledonous leaf-remains in the mudstone of the Runnymede Formation in south-western Victoria. The flora of this Formation was assigned to the Lower Cretaceous by Medwell (1954b.).

Concurrently, on palynological grounds, Cookson (1953, 1954) suggested a probable Cretaceous age for the lower section of the Birregurra Bore, 1,073-90 ft., and the sediments in the Comaum Bore, 651-708 ft., and soon afterwards Baker and Cookson (1955) recognized Upper Cretaceous sediments in the Nelson Bore of south-western Victoria, 5,782-6,192 ft.

On the evidence of megaspores, Cookson and Dettmann (1958) have suggested a Lower Cretaceous (Albian) rather than a Jurassic age for certain additional deposits in Victoria and South Australia. Some of the megaspores are referable to species which occur in Lower Cretaceous deposits in the Netherlands and England, others permit correlations with Australian deposits known, by their microplankton content, to be Lower Cretaceous.

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The individual microspore types and microspore assemblages to be considered below give added support to the Lower Cretaceous age-determinations previously mentioned, and clearly indicate a more extensive distribution of Cretaceous sediments in Victoria than was previously recognized.

Furthermore, they suggest that for the Victorian black coal measures, mentioned above, and beds of similar stratigraphic position, a Lower Cretaceous (Neocomian-Aptian) age.

Consideration has been restricted to trilete forms and the system of nomenclature suggested by Potonié (1956) for form-genera of such types has been followed throughout.

Unless otherwise specified, the polar dimensions included in the descriptions have been derived from at least ten examples.

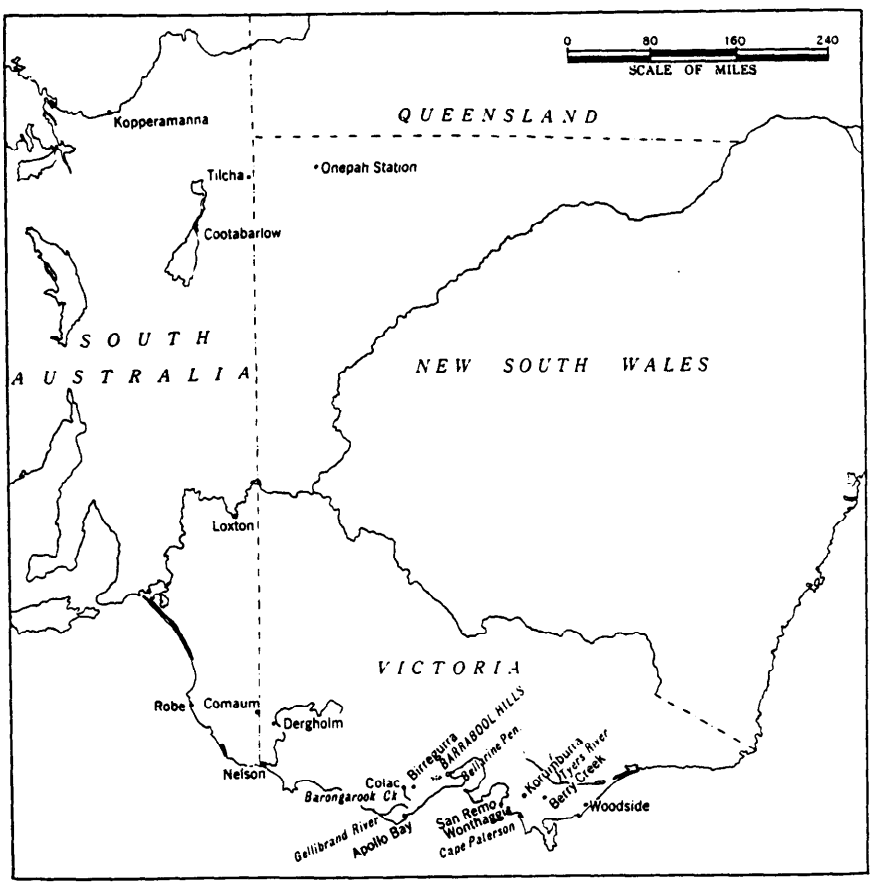

FIG. 1.—Map of south-eastern Australia, showing location of deposits in which the Upper Mesozoic spore associations have been found. (Prepared by the Geological Survey of Victoria.)

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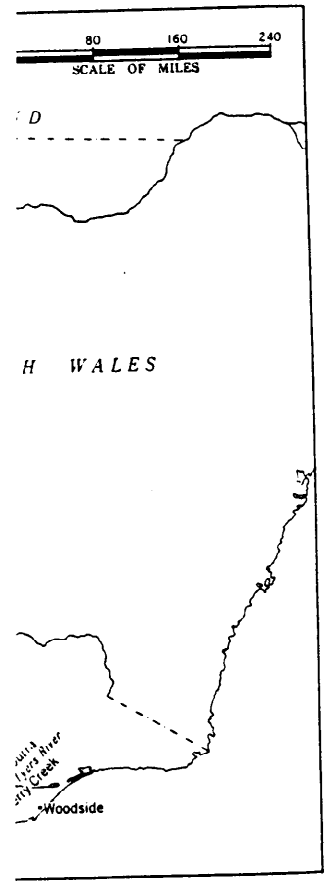

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ie Geological Survey of Victoria.)

