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1962/57

PALYNOLOGICAL OBSERVATIONS ON F.B.H. FLAXMAN'S HILL NO.1 WELL

by

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CONTENTS

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SUMMARY

Thirty-four core samples from the Commonwealth subsidized Frome-Broken Hill Co. Pty Ltd Flaxman's Hill No.1 well, Otway Basin, Victoria, provided spores identifying the Cretaceous age of the Otway Group penetrated in the well. Microplankton, spores and pollens which might form the basis of future correlation of the Upper Cretaceous of the basin, following comparison with their distribution in Port Campbell No.1 well and Belfast No.4 bore, are noted. Cretaceous outcrop samples from the Otway Group were also examined. Problems arising from tentative correlations between the Lower Cretaceous Merino Group and the Otway Group and the relation of subsurface and outcrop Wangerrip Group are outlined, but no solutions to them are offered at this stage.

INTRODUCTION

Between May and August 1961 Frome-Broken Hill Co. Pty Ltd, with Commonwealth subsidy, drilled Flaxman's Hill No.1 well to a total depth of 11,528 feet in the Otway Basin of western Victoria. The distribution of fossil microspores and microplankton in thirty-four core samples from the Mesozoic of the well has been examined to determine the species present in the Otway Group (the thickest section yet known of the Group was penetrated) and to compare this distribution with that in Port Campbell Nos 1 and 2 wells (Evans, 1961b) and Belfast No.4 bore (Cookson & Eisenack, 1961) to select species which might be used as zonal marker fossils.

Observations on three outcrop samples from the Otway Group, submitted by Frome-Broken Hill, are also included.

OBSERVATIONS

Species observed in samples from the well are recorded in the distribution chart at the back of the report. Those species which were also observed in Port Campbell Nos 1 & 2 wells are marked in addition with their number on the Port Campbell distribution chart (Evans, 1961b). The lithological column has been compiled from the weekly drilling reports; a detailed log will be available in the well completion report. The formations and their boundaries are those chosen by the company. The "Flaxmans Beds" is a new name, details and authorship of which will also be found in the completion report.

Species observed in the outcrop samples WO-1, WO-2, WO-3 from the Otway Group are listed in Appendix I (p. 9).

STRATIGRAPHIC IMPLICATIONS

1. Microspores in the oldest beds of the Otway Group encountered in the well had suffered appreciable alteration which could be attributed to the effects of load metamorphism and, in consequence, the microspore assemblages in these beds cannot be fully assessed. Only the grosser characteristics of species remain; the bisaccate nature of gymnosperm pollens is discernible and thicker and thus more durable ornamentation of apiculate and striate pteridophyte spores has survived. Thus,

Cicatricosisporites australiensis, with characteristic striate muri, was recognizable even in core 44 (11517-11528 feet).

C. australiensis is a persistent species within the Cretaceous System and its presence in core 44 indicates that the base of the well was still within sediments of Cretaceous age (Balme, 1957b; Evans, 1961a). Recent examination of several wells within the Artesian Basin, e.g. Pickanjinnie No.1, Cabawin No.1, has provided additional evidence of spore distributions within the Triassic and Jurassic Systems, which confirms this view. All of the Victorian Otway Group which has been palynologically examined so far is Cretaceous in age and Jurassic members of the group have yet to be found (Appendix I,p.9)

Core 41 (10801 - 10817 feet) was the lowest to yield a quantity of microspores; C. australiensis was present in it in comparitively large numbers. The general paucity of microspores in the Otway Group persisted to core 34 (8470 - 8486 feet) at which depth the effects of load metamorphism should be insignificant; the lack of variety of species is, therefore, an environmental feature of the containing strata or of the source of the spores.

The presence of very rare hystrichosphaerids in core 34 is an indication of brackish or marine conditions of deposition at this point.

2. Only two fossiliferous horizons in the remainder of the Otway Group, core 32 (8139 - 8150 feet) and core 28 (7473 - 7493 feet), have been sampled but they contained more varied assemblages of spores than the lower section. C. australiensis was rare but Pilosisporites notensis, a distinctive Cretaceous species, was present. Diagnostic species of sections of the Cretaceous were lacking. Hystrichosphaerids were recognized in core 28.

