BULLETIN 189

Palynological studies in the Lower Cretaceous of the Surat Basin, Australia

D. BURGER

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1980

DEPARTMENT OF NATIONAL DEVELOPMENT

MINISTER: THE HON. K. E. NEWMAN, M.P.

SECRETARY: A. J. WOODS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Published for the Bureau of Mineral Resources, Geology and Geophysics by the Australian Government Publishing Service

ISBN 0 642 04452 X

DATE OF ISSUE: 15.FEB.1980

This Bulletin was edited by W. H. Oldham

Printed by Graphic Services Pty Ltd, Northfield, S.A.

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ABSTRACT

This study deals with palynological work in Aptian and lower to middle Albian sediments of marine and terrestrial origin in the Surat Basin of southeastern Queensland and northeastern New South Wales. It comprises stratigraphic coverage of (a) the spore and pollen sequence, which is subdivided into three intervals: the *Osmundacidites dubius* Zone of Aptian age, the *Crybelosporites striatus* Zone of early Albian age, and the *Coptospora paradoxa* Zone of mid-Albian age; and (b) the dinoflagellate sequence, in which a lower subdivision, the *Odontochitina operculata* Zone of Aptian age, and an upper subdivision, the *Pseudoceratium turneri* Zone of early to middle Albian age, are distinguished.

Systematic study includes a discussion of problems concerning dinoflagellate classification, and outlining a system for Australian fossil dinoflagellate cysts, based on paratabulation, mode of archaeopyle formation, and ornamental structure. Description and documentation of the microfossils includes 38 genera and 72 species of spores, 18 genera and 21 species of pollen grains, and 35 genera and 60 species of dinoflagellates. Four new species of spores: *Lycopodiacidites dettmannae, Lycopodiumsporites solidus, Osmundacidites dubius, Stereisporites pocockii;* eight new species of fossil dinoflagellates: *Cleistosphaeridium granulatum, Diconodinium paucigranulatum, Leptodinium simplex, Membranosphaera coninckii, M. norvickii, M. romaensis, Tenua aptiense, Trichodinium eisenackii;* and one new variety: *Canningia minor* var. *psilata* are proposed.

A total of 17 species and form groups ranked as species assigned to 7 genera of acritarchs and 'chlorophytes' are described and documented. One new acritarch species, *Palaeostomocystis pergamentaceus,* is proposed.

The spore and pollen floras include a large proportion of pteridophyte and pteridosperm elements; gymnosperms form only a small minority. Angiosperm pollen grains first appear in the Albian sequence. *Clavatipollenites hughesii* and *Asteropollis asteroides* appear in the *Crybelosporites striatus* Zone, and other monosculate forms (*Liliacidites*) as well as tricolpate pollen grains (*Tricolpites variabilis, Rousea georgensis*) appear sporadically in the *Coptospora paradoxa* Zone.

The dinoflagellate assemblages consist mainly of gonyaulacacean proximate cyst genera; chorate forms (*Cleistosphaeridium, Hystrichosphaeridium*) form a small minority in the Aptian, and slightly increase in the Albian. Acritarch assemblages are dominated throughout the record by the genera *Leiosphaeridia* and *Micrhystridium.*

From analysis of proportional abundances of the groups of spores and pollen, dinoflagellates, and acritarchs in the total assemblage counts, and fluctuations of these abundances with time, a tentative approach is outlined towards reconstruction of past environments and palaeogeography in the Surat Basin. It is shown that statistical (numerical) records of individual fossils as abundance fractions of the group of which they are part (i.e. spores and pollen; dinoflagellates; acritarchs) may lead to preliminary conclusions on how these fossils behaved with changing conditions, and thus give some indications as to their ecological preferences.

CHAPTER I. INTRODUCTION

1. ORIGIN AND PURPOSE OF STUDY

The Surat Basin extends across southeastern Queensland and northeastern New South Wales (Fig. 1) and includes marine and non-marine clastic sediments of Early Jurassic to Early Cretaceous age (Exon, 1976). It is separated from the Eromanga Basin, which extends mainly across central and southern Queensland, by the Nebine Ridge in the northwest, and the Cunnamulla Shelf farther south.

The palynology of the Jurassic rock sequence in the Queensland portion of the basin is being studied by the Geological Survey of Queensland. The Cretaceous sequence—including samples from New South Wales—has been periodically studied for more than 15 years by P. R. Evans and D. Burger. The deeply weathered outcrop sediments are almost invariably barren of plant microfossils, so that palynological work has depended mainly on the availability of subsurface rock material obtained from commercial drilling (especially in the Roma area), and shallow stratigraphic drilling by the Bureau of Mineral Resources. This work usually was advisory and the results were mostly presented in petroleum company well completion reports, and geological progress reports by the Bureau of Mineral Resources, which offered limited opportunity to discuss problems of biostratigraphy, taxonomy, and palaeoenvironments.

Gradually, however, a wealth of study material was accumulated from various drilling projects, including shallow stratigraphic drilling by the Geological Survey of Queensland. Consequently, after regional fieldwork and the various drilling activities had been completed, the author was given the task of synthesising all available information in order to describe and formalise the Cretaceous microfloral zonal scheme so that a higher degree of accuracy could be achieved in correlative studies, and also to update and complement taxonomic and descriptive work on the plant microfossils.

The results of biostratigraphic work in the earliest Cretaceous (Neocomian) sequence of the Surat and Eromanga Basins have already been published (Burger, 1973b, 1974).

2. OTHER RELEVANT PALYNOLOGICAL AND MICROPALAEONTOLOGICAL STUDIES

Stratigraphic and taxonomic spore and pollen studies in the Cretaceous of the Otway, Gippsland, and Eromanga Basins in Victoria, New South Wales, and South Australia by Dettmann (1963), Dettmann & Playford (1968, 1969), and Dettmann & Douglas (1976) have described significant zone-indicative sporomorph species and delineated microfloral intervals that are also recognised in the Cretaceous of Queensland. The proposed pollen zones into which the Surat Basin sequence is subdivided can be correlated in detail with Dettmann & Douglas's (1976) scheme (Fig. 23).

Many dinoflagellate species here documented were first described during extensive work on Australian Mesozoic marine microplankton by Alfred Eisenack and the late Isabel Cookson. Dinoflagellate studies in the Aptian and Albian of New South Wales and Queensland by R. Morgan, of the Geological Survey of New South Wales, include a revision of Evans's (1966b) dinoflagellate zonal scheme for the marine Cretaceous sequence in northeastern Australia. The present study on dinoflagellates has been closely correlated with Morgan's work, and the zonation which he (1977) erected for the Neocomian to Albian sequence can be recognised in detail in the Surat Basin record.

A recently completed environmental and biostratigraphic study of Early Cretaceous foraminifera in Queensland and South Australia by D. W. Haig has given additional control on correlation between the Lower Cretaceous sediments of the Eromanga and Surat Basins.

Cretaceous foraminifera from the Eromanga Basin in Queensland and New South Wales have also been studied (Scheibnerová, 1976, with refs.) in the Geological Survey of New South Wales.

3. METHODS OF ANALYSIS AND DATA PRESENTATION

The Aptian and Albian microfloral sequence preserved in the Surat Basin was compiled from analysis of samples collected by the Bureau of Mineral Resources, the Geological Survey of Queensland, and a number of private companies drilling for oil and natural gas. Altogether, 84 samples were examined; they include 11 cores and 1 cuttings sample from the Bungil Formation, 12 cores from the Doncaster Member, 14 cores, 1 sidewall core, and 1 cuttings sample from the Coreena Member, 14 cores, 1 sidewall core, and 3 cuttings samples from the Surat Siltstone, and 16 cores and 10 cuttings samples from the Griman Creek Formation.

The stratigraphic positions of the samples are shown in three correlation diagrams, which cover successive intervals of the rock sequence (Figs. 6-8). The

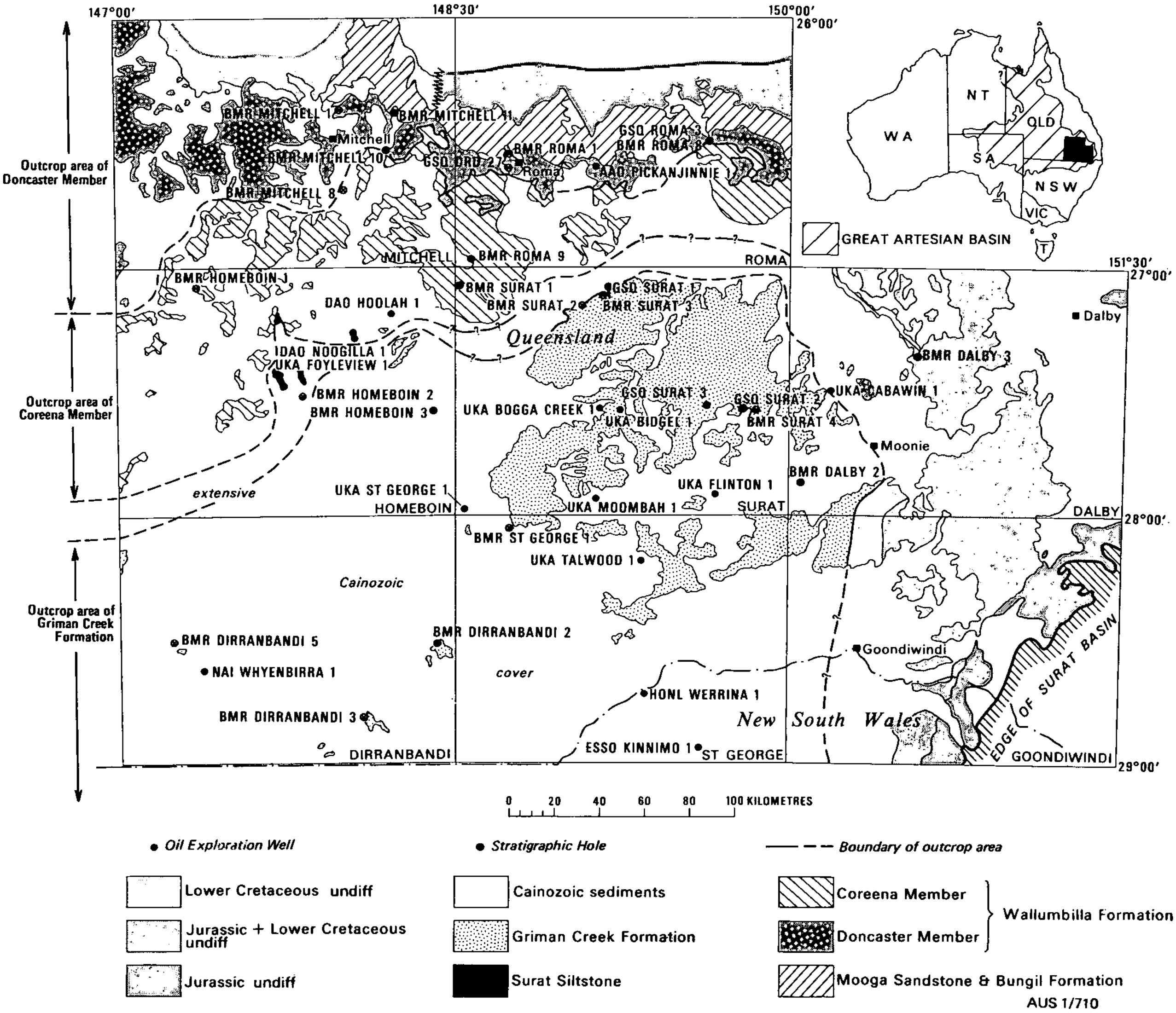

Fig. 1. Geology of the Surat Basin (simplified after Exon, 1976), and locations of wells and boreholes.

locations of drilled sections from which the samples were taken are plotted in Figure 1. Specifications regarding commercially drilled wells are given in Table 1.

This study contains a selection of all available palynological information on the Surat Basin. Data from cores and sidewall cores were given highest importance. Samples from cuttings examined from several wells (among which are UKA Foyleview 1, UKA Moombah 1, UKA St George 1) had to be rejected because of contamination from caving. Selected well sections from which no cores were available were sampled (cuttings) from immediately underneath the casing, thus minimising the risk of contamination. Specifications of samples are given in Figures 3 and 4.

Two preparations (or more if necessary) were made up from each sample residue, and each preparation was completely scanned. Species and genera of plant microfossils are listed in the alphabetical register in the back of the Bulletin. Spores and pollen grains are illustrated in Plates 1-20, dinoflagellates in Plates 21-46, acritarchs and other plant microfossils in Plates 46-48. Documentation on illustrated specimens (see the Plate legends) is given in the form of generic and (if possible) specific identification, author's reference, location (well, stratigraphic hole, and depth below surface), lithostratigraphic unit, sample and preparation number (MFP), microscope stage coordinates, and Commonwealth Palaeontological Collection (CPC) registration number.

The specimens selected for illustration have been lodged in the Commonwealth Palaeontological Collection, Bureau of Mineral Resources, Canberra, under CPC numbers 13893 and 16092-16497.

Tables and Figures including occurrence and stratigraphic distribution of fossil species are given in various chapters, and the figure numbers are here given for convenience.

	Sample occurrence	*Stratigraphic distribution*	*Statistical data*
Spores and pollen grains	Fig. 3 Fig. 4	Fig. 5	Fig. 18 Fig. 19 Fig. 20
Dinoflagellates	Fig. 10 Fig. 11 Fig. 12	Fig. 13	Fig. 21
Acritarchs and other microfossils	Fig. 10 Fig. 11 Fig. 12	Fig. 13	Fig. 22

The results of statistical analysis are tabulated in Appendixes A-D. Appendix A contains the total-assemblage analyses, Appendix B the spore and pollen assemblage analyses, Appendix C the marine (dinoflagellate) assemblage analyses, and Appendix D the acritarch assemblage analyses.

4. CRETACEOUS STRATIGRAPHY OF THE SURAT BASIN

The results of detailed regional mapping by the Bureau of Mineral Resources (in which the author participated) and the Geological Survey of Queensland have been presented in various BMR Records and Explanatory Notes. Exon (1976) summarised the lithological and palaeontological information to date, regarding the entire basin; the Cretaceous stratigraphic nomenclature here used (Table 2) has been derived from his study, as has the simplified geological map shown in Figure 1.

The formations may be traced in the subsurface throughout most of the Surat Basin as a result of

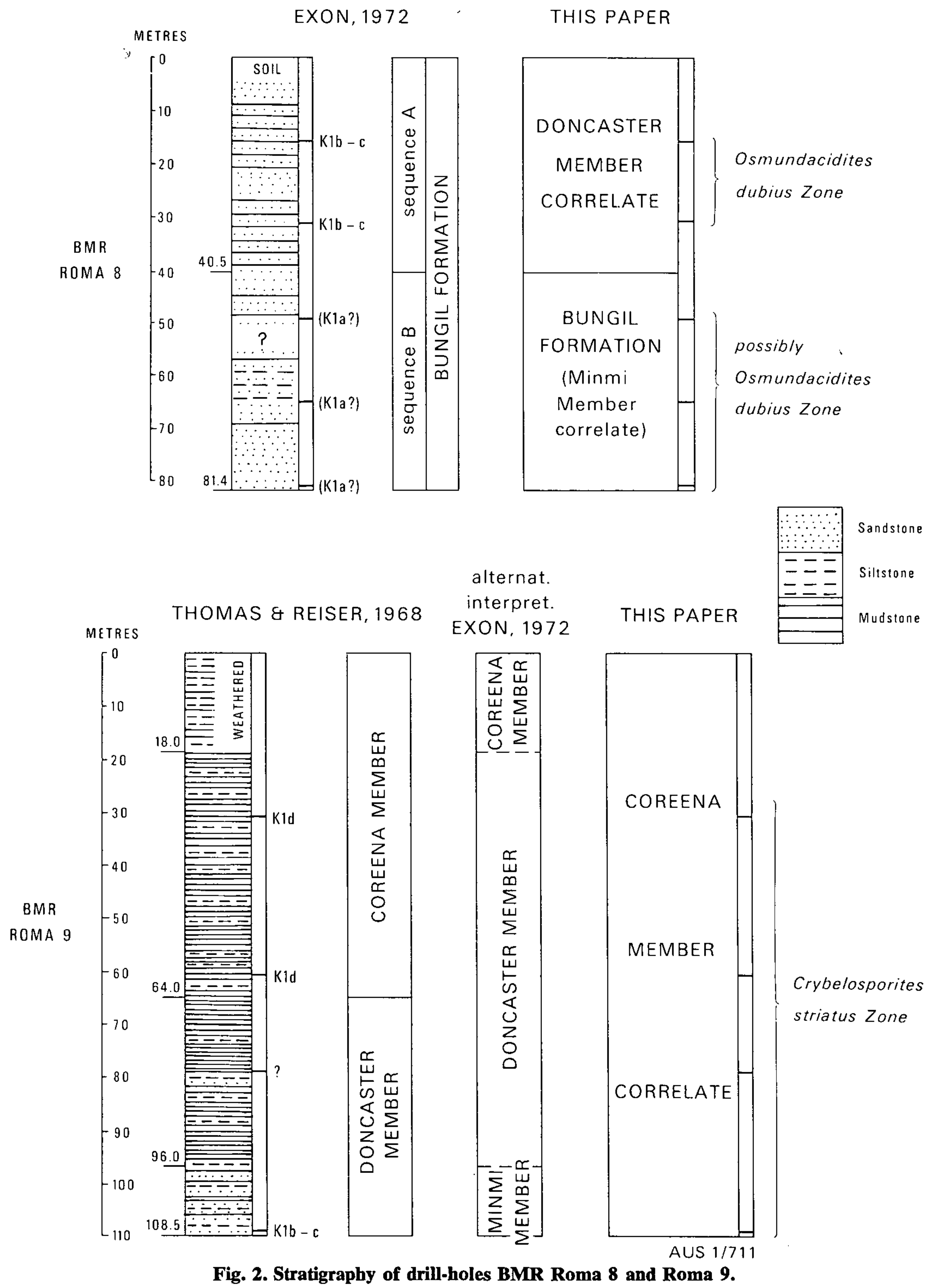

Fig. 2. Stratigraphy of drill-holes BMR Roma 8 and Roma 9.

TABLE 1. SPECIFICATIONS OF COMMERCIAL WELLS REFERRED TO IN THIS BULLETIN

Well	*Location*	*1:250 000 Sheet area*	*Year drilled*	*Full reference**	*Stratigr. data*
UKA BIDGEL 1	27°34′41″ S 149°14′08″ E	Surat	1963	†U.O.C., 1964—Union Oil Development Corporation A. to P. 57P, Qld, Well Completion Report No. 23. Union-Kern-AOG Bidgel No. 1 (unpubl.).	1
UKA BOGGO CREEK 1	27°34′14″ S 140°08′46″ E	Surat	1964	Herrmann, F. A., 1964—Union Oil Development Corporation A. to P. 57P, Qld, Well Completion Report No. 25. Union-Kern-AOG Boggo Creek No. 1 (unpubl.).	1
UKA CABAWIN 1	27°29′46″S 150°11′22″ E	Dalby	1961	†U.O.C., 1964—UKA Cabawin No. 1, Queensland. *P.S.S.A. Publ.* 43‡.	1
UKA FLINTON 1	27°54′52″ S 149°40′10″ E	Surat	1963	†U.O.C., 1965—UKA Flinton No. 1; UKA Coomrith No. 1; UKA Wunger No. 1. *P.S.S.A. Publ.* 61‡.	1
UKA FOYLEVIEW 1	27°17′30″ S 148°02′52″ E	Homeboin	1968	†U.O.C., 1968—Union Oil Development Corporation A. to P. 57P, Qld, Well Completion Report No. 36. Union-Kern-AOG Foyleview No. 1 (unpubl.).	2
DOA HOOLAH 1	27°11′18″ S 148°08′49″ E	Homeboin	1971	Damson Oil (Australia) Ltd, 1971—Well Completion Report: Drilling of Foyleview Prospect (unpubl.).	2
ESSO KINNIMO 1	28°56′30″ S 149°35′56″ E	St George	1966	Esso Exploration Australia Inc., 1966—Esso Kinnimo 1 NSW Well Completion Report (unpubl.).	3
UKA MOOMBAH 1	27°56′00″ S 149°07′50″ E	Surat	1964	†U.O.C., 1964—Union-Kern-AOG (1964) Moombah No. 1 Union Oil Development Corporation A. to P. 57P, Qld. Well Completion Report No. 27 (unpubl.).	1
DOA NOOGILLA 1	27°16′53″ S 148°03′21″ E	Homeboin	1971	See DOA Hoolah 1.	2
AAO PICKANJINNIE 1	26°35′42″ S 149°07′18″E	Roma	1960	Derrington, S. S., 1964—A.A.O. Pickanjinnie No. 1, Qld, of Associated Australian Oilfields N.L. *P.S.S.A. Publ.* 22‡.	3
UKA ST GEORGE 1	27°58′48″ S 148°32′48″ E	Surat	1963	†U.O.C., 1963—Union Oil Development Corporation A. to P. 57P, Qld, Well Completion Report No. 21. Union-Kern-AOG St George No. 1 (unpubl.).	1
UKA TALWOOD 1	28°11′02″ S 149°20′10″ E	St George	1964	†U.O.C., 1965—Union Oil Development Corporation A. to P. 57P, Qld, Well Completion Report No. 33. Union-Kern-AOG Talwood No. 1 (unpubl.).	3
HONL WERRINA 1	28°43′26″ S 149°20′50″ E	St George	1969	Woolridge, P., 1969—A.O.G. Harbourside Werrina 1 Well Completion Report (unpubl.).	3
NAI WHYENBIRRA 1	28°36′50″ S 147°21′55″ E	Dirranbandi	1966	Cundill, Meyers & Associates, 1967—North American International Inc. Whyenbirra No. 1 Well Completion Report (unpubl.).	2

* Full Reference, i.e. not repeated in List of References
† U.O.C., read Union Oil Devel. Corp., Kern County Land Co., & Aust. Oil and Gas Corp. Ltd
‡ P.S.S.A., read *Bur. Miner. Resour. Aust. Petrol Search Subs. Acts*

1—see Thomas & Reiser, 1968
2—see Exon, 1976
3—this Bulletin

intensive study of samples and wireline logs of numerous commercial wells, water bores, and shallow holes drilled by the Bureau of Mineral Resources and the Geological Survey of Queensland. Stratigraphic subdivisions of drilled sections may be found in (unpublished) Well Completion Reports, Records, Reports on the regional geology, and special reports on shallow drilling activities (Mond & Senior, 1970; Gray, 1972; Exon, 1972). Age determination of the Aptian and Albian formations is based largely on a series of publications dealing with the marine macrofossil faunas collected from outcrop localities by R. W. Day (1964, 1967, 1969, 1974). The age of the underlying non-marine sediments was discussed earlier by the author (Burger, 1973b).

The density of sampling has been satisfactory for regional biostratigraphic study throughout the rock sequence, so that the rock association of various spore and pollen zones could be determined very accurately. However, several seemingly anomalous observations were made in sections whose interpretation was difficult owing to the unusual lithological properties of the sampled sediments. During discussions with Dr N. F. Exon various alternative interpretations were analysed for each of these sections. This resulted in a revised stratigraphic interpretation of BMR Roma 8 and BMR Roma 9 stratigraphic holes (Fig. 2). These bores are briefly discussed below.

BMR Roma 8 was drilled through glauconitic fine-grained sandstone, siltstone, and mudstone, which were regarded as part of the Bungil Formation (Exon, 1972). Unfortunately only those assemblages from the upper part of the section ('sequence A') could be dated

TABLE 2. CRETACEOUS ROCK FORMATIONS IN THE SURAT BASIN

FORMATION/Member	*Environment of deposition*	*Age*
GRIMAN CREEK FORMATION	freshwater to lacustrine, lagoonal, and sea-shore sediments	Early and middle Albian
SURAT SILTSTONE	sediments from strandline, tidal flats, coastal swamps	
WALLUMBILLA FORMATION Coreena Member	sediments formed in regressive conditions, coastal mudflats, lagoons and swamps	
Doncaster Member	sediments formed in coastal to offshore, shallow marine, quiet environments	Late Aptian
BUNGIL FORMATION Minmi Member	strandline and lagoonal, brackish to non-marine deposits	Early Aptian
Nullawurt Sandstone Member	brackish, nearshore, current- and wave-action deposits	Neocomian
Kingull Member	non-marine, coastal swamp deposits	
MOOGA SANDSTONE	non-marine, current-action deposits	

(*Osmundacidites dubius* Zone). More recently the Geological Survey of Queensland drilled a stratigraphic hole (GSQ Roma 3) close to the site of BMR Roma 8 and continuously cored the entire section to a total depth of 271 m. Gray (1972) interpreted the interval from surface to 40.5 m (133 feet) depth, which is the 'sequence A' equivalent interval, as part of the Doncaster Member of the Wallumbilla Formation, and the remainder of the section as the Bungil Formation. Palynological examination of this bore (Burger, 1974) proved most of the 'sequence A' and 'sequence B' equivalent sediments to be associated with the *Osmundacidites dubius* Zone. Statistical analysis favoured Gray's interpretation by demonstrating that these assemblages, as well as those from BMR Roma 8, were closer in composition to assemblages from the Doncaster Member in GSQ DRD 27 and GSQ Surat 1 than to those from the Minmi Member (Bungil Formation) of various BMR bores in the Roma and Mitchell Sheet areas. For this reason 'sequence B' in BMR Roma 8 is interpreted as equivalent to the upper Minmi Member, and 'sequence A' as equivalent to the Doncaster Member, although unusually sandy owing to marginal conditions.

BMR Roma 9 penetrated silty mudstone and siltstone, resting on finely laminated sandstone and mudstone. Initial palynological examination (Burger, 1968a) established the presence of *Crybelosporites striatus* of the nominate zone (unit K1d) at 30.5 m. and 61 m. The sample from 108 m was dated as Aptian (unit K1b-c). Mainly on these preliminary data Thomas & Reiser (1968) interpreted the section down to 64 m depth as the Coreena Member, Wallumbilla Formation, and the remainder of the section as the Doncaster Member, of the same formation. Exon (1972), however, commented on the atypical lithology of the upper part of the section, pointing out that on lithological grounds the interval between 18 m and 96 m could equally well be regarded as the Doncaster Member. Re-examination of fresh samples proved that the entire rock interval between 30.5 m and 10.8 m is associated with the *Crybelosporites striatus* Zone. Since the zone is known only from the Coreena Member and part of the overlying Surat Siltstone the section of BMR Roma 9 is now regarded as the Coreena Member correlate. The argillaceous lithology may indicate that conditions were more marine than elsewhere (see page 27).

CHAPTER II. EARLY CRETACEOUS STRATIGRAPHIC PALYNOLOGY

1. The spore and pollen sequence
2. The dinoflagellate sequence

1. THE SPORE AND POLLEN SEQUENCE

From detailed study of the Early Cretaceous in the Surat Basin (Burger, 1973b, 1974; *in* Gray, 1972), in the Eromanga Basin (Burger, 1968a, 1969; Burger & Mond, 1973; and other unpublished reports), and in the Carpentaria Basin (Burger, 1973a) it gradually became clear that the Early Cretaceous sequence is remarkably uniform throughout Queensland and is also closely comparable with the sequence in southeastern Australia investigated in detail by Dettmann (1963, 1973), Dettmann & Playford (1969), and Dettmann & Douglas (1976). In delineating individual zones about 30 species have proven their value for correlation and have given great confidence in the accuracy with which these zones can be traced on an interbasinal scale. Given the added benefit that several intervals are associated with sediments which have been faunally dated it can be concluded that each of the Early Cretaceous zones is approximately time-concordant throughout eastern Australia.

The Cretaceous spore and pollen sequence preserved in the Surat Basin (Figs. 3 and 4) can be divided into six major intervals, whose limits are defined by first and/or last occurrence of selected spore species (Fig. 5). The oldest three intervals, which together represent the *Murospora florida* Zone, have been discussed earlier (Burger, 1973b, 1974); they comprise the entire Neocomian of Queensland. The succeeding intervals, of Aptian to middle Albian age, are discussed in the following pages, in stratigraphic succession.

The Osmundacidites dubius *Zone*

Characteristics: The *Osmundacidites dubius* Zone succeeds the (Neocomian) *Murospora florida* Zone, and is in turn succeeded by the (early Albian) *Crybelosporites striatus* Zone. It is the equivalent interval of Evans's (1966a) palynological unit K1b-c, and the middle and upper intervals of Dettmann & Playford's (1969) *Cyclosporites hughesii* Subzone (see Dettmann & Douglas, 1976).

Characteristic of this part of the sequence is the absence of *Murospora florida,* which occurs in the previous Zone, and *Crybelosporites striatus, Crybelosporites punctatus, Clavatipollenites hughesii,* and *Asteropollis asteroides,* which have been observed in the following (Albian) sequence. The following species are common to abundant in every sample:

Cyathidites minor
Cyathidites rafaeli
Baculatisporites comaumensis
Stereisporites antiquasporites
Gleicheniidites circinidites
Lycopodiumsporites austroclavatidites

Less common but present in every or nearly every sample are:

Ceratosporites equalis
Leptolepidites verrucatus
Monosulcites minimus
Microcachryidites antarcticus
Cepulina truncata
Osmundacites dubius sp. nov.

Species relatively uncommon to rare, but present in many samples are:

Polycingulatisporites clavus
Cicatricosisporites australiensis
Cyathidites australis
Cyclosporites hughesii
Lycopodiumsporites circolumenus
Alisporites similis

Rare species which occur in approximately half of the samples are:

Araucariacites australis
Alisporites grandis
Callialasporites dampieri
Reticulatisporites pudens
Foraminisporis wonthaggiensis
Dictyophyllidites crenatus
Dictyotosporites complex
Dictyotosporites speciosus
Vitreisporites pallidus
Trilites cf. *T. tuberculiformis*
Lycopodiumsporites eminulus
Lycopodiumsporites nodosus
Lycopodiumsporites rosewoodensis
Velosporites triquetrus
Osmundacidites wellmanii
Podocarpidites ellipticus
Polycingulatisporites densatus

Rare species occurring in a few samples only are:

Sestrosporites pseudoalveolatus
Concentrisporites hallei
Contignisporites multimuratus
Cicatricosisporites ludbrookiae
Stereisporites pocockii sp. nov.
Crybelosporites stylosus
Trisaccites microsaccatus
Foraminisporis dailyi
Foveosporites canalis
Ischyosporites punctatus
Klukisporites scaberis
Lycopodiumsporites solidus
Leptolepidites major
Lycopodiacidites asperatus
Matonisporites cooksonae
Punctatosporites scabratus
Podocarpidites multesimus
Pilosisporites notensis

Scattered specimens of the following species were recovered (some are no doubt reworked):

Aequitriradites verrucosus
Aequitriradites spinulosus
Cyathidites punctatus
Crybelosporites berberioides

● SPECIES POSITIVELY IDENTIFIED

○ SPECIES IDENTIFICATION TENTATIVE

? SPECIES REGARDED AS OF SECONDARY ORIGIN

MICROFOSSIL SPECIES	BMR DALBY 3 CORE, 200-210'	GSQ ROMA 3 CORE, 199'	BMR MITCHELL 1 CORE, 53'	GSQ ROMA 3 CORE, 141'	BMR ROMA 1 CORE, 146'11"	BMR ROMA 1 CORE, 101'5"	GSQ SURAT 1 CORE, 1139'6"	GSQ DRD 27 CORE, 178'	GSQ SURAT 1 CORE, 1102'5"	AAO PICKANJINNIE 1 CUTT., 200-210'	BMR ROMA 1 CORE, 52'5"	BMR MITCHELL 11 CORE, 48'	GSQ DRD 27 CORE, 117'	GSQ SURAT 1 CORE, 1049'10"	BMR ROMA 8 CORE, 102'2"	GSQ ROMA 3 CORE, 94'	GSQ DRD 27 CORE, 67'	GSQ SURAT 1 CORE, 1001'6"	BMR ROMA 8 CORE, 54'1"	UKA CABAWIN 1 CORE, 1108'	GSQ SURAT 1 CORE, 797'8"	BMR HOMEBOIN 1 CORE, 477'	BMR MITCHELL 10 CORE, 394'	BMR MITCHELL 10 CORE, 281'
PALYNOLOGICAL ZONATION	OSMUNDACIDITES DUBIUS																							
ROCK UNIT	BUNGIL FORMATION												WALLUMBILLA FORMATION											
	Undiv.	Minmi equiv.			Minmi Member								Doncaster Member											
AEQUITRIRADITES SPINULOSUS																						●		
AEQUITRIRADITES VERRUCOSUS						●											●							
ALISPORITES GRANDIS	●	●	●	●	●	●		●		●	●	●				●	●	○				●	●	●
ALISPORITES SIMILIS	●	●	●	●	●	●	●	●	●	●	●	●		●		●		●	●	●	●	●	●	●
ARAUCARIACITES AUSTRALIS	●	●	●	●		●				●		●					●			●			○	●
BACULATISPORITES COMAUMENSIS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
BIRETISPORITES SPECTABILIS	●			●				●		○	●	○					?	○			○	●	●	
CALLIALASPORITES DAMPIERI				●	●					●		●	●	●	●	●			●		●	●	●	●
CEPULINA TRUNCATA	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CERATOSPORITES EQUALIS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CICATRICOSISPORITES AUSTRALIENSIS	●	●	●	●				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
CICATRICOSISPORITES HUGHESII																						○		
CICATRICOSISPORITES LUDBROOKIAE		●		●			○		●		○						○				?			
CICATRICOSISPORITES SPP. INDET.		●			●			●								●					●	●	●	
CLASSOPOLLIS CF. C. CHATEAUNOVI	●	●		●	●	●		●	●	●	●	●	●	●	●	●	●		?		○	●		
CONCENTRISPORITES HALLEI				●	●	●			●	●	○	●		○	○									
CONTIGNISPORITES COOKSONAE															●					○		●		
CONTIGNISPORITES CF. C. FORNICATUS										●														
CONTIGNISPORITES MULTIMURATUS		○		●								?		●	●								?	
CRYBELOSPORITES BERBERIOIDES					●			●	?	●										○	●			
CRYBELOSPORITES PUNCTATUS																						?		
CRYBELOSPORITES STRIATUS																					?	?		
CRYBELOSPORITES STYLOSUS	●	●			●	○				○					●					●				
CYATHIDITES AUSTRALIS		●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	
CYATHIDITES MINOR	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CYATHIDITES RAFAELI	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CYATHIDITES PUNCTATUS																						●		
CYCLOSPORITES HUGHESII	●	●	●	●	●	●	●	●	●	●	●	●			●			●	●	?			●	
DICTYOPHYLLIDITES CRENATUS	●	●	?	●	●		●	●	●	●	●	●				●	●	●	●			●	○	
DICTYOTOSPORITES COMPLEX		●		●	●	●	○	●	●	○		●	○		●	●	●	●	●			○	●	
DICTYOTOSPORITES SPECIOSUS	○	●				●		●	●		●	●	○				●	●	○			●	○	
ENDOCULEOSPORA DELICATA										●		●												
FORAMINISPORIS ASYMMETRICUS								●													●	●		
FORAMINISPORIS DAILYI	○	●					●	●	●		●	●			○							●	●	
FORAMINISPORIS WONTHAGGIENSIS	●	●	●		○	●					●	●		●	●							●	●	
FOVEOSPORITES CANALIS	●	●		●				●		●													○	
GLEICHENIIDITES CIRCINIDITES	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ISCHYOSPORITES PUNCTATUS	●		●	●				○	●						●							●		
KLUKISPORITES SCABERIS		●		●	●	●		○					●		●	●	●		●			●	●	○
LEPTOLEPIDITES MAJOR	●			●					●	●								●						●
LEPTOLEPIDITES VERRUCATUS	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●
LYCOPODIACIDITES ASPERATUS	●	●						○											●					
LYCOPODIUMSPORITES AUSTROCLAVATIDITES	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
LYCOPODIUMSPORITES CIRCOLUMENUS	●	●	●	●	●		●	●	●	●	●	●			●	●	●		●	●			●	●
LYCOPODIUMSPORITES EMINULUS	●		●	○	●	●	●	●	●	○	●	●			●				●					
LYCOPODIUMSPORITES FACETUS		●		●		○		●	○	●														
LYCOPODIUMSPORITES NODOSUS	●	●		●	●	●	●	●	●	●	●				●		●			●		●		
LYCOPODIUMSPORITES ROSEWOODENSIS	●	●		●		●	○	●		●	●	●			●		●	●	●	●	○		●	
LYCOPODIUMSPORITES SOLIDUS	●	●			●		●	●				●							●	?			●	
MATONISPORITES COOKSONAE	○			●				●				●										●		
MICROCACHRYIDITES ANTARCTICUS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●
MONOSULCITES MINIMUS	●	●	●	●		●	●		●	●	●	●	●	●	●	●	●					●	●	
OSMUNDACIDITES DUBIUS		●	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	
OSMUNDACIDITES WELLMANII		●		●	●	●			●	●	●	●			●			●	●			●	●	
PILOSISPORITES NOTENSIS	●							●			?	●					●			●		●	●	
PILOSISPORITES PARVISPINOSUS				●															○			●		
PODOCARPIDITES ELLIPTICUS	●	●	●			●		●	●	●	●				●	●	●		●			●		
PODOCARPIDITES MULTESIMUS		○		○	●	●					●	●										○		
POLYCINGULATISPORITES CLAVUS	●	●	●	●	●	●	●	●	●	●	●	●	●		●			●	●		●			
POLYCINGULATISPORITES DENSATUS	●	●	●	●		●		●		●	●	●			●									
PUNCTATOSPORITES SCABRATUS	●			○		●					●							○					●	
RETICULATISPORITES PUDENS	●	●		●	○	●	●	●	●	●	●	●					●							
SESTROSPORITES PSEUDOALVEOLATUS	○	●	○					●	○						●				●			●	●	
STEREISPORITES ANTIQUASPORITES	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
STEREISPORITES POCOCKII							●				●							●			●		●	
TRILITES CF. T. TUBERCULIFORMIS	●	●		●		●	●		●	●	●	●		●	●		●	●		●		○		
TRILOBOSPORITES ANTIQUUS		●					●		●													○		
TRISACCITES MICROSACCATUS	●		●							●		●							●		○	●	●	●
VELOSPORITES TRIQUETRUS		●	●	○		●	○	●	●	●		●							●	●		●	●	
VITREISPORITES PALLIDUS			●	●	●	●			●	●		●	●		●	●			●	●	●		●	●

AUS 1/712

Fig. 3. Distribution of spores and pollen grains in the Aptian of the Surat Basin.

PALYNOLOGICAL ZONATION: CRYBELOSPORITES STRIATUS

ROCK UNIT: GRIMAN CREEK FORMATION →

● SPECIES POSITIVELY IDENTIFIED

○ SPECIES IDENTIFICATION TENTATIVE

? SPECIES REGARDED AS OF SECONDARY ORIGIN

MICROFOSSIL SPECIES / SAMPLE SPECIFICATIONS	NAI WHYENBIRRA 1 SWC., 1000'	GSQ SURAT 1 CORE, 617'9"	BMR ROMA 9 CORE, 354'8"	GSQ SURAT 1 CORE, 551'2"	UKA CABAWIN 1 CORE, 569'8"	BMR ROMA 9 CORE, 258'6"	GSQ SURAT 3 CORE, 1489'1"	BMR ROMA 9 CORE, 200'1"	DAO NOOGILLA 1 CUTT., 850-880'	BMR MITCHELL 10 CORE, 83'6"	BMR ROMA 9 CORE, 100'2"	BMR MITCHELL 8 CORE, 86'10"	BMR SURAT 1 CORE 428'1"	BMR SURAT 3 CORE, 452'4"	UKA FLINTON 1 CUTT., 1030-1040'	BMR SURAT 3 CORE, 350'	UKA CABAWIN 1 CUTT., 100-110'	NAI WHYENBIRRA 1 SWC., 600'	GSQ SURAT 1 CORE, 300'	GSQ SURAT 3 CORE, 1326'6"	BMR SURAT 3 CORE, 246'5"	GSQ SURAT 1 CORE, 179'1"	ESSO KINNIMO 1 CUTT., 610-640'
AEQUITRIRADITES SPINULOSUS			●		?								●								?		
AEQUITRIRADITES VERRUCOSUS	?				?											?							
AEQUITRIRADITES SP. A																		●			●		
ALISPORITES GRANDIS	●		●	●	●	●	●	●	●		●					○	●	●		●		●	
ALISPORITES SIMILIS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●
ARAUCARIACITES AUSTRALIS	●				●									●				●					
ARCELLITES RETICULATUS																							
ASTEROPOLLIS ASTEROIDES	●	●		●			●						○			●					●	●	●
BACULATISPORITES COMAUMENSIS	●		●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●		●	●	
BALMEISPORITES HOLODICTYUS																							
BIRETISPORITES SPECTABILIS	○		●										●		○					●		●	
CALLIALASPORITES DAMPIERI					●	●		●		●		●	●							●			
CEPULINA TRUNCATA	●		●		●			●	●	●	●	●	●		●		●	●	●	●	●		
CERATOSPORITES EQUALIS	●		●	●	●			●	●	●	●	●	●	●	●	●	●	●	●	●		●	●
CICATRICOSISPORITES AUSTRALIENSIS	●		●	●	●			●	●	●	●	○	●	●	●	●	●	●			●	●	
CICATRICOSISPORITES HUGHESII					●								●					●			?		
CICATRICOSISPORITES LUDBROOKIAE	●												●			○	○				○		○
CICATRICOSISPORITES PSEUDOTRIPARTITUS																							
CICATRICOSISPORITES SPP. INDETERM.	●								●		●		●		●	●	●	●			●		
CLASSOPOLLIS CF. C. CHATEAUNOVI		●	●	●				●		●		●			●		●			●	●	●	
CLAVATIPOLLENITES HUGHESII				●			●		●		●		●		●	●		●	●	●	●	●	●
CLAVATIPOLLENITES SP. A														●		●							
CONCENTRISPORITES HALLEI			●		●					○	●		●	●	●	●		●			●		
CONTIGNISPORITES COOKSONAE																				○			
CONTIGNISPORITES CF. C. FORNICATUS	●									●								●					
CONTIGNISPORITES MULTIMURATUS	●					●									●				●				
COPTOSPORA PARADOXA													●								?		
CRYBELOSPORITES BERBERIOIDES		○			●			●			●		●					●					
CRYBELOSPORITES PUNCTATUS			○				●	●	○		○		●		●	●		●		●	●		○
CRYBELOSPORITES STRIATUS		●			●	●	●	●	●	○	●		●	●	●	●	●	●	●	●	●	●	●
CYATHIDITES ASPER																							
CYATHIDITES AUSTRALIS	●		●	●	●	●	●		●	●	●		●	●	●	●		●		●	●	●	●
CYATHIDITES MINOR	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CYATHIDITES PUNCTATUS		●	●						●							●		○			●	●	●
CYATHIDITES RAFAELI	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CYCLOSPORITES HUGHESII	●										●					●		●					
DICTYOPHYLLIDITES CRENATUS	●	●			●		○		●		○		●			○		●		●		●	●
DICTYOTOSPORITES COMPLEX	?								●	●						●							
DICTYOTOSPORITES FILOSUS														●				●					
DICTYOTOSPORITES SPECIOSUS	○	?	●	○					●					●			?	●		○		○	●
EPHEDRIPITES MULTICOSTATUS																		●					
FORAMINISPORIS ASYMMETRICUS	●	●	●	●	●	●		●	●	●		●	●	●	●	●		●	●	●	●	○	●
FORAMINISPORIS DAILYI		●	●	●			●	●	●					○	●			●		○		●	●
FORAMINISPORIS WONTHAGGIENSIS			●			●			○	○	●		●			●	●	●	●	○	●	●	●
FOVEOSPORITES CANALIS									●													●	
GLEICHENIIDITES CIRCINIDITES	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ISCHYOSPORITES PUNCTATUS																?				●			
KLUKISPORITES SCABERIS										○										●			
LAEVIGATOSPORITES OVATUS			?				●						●						○	●			
LEPTOLEPIDITES MAJOR				●				○					●					●					●
LEPTOLEPIDITES VERRUCATUS					●				●	●		●				●	●	●					
LILIACIDITES SPP.																							
LYCOPODIACIDITES ASPERATUS	●		●										●			●		●		?			○
LYCOPODIACIDITES DETTMANNAE							●											●					●
LYCOPODIUMSPORITES AUSTROCLAVATIDITES	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●
LYCOPODIUMSPORITES CIRCOLUMENUS				●								●											
LYCOPODIUMSPORITES EMINULUS		●	●	○			●														○		
LYCOPODIUMSPORITES FACETUS											○	●											
LYCOPODIUMSPORITES NODOSUS		●	●				●	●	●		○		●	○	●	●	○	●		○	○	●	●
LYCOPODIUMSPORITES ROSEWOODENSIS					●		●	●										●					
LYCOPODIUMSPORITES SOLIDUS								●										●					
MATONISPORITES COOKSONAE			●				●		●					○						●			●
MICROCACHRYIDITES ANTARCTICUS	●	●	●	●	●	●	●		●	●		●		●	●	●	●	●	●	●	●		●
MONOSULCITES MINIMUS	●	●	●		●	●	●	●	●		●	●	●			●		●			●	●	●
OSMUNDACIDITES DUBIUS	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●	●		
OSMUNDACIDITES WELLMANII			●	●	●	●		●				●	●	●	●	●		●	●		●		●
PILOSISPORITES GRANDIS																							
PILOSISPORITES NOTENSIS			?		?																		
PILOSISPORITES PARVISPINOSUS				●	?			●		●		?	●			●		●		●		●	●
PODOCARPIDITES ELLIPTICUS	●	●	●	●	●	●	●	●		●	●	●		○	●		●	●	○	●		●	●
PODOCARPIDITES MULTESIMUS			●																				
POLYCINGULATISPORITES CLAVUS	●		●		●																		
POLYCINGULATISPORITES DENSATUS			●		●				●	●	●		●		●	●		●			●		
PUNCTATOSPORITES SCABRATUS	●														●		●					●	
RETICULATISPORITES PUDENS							●		○					●		○				●		●	
RETIMONOCOLPITES PERORETICULATUS																○							
ROUSEA GEORGENSIS																							
RUGUBIVESICULITES SP. A			●	●						○					○								●
SESTROSPORITES PSEUDOALVEOLATUS															●				?				
STEREISPORITES ANTIQUASPORITES	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
STEREISPORITES POCOCKII		●			●	●				●	●	●		●			●	●	●			●	
TRICOLPITES VARIABILIS																							
TRICOLPATE POLLEN GRAINS INDET																							
TRILITES CF. T. TUBERCULIFORMIS	●	●			●	●			●		○			●	●	●	●	●		●		●	
TRILOBOSPORITES ANTIQUUS		●					●						●							●			
TRILOBOSPORITES TRIBOTRYS																							
TRILOBOSPORITES TRIORETICULOSUS																							
TRIPOROLETES CF. T. LAEVIGATUS			●													●	●						
TRIPOROLETES RADIATUS			●										●			●					●		
TRIPOROLETES SIMPLEX			○		●						●		●			●	●				●		
TRISACCITES MICROSACCATUS		●				●	●		●	●						○		●			●	●	●
TUBERCULATOSPORITES SP. A															●	●	●		●				
VELOSPORITES TRIQUETRUS												●				?		●					
VITREISPORITES PALLIDUS	●	●	●		●	●			●	●	●	●		●	●			●	●	●	●		●

Fig. 4. Distribution of spores and pollen grains in the Albian of the Surat Basin.

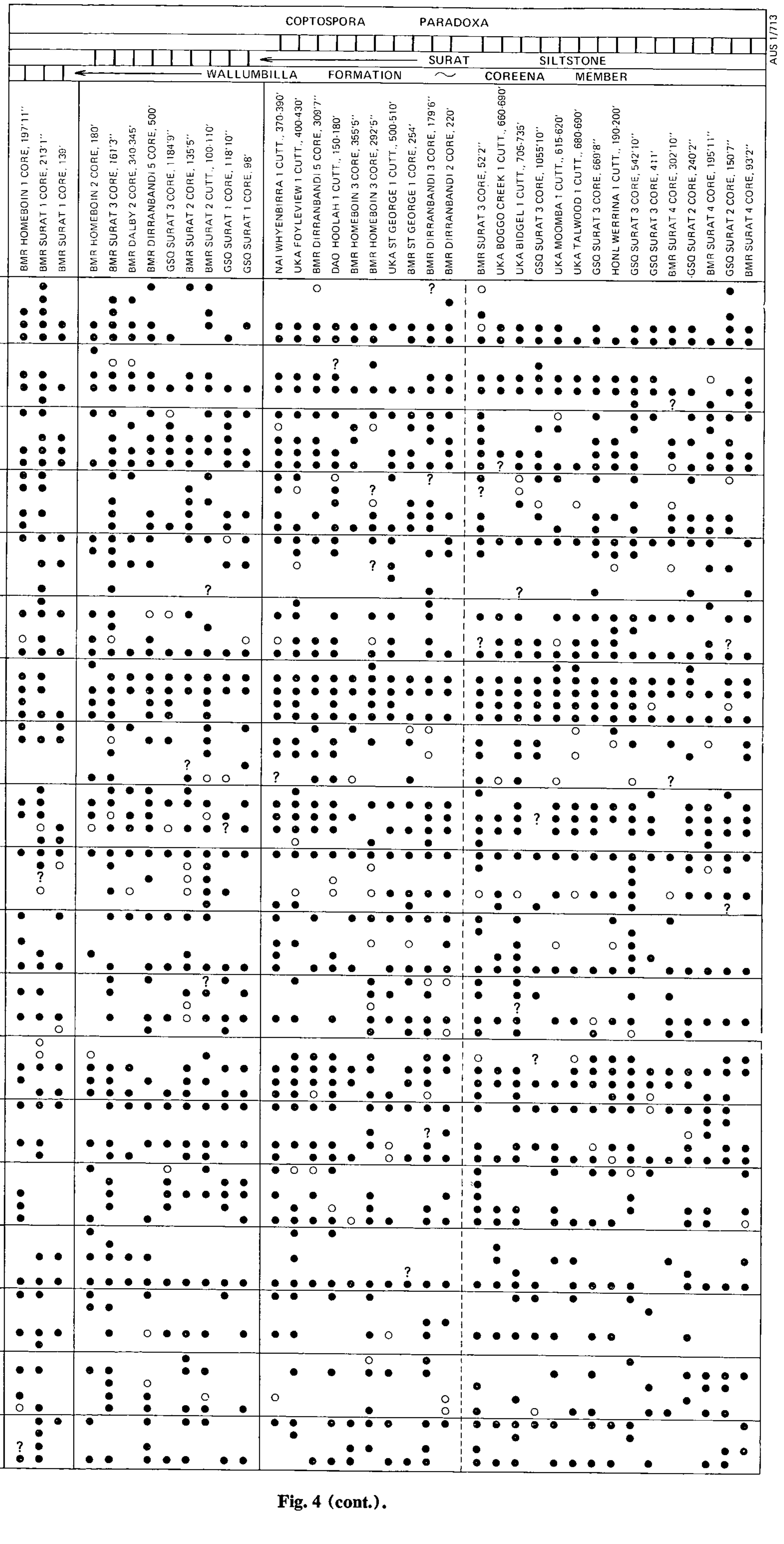
COPTOSPORA PARADOXA
SURAT SILTSTONE
WALLUMBILLA FORMATION
COREENA MEMBER
AUS 1/713
BMR HOMEBOIN 1 CORE, 197'11"
BMR SURAT 1 CORE, 213'1"
BMR SURAT 1 CORE, 139'
BMR HOMEBOIN 2 CORE, 180'
BMR SURAT 3 CORE, 161'3"
BMR DALBY 2 CORE, 340-345'
BMR DIRRANBANDI 5 CORE, 500'
GSQ SURAT 3 CORE, 1184'9"
BMR SURAT 2 CORE, 135'5"
BMR SURAT 2 CUTT., 100-110'
GSQ SURAT 1 CORE, 118'10"
GSQ SURAT 1 CORE, 98'
NAI WHYENBIRRA 1 CUTT., 370-390'
UKA FOYLEVIEW 1 CUTT., 400-430'
BMR DIRRANBANDI 5 CORE, 309'7"
DAO HOOLAH 1 CUTT., 150-180'
BMR HOMEBOIN 3 CORE, 355'5"
BMR HOMEBOIN 3 CORE, 292'5"
UKA ST GEORGE 1 CUTT., 500-510'
BMR ST GEORGE 1 CORE, 254'
BMR DIRRANBANDI 3 CORE, 179'6"
BMR DIRRANBANDI 2 CORE, 220'
BMR SURAT 3 CORE, 52'2"
UKA BOGGO CREEK 1 CUTT., 660-690'
UKA BIDGEL 1 CUTT., 705-735'
GSQ SURAT 3 CORE, 1055'10"
UKA MOOMBA 1 CUTT., 615-620'
UKA TALWOOD 1 CUTT., 680-690'
GSQ SURAT 3 CORE, 669'8"
HONL WERRINA 1 CUTT., 190-200'
GSQ SURAT 3 CORE, 542'10"
GSQ SURAT 3 CORE, 411'
BMR SURAT 4 CORE, 302'10"
GSQ SURAT 2 CORE, 240'2"
BMR SURAT 4 CORE, 195'11"
GSQ SURAT 2 CORE, 150'7"
BMR SURAT 4 CORE, 93'2"

Fig. 4 (cont.).

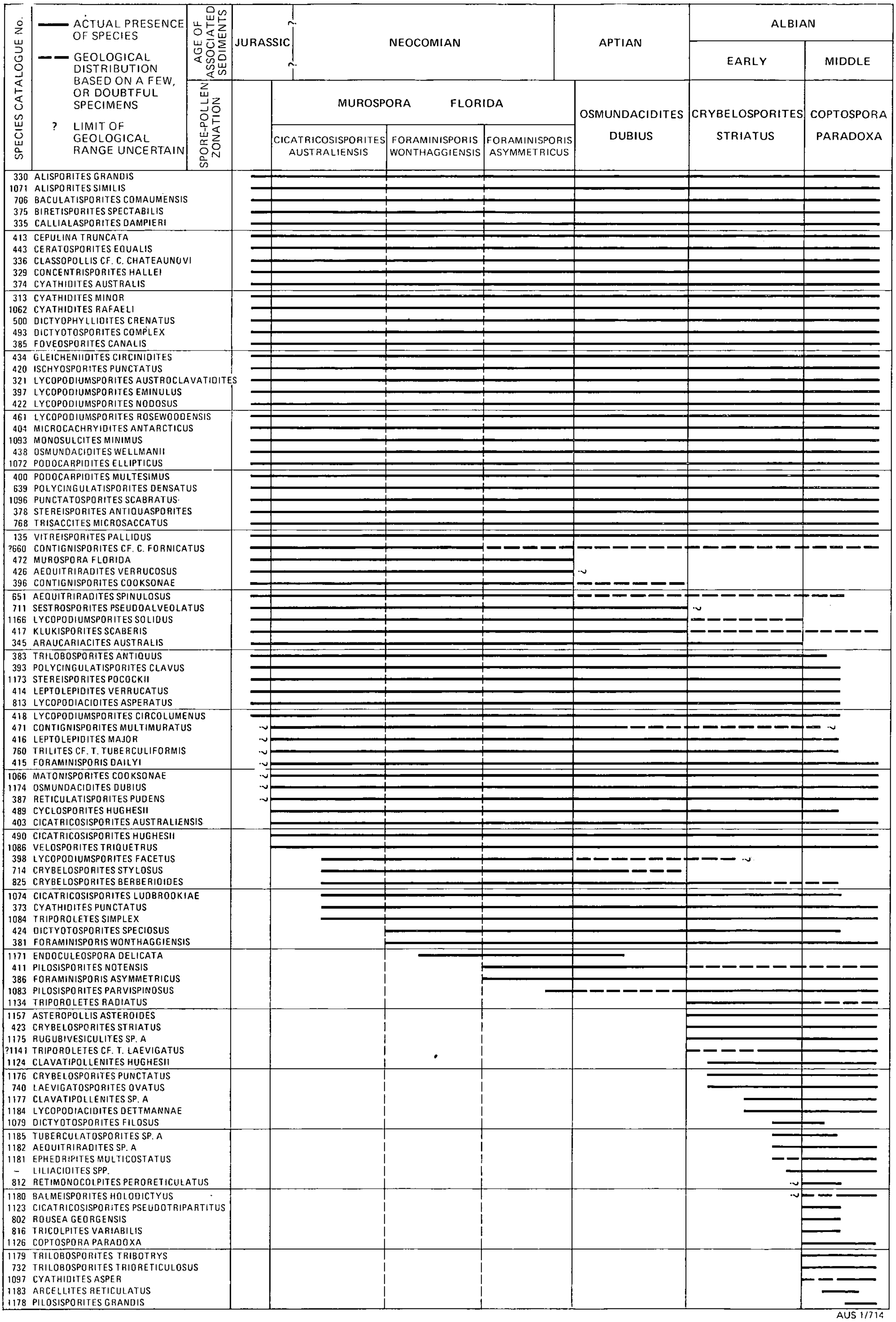

Fig. 5. Stratigraphic distribution of spores and pollen grains in the Early Cretaceous of the Surat Basin.

