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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1966/198

CONTRIBUTION TO THE PALYNOLOGY OF NORTHERN QUEENSLAND AND PAPUA

by

P.R. Evans

15928/65

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ABSTRACT

The fossil microflora in seismic shot hole core and cuttings samples, supplied by Australian Aquitaine Petroleum Pty Ltd from the region of Cape York Peninsula, northern Queensland, permits correlation of sediments which form part of that peninsula with subsurface Mesozoic sediments in the Papuan Basin to the north and the Carpentaria, Eromanga and Laura Basins to the south.

Correlation is achieved by means of spore/pollen units and zones of microplankton. Marine Jurassic sediments, with the exception of a Lower or Middle Jurassic horizon in the Laura Basin, are confined to the Papuan Basin. Marine sedimentation commenced in the Cape York Peninsula area in Neocomian times, in the Zone of Dingodinium cerviculum/Scriniodinium attadalense, equivalent to the Blythesdale Formation below the Minmi Member in the Great Artesian Basin. A similar marine version of the zone has only been recognized previously in continental Australia in the South Perth Formation of the Perth Basin. Marine conditions extended into the southern Carpentaria, Eromanga and Surat Basins during the later period of the Dingodinium cerviculum Zone. The Aptian - Albian Zones of D. cerviculum and Odontochitina operculata of the Eromanga Basin also comprise a normal succession in the Cape York area, but the Cenomanian Zone of Ascodinium parvum of the western Carpentaria Basin has yet to be recognized. No Cretaceous zone younger than that of D. cerviculum has been determined in Papua because of lack of samples; undoubtedly at least some of the zones exist if they have not been eliminated by (?) late Cretaceous - early Tertiary erosion. The zones on which these correlations are based are defined and some of the zone fossils illustrated and discussed. Various palynological and lithological scales appropriate to the region and covering the Jurassic and the Lower Cretaceous are compared. The presence of Upper Palaeozoic, (?) Pre-Permian, undetermined, carbonized spores in the Cape York Peninsula is recorded.

INTRODUCTION

Australian Aquitaine Petroleum Pty Ltd conducted a subsidized seismic survey (Archer River Survey) in Petroleum Exploration Area 95P of the Cape York Peninsula, northern Queensland (Compagnie générale de Geophysique, 1965), during which cores were cut from the bottom of certain holes and cuttings from all holes were sampled. A selection of these cores and cuttings have been examined at the company's request for their microfloral content.

Most of the holes were drilled into Mesozoic strata, in the north-eastern flank of the Carpentaria Basin.

From the outset it was apparent that stratigraphic indicators had to be found among the abundant microplankton encountered; in many samples useful spores and pollen grains were rare. However, little has been written about the stratigraphic sequence of Mesozoic microplankton, although taxonomic studies of these fossils by Dr Isabel Cookson and her collaborators are available. The choice of indicator fossils is thereby limited. The unusual assemblages in the Archer River area necessitated reconsideration of previously examined material from deep wells in Papua. As observations from the Papuan sections have not been made generally available and as the definitions of some of the zones on which correlations are based have not been previously discussed it became necessary to expand the study to incorporate the Papuan sections and to compare them with strata in the southern Carpentaria, Eromanga and Laura Basins.

Formally named zones of microplankton for the Jurassic have yet to be proposed. Cookson & Eisenack (1960) noted the existence of two Jurassic assemblages which they referred to as "A. Oxfordian to Lower Kimeridgian" and "B. Probably Tithonian". The separation of these assemblages in the Canning Basin is confirmed by the evidence from BMR 4 (Wallal) (Evans, in Henderson <u>et al</u>., 1963) and from a composite plot of data available from the Broome water bores (Cookson & Eisenack, 1958, 1960; unpublished BMR information) and WAPET Fraser River No.1 Well (BMR unpublished information). The upper assemblage is represented in Papua in Omati No.1, Iehi No. 1 and Iamara No.1 and the lower assemblage is present in Omati No.1. There is no reason to consider that an hiatus exists between these assemblages, represented by the Upper Kimeridgian, as their names would indicate. Cookson & Eisenack derived their terms from the Australian sections which had already been referred to European "standards" on the basis of faunal content. No other nomenclatural system would have readily indicated the apparent relationships of the microplankton assemblages. However, once the microplankton are used to correlate sections where no microfaunas are present this terminology is impracticable. The life spans of the microplankton do not always correspond to those of the ammonites from which the European stages were derived (Arkell, 1956). Grouping of the stage names is required to indicate the ranges of the microplankton assemblages: terms such as Oxfordian - Kimeridgian, Neocomian - Aptian must be employed. If the European nomenclature is used, the definitions of these units should also be applied. The macrofaunal occurrences in Western Australia and Papua may be thought of as points within the relevant stages of the geological scale, but the criteria necessary to define most of these stage boundaries within anything less than a broad band of uncertainty are not available. Any adaption of the European stage nomenclature to the microplankton sequence will also inherit these approximations. As the microplankton occur so abundantly in the Mesozoic of Western Australia, Papua and northern Queensland, there is no need to perpetuate this impression. Correlation problems are best served by referring to the distribution of the microplankton alone, by recognizing zones from their apparent life-spans, and from the groupings of species, and then investigating the relation of these zones to other geological scales.

Examination of the distribution of fossils will always bring to light a number of alternative correlations. The choice of parameters for correlation (index fossils) depends on the number of sample points, the frequency and abundance with which species occur, the nature of the geological problems to be solved and the visual appearance of any charted expression of the sequence.

Edgell (1964) followed this course and defined a sequence of dinoflagellate zones for the Cretaceous of the Perth Basin, but the separation of the ranges of species observed by Edgell is not apparent in the Archer River area. Comparison of detailed distribution charts from both Western and eastern Australia is necessary before the Perth Basin zones can be readily applied to the Queensland and Papuan sections.

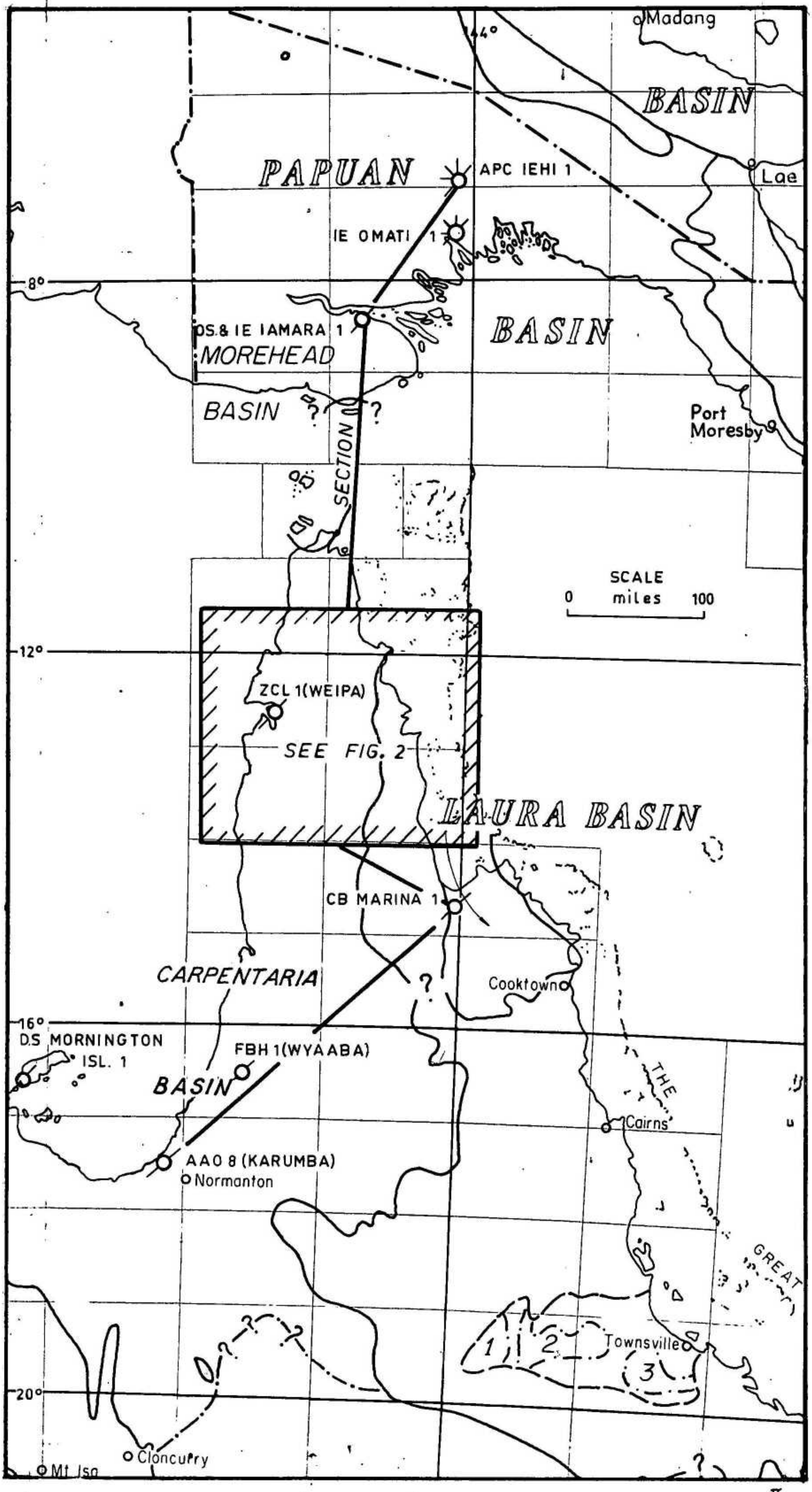

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FIGURE 1 LOCALITY MAP - GENERAL

