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PALYNOLOGICAL ZONATION OF THE OTWAY GROUP

BY

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PALYNOLOGICAL ZONATION OF THE OTWAY GROUP

1. INTRODUCTION

The information detailed in this report is intended to supplement the observations contained in a previous account (Dettmann 1969a) on the palyno-stratigraphic zonation of the Otway Group developed within the Otway Basin. The aims of the earlier report were to document palynological data obtained from Victorian developments of the Otway Group, and to summarize this data in terms of the palynological zonation scheme formulated by Dettmann and Playford (1969) and Dettmann (1968a). In the present account the zonation scheme is applied to subsurface developments of the Otway Group in the South Australian portion of the basin. The sequence of palyno-stratigraphic units thus delineated within the Otway Group is compared with the lithostratigraphic framework recognized by White and Ribis (1969), and the timings of litho-stratigraphic changes across the basin are established.

2. THE SPORE-POLLEN ZONES

The scheme adopted for biostratigraphic subdivision of Otway Group sediments is outlined by Dettmann and Playford (1969) and Dettmann (1968a) and summarized herein in Table 1 (a reproduction of Table 1 in Dettmann 1969a). Palynological evaluation of the designated limits of the Otway Group (as quoted by White and Ribis 1969) indicates that the zonation scheme requires to be extended and possibly modified to incorporate the oldest and youngest Otway Group horizons thus far recognized within the basin.

The oldest Mesozoic sediments recognized on palynological grounds within the Otway Group occur in Casterton No.1 well, 7385-95 feet. These were suggested (Dettmann 1969a) to be of Middle-Upper Jurassic age. Further evaluation of the palynological floras and their comparison with the Western Australian microfloral sequence (Balme 1957, 1964) indicates that they may be dated as Oxfordian - Kimeridgian. Stratigraphically higher sediments in Casterton No.1 (6396 - 6769 feet) contain microfloras of undifferentiated late Jurassic -early Cretaceous age; these may eventually be shown to be

distinct from the Oxfordian-Kimeridgian microfloras and from the ones diagnostic of the Crybelosporites stylosus Zone of ?uppermost Jurassic - lowermost Cretaceous age. Further study of the microfloral changes that occurred during late Jurassic and early Cretaceous times in the Otway Basin is thus necessitated.

The early Cretaceous palynological units, the Murospora florida and Rouseisporites reticulatus Units, were delineated upon the basis of a study of the palynological sequence in Woolsthorpe No.1 and Garvoc No.1 wells (Dettmann 1958a). It is now known that an unconformity occurs within these well sequences at or near the boundary between the two palynological units, and thus the precise stratigraphical relationships of their palynological contents have not been accurately determined. Data presented by Hodgson (1964) and Dettmann (1965a,b) on Heathfield No.1 well indicates that Murospora florida does in fact persist into horizons that contain the earliest appearances of Rouseisporites reticulatus (cf. Table 1). The concurrence of these species may provide suitable basis for the distinction of a further biostratigraphic unit between the M. florida and R. reticulatus Units.

Sediments comprising the designated top of the Otway Group are now known to be in places attributable to the Appendicisporites distocarinatus Zone of ?Cenomanian - Turonian age.

The accumulated evidence thus indicates that the Otway Group ranges in age from at least Oxfordian-Kimeridgian to ?Cenomanian-Turonian.

3. PALYNOLOGICAL ZONATION OF THE OTWAY GROUP IN SOUTH AUSTRALIA

Seven South Australian subsurface sections of the Otway Group have been examined palynologically by the author. These sequences are herein evaluated in terms of the zonation scheme summarized in Table 1. In several sections samples representative of succeeding lithostratigraphic units have been investigated and the ages of these samples are indicated. In addition the occurrence of dinoflagellates within the sections studied is noted. Reworked spores and pollen occur in minor proportions in at least some of

the samples, but their documented distribution must be regarded as incomplete since many of the author's records have not been available in Canada.