Location and Age of Sediments

WESTERN AUSTRALIA. Carnarvon Basin, Exmouth Gulf area, Gearle Siltstone (lower part). West Australian Petroleum Pty. Ltd., Rough Range Well No. 1 at 2,750 ft. Age: Lower Cretaceous (Albian Cookson and Eisenack 1958. Perth Basin, Moora Bore 86-170 ft. Age: Lower Cretaceous (Albian) Cookson and Eisenack 1958. Canning Basin, Broome No. 1 Artesian Bore at 977 ft. Age: Upper Jurassic Cookson (unpublished).

SOUTH AUSTRALIA. Near Robe, northern portion of section 714, Hundred of Waterhouse. South Australian Oil Wells (No Liability), Bore No. 1. (a) 1,400-2,630 ft. Age: Lower Cretaceous (Albian) Cookson and Dettmann 1958. (b) 2,630-3,500 ft. Age: Jurassic (Ward 1917), Lower Cretaceous (Albian) authors. (c) 3,860-4,300 ft. Age: Jurassic (Ward 1917), Lower Cretaceous (Neocomian-Aptian) authors. Cootabarlow near Lake Frome, Bore No. 2 (a) at 581 ft. and 810 ft. Age: Lower Cretaceous (Albian) Cookson and Eisenack 1958. (b) at 1,354 ft. Age: Lower Cretaceous (Aptian) Cookson and Eisenack 1958. (c) at 1,465 ft. Age: Lower Cretaceous (Neocomian-Aptian) authors. Kopperamanna near Lake Frome, Bore No. 1 at 2,970 ft. Age: Lower Cretaceous (Neocomian-Aptian) Woodard 1955. Tilcha Bore near Lake Frome, at 460 ft. and 1,040 ft. Age: Lower Cretaceous (Albian) Cookson and Dettmann 1958. Loxton near Renmark, Australian Oil and Gas Corporation Ltd., Bore No. 1. at 1,410 ft. and 1,470 ft. Age: Lower Cretaceous (Albian) N. H. Ludbrook, South Australian Department of Mines Palaeontological Report—14/56, 1956 unpublished. Comaum, Hundred of Comaum, Bore No. 1, at 651 ft. and 708 ft. Age: Lower Cretaceous (possibly Albian) Cookson and Dettmann 1958.

VICTORIA. Nelson, Parish of Glenelg. Carbonaceous sediments from Victorian Department of Mines Bore at 4,782 ft., 6,233 ft., and 6,485-7 ft. Age: Upper Cretaceous Baker and Cookson 1955. Parish of Dergholm. Victorian Department of Mines Dergholm Bore No. 1 at 532 ft. and 582 ft. Age: Lower Cretaceous authors. Dergholm Bore No. 2 329-31 ft. Age: Lower Cretaceous (possibly Albian) Cookson and Dettmann 1958. Barongarook Creek, SW. of Colac. Age: Lower Cretaceous (Albian) Cookson and Dettmann 1958. Birregurra, Parish of Birregurra, carbonaceous sediments from Victorian Department of Mines Bore 1,070-80 ft., 1089-90 ft., and 1,101-2 ft. Age: Lower Cretaceous Cookson 1954. SE. of mouth of Gellibrand River, E. side of Devil's Kitchen, mudstone from near Mesozoic-Paleocene unconformity. Age: Lower Cretaceous (Albian) authors. Apollo Bay, shale containing *Cladophlebis denticulata*. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Bellarine Peninsula, near Geelong, Little's Shaft No. 2 38-47 ft. Age: Lower Cretaceous (Albian) Cookson and Dettmann 1958. Barrabool Hills, 1 m. SW. Fyansford, Geelong. Sample from outcrop along Barwon River. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (?Albian) authors. San Remo Peninsula. Shale conatining *Taeniopteris hislopi* taken from above Coal Measures. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Cape Paterson, W. of Inverloch. Shore platform outcrop. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Whitelaw Railway Station, South Gippsland. Shale containing *Brachyphyllum gippslandicum* (N.M.V. P12805). Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Wonthaggi State Coal Mine Area. (a) Victorian Department of Mines Bore No. 175 at 760 ft. Shale containing *Equisetites wonthaggiensis* (N.M.V. P12893). (b) Shale containing *Coniopteris hymenophylloides*. (c) West Area Mine. (1) Carbonaceous seam, west dip section, 400 ft., below sea level. (2)