Endoculeospora delicata
Foraminisporis asymmetricus
Lycopodiumsporites facetus
Pilosisporites parvispinosus
Trilobosporites antiquus

The following species have not been seen above the *Murospora florida* Zone:

Callialasporites trilobatus
Tsugaepollenites segmentatus
Reticuloidosporites arcus
Coronatispora perforata
Cooksonites variabilis
Staplinisporites caminus
Triporoletes reticulatus
Trilobosporites purverulentus
Couperisporites tabulatus
Foveotriletes parviretis
Januasporites spinulosus
Laevigatosporites belfordii
Lycopodiumsporites reticulumsporites
Nevesisporites vallatus
Stoverisporites lunaris

Standard reference: Dettmann & Playford (1969) established a reference section for their *Cyclosporites hughesii* Subzone (Santos Oodnadatta No. 1 Well, Bulldog Shale, 728-964 feet; South Australia), of which the middle and upper intervals are equivalent to the *Osmundacidites dubius* Zone (Fig. 23). An alternative standard for this Zone, if required, may be established as the 243.1-347.3 m interval in GSQ Surat 1 stratigraphic hole, including the upper part of the Minmi Member of the Bungil Formation, and the Doncaster Member of the Wallumbilla Formation.

Distribution: The Zone is associated with the Minmi Member of the Bungil Formation and its correlates in BMR bores Roma 1, Roma 8, Dalby 3, Mitchell 11, and Mitchell 1, in GSQ bores Surat 1, DRD 27, and Roma 3, and also in AAO Pickanjinnie No. 1 well.

Association with the Doncaster Member of the Wallumbilla Formation was established in BMR bores Roma 8, Homeboin 1, and Mitchell 10, and the GSQ bores DRD 27, Roma 3, and Surat 1, as well as in UKA Cabawin No. 1 well (Fig. 6).

The Zone has been found in association with the Doncaster Member in the Eromanga Basin, and with the lower part of the Wallumbilla Formation in the Carpentaria Basin, and has also been traced into the Papuan Basin. R. Morgan (pers. comm.) observed equivalent microfloral assemblages in the Aptian of northern New South Wales.

Age: The Minmi Member, dated as lower Aptian, is restricted to the Surat Basin. The Doncaster Member is the most extensive unit in both Surat and Eromanga Basins, and contains the well-known late Aptian 'Roma' faunas. The horizons containing the Zone in the Papuan Basin overlie sediments which have been dated as upper Neocomian (see Burger, 1973b).

Direct faunal correlation can be established in a few instances only. Terpstra (1969) recovered Aptian foraminiferal faunas from samples of the Doncaster Member in the 660-1005 feet interval of GSQ Surat 1, including a sample from 1000′4″-1005′4″ depth; this sample is here designated MFP 5015. D. Haig (pers. comm.) recovered a late Aptian foraminiferal fauna from the same member in BMR Homeboin 1 at 145.4 m; that sample is here designated MFP 2350. Less direct evidence is obtained from initial work by Haig (1973), who recovered his foraminiferal faunas, designated, I, II, and III and dated as Aptian by inference, from the Doncaster Member in GSQ DRD 27 at 48-98 feet, which includes the sample here designated MFP 5800, and from GSQ Surat 1 at 637-1001 feet, which contains samples MFP 5015 and MFP 5006.

Evidence from the Eromanga Basin includes Burger's (1968a) examinations of the Zone in the Doncaster Member of BMR Richmond 1, 150-280 feet, and BMR Richmond 2, 110-257 feet, from which intervals Terpstra (1970) recovered Aptian foraminifera.

On the basis of this evidence the *Osmundacidites dubius* Zone is considered to represent most of the Aptian.

The Crybelosporites striatus *Zone*

Characteristics: The *Crybelosporites striatus* Zone succeeds the *Osmundacidites dubius* Zone and is itself succeeded by the *Coptospora paradoxa* Zone. It is equivalent to that part of the sequence which Evans (1966a) designated palynological unit K1d; it is identical with, and thus named after, Dettmann & Playford's (1969) *Crybelosporites striatus* Subzone, but has been upgraded in rank for nomenclatural reasons (Fig. 23).

Characteristic of the Zone in the Surat Basin is the first appearance of *Crybelosporites striatus,* and also of *Clavatipollenites hughesii, Crybelosporites punctatus, Laevigatosporites ovatus,* and *Asteropollis asteroides.* The Zone includes the earliest observed specimens of *Triporoletes radiatus, Lycopodiacidites dettmannae* sp. nov., *Ephedripites multicostatus,* and *Tuberculatosporites* sp. A. The upper limit of the Zone is established by the first appearance of *Coptospora paradoxa* and *Trilobosporites trioreticulosus.*

The assemblages of the Zone resemble those of the *Osmundacidites dubius* Zone in average composition; there is only a difference in relative frequencies. *Gleicheniidites circinidites* and *Ceratosporites equalis* occur in lesser abundance; *Foraminisporis asymmetricus* is found in much higher sample frequency, and *Lycopodiumsporites circolumenus* is present in relatively fewer preparations.

Standard reference: Santos Oodnadatta No. 1 well, South Australia, 642-700 feet interval, as designated by Dettmann & Playford (1969). This interval lies within the Bulldog Shale (Wopfner & others, 1970).

Distribution: The *Crybelosporites striatus* Zone is associated with the Coreena Member of the Wallumbilla Formation in NAI Whyenbirra 1, DOA Noogilla 1, UKA Cabawin 1, BMR bores Roma 9, Mitchell 8, Mitchell 10, and probably Surat 1, and GSQ bores Surat 1 and Surat 3. It is associated with the Surat Siltstone in UKA Flinton 1, UKA Cabawin 1, BMR Surat 3, and GSQ Surat 3 (Fig. 7); it may also be associated with the basal part of the Griman Creek Formation in Esso Kinnimo 1 (see: Additional Comments, below). The Zone is known from the Coreena and Ranmoor Members in the Eromanga Basin, and the upper part of the Wallumbilla Formation in the Carpentaria Basin. It was also described from the Murray Basin, New South Wales (Dettmann, 1963), and the Otway and Gippsland Basins, Victoria (Dettmann, 1963; Dettmann & Playford, 1969).

Age: The Coreena Member, of lower Albian age, is known in subsurface and outcrop of the Eromanga and Surat Basins, Queensland. The Surat Siltstone is vir-

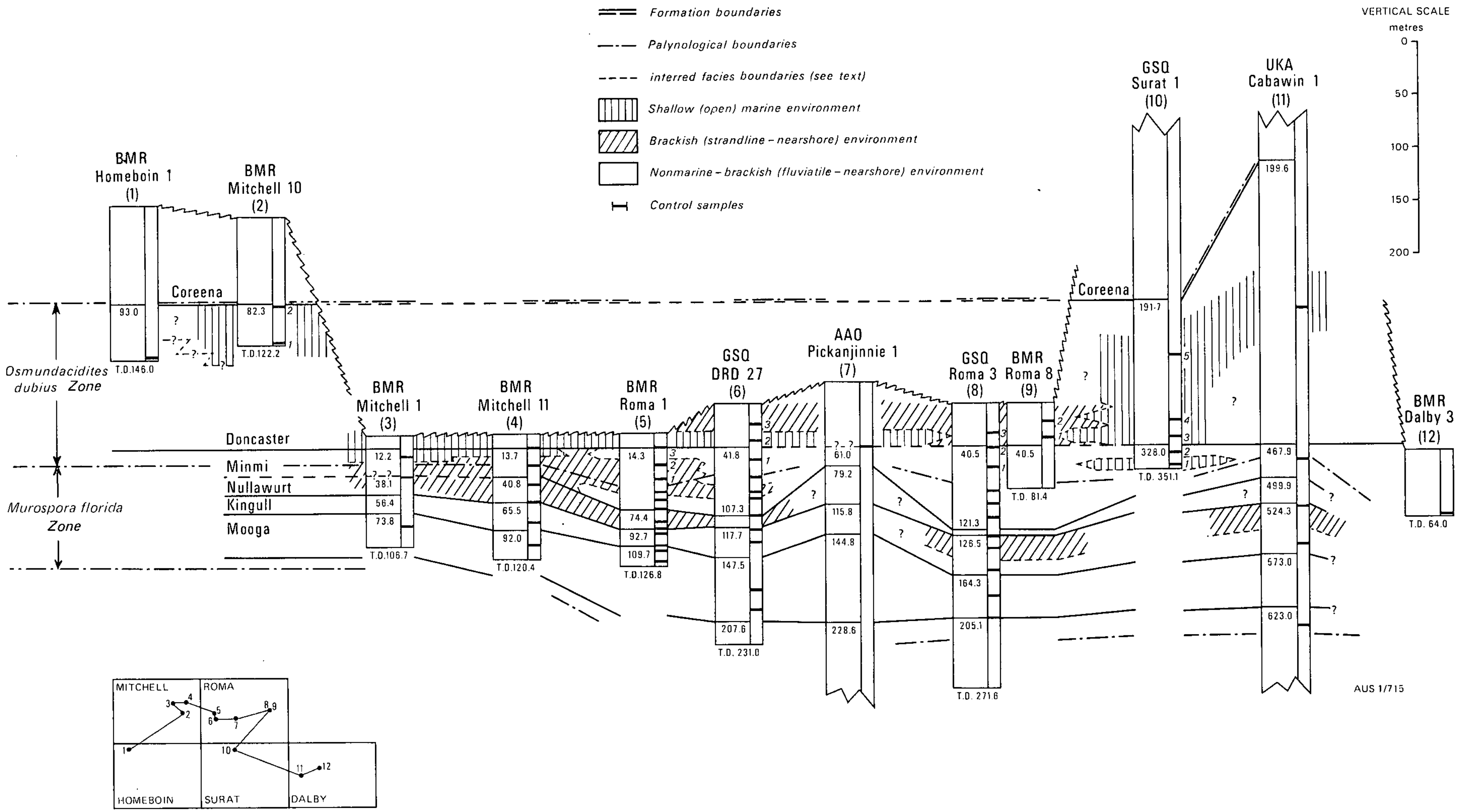

Fig. 6. Correlation of subsurface sections, depositional environments of Aptian sediments, and stratigraphic positions of palynological samples.

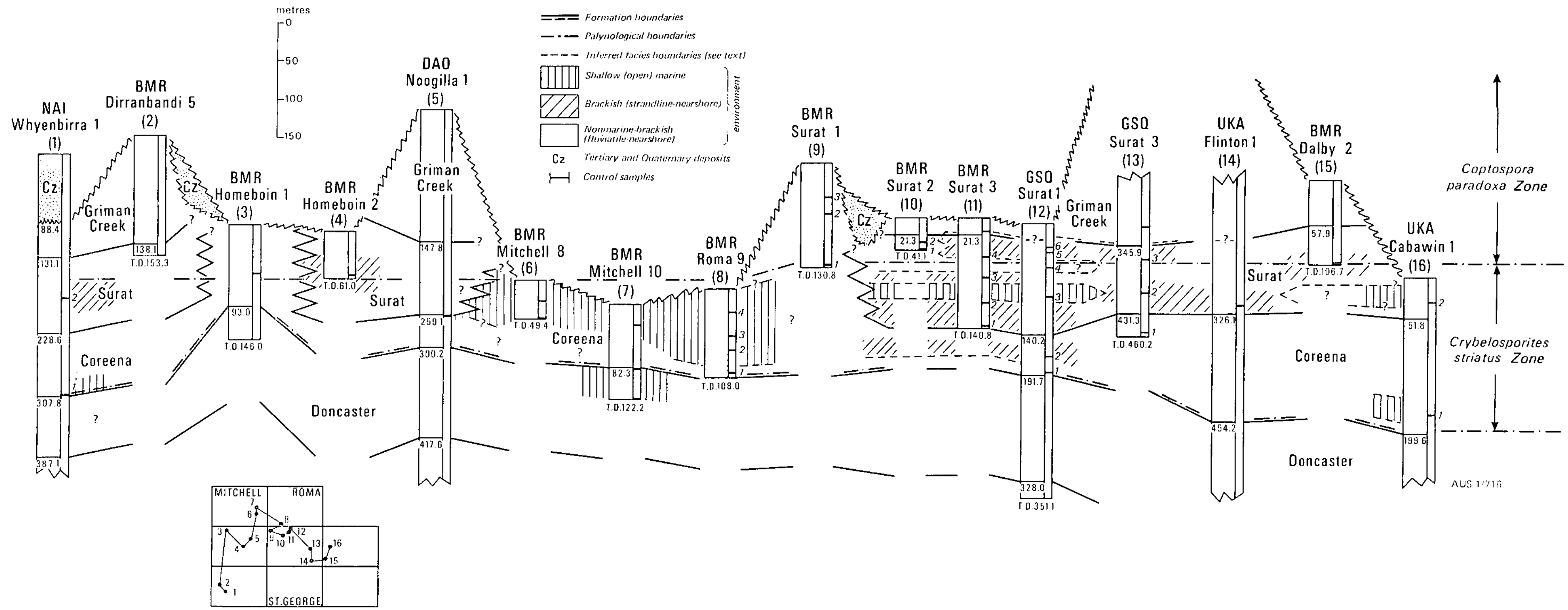

Fig. 7. Correlation of subsurface sections, depositional environments of lower Albian sediments, and stratigraphic positions of palynological samples.

tually unknown in outcrop but has been traced in subsurface throughout much of the Surat Basin.

Direct faunal correlation is possible in a few samples only. Jones (in Thomas & Reiser, 1968) found an Early Cretaceous, probably middle Albian, ostracod species in the Coreena Member of BMR Surat 1 at 423-428 feet, which contains sample MFP 4538. Terpstra (1969) recovered early Albian (?late Aptian) foraminifera from the Surat Siltstone in GSQ Surat 1 at 355-367 feet. The samples which I examined (MFP 5005, MFP 5216) from the Zone in this bore are from higher intervals and can thus be dated Albian. More recently Haig (1973) described his foraminiferal fauna IV from the Surat Siltstone in GSQ Surat 1 at 390-448 feet and GSQ Surat 3 at 1266-1349 feet, which includes MFP 5221. His fauna V occurs in the same formation in GSQ Surat 1 at 264-318 feet, slightly below sample MFP 5005, and in GSQ Surat 3 at 1182-1196 feet, which includes sample MFP 5021. Both faunas lie within the Albian rock sequence; fauna V was also identified as equivalent to Ludbrook's (1966) *Verneuilina howchini-Trochammina flosculus* Zone, of Albian age, in the Eromanga Basin of South Australia.

Dettmann & Playford (1969) described the Zone in the Santos Oodnadatta well from the interval which according to Ludbrook (1966) lies within her Aptian *Herrgottella jonesi* Zone, which is associated with the lower 'Marree Formation' (equivalent to the Bulldog Shale; see Wopfner & others, 1970). Dettmann & Playford, who were aware of Evans's (1966a) suggestion that the Zone (his unit K1d) might be present in the (Albian) Ranmoor Member, northern Eromanga Basin, considered an alternative Albian age for the Zone. Evans & Hawkins (1967), in connection with their palynological work in the Murray Basin, discussed the problem of the Aptian/Albian boundary in the rock sequence of the southwestern Eromanga Basin. They demonstrated convincingly that Ludbrook's evidence based on foraminifera allowed room for alternative interpretations, and suggested that her *Herrgottella jonesi* Zone could very well represent the earliest Albian. My own examination of samples from the 'Marree Formation' in DFS Innamincka 1 well, South Australia, corroborates their interpretation. It is hoped that this problem will be conclusively dealt with by Haig.

With more recent work in the basal Ranmoor Member of BMR Richmond 1 stratigraphic hole, Terpstra (1970) established an Albian age for the foraminifera from 80-110 feet, and Burger (1968a) confirmed the presence of the *Crybelosporites striatus* Zone at 113 feet.

Haig's and Jones's work corroborates the palaeontological data obtained from outcrop; the available evidence points to an early Albian age for the *Crybelosporites striatus* Zone.

Additional comments on the Crybelosporites striatus *Zone:*

Cuttings from the basal Griman Creek Formation in ESSO Kinnimo 1 at a depth of 186-195 m yielded a well preserved spore and pollen assemblage rich in species, which probably represents the *Crybelosporites striatus* Zone. Since the formation is associated with the *Coptospora paradoxa* Zone in the Homeboin, Dirranbandi, Surat, and northern St George Sheet areas, it must be assumed that either the base of the formation is slightly diachronous and moves downwards in the sequence towards the southern margin of the basin, or that the information from Kinnimo 1 has to be re-interpreted.

The Coptospora paradoxa *Zone*

Characteristics: The *Coptospora paradoxa* Zone was instituted by Dettmann & Playford (1969) and is equivalent to Dettmann's (1963) lower Paradoxa Assemblage; it includes Evans's (1966a) palynological unit K2a and the basal interval of his unit K2b. The Zone succeeds the *Crybelosporites striatus* Zone and is itself succeeded by the *Phimopollenites* (al. *Tricolpites*) *pannosus* Zone, which occurs in the Eromanga Basin but is not preserved in the Surat Basin.

The Zone is characterised by the first appearance of *Coptospora paradoxa* and *Trilobosporites trioreticulosus*. In the Surat Basin the Zone contains the oldest observed specimens of:

Cicatricosisporites pseudotripartitus
Balmeisporites holodictyus
Retimonocolpites peroreticulatus
Cyathidites asper
Pilosisporites grandis
Tricolpites variabilis
Rousea georgensis

Cyclosporites hughesii and *Dictyotosporites speciosus* occur in the Zone but have not been observed in the succeeding Albian sequence of the Eromanga and Carpentaria Basins (units K2b-c, see Burger, 1973a). The following species are common to abundant in almost every assemblage:

Cyathidites minor
Cyathidites rafaeli
Baculatisporites comaumensis
Stereisporites antiquasporites
Alisporites similis
Microcachryidites antarcticus

Rare to common species, present in most of the assemblages are:

Lycopodiumsporites austroclavatidites
Gleicheniidites circinidites
Crybelosporites striatus
Crybelosporites punctatus
Ceratosporites equalis
Clavatipollenites hughesii
Asteropollis asteroides
Foraminisporis asymmetricus
Alisporites grandis
Foraminisporis dailyi
Laevigatosporites ovatus
Lycopodiumsporites nodosus
Matonisporites cooksonae
Monosulcites minimus
Osmundacidites wellmanii
Pilosisporites parvispinosus
Coptospora paradoxa

The following species were observed as rare to infrequent forms in about half of the total number of preparations:

Biretisporites spectabilis
Concentrisporites hallei
Classopollis cf. *C. chateaunovi*
Cicatricosisporites hughesii
Cicatricosisporites pseudotripartitus
Dictyophyllidites crenatus
Dictyotosporites complex
Lycopodiumsporites eminulus

Lycopodiumsporites rosewoodensis
Vitreisporites pallidus
Cepulina truncata
Podocarpidites ellipticus
Punctatosporites scabratus
Reticulatisporites pudens
Rugubivesiculites sp. A
Trilobosporites trioreticulosus
Trilites cf. *T. tuberculiformis*
Triporoletes simplex
Trisaccites microsaccatus

Occasional specimens of the following species are present in some preparations:

Aequitriradites spinulosus
Aequitriradites verrucosus
Araucariacites australis
Pilosisporites notensis
Triporoletes cf. *T. laevigatus*
Callialasporites dampieri
Polycingulatisporites clavus
Klukisporites scaberis
Podocarpidites multesimus
Polycingulatisporites densatus
Crybelosporites berberioides
Dictyotosporites filosus
Endoculeospora delicata
Contignisporites cooksonae
Contignisporites multimuratus
Tuberculatosporites sp. A
Triporoletes radiatus
Contignisporites cf. *C. fornicatus*
Stereisporites pocockii sp. nov.
Foveosporites canalis
Lycopodiacidites asperatus
Ischyosporites punctatus
Pilosisporites grandis
Sestrosporites pseudoalveolatus
Velosporites triquetrus
Trilobosporites tribotrys

Undoubtedly a large proportion of these specimens are of secondary (recycled) origin, and will probably be recognised as such with detailed work in the Eromanga Basin.

Standard reference: Santos Oodnadatta No. 1 well, South Australia, 407-596 feet interval (see Dettmann & Playford, 1969; Playford, Haig, & Dettmann, 1975). This interval includes the upper part of the Bulldog Shale and the basal part of the Oodnadatta Formation (see Wopfner & others, 1970).

Distribution: The *Coptospora paradoxa* Zone is associated with the Griman Creek Formation of BMR bores Dirranbandi 5, Dirranbandi 3, Dirranbandi 2, St George 1, Homeboin 3, Surat 3, Surat 4; also GSQ Surat 2 and Surat 3, and NAI Whyenbirra 1, UKA St George 1, DOA Hoolah 1, UKA Foyleview 1, HONL Werrina 1, UKA Talwood 1, UKA Moombah 1, UKA Bidgel 1, and UKA Boggo Creek 1. The Zone is associated with the Surat Siltstone of BMR Surat 2, BMR Surat 3, and BMR Homeboin 2, and the Coreena Member of BMR Surat 1 and BMR Homeboin 1 (Fig. 8).

Coptospora paradoxa was not found in the upper Surat Siltstone of GSQ Surat 1 (MFP 5004, MFP 5012) and BMR Dalby 2 (MFP 4763); one doubtful specimen of the species occurs in the formation of GSQ Surat 3 (MFP 5021), but in view of the evidence from the other sections these samples are tentatively regarded as part of the Zone.

Age: Exon (1976) and Burger (*in* Gray, 1972) pointed out that age determination of the Griman Creek Formation is largely circumstantial as faunal evidence is scarce and of little value. The formation can be broadly dated as not older than Albian on account of its stratigraphic position. Terpstra (1969) recovered early Albian (?late Aptian) foraminifera from the immediately underlying Surat Siltstone in GSQ Surat 3 at 1184 feet (sample here referred to as MFP 5021). The association of the *Coptospora paradoxa* Zone with the upper Coreena Member in the western Surat Basin confirms the foraminiferal evidence and dates the zone as of (middle?) Albian age.

Additional comments on the Coptospora paradoxa *Zone:*

1: Dettmann (see Dettmann & Douglas, 1976) subdivided the *Coptospora paradoxa* Zone in the Otway and Gippsland Basins, Victoria, into a lower part characterised by *Dictyotosporites speciosus* and *D. filosus,* and an upper part without these species and including the initial appearance of *Pilosisporites grandis.* This subdivision is not apparent from the present record of the Albian sequence in the Eromanga Basin, probably because of the relative poverty of the information. In the Surat Basin *D. filosus* is too rarely present to be very useful, but *D. speciosus* occurs in moderate sample frequency in the Coreena Member, the Surat Siltstone, and the lower part of the Griman Creek Formation. It seems to be absent in the upper part of that unit, as it was not seen in the preparations from BMR Homeboin 3, BMR Dirranbandi 3, BMR Dirranbandi 2, BMR Surat 4, GSQ Surat 2, UKA St George 1, and GSQ Surat 3 above 542 feet. It is noteworthy that this part of the Griman Creek Formation in GSQ Surat 2 and BMR Surat 4 includes the earliest known specimens of *Pilosisporites grandis.* This suggests that Dettmann's subdivision of the Zone is also to be traced into Queensland (Fig. 23).

2: The oldest known tricolpate angiosperm pollen grains were described and reported from the latter part of the Albian in Queensland (Burger, 1970, 1973a) and Victoria (Dettmann, 1973). The lower limit of the *Phimopollenites* (al. *Tricolpites*) *pannosus* Zone in the Otway Basin is characterised by the introduction of *Phimopollenites pannosus* (Dettmann & Playford) Dettmann, 1973, and *Rousea georgensis* (Brenner) Dettmann, 1973. The equivalent interval in the pollen sequence of the Eromanga Basin (palynological unit K2b) is characterised by the first appearance of *Tricolpites variabilis* Burger, 1970, *Phimopollenites* cf. *Ph. pannosus,* and *Ph. augathellaensis* (Burger) Dettmann, 1973 (Fig. 9).

The occasional presence of tricolpate pollen grains in the Surat Sheet area (identified as *Tricolpites variabilis* and *Rousea georgensis*) was taken as evidence that the *Phimopollenites pannosus* Zone was also preserved in the Surat Basin sequence; this was already more or less expected in view of the thickness of the rock column in the Mimosa Syncline, where *Coptospora paradoxa* was found (Burger, *in* Gray, 1972). However, detailed examination of new, rich and well-preserved assemblages from the youngest part of the sequence (Griman Creek Formation) drilled in BMR Dirranbandi 2, BMR Dirranbandi 3, UKA St George 1, and BMR St George 1, yielded negative results. One isolated occurrence of *Striatopollis* cf. *S. paraneus* (Norris) in BMR Dirranbandi 3 cannot be evaluated at present. The species is a common form in the Ceno-

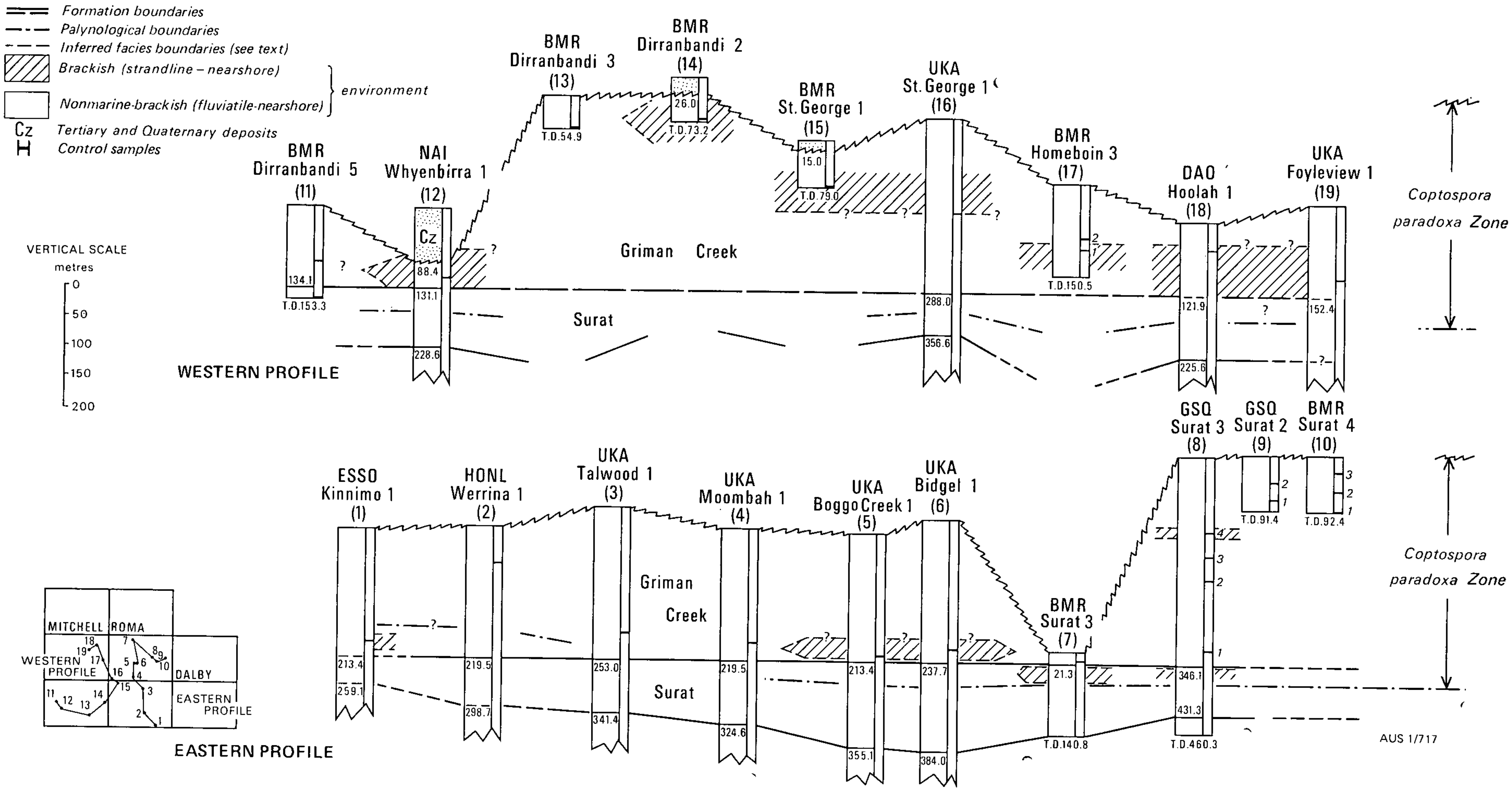

Fig. 8. Correlation of subsurface sections, depositional environments of middle Albian sediments, and stratigraphic positions of palynological samples.

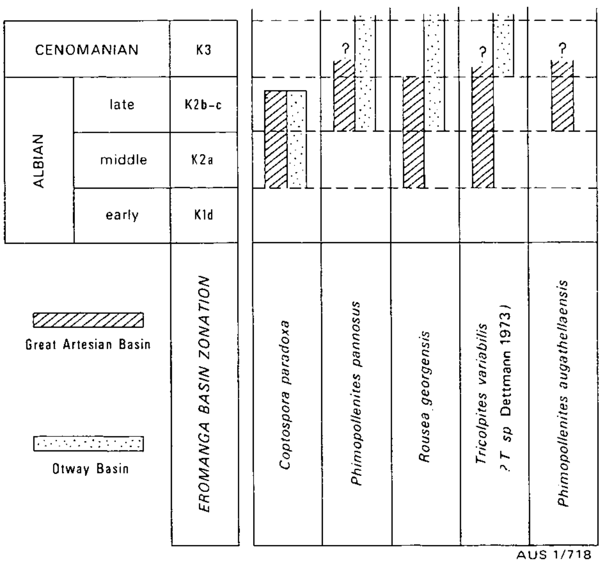

Fig. 9. Vertical distribution of angiosperm (tricolpate) pollen in the Early Cretaceous of eastern Australia.

manian of Bathurst and Melville Islands, north of Darwin. Singh (1971) reported striate tricolpate pollen among the earliest occurring tricolpate forms in the mid-Albian of Alberta, Canada, but so far these forms were not known from the Early Cretaceous of Queensland.

In view of the number of preparations examined this is a very poor record compared with that from the Eromanga Basin, where tricolpate pollen grains occur in every assemblage from the Allaru Mudstone. It is clear that the angiosperm record so far known from the Eromanga and Carpentaria Basins has to be slightly revised. If the sequence containing *Coptospora paradoxa* in the Surat Basin is interpreted as palynological unit K2b solely on account of the presence of *Tricolpites variabilis* and *Rousea georgensis* there would be no room for unit K2a. However, the sequence contains *Dictyotosporites speciosus* and *Cyclosporites hughesii,* which have their upper range limits within unit K2a, and lacks species such as *Appendicisporites* spp., *Hoegisporis uniforma, Microfoveolatosporis canaliculatus, Camarozonosporites* sp., and various tricolpate species already mentioned, all of which are common elements in unit K2b. Besides, the sequence represents a period of rapid and uninterrupted deposition, at least in the Dirranbandi and Mimosa Depressions, so it is highly unlikely that there would be a hiatus of any significance. Therefore it must be concluded, in contrast to earlier reports (Burger, *in* Gray, 1972), that the *Phimopollenites pannosus* Zone/unit K2b is not preserved in the Surat Basin pollen record and that the sequence in question, which is associated with the upper part of the Surat Siltstone and the Griman Creek Formation, represents the *Coptospora paradoxa* Zone/unit K2a. *Tricolpites variabilis* and *Rousea georgensis* thus appear slightly earlier in Queensland than was previously suspected.

3: From the rock association of the *Crybelosporites striatus* and *Coptospora paradoxa* Zones it is clear that the stratigraphic relation between the Coreena Member and Surat Siltstone is more complicated than that which emerged from the field data. The identification of the *Coptospora paradoxa* Zone in the upper part of the Surat Siltstone, as well as in two sections in the Coreena Member (viz. BMR Surat 1 and BMR Homeboin 1) which were drilled outside the assumed outcrop margin of the Surat Siltstone, proves that the two units are in part contemporaneous developments. It thus follows that outside the area in which the Surat Siltstone is developed the Coreena Member and Griman Creek Formation must be in direct contact, and as a consequence can be expected to be mapped as a single unit, as they are lithologically similar. This is indeed the case in the eastern Eromanga Basin; the Coreena Member overlying the Cunnamulla Shelf in the Cunnamulla, Wyandra, and Homeboin Sheet areas contains the *Crybelosporites striatus* Zone as well as the *Coptospora paradoxa* Zone and is in fact considerably thicker than anywhere else in the Great Artesian Basin (Senior, 1978).

Closer investigation of the Surat Siltstone can be continued only with the aid of additional drilling and sampling in the Homeboin and Dirranbandi Sheet areas. The data here presented suggest that the Surat Siltstone forms a brief and restricted coastal facies of the early and middle Albian, and wedges out towards the northwest between BMR Surat 1 and BMR Surat 2 and 3, and towards the west between BMR Homeboin 2 and BMR Homeboin 1. Exon & Senior (1976) made similar correlations on the basis of gamma-ray logs of water bores in the Homeboin Sheet area.

2. THE DINOFLAGELLATE SEQUENCE

The Cretaceous dinoflagellate sequence in the Great Artesian Basin extends throughout the Aptian and Albian. Sporadic dinoflagellates occur also in Neocomian and Cenomanian sediments but they are too rare to be of much practical value. Because of its marginal-facies character the marine record of the Surat Basin is restricted to the Aptian and early to middle Albian.

The occurrence of species is given in the distribution charts of Figures 10, 11, and 12, and stratigraphic distribution of each species is shown in the range chart of Figure 13. The gradual advance of the Aptian sea is clearly illustrated by the increase in number of dinoflagellate species upwards in the Minmi Member, culminating in a total of 43 recorded species at the base of the Doncaster Member. Regressive conditions set in during the early Albian, but the remaining water body was in sufficiently close contact with the open sea to allow diversified dinoflagellate life, in which certain species such as *Spinidinium boydii* and *Chlamydophorella nyei* even proliferated. The upper range limits of many species in the Coreena-Surat interval are a sign of diminishing plankton growth and illustrate near-shore conditions.

The first attempt to subdivide the dinoflagellate sequence in Queensland on the basis of incoming and outgoing species was made by Evans. He (1966a) delineated a lower interval in the Surat and Eromanga Basins on the presence of *Dingodinium cerviculum,* a form with an Australia-wide distribution during the Aptian, and an upper interval on the presence of *Cribroperidinium edwardsii* and various species of *Diconodinium.* In a subsequent report, Evans (1966b) described two Late Jurassic and three Early Cretaceous

DINOFLAGELLATE ZONATION	ODONTOCHITINA OPERCULATA																							
ROCK UNIT	BUNGIL FORMATION												WALLUMBILLA FORMATION											
	Undiv.	Minmi equiv.			Minmi Member								Doncaster Member											
MICROFOSSIL SPECIES / SAMPLE SPECIFICATIONS	BMR DALBY 3 CORE, 200-210'	GSQ ROMA 3 CORE, 199'	BMR MITCHELL 1 CORE, 53'	GSQ ROMA 3 CORE, 141'	BMR ROMA 1 CORE, 146'11"	BMR ROMA 1 CORE, 101'5"	GSQ SURAT 1 CORE, 1139'6"	GSQ DRD 27 CORE, 178'	GSQ SURAT 1 CORE, 1102'5"	AAO PICKANJINNIE 1 CUTT., 200-210'	BMR ROMA 1 CORE, 52'5"	BMR MITCHELL 11 CORE, 48'	GSQ DRD 27 CORE, 117'	GSQ SURAT 1 CORE, 1049'10"	BMR ROMA 8 CORE, 102'2"	GSQ ROMA 3 CORE, 94'	GSQ DRD 27 CORE, 67'	GSQ SURAT 1 CORE, 1001'6"	BMR ROMA 8 CORE, 54'1"	UKA CABAWIN 1 CORE, 1108'	GSQ SURAT 1 CORE, 797'8"	BMR HOMEBOIN 1 CORE, 477'	BMR MITCHELL 10 CORE, 394'	BMR MITCHELL 10 CORE, 281'
APTEODINIUM CONJUNCTUM											○				●				●					
APTEODINIUM MACULATUM														?										
BROOMEA JAEGERI			●																	●			?	
CANNINGIA COLLIVERI			●			●	●		●	●	●	●			●		●	●	●	●	●	●	○	○
CANNINGIA MINOR		●	●			●	●	●	●		●	●		●	●			○	○			●		
CANNINGIA MINOR VAR. PSILATA	○	●			○	●	●		●			●	●	●	●		●	●	●	●	●		●	
CANNINGIA SP. A																								●
CASSICULOSPHAERIDIA CF. C. RETICULATA			●		●	○					●			●	●			●	●	●	●	●	●	●
CHLAMYDOPHORELLA NYEI		●	●	●						○	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CLEISTOSPHAERIDIUM ACICULARE			○																	●				
CLEISTOSPHAERIDIUM GRANULATUM			●									●			●	●				●				●
CLEISTOSPHAERIDIUM CF. C. POLYTRICHUM					○					●				○										
CLEISTOSPHAERIDIUM SP. A		●												●		●			●	○				
CORONIFERA OCEANICA														●			●			○				
CORONIFERA SP. A			○											●							●			●
CRIBROPERIDINIUM MUDERONGENSIS														●						●				
DICONODINIUM DAVIDII																					●			●
DICONODINIUM PAUCIGRANULATUM																		●			●		●	●
DINGODINIUM CERVICULUM	●	●	●		○	●	●	○		○	●	●	●	●	●	●	●	●	●	●			●	●
EXOCHOSPHAERIDIUM CF. E. PHRAGMITES														●						●				●
GONYAULACYSTA HELICOIDEA		●	●									●		●				○	●	●	●			●
HEXAGONIFERA CF. H. DEFLOCCATA			●			○	●	●			●	●	●	●	●		●	●	●	●	●		●	●
HEXAGONIFERA SP. A																					●			
HEXAGONIFERA SP. B			●	●							●	●												
HYSTRICHOSPHAERIDIUM CF.H. BOWERBANKII																				○				
LEPTODINIUM ALECTROLOPHUM													●					●						
LEPTODINIUM SIMPLEX			●		●	○						●	●	●	●		○	●	○	●	●			
LITOSPHAERIDIUM SP. A					○	●								●										
MEMBRANOSPHAERA CONINCKII														●							●			●
MEMBRANOSPHAERA GRANULATA														●						○				
MEMBRANOSPHAERA NORVICKII														●							●			
MEMBRANOSPHAERA ROMAENSIS		●	●				●			●	●	●		●	●		●	●	○	●	●		●	●
MEMBRANOSPHAERA SP. A		○										●								●	●			
MUDERONGIA CF. M. STAUROTA			●				●			○	○									●				
MUDERONGIA TETRACANTHA			●			●					●	●		●	●					●			●	●
NUMMUS MONOCULATUS						●	●				●	●			●									
ODONTOCHITINA OPERCULATA			●	○		●				○				●	●	●	●	●		●		●	●	●
OLIGOSPHAERIDIUM COMPLEX																●				●				?
OLIGOSPHAERIDIUM NANNUM											●					●				●				●
OLIGOSPHAERIDIUM PULCHERRIMUM	●		●		○						○			?						○				
PAREODINIA CERATOPHORA			●									●												
PROLIXOSPHAERIDIUM PARVISPINUM						●					●													○
PROTOELLIPSODINIUM SP. A																					●			
RHOMBODELLA NATANS			●											●							●		●	●
SPINIDINIUM BOYDII														●				●						●
SPINIFERITES RAMOSUS SUBSP. GRANOMEMBRANACEUS														●										
SPINIFERITES RAMOSUS VAR. RAMOSUS							?						●	●			●		○	●	●		●	
TANYOSPHAERIDIUM ISOCALAMUS			○								○			●						●			●	
TANYOSPHAERIDIUM SP. A																					●			●
TENUA APTIENSE			●				●					●	○			●								
TENUA PILOSA			●		○								●	●				○		●	●		●	
TRICHODINIUM EISENACKII			●								●			●			○	●	●	●			●	
VOZZHENNIKOVIA VILLOSA														●										
FROMEA CF. F. AMPHORA			●			●					●						●						○	
LEIOSPHAERIDIA SP. A		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
LEIOSPHAERIDIA SP. B.	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●					●	
LEIOSPHAERIDIA SP. C		●	●		●	●	●				●			●							●			
MICRHYSTRIDIUM SP. A	●											●	●	●	●			●	●			●	●	
MICRHYSTRIDIUM SP. B		●	●		●	●	●	●			●	●	●	●	●	●		●	●	●	●		●	
MICRHYSTRIDIUM SP. C		●	●		●	●	●				●			●						●	●		●	
MICRHYSTRIDIUM SP. D													●	●		●					●		●	●
PALAEOSTOMOCYSTIS FRAGILIS	○	○	○			●				●	●	●		●		●	●	●	●	●	●		●	●
PALAEOSTOMOCYSTIS PERGAMENTACEUS					●	●	●				●	○		●				●			●		●	●
PTEROSPERMELLA AUSTRALIENSIS			●		●	●					●	●					●	●	●	●			●	●
SCHIZOSPORIS RETICULATUS												●												
SCHIZOSPORIS SPRIGGII																				?				
? SCHIZOSPORIS SP. A																					●			
VERYHACHIUM REDUCTUM			●			●					●	●	●	●		●	●	●	●	●	●		●	●
VERYHACHIUM SINGULARE	●											●		●					●		○	●	●	●

● SPECIES POSITIVELY IDENTIFIED

○ SPECIES IDENTIFICATION TENTATIVE

? SPECIES REGARDED AS OF SECONDARY ORIGIN

AUS 1/719

Fig. 10. Distribution of dinoflagellates, acritarchs, and chlorophyta in the Aptian of the Surat Basin.

● SPECIES POSITIVELY IDENTIFIED

○ SPECIES IDENTIFICATION TENTATIVE

? SPECIES REGARDED AS OF SECONDARY ORIGIN

DINOFLAGELLATE ZONATION	PSEUDOCERATIUM TURNERI																														
ROCK UNIT	WALLUMBILLA FORMATION, Coreena Member												SURAT SILTSTONE																	Coreena Member	
MICROFOSSIL SPECIES / SAMPLE SPECIFICATIONS	NAI WHYENBIRRA 1 SWC., 1000'	GSQ SURAT 1 CORE, 617'9"	BMR ROMA 9 CORE, 354'8"	GSQ SURAT 1 CORE, 551'2"	UKA CABAWIN 1 CORE, 569'8"	BMR ROMA 9 CORE, 258'6"	BMR ROMA 9 CORE, 200'1"	DAO NOOGILLA 1 CUTT., 850-880'	BMR MITCHELL 10 CORE, 83'6"	BMR ROMA 9 CORE, 100'2"	BMR MITCHELL 8 CORE, 86'10"	BMR SURAT 1 CORE, 428'1"	BMR SURAT 3 CORE, 452'4"	UKA FLINTON 1 CUTT., 1030-1040'	BMR SURAT 3 CORE, 350'	UKA CABAWIN 1 CUTT., 100-110'	NAI WHYENBIRRA 1 SWC., 600'	GSQ SURAT 1 CORE, 300'	GSQ SURAT 3 CORE, 1326'6"	BMR SURAT 3 CORE, 246'5"	GSQ SURAT 1 CORE, 179'11"	BMR HOMEBOIN 2 CORE, 180'	BMR SURAT 3 CORE, 161'3"	BMR DIRRANBANDI 5 CORE, 500'	GSQ SURAT 3 CORE, 1184'9"	BMR SURAT 2 CORE, 135'5"	BMR SURAT 2 CUTT., 100-110'	GSQ SURAT 1 CORE, 118'10"	GSQ SURAT 1 CORE, 98'	BMR HOMEBOIN 1 CORE, 197'11"	BMR SURAT 1 CORE, 213'1"
APTEODINIUM CONJUNCTUM	●					?	●		●		○																				
APTEODINIUM MACULATUM							●		●	●	●	●	●			●		●	●	●					○				●		
CANNINGIA COLLIVERI	●		●		●	●	●		●	●	●	●		●	○	●	●			●	●				○	●		○			
CANNINGIA MINOR			●		●	?				○						?	○														
CANNINGIA MINOR VAR. PSILATA	●				●	●	●		●	●	●		○	●	●	●	●	●							●						
CANNINGIA SP. A						●	●																								
CASSICULOSPHAERIDIA CF. C. RETICULATA	●				●	○	●			●	●					●															
CHLAMYDOPHORELLA NYEI	●				●	●	●	●	●	●	●	○	●	●	●	●	●	●	●	○	●		●	●	●				●		●
CLEISTOSPHAERIDIUM ACICULARE					●		●		●	●	●					●	●												●		●
CLEISTOSPHAERIDIUM GRANULATUM					●	●	●			●	●	●	●			●	?			●					●				●		
CLEISTOSPHAERIDIUM POLYPES					●		●				●					?		●													
CLEISTOSPHAERIDIUM SP. A	●				●		●											●							●						
CORONIFERA OCEANICA							●			●	●			●		●									●						
CRIBROPERIDINIUM EDWARDSII							●				○					●	●								●		●				
CRIBROPERIDINIUM MUDERONGENSIS							●		●		●		●			●							○					●			
DICONODINIUM DAVIDII	●				●						●																				
DICONODINIUM PAUCIGRANULATUM						○																									
DINGODINIUM CERVICULUM	●					●	●				●					●															
EXOCHOSPHAERIDIUM CF. E. PHRAGMITES	●				●		●		●	●				●		●	●	●													
GONYAULACYSTA CF. G. CASSIDATA							●		●									●													
GONYAULACYSTA HELICOIDEA					●		●		●		●					●													●		
HESLERTONIA STRIATA					●		●			●			●			●													?		
HEXAGONIFERA CF. H. DEFLOCCATA	●				●	●	●		●	●	●					●		●							●	○					
HEXAGONIFERA SP. A	●				○	●					?												●		●		○				
HYSTRICHOSPHAERIDIUM CF. H. BOWERBANKII	●				●												○														
LEPTODINIUM ALECTROLOPHUM	●					●																									
LEPTODINIUM SIMPLEX	●				●		●		●	●	●			●		●	●	○							○				●		
LITOSPHAERIDIUM SP. A							●			●					●																
MEMBRANOSPHAERA CONINCKII						●	●			●			●		●	●		●		●					●				●		
MEMBRANOSPHAERA NORVICKII	●				○		●			○	●					●															
MEMBRANOSPHAERA ROMAENSIS					●	?	●		●		●		●					●					●						●		
MEMBRANOSPHAERA SP. A	●																														
MUDERONGIA CF. M. STAUROTA	●				●		●			●		●			●	●				●								?			
MUDERONGIA TETRACANTHA					●		●			●		●	●	○	●	●	●	●					●								
NECROBROOMEA MICROPODA									●	●				●			●														
ODONTOCHITINA OPERCULATA					●	●	●		●	●			●	●	●	●	○	●		●			●		●				●	○	
ODONTOCHITINA SP. A	●						○									●															
OLIGOSPHAERIDIUM COMPLEX	●				●		●		●		●	●		●		○	●	●								●	●		?		
OLIGOSPHAERIDIUM NANNUM							?				●					●															
OLIGOSPHAERIDIUM PULCHERRIMUM					●		●			●						○													?		
PAREODINIA CERATOPHORA										●	●		●			●				●											
PROLIXOSPHAERIDIUM PARVISPINUM					●											●															
PROTOELLIPSODINIUM SP. A	●					●								●		●															
PSEUDOCERATIUM TURNERI	●				●				●		●			○		●	●	●													
RHOMBODELLA NATANS					●	●	●		●	●	●			●		●	●	●		●				○					?		
SPINIDINIUM BOYDII						●	●		●		●			●		●	○	●	●	●	●				○						
SPINIFERITES RAMOSUS SUBSP. GRANOMEMBRANACEUS	○				●	●	●		●		●							●													
SPINIFERITES RAMOSUS VAR. RAMOSUS	●				●	●	●		●		●			●		●	●	●							●	?					
SYSTEMATOPHORA COMPLICATA					●																										
TANYOSPHAERIDIUM ISOCALAMUS					●																										
TANYOSPHAERIDIUM SP. A							●							●	●	●		●													
TENUA PILOSA	●				●	●	●	●			●					●		●							●				●		
TRICHODINIUM EISENACKII	●		●		●	●	●		●	●	●	●				●															
VOZZHENNIKOVIA VILLOSA				●		?	●											?													
FROMEA CF. F. AMPHORA	●						●	●							●		●	●					●								
LEIOSPHAERIDIA SP. A	●	●			●	●	●	●	●	●			●	●	●	●	●			●		●	●	●						●	
LEIOSPHAERIDIA SP. B.	●	●		●	●	●	●		●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●		●	●	●	●
LEIOSPHAERIDIA SP. C			●			●				●		●		●	●							●								○	
MICRHYSTRIDIUM SP. A		●				●					●				●							●	●		●						
MICRHYSTRIDIUM SP. B	●					●	●		●				●										●					●			
MICRHYSTRIDIUM SP. C							●							●	●	●		●						●	●				●	●	
MICRHYSTRIDIUM SP. D								●		●			●	●	●	●		●		●		●		●	●					●	
PALAEOSTOMOCYSTIS FRAGILIS		○		○	○	●	●		●	●	●			●	●	●	●	●		●					○				●	○	
PALAEOSTOMOCYSTIS PERGAMENTACEUS						●			●	○								●													
PTEROSPERMELLA AUSTRALIENSIS	●				●	●	●			●	●			●	●										●				●		
SCHIZOSPORIS RETICULATUS															●		●						●			●	?				
SCHIZOSPORIS SPRIGGII										○													○			○					
? SCHIZOSPORIS SP. A					○	●	●			●						●		○	●										●		
VERYHACHIUM REDUCTUM	●	●			●	●	●		●	●	●			●	●	●	●	●		●	●	●	●		●				○		
VERYHACHIUM SINGULARE					●		●				●			●		●	●	●						●							

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Fig. 11. Distribution of dinoflagellates, acritarchs, and chlorophyta in the early Albian of the Surat Basin.

(Neocomian) dinoflagellate zones in the marine sequence of the Papuan Basin, and four Early Cretaceous (Neocomian to Albian) zones in the Carpentaria Basin (Archer River area), northern Queensland. These zones were based on first and/or last occurrence of selected fossils and cover the entire Late Mesozoic marine sequence known in the northern Australian region (Fig. 14).

The marine sequence in the Great Artesian Basin is at present being studied in considerable detail, and it is clear that the ranges of some zone-indicative species which Evans nominated must be revised. The dinoflagellate record in the southern Eromanga Basin (Morgan, pers. comm.) and the Surat Basin agree in detail, in spite of the fact that the brackish-marine sediments of the Mimosa Syncline and the Roma Shelf represent extremely shallow marginal environments, indicating southeastern limits of the Aptian inland sea. Two of the main intervals which Morgan (1977) described as part of a revised zonal scheme which he introduced for the Great Artesian Basin can be recognised and are briefly reviewed.

The Odontochitina operculata *Dinoflagellate Zone*

Detailed work on the marine Aptian sequence in the Surat and Eromanga Basins (Morgan, op. cit.; this paper) necessitated a revision of Evans's (1966b) *Dingodinium cerviculum* Zone concept. The earliest specimens of *D. cerviculum* occur in Neocomian sedi-

● SPECIES POSITIVELY IDENTIFIED

○ SPECIES IDENTIFICATION TENTATIVE

DINOFLAGELLATE ZONATION	PSEUDOCERATIUM TURNERI ?															
ROCK UNIT	GRIMAN CREEK FORMATION															
SAMPLE SPECIFICATIONS / MICROFOSSIL SPECIES	NAI WHYENBIRRA 1 CUTT., 370-390'	UKA FOYLEVIEW 1 CUTT., 400-430'	BMR DIRRANBANDI 5 CORE, 309'7"	DAO HOOLAH 1 CUTT., 150-180'	BMR HOMEBOIN 3 CORE, 355'5"	BMR DIRRANBANDI 2 CORE, 220'	ESSO KINNIMO 1 CUTT., 610-640'	BMR SURAT 3 CORE, 52'2"	UKA BOGGO CREEK 1 CUTT., 660-690'	UKA BIDGEL 1 CUTT., 705-735'	UKA MOOMBA 1 CUTT., 615-620'	UKA TALWOOD 1 CUTT., 680-690'	HONL WERRINA 1 CUTT., 190-200'	GSQ SURAT 3 CORE, 411'	BMR SURAT 4 CORE, 302'10"	GSQ SURAT 2 CORE, 240'2"
APTEODINIUM MACULATUM		●														
CANNINGIA COLLIVERI		●														
CANNINGIA MINOR VAR. PSILATA															●	
CHLAMYDOPHORELLA NYEI	●	●														
EXOCHOSPHAERIDIUM CF. E. PHRAGMITES		●														
HEXAGONIFERA CF. H. DEFLOCCATA											●					
MEMBRANOSPHAERA ROMAENSIS		●								●						
ODONTOCHITINA OPERCULATA		●									●					
RHOMBODELLA NATANS			○										●			
SPINIFERITES RAMOSUS VAR. RAMOSUS	●	●									○					
TENUA PILOSA		●														
VOZZHENNIKOVIA VILLOSA	○															
LEIOSPHAERIDIA SP. A	●	●		●					●	●	●	●	●			
LEIOSPHAERIDIA SP. B	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●
LEIOSPHAERIDIA SP. C		●	●		○	●	●				●	●	●			
MICRHYSTRIDIUM SP. A	○		●	●			●	●								
MICRHYSTRIDIUM SP. B		●		●					●	●						
MICRHYSTRIDIUM SP. C		●														
MICRHYSTRIDIUM SP. D		●		●					●				●			
PALAEOSTOMOCYSTIS FRAGILIS		●	○	○												
SCHIZOSPORIS RETICULATUS				●												
SCHIZOSPORIS SPRIGGII	○	○	●	●			○							●		
? SCHIZOSPORIS SP. A										○						
VERYHACHIUM REDUCTUM	●	●							●		○					○
VERYHACHIUM SINGULARE		●														

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Fig. 12. Distribution of dinoflagellates, acritarchs, and chlorophyta in the mid-Albian of the Surat Basin.