Esso Crayfish A-1

	SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE
+	sidewall cores	1239-1305	Tricolpites pachyexinus
	core 2	1473-1515	?Tricolpites pannosus
	cuttings	1610-1700	" "
	"	1710-1800	Coptospora paradoxa (unamed unit)
	core 3 and sidewall cores	1803-2792	" "
	sidewall cores	2910-3165	Coptospora paradoxa (Dictyotosporites filosus Unit)
	core and sidewall cores	3296-4452	Crybelosporites striatus
	core and sidewall cores	4608-5017	Foraminisporis asymmetricus
	sidewall cores	5171-5236	Rouseisporites reticulatus
	core and sidewall cores	5579-8780	Murospora florida
	cores and sidewall cores	9000-9135	?Murospora florida
	core and sidewall cores	9224-9542	?Crybelosporites stylosus
	core and sidewall cores	9840-10,493	?uppermost Jurassic - lowermost Cretaceous

Reference: Dettmann 1968b.

Comments: Dinoflagellates occur initially within the Tricolpites pachyexinus Zone to the Tricolpites pannosus Zone. Assignment of horizons between 1473 feet and 1700 feet is tentative because of insufficient representation of diagnostic species in core 2 and possibility of contamination of cuttings at 1610-1700 feet. Sediments between 9000 feet and 10,493 feet are of Lower Cretaceous or Upper Jurassic age; those at 9000-9135 feet may be within the Murospora florida Unit and the Crybelosporites stylosus Zone is possibly represented at 9224-9542 feet. Information on the occurrence of reworked spores and pollen grains is not currently available.

Robe No.1

SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE
junk basket and cuttings	1400-2630	Coptospora paradoxa (unamed unit)
" "	3150-3500	Crybelosporites striatus
junk basket	3860	?Rouseisporites reticulatus/Murospora florida
" "	4300	?Murospora florida

Reference: Dettmann 1963b.

Comments: The above determinations are based upon the work of Dettmann (1963b) and upon a subsequent examination of additional samples. The sample at 3860 feet is within the Cyclosporites hughesi Subzone and contains initial appearances of Rouseisporites reticulatus and possible representatives of Murospora florida. Neither species was recorded from 4300 feet which is within the Cyclosporites hughesi Subzone. Dinoflagellates and reworked spores have not been observed in the material studied.

South-East Oil Beachport No.1

SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE	REMANIÉ FOSSILS
core 1	2094	Coptospora paradoxa (unnamed unit)	Permian, Triassic
" 2	2288-98	" "	" "
" 3	2504-05	" "	
" 4	2702	" "	Permian, Triassic
" 5	2827	" "	
" 6	3033	" "	
" 7	3162	" "	
" 8	3405	" "	Permian, Triassic
" 9	3670	C. paradoxa (Dictyotosporites filosus Unit)	" "
" 10	3944-46	Crybelosporites striatus	

Reference: Dettmann 1963a.

Comments: Dinoflagellates have not been observed in the material examined.

Beach Pet. Geltwood Beach No.1

	SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE	REMARKS FOSSILS
+	core 8	3771-91	Tricolpites pannosus	
	" 9	4090-4100	not determinable	
	" 10	4402-12	Coptospora paradoxa (Unnamed unit)	Permian
	" 11	4508-24	" "	
	" 12	4770-80	" "	
	" 13	5055-70	" "	
	" 14	5333-44	" "	
	" 15	5655-63	" "	
	" 16	6081-96	" "	
	" 17	6519-30	C. paradoxa (Dictyotosporites filosus Unit)	
	" 18	7030-40	" "	
	" 19	7546-56	" "	Permian
	" 20	8046-56	Crybelosporites striatus	
	" 21	8476-86	" "	
	" 22	8937-52	" "	
	" 23	9360-70	" "	Permian
	" 24	9857-67	?Foraminisporis asymmetricus	
	" 25	10,316-26	Foraminisporis asymmetricus	
	" 26	10,781-91	" "	
	" 27	11,231-43	" "	
	" 28	11,733-43	" "	
	" 29	12,220-32	Unit not determinable Cyclosporites hughesi Subzone	

Reference: Dettmann 1965 a.

