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STRATIGRAPHY AND PALYNOLOGY OF THE POLDA BASIN, EYRE PENINSULA

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ABSTRACT

The intracratonic Polda Basin is a narrow east-west feature extending from near Elliston on the coast to Lock, near the centre of Eyre Peninsula. Geophysical surveys indicate its extent considerably offshore to the west. Regional gravity and aeromagnetic surveys define its shape and probable limits. The feature is entirely subsurface, blanketed by a variable thickness of Quaternary aeolianites. The oldest rocks in the succession range from Precambrian granites and metamorphics to ?Precambrian coarse grained sediments that outcrop at Mt. Wedge and Talia.

The drilling of Polda Stratigraphic Hole No. 1 proved a sedimentary section in excess of 170 m made up of Jurassic (J6 age) non-marine fluviatile sands, lignites and clays and Middle Eocene (Proteacidites confragosus Zonule) non-marine fluviatile sands and lignites. North of the major topographic feature of Mt Wedge, marginal marine sapropelic clays and sands carry a rich middle-late Eocene dinoflagellate flora and a sparse foraminiferal fauna. On the southern margin of the basin non-marine lignitic sands and clays are of late Eocene to early Oligocene age.

INTRODUCTION

The Polda Basin has long been the subject of intense hydrogeological study by the South Australian Department of Mines. The investigations, over 2 500 km^2, starting in 1962 included drilling, geological mapping, maintaining of water levels, geophysical surveys and pumping tests to assess the potential annual groundwater yield from the area within County Musgrave (see Text fig. 1). Groundwater of varying quality but containing less than 1 000 parts per million total dissolved salts has been proved in six separate groundwater basins. These are defined on the basis of water quality but are inter-connected both geologically and hydrologically. Two aquifers have been recognised and a third is suspected (Painter, 1970).

Petroleum exploration in the adjacent offshore regions has been reported by Smith & Kammerling (1969). Their figure 3 shows the Elliston Trough extending onshore into the feature referred to in this report as the Polda Basin. (The two have been named the Polda Trough on the Geological Society of Australia, 1971 - Tectonic map of Australia and New Guinea 1:5 000 000, Sydney).

This report summarises the geology of the Polda Basin and in particular details the palynology of the Jurassic sediments. A previous report of Jurassic microfloras by Harris (1964) in the region initiated this study and led to the drilling of the Polda Stratigraphic Hole No. 1 in 1965. To this date it is the only bore that has penetrated more than a metre or so of Jurassic sediments for which samples are still available.

All available and suitable samples from the basin have been examined palynologically and the results of the Jurassic sequences are plotted on Text figs. 2 & 4. Test fig. 3 attempts to show major plant group fluctuations in the Jurassic sequence of Polda No. 1. Additionally the majority of Jurassic species have been figured (Figs. 1-101) together with two important early Tertiary microplankton species (Figs. 102-105).

Data in the appendices include lithological logs, coal and water analyses, petrological descriptions, palynological sample information, and a palaeontological report.

REGIONAL GEOLOGY

Basin limits and topography

The Polda Basin lies within Co. Musgrave, central Eyre Peninsula and has little if any surface expression. Typically the area is flat lying (see fig. 106 & 108) broken only by the prominence of Mt. Wedge (240 m in height) in the west (fig. 106), a small scarp 10 km west of Lock and the Dark Peake and Blue Range further east towards the centre of the Peninsula. The lateral extent of the Tertiary and Jurassic sediments is unknown and thus the margins of the sedimentary basin remain largely undefined. The basin is bounded in the west near Elliston by ?Precambrian conglomerates and sands, resting on older granites (see Appendix III). The coarse grained sediments of Mt. Wedge (fig. 107) and of Talia (figs. 109-111) dip gently at 10-15^{o} westwards and because of their lithological similarities with the Corunna Conglomerate are possibly of Precambrian age. Similar lithologies on Rudall have been mapped as Cambrian? (Johns, 1957b). East of Lock and north of Polda the basin is encompassed by Precambrian sedimentary, metamorphic and plutonic rocks (Johns, 1957a & b). The southern boundary of the basin is obscure.

Regional Geophysics

Recent geophysical work by Rowan (1968) indicates a narrow major gravity low running west inland from the coast, just north of Elliston and south of Mt. Wedge, through to Lock (see text fig. 1). Another branch of the feature, appears to run northwest of Mt. Wedge. It is in the longer east-west depression that Jurassic sediments are known, elsewhere (see later section) only carbonaceous early Tertiary sediments have been proved.

Aeromagnetic surveys flown by the Bureau of Mineral Resources over ELLISTON and KIMBA show a narrow aeromagnetic low feature in the position of the Polda Basin. Features such as Mt. Wedge and the granites of Bramfield show increased magnetic susceptibility. The Kopi gravity plateau of Rowan (1968) also shows up as an obvious feature as does the bifurcation of the two gravity low trends west of Mt. Wedge. The offshore aeromagnetic survey of Shell Development Company (Australia) (Smith & Kammerling, 1969) shows a similar linear aeromagnetic low to that of the Polda Basin, striking the coast west of Mt. Wedge.

Both gravity and aeromagnetic surveys confirm the presence of a narrow trough like depression with low density and low magnetic susceptibility material in the position of the Polda Basin. Furthermore, this onshore feature lines up with Smith & Kammerling's (1969) offshore Elliston Trough. The northern boundary of the Polda Basin is clearly defined as the Kopi gravity plateau. A preliminary map of contours of basement derived from electrical resistivity soundings by Nelson (1972) is in general agreement with the gravity and aeromagnetic evidence.

Stratigraphic sequence

The basin was first named by J.I. Miller, then District Engineer of the E. & W.S. Department in 1928 and primarily defined hydrologically, the best quality water occurring at shallow depth in the widespread calcareous - cemented dune sands of the Bridgewater Formation.

The Bridgewater Formation is of variable thickness but in the south of the area it exceeds 30 m. It is commonly an off white cemented calcareous sand with occasional calcareous clayey interbeds. The unit forms the main aquifer in the Polda Basin.

Unnamed? Quaternary clays

These underlay the Bridgewater Formation and are vari-coloured calcareous, sometimes nodular clays never exceeding 6 or 7 m in thickness.

Poelpena Formation - Early Tertiary sands and lignites

The early Tertiary sequence has only been penetrated fully in Polda Stratigraphic Hole No. 1. The various lithologies, represented on the graphic log (Text fig. 2) and in Appendix 1, are dominated by highly carbonaceous, commonly dark brown sediments comprising coarse grained sands through to lignites. Northwest of Mt. Wedge less than a metre or so of the carbonaceous sediments has been penetrated. They are less sandy and sapropelic. The significance of this is discussed in a later section. Bores in the Hds. of Pearce and Haig just penetrated the top few centimetres of the early Tertiary sequences. Here the sediments are fine grained highly carbonaceous sands and silts.

Poelpena Formation is absent in the area of bores 332,333 and P.T.10 and the area near the coal shaft.

"Polda formation"- Late Jurassic sands, silts and lignites

Text fig. 2 and appendix I detail the varied lithologies of the Jurassic sequence in Polda No. 1. The similarity of lithologies between the early Tertiary and Jurassic sequences is at once striking and colour is the main distinguishing feature. A higher free carbon/bonded carbon ratio is reflected in the predominantly grey colour in contrast to the brown of Tertiary sediments. Lithologies range from dark grey to black highly carbonaceous fine sands, silts and lignites, to very coarse grey sands. Because of the limited amount of lithostratigraphic information available at the moment, the name is not formally proposed.

?Precambrian grits and conglomerates

The often cross-bedded coarse feldspathic and arkosic sands, grits and conglomerates of Mt. Wedge and Talia Caves (see Appendix III) probably underlay unconformably the Jurassic sequence but this is not known with certainty as Polda No. 1, because of drilling difficulties, failed to penetrate beyond (or through) the Polda formation. They probably exceed 200 m in thickness and possibly overly granites similar to those at Bramfield.

BIOSTRATIGRAPHY & ENVIRONMENTS

It will be appreciated that from the descriptions of the Jurassic and Tertiary sequences, palynology is the obvious means of correlating and dating these strata. Nevertheless the finding of a very rich dinoflagellate cyst assemblages in cores from bores 601, 599 and Pt.22A north west of Mt. Wedge prompted a search for foraminifera in these sediments and J.M. Lindsay reports on these fossils in appendix VI. Other sediments in the succession are unsuitable for palynological analysis for reasons such as oxidation and unfavourable modes of deposition.

Early Tertiary

These sediments can be conveniently grouped into three distinct areas viz:-

a. North of Mt. Wedge,

b. Central Polda trough,

c. Southern areas, Hds. Pearce & Haig.

a. Bores 559 and 601 all yielded a most characteristic and interesting assemblage dominated by marine dinoflagellate cysts which include *Chordosphaeridium* sp., *Hystrichokolpoma* sp., *Wetzeliella* sp., *Deflandrea phosphoritica* Eisenack, and *Hystrichosphaeropsis* cf. *H. borussica*

(Eisenack). Very few terrestrially derived sporomorphs were recovered and included Triorites magnificus Cookson, Nothofagidites spp. and Podocarpidites spp. The presence of the first named pollen indicates that the assemblage is identified with Triorites magnificus Zonule of middle to late Eocene age (Harris, 1971).

These samples warrant further discussion because in terms of known biofacies distribution of dinoflagellate cyst assemblages this represents a marked deviation from the apparent norm. Palynological assemblages dominated by cysts are generally characteristic of marl lithofacies which carry a diverse foraminiferal fauna. The sediment described here is virtually non-calcareous, highly carbonaceous dark grey silty clay and is characteristically sapropelic in texture and probably origin. Lindsay (see Appendix VI) notes also the presence of rare glauconite and a few small and poorly preserved foraminifera. Whilst the sediment is carbonaceous the proportion of terrestrially derived organic matter (spores, pollen, wood, cuticle etc.) is very low and the "carbonaceous" character appears to be almost entirely derived from the dinoflagellate cysts. This confirms the sapropelic nature of the sediment. The environment invisaged is a barred basin with a low energy regime and salinities lower than normal sea water (more like those of deltaic environments) but sufficiently high to support a very rich microplankton component. Access to open marine conditions was very limited and there was little contribution of organic matter from streams.

Further drilling and sampling of the sequence in this area would be of great interest and confirm these speculations.

b. Assemblages from this area are derived entirely from Polda No. 1. There is little change in the assemblages within the Tertiary sequence and certainly none of biostratigraphic importance. Microfloras in contrast to the previous assemblages consist entirely of terrestrial forms. These are dominated by a suite of Proteacidites spp. including P. incurvatus Cookson, P. kopiensis Harris, P. tripartitus Harris, P. pachypolus Cookson & Pike, P. aff. P. pachypolus, "Triorites" psilatus Harris, and a low diversity of Nothofagidites spp. - N. falcata Cookson, N. mataurensis Couper, N. flemingii Couper.

The presence of P. aff. P. pachypolus and P. pachypolus and a largely undescribed, but nevertheless characteristic assemblage, correlates these sediments with the Proteacidites confragosus Zonule of Middle Eocene age (Harris, 1971).

The environment is non-marine, alternating paludal and fluviatile.

c. Bores 503, 504 and 532.

Like the area to the north of Mt. Wedge, there are few samples available for analysis and no indication of sequence or of sediment thickness is available.

Acid insoluble residues in this area are of entirely terrestrial plants. The genus Proteacidites is less common than in b. but is represented by P. clintonensis Harris and P. annularis Cookson together with abundant Nothofagidites spp., including N. aspera, Graminidites sp. and numerous undescribed tricolpate and tricolporate forms. On negative evidence (lack of both T. magnificus and a diverse Proteacidites assemblage) the microflora is equated with the Sparganiaceaepollenites barungensis Zonule of Harris (1971) and is of Late Eocene to Early Oligocene age.

The sediments examined are representative of the paludal environment.

Jurassic

a. Biostratigraphy

The detailed distribution of palynomorphs for Polda No. 1 is listed on text figure 2 and for the other Jurassic localities, bores 332, 333, P.T. 10 and the "Coal Shaft" on text figure 3. In general the assemblages were diverse and well preserved.

Harris (1964) listed the major components of the assemblages derived principally from bores 332 and 333. On the available evidence the age was regarded as "post-Kimmeridgian, pre-Valanginian". Further work by Harris (1970) suggested that the Polda Basin assemblages were a little older than those from the Arckaringa Basin and assigned Evan's (1966) units J5 and J6 respectively to the two microfloras.