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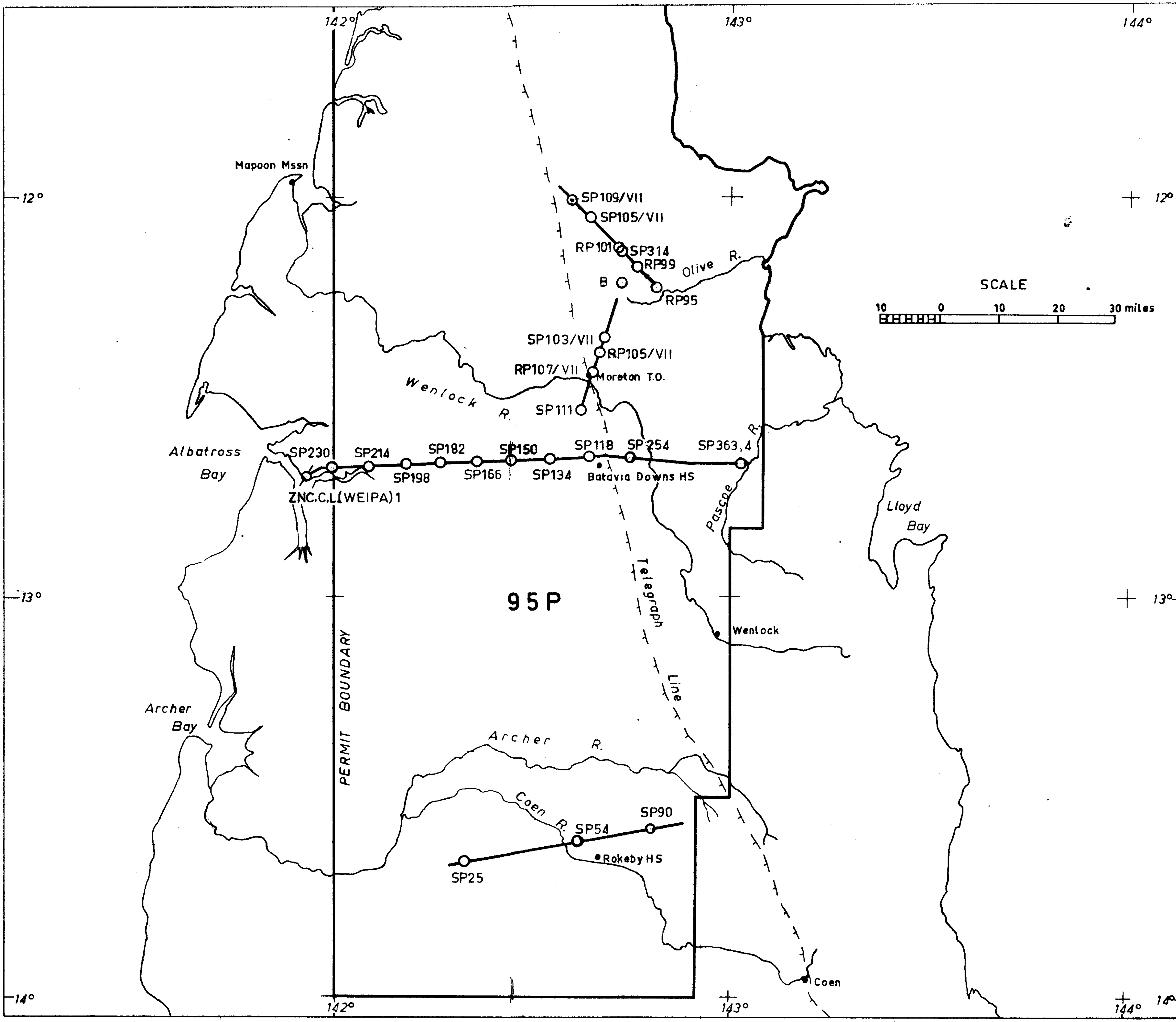

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FIGURE 2: LOCATIONS OF SEISMIC TRAVERSES & SAMPLED HOLES

OBSERVATIONS

The approximate location of sections discussed is illustrated in figure 1. The position of seismic traverses and the holes sampled in the Archer River area are plotted at the 1:1,000,000 scale in figure 2. The microflora observed in these samples are listed in Table 1. It is emphasized that the species and forms listed comprise only a portion of the types actually present; they represent only those on which stratigraphic conclusions are based.

The fossils located in samples from A.P.C. Iehi No.1 and I.E. Iamara No.1 in Papua are listed in Tables 2 and 3 respectively. The Iehi list incorporates a fairly complete record of species of microplankton which could be identified with published Australian taxa. The Iamara list includes species thought to be of stratigraphic use. Cookson & Eisenack (1958, 1960) described species from A.P.C. Omati No.1, but gave no indication of the depths of samples from which the fossils were obtained. The Australian Petroleum Company has kindly supplied the core numbers and depths sampled, and, in order to complete the record, Cookson & Eisenack's discoveries are listed against these figures in Table 4.

Comments on the palynology of other sections discussed have already been recorded - Marina No.1 (Evans, in Mines Administration Pty Ltd 1962); A.A.O. 8 (Karumba) (Terpstra & Evans, 1962) - and are not repeated here.

No observations of the microflora of the one deep well in the Archer River area, Z.C.L. No.1 (Weipa) have been possible as insufficient samples from that well are available in the BMR collection. However, **Laing** & Power (in Hill & Denmead, 1960, p.303) reported that Dr de Jersey had recognized Jurrassic spores in a coal sample from 2860 feet. The spores are not listed, but would be worthy of re-examination in the light of more recent work on the Jurassic microfloral sequence.

A water well on Batavia Downs Station, within 20 yards of the main road, 24 miles south of Moreton Telegraph Station in the Archer River area, was the source of material from which Dr Cookson and collaborators described species of microplankton consisting of: (Cookson & Eisenack, 1958)

- Dingodinium cerviculum
- Hystrichosphaeridium complex
- Cyclonephelium compactum
- Muderongia (al. Pseudoceratium) tetracantha
- Pseudocertium turneri
- Formea aphora

Chlamydophorella nyei
(Cookson & Eisenack, 1960)
Canningia colliveri
(Eisenack & Cookson, 1960)
Conyaulax helicoidea subsp. cassidata
Apteodinium maculatum
Apteodinium conjunctum
Broomea micropoda
Cymatiosphaera striata

Cookson & Eisenack (1958) thought that the assemblage from this horizon was a "mixture" of "Aptian" and "Albian" forms, which needed further explanation.

STRATIGRAPHY

No detailed map of the distribution of strata in the Archer River area is available. However, Mr Zolnai of Australian Aquitaine Petroleum Pty Ltd has identified formations from which the samples were taken, and his terminology is employed in quotes in this report, as for example in figure 3. Neither measured nor estimated thicknesses of each "formation" are available and hence the samples are arranged in figure 3 according to relative stratigraphic position only and not to a sectional scale. The other sections illustrated in figure 3 have been previously interpreted by authors whose notations are reproduced for this report.

Critical discussion of the value of these nomenclatures is not attempted.

UPPER PALAEOZOIC

?Pre-Permian

Two samples, cuttings from Line 5, Shot Points 363 and 364, in the Archer River area, thought by Mr Zolnai to have been taken from the Upper Palaeozoic "Pascoe River Group", and consisting of dark grey, silty and argillaceous rocks, grey-white sand and black, carbonaceous sandstone, yielded very carbonized organic tissue and fairly numerous but indeterminate trilete, mainly apiculate spores. Some zonate forms were recognized, but no saccate grains could be seen. The presence of these fossils confirms that the rocks drilled were no older than the Devonian. The apparently complete absence of saccate grains, although

TABLE 1 : ARCHER RIVER AREA - MICROFLORAL DISTRIBUTION CHART

ZONE / AGE	MFP	LINE	POINT	DEPTH
O. operculata	4021	1	SP 25	c. 38'
D. cerviculum	4080		90	cutt. 100'
	4081			450'
? Tertiary	4028	2	SP230	c. 98-100'
	4027		214	c. 98'
O. operculata	4026		198	c. 98-100'
	4025		182	c. 98-100'
	4024		166	c. 60'
O. operculata/M. tetracantha (Barren)	4023		150	c. 58- 60'
	4022		134	c. 60'
	4082		118	c. 56- 58'
D. cerviculum	4083	5	SP254	cutt. 45'
U. Palaeozoic/?pre-Permian	4084		363	cutt. 45'
	4085		364	cutt. 30'
D. cerviculum	4052	4	SP111	c. 102'
D. cerviculum/S. attadalense	4049		WP105/VII	c. 102'
	4050		107/VII	c. 60'
	4051			c. 102'
	4048		103/VII	c. 100'
	4030		SP B	c. 100'
	4029	3	RP 99	c. 75'
	4031		95	c. 100'
	4032		101	c. 58'
	4047		SP314	c. 57'
? C. mirabilis/S. attadalense	4033		109/VII	c. 60- 62'
	4034			c. 100'

SPECIES PRESENT

MICROPLANKTON

MFP	Diconodinium spp.	Odontochitina operculata	Hystrichosphaeridae undiff.	Hystrichosphaeridium anthophorum	Hystrichosphaeridium perforans	Hystrichosphaeridium cf. eisonides	Canningia spp. undiff.	Canningia colliveri	Canningia sp. nov.	Muderongia tetracantha	Muderongia mcwhaei	Muderongia sp. nov.	Micrhystridium spp. undiff.	Hystrichosphaera spp. undiff.	Baltisphaeridium spp. undiff.	Dingodinium cerviculum	Deflandrea cincta	"Gen. et sp. indet. Forma A"	Scriniodinium attadalense	Pterospermopsis spp. undiff.	Hystrichodinium cf. oligacanthum
4021	fc	+	+																		
4080			+				+			+											
4081										+						?					
4028			+							+			c								
4027							+							+							
4026		+	+																		
4025	+	+	+				+														
4024	+	+													+						
4023										?											
4022		+												+							
4082																					
4083										+						+					
4084																					
4085																					
4052				+				+		+						+	+				
4049			+	+					+		+	+				+		+			
4050				+	+							+						+	+	+	
4051				+					+	+					+		+	+			
4048						+			+		+			+	+	+	+				+
4030																					
4029													c			cf					
4031														+		+		+			
4032										?		+	c			+			+	+	
4047										+						+			+	+	
4033													c						+	+	
4034									+					+				+			

SPORES & POLLEN GRAINS

MFP	Cicatricosisporites australiensis	Cicatricosisporites hughesi	Cicatricosisporites ludbrooki	Cicatricosisporites spp. undiff.	Plicatella tricornitata	Laevigatosporites ovatus	Dictyotosporites complex	Lycopodiumsporites circolumenus	Murospora florida	Aequitriradites verrucosus	Coronatispora perforata	Foveosporites canalis	Apiculati spp.
4021	+	+	+		+	fc							
4080													
4081													
4028							+						
4027				+									
4026						+							
4025				+									
4024				+									
4023													
4022				?									
4082													
4083													
4084													+
4085													+
4052													
4049							+						
4050				+				+	+	+	+		
4051	+			+				+					
4048								+			+		
4030													
4029										+			
4031							+	+					
4032								+			+		
4047													
4033											+	+	
4034				+				+					

TABLE 2 : IEHI NO.1, PAPUA - FAUNAL & MICROFLORAL DISTRIBUTION CHART

SPECIES PRESENT — MACROFAUNA

ZONE	MFP	CORE	DEPTH	Aulacoteuthis sp.	Hibolites sp.	Neohibolites aff. spicatus	Oxyteuthis cf. germanicus	?Otoparia	Belemnopsis sp.	Inoceramus haasti
D. cerviculum	2290	21	3749'							
	2291	22	4062'							
?	2292	25	4646'							
S. attadalense/C. mirabilis	2293	26	4712'*							
	2294	27	4748'*	+	+	+	+			
	2295	28	5048'							
	2296	29	5084'							
	2297	30	5248'							
? C. mirabilis	2298	33	5316'							
	2299	34	5548'							
Jurassic undiff.		47	9606-08'					+	+	
		48	10033,37'							+

SPECIES PRESENT — MICROPLANKTON

ZONE	MFP	CORE	DEPTH	Pterospermopsis aureolata	Muderongia tetracantha	Hystrichosphaera furcata	Dingodinium cerviculum	Omatia montgomeryi	Hystrichosphaeridium complex	Pareodinia sp.	Scriniodinium attadalense	Leptodinium eumorpha	Chlamydophorella wallala	Scriniodinium apatelum	Cannosphaeropsis mirabilis	Broomea ramosa	Gonyaulax scotti	Gonyaulax serrata	Hystrichosphaeridium anthophorum	Palaeostomocystis sp.	Kalyptea monoceras	Cyclonephelium densebarbatum	Hystrichodinium amphiacanthum	Dingodinium sp.	Wanaea clathrata	Gonyaulax perforans	Scriniodinium dictyotum	Belodinium dysculum	Nannoceratopsis pellucida	Broomea simplex
D. cerviculum	2290	21	3749'	+	+	+	+		+																					
	2291	22	4062'		+	+	+		+																					
?	2292	25	4646'						+																					
S. attadalense/C. mirabilis	2293	26	4712'*																											
	2294	27	4748'*					+			+				+	+	+	+	+	+	+	+								
	2295	28	5048'																											
	2296	29	5084'						+	+	+						+						+							
	2297	30	5248'								+	+	+	+	+			+				+	+	+			+			
? C. mirabilis	2298	33	5316'												+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	2299	34	5548'																								+	+	+	+
Jurassic undiff.		47	9606-08'																											
		48	10033,37'																											

SPECIES PRESENT — SPORES

ZONE	MFP	CORE	DEPTH	Klukisporites scaberis	Aequitriradites verrucosus	Foveosporites canalis	Dictyotosporites complex	Lycopodiumsporites circolumenus	Murospora florida	Cicatricosisporites spp. undiff.	Ischyosporites crateris	Coronatispora telata	Contignisporites cooksonii
D. cerviculum	2290	21	3749'	+				+					
	2291	22	4062'										
?	2292	25	4646'										
S. attadalense/C. mirabilis	2293	26	4712'*										
	2294	27	4748'*	+	+	+	+	+	+	+		+	+
	2295	28	5048'										
	2296	29	5084'						+	+	+	+	+
	2297	30	5248'									+	+
? C. mirabilis	2298	33	5316'					+	+	+	+		+
	2299	34	5548'									+	+
Jurassic undiff.		47	9606-08'										
		48	10033,37'										

* Macrofauna from levels - 4717', 4719', 4745', 4746'

Cores 47,48 from below fault zone, but correlate by electric logs in upper section between 6000' and 6300'.