Comments: Dinoflagellates occur in core 8 (Tricolpites pannosus Zone). Core 9 yielded a sparse microflora in which diagnostic species are lacking. Core 24 is not certainly referable to the Foraminisporis asymmetricus Unit; it yielded F. asymmetricus and Dictyotosporites speciosus, but neither Crybelosporites striatus nor Cyclosporites hughesi. Core 29 is referable to the Cyclosporites hughesi Subzone, but the poorly preserved microflora lacks species diagnostic of the units within this subzone.

Alliance Kalmaadoo No.1

	SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE	REMANIÉ FOSSILS
+	Core 1	1993-2008	Nothofagidites	Permian, L. Cret.
+	" 2	2503-13	Tricolpites pannosus	
	" 3	2950-40	not determinable	
	" 4	3404-14	Coptospora paradoxa (unnamed unit)	Permian, Triassic
	" 5	3917-27	" "	" "
	" 6	4353-63	C. paradoxa (Dictyotosporites filosus Unit)	
	" 7	4771-76	Crybelosporites striatus	
	" 9	5285-95	Foraminisporis asymmetricus	
	" 10	5634-44	" "	
	" 11	6120-34	?Foraminisporis asymmetricus	
	" 12	6632-42	" "	

Reference: Dettmann 1965b.

Comments: Dinoflagellates occur in core 2 (Tricolpites pannosus Zone) and in uppermost Cretaceous sediments containing the Nothofagidites Microflora (core 1). Core 3 yielded a sparse microflora that lacks diagnostic species. Cores 11 and 12 are within the Cyclosporites hughesi Subzone, and are at the oldest referable to the Rouseisporites reticulatus Unit; their poorly preserved microfloras yielded possible representatives of Foraminisporis asymmetricus and hence the sediments are tentatively assigned to the F. asymmetricus Unit.

Oil Development Penola No.1

SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE
core 1	1200-10	Coptospora paradoxa (unnamed unit)
" 2	1400-10	" " "
" 3	1610-20	" " "
" 4	1805-15	" " "
" 5	2010-20	" " "
" 6	2200-10	" " "
" 7	2380-90	" " "
" 8	2586-96	" " "
" 9	2790-98	Coptospora paradoxa (Dictyotosporites filosus Unit)

core 10	2[illegible]00-3000	Crybelosporites striatus
" 11	3180-90	" "
" 12	3365-73	Rouseisporites reticulatus
" 13	3514-24	" "
" 14	3715-21	" "
cuttings	3850-55	Cyclosporites hughesi (unit not determined)
core 19	4592	Murospora florida
" 20	4618	" "
" 21	4766-76	Crybelosporites stylosus

Reference: Dettmann 1963b

Comments: Evans (1961) documents reworked Permian types from core nos. 6 and 8. Dinoflagellates have not been observed in the material examined.

Comaum No.2

SAMPLE	DEPTH (ft.)	SPORE-POLLEN ZONE
core	651	Crybelosporites striatus
"	708	" " (base)

Reference: Dettmann 1963b.

Comments: Harris and Cookson (1965) re-assessed Tertiary samples from between 360 feet and 480 feet; this sequence includes horizons of Palaeocene and Upper Eocene age. The authors also examined Lower Cretaceous sediments from between 480 feet and 1122 feet, and present evidence indicating that the Coptospora paradoxa Zone extends from 480 feet to 526 feet. The remainder of the section studied (571-1122 feet) by Harris and Cookson is apparently referable to the Dictyotosporites speciosus Zone. On the basis of this evidence and data presented above it would appear that the Crybelosporites striatus Subzone extends from 571 feet to 708 feet; and that the lower portion of the section (708-1122 feet) is within the Cyclosporites hughesi Subzone. Unfortunately Harris and Cookson did not document all microfloral data and thus the C. hughesi Subzone cannot be further subdivided on available evidence.