3. The sandy or silty beds to the top of the Waarre Formation provided assemblages comparable in abundance and species to the higher part of the Otway Group. Trilobosporites trioreticulatus was observed in core 25 (6902 - 6913 feet) at the top of the Waarre Formation and, in association with Gonyaulax edwardsi, they mark an approximately Albian age for that horizon.

4. The lack of fossiliferous samples from the "Flaxmans Beds" precludes comments on the formation. The lowest sample examined from the Belfast Mudstone, core 17 (6375 - 6391 feet), contained Hystrichosphaeridium heteracanthum, Odontochitina cf. O.cribropoda and very few pollens or spores and is considered to be Upper Cretaceous in age.

5. Core 16 (5950 - 5970 feet) introduced the characteristically marine Upper Cretaceous with Odontochitina porifera and Deflandrea cretacea. D. cretacea was accompanied in the upper part of its range by Hexagonifera vermiculata. Nelsoniella aceras and Xenikoon australis continued a replacement sequence through the remainder of the Upper Cretaceous while spores in the same section became increasingly diluted with angiospermous pollens.

6. During examination of Port Campbell No.1 (Evans, 1961b) it was assumed that the Tertiary commenced with the deposition of the Wangerrip Group at 4245 feet (Bain & McQueen, 1960). Species of pollens originally described from Tertiary sediments, e.g. Dacrydiumites mawsonii, Triorites edwardsi, were present in Port Campbell No.1, core 14 (4280 - 4281 feet) associated with Xenikoon australis (originally described from the Upper Cretaceous of Western Australia (Cookson & Eisenack, 1960) and the Tertiary was thought to be close to that horizon.

X. australis persisted throughout a thicker section of Flaxman's Hill No.1 than Port Campbell No.1 (but see p.5) and was not associated with microplankton originally described from the Tertiary until core 3 (4126 - 4134 feet) where Membranilarnax clathrodermum was found: it is possible that beds at least as high as 4309 feet are Cretaceous in age.

Systematic examination of sections across the Cretaceous - Tertiary boundary (adequately dated by other fossils) is required before a satisfactory means of identifying the boundary can be chosen (see page 6).

COMPARISON WITH PORT CAMPBELL NOS 1 & 2 WELLS.

1. LOWER CRETACEOUS

Adequate comparative data on the Otway Group below surface are not available. No map of components has been published so that the relative stratigraphic positions of the six localities of the group examined by Cookson & Dettmann (1958) and of three new samples (Appendix I, p. 9) are unknown. The generally poor preservation of spores in both subsurface and outcrop, and the limited spore change over approximately 4200 feet of well section reduce the possibility of subdivision of the group by palynological means.

Assemblages in core 34 and core 28, from the upper part of the Otway Group compare with those in the top of the group in Port Campbell No.2, while the appearance of Trilobosporites trioreticulatus in core 25, at the top of the Waarre Formation, compares with its occurrence in Port Campbell No.1 at the top of the same formation. However, associate microplankton at Port Campbell were not detected in Flaxman's Hill No.1 although rare hystrichosphaerids and the dinoflagellate Gonyaulax edwardsi were isolated from core 25. Whether the absence of the Port Campbell species is due to alteration of facies, erosion or non-deposition of the unit cannot be judged from the present sample record.