TABLE 3 : IAMARA NO.1 - MICROFLORAL DISTRIBUTION CHART

SPECIES PRESENT									
ZONE	D. cerviculum	?D.cerviculum/S.attadalense	S.attadalense/C. mirabilis	? C.mirabilis			No older than spore unit J5	Jurassic undiff.	
DEPTH	3005'	3375'	3519'	3870'	4200'	4498'	4806'	5101'	5718'
CORE	7	9	10	11	12	13	14	15	17
MFP	2657	2611	2615	2612	2613	2614	2616	2617	2618
MICROPLANKTON									
Dingodinium cerviculum	+								
Muderongia tetracantha	++								
Muderongia mcwhaei		+							
Canningia colliveri	+								
Canningia sp. nov.	+	+							
Hystrichosphaera spp. undiff.	+								
Hystrichosphaeridium anthophorum	+	+							
Hystrichosphaeridium perforans		+							
Micrhystridium spp. undiff.		frC		+	+	+	+	+	
Broomea ramosa			+						
Scriniodinium attadalense			+						
Palaeostomocystis sp.			+						
Palaeostomocystis cylindrica				+					
Cannosphaeropsis mirabilis			+						
Broomea simplex				+					
Hystrichosphaeridium pachydermum					cf				
Hystrichosphaeridium torynum					+				
Gonyaulax serrata					+				
Nannoceratopsis pellucida					cf	+			
Dingodinium jurassicum						+			
Scriniodinium dictyotum						+			
Wanaea spectabilis						+			
SPORES									
Lycopodiumsporites circolumenus		+	+				+		
Contignisporites cooksonii		+	+	+	+	+	+		
Murospora florida			+		+		+		
Coronatispora telata			+						
Crybelosporites stylosa			+						
Klukisporites scaberis			+				+		
Concavissimisporites sp.				+					
Ischyosporites punctatus			+	+					

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TABLE 4 : OMATI NO.1 - MICROFLORAL DISTRIBUTION CHART

ZONE	SAMPLE	CORE	DEPTH	Pseudoceratium turneri	Hystrichosphaeridium complex	Baltisphaeridium cf. hirsutum	Baltisphaeridium parvispinum	Chlamydophorella nyei	Dingodinium cerviculum	Hystrichosphaeridium anthophorum	Muderongia tetracantha	Omatia pisciformis	Leiosphaeridia similis	Hystrichodinium amphiacanthum	Broomea simplex	Gonyaulax serrata	Omatia montgomeryi	Broomea ramosa	Hystrichosphaeridium dictyophorum	Cannosphaeropsis mirabilis	Gonyaulax perforans	Wanaea clathrata	Scriniodinium crystallinum	Nannoceratopsis pellucida	Cannosphaeropsis semula	Gonyaulax ambigua	Wanaea spectabilis
	4	398	10418'	+																							
D. cerviculum	5	400	10590'		+	+	+	+	+	+	+																
	9	402	10987'						+	+	+																
C. mirabilis	19	408	11918'											+		+	+	+		+					+		
	20	cutt	12044'									+		+		+	+			+		+			+		
	21	409	12156'										+														
	24	412	12470'*											+	+								+			+	
	25	cutt	12554'													+	+	+	+	+							
	26	cutt	12652'																	+		+			+		
	27	413	12766'																								
	29	416	13055'																	+							
	31	417	13264'																		+			+	+		
?D. jurassicum	33	418	13476'																						+		
	35	419	13671'																			+	+	+	+		
	36	420	13769'																						+	+	+

SPECIES PRESENT (Cookson & Eisenack, 1958; 1960) — MICROPLANKTON

* at 12476 ft; Buchia subpallasi, Belemnopsis alfurica (Gay & Brown, 1961)

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negative evidence, strongly suggests that pre-Permian even pre-Upper Carboniferous Unit Cl (Evans, 1964) sediments were tested.

The resultant limits Devonian - ?Lower Carboniferous, within which the ages of these samples should be placed, are in accord with the Lower Carboniferous age assigned by Walkom (in Morton, 1924) to Lepidodendroid macrofloras from exposures downstream along the Pascoe River.

The mere existence of these spores is of interest in that the country rock is apparently not greatly metamorphosed, but the very poor state of preservation of the fossils does not encourage further study of their systematics and taxonomy.

Permian

No Permian horizons in the Cape York region to the north of Mount Mulligan have yet been dated by palynology. The one core from Marina No.1, which contained Permian plants failed to yield spores (Woods and Evans in Mines Adminstrations Pty Ltd 1962).

MESOZOIC

The oldest Mesozoic Rocks in the sections considered are of Jurassic age. Because sediments of Middle Jurassic and younger age contain microplankton, a dual classification is used, the first based on spores and pollen grains (Evans, 1966a) and the second on the ranges of dinoflagellates. As explained in the introduction, it is necessary to define the stratigraphic position of the dinoflagellate zones discussed and digress briefly to sections in areas other than that under review.

A. SPORES AND POLLEN GRAINS.

Jurassic Units J3(?) - J4

The oldest Jurassic rocks encountered are near the base of Marina No.1 (Dalrymple Sandstone according to Lucas, 1964), and Iamara No.1, where sediments with Tsugaepollenites segmentatus and Lycopodiumsporites undiff. were found. By the presence of these fossils the sections (figure 3) are dated as no older than Jurassic unit J2, and as they underlie beds of unit J5, they appear to have been laid down during the interval of units J2 - J4. The low content of Classopollis in the basal cores implies that the age of these beds is limited to the period J3 - J4.

In broad terms the basal Mesozoic sediments in the Laura Basin and the southern margin of the Papuan Basin are of Lower to Middle Jurassic age. Nothing is known of their equivalents at Iehi, further north in the Papuan Basin, although such may be presumed to exist, or of their equivalents in the Cape York region. It is possible that units J3(?) - J4 are not represented in the Archer River area, unless they form part of the "Cape York Group".

Jurassic Units J5 - J6

The spores Murospora florida, Lycopodiumsporites circolumenus and Contignisporites spp. make their first appearance in Iamara No.1, core 14, 4806 feet and the Dalrymple Sandstone in Marina No.1, core 7, 1933 feet, and indicate a lower limit to unit J5. The available spore evidence is insufficient to distinguish the upper boundary of J5.

Dalrymple Sandstone of J5 - J6 age in Marina No.1 appears to be of non-marine origin, but in Iamara No.1 correlates contain micro-plankton of the Cannosphaeropsis mirabilis Zone, of a marine facies. As with older Jurrassic units, there is no indication whether units J5 - J6 are represented in the Archer River area, unless they rest within the unsampled "Cape York Group".

Jurrassic (?) - Cretaceous Unit Kla.

This zone, recognized by the overlap of the ranges of Murospora florida and Cicatricosisporites spp., is well represented in Iehi No.1 in the Papuan Basin between core 26, 4712 feet and core 33, 5316 feet, and in Iamara No.1, core 19, 3519 feet. At least the top of this zone (in Iehi No.1) is associated with a Neocomian fauna (Glaessner, in Gay & Brown, 1961).

The lower limit of the unit, although arbitrarily chosen as the base of the Cretaceous (Evans, 1966a) may well commence within the Jurassic. This reservation is based on the occurrence of Cicatricosi-sporites sp., reported as C.australiensis by Evans (in Henderson et al., 1963)* from sediments identified with the Anketell/Parda Formation+ in BMR 4 (Wallal) in the Canning Basin. The microplankton assemblage

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+ For opinions on the relation between the Ankatell and Parda Formations and the Jarlemai Siltstone see Veevers & Wells (1961), McWhae et al. (1958), and Henderson et al. (1963).

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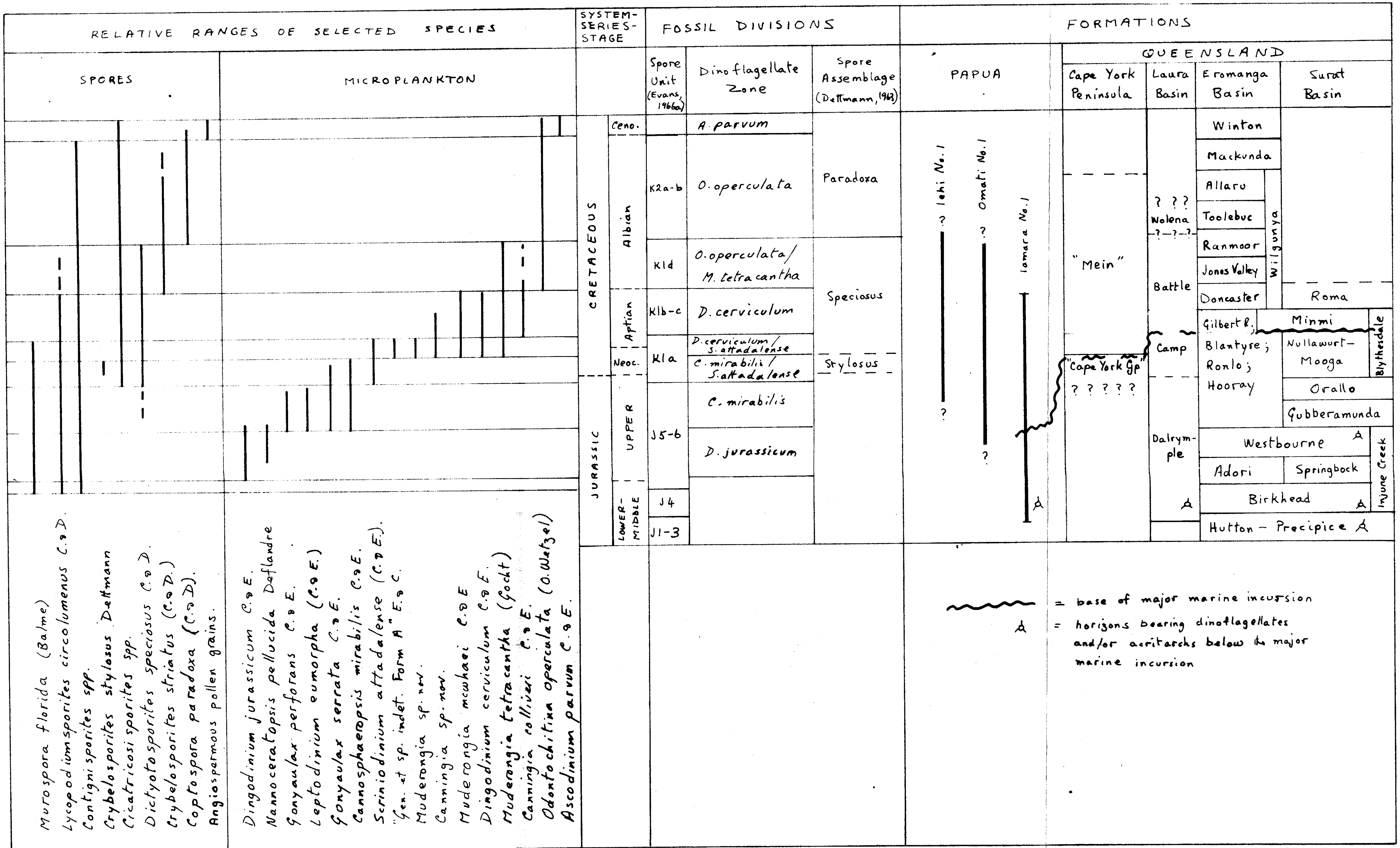
* This report is based on an unpublished paper by Bastian (1962). The published version by editoral error, failed to include the fossil distribution chart, which was origninally presented in Bastian's paper.