4. DISTRIBUTION OF THE SPORE-POLLEN ZONES WITHIN THE OTWAY GROUP IN SOUTH AUSTRALIA

Jurassic

Microfloras of Jurassic age have not been positively identified in the sections studied. Samples between 9840 feet and 10,493 feet within the Pretty Hill Sandstone in Crayfish A-1 yielded extremely poorly preserved microfloras that may be of uppermost Jurassic or lowermost Cretaceous age.

Crybelosporites stylosus Zone

Sediments attributable to the Crybelosporites stylosus Zone occur in Penola No.1, 4766-76 feet within "Unit 2" of the Eumeralla formation, and may also be represented in Crayfish A-1, 9224-542 feet within the Pretty Hill sandstone.

Murospora florida Unit

Horizons of this unit are represented in Penola No.1, Crayfish A-1, and possibly Robe No.1. In Crayfish A-1, the Murospora florida Unit comprises the major portion and extends to or near the top of the known development of the Pretty Hill sandstone, and in Penola No.1 is represented within "Unit 2" of the Eumeralla formation. Sediments between 5860 feet and 4300 feet in Robe No.1 (?within "Unit 1" of the Eumeralla formation) are not certainly attributable to the M. florida Unit. The sample at 3860 feet may in fact be representative of a biostratigraphic unit between the M. florida and Rouseisporites reticulatus Units (see above).

Rouseisporites reticulatus Unit

The Rouseisporites reticulatus Unit occurs in Penola No. 1 within the upper portion of "Unit 2" of the Eumeralla formation and at the base of the same lithological unit in Crayfish A-1. It has not been recognized in the other sections studied but may comprise the top of "Unit 2" of the Eumeralla formation in Kalangadoo No.1.

Foraminisporis asymmetricus Unit

Horizons of this biostratigraphic interval have been recognized in

Kalangadoo No.1 within the lower portion of "Unit 1" of the Eumeralla formation and possibly extending into "Unit 2" of the same formation (see above). It also occurs in Geltwood Beach No.1 where it is well developed in the lower intersections of "Unit 2" of the Eumeralla formation, and in Crayfish A-1 comprises a thin development within, but near the top, of the same lithological unit. The Foraminisporis asymmetricus Unit was not detected in the Penola No.1 and Robe No.1 sequences, and if present would comprise a thin development of sediments.

Crybelosporites striatus Subzone

The subzone has been recognized in all sequences examined. In Geltwood Beach No.1 it occurs within "Unit 2" of the Eumeralla formation and in Crayfish A-1 the subzone embraces uppermost horizons of "Unit 2" and the basal portion of "Unit 1" of the same formation. Elsewhere the subzone is represented at the base (as in Penola No.1) or within (Beachport No.1, Kalangadoo No.1, and Robe No.1) "Unit 1" of the Eumeralla formation.

Dictyotosporites filosus Unit

This the basal portion of the Coptospora paradoxa Zone has been identified in Crayfish A-1, Penola No.1, Kalangadoo No.1, Beachport No.1, and Geltwood Beach No.1 wells. Its thickest development is in Geltwood Beach No.1 where it includes uppermost horizons of "Unit 2" and the basal portion of "Unit 1" of the Eumeralla formation. At other localities the D. filosus Unit incorporates a thin sequence of sediments within "Unit 1" of the Eumeralla formation. The D. filosus Unit has not been identified in Robe No.1 but may be present in the unsampled interval between 2650 feet (C. paradoxa Zone, unnamed unit) and 3150 feet (Crybelosporites striatus Subzone).

Coptospora paradoxa Zone (unnamed unit)

This biostratigraphic unit occupies the upper portion of "Unit 1" of the Eumeralla formation in Crayfish A-1, Robe No.1, Beachport No.1, Geltwood Beach No.1, Kalangadoo No.1, and Penola No.1. It also occurs in the Comaum No.2 sequence.