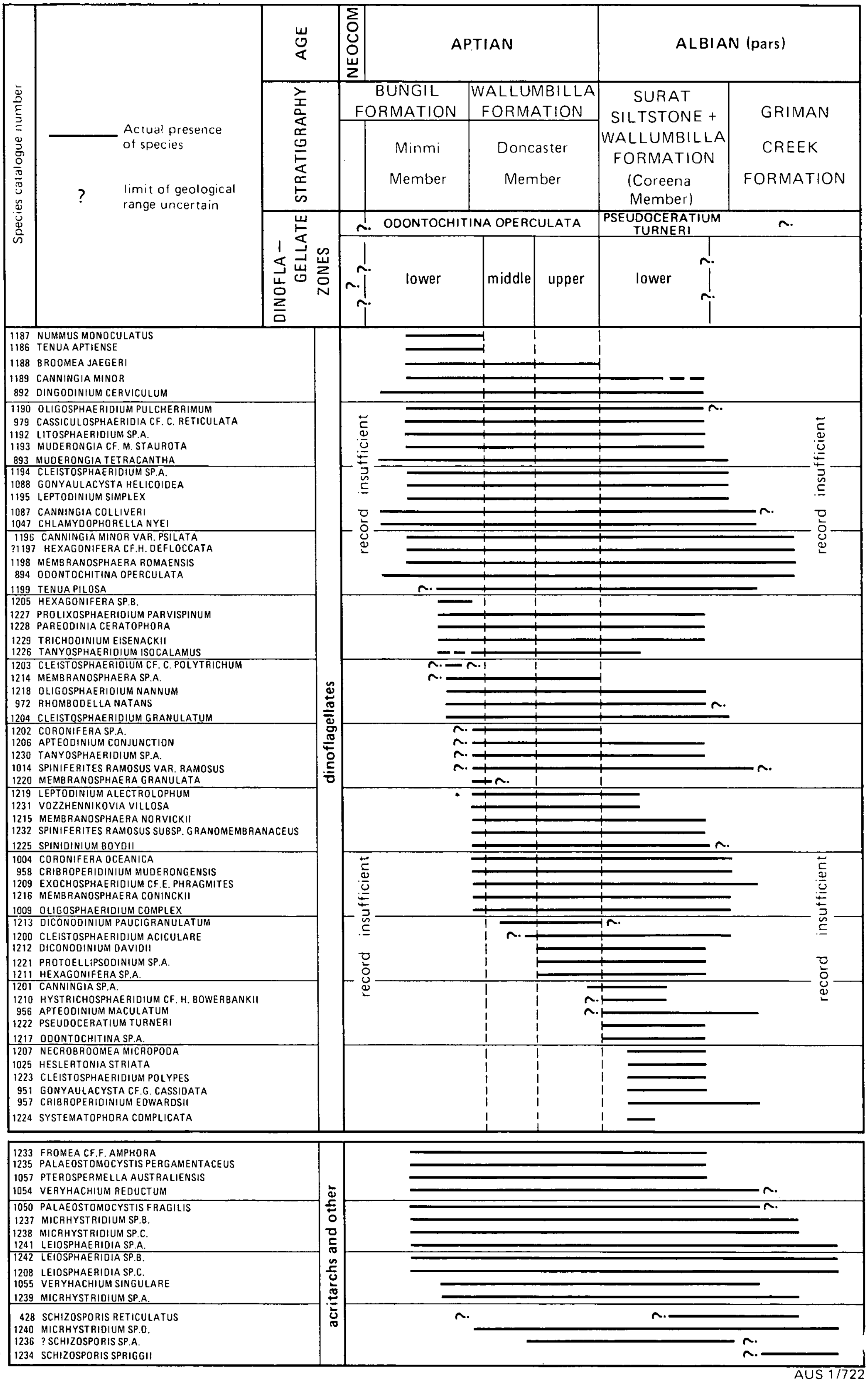


Fig. 13. Vertical distribution of dinoflagellates, acritarchs, and chlorophyta in the Early Cretaceous of the Surat Basin.

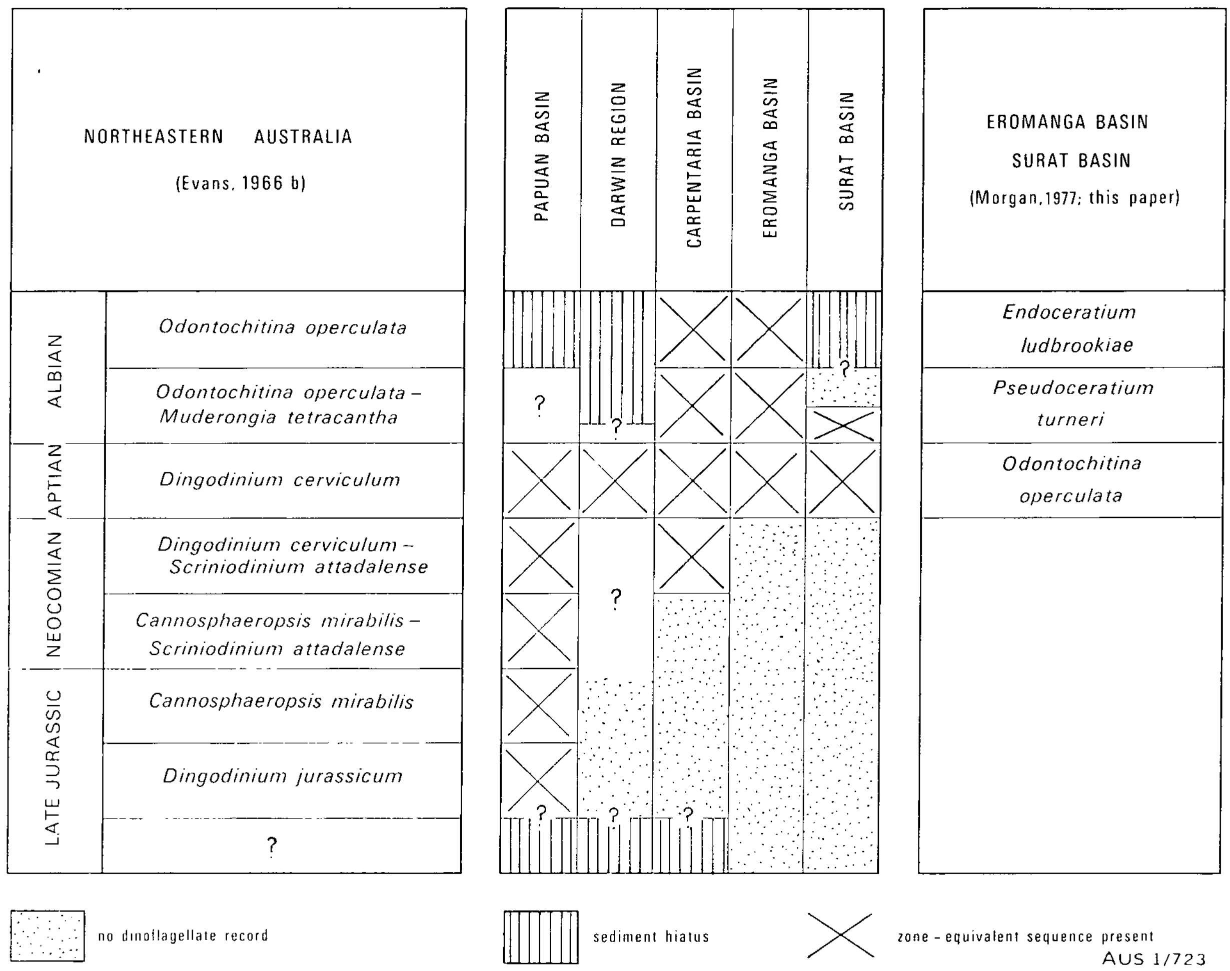


Fig. 14. Distribution and stratigraphic relationship of marine rock sequences in northern and eastern Australia and Papua New Guinea.

ments in Queensland (Burger, 1973b, also in prep.) as well as the Papuan Basin (unpublished data), and it was felt that the Zone would become too extended if it were to include the full range of the species. Initially, Burger (1973b) attempted to keep the Zone stratigraphically more restricted by suggesting that its lower limit be marked by the upper range limits of *Scriniodinium attadalense* and *Cannosphaeropsis mirabilis*, which he recovered from strata at the Neocomian/Aptian boundary in the northern Eromanga Basin. However, these species are not accurately documented in Australia; ideas on their upper range limits differ in various (unpublished) reports on the Papuan Basin.

Recently, Morgan (1977) proposed the *Odontochitina operculata* Dinoflagellate Zone for the (mainly Aptian) sequence; this unit includes the lower range interval of the nominate species, prior to the first appearance of *Pseudoceratium turneri*. This concept can be expected to have a wider application, as *O. operculata* first appears close to the Neocomian/Aptian boundary, in Papua New Guinea as well as in Western Australia (Wiseman & Williams, 1974), and probably also the Great Artesian Basin (Burger, op. cit.).

Characteristics: The *Odontochitina operculata* Zone represents the interval in which the nominate species occurs before the first appearance of *Pseudoceratium turneri*. In the Papuan Basin it succeeds a poorly known interval in which *Cannosphaeropsis mirabilis, Scriniodinium attadalense, Dingodinium cerviculum,* and various species of *Cyclonephelium* and *Gonyaulacysta/Cribroperidinium* constitute the earliest Cretaceous elements, and is in that basin, as well as in Queensland, succeeded by the *Pseudoceratium turneri* Zone. The following species are common elements within the Zone in the Surat Basin:

- *Chlamydophorella nyei*
- *Canningia colliveri*
- *Canningia minor* var. *psilata* nov.
- *Hexagonifera* cf. *H. defloccata*
- *Membranosphaera romaensis* sp. nov.
- *Dingodinium cerviculum*

Other species present in many assemblages of the Zone are:

- *Odontochitina operculata*
- *Cassiculosphaeridia* cf. *C. reticulata*
- *Canningia minor*
- *Leptodinium simplex* sp. nov.
- *Muderongia tetracantha*

The following species are restricted mainly to the upper part of the Zone, associated with the shallow (open) marine sediments of the Doncaster Member:

- *Cleistosphaeridium aciculare*
- *Rhombodella natans*
- *Spiniferites ramosus* subsp. *ramosus*

Tenua pilosa
Trichodinium eisenackii sp. nov.

Standard reference: Santos Oodnadatta 1 well, South Australia, 286.5-232.3 m interval, as designated by Morgan (1977). This interval lies within the Bulldog Shale.

Distribution: The Zone is associated with the Minmi Member, Bungil Formation, and correlate strata in BMR Mitchell 1, BMR Roma 1, and BMR Mitchell 11. Marine assemblages from the member in other subsurface sections are considerably poorer in number of species, and lack both *D. cerviculum* and *O. operculata*. The Zone is associated with the Doncaster Member in GSQ DRD 27, GSQ Surat 1, GSQ Roma 3, BMR Roma 8, BMR Mitchell 10, UKA Cabawin 1, and BMR Homeboin 1.

Age: On the basis of the age established for the Minmi Member and Doncaster Member, and the evidence for individual samples discussed on page 11, the *Odontochitina operculata* Zone is regarded as of Barremian to Aptian age.

Additional comments: Morgan (op. cit.) distinguished three intervals of the Zone in the marine sediments at the southern margin of the Great Artesian Basin, which also can be traced in the Surat Basin. A lower interval characterised by *Nummus monoculatus, Tenua aptiense* sp. nov., and *Cleistosphaeridium* cf. *C. polytrichum* was recognised in the Minmi Member and correlate sediments in BMR Roma 1, BMR Mitchell 11, BMR Mitchell 1, GSQ Surat 1, and the basal part of the Doncaster Member in BMR Roma 8 and GSQ Roma 3. An intermediate interval, with abundant *Membranosphaera romaensis* sp. nov., could be traced in the same member in GSQ DRD 27, GSQ Surat 1, and UKA Cabawin 1. An upper interval, characterised by the first appearance of *Diconodinium davidii,* was traced in the upper part of the member in GSQ Surat 1 and BMR Mitchell 10. The upper and lower intervals are as recorded by Morgan from the southern Eromanga Basin. The intermediate interval is different in character: *M. romaensis* sp. nov. seems to be abundant only in the Surat Basin.

The Pseudoceratium turneri *Dinoflagellate Zone*

The Albian palynological record reflects shallow marine, regressive conditions in the Eromanga and Carpentaria Basins. Evans (1966b) subdivided the dinoflagellate sequence in the Carpentaria Basin into a lower *Muderongia tetracantha/Odontochitina operculata* Zone (which succeeds his *Dingodinium cerviculum* Zone) and an upper *Odontochitina operculata* Zone. Both intervals are characterised by the presence of the nominate species. He subsequently recognised the two Zones in some deep wells drilled in the Eromanga Basin, and Evans & Hawkins (1967) traced the lower Zone into the Cretaceous of the Murray Basin area, New South Wales.

Continued work in the Surat and Eromanga Basins established that these three species occur in late Neocomian, Aptian, and also many early Albian assemblages. It is now assumed that the upper range limits of *D. cerviculum* and *M. tetracantha* in Australia lie within the earliest Albian sequence; specimens found in higher intervals are presumably of secondary origin, owing to intensive reworking of sediments during withdrawal of the Queensland inland sea. On the basis of this record the *Muderongia tetracantha/Odontochitina operculata* Zone cannot be defined in a qualitative sense in Queensland. Instead, the *Pseudoceratium turneri* Zone instituted by Morgan (1977) appears to be a workable unit and is here also applied to the Surat Basin sequence.

Characteristics: Morgan subdivided the dinoflagellate sequence succeeding the *Odontochitina operculata* Zone in the Eromanga Basin into a lower interval, the *Pseudoceratium turneri* Zone, and an upper interval, the *Endoceratium ludbrookiae* Zone. The former Zone is characterised by the initial presence of *Ps. turneri,* before the first appearance of *E. ludbrookiae.*

The record of the Zone in the Surat Basin is rather restricted, in that only the earliest interval observed by Morgan, containing *Diconodinium davidii,* can be recognised. Many of the assemblages from the higher part of the sequence are poor in number of dinoflagellate species, so the upper limit of the Zone cannot be determined.

Common to abundant species in the interval of the Zone in the Surat Basin are:

Chlamydophorella nyei
Canningia colliveri
Canningia minor var. *psilata* nov.
Cleistosphaeridium spp.
Spinidinium boydii
Spiniferites spp.
Tenua pilosa

Less abundant, but present in many assemblages are:

Apteodinium maculatum
Exochosphaeridium cf. *E. phragmites*
Membranosphaera romaensis sp. nov.
Leptodinium simplex sp. nov.
Muderongia tetracantha
Odontochitina operculata
Pseudoceratium turneri
Rhombodella natans

The following species: *Gonyaulacysta* cf. *G. cassidata, Cribroperidinium edwardsii,* and *Heslertonia striata,* are characteristic of the Albian sequence, but relatively uncommon in the Surat Basin. The ranges of *Coronifera* sp. A, *Diconodinium paucigranulatum* sp. nov., *Membranosphaera* sp. A, and *Broomea jaegeri* do not seem to extend into the Zone.

Standard reference: Santos Oodnadatta 1 well, South Australia, in the 221.9-128.0 m interval, as designated by Morgan (1977). This interval lies within the Bulldog Shale and the Oodnadatta Formation.

Distribution: Ps. turneri and *S. boydii* were found together in assemblages from the Coreena Member in BMR Mitchell Nos. 8 and 10, and from the Surat Siltstone in UKA Flinton 1, UKA Cabawin 1, and GSQ Surat 1.

Age: On the basis of the age of the associated sediments, and the evidence for individual samples discussed on pp. 13-14, the lower *Pseudoceratium turneri* Zone is regarded as of early to middle Albian age.

CHAPTER III. STATISTICAL STUDIES

1. Introduction
2. Statistical analysis of the spore and pollen record
3. Statistical analysis of the dinoflagellate record
4. Statistical analysis of the acritarch record

1. INTRODUCTION

The purpose of statistical (numerical) analysis of microfloral communities (assemblages) is to elucidate the significance of relative proportions of groups of organisms in the assemblages, and their variations in time, as an expression of changes in the environment, and so to provide a record of past living conditions. In palynological assemblages organic-walled, unicellular organisms of both terrestrial and marine origins (spores, pollen grains, dinoflagellate cysts, acritarchs) may be present, and their relative mutual abundances will be closely tied to depositional environments, and to some extent will express contemporary geographical and ecological conditions.

A statistical study of the Cretaceous palynological record in the Surat Basin was made, to investigate (a) periodical domination of certain fossils in microfloral assemblages, (b) possible biostratigraphic application of changes with time of the relative abundance of selected fossils, and (c) the feasibility of expressing the analyses into terms of regional palaeoenvironments. The geological set-up appeared favourable to this type of study. The Lower Cretaceous rock sequence preserved in the Surat Basin is uninterrupted. Sedimentary units overlying the Roma Shelf and Cunnamulla Shelf (from where most samples were collected) are virtually undisturbed; they vary very gradually in thickness laterally, and are quite consistent in lithological composition. Individual rock units are clearly distinguished in the subsurface, owing to vigorous drilling and logging, so that sample control generally is very accurate.

This chapter includes discussion of analysis of marine and non-marine factors expressed by abundance of organisms in the entire microfloral ensemble, and analysis of individual species and genera of fossils within the group of which they are part. Interpretation of this kind of analyses requires an understanding of the distribution mechanics of the organisms involved. Geographical distribution of various types of fossil palynomorphs depends on combinations of factors which are not the same for each type, although some of these factors clearly affect all of them. The relation between present-day geography and palynomorph dispersal has been investigated by various workers in offshore locations where physical conditions could be surveyed in detail. Three case studies, representing different geographical settings, are here briefly reviewed, as the results to which they have led are relevant to the present study.

Selected case studies

(i) The continental shelf at the southwest coast of South Africa at latitude 25°-35°S (Davey, 1971; Davey & Rogers, 1975), and the Orinoco River delta region in Venezuela at latitude 10°N (Muller, 1959) represent open marine environments. The coastline is convex, and sea currents run parallel to the shore. The edge of the shelf in both areas is slightly over 80 km from the coast, at depths of 300 m and 180 m respectively. Contours of spore and pollen distribution in the shelf sediments are more or less parallel to the shoreline, as a result of interactions of both current activity and dilution with distance, and are closer aligned, thus showing a steeper gradient, as sea currents are stronger.

Dinoflagellate assemblages are dominated by a few species in both areas. Davey and Davey & Rogers recovered *Spiniferites ramosus ramosus* (Ehrenberg) and *Operculodinium centrocarpum* (Deflandre & Cookson) amounting to more than 80 per cent of the entire cyst assemblages. Muller described and illustrated forms reminiscent of *Spiniferites* as the major hystrichosphere component in the Orinoco shelf assemblages. Here dinoflagellates are virtually absent in a wide zone adjacent to the coast, but are abundant farther offshore and along the coast of the island of Trinidad, probably as a result of sea current activity. In southwest Africa the distribution pattern is determined largely by local concentrations of *O. centrocarpum,* whose abundance shows no marked decrease with increasing distance from the shore. The picture is complicated by the fact that *O. centrocarpum* dominates the assemblages with over 75 percent in the south, wheras *S. ramosus* constitutes up to 77 percent of the assemblages in the north. The distribution of the latter species shows a gradual decrease in absolute abundance towards the edge of the shelf, and a rapid increase again on the continental slope.

It is interesting to note that both groups of organisms were least abundant along the edge of the shelf, where the concentration of glauconite in the sediment was significantly higher than elsewhere. Such a phenomenon was also commented upon by Williams & Sarjeant (1967).

(ii) The Bahamas, at latitude 25°N (Traverse & Ginsburg, 1966), and the region adjacent to the Orinoco River delta, represent open marine but shallower conditions, where island complexes occur and the coast forms peninsulas. In these environments the overriding factor determining both pollen and dinoflagellate distribution clearly is water activity. Traverse & Ginsburg found that frequency distribution of (highly buoyant) pine pollen in the waters of the Great Bahama Bank was very sensitive to the current pattern (streams, tidal action) and turbulence of the water. Pollen settlement was distinctly related to the size of sedimentary particles. Low pollen concentrations were found in pelletoidal and oolitic sands; the highest concentrations coincided with calcareous mud areas, and had little or no relation to areal distribution of the pine itself. In the Bahamas, degree of salinity appears to have an additional influence on pollen dispersal, but precise data are not available from the Orinoco River area. Here the situation is complicated by a low pollen yield and uneven density of sampling, and computer trend analyses of relative abundance of various groups of organisms only remotely resemble actual geographic conditions (Williams & Sarjeant, 1967).

(iii) The Gulf of California, at latitude 22°-30°N (Cross, Thompson & Zaitzeff, 1966) represents more or less sheltered marine environments; it is an elongate water body about 2000 km by 150 km, separated from the Pacific

Ocean by the Baja California Peninsula except at the southern end, where the entrance to the Gulf is about 700 km wide. Samples were taken to depths of over 2700 m.

The distribution patterns of spores and pollen grains showed clear concentration maxima fanning out from the major tributaries (Rio Yaqui, Rio Mayo, Rio Fuerte). Although the assemblages are dominated by pine pollen, this pattern is also seen in individual groups, for instance the Chenopodiaceae-Amaranthaceae. Poor pollen abundance in the coarser sediments just offshore seems to indicate winnowing and sorting during transport. Near the mouth of the Gulf local concentrations of pollen in the deeper sediments are interpreted by the authors as a result of interactions of sea currents, supply of (pine) pollen, and type of sediment.

Dinoflagellate dispersal has in common with other marine organisms a tendency to increasing abundance farther away from the shore, with local concentrations, particularly in the deeper sediments at the mouth of the Gulf. The authors thought that the supply of terrigenous sediments could be a dilution factor in shaping dispersal contours. Other agents determining the distribution of benthic foraminifera, radiolaria, and diatoms—e.g. low oxygen content, production rate, and sorting processes—were also thought to play a role in dinoflagellate distribution.

The acritarch record is poor. Cross & others plotted the distribution pattern of one type of palynomorph (very similar to *Micrhystridium* sp. C, see p. 90). This organism distinctly increases in abundance in the deeper sediments (up to 8000 specimens per gram of sediment in the mouth of the Gulf) and rapidly diminishes farther seawards. The authors noticed comparable distribution patterns of certain plant detritus and land-derived pollen supplied from the southern end of the Baja California Peninsula (La Paz), but thought this fortuitous; they were inclined to regard the organism as of marine planktic origin.

Absolute and relative palynomorph dispersal

In the three case studies just described, similar field and laboratory procedures were followed. Absolute quantities of selected palynomorphs and groups of palynomorphs (i.e. quantities calculated per unit mass of sampled sediment) were determined in a large number of locations, and areal dispersal patterns were computed from them. In this way it was possible to demonstrate how spores, pollen grains, and dinoflagellates are dispersed offshore and accumulate in the bottom sediments through interaction of locally operating forces such as water current activity, rate of mineral sedimentation, temperature, and degree of salinity.

Unlike the raw data on which those studies based their conclusions the Surat Basin analyses represent proportional (and not absolute) abundances of various organisms and must be interpreted in a comparative sense. This is not entirely disadvantageous; by means of plotting ratios of selected fossil groups, for instance spores and pollen versus dinoflagellates, distorting influences may be cancelled out.

This was illustrated clearly by Davey (1971). Davey's plots of absolute dinoflagellate distribution resulted in contours which are highly irregular and difficult to interpret on account of (1) the dominating effect of one species (*O. centrocarpum*) upon the dinoflagellate totals, which tends to over-accentuate local favourable conditions for that species alone, and (2) apparent local differences in sedimentation. For instance, the rate of sedimentation on the shelf slope is low, and the sediments are well sorted; they contain considerably higher numbers of dinoflagellate cysts *and* sporomorphs than on the shelf itself. Also, dinoflagellate occurrence is particularly low in sediments with high glauconite concentrations.

By plotting the abundance of *O. centrocarpum* in relation to that of *Spiniferites,* however, smooth contour lines were obtained, which Davey thought indicated clearly that the former species was carried into the area from the east and southeast by warmer currents. Likewise, contours which Davey obtained by trend surface analysis of the sporomorph/dinoflagellate cyst ratio were oriented approximately parallel to the coastline and showed gradual proportional increase of dinoflagellates seawards on the shelf.

Further comparative data on proportional frequencies of palynomorph groups were provided from shelf studies by Williams & Sarjeant (1967) and Davey & Rogers (1975). Those authors examined assemblages from bottom sediments in some transects normal to the coast, respectively in the Gulf of Guinea off Nigeria, and off South West Africa. Briefly, Davey & Rogers found that in the two traverses which they examined, the ratio of sporomorphs to dinoflagellates decreased in an offshore direction. Williams & Sarjeant recorded the following five main assemblage components in two traverses: dinoflagellates, small leiospheres, *Rhizophora* pollen, other pollen, and trilete spores. The dinoflagellates and leiospheres increased in abundance farther away from the coast, the leiospheres reaching proportions of more than 75 percent of the total assemblages farthest offshore, with a corresponding reduction of the pollen fractions. The abundance of trilete spores remained small but constant. By subjecting various combinations of data to computer trend analysis the authors found that the contours best fitting the coastline configuration were based on relative frequencies of leiospheres, chorate dinoflagellate cysts, *Rhizophora* pollen, and spores.

Strangely, dinoflagellates were first encountered by Williams & Sarjeant in samples at about 40 km distance offshore. It seems that the volume of fresh water discharged by the Niger River sufficiently lowers the salinity of the surface waters in the Gulf of Guinea to curb dinoflagellate growth for a considerable distance away from the coast, and creates conditions favourable for acritarchs. Davey & Rogers (op. cit.) likewise attributed the absence of dinocysts in offshore samples nearest to the coast to fresh water from the Orange River.

Palaeo-environments in the Surat Basin

The above examples, and in particular that described by Davey (1971), however different the conditions which they represent, are very useful when trying to evaluate the total-assemblage analyses from the Surat Basin (tabulated in Appendix A) in terms of palaeoenvironments.

The quiet Cretaceous geology of the basin indicates that events took place gradually and on a basin-wide scale. During the peak of the Aptian transgression the 'Roma' sea was probably enclosed in a shallow, oblong, depression well over 400 km in diameter, with outlets to the west and, as we shall see, probably also to the northeast. Maximum depth probably did not exceed 50-100 m. In these sheltered conditions major sustained sea currents may not have existed except in the outlet channels; tidal action may have been the principal water activity. The physical conditions then prevailing possibly resemble those operating at present in the Gulf of California.

In drawing this analogy we assume that palynomorph dispersal followed comparable patterns. Spores and pollen grains discharged from major rivers spread offshore in fan-like distribution patterns, and many were carried much farther into the sea. Wind action probably played a minor role in dispersing the (mainly trilete) sporomorphs. The dinoflagellates proliferated in the deeper parts of the basin and diminished towards the coast, except for possible occasional concentrations.

The information from the Surat Basin is too meagre to be subjected to advanced computer analysis. Instead, a simpler technique is developed based on Davey's (1971) and Davey & Rogers's (1975) approach, whereby it is postulated that (1) contour lines of sporomorph and dinoflagellate distribution followed approximately the shape of the coastline, and (2) an increase of the dinoflagellate percentage in the assemblages, with a corresponding decrease of pollen and spores, indicates a rise in degree of salinity.

The calculations for translating the statistical data of Appendix A into terms of palaeo-environments are worked out as follows. Assemblages from the Minmi Member in the Roma Sheet area (BMR Roma 1, MFP 4320, AAO Pickanjinnie 1, MFP 773, GSQ Roma 3, MFP 5790) include 0-3.5 percent of dinoflagellate cysts. Samples from BMR Roma 8 (MFP 4676), GSQ DRD 27 (MFP 5801), and GSQ Roma 3 (MFP 5789) are all from immediately above the base of the Doncaster Member in the same area. They yielded assemblages with fractions of dinocysts averaging as much as 8.3 percent. As these samples represent the very start of open marine conditions (see Table 2) a maximum of 8 percent of dinocysts is taken as the limit above which assemblages represent open (shallow) marine environments. For practical purposes assemblages containing less than 3 percent of dinocysts and less than 15 percent of acritarchs are considered to indicate marginally brackish to non-marine environments, and assemblages containing 3-8 percent of dinocysts, and

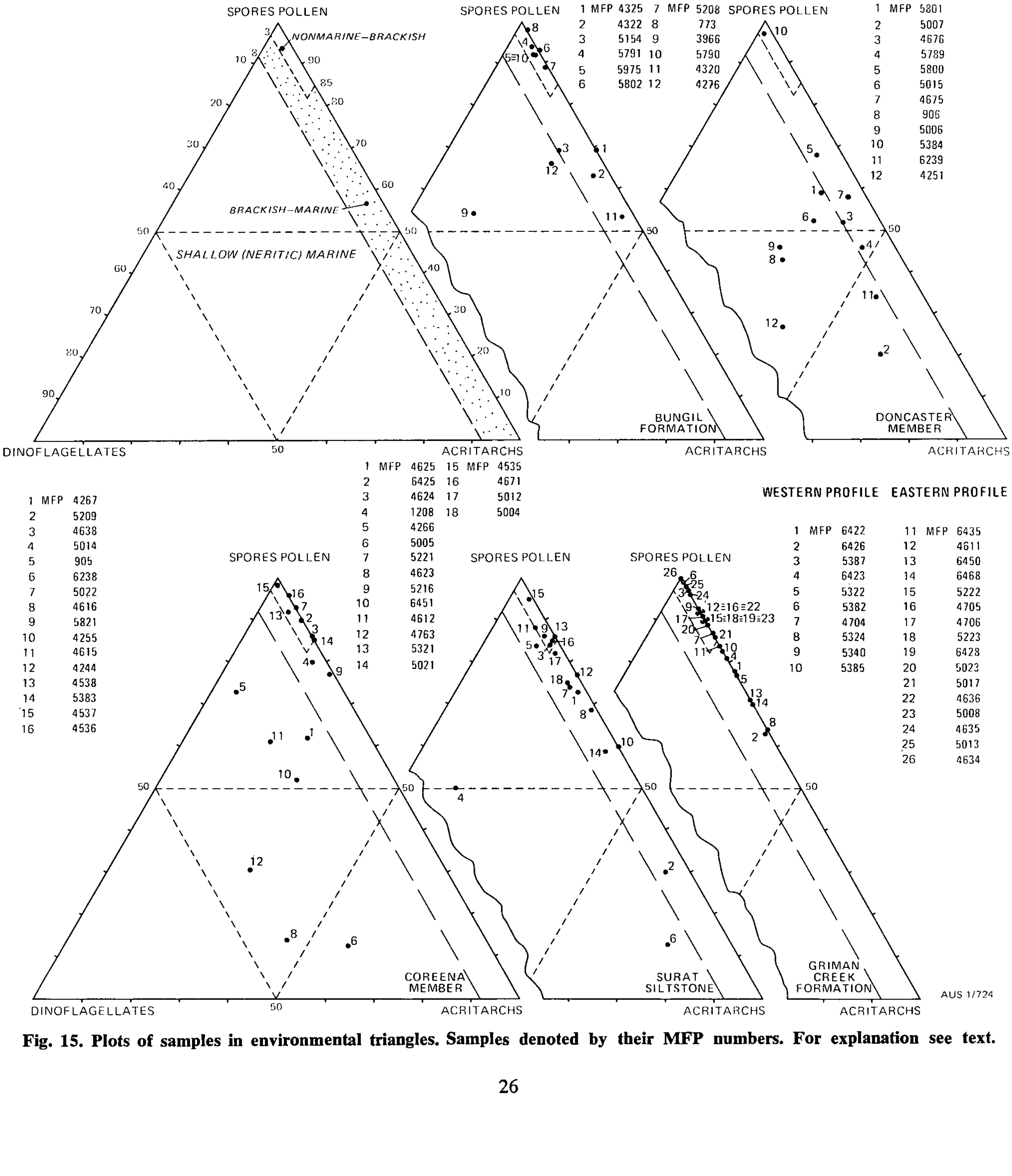


Fig. 15. Plots of samples in environmental triangles. Samples denoted by their MFP numbers. For explanation see text.

over 15 per cent of acritarchs, marginally brackish-marine conditions.

These percentages are taken as limits by which regional conditions may be broadly classified. On the basis of the counts summarised in Appendix A, every assemblage was plotted in one of several 'environmental triangles', as shown in Figure 15, so that each assemblage represents a certain environment, depending on its place in the triangle diagram.

An assemblage-plot can shift considerably in the diagram on account of an excessive abundance increase of a certain fossil, for instance as a result of a local dinoflagellate concentration, or an over-supply of one type of sporomorph. However, the large number of species and genera counted may neutralise the importance of such fluctuations to a certain extent. Excessive peaks in pollen abundance also have their value in that they indicate reasonably nearshore conditions and may be a sign of unstable geographical patterns. As we shall see, almost all assemblages dominated by one or two species are confined to the early Albian, when regressive conditions prevailed.

The correlation diagrams of Figures 6-8, in which the positions of the samples are indicated, illustrate successive marine and non-marine phases in the Surat Basin. The sections of the Neocomian rock units near outcrop (including samples from within the *Murospora florida* Zone, discussed elsewhere) show that the lowermost Neocomian sediments were marginally non-marine (Fig. 6). The Mooga Sandstone consists of quartzitic arenites, with minor silty and argillaceous horizons. Well developed cross-bedding indicates a shallow water and strong current environment (Day, 1964).

Quieter (and even reducing) conditions during deposition of the Kingull Member (Bungil Formation) are indicated by the constant thickness of the member in subsurface, and by the predominance of sediments with abundant calcareous and carbonaceous material. Brackish-marine conditions are apparent in UKA Cabawin 1 and BMR Roma 3. Farther west the member accumulated in marginally non-marine conditions, and loses its distinctive nature in the Mitchell Sheet area, where it merges with sandstones developed locally on the Nebine Ridge. Apparently a sea arm briefly approached the region from the east or northeast, but the open sea failed to flood the entire basin.

During late Neocomian and early Aptian times distinct marine and brackish-marine influences, as precursors of the main Aptian transgression, are apparent in the Nullawurt Sandstone Member and Minmi Member of BMR Mitchell 1 and 11, BMR Roma 1, and GSQ Surat 1. Farther east, in GSQ Roma 3, GSQ DRD 27, and AAO Pickanjinnie 1, the Minmi Member still represents predominantly non-marine conditions. The entirely marine, mainly argillaceous Doncaster Member (Wallumbilla Formation), which contains the late Aptian 'Roma' faunas, represents the peak of the transgressive phase. The brackish-marine samples from GSQ Roma 3 and BMR Roma 8 delineate approximately northern shores of the Surat Basin sea.

The gradual withdrawal of the sea in the early Albian brings in a period of complex environmental changes (Fig. 7). The Coreena Member incorporates flat-lying calcareous sandstone and siltstone beds containing glauconite; local intraformational conglomerates and cross-lamination are common. Towards the east (GSQ Surat 1 and 3) the member was laid down in brackish to brackish-marine conditions, whereas in the northwest the marine samples from BMR Mitchell 8 and 10 and BMR Roma 9 indicate that an arm of the Eromanga (Tambo) inland sea extended to the east.

The Surat Siltstone consists of carbonaceous mudstone, siltstone, and minor fine-grained sandstone. Plant remains and very fine cross-bedding are common. Apparently the unit represented a brief interval of restricted marginally brackish-marine (coastal strandline) conditions, and merged with the Coreena Member farther northwest (see page 17). The subsequent record indicates the gradual return towards marginal, non-marine to brackish environments (Fig. 8). The locally developed Griman Creek Formation represents a period of rapid accumulation of interbedded fine-grained sandstone, with carbonate cement, siltstone, and mudstone. Coquinite beds restricted to the basal part of the formation indicate marginal-facies and rapidly disappearing saline environments.

Attempts to reconstruct regional palaeo-environments by means of plotting samples as 'indicators' in a palaeogeographic map are shown in Figures 16 and 17. The maps of Figure 16 show successive stages of the initial marine transgression during the earliest Aptian, and clearly establish the penetration of the sea from the west or southwest (see also Fig. 6). This reconstruction agrees with, and complements, that of the Eromanga Basin drawn on the basis of the first appearance of dinoflagellates, showing the Aptian sea expanding towards the south and southeast (Burger, 1973b).

The maps of Figure 17 show successive stages of withdrawal of the sea during deposition of the upper Coreena Member, Surat Siltstone, and Griman Creek Formation. The correlation diagram of Figure 7 illustrates the rapid changes in environment during Surat Siltstone deposition, which cannot be presented adequately in a palaeogeographic map. Nevertheless, the Coreena Member is seen as being restricted mainly to onshore areas, and the Surat Siltstone as occurring in the central (and deeper) parts of the basin, i.e. the Mimosa and Dirranbandi Depressions (Fig. 17A). The connection with the open 'Tambo' sea seems to have been restricted to narrow channels opening to the west across the Cunnamulla Shelf, and possibly across the Nebine Ridge as well. Figures 17B and 17C show successive stages of retreat of the sea during the middle Albian, and the influence of marginal, littoral, brackish conditions gradually shrinking to narrow channels, possibly expressing major river systems flowing into the Tambo sea.

The picture at the eastern margin of the basin is not clear. The assemblages from the Doncaster Member, Coreena Member, and Surat Siltstone in UKA Cabawin 1 are all marine (Figs. 6, 7), which demonstrates that the sea had continued access to the region in the late Aptian and Albian. Together with the evidence of marine influence in the Kingull Member (Bungil Formation) this lends support to Day's (1969) contention that a northeastern seaway existed between the Surat Basin and the Maryborough-Stanwell area in the late Neocomian and Aptian. This channel may have continued intermittently in the early Albian, but was apparently cut off permanently at the onset of Griman Creek deposition (Figs. 17B, 17C).

Distribution of individual fossils

We see that total-assemblage analysis discussed above agrees very well with the field data regarding palaeogeography and palaeo-environment, and may add details to those intervals which lack marine faunal evidence.

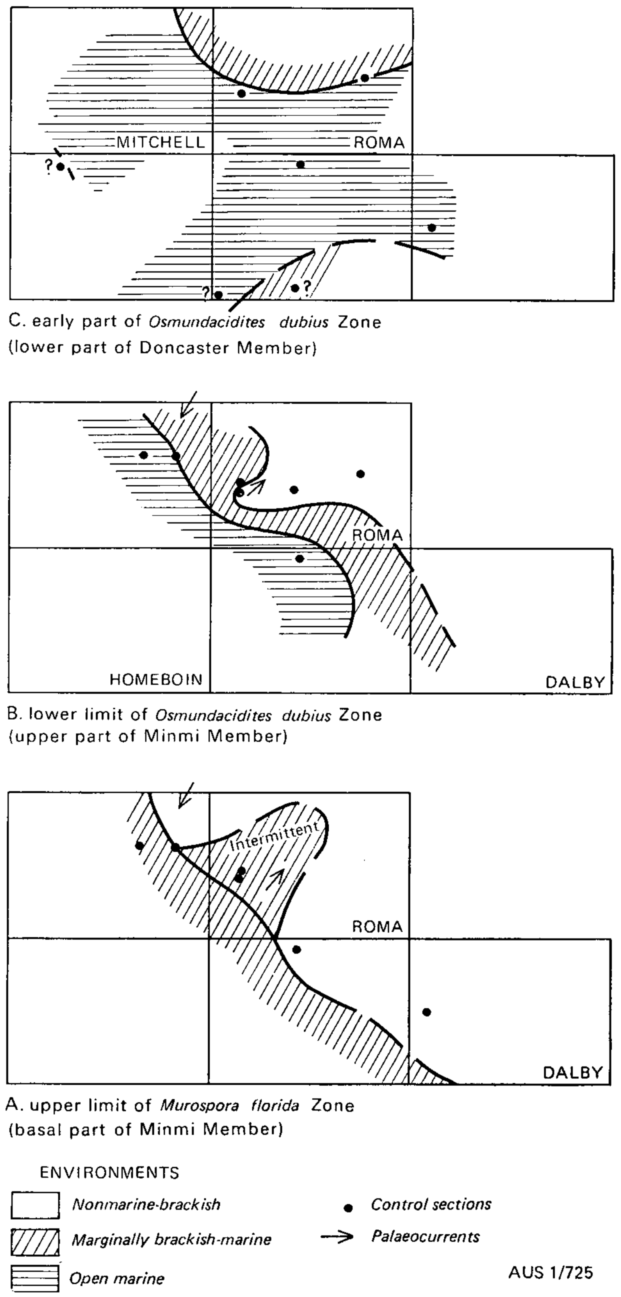


Fig. 16. Early Aptian distribution of land and sea in the Surat Basin region.

This section includes a discussion of analyses of the composition of spore and pollen assemblages, dinocyst assemblages, and acritarch assemblages separately. Relative abundance, and its fluctuations in time, of organisms within these groups graphically illustrates the behaviour of these organisms with respect to changing conditions and thus may give some indications as to their ecological preferences.

The case studies reviewed above gave some indications as to offshore distribution of certain types of spores, pollen, and dinoflagellates. Other studies (referred to below) have also tried to throw more light on the dispersal of various organisms, and it is possible to outline some broad principles. As far as possible the statistical data here reviewed are interpreted according to these principles.

SPORES AND POLLEN GRAINS: Growth and migration of the parent vegetation are determined mainly by climate, topography, geography, and geology (i.e. soil type). After release at maturation the pollen is dispersed by wind and biotic activity. Pollen dispersal is related to plant distribution to the extent that the amount of pollen initially deposited at a given point depends on the nearness of the parent plant, its relative abundance in the regional vegetation, and its pollen-productive capacity. Prevailing wind directions may influence the initial settlement area of certain types of winged pollen (Cross, Thompson & Zaitzeff, 1966) but in general, wind-dispersed pollen seems to be of minor importance, at least in offshore pollen assemblages (Muller, 1959; Stanley, 1965; Traverse & Ginsburg, 1966).

After initial settlement aquatic transport takes over. The free sporomorphs behave like sedimentary particles, and the total area of dispersal is thus determined by regional drainage and sedimentation patterns, as well as current activity, and may well stretch far beyond the coastline. This area may vary, depending on size, shape, and density of the sporomorph. Groot (1966) found, for instance, that extensive transport may result in the destruction of certain types of pollen.

It is clear that local differences in the composition of the pollen rain from the air are gradually smoothed out with increasing transport (Groot, 1966). Offshore sediments will carry highly variable mixtures of coastal and backland pollen complexes, from which only the most general conclusions can be drawn concerning regional plant life.

DINOFLAGELLATES: These organisms are restricted almost entirely to brackish and marine environments, where the principal agents controlling growth are light, degree of salinity, concentration of nutrients, and water temperature. They are widely dispersed by ocean currents, and after burial of the cast-off cysts lateral transport is minimal by comparison. This is in marked contrast to the pollen picture. The composition of dinocyst assemblages in the sediment will therefore on the whole represent a truer picture of local life communities. This is a factor of considerable potential value for palaeo-environmental study, in that conclusions to which study of modern dinoflagellate cysts may lead (for instance, Wall & Dale, 1968b; Wall & others, 1977) are very likely also applicable to the fossil record.

ACRITARCHS: This large group of organisms, which is abundant in the Surat Basin Cretaceous, is still very little understood in terms of environmental behaviour. The organisms have been discussed by Staplin (1961), Wall (1965), William & Sarjeant (1967), and others. Very briefly, these studies demonstrated that, either in reef complex environments or inshore basins, forms with long, thick spines (i.e. with the highest surface area per volume) settle in quiet, deeper water far from areas of high turbulence. Forms with smaller and thinner spines may also settle in more turbulent surroundings where coarser clastics are deposited. Smooth-walled organisms are present everywhere, but seem to decrease in abundance farther offshore.

Unfortunately, these data only seem to demonstrate the overriding influence of water turbulence upon acritarch distribution, and reveal very little of the behaviour proper to the living organisms (see also Davey, 1971). Statistical analysis of the acritarch floras from the Surat Basin seems to point to a more complex hehaviour pattern, and is discussed below.

Unlike Burger's (1974) Neocomian study, the present paper presents analyses from samples collected in many localities scattered across seven 1:250 000 Sheet areas. Sample density is low in many sections. The samples from every formation except the Griman Creek Formation have been arranged into a tentative stratigraphic order on the basis of their relative positions vis-a-vis top and bottom of the respective rock units. Where this could not be done, for instance below formation outcrop areas, thickness of the formation as logged in nearby water-bores was taken as a guide (Figs. 18, 19).

The samples from the Griman Creek Formation have been grouped into two diagrams (see Fig. 20). The lower diagram includes samples from sections drilled in the central part of the Surat Basin (St George and Surat Sheet areas), where the stratigraphic succession

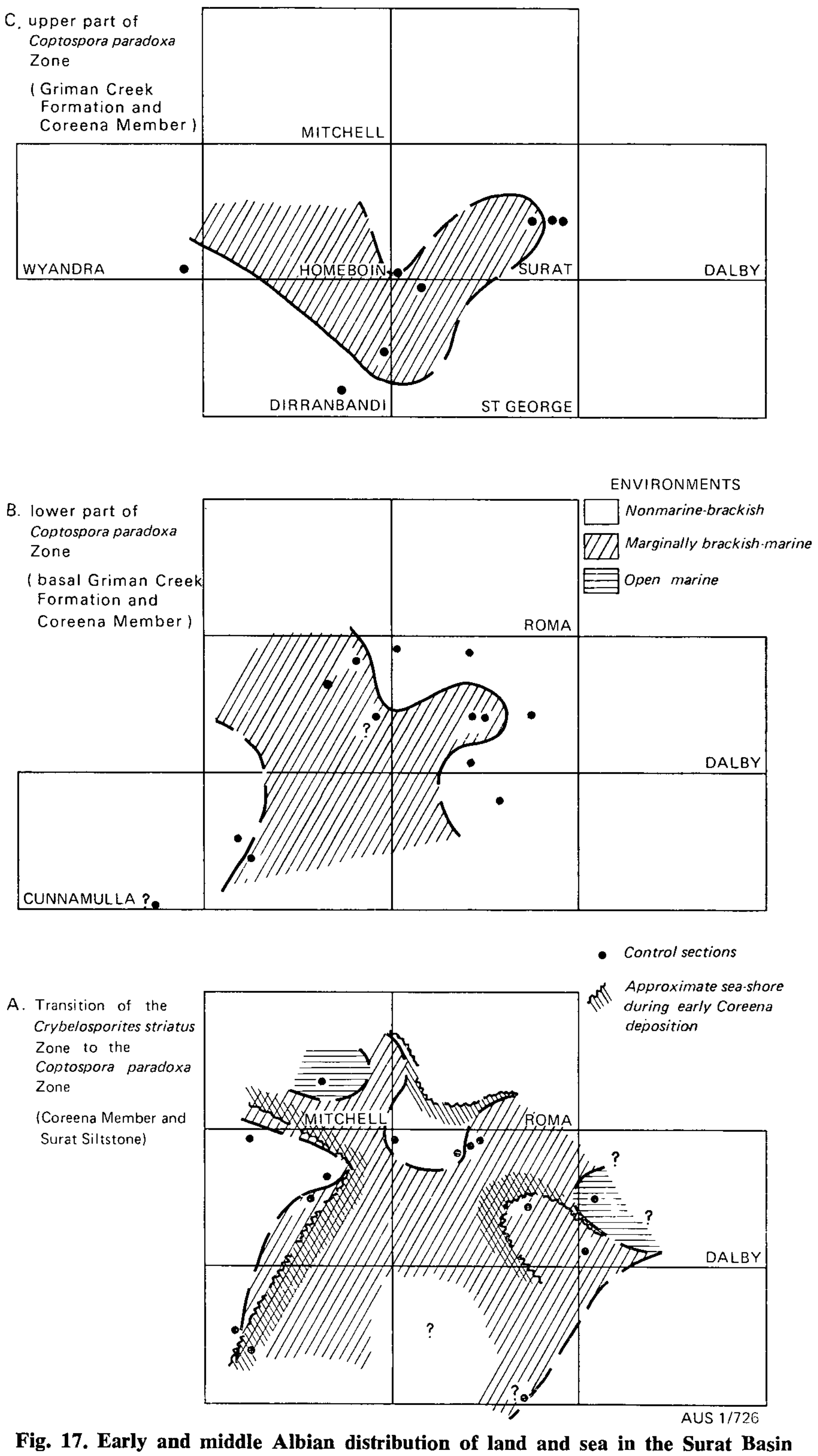


Fig. 17. Early and middle Albian distribution of land and sea in the Surat Basin region.

of the samples was established by juxtaposition of neighbouring sections. The upper diagram includes samples from widely scattered wells and bores drilled farther west (mainly in the Homeboin and Dirranbandi Sheet areas). Since the Surat Siltstone is poorly distinguished in the logs of various sections near outcrop, the succession of samples as given is by no means certain.

These methods of attaining a stratigraphic sample succession within a rock unit and fossil interval, although far from perfect, are unavoidable in this study. It is thought, however, that in view of the broad and general aims of the study the degree of accuracy permitted outweighs the risks of inherent errors.

It is clear that this type of composite graph will record mainly long-range trends in abundance of fossils. This has the advantage that local, temporary changes are smoothed out, but changes of minor amplitude which might be otherwise recordable throughout the basin in individual sections may also remain undetected. Considerable fluctuations in pollen sedimentation, owing to local differences in geography, may not necessarily come out sufficiently in the pollen diagrams, and may be interpreted mistakenly as basin-wide features. As a measure of control, likely trends shown in individual graphs are checked wherever possible against the readings of the corresponding fossils in single boreholes.

2. STATISTICAL ANALYSIS OF THE SPORE AND POLLEN RECORD

Methods

Statistical (numerical) analysis of Aptian and Albian spore and pollen assemblages from the Surat Basin, discussed in the following pages, is an extension of a similar study which the author (Burger, 1974) made in predominantly non-marine Neocomian sediments drilled in the northern part of the basin. In that study samples from three sections (BMR Roma 1, GSQ DRD 27, and GSQ Roma 3) through the Mooga Sandstone and the Bungil Formation were examined statistically.

It was found that each of the fossil groups selected was present in comparable quantities in all three sections. Statistical variations of relative abundance in time were less intense than had been expected. Sampling of each section had been sufficient to detect relative abundance variations affecting certain groups in all three sections simultaneously. Six levels (events) were recognised, at which changes occurred within two or more groups. As some of these changes were clearly of permanent duration, and not tied to a specific lithology, they were thought to be directly related to mutations within the local floral record.

It was thus shown that statistical analysis could be useful in short-distance correlation. The present study provided an opportunity to test the ideas then formulated on a wider scale. Similar methods of analysis are used. Spores and pollen grains (to a total of 200) are counted at random in preparations from each sample, and relative abundance of selected groups in every sample is expressed in fractions of the total spore and pollen assemblage. Twenty groups in total are distinguished and recorded in the pollen spectra. The results of the analyses are tabulated in Appendix B. The pollen spectra are set out in the form of 'sawtooth' diagrams (Figs. 18-20). At the left of each diagram details of every sample are given; the samples examined are grouped by formation, and within each formation are arranged in stratigraphic succession, as far as possible. The central part includes spectral analyses of the spore and pollen assemblages, and at the right the basic assemblage composition expressed in terms of proportional abundances of the major groups of fossils is given. The graphs of individual groups represented bear identical Roman numerals in every diagram.

A number of events have been registered which are thought to be sufficiently important and widespread in occurrence to be distinguished from statistical and other erratic fluctuations (Table 3).

Description of the Aptian pollen sequence

This part of the sequence includes the entire *Osmundacidites dubius* Zone. The diagram of Figure 18 graphically represents statistical analysis of 24 spore and pollen assemblages associated with the Zone.

GRAPH I represents the following species: *Cyathidites minor, C. australis, C. punctatus, Dictyophyllidites crenatus,* and *Biretisporites spectabilis.* Of these species, *C. minor* is by far the most abundant species, and in many assemblages even the only species in the group. In its lower part, associated with the Bungil Formation, the graph fluctuates between 17 and 34 percent, with a significant oscillation to a maximum of 47 percent, which is apparent only in the east (BMR Dalby 3 and GSQ Roma 3) but not in the well-sampled sections farther west. This may suggest that the associated flora was concentrated mainly in the eastern region.

At the start of Doncaster Member deposition the graph indicates a second temporary maximum, which is traceable in the sections of GSQ Roma 3, GSQ DRD 27, and GSQ Surat 1, where the count reaches 52 percent. A considerable decline in abundance towards the top of the sequence (to a minimum of 10%) might possibly be explained as an effect of the vegetation receding as the sea gradually submerged the entire area.

GRAPH II represents *Cyathidites rafaeli,* which is here recorded separately to show its considerable numbers in the Early Cretaceous sequence. It is represented in the Bungil Formation assemblages between 3 and 16 percent (average 10%), and in the Doncaster Member assemblages between 8 and 17 percent (average 10%). The maxima are not very pronounced; they coincide with minimum abundance readings in the previous graph, and vice versa, which seems to indicate a certain degree of statistical influence.