FIGURE 3 : SCHEMATIC CORRELATION : KARUMBA - MARINA - ARCHER RIVER - IEHI

Rec. 1966/198.

TABLE 5: SUMMARY OF FOSSIL RANGES & STRATIGRAPHIC DIVISIONS



of this horizon is similar to that from the Jarlemai Siltstone+ in the nearby WAPET Wallal Corehole which was referred to as "probably Tithonian" by Cookson & Eisenack (1960). Note was also taken of Balme's record (1957) of a ? C. australiensis from 1001-1042 feet in Broome No.3 Bore, which lies within the range of Buchia subpallasi in the "Broome Buchia Beds", taken by Veevers & Wells (1961) to be no younger than the Kimeridgian. Furthermore, in Europe the genus Cicatricosisporites made its first appearance at least as early as Purkeckian (Couper, 1958; Lantz, 1958).

Unit K1a includes the Stylosus Assemblage and a lower portion of the Speciosus Assemblage (Dettmann, 1963). Dettmann considered that the association of the zone fossil Crybelosporites stylosus with Cicatricosisporites australiensis and Aequitriradites verrucosus reason to consider the Stylosus Assemblage to be Cretaceous in age. However, species of Aequitriradites, including A. verrucosus have been found within J5 - J6 horizons in the Surat Basin and Dettmann's contention cannot be upheld without modification.

Crybelosporites stylosus is not a common fossil and its presence in unit K1a in Iamara No.1, core 10, 3519 feet, is of special interest. Unfortunately representatives of the species could not be found in Iehi No.1 where the Neocomian macrofauna was located. For the present, the presence of C. stylosus in the same palynological zone as the Neocomian fossils supports Dettmann's thesis, but more records of the species' occurrence are needed to indicate whether it is a reliable Cretaceous marker.

Unit K1a appears to be well represented in the Archer River area, in the "Mein Formation". The association of Murospora florida and Cicatricosisporites was seen only in Line 3 RP 107/V11, 60 feet. However evidence from Papuan sections shows that unit K1a is not represented above the Dingodinium cerviculum/Scriniodinium attadalense Zone (see below) and those samples from the Archer River area of that age are also allocated to unit K1a. Support for this action is raised from the appearance of the problematicum "Gen. et. sp. indet. Form A" Eisenack & Cookson which seems to be restricted to horizons of unit K1a age (Eisenack & Cookson, 1960, Evans & Hodgson, 1964; Evans, 1966b; Evans, in Exon et al., 1966). As this species has the habit of appearing in swarming proportions, it is significant to note its apparently complete absence from the Papuan sections and its only rare, but persistent occurrence in the Archer River area.

+For opinions on the relation between the Ankatell and Parda Formations and the Jarlemai Siltstone see Veevers & Wells (1961), McWhae et al. (1958), and Henderson et al. (1963).

Unit Kla may be present in the basal Battle Camp Formation in the Laura Basin, although it was not detected in Marina No.1 (cf. Lucas, 1964). There is no room for its development in the southern Carpentaria region, in A.A.O.8 (Karumba), but it is developed within the Blythesdale Formation below the Minmi Member of the Surat Basin (Evans in Exon et al. 1966).

Cretaceous Units Klb +

As the remainder of the Archer River samples are of marine origin, and many had poor spore assemblages, a search for the key spores of units younger than Kla was not attempted.

B. MICROPLANKTON

The older Jurassic strata in the Papuan and Laura Basin sections of J3(?) - J4 age do not appear to be products of an open marine environment, and their equivalents and have not been recognized in the Archer River area. Acritarchs (Micrhystridium spp.) were present in Iamara No.1, core 15, 5101 feet, but no dinoflagellates could be recognized. A dinoflagellate, cf. Apteodinium sp. and acritarchs Micrhystridium sp. and Cymatiosphaera sp. were present in Marina No.1, core 12, 3205 and 3211 feet, but no other samples from J3(?) - J4 in these wells yielded fossils which might be construed as marine indicators.

Of the microplankton described by Cookson & Eisenack (1958, 1960) from Jurassic sediments in Western Australia and Papua, the ranges of two species, Dingodinium jurassicum and Cannosphaerapsis mirabilis provide convenient markers for the present discussion.

Zone of Dingodinium jurassicum

Dingodinium jurassicum has not been recorded from the probably oldest dinoflagellate-bearing Jurassic sediments in Western Australia, in the Cape Range Nos 1 and 2 Wells, Carnarvon Basin, the Dingo Claystone, no older than unit J5 (compare Cookson & Eisenack, 1958 with Balme 1957). However D. jurassicum is the first dinoflagellate to appear in the Wallal section in the Canning Basin, where it becomes a common member of the lower of Cookson & Eisenack's two assemblages and extends into the base of the succeeding assemblage. Its range overlaps briefly with the commencement of the range of Cannosphaeropsis mirabilis in the Broome bores so that the Zone of Dingodinium jurassicum is defined by the appearance of D. jurassicum, prior to the appearance of Cannosphaeropsis mirabilis.

Whether or not the D. jurassicum Zone has been sampled in the Papuan wells is not completely clear. Most of the species which commenced their life-span in the D. jurassicum Zone continued into the succeeding

Zone of Cannosphaeropsis mirabilis. Only Dictyopyxis aureolata and Gonyaulox hyalodermum appear to be confined within the D.jurassicum Zone.

New species appearing with C.mirabilis include Gonyaulax perforans, G. serrata, Leptodinium eumorpha, and Scriniodinium dictyotum. G.perforans was recorded from Omati No.1, core 417, 13264 feet, and S.dictyotum from Iehi No.1, core 34, 5548 feet, and Iamara No.1, core 13, 4498 feet. Sampled horizons below these levels may belong to the D.jurassicum Zone, but, except from Omati, there are no dinoflagellate bearing samples in which to identify the zone. There is however room for its presence within the basal limits of units J5 - J6 in Iamara No.1. The D.jurassicum Zone has not been identified on the Queensland mainland.

Zone of Cannosphaeropsis mirabilis

As explained in the preceding paragraphs, the span of C.mirabilis is marked by the appearance of a number of new species and the continuation of many from the D.jurassicum Zone. The upper limit to the C.mirabilis Zone is taken at the incoming of Scriniodinium attadalense. It is marked by the continuing presence of Nannoceratopsis pellucida and Dingodinium jurassicum (at least in its lower portions).

Well developed in the Papuan region, it has not been detected on the Queensland mainland, although in theory it could be represented in the "Cape York Group" of the Archer River area.

Zone of Cannosphaeropsis mirabilis/Scriniodinium attadalense

Scriniodinium attadalense has been previously recorded only from the Perth Basin (Cookson & Eisenack, 1958; Edgell, 1964), but fossils thought to compare with this species are prevalent in both the Papuan and Archer River area. The overlap of its range with that of Cannosphaeropsis mirabilis is taken to form the C.mirabilis/S.attadalense Zone in order to distinguish such strata from the overlying beds with S.attadalense and Dingodinium cerviculum.

This zone is best represented in Iehi No.1, where, at the top of the zone a Neocomian macrofauna has been recorded (Glaessner, in Gay & Brown, 1961), and in Iamara No.1, core 10, 5319 feet, where spores of unit Kla and the Stylosus assemblage are present.

As with older zones, it is uncertain whether the S.attadalense/ C.mirabilis Zone is present in the Archer River area. Core from Line 3, bore 109/V11, 100 feet, may belong to this zone as it contained no Dingodinium cerviculum. But neither did it appear to contain C.mirabilis. There may of course be an intermediate zone between the end of C.mirabilis and the commencement of D.cerviculum to which this core should be referred. The core was the deepest of the most northerly corehole examined, and is thought by Mr Zolnai to have come from the "Mein Formation".

Zone of Dingodinium cerviculum/Scriniodinium attadalense

Edgell (1964) listed a sequence of Cretaceous assemblages from the Perth Basin, but included no detailed distribution charts. His tabulated assemblages include several species common to the Archer River area, where their order of occurrence does not support application of Edgell's zones to the Queensland and Papuan sections. Discrepancies may arise from differing opinions of the circumscription of species, discussed further in Appendix 1.

The zone of Dingodinium cerviculum/Scriniodinium attadalense is defined by the overlap of the ranges of the nominate species. S.attadalense is common at several horizons in the Archer River area, always in the company of D.cerviculum, except in hole 109/V11 on line 3. All such points are logged from the "Mein Formation". Muderongia sp. nov. Canningia sp. nov., Hystrichosphaeridium perforans, common Micrhystridium spp. and Pterospermopsis spp., particularly P. eurypteris and P.aureolata, are characteristic of this horizon. Muderongia tetracantha, M.mcwhaei and Deflandrea cincta make their first appearance in the zone. At least in Line 4, RP 107/V11 the zone is associated with spores of unit Kla, and in several samples it occurs with the problematicum "Gen. et sp. indet. Form A" Eisenack & Cookson, which elsewhere in Australia appears to be confined to unit Kla.

The position of this zone in the eastern Australian sequence is particularly interesting as it has not been recognized in the Laura and Great Artesian Basins, where its equivalents are apparently absent, as in A.A.O. No. 8 (Karumba), or of non-marine origins (Blythesdale Formation undiff., below the Minmi Member). Its presence in the Papuan region in Iamara No.1, core 9, 3375 feet, is deduced by the presence of M.mcwhaei, H.perforans and Canningia sp. nov. There is room for its existence in Iehi No.1 and Omati No.1 (see figure 3 and Table 4).