Phacrites pannosus Zone

The zone occurs in horizons stratigraphically above "Unit 1" of the Eumeralla Formation in Kalangadoo No.1, Geltwood Beach No.1, and possibly Crayfish A-1 wells. The Kalangadoo horizons are attributed to the Belfast Mudstone (White and Ribis 1969) and contain dinoflagellates. Dinoflagellates were also recovered from the zone in Geltwood Beach No.1, from within the Flaxmans Formation, but were not observed in the Crayfish A-1 section tentatively referred to the T. pannosus Zone.

5. RELATIONSHIPS BETWEEN LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY OF THE OTWAY GROUP

The sequence of palyno-stratigraphic units established for the Otway Group development may be used to determine the timing of lithostratigraphic facies changes across the basin. Figures 1 and 2 illustrate the relationships existing between the biostratigraphic and lithostratigraphic units in the majority of the well sequences examined; they also indicate the occurrence and timing of the unconformities detected within the individual sequences. The lithostratigraphic data has been taken from White and Ribis (1969) who delineate the following formations within the Otway Group (from the base up):- "Basal unit", Pretty Hill sandstone, and Eumeralla formation (comprising "Unit 2" and "Unit 1").

The "Basal unit" is known in Casterton No.1, Tullich No.1, Pretty Hill No.1, and Woolsthorpe No.1 wells. Although palynological contents of the "Basal unit" in these wellsare incompletely known, there is some evidence that it is distinctly older in Casterton No.1 (Middle -Upper Jurassic) than in Woolsthorpe No.1 (?Crybelosporites stylosus Zone) and Tullich No.1 (Cyclosporites hughesi Subzone).

The precise time-stratigraphic relationships of the Pretty Hill sandstone have not been determined in all sequences in which it is represented. In Crayfish A-1 a possible uppermost Jurassic - lowermost Cretaceous sequence

(in which the Crybelosporites stylosus Zone may be represented) is succeeded by the Murospora florida Unit. The formation as represented in Casterton No.1 and Pretty Hill No.1 is at least partially correlative with the Crayfish A-1 section. To the east, in Woolsthorpe No.1 the Pretty Hill sandstone is entirely within the Murospora florida Unit, whilst in Garvoc No.1 the formation includes horizons of the M. florida Unit and at the top is attributable to the Rouseisporites reticulatus Unit. Within several of these sequences (Crayfish A-1, Pretty Hill No.1, Woolsthorpe No.1, and Garvoc No.1) palynological evidence suggests that an unconformity may exist at or near the top of the Pretty Hill sandstone. This unconformity represents to a varying extent portion of the time interval during which the M. florida - R. reticulatus Units were deposited.

"Unit 2" of the Eumeralla formation does not appear to parallel time planes. In fact, available evidence indicates that the unit was in places formed contemporaneously with the "Basal unit", the Pretty Hill sandstone, and "Unit 1" of the Eumeralla formation. The oldest known development of "Unit 2" occurs in Penola No.1; here it includes horizons of the Crybelosporites stylosus Zone, the Murospora florida Unit and the Rouseisporites reticulatus Unit. As is evident from the above discussion, the lower portion of this sequence is equivalent to developments of the Pretty Hill Sandstone (as in Crayfish A-1, Woolsthorpe No.1 and Garvoc No.1) and to the "Basal unit" in Woolsthorpe No.1.

The upper limit of "Unit 2" clearly does not form a time-concordant surface, and from present evidence appears to be younger in more southerly areas of the basin. In places an unconformity is suspected to occur between "Unit 1" and "Unit 2" (Penola No.1, Eumeralla No.1, Pretty Hill No.1, Garvoc No.1, Flaxmans No.1, and Fergusons Hill No.1), but nevertheless, upper horizons of "Unit 2" as developed in the apparently conformable sequences in Geltwood Beach No.1 and Port Campbell No.4 are equivalent in age to basal horizons of "Unit 1" as represented in more northerly sections. Moreover, the unconformity

developed between "Unit 1" and "Unit 2" of the Eumeralla formation appears to be expressed in older sediments(Foraminisporis asymmetricus Unit and/or Crybelosporites striatus Subzone) in Penola No.1, Pretty Hill No., and Garvoc No.1 than in Eumeralla No.1, Flaxmans No.1, and Fergusons Hill No.1 (Dictyotosporites filosus Unit).