The more detailed analysis of a thicker sequence presented here contributes further evidence for correlation. In particular the occurrence, albeit infrequent, of Dictyotosporites complex Cookson & Dettmann indicates a correlation with Evan's unit J6. It is now clear that the assemblages from LPC 86 (Harris, 1970) and that from Polda No. 1 are closely similar. Harris (op.cit.) reported the presence of Crybelosporites stylosus Dettmann in LPC 86 and this would support a slightly younger age within J6 for the Algebuckina Sandstone.

The assemblage is similar to Dettmann's (1963) Lower Cretaceous Zone of Crybelosporites stylosus but does not included Aequitriradites spp., Cicatricosisporites spp. or Cyclosporites hughesi (Cookson & Dettmann) and is therefore older. It is distincly younger than those described from the Leigh Creek Basin (Playford & Dettmann, 1965), the Rosewood Coalfield (de Jersey, 1959) the Marburg Sandstone (de Jersey, 1963) and the Surat Basin (de Jersey & Paten, 1964; Reiser & Williams, 1969).

b. Environments

Text figure 4 presents a plot of relative frequencies (based on counts of 200 specimens in each assemblage) of eight spore and pollen classes. The classes have been erected more or less arbitrarily but with due regard for the postulated natural relationships within a particular class. Thus Araucariacites spp. and Inaperturopollenites spp. form a class distinct from Tsugaepollenites spp. or bicaccate pollen. In the final column the relative ratio is plotted of total pollen (in the Jurassic this is mostly arboreal) to total spores (generally non arboreal). From this graph preliminary environmental deductions can be made which may be useful for future correlations of thick sections of Jurassic in the Basin. There appear to be four major arboreal advances marked by a preponderance of pollen as against spores. These "times" represent a shrinking of marsh lands probably in response to climatic changes such as increased rainfall and subsequent run-off. Most of the individual classes reflect this general pattern. The curve for Classopollis spp. (class I) shows an interesting peak at sample S998 and this is in contrast to the low frequencies of other arboreal classes (I-IV).

Between 116.4 and 131.1 m there is a dramatic increase in arboreal pollen, particularly of class III and this may provide a means of subdividing the section. It is noteworthy that between these limits there is a thick sand unit. The succeeding lithologies are more carbonaceous and lignitic.

c. Taxonomic notes.

The accompanying plates illustrate the majority of Jurassic species identified in this study and where appropriate are annotated.

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Explanation to Figures

All figures x500 in normal transmitted light, unless otherwise specified.

Data in parenthesis refers to sample and slide No. followed by specimen coordinates.

Fig. 1 Araucariacites australis Cookson
(S2350/2; 36.2:110.6)

2 Podocarpidites ellipticus Cookson
(S2349/2; 16.0:104.2)

3,4 Microcachyridites antarcticus Cookson
(S2350/4; 28.7:104-3) (S991/3; 25.6:106.2)

5 Podocarpidites ellipticus Cookson
(S2350/2; 24.3:104.3)

6 Podocarpidites sp.
(S2349/1; 34.6:97.2)

7 Alisporites grandis Cookson
(S2349/2; 31.3:104.1)

8,9 A. similis (Balme)
(S2350/3; 32.4:104.3) (S2349/1; 28.1:95.5)

10,11 Podocarpidites ellipticus Cookson
(S2350/2; 34.9:112.7) (S2349/1; 21.0:108.5)

12 Vitreisporites pallidus (Reissinger)
(S2350/2; 41.3:108.0)

13 Alisporites sp., lateral view
(S991/3; 25.3:106.8)

14 Tsugaepollenites segmentatus (Balme)
(S2349/1; 31.2:105.5)

15,16 *T. trilobatus* Balme

(S2349/1; 32.7:94.6) (S2350/2; 36.4:100.8)

17 *T. dampieri* Balme

(S2349/1; 26.3:109.2)

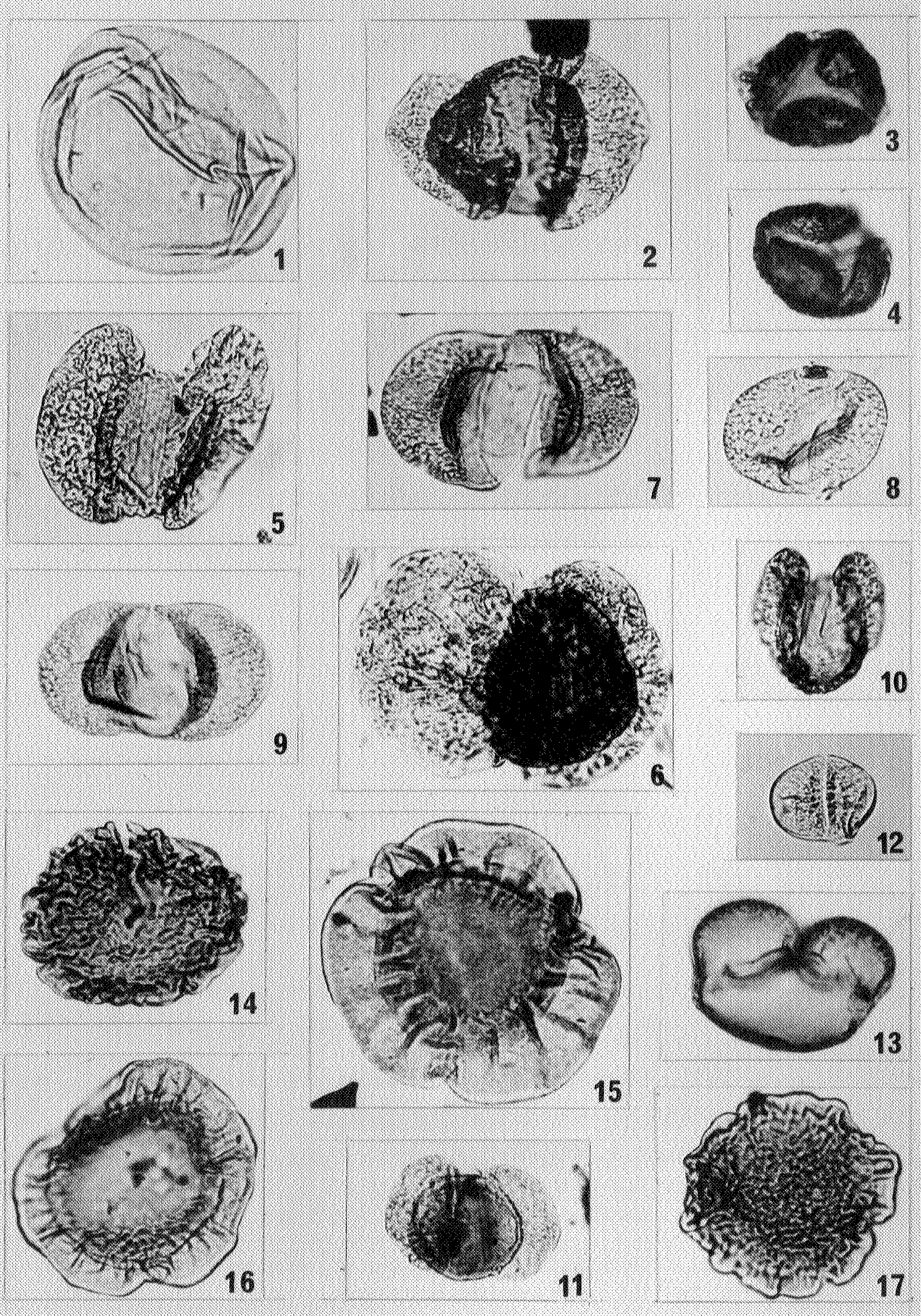
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Fig.	18	*Inaperturopollenites turbatus* Balme
		(S997/1; 13.5:101.1)
	19	*Classopollis classoides* (Pflug)
		(S670/3; 30.5:107.1)
	20,21	*Classopollis* sp.
		(S670/3; 30.5: 106.5) (S998/2; 25.9:106.9)
	22,23	*Ginkgocycadophytus nitidus* (Balme)
		(S2349/1; 33.8:103.1) (S2349/2; 29.5:108.8)
	24	?Folded specimen of an *Osmundacidites* sp.
		(S2349/2; 13.4:106.7)
	25	*Punctatosporites walkomi* de Jersey
		(S993/1; 38.1:105.9)
	26	*Laevigatosporites ovatus* Wilson & Webster
		(S2350/4; 43.2:99.7)
	27,28,29	*Stereisporites antiquasporites* (Wilson & Webster)
		(S2349/1; 25.5:105.6), (S2350/2;34.6:110.4)
		(S2350/4; 26.2:112.2)
	30	cf.*Dictyophyllidites crenatus* Dettmann
		(S2350/3; 33.2:99.4)
	31	*Cyathidites minor* Couper
		(S2349/2; 28.1:104.9)
	32	cf. *C. australis* Couper
		(S2350/3; 37.2:109.4)
	33	?*Cyathidites* sp.
		(S2350/3; 23.4:105.8)
	34	cf. *Dictyophyllidites equiexinous* (Couper)
		(S2350/4; 27.1:113.3)

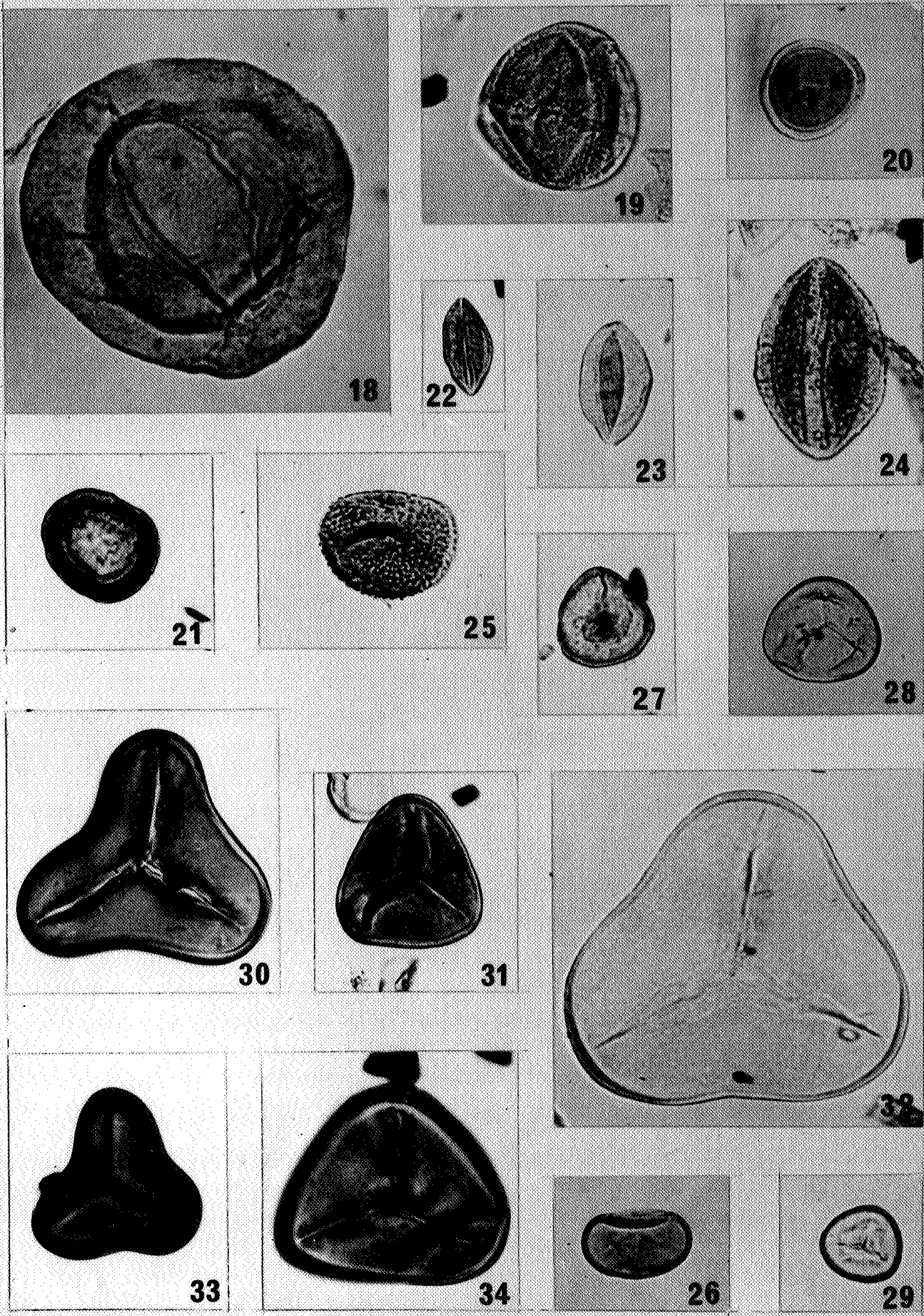
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Fig. 35 _Dictyophyllidites_ sp.
(S2349/1; 30.4:108.2)