Carbonaceous mudstone immediately above bottom seam. (3) Mudstone cuttings from floor of bottom coal seam. (d) No. 20 shaft. Carbonaceous mudstone from above top coal seam. (e) Kirrak Area. (1) Main coal seam, 103 ft. below sea level. (2) Mudstone from floor of coal seam. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Korumburra, Sunbeam Collieries. (a) Coal taken from seam at 350 ft. (b) Shale above coal seam. Age: Lower Jurassic Medwell 1954, Lower Cretaceous (Neocomian-Aptian) authors. Alberton, Parish of Alberton West. Victorian Department of Mines Bore No. 137, 174-8 ft., and Bore No. 159, 250-65 ft. Age: Jurassic Victorian Department of Mines Boring Records, 1951-2, published 1955, Lower Cretaceous (?Albian) authors. Berry Creek, Parish of Mardan, Victorian Department of Mines Bore No. 7, samples 10, 17, 18, 19, 65 and 68, and Bore No. 18 at 278 ft. Age: Lower Cretaceous (Neocomian-Aptian) authors. Tyers River, Latrobe Valley, Victorian Department of Mines Bore No. 2 850-1,200 ft. Age: Lower Cretaceous (Neocomian-Aptian) authors. Woodside, near Lakes Entrance. Woodside Well No. 2 sunk by Woodside (Lakes Entrance) Oil Company (No Liability), 4,114-27 ft., 4,251-7 ft., and at 6,402 ft. Age: Lower Cretaceous (Albian) authors. Hedley, near Lakes Entrance. Hedley Well No. 1 sunk by Woodside (Lakes Entrance) Oil Company (No Liability) at 1,460 ft., 2,099 ft., and 2,132 ft. Age: Lower Cretaceous (Albian) authors.

NEW SOUTH WALES. Onepah Station near Tibooburra. Soft fine-grained sandstone dug from a well at an unspecified depth. Age: Lower Cretaceous (Albian) Cookson and Eisenack 1958.

QUEENSLAND. Styx Coal Measures. Carbonaceous shales from Queensland Geological Survey's Bore No. 21, at 327 ft., and Bore No. 20, at 454 ft., sunk in the Tooloombah Creek area. Age: Lower Cretaceous (Albian) Walkom 1919, Cookson and Dettmann 1958. Near Weipa Mission, Albatross Bay, Gulf of Carpentaria. Zinc Corporation's Weipa No. 1 Bore, 2,022-41 ft. Age: Aptian authors.

NEW GUINEA. Omati, Papua, Island Exploration Co.'s Bore, Samples 1 and 2. Age: Lower Cretaceous (Albian) Cookson and Eisenack 1958.

Systematic Descriptions

TURMA TRILETES Reinsch (1881) emend Potonié and Kremp 1954

Subturma AZONOTRILETES Luber 1935

Infraturma LAEVIGATI Bennie and Kidston 1886

Genus **Divisisporites** Thomson 1952

Divisisporites euskirchenensis Thomson

(Pl. XIV, fig. 1)

Occurrence. South Australia—Robe Bore, at 1,400 ft.; Tilcha Bore, at 460 ft. Victoria—Birregurra Bore No. 1, at 1,102 ft.; Woodside Well No. 2, at 4,251 ft.

Geological Range in Australia. Lower Cretaceous (probable Albian).

Comments. This species was described by Thomson in Thomson and Pflug (1952) from Middle European Tertiary deposits (Paleocene) and subsequently recorded by Delcourt and Sprumont (1955) from the Wealden of Hainaut. The occurrence of *Divisisporites euskirchenensis* in Australian Lower Cretaceous sediments is therefore of interest.

D. euskirchenensis strongly resembles the Lower Cretaceous species *Cingulatisporites euskirchensoides* described by Delcourt and Sprumont (1955) from the

Description. Spore trilete, subtriangular to subcircular; equatorial flange membranous 5-9μ wide with a serrated margin; tetrad-scar prominent, laesurae extending to the periphery of the spore-body. Exine thin, proximal surface smooth, distal surface ornamented by rather widely-spaced conical spines or more usually straight-sided blunt projections, which broaden slightly at the base.

Dimensions. Overall equatorial diameter 54-62μ; equatorial diameter of spore-body 43-49μ; length of exinous projections 7-9μ.

Geological Range. A rare type which appears to be restricted to deposits of Neocomian-Aptian age.

Styxisporites majus sp. nov.

(Pl. XIX, figs. 10-14; holotype, fig. 10)

Occurrence. Western Australia—Gearle Siltstone (lower part)—West Australian Petroleum Co.'s Rough Range Well No. 1, at 2,750 ft.; Moora Bore, 86-170 ft. South Australia—Tilcha Bore, at 460 ft. and 1,040 ft.; Cootabarlow Bore No. 2, at 581 ft.; Robe Bore, at 1,400 ft. Victoria—Birregurra Bore No. 1, at 1,089 ft. and 1,102 ft. New South Wales—Onepah Station Well. Queensland—Styx Coal Measures Bore No. 21, at 327 ft., Bore No. 20, at 450 ft.