GRAPH III represents *Baculatisporites comaumensis* together with *Osmundacidites wellmanii;* the latter species has by far the lesser sample frequency and relative abundance in the assemblages. Within the interval of the Bungil Formation the graph fluctuates considerably from a minimum of less than 1 percent in GSQ DRD 27 to considerable maxima in BMR Mitchell 1 (21%), BMR Dalby 3 (15%), and BMR Roma 1 (15%). In the Doncaster Member assemblages the abundance readings vary between 9 and 20 percent, with an average of 12 percent, considerably higher than that (8%) in the previous formation. A slight increase

TABLE 3. SCHEME OF EVENTS SUMMARISING MAJOR FLUCTUATIONS OF SPORE AND POLLEN ABUNDANCE IN THE EARLY CRETACEOUS OF THE SURAT BASIN

	Event	*Rock unit*	*Zonal affinity*	*Remarks*
L	increase GLEICHENIIDITES (X) increase CICATRICOSISPORITES (VII)	Griman Creek Formation (d)	*Coptospora paradoxa*	
K-2	maximum CRYBELOSPORITES (XIII) maximum CLAVATIPOLLENITES-ASTEROPOLLIS (XX)	basal Griman Creek Formation (c) & Coreena Member (c)	*Coptospora paradoxa*	Accompanied by maximum occurrence of CICATRICOSISPORITES (VII), BACULATISPORITES/OSMUNDACIDITES (III), and saccate pollen (XVI, XVIII)
K-1	maximum CRYBELOSPORITES (XIII) maximum CLAVATIPOLLENITES-ASTEROPOLLIS (XX) decrease GLEICHENIIDITES (X)	Surat Siltstone (b/c) Coreena Member (b/c)	*Coptospora paradoxa* (lower limit)	
J	continuous record CRYBELOSPORITES (XIII) decrease STEREISPORITES (XII)	Surat Siltstone (b) Coreena Member (b)	*Crybelosporites striatus*	possible maximum GLEICHENIIDITES (X)
H	increase FORAMINISPORIS (XI) increase bisaccate pollen (XVI, XVII) decrease GLEICHENIIDITES (X) decrease OSMUNDACIDITES DUBIUS (IV)	basal Coreena Member (a)	*Crybelosporites striatus* (lower limit)	
G	maximum CICATRICOSISPORITES (VII) maximum OSMUNDACIDITES DUBIUS (IV) decrease CYATHIDITES etc. (I) increase STEREISPORITES (XII)	Doncaster Member	*Osmundacidites dubius*	
F	decrease LYCOPODIUMSPORITES (VIII) decrease saccate pollen (XVI, XVII, XVIII) increase BACULATISPORITES/OSMUNDACIDITES (III)	basal Doncaster Member	*Osmundacidites dubius*	
E	increase STEREISPORITES (XII)	Bungil Formation (upper part)	*Osmundacidites dubius*	possible maximum saccate pollen (XVI, XVII, XVIII)
A-D		Bungil Formation Mooga Sandstone	*Murospora florida*	see Burger, 1974

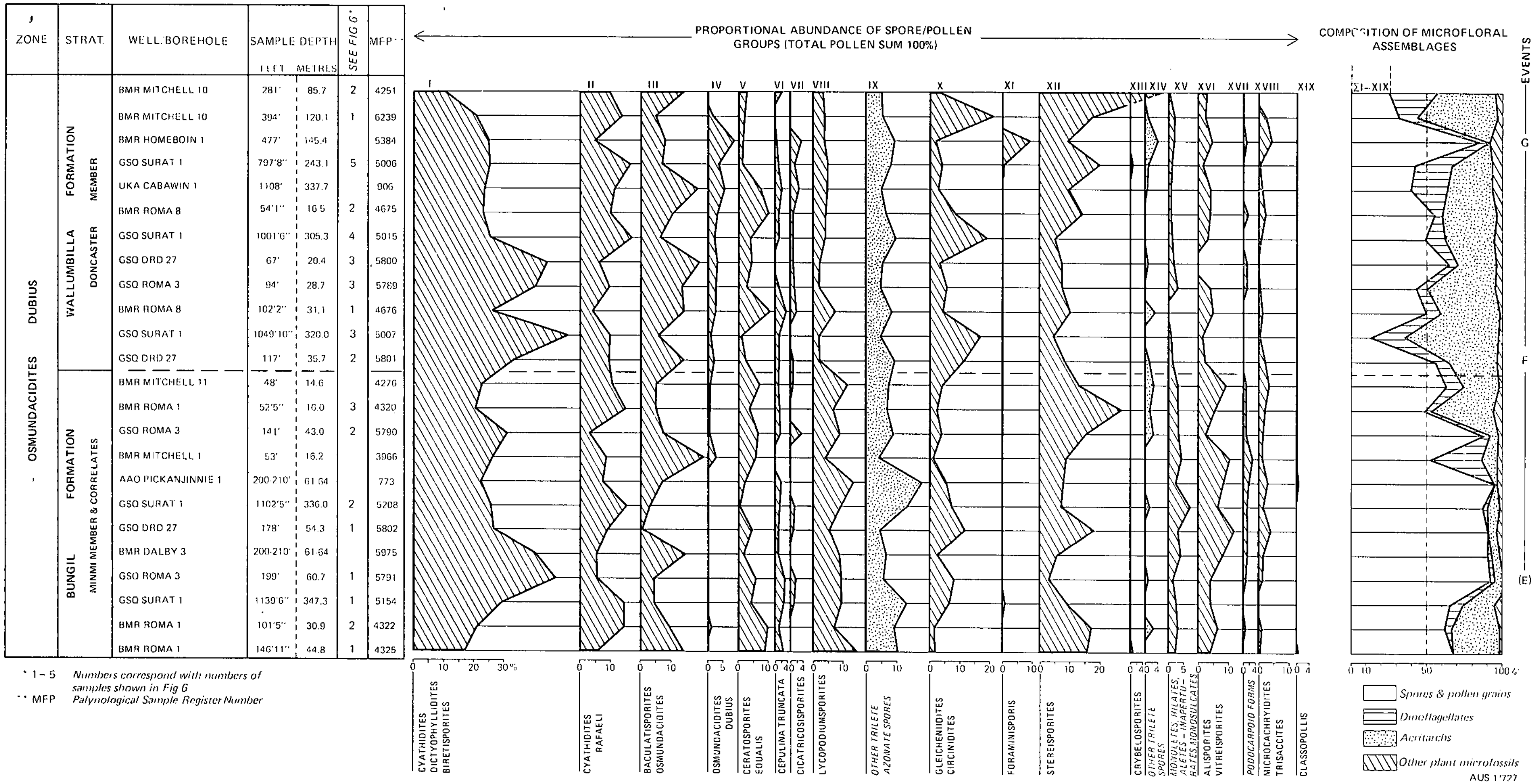


Fig. 18. Proportional abundances of fossils in spore and pollen assemblages from the Bungil Formation and Doncaster Member (Wallumbilla Formation).

is indeed apparent in the readings from successive samples in the sections of GSQ DRD 27, GSQ Roma 3, and GSQ Surat 1.

GRAPH IV represents *Osmundacidites dubius* sp. nov., which is very rare in the Neocomian of the Surat Basin but attains countable numbers in the Aptian and Albian. The graph shows relative abundance counts varying from 1 to 9 percent in the Doncaster Member, and a gradual increase towards the top of the member. Successive minima and maxima are very weak, and coincide with those of the previous graph, but they are too weak to suggest anything else than statistical erratics.

GRAPHS V and VI represent *Ceratosporites equalis* and *Cepulina truncata* respectively. The two species have been recorded as separate units in order to compare their relative abundances; they are commonly found together in the same preparations, and are morphologically very close (see page 51). The graphs show little differentiation; *C. equalis* varies between 1 and 11 percent and *C. truncata* between 0 and 4 percent. Minima and maxima of the two graphs appear to coincide within the interval of the Doncaster Member, but seemingly not in the Bungil Formation.

GRAPH VII represents the sum total of *Cicatricosisporites australiensis,* which is the principal species in the group, *C. ludbrookiae, C. hughesii,* plus a few isolated and undetermined specimens of the genus. The relative abundance is comparable with that of the previous graph, and minima and maxima of *Cicatricosisporites* coincide well with those of *Cepulina.*

GRAPH VIII represents the genus *Lycopodiumsporites* and includes the sum totals of the following species: *L. austroclavatidites, L. eminulus, L. facetus* (very rare), *L. nodosus, L. rosewoodensis* (rare), and *L. solidus* sp. nov. (very rare). The group varies in abundance between 14 and 15 percent, with an average of 9 percent, in the Bungil Formation, and decreases to between 2 and 15 percent, with an average of 3 percent, in the Doncaster Member.

GRAPH IX represents the following trilete azonate spore species, not included in the previous graphs:

Dictyotosporites speciosus
Dictyotosporites complex
Cyclosporites hughesii
Foveosporites canalis
Klukisporites scaberis
Leptolepidites major
Leptolepidites verrucatus
Lycopodiacidites asperatus
Pilosisporites notensis
Pilosisporites parvispinosus
Reticulatisporites pudens

Except perhaps for *Reticulatisporites pudens,* all these species occur in very low numbers and low sample frequencies in the Aptian interval, and recording every species separately is of no practical value. The graph shows little differentiation; relative abundances vary between 5 and 19 percent, and the maxima and minima are not very marked.

GRAPH X represents *Gleicheniidites circinidites.* The relative abundance readings in the Bungil Formation and lower Doncaster Member for this species demonstrate that the maxima are restricted to only two sections: the highest counts were made in GSQ Surat 1 (6-7% in the Bungil Formation, 17-19% in the basal Doncaster Member) and GSQ DRD 27 (12% in the Bungil Formation, up to 11% in the basal Doncaster Member). Readings from other bores vary between 1 and 8 percent (average 4%), with an isolated maximum of 22 percent in the upper part of the Doncaster Member in BMR Mitchell 10. Other relatively high counts of the species were made in the Bungil Formation of AAO Pickanjinnie 1 and GSQ Roma 3. All these high counts appear to be restricted to a relatively small area; the readings from the more remote locations (BMR Mitchell 11, BMR Mitchell 1, BMR Dalby 3) are the lowest recorded from within the Aptian. It is odd that the consistently high percentages in GSQ DRD 27 are not matched by those in nearby BMR Roma 1, which are not over 3 percent. This pattern of dispersal is reminiscent of local concentrations of the *Gleicheniidites* parent species within the coastal swampy regions of the basin.

GRAPH XI represents the genus *Foraminisporis,* of which the species *asymmetricus, dailyi,* and *wonthaggiensis* occur in most samples. However, they are counted in only a few spectra. One isolated high reading from the upper part of the Doncaster Member (BMR Homeboin 1), in which all three species are represented, may be seen as the precursor of the increase of the genus in the Albian, but could not be traced elsewhere because of insufficient sampling.

GRAPH XII includes *Stereisporites antiquasporites,* which is the most abundant component, and *S. pocockii* sp. nov. The graph represents one of the most abundant single species present. In the interval of the Bungil Formation the highest readings were made in BMR Roma 1 (16-27%) and GSQ DRD 27 (18%). The counts from the other sections lie between 3 and 15 percent (average 9%). A gradual percentage increase towards the top of the formation is apparent from the successive readings in samples from BMR Roma 1 and GSQ Roma 3; single counts of other sections show a similar trend. This increase is continued in the Doncaster Member interval; readings from the basal part of the Member vary between 5 and 15 percent (average 8%), whereas those from the middle and upper part of the Member lie between 10 and 41 percent (average 22%).

The large differences in relative abundance of the species within the Bungil Formation, and the restricted area from which the highest counts were recorded, seem to indicate that the parent plant occurred in scattered clusters in the coastal swampy regions. The abundance of *S. antiquasporites* in the overlying offshore sediments implies that the parent plant was a prolific spore producer.

GRAPHS XIII and XIX, of *Crybelosporites* and *Classopollis* cf. *C. chateaunovi* respectively, reflect the low abundance and low sample frequency of the species represented in the assemblages.

GRAPHS XIV and XV include a number of genera and species which do not occur in sufficient quantities to be recorded separately. Graph XIV includes the following trilete species which were not accounted for in the previous graphs:

Contignisporites cooksonae
C. cf. *C. fornicatus*
C. multimuratus
*Endoculeospora delicata**
*Ischyosporites punctatus**

Matonisporites cooksonae
Polycingulatisporites clavus
P. densatus
Sestrosporites pseudoalveolatus
Trilites cf. *T. tuberculiformis*
*Velosporites triquetrus**
(*very rare)

Many of these species were found as single specimens in a few assemblages only; their combined presence attains recordable levels (up to 4%) in about half of the listed samples. Graph XV represents the sum total of the following genera and species:

Aequitriradites spinulosus
Ae. verrucosus
Araucariacites australis
Concentrisporites hallei
Monosulcites minimus
Punctatosporites scabratus

Of these species, *Monosulcites minimus* is the most common and frequently occurring form. The record of the group in the Aptian is virtually uninterrupted, and the relative abundance varies between 2 and 8 percent (average 4%) in the Bungil Formation, and between 0 and 3 percent (average 2%) in the Doncaster Member.

GRAPH XVI represents the combined totals of *Alisporites similis, A. grandis,* and *Vitreisporites pallidus. A. similis* is the most common and abundant form, the two other species are only sporadically represented. The record of the group varies between 3 and 12 percent (average 7%) in the Bungil Formation, and up to 5 percent (average 3%) in the Doncaster Member. (The record does not include *Callialasporites dampieri,* which was not present in countable numbers.)

GRAPH XVII represents the podocarpoid forms *Podocarpidites ellipticus* and *P. multesimus.* The group is statistically recorded in most samples from the Bungil Formation interval, with a maximum reading of 3 percent. Its record in the Doncaster Member is much poorer (not over 1%).

GRAPH XVIII includes the sum totals of *Microcachryidites antarcticus* and *Trisaccites microsaccatus.* The latter species is relatively rare in the Aptian but occurs more regularly in the Albian. The counts in the interval of the Bungil Formation vary between 0 and 4 percent (average 1.7%), and in the Doncaster Member between 0 and 5 per cent (average 1.5%).

The three graphs XVI, XVII, and XVIII, which represent the group of bisaccate and trisaccate pollen, appear to have one factor in common, which they share with that of *Lycopodiumsporites* (graph VIII): the average of the counts from the Bungil Formation samples is higher than that of the Doncaster Member. A relative under-representation of part of the regional vegetation in pollen complexes buried offshore may indicate that this vegetation grew mainly in the backland regions and not near the coast.

Within the interval of the *Osmundacidites dubius* Zone two distinct events (F and G) can be defined (Table 3). Burger (1974) recognised an earlier, third event (E) at the onset of the Zone (upper Minmi Member), characterised by a minimum abundance of *Cicatricosisporites* (graph VII) and an increase in the total percentage of saccate forms (graphs XVI-XVIII). Both features were weak; in fact, the new data only confirm a slightly temporary increase of the latter group. Furthermore, a simultaneous increase of *Stereisporites* (graph XII) is discernible in GSQ Roma 3 and BMR Roma 1.

Event F indicates a decrease in the abundance of *Lycopodiumsporites* (graph VIII) and the group of saccates at the base of the Doncaster Member. A slight increase of *Baculatisporites-Osmundacidites* (graph III) is also apparent at this level. Burger's (op. cit.) observation of an increase of *Cicatricosisporites* (graph VII) at this point is not substantiated by the new data.

Event G is characterised by concurrent abundance maxima of *Cicatricosisporites* and *Osmundacidites dubius* (graph IV), a decrease of *Cyathidites-Dictyophyllidites-Biretisporites* (graph I), and a significant increase of *Stereisporites* (graph XII), all in the upper part of the Doncaster Member.

Events F and G seem to be of little biostratigraphic value in that they appear to reflect the adaptations of the regional vegetation to the changing geography, rather than intrinsic changes in the course of the floral evolution. It is doubted, therefore, whether they can be traced outside the Roma-Mitchell area, where depositional and geographic conditions were different.

Description of the early Albian pollen sequence

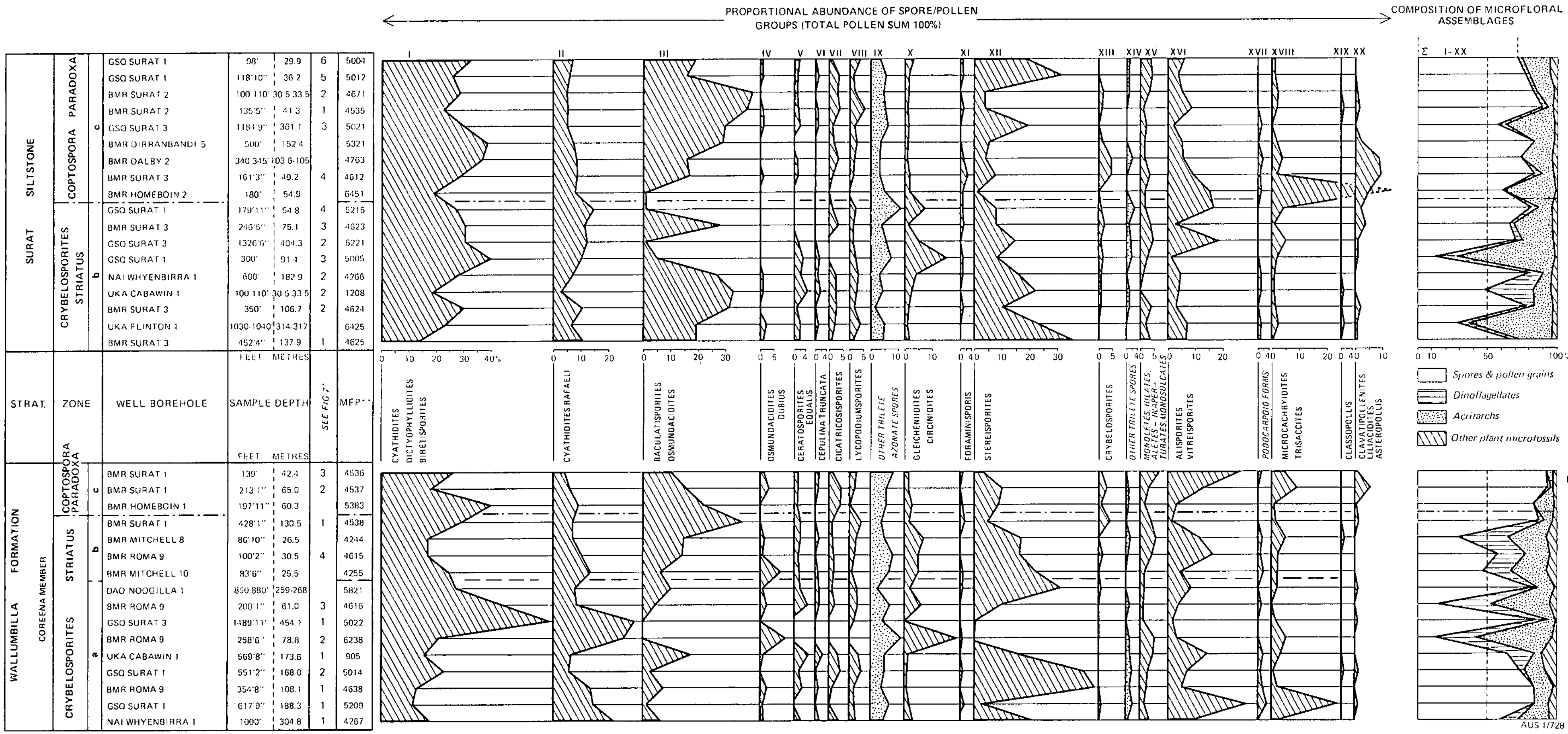
This part of the sequence represents the *Crybelosporites striatus* Zone (former unit K1d). The associated sediments include the Coreena Member and the lower part of the Surat Siltstone. Spectral analyses are set out graphically in Figure 19. The samples are grouped by formation, and as far as possible arranged in stratigraphic succession within each formation. The sample arrangement within the Coreena Member involved a fair degree of interpretation as it is difficult to assess stratigraphic relations between samples which were collected from widely dispersed areas.

This sample arrangement results in a certain overlap of the palynological record. The degree of overlap is shown by subdividing the sequence into a lower interval *a*, including the lowermost part of the Coreena Member, and an upper interval *b*, associated with the Surat Siltstone and the correlate interval of the Coreena Member in BMR Mitchell 8 and 10, BMR Roma 9, and BMR Surat 1 (see page 17).

GRAPH I shows considerable fluctuations in the Coreena Member, with readings varying from 12 to 29 percent, and unusually high maxima of 61 percent in GSQ Surat 3 and 44 percent in BMR Roma 9. The readings of successive samples from BMR Roma 9 and GSQ Surat 1 suggest a temporary increase within interval *a*; the maximum readings thus probably coincide in time. The volume of spores then dispersed must have been considerable, as the abundance maxima occur in marine and non-marine assemblage spectra alike.

The counts of this group of spores in the Surat Siltstone vary between 14 and 40 percent; the fluctuations are relatively moderate and do not indicate a distinct trend.

GRAPH II fluctuates strongly and shows high maximum readings in the Coreena Member (interval *a*) of GSQ Surat 3 (30%), BMR Roma 9 (25%), and NAI Whyenbirra 1 (22%); the other counts between 6 and 15 percent. Counts from the Surat Siltstone and Coreena Member in interval *b* vary between 3 and 15 percent with insignificant oscillations.



* 1-6 Numbers correspond with numbers of samples shown in Fig 7
** MFP Palynological Sample Register Number

Fig. 19. Proportional abundances of fossils in spore and pollen assemblages from the Coreena Member (Wallumbilla Formation) and Surat Siltstone.

GRAPH III displays strong fluctuations within the Coreena Member, which are no doubt partly induced by coinciding maxima of the previous graphs. The counts vary between 0 and 36 percent, showing the group to increase to a maximum at the transition of the *Crybelosporites striatus* Zone to the *Coptospora paradoxa* Zone. The readings from the Surat Siltstone show a similar trend; the lowest counts are restricted to the upper part of the sequence in GSQ Surat 1 (1-5%) and GSQ Surat 3 (1%), the highest occur in BMR Surat 3 (20-31%), UKA Cabawin 1 (33%), and NAI Whyenbirra 1 (27%).

This pattern of spore dispersal might have originated from patchy distribution of the source vegetation, probably in swampy, marginal areas.

GRAPH IV includes counts of *Osmundacidites dubius* sp. nov. up to 9 percent in intervals *a* and *b* of the Coreena Member. The species has a poor record in the Surat Siltstone, as it occurs in countable numbers (maximum reading 2%) in only half of the samples.

GRAPHS V, VI, VII, and VIII demonstrate the low abundance of the species involved within the *Crybelosporites striatus* Zone, although each group is present with a virtually uninterrupted record. The maxima and minima of the graphs are most probably influenced, if not entirely caused, by the large oscillations of the major groups of trilete forms. No significant difference in average abundance becomes apparent for each group by comparing intervals *b* of the Coreena Member and the Surat Siltstone.

GRAPH IX includes the total of the newly incoming species *Dictyotosporites filosus* and *Lycopodiacidites dettmannae* sp. nov., which have not been recovered from the preceding *Osmundacidites dubius* Zone. The relative quantities with which the group is represented are comparable to those within the late Aptian interval; fluctuations are weak and do not display any particular trend.

GRAPH X occurs with low abundance in the early part of interval *a*; counts vary between 0.5 and 3 percent. In the upper part of the interval and in interval *b* of the Coreena Member the species abundance is consistently higher; the counts vary between 2 and 19 percent with an average of 4.5 percent (not including GSQ Surat 3, MFP 5022). The counts from the Surat Siltstone samples are consistently low and vary between less than 1 and 5 per cent; the only higher readings were made in GSQ Surat 1 (8-15%).

GRAPH XI shows that the genus increases slightly in relative abundance; from near-absence in the Aptian pollen spectra it increases to countable numbers (up to 1.5%) in half of the assemblages of the *Crybelosporites striatus* Zone in the Surat Siltstone and the Coreena Member.

GRAPH XII shows very wild fluctuations in abundance within interval *a*, with maximum counts of 43 percent in BMR Roma 9, and 40 percent in GSQ Surat 1. These maxima could perhaps be the culmination of a gradual increase of the species in the Doncaster Member, but cannot be verified because of lack of sampling in other sections. Interval *b* in the Coreena Member seems to show a gradual decrease from a second maximum count of 32 percent in DOA Noogilla 1 to 5 percent in BMR Surat 1 at the upper limit of the *Crybelosporites striatus* Zone. A similar trend is apparent in the Surat Siltstone of BMR Surat 3, where the counts indicate a decrease from a maximum of 36 percent to 8 percent.

GRAPH XIII includes the sum totals of *Crybelosporites striatus, C. punctatus,* and *C. berberioides.* The last species was represented in the preceding Zone together with *C. stylosus,* which is no longer present in the early Albian. The group attains a regular record only in interval *b* of the Coreena Member and the Surat Siltstone, where it initially appears in relative abundance not over 1 percent, but increases at the upper limit of the interval to 2 percent in the Surat Siltstone of BMR Surat 3, and 4 percent in the Coreena Member of BMR Surat 1.

GRAPH XIV no longer includes the totals of *Endoculeospora delicata, Sestrosporites pseudoalveolatus,* and *Contignisporites cooksonae;* the occasional specimens of the latter two species present in the Zone are regarded as of secondary (recycled) origin. The group is represented (up to 2.5%) in interval *a*; it diminishes in quantity and does not reach countable quantities in a number of samples in interval *b*. Here the maximum reading is 1 percent in the Coreena Member of BMR Mitchell 8, and 3 percent in the Surat Siltstone of BMR Surat 1.

GRAPH XV now includes in addition the following species, which were not present in the Aptian sequence: *Triporoletes radiatus, T.* cf. *T. laevigatus, Aequitriradites* sp. A, *Tuberculatosporites* sp. A, and *Laevigatosporites ovatus.* The fluctuations are weak; the readings from the Coreena samples vary between 1 and 6 percent, and those from the Surat Siltstone between 0 and 5 percent.

GRAPH XVI shows a slight increase of the average abundance in interval *a.* The counts vary between 2 and 8 percent (average 5%), with isolated maxima in UKA Cabawin 1 (19%) and GSQ Surat 1 (30%). The counts from interval *b* in the Coreena Member vary between 1 and 17 percent, and those from the Surat Siltstone between 2 and 7 percent, with isolated maximum counts in GSQ Surat 1 (17%) and GSQ Surat 3 (18%). The readings from successive samples in BMR Roma 9 and GSQ Surat 1 suggest an increase in abundance towards the top of interval *b* in both the Coreena Member and the Surat Siltstone; this trend is also shown by counts from GSQ Surat 3 and BMR Mitchell 8.

GRAPH XVII incorporates the added presence of *Rugubivesiculites* sp. A, of which the earliest specimens were found in the basal Coreena Member of BMR Roma 9 and GSQ Surat 1. In comparison with the record of the Doncaster Member the group is relatively well represented in the Coreena Member, where the counts vary between 0 and 3 percent. In the Surat Siltstone the group is only counted in a few samples and remains below 1 percent.

GRAPH XVIII shows identical variations of relative quantity in the Coreena Member (counts of 0-5%) and the Surat Siltstone (counts of 0.5-5%), without apparent trends. An isolated maximum count in the basal Coreena Member of GSQ Surat 1 (22%) coincides with maxima in the other saccates (graphs XVI, XVII), and probably reflects a temporary abundance of the conifers in the local vegetation.

GRAPH XIX indicates the continuing poverty of the *Classopollis* representation in the interval of the Zone.

GRAPH XX is here introduced, as representing the earliest record of the group of 'proto-angiosperm' pollen grains. It includes the totals of *Clavatipollenites hughesii, Clavatipollenites* sp. A, and *Asteropollis asteroides*.

The record of the group in the Coreena Member is relatively poor and the maximum count, near the upper limit of the Zone (BMR Surat 1), is no more than 1 percent. The counts from the Surat Siltstone vary between 0 and 4 percent; they include comparable fractions of *Clavatipollenites* and *Asteropollis*.

It is very difficult to discern eventual longer-ranging trends underneath the masking effects of many graphs of huge but apparently incidental fluctuations in abundance of single species such as *Cyathidites minor* (graph I), *C. rafaeli* (graph II), *Baculatisporites comaumensis* (graph III), and *Stereisporites antiquasporites* (graph XII). Nevertheless, a number of longer-ranging changes are visible at the onset of the *Crybelosporites striatus* Zone (event H). The records of *Foraminisporis* (graph XI), *Alisporites-Vitreisporites,* i.e. predominantly *A. similis* (graph XVI), and the podocarpoid pollen (graph XVII) indicate slight but consistent increases in abundance, coinciding with slight reductions in the graphs of *Gleicheniidites circinidites* (graph X) and *Osmundacidites dubius* (graph IV).

Near the transition from interval *a* to *b*, in the Coreena Member as well as the lowermost part of the Surat Siltstone, a decrease of *Stereisporites antiquasporites* (graph XII) is seen, which follows an apparent maximum of this species coinciding with the beginning of the regular presence of *Crybelosporites* (graph XIV). At about the same level a temporary increase of *Gleicheniidites circinidites* (graph X) is apparent. These variations are provisionally referred to as event J, although they are of uncertain value as at this level the succession of samples in the Coreena Member is more or less obscure (see Table 3).

Description of the middle Albian pollen sequence

This interval is the youngest sequence preserved in the Surat Basin, and represents most (if not all) of the *Coptospora paradoxa* Zone. It is associated with the upper part of the Surat Siltstone and the Griman Creek Formation in most drilled sections, and with the upper part of the Coreena Member in BMR Surat 1 and BMR Homeboin 1 (Figs. 19 and 20). The record of the early part of the Zone in the Surat Siltstone and basal Griman Creek Formation is very detailed in comparison with that in the Coreena Member, from which unit only three samples were available.

In order to facilitate comparison of the diagram, the pollen sequence is subdivided into intervals *c* and *d* on the basis of parallel trends in the graphs of *Cicatricosisporites, Gleicheniidites circinidites, Crybelosporites,* and *Clavatipollenites-Asteropollis*.

GRAPH I now includes the added presence of *Cyathidites asper*. It displays considerable fluctuations, mainly in the Griman Creek Formation, but no trend is apparent; instead, abundance variations in the various diagrams are of the same order. The readings from the Surat Siltstone (interval *c*) vary between 19 and 39 percent (average 29%), those from the Griman Creek are between 14 and 52 percent (average 34%) for the eastern profile, and between 20 and 45 percent (average 31%) for the western profile.

GRAPH II is very constant in the Surat Siltstone; the relative abundance counts vary between 4 and 8 percent (average 6%). In the Griman Creek Formation some gradual increases and declines are apparent; the counts vary between 2 and 18 percent (average 8%) in the eastern profile, and between 3 and 18 percent (average 10%) in the western profile. There is the suggestion of a temporary minimum within interval *d* of both profiles, but the trend is not very distinct.

GRAPH III shows the readings from the Surat Siltstone (interval *c*) varying between 0.5 and 38-40 percent in BMR Surat 2, and 30 percent in GSQ Surat 3. The readings from the Griman Creek Formation are less variable, lying between 9 and 20 percent, with isolated minima of 0.5-1 percent in the eastern profile, and between 5 and 17 percent with one single minimum count of 1 percent in the western profile. The counts from GSQ Surat 3, GSQ Surat 1, and BMR Surat 2 suggest that the group is represented with a temporary maximum abundance within interval *c* of the Surat Siltstone. Counts from the interval of the Coreena Member in BMR Surat 1 indicate a decrease from 36 percent to 11 percent; it seems likely that the maximum in this bore at 130.5 m (MFP 4538) and the maximum in interval *c* of the Surat Siltstone are contemporaneous phenomena. A discrepancy between the positions of the two culmination points may be misleading, as it hangs on the uncertain dating of MFP 4538.

GRAPHS IV, V, VI, VIII, XI, XIV, and XIX are each represented with abundances not over 4 percent each within the *Coptospora paradoxa* Zone; except for graph VIII they have in common a more or less fragmented record, and a lesser average representation compared with the previous *Crybelosporites striatus* Zone.

GRAPH VII shows the presence of the *Cicatricosisporites* group (which now includes *C. pseudotripartitus*), with relative abundance counts up to 4 percent in interval *c* of both the Coreena Member and the Surat Siltstone. A slight increase occurs at the onset of the Zone in both units, but does not continue in the lower Griman Creek Formation, from which the readings are consistently lower (0-2%). An increase is noted within interval *d,* culminating in a maximum of 7 percent in GSQ Surat 2 (eastern profile), and 21 percent in BMR Homeboin 3 (western profile). The average relative abundances in this interval are 3.4 and 7.5 percent respectively.

GRAPH IX includes the added presence, within the *Coptospora paradoxa* Zone, of *Trilobosporites trioreticulosus, T. tribotrys,* and *Pilosisporites grandis,* none of which are known from the previous sequence. It no longer includes *Lycopodiumsporites solidus* sp. nov. The graph fluctuates weakly in the Surat Siltstone and Griman Creek Formation. The readings vary between 1 and 8 percent, and are comparable with those from the preceding interval.

GRAPH X shows a decrease at the onset of the Zone, with counts of 0.5-2.5 percent in interval *c* of the Coreena Member and Surat Siltstone, and 0.5-3 percent (one count of 10% in interval *d,* GSQ Surat 3) in intervals *c* and *d* of the Griman Creek Formation. Within interval *d* the species increases to 6-8 percent in the samples from the Surat Sheet area, and 1-8 percent (average 4.5%) in those from BMR St George 1 and from the Dirranbandi Sheet area.

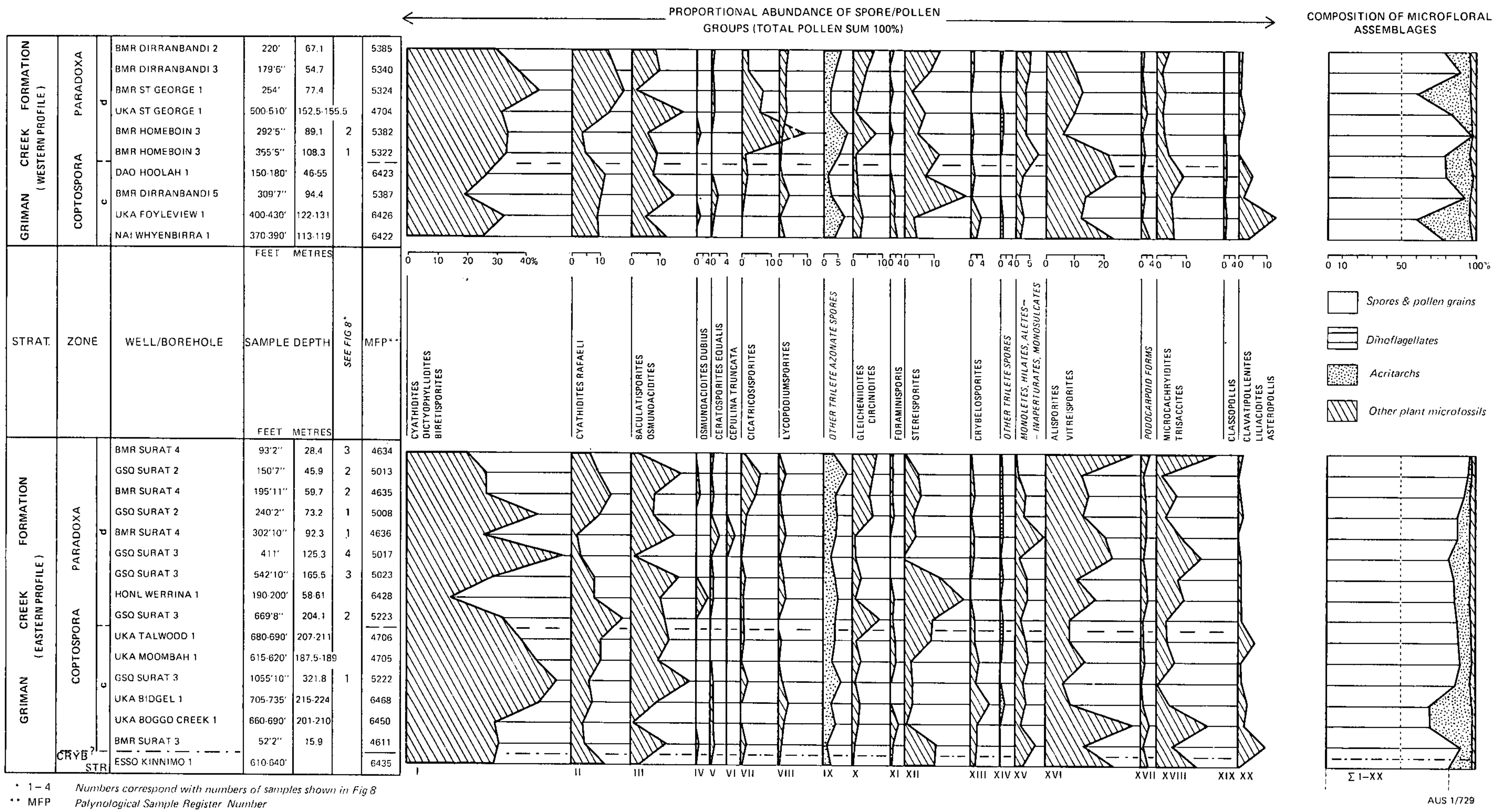


Fig. 20. Proportional abundances of fossils in spore and pollen assemblages from the Griman Creek Formation.

GRAPH XII records highly varying counts of 3-10 percent from the Coreena Member, and 1-8 percent from the Surat Siltstone; maximum percentages were counted in GSQ Surat 1 (19-32%) and GSQ Surat 3 (20%). The counts from the Griman Creek Formation (eastern profile) indicate a gradual increase from 0.5 percent (UKA Boggo Creek 1) in interval *c*, culminating in a maximum of 21 percent (HONL Werrina 1) in lower interval *d*. This trend is not distinct in the poorly sampled sequence farther southwest, where the group is more abundant in interval *c* (3-21%), and decreases slightly without pronounced maxima in interval *d*.

GRAPH XIII registers distinct maximum counts of the group within interval *c* in all diagrams, with counts of 0.5-3 percent in the Coreena Member, and up to 5 percent in the Surat Siltstone. Counts from the Griman Creek Formation are 1.5-7 percent in the eastern profile, and 0-3.5 percent in the western profile. The counts from interval *d* in the formation are lower, 0-1.5 and 0-0.5 percent respectively.

GRAPH XV includes the additional presence of *Coptospora paradoxa*, and no longer includes *Araucariacites australis*. The counts vary little throughout the interval of the Zone. Within the Surat Siltstone and Coreena Member they vary between 1-4 and 1.5-7 percent respectively, and in the Griman Creek Formation they vary between 0.5 and 10 percent in the eastern profile, and 2-8 percent in the western profile, without significant oscillations.

GRAPH XVI shows temporary maxima in the Surat Siltstone of GSQ Surat 1 (17%), BMR Surat 3 (9%), BMR Homeboin 2 (15%), and GSQ Surat 3 (18%), at the lower limit of interval *c*. Counts from the remaining samples vary between 1.5 and 8.5 percent (average 5%). The samples from the Coreena Member, however, indicate a temporary minimum in BMR Homeboin 1 (3%) and BMR Surat 1 (1%), and a subsequent increase in the Member in BMR Surat 1 (maximum 27%). High readings within interval *c* occur also in the Griman Creek Formation of UKA Boggo Creek 1 (29%) and NAI Whyenbirra 1 (23%). Other counts from the formation vary between 5.5 and 13.5 percent (average 10%).

The graphs from the Griman Creek Formation show a gradual increase of the group in the eastern profile, from 8-22 percent (average 15%) in the lower part of interval *d* to 12-35 percent (average 18%) in the upper part. The fluctuations shown within individual sections confirm this. Counts from the western profile vary between 6 and 12 percent (average 9%), and show no clear trend.

GRAPH XVII shows a very poor presence of podocarpoid pollen in the Surat Siltstone (maximum 1.5%), and a distinctly higher, continuous presence in the Griman Creek Formation (maximum 3%).

GRAPH XVIII registers low counts (up to 3%, average 1.6%) in interval *c* of the Surat Siltstone, with one extraordinary (isolated) maximum of 43 percent in BMR Homeboin 2. The readings for the interval in the Griman Creek Formation lie between 0.5 and 17 percent (average 6%) for the eastern profile, and between 5 and 9 percent for the western profile. The group is present with 4-15 percent (average 9%) in the lower part of interval *d*, eastern profile, and 3-20 percent (average 8%) in the upper part. The counts from the western profile are significantly lower, varying between 2 and 4 percent (average 2.7%).

The peaks of graphs XVI and XVIII within interval *c* seem to represent successive instances when the volume of supply of saccate pollen into the basin increased, which implies that the regional coniferous vegetation proliferated at certain stages, possibly coinciding with phases of minimum expansion of the Albian sea during its retreat. Accordingly, as the sea withdrew farther to the west the conifers were able to spread in the emerging dry areas, thus accounting for a gradually increasing pollen supply, as shown in the samples from interval *d* in the eastern profile.

GRAPH XX indicates high readings for the group of 'proto-angiosperms' in interval *c*, culminating in maximum counts of 10 percent in the Surat Siltstone and Coreena Member, and 12 and 9 percent in the basal Griman Creek Formation. The counts include comparable proportions of *Asteropollis and Clavatipollenites*. The group has a much poorer record in the succeeding interval, with maximum occurrences not over 2 percent.

The graph indicates that two successive maxima of abundance occurred, but the fluctuations within individual sections (BMR Surat 3, GSQ Surat 1, BMR Surat 1) are not sufficiently detailed to verify this.

At the onset of the *Coptospora paradoxa* Zone a number of major changes took place, referred to as event K-1 (Table 3). Temporary maxima of *Crybelosporites* (graph XIII) and the 'proto-angiosperms' (graph XX) coincide with a decrease of *Gleicheniidites* (graph X). A second maximum of the 'proto-angiosperms' is accompanied by a temporary increase of *Crybelosporites* (graph XIII) and a decrease of *Cicatricosisporites* (graph VII) in the basal Griman Creek Formation (interval *c*) and is here referred to as event K-2. Intense fluctuations of *Baculatisporites/Osmundacidites* (graph III) and the group of saccate pollen (graphs XVI and XVIII) coincide with event K in the Coreena Member and Surat Siltstone.

In the upper part of the Griman Creek Formation (interval *d*) an increase of *Gleicheniidites* (graph X) and *Cicatricosisporites* (graph VII), however slight, is discernible in both the eastern and western profiles and is designated event L (Table 3).

Conclusions

We have seen that, allowing for a certain margin of statistical variation, the Aptian-Albian spore and pollen record is remarkably monotonous. Neither a succession of changes in lithology, nor the considerable increase of the number of species, has an appreciable permanent effect upon the abundance of genera and species in time. However, there are good reasons to assume a more than fortuitous origin for many of the changes described above. In order to try to understand possible origins of fluctuations recorded in individual spore and pollen groups, three types are distinguished:
1. Fluctuations closely connected with major rock unit boundaries. These were recorded in *Baculatisporites-Osmundacidites* (graph III), *Osmundacidites dubius* (graph IV), *Lycopodiumsporites* (graph VIII), and *Foraminisporis* (graph XI). Many of these changes seem to have little to do with events pertinent to the parent vegetation, but may be largely a consequence of mechanical factors also responsible for the distribution and settling of sedimentary particles.

2. Incidental fluctuations, which in some assemblages amount to almost complete domination by one or two species. Such fluctuations were recorded in *Cyathidites-Dictyophyllidites-Biretisporites* (graph I), *Cyathidites rafaeli* (graph II), *Stereisporites antiquasporites* (graph XII), *Alisporites similis* (graph XVI), and *Microcachryidites-Trisaccites* (graph XVIII). Most of these occur in the early Albian interval, in association with Coreena Member and Surat Siltstone deposition, and they are interpreted as a sign of the nearness of land, where pollen complexes in the sediment are less thoroughly mixed than those farther offshore.

3. Short-term to medium-range fluctuations of more than incidental character. Such fluctuations were registered in *Baculatisporites-Osmundacidites* (graph III), *Cicatricosisporites* (graph VIII), *Gleicheniidites circinidites* (graph X), *Stereisporites antiquasporites* (graph XII), *Crybelosporites* (graph XIII), *Alisporites similis* (graph XVI), and *Clavatipollenites-Asteropollis* (graph XX). Many have been recorded as events occurring in the overlapping sequences of the Coreena Member and Surat Siltstone (intervals *b* and *c*, *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone). Some fluctuations, such as those of *Gleicheniidites circinidites* and *Clavatipollenites-Asteropollis,* can be traced in large parts of the basin, which is remarkable in view of the low average abundance of these species. Others are traceable in a relatively small area only and are more difficult to understand. The distribution of *Stereisporites antiquasporites* and *Gleicheniidites circinidites* in the Aptian, for instance, could have resulted from the parent plant having grown in thickets in restricted nearshore areas, but it is possible, although perhaps less likely in the present case, that mechanical sorting and winnowing of particles in suspension locally resulted in increased accumulation of these sporomorphs.

Special attention is drawn to the trend shown in graph XX. Low angiosperm readings were made in the marine assemblages from the Coreena Member (Fig. 19, intervals *a* and *b*), and in the non-marine assemblages from the Griman Creek Formation (Fig. 20, interval *d*). The higher readings are all within interval *c* and are connected with strandline deposits (Surat Siltstone) and the marginally marine parts of the Coreena Member (Fig. 19) and basal Griman Creek Formation (Fig. 20). This trend strongly suggests that the parent vegetations grew mainly in the immediate vicinity of the coast, and rarely ventured into the back country.

Within the degree of resolution achieved in this study the type 2 fluctuations appear to be incidental and cannot be interpreted adequately. The type 3 fluctuations may have distinct biostratigraphic and environmental significance. Although of much lesser amplitude, they are more explicit in that they are manifested in more than one section, and also in contemporaneous intervals of different formations. It is thought that they are the clearest evidence that there were geographically restricted vegetation belts, which originated possibly from differences in humidity.

On the basis of this record possible source regions of a few sporomorph species are given here.

In this way statistical analysis suggests that the pollen floras from the Surat Basin may represent intermixed complexes of two different plant communities.

MARGINAL-COASTAL REGIONS (humid?)	BACKLAND REGIONS (dry?)
Baculatisporites comaumensis (Osmundaceae)	*Cyathidites minor* (Cyatheaceae)
Osmundacidites dubius sp. nov. (Osmundaceae)	*Lycopodiumsporites* spp. (Lycopodiaceae)
Gleicheniidites circinidites (Gleicheniaceae)	*Alisporites similis* (Caytoniales?)
Stereisporites antiquasporites (Sphagnaceae)	*Microcachryidites antarcticus* (Podocarpaceae?)
Clavatipollenites hughesii (Angiospermae indet.)	
Asteropollis asteroides (Angiospermae indet.)	

3. STATISTICAL ANALYSIS OF THE DINOFLAGELLATE RECORD

The main purpose of the statistical analysis of the dinoflagellate record was to obtain basic data which might indicate the influence of the environment upon abundance and dispersal of dinoflagellates, in addition to the data given by their stratigraphic distribution. The analysis was made along similar lines to those for the spores and pollen. Because of the low overall dinocyst recovery the statistical record is restricted almost entirely to the most marine assemblages from within the Wallumbilla Formation. Only a few assemblages contained sufficient specimens to attain totals of 200 specimens per sample.

The assemblages are composed mainly of proximate and proximochorate cysts; cavate and chorate cysts form a small minority. Twenty-five genera and species are represented as separate groups. The individual percentages are given in Appendix C, and are plotted in Figure 21.

The following eleven groups occur in small and unchanging fractions throughout the entire sequence: Graph I (mainly *Canningia colliveri*), Graph II (with *Canningia minor* var. *psilata* nov. as dominant form), Graph VII (*Chlamydophorella nyei*), Graph X (*Membranosphaera coninckii* sp. nov), Graph XV (mainly *Coronifera oceanica*), Graph XVI (*Gonyaulacysta* and *Cribroperidinium*), Graph XVII (almost entirely *Leptodinium simplex* sp. nov.), Graph XVIII (*Spiniferites*), Graph XXIII (*Muderongia*), Graph XXIV (*Odontochitina operculata*), and Graph XXV (*Rhombodella natans*). The following forms are stratigraphically restricted, and occur in low numbers in a few samples only: Graph V (*Tenua aptiense* sp. nov.) and Graph XXII (*Vozzhennikovia villosa*).

GRAPH III mainly represents *Hexagonifera* cf. *H. defloccata,* and shows a slight decrease from 3-5 percent (average 2.8%) in the *Odontochitina operculata* Zone, to 0.5-6 percent (average 1.8%) in most of the *Pseudoceratium turneri* Zone.

GRAPH IV (*Dingodinium cerviculum*) shows counts from 0 to 9 percent (average 3.3%) of the species in the *Odontochitina operculata* Zone, and only sporadic (recycled?) occurrences in sample counts from the *Pseudoceratium turneri* Zone.

GRAPH VI (*Tenua pilosa*) shows a slight increase of the species from 1-9 percent (average 3.5%) in the *Odontochitina operculata* Zone to 6-9 percent (average 4.8%) in the *Pseudoceratium turneri* Zone.

GRAPH VIII (*Membranosphaera norvickii* sp. nov.) shows that the species occurs in countable numbers in the *Pseudoceratium turneri* Zone, where the readings vary from 0 to 6 percent in the assemblages from the Coreena Member.

GRAPH IX (*Membranosphaera romaensis* sp. nov.) shows a significant representation of the species in the *Odontochitina operculata* Zone, with counts between 6 and 19 percent (average 13.8%), and a significant decrease, with counts of 0-7 percent (average 2.9%), in the *Pseudoceratium turneri* Zone.

GRAPH XI represents the entire group of *Cleistosphaeridium*, in which *C. aciculare* and *C. granulatum* sp. nov. are the commonest forms. The counts show a scattered, low abundance distribution in the *Odontochitina operculata* Zone, increasing to a continuous record of 2-4 percent in the lower part of the *Pseudoceratium turneri* Zone, gradually increasing to a maximum count of 9 percent in GSQ Surat 1 (MFP 5005) at the upper limit of the recorded sequence (including 6% *Cleistosphaeridium* sp. A).

GRAPH XII (*Cassiculosphaeridia* cf. *C. reticulata*), GRAPH XIII (*Apteodinium*, mainly *A. conjunctum*), and GRAPH XIV (*Trichodinium eisenackii* sp. nov.) show that the species included are poorly or not at all represented in the *Odontochitina operculata* Zone, and slightly increase in the *Pseudoceratium turneri* Zone.

GRAPH XIX (*Diconodinium paucigranulatum* sp. nov.) shows a brief appearance of the species (maximum 6%) in the upper part of the *Odontochitina operculata* Zone shortly before its disappearance.

GRAPH XX (*Diconodinium davidii*) shows that the species briefly proliferates in the upper part of the *Odontochitina operculata* Zone, with a maximum count of 25 percent in BMR Mitchell 10 (MFP 4251), and decreases to below countable proportions in most assemblages of the *Pseudoceratium turneri* Zone.

GRAPH XXI (*Spinidinium boydii*) shows a very poor representation of this species in the *Odontochitina operculata* Zone, and its continuous presence in the *Pseudoceratium turneri* Zone, gradually increasing to 10 percent at the upper limit of the recorded sequence, with a sudden surge up to 19 percent and 50 percent in BMR Roma 9 (MFP 4616, MFP 6238).

Since statistical analysis of the dinoflagellate record includes only the most marine assemblages, large and sudden changes were not expected to occur. Nevertheless, possibly significant fluctuations were observed in not fewer than 14 groups. The most significant changes appear simultaneously at the Aptian/Albian boundary and undoubtedly reflect changing conditions during the early Albian retreat of the sea. However, relative abundance of dinocysts does not diminish in the Albian assemblages: the average for the readings in the Coreena Member (25%) differs very little from that in the Doncaster Member-Bungil Formation interval (23%). Ten species are newly introduced at this stage, and very few regularly occurring forms disappear from the record. The sea must have had continuous access to the region, at least during Coreena and Surat Siltstone deposition. It is thought, therefore, that the graphs indicate increasing turbidity of the water as drainage accelerated from the newly emerging dry areas.

A number of graphs show a gradual increase towards the upper limit of the marine sequence; they include almost all chorate forms (*Coronifera, Cleistosphaeridium*) and some proximochorate forms (*Tenua*). It is possible that these are the hardy elements which statistically increased in the assemblages as other species gradually disappeared, but we have seen that there is no firm evidence of the disappearance of more than a few species in the Albian (the upper range limits of many species in Figure 13 are doubtful because of insufficient numbers of specimens). It is also possible that the increase of chorate cysts was a lasting trend, in which case confirmation must be sought in the marine Albian of the Eromanga Basin.

In view of this possibility it is interesting to note that Davey (1970) observed common to abundant *Deflandrea*, and relatively few chorate cysts, in mid-Cretaceous assemblages from the Boreal Ocean in Germany, and from the Arctic Sea in Saskatchewan and Arctic Canada. The contemporaneous Tethys assemblages from the Cenomanian of England, France, and Texas lack *Deflandrea* and have abundant chorate forms, of which many are present in all three regions. Davey thus assumed that *Deflandrea* preferred cooler water, and interpreted the increased presence of chorate cysts in the Tethys assemblages as an attempt of the dinoflagellates to form cysts with increased surface area in order to slow down their rate of sinking in the warmer, less dense water of the Tethys Ocean.

According to this view the Surat Basin assemblages would indicate cool environments (the lack of *Deflandrea* is in keeping with the poor record of the genus prior to the Late Cretaceous); this conforms with current ideas on the palaeoclimate in eastern Australia (Day, 1969; Dettmann & Playford, 1969). The apparent rise of the chorate cyst group during the Albian would indicate that the northern Australian 'Tambo' sea gradually opened up towards the temperate (Indo-Pacific) Ocean in the late Albian and Cenomanian. However, the contemporary record in northern Australia is poor. Marine Cenomanian sediments from Bathurst Island, Northern Territory, indicate warm to temperate conditions (Norvick & Burger, 1975), but they accumulated at much lower palaeolatitudes. The marine Upper Cretaceous in Western Australia has been studied onshore as well as offshore, but very little has been published in the palynological field at present.

STRATIGR	ZONATION	WELL / BOREHOLE	SAMPLE DEPTH FEET	SAMPLE DEPTH METRES	SEE * FIGS 6,7	MFP **
SURAT	PSEUDOCERATIUM TURNERI	GSQ SURAT 1	300'	91.4	3	5005
SURAT	PSEUDOCERATIUM TURNERI	UKA CABAWIN 1	100'–110'	30.5–33.5	2	1208
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	BMR MITCHELL 8	86'10"	26.5		4244
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	BMR ROMA 9	100'2"	30.5	4	4615
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	BMR MITCHELL 10	83'6"	25.5		4255
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	BMR ROMA 9	200'1"	61.0	3	4616
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	BMR ROMA 9	258'6"	78.8	2	6238
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	UKA CABAWIN 1	569'8"	173.6	1	905
WALLUMBILLA – Coreena	PSEUDOCERATIUM TURNERI	NAI WHYENBIRRA 1	1000'	304.8	1	4267
WALLUMBILLA – Doncaster	ODONTOCHITINA OPERCULATA	BMR MITCHELL 10	281'	85.7	2	4251
WALLUMBILLA – Doncaster	ODONTOCHITINA OPERCULATA	BMR MITCHELL 10	394'	120.1	1	6239
WALLUMBILLA – Doncaster	ODONTOCHITINA OPERCULATA	GSQ SURAT 1	797'8"	243.1	5	5006
WALLUMBILLA – Doncaster	ODONTOCHITINA OPERCULATA	UKA CABAWIN 1	1108'	337.7		906
WALLUMBILLA – Doncaster	ODONTOCHITINA OPERCULATA	GSQ SURAT 1	1049'10"	320.0	3	5007
BUNGIL	ODONTOCHITINA OPERCULATA	BMR MITCHELL 1	53'	16.2		3966

* Numbers correspond with numbers of samples shown in figs 6 and 7

** Palynological Sample Register Number

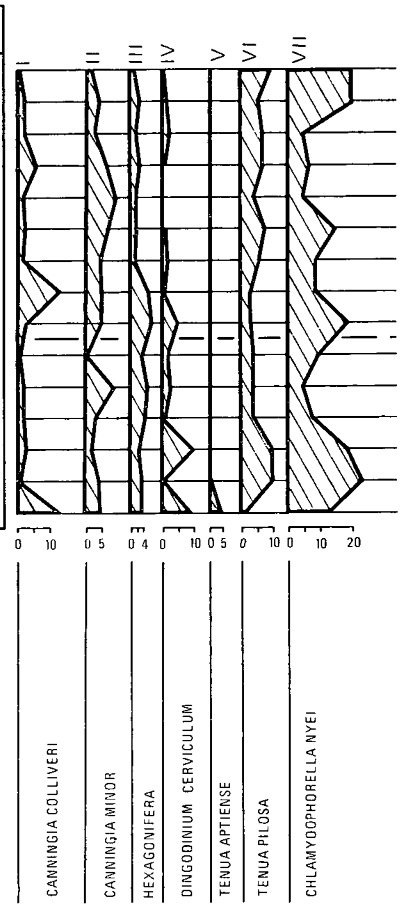


Fig. 21. Proportional abundances of genera and species in dinoflagellate assemblages from the Surat Basin.

4. STATISTICAL ANALYSIS OF THE ACRITARCH RECORD

Since acritarchs have been found in countable numbers in every preparation, a statistical analysis of the acritarch floras similar to that made of the other microfossil groups was considered worthwhile for the purpose of collecting possible evidence as to their environmental behaviour.