2. UPPER CRETACEOUS

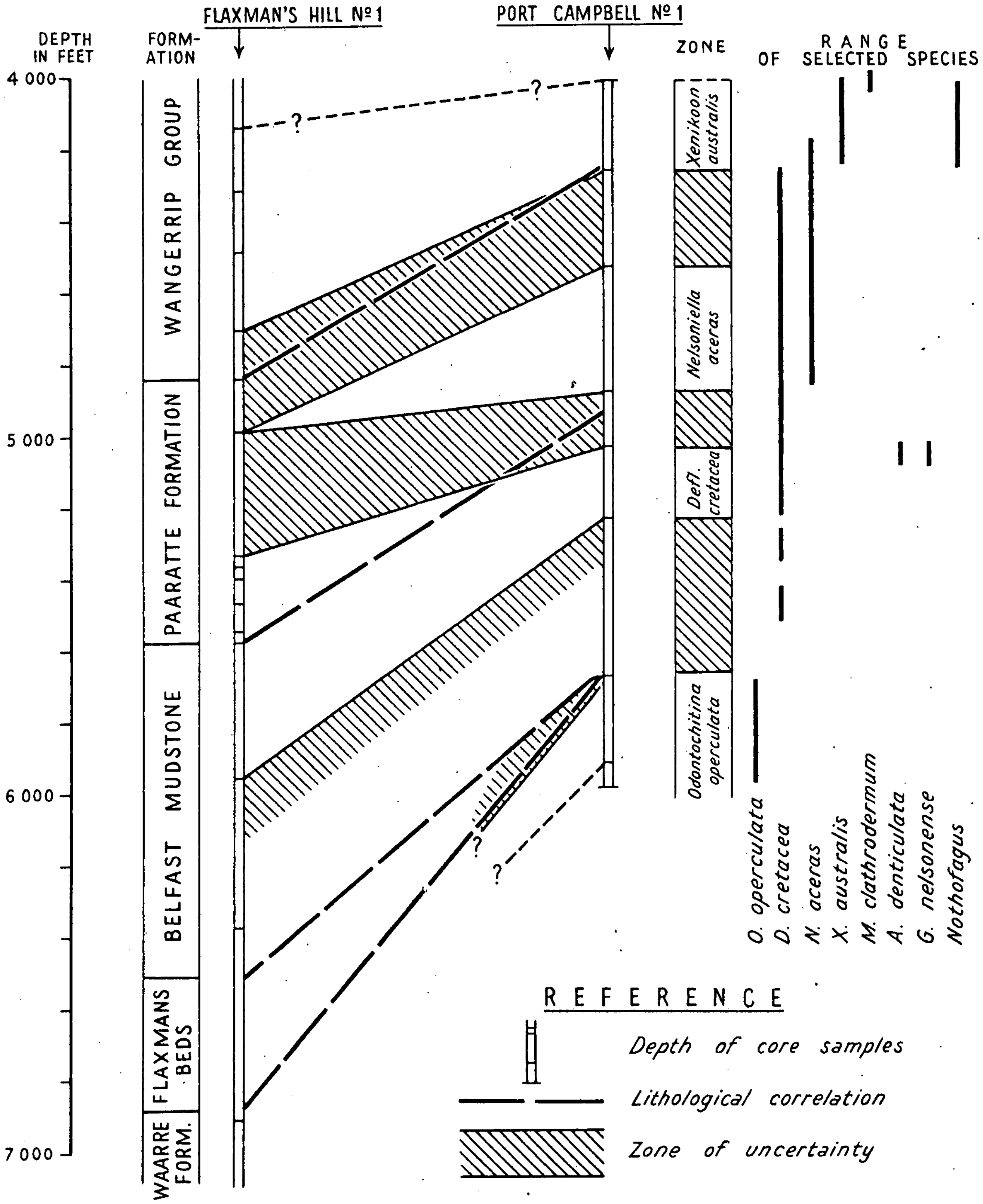
Although Upper Cretaceous beds have been recognized in the Otway Basin in the Nelson bore (Baker & Cookson, 1955) and Belfast No.4 bore (Kenley, 1959; Cookson & Eisenack, 1961), Flaxman's Hill No.1 has provided the first section with which the Upper Cretaceous pollen - spore - microplankton sequence of Port Campbell No.1 may be directly compared.

The Odontochitina operculata - Deflandrea acuminata beds of Port Campbell No.1 were either not present or not sampled, but the microplankton sequence of the remainder of the Upper Cretaceous again appeared and certain species may, after further testing, form the basis of a number of zones in the basin.

For example, Deflandrea cretacea, the oldest, is succeeded by Nelsoniella aceras which, in turn, is replaced by Xenikoon australis. The ranges of each overlap, but, if the first appearance of each species is taken as the commencement of a zone, correlation between the wells would be achieved as shown in Figure 1. The intervals between samples leaves "zones of uncertainty" (de Jekowsky, 1958) about which nothing can be decided. If a lithological boundary passed completely through a zone of uncertainty, the boundary would probably be diachronous: this does not occur.