Cookson & Eisenack (1958) listed a very similar assemblage, comprising D.jurassicum, S.attadalense, P.eurypteris and M.mcwhaei from the South Perth Formation, Perth Basin, Western Australia. Edgell (1964) divided the South Perth Formation (s.l.) between four zones, the lowest of which has no known counterpart in the eastern states. The record from the bottom is characterized and named after Wetzeliella ? neocomica Gocht. A fossil which could be compared with Gocht's species occurred in Line 3, RP 101 with D.cerviculum and S.attadalense. The determination is doubtful (see Page 25.), but it implies that a separate zone of W? neocomica cannot be upheld. Edgell separated two other zones, of M.mcwhaei, with S.attadalense and M.(al.Pseudoceratium) tetracantha and of D.cerviculum with Horologinella lineata. The range zone of M.mcwhaei is perhaps akin to the D.cerviculum/S.attadalense Zone of the Archer River area, but its separation from the D.cerviculum Zone is unsupportable in view of records by Cookson & Eisenack (1958) and the Archer River associations.

However the D.cerviculum/S.attadalense Zone of Queensland and Papua is correlated with other sequences, it seems to represent a relatively narrow portion of the geological scale and is important as a measure of facies changes within the interval of unit Kla.

Zone of Dingodinium cerviculum

The range of Dingodinium cerviculum has proved a useful means of correlating the Aptian Doncaster Member of the Wilgunya Formation of the Eromanga Basin with the Roma Formation of the Surat Basin (Evans 1963; in Vine & Jauncey, 1962; in Terpstra and Evans, 1962; in Mcphee, 1963; in Union Oil Development Corporation, 1964). It is now apparent that these occurrences do not represent the full range of the species and that the zone so recognized was restricted at the base by unfavourable conditions of deposition in the more southerly basins. However, by restricting the Zone of Dingodinium cerviculum to that portion of the species range beyond that of Scriniodinium attadalense the concept of the zone remains unchanged. M.tetracantha continues as a common associate of D.cerviculum, and, in the Archer River area at least, it appears that Canningia colliveri does not appear until S.attadalense has disappeared, thus becoming a useful marker of the D.cerviculum Zone as now defined.

The Zone of D.cerviculum is one of the most widespread Lower Cretaceous dinoflagellate units yet recognized, present in all Australian basins where marine Cretaceous sediments are known, except in the Maryborough Basin.

Zone of Odontochitina operculata/Muderongia tetracantha

Evans (in Vine & Jauncey, 1962; in Terpstra & Evans, 1962; in McPhee, 1963) made several attempts to divide this sequence, but it is apparent that marine facies of unknown character greatly influence the assemblages viewed. Although not admitted at the time of writing, it also appears that too much faith was placed on the supposed lack of contamination in a cable-tool drilled bore in which casing was driven behind the bit (St. Andrews bore). The relationship of two species Muderongia tetracantha and Odontochitina operculata, emerges.

The overlap of these forms occurs above the Zone of D.cerviculum. Both forms are widespread in occurrence, irrespective of the facies problem, and recognition of a zone in which the forms overlap is possible and useful. Thereby a broad zone, taking in most of the sequence above the D.cerviculum Zone = Doncaster Member of the Wilgunya Formation and below the Toolebuc Member, is defined. Such a zone is present in the Carpentaria Basin at Karumba and in the Archer River area. It seems also to exist in the Laura Basin in Marina No.1. It incorporates most of the Ranmoor Member of the Wilgunya Formation from which Vine & Day (1965) recorded a Lower Albian fauna. It includes division 2 of the Carpentaria sequence (Terpstra & Evans, 1962) for which Laing & Power (1959) rejected the possible Albian age proposal by Belford after study of foraminifora from FBH No.1 (Wyabba).

Like their counterparts in the Eromanga Basin, those samples from the Archer River area allocated to the M.tetracantha/O.operculata Zone are generally bituminous and contain only a small microflora.

Zone of Odontochitina operculata

O.operculata continues to be a common member of marine Cretaceous sediments around Australia until about Cenomanian, possibly Lower Turonian times (Cookson & Eisenack 1958; Evans 1966b) but for the present purposes the O.operculata Zone is taken as that portion of its range after the appearance of Muderongia tetracantha and before the appearance of Ascodinium parvum.

In general O.operculata is associated in this zone with abundant Diconodinium spp., particularly above the Toolebuc limestone in the Eromanga Basin and the Kamileroi Limestone in the southern Carpentaria Basin. Samples from the Archer River area allocated to the zone are no exception, where the Kamileroi Limestone or its equivalent may therefore be expected to occur in the vicinity of Line 2, Sp 166.

TERTIARY (?)

No palynological studies of the Tertiary of Papua or the Carpentaria region have been previously made, but samples from western end of the Archer River area line 2, SP 214 and 230 may be of such age. Their position close to ZCL No.1 (Weipa) suggests that, unless considerable local faulting has taken place, they must be of late Lower Cretaceous age at the earliest. They yielded only Mesozoic fossils. SP 230 in particular contained Muderongia tetracantha and abundant Micrhystridium spp. identical with forms in the D.cerviculum/S.attadalense Zone. SP 214 is a doubtful case as the few fossils recovered were very oxidized, but bore little relationship to fossils in the next sample in line, S P 198 from the O.operculata Zone.

This anomaly is understandable if the rocks sampled are post-Mesozoic in age, derived locally from stripping of exposed early Cretaceous strata. Mr Zolnai had previously deduced on lithological grounds that these cores came from the Tertiary. However, no indicator fossils of a post-Mesozoic age, such as angiosperm pollen grains could be found.

COMMENTS ON SOME OF THE MICROFLORA

The species discussed below are arranged in alphabetical order of genera and species, firstly of spores then microplankton. Higher taxa are not considered. Only those forms illustrated in Plates 1 - 3 are discussed.

Fungal Conidiophore Indet.
Plate 1, figure 13

Conidiphora spasmodically appear in Cretaceous and younger strata, throughout Australia. The writer is unaware of similar fossils in Jurassic and older beds, and the figured specimen, from the ? C.mirabilis/S.attadalense Zone in the Archer River area is probably one of the oldest known. Variations in tube outline and length and cell proportions are apparent among the few known or illustrated specimens, and might, after further study, be classified on the basis of these parameters. However, it is impossible to determine the larger taxon of fungi to which the figured specimen should be ascribed without knowledge of its soft parts (Bessey, 1952; Rao, 1959).

The figured specimen is 135 μ long, about 18 μ wide and the septa are spaced about 8 μ apart.

Cicatricosisporites Pot.& Gell.
Plate 1, figures 3 - 4

Dettmann (1963) described three Australian species of Cicatricosisporites; C.australiensis, C.ludbrooki, and C.hughesi. The latter two are represented in figures 2 and 3 respectively.

The confluence of intermarginal ribs at the radial corners in C.ludbrooki thickens the exine only by the height of the ribs. In C.hughesi, however, the ribs merge into radially disposed muri which tend to form "ears". An intermediate stage resembling C.ludbrooki in the number and roundness of the ribs, but forming radially disposed thickenings or "ears", as in C.hughesi is illustrated in figure 4.

It should be compared to Plicatella tricornitata (Weyl & Greif) from the same sample and illustrated in Plate 1, figure 1.

Crybelosporites stylosus Dettmann
Plate 1, figure 5

Dettmann (1963) chose the appearance of C.stylosus to characterize a basal zone of the Lower Cretaceous. In the author's experience, however, C.stylosus is a rare species and its vertical limits not fully tested. The appearance of C.stylosus in the Mesozoic of Papua is therefore of special stratigraphic interest.

Lycopodiumsporites circolumenus Cookson & Dettmann
Plate 1 figure 6

The distinctively moulded L.circolumenus has proved to be a widely distributed species of considerable stratigraphic value. Its occurrence in the Archer River area and Papua is in accord with its previously observed range from the late Middle Jurassic to the Lower Cretaceous (J5 - KlC).

Murospora florida (Balme)
Plate 1, figure 7

Like Lycopodiumsporites circolumenus, Murospora florida is another widely distributed, frequently abundant spore of restricted stratigraphic range, Jurassic to Lower Cretaceous (J5 - Kla). The specimen figured was associated with Crybelosporites stylosus, Cannosphaeropsis mirabilis and Scriniodinium attadalense in Iamara No.1, c.10, 3519 feet, where a useful link between the spore and microplankton zones is demonstrated.

Plicatella tricornitata (Weyland & Greifeld)
Plate 1, figure 1

Reasons for maintaining the name Plicatella and an emendation of its diagnosis were offered by Burger (1966) and accepted here. The specimen from the Archer River area illustrated here is 76 u across, larger than specimens attributed by Burger to P.tricornitata, but otherwise the forms are very similar. The muri coalesce at the tetrahedral margins of the distal half of the grain to form distinctive apical thickenings. Such fossils have not been previously recorded in Australia, although no doubt they have been observed.

Baltisphaeridium Parvispinum (Deflandre)

Plate 3, figure 9

Syn:

Hystrichosphaeridium xanthiopyxides var. parvispinum Deflandre, 1937, 29, Pl. XVl, fig.5.

Hystrichosphaeridium parvispinum (Deflandre) Cookson & Eisenack, 1958, p. 45 Pl. XII, fig. 10-12.

Baltisphaeridium parvispinum (Deflandre 1937) Cookson & Eisenack - Klement, 1960, p.59.

Cookson & Eisenack (1958) recorded B.parvispinium only from Papua and Batavia Downs in the Archer River area. Both localities are thought to be Lower Cretaceous, about Aptian in age, comparable with the Aptian occurrence of the holotype. Its occurrence in AR3 HP109/V11 in association with Scriniodinium attadalense indicates a downwards extension of its range in Australia. Sarjeant (1962) recorded forms of B.parvispinium from the Jurassic and Conrad (1941) from the Upper Cretaceous, and hence its stratigraphic value is limited, although for local correlation purposes it may be a useful species.

Baltisphaeridium spp.

Plate 3, figures 8, 11

Large specimens of acritarchs with long simple spines of variable number and rigidity occur in many of the Archer River Samples. That illustrated in figure 8 resembles Hystrichosphaeridium cf. hirsutum (Ehrenberg) depicted by Cookson & Eisenack (1958, p 44 Pl.Xl, figs. 5, 6), but, as noted by those authors, species of this type are not easily separated from each other and a considerable number of specimens from which the degrees of variation could be measured are required before they may be confidently assigned to species.

Broomea micropoda Eisenack & Cookson

Plate 2, figure 10

The genus Broomea was first erected by Cookson & Eisenack (1958) for the Jurassic species with elongate antapical processes, B.simplex and B.ramosa. Eisenack & Cookson (1960) erected the Cretaceous species B.micropoda for a test with short antapical horns and a "rather thick, coarsely and closely granular" shell-membrane. Eisenack & Cookson first discovered B.micropoda in the Archer River area, from the Batavia Downs bore. The Archer River specimens represented in figure 10 have the short antapical horns of B.micropoda but lack the strong wall ornament of that species. Alberti (1961) figured several species of Broomea, the closest of which to the Archer River specimen is B.jaegeri. However, B.jaegeri develops an elongate apical horn not seen in the local material. Alberti's more numerous illustrations show that considerable variations in shell and process shape and wall ornament may be expected in Broomea spp. and further work on the Archer River material is required before its taxonomic position is determined.