36 _Cyathidites_ cf. _C. australis_ Couper
(S2349/1; 24.2:109.3)

37,38 _Dictyophyllidites_ sp. nov.
(S2349/2; 29.1:102.6) (S2349/2; 29.4:101.5)

39,40 _Murospora florida_ (Balme)
(S2350/4; 36.5:112.3) (S993/2; 24.3:99.2)

41,42 _Klukisporites scaberis_ (Cookson & Dettmann)
(S997/1; 31.5:104.5) (S2349/1; 26.0:98.9)
fig. 41 - distal focus, fig. 42 - proximal focus

43 _Klukisporites_ sp.
(S2348/1; 38.5:100.7)

44,45 _Trilobosporites_ cf. _T. perverulentus_ (Verbitskaya)
(S2349/2; 28.2:104.6) (S2349/1; 24.2:95.4)

46,47,48 _Dictyotosporites complex_ Cookson & Dettmann
(S2349/1; 18.9:93.5) (S2350/4; 25.2:96.6)
(S2350/4; 31.3:110.3) fig. 48, equatorial view

49 aff. _Minerisporites_ sp.
(S993/1; 48.6:111.3)

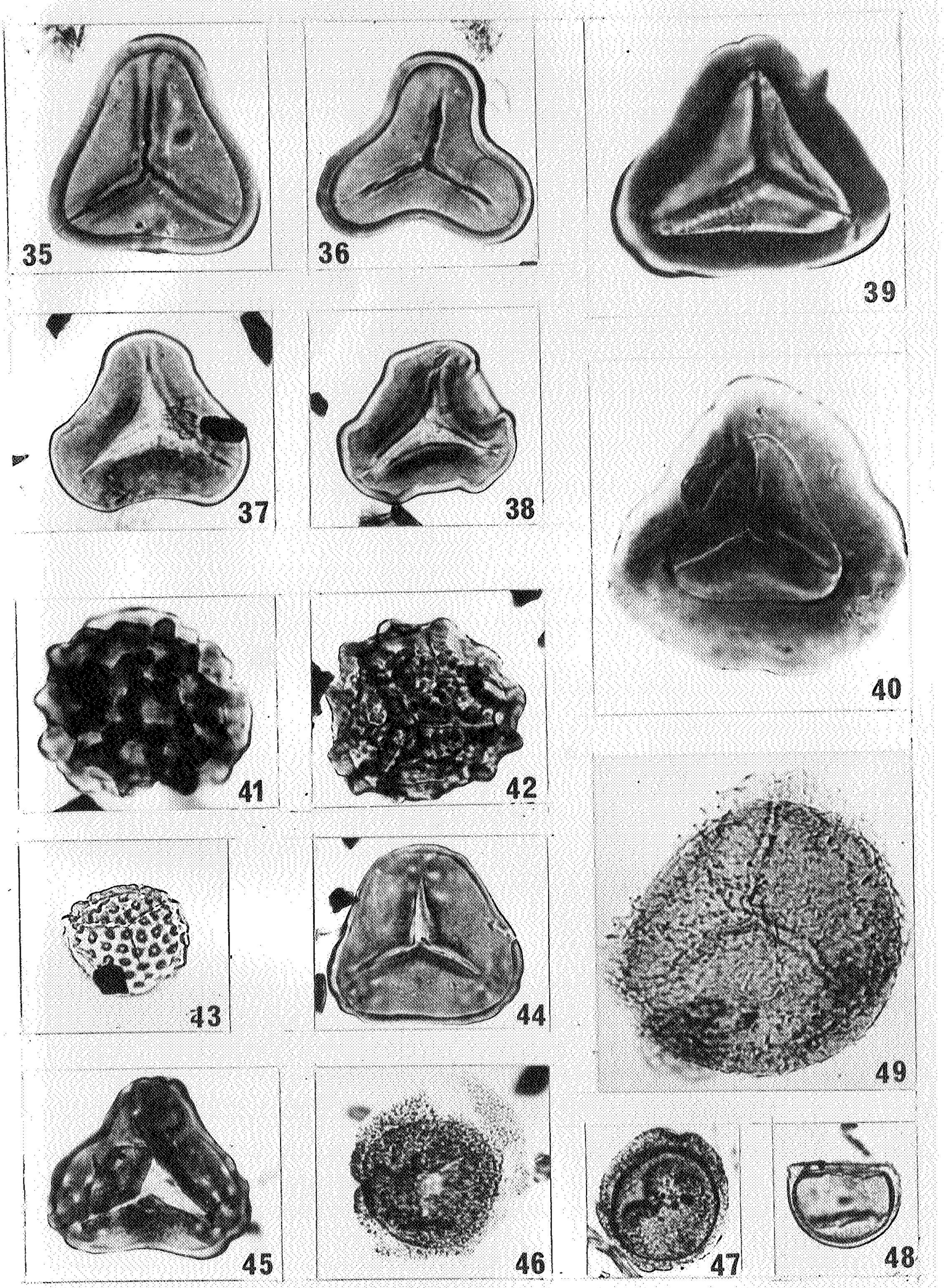
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Fig. 50 *Ceratosporites equalis* Cookson & Dettmann
(S353/1; 21.4:107.0)

51 *Neoraistrickia truncatus* Cookson
(S288/1; 15.6:108.0)

52,53,54 *Leptolepidites* sp. nov.
(S996/1; 36.5:109.1) (S997/2; 49.1:103.1)
(S996/2; 27.1:100.4)

55 *Leptolepidites verrucatus* Couper
(S2350/4; 33.3:109.5)

56,57 cf. *Neoraistrickia truncatus* Cookson
(S2350/2; 34.9:97.4) (S2349/1; 23.2:97.2)

58,59 *Foraminisporites* cf. *F. caelatus* Reiser & Williams
(S998/1; 46.2:107.7) (S998/1; 46.3:110.8)

60 *Osmundacidites wellmanii* Couper
(S2350/2; 27.9:112.2)

61 *Baculatisporites comaumensis* (Cookson)
(S993/1; 48.6:103.4)

62,63 *Osmundacidites wellmanii* Couper
(S2349/2; 14.7:99.0)

64 *Gleicheniidites* sp.
(S2350/4; 32.0:109.2)

65 ?*Dictyophyllidites* sp.
(S2350/4; 28.2:101.7)

66,67 ?*Verrucosisporites* sp.nov.
(S993/2; 27.7:98.6) (S2349/2; 22.8:100.0)

68,69 *Cingulatisporites saevus* Balme
(S2350/4; 33.1:111.6) Distal and proximal
focus respectively.

Fig. 70,71 <u>Staplinisporites caminus</u> (Balme)

(S2349/2; 30.5:100.1) (S2349/1; 25.1:104.6)

72 <u>Contignisporites</u> sp.

(S2350/3; 32.9:110.9)

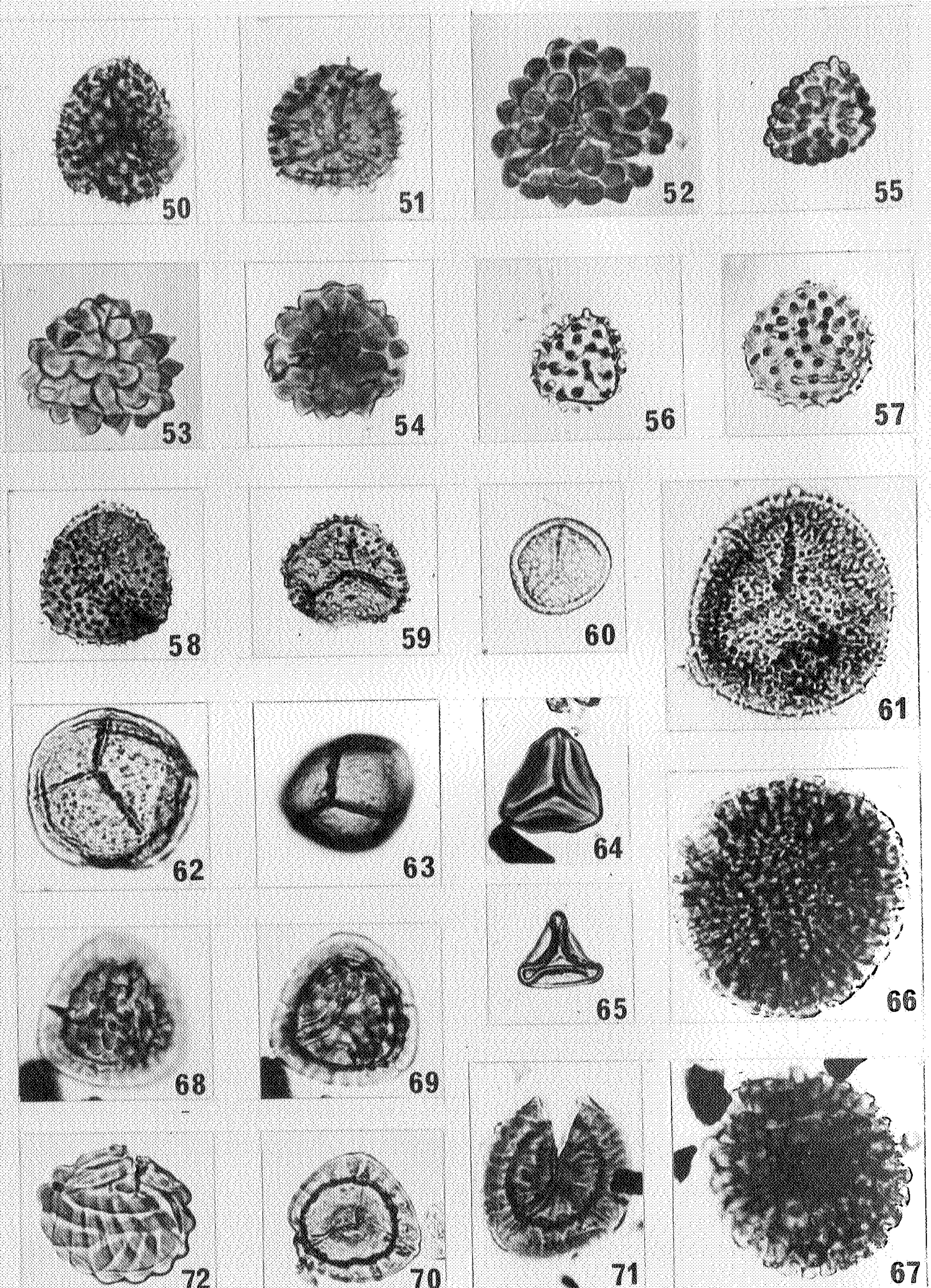
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Fig. 73 *C. cooksonii* (Balme)
(S670/3; 26.5:100.4)

74,75 *Contignisporites glebulentus* Dettmann
(S2350/3; 41.3:94.6) Distal and proximal focus respectively

76,77 *C. cooksonii* (Balme)
(S996/2; 21.9:106.8) (S354/1; 27.9:103.2)

78,79 *Sestrosporites pseudoalveolatus* (Couper)
(S2349/1; 24.5:104.9) (S2349/2; 28.6:106.7)

80,81 *Coronatispora* cf. *C. perforata* Dettmann
(S2349/1; 22.3:103.3) (S996/2; 32.7:97.7)
Note the characteristic ornament of the species

82 *Foveosporites canalis* Balme
(S993/1; 31.5:106.3)