Fig 1

TENTATIVE PALYNOLOGICAL CORRELATION IN THE UPPER CRETACEOUS OF FLAXMAN'S HILL Nº 1 AND PORT CAMPBELL Nº 1



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Species of the Deflandreidae were chosen for initial correlation because most appeared in more than one sample in both wells. Species of wide distribution, but considerable rarity, such as Gymnodinium nelsonense and Amphidiadema denticulata appeared in only one sample in each of the wells, but the stratigraphic position of their occurrence fits within the higher part of the zone of D. cretacea, i.e. near the top of the Belfast Mudstone and the base of the Paaratte Formation. Hexagonifera vermiculata, which is associated with G. nelsonense and A. denticulata was not recognized in Port Campbell No.1.

The recognition of approximately 600 feet of section in Flaxman's Hill No.1 containing Xenikoon australis led to an examination of higher levels of the Wangerrip Group in Port Campbell No.1: core 13 (3997 - 3999 feet) and the Junk Basket core (3740 - 3742 feet) were processed; core 13 contained abundant X. australis associated with Membranilarnax clathrodermum. The latter species, which appeared also in Flaxman's Hill No.1 core 3 (4126 - 4134 feet), could mark an even higher unit (Figure 1).

It is premature to erect a zonal scheme on the knowledge of only two wells; others are needed to check such biostratigraphic subdivision. The Nelson bore in the far west of Victoria yielded Deflandrea cretacea to Cookson (1956a) stratigraphically below Nelsoniella aceras (Cookson & Eisenack, 1960), suggesting that this arrangement common to Port Campbell and Flaxman's Hill may be persistent throughout the Otway Basin. X. australis, however, has not been recognized at Nelson, even in additional samples processed in the Bureau of Mineral Resources, and the lateral distribution of this species may be limited.

Data on parallel or diachronous lithological boundaries are also insufficient. Bain & McQueen (1960) recognize the transitional nature of the Paaratte Formation between the Belfast Mudstone and the Wangerrip Group and the boundaries were chosen from electric logs rather than lithology. General lithological comparison led McQueen (1961) to recognize the Paaratte Formation in the Nelson bore. However, no electric logs were run in that well so that the same criteria for identification cannot be used. A check on the time relationships of the formation boundaries in the Otway Basin can only be made by further drilling.

Pollens and spores in the Upper Cretaceous are not abundant or in great variety until the horizon corresponding approximately to the first appearance of X. australis, where e.g. Dacrydiumites florinii, Nothofagus cf. N. diminuta, Proteacidites ananthoides are present (see Figure 1). Somewhat lower in the zone of Nelsoniella aceras, in the Paaratte Formation Polyporate gen. et sp. indet. and Triorites minor first appear. Other species appeared spasmodically at different relative positions in each well and further understanding of their ranges is required.

Whereas the first stratigraphic appearance of several species provides relatively consistent correlations between each well, the final appearance of species cannot yet be used for accurate comparisons. Of the species used to discuss the age of sections in Port Campbell No.1 (Evans, 1961b), Balmeisporites glenelgensis and Cicatricosisporites australiensis both appeared at much higher horizons in Flaxman's Hill No.1.

COMPARISON WITH BELFAST NO.4 BORE

Cookson & Eisenack (1961) described microplankton in samples from depths of 4492 - 4499 feet and 4652 feet in the Belfast No.4 bore, where Kenley (1959) had first observed a Cretaceous marine fauna. The association of Deflandrea cretacea D. belfastensis, Amphidiadema denticulata, Odontochitina porifera Hystrichosphaeridium heteracanthum at 4652 feet in Belfast No.4 compares with that of Flaxman's Hill No.1 core 15 (5543 - 5546 feet). Hexagonifera vermiculata is common at these levels also, but H. glabra (present only at 4652 feet in Belfast No.4) was observed in core 16 (5950 - 5970 feet), so that the overlap of the ranges of H. vermiculata and H. glabra could occur between core 15 and core 16 (5546 - 5950 feet), an horizon comparing with 4652 feet in Belfast No.4.