In the Gambier Sub-basin uppermost horizons of "Unit 1" are within or near the top of the Coptospora paradoxa Zone (unnamed unit) in Crayfish A-1 Robe No.1, Beachport No.1, Geltwood Beach No.1, Kalangadoo No.1, and Penola No.1. In Heathfield No.1 upper horizons of "Unit 1" may be younger (? within the Tricolpites pannosus Zone) and equivalent in age to the Flaxmans formation in Geltwood Beach No.1 and the Belfast mudstone in Kalangadoo No.1. The top of "Unit 1" in the Tyrendarra Embayment is within the Dictyotosporites filosus Unit in Belfast No.4 and Yangery No.1 and within the Tricolpites pannosus Zone in Eumeralla No.1 and Pretty Hill No.1. Uppermost horizons of "Unit 1" in the latter two wells may thus be age equivalent to the Waarre formation as developed in Codrington No.1 (see Dettmann 1969a,b).

As discussed by Dettmann (1969a) the top of "Unit 1" in the Port Campbell Embayment does not form a time-concordant surface. In northerly areas of the embayment, the top of "Unit 1" is oldest (Rouseisporites reticulatus - Dictyotosporites filosus Units) and is unconformably overlain by a Tertiary sequence. To the south the top of "Unit 1" is younger (Coptospora paradoxa Zone, unnamed unit - Appendicisporites distocarinatus Zone) and in places appears to be laterally connected with the Waarre formation. This is most clearly evident in Fergusons Hill No.1, Timboon No.5, and Wangoom No.2 where uppermost horizons of "Unit 1" are within the Appendicisporites distocarinatus Zone and thus correlatives of portions of the Waarre formation as developed in Pecten A-1, Flaxmans No.1, Port Campbell Nos.1-4, and Sherbrook No.1. In the last-named well an unconformity may exist between the Waarre formation and "Unit 1"; in other sections studied the unconformity, if present, represents a lesser time interval.

Dinoflagellates occur within uppermost horizons of "Unit 1" at several localities in the Port Campbell Embayment. Their initial appearances are within the Tricolpites pannosus Zone in Flaxmans No.1 and in the Appendicisporites distocarinatus Zone in Timboon No.5 and Fergusons Hill No.1. Elsewhere dinoflagellates are known only from the Waarre formation or succeeding lithological units.

6. CONCLUSIONS

Palynological evidence suggests that the formations developed within the Otway Group do not parallel time planes; and that the uppermost portion of the Otway Group was in places deposited contemporaneously with the Waarre formation, the Flaxmans formation, and the Belfast mudstone. Palynological evidence also indicates that several unconformities exist within the Otway Group at certain localities. The unconformities detected occur at or near the top of the Pretty Hill sandstone, between "Unit 1" and "Unit 2" of the Eumeralla formation, and at the top of "Unit 1". The unconformities if laterally connected do not span the same time interval in all sections in which they have been detected.

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1st December, 1969.