Smooth-walled (genus *Leiosphaeridia* Eisenack) and minutely spinose forms (genus *Micrhystridium* Deflandre) form the large majority of the acritarch assemblages. Relative abundance, and its variation in time, of species of these and other genera are given in Appendix D and shown in Figure 22. Other, sparsely occurring forms of uncertain affinity, assigned to the genus *Schizosporis* Cookson & Dettmann, are not discussed at present.

GRAPH I (*Leiosphaeridia* sp. A) shows that the species occurs in highly variable relative numbers throughout the sequence. The averages for each successive formation (Minmi Member 28.3%, Doncaster Member 23.4%, Coreena Member 21.7%, Surat Siltstone 16.5%, and Griman Creek Formation 11.5%) show a gradual decrease which does not seem to be controlled by local environmental factors. The species does not react visibly to major changes in geography, degree of salinity, and type of sediment, and appears to be a very tolerant organism. The gradually decreasing numbers probably reflect to some degree statistical influence by some of the other species.

GRAPH II (*Leiosphaeridia* sp. B) shows highly irregular incidental fluctuations throughout the sequence. However, the reading averages from each formation (Minmi Member 11.3%, Doncaster Member 27.2%, Coreena Member 55.5%, Surat Siltstone 58.5%, and Griman Creek Formation 78.6%) show a definite increase towards almost absolute domination in the Griman Creek Formation. As in the previous graph, the trend cuts across environmental changes in time and is not notably affected by them.

GRAPH III (*Leiosphaeridia* sp. C) shows the persistent occurrence and relative scarcity (maximum count 6%) of the species throughout the sequence.

GRAPH IV (*Micrhystridium* sp. A) shows that the species occurs in countable numbers in few samples. Readings are concentrated mainly within the Bungil and Wallumbilla Formations (maximum 8%).

GRAPH V (*Micrhystridium* sp. B) shows a relatively abundant representation of the species in the Minmi Member (maximum count 74%, average of all readings 51%) and Doncaster Member (maximum count 62%, average of all readings 22%). In the Coreena Member the species is present in only a few samples (maximum count 12%), and it rarely reaches recordable levels in the Surat Siltstone. It returns in most samples from the lower part of the Griman Creek Formation, where a maximum of 12 percent was counted. The graph

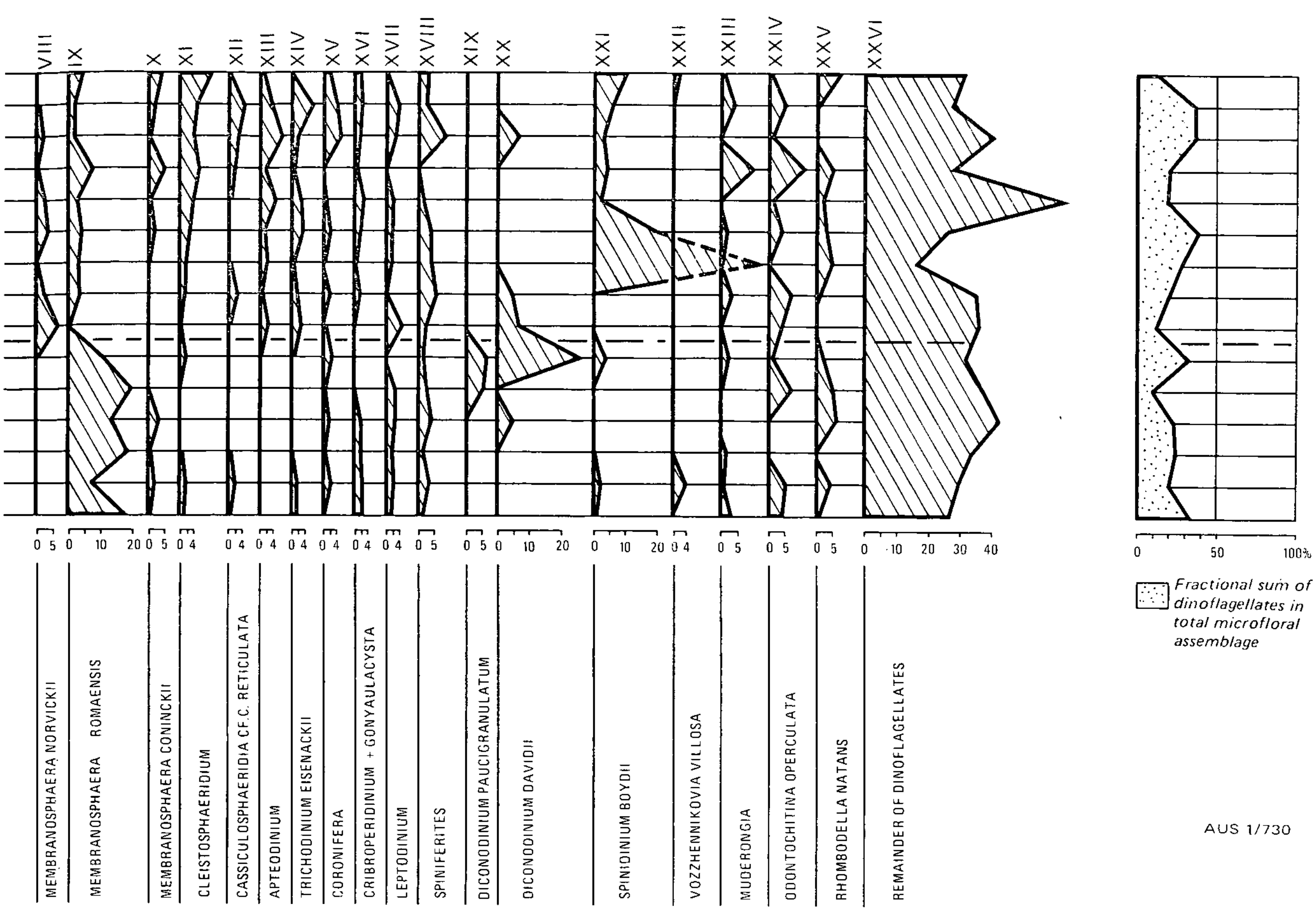


Fig. 21 (cont.). Proportional abundances of genera and species in dinoflagellate assemblages from the Surat Basin.

shows an opposite trend to that of graph II and may in fact be directly influenced by it.

GRAPH VI (*Micrhystridium* sp. C) shows that this species is present in almost every sample from the Bungil Formation, Wallumbilla Formation, and Surat Siltstone, in which it occurs in highly varying quantities. In the Griman Creek Formation it occurs in recordable abundance in only a few samples. The averages for each of the formations are: Bungil Formation 2.3 percent, Doncaster Member 12.0 percent, Coreena Member 6.7 percent, and Surat Siltstone 12.6 percent. The species is poorly represented in many non-marine assemblages; the highest values coincide with average to high relative abundance of dinoflagellates.

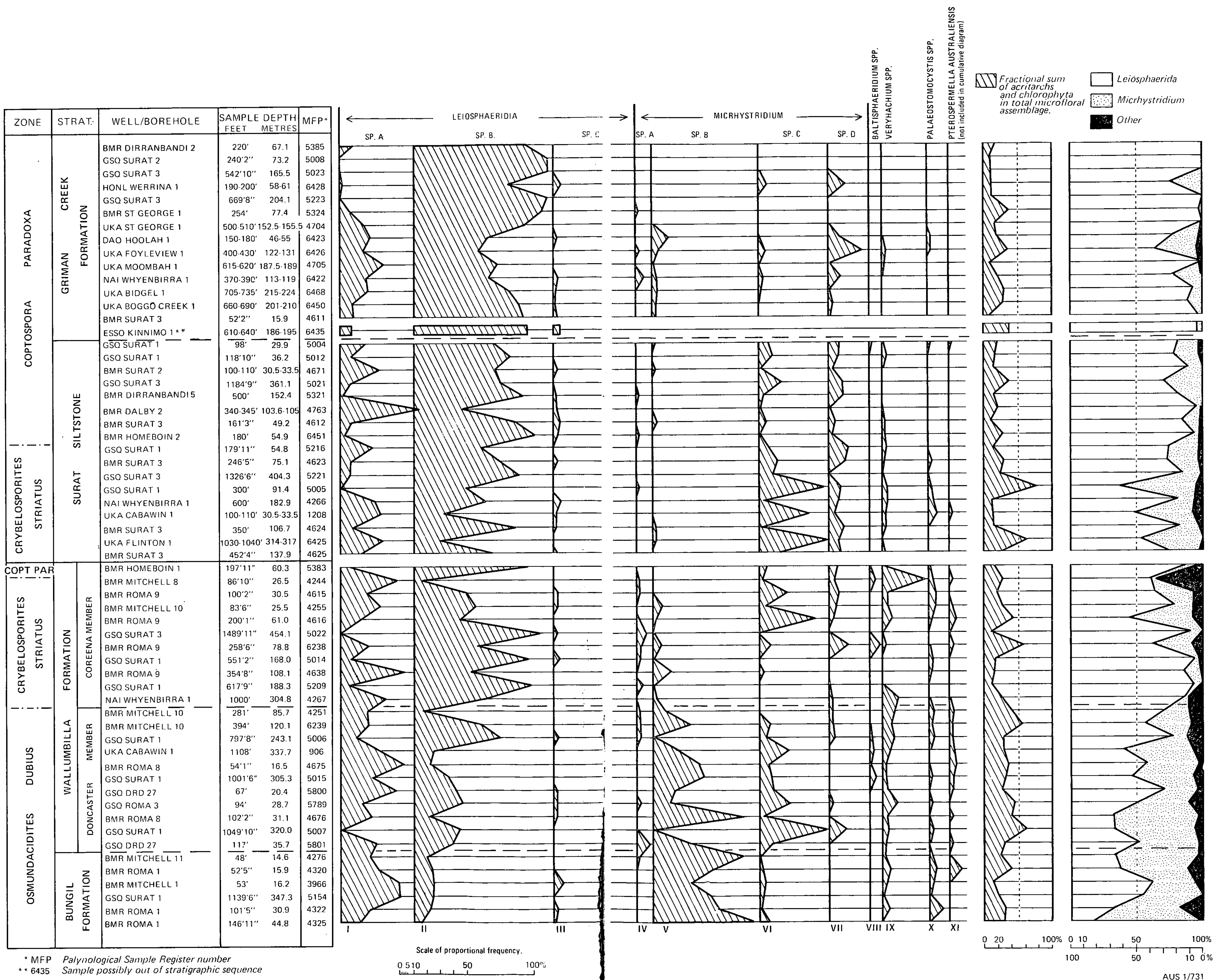
GRAPH VII (*Micrhystridium* sp. D) shows the occurrence of the species in the Doncaster Member and the succeeding Albian sequence, including the Griman Creek Formation. Fluctuations of relative quantities are rather weak in comparison with those of the previous graphs. The averages for each formation are: Doncaster Member 1.7 percent (maximum count 12%), Coreena Member 3.1 percent (maximum count 13%), Surat Siltstone 6.9 percent (maximum count 13%), and Griman Creek Formation 3.8 percent (maximum count 23%). There appears to be a gradual increase from a minimum average in the marine Doncaster Member to a maximum in the (mainly brackish) Surat Siltstone. The values from the Griman Creek Formation seem to be totally subordinate to the fluctuations of *Leiosphaeridia* sp. B (graph II), but they suggest that the increase is a trend which continues in this formation.

GRAPH VIII (*Baltisphaeridium* spp.) represents a morphologically indistinct group of spinose forms which are smaller than the species of *Cleistosphaeridium* described in this paper, and do not form an obvious pylome. These forms have been found in only a few samples. The highest counts are confined to within the Wallumbilla Formation (7%). Specimens of this type have not been found in the assemblages from the Bungil Formation and the Griman Creek Formation.

GRAPH IX includes *Veryhachium reductum* and *V. singulare* (ratio of occurrence approximately 2 or 3 to 1). The maximum counts and averages of the readings for each formation are: Bungil Formation 2.0 percent (maximum count 5%), Doncaster Member 4.0 percent (maximum count 9%), Coreena Member 4.6 percent (maximum count 28%), Surat Siltstone 0.9 percent (maximum count 3%). This record is too poor to show eventual trends, but the maximum values coincide with medium to high relative totals of dinoflagellates.

GRAPH X (*Palaeostomocystis fragilis, P. pergamentaceus* sp. nov.) shows that this genus regularly occurs in recordable quantities in the Bungil Formation, Wallumbilla Formation, and the lower part of the Surat Siltstone.

GRAPH XI (*Pterospermella australiensis*) represents the relative abundance of the species in various samples expressed as fractions of the total of acritarchs, but it is not included in that total. The species appears to occur in recordable numbers in those assemblages which also have the highest dinoflagellate counts.



* MFP *Palynological Sample Register number*
** 6435 *Sample possibly out of stratigraphic sequence*

Fig. 22. Proportional abundances of genera and species in acritarch assemblages from the Surat Basin.

Fig. 22 (cont.). Proportional abundances of genera and species in acritarch assemblages from the Surat Basin.

The genus *Leiosphaeridia* quantitatively dominates the group of acritarchs by well over 50 percent in all but the lowermost sequence. Its omnipresence may well point to an aquatic way of life for the living organism, and indicates a high tolerance towards changing conditions. However, the relative scarcity of *Leiosphaeridia* sp. B in the mainly marine Aptian floras, and its subsequent increase, is perhaps connected with a preference for less saline environments; the fact that the low abundance counts of the species in the acritarch floras correspond with high dinoflagellate counts also points that way. An identical trend shown by graph VII may indicate similar environmental preferences of *Micrhystridium* sp. D. It is interesting to speculate to what extent increasing water temperature may have contributed towards the growing numbers of these forms.

The fluctuations in graph VI suggest that *Micrhystridium* sp. C thrives in saline conditions; it is present in moderate quantities in the Doncaster Member, and makes up considerable fractions of some marine assemblages from the Coreena Member and the Surat Siltstone (i.e. with a dinoflagellate/spore-pollen ratio of 0.1 or higher). Traverse & Ginsburg (1966) noticed high concentrations of a similar organism in surface sediments just offshore on the Great Bahama Bank, and thought that it flourished in shallow, saline environments. We have seen that Cross & others (1966) retrieved a similar form from the Gulf of California, where it is concentrated mainly in deeper sediments, likewise indicating its preference for saline conditions.

The 'trends' shown in various other graphs probably do not reflect environmental behaviour of the corresponding species; they are merely statistical reactions to the numbers of *Leiosphaeridia* sp. B and *Micrhystridium* sp. B. The fluctuations of *Veryhachium* (graph IX) do not show a distinct pattern with regard to environment, but the absence of *V. reductum* in non-marine samples agrees with the record of the species from marine sediments elsewhere.

Without the backing of absolute data (i.e. numbers of organisms per unit mass of sediment) it is not possible to estimate the influence which water current activity might have had on the dispersal of the acritarchs. No distinct correlation seems to emerge from the analyses between the geographical distribution of an organism and the surface area of that organism per body volume (as a measure of its buoyancy). Certain spinose elements (*Micrhystridium* sp. B, *M.* sp. D) seem to thrive just as well in marginal, non-marine, as in less turbulent, open marine environments. The apparent restriction of *Veryhachium*, which has long and thick spines, to marine environments does not necessarily confirm previous studies mentioned above (p. 28), and may well signify that the organism preferred saline conditions and could not survive in marginally brackish surroundings.

Although the present data do not warrant any dogmatic conclusions on the environmental behaviour of acritarchs it seems justified to accept that organisms of unrelated habits are included in the group. Most organisms seem to proliferate in conditions adverse to dinoflagellate growth, so that on the whole they appear to be brackish rather than marine 'indicators'. However, the approach of regarding the entire group as a brackish element between the marine (dinocysts) and non-marine (spores, pollen) fractions of microfloral assemblages is probably too unpolished. More sophisticated statistical analyses of individual taxa will probably give a better indication as to which organisms can be classified as 'marine' or 'indifferent', or truly 'brackish', and allow readjustments of the environmental boundaries in the triangle-diagram of Figure 15.

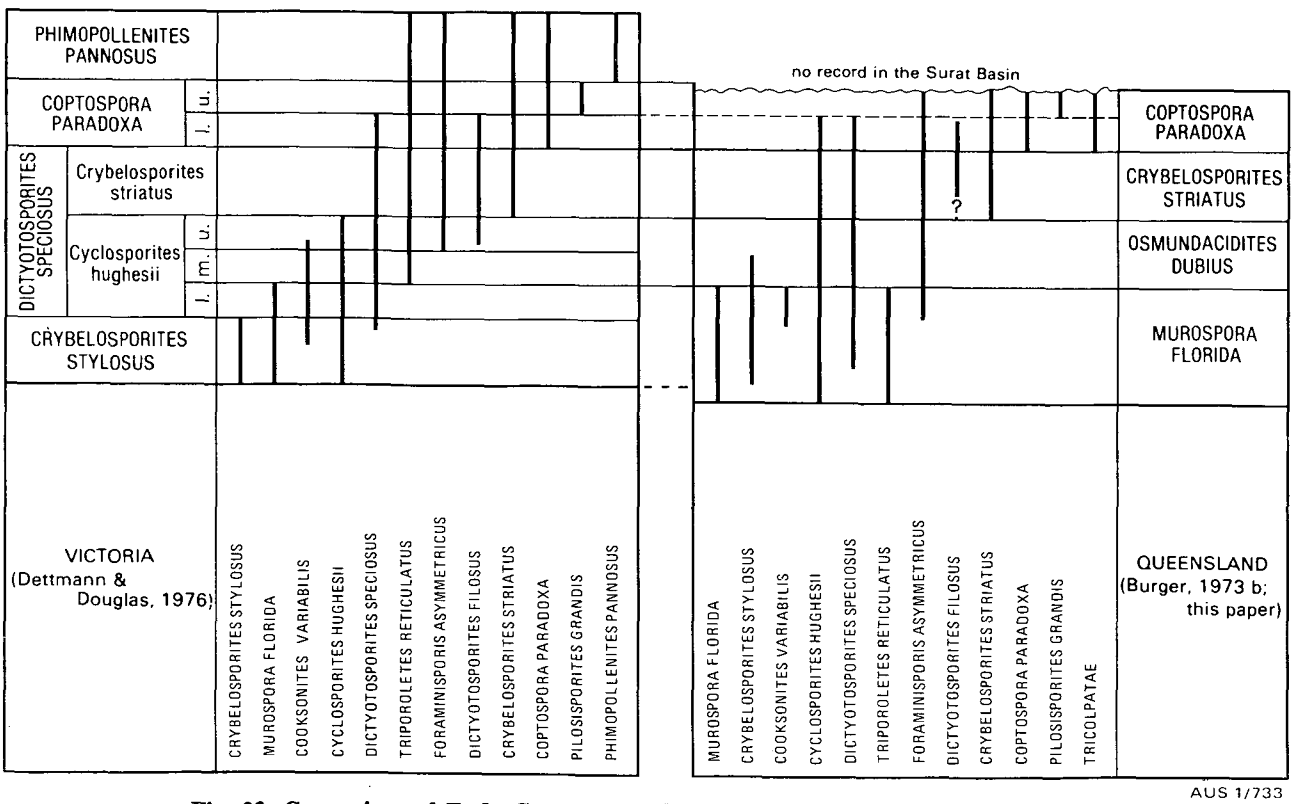


Fig. 23. Comparison of Early Cretaceous pollen sequences in Victoria and Queensland.

5. GENERAL CONCLUSIONS

The microfloral record indicates that the Surat Basin was a flat, coastal, in part deltaic watery region, which was periodically submerged during Early Cretaceous times. The regional vegetation was rich and varied and was dominated by pteridophytic and coniferous elements. No sweeping changes are apparent in the floral record with time; one of the most salient features is the first arrival of primitive angiosperms in basal Albian times. This uniformity implies that the climate was relatively constant (cool-temperate) throughout the Early Cretaceous.

The endemic, marginal-facies character of the local marine record is manifested by the presence of 19 previously unreported dinoflagellate species, which amount to 30 percent of the total species tally recorded. Most of the remaining forms are well known in the Australian marine Cretaceous; many have a worldwide distribution, as 16 species have been found in North America, and 28 species in Western Europe.

Statistical study of the floral sequence was made to investigate (1) the relative abundance of spores and pollen, dinoflagellates, and acritarchs in the assemblages, in order to add to the field data on palaeo-environments and palaeogeography, and (2) the relative abundance of species and genera of fossils within the groups which they represent (spores and pollen, dinoflagellates, acritarchs), to seek for clues as to their ecological preferences. Analysis of the spore and pollen floras suggests that various vegetation complexes (coastal, possibly humid; and inland, possibly dry) may have existed, but the evidence is not strong. The dinoflagellate record, although incomplete, is fairly uniform and suggests vaguely that milder climatic conditions may have existed in the early Albian. The group of acritarchs is dominated by smooth-walled and minutely spinose forms, and probably incorporates elements with divergent environmental requirements.

The Surat Basin record makes it clear that the rock association of the *Coptospora paradoxa* Zone, and the earliest appearance of various angiosperms in the Eromanga Basin, must be re-examined. The relationships of the Cretaceous rock units in the two basins need to be re-appraised. Interfingering of the Neocomian formations across the Nebine Ridge is now reasonably well understood, but intermerging of the Aptian and Albian formations farther south across the Cunnamulla Shelf is insufficiently known, and it is hoped that palynological work may help in developing a more accurate picture.

CHAPTER IV. TAXONOMIC AND DESCRIPTIVE STUDIES

1. Systematic study of spores and pollen grains
2. Systematic study of dinoflagellates
3. Systematic study of acritarchs and unclassified palynomorphs

1. SYSTEMATIC STUDY OF SPORES AND POLLEN GRAINS

A total of 93 species of spores and pollen grains from the Early Cretaceous of the Surat Basin, assigned to 56 form-genera, are documented, described, and illustrated. The position of each genus in the hierarchy of suprageneric taxa is shown in Table 4. This scheme has been discussed by Dettmann (1963) for SPORITES and Burger (1975) for POLLENITES.

The descriptive terms used were coined by Erdtman (1952), Faegri & Iversen (1964), and Dettmann (1963, 1973). Many well known species have not been re-described, but reference is given in the text to those authors whose discussions are regarded as most informative.

Anteturma SPORITES Potonié, 1893

Turma TRILETES Reinsch, 1881 emend. Dettmann, 1963

Suprasubturma ACAVATITRILETES Dettmann, 1963

Subturma AZONATI Luber, 1935 emend. Dettmann, 1963

Infraturma LAEVIGATI Bennie & Kidston, 1886 emend. Potonié, 1956

Genus **Cyathidites** Couper, 1953

Type species (by original designation): *Cyathidites australis* Couper, 1953; Jurassic, New Zealand.

Cyathidites australis Couper
Pl. 1, figs. 1, 2, 6

1953 *Cyathidites australis* Couper, p. 27, pl. 2, fig. 11

Comments: The species has been found infrequently in almost every preparation examined. It is slightly larger than the variety *rimalis* Balme, 1957, here illustrated in Pl. 1, figs. 3, 7, and lacks its exine thickenings along the laesurae. Not included in *australis* are spores with comparable equatorial dimensions but with a thicker, psilate exine (up to 3.5 μm), such as illustrated in Pl. 3, fig. 4. These may represent species of *Cyathidites* or *Biretisporites,* and occur in low abundance in a number of preparations. The difference between *australis* and this type is slight and may perhaps be demonstrable by statistical analysis, but the material at hand was not sufficiently rich for such an examination.

Cyathidites minor Couper
Pl. 1, figs. 4, 5

1953 *Cyathidites minor* Couper, p. 28, pl. 2, fig. 13

Distribution: As one of the commonest species in the Early Cretaceous of Australia, it constitutes between 10 and 50 percent of the spore and pollen assemblages from the Surat Basin.

Cyathidites asper (Bolchovitina) Dettmann
Pl. 2, figs. 3, 6

1953 *Stenozonotriletes asper* Bolchovitina, p. 49, pl. 7, fig. 2
1959 *Lygodium asper* (Bolchovitina) Bolchovitina, pl. 10, fig. 4
1963 *Cyathidites asper* (Bolchovitina) Dettmann, p. 24, pl. 1, figs. 10-16

Description: see Dettmann, 1963.

Dimensions: Overall equatorial diameter (5 specimens) 58-72 μm, exine 3-4 μm thick.

Comments: Occasional specimens believed to be conspecific to *C. asper* have been found in some assemblages of the *Coptospora paradoxa* Zone. Dettmann (1963) described the species as a widespread element in the Early Cretaceous of southeastern Australia.

Cyathidites punctatus (Delcourt & Sprumont) Delcourt, Dettmann & Hughes
Pl. 1, fig. 10; Pl. 2, figs. 1, 2

1955 *Concavisporites punctatus* Delcourt & Sprumont, p. 25, pl. 1, fig. 8
1963 *Cyathidites punctatus* (Delcourt & Sprumont) Delcourt, Dettmann & Hughes, p. 283, pl. 42, fig. 3

Description: see Dettmann, 1963, p. 23.

Dimensions: Equatorial diameter (27 specimens) 55-(64)-80 μm.

Distribution: An uncommon species in the Early Cretaceous of Belgium (Delcourt & Sprumont, 1955), the Albian of Spain (Busnardo & Taugourdeau, 1964), the Middle Jurassic (Dogger) to Aptian of the Sahara (Reyre, 1973), and the Early Cretaceous of Australia (Dettmann, 1963; Burger, 1973b, 1974). Uncommon to rare in the Early Cretaceous of the Surat Basin.

Cyathidites rafaeli (Burger) nov. comb.
Pl. 1, figs. 8, 9

1966 *Deltoidospora rafaeli* Burger, p. 238, pl. 4, fig. 3

Dimensions: Equatorial diameter (26 specimens) 16-(22)-25 μm.

Distribution: Present in varying quantities in every preparation examined. The species also occurs in assemblages from the Cenomanian of Bathurst Island.

Comments: Burger reported *C. rafaeli* from the Jurassic and Early Cretaceous of Queensland as *Dictyophyllidites mortonii* (De Jersey) Playford & Dettmann, 1965,

TABLE 4. CLASSIFICATION OF FOSSIL DISPERSED SPORES AND POLLEN GRAINS

genus	*infraturma*	*subturma*	*suprasubturma*	*turma*
Cyathidites *Biretisporites* *Dictyophyllidites*	LAEVIGATI	AZONATI	ACAVATI-TRILETES	TRILETES
Osmundacidites *Baculatisporites* *Leptolepidites* *Ceratosporites* *Cepulina* *Lycopodiacidites* *Pilosisporites*	APICULATI			
Lycopodiumsporites *Cyclosporites* *Foveosporites* *Reticulatisporites* *Klukisporites* *Dictyotosporites* *Cicatricosisporites* *Balmeisporites* *Arcellites*	MURORNATI			
Matonisporites *Trilobosporites* *Trilites* *Ischyosporites*		AURICULATI		
Gleicheniidites *Sestrosporites*		TRICRASSATI		
Polycingulatisporites *Stereisporites* *Foraminisporis* *Contignisporites*		CINGULATI		
Crybelosporites *Endoculeospora* *Velosporites*		azonate forms	PERINO-TRILETES	
Laevigatosporites	LAEVIGATOMONOLETI	AZONOMONOLETES	ACAVATO-MONOLETES	MONOLETES
Punctatosporites *Tuberculatosporites*	APICULATOMONOLETI			
Coptospora *Aequitriradites* *Triporoletes*				HILATES
Callialasporites *Alisporites* *Vitreisporites* *Podocarpidites* *Rugubivesiculites* *Microcachryidites* *Trisaccites*		DIVISION SACCATES		
Araucariacites				INAPERTURATES
Classopollis			acavate forms	MONOPORINES
Ephedripites				POLYPLICATES
Monosulcites *Clavatipollenites* *Liliacidites* *Retimonocolpites*			acavate forms	MONOSULCATES
Concentrisporites			perinate forms	
Asteropollis				TRICHOTOMO-SULCATES
Tricolpites *Rousea*				TRICOLPATES

but it differs from that species in that the trilete laesurae are not raised. *Cyathidites minor* Couper is larger but otherwise similar. Couper (1958) established a minimum equatorial diameter of 25 μm for *C. minor* from Britain; this value is approximately the same in the Surat Basin and is here also used to separate *minor* from *rafaeli*.

Genus **Biretisporites** Delcourt & Sprumont, 1955 emend. Delcourt, Dettmann & Hughes, 1963

Type species (by original designation): *Biretisporites potoniaei* Delcourt & Sprumont, 1955; Early Cretaceous, Belgium.

Biretisporites spectabilis Dettmann
Pl. 3, figs. 1-3, 5, cf. 4

1963 *Biretisporites spectabilis* Dettmann, p. 26, pl. 2, figs. 3, 4

Dimensions: Equatorial diameter (13 specimens) 60-90 μm. Exine 3-5 μm thick.

Distribution: An uncommon species in the *Murospora florida* Zone and *Osmundacidites dubius* Zone, slightly more frequent in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Dettmann reported the species from early Lower Cretaceous sediments in southeastern Australia. Similar spores also occur in the Cenomanian of Bathurst Island (Burger, 1975).

Comments: The representatives of the species found in the Surat Basin lack the well developed laesurate lips typical of those from southeastern Australia, which may perhaps be attributed to poor preservation. *Concavisporites parkinii* Pocock, 1962, from the Neocomian to ?Aptian of western Canada, is similar but has an evenly granulate exine.

Genus **Dictyophyllidites** Couper, 1958 emend. Dettmann, 1963

Type species (by original designation): *Dictyophyllidites harrisii* Couper, 1958; Jurassic, Britain.

Dictyophyllidites crenatus Dettmann
Pl. 2, figs. 4, 5, 7-9

1963 *Dictyophyllidites crenatus* Dettmann, p. 28, pl. 3, figs. 1, 2

Dimensions: Equatorial diameter (17 specimens) 36-(47)-60 μm.

Distribution: This species occurs rarely in most assemblages of the *Murospora florida* Zone and the *Osmundacidites dubius* Zone, and is uncommon to rare in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. It is widely distributed in the Early Cretaceous of southeastern Australia, but has not been observed in the Cenomanian of Bathurst Island. Identical spores have been reported as *Concavisporites antweilerensis* Thomson (in Thomson & Pflug, 1953) from the Jurassic of the Sahara (Reyre, 1973, p. 110, pl. 3, fig. 10).

Comments: Laesurate margins in many specimens from the Surat Basin are very weakly, or not at all, crenulate, but otherwise the spores conform with Dettmann's description of the species. They can be distinguished from *Cyathidites minor* Couper by their slightly thicker exine and more accentuated laesurate lips.

Infraturma Apiculati Bennie & Kidston emend. Potonié, 1956

Genus **Osmundacidites** Couper, 1953

Type species (by original designation): *Osmundacidites wellmanii* Couper, 1953; Jurassic, New Zealand.

Osmundacidites wellmanii Couper
Pl. 4, figs. 1, 2

1953 *Osmundacidites wellmanii* Couper, p. 20, pl. 1, fig. 5

Description: see Dettmann, 1963, pp. 32-4.

Distribution: A rare to uncommon species in many preparations from the Surat Basin; also present in the Early Cretaceous of southeastern Australia.

Osmundacidites dubius sp. nov.
Pl. 4, figs. 3-5

Holotype: BMR Mitchell 11, depth 14.6 m (48 ft); Bungil Formation, Minmi Member; Cretaceous, early Aptian (MFP 4276-1, 279/1105, CPC 16119. Pl. 4, fig. 4).

Description: Medium-sized, trilete, azonate miospores, usually compressed, outline circular. Exine 1-2 μm thick, densely and evenly granulate. A tetrad mark is very seldom visible; in some specimens the exine is slightly raised where the trilete laesurae are presumably located. In those specimens exhibiting an aperture the laesurae are straight and simple, and reach entirely to the equator of the spore.

Dimensions: Equatorial diameter (22 specimens) 35-(44)-54 μm.

Distribution: Present in low to moderate numbers in most preparations from the Surat Basin.

Comments: The species differs from *Osmundacidites wellmanii* Couper in its slightly smaller equatorial dimensions, the smaller and more closely crowded sculpture elements, and the inconspicuous aperture. *Osmundacidites mollis* (Cookson & Dettmann) Dettmann, 1963, differs in that the exine, although unthickened, bulges slightly in the equatorial region.

Genus **Baculatisporites** Thomson & Pflug, 1953

Type species (by original designation): *Baculatisporites* (al. *Sporites*) *primarius* (Wolff, 1934) Thomson & Pflug, 1953; Pliocene, Germany.

Baculatisporites comaumensis (Cookson) Potonié
Pl. 4, figs. 6, 8, 9

1953 *Trilites comaumensis* Cookson, p. 470, pl. 2, figs. 27, 28

1956 *Baculatisporites comaumensis* (Cookson) Potonié, p. 33

Description: see Dettmann, 1963, p. 35.

Distribution: A common to infrequent species in nearly every preparation examined. Common in the Jurassic and Early Cretaceous of Western and southeastern Australia (Balme, 1957; Dettmann, 1963). Not observed in the Cenomanian of Bathurst Island.

Genus **Leptolepidites** Couper, 1953

Type species (by original designation): *Leptolepidites verrucatus* Couper, 1953; ?Albian, New Zealand. (The species was typified by a specimen from Hawks Crag Breccia, which at the time was thought to be of Jurassic age, but Norris & Waterhouse (1970) deduced a Lower Cretaceous (?Albian) age for the formation from detailed study of its pollen contents).

Leptolepidites major Couper
Pl. 5, fig. 5

1958 *Leptolepidites major* Couper, p. 141, pl. 21, figs. 7, 8
1968 *Rubinella major* (Couper) Norris, p. 316, figs. 16, 17

Description: see Dettmann, 1963, p. 29.

Dimensions: Verrucae in basal diameter 2-7 μm, equatorial diameter of 6 specimens 38-44 μm.

Distribution: A rare to very rare species in some of the assemblages from the Surat Basin. Present in the Early Cretaceous of southeastern Australia (Dettmann, 1963), the Middle Jurassic of Britain (Couper, 1958), the Late Jurassic to Early Cretaceous of New Zealand (Norris, 1968), the Albian of Spain (Busnardo & Taugourdeau, 1964), and the Maastrichtian of Arctic Canada (Felix & Burbridge, 1973).

Comments: In reviewing the genus *Rubinella,* Potonié (1960) noted that Maliavkina (1949) proposed the genus to incorporate a number of spore types (Maliavkina, 1949, 1953) having small verrucae and bacula, such as found in *Osmundacidites* Couper and *Baculatisporites* Thomson & Pflug. Potonié validated the genus by proposing *Rubinella bacciformis* Maliavkina, 1949, as its lectotype. Unlike the other species of *Rubinella, R. bacciformis* develops relatively large, hemispherical sculptural elements, and is in my opinion not typical of the genus (sensu Maliavkina). Moreover, the genus is poorly known and forms no distinct taxonomic entity, in that it incorporates forms readily assignable to other genera. For these reasons Norris's (1968) transfer of the species *major* to *Rubinella* is not followed here.

Leptolepidites verrucatus Couper
Pl. 4. fig. 7

1953 *Leptolepidites verrucatus* Couper, p. 28, pl. 2, figs. 14, 15

Description: see Couper, 1953; Dettmann, 1963, p. 29.

Dimensions: Equatorial diameter (12 specimens) 23-34 μm.

Distribution: Present in low numbers in many Late Jurassic and Early Cretaceous assemblages from the Great Artesian Basin, and the Early Cretaceous of southeastern Australia (Dettmann, 1963). The species seems to range into the Late Cretaceous (Cookson & Dettmann, 1958a; Dettmann, 1959), but it was not observed in the Cenomanian of Bathurst Island.

Genus **Ceratosporites** Cookson & Dettmann, 1958a

Type species (by original designation): *Ceratosporites equalis* Cookson & Dettmann, 1958a; Early Cretaceous, Victoria.

Ceratosporites equalis Cookson & Dettmann
Pl. 5, figs. 1-3

1958a *Ceratosporites equalis* Cookson & Dettmann, p. 101, pl. 14, figs. 17-19

Distribution: Present in low to moderate numbers in most assemblages from the Surat Basin. Widely distributed in the Late Jurassic and Early Cretaceous of Queensland (Burger, 1973a,b, 1974) and Early Cretaceous of southeastern Australia (Dettmann, 1963). Also recovered from the Cenomanian of Bathurst Island. Busnardo & Taugourdeau (1964) reported the species from the Albian of Spain.

Genus **Cepulina** Maliavkina, 1949 ex Schulz, 1967

Type species (designated by Schulz, 1967): *Cepulina bacculifera* Maliavkina 1949; mid-Jurassic, USSR.

Cepulina truncata (Cookson) Schulz
(not illustrated)

1953 *Trilites truncatus* Cookson, p. 471, pl. 2, fig. 36
1956 *Neoraistrickia truncatus* (Cookson) Potonié, p. 34
1957 *Baculatisporites truncatus* (Cookson) Balme, p. 18, pl. 1, figs. 21, 22
1967 *Cepulina truncata* (Cookson) Schulz, p. 563, pl. 3, figs. 11, 12

Description: see Dettmann, 1963, p. 36.

Dimensions: Equatorial diameter, exclusive of sculpture (15 specimens) 20-33 μm.

Distribution: Present in low numbers in many Surat Basin assemblages; also present in the Late Jurassic-Early Cretaceous of Western Australia (Balme, 1957), the Early Cretaceous of southeastern Australia (Dettmann, 1963), and the Cenomanian of Bathurst Island.

Comments: The species differs from *Ceratosporites equalis* Cookson & Dettmann in having shorter and thicker distal sculptural elements. The range of variation, however, is such that many specimens are morphologically close to *Ceratosporites equalis.* This partial intergradation was also observed in the Cenomanian microfloras from Bathurst Island and suggests that the two species, if they do represent different botanical taxa, are closely related. Schulz (1967) redescribed and typified the genus *Cepulina* and placed *Neoraistrickia* into synonymy; he suggested that *Cepulina* and *Ceratosporites* also be joined. Potonié (1970) discussed this possibility but observed that in this case the generic diagnosis would have to be widened beyond Schulz's concept. Since the genus *Cepulina* (*Neoraistrickia*) includes species, such as *Neoraistrickia robusta* Brenner, 1963 (pp. 65-66, pl. 19, fig. 2), which differ considerably from *Ceratosporites,* it seems more convenient to maintain the two genera as separate taxa.

Genus **Lycopodiacidites** Couper, 1953 emend. Potonié, 1956

Type species (by original designation): *Lycopodiacidites bullerensis* Couper, 1953; Jurassic, New Zealand.

Lycopodiacidites asperatus Dettmann
Pl. 5, fig. 4

1963 *Lycopodiacidites asperatus* Dettmann, p. 40, pl. 6, figs. 1, 2

Description: see Dettmann, 1963, and Burger, 1976, p. 4.
Dimensions: Equatorial diameter (18 specimens) 40-64 μm.
Distribution: Dettmann reported the species as a sporadic element in many Early Cretaceous microfloral assemblages from southeastern Australia. Burger (1976) occasionally observed the species in Late Jurassic and Early Cretaceous strata of the Surat and Eromanga Basins.

Lycopodiacidites dettmannae sp. nov.
Pl. 5, figs. 6-8

Holotype: BMR Surat 2, depth 41.3 m (135 ft 5 in.); Surat Siltstone, Cretaceous, mid-Albian (MFP 4535-1, 285/1025, CPC 16132. Pl. 5, fig. 8).
Description: Small to medium-sized, trilete, azonate miospores, initially spherical, usually compressed, with circular to oblong amb. Trilete mark indistinct, laesurae simple, straight, extending to equator. Exine inclusive of sculpture 2-4 μm thick, at distal face covered with closely spaced, short bacula and rugulae 1-1.5 μm high and 1-3 μm in cross-section. Individual elements with flattened, slightly expanded tops, two or three elements occasionally aligned with low exine thickenings connecting the bases. Sculpture elements at proximal face reduced in size, approximately circular (1 μm) in cross-section.
Dimensions: Equatorial diameter (15 specimens) 32-50 μm.
Distribution: The species was found in two assemblages of the *Crybelosporites striatus* Zone, and occurs persistently in low numbers in the *Coptospora paradoxa* Zone.
Comments: The species is slightly smaller than *L. asperatus* Dettmann, and its markedly smaller, uniformly shaped sculptural elements distinguish it from *asperatus* and other species of the genus, such as *L. cristatus* Couper, 1953, *L. bullerensis* Couper, 1953, and *L. irregularis* Brenner, 1963.

Genus **Pilosisporites** Delcourt & Sprumont, 1955

Type species (by original designation): *Pilosisporites* (al. *Sporites*) *trichopapillosus* (Thiergart, 1949) Delcourt & Sprumont, 1955; Early Cretaceous, Germany.

Pilosisporites notensis Cookson & Dettmann
Pl. 6, fig. 5

1958a *Pilosisporites notensis* Cookson & Dettmann (pars), p. 102, pl. 15, fig. 3

Description: see Dettmann, 1963, p. 37.
Dimensions: Exine 2-(3)-5 μm thick. Spines in radial proximal and distal regions 2-5 μm long. Equatorial diameter (22 specimens) 75-(91)-113 μm.
Distribution: A rare species in the higher interval of the *Murospora florida* Zone, the *Osmundacidites dubius* Zone, the *Crybelosporites striatus* Zone, and the *Coptospora paradoxa* Zone. Dettmann (1963) reported the species from the Early Cretaceous of southeastern Australia.

Pilosisporites parvispinosus Dettmann
Pl. 5, fig. 9; Pl. 6, figs. 1-3

1963 *Pilosisporites parvispinosus* Dettmann, p. 38, pl. 5, figs. 1, 2

Dimensions: Exine 2-3 μm thick, spinules 2-3 μm high; equatorial dimensions (28 specimens) 77-(96)-113 μm.
Distribution: A rare component in most assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Single specimens were also recovered from samples associated with the highest interval of the *Murospora florida* Zone and the basal interval of the *Osmundacidites dubius* Zone. Not observed in the Cenomanian of Bathurst Island. Dettmann (1963) reported the species from Aptian and Albian sediments of southeastern Australia.

Pilosisporites grandis Dettmann
Pl. 6, fig. 4

1963 *Pilosisporites grandis* Dettmann, pp. 38-39, pl. 5, figs. 1-3, text-fig. 4e

Comments: Two specimens of the species were found in preparations from the youngest interval of the Griman Creek Formation in BMR Surat 4 and GSQ Surat 2. The species occurs rarely in late Albian microfloras from the Eromanga Basin, and was observed in the Cenomanian of Bathurst Island. Dettmann & Playford (1969) restricted the range of the species to within the *Coptospora paradoxa* Zone in southeastern Australia, and Dettmann (1963) reported it from equivalent horizons of the Eromanga Basin in South Australia.

Infraturma MURORNATI Potonié & Kremp, 1954

Genus **Lycopodiumsporites** Thiergart, 1938 ex Delcourt & Sprumont, 1955

Type species (designated by Delcourt & Sprumont, 1955): *Lycopodiumsporites* (al. *Sporites*) *agathoecus* (Potonié, 1934) Thiergart, 1938; Eocene, Germany.

Lycopodiumsporites austroclavatidites (Cookson) Potonié
Pl. 7, fig. 1

1953 *Lycopodium austroclavatidites* Cookson, p. 469, pl. 2, fig. 35

1956 *Lycopodiumsporites austroclavatidites* (Cookson) Potonié, p. 46

See Dettmann, 1963, p. 44 for more complete list of synonymy.

Distribution: Widespread, although in low numbers, in Jurassic and Early Cretaceous microfloras from Queensland and elswhere in Australia. Also present in the Cenomanian of Bathurst Island.

Lycopodiumsporites circolumenus Cookson & Dettmann
Pl. 7, fig. 2

1958a *Lycopodiumsporites circolumenus* Cookson & Dettmann, p. 105, pl. 15, figs. 10, 11

Description: see Dettmann, 1963, pp. 44-45.

Dimensions: Maximum diameter of lumina 3-5 μm, equatorial dimensions (13 specimens) 28-46 μm.

Distribution: A rare species in a number of preparations from the Surat Basin. Present in low numbers in many Late Jurassic to Aptian microfloras elsewhere in Queensland. Also found in Jurassic and Aptian sediments from Western Australia (Cookson & Dettmann, 1958a), and in Lower Cretaceous strata from southeastern Australia (Dettmann, 1963).

Lycopodiumsporites eminulus Dettmann
Pl. 7, fig. 6

1963 *Lycopodiumsporites eminulus* Dettmann, p. 45, pl. 7, figs. 11, 12

Distribution: A rare species in the Early Cretaceous of the Surat Basin. Common in Early Cretaceous microfloras from southeastern Australia.

Lycopodiumsporites facetus Dettmann
Pl. 7, fig. 7, cf. fig. 8

1963 *Lycopodiumsporites facetus* Dettmann, p. 47, pl. 17, figs. 17-20

Distribution: Dettmann described the species as a widespread element in the Early Cretaceous of southeastern Australia. Single specimens occur in some of the assemblages of the *Murospora florida* Zone and the *Osmundacidites dubius* Zone.

Lycopodiumsporites nodosus Dettmann
Pl. 7, figs. 3-5; Pl. 8, fig. 1

1963 *Lycopodiumsporites nodosus* Dettmann, p. 46, pl. 7, figs. 13, 14

Dimensions: Diameter of distal lumina 4-13 μm, height of muri 3-4 μm, overall equatorial diameter (20 specimens) 40-(47)-57 μm.

Distribution: Present in low numbers in many Late Jurassic and Early Cretaceous microfloras from the Great Artesian Basin. Not observed in the Cenomanian of Bathurst Island. Common in the Early Cretaceous of southeastern Australia (Dettmann, 1963).

Comments: L. nodosus is easily distinguished by the wide-meshed reticulum and coarse granulation of the exine. In a number of specimens the granulation is absent in smaller or larger areas of the spore body and may be restricted, for instance, to the proximal polar area of the exine. Other specimens lack granulation altogether but, being in other aspects similar to *nodosus,* have also been included in the species (see Plate 8, fig. 1).

Lycopodiumsporites rosewoodensis (De Jersey) De Jersey
Pl. 8, fig. 2

1959 *Lycopodium rosewoodensis* De Jersey, p. 3, pl. 1, figs. 5, 6

1963 *Lycopodiumsporites rosewoodensis* (De Jersey) De Jersey, p. 4, pl. 2, fig. 3

Dimensions: Equatorial diameter (18 specimens) 24-38 μm.

Distribution: Present in low numbers in many Jurassic and Early Cretaceous microfloras from the Great Artesian Basin. Comparable specimens occur in some samples from the Cenomanian of Bathurst Island (Burger, 1976).

Lycopodiumsporites solidus sp. nov.
Pl. 8, figs. 4, 5, 7

1976 *Lycopodiumsporites* cf. *L. facetus* Dettmann; Burger p. 7, pl. 5, figs. 2, 3; pl. 6, fig. 1; text-fig. 3

Holotype: BMR Surat 1, depth 65.0 m (213 ft 1 in.); Wallumbilla Formation, Coreena Member. Cretaceous, mid-Albian (MFP 4537-2, 397/1153. Pl. 8, fig. 7).

Description: Medium to large, trilete, azonate miospores, spherical to ovoidal-ellipsoidal, with a dark, dense, acavate exine 8-9 μm thick consisting of a thin, psilate, highly refractive inner layer 0.5-1 μm thick, an intermediate porous, spongy layer 3-8 μm thick, granulate in appearance, and an outer, uniformly reticulate layer, with thin, psilate muri 2-6 μm high enclosing polygonal, equidimensional to elongated lumina 3-(6-8)-14 μm in diameter. Tetrad mark rarely visible, laesurae straight, simple and approximately as long as radius of spore cavity. The regularity of the outermost network precludes locating the tetrad mark; the laesurae are probably developed only in the innermost layer.

Dimensions: Long axis of spore cavity (orientation uncertain) of 3 specimens 34-38 μm, maximum diameter of 20 specimens 50-(59)-70 μm.

Distribution: A sporadic species in the Late Jurassic of the Surat Basin; rare to uncommon in the *Murospora florida* Zone and *Osmundacidites dubius* Zone of the Surat and Eromanga Basins, sporadic in the *Crybelosporites striatus* Zone of the Surat Basin. Some Albian occurrences of the species are probably not genuine, but reworked from older strata.

Comments: The species resembles *L. facetus* Dettmann in its exine stratification but the exine is thicker; the reticulate pattern is regular, and unlike *facetus* lacks modifications in the arrangement of the muri which indicate the position of the trilete laesurae. The exine stratification of *solidus* resembles that of *Crybelosporites* (see p. 60) but in no specimen was the exine found to be cavate. The outermost layer is partially, but probably accidentally, detached in the specimen figured in Plate 8, figure 4.

Genus **Cyclosporites** Cookson & Dettmann, 1959a

Type species (by original designation): *Cyclosporites* (al. *Radiatisporites*) *hughesii* (Cookson & Dettmann, 1958b) Cookson & Dettmann, 1959a; Early Cretaceous, Victoria.

Cyclosporites hughesii (Cookson & Dettmann) Cookson & Dettmann
Pl. 8, fig. 8

1958b *Radiatisporites hughesi* Cookson & Dettmann, p. 103, pl. 15, figs. 4-6
1959a *Cyclosporites hughesi* (Cookson & Dettmann) Cookson & Dettmann, p. 260

Description: see Dettmann, 1963, pp. 41-42.
Dimensions: Exine (without sculpture) 2 μm thick, muri 3-7 μm high, overall equatorial diameter of 14 specimens 34-50μm.
Distribution: An uncommon but persistent species in the *Murospora florida* Zone and the *Osmundacidites dubius* Zone, rare in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone, in which intervals some of its occurrences may be due to recycling. Dettmann (1963) reported the species from the Early Cretaceous of southeastern Australia.

Genus **Foveosporites** Balme, 1957

Type species (by original designation): *Foveosporites canalis* Balme, 1957; ?Early Cretaceous, Western Australia.

Foveosporites canalis Balme
Pl. 8, figs. 6, 9

1957 *Foveosporites canalis* Balme, p. 17, pl. 1, figs. 15-17

Description: see Dettmann, 1963, p. 43.
Dimensions: Equatorial diameter (11 specimens) 30-39 μm.
Distribution: Sporadically present in the Early Cretaceous of the Great Artesian Basin; widely distributed in the Early Cretaceous of southeastern Australia and Western Australia. Balme (1957) recovered doubtful specimens of the species from Upper Jurassic sediments of the Perth Basin.
Comments: In some specimens the exine is slightly thickened in the equatorial interradial regions (Pl. 8, fig. 6). Since neither Balme nor Dettmann mentioned this detail, it is not certain if this is authentic or results from excessive compression of the spore.

Genus **Reticulatisporites** Ibrahim, 1933 emend. Potonié & Kremp, 1954

Type species (by monotypy): *Reticulatisporites reticulatus* Ibrahim, 1933 emend. Potonié & Kremp, 1954; Late Carboniferous, Germany.

Reticulatisporites pudens Balme
Pl. 8, fig. 3

1957 *Reticulatisporites pudens* Balme, pp. 17-18, pl. 1, figs. 12-14

Description: see Dettmann, 1963, p. 47.
Dimensions: Equatorial diameter (13 specimens) 20-27 μm.
Distribution: An uncommon species in the Early Cretaceous of the Surat Basin; common in the Neocomian-Aptian of Western Australia, and the Early Cretaceous of southeastern Australia (Dettmann, 1963).

Genus **Klukisporites** Couper, 1958

Type species (by original designation): *Klukisporites variegatus* Couper, 1958; mid-Jurassic, Britain.

Klukisporites scaberis (Cookson & Dettmann) Dettmann
Pl. 9, fig. 1

1958a *Ischyosporites scaberis* Cookson & Dettmann, p. 104, pl. 15, figs. 7-9
1963 *Klukisporites scaberis* (Cookson & Dettmann) Dettmann, p. 48, pl. 8, figs. 1-7

Distribution: Widely distributed in southeastern Australia. Rare to uncommon in the *Murospora florida* Zone and the *Osmundacidites dubius* Zone, rare in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Some of the Albian observations from the Surat Basin are suspect and may include secondary (recycled) specimens.

Genus **Dictyotosporites** Cookson & Dettmann, 1958a

Type species (by original designation): *Dictyotosporites speciosus* Cookson & Dettmann, 1958a; Early Cretaceous, Victoria.

Dictyotosporites speciosus Cookson & Dettmann
Pl. 9, fig. 2

1958a *Dictyotosporites speciosus* Cookson & Dettmann, p. 107, pl. 16, fig. 5

Description: see Dettmann, 1963, p. 49.
Dimensions: Overall equatorial diameter (10 specimens) 38-45 μm.
Distribution: A rare species in many preparations from upper Neocomian, Aptian, and Albian strata of the Surat Basin. Widely distributed in the Early Cretaceous of southeastern Australia. Not observed beyond the *Coptospora paradoxa* Zone in the Eromanga Basin. Dettmann & Playford (1969) recorded the species mainly from within the interval of their *Dictyotosporites speciosus* Zone.

Dictyotosporites complex Cookson & Dettmann
Pl. 9, figs. 5, 6

1958a *Dictyotosporites complex* Cookson & Dettmann, p. 107, pl. 16, figs. 11-13, 15, 16

Description: see Dettmann, 1963, p. 49.
Dimensions: Equatorial diameter (9 specimens) 32-47 μm.
Distribution: A rare species in many Late Jurassic to Albian microfloras from the Surat Basin. Widely distributed in the Early Cretaceous of southeastern Australia.

Dictyotosporites filosus Dettmann
Pl. 8, fig. 10

1963 *Dictyotosporites filosus* Dettmann, p. 50, pl. 8, figs. 15-20

Distribution: Single specimens of the species are present in some microfloras of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. The species has also been recovered from Aptian and Albian strata in southeastern Australia.

Genus **Cicatricosisporites** Potonié & Gelletich, 1933

Type species (by monotypy): *Cicatricosisporites dorogensis* Potonié & Gelletich, 1933; Early Tertiary, Hungary.

Cicatricosisporites australiensis (Cookson) Potonié
Pl. 9, figs. 4, 7, 8, cf. 9, 10

1953 *Mohrioisporites australiensis* Cookson, p. 470, pl. 2, figs. 29-34
1956 *Cicatricosisporites australiensis* (Cookson) Potonié, p. 48

Description: see Dettmann, 1963, p. 53.

Dimensions: Width of 4 striae and adjacent grooves on distal exine 5-(9)-13 μm; equatorial diameter (39 specimens) 33-(47)-62 μm.

Distribution: Widely distributed in the Early Cretaceous of Australia and Papua New Guinea and the Cenomanian of Bathurst Island.

Comments: The proximal exine of *C. australiensis* is occasionally unornamented but usually striate, whereby in each segment two to four ribs may be arranged parallel to adjacent side of amb (Pl. 9, fig. 7), or diverge from the distal-equatorial striae in varying angles, and extend partially or entirely towards the laesurate margins (Pl. 9, fig. 4). The latter arrangement is also found in *C. ludbrookiae* Dettmann, but the ribs and grooves in *ludbrookiae* are much coarser.

Cicatricosisporites hughesii Dettmann
(not illustrated)

1963 *Cicatricosisporites hughesi* Dettmann, p. 55, pl. 10, figs. 6-16

Dimensions: Equatorial diameter (14 specimens) 38-56 μm.

Distribution: A rare species in the Early Cretaceous of the Surat Basin. Present in many Early Cretaceous microfloras from southeastern Australia.