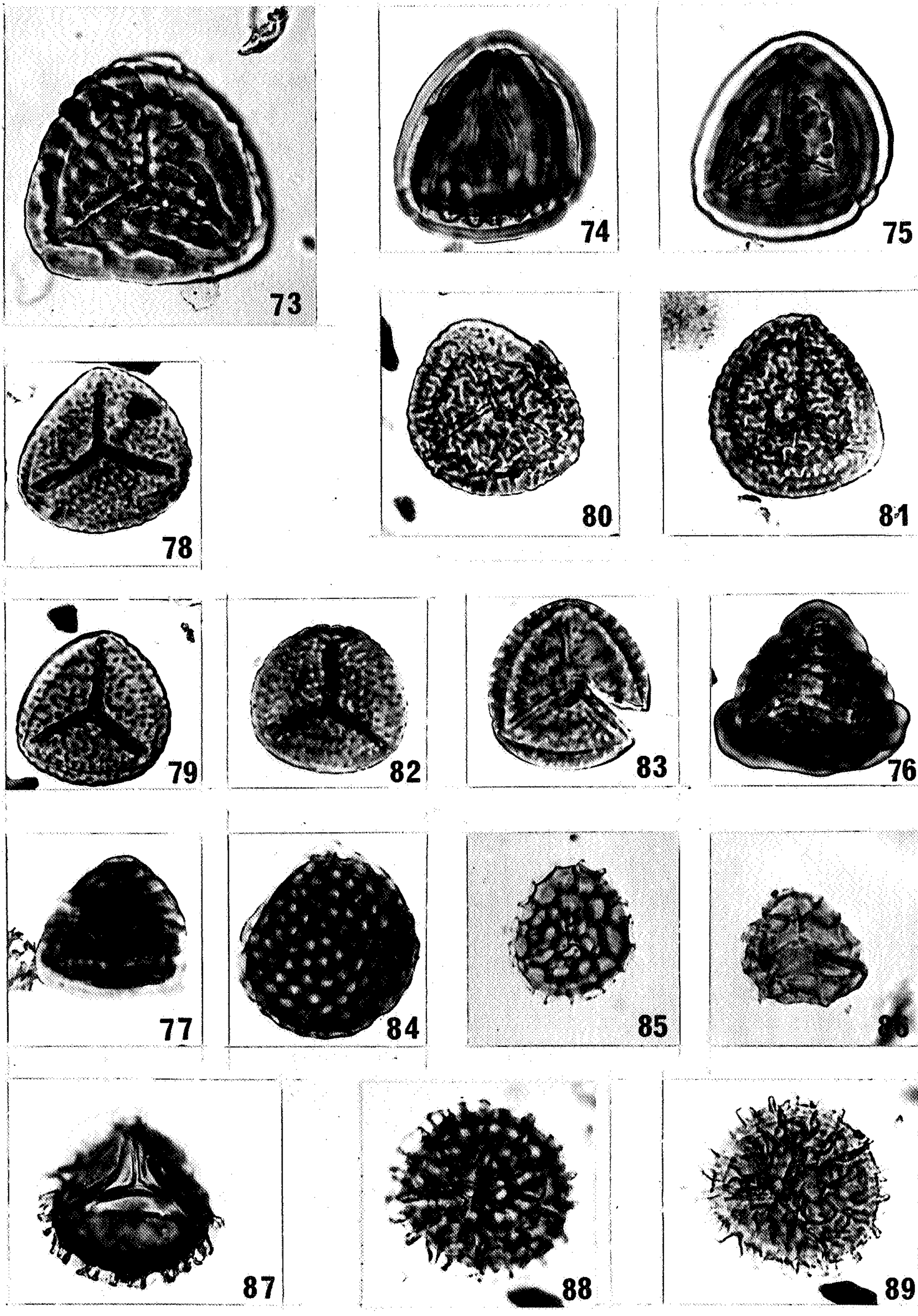
83 *Coronatispora perforata* Dettmann
(S2350/2; 29.9:93.3)

84 *Lycopodiumsporites circolumenus* Cookson & Dettmann)
(S996/2; 34.0:108.4)

85 *L. rosewoodensis* de Jersey
(S992/1; 43.3:106.1)

86 aff. *L. semimurus* (Danze-Corsin & Laveine)
(S996/1; 29.9:99.6)

87,88,89 *Lycopodiumsporites austroclavatidites*
(S2350/2; 28.6:108.8) (S2350/4; 25.8:113.5)
figs. 88 and 89 distal and proximal focus respectively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Figs. 90,91 Lycopodiumsporites sp.
(S2350/4; 32.4:108.8) Proximal and distal focus respectively

92,93 L. sp.
(S2350/4; 44.7:100.4) Distal and proximal focus respectively

94,95 L. sp.
(S2350/3; 35.3:105.8) Distal and proximal focus respectively

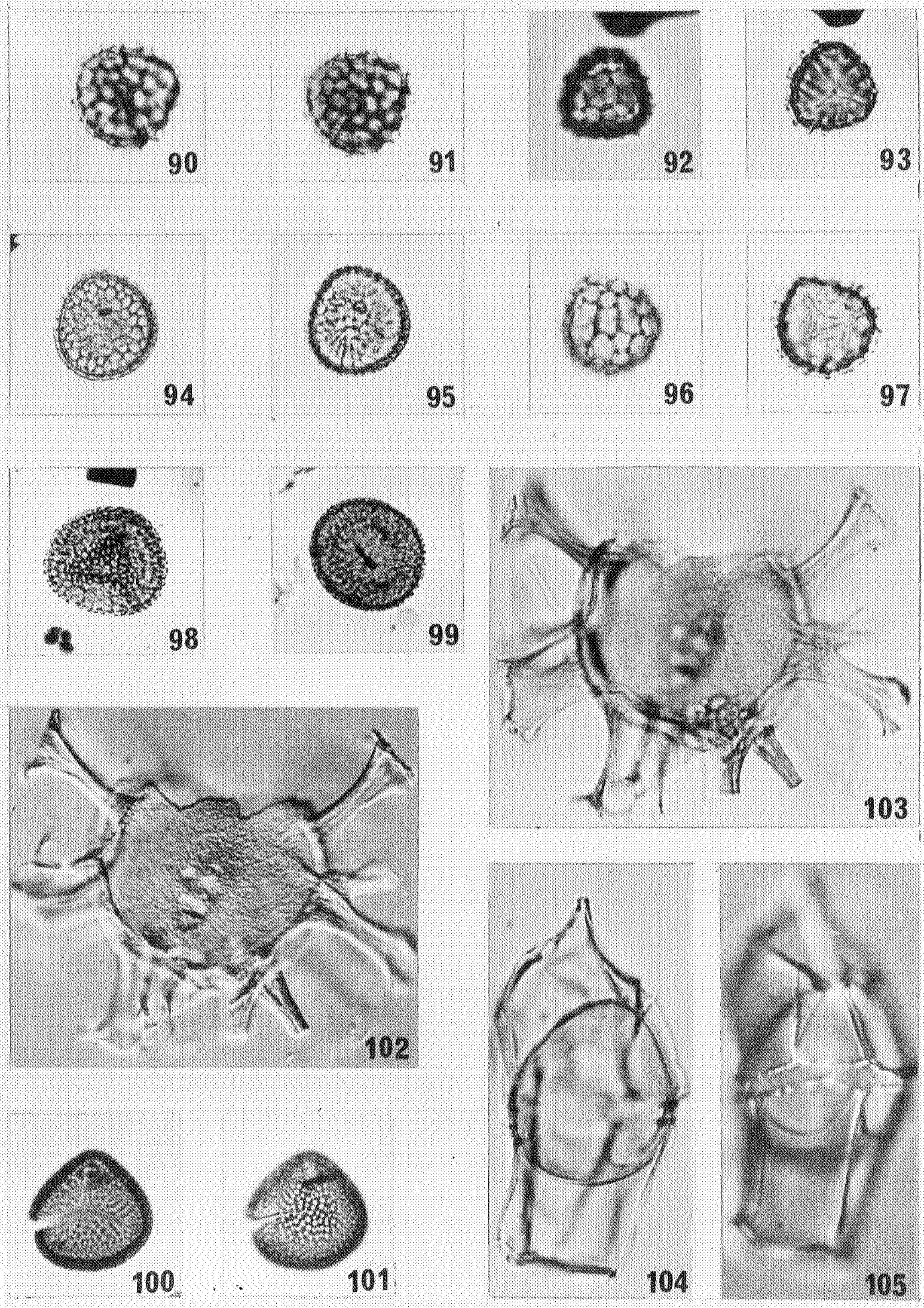
96,97 L. cf. L. rosewoodensis de Jersey
(S2350/3; 107.7:36.3) Distal and proximal focus respectively

98,99 aff. Microreticalatisporites diatretus Norris 1969
(S2349/1; 20.7:94.6) (S2350/4; 24.9:94.9)

100,101 Microreticulatisporites sp. nov.
(S2350/2; 40.8:110.3) Proximal and Distal focus respectively

102,103 Cleistosphaeridium sp.
(ST2371/1; 42.7:103.4) Nomarski Differential Interference contrast and normal transmitted light respectively

104,105 Hystrichosphaeropsis aff. H. borussica (Eisenack)
(ST2371/2; 40.1:98.0) Normal transmitted light and Nomarski Differential Interference contrast respectively.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Figs.106-108

Fig. 106. - Mt. Wedge from the south east on the Elliston - Lock Road. Distance approximately 4 km. (Neg. No. 22026).

Fig. 107. - Coarse grained and conglomeratic sandstones, cross bedded, at the base of Mt. Wedge. (Neg. No. 22027).

Fig. 108. - Flat topography of the Polda Basin from the eastern scarp of Mt. Wedge. View looking south. Note the almost flat dip of the sediments of Mt. Wedge. (Neg. No. 22028).

Fig. 106

Fig. 107

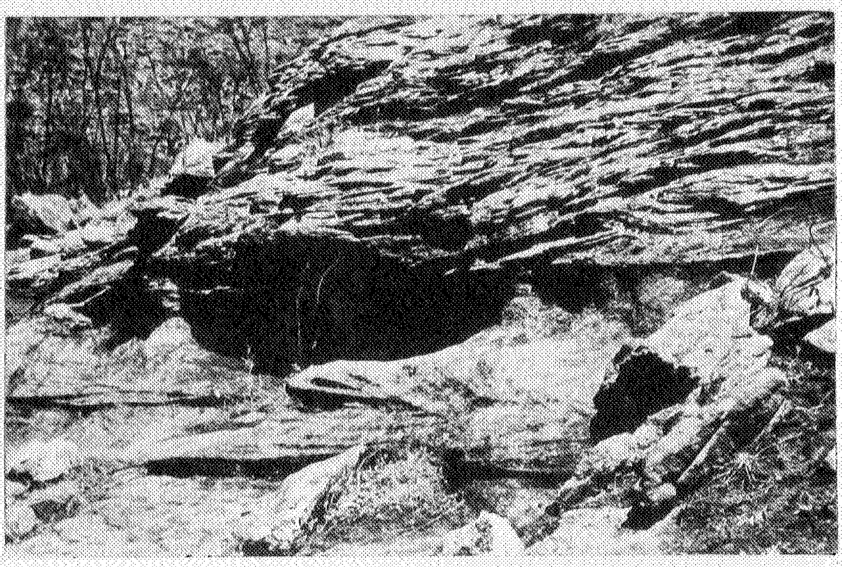


Fig. 108

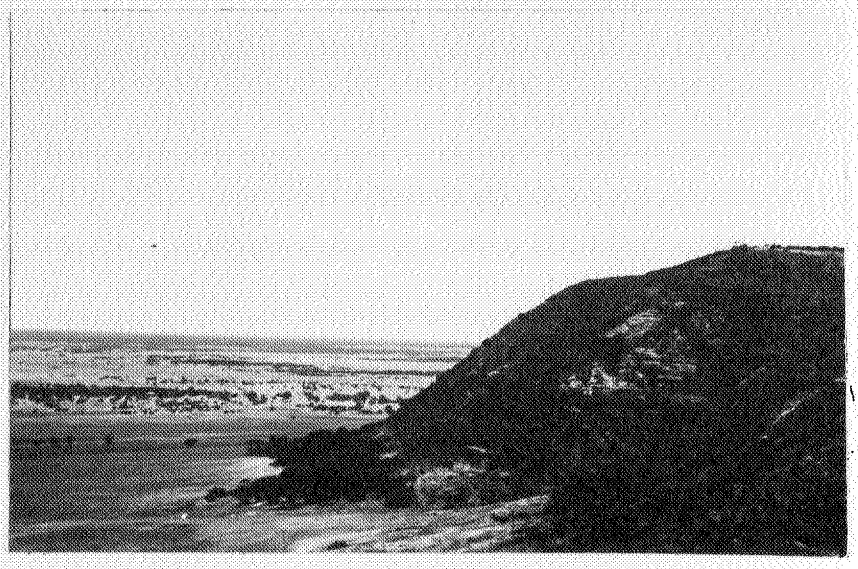


Fig. 109. - Bridgewater Formation aeolianite underlain unconformably by gently westward dipping? Pre-Cambrian sediments, coast near Talia caves. View looking south.
(Neg. No. 22029).