Description. Spore trilete with a subtriangular to subcircular amb; the equatorial flange is relatively wide with a finely scabrate surface and serrated margin. The laesurae of the tetrad-scar are straight and extend to the periphery of the spore-body. The exine is about 1·5μ thick, smooth on the proximal surface and ornamented on the distal surface by rather widely-spaced conical spines or occasionally blunt straight-sided projections which usually arise from low ridges running parallel to the equatorial contour of the spore-body. Occasionally, as in the specimen shown in Pl. XIX, fig. 12, the ridges are more prominent and jagged and the spines reduced.

Dimensions. Overall equatorial diameter 60-79μ, equatorial diameter of spore-body 45-58μ, flange 9-16μ, length of spines 4-7μ.

Geological Range. Lower Cretaceous (Albian).

Comments. A few of the specimens from the Tilcha Bore and all those from Little's Shaft in the Bellarine Peninsula have smaller and more numerous spines than typical examples of *Styxisporites majus* (Pl. XIX, fig. 14). While it seems likely that they represent a distinct type too few of them have been recovered to justify specific separation.

S. majus differs from *S. linearis* in its larger size and in the presence of the low ridges from which the spines arise.

Spore Assemblages

As stated earlier, only a relatively small number of the trilete spore types present in the various deposits analysed have been described and classified. The lists included in this section give little idea of the microfloras as a whole and are included only as records and for comparative purposes.

A. Lower Cretaceous (Neocomian-Aptian)

1. South Australia
   (a) Robe Bore at 4,300 ft.
   Microspores—

Ceratosporites equalis
Dictyotosporites speciosus
Granulatisporites dailyi
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites circolumenus
Lycopodiumsporites austroclavatidites
Neoraistrickia truncatus
Pilosisporites notensis
Radiatisporites hughesi

(b) Robe Bore at 3,860 ft.

Microspores—

Apiculatisporis wonthaggiensis
Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus
Cirratriradites tilchaensis
Dictyotosporites speciosus
Dictyotosporites complex
Granulatisporites dailyi
Ischyosporites scaberis
Leptolepidites verrucatus
Lycospora mollis
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis
Pilosisporites notensis
Radiatisporites hughesi
Styxisporites linearis

Megaspores—

Minerisporites marginatus

(c) Kopperamanna Bore at 2,970 ft.

Microspores—

Ceratosporites equalis
Cirratriradites spinulosus
Dictyotosporites speciosus
Dictyotosporites complex
Ischyosporites scaberis
Ischyosporites punctatus
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus
Lycospora mollis
Neoraistrickia truncatus
Osmundacidites comaumensis
Radiatisporites hughesi

(d) Cootabarlow Bore No. 2 at 1,465 ft.

Microspores—

Ceratosporites equalis
Dictyotosporites speciosus
Dictyotosporites complex
Ischyosporites punctatus
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis
Radiatisporites hughesi

Megaspores—

Minerisporites marginatus

2. Victoria

(a) Apollo Bay

Microspores—

Apiculatisporis wonthaggiensis
Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus
Dictyotosporites speciosus
Ischyosporites scaberis
Leptolepidites verrucatus
Lycospora mollis
Neoraistrickia truncatus
Osmundacidities comaumensis
Pilosisporites notensis

(b) San Remo

Microspores—

Ceratosporites equalis
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis

(c) Cape Paterson

Microspores—

Ceratosporites equalis
Cicatricosiporites australiensis
Cirratriradites spinulosus
Dictyotosporites speciosus
Granulatisporites dailyi
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Neoraistrickia truncatus
Osmundacidites comaumensis
Pilosisporites notensis
Radiatisporites hughesi

(d) Wonthaggi State Coal Mine Area, localities (a), (b), (c^3), (e^2)

Microspores—

Apiculatisporis wonthaggiensis localities (c^3), (e^2) only
Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus localities (a), (b), (e^2) only
Dictyotosporites speciosus
Dictyotosporites complex
Granulatisporites dailyi
Ischyosporites punctatus locality (b) only
Ischyosporites scaberis
Kuylisporites lunaris localities (b), (e^2) only
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus localities (a), (b) only
Lycospora mollis locality (b) only
Neoraistrickia truncatus
Osmundacidites comaumensis
Pilosisporites notensis
Radiatisporites hughesi localities (a), (b), (c^3) only
Styxisporites linearis localities (a), (b), (e^2) only

Megaspores—

Minerisporites marginatus, localities (b), (e^2) only

(e) Whitelaw Railway Station

Microspores—

Apiculatisporis wonthaggiensis
Ceratosporites equalis
Cicatricosisporites australiensis
Dictyotosporites speciosus
Granulatisporites dailyi
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites austraclavatidites
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis
Radiatisporites hughesi

(f) Berry Creek Bore at 278 ft., Bore 7, sample 18

Microspores—

Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis
Pilosisporites notensis
Radiatisporites hughesi

(g) Tyers Bore No. 2 at 860 ft.