Cannosphaeropsis mirabilis Cookson & Eisenack
Plate 1, figure 10

C.mirabilis was not found in the Archer River area, but is present in the Mesozoic of Western Australia and Papua, (Cookson & Eisenack, 1958, 1960), where it may be used as a distinctive marker in two zones. Its range apparently straddles the Jurassic - Cretaceous boundary. The figured specimen, from Iamara No.1, core 10, 5319 feet, was associated with Scriniodinium attadalense, Crybelosporites stylosus and spores of unit Kla.

Canningia sp. nov.
Plate 3, figure 7

Only one species of Canningia, C.colliveri Cookson & Eisenack has been described from the Australian Lower Cretaceous. The figured specimen, although fitting the generic diagnosis in that it is a flattened shell, roughly five sided with a broadly indented base, (but lacking any apical structure through development of the archeopyle), does not match C.colliveri because of the numerous parallel sided, short, trifurcating processes developed on its shell. Other material is required in order to fully establish the species' morphology, but the presence in the Scriniodinium attadalense Zone of this apparently undescribed member of a generally common genus may prove to be a useful stratigraphic index in later work.

The figured specimen in 95 u wide across the girdle.

Chlamydophorella (?) sp. Cookson & Eisenack
Plate 2, figure 1

Cookson & Eisenack (1958) described Chlamydophorella nyei from Lower Cretaceous sediments in both Western and eastern Australia and at the same time depicted Chlamydophorella ? sp. (1958, pl.1, fig.4) with what could now be explained as an apical archeopyle. The caution exhibited by Cookson & Eisenack by not referring Chlamydophorella ? sp. to C.nyei may be further justified by the fact that the processes which support the outer membrane in Chlamydophorella ? sp. are shorter in proportion to the width of the inner capsule than in C.nyei, and the former displays a distinctive equatorial constriction like a girdle.

Both these characteristics are displayed by the Archer River specimen. It is important to discover an entire specimen possessing the apical cap and process, because, if the process is an elongate horn, the specimen should be referred to Gardodinium Alberti.

From a stratigraphic view point, it may be important to note that Chlamydophorella ? sp. was identified in the Attadale Bore at 999 feet, in the Perth Basin in association with Dingodinium cerviculum and Scriniodinium attadalense, as in its Archer River occurrence.

Diconodinium multispinum (Deflandre & Cookson)
Plate 3, figures 3, 4

D.multispinum is a common component of strata younger than the Zone of Dingodinium cerviculum. Evans (in Evans & Terpstra, 1962; in Vine & Jauncey, 1962) thought that its range extended down into the D.cerviculum Zone, but this is probably due to contamination from cavings. The species is prolific above the Toolebuc Member of the Wilgunya Formation in the Eromanga Basin, and the Kamileroi Limestone of the Carpentaria Basin. Its presence in the Archer River area is taken to mark similar horizons within the Zone of Odontochitina operculata in the Archer River area.

Dingodinium cerviculum Cookson & Eisenack
Plate 1, figure 12

The figured specimen shows the outer membrane, girdle, inner, granular walled capsule, and elongate apical horn, open at the end, so characteristic of this widespread species. It was taken from the region of Batavia Downs, where Cookson & Eisenack (1958) also found it.

Evans (in Terpstra & Evans, 1962; in Vine & Jauncey, 1962; 1963, 1966a) has repeatedly used the limited range of D.cerviculum to mark a stratigraphic interval at the base of the marine Cretaceous in the Great Artesian Basin. The presence of this species in the "Roma Formation" of the Surat Basin, but only in the Doncaster member of the Wilgunya Formation of the Eromanga Basin has long confirmed the correlation of these formations indicated by macrofaunas (Vine & Day, 1965).

Specimens retaining the apical horn are fairly common, although the delicate outer membrane, if ruptured, tends to loose the horn. It is not clear whether this represents formation of an apical archeopyle, or whether it is merely the most likely way the specimens could be damaged on account of their shape.

The only other described species of the genus, D.jurassicum (the genotype), does not develop a horn according to its authors Cookson & Eisenack. However, specimens in the writer's possession show the presence of an incipient horn in D.jurassicum together with an apical pore similar to that at the end of the horn of D.cerviculum. A pore apparently exists in the figured holotype (Cookson & Eisenack, 1958, Pl.1, fig. 10), which, if conventions of orientation are to be observed, should be figured the other way up.

Although D.jurassicum and D.cerviculum are morphologically very closely related, there is a stratigraphic break between the last appearance of D.jurassicum and the first appearance of D.cerviculum. In the interval between, an intermediate form, with short horn might be expected to occur. Such specimens are in the BMR collection.

It is of stratigraphic significance to note that Alberti (1960) recorded and illustrated specimens referred to D.cerviculum and derived from the Lower Hauterivian of the late Neocomian to the Upper Aptian. He also recorded it from the Cenomanian of north and central Germany, but did not find it in the intervening Albian. Except for the Cenomanian occurrence, this is in accord with its apparent range in Australia.

"Gen. et sp. indet. Form A" Eisenack & Cookson

Plate 3, figure 6

Although Eisenack & Cookson (1960) observed "Gen. et sp. indet. Form A" in a number of samples from the Carnarvon, Carpentaria and Eromanga Basins, they refrained from formally naming it. Evans & Hodgson (1964) and Evans (1966b) showed that it occurred in swarming proportions over a limited stratigraphic interval in the Gippsland and Otway Basins, and Evans (in Exon. et al., 1966) discovered its presence in a similar stratigraphic interval in the Surat Basin. The widespread occurrence of this fossil and its limited vertical range in unit Kla make it a very useful stratigraphic marker. Both its areal and stratigraphic occurrence in the Archer River area extend confidence in its value to geological correlation. The species has not yet been recorded from Papua.

Hystrichosphaeridium isocalamus Deflandre & Cookson

Plate 3, figure 10

Found with Dingodinium cerviculum in northern New South Wales, this new record of H.isocalamus from the Archer River area, extends the area in which it might be expected to occur.

Hystrichosphaeridium spp.

Plate 3, figures 1, 2

Specimens of Hystrichosphaeridium, with the typical hollow processes are numerous throughout the Archer River samples, although few are so complete as those illustrated. Allocation of such specimens to described species and the distinction of new ones has proved difficult on account of the apparently wide variations in their form. Those illustrated represent two basically common types. The first (e.g. figure 1) possesses wide, tubular processes which flare slightly at the extremities and develop serrated flanges. Hystrichosphaeridium arundum Eisenack & Cookson is similar to it, but has more numerous appendages. On the other hand the illustrated specimen closely resembles Hystrichosphaeridium eionides Eisenack, as illustrated by Gocht (1959, Pl.3, figs. 5, 6). The processes of the second type (e.g. figure 2) are hollow, but narrow in comparison to their width, and their extremities flare into trumpet shaped orifices, the margins of which are perforated to form irregular reticula. Hystrichosphaeridium anthophorum Cookson & Eisenack has such processes, but is described as having "short" processes composed of longitudinal fibrils. Hystrichosphaeridium perforatum Gocht, from the ? Upper Barremian of northwest Germany is very similar to the figured specimen.

Muderongia mcwhaei Cookson & Eisenack
Plate 1, figure 14; Plate 2, figure 6

The specimen figured in Plate 1 is complete, but contorted so that the hypotheca is compressed and the dimensions of the antapical horn not clearly apparent.

Its presence in the Zone of Dingodinium cerviculum in the Archer River area is in accordance with its recorded occurrences in Western Australia and South Australia (Cookson & Eisenack, 1958).

Muderongia tetracantha (Gocht)
Plate 2, figure 9

Both Gocht and Alberti recognized M.tetracantha in Neocomian strata only. Cookson & Eisenack and the writer have recorded it from stratigraphically younger beds of both Aptian & Albian age. This is one of the few species of microplankton apparently common to both Europe and Australia whose occurrences in these regions represent different geological periods.

Muderongia sp. nov.
Plate 2, figures 2, 3
Syn: Muderongia mcwhaei Cookson & Eisenack - Edgell, 1964, Pl.31 fig. 4.

This species consists of a flattened pentagonal shaped membrane from each corner of which a process extends. A capsule fits closely within the main body of the membrane. The processes of the only complete specimen found (figure 2) are orientated in the typical cruciforms shape of Muderongia and may be distinguished as an apical horn, two shorter conical antapical horns, and two lateral processes which are broad and without taper until the "elbow" region, where they commence a rapid taper and are aligned in the antapical direction. Most specimens lose their apical horn and a portion of the epithecal membrane and capsule to an apical archeopyle. The shape of the margin of the archeopyle and lines of faint granulation indicate the existence of an as yet unresolved plating structure, (figure 3).

The species is new to Australia as it differs from M.mcwhaei in its strongly pentagonal outline and the presence of two equi-sized antapical horns, and from M.tetracantha in the number and size of its processes. Edgell (1964) figured a very similar form under the name of Muderongia mcwhaei, which he discovered in the Perth Basin of Western Australia. As with the Archer River species, Edgell's form has equi-sized antapical horns and a more pentagonal, elongate body than M.mcwhaei. The European species M.simplex and M.perforata (Alberti, 1960) display incipient development of an antapical horn, and M.simplex has incipient plating, as seen in this Australian species. The lateral processes of M.crucis Neal & Sarjeant taper in a similar manner of those of Muderongia sp. nov., but M.crucis lacks the short antapical horns.

Muderongia sp. nov. is a prominent component of several samples in the Archer River area, associated with Dingodinium cerviculum and Scriniodinium attadalense.

Odontochitina operculata (O. Wetzel)
Plate 1, figure 8

O.operculata is usually found in the fractured state, with the hypothecal body and two processes (as in figure 8) separated from the epithecal horn.

Evans (in Terpstra & Evans, 1962) thought that O.operculata ranged down into the Zone of Dingodinium cerviculum, but such an association could not be found in the Archer River area, where O.operculata succeeded D.cerviculum. The previous conclusions were based on examination of bore cuttings which are now thought to be much more contaminated by cavings than originally supposed.

Palaeostomocystis Deflandre
Plate 2, figures 8, 11

Palaeostomocystis is a broadly defined genus with both smooth and ornamented tests (Deflandre, 1937). Two Australian species, P. cylindrica (ornamented) and P.sinuosa (granulate) have been described by Cookson & Eisenack (1960). P.cylindrica occurs in

Western Australia and Papua. P.sinuosa was described from the Canning Basin, but has been observed by Evans (in Laing, 1966) in ? non-marine sediments in the eastern Eromanga Basin, and consequently may be the product of a different environment to that of P.cylindrica. Forms like P.cylindrica are common in Papua. That illustrated in figure 11, however, differs from the typical P.cylindrica in the development of a constricted "waist". This shape is induced in a large number of specimens from the same sample.

The specimen illustrated in figure 8 clearly belongs to another species. It is urn shaped with a maximum diameter at its equator, of 42 u, and a wall ornamented in a low, open reticulum. Its ornament in fact makes this species closely resemble the genotype P.reticulata Deflandre.

"Pareodinia" aphelia Cookson & Eisenack

Plate 3, figure 5

Syn: Pareodinia aphelia Cookson & Eisenack 1958, p.60, Pl. XII, figs. ? 3, 4. (non 9).