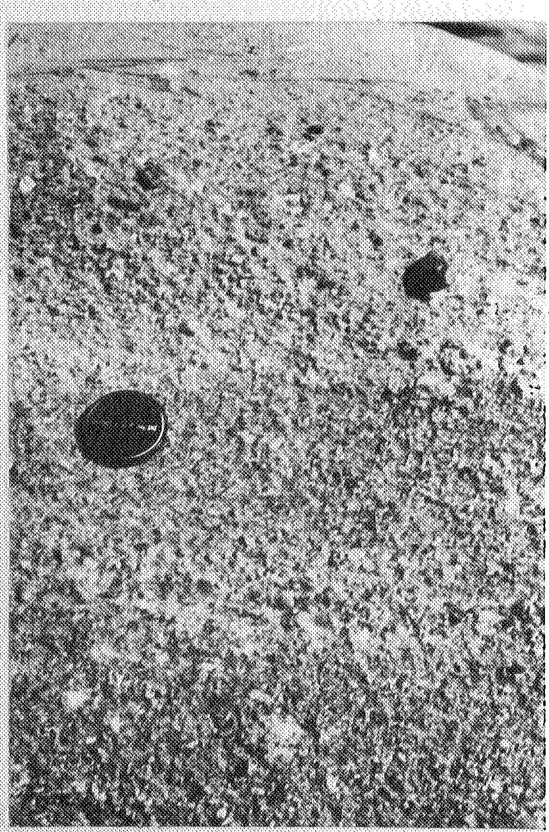
Fig. 110. - View westwares from Talia caves. Figure standing on gently dipping coarse grained ?Pre-Cambrian sediments. Caves formed at unconformity between sandstones and Bridgewater Formation.
(Neg. No. 22030).

Fig. 111. - Coarse grained feldspathic sandstone, Talia Caves.
(Neg. No. 22031).

Fig.109

Fig.110

Fig.111



APPENDIX I

Lithological Log, Polda Stratigraphic Hole No. 1

Depth		Description
In metres	In feet	
0 - 1.5	0 - 5	Limestone, sandy, well rounded grains, frosted (aeolianitic).
1.5 - 4.6	5 - 15	Limestone, buff, sandy and clayey (aeolianitic).
4.6 - 11.6	15 - 38	Limestone, light brown, sandy and clayey (aeolianitic).
11.6 - 16.8	38 - 55	Clays, orange, brown, sandy, calcareous.
16.8 - 19.8	55 - 65	Sand, brown fine-grained, slightly clayey.
19.8 - 21.3	65 - 70	Sand, brown, poorly sorted, with angular to sub-angular quartz fragments (slightly calcareous, slightly clayey).
21.3 - 30.5	70 -100	Sand, medium grained, poorly to well sorted, some clay present.
30.5 - 32.0	100 -105	Sand, very dark brown to black, medium grained, slightly clayey. Grains well sorted, well rounded.
32.0 - 33.5	105 -110	Sand, dark brown to black, carbonaceous, micaceous, fine to medium grained with a few coarse grains up to 5 mm. Grains well rounded poorly sorted. Some clay present in small amounts.
33.5 - 35.1	110 -115	Sand, dark grey, carbonaceous, silty. Grains poorly sorted, up to 5 mm, well rounded.

In metres	In feet	
35.1 - 36.0	115 - 118	<u>Core</u> Silt, dark to pale brown, carbonaceous, micaceous with occasional wood fragments.
36.0 - 36.6	118 - 120	<u>Core</u> Silt, dark brown, carbonaceous, micaceous, with occasional pockets of poorly sorted well rounded quartz sand, some wood fragments.
36.6 - 37.2	120 - 122	<u>Core</u> Sand, brown, carbonaceous, micaceous, fine grained to silty with occasional concretions of marcasite.
37.2 - 37.5	122 - 123	<u>Core</u> Silt, brown to grey, carbonaceous, micaceous, some fine sand.
37.5 - 38.4	123 - 126	Sand, brown, fine to medium grained quartz, sub-angular to rounded, carbonaceous micaceous.
38.4 - 48.2	126 - 158	Sand, dark brown, predominatly coarse quartz, sub-angular to rounded.
48.2 - 49.2	158 - 162	Lignite, dark brown.
49.4 - 51.8	162 - 170	<u>Core</u> Lignite, contains angular fragments of quartz up to 4 mm. Becomes very gritty in places.
51.8 - 52.4	170 - 172	<u>Core</u> Lignite, dark brown to black, with occasional medium grained quartz sand pockets.

In metres	In feet	
52.4 - 54.9	172 - 180	Sand, lignitic, medium, sub-angular to rounded, quartz grains.
54.9 - 57.0	180 - 187	<u>Core</u> Sand, lignitic, coarse to medium, sub-angular to rounded quartz grains.
57.0 - 57.3	187 - 188	<u>Core</u> Lignite, dark brown.
57.3 - 57.6	188 - 189	<u>Core</u> Liginite with angular quartz fragments, poorly sorted, and some clay.
57.6 - 57.9	189 - 190	<u>Core</u> Lignite, dark brown.
57.9 - 58.2	190 - 191	<u>Core</u> Lignite, dark brown, slightly sandy and marcasitic.
58.2 - 58.4	191 - 191.5	<u>Core</u> Lignite, dark brown.
58.4 - 58.8	191.5- 193	<u>Core</u> Silt, light brown, lignitic, pyritic, slightly clayey.
58.8 - 59.1	193 - 194	<u>Core</u> Sand, black, lignitic, medium, sub-angular to rounded quartz grains.
59.1 - 60.4	194 - 198	Sand, brown, coarse, angular to sub-rounded quartz grains.
60.4 - 65.5	198 - 215	Sand, brown very coarse, angular to sub-rounded quartz grains.

In metres	In feet	
65.5 - 68.3	215 - 224	Sand, brown, coarse to medium, angular to rounded quartz grains.
68.3 - 98.1	224 - 322	Sand, grey, medium, sub-rounded, quartz grains, slightly clayey.
98.1 - 99.1	332 - 325	Clay, black, carbonaceous, slightly silty, very coarse quartz fragments up to 3 mm, pyritic.
99.1 - 99.7	325 - 327	<u>Core</u> Silt, grey, micaceous, crenulated.
99.7 -101.5	327 - 333	<u>Core</u> Silt, grey-black, micaceous.
101.5 -102.1	333 - 335	<u>Core</u> Silt, grey, carbonaceous, clayey, micaceous.
102.1 -102.7	335 - 337	<u>Core</u> Clay, very dark brown, carbonaceous, silty, pyritic.
102.7 -103.6	337 - 340	<u>Core</u> Silt, grey, clayey, carbonaceous.
103.6 -103.9	340 - 341	<u>Core</u> Sand, grey, clayey and silty, carbonaceous.
103.9 -104.5	341 - 343	<u>Core</u> Clay, grey brown, carbonaceous, silty.
104.5 -108.8	343 - 357	<u>Core</u> Clay, grey brown. Carbonaceous, micaceous, silty.
108.8 -109.4	357 - 359	<u>Core</u> Lignitic, very dark brown to black, some minor silty clay laminae.

In metres	In feet	
109.4 - 110.3	359 - 362	<u>Core</u>
		Silt, grey carbonaceous, micaceous, slightly clayey.
110.3 - 111.6	362 - 366	<u>Core</u>
		Clay, very dark brown silty, carbonaceous.
111.6 - 112.5	366 - 369	<u>Core</u>
		Silty, grey brown, carbonaceous, clayey.
112.5 - 116.1	369 - 381	<u>Core</u>
		Silt, grey, clayey, carbonaceous to lignitic.
116.1 - 117.3	381 - 385	<u>Core</u>
		Clay, dark brown, silty, carbonaceous, micaceous, lignitic.
117.3 - 127.4	385 - 418	Sand, grey, silty and clayey, medium grained sub-angular quartz sand.
127.4 - 143.3	418 - 470	Clay, very dark grey, carbonaceous.
143.3 - 151.2	470 - 496	<u>Core</u>
		Clay, very dark grey, silty carbonaceous - becomes gritty.
151.2 - 154.8	496 - 508	Sand, grey, silty, coarse, sub-angular quartz grains.
154.8 - 156.4	508 - 513	Silt, grey, clayey, carbonaceous.
156.4 - 157.6	513 - 517	<u>Core</u>
		Silt, green-grey, slightly sandy, abundant weathered feldspar (kaolinitic) and gneissic fragments showing relict foliation. Occasional angular quartz grains.
157.6 - 161.2	517 - 529	As above.

In metres	In feet	
161.2 - 162.8	529 - 534	Sand, brown, medium sub-angular quartz, clayey, silty occasional gravel size granitic fragments, subrounded.
162.8 - 166.1	534 - 545	Clay, dark brown, sandy, with occasional weathered igneous and metamorphic fragments.
166.1 - 167.9	545 - 551	<u>Core</u> Clay, grey-green, sandy, with occasional weathered igneous and metamorphic fragments.
167.9 - 172.2	551 - 565	Clay, brown sandy.

END OF BORE at 565 feet.

Logged by W.K. Harris & C.B. Foster

APPENDIX II

Analyses of coal. Polda Stratigraphic Hole No. 1 by The Australian Mineral Development Laboratories

Depth in metres	Sample Mark	Moisture (%)	Volatile (%)	Ash(%)	Fixed Carbon (%)	Calorific value in Kcals/gm. BTU/lb in parenthesis
108.8	A832/65	25.7	24.0	34.8	15.5	2.352 (4,235)
48.8 - 51.3	A855/64	15.4	39.3	35.4	9.9	4.767 (8,580)
51.5 - 52.1	A856/64	3.4	13.4	10.7	72.5	1.483 (2,670)
57.0 - 58.2	A857/64	14.4	31.0	26.2	28.4	3.583 (6,450)

Analysis A832/65 by M.R. Hanckel,

Analysis A855/-A857/67 by D.C. Bowditch

APPENDIX III

Petrographic Descriptions

The Australian Mineral Development Laboratories

P492/64: TS 14900, Mount Wedge, Description by D.E. Ayres

This is a poorly cemented rock which grades from a medium-grained, feldspathic sandstone type into a coarse-grained arkosic sandstone or pebble conglomerate. In both types the grains are cemented by clay material and also by recrystallisation along quartz grain boundaries where the clay is not abundant.

The feldspathic sandstone is cream-coloured and consists essentially of sub-angular to rounded quartz grains, metaquartzite fragments, feldspar grains and scattered aggregates of clay. Overall the grains are scattered through the rock. The pebble conglomerate is reddish-coloured and contains abundant altered feldspar grains. Most grains are in the 1 to 5 mm size range.

P493: TS 14901, Talia Caves, Description by D.E. Ayres.

This rock is generally quite similar to the previous specimen and shows a gradation from a cream, medium-grained sandstone type to a coarser reddish rock containing abundant pebbles. Generally the grains range from 0.25 to 0.5 mm in size but many are coarser and in the 1 to 5 mm range.

Quartz and potash feldspar (mainly microline) are the abundant constituents and quartzite fragments are present in minor amount. Composite microline-quartz fragments and altered biotite and muscovite laths occur sparsely. The matrix is extremely ~~fine-~~grained and appears to be composed of clay material. Commonly the matrix completely surrounds individual grains. The grains range in shape from angular to sub-rounded indicating that some at least have undergone abrasion.

The scattered composite grains , the abundance of potash feldspar and quartz and the numerous angular grains indicate close proximity to a granitic terrane.

P110/65: TS 15660, Bramfield Granite, Description by A.R.Turner.

This rock is a pink alkali-granite. It consists of numerous aggregates of anhedral quartz crystals interspersed with anhedral masses of alkali feldspar and green pleochroic biotite. The biotite occupies interstitial spaces and is sometimes found included within the alkali feldspar. Plagioclase crystals exhibiting poorly defined albite twinning are found in accessory amounts. They have the composition of oligoclase. Occasionally mymrekitic intergrowths of quartz and alkali feldspar are found between large quartz and feldspar grains. Rarely the alkali feldspars are observed to be perthitic. Primary opaque minerals are rare and form minute concentrations in association with aggregates of biotite laths. Apatite is another important accessory mineral forming relatively large grains which are randomly distributed throughout the quartz and rarely within the feldspar fractions.