Microspores—

Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus
Dictyotosporites speciosus
Granulatisporites dailyi
Ischyosporites scaberis
Kuylisporites lunaris
Leptolepidites verrucatus
Neoraistrickia truncatus
Osmundacidites comaumensis

(h) Korumburra, shale above coal

Microspores—

Apiculatisporites wonthaggiensis
Ceratosporites equalis
Cicatricosisporites australiensis
Dictyotosporites speciosus
Granulatisporites dailyi
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Osmundacidites comaumensis
Pilosisporites notensis
Radiatisporites hughesi

B. Lower Cretaceous (Aptian and Albian)

1. South Australia

(a) Robe Bore

(i) 3,500 ft.

Microspores—

Ceratosporites equalis
Cicatricosporites australiensis
Cingulatisporites euskirchensoides
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Neoraistrickia truncatus
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis

(ii) 3,325 ft.

Microspores—

Apiculatisporis asymmetricus
Ceratosporites equalis
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cirratriradites spinulosus
Ischyosporites scaberis
Leptolepidites verrucatus
Neoraistrickia truncatus
Perotrilites striatus

Megaspores—

Minerisporites marginatus

(iii) 2,630 ft.

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cingulatisporites simplex
Cirratriradites spinulosus
Ischyosporites scaberis
Lycopodiumsporites austroclavatidites
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis

Megaspores—

Balmeisporites holodictyus

(iv) 2,325 ft.

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cirratriradites spinulosus
Cirratriradites verrucosus
Lycopodiumsporites austroclavatidites
Osmundacidites australiensis
Perotrilites striatus
Pilosisporites notensis

(v) 1,780 ft.

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cirratriradites spinulosus
Cirratriradites verrucosus
Lycopodiumsporites austroclavatidites
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Minerisporites marginatus

(vi) 1,400 ft.

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cingulatisporites simplex
Cirratriradites spinulosus
Cirratriradites verrucosus
Cirratriradites tilchaensis
Divisisporites euskirchenensis
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Pyrobolospora hexapartita
Pyrobolospora reticulata
Pyrobolospora nuda
Balmeisporites holodictyus
Balmeisporites tridictyus
Minerisporites marginatus

(b) Tilcha Bore No. 1, 460-1,040 ft.

Microspores—

Apiculatisporis asymmetricus 460 ft.
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides 1,040 ft.
Cingulatisporites paradoxus
Cingulatisporites simplex 1,040 ft.
Cirratriradites spinulosus 460 ft.
Cirratriradites tilchaensis 460 ft.
Divisisporites euskirchenensis 460 ft.
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Balmeisporites tridictyus
Pyrobolospora hexapartita 460 ft.
Pyrobolospora nuda 460 ft.
Pyrobolospora reticulata 1,040 ft.

(c) Cootabarlow Bore No. 2

(i) 1,354 ft.

Microspores—

Ceratosporites equalis
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Dictyotosporites speciosus
Ischyosporites punctatus
Leptolepidites verrucatus
Lycopodiumsporites circolumenus
Lycopodiumsporites austroclavatidites
Neoraistrickia truncatus
Osmundacidites comaumensis
Pilosisporites notensis

(ii) 581 ft.

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cirratriradites spinulosus
Cirratriradites verrucosus
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Pyrobolospora reticulata

(d) Loxton Bore, 1,410-70 ft.

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cirratriradites spinulosus
Ischyosporites punctatus 1,410 ft.
Ischyosporites scaberis
Leptolepidites verrucatus
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis

Megaspores—

Balmeisporites holodictyus 1,410 ft.
Minerisporites marginatus 1,410 ft.
Pyrobolospora reticulata 1,410 ft.

(e) Comaum Bore at 708 ft.

Microspores—

Ceratosporites equalis
Cicatricosisporites australiensis
Cirratriradites spinulosus
Dictyotosporites speciosus
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Neoraistrickia truncatus
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Radiatisporites hughesi

Megaspores—

Minerisporites marginatus

2. Victoria

(a) Dergholm Bore No. 1 at 532 ft.

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cingulatisporites simplex
Cirratriradites spinulosus
Cirratriradites verrucosus
Ischyosporites scaberis
Leptolepidites verrucatus
Osmundacidites comaumensis
Perotrilites striatus

Megaspores—

Pyrobolospora reticulata

(b) Dergholm Bore No. 2 at 329 ft.

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cirratriradites spinulosus
Leptolepidites verrucatus
Perotrilites striatus

Megaspores—

Minerisporites marginatus
Pyrobolospora reticulata

(c) Gellibrand River (Devil's Kitchen)

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cirratriradites spinulosus
Perotrilites striatus
Trilobosporites trioreticulosus

(d) Birregurra Bore No. 1, 1,102-1079 ft.

Microspores—

Apiculatisporis asymmetricus 1,102-1,089 ft.
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides 1,089-1,102 ft.
Cingulatisporites paradoxus
Cingulatisporites simplex 1,102-1,089 ft.
Cirratriradites spinulosus 1,102-1,089 ft.
Divisisporites euskirchenensis 1,102 ft.
Leptolepidites verrucatus 1,102 ft.
Lycopodiumsporites austroclavatidites 1,102-1,089 ft.
Lycospora mollis 1,102-1,089 ft.
Osmundacidites comaumensis
Perotrilites striatus
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus 1,102-1,089 ft.