Cookson & Eisenack described P.aphelia as having a wall "varying somewhat in thickness and firmness granular to almost smooth". Although not mentioned in this description, the illustration of the holotype (pl. XII, fig. 4), from the ? Upper Jurassic Learmonth Formation of the Carnarvon Basin, showed a thin outer membrane around an inner faintly granulate capsule, but no outer membrane is recorded for the genotype Pareodinia ceratophora (Deflandre, 1947; Sarjeant, 1959; 1961, 1962). The only strongly granulated specimen figured by Cookson & Eisenack (Pl.12, fig.9) was taken from stratigraphically older beds, the Dingo Claystone, and apparently lacked the outer membrane. Cookson & Eisenack (1960, Pl. 39, figs. 2, 3) illustrated a larger, but mono-horned, plateless body under the name Kalyptea monoceras, noting that the genus Kalyptea is characterized by an outer diaphonous membrane, and remarking that P.aphelia Cookson & Eisenack 1958, Pl. 12, fig. 4, i.e. the holotype of P.aphelia, "might be an imperfect example of K.monoceras", if the latter observation is correct, K.monoceras is a synonym of P.aphelia. As Pareodinia has no outer membrane, in future taxonomic work, P.aphelia should not be included in that genus but in Kalyptea, thus - Kalyptea aphelia (Cookson & Eisenack 1958): Syn. - K.monoceras C & E 1960. Another taxon should be found for the granulate specimen, Cookson & Eisenack 1958, Pl.12, fig. 9.

Pterospermopsis australiensis Deflandre & Cookson
Plate 2, figure 4

This is a common fossil in many Lower Cretaceous samples from the Archer River area.

Scriniodinium attadalense (Cookson & Eisenack)
Plate 1, figure 11

Syn: Gymnodinium attadalense Cookson & Eisenack 1958, Pl.1, fig.7
Scriniodinium (Scriniodinium) attadalense (Cookson & Eisenack) 1958) Klement 1960, P.18.

Cookson & Eisenack distinguished S.attadalense from the Jurassic S.crystallinum, S.luridum, and S.parvimarginatum, by the shape of its test, its squarish outline and unequally divided body with a longer and somewhat more pointed hypotheca. However Cookson & Eisenack (1960, Pl.37, fig.10) depicted a similarly trapezoid Scriniodinium as S.luridum making their distingiushing criteria difficult to uphold. Klement (1960) placed S.attadalense in the subgenus S.(Scriniodinium) and S.luridum in the subgenus S.(Endoscrinium) on the apparent absence of plating in the former and its presence in the latter.

The Archer River and Papuan specimens lack plates and shows variations in shape from the trapezoid outline of the holotype of S.attadalense to the sub-circular line of S.luridum. Because of the lack of plating, other than the obvious development of an apical cum intercalary archeopyle, the Archer River specimens are referred to S.attadalense.

The overlaps of the range of this species with those of Cannosphaeropsis mirabilis in the lower part and Dingodinium cerviculum in its upper part are useful stratigraphic markers.

Veryhachium Deuff
Plate 1, figure 9; Plate 2, figure 7

Forms of Veryhachium occur throughout the Mesozoic and are of questionable environmental significance. They are particularly abundant in RP 101 of the D.cerviculum/S.attadalense Zone from which the specimen illustrated in Pl.1, figure 9 was extracted.

aff. "Wetzeliella (?) neocomica Gocht"
Plate 2, figure 5

Only one specimen referable to this peculiar species has been observed in the Archer River area. It consists of a flattened membrane with an inner, polygonal capsule. The outer membrane displays a thin smooth apical horn (not figured, but lying close by on the slide) and irregular protruberances around the margin of the hypothecal region.

The larger protruberances include an antapical horn and an equatorial growth (on one side only) not as long as the typical processes of Muderongia. Growths of this sort are found in several specimens figured by Gocht (1957, Pl.19, fig. 2; Pl. 20, fig.1) under the name Wetzeliella in its diamond shaped outline, but it lacks the secondary processes from the apical region. It is figured here as it is such a distinctive form, unlike any yet depicted from the Australian region, other than those reproduced by Edgell (1964, Pl.31, fig.1 - 3) from the Perth Basin. Edgell's specimens 2 and 3 had more numerous, fine secondary processes than both Gocht's German fossils and the Archer River specimen. Edgell's figure 1 appears to be complete with a slender apical horn, as possessed by the Archer River specimen, but lacks the secondary processes. Nevertheless it is perhaps stratigraphically significant that dinoflagellates of the same basic construction as Wetzeliella (?) neocomica occur in beds of comparable age in both Europe and Australia.

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EXPLANATION OF PLATES 1 - 3

PLATE 1.

Figure

1. Plicatella tricornitata (Weyland & Greifeld).
MFP 4021.2.053.200. Archer River S.S., AR1, SP 25,
38 feet. Lower Cretaceous ?Kld.

2. Cicatricosisporites ludbrooki Dettmann.
MFP 4050.2.069.102. Archer River S.S., AR4, RP
107/V11, 60 feet. Lower Cretaceous, D.Cerviculum/
S.attadalense Zone.

3. Cicatricosisporites hughesi Dettmann.
MFP 4021.2.107.106. Archer River S.S., AR1, SP 25,
38 feet. Lower Cretaceous, O.operculata Zone.

4. Cicatricosisporites sp.
MFP 4021.2.109.107. Archer River S.S., AR1, SP 25,
38 feet. Lower Cretaceous, O.operculata Zone.

5. Crybelosporites stylosus Dettmann.
MFP 2615.1.020.051. O.S.L. Iamara No.1, c.10,
3519 feet. Lower Cretaceous Kla, C.mirabilis/S.attadalense
Zone.

7. Murospora florida (Balme).
MFP 2615.1.126.082. O.S.L. Iamara No.1, c.10, 3519
feet. Lower Cretaceous Kla, C.mirabilis/S.attadalense
Zone.

8. Odontochitina operculata (O. Wetzel).
MFP 4022.1.165.117. Archer River S.S., AR2, SP 134,
60 feet. Lower Cretaceous. O.operculata Zone.

9. Veryhachium sp.
MFP 4032.1.138.155. Archer River S.S., AR2, SP 101,
58 feet. Lower Cretaceous, D.cerviculum/S.attadalense Zone.

10. Cannosphaeropsis mirabilis Cookson & Eisenack.
MFP 2615.1.005.096. O.S.L. Iamara No.1, c.10, 3519 feet.
Lower Cretaceous, C.mirabilis/S.attadalense Zone.

11. Scriniodinium attadalense (Deflandre & Cookson).
MFP 4032.2.165.072. Archer River S.S., AR2, SP 101 58 feet.
Lower Cretaceous, C.mirabilis/S.attadalense Zone.

12. Dingodinium cerviculum Cookson & Eisenack.
MFP 4048.1.061.093. Archer River S.S., AR4, RP 103/V11,
100 feet. Lower Cretaceous, D.cerviculum/S.attadalense Zone.

13. Fungal conidiophore, undetermined.
MFP 4033.2.069.159. Archer River S.S., AR4, RP 109/V11,
60 - 62 feet. Lower Cretaceous ?C.mirabilis/S.attadalense
Zone.

14. Muderongia mcwhaei Cookson & Eisenack.
MFP 4052.1.178.104. Archer River S.S., AR4, SP 111,
102 feet. Lower Cretaceous D.cerviculum Zone.

PLATE 2.

Figure

1. *Chlamydophorella* sp.
MFP4047.1.054.069. Archer River S.S., AR 3, SP314, 57 Feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

2. *Muderongia* sp. nov.
MFP4032.1.262.917. Archer River S.S., AR 2, SP101, 58 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

3. *Muderongia* sp. nov.
MFP4047.1.064.171. Archer River S.S., AR 3, SP314, 57 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

4. *Pterospermopsis australiensis* Deflandre & Cookson.
MFP4033.1.119.138. Archer River S.S., AR 4, RP109/V11, 60-62 feet. Lower Cretaceous, ?*C.mirabilis/S.attadalense* Zone.

5. aff. "*Wetzeliella? neocomica* Gocht"
MFP4032.1.109.075. Archer River S.S., AR 3 RP101, 58 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

6. *Muderongia mcwhaei* Cookson & Eisenack.
MFP4051.1.143.164. Archer River S.S., AR 4, RP107/V11, 102 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

7. *Veryhachium* sp.
MFP4048.1.079.047. Archer River S.S., AR 4, RP103/V11, 100 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

8. *Palaeostomocystis* sp. nov.
MFP4049.2.092.116. Archer River S.S., AR 4, RP105/V11, 102 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

9. *Muderongia tetracantha* (Gocht).
MFP4081.1.003.123. Archer River S.S., AR 1, SP90, cuttings 450 feet. Lower Cretaceous, *D.cerviculum* Zone.

10. *Broomea micropoda* Cookson & Eisenack.
MFP4051.2.028.119. Archer River S.S., AR 4, RP107/V11, 102 feet. Lower Cretaceous, *D.cerviculum/S.attadalense* Zone.

11. *Palaeostomocystis* sp. aff. *P.cylindrica* Cookson & Eisenack.
MFP2615.1.086.103. O.S.L. Iamara No.1, c.10, 3519 feet. Lower Cretaceous, *C.mirabilis/S.attadalense* Zone.

PLATE 3.

Figure

1. Hystrichosphaeridium cf. eionides Eisenack.
MFP4048.1.145.025. Archer River S.S., AR 4,
SP103/V11, 100 feet. Lower Cretaceous,
D.cerviculum/S.attadalense Zone.

2. Hystrichosphaeridium perforans Gocht.
MFP4049.1.050.036. Archer River S.S., AR 4,
RP105/V11, 102 feet. Lower Cretaceous.
D.cerviculum/S.attadalense Zone.

3. Diconodinium multispinum (Deflandre & Cookson).
MFP4025.2.082.125. Archer River S.S., AR 2,
SP182, 98-100 feet. Lower Cretaceous.
O.operculata Zone.

4. Diconodinium multispinum (Deflandre & Cookson).
MFP4025.2.069.140. Archer River S.S., AR 2,
SP182, 98-100 feet. Lower Cretaceous.
O.operculata Zone.

5. "Pareodinia" aphelia Cookson & Eisenack.
MFP4034.1.025.196. Archer River S.S., AR 4,
RP109/V11, 100 feet. Lower Cretaceous,
?C.mirabilis/S.attadalense Zone.

6. "Gen. et sp. indet Form A" Eisenack & Cookson,
MFP4031.1.175.142. Archer River S.S., AR 3,
SP95/V11, 100 feet. Lower Cretaceous, unit Kla,
D.cerviculum/S.attadalense Zone.

7. Canningia sp. nov.
MFP4049.2.183.073. Archer River S.S., AR 4,
RP105/V11, 102 feet. Lower Cretaceous,
D.cerviculum/S.attadalense Zone.

8. Baltisphaeridium sp.
MFP4051.2.193.038. Archer River S.S., AR4,
RP107/V11, 102 feet. Lower Cretaceous,
D.cerviculum/S.attadalense Zone.

9. Baltisphaeridium parvispinum (Deflandre)
MFP4034.2.199.088. Archer River S.S., AR 4,
RP109/V11, 100 feet. Lower Cretaceous,
?C.mirabilis/S.attadalense Zone.

10. Hystrichosphaeridium isocalamus Deflandre & Cookson.
MFP4034.2.201.166. Archer River S.S., AR 4,
RP109/V11, 100 feet. Lower Cretaceous,
?C.mirabilis/S.attadalense Zone.

11. Baltisphaeridium sp.
MFP4024.1.193.159. Archer River S.S., AR 2,
SP166, 60 feet. Lower Cretaceous, O.operculata Zone.