The rock has no apparent structure but exhibits a typical xenomorphic granualr texture with crystals of quartz and feldspar set in a fine-grained quartz matrix which contains numerous laths of green biotite. When the biotite is found included within alkali-feldspar it crystallizes along cleavage traces as elongated needles which are surrounded by a zone of alteration. This zone contains finely disseminated opaque minerals and sericite. Some other feldspar crystals show considerable alteration to sericite along cleavage traces. Rarely muscovite forms in these situations. Incipient kaolinisation of the alkali feldspar has taken place probably as a result of deuteric alteration associated with a late magmatic phase. Apart from the alteration exhibited by the feldspars the rock is comparatively fresh.

The visually estimated mineralogical composition of the rock is as follows:-

%	
40	quartz
45	alkali feldspar (orthoclase)
5	plagioclase (oligoclase)
10	biotite

accessory opaque minerals, apatite, sericite, muscovite.

P432/65: TS 16503, Polda Stratigraphic Hole No. 1 at 170.7 m (560 ft). Description by R. Townsend.

This is an even-grained, slightly metamorphosed arkose. It consists of about equal quantities of feldspar and quartz, both with interfering anhedral forms, and averaging 0.1 mm. The feldspars, which are quite fresh, consist of microline perthite and oligoclase and displacement of twinning in the latter indicates late stage shearing. There is a small quantity of incipient green-brown biotite developing in the interstices; otherwise sericite is commonly rimming the clastics.

Other mafics consist of minor chlorite, green hornblende, with rare epidote. Zircon and apatite are accessories. In addition to the biotite, some recrystallization of the quartz has occurred.

APPENDIX IV

Water analyses, Polda Stratigraphic Hole No. 1

Depth in metres	Sample No.	Salinity in ppm
6.1	W 661/65	2170
21.3	W 2398/64	7850
37.8	W 2399/64	8920

APPENDIX V

Data on palynological samples studied

Bore name	Depth in metres (feet in parenthesis)	Sample No.	Age
Polda Stratigraphic Hole No. 1	36.0 (118)	S559	M.Eocene
	36.0 - 36.3(118-119)	S2341	M.Eocene
	37.5 (123)	S560	M.Eocene
	49.1 (161)	S561	M.Eocene
	49.4 - 49.7(162-163)	S2342	M.Eocene
	51.8 (170)	S562	M.Eocene
	55.2 (181)	S563	M.Eocene
	57.9 (190)	S564	M.Eocene
	58.5 (192)	S568	M.Eocene
	99.1 - 99.4(325-326)	S619	U.Jurassic
	101.8 (334)	S632	U.Jurassic
	102.4 (336)	S996	U.Jurassic
	105.1 (345)	S2343	U.Jurassic
	108.8 -109.1(357-358)	S992 S997	U.Jurassic
	110.9 (364)	S993	U.Jurassic
	111.2 (365)	S670	U.Jurassic
	116.4 (382)	S994	U.Jurassic
	127.4 -129.5(418-425)	S2344	U.Jurassic
	131.0 -132.6(430-435)	S2345	U.Jurassic
	138.7 -140.2(455-460)	S2346	U.Jurassic
	143.3 -144.8(470-475)	S2347	U.Jurassic
	145.7 -147.2(480-485)	S2348	U.Jurassic

Bore name	Depth in metres (feet in parenthesis)	Sample No.	Age
	147.2 -148.7(485-490)	S998	U.Jurassic
	148.7 -151.2(490-496)	S2349	U.Jurassic
	167.9 (551)	S990	U.Jurassic
	169.2 -170.7(555-560)	S991	U.Jurassic
	170.7 -172.2	S2350	U.Jurassic
Ob Bore 332	42.1 - 44.9(138-147)	S353	U.Jurassic
Ob Bore 332	62.2 - 76.2(204-250)	S358	U.Jurassic
Ob Bore 333	44.9 - 51.8(147-170)	S354	U.Jurassic
Bore P.T.10D	43.3 (142)	S1606	U.Jurassic
Ob Bore 503	17.7 (58)	S1479	M-U.Eocene
Ob Bore 504	18.0 - 18.3(59-60)	S2369	M-U. Eocene
Ob Bore 532	14.6 - 14.9(48-49)	S2370	M-U.Eocene
Ob Bore 599	39.6 - 39.9(130-131)	S2372	M-U.Eocene
Ob Bore 599	59.3 - 59.6(129-130)	S2373	M-U.Eocene
Ob Bore 601	25.1 - 25.6(82.5-84)	S2371	M-U.Eocene
Coalshaft	24.4 (80)	S288	U.Jurassic
	24.4 (80)	S2351	U.Jurassic

APPENDIX VI

MARINE FORAMINIFERA FROM EOCENE CARBONACEOUS SEDIMENTS:

POLDA, CUMMINS, AND WANILLA BASINS, EYRE PENINSULA

by

J.M. LINDSAY

PALAEONTOLOGY SECTION

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SOUTH AUSTRALIA

Rept.Bk.No. 72/83
G.S. No. 4852
Pal.Rept. 8/72
DM. No. 1738/57

MARINE FORAMINIFERA FROM EOCENE CARBONACEOUS SEDIMENTS: POLDA, CUMMINS, AND WANILLA BASINS, EYRE PENINSULA

ABSTRACT

The first foraminifera reported from the Polda Basin are in highly carbonaceous glauconitic clays palynologically dated middle-upper Eocene. The microfauna comprises sparse and stunted marine benthonic forms whose origin and mode of association with the sediment are discussed. Microfaunas first found in the Cummins and Wanilla Basins in 1958 by N.H. Ludbrook are more diverse but still restricted-marine. The planktonic component has been re-studied and some more precise ages can be deduced, including Upper Eocene, and late Eocene/early Oligocene.

INTRODUCTION

During recent palynological examination of subsurface carbonaceous sediments from the Polda Basin (Harris and Foster, 1972), it was found that a suite of bore cores from hundred of Talia contained abundant microplankton of "marine" type (and middle to upper Eocene age). Palaeontological examination was requested for any other evidence of marine deposition and age. Three cores were selected by Mr. Harris, Assistant Senior Palynologist, as being richest in "marine" microplankton, and so most suitable for such study. They are from Department of Mines bores 599 and 601, about 3 km (2 ml) apart, in the northern part of hundred of Talia, county Musgrave, western central Eyre Peninsula (Text Fig. 1). Structurally, the bores appear to be in a northern lobe of the Polda Basin. Stratigraphically, the samples are from Poelpena

Formation (Harris, 1966) whose subsurface type section is some 31 km (19 ml) to the southeast, in Polda Stratigraphic Bore No. 1.

In order to compare the Talia foraminifera with other restricted-marine Eocene microfaunas of Eyre Peninsula, material reported on by Ludbrook (1958, 1963) from the Cummins and Wanilla Basins has been re-studied.

DESCRIPTION OF SAMPLES, TALIA BORES, POLDA BASIN

Sample F54/72:

Tube core from bore D.M.599, section C, hundred of Talia, depth 39.3-39.6 m (129-130ft.). Dark grey, highly carbonaceous, sapropelic silty clay, rather soft and sectile; quartzose (silt, very fine to very coarse sand), somewhat ferruginous (abundant sand-sized brown grains) and pyritic; sparsely micaceous; only occasional grains of glauconite (fine sand size).

No foraminifera found; abundant hystrichospherids; rare small black plant "stems" and fragments, but little woody matter; organic material mostly clay to fine silt size.

Sample F55/72:

Tube core from bore D.M.599 as above but from depth 39.6-39.9 m (130-131ft.), at total depth of bore. Dark grey and chocolate-brown highly carbonaceous, sapropelic silty clay, compact; quartzose (silt, very fine to very coarse sand); abundant green glauconite grains (sand size); frequent grains of pyrite (fine sand size) many with crystal faces developed; rather common angular fragments (sand size) of white, porous, fine-grained bioclastic limestone, recrystallised, and with calcite rhombs.

Hystrichospherids are rare. Animal remains comprise rare bryozoal fragments and foraminifera, and occasional sponge spicules, ostracode valves, echinoid and ?mollusc fragments, all in white recrystallised preservation similar to the limestone fragments. Foraminifera are small and poorly preserved, but include:

Brizalina sp. (one specimen)

Anomalinoides sp. (one specimen)

Discorbinella sp. (one specimen)

? *Astrononion* sp. (one specimen)

rotaliid forms indet. (four different specimens)

Sample F53/72

Tube core from bore D.M.601, section D, hundred of Talia, depth 25.1-25.6 m (82½-84ft.). Black, highly carbonaceous, sapropelic clay, quartzose (silt, very fine to coarse sand); ferruginous (abundant sand-sized grains); sparsely glauconitic, micaceous, pyritic.

Hystrichospherids are abundant. There are occasional black, plant "stems", but organic material is mostly clay to fine silt size, as for F54/72.

Two ?sponge spicule fragments are impregnated with glauconite.

Foraminifera are rare and small. Some are quite well preserved, others are recrystallized white or pale yellow. They include:

turrilinid indet. (*Buliminella* or *Turrilina*) (one specimen)

Cibicidoides sp. aff. *C. pseudoungerianus* (Cushman) (four specimens)

?*Astrononion* sp. (one specimen)

Cassidulina sp. (one specimen)

Discorbis sp. aff. *D. balcombensis* Chapman, Parr, and Collins (one specimen)

Cibicides sp. aff. *C. vortex* Dorreen (one specimen)
rotaliid forms indet. (three forms, four specimens)

SIGNIFICANCE OF THE TALIA MICROFAUNAS

1. Foraminifera, bryozoans, and other animal remains have not been reported previously from the Poelpena Formation, Polda Basin.
2. The variety of calcitic foraminifera in F55/72, F53/72, and the presence of bryozoans in F55/72, point to a definitely marine origin for these microfaunal elements.
3. Conversely, there is a lack of these marine elements in F54/72.
4. There appears to be a positive correlation between variety of such marine elements and abundance of glauconite. F54/72 has no animal remains and only occasional grains of glauconite. F53/72 has foraminifera and occasional ?sponge spicules, and glauconite is sparse. F55/72 has foraminifera, bryozoans, and occasional sponge spicules and echinoid fragments, together with common grains of bioclastic limestone; and abundant glauconite.

    These findings may be compared with the conclusions of e.g. Cloud (1955) and Triplehorn (1966), that glauconite usually forms in shallow to moderate neritic marine water, and is not known to occur in saline lakes nor in fresh water deposits.
5. There are problems which arise from the presence of marine microfaunal elements in such sapropelic sediments (richly organic aquatic ooze) formed under anaerobic reducing conditions. To what extent could these organisms live, and their remains accumulate together with glauconite under such conditions?

Lochman (1949), quoted by Cloud (1955), summarised work by Galliher, Takahashi, Yagi, and Hadding, which linked glauconitization with a moderately anaerobic environment, an essential element being the presence of putrefying organic material. Whether the reducing conditions in the Talia sediments were too severe for the formation of glauconite is not known.

However in such sediments, recrystallised calcitic marine foraminifera, bryozoans, and grains of bioclastic limestone seem to be rather incongruous. They may be autochthonous but it has been seriously considered whether the calcitic grains (including microfossils) are (i) contaminants introduced during preparation of the samples; or (ii) allochthonous to the sediments e.g. introduced by wind or water during deposition, involving some measure of reworking from a more oxygenated marine source.

(i) To avoid contamination during processing, only the inner, apparently undisturbed, portion of each core was used, and all preparation was carefully done by the writer, with avoidance of contamination in mind. The absence of foraminifera etc. in F54/72 during the same run of samples, is evidence against a continuing source of contamination. The microfaunas are not recognisably similar to those from any other samples recently processed. It is concluded that contamination was not a significant factor.

(ii) The correlation noted above between calcitic component and abundance of glauconite suggests that the two are meaningfully related and are not associated by chance. That is, the calcitic grains and the glauconite grains are likely to have accumulated together either in situ or by being transported together in roughtly original proportions to their ultimate site of deposition. Some of the foraminifera are broken, possibly due to wear, and these could have suffered transport. As to the reworking of glauconite, Cloud (1955) warns that "glauconite may be transported from its place of origin, reworked, or chemically mobilized and moved after burial...... Little value accrues to interpretations based on material transported from a distance or reworked, except as the situation is recognised and the evidence properly evaluated". Triplehorn (1966) agrees that "erosion and re-deposition of glauconite in non-marine or younger marine sediments could reduce its environmental significance", but he concludes that "Fortunately this is not likely to occur. Glauconite weathers rapidly when exposed to the atmosphere, and does not survive long fluvial transport. Submarine or coastal erosion could lead to its incorporation in much younger marine sediments, but such occurrences are probably not common".