(e) Barongarook Creek

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cingulatisporites simplex
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Mincrisporites marginatus

(f) Barrabool Hills

Microspores—

Cicatricosisporites australiensis
Cingulatisporites paradoxus
Granulatisporites dailyi
Ischyosporites scaberis
Kuylisporites lunaris
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycospora mollis
Neoraistrickia truncatus
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus

(g) Little's Shaft, Bellarine Peninsula

Microspores—

Apiculatisporis asymmetricus
Ceratosporites equalis
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cingulatisporites simplex
Cirratriradites spinulosus
Kuylisporites lunaris
Leptolepidites verrucatus
Lycopodiumsporites austroclavatidites
Lycopodiumsporites circolumenus
Neoraistrickia truncatus
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Pyrobolospora reticulata

(h) Woodside Well No. 2 at 4,251 ft. and 6,402 ft.

Microspores—

Apiculatisporis asymmetricus
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
4,251 ft.
Cirratriradites spinulosus
Divisisporites euskirchenensis
4,251 ft.
Ischyosporites scaberis
Leptolepidites verrucatus
Lycopodiumsporites circolumenus
6,402 ft.
Lycospora mollis
4,251 ft.
Osmundacidites comaumensis
Perotrilites striatus
6,402 ft.
Pilosisporites notensis
4,251 ft.

3. New South Wales

Onepah Station Well

Microspores—

Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
Cingulatisporites paradoxus
Cirratriradites spinulosus
Cirratriradites verrucosus
Cirratriradites tilchaensis
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites trioreticulosus

Megaspores—

Balmeisporites holodictyus
Mincrisporites marginatus
Pyrobolospora hexapartita
Pyrobolospora reticulata

4. Queensland

Styx Coal Measures, Bore 21 at 327 ft., Bore 20 at 454 ft.

Microspores—

Ceratosporites equalis
327 ft.
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
454 ft.
Cirratriradites spinulosus
Cirratriradites verrucosus
Cirratriradites tilchaensis
327 ft.
Ischyosporites scaberis
454 ft.
Leptolepidites verrucatus
327 ft.
Osmundacidites comaumensis
Perotrilites striatus
Pilosisporites notensis
Styxisporites majus
Trilobosporites triorcticulosus

Megaspores—

Balmeisporites holodictyus

5. Papua

Omati Bore, samples 1 and 2

Microspores—

Apiculatisporis asymmetricus (2)
Cicatricosisporites australiensis
Cingulatisporites euskirchensoides
(2)
Leptolepidites verrucatus
Perotrilites striatus

Megaspores—

Balmeisporites holodictyus

Stratigraphical Implications

The samples from which the spores recorded above were recovered were portions of bore cores and outcrops of both fresh- and salt-water origin. The age of the salt-water deposits is known by the contained foraminifera, mollusca, and microplankton to be Lower Cretaceous; the freshwater sediments have been referred to the Jurassic on the basis of their macroscopic plant remains.

Although only a small proportion of the spores contained in both kinds of sediments have been considered in this contribution, it has been found that some of them are restricted to particular deposits while others are common to most, if not all, of them. Thus it seems possible to distinguish between "long" and "short-range" species and by means of the latter, to correlate the dated salt-water samples with the less reliably dated freshwater deposits, and to correlate individual freshwater deposits with one another.

The only continuous sequence available for study, has been the conformable succession of freshwater sediments intersected by the Robe Bore, 1,400-4,300 ft. In this section, a marked change in spore composition is noticeable above 3,500 ft., the sediments below this depth containing a different assemblage from that at or above it. It seems probable therefore that this change was coincident with a change in age which resulted in the passing out of older types and the incoming of newer ones in the vicinity of this level.

The Lower Cretaceous salt-water deposits comprise those from the Cootabarlow Bore at 581 ft. and 1,354 ft., the Tilcha Bore at 460 ft. and 1,040 ft., the Loxton Bore at 1,410 ft. and 1,470 ft., the Tooloombah Creek Bore No. 21 at 327 ft., and the Onepah Station Well. All these deposits are of Albian age, with the exception of the one at 1,354 ft. from the Cootabarlow Bore which is Aptian on the basis of foraminifera (N. H. Ludbrook, South Australian Department of Mines) and microplankton (Cookson and Eisenack 1958).

The short-range spores which occur in the Albian deposits are: *Divisisporites cuskirchenensis, Cingulatisporites cuskirchensoides* (Wealden in Belgium), *Cingulatisporites paradoxus, Cingulatisporites simplex, Trilobosporites triorcticulosus, Apiculatisporis asymmetricus, Perotrilites striatus, Pyrobolospora rcticulata, Balmeisporites holodictyus.* A comparable association (Fig. 1) has been found in the upper section of the Robe Bore, 1,400-3,500 ft.; Dergholm Bore No. 1, at 532 ft. and 582 ft., Dergholm Bore No. 2, 329-31 ft.; Barongarook Creek; Birregurra Bore No. 1, 1,079-1,102 ft.; Gellibrand River (Devil's Kitchen); Barrabool Hills; Little's Shaft, Bellarine Peninsula, and Woodside Well No. 2, 4,257-6,402 ft. It appears therefore that the age of these deposits is Lower Cretaceous (approximately Albian) and not Lower Jurassic as was suggested for some of them by Medwell (1954a).