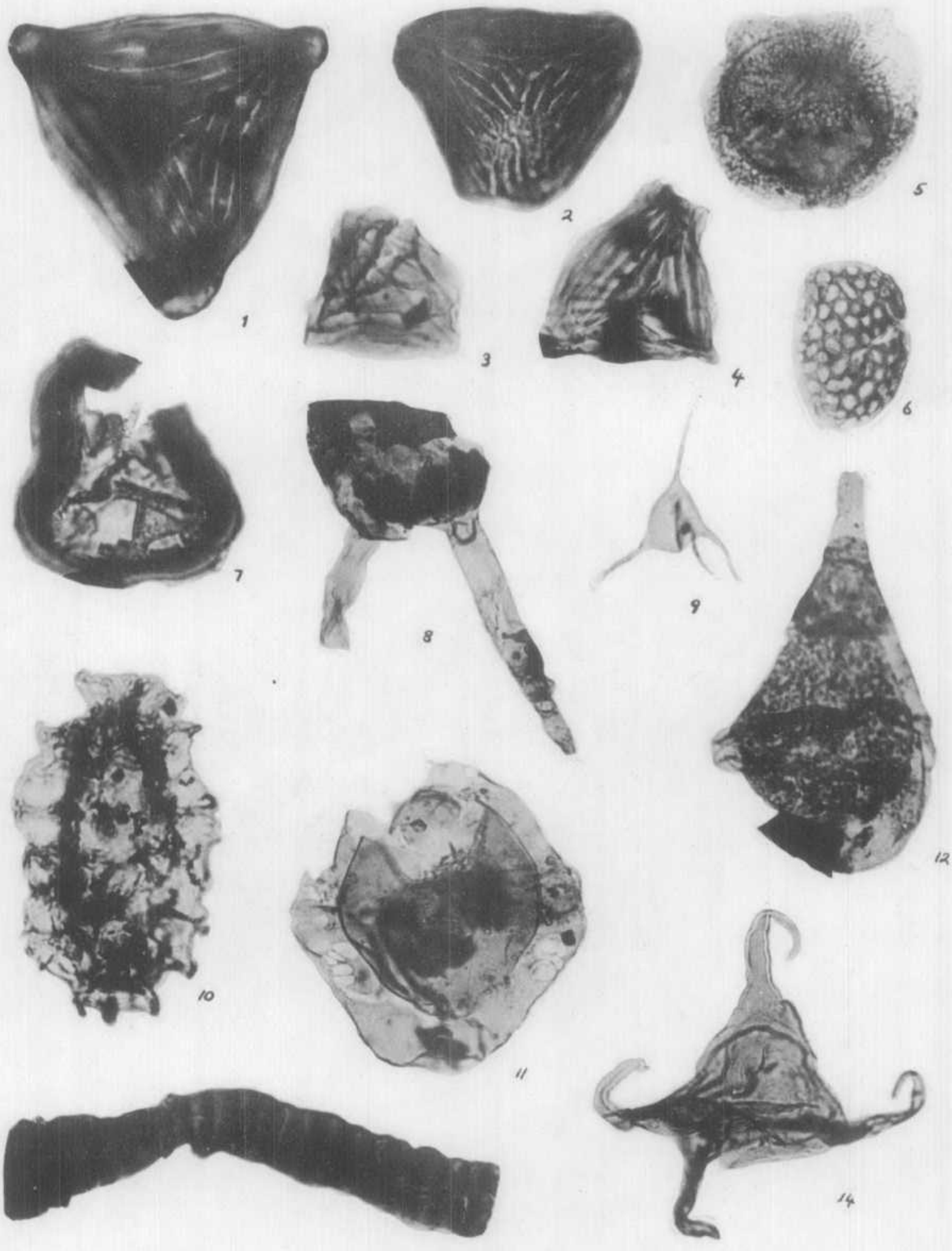

PLATE 1

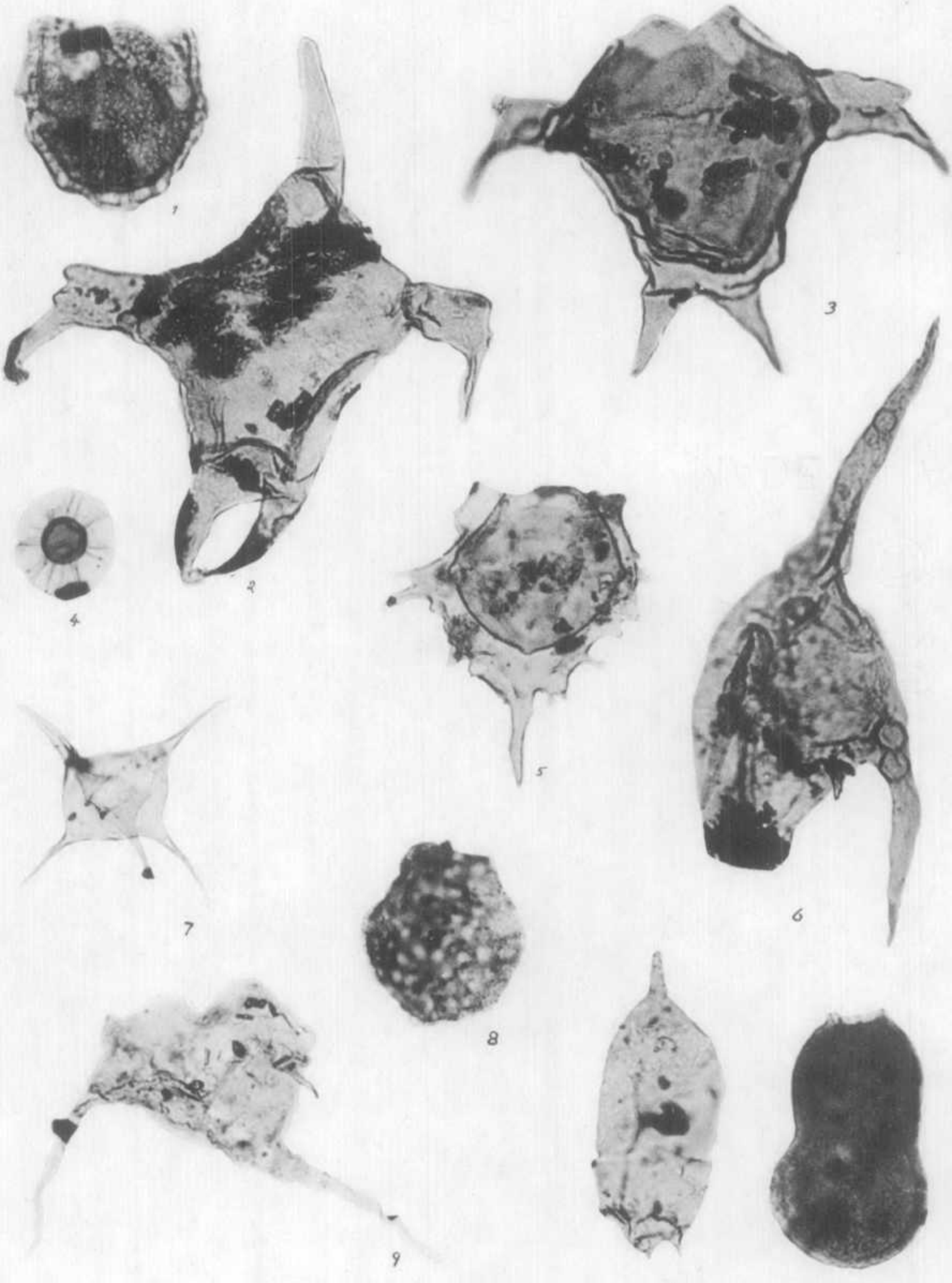

PLATE 2

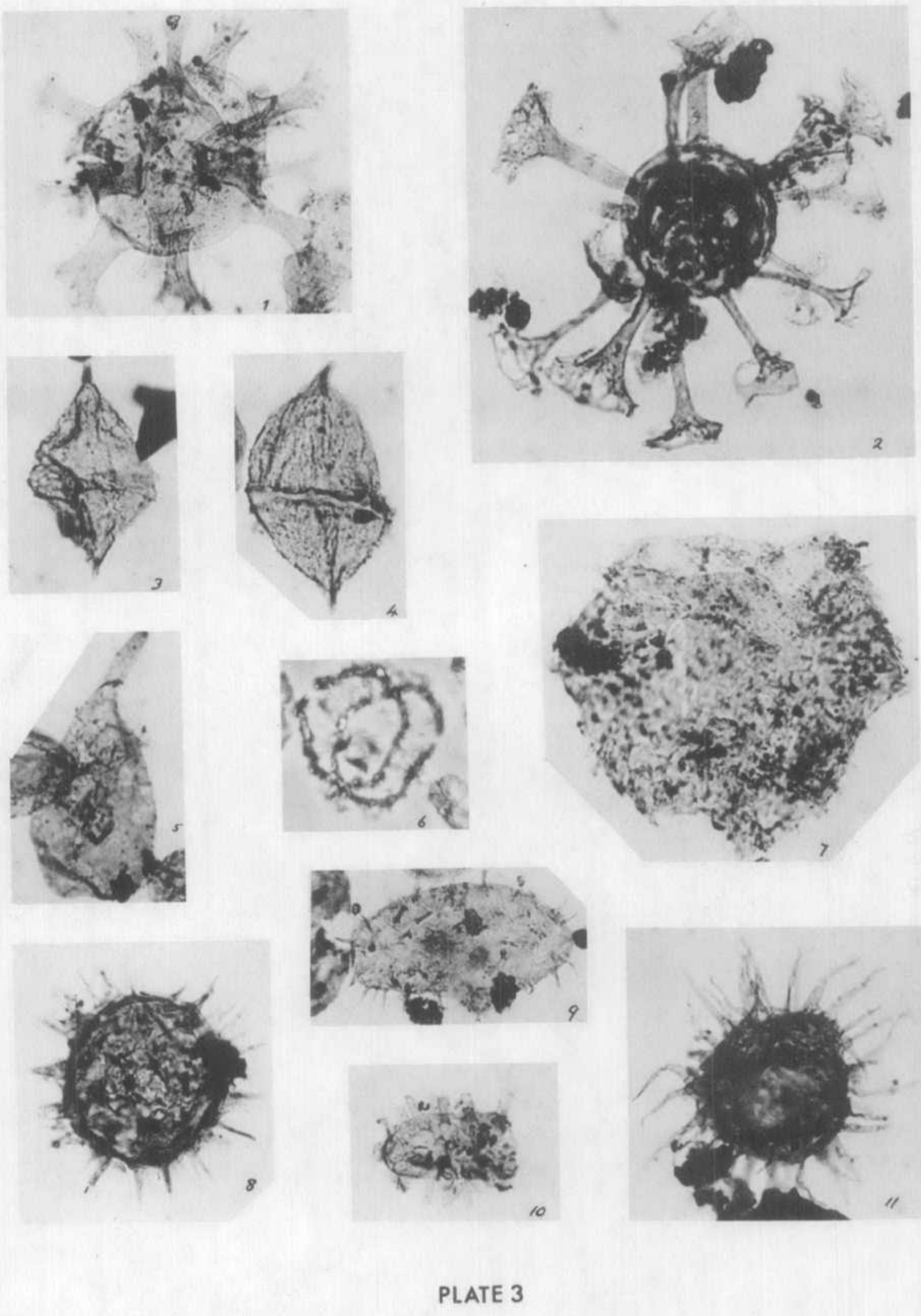

PLATE 3