More likely (and quite possible for the Talia sediments) is a process of more or less marine sedimentation on a bottom topography in which local depressions (or a larger-scale barred basin) accumulated dark organic muds under reducing, anaerobic conditions, while local rises (or a nearby more open-marine environment) contributed by means of wave or current action the products of a more oxygenated regime. The significance of such close juxtaposition of reducing and oxygenous conditions was recognised by Lochman (1949) and Cloud (1955).

A middle to upper Eocene age for the Talia sediments (on palynological evidence) would mean that their deposition was contemporaneous with the accumulation in the Eucla Basin to the west, of the Wilson Bluff Limestone which formed in a sedimentary regime characterised by glauconite marl to skeletal limestone. The recrystallised foraminifera and bryozoans, and the skeletal limestone grains are indeed similar in preservation and appearance to material from that formation. This could suggest either derivation from at least partly-cemented Wilson Bluff Limestone material e.g. influx during storms into a barred anaerobic basin, or the incipient formation of Wilson Bluff - type material under less favourable conditions in the Talia area. In the latter case, the skeletal limestone grains in sample F55/72 could be interpreted as centres of carbonate aggregation in an otherwise muddy, highly carbonaceous, but marine environment, perhaps in situations locally more oxygenated.

6. The foraminiferal assemblages in F55/72, F53/72 have puzzling features when considered in relation to the enclosing sediments. No arenaceous forms are present, although these characterise marginal-marine and restricted-marine faunas (Taylor, 1971). On the other hand, any degree of open-marine sedimentation seems to be excluded by the absence of planktonic species. Again, there is a high faunal diversity relative to the numbers of foraminifera present. Of the fifteen or so forms recognised, most are represented by one specimen only. Yet despite this relatively high diversity of calcareous benthonic forms (said to characterise marine shelf faunas) it is hard to escape the conclusion that stress factors operated to produce the stunted individuals present, and one need not look further than the enclosing dark sapropelic sediment to provide an appropriately harsh environment. None of the depositional environments listed by Taylor (1971) fits the Talia material, and again as discussed in section 5 above, it seems to be necessary to invoke juxtaposition of environments and some degree of mixing of their contributions.

7. Microplankton considered to be of "marine" type (Harris and Foster, 1972) are abundant in both F54/72 (no microfauna, little glauconite) and F55/72 (marine microfauna, abundant glauconite). This could suggest that these "marine" microplankton occupied a broad spectrum of environments including one with too little marine influence to sustain foraminifera or to enable significant formation of glauconite. However there are at least two other alternatives. The floating habit of microplankton could conceivably carry them in from the sea to, say, an estuarine situation with little marine influence and no foraminifera or glauconite. Or the environment of deposition of both samples could be regarded as basically marine with a "rain" of marine microplankton on a bottom topography having juxtaposed anaerobic and oxygenous regimes as discussed above. This would provide various associations of "marine" microplankton with more or less of a "marine"-type benthos depending on the degree of distribution of the latter by currents, wave action or slumping.

8. At present, the foraminifera can only be dated as Eocene to Miocene, i.e. mid-Tertiary. This is of course consistent with the middle to upper Eocene age derived from palynological evidence. All the forms appear to be stunted, many are poorly-preserved, and there is a lack of Australian studies of such mid-Tertiary benthonic faunas. Most individuals can only be identified to generic level.

Cibicides vortex ranges from Eocene to early Miocene in South Australia (e.g. Lindsay, 1969), and from Middle Eocene to Middle Miocene in New Zealand (Hornibrook, 1961).

Hornibrook included Discorbis finlayi Dorreen, 1948 (from the Upper Eocene of New Zealand) in D. balcombensis, and gave the stratigraphic range of the species in New Zealand as ?Lower Eocene, Upper

Eocene to upper Middle Miocene. The observed South Australian range of Eocene to Middle Miocene agrees.

Cibicidoides pseudoungerianus has a long range through the middle and upper Tertiary in South Australia.

EOCENE PLANKTONIC FORAMINIFERA OF THE CUMMINS AND WANILLA BASINS

The foraminifera recorded by Ludbrook (1958, 1963) and noted by Johns (1961, p.26, Erratum insert) have been re-examined by the writer, and selected samples have been re-picked. Compared with the microfaunas from the Talia bores (more than 120 km (75 ml) to the north-northwest) they are in general more diverse and abundant, are less stunted, better preserved, and have a more normally "marine" aspect with a rare but identifiable planktonic component, although they are in glauconite-bearing carbonaceous quartz sands which no doubt were deposited under restricted-marine conditions. Black, woody fragments are common.

The planktonic foraminifera were only identified as "Globigerina" by Ludbrook (1958, 1963) and no age was deduced from them apart from the general statement that "the foraminifera .... appear to be similar to those occurring in Eocene paralic sediments elsewhere in South Australia" (Ludbrook, 1958, p. 1). The "middle to upper Eocene" age has rested on the palynological evidence, first of Cookson (written communication in Ludbrook, 1958) then of Harris (1966). Opportunity has now been taken to identify and date the planktonic foraminifera in the light of more recent studies in South Australia and overseas.

1. Cummins School Drainage Bore

This bore contains, between 115 and 400 ft. (35.1-121.9m), the subsurface type section of the Wanilla Formation (Harris, 1966), dated palynologically by Harris as Middle-Upper Eocene. A microfauna from this formation at 195-240ft. (59.4-73.2 m), was reported by Ludbrook (1958, 1963). The sample has now been repicked and yields the following planktonic species, preserved as white, somewhat recrystallised, calcitic tests:

Cassigerinella eocaenica Cordey (rare)
Turborotalia gemma (Jenkins) (rare)
Subbotina sp. aff. *S. angiporoides minima* (Jenkins) (v. rare)
Globigerina angustiumbilicata Bolli (rare).

According to Blow (1969, 1970), *C. eocaenica* and *T. gemma* both range from Zone P.16 to Zone P.19/20, and *G. angustiumbilicata* from P.16 probably to the present. These species provide a lower limit to the age of the sample i.e. Zone P.16, Upper (but not uppermost) Eocene. Blow does not differentiate *S. angiporoides minima* from *S. angiporoides* (P.15-P.19/20), but Jenkins (1966, 1971) gives the range of his subspecies in New Zealand as ?Porangan, and Bortonian to Kaiatan Stages, *Globigerapsis index index* Zone to upper *Globorotalia* (*Turborotalia*) *inconspicua* Zone, Middle to Upper (but not uppermost) Eocene. Thus the specimen of *Subbotina* could provide an upper limit to the age of the sample which is similar to the lower limit.

2. Cummins Police Station Drainage Bore

Ludbrook (1958) recorded foraminifera at two levels.

(a) At 142-169ft. (43.3-51.5m) she noted benthonic forms and *Globigerina* sp. The sample has been repicked and yields the following planktonic species as relatively well-preserved, white, calcitic tests:

Cassigerinella chipolensis (Cushman and Ponton) (frequent)
C. eocaenica (very rare)
Turborotalia gemma (very rare)
Globigerina angustiumbilicata (common)

Subbotina angiporoides angiporoides (Hornibrook) (very rare)

Globigerapsis sp. aff. G. index (Finlay) (very rare)

The specimens of C. chipolensis are well-developed and provide a lower limit to the age of the sample. This lower limit would be Zone P.18, basal Oligocene, according to Blow (1969). However an uppermost Eocene age could also be possible, as the writer found C. chipolensis commencing its range high in the Subbotina linaperta Zone at Port Noarlunga (Lindsay, 1970).

An upper age limit is suggested by Globigerapsis sp. aff. G. index. The genus Globigerapsis is restricted to the Eocene, and G. index only ranges to the top of the Runangan Stage (uppermost Eocene) in New Zealand (Jenkins, 1966, 1971).

The sample thus can be dated close to the Eocene-Oligocene boundary, perhaps latest Eocene.

(b) Ludbrook recorded Globigerina spp. from the lower microfauna at 205-214ft. (62.5-65.2 m). The sample has been repicked and includes the following planktonic forms:

Subbotina sp. aff. S. linaperta (Finlay) (very rare)

Globigerina sp. aff. G. ampliapertura Bolli (very rare)

This association suggests an Upper Eocene age. G. ampliapertura sensu stricto is not older than Zone P.17 (uppermost Eocene) according to Blow (1969). The species of Subbotina has more affinity with the Eocene S. linaperta than with the Upper Eocene - Middle Oligocene S. angiporoides.

3. Bore, G. Christopher, Section 79, Hundred of Mortlock

From this bore in the Wanilla Basin, Ludbrook (1958, 1963) recorded Globigerina, in sample F141/55, 62-71ft. (18.9-21.6 m). The sample has been repicked and it contains rare specimens of the planktonic species Subbotina linaperta, of Eocene age.

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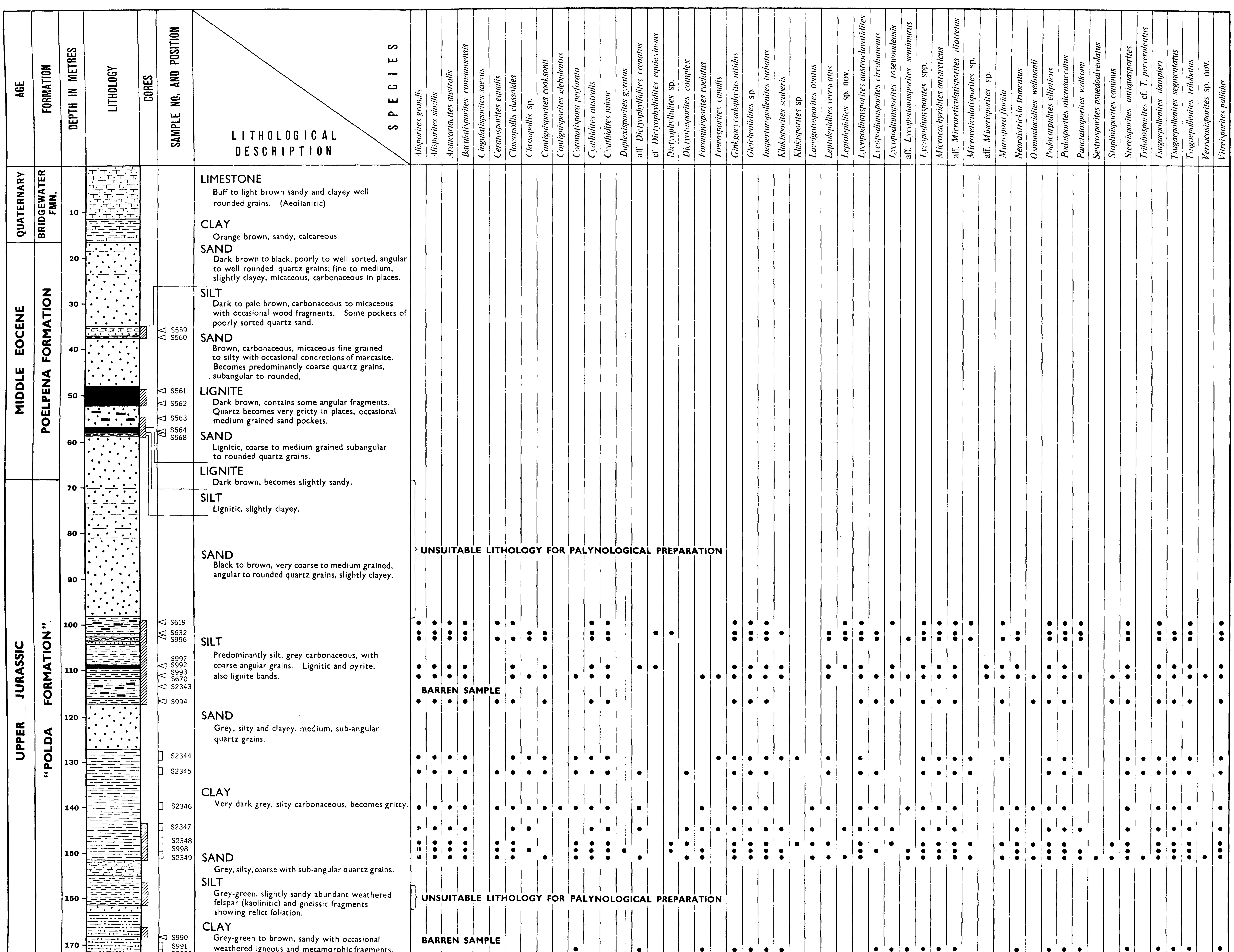