The spore association taken as typifying the lower portion of the Robe sequence represented by the samples taken at 3,860 ft. and 4,300 ft. comprises species such as *Granulatisporites dailyi, Apiculatisporis wonthaggiensis, Radiatisporites hughesi, Dictyotosporites speciosus, Dictyotosporites complex* and *Styxisporites majus,* none of which appear to be present in the Albian sediments. This difference in composition suggests that the age of the lower portion is almost certainly pre-Albian.

The number of spore types common to both the Albian and pre-Albian sediments of the Robe Bore for example, *Pilosisporites notensis, Ceratosporites equalis, Neoraistrickia truncatus, Lycospora mollis, Cirratriradites spinulosus, Cirratriradites verrucosus,* indicates that the older sediments approximate more closely to a Lower Cretaceous (pre-Albian) age than to the Jurassic age suggested for them by Ward (1917).

A comparable spore association to that found in the pre-Albian section of the Robe Bore occurs in deposits from the Wonthaggi State Coal Mine Area, and some of the same types occur in the deposit from the Kopperamanna Bore at 2,970 ft., and Cootabarlow Bore No. 2 at 1,465 ft., along with others that appear to be absent from the Robe sediments. The general agreement between these respective spore associations suggests that all are of approximately the same age, and that the Wonthaggi deposits are probably Lower Cretaceous (pre-Albian) rather than Lower-Middle Jurassic as suggested by Seward (1904) or Lower Jurassic as suggested by Medwell (1954a). Additional evidence for this younger age is provided by the occurrence of the megaspore *Minerisporites marginatus,* a type which occurs in the Wealden of the Netherlands Dijkstra (1951), and in England in the Ashdown Sands of the Wealden formation (Valanginian, Hughes 1958, p. 43).

When Seward compared the macroflora of the Wonthaggi Area with that of the Inferior Oolite of England and Rajmahal Hills of India, the age of the latter was considered to be Lower Jurassic. However, as the result of Dr. Spath's discovery of Neocomian ammonites in the Rajmahal Formation, a Lower Cretaceous (Neocomian) age has now been suggested for this formation (Arkell 1956).

A similar age for the sediments from bores and outcrops at Wonthaggi, Cape Paterson, Berry Creek and Tyers River would conform with the spore content as as present known. Mr. B. E. Balme, who has investigated the Upper Mesozoic of Western Australia, has remarked upon the greater resemblance of the Wonthaggi microflora to that of the West Australian Lower Cretaceous than to the microfloras of the Upper Jurassic of the same area.

The South Australian deposits in the Cootabarlow No. 2 Bore at 1,465 ft. and in the Kopperamanna Bore at 2,970 ft., contain microflora assemblages comparable with those found in the Robe Bore, 4,300-3,860 ft., and in the Wonthaggi coals and associated shales. The sandstones, 3,000-2,810 ft., in the Kopperamanna Bore which underlie marine Cretaceous sediments were assigned by Whittle and Chebotarev

c

(1952, Fig. 2) to the Jurassic. More recently Woodard (1955, p. 15) suggested that "Interbedded coarse sandstones and subordinate clay shales underlying lower Cretaceous marine beds and regarded by Whittle (1952) as Jurassic, more probably represent the basal Cretaceous Blythesdale Sandstones".

There is thus some evidence for a Lower Cretaceous (pre-Albian) age for the Mesozoic deposits in the Wonthaggi State Coal Mine Area of Victoria and the lower sediments of the Robe Bore, 3,860-4,300 ft. These beds are tentatively referred to

TABLE 1

		LOCATION OF SEDIMENTS	Microspores: *Dictyotosporites complex*	*Dictyotosporites speciosa*	*Granulatisporites dailyi*	*Radiatisporites hughesi*	*Lycopodiumsporites circolumenus*	*Pilosisporites notensis*	*Leptolepidites verrucatus*	*Ischyosporites scaberis*	*Cicatricosisporites australiensis*	*Trilobosporites trioreticulosus*	*Cingulatisporites euskirchensoides*	*Cingulatisporites paradoxus*	*Perotrilites striatus*	Megaspores: *Minerisporites marginatus*	*Pyrobolospora reticulata*	*Balmeisporites holodictyus*
LOWER CRETACEOUS	Albian	Robe Bore																
		Cootabarlow 581ft.																
		Onepah																
		Dergholm No.1 532ft.																
		1400ft. Tilcha 460ft.																
		Bellarine Peninsula																
		Styx No.21 327ft.																
		Barongarook Creek																
		Birregurra 1079-1102ft.																
	? Albian	2630ft. Barrabool Hills																
		Comaum 708ft.																
	Aptian	3500ft. Cootabarlow 1354ft.																
	Neocomian-Aptian	Wonthaggi																
		Whitelaw																
		3860ft. Cape Paterson																
		Apollo Bay																
		Berry Creek																
		4300ft. Cootabarlow 1465ft.																
		Kopperamanna 2970ft.																

the Lower Cretaceous (Neocomian-Aptian). However, the possibility of an age older than Lower Cretaceous, but younger than Lower Jurassic, must not be overlooked.