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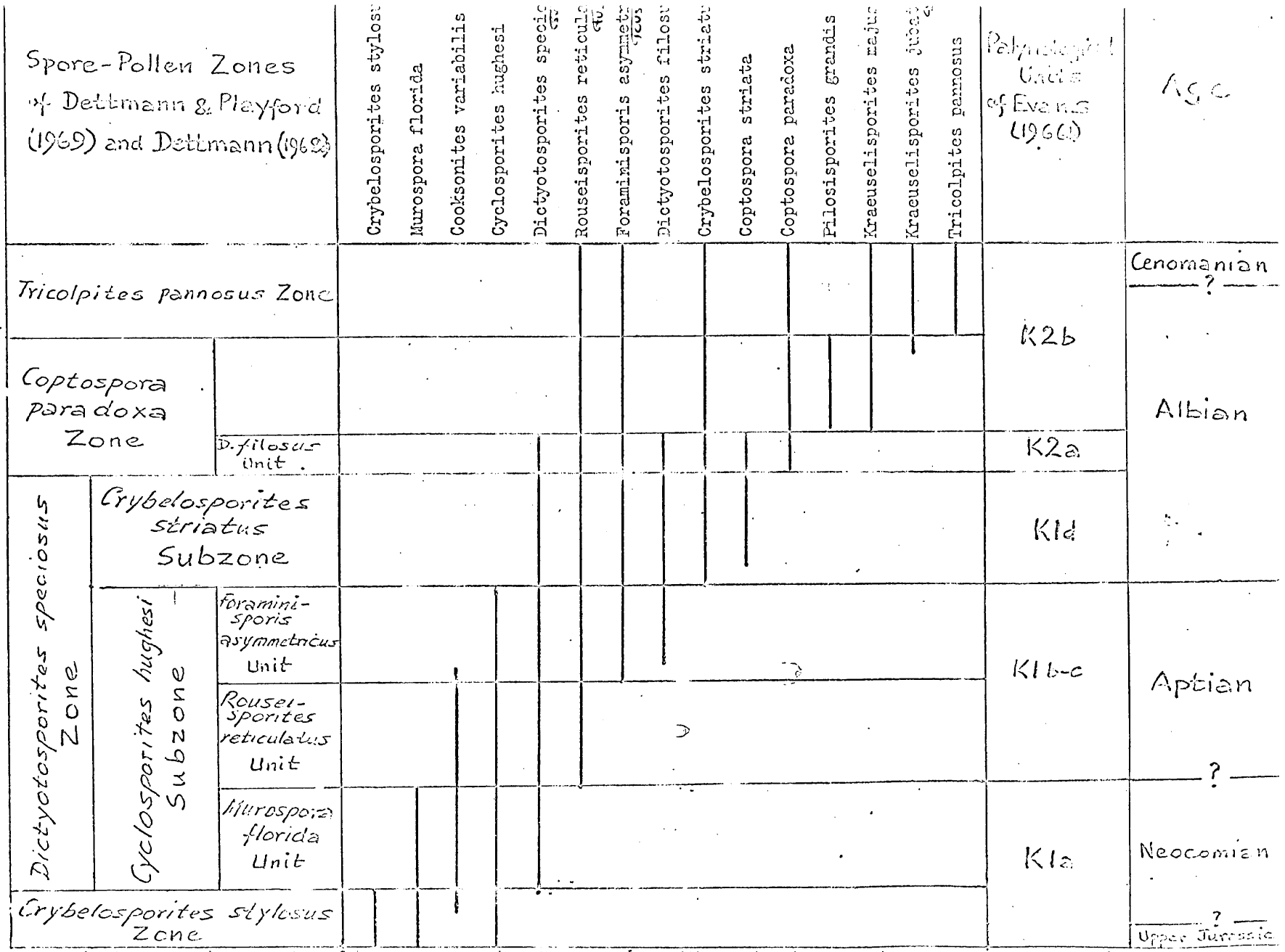

Fig. 1 : Vertical distribution of key spore and pollen species within palynological stratigraphic units.