Cicatricosisporites ludbrookiae Dettmann
Pl. 10, cf. figs. 1, 2; figs. 5, 6

1963 *Cicatricosisporites ludbrooki* Dettmann, p. 54, pl. 9, figs. 17-22

Distribution: A rare species in the Early Cretaceous of the eastern Australian region.

Comments: C. ludbrookiae is distinguished from other species of *Cicatricosisporites* in Australia by its larger dimensions and the breadth and relatively low number of striae on the distal and proximal exine.

Cicatricosisporites pseudotripartitus (Bolchovitina) Dettmann
Pl. 9, fig. 3

1961 *Anemia pseudotripartita* Bolchovitina, p. 53, pl. 15, figs. 3a-c
1963 *Cicatricosisporites pseudotripartitus* (Bolchovitina) Dettmann, p. 54, pl. 10, figs. 1-5

Dimensions: Equatorial diameter (4 specimens) 32-45 μm.

Distribution: A rare species in some microfloras of the *Coptospora paradoxa* Zone. Dettmann (1963) reported the species from Albian strata of the Great Artesian Basin in South Australia and some horizons within the Paradoxa Assemblage/*Coptospora paradoxa* Zone, Otway Basin, Victoria and South Australia. Burger (1975) recovered the species from Cenomanian sediments of Bathurst Island.

Genus **Balmeisporites** Cookson & Dettmann, 1958b

Type species (by original designation): *Balmeisporites holodictyus* Cookson & Dettmann, 1958b; Early Cretaceous, South Australia.

Balmeisporites holodictyus Cookson & Dettmann
Pl. 11, fig. 1

1958b *Balmeisporites holodictyus* Cookson & Dettmann, p. 42, pl. 2, fig. 1

Dimensions: Exine (without muri) 3-5 μm thick, maximum diameter of lumina 10-26 μm, equatorial diameter of central cavity (one specimen) 120 μm, laesurate lips attain a height of 80, 110 μm; polar dimensions of entire spore (one specimen) 250μm.

Distribution: Single specimens of the species have been found in some of the assemblages of the *Coptospora paradoxa* Zone. Dettmann & Playford (1969) recorded the species from the Albian of southeastern Australia, including the upper part of their *Dictyotosporites speciosus* Zone up to the lower part of their *Appendicisporites distocarinatus* Zone.

Comments: The species has a very poor record in the Eromanga and Carpentaria Basins of central and northern Queensland, and the above-mentioned measurements are based on only a few specimens, of which some are present only as fragments.

Genus **Arcellites** Miner, 1935 ex Ellis & Tschudy, 1964

Type species (designated by Ellis & Tschudy): *Arcellites disciformis* Miner, 1935; Early Cretaceous, Greenland.

Arcellites reticulatus (Cookson & Dettmann) Potter
Pl. 10, fig. 7

1958b *Pyrobolospora reticulata* Cookson & Dettmann, p. 40, pl. 1, figs. 2-6
1963 *Arcellites reticulatus* (Cookson & Dettmann) Potter, p. 230

Dimensions (measured on 2 specimens): Total thickness of equatorial and distal exine 24, 40 μm, equatorial diameter of central cavity 210, 300 μm, overall polar dimensions 480, 490 μm.

Distribution: A few fragments of spores, and two entire specimens, were found in some of the assemblages of the *Coptospora paradoxa* Zone. Dettmann & Playford (1969) recorded the species as ranging from the higher part of their *Dictyotosporites speciosus* Zone (early Albian, see p. 14) up to the early part of their *Clavifera triplex* Zone (early Late Cretaceous) of eastern Australia.

Subturma AURICULATI Schopf emend. Dettmann, 1963

Genus **Matonisporites** Couper, 1958 emend. Dettmann, 1963

Type species (by original designation): *Matonisporites phlebopteroides* Couper 1958; mid-Jurassic, Britain.

Matonisporites cooksonae Dettmann
Pl. 11, figs. 2, 3

1963 *Matonisporites cooksoni* Dettmann, p. 59, pl. 11, figs. 1-8

Dimensions: Exine 1-3 μm thick, increasing to 3-6 μm in the equatorial radial regions. Equatorial diameter (18 specimens) 42-(57)-68 μm.

Distribution: A rare species in many microfloras of the *Murospora florida* Zone, the *Osmundacidites dubius* Zone, and the *Crybelosporites striatus* Zone; more frequent in the *Coptospora paradoxa* Zone. Widespread in the Early Cretaceous of southeastern Australia. Not observed in the Cenomanian of Bathurst Island.

Genus **Trilobosporites** Pant, 1954 ex Potonié, 1956

Type species (designated by Potonié, 1956): *Trilobosporites* (al. *Concavisporites*) *hannonicus* (Delcourt & Sprumont, 1955) Potonié, 1956; Early Cretaceous, Belgium.

Trilobosporites trioreticulosus Cookson & Dettmann
Pl. 11, fig. 5

1958a *Trilobosporites trioreticulosus* Cookson & Dettmann, p. 109, pl. 17, figs. 1-3

Description: see Dettmann, 1963, p. 60.

Dimensions: Equatorial diameter (10 specimens) 64-110 μm.

Distribution: A rare to uncommon species in many assemblages of the *Coptospora paradoxa* Zone, and in Upper Albian sediments of the Eromanga and Carpentaria Basins. Also present in the Cenomanian of Bathurst Island. Dettmann & Playford (1969) recorded the species from the Albian (their *Coptospora paradoxa* Zone and *Tricolpites pannosus* Zone) of southeastern Australia.

Trilobosporites antiquus Reiser & Williams
Pl. 12, fig. 8

1969 *Trilobosporites antiquus* Reiser & Williams, p. 8, pl. 3, fig. 15, pl. 4, fig. 1

Distribution: The species occurs in the Early Jurassic (De Jersey & Paten, 1964; Reiser & Williams, 1969) and rarely also in the Middle Jurassic (McKellar, 1974) of the Surat Basin. Burger (1973b, 1974; various unpublished reports) recovered the species from Upper Jurassic and Neocomian sediments of the Surat and Eromanga Basins. Single specimens occur in some assemblages of the *Osmundacidites dubius* Zone and the *Crybelosporites striatus* Zone. The single specimens are probably reworked from older sediments; it is possible, however, taking into account the wide area of dispersal in the Great Artesian Basin, that the Upper Jurassic and Neocomian occurrences of the species are genuine.

Trilobosporites tribotrys Dettmann
Pl. 11, fig. 4; Pl. 12, fig. 1

1963 *Trilobosporites tribotrys* Dettmann, p. 61, pl. 12, figs. 10-14

Dimensions: Equatorial diameter (4 specimens) 64-87 μm.

Distribution: The species occurs in a few preparations of the *Coptospora paradoxa* Zone. Dettmann (1963) reported the spore in a few Albian samples from the Otway and Great Artesian Basins.

Genus **Trilites** Erdtman, 1947 ex Couper, 1953 emend. Dettmann, 1963

Type species (designated by Couper, 1953): *Trilites tuberculiformis* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Trilites cf. **T. tuberculiformis** Cookson
Pl. 10, figs. 3, 4

?1947 *Trilites tuberculiformis* Cookson, p. 136, pl. 16, fig. 61

Description: see Dettmann, 1963, p. 63.

Distribution: An uncommon species in many Early Cretaceous microfloras from the Surat Basin. Rare in the Early Cretaceous of southeastern Australia. Not observed in the Cenomanian of Bathurst Island.

Comments: The valvate nature of the exine commented on by Dettmann (1963) is not conspicuous; many specimens found in the Surat Basin preparations which otherwise are identical to cf. *tuberculiformis* lack apiculate exine thickenings (see Pl. 10, fig. 4).

Genus **Ischyosporites** Balme, 1957

Type species (by original designation): *Ischyosporites crateris* Balme, 1957; Early Cretaceous, Western Australia.

Ischyosporites punctatus Cookson & Dettmann
Pl. 12, fig. 2

1958a *Ischyosporites punctatus* Cookson & Dettmann, p. 104, pl. 16, figs. 1-4

Description: see Dettmann, 1963, pp. 63-64.

Distribution: A rare species in a number of microfloras of the *Murospora florida* Zone and the *Osmundacidites dubius* Zone, and in some microfloras of the (Albian) *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone, where the specimens observed may well be of secondary origin. Dettmann (1963) recorded the species from the Early Cretaceous of southeastern Australia and mentioned its occurrence in the Late Jurassic and Aptian of Western Australia.

Subturma TRICRASSATI Dettmann, 1963

Genus **Gleicheniidites** Ross, 1949 ex Delcourt & Sprumont, 1955 emend. Dettmann, 1963

Type species (designated by Delcourt & Sprumont, 1955): *Gleicheniidites senonicus* Ross, 1949; Late Cretaceous, Sweden.

Gleicheniidites circinidites (Cookson) Dettmann
Pl. 12, figs. 4-6

1953 *Gleichenia circinidites* Cookson, p. 464, pl. 1, figs. 5, 6
1963 *Gleicheniidites cercinidites* (Cookson) Dettmann, p. 65, pl. 13, figs. 6-10

Distribution: Present rarely in the early interval of the *Murospora florida* Zone, rare to abundant in microfloras from the remainder of the Early Cretaceous sequence in the Surat Basin. The species is widely distributed in the Cretaceous and Tertiary of Australia (Balme, 1957), and has been observed in the Jurassic of Western Australia and Queensland. McKellar (1974) referred similar spores from the mid-Jurassic of the Surat Basin to *G. senonicus* Ross.

Genus **Sestrosporites** Dettmann, 1963

Type series (by original designation): *Sestrosporites* (al. *Foveotriletes*) *irregulatus* (Couper, 1958) Dettmann, 1963; mid-Jurassic, Britain.

Sestrosporites pseudoalveolatus (Couper) Dettmann
Pl. 12, fig. 3

1958 *Cingulatisporites pseudoalveolatus* Couper, p. 47, pl. 25, fig. 5, 6
1963 *Sestrosporites pseudoalveolatus* (Couper) Dettmann, p. 66, pl. 13, figs. 11-16
1964 *Vallizonosporites pseudoalveolatus* (Couper) Döring, p. 60

Description: see Dettmann, 1963.

Dimensions: Overall equatorial dimensions (11 specimens) 38-50 μm.

Distribution: A rare species in a number of assemblages of the *Murospora florida* Zone and the *Osmundacidites dubius* Zone; sporadic in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone, where the presence of the species is very probably secondary, owing to erosion and redeposition of older sediments. Dettmann reported the species from the Early Cretaceous of southeastern Australia. Couper described the species from the mid-Jurassic to the Aptian of Britain.

Comments: Döring's (1964, p. 60) transfer of the species to *Vallizonosporites* Döring is incorrect. According to the generic diagnosis and the illustrations of the type species *V. vallifoveatus* Döring (Döring, 1964, p. 60, pl. 13, figs. 1, 2) only zonate spores should be included, whereas *Sestrosporites* incorporates tricrassate spores.

Subturma CINGULATI Potonié & Klaus, 1954, emend. Dettmann, 1963

Genus **Polycingulatisporites** Simoncsics & Kedves, 1961 emend. Playford & Dettmann, 1965

Type species (by monotypy): *Polycingulatisporites circulus* Simoncsics & Kedves, 1961; Early Jurassic, Hungary.

Polycingulatisporites clavus (Balme) nov. comb.
Pl. 12, figs. 13, 18

1957 *Sphagnites clavus* Balme (pars?), p. 16, pl. 1, fig. 4
1963 *Cingutriletes clavus* (Balme) Dettmann, p. 69, pl. 14, fig. 5
1975 *Antulsporites clavus* (Balme) Filatoff, p. 42, pl. 1, fig. 4; text-fig. 15A

Emended description: Medium-sized, trilete, cingulate miospores. Amb rounded triangular to circular. Trilete laesurae short, measuring half to two-thirds of radius of spore cavity, and bordered by narrow exine thickenings which merge at extremities of laesurae. Cingulum narrow, 2-3 μm wide, usually darker-coloured than spore body. Exine proximally psilate, distally faintly to distinctly granulate, occasionally with a few small verrucae. About half-way between distal pole and spore margin a set of verrucae with truncated tops and circular to polyangular projections 3-4 μm in diameter is arranged in a sharply delimited circumpolar ridge. A triangular to circular area of exine thickening 5-6 μm across and approximately coinciding with the distal pole is consistently present.

Dimensions: Equatorial diameter (7 specimens) 27-35 μm.

Distribution: Balme (1957) reported the species from Lower Cretaceous (Neocomian-Aptian) sediments of the Perth Basin, Western Australia. In the Great Artesian Basin the species occurs in the upper part of the Jurassic sequence; it is rare to uncommon in the *Murospora florida* Zone and the *Osmundacidites dubius* Zone, and occasional specimens were also found in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone.

Comments: The species differs from other representatives of *Polycingulatisporites* in that the distal circumpolar ridge is invariably broken up into verrucae with irregularly rounded, oblong, or quadrangular projections. Balme (1957) did not specify this detail in his description of the species but the holotype (Balme, op. cit., pl. 1, fig. 4) which I re-examined clearly shows its true nature. The persistent fracturing of the distal ridge in the Surat Basin specimens is clearly authentic and not a result of preservational deterioration.

Balme's paratype (Balme, pl. 1, fig. 5) which I also re-examined is very poorly preserved. The body exine is extremely thin and smooth except for the occurrence of small irregular elevations, 1-2 μm in basal projection, in the distal polar region. These elevations are randomly distributed and give no suggestion of a circumpolar ring or polar exine thickening; a similar type of ornament is characteristic of species of the genus *Antulsporites* Archangelsky & Gamerro. The paratype is thus perhaps unrelated to the holotype.

Filatoff's (1975) suggestion that the holotype and paratype of *clavus* intergrade is not borne out by the Surat Basin material, which includes only specimens matching the holotype; no specimens comparable to the paratype have been found. The description of *clavus* here presented is therefore more restricted than Filatoff's description in that it includes only spores which display the typically fractured circumpolar ridge as shown by the holotype.

Dettmann (1963, pl. 14, figs. 5-8) illustrated under the name *clavus* cingulate spores from the southeastern Australian Cretaceous which do not convincingly show such a ridge; her specimens seem to be closer to *Stereisporites* Pflug. McKellar (1974) also identified as cf. *clavus* specimens reminiscent of *Stereisporites* from the Jurassic of southeastern Queensland.

The genera *Sphagnites* Cookson, which Potonié (1956) says is a junior synonym of *Sphagnumsporites* Raatz, and *Cingutriletes* Pierce emend. Dettmann, which in Potonié's (1966) opinion is a junior synonym of *Murospora* Somers, both lack this distal circumpolar ridge. *Annulispora* De Jersey, 1959 emend. McKellar, 1974, incorporates azonate to cingulate spores in which the distal ridge is smooth and uninterrupted.

Polycingulatisporites densatus (De Jersey) Playford & Dettmann
Pl. 12, fig. 7

1959 *Annulispora densata* De Jersey, pp. 358, 359, pl. 2, figs. 3, 4
1965 *Polycingulatisporites densatus* (De Jersey) Playford & Dettmann p. 145, pl. 14, figs. 28, 29

Distribution: A common species in Lower and Middle Jurassic sediments of eastern Australia (De Jersey, 1969; Playford & Dettmann, 1965; Reiser & Williams, 1969; various informal reports on the Great Artesian Basin). Present in low numbers (reworked?) in many Early Cretaceous microfloras from the Surat and Eromanga Basins.

Genus **Stereisporites** Pflug, in Thomson & Pflug, 1953

Type series (by original designation): *Stereisporites* (al. *Sporites*) *stereoides* (Potonié & Venitz, 1934) Pflug, in Thomson & Pflug, 1953; Late Tertiary, Germany.
Remarks: For a list of synonymous genera see Krutzsch, 1963, p. 9.

Stereisporites antiquasporites (Wilson & Webster) Dettmann
Pl. 12, figs. 9-12

1946 *Sphagnum antiquasporites* Wilson & Webster, p. 273, fig. 2
1956 *Sphagnumsporites antiquasporites* (Wilson & Webster) Potonié, p. 17
1963 *Stereisporites antiquasporites* (Wilson & Webster) Dettmann, p. 25, pl. 1, figs. 20, 21

Description: Small, trilete, initially cingulate to azonate miospores. Amb circular to rounded triangular. Trilete mark simple, usually partly opened, laesurae straight and measuring about half to two-thirds of radius of spore. Exine about 0.5 μm thick, psilate, in many specimens thickened at equator to 1-2.5 μm. Cingulum often slightly wider in the radial regions. Distal exine weakly thickened in an area 4-8 μm in diameter, approximately coinciding with the distal pole, and in some specimens divided into three separate 'verrucae' opposite the proximal interlaesurate areas.

Dimensions: Equatorial diameter (37 specimens) 15-(22)-28 μm.

Distribution: A common species in the Late Mesozoic of the Australian region. Common to abundant in the microfloras from the Surat Basin.

Comments: The type species *S. stereoides* (Potonié & Venitz) includes both azonate and weakly cingulate spores; the holotype appears to be azonate (see Dettmann, 1963, p. 25: Remarks). Wilson & Webster (1946) described *S. antiquasporites* as 'structurally similar to those of modern species' (i.e. of *Sphagnum*), hence cingulate. Similar spores are found globally in Mesozoic and Tertiary sediments, and the various genera and subgenera to which many authors allocated these spores are undoubtedly to a large extent synonymous. It is clear from the literature that in the fossil material the distinction between cingulate and azonate spores cannot be drawn sharply (see, for instance, Krutzsch, 1963). Dettmann (op. cit.) described the specimens from southeastern Australia as auriculate on account of the presence of slight exine thickenings in the equatorial radial regions. Similar thickenings were also observed in the cingulate spores from the Surat Basin, but in many specimens they occur only in one or two of these regions. Consequently, the species *antiquasporites* is here interpreted as including spores of each of the azonate, auriculate, and cingulate varieties.

Stereisporites pocockii sp. nov.
Pl. 12, figs. 14-17

Holotype: BMR Roma 9, depth 30.5 m (100 ft 2 in); Wallumbilla Formation, Coreena Member. Cretaceous, early Albian (MFP 4615-2, 315/1167; CPC 16195. Pl. 12, fig. 17).

Description: Small to medium-sized, trilete, cingulate miospores. Trilete mark inconspicuous, laesurae straight, simple, variable in length. Exine psilate, at proximal and distal sides thin, 0.5 μm or less, widening at equator into a cingulum of 4-9 μm wide, either smooth or with radial lineation, in cross-section wedge-shaped and narrowing at the point of contact with the spore body. Exine in many specimens weakly thickened in a small, circular to triangular area at or near distal pole. Area of thickening in some specimens divided into three closely spaced 'verrucae' located opposite the proximal interlaesurate regions.

Dimensions: Overall equatorial diameter (14 specimens) 29-(34)-40 μm.

Distribution: An uncommon species in many Early Cretaceous assemblages from the Surat and Eromanga Basins. Hedlund (1966) described similar forms as *Cingulatisporites* cf. *C. levispeciosus* Pflug from the Cenomanian of Oklahoma, USA.

Comments: In discussing the genus *Cingulatisporites* Pflug, Pocock (1961) proposed to restrict this genus to forms in which the cingulum has the typical spear-head shape in cross-section which is developed in *S. pocockii* sp. nov. Krutzsch (1963), however, who reexamined *Cingulatisporites,* found the holotype of the type species *C. levispeciosus* Pflug to be azonate (Thomson & Pflug, 1953, pl. 1, fig. 16; also Krutzsch, 1963, fig. 5a). He therefore incorporated *Cingulatisporites* sensu Pocock into the genus *Stereisporites*. I agree with Krutzsch (see the comments to *S. antiquasporites*), and the species *pocockii* sp. nov. is here assigned to *Stereisporites*.

S. pocockii sp. nov. is larger and has a wider cingulum than *antiquasporites*. Some species of *S.* subgenus *Distverrusporis* Krutzsch, 1963, are comparable to *S. pocockii* but have a more or less distinctly punctate exine.

Genus **Foraminisporis** Krutzsch, 1959

Type species (by original designation): *Foraminisporis foraminis* Krutzsch, 1959; Eocene, Germany.

Foraminisporis dailyi (Cookson & Dettmann) Dettmann
Pl. 13, figs. 5-7

1958a *Granulatisporites dailyi* Cookson & Dettmann, p. 99, pl. 14, figs. 2-4
1963 *Foraminisporis dailyi* (Cookson & Dettmann) Dettmann, p. 72, pl. 14, figs. 15-18

Dimensions: Equatorial diameter (29 specimens) 31-(45)-54 μm.

Distribution: An uncommon species in many Early Cretaceous assemblages from the Surat Basin. Widely distributed in the Early Cretaceous of southeastern Australia. Not observed in the Cenomanian of Bathurst Island.

Foraminisporis asymmetricus (Cookson & Dettmann) Dettmann
Pl. 13, figs. 3, 4

1958a *Apiculatisporis asymmetricus* Cookson & Dettmann, p. 100, pl. 14, figs. 11, 12
1963 *Foraminisporis asymmetricus* (Cookson & Dettmann) Dettmann, p. 72, pl. 16, figs. 15-19

Dimensions: Equatorial diameter (36 specimens) 32-(42)-65 μm.

Distribution: An uncommon species in the uppermost interval of the *Murospora florida* Zone, the *Osmundacidites dubius* Zone, the *Crybelosporites striatus* Zone, and the *Coptospora paradoxa* Zone. Dettmann & Playford (1969) recorded the species from the *Dictyotosporites speciosus* Zone, *Coptospora paradoxa* Zone, and *Phimopollenites* (*Tricolpites*) *pannosus* Zone of southeastern Australia. The species also occurs in Cenomanian sediments on Bathurst Island.

Foraminisporis wonthaggiensis (Cookson & Dettmann) Dettmann
Pl. 13, figs. 1, 2

1958a *Apiculatisporis wonthaggiensis* Cookson & Dettmann, p. 100, pl. 14, figs. 7-10
1963 *Foraminisporis wonthaggiensis* (Cookson & Dettmann) Dettmann, p. 71, pl. 14, figs. 19-23

Dimensions: Equatorial diameter (26 specimens) 26-(41)-52 μm.

Distribution: A rare species in most of the late Neocomian to Albian microfloras from the Surat Basin. Present in the Early Cretaceous of southeastern Australia, and the Cenomanian of Bathurst Island. Lantz (1958) described comparable forms from the Purbeck of France as *Osmundacidites hirtus*.

Genus **Contignisporites** Dettmann, 1963

Type species (by original designation): *Contignisporites glebulentus* Dettmann, 1963; Early Cretaceous, South Australia.

Contignisporites cooksonae (Balme) Dettmann
Pl. 13, fig. 10

1957 *Cicatricosisporites cooksonii* Balme, p. 19, pl. 1, figs. 23, 24, pl. 2, figs. 25, 26
1961 *Anemia cooksonii* (Balme) Bolchovitina, p. 59, pl. 17, figs. 6b-e
1963 *Contignisporites cooksoni* (Balme) Dettmann, p. 75, pl. 15, figs. 11-16

Dimensions: Ribs on distal exine 3-5 μm wide, intervening grooves 1-2 μm wide. Four ribs and adjacent grooves measure 15-26 μm in width; number of distal ribs 6-9. Overall equatorial diameter (12 specimens) 35-64 μm.

Distribution: An uncommon species in many Late Jurassic and Neocomian microfloras from the Great Artesian Basin, and sporadic in the Aptian and Albian. Specimens present in the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone are possibly of secondary (recycled) origin; Dettmann & Playford (1969) recorded the species only from the *Crybelosporites stylosus* Zone (Neocomian) and the lower interval of the *Dictyotosporites speciosus* Zone (Neocomian-Aptian).

Contignisporites multimuratus Dettmann
Pl. 13, fig. 11

1963 *Contignisporites multimuratus* Dettmann, pp. 76-77, pl. 16, figs. 6-13

Dimensions: Striae on distal exine 1-2 μm wide, intervening grooves up to 1 μm wide. A set of 4 striae and adjacent grooves measures 8-20 μm in width. Number of distal ribs 11-17. Overall equatorial diameter (10 specimens) 34-72 μm.

Distribution: An uncommon species in the Early Cretaceous of the Surat Basin; rare in the Early Cretaceous of southeastern Australia.

Contignisporites cf. **C. fornicatus** Dettmann
Pl. 13, fig. 9

?1963 *Contignisporites fornicatus* Dettmann, p. 76, pl. 16, figs. 1-5

Dimensions: Distal exine with 6-10 striae, each 3-6 μm wide; intervening grooves 0.5-2 μm wide. A set of 4 ribs and adjoining grooves measures 16-23 μm in width. Proximal exine with one set of ribs, and additional verrucae irregularly distributed and confined to the proximal polar region. Cingulum 4-10 μm wide. Overall equatorial diameter (7 specimens) 42-62 μm.

Distribution: Burger (1973b, 1974) reported the species as *C. fornicatus* Dettmann from the *Murospora florida* Zone in the Surat and Eromanga Basins. Similar specimens are infrequently present in the *Osmundacidites dubius* Zone, *Crybelosporites striatus* Zone, and *Coptospora paradoxa* Zone.

Comments: In order to show how *Contignisporites* cf. *C. fornicatus* relates to other species of the genus, overall dimensions and statistical details of exine features of all species such as described from southeastern Australia are here compared.

	Equatorial diameter	Number of distal ribs	Width of ribs	Width of grooves	Proximal sculpture	Width of cingulum
C. fornicatus	42-62 μm	5-8	5-6 μm	2-3 μm	striae + verrucae	5-8 μm
C. glebulentus	59-78 μm	7-10	3-5 μm	1-2 μm	striae + verrucae	9-14 μm
C. multimuratus	58-76 μm	11-16	2-3 μm	2-3 μm	striae + verrucae	7-10 μm
C. cooksonae	39-59 μm	6-9	3.5-4.5 μm	1.5-2.5 μm	striae	4-7 μm
C. cf. *C. fornicatus*	42-62 μm	6-10	3-4 μm	0.5-2 μm	striae + verrucae	4-10 μm

The Surat Basin species apparently shares an equal number of these statistics with *C. glebulentus* Dettmann, 1963, and *C. fornicatus*. *C. glebulentus*, which is almost completely absent in the Surat Basin sequence, is considerably larger and has a broader cingulum (see Pl. 14, fig. 1), and for that reason the Surat Basin species is thought to be closer to *C. fornicatus*, which differs only in having broader distal ribs. Very few, isolated specimens of *fornicatus* have been found in the Surat Basin (see Pl. 13, fig. 8).

Suprasubturma Perinotriletes Erdtman, 1947 emend. Dettmann, 1963

Genus **Crybelosporites** Dettmann, 1963

Type species (by original designation): *Crybelosporites* (al. *Perotrilites*) *striatus* (Cookson & Dettmann, 1958b) Dettmann, 1963; Albian, South Australia.

Crybelosporites striatus (Cookson & Dettmann) Dettmann
Pl. 15, figs. 1-8; cf. Pl. 14, fig. 11

1958b *Perotrilites striatus* Cookson & Dettmann, p. 43, pl. 1, figs. 8-12
1963 *Crybelosporites striatus* (Cookson & Dettmann, p. 81, pl. 18, figs. 1-6

Dimensions: Equatorial diameter of inner sclerine layer (31 specimens) 24-(34)-42 μm, sculptine 2-5 μm thick, lumina of reticulum 2-4 μm across; overall polar dimensions (13 specimens) 38-56 μm.

Distribution: Present in low abundance in most assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone; a common species in most Albian preparations from the Eromanga Basin sequence; rare to common in the Albian of southeastern Australia. Dettmann & Playford (1969) recorded the species also from the early Late Cretaceous of Victoria.

Crybelosporites stylosus Dettmann
Pl. 14, figs. 2, 3

1963 *Crybelosporites stylosus* Dettmann, p. 82, pl. 18, figs. 12-20

Dimensions: Equatorial diameter of inner sclerine layer (6 specimens) 30-40 μm.

Distribution: A rare species in a number of Neocomian and early Aptian assemblages of the *Murospora florida* Zone and the *Osmundacidites dubius* Zone. Also present in Dettmann & Playford's (1969) *Crybelosporites stylosus* Zone, southeastern Australia.

Crybelosporites berberioides Burger
Pl. 14, figs. 4-6

1976 *Crybelosporites berberioides* Burger, p. 11, pl. 8, figs. 1-3; pl. 9, figs. 1, 2

Dimensions: Equatorial diameter of inner sclerine layer (16 specimens) 27-36 μm.

Distribution: A rare species in a number of assemblages of the *Murospora florida* Zone, the *Osmundacidites dubius* Zone, and the basal interval of the *Crybelosporites striatus* Zone.

Comments: Specimens of the species are almost invariably found still united in tetrads, which implies that the parent plant occurred in the vicinity of the location of burial.

Crybelosporites punctatus Dettmann
Pl. 14, figs. 7-10

1963 *Crybelosporites punctatus* Dettmann, p. 81, pl. 18, figs. 7-11

Dimensions: Equatorial diameter of inner sclerine layer (14 specimens) 33-43 μm, overall polar dimensions 46-62 μm.

Distribution: A rare species in a number of microfloras of the *Crybelosporites striatus* Zone and the *Coptospora paradoxa* Zone, and in the Albian-Cenomanian sequence of the Eromanga Basin. Dettmann reported the species from upper Aptian and Albian sediments of southeastern Australia.

Genus **Endoculeospora** Staplin, 1960

Type species (by original designation): *Endoculeospora rarigranulata* var. *rarigranulata* Staplin, 1960; Early Carboniferous (Mississippian), Alberta, Canada.

Endoculeospora delicata Burger
Pl. 15, fig. 9

1976 *Endoculeospora delicata* Burger, p. 10, pl. 6, figs. 2-6

Distribution: The species was initially described from the *Murospora florida* Zone in the Surat Basin; single specimens have also been recovered from the *Osmundacidites dubius* Zone. Two isolated specimens occurring in the succeeding (Albian) sequence are probably of secondary origin.

Genus **Velosporites** Hughes & Playford, 1961

Type species (by original designation): *Velosporites echinatus* Hughes & Playford, 1961; Early Carboniferous, Spitzbergen.

Velosporites triquetrus (Lantz) Dettmann
Pl. 15, figs. 10, 16

1958 *Laricoidites triquetrus* Lantz, p. 926, pl. 5, figs. 51-54
1963 *Velosporites triquetrus* (Lantz) Dettmann, pp. 82-83, pl. 19, figs. 1-3

Dimensions: Equatorial diameter of central cavity (18 specimens) 20-40 μm, overall equatorial dimensions (20 specimens) 40-(56)-80 μm.

Distribution: Present in low abundance in the *Murospora florida* Zone and *Osmundacidites dubius* Zone, and in some assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Dettmann reported the species as of infrequent occurrence in the Early Cretaceous of southeastern Australia. Lantz (1958) described the species from the Bathonian-Kimmeridgian of Britain.

Turma Monoletes Ibrahim, 1933

Suprasubturma Acavatomonoletes Dettmann, 1963

Subturma Azonomonoletes Luber, 1935

Infraturma Laevigatomonoleti Dybova & Jachowicz, 1957

Genus **Laevigatosporites** Ibrahim, 1933

Type species (by monotypy): *Laevigatosporites* (al. *Sporonites*) *vulgaris* (Ibrahim, in Potonié, Ibrahim & Loose, 1932) Ibrahim, 1933; Late Carboniferous, Germany.

Laevigatosporites ovatus Wilson & Webster
Pl. 15, fig. 13

1946 *Laevigatosporites ovatus* Wilson & Webster, p. 273, fig. 5

Distribution: A rare species in the *Crybelosporites striatus* Zone, more frequent in the *Coptospora paradoxa* Zone. Infrequent to common in the Late Albian sequence of the Eromanga and Carpentaria Basins, and common in the Cenomanian of Bathurst Island. Dettmann (1963) reported the species from the Albian of southeastern Australia.

Infraturma Apiculatomonoleti nov. cat.

Remarks: This category includes genera such as *Punctatosporites* Ibrahim, *Polypodiisporites* Potonié, *Polypodiidites* Ross, *Tuberculatosporites* Imgrund, and *Spinosporites* Alpern, all of which incorporate spores having discrete sculptural elements with approximately equidimensional basal projections. Monolete forms with elongate or negative sculptural elements (muri, rugulae, foveolae, etc.) are incorporated in Infraturma MURORNATOMONOLETI Burger, 1975.

Genus **Punctatosporites** Ibrahim, 1933

Type species (by monotypy): *Punctatosporites minutus* Ibrahim, 1933; Late Carboniferous, Germany.

Punctatosporites scabratus (Couper) Norris
Pl. 15, figs. 11, 12

1958 *Marattisporites scabratus* Couper, p. 133, pl. 15, fig. 20
1965 *Punctatosporites scabratus* (Couper) Norris, p. 248, figs. 34, 35
1971 *Punctatosporites scabratus* (Couper) Singh, p. 106, pl. 14, fig. 15

Description: see Norris, 1965, and Burger, 1976, p. 14.

Dimensions: Length of spore (30 specimens) 22-(27)-35 μm, polar diameter (23 specimens) 14-25 μm.

Distribution: Present in low numbers in many Jurassic and Early Cretaceous assemblages from the Great Artesian Basin.

Genus **Tuberculatosporites** Imgrund, 1952

Type species (by original designation): *Tuberculatosporites anicystoides* Imgrund, 1952; Early Permian, China.

Tuberculatosporites sp. A
Pl. 15, figs. 14, 15

Description: Small, bean-shaped azonate, monolete miospores. Tetrad mark simple, 10-21 μm long. Exine exclusive of sculpture about 1 μm thick. Sculptural elements irregularly scattered on distal and equatorial areas of exine, reduced in size or absent next to laesura. Elements variable, small bacula and spines 0.5-1.5 μm high predominate, with circular to oval basal projection 0.5-1.4 μm diameter. Larger verrucae up to 2 μm basal diameter are occasionally present in distal and equatorial regions.

Dimensions: Length of spore (12 specimens) 21-34 μm, polar dimensions (6 specimens) 15-20μm.

Distribution: A rare species in some assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone.

Comments: Although the species appears to have a restricted stratigraphic occurrence and is therefore a potentially significant marker fossil, more specimens must be examined before it can be formally designated a new species. The specimens so far recovered differ from other apiculate monolete forms by their relatively small overall dimensions and small sculptural elements. According to Imgrund (1960) the type species *T. anicystoides* incorporates larger (30-50 μm) spores with a spinose ornament ('Coni bis Spinae').

Turma HILATES Dettmann, 1963

Genus **Coptospora** Dettmann, 1963

Type species (by original designation: *Coptospora striata* Dettmann, 1963; Albian, South Australia.

Coptospora paradoxa (Cookson & Dettmann) Dettmann
Pl. 16, figs. 1, 2

1958a *Cingulatisporites paradoxus* Cookson & Dettmann, p. 100, pl. 17, figs. 9-13
1963 *Coptospora paradoxa* (Cookson & Dettmann) Dettmann, p. 89, pl. 21, figs. 1-7

Dimensions: Equatorial diameter (21 specimens) 44-(55)-60 μm.

Distribution: Present in low abundance in almost every preparation of the *Coptospora paradoxa* Zone in the Surat Basin, and in many assemblages from upper Albian sediments of the Eromanga Basin; not observed in the Cenomanian of Bathurst Island. Dettmann (1963) and Dettmann & Playford (1969) reported the species from the *Coptospora paradoxa* Zone and *Tricolpites pannosus* Zone in southeastern Australia.

Genus **Aequitriradites** Delcourt & Sprumont, 1955 emend. Cookson & Dettmann, 1961

Type species (by original designation): *Aequitriradites dubius* Delcourt & Sprumont 1955 emend. Delcourt, Dettmann & Hughes, 1963; Early Cretaceous, Belgium.

Aequitriradites spinulosus (Cookson & Dettmann) Cookson & Dettmann
Pl. 16, fig. 5

1958a *Cirratriradites spinulosus* Cookson & Dettmann, p. 113, pl. 18, figs. 9-13, pl. 19, figs. 1, 2, 5-7
1961 *Aequitriradites spinulosus* (Cookson & Dettmann) Cookson & Dettmann, p. 427, pl. 52, figs. 7-12

Dimensions: Equatorial diameter of central cavity (14 specimens) 32-46 μm, equatorial diameter of spore (13 specimens) 43-70 μm.

Distribution: A rare species in the Early Cretaceous of the Surat Basin; not observed in the Cenomanian of Bathurst Island. Cookson & Dettmann (1958a) and Dettmann (1963) reported the species from the Early Cretaceous of southeastern Australia but they did not observe it in the interval of the *Crybelosporites stylosus* Zone.

Aequitriradites verrucosus (Cookson & Dettmann) Cookson & Dettmann
Pl. 16, figs. 3, 4

1958a *Cirratriradites verrucosus* Cookson & Dettmann, p. 112, pl. 18, figs. 2-6
1961 *Aequitriradites verrucosus* (Cookson & Dettmann) Cookson & Dettmann, p. 427, pl. 52, figs. 1-6

Description: see Dettmann, 1963, p. 92.

Dimensions: Equatorial diameter of central cavity (8 specimens) 34-60 μm, equatorial diameter of spore (7 specimens) 40-70 μm.

Distribution: A rare species in the *Murospora florida* Zone. Single specimens are also present (recycled?) in the *Osmundacidites dubius* Zone, *Crybelosporites striatus* Zone, and *Coptospora paradoxa* Zone. Not observed in the Cenomanian of Bathurst Island. Dettmann (1963) described the species from the Early Cretaceous of southeastern Australia.

Aequitriradites sp. A
Pl. 16, fig. 6

Description: Medium-sized miospores with a proximo-distally compressed body and a thin, poorly preserved, sparsely granulate zona of which the outer rim is smooth to finely crenulate. Amb approximately circular. Exine of body 1.5-2 μm thick, densely and evenly covered with spines and bacula spaced 0.5-3 μm apart, 0.5 μm in basal cross-section and 0.5-2 μm high. Smaller sculptural elements, grana or microverrucae, occur in the equatorial regions. An aperture—hilum, break-down of the exine, or tetrad mark—has not been observed.

Dimensions: Diameter of spore cavity (7 specimens) 36-49 μm, zone 5-12 μm wide.

Distribution: A rare species in a number of assemblages of the *Coptospora paradoxa* Zone.

Comments: This type of spore appears to have stratigraphic significance, but the number of specimens available was insufficient for the formal institution of a new species. Unlike other species of *Aequitriradites,* the Surat Basin specimens have a sculpture evenly distributed and uniform on both faces of the spore. They superficially resemble *Vallizonosporites vallifoveatus* Döring, 1964, but have an apiculate and not foveo-reticulate sculpture. They differ from species of *Hymenozonotriletes* Naumova, 1939, in lacking a triradiate mark.

Genus **Triporoletes** Mtchedlishvili, 1960 emend. Playford, 1971

Type species (by monotypy): *Triporoletes singularis* Mtchedlishvili, in Mtchedlishvili & Samoilovich, 1960; Cretaceous, USSR.

Triporoletes simplex (Cookson & Dettmann) Playford
Pl. 17, figs. 1, 2, 5

1958a *Cingulatisporites simplex* Cookson & Dettmann, p. 110, pl. 17, figs. 7, 8
1963 *Rouseisporites simplex* (Cookson & Dettmann) Dettmann, pp. 97-98, pl. 23, figs. 10-12
1971 *Triporoletes simplex* (Cookson & Dettmann), Playford, p. 552, pl. 106, fig. 2

Dimensions: Equatorial diameter of central body (21 specimens) 37-(48)-56 μm, zona 2-4 μm wide.

Distribution: A rare species in a number of assemblages from the Surat Basin, and in the Early Cretaceous of southeastern Australia.

Triporoletes radiatus (Dettmann) Playford
Pl. 16, figs. 7-9; cf. Pl. 17, fig. 3

1963 *Rouseisporites radiatus* Dettmann, p. 98, pl. 23, figs. 13-17

1971 *Triporoletes radiatus* (Dettmann) Playford, p. 552, pl. 106, figs. 3, 4

Dimensions: Equatorial diameter of central body (14 specimens) 38-56 μm, zona 2-4 μm wide.

Distribution: A rare species in some assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Dettmann (1963) reported the species from the Albian of southeastern Australia.

Triporoletes cf. **T. laevigatus** (Pocock) Playford
Pl. 16, figs. 10, 11

?1962 *Rouseisporites laevigatus* Pocock, pp. 53-54, pl. 7, figs. 106-109
?1971 *Triporoletes laevigatus* (Pocock) Playford, p. 552

Dimensions: Overall equatorial diameter (6 specimens) 38-56 μm.

Distribution: Single specimens have been found in a few preparations of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Specimens attributed to the species are infrequently present in the Cenomanian of Bathurst Island.

Comments: The Surat Basin specimens are compared with *T. laevigatus* as they display anastomosing exine ridges (folds) without preferred orientation which enclose shallow lumina of various shapes and dimensions; they lack the pronounced radially oriented ridges of *T. simplex* (Cookson & Dettmann) and *T. radiatus* (Dettmann).

Anteturma Pollenites Potonié, 1931

'Division' Saccates Erdtman, 1947

Genus **Callialasporites** Dev, 1961 emend. Potonié, 1966

Type species (by original designation): *Callialasporites* (al. *Zonalapollenites*) *trilobatus* (Balme, 1957) Dev, 1961; Late Jurassic, Western Australia.

Callialasporites dampieri (Balme) Dev
Pl. 17, figs. 6, 7

1957 *Zonalapollenites dampieri* Balme, p. 32, pl. 8, figs. 88-90
1961 *Callialasporites dampieri* (Balme) Dev, p. 48, pl. 4, figs. 26, 27

Distribution: Common to infrequent in Jurassic and Lower Cretaceous sediments of the Australian region; not observed in situ in the Cenomanian of Bathurst Island.

Genus **Alisporites** Daugherty, 1941 emend. Jansonius, 1971

Type species (by monotypy): *Alisporites opii* Daugherty, 1941; Triassic, Arizona, USA.

Alisporites similis (Balme) Dettmann
Pl. 17, figs. 9, 10

1957 *Pityosporites similis* Balme, p. 36, pl. 10, figs. 108, 109
1963 *Alisporites similis* (Balme) Dettmann, p. 102, pl. 25, figs. 5-7

Distribution: Widespread in the Jurassic and Early Cretaceous of Australia and Papua New Guinea; sporadically present in the Cenomanian of Bathurst Island.

Alisporites grandis (Cookson) Dettmann
Pl. 17, figs. 8, 12

1953 *Disaccites grandis* Cookson, p. 471, pl. 2, fig. 41
1963 *Alisporites grandis* (Cookson) Dettmann, p. 102, pl. 25, figs. 1-4

Distribution: A rare species in the Jurassic of Queensland; common to infrequent in the Early Cretaceous of eastern Australia; sporadically present in the Cenomanian of Bathurst Island.

Genus **Vitreisporites** Leschik, 1955 emend. Jansonius, 1962

Type species (by original designation): *Vitreisporites signatus* Leschik, 1955; Triassic, Switzerland.

Vitreisporites pallidus (Reissinger) Nilsson
Pl. 17, fig. 11

1950 *Pityopollenites pallidus* Reissinger, p. 109, pl. 15, figs. 1-5
1958 *Caytonipollenites pallidus* (Reissinger) Couper, p. 150, pl. 26, figs. 7, 8
1958 *Vitreisporites pallidus* (Reissinger) Nilsson, p. 78, pl. 7, figs. 12-14

Distribution: A common species in the Mesozoic of the Australian region.

Genus **Podocarpidites** Cookson, 1947 ex Couper, 1953 emend. Potonié, 1958

Type species (designated by Couper, 1953): *Podocarpidites ellipticus* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Podocarpidites ellipticus Cookson
Pl. 18, figs. 1, 2

1947 *Podocarpidites elliptica* Cookson, pp. 131-132, pl. 13, figs. 5-7

Distribution: A rare to uncommon species in many Late Jurassic and Early Cretaceous microfloras from the Australian region. Comparable specimens occur in some Cenomanian microfloras from Bathurst Island.

Podocarpidites multesimus (Bolchovitina) Pocock
Pl. 18, fig. 3

1956 *Podocarpus multesima* Bolchovitina, p. 127 pl. 24, fig. 235
1962 *Podocarpidites multesimus* (Bolchovitina) Pocock, p. 67, pl. 10, figs. 161, 162; pl. 11, fig. 163

Distribution: A rare species in the Late Jurassic and Early Cretaceous of eastern Australia. Present in the Early Cretaceous of the Viliuisk Basin, USSR, and western Canada.

Genus **Rugubivesiculites** Pierce, 1961

Type species (by original designation): *Rugubivesiculites convolutus* Pierce, 1961; Late Cretaceous, Minnesota, USA.

Rugubivesiculites sp. A
Pl. 18, figs. 4-6

Description: Bisaccate pollen grains, central corpus ovoid, 32-45 μm long, exine proximally outside area of roots and sacci rugulate, maximum thickness 1.5-4 μm, distally in sulcal area thin, faintly granulate. Sacci spherical, commonly crumpled, height 15-28 μm, maximum width 24-54 μm, narrower at contact with main corpus.

Dimensions: Length of 2 specimens 48, 60 μm.

Distribution: A rare species in a number of microfloras of the *Coptospora paradoxa* Zone. Occasionally present in younger Albian sediments of the Eromanga Basin, and in the Cenomanian of Bathurst Island.

Comments: As both corpus and sacci of this type of pollen have extremely thin walls, specimens were commonly found crumpled or otherwise distorted. No satisfactory description or illustration can be given at present, and the above-mentioned measurements were taken from only 15 specimens. However, the species is easily distinguished from the other bisaccate forms present in the assemblages by its rugulate proximal cap.

Genus **Microcachryidites** Cookson, 1947 ex Couper, 1953

Type species (designated by Couper, 1953): *Microcachryidites antarcticus* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Microcachryidites antarcticus Cookson
Pl 18, figs. 7-9

1947 *Microcachryidites antarcticus* Cookson, p. 132, pl. 14, fig. 19

Distribution: In moderate to high numbers in many Early Cretaceous microfloras from the Great Artesian Basin, and in the Cenomanian of Bathurst Island. Widely distributed in the Late Mesozoic elsewhere in Australia.

Genus **Trisaccites** Cookson & Pike, 1954

Type species (by monotypy): *Trisaccites* (al. *Dacrydium*) *microsaccatus* (Couper, 1953) Couper, 1960 (= *Trisaccites micropterus* Cookson & Pike, 1954); Late Cretaceous, New Zealand.

Trisaccites microsaccatus (Couper) Couper
Pl. 18, figs. 10-12, 14

1953 *Dacrydium microsaccatum* Couper, p. 35, pl. 4, fig. 30
1954 *Trisaccites micropterus* Cookson & Pike, pl. 64, pl. 2, figs. 21-29
1960 *Trisaccites microsaccatus* (Couper) Couper, p. 46, pl. 104, figs. 12, 13
1963 *Podosporites microsaccatus* (Couper) Dettmann, p. 104, pl. 26, figs. 6, 7

Distribution: An inconspicuous form in many Late Jurassic and Early Cretaceous microfloras from Australia and Papua New Guinea, and in the Early Tertiary of southeastern Australia (Cookson & Pike, 1954).

Turma INAPERTURATES, KRYPTAPERTURATES Iversen & Troels-Smith, 1950; Potonié, 1970

Genus **Araucariacites** Cookson, 1947 ex Couper, 1953

Type species (designated by Couper, 1953): *Araucariacites australis* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Araucariacites australis Cookson
Pl. 17, fig. 4

1947 *Araucariacites australis* Cookson, p. 130, pl. 13, figs. 1-4

Distribution: Common to infrequent in the *Murospora florida* Zone, infrequent to rare in the *Osmundacidites dubius* Zone and *Crybelosporites striatus* Zone. Also present in Cretaceous microfloras elsewhere in Australia.

Turma MONOPORINES Naumova, 1939

Genus **Classopollis** Pflug, 1953 emend. Pocock & Jansonius, 1961 emend. Reyre, 1970

Type species (by original designation): *Classopollis classoides* Pflug, 1953; Early Jurassic (Lias); Germany.

Classopollis cf. **C. chateaunovi** Reyre
Pl. 18, figs. 13, 15-17

?1970 *Classopollis chateaunovi* Reyre, p. 313, pl. 55, figs. 11-14

Description: see Reyre, 1970; De Jersey, 1973, p. 129.

Dimensions: Equatorial diameter (6 specimens) 26-43 μm.

Distribution: A rare species in the Early Cretaceous palynosequence of the Surat Basin. De Jersey (1973) described similar spores from the Early Jurassic of Queensland. Burger (1975) reported comparable specimens as *C. simplex* (Danzé-Corsin & Laveine) Reiser & Williams, 1969, from the Cenomanian of Bathurst Island.

Comments: Reyre (1970) reviewed the genus *Classopollis* and described a number of new species from the Sahara, France, and Israel, based on exine surface features which were revealed by scanning electron microscope study. The scarce material recovered from the Cretaceous of the Surat Basin does not lend itself to proper taxonomic and systematic treatment; the specimens examined cannot be compared accurately with Reyre's detailed specific descriptions but they are closely comparable to pollen grains which De Jersey (1973) recovered from the Early Jurassic of Queensland and described as *C. chateaunovi;* the Surat Basin specimens, however, have small, sparsely distributed grana which *chateaunovi* appears to lack.

Turma Polyplicates Erdtman, 1952

Genus **Ephedripites** Bolchovitina, 1953

Type species (by original designation): *Ephedripites mediolobatus* Bolchovitina, 1953; Cretaceous, Central USSR.

Ephedripites multicostatus Brenner
Pl. 19, fig. 1

1963 *Ephedripites multicostatus* Brenner, p. 90, pl. 38, figs. 1, 2

1967 *Equisetosporites multicostatus* (Brenner) Norris, p. 105, pl. 16, fig. 15

Description: Shape elongated ellipsoidal with rounded ends. Exine 0.5-1 μm thick, with about 20 straight costae 1-1.5 μm wide, parallel to long axis of grain; intervening grooves shallow, smooth-edged, 0.5-1.5 μm wide, gradually narrowing and fading away near the ends, where the exine is psilate. No colpi, other apertures, or exine fractures observed.

Dimensions: Length (11 specimens) 37-56 μm, maximum width 17-22 μm.

Distribution: Brenner described the species as a rare element in the Aptian and Albian of Maryland. Norris (1967) recorded the species from the Albian-?Cenomanian of Alberta, Canada. In the Surat Basin it occurs in a number of assemblages of the *Coptospora paradoxa* Zone, and in the Eromanga Basin it is a rare form in the late Albian pollen sequence.

Comments: The species is distinguished from other types of the genus by the relatively large number of straight-running costae. The specimens from the Surat Basin are slightly larger than, but otherwise equal to, those from Maryland.

Turma Monosulcates, Monocolpates Erdtman, 1952

Genus **Monosulcites** Cookson, 1947 ex Couper, 1953

Type species (designated by Couper, 1953): *Monosulcites minimus* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Monosulcites minimus Cookson
Pl. 19, figs. 5, 6

1947 *Monosulcites minimus* Cookson, pp. 134-135, pl. 15, fig. 48

Distribution: Widely spread in the Late Mesozoic of the Australian region. In low numbers present in most Early Cretaceous assemblages from the Surat Basin.

Genus **Clavatipollenites** Couper, 1958

Type species (by original designation): *Clavatipollenites hughesii* Couper, 1958; Early Cretaceous (Wealden), Britain.

Remarks: Monosulcate pollen grains with a retipilate, semitectate exine structure, such as found in *Liliacidites* Couper, 1953, and *Clavatipollenites* Couper, 1958, are common elements in eastern Australian Albian and Cenomanian microfloras. Generic assignment of this type of pollen has presented some difficulties, as it was not clear from their original diagnoses how these genera should be separated on morphological grounds.

This question has been discussed in some detail by Dettmann (1973) and Laing (1975). In her study of mid-Cretaceous angiosperm pollen from eastern and northern Australia Dettmann described specimens from the Northern Territory, closely comparable to *Liliacidites kaitangataensis* Couper, 1953 (type species of the genus), with a differentially thickened exine and a sulcus which is clearly developed in both nexine and sexine. She also retrieved monosulcate forms which she assigned to *Clavatipollenites*. These forms exhibit different sulcal characteristics and have an exine of uniform thickness. The sulcus is always present in the nexine but rarely in the sexine; the sexine may be entire or broken down in an irregular area broadly corresponding to the nexine sulcus. These differences provided a distinct morphological basis on which to separate *Clavatipollenites* from *Liliacidites*. Dettmann thus reformulated the generic characteristics of *Clavatipollenites*; she believed that the Australian specimens were probably conspecific with the type species *C. hughesii*.

Laing (1975) rejected Dettmann's grounds for separation of the two genera. He argued that presence or absence of differential exine thickening is of insufficient importance to justify the distinction of two genera. Also, in his opinion, the sulcus in the holotype of *C. hughesii* is developed in both sexine and nexine, as in *Liliacidites*, and consequently he placed *Clavatipollenites* into junior synonymy with *Liliacidites*.

Although there is some truth in Laing's argument regarding the exine thickness, it is clear from other studies that the sulcal properties of *C. hughesii* needed closer scrutiny. In her study of type material of *C. hughesii* from the Kingsclere Borehole, Kemp (1968) explicitly mentioned the often ragged appearance of the sulcus margin. This is also a characteristic feature of the specimens which Dettmann attributed to *Clavatipollenites*. The nature of the sexine breakdown observed in the Australian specimens is clearly that of a rupture, in contrast with the long, narrow, lancet-shaped sulcus which has been seen in sporadic specimens from the Surat Basin stripped of the sexinous layer. Remains of the columellate structure may be preserved in the area of sexine breakdown, partly covering the nexine sulcus. This is clearly shown in Dettmann's illustrations, and in the specimens here illustrated in Plate 19, figs. 7, 8, and 13. In compressed or deflated specimens, however, the appearance of the sulcus is often misleading; under oil immersion individual columellae can be seen in side projection near the margin, indicating that the exine curves slightly inwards, thus hiding the edge of the sulcus from view. Judging by the illustrations (see Couper, 1958, pl. 31, figs. 21, 22; Laing, 1976, pl. 1, fig. A) this might also be the case in the holotype of *hughesii*; unfortunately, Laing does not elaborate on this detail. However, re-examination of material from the type locality with the scanning electron microscope is under way (Laing, pers. comm.).

A similar study by Doyle, Campo & Lugardon (1975) on Early Cretaceous *Clavatipollenites* from the USA has demonstrated the presence of a sulcal membrane, built up of tectal and columellate elements supported by a 'footlayer' (= exonexine). This footlayer is supported by the 'endexine' (= endonexine) whose inner surface carries baculate/clavate rods which point inwards towards the centre of the pollen cavity, and seem to be absent outside the sulcal area.

At the present time Dettmann's criteria for separating *Clavatipollenites* and *Liliacidites,* and her concept of the former genus, are adhered to in this paper. In Kemp's opinion (pers. comm.) the Surat Basin specimens are essentially similar to the British representatives of *hughesii,* so there appears to be no reason to accommodate them into a new species.

Clavatipollenites hughesii Couper
Pl. 19, figs. 7-9, 13, 14

1958 *Clavatipollenites hughesii* Couper, p. 159, pl. 31, figs. 21, 22
1973 *Clavatipollenites* sp. Dettmann, p. 11, pl. 2, figs. 8-10

Dimensions: Length (69 specimens) 18-(25)-39 μm, width in equatorial plane 15-(21)-33 μm. Diameter of lumina 0.4-0.9 μm, average 0.5 μm.