The sediments in the Comaum Bore, 651-708 ft., are of interest in containing a spore assemblage "intermediate" between typical Albian and Neocomian-Aptian microfloras. The presence of the microspore *Perotrilites striatus*, a species that has been invariably present in all the Albian deposits examined, leaves no doubt as to the Lower Cretaceous age of these deposits.

The spore assemblage of the Aptian deposit at 1,354 ft. in the Cootabarlow Bore No. 2, is closely similar to that of typical Albian deposits, but neither the microspore *Perotrilites striatus* nor the megaspores *Pyrobolospora reticulata*, and *Balmeisporites holodictyus* have been observed in it.

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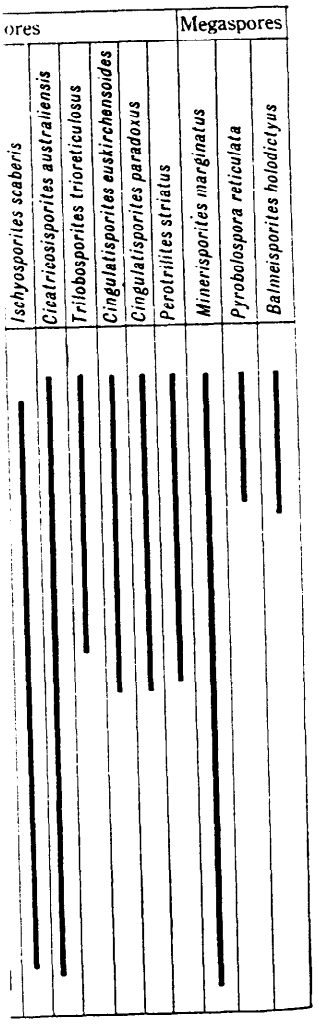

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Explanation of Plates

All the figures are from untouched negatives. Registered numbers in the palaeobotanical collection of the National Museum of Victoria are given.

PLATE XIV

Fig. 1.—*Divisisporites euskirchenensis* Thomson. Robe Bore, S.A., at 1,400 ft. × *c.* 580.

Figs. 2, 3.—*Granulatisporites dailyi* sp. nov. Proximal and distal surfaces of holotype. Wonthaggi State Coal Mine Area, Vic., locality (c^3). × *c.* 590. P17605.

Fig. 4.—*Granulatisporites dailyi.* Paratype. Comaum Bore, S.A., at 708 ft. × *c.* 560.

Fig. 5.—*Leptolepidites verrucatus* Couper. Wonthaggi State Coal Mine Area, Vic., locality (b). × *c.* 650.

Fig. 6.—*Leptolepidites verrucatus.* Apollo Bay, Vic. × *c.* 650.

Figs. 7, 9, 10.—*Apiculatisporis wonthaggiensis* sp. nov. Paratypes. Wonthaggi State Coal Mine Area, Vic., locality (c^3). Fig. 7, × *c.* 840; Fig. 9, × *c.* 570; Fig. 10, × *c.* 620.

Fig. 8.—*Apiculatisporis wonthaggiensis.* Holotype. Wonthaggi State Coal Mine Area, Vic., locality (c^3). × *c.* 610. P17606.

Fig. 11.—*Apiculatisporis asymmetricus* sp. nov. Holotype. Birregurra Bore No. 1, Vic. at 1,102 ft. × *c.* 590. P17607.

Fig. 12.—*Apiculatisporis asymmetricus.* Paratype. Dergholm Bore No. 1, Vic. at 532 ft. × *c.* 590.

Fig. 13.—*Osmundacidites comaumensus* (Cookson). Holotype. Comaum Bore, S.A. at 674 ft. × *c.* 550. P17608.

Fig. 14.—*Neoraistrickia truncatus* (Cookson). Holotype. Comaum Bore, S.A. at 708 ft. × *c* 600.

Fig. 15.—*Neoraistrickia truncatus.* Paratype. Comaum Bore, S.A. at 708 ft. × *c.* 620.

Fig. 16.—*Neoraistrickia truncatus.* Showing the small processes of the proximal surface. Wonthaggi State Coal Mine Area, Vic., locality (b). × *c.* 870.

Figs. 17-19.—*Ceratosporites equalis* sp. nov. Proximal, sectional and distal views of holotype. Wonthaggi State Coal Mine Area, Vic., locality (b). × *c.* 640. P17609.