REWORKED PERMIAN SPORES

Well preserved, reworked specimens of the Permian Granulatisporites trisinus, Nuskoisporites triangularis, Dulhuntyispora egregius, Lunatisporites sp. were found at several horizons (see chart), particularly in the Upper Cretaceous. They are common in Cretaceous and Tertiary sediments of the Otway Basin (Cookson, 1956b; Evans, 1961c), emphasizing that Permian sediments must have formed part of the source of the Mesozoic deposits. N. triangularis is the most easily recognized and probably most common form. It is relatively abundant in particular horizons of the Lower Permian in southern Australia (Balme, 1957a ; Evans, 1962) but most of the source rocks were probably of Upper Permian age as species of Vestigisporites which normally appear in the Lower Permian have not yet been seen among the Victorian forms while D. egregius characterizes the younger Permian only (Upper Coal Measures of the Sydney Basin (Balme & Hennelly, 1956), Middle and Upper Bowen beds of Queensland).

PROBLEMS ARISING FOR FUTURE ANALYSIS

Two problems accentuated during the course of this examination require further examination. The first is the relation of the Otway Group of outcrop and subsurface at Flaxman's Hill No.1, to the Lower Cretaceous of O.D. Penola No.1 (Evans, 1961c) and the outcrop Merino Group (Evans, 1961d) which, in spite of greatly differing lithology (Edwards & Baker, 1943) seem to be time equivalents.

The second concerns the relation of the Xenikoon australis beds of Flaxman's Hill No.1 to the outcrop sections of the Wangerrip Group. Cookson (1954) recorded Triorites edwardsi (in "microflora B") from the Pebble Point Formation and followed the conclusions of Singleton (1943), Teichert (1943) and Baker (1953) that the formation was of Eocene, if not Palaeocene age. She compared the Pebble Point Formation with the Eastern View Coal Measures on the common presence of T. edwardsi, supported by the Palaeocene age of the coal measures recognized by Raggatt & Crespin (1955). T. edwardsi appears towards the base of the zone of X. australis in Port Campbell No.1 and, on Cookson's criteria, would be taken to mark an Eocene or Palaeocene age. Such a contention would be supported by the appearance at a somewhat later stage in the well section of Nothofagus which was absent from "microflora B" in the Pebble Point Formation but appeared in the overlying "microflora C" (Deflandre & Cookson, 1955) (which was regarded by Cookson (1954) as (?)Lower Eocene in age) that was found in the Princetown Member of the Dilwyn Clay. However, it is recalled that both Singleton and Teichert, on whose opinions the age determinations are primarily based, considered the possibility that the Pebble Point fauna might be as old as the Upper Cretaceous. Singleton (1943) compared the Pebble Point fauna to that from the Wangaloan in New Zealand. Hornibrook & Harrington (1957), Wellmann (1959) did not consider that the Wangaloan was a valid stage but that its outcrops are part of the Teurian (Danian). Also, Couper (1960) records e.g. Nothofagus spp., Dacrydiumites mawsonii, Triorites minor, species which make their first appearance in approximately the Wangerrip Group in Victoria, from the Rankumara Series (Senonian). Further analysis of the outcrop sections in the light of evidence from the probably continuously deposited sections at Port Campbell and Flaxman's Hill may warrant revision of the previously accepted ages of the lower part of the outcrop Wangerrip Group.

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APPENDIX I.

SPORES FROM THE OTWAY GROUP OUTCROP

Cookson & Dettmann (1958) described spores from outcrops of the Otway Group at the mouth of the Gellibrand River, Apollo Bay, Barongarook Creek and the Barabool Hills and from samples of Birregurra No.1 and Little's Shaft No.2, Geelong, bores. Frome-Broken Hill Co. Pty Ltd recently submitted three outcrop samples for analysis which contained the following spores :

WO-1 (Colac 4-mile: J54/18: 171223).

Very rare but relatively well preserved microspores including :

Cyathidites sp.,
Baculatisporites comaumensis,
Lycopodiumsporites sp.,
Classopollis torosus,
Microcachryidites antarcticus,
Ginkocycadophytus sp.