Distribution: A rare to common species in the assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Present in the Albian and Cenomanian elsewhere in eastern and northern Australia (Dettmann, 1973; Burger, 1975).

Comments: The sexine is often but not always broken down at the location of the sulcus. The area of breakdown may be wide or narrow, according to the degree of compression of the specimens, with smooth or ragged edges, and may be covered by more or less cohesive remnants of the columellate structure. The specimens which Dettmann (1973) described from the Albian-Cenomanian of eastern Australia concur in all aspects with those from the Surat Basin; their length varies between 17 and 26 μm (average 20 μm).

Clavatipollenites sp. A
Pl. 19, fig. 10

Description: Small to medium-sized monosulcate pollen grains; shape almost spherical or prolate with pointed or rounded ends. Exine relatively thin, two-layered, 1-2 μm thick; sexine consists of minute columellae with slightly expanded capita which are connected by tiny 'bridges' enclosing lumina less than 0.3 μm in diameter. Sulcus apparent as an area of breakdown of the sexine, with smooth to ragged edges.

Dimensions: Length (15 specimens) 20-33 μm, width in equatorial plane 16-29 μm.

Distribution: A rare species in some assemblages of the *Crybelosporites striatus* Zone and the *Coptospora paradoxa* Zone.

Comments: The specimens here designated as *Clavatipollenites* sp. A are comparable with *C. hughesii* in general shape and type of sulcus, but have a finer retipilate structure; the individual columellae are visible only under oil immersion with magnifications over 1500x. Although no special mention of this type is made in the literature consulted it may well have been observed elsewhere and registered as *C. hughesii.*

Genus **Liliacidites** Couper, 1953

Type species (by original designation): *Liliacidites kaitangataensis* Couper, 1953; Late Cretaceous, New Zealand.

Remarks: Some of the preparations of the *Coptospora paradoxa* Zone contain sporadic specimens of a type not unlike *Clavatipollenites,* with a tectate, minutely reticulate exine, and a well-defined sulcus. These specimens are illustrated in Plate 19, figs. 11, 12. The specimen of Plate 19, fig. 12 shows differential spacing of the sexinous rods. These forms are recorded as *Liliacidites* spp. in this study, as they approximately correspond to Dettmann's (1973) concept of the genus.

Genus **Retimonocolpites** Pierce, 1961

Type species (by original designation): *Retimonocolpites dividuus* Pierce, 1961; Cenomanian, Minnesota, USA.

Retimonocolpites peroreticulatus (Brenner) Doyle
Pl. 19, fig. 18

1963 *Peromonolites peroreticulatus* Brenner, p. 94, pl. 41, fig. 1
1971 *Liliacidites peroreticulatus* (Brenner) Singh, p. 188, pl. 28, figs. 6-11
1975 *Retimonocolpites peroreticulatus* (Brenner) Doyle, in Doyle, Campo & Lugardon, p. 456, pl. 5, figs. 1-4, 9, 10

Dimensions: Length of central body (5 specimens) 16-32 μm, width 13-26 μm; overall length of one specimen 24 μm.

Distribution: Occasionally present in the *Coptospora paradoxa* Zone, and the late Albian of the Eromanga and Carpentaria Basins; common in the Cenomanian of Bathurst Island.

Genus **Concentrisporites** Wall, 1965 emend. Pocock, 1970

Type species (by original designation): *Concentrisporites* (al. *Equisetosporites*) *hallei* (Nilsson, 1958) Wall, 1965; Rhaetic, Sweden.

Concentrisporites hallei (Nilsson) Wall
Pl. 19, figs. 2-4

1958 *Equisetosporites hallei* Nilsson, p. 66, pl. 5, fig. 20
1965 *Concentrisporites hallei* (Nilsson) Wall, p. 166, pl. 9, fig. 13

Description: see Burger, 1976, pp. 15-16.

Distribution: Present in low numbers in many Early Cretaceous preparations from the Surat Basin; also in the Jurassic of Queensland (see Burger, op. cit.).

Turma TRI(TETRA-, PENTA-)CHOTOMOSULCATES Erdtman, 1945

Genus **Asteropollis** Hedlund & Norris, 1968

Type species (by original designation): *Asteropollis asteroides* Hedlund & Norris, 1968; Albian, Oklahoma, USA.

Asteropollis asteroides Hedlund & Norris
Pl. 19, figs. 15-17, 19, 20; Pl. 20, figs. 1-6, 8

1968 *Asteropollis asteroides* Hedlund & Norris, p. 153, pl. 7, fig. 2
?1969 *Utriculites visus* Chlonova, p. 58, pl. 13, figs. 3-5

Description: see Dettmann, 1973, pp. 17-18; Davies & Norris, 1976, pp. 138-140.

Dimensions: Exine 1.5-3 μm thick, mesh of surface reticulum under 0.5 μm; equatorial diameter (46 specimens) 22-(28)-34 μm.

Distribution: A rare to uncommon species in many assemblages of the *Crybelosporites striatus* Zone and *Coptospora paradoxa* Zone. Common in the Cenomanian of Bathurst Island. Dettmann (1973) recovered the species also from Cenomanian-Turonian sediments of the Otway Basin, Victoria. Chlonova (1969) described as *Utriculites visus* similar and very likely identical types from the Albian of eastern Siberia.

Comments: The specimens are mostly spherical, the aperture is restricted to one (the distal?) hemisphere, where it is observed in an array of shapes, depending on the differential breakdown of the sexinous layer. Nexinous aperture rarely with 3, usually with 4, and infrequently with 5 narrow, smooth-edged branches of varying length. In a number of specimens the sexine continues without interruption across the apertural branches and is somewhat modified by the presence of structural sexinous elements slightly coarser than average at the location of the aperture (Pl. 20, figs. 2, 4). In other specimens the sexine breaks down and is partly or wholly absent in 4 or 5 oval to circular areas. These areas are located sub-equatorially near the extremities of the apertural branches and are delineated by marginal sexinous elements apparently coarser than average (Pl. 19, fig. 20; Pl. 20, figs. 1, 3). In most specimens, however, the sexine is absent along the entire length of the apertural branches and has smooth to ragged edges (Pl. 19, figs. 16, 17; Pl. 20, fig. 6).

Recent scanning electron microscope study of the exine by Davies & Norris (1976) reveals a perfectly regular semitectate reticulum, supported by more or less irregular columellate elements implanted on a nexinous membrane. The inner surface of this membrane bears rugulate-vermiculate elevations. In some specimens the tectate reticulum continues across the aperture without interruption (Davies & Norris, pl. 3, fig. 2), and in other specimens columellae form clusters in the sulcal regions, their heads being fused into irregular tectate growths (their pl. 4, fig. 4).

Hedlund & Norris diagnosed the genus as to incorporate tetra- and pentachotomosculate forms, but Dettmann (1973) also included trichotomosulcate forms in *asteroides*. In the Surat Basin, specimens with three-branched apertures are much more common than in the Cenomanian microfloras from Bathurst Island; except for the aperture they are indistinguishable from the other types. It thus seems likely that trichotomosulcate forms reported from the mid-Cretaceous in other parts of the world could be synonymous to *asteroides*. These forms are:

Baculatisporites parvopunctatus Weyland & Greifeld, 1953 (p. 42, pl. 10, fig. 40); Late Cretaceous, Germany.

Apiculatisporites vulgaris Groot & Groot, 1962, pars (p. 155, pl. 6, figs. 4-8); Aptian to early Cenomanian, Portugal.

Liliacidites trichotomosulcates Singh, 1971 (p. 191, pl. 29, figs. 5-7); Albian, Alberta, Canada.

Porotrichotomosulcus clavatus Phillips, *in* Phillips & Felix, 1971 (pp. 471-472, pl. 16, figs. 15, 16); Albian, Louisiana, USA.

Turma TRICOLPATES Iversen & Troels-Smith, 1950

Genus **Tricolpites** Cookson, 1947 ex Couper, 1953 emend. Belsky, Boltenhagen & Potonié, 1965

Type species (designated by Couper, 1953): *Tricolpites reticulatus* Cookson, 1947; Tertiary, Kerguelen Archipelago.

Remarks: For additional comments on the group of tricolpate pollen grains see pp. 15 and 17.

Tricolpites variabilis Burger
Pl. 20, fig. 10

1970 *Tricolpites variabilis* Burger, p. 8, pl. 1, figs. 1, 4

Dimensions: Polar diameter (4 specimens) 26-30 μm, width at equator 17-22 μm.

Distribution: Single specimens of the species occur in a few assemblages of the *Coptospora paradoxa* Zone. The species is infrequently present in the late Albian of the Eromanga Basin and the Cenomanian of Bathurst Island. Dettmann (1973) described similar and possibly conspecific forms (see Burger, 1975) as *Tricolpites* sp. from the Cenomanian-Turonian of the Otway Basin.

Comments: The specimens recovered from the *Coptospora paradoxa* Zone have distinct nexinal-sexinal colpi with smooth, straight edges. There is no sign of the presence of an apertural membrane which typifies the representatives of the genus *Phimopollenites* Dettmann, 1973. The specimens are initially united in tetrahedral tetrads with the colpi arranged so as to meet two by two, a construction adopted by many Australian Early Cretaceous tricolpate forms (Dettmann, op. cit.).

The presence of the species in the *Coptospora paradoxa* Zone of the Surat Basin means that it appears earlier in the Cretaceous of Queensland than previously thought. Until now the earliest known tricolpate specimens were known from palynological unit K2b of the Eromanga Basin (Burger, 1970). However, that part of the sequence has been studied insufficiently in the Eromanga Basin, as it includes the Toolebuc Formation, from which very few palynomorphs have been recovered so far.

Genus **Rousea** Srivastava, 1969

Type species (by original designation): *Rousea subtilis* Srivastava, 1969; Maastrichtian, Canada.

Rousea georgensis (Brenner) Dettmann
Pl. 20, figs. 7, 9

1963 *Retitricolpites georgensis* Brenner, p. 91, pl. 38, fig. 6
1970 *Tricolpites georgensis* (Brenner) Burger, p. 7, pl. 3, figs. 2, 4
1973 *Rousea georgensis* (Brenner) Dettmann, p. 14, pl. 2, figs. 16, 17

Dimensions: Polar diameter (4 specimens) 24-31 μm, width at equator 18-22 μm; exine 1-2 μm thick.

Distribution: A rare species in the *Coptospora paradoxa* Zone, Surat Basin; infrequent in the *Phimopollenites pannosus* Zone and *Appendicisporites distocarinatus* Zone of Victoria and Queensland (Burger, 1970; Dettmann, 1973); infrequent in the Cenomanian of Victoria and Bathurst Island, Northern Territory (Dettmann, op. cit.). Also widely distributed in the Albian and Cenomanian of Canada and the USA.

Comments: The species is easily distinguished from other tricolpate reticulate forms in that its surface reticulum is usually reduced alongside the colpi and the polar areas.

2. SYSTEMATIC STUDY OF DINOFLAGELLATES

During the last two decades systematic studies probing into the resting life stage of modern dinoflagellates have given a new insight into the nature and origin of their fossil counterparts. As a result, systematic approach towards both fossil and Recent dinoflagellates is being re-appraised. Recently a number of workers have critically reviewed current approaches towards dinoflagellate classification, and commented with regret upon the lack of unifying principles on which these approaches are based. At the present time the subject is 'in a state of flux' (Davey & Verdier, 1971) because of the problems involved; many workers, apparently dissatisfied with existing procedures, avoid the subject altogether and use an alphabetical arrangement of cyst genera (Davey & Verdier, 1971; Lentin & Williams, 1973, 1977; and others).

Although descriptive literature on Australian Jurassic and Cretaceous dinoflagellates is considerable, no uniform principles have been worked out towards their suprageneric classification. Cookson and Eisenack, who described a large number of genera and species from this part of the world, grouped them into families (see below) under the Class Dinoflagellata. One of the aims of this study was to seek a classification for the fossils of the Surat Basin, based on well-defined principles, and consisting of a hierarchy of mutually exclusive suprageneric taxa. The principles underlying such an approach have been discussed by Dettmann (1963) and form the basis of her classification of fossil dispersed spores. The problems and possibilities of achieving such a system for dinoflagellates are here briefly reviewed.

Early taxonomic concepts

Fossil dinoflagellates have been known since 1838 and 1843, when C. G. Ehrenberg recognised and described 'peridiniacean' forms with two furrows occurring in Upper Cretaceous flints from Germany and Denmark. He also described spinose organisms (nowadays assigned to the fossil dinocyst genera *Hystrichosphaeridium, Spiniferites, Tenua, Oligosphaeridium,* and others) whose affinity he did not realise and which he placed into the genus 'Xanthidium'. It was not until 1905 that P. F. Reinsch established that these organisms also were fossil dinoflagellates.

In the period 1930-1960 peridiniacean dinoflagellates, 'hystrichospheres' and acritarchs were described from sediments ranging in age from early Cambrian to Miocene. Sarjeant (1961, 1974) and Sarjeant & Downie (1966) gave instructive reviews of the progress in taxonomic thinking during that period. Uncertainty as to the nature of the peridiniacean fossils is clearly expressed in their being incorporated either into the Plant Kingdom (Class Dinophycae Fritsch) or the Animal Kingdom (Class Dinoflagellata Buetschli), according to the author's preference. However, their internal classification posed no problems. Up to 1961 only five families based on fossil types had been established according to the rules of zoological nomenclature.

Difficulties arose from attempts after 1961 to put the growing number of fossil genera into some kind of order (Sarjeant & Downie, 1966; Wall & Dale, 1968a). As the idea gradually gained ground that the fossils represented dinoflagellate cysts (Downie, Williams & Sarjeant, 1961) new classificatory procedures were developed conforming to the rules of the International Code of Botanical Nomenclature (see Sarjeant & Downie, 1966, pp. 505-508). From then on Eisenack (1961, 1964), Alberti (1961), Vozzhennikova (1965), and others began to incorporate fossil genera into the already existing system based on modern dinoflagellates, and scores of new families were created to accommodate them.

This approach soon proved to be unsatisfactory. The modern classification, which was developed by planktonologists studying motile cells, pays little regard to certain features developed in both modern and fossil dinoflagellate cysts, such as mode of archaeopyle formation, whose diagnostic value is fully recognised today. Furthermore, new taxonomic problems emerged from the discovery that certain modern (thecate) genera are heterosporous, i.e. they form a variety of cyst types. The genus *Gonyaulax,* for instance, breeds resting cysts of which equivalent counterparts have been described in fossil genera, such as *Spiniferites, Leptodinium, Nematosphaeropsis,* and *Exochosphaeridium* (Evitt & Davidson, 1964; Wall & Dale, 1966, 1967, 1968a).

Modern classificatory methods

These and other problems gradually convinced certain workers (Deflandre, 1964; Sarjeant & Downie, 1966) that maintaining an independent classification based primarily on cyst morphology would have clear advantages. It would be able to absorb the hystrichospheres, which were still a neglected group (with exclusion of the Chlorophycae and the acritarchs, see Downie, Evitt & Sarjeant, 1963) and could more fully bring forward phylogenetic tendencies. Sarjeant & Downie (1966) initially developed a cyst classification in which families and genera were given independent status, irrespective of eventual affinity to modern thecate genera. They listed and described a considerable number of cyst families under the Class Dinophycae, and typified them by fossil dinoflagellate genera. They refrained from discussing the classification on ordinal and higher levels as they foresaw no difficulties in arranging cyst families into higher taxa based on motile dinoflagellates.

On the merits of studies by Wall & Dale, which are discussed below, Sarjeant & Downie later (1974) abandoned their approach towards a separate cyst classification. They also recognised the need for a gradation in importance of morphological characteristics appurtenant to cysts and motile cells, which is the backbone of any effective vertical hierarchy of taxa, and they (p. 13) acknowledged that 'the reflection of the tabulation and/or position of cingulum and sulcus, the mode of archaeopyle formation and character of the operculum or opercular pieces, and the overall shape are considered to be the features of prime importance in determining relationships and lineages. However, due regard must also be paid to the degree (and mode) of separation of the wall layers, the character, situation, proportional height and number of the processes . . . and any other special features'. Accordingly, Sarjeant & Downie proposed that their 'cyst families' be given the status of families, and offered amended diagnoses for a number of them. These concepts are widely followed in systematic literature today.

A more sharply defined approach towards dinoflagellate classification has been formulated by Wall & Dale (1968a). Those authors are of the opinion that an efficient system should express biological and evolutionary tendencies as fully as possible, and should be based on cyst as well as thecate morphology. A classification based on the motile stage is no more natural than one used exclusively for fossil dinoflagellates (see also Evitt, 1970), and either approach leads to taxonomic (and other) difficulties. Wall & Dale formulated a number of concepts, and made recommendations to realise them, for the purpose of achieving a single system which incorporates both fossil and modern dinoflagellates (see also the discussion in Sarjeant & Downie, 1974).

Wall & Dale concluded from their work on modern resting cysts that many morphological features of cysts have a fixed but unequal value, some being more stable than others. Their recommendations clearly express the importance of a gradation, or ranking in value, of suitable morphological features for the purposes of classification. They (p. 293) formulated two possible procedures for future classification which clearly establish successive levels or ranks in realising an effective vertical hierarchy of taxa. They attached prime importance to reflected or paratabulation (when present) and mode of archaeopyle formation, in that order. This is expressed in their first proposal, which reads: 'Families should be characterised primarily by a pattern of tabulation, for example, gonyaulacacean or peridiniacean, and might therefore contain cyst morphotypes possessing several different types of archaeopyles, and structural and elemental ornamentation. However, dinoflagellates either with archaeopyles of different plate series equivalence or different types of structural ornamentation (sutural, intratabular, etc.) should be allocated to different subfamilies . . .' (see also Wall, 1970, 1971). Wall & Dale's second proposal defines their genus concept as follows: 'Genera should be restricted to dinoflagellates with one pattern of tabulation (formula), one type of archaeopyle (precingular, intercalary, apical or otherwise), and usually one type of structural ornamentation and one type of element but sometimes with several types . . .'.

The evaluation of parameters expressed by Wall & Dale is taken as the base on which the Surat Basin fossils are classified.

Classification of Australian fossil dinoflagellates

The classification here outlined consists of a vertical succession of strata or ranks, each of which is linked with one morphological parameter. Each stratum includes taxa or categories which stand for one of the topics within the appropriate parameter, and is defined in such a way as to avoid overlap as much as possible. Following Wall & Dale's recommendations the primary rank in the scheme (the 'Division'—see Table 5) comprises categories based on thecate plate arrangement. Two of these, the gonyaulacacean and peridiniacean categories, incorporate most of the fossils described in this paper. The level or rank below the Division is the 'Subdivision', based on mode of archaeopyle formation: various subdivisional categories stand for elementary archaeopyle types (type A, P, etc.); this is further discussed below. Following Sarjeant & Downie's suggestion (see above citation) the mode of archaeopyle formation is here regarded as of higher importance than the arrangement of ornate elements, and consequently the latter parameter defines the third and lowest suprageneric rank (the 'Section'). Six sectional categories are distinguished.

The framework of this scheme allows the definition of genera and species according to uniform rules. Genera may be typified by one of the following possible combinations *Roman numeral/capital/digit*; this fulfils Wall & Dale's second proposal cited above. Distinctions on generic and specific levels can be made on the basis of the following characteristics:

TABLE 5. KEY TO SUPRAGENERIC CATEGORIES IN DINOFLAGELLATE CLASSIFICATION

Rank	*Diagnostic feature*	*Category*
Division	Tabulation formula	I GONYAULACACEAN II PERIDINIACEAN III CERATIACEAN IV PYROPHACIACEAN
Subdivision	Mode of archaeopyle formation	A Archaeopyle apical B Archaeopyle precingular C Archaeopyle intercalary D Archaeopyle apical + precingular E Archaeopyle apical + intercalary F Archaeopyle epitractal G Archaeopyle marginal H etc. Other archaeopyle types
Section	Arrangement of ornamental elements	1 non-tabular 2 intratabular 3 sutural 4 gonal (+ sutural) 5 penitabular 6 pterate/marginate

TABLE 6. CLASSIFICATION OF AUSTRALIAN CRETACEOUS DINOFLAGELLATES FROM THE SURAT BASIN

Mode of archaeopyle formation	*Structural ornament*	*Genus*	*Suggested lineage* (Wall & Dale, 1968a)	*Affinity*
Apical	non-tabular	CANNINGIA		GONYAULACEAN
		CASSICULOSPHAERIDIA		
		DINGODINIUM		
		HEXAGONIFERA		
		MEMBRANOSPHAERA		
		MUDERONGIA		
		NECROBROOMEA		
		?ODONTOCHITINA		
		?PROLIXOSPHAERIDIUM		
		TENUA		
	intratabular	CHLAMYDOPHORELLA		
		CLEISTOSPHAERIDIUM	Hystrichosphaeridioid	
		HYSTRICHOSPHAERIDIUM	Hystrichosphaeridioid	
		LITOSPHAERIDIUM	Hystrichosphaeridioid	
		OLIGOSPHAERIDIUM		
		PSEUDOCERATIUM	Pseudoceratioid	
		SYSTEMATOPHORA		
		?TANYOSPHAERIDIUM		
Precingular	non-tabular	APTEODINIUM	Apteodinioid	
		?EXOCHOSPHAERIDIUM		
		?PROTOELLIPSODINIUM		
		TRICHODINIUM	Apteodinioid	
	intratabular	CORONIFERA		
	sutural	CRIBROPERIDINIUM	Gonyaulaceoid	
		GONYAULACYSTA	Gonyaulaceoid	
		HESLERTONIA	Gonyaulaceoid	
		LEPTODINIUM	Gonyaulaceoid	
	sutural-gonal	SPINIFERITES		
Intercalary	non-tabular	BROOMEA		PERIDINIACEAN
		PAREODINIA		
		VOZZHENNIKOVIA		
	intratabular	DICONODINIUM		
		SPINIDINIUM	Deflandreoid	
Marginal	non-tabular?	NUMMUS		INCERTAE SEDIS
?	undefined	RHOMBODELLA		

1. Shape and overall size of the organism.
2. Presence or absence of horns, processes, and other ornate elements.
3. Shape, size, and density of distribution of ornate elements.

The systematic 'niches' of various genera represented in the Surat Basin floras are shown in Table 6. Some fossil genera have no visible paratabulation and their position in the scheme remains uncertain. In some instances the shape and position of the archaeopyle gives an indication as to the possible tabulation pattern; these forms are given provisional assignment.

The divisional categories agree with Wall & Dale's concept of dinoflagellate families, and seem to represent broader groupings than Sarjeant & Downie's dinoflagellate families. However, as the scheme here used is set up primarily to serve as a key for Australian fossil dinoflagellates no biological interrelationships are implied. The validity and practical usefulness of various categories here used will be determined by continuing study of modern resting cysts. Two problems directly related to this study—archaeopyle types and cyst wall stratification—are mentioned here.

Archaeopyle types

Evitt's (1967) classification of archaeopyle types is based on the following parameters.

1. Location of the archaeopyle on the cyst, i.e. the paraplate series equivalence involved (apical, precingular, etc.).
2. Number and designation of paraplates involved in each of the basic archaeopyle types (for instance, precingular archaeopyle types P, 2P, 3P, etc.).

Several possible combinations within each of the basic archaeopyle types appear to have biological and taxonomic significance, as they have been recorded from different intervals of the geological record (Evitt, 1967; Wall & Dale, 1968a). These combinations may eventually be represented separately as subdivisional categories. At present a suprageneric recognition of the difference between single-plate and multi-plate equivalence archaeopyles cannot be realised; certain genera (for instance *Pareodinia* and *Spinidinium*) include species in which the number of paraplates removed in archaeopyle formation is not fixed.

Evitt (1967) described the possibility that dissimilar archaeopyles may be formed in endocyst and pericyst of cavate forms. Properly defined subdivisional categories may be included in the scheme without difficulty should the need arise. The Surat Basin assemblages include a few cavate species (*Dingodinium cerviculum, Hexagonifera* cf. *H. defloccata*) which develop similar archaeopyles in both endophragm and periphragm (type A/A).

Cyst wall stratification

No provision is made in the present scheme to distinguish between the presence or absence of a pericoel. This feature is an essential part of the description of dinoflagellate cysts but it may be of little diagnostic value at generic level; Wall & Dale (1968a) and Wall (1971) observed both cavate and acavate cysts of widely divergent morphology associated with the modern genus *Peridinium* Ehrenberg. The fossil genus *Gonyaulacysta* Deflandre also incorporates both partly cavate and acavate species. At present it seems that this parameter should be regarded as unstable and therefore not fit to be used in suprageneric classification.

Description of dinoflagellates from the Surat Basin

A total of 60 species, assigned to 35 genera, of fossil dinoflagellates are described or documented below. The descriptive terminology used is taken from Williams, Sarjeant & Kidson (1973), and Evitt & others (1977).

DIVISION CATEGORY I

Incorporating all dinoflagellates of gonyaulacacean affinity, i.e. with a tabulation including 6 precingular plates and 1 antapical plate.

SUBDIVISION CATEGORY I-A

Incorporating all gonyaulacacean forms with an apical (type A, Aa) archaeopyle.

SECTION CATEGORY I-A-1

Incorporating all forms with an apical archaeopyle and with a nontabular arrangement of ornate elements. The following genera are included: *Canningia, Dingodinium, Cassiculosphaeridia, Hexagonifera, Membranosphaera, Muderongia, Necrobroomea, Tenua.* The genera *Odontochitina* and *Prolixosphaeridium* are also tentatively included.

Genus **Canningia** Cookson & Eisenack, 1960b

Type species (by original designation): *Canningia reticulata* Cookson & Eisenack, 1960b; Late Jurassic, Western Australia.

Canningia colliveri Cookson & Eisenack
Pl. 21, figs. 1-3

1960b *Canningia colliveri* Cookson & Eisenack, p. 251, pl. 38, figs. 3, 4

Description: Cyst approximately spherical, usually dorso-ventrally compressed, with one low, broadly based, conical apical horn 3-10 μm high, and two (occasionally one) broadly conical unequal antapical horns 4-20 μm high. Archaeopyle large, apical, outline circular, with a zigzag-shaped, notched margin indicating 6 precingular paraplates. Some specimens display a vague cingulum; no other traces of paratabulation are seen. Cyst wall single-layered, thin, psilate, punctate, or sparsely granulate.

Dimensions: Length of 8 entire specimens 72-104 μm; apical diameter of 39 dehisced specimens 48-(69)-90 μm, width 60-(80)-105 μm.

Distribution: A rare species in most marine assemblages from the Surat Basin. Otherwise present in the Aptian of Queensland and Western Australia (Cookson & Eisenack, 1960b), and the late Albian to early Cenomanian of France (Davey & Verdier, 1973).

Comments: Specimens with a psilate wall have been found throughout the marine sequence of the Surat Basin; specimens with an indication of punctate and granulate ornament, as in the holotype of the species (pers. obs.) are proportionally rarer in the lower interval of the *Odontochitina operculata* Zone, and become relatively more common in the upper interval. All specimens have been determined as *colliveri* as there is no sharp division between the psilate and slightly punctate-granulate forms.

Canningia minor Cookson & Hughes
Pl. 26, figs. 1-4

1964 *Canningia minor* Cookson & Hughes p. 43, pl. 8, figs. 1-3, 5

Dimensions: Cyst wall single-layered, granulate, about 1 μm thick; width of 27 specimens 44-(59)-74 μm.

Distribution: Commonly present in the lower part of the *Odontochitina operculata* Zone, infrequent to rare in the remainder of the marine sequence of the Surat Basin. Cookson & Hughes described the species from the mid-Cretaceous of England.

Canningia minor var. **psilata** nov.
Pl. 25, figs. 5-11

Holotype: BMR Roma 9, depth 78.8 m (258 ft 6 in.); Wallumbilla Formation, Coreena Member; Cretaceous, early Albian (MFP 6238-2, 323/1195; CPC 16341. Pl. 25, fig. 10).

Description: Cyst spherical to egg-shaped, without apical or antapical horns. Archaeopyle apical with a circular outline, margin notched, outlining the presence of 6 precingular paraplates. No other traces of paratabulation are visible. Cyst wall single-layered, psilate, 0.5-1.5 μm thick.

Dimensions: Apical diameter (26 dehisced specimens) 32-(50)-65 μm, width (34 specimens) 26-(46)-84 μm.

Distribution: A rare to uncommon species in marine assemblages from the Surat Basin. Norvick (1975) reported similar specimens from the Cenomanian of Bathurst Island as *Chytroeisphaeridia* sp. aff. *C. chytroeides* (Sarjeant) Downie, Evitt & Sarjeant, 1963, and *?Chytroeisphaeridia* sp. A; however, the genus *Chytroeisphaeridia* incorporates specimens with a precingular archaeopyle (Davey, pers. comm.).

Comments: The specimens from the Surat Basin are consistently psilate, in which respect they vary from *Canningia minor* itself.

Canningia sp. A
Pl. 21, fig. 4

Description: Cyst dorso-ventrally compressed, with one prominent, broadly based, rounded antapical horn 5-9 μm high, accompanied by a slight additional protrusion but no fully developed horn. Archaeopyle apical, large, outline circular, margin notched, indicating 6 broad, low precingular paraplates. No other traces of paratabulation are visible. Cyst wall single-layered, thin, faintly granulate, with regularly and sparsely distributed baculae and spines 1-3 μm high.

Dimensions: Apical diameter of 2 dehisced specimens 62, 70 μm, width of 4 specimens 60-86 μm.

Distribution: A rare form in some assemblages from the lower part of the *Pseudoceratium turneri* Zone. Not observed in the *Odontochitina operculata* Zone.

Comments: These specimens, although possibly conspecific with *C. colliveri,* are here separated for the present time as they are stratigraphically more restricted, and more strongly granulate-spinulose than the holotype of *colliveri,* which is granulate. No undehisced specimens were observed, so the apical cyst portion is not known.

Genus **Cassiculosphaeridia** Davey, 1969

Type species (by original designation): *Cassiculosphaeridia reticulata* Davey, 1969; Cenomanian, France.

Cassiculosphaeridia cf. **C. reticulata** Davey
Pl. 27, figs. 7-8

?1969 *Cassiculosphaeridia reticulata* Davey, p. 142, pl. 3, fig. 7; pl. 4, fig. 3

Description: Cyst spherical, prolate or slightly oblate, without horns. Archaeopyle apical, of variable size, outline circular, margin smooth or sometimes notched, indicating an undetermined number of precingular paraplates. No other traces of paratabulation are present. Cyst wall thin, psilate, with a network of low lists enclosing circular, oval, and polyangular lumina 1-5 μm in diameter. Total thickness of wall 2-4 μm.

Dimensions: Apical diameter (11 dehisced specimens) 40-54 μm.

Distribution: Infrequently present in marine assemblages from the Surat Basin. Also present in the Cenomanian of Bathurst Island (Norvick, 1975), the Cenomanian of Britain (Davey, 1969), and the Barremian to Cenomanian of France (Davey, 1969; Verdier, 1975).

Comments: In some specimens the archaeopyle margin is dented and occasionally a parasulcal notch is seen, but the specimens are very poorly preserved, so the number of precingulars could not be determined with certainty. The Surat Basin specimens are similar to Davey's species but have lower lists and lack granulation of the wall. Norvick observed some Bathurst Island specimens in which a paracingulum was indicated by a slight variance of the reticulate pattern. Fragments of an outermost enveloping membrane are preserved in some specimens.

Deflandre (1947) described reticulate specimens from the Jurassic of France, *Valensiella* (al. *Membranilarnax*) *ovulum* (Deflandre) Eisenack, 1963, with a similar, enveloping outermost membrane, but the lists are distally forked and may locally be dissolved into discrete processes. The reticulate pattern in *ovulum* is considerably coarser, and the lists are higher than those in the Surat Basin specimens.

Genus **Dingodinium** Cookson & Eisenack, 1958

Type species (by original designation): *Dingodinium jurassicum* Cookson & Eisenack, 1958; Late Jurassic, Western Australia.

Dingodinium cerviculum Cookson & Eisenack
Pl. 22, figs. 5, 6

1958 *Dingodinium cerviculum* Cookson & Eisenack, p. 40, pl. 1, figs. 12-14

Description: Cyst bilamellate, asymmetrically cavate; endocyst broadly ellipsoidal, endophragm thin, densely and evenly granulate to microbaculate, in fractured specimens reflecting a partial tabulation pattern 1′, (5)-6″. A paracingulum is more or less clearly indicated. Periphragm untabulated, thin and transparent, psilate, with a distinct fold at the location of the paracingulum, and a distally closed, 20-40 μm long, tapering, hollow apical horn, offset to the (ventral?) side. The horn cavity continues as a pericoel on one side and widens in the antapical region. Both endocyst and pericyst dehisce apically; archaeopyle small to medium-sized, circular, with a smooth margin in the periphragm and a notched margin in the endophragm.

Dimensions: Total length (11 specimens) 78-120 μm; endocyst (15 specimens) 42-64 μm long and 35-50 μm wide.

Distribution: A common species in the *Odontochitina operculata* Zone, rarely to uncommonly present in some assemblages of the *Pseudoceratium turneri* Zone, where many of the specimens found are suspected to be of secondary (recycled) origin. The species is also known from the Neocomian of the Carpentaria and Papuan Basins. Cookson & Eisenack (1958) reported it from the late Neocomian? to Aptian of Western Australia, and the Early Cretaceous of Papua New Guinea. Singh (1971) reported the species from the Albian of Alberta, Canada.

Genus **Hexagonifera** Cookson & Eisenack, 1961 emend. Cookson & Eisenack, 1962b

Type species (by original designation): *Hexagonifera glabra* Cookson & Eisenack, 1961; Late Cretaceous (?Senonian), Victoria.

Hexagonifera cf. **H. defloccata** Davey & Verdier
Pl. 21, fig. 5; Pl. 22, fig. 1

?1973 *Hexagonifera defloccata* Davey & Verdier, p. 198, pl. 3, figs. 6, 8

Description: Cyst spherical to ellipsoidal, with irregular outline. Cyst wall bilamellate, cavate; both membranes thin, less than 1 μm thick, transparent, psilate. Periphragm broadly and irregularly folded, nowhere obviously connected with endophragm. An apical archaeopyle with circular outline, large or small, with a zigzag or notched margin is formed in both membranes. No traces of paracingulum, parasulcus, or other paratabulation are visible.

Dimensions: Length (21 specimens) 49-(62)-82 μm, width (23 specimens) 46-(55)-70 μm; endocyst (13 specimens) 43-66 μm long.

Distribution: A rare to common species in many marine assemblages from the Surat Basin. Norvick (1975) described similar specimens from the early Cenomanian of Bathurst Island.

Comments: The Surat Basin specimens are possibly slightly thinner-walled than *H. defloccata*. *Chiropteridium inornatum* Drugg, 1970, is larger and only partially cavate, and has a considerably thicker endophragm.

In some dehisced specimens the archaeopyle is seen somewhat displaced to one side as shown in *Hexagonifera* sp. A, probably owing to distortional folding.

Hexagonifera sp. A
Pl. 22, fig. 4

Description: Cyst ellipsoidal to subspherical, outline irregular; cyst wall bilamellate, cavate, periphragm thin, psilate, and closely enveloping the endophragm which is only seen in outline. Archaeopyle, if formed, small with a smooth margin, and slightly displaced in some specimens. No other traces of paratabulation are visible.

Dimensions: Length of 8 specimens 54-100 μm.

Distribution: A rare species in the upper part of the *Odontochitina operculata* Zone and in some assemblages of the *Pseudoceratium turneri* Zone.

Comments: The specimens are similar in size to *H.* cf. *H. defloccata* but the periphragm is often folded in an arcuate fashion and envelops the endophragm more narrowly than in *defloccata*. The aperture has no typical archaeopyle characteristics, but its position, and the cavate nature of the wall, suggest affinity of the species to *Hexagonifera*.

Hexagonifera sp. B
Pl. 22, figs. 2, 3

Description: Cyst spherical to broadly ellipsoidal; cyst wall bilamellate, cavate; membranes thin, unfolded, transparent, psilate to faintly punctate. Endocyst spherical, dehisced specimens display a large apical archaeopyle with an irregular, angular margin. An operculum is usually still attached. In a few specimens the periphragm shows faint traces of a paracingulum. No other traces of paratabulation are visible.

Dimensions: Length of entire fossil (7 specimens) 26-38 μm; endocyst (7 specimens) 22-23 μm long and 26-33 μm wide.

Distribution: Rarely present in some assemblages of the lower part of the *Odontochitina operculata* Zone.

Comments: These specimens differ from other species of the genus here described by their smaller dimensions and smooth, unwrinkled cyst membranes. They are assigned to *Hexagonifera* on account of the presence of the apparently apical aperture which has the characteristics of an archaeopyle.

Genus **Prolixosphaeridium** Davey, Downie, Sarjeant & Williams, 1966

Type species (by original designation): *Prolixosphaeridium parvispinum* (Deflandre) Davey, Downie, Sarjeant & Williams, 1969; Aptian, France.

Prolixosphaeridium parvispinum (Deflandre) Davey & others
Pl. 22, fig. 7

1937 *Hystrichosphaeridium xanthiopyxides* var. *parvispinum* Deflandre, p. 29, pl. 16, fig. 5
1958 *Hystrichosphaeridium parvispinum* Deflandre; Cookson & Eisenack, p. 45, pl. 8, figs. 10-12
1966 *Prolixosphaeridium deirense* Davey & others, p. 171, pl. 3, fig. 2; text-fig. 45
1969 *Prolixosphaeridium parvispinum* (Deflandre) Davey & others, p. 17

Description: Cyst elongate ellipsoidal to almost cylindrical; antapex rounded, apex lost in archaeopyle formation. Margin of archaeopyle notched, indicating the presence of 6 precingular paraplates; no other traces of paratabulation observed. Autophragm coarsely granulate to micro-echinate, with less than 100 additional thin, solid, pointed processes seemingly distributed at random, and 5-9 μm high.

Dimensions: Apical diameter of dehisced cyst, not including ornament (4 specimens) 40-58 μm, width 28-33 μm.

Distribution: Sporadically present in the Surat Basin. Davey & others (1966) described the species as *P. deirense* from the Barremian of Yorkshire, U.K., and Davey & Verdier (1971) reported it from the Barremian, Aptian, and Albian of France. Also present in the Aptian of Papua New Guinea (Cookson & Eisenack, 1958).

Genus **Membranosphaera** Samoilovich in Samoilovich & Mtchedlishvili, 1961 ex Norris & Sarjeant, 1965 emend. Drugg, 1967

Membranosphaera granulata Norvick
Pl. 27, fig. 4

1975 *Membranosphaera granulata* Norvick, p. 79, pl. 11, fig. 9; pl. 12, fig. 3

Description: Cyst egg- or cup-shaped; archaeopyle large, apical, outline circular with an irregularly zigzag margin. No other traces of paratabulation are seen. Wall thin, with sparsely and evenly distributed grana.

Dimensions: Apical diameter (4 dehisced specimens) 24-40 μm, width 33-52 μm.

Distribution: The species has been observed only in a few assemblages of the *Odontochitina operculata* Zone. Norvick (1975) described it from the Cenomanian of Bathurst Island.

Comments: The Surat Basin specimens are minutely granulate and do not display the variation in ornament observed in the Bathurst Island specimens. They are smaller than *Canningia minor* Cookson & Hughes, 1964.

Membranosphaera norvickii sp. nov.
Pl. 26, figs. 7, 8

Holotype: BMR Roma 9, depth 61.0 m (200 ft 1 in); Wallumbilla Formation, Coreena Member. Cretaceous, early Albian (MFP 4616-4, 431/1042; CPC 16349. Pl. 26, fig. 7).

Description: Cyst approximately spherical; cyst wall two-layered, acavate, and 1.5-2 μm thick. Archaeopyle apical, large, circular in outline; margin undulate or notched. No paracingulum or other paratabulation are apparent. Endophragm thin, psilate, periphragm of a finely spongy nature, in top view microgranulate to microrugulate, or imperfectly microreticulate.

Dimensions: Length of one entire specimen 74 μm; apical diameter (11 dehisced specimens) 54-67 μm, width (14 specimens) 53-84 μm.

Distribution: A rare species in some assemblages of the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone.

Comments: This species is readily distinguished by its size, its large apical archaeopyle, and evenly, finely sculptured periphragm. It differs from *Canningia minor* Cookson & Hughes by its stratified wall and the more intricate surface pattern. An archaeopyle is always present, and an operculum is still attached in a few specimens.

Membranosphaera coninckii sp. nov.
Pl. 26, figs. 5, 6

Holotype: BMR Roma 9, depth 61.0 m (200 ft 1 in); Wallumbilla Formation, Coreena Member. Cretaceous, early Albian (MFP 4616-1, 405/1178; CPC 16348. Pl. 26, fig. 6).

Description: Cyst spherical to egg-shaped. Archaeopyle large, apical, with an approximately circular outline, margin notched and indicating the presence of 6 precingular paraplates. An operculum is still attached in a number of specimens. No traces of a paracingulum or other paratabulation are visible. Cyst wall thin and densely covered with numerous tiny, hairlike spines 2-6 μm long.

Dimensions: Apical diameter of 5 dehisced specimens 32-45 μm, width (10 specimens) 32-50 μm.

Distribution: A rare species in assemblages of the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone.

Comments: Dinoflagellates of this type have not often been reported. Deflandre & Courteville (1939) described from the Senonian of France their *Hystrichosphaeridium whitei,* which has densely spaced and hairlike processes up to 28 μm long, but does not develop an archaeopyle and has no traces of parasutures. De Coninck (1968) described as *Kallosphaeridium brevibarbatum* a few comparable (if not identical) but very poorly preserved specimens, measuring 68 μm in total, with a dense cover of hairs 4 μm long, from the Tertiary of Belgium. *M. coninckii* sp. nov. differs from *M. romaensis* sp. nov. by its longer hairlike processes.

Membranosphaera romaensis sp. nov.
Pl. 27, figs. 1-3

Holotype: BMR Mitchell 10, depth 120.1 m (394 ft); Wallumbilla Formation, Doncaster Member. Cretaceous, late Aptian (MFP 6239-1, 403/1142; CPC 16353. Pl. 27, fig. 3).

Description: Cyst spherical to egg-shaped. Archaeopyle, if formed, large, apical, outline circular; margin with notches, including a parasulcal notch, and indicating the presence of 6 precingular paraplates. No other traces of paratabulation are apparent. Wall thin, densely covered with numerous short, tiny spinules 1 μm high.

Dimensions: Apical diameter of 11 undehisced specimens 35-51 μm, width (13 specimens) 32-52 μm.

Distribution: A rare to relatively common species in many marine assemblages from the Surat Basin.

Comments: The species is smaller than *Kallosphaeridium brevibarbatum* De Coninck, 1968, and has shorter hairlike spines. It resembles *Tenua neophytensa* Ioannides & others, 1976, but does not display the prominent apical process of that species.

Membranosphaera sp. A
Pl. 27, figs. 5, 6

Description: Cyst spherical, cup-shaped, or broadly ellipsoidal. Archaeopyle large to medium-sized, apical, with an irregular outline; margin undulate or notched, outlining the presence of 6 precingular paraplates. In some specimens an operculum is still attached. No traces of paracingulum or other paratabulation are seen. Wall very thin, covered with tiny processes arranged in a dense, regular, vermiculate pattern.

Dimensions: Apical diameter of 8 dehisced specimens 45-55 μm.

Distribution: An uncommon to rare species in some assemblages of the *Odontochitina operculata* Zone.

Comments: The species is distinguished from other species of the genus described from the Surat Basin by its dense and even, vermiculate surface pattern. It differs from *Canningia rotundata* Cookson & Eisenack, 1961, by its thinner wall and the absence of an apical horn, and it is larger than *Canningia circularis* Cookson & Eisenack, 1971.

Genus **Necrobroomea** Wiggins, 1975

Type species (by monotypy?): *Odontochitina* (al. *Ceratium* [*Euceratium*]) *operculata* (O. Wetzel, 1933) Firtion, 1952; Late Cretaceous (Senonian), Germany.

Necrobroomea micropoda (Eisenack & Cookson) Wiggins
Pl. 45, fig. 3

1960 *Broomea micropoda* Eisenack & Cookson, p. 7, pl. 2, figs. 8, 9
1961 *Broomea pellifera* Alberti, p. 26, pl. 5, figs. 11-13
1975 *Necrobroomea micropoda* (Eisenack & Cookson) Wiggins, p. 111
1975 *Batioladinium micropodum* (Eisenack & Cookson) Brideaux, p. 1240

Dimensions: Total length (3 specimens) 88-99 μm, width 30-38 μm; longest antapical projection 4-6 μm long.

Distribution: A number of specimens were found in some assemblages of the *Pseudoceratium turneri* Zone. Eisenack & Cookson described the species from the Albian of South Australia, and the Aptian-Albian of Queensland.

Comments: After having re-examined the type material of the species, Morgan (pers. comm.) regards the species as dehiscing apically, therewith confirming Wiggins's transference of the species from the genus *Broomea.*

Genus **Muderongia** Cookson & Eisenack, 1958

Type species (by original designation): *Muderongia mcwhaei* Cookson & Eisenack, 1958; Aptian, South Australia.

Remarks: Wall & Evitt (1975) derived a gonyaulacacean type paratabulation formula for the genus (4′, Oa, 6″, 6c, 6‴, 1p, 1⁗) from examination of Early Cretaceous specimens from California which they compared with *M. mcwhaei.* The holotype of this species likewise displays clear paratabulation.

Muderongia cf. **M. staurota** Sarjeant
Pl. 35, figs. 2, 4

?1966b *Muderongia staurota* Sarjeant, p. 203, pl. 21, figs. 6, 7; pl. 23, fig. 4; text-fig. 53

Description: Cyst cavate, both cyst membranes very thin, psilate, often wrinkled. Endocyst spherical to ellipsoidal, pericyst with one antapical, one apical, and two shorter lateral horns. Pericoel mostly restricted to the horns, in some specimens extending slightly beyond the base of the horns. Archaeopyle formed by removal of a large portion of the pericyst supporting the apical horn; archaeopyle outline asymmetrical, with a smooth to undulate margin. No paracingulum or other paraplate sutures are observed. Apical and antapical horns straight, in some specimens with a few small, random perforations. Lateral horns abruptly bent backwards at 7-20 μm from their points of implantation.

Dimensions: Length of antapical horn (11 specimens) 42-64 μm, width of base antapical horn 6-14 μm; apical diameter of dehisced fossil (11 specimens) 84-120 μm, width of pericyst 45-65 μm.

Distribution: A rare species in some marine assemblages from the Surat Basin. Sarjeant (1966b) described the species from the Early Cretaceous (Barremian) of England, and Davey & Verdier (1974) reported similar specimens as cf. *staurota* from the Aptian of France.

Comments: The Surat Basin specimens have a cyst body similar in size to *staurota,* but the antapical horn is longer and thinner. Davey (pers. comm.) compared them with specimens of the species which he observed from the Early Cretaceous of the U.K. and France. The lateral horns in the type species *M. mcwhaei* are bent in a similar abrupt fashion but that species has additional periphragmic protrusions, in particular on the hypotract, which none of the Surat Basin specimens develop. Specimens of the *mcwhaei* type have not been observed in the assemblages from the Surat Basin.

Muderongia tetracantha (Gocht) Alberti
Pl. 35, figs. 1, 3

1957 *Pseudoceratium? tetracanthum* Gocht, p. 168, pl. 18, figs. 7-9; text-fig. 5

1958 *Pseudoceratium tetracanthum* Cookson & Eisenack, p. 55, pl. 5, fig. 1

1961 *Muderongia tetracantha* (Gocht) Alberti, p. 14, pl. 2, figs. 14-18

Dimensions: Total length of 4 specimens 180-240 μm, length of dehisced fossil (27 specimens) 86-(107)-125 μm; length of antapical horn 38-(57)-80 μm, width of base antapical horn 5-22 μm; width of pericyst 35-83 μm.

Distribution: The species is present in most marine assemblages from the Surat Basin. Cookson & Eisenack (1958) reported it from the Aptian of Queensland and Western Australia, and the Early Cretaceous (?Aptian) of Papua New Guinea. Gocht described it from the Hauterivian of Germany, and Verdier (1975) reported it from the Barremian of France.

Comments: This species differs from *M.* cf. *M. staurota* and from *M. crucis* Neale & Sarjeant, 1962, only in having slightly curving and gradually tapering lateral horns. Its dimensions are comparable to those which Gocht gave for the German specimens of the *tetracantha.*

Genus **Odontochitina** Deflandre, 1935 emend. Davey, 1970

Type species (by monotypy?): *Odontochitina* (al. *Ceratium [Euceratium]*) *operculata* (O. Wetzel, 1933) Firtion, 1952; Late Cretaceous (Senonian), Germany.

Remarks: On the basis of the close ceratoid affinity of *Odontochitina* observed by Wall & Evitt (1975) the genus is tentatively included (with *Muderongia*) in category I-A.

Odontochitina operculata (O. Wetzel) Firtion
Pl. 34, figs. 1, 3, 4

1933 *Ceratium (Euceratium) operculatum* O. Wetzel, p. 170, pl. 11, figs. 21, 22

1952 *Odontochitina operculatum* (O. Wetzel) Firtion, p. 160, pl. 8, fig. 9

for more extensive synonymy see Sarjeant, 1966b, p. 208.

Dimensions: Total length of 4 undehisced specimens 180-300 μm; apical dimensions of dehisced fossil (34 specimens) 80-(148)-218 μm, width of pericyst 29-(49)-78 μm; length of antapical horn 40-155 μm, width of base antapical horn 6-28 μm.

Distribution: Present in many marine assemblages from the Surat Basin. Also present in the Cenomanian of Bathurst Island (Norvick, 1975), the Early Cretaceous of New South Wales and the ?Late Cretaceous of Victoria (Deflandre & Cookson, 1955). Outside the Australian region the species has been reported from the Barremian to Cenomanian of England and France (Davey & Verdier, 1973; Davey, 1970; Sarjeant, 1966b), the late Jurassic(?), Albian, and Cenomanian of Canada (Pocock, 1962; Singh, 1971; Davey, 1970), the late Albian of Romania (Baltes, 1967a), and the Cenomanian-Campanian of Poland (Górka, 1963).

Comments: In many specimens the antapical horn is locally perforated, the holes are small and few in number, and some may be aligned. Deflandre's illustration of the species shows identical perforations in the apical horn. *O. striatoperforata* Cookson & Eisenack, 1962b, and *O. costata* Alberti, 1961, develop more numerous and more rigidly aligned perforations. I agree with Norvick (1975) that these are authentic structures representing local weak areas of the periphragm, which in time became confined to long narrow strips separated by thick ridges. The degree to which this perforate character may be considered as of specific value remains an open question. Clarke & Verdier (1967) were of the opinion that *costata* and *striatoperforata* were synonymous species. Specimens comparable with these species were not found in the Surat Basin assemblages, but Norvick (op. cit.) found similar specimens together with *operculata* in the Bathurst Island microfloras and regarded them as end members of a morphologically variable series, rather than strictly separable species. It is thought that the *costata* type separated from the main *operculata* line of development in late Albian times.

Odontochitina sp. A
Pl. 34, fig. 2

Description: Cyst bilamellate, considerably elongate; both cyst membranes thin and psilate. Pericyst extended into an apical, an antapical, and a shorter, curved, lateral horn. Endocyst is in close contact with pericyst but does not extend into the horn cavities. An archaeopyle is formed by detachment of an asymmetrical part of the anterior periphragm, including the horn. No further traces of paratabulation are visible.

Dimensions: Total length of 2 specimens, 90, 120 μm; width of pericyst 32 μm; length of apical horn 102, 170 μm, antapical horn 105 μm; width of base antapical horn 12 μm.

Distribution: Occasionally present in a few assemblages of the *Pseudoceratium turneri* Zone.

Comments: These specimens differ from other species of the genus by their elongate, spindle-shaped form. *Necrobroomea longicornuta* (Alberti) Wiggins, 1975, has shorter, perforate horns, and lacks a lateral horn.

Genus **Tenua** Eisenack, 1958b emend. Sarjeant, 1968

Type species (by original designation): *Tenua hystrix* Eisenack, 1958b; Aptian, Germany.

Tenua aptiense sp. nov.
Pl. 23, figs. 1, 5; Pl. 24, fig. 1

Holotype: BMR Mitchell 11, depth 14.6 m (48 ft); Bungil Formation, Minmi Member. Cretaceous, early Aptian (MFP 4276-1, 303/1026; CPC 16319. Pl. 23, fig. 1).

Description: Cyst spherical to egg-shaped; archaeopyle medium to large, apical, with a circular outline, margin irregularly dentate; a parasulcal notch is recognised in some specimens. No other traces of paratabulation are visible. Autophragm thin, transparent, finely and evenly granulate, with more than 150 small, thin, tubular to conical, hollow processes 1-4 μm long, with acuminate or bifid tips.

Dimensions: Apical diameter of 6 dehisced specimens 33-36 μm, width 35-42 μm.

Distribution: A rare species in some assemblages of the lower part of the *Odontochitina operculata* Zone.

Comments: Because of the thin wall, specimens are usually badly torn in the preparations, so there are not enough suitable specimens to determine a satisfactory size range. The species is smaller than *Tenua rioulti* Sarjeant, 1968, and lacks a paracingulum and parasulcus. *Batiacasphaera baculata* Drugg, 1970, resembles *T. aptiense* sp. nov. but has fewer and shorter, tuberculate processes.

Tenua pilosa (Ehrenberg) Sarjeant
Pl. 22, figs. 8-10; Pl. 23, figs. 2-4

1843 *Xanthidium pilosum* Ehrenberg, pp. 61-63
1968 *Tenua pilosa* (Ehrenberg) Sarjeant, p. 231, pl. 2, fig. 7

Description: Cyst egg- or cup-shaped with a broadly rounded antapex. Archaeopyle large, apical, with a circular outline; margin irregularly undulate or zigzag-shaped, outlining the presence of 6 precingular paraplates. In some specimens an operculum is still attached. No traces of a paracingulum are observed. Cyst wall very thin, psilate to punctate, with over 500 thin, simple processes 2-8 μm high, with acuminate, occasionally capitate tips.

Dimensions: Apical diameter (7 dehisced specimens) 38-50 μm, width (10 specimens) 38-54 μm.

Distribution: A rare to uncommon species in many marine assemblages from the Surat Basin. Also present in the upper Callovian-Oxfordian of Britain and France (Sarjeant, 1968) and Poland (Ehrenberg, 1843). Gitmez (1970) reported identical specimens as *Tenua hystrix* Eisenack, 1958, from the Late Jurassic of Britain.

Comments: The species is distinguished by its unusually thin cyst wall and the numerous tiny spinules. The Surat Basin specimens match Sarjeant's emended description of the species; specimens with the longer spinules usually have a finely granulate membrane but are here regarded as a possible subspecific variety.

SECTION CATEGORY I-A-2

Incorporating all gonyaulacacean forms which dehisce apically, and with an intratabular arrangement of ornamental elements. Included are the genera *Chlamydophorella, Cleistosphaeridium, Litosphaeridium, Hystrichosphaeridium, Oligosphaeridium, Pseudoceratium, Systematophora,* and tentatively also *Tanyosphaeridium.*

Genus **Chlamydophorella** Cookson & Eisenack, 1958

Type species (by original designation): *Chlamydophorella nyei* Cookson & Eisenack, 1958; Aptian, Queensland.