Fig.2 JURASSIC SPECIES DISTRIBUTION CHART POLDA STRATIGRAPHIC HOLE No.1

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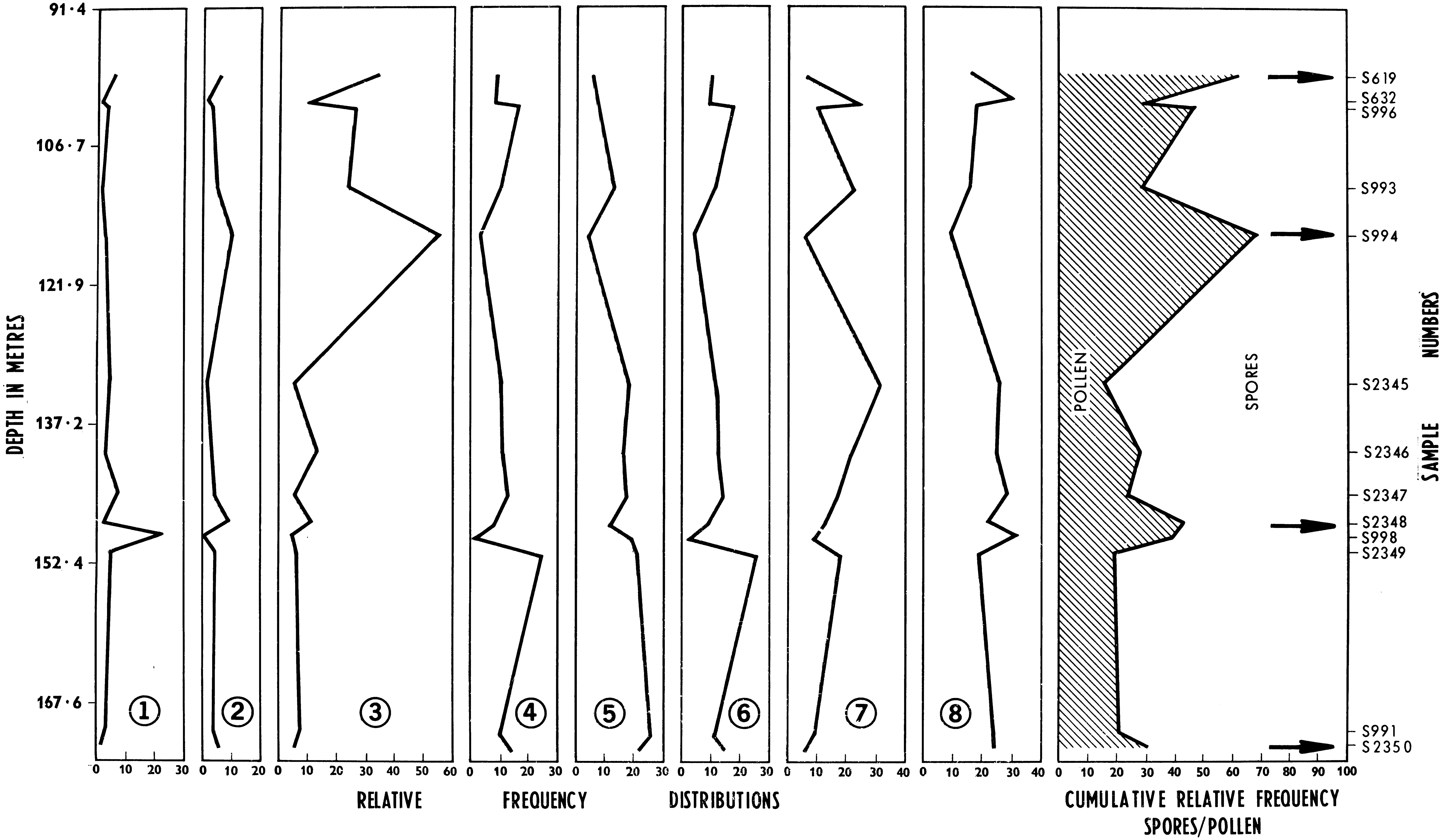


REFERENCE

CLASS **1** *Classopollis* spp.

2 *Tsugaepollenites* spp.

3 *Araucariacites* and *Inaperturopollenites* spp.

4 Bi–& multisaccate pollen

CLASS **5** *Cyathidites* spp.

6 *Lycopodiumsporites* spp.

7 *Baculatisporites* and *Osmundacidites* spp.

8 All other species

→ Arboreal advance

METRES 0 10

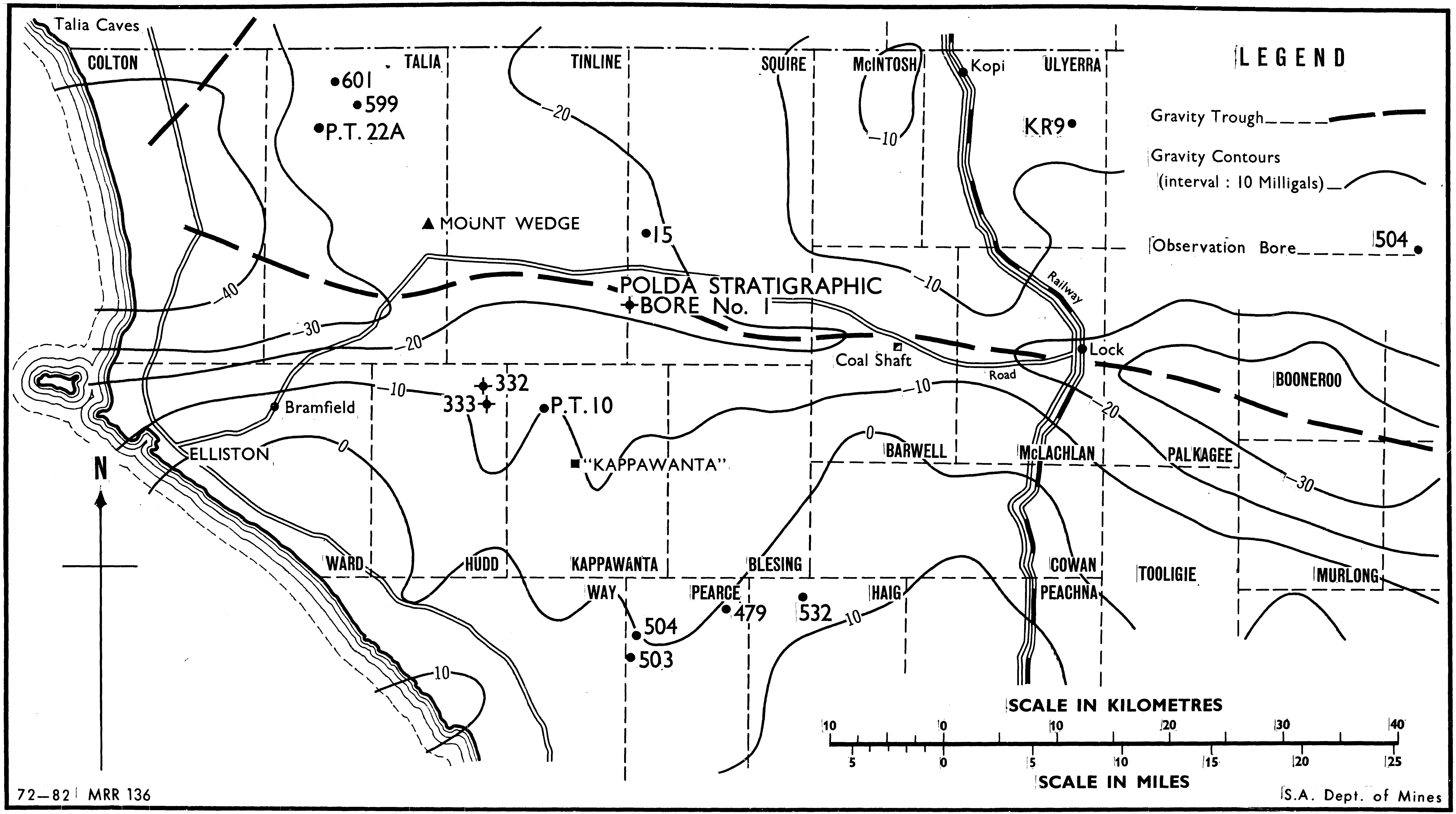
INCHES 0 1 2 3 4

72–159 MRR 136

W.K. Harris Palynologist

S. A. Department of Mines

RELATIVE FREQUENCY DISTRIBUTIONS OF EIGHT JURASSIC SPORE/POLLEN CLASSES POLDA STRATIGRAPHIC HOLE No.1



Talia Caves
COLTON
TALIA
TINLINE
SQUIRE
McINTOSH
Kopi
ULYERRA
LEGEND
Gravity Trough
Gravity Contours
(interval : 10 Milligals)
Observation Bore
504
601
599
P.T. 22A
KR9
MOUNT WEDGE
15
POLDA STRATIGRAPHIC
BORE No. 1
Railway
Coal Shaft
Lock
Road
BOONEROO
332
333
P.T. 10
Bramfield
ELLISTON
"KAPPAWANTA"
BARWELL
McLACHLAN
PALKAGEE
N
WARD
HUDD
KAPPAWANTA
BLESING
COWAN
TOOLIGIE
MURLONG
WAY
PEARCE
HAIG
PEACHNA
504
479
532
503
SCALE IN KILOMETRES
SCALE IN MILES
72—82 MRR 136
S.A. Dept. of Mines

SPECIES \ SAMPLE	BORE 332 AT 42.1—44.9m	BORE 332 AT 62.2—76.2m	BORE 333 AT 44.9—51.8m	BORE PT 10 D AT 43.3m	COAL SHAFT AT ca 25m
Alisporites grandis	•	•	•	•	•
Alisporites similis	•	•	•	•	•
Araucariacites australis	•	•	•	•	•
Baculatisporites comaumensis	•	•	•	•	•
Cingulatisporites saevus			•		
Ceratosporites equalis	•		•		•
Classopollis classoides	•	•	•	•	•
Classopollis sp.	•	•	•	•	•
Contignisporites cooksonii	•	•	•	•	•
Coronatispora perforata	•		•		
Cyathidites australis	•	•	•	•	•
Cyathidites minor	•	•	•	•	•
aff. *Dictyophyllidites crenatus*	•		•		•
cf. *Dictyophyllidites equiexinous*			•		
Dictyophyllidites complex				•	•
Foraminisporites caelatus					•
Foveosporites canalis	•				
Ginkgocycadophytus nitidus	•	•	•	•	•
Gleicheniidites sp.	•	•	•	•	•
Inaperturopollenites turbatus	•	•	•	•	•
Klukisporites scaberis	•		•		
Laevigatosporites ovatus	•	•	•	•	•
Leptolepidites verrucatus	•		•		
Lycopodiumsporites austroclavatidites	•	•	•	•	•
Lycopodiumsporites circolumenus	•	•	•	•	•
Lycopodiumsporites rosewoodensis	•	•	•		•
aff. *Lycopodiumsporites semimurus*			•		
Microcachyridites antarcticus	•	•	•	•	•
aff. *Minerisportes* sp.				•	•
Murospora florida	•	•	•	•	•
Neoraistrickia truncatus	•		•		•
Osmundacidites wellmanii	•	•	•	•	•
Osmundacidites sp.	•	•	•	•	•
Podocarpidites ellipticus	•	•	•	•	•
Podocarpidites sp.	•	•	•	•	•
Punctatosporites walkomi	•	•	•	•	•
Sestrosporites psuedoalveolatus			•		
Staplinisporites caminus			•		•
Stereisporites antiquasportes	•	•	•	•	•
Trilobosporites cf. *T. perverulentus*	•				
Tsugaepollenites dampieri	•	•	•	•	•
Tsugaepollenites segmentatus	•	•	•	•	•
Tsugaepollenites trilobatus	•	•	•	•	•
Vitreisporites pallidus	•	•	•	•	•

72-3:0 MRR 136 W.K. Harris S.A. Department of Mines

FIG.3 JURASSIC LOCALITY
SPECIES DISTRIBUTION CHART
POLDA BASIN