C. torosus is relatively common. Nothing more precise than Mesozoic can be stated for the age of the assemblage. Common C. torosus was a characteristic of Flaxman's Hill No.1 core 32 (8139 - 8150 feet), but it is known to range from the Lower Jurassic to the Tertiary.

WO-2 (Colac 4-mile: J54/18:170226).

Relatively abundant but poorly preserved microspores including :

Cyathidites sp.,
Gleicheniidites circinidites,
Cicatricosisporites australiensis (relatively common)
Bisaccate spp. indet.

The poor state of preservation of other specimens prevented their identification with confidence. Under favourable circumstances a greater variety of species could be listed. C. australiensis, the only key species observed, signifies a Cretaceous age for the sample. It is a common species in the fossiliferous cores from Flaxman's Hill No.1 including and below core 34 (8470 - 8486 feet) and in the outcrop sample W-37 of the Merino Group (Evans, 1961d).

WO-3 (Colac 4-mile: J54/18:169222).

Poorly preserved species of:

Cyathidites incl. C.australis rimalis,
Baculatisporites comaumensis,
Cicatricosisporites australiensis (fairly common),
Bisaccate spp. indet.,
Classopollis torosus,

Again, C. australiensis is the only key species recognizable and denotes a Cretaceous age for the sample.

APPENDIX II.

SPECIES CHECK LIST.

	Chart No.
MICROPLANKTON	
Amphidiadema denticulata	13
Deflandrea belfastensis	9
Deflandrea cretacea	11
Gonyaulax edwardsi	17
Gymnodinium nelsonense	12
Hexagonifera glabra	14
Hexagonifera vermiculata	10
Hystrichosphaera furcata	15
Hystrichosphaeridae spp.	5
Hystrichosphaeridium complex	6
Hystrichosphaeridium heteracanthum	8
Membranilarnax clathrodermum	1
Membranilarnax sp.	2
Nelsoniella aceras	7
Odontochitina cribropoda	16
Odontochitina porifera	4
Xenikoon australis	3
MICROSPORES	
Apiculati indet.	64
Appendicisporites spp.	28
Araucariacites australis	47
Baculatisporites comaumensis	38
Balmeisporites glenelgensis	42
Casuarinidites cf. C. cainozoicus	20
Cicatricosisporites australiensis	39
Cirratriradites sp. nov.	19
Classopollis torosus	62
Cyathidites australis	50
Cyathidites australis rimalis	45
Cyathidites spp. incl. C. minor	51
Dacrydiumites florinii	29
Dictyotosporites speciosus	31
Disaccites spp.	40
aff. Dysoxylum	21
Ginkocycadophytus sp. 1	43
Ginkocycadophytus sp. 2	61
Gleicheniidites circinidites	36

APPENDIX II contd

	Chart No.
MICROSPORES contd	
Inaperturopollenites spp.	58
Leptolepidites verrucatus	59
Lycopodiumsporites austroclavidites	52
Lycopodiumsporites rosewoodensis	63
Microcachryidites antarcticus	37
Murornati gen. et sp. nov. 3	41
Myrtaceidites parvus anesus	23
Neoraistrickia sp.	24
Nothofagus cf. N. diminuta	30
Perinotriliti sp.	53
Pilosisporites notensis	54
Podocarpidites grandis	35
Podosporites micropterus	60
Polyporate gen. et sp. indet.	46
Polypodiaceaeidites sp.	56
Proteacidites ananthoides	32
Proteacidites sp. 1	34
Proteacidites sp. 2	55
Rugulatisporites sp. 1	27
Schizosporis reticulatus	25
Sphagnumsporites australis	18
Todisporites sp.	49
Tricolpites sp. 2	22
Trilobosporites trioreticulatus	57
Triorites edwardsi	33
Triorites gillii	44
Triorites minor	48
Triorites sp.	26
REWORKED PERMIAN MICROSPORES	
Dulhuntyispora egregius	68
Granulatisporites trisinus	65
Lunatisporites sp.	67
Nuskoisporites triangularis	66

MICROFOSSIL DISTRIBUTION CHART: F.-B.H. FLAXMAN'S HILL No. 1.