NOTE: THE PENCIL LINES ADDED BY P.R.K. 5.3.70

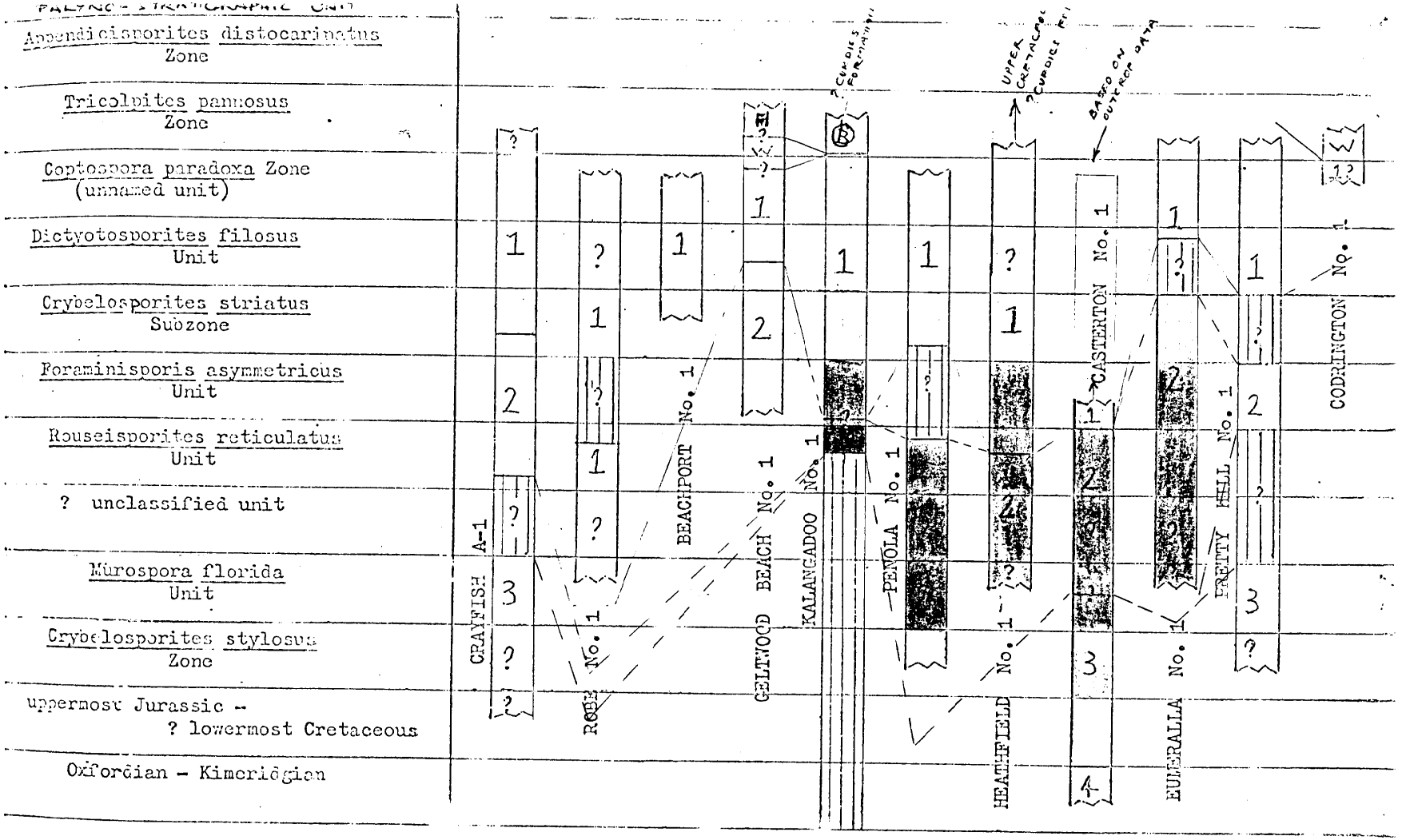

FIGURE 2 – Relationships between palyno-stratigraphic and lithostratigraphic units in well sequences of the Otway Group, Gambier Sub-basin and Tyrendarra Embayment.
Legend B – Belfast mudstone; Fl – Flaxmans formation; W – Waarre formation; 1 – "Unit 1", Eumeralla formation; 2 – "Unit 2", Eumeralla formation; 3 – Pretty Hill sandstone; 4 – "Basal unit"; [] [?] – unconformity or suspected unconformity; ? – palyno-stratigraphic unit not certainly represented.