Chlamydophorella nyei Cookson & Eisenack
Pl. 24, figs. 4-6; Pl. 25, figs. 1-4

1958 *Chlamydophorella nyei* Cookson & Eisenack, p. 56, pl. 11, figs. 1-3

Description: Cyst spherical with a low, broadly based apical horn. Archaeopyle, if formed, large, apical, with a circular outline; margin smooth, occasionally notched at the junctions of the precingular paraplates. Cingular paraplates are probably not present. Traces of paratabulation are visible on the hypocyst by the absence of processes at the plate junctions, but do not allow determination of a paratabulation formula. Cyst wall very thin, psilate to finely granulate, with over 100 short, thick, tubular, bifid or trifid processes 2-6 μm high and 1-2 μm wide. Processes support an extremely delicate, transparent and finely granulate membrane which is preserved in a few specimens only.

Dimensions: Diameter of cyst body (12 specimens) 34-50 μm.

Distribution: A common species in the marine sequence of the Surat Basin. Widely distributed in the mid-Cretaceous of the Australian region (Cookson & Eisenack, 1958, 1968, 1971; Norvick, 1975; Burger, 1973a, 1974). The species also occurs in the Albian of Romania (Baltes, 1967a) and Alberta, Canada (Singh, 1971), the Albian and Cenomanian of Saskatchewan, Canada (Davey, 1970), and the Barremian, Aptian, and early Albian of France (Verdier, 1975).

Comments: In a number of specimens the operculum is still attached. Free opercula (Pl. 24, fig. 6) have a smooth, circular to hexagonal outline; they are thought to be composed of only one apical paraplate, as the distribution of operculate processes does not indicate any additional parasutures.

The processes themselves display a large variation in relative length, but attempts to separate subgroups within the species on this basis were unsuccessful, so all specimens have been incorporated into *nyei* sensu lato.

Genus **Cleistosphaeridium**

Davey, Downie, Sarjeant & Williams, 1966

Type species (by original designation): *Cleistosphaeridium diversispinosum* Davey & others, 1966; Eocene, England.

Cleistosphaeridium cf. **C. polytrichum** (Valensi)

Davey, Downie, Sarjeant & Williams

Pl. 31, figs. 1-3

?1947 *Hystrichosphaeridium polytrichum* Valensi, p. 318, text-fig. 4
?1962 *Baltisphaeridium polytrichum* (Valensi) Sarjeant, p. 487, pl. 70, fig. 2; text-fig. 66
?1969 *Cleistosphaeridium polytrichum* (Valensi) Davey & others, p. 16

Description: Cyst body spherical; archaeopyle, if formed, large, apical?, outline circular or irregular, margin undulate or angular. No paracingulum or other paratabulation are apparent. Cyst wall single-layered, very thin, psilate, punctate, or minutely spinose, supporting 150-200 regularly distributed, solid and slender, straight or slightly curved processes of uniform length. Processes mostly simple, occasionally branching, with pointed or bifid tips, and 8-18 μm long.

Dimensions: Diameter of cyst cavity (10 specimens) 40-60 μm.

Distribution: The specimens have been observed in some assemblages of the *Odontochitina operculata* Zone. *C. polytrichum* has been reported from the late Jurassic of England (Gitmez, 1970), the mid-Jurassic of France (Valensi, 1947), and the early Jurassic of England (Sarjeant, 1962).

Comments: The archaeopyle is thought to be apical on account of its shape and the absence of differentiated apical features. The Surat Basin specimens are distinguished from other species of the genus by the large number of processes. *C. polyacanthum* Gitmez, 1970, *C. disjunctum* Davey, Downie, Sarjeant & Williams 1966, and *C. polypes* var. *claviculum* Davey, 1969, are smaller. Gitmez (1970) described *C. polytrichum* as having fewer (approximately 86-100) processes, but the Surat Basin specimens are otherwise similar and are therefore tentatively assigned to this species.

Cleistosphaeridium granulatum sp. nov.

Pl. 33, figs. 2-4, 6-10

Holotype: BMR Roma 9, depth 30.5 m (100 ft 2 in); Wallumbilla Formation, Coreena Member. Cretaceous, early Albian (MFP 4615-1, 419/1184; CPC 16385. Pl. 33, fig. 2).

Description: Cyst spherical, dehisced cyst cup-shaped. Archaeopyle, if formed, medium to large, apical, outline circular; margin almost smooth or undulate. Cyst wall single-layered, granulate, and covered with about 100 thin, solid, slightly tapering and frequently curved spines 2-8 μm high, with acuminate tips. No parasuture pattern is apparent from the distribution of the processes.

Dimensions: Width (16 specimens) 27-62 μm.

Distribution: A rare to uncommon species in the marine sequence of the Surat Basin.

Comments: This species is distinguished by its granulate cyst wall and the relatively small number of short, curved spines. *C. aciculare* Davey, 1969, has longer and thicker processes and a thicker wall.

Cleistosphaeridium aciculare Davey

Pl. 32, figs. 4, 5, 7-9; Pl. 33, fig. 1, cf. 5

1969 *?Cleistosphaeridium aciculare* Davey, p. 158, pl. 6, figs. 11, 12

Description: Cyst spherical, archaeopyle rarely formed, apical in position; a rudimentary operculum is still attached in some specimens. Archaeopyle outline circular, margin undulate, indicating the presence of 5? to 6 precingular paraplates. No other paratabulation or apical features are apparent. Cyst wall single-layered, 1-1.5 μm thick, finely to coarsely granulate, with 100 or more uniform, slender, slightly tapering, straight or curved processes 6-18 μm high, solid or partly hollow, proximally closed, with pointed tips.

Dimensions: Diameter of cyst cavity (16 specimens) 33-52 μm.

Distribution: An uncommon species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Also present in the Albian and Cenomanian of Saskatchewan, Canada (Davey, 1969).

Comments: The species resembles *C. disjunctum* Davey, Downie, Sarjeant & Williams, 1966, but has more uniform processes. It has fewer processes and a more coarsely granulate wall than *C. polytrichum.* As in *C. aciculare,* the Surat Basin specimens display some variation in number of spines, which appears to be connected with their basal diameter. Davey did not definitely assign the species to *Cleistosphaeridium,* as none of his specimens developed an archaeopyle, but the Surat Basin specimens have confirmed his provisional assignment.

Cleistosphaeridium polypes (Cookson & Eisenack) Davey

Pl. 24, figs. 7, 8

1962b *Hystrichosphaeridium recurvatum* subsp. *polypes* Cookson & Eisenack, p. 491, pl. 4, figs. 11-13
1969 *Cleistosphaeridium polypes* (Cookson & Eisenack) Davey, p. 154, pl. 6, figs. 7, 8

Description: Cyst spherical; an (apical?) archaeopyle, slightly elongate with a smooth margin, is developed in a few specimens only. No apical features—horn or differential processes — paratabulation, or paracingulum are visible. Cyst wall single-layered, punctate to granulate, with approximately 40 uniform, thin, tubular, (solid?) processes 12-24 μm high, with bifid, trifid, or irregularly aculeate distal extremities.

Dimensions: Diameter (14 specimens) 36-55 μm.

Distribution: An uncommon form in the *Pseudoceratium turneri* Zone.

Cleistosphaeridium sp. A
Pl. 31, fig. 6; Pl. 32, figs. 1, 6

Description: Cyst spherical; archaeopyle medium-sized, apical, margin irregularly undulate. Cyst wall single-layered, very thin, psilate, and covered with over 300 short, stiff, conical processes 2-5 μm high, with closed, acuminate to bifid tips.

Dimensions: Diameter (5 specimens) 30-38 μm.

Distribution: An infrequently occurring species in the marine sequence of the Surat Basin.

Comments: The species differs from other forms here assigned to *Cleistosphaeridium* by its numerous short, stiff, conical processes. *C. ancoriferum* (Cookson & Eisenack, 1960a) is larger and has stouter tubiform processes.

Genus **Hystrichosphaeridium** Deflandre, 1937 emend. Davey & Williams, 1966

Type species (by original designation): *Hystrichosphaeridium* (al. *Xanthidium*) *tubiferum* (Ehrenberg, 1838) Deflandre, 1937; Senonian, Germany.

Hystrichosphaeridium cf. **H. bowerbankii** Davey & Williams
Pl. 30, fig. 4

?1966 *Hystrichosphaeridium bowerbanki* Davey & Williams, in Davey & others, p. 69, pl. 8, figs. 1, 4

Dimensions: Diameter (6 specimens) 38-52 μm; processes 22-26 in number, 10-26 μm long, with bifid, trifid, or multifurcate distal extremities.

Distribution: A very rare species in some assemblages of the *Pseudoceratium turneri* Zone. The species occurs in the Cenomanian of Britain (Davey & Williams, 1966), and the late Albian (Vraconian) and Cenomanian of France and Switzerland (Davey & Verdier, 1973).

Genus **Litosphaeridium** Davey & Williams, 1966

Type species (by original designation): *Litosphaeridium* (al. *Hystrichosphaeridium*) *siphoniphorum* (Cookson & Eisenack, 1958) Davey & Williams, 1966; ?Albian, Western Australia.

Litosphaeridium sp. A
Pl. 28, fig. 2

Description: Cyst spherical, cyst wall single-layered, very thin, psilate, with eleven uniform, short, hollow, cylindrical processes which are distally open, with smooth edges. Height of processes 12-14 μm, width 14-20 μm.

Dimensions: Diameter of central cavity (1 specimen) 48 μm.

Distribution: A rare species in a few marine assemblages from the Surat Basin.

Comments: The species is easily distinguished by its large dimensions, transparent wall, and shape of processes. The specimens observed do not display a convincing archaeopyle; of some the body displays oblong, irregular and possibly accidental fractures. The species differs from the type species *siphoniphorum* in having shorter processes and a thin, psilate wall. Specimens assignable to the genus *Callaiosphaeridium* have processes of variable size and morphology.

Genus **Oligosphaeridium** Davey & Williams, 1966

Type species (by original designation): *Oligosphaeridium* (al. *Xanthidium tubiferum complex*) *complex* (White, 1842) Davey & Williams, 1966; neotype from the Cenomanian, Britain.

Oligosphaeridium complex (White) Davey & Williams
Pl. 30, figs. 1, 3, cf. 2

1842 *Xanthidium tubiferum complex* White, p. 39, pl. 4, div. 3, fig. 11

1946 *Hystrichosphaeridium complex* (White) Deflandre, p. 11

1966 *Oligosphaeridium complex* (White) Davey & Williams, p. 71, pl. 7, figs. 1, 2; pl. 10, fig. 3; text-fig. 14

Dimensions: Width of cyst cavity (11 specimens) 32-55 μm; number of processes counted 12-14; length of processes 16-46 μm, width of stalks 2-5 μm.

Distribution: The recorded range of the species is Neocomian to Danian. It is a rare element in many assemblages from the Surat Basin. It is also documented, among other localities, from the Cenomanian of Bathurst Island (Norvick, 1975), the Neocomian of Germany (Gocht, 1959), the Hauterivian and Valanginian of France and Switzerland (Millioud, 1967), the Neocomian to Cenomanian of England (Davey & Williams, 1966; Cookson & Hughes, 1964) and France (Verdier, 1975), the Albian to Cenomanian of England, France, and the USA (Davey, 1969), the late Albian to early Cenomanian of France (Davey & Verdier, 1973), the Albian of Alberta, Canada (Singh, 1971), the Early Cretaceous of Israel (Brenner, 1974), and the Danian of California (Drugg, 1967).

Oligosphaeridium pulcherrimum (Deflandre & Cookson) Davey & Williams
Pl. 28, fig. 1; Pl. 29, figs. 1?, 2

1955 *Hystrichosphaeridium pulcherrimum* Deflandre & Cookson, p. 270, pl. 1, fig. 8; text-figs. 21, 22

1969 *Oligosphaeridium pulcherrimum* (Deflandre & Cookson) Davey & Williams, in Davey & others, p. 75, pl. 10, fig. 9; pl. 11, fig. 5

Dimensions: Width of cyst cavity (18 specimens) 42-(54)-64 μm; number of processes counted 10-13; length of process stalks 15-30 μm, width 2-10 μm.

Distribution: A rare species in the marine sequence of the Surat Basin. Also in the Early Cretaceous elsewhere in Queensland (Deflandre & Cookson, 1955), and the Eocene of England (Davey & Williams, 1966).

Oligosphaeridium nannum Davey
Pl. 27, figs. 9, 10

1974 *Oligosphaeridium nannum* Davey, p. 59, pl. 4, figs. 9, 10

Description: Cyst spherical, readily deformed by compression. A small ?apical archaeopyle with a smooth margin is developed in some specimens. No traces of paracingulum or parasulcus are visible. Wall thin, faintly granulate, supporting 9-13 broad, short and approximately tubiform processes which are hollow and display distinct vertical striping.

Dimensions: Diameter of cyst cavity (6 specimens) 28-33 μm. Processes 8-20 μm high and 4-12 μm wide.

Distribution: A rare form in some marine assemblages from the Surat Basin. Cookson & Eisenack (1970) reported similar specimens as Object A, gen. and sp. indeterm., from the Albian-Cenomanian of the Eucla Basin, Western Australia. Davey described the species from the Barremian of England.

Comments: The specimens differ from *Kleithriasphaeridium fasciatum* (Davey & Williams, 1966) Davey, 1974, by their larger size and smooth instead of fibrous wall. *Polystephanephorus urnaformis* (Cookson, 1953) Sarjeant, 1960, is larger and has fenestrate processes.

Genus **Pseudoceratium** Gocht, 1957

Type species (by original designation): *Pseudoceratium pelliferum* Gocht 1957; Neocomian, Germany.

Pseudoceratium turneri Cookson & Eisenack
Pl. 31, figs. 4, 5; Pl. 32, figs. 2, 3

1958 *Pseudoceratium turneri* Cookson & Eisenack, p. 55, pl. 5, figs. 2-6

Description: Cyst with a cup-shaped posterior part, having a blunt or elongated conical antapical horn 10-18 μm long, and a conical anterior part ending in an elongated apical horn 18-30 μm long. In a number of specimens a thick, short lateral protuberance is developed. Archaeopyle apical, large, outline irregularly rounded, with a dentate or undulate margin indicating the presence of 6 precingular paraplates. Traces of a paracingulum, parasulcus, and hypocyst paratabulation are indicated by the absence of processes at paraplate sutures. Cyst wall double-layered, 2 μm thick, psilate to punctate; processes are aligned near parasutures and in irregular clusters on the paraplate areas. Processes tubiform, occasionally septate with vertical striping, closed proximally and open distally, bi- or polyfurcating, trabeculate, in top view having the appearance of discontinuous, short and curved ridges or muri. Processes 5-10 μm high, stalks 2 μm wide.

Dimensions: Apical diameter of 5 dehisced specimens 84-110 μm, width of 6 specimens, not including lateral horn, 85-110 μm.

Distribution: A rare species in assemblages of the *Pseudoceratium turneri* Zone. Also present in the Albian of Western Australia, the Aptian and Albian of Queensland, and the ?Albian of Papua New Guinea (Cookson & Eisenack, 1958). Outside Australia the species was reported from the mid-Cretaceous of England (Cookson & Hughes, 1964) and the late Albian of France (Davey & Verdier, 1973).

Comments: The material studied was not sufficiently abundant to reconstruct a paratabulation pattern for the species.

Genus **Systematophora** Klement, 1960

Type species (by original designation): *Systematophora areolata* Klement, 1960; Late Jurassic, Germany.

Systematophora complicata Neale & Sarjeant
Pl. 43, figs. 5-7

1962 *Systematophora complicata* Neale & Sarjeant, p. 455, pl. 19, figs. 6, 7; text-fig. 9

Description: Cyst spherical, dehisced cyst broadly cup-shaped. Archaeopyle large, with a zigzag-shaped margin with notches at the lowest points and, in a number of specimens, a depression (parasulcal notch). From the intratabular plate-centred position of the processes, and the shape of the archaeopyle, the partial paratabulation formula ?4′, 6″, 5c? is reconstructed. No traces of parasutures are visible. Cyst wall very thin, psilate to punctate, with single and paired processes as well as processes implanted in annular clusters, one cluster for each of the precingular paraplates, one at the antapex, and one or two clusters in unspecified position on the hypocyst. Paired processes occur on the cingular paraplates, and in unspecified positions on the hypocyst. Processes 12-24 μm long, thin, straight to sinuous, frequently joined at their bases by low ridges and occasionally at intervals along the stalks by short 'bridges'. Distal portions sometimes buccinate and fenestrate, usually simple or branching, with bifid to aculeate, trifurcate, or lobulate extremities.

Dimensions: Length of cyst cavity (3 specimens) 42-48 μm, width (7 specimens) 34-46 μm.

Distribution: The species was recovered from only one sample of the *Pseudoceratium turneri* Zone. Neale & Sarjeant (1962) described the species from the Early Cretaceous (Barremian) of England.

Genus **Tanyosphaeridium** Davey & Williams, 1966

Type species (by original designation): *Tanyosphaeridium variecalamum* Davey & Williams, 1966; Cenomanian, England.

Tanyosphaeridium isocalamus (Deflandre & Cookson) Davey & Williams
Pl. 24, fig. 3

1955 *Hystrichosphaeridium isocalamus* Deflandre & Cookson, p. 272, pl. 2, figs. 7, 8; text-figs. 30-35
1969 *Tanyosphaeridium isocalamus* (Deflandre & Cookson) Davey & Williams, in Davey & others, 1969, p. 7

Dimensions: Apical diameter of dehisced cyst (7 specimens) 32-44 μm, width 22-35 μm; length of processes 8-18 μm, width 1-2 μm.

Distribution: Present in some assemblages from the upper part of the *Odontochitina operculata* Zone and the *Pseudoceratium turneri* Zone. Also present in the Late Cretaceous of the Perth Basin, Western Australia (Cookson & Eisenack, 1968), the Early Cretaceous of New South Wales (Deflandre & Cookson, 1955), and the late Albian of France (Davey & Verdier, 1973).

Comments: The processes are typically tubiform, occasionally acuminate but usually open distally with smooth edges. Close examination of the archaeopyle margin shows the presence of tiny notches at the paraplate junctions, from which the presence of 5-6 precingulars can be established.

Tanyosphaeridium sp. A
Pl. 24, fig. 2

Description: Cyst elongate with rounded antapex. Archaeopyle apical, small to medium-sized, with a smooth to undulate margin. No traces of a paracingulum or paraplate sutures are visible. Cyst wall thin, evenly granulate, supporting less than 50 uniformly shaped, slender, hollow, tubiform processes 1-3 μm wide and 7-16 μm high. Processes distally open, with trifid terminations.

Distribution: A rare species in some marine assemblages from the Surat Basin.

Comments: The Surat Basin specimens resemble, and could be identical with, *T. regulare* Davey & Williams, 1966. *T. salpinx* Norvick, 1975, is also closely comparable. *T. variecalamum* Davey & Williams has tapering processes, and *T. isocalamus* (Deflandre & Cookson) has processes with smooth distal edges.

SUBDIVISION CATEGORY I-B

Incorporating all gonyaulacacean forms with a precingular archaeopyle (Evitt, 1967).

SECTION CATEGORY I-B-1

Incorporating all forms with a precingular archaeopyle and whose structural ornament is non-tabular. The following species are included in this section: *Apteodinium, Trichodinium,* and tentatively also *Exochosphaeridium* and *Protoellipsodinium.*

Genus **Apteodinium** Eisenack, 1958b

Type species (by original designation): *Apteodinium granulatum* Eisenack, 1958b; Aptian, Germany.

Apteodinium conjunctum Eisenack & Cookson
Pl. 36, fig. 1

1960 *Apteodinium conjunctum* Eisenack & Cookson, p. 5, pl. 1, figs. 7-8

Description: Cyst ellipsoidal to spherical, with a small, cylindrical to conical apical horn 4-12 μm long. A large and roundly triangular archaeopyle is formed by the loss of paraplate 3″. A paracingulum and faint traces of parasutures are usually indicated by the absence of structural elements. Cyst wall 2-6 μm thick, double-layered; endophragm homogeneous, thin, psilate, periphragm slightly thicker and composed of tiny bristles, cones, papillae, which are distally interlocked so as to present a rugulate-vermiculate pattern, and are detached from the endophragm in the apical area, forming the hollow horn.

Dimensions: Overall length (7 specimens) 44-58 μm, width 37-58 μm.

Distribution: A rare species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Eisenack & Cookson reported the species from the (late) Aptian of Queensland, and one Late Mesozoic sample from Western Australia.

Comments: The species differs from *A. maculatum* Eisenack & Cookson, 1960, by its smaller size, thicker cyst wall, and coarser surface pattern. It also differs from *A. granulatum* Eisenack, 1958b, by the more accentuated traces of paratabulation, a consistent thickness of the cyst wall, and hollow apical horn. *Gardodinium deflandrei* Clarke & Verdier, 1967, has a thicker cyst wall and an additional membrane covering the processes of 'pillars'. *A. cribrosum* Cookson & Eisenack, 1968, is larger and has a thicker wall. *Trichodinium ciliatum* (Gocht, 1959) Eisenack & Klement, 1964, has longer and more discrete processes in the form of bristles.

Apteodinium maculatum Eisenack & Cookson
Pl. 36, figs. 2, 3

1960 *Apteodinium maculatum* Eisenack & Cookson, p. 4, pl. 2, figs. 1-3

Description: Cyst spherical, with a conical apical horn 5-15 μm high. A large and roundly triangular archaeopyle is formed by the dislodgement of paraplate 3″. Traces of paratabulation are occasionally seen; usually a paracingulum is more or less distinctly outlined. Cyst wall thin, 1-1.5 μm thick, and composed of a homogeneous endophragm and a closely appressed periphragm consisting of minute, interwoven sculptural elements which give a granulate to microrugulate appearance and are detached in the apical area, forming the apical horn.

Dimensions: Overall length (13 specimens) 70-95 μm, width (9 specimens) 60-68 μm.

Distribution: A rare species in a number of microfloras of the *Pseudoceratium turneri* Zone. The species occurs in the Cenomanian of Bathurst Island (Norvick, 1975), the Aptian of Queensland, the Albian of Western Australia and South Australia (Cookson & Eisenack, 1968), and the Barremian of England (Sarjeant, 1966b).

Comments: There was no trace of the presence of small thickened areas or 'papillae' in the cyst wall, such as occur in the holotype of the species, and also in Cenomanian specimens of the species described by Norvick (1975), and Aptian specimens of the species from New South Wales (Morgan, pers. comm.). The species is smaller than *A. grande* Cookson & Hughes, 1964, and has a thinner cyst wall than the type species *A. granulatum.*

Genus **Exochosphaeridium** Davey, Downie, Sarjeant & Williams, 1966

Type species (by original designation): *Exochosphaeridium phragmites* Davey & others, 1966; Cenomanian, England.

Exochosphaeridium cf. **E. phragmites** Davey & others
Pl. 37, figs. 2, 5; Pl. 38, figs. 1, 2

?1966 *Exochosphaeridium phragmites* Davey, Downie, Sarjeant & Williams, p. 165, pl. 2, figs. 8-10

Description: Cyst spherical to egg-shaped; a tiny apical horn is formed in a few specimens. Archaeopyle precingular. A paracingulum is vaguely outlined in some specimens; no other traces of paratabulation are apparent. Cyst wall double-layered, acavate, 2-5 μm thick exclusive of processes. Endophragm thin, psilate, periphragm irregularly granulate to fibrous, and supporting solid, fibrous processes which are broadly based and conical, or slender and slightly tapering, with pointed, digitate, or bifurcate tips. Processes 6-20 μm high, apparently distributed at random; two or three processes may be aligned with confluent bases, without preferred orientation.

Dimensions: Length of cyst cavity (11 specimens) 46-68 μm, width (16 specimens) 40-(54)-72 μm.

Distribution: A rare to uncommon form in the marine sequence of the Surat Basin. Norvick (1975) described as *E.* cf. *E. phragmites* Davey & others similar specimens from the Cenomanian of Bathurst Island. The species also occurs in the Cenomanian of England.

Comments: The Surat Basin specimens are assigned to *Exochosphaeridium,* although they lack an irregularly branched apical process; in this respect they are closer to the genus *Trichodinium.* They do not seem to match the diagnoses of the genera *Operculodinium* Wall and *Xenicodinium* Klement in that they sometimes develop an apical protuberance and have more differentiated ornate elements. They differ from *Exochosphaeridium pseudhystrichodinium* (Deflandre, 1937) Davey & others, 1969, in having broader-based processes. *E. cenomaniensis* Norvick, 1975, and *E. brevispinum* Norvick, 1975, both develop a distinct, irregular, periphragmic network. *E. phragmites* seems to have a thinner cyst wall, longer and thinner processes, and a foliate apical process, but is otherwise closely comparable (Davey, pers. comm.). *E. arnace* Davey & Verdier, 1973, has a slightly thicker wall and more closely spaced and longer processes.

Genus **Protoellipsodinium** Davey & Verdier, 1971

Type species (by original designation): *Protoellipsodinium spinocristatum* Davey & Verdier, 1971; Albian, France.

Protoellipsodinium sp. A
Pl. 37, figs. 3, 6, 7

Description: Cyst elongated ellipsoidal to cylindrical with rounded apices. A large precingular archaeopyle is recognised in undamaged specimens; a paracingulum and traces of paraplate sutures are usually visible. Cyst wall thin, covered with vertical ridges and cross-ridges bearing rows of spines 0.5 μm in basal width and 1-3 μm high, with truncated to pointed tips.

Dimensions: Length (4 specimens) 48-60 μm, width (6 specimens) 29-38 μm.

Distribution: Sporadically present in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone.

Comments: The specimens resemble the type species *P. spinocristatum* but are slightly larger and have smaller spines.

Genus **Trichodinium** Eisenack & Cookson, 1960 emend. Clarke & Verdier, 1967

Type species (by original designation): *Trichodinium pellitum* Eisenack & Cookson, 1960; Aptian, Queensland.

Trichodinium eisenackii sp. nov.
Pl. 37, figs. 1, 4

Holotype: GSQ Surat 1, depth 305.3 m (1001 ft 6 in); Wallumbilla Formation, Doncaster Member. Cretaceous, late Aptian. (MFP 5015-1, 329/1180; CPC 16397. Pl. 37, fig. 1).

Description: Cyst broadly ellipsoidal; some specimens have a tiny apical horn about 4 μm high, formed by a cluster of processes or by a thickening of the cyst wall, and which bears a few tiny spinules. A large and roundly triangular archaeopyle is usually present at the location of paraplate 3″. A paracingulum is faintly outlined, other traces of paratabulation are not visible. Cyst wall single-layered, about 1.5 μm thick, irregularly and finely punctate to faintly fibrous, and sparsely covered with short, conical and some tubiform processes 2-5 μm high, with truncate or acuminate, bifid, digitate or capitate distal ends. Many of the processes are aligned in short anastomosing rows without preference in orientation.

Dimensions: Overall length (17 specimens) 46-(61)-80 μm, width 38-76 μm.

Distribution: A rare to very rare species in the lower and middle intervals of the *Odontochitina operculata* Zone, more commonly present in the upper interval of the Zone and the *Pseudoceratium turneri* Zone.

Comments: *T. eisenackii* sp. nov. is smaller than *T. intermedium* Eisenack & Cookson, 1960. It differs also from *T. ciliatum* (Gocht, 1959) Eisenack & Klement, 1964, in having traces of a paracingulum, and solid and conical instead of bristly processes. *Xenicodinium densispinosum* Klement, 1960, has a comparable ornamental arrangement in which the individual processes are aligned into short and curved beads or 'Schnuren', but does not develop either a paracingulum or distinct apical horn.

However, all these species are morphologically very close, and Clarke & Verdier (1967) already suggested that *intermedium* and *ciliatum* be regarded as synonyms of *T. castaneum* (Deflandre, 1935) Clarke & Verdier, 1967 (Davey (1974), however, preferred to keep these three species separated). *T. castaneum* differs from *T. eisenackii* sp. nov. in having a denser spine cover, a broader paracingulum, and more accentuated traces of paratabulation.

SECTION CATEGORY I-B-2

Incorporating all gonyaulacacean forms with a precingular archaeopyle and an intratabular arrangement of ornamental elements. The genus *Coronifera* is here incorporated.

Genus **Coronifera** Cookson & Eisenack, 1958 emend. Davey, 1974

Type species (by original designation): *Coronifera oceanica* Cookson & Eisenack, 1958; Albian, Western Australia.

Coronifera oceanica Cookson & Eisenack
Pl. 38, figs. 3, 4; Pl. 39, figs. 1, 2

1958 *Coronifera oceanica* Cookson & Eisenack, p. 45, pl. 12, figs. 5?, 6

Description: Cyst ellipsoidal to spherical, adorned with a short, solid, inconspicuous apical horn 6 μm long, and a hollow, tubular, distally open antapical horn of variable width and 12-20 μm high, with a dentate to smooth distal margin. Archaeopyle present in only a few specimens, formed by removal of paraplate 3″. Cyst wall thin, not visibly lamellated, punctate, and covered with about 100 slender, simple or branching, occasionally trifurcate processes with pointed tips, of which some may be connected distally. Processes 8-20μm high, much reduced in the apical region; small spinose processes also cover the apical horn.

Dimensions: Length (5 specimens) 54-61 μm, width 42-55 μm.

Distribution: A rare species in the upper interval of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Also present in the Albian of Western Australia and the late Aptian of Germany (Cookson & Eisenack, 1958), the Cenomanian of Bathurst Island (Norvick, 1975), and the Late Cretaceous of the Perth Basin, WA (Cookson & Eisenack, 1968). Outside the Australian region the species has been observed in the Neocomian to Cenomanian of France (Clarke & Verdier, 1967; Davey & Verdier, 1973; Davey, 1974; Verdier, 1975), the Albian to Cenomanian of England (Cookson & Hughes, 1964; Davey, 1969), and the Albian of Saskatchewan (Davey, 1969).

Comments: The cyst of the holotype is granulate, and specimens of the species from the Cenomanian of Bathurst Island as well as Europe (Norvick, 1975; Davey, 1969) have a more intricate cyst wall sculpture, ranging from reticulate to fibrous. Neither the holotype nor the specimens from the Surat Basin have processes joined proximally by low ridges, such as described by Davey. Nevertheless, these differences may be acceptable infraspecific variations.

Coronifera sp. A
Pl. 39, fig. 3

Description: Cyst spherical to ellipsoidal, with a short, rounded to tubular apical horn 5-14 μm long, 4-8 μm wide at the base, and a shorter, wart-like antapical protuberance. Archaeopyle large, formed by the loss of paraplate 3″, with a rounded triangular outline. In some specimens a paracingulum is vaguely indicated. No other traces of paratabulation are visible. Cyst wall 0.5-1 μm thick, punctate, covered by more than 100 thin, simple or branching processes 3-8 μm high, with closed and pointed distal tips, and reduced on the apical horn.

Dimensions: Length of 1 specimen 62 μm, width (2 specimens) 52, 55 μm.

Distribution: A rare form in the upper part of the *Odontochitina operculata* Zone.

Comments: The specimens have shorter processes and a shorter, wart-like antapical horn than the type species *oceanica.* They have been assigned provisionally to *Coronifera* on account of the shape of the cyst, the identical archaeopyle, the presence of both apical and antapical horns, and the similar type of processes. The paratype of *C. oceanica* (Cookson & Eisenack, pl. 12, fig. 5) which I have re-examined, also lacks a distinct tubular antapical horn but has longer processes than *C.* sp. A.

SECTION CATEGORY I-B-3

Incorporating all gonyaulacacean forms with a precingular archaeopyle and a sutural ornament. The following genera are included: *Cribroperidinium, Gonyaulacysta, Heslertonia,* and *Leptodinium.*

Genus **Cribroperidinium** Neale & Sarjeant, 1962 emend. Davey, 1969

Type species (by original designation): *Cribroperidinium sepimentum* Neale & Sarjeant, 1962; Early Cretaceous (Hauterivian), Britain.

Cribroperidinium edwardsii (Cookson & Eisenack) Davey
Pl. 41, fig. 3

1958 *Gonyaulax edwardsi* Cookson & Eisenack, pp. 32-33, pl. 3, figs. 5, 6; text-fig. 7
1958 *Gonyaulax apionis* Cookson & Eisenack, p. 36, pl. 3, fig. 7; text-figs. 3, 4
1966a *Gonyaulacysta edwardsi* (Cookson & Eisenack) Sarjeant, p. 130
1969 *Cribroperidinium edwardsi* (Cookson & Eisenack), Davey, p. 128

Distribution: Specimens similar to *edwardsii* occur sporadically in the *Pseudoceratium turneri* Zone. Isolated paraplate fragments of *?edwardsii* also occur in other assemblages from the Surat Basin. The species has been described and reported from the Aptian and Cenomanian of Western Australia, the ?Aptian of Queensland (Cookson & Eisenack, 1958), the Cenomanian of Bathurst Island (Norvick, 1975), and the Albian of South Australia, from where the specimens, initially assigned to a new species *Gonyaulax apionis* Cookson & Eisenack, 1958, are in fact synonymous with *edwardsii* (according to Norvick, 1975, p. 33).

Outside Australia, the species is known from the mid-Cretaceous of Britain (Cookson & Hughes, 1964), the Barremian to Cenomanian of France (Davey & Verdier, 1973; Verdier, 1975), and the Albian of Alberta, Canada (Singh, 1971).

Cribroperidinium muderongensis (Cookson & Eisenack) Davey
Pl. 40, fig. 3; Pl. 41, fig. 2

1958 *Gonyaulax muderongensis* Cookson & Eisenack, p. 32, pl. 3, figs. 3, 4; text-fig. 15.
1966a *Gonyaulacysta muderongensis* (Cookson & Eisenack) Sarjeant, p. 131
1969 *Cribroperidinium muderongensis* (Cookson & Eisenack) Davey, p. 128

Dimensions: Apical diameter, not including horn, (15 specimens) 84-130 μm, width 75-115 μm; length of apical horn 24-55 μm, maximum height of cingular paraplates 3-5 μm.

Distribution: A rare to uncommon species in the upper part of the *Odontochitina operculata* Zone, and the

Pseudoceratium turneri Zone. Norvick (1975) reported the species from the Cenomanian of Bathurst Island, and Cookson & Eisenack (1958) described the species from the Aptian of Western Australia.

Comments: Specific differences within the genus are often very subtle and hard to observe. In his study of Cenomanian dinoflagellates from Bathurst Island, Norvick (1975) separated *muderongensis* from *edwardsii* on the presence of verrucae and grana on the paraplate surfaces and the presence of more than 4 apical paraplates. The Surat Basin specimens at present assigned to *muderongensis* do not have the 'worm-like surface ridges' described by Cookson & Eisenack, but exhibit large grana and verrucae on the plate areas which are otherwise psilate to granulate. Parasutural lists are thin and low, with notched to serrate crests.

Genus **Gonyaulacysta** Deflandre, 1964 ex Norris & Sarjeant, 1965 emend. Sarjeant, in Davey, Downie, Sarjeant & Williams, 1969

Type species (designated by Norris & Sarjeant, 1965): *Gonyaulacysta* (al. *Gonyaulax*) *jurassica* (Deflandre, 1938) Norris & Sarjeant, 1965; Late Jurassic, France.

Gonyaulacysta cf. **G. cassidata** (Eisenack & Cookson) Sarjeant
Pl. 40, fig. 2

?1960 *Gonyaulax helicoidea* subsp. *cassidata* Eisenack & Cookson, p. 3, pl. 1, figs. 5, 6

?1962b *Gonyaulax cassidata* (Eisenack & Cookson) Cookson & Eisenack, p. 486, pl. 2, figs. 1, 2

?1966a *Gonyaulacysta cassidata* (Eisenack & Cookson) Sarjeant, p. 125, pl. 14, figs. 3, 4; text-fig. 31

Dimensions: Length of 1 specimen 82 μm.

Distribution: Single specimens of the species occur in a few assemblages of the *Pseudoceratium turneri* Zone. The species also occurs in the Aptian of Queensland, the Albian of South Australia, the Albian to Cenomanian of Western Australia (Eisenack & Cookson, 1960; Cookson & Eisenack, 1962b), and the Cenomanian of Bathurst Island (Norvick, 1975). Davey & Verdier (1973) and Verdier (1975) reported it from the Aptian to Cenomanian of France.

Comments: The species could not be adequately examined as only a few suitable specimens were found. These specimens resemble the *cassidata* type in their general appearance and the presence of an epicyst pericoel of variable size.

Gonyaulacysta helicoidea (Eisenack & Cookson) Sarjeant
Pl. 41, fig. 1

1960 *Gonyaulax helicoidea* Eisenack & Cookson, p. 2, pl. 1, figs. 4-9

1969 *Gonyaulacysta helicoidea* (Eisenack & Cookson) Sarjeant, in Davey & others, p. 10

Dimensions: Length of endocyst (6 specimens) 42-64 μm, width (8 specimens) 36-59 μm; length of entire fossil (7 specimens) 57-75 μm; length of apical horn 5-13 μm.

Distribution: A rare species in a number of marine assemblages from the Surat Basin. Also present in the Early Cretaceous (Aptian) of Queensland and South Australia (Eisenack & Cookson, 1960), the Albian of Alberta, Canada (Singh, 1971), and the late Neocomian (Barremian) to Cenomanian of France (Davey & Verdier, 1973; Verdier, 1975).

Genus **Heslertonia** Sarjeant, 1966a

Type species (by original designation): *Heslertonia* (al. *Gonyaulax*) *heslertonense* (Neale & Sarjeant, 1962) Sarjeant, 1966a; Early Cretaceous, Britain.

Heslertonia striata (Eisenack & Cookson) Norvick
Pl. 39, figs. 4, 5, 6; Pl. 40, fig. 4, cf. fig. 1

1960 *Cymatiosphaera striata* Eisenack & Cookson, p. 9, pl. 3, figs. 10, 11

1975 *Heslertonia striata* (Eisenack & Cookson) Norvick, p. 47, pl. 10, fig. 10

Description: Cyst ellipsoidal to almost spherical; archaeopyle formed in few of the specimens found. Cyst wall minutely punctate to granulate, occasionally psilate, with thin, transparent parasutural lists 10-28 μm high, vertically striate or granulate, with smooth to finely undulate crests, and outlining paratabulation, paracingulum and parasulcus.

Dimensions: Overall length (8 specimens) 56-72 μm, length of cyst cavity 41-50 μm, width 29-46 μm.

Distribution: A rare species in some assemblages of the *Pseudoceratium turneri* Zone. Eisenack & Cookson (1960) described it from the Albian and Cenomanian of Western Australia, and Norvick (1975) reported it from the Cenomanian of Bathurst Island.

Comments: The species differs from *Gonyaulacysta striata* Clarke & Verdier, 1967, by its punctate-granulate cyst wall and higher parasutural lists.

Genus **Leptodinium** Klement, 1960 emend. Sarjeant, in Davey, Downie, Sarjeant & Williams, 1969

Type species (by original designation): *Leptodinium subtile* Klement, 1960; Late Jurassic (Kimmeridge), Germany.

Remarks: There is very little difference between this genus and *Spiniferites* in paratabulation and overall morphology. Sarjeant (in Davey & others, 1969) defined *Leptodinium* so as to incorporate specimens with parasutures 'typically marked by ridges or low crests . . . without spines or denticles', and thus separated it from the genus *Spiniferites*, which he diagnosed (1970) as having 'Plate boundaries indicated by variably developed sutural crests or membranes and gonal and sutural processes'.

In this respect many fossils (for instance within the *Spiniferites cingulatus* group) fall between the two genera, so their generic allocation becomes a matter of personal preference. The specimens from the Surat Basin here described as *alectrolophum* Sarjeant and *simplex* sp. nov. also are more or less intermediate; they have psilate to faintly punctate lists with smooth to wavy crests, and are therefore thought to fit best into *Leptodinium*. The genus *Pterodinium* Eisenack includes specimens which seem to develop proportionally higher parasutural lists (Brideaux, pers. comm.).

Leptodinium alectrolophum Sarjeant
Pl. 42, figs. 6, 7

1966a *Leptodinium alectrolophum* Sarjeant, p. 134, pl. 15, figs. 3-6; text-fig. 34

Description: Cyst spherical, tabulated, paracingulum and parasulcus well defined. Paraplates large and bordered by thin, psilate to punctate lists up to 8 μm high. Archaeopyle, if present, formed by the loss of paraplate 3″. Wall thin, distinctly granulate.

Dimensions: Length and width, not including height of the lists, of 3 specimens 42-50 μm.

Distribution: Rarely to uncommonly present in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Sarjeant (1966a) described the species from the Barremian of Britain.

Comments: The Surat Basin specimens show the slight jutting-out of the lists at their gonal junctions, which is typical of the species.

Leptodinium simplex sp. nov.
cf. Pl. 41, fig. 4; Pl. 42, figs. 1-5

Holotype: BMR Roma 8, depth 31.1 m (102 ft 2 in); Wallumbilla Formation, Doncaster Member. Cretaceous, late Aptian (MFP 4676-2, 432/1027; CPC 16425. Pl. 42, fig. 4).

Description: Cyst spherical to roundly ellipsoidal, tabulated, without horns. Paracingulum and parasulcus well defined; cingulum slightly helicoid, height of paracingular plates 4-7 μm; sulcal area may be composed of several paraplates. Plates bordered by thin, psilate, smoothly crested lists 4-10 μm high. Archaeopyle large, triangular, with a broad or narrow base, formed by dislodgement of paraplate 3″. Wall thin, psilate to punctate.

Dimensions: Overall length of 15 specimens 45-70 μm, width 44-60 μm.

Distribution: A frequently occurring species in the marine sequence of the Surat Basin. Tralau (1972) reported similar specimens as *Leptodinium* sp. (his fig. 7) from the Late Cretaceous of Sweden.

Comments: The species is distinguished by its spherical shape, psilate cyst wall and regular, symmetrical paratabulation. In some specimens the parasutural lists are higher in the antapical region. *L. simplex* sp. nov. is smaller than *L. eumorphum* (Cookson & Eisenack, 1960b) Eisenack, 1961, and *Pterodinium cornutum* Cookson & Eisenack, 1962b. It is similar to the type species *L. subtile* Klement, but the paracingulum appears to divide the cyst into two more symmetrical portions. It is also close to *Leptodinium modicum* Brideaux & McIntyre, 1975, from the middle Albian of Horton River, Canada, but has a less helicoidal paracingulum, higher parasutural lists, and a less sinuous (almost straight) parasulcus. In these respects it is closer to *Pterodinium* sp. A (see Brideaux & McIntyre, p. 31, pl. 9, fig. 9).

The Surat Basin specimens resemble those from the upper Tertiary of Victoria which Deflandre & Cookson (1955) identified with *Spiniferites cingulatus* (O. Wetzel) and described as having no processes.

SECTION CATEGORY I-B-4

Incorporating all gonyaulacacean forms with a precingular archaeopyle and whose ornament is gonal (+ sutural). This category includes the genus *Spiniferites*.

Genus **Spiniferites** Mantell, 1850 emend. Sarjeant, 1970

Type species (designated by Loeblich & Loeblich, 1966): *Spiniferites* (al. *Xanthidium*) *ramosus* (Ehrenberg, 1838) Loeblich & Loeblich, 1966; Senonian, Germany.

Spiniferites ramosus (Ehr.) Mantell, subsp. **ramosus** Lentin & Williams
Pl. 42, fig. 8; Pl. 43, figs. 1-3

1838 *Xanthidium ramosum* Ehrenberg, p. 1, figs. 1, 2, 5
1854 *Spiniferites ramosus* (Ehrenberg) Mantell, text-fig. 77, nos. 4, 6.
1933 *Hystrichosphaera ramosa* (Ehr.) Wetzel, p. 144
1966 *Hystrichosphaera ramosa* (Ehr.) Wetzel, var. *ramosa* Davey & Williams, p. 33, pl. 1, figs. 1, 6; pl. 3, fig. 1; text-fig. 8
1971 *Spiniferites ramosus* (Ehr.) Davey & Verdier, p. 33, var. *ramosus* Davey & Williams, 1966.
1973 *Spiniferites ramosus* (Ehr.) Davey & Verdier, 1971, subsp. *ramosus* Lentin & Williams, stat. nov., p. 130

Dimensions: Length of cyst, without lists and processes, (19 specimens) 34-(44)-58 μm; length of gonal processes 8-20 μm, width of paracingulum varies between 4 and 9 μm.

Distribution: A common to rare species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Widely distributed elsewhere in the Cretaceous and Cainozoic of Australia (Cookson & Eisenack, 1971; Norvick 1975). Outside Australia, the species has been reported, among other localities, from the mid-Cretaceous of England (Cookson & Hughes, 1964), the Cenomanian of England and Saskatchewan, Canada (Davey, 1969), the Barremian to Cenomanian of France (Davey & Verdier, 1971, 1973; Verdier, 1975) and the Early Cretaceous of Israel (Brenner, 1974).

Spiniferites ramosus subsp. **granomembranaceus** (Davey & Williams) Lentin & Williams
Pl. 43, fig. 4

1966 *Hystrichosphaera ramosa* var. *granomembranacea* Davey & Williams, p. 37, pl. 4, fig. 4
1973 *Spiniferites ramosus* subsp. *granomembranaceus* (Davey & Williams) Lentin & Williams, comb. nov. & stat. nov., p. 130

Description: Cyst spherical to broadly ellipsoidal, distinctly tabulate; paraplates large and bordered by thin, psilate or proximally granulate lists, extending at the intersection points into conical processes 10-18 μm long, with trifid tips. Parasulcus and paracingulum outlined, cingulum 4 μm wide. Archaeopyle large, rounded triangular, occurring in the position of paraplate 3″. Cyst wall double-layered, endophragm about 1 μm thick, densely and evely granulate, periphragm very thin, closely appressed, and forming the lists and processes.

Dimensions: Length of cyst, not including lists and processes, (7 specimens) 44-62 μm, width 38-50 μm.

Distribution: A rare species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium* *turneri* Zone. Davey & Williams (1966) reported this form from the Eocene of the U.K.

Comments: The Surat Basin specimens are similar to *S. ramosus* subsp. *granomembranaceus* but have lower gonal processes and lists. *S. scabrosum* (Clarke & Verdier, 1967) Norvick, 1975, has scabrate instead of psilate lists and processes. The specimens which Norvick identified with *scabrosum* from the Cenomanian of Bathurst Island are very probably conspecific with *granomembranaceus*.

DIVISION CATEGORY II

Incorporating all dinoflagellates of peridiniacean affinity, characterised by a tabulation of 7 precingular plates, 5 postcingular plates, and/or 2 antapical plates.

SUBDIVISION CATEGORY II-C

Incorporating all peridiniacean forms with an intercalary archaeopyle.

SECTION CATEGORY II-C-1

Incorporating all forms with an intercalary archaeopyle and a non-tabular arrangement of ornamental elements. This category includes the genera *Broomea, Pareodinia,* and *Vozzhennikovia.*

Genus **Broomea** Cookson & Eisenack, 1958

Type species (by original designation): *Broomea ramosa* Cookson & Eisenack, 1958; Late Jurassic, Western Australia.

Broomea jaegeri Alberti
Pl. 45, figs. 6, 7

1961 *Broomea jaegeri* Alberti p. 26, pl. 5, figs. 1-7
1975 *Necrobroomea jaegeri* (Alberti) Wiggins, p. 111
1975 *Batioladinium jaegeri* (Alberti) Brideaux, p. 1241, figs. 1-3

Dimensions: Total length (1 specimen) 98 μm, apical horn 30 μm long; width of cyst (2 specimens) 22, 27 μm, antapical horns slightly unequal, maximum 4-12 μm long.

Distribution: A sporadic form in the *Odontochitina operculata* Zone. The species occurs in the Barremian of Germany (Alberti, 1961), the Albian of France (Davey & Verdier, 1971) and Alberta, Canada (Singh, 1971), and the mid-Cretaceous of England (Cookson & Hughes, 1964).

Comments: The species was found in only three preparations, and although the specimens are fairly well preserved it is not certain that they are in situ fossils in the assemblages. They gave no positive indication as to mode of dehiscence; in a few specimens (see Pl. 45, fig. 6) the apical portion of the cyst is removed. This seems to be typical of the species; Alberti (1961) wrote that specimens from Haverlahwiese usually show fracture marks in the apical cyst wall. He also observed two specimens with an aperture ('Schlupfloch') underneath the apex, suggesting an intercalary archaeopyle, such as in the type species *Broomea ramosa.*

Both Wiggins (1975) and Brideaux (1975) felt the need to restrict the genus *Broomea* by excluding those species which they regarded as dehiscing apically. Those authors agree that *jaegeri* dehisces apically, but apparently neither author has re-examined the type material from Germany. It is felt that Evitt's (1967) reference to the apical mode of dehiscence of *jaegeri,* cited by Brideaux, does not consider the possibility of accidental detachment of the apical cyst portion along fracture lines unrelated to paraplate boundaries, such as occur in *Broomea simplex* (pers. obs.), and that the authors have not attached sufficient weight to Alberti's comments on the species. For this reason the matter seems undecided, and Wiggins's transfer of *jaegeri* to *Necrobroomea* is not followed here.

Genus **Pareodinia** Deflandre, 1947 emend. Wiggins, 1975

Synonyms: Kalyptea Cookson & Eisenack, 1960a.

Type species (by monotypy?): *Pareodinia ceratophora* Deflandre, 1947; mid-Jurassic, France.

Pareodinia ceratophora Deflandre
Pl. 45, figs. 4, 5, 8

1947 *Pareodinia ceratophora* Deflandre, p. 4, figs. 1-3
1960b *Kalyptea monoceras* Cookson & Eisenack, p. 257, pl. 12, fig. 11
?1966b *Paranetrelytron strongylum* Sarjeant, pp. 201-2, pl. 21, fig. 5
1970 *Pareodinia ceratophora* Deflandre, Gocht, p. 154

Description: Cyst ellipsoidal with a rounded antapex and a short, conical, more or less slender apical horn 8-12 μm high. Some specimens are enveloped in a transparent membrane (kalyptra) of varying thickness with a punctate appearance. An archaeopyle is formed immediately underneath the base of the horn, either by loss of only one intercalary paraplate, or with an elongated outline indicating the removal of several intercalaries. No traces of a paracingulum or paratabulation are visible. Cyst wall apparently single-layered, thin and psilate to punctate.

Dimensions: Length (4 specimens) 60-90 μm.

Distribution: Occasionally present in a few marine assemblages from the Surat Basin. Some of the specimens occurring in the Albian part of the sequence may be of secondary origin, as they are thought to be recycled from older (Jurassic?, Neocomian?) sediments. The species is present in the Jurassic of Western Australia and Papua New Guinea (Cookson & Eisenack, 1960b), and the Cenomanian of Bathurst Island (Norvick, 1975). Deflandre (1947) described the species from the Jurassic (Bajocian) of France, and Gocht (1970) reported it from the Jurassic (Bathonian) of Germany.

Genus **Vozzhennikovia** Lentin & Williams, 1975

Type species (by original designation): *Vozzhennikovia* (al. *Spinidinium*) *apertura* (Wilson, 1967) Lentin & Williams, 1975: Early Tertiary, Antarctica.

Vozzhennikovia villosa (Eisenack & Cookson) nov. comb.
Pl. 45, figs. 1, 2

1960 *Dioxya villosa* Eisenack & Cookson, p. 10, pl. 2, figs. 15, 16

Description: Cyst with a cup-shaped posterior part, with a small antapical horn or two protuberances, and a more or less conical anterior part, ending in a small, truncated or indented apical horn 2-4 μm long. Occasionally a small intercalary single-plate archaeopyle is developed. Usually a paracingulum is outlined but no other traces of paratabulation are visible. Cyst wall apparently unstratified, thin, densely covered with short, tiny, round-tipped spinules or grana.

Dimensions: Length of 4 specimens 44-53 μm, width of 5 specimens 33-45 μm.

Distribution: A rare form in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Eisenack & Cookson described the species from the mid-Cretaceous (Albian) of Western Australia.

Comments: Morgan, who re-examined the holotype of *Dioxya villosa,* observed a paracingulum as well as 'a fracture suggesting strongly an intercalary archaeopyle' (Morgan, pers. comm.). On the basis of his observation, and the non-tabular arrangement of surface ornament, the species is here transferred to the genus *Vozzhennikovia.* The specimens found in the Surat Basin are identical to *villosa;* they are slightly smaller than *Diconodinium dispersum* Cookson & Eisenack, 1958.

SECTION CATEGORY II-C-2

Incorporating all peridiniacean forms with an intercalary archaeopyle and an intratabular ornamental structure. This category includes the genera *Diconodinium* and *Spinidinium.*

Genus **Diconodinium** Eisenack & Cookson, 1960

Type species (by original designation): *Diconodinium* (al. *Palaeohystrichophora*) *multispinum* (Deflandre & Cookson, 1955) Eisenack & Cookson, 1960; Senonian, Western Australia.

Diconodinium paucigranulatum sp. nov.
Pl. 44, figs. 1-3

Holotype: GSQ Surat 1, depth 305.3 m (100 ft 6 in); Wallumbilla Formation, Doncaster Member; Cretaceous, late Aptian (MFP 5015-1, 282/1117; CPC 16439. Pl. 44, fig. 3).

Description: Cyst biconical, epicyst longer than hypocyst, with a prominent and thin, tubular or tapering horn 8-18 μm long; hypocyst with a similar but shorter (2-10 μm) horn. A small intercalary archaeopyle with a triangular to hemispherical outline is formed in a few specimens. A paracingulum is vaguely indicated in several specimens; no other traces of paratabulation are visible. Cyst wall thin, sparsely and to all appearances randomly granulate.

Dimensions: Length (14 specimens) 67-85 μm, width (11 specimens) 40-56 μm.

Distribution: A rare to common species in the *Odontochitina operculata* Zone.

Comments: The species is a typical representative of *Diconodinium.* It differs from *D. arcticum* Manum & Cookson, 1964, in lacking a broad paracingulum and having longer horns. *D. glabrum* Eisenack & Cookson, 1960, displays a more or less prominent parasulcus and paracingulum. *D. inflatum* Eisenack & Cookson, 1960, has shorter horns and a clearly delimited parasulcus. *D. davidii* Morgan, 1975, is of similar size but has a much denser and more accentuated granulate-verrucate ornament, which clearly shows alignment along parasutural boundaries.

Diconodinium davidii Morgan
Pl. 44, figs. 4, 5

1975 *Diconodinium davidii* Morgan, p. 157, pl. 1, figs. 1a,b, 2a-d

Dimensions: Length (15 specimens) 73-105 μm, width (14 specimens) 44-68 μm; apical and antapical horns 10-20 μm and 6-12 μm long respectively; paracingulum 4-5 μm wide; ornamental elements (grana, verrucae) 0.5-1 μm high.

Distribution: A rare to common species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Morgan (1975) described the species from the Aptian to mid-Albian of New South Wales.

Comments: The species has a granulate-verrucate-baculate ornament which shows distinct alignment along the paracingulum and parasutures. In some specimens from the upper interval of the *Odontochitina operculata* Zone the sutural elements are partly fused onto slightly raised ledges. An archaeopyle is not often developed. Detachment of the intercalary operculum results also in partial dislodgement of the adjoining precingular paraplate in some specimens, so that the aperture thus formed is not unlike a precingular archaeopyle.

Genus **Spinidinium** Cookson & Eisenack, 1962b

Type species (by original designation): *Spinidinium styloniferum* Cookson & Eisenack, 1962b; Early Cretaceous (?Aptian-Albian), Western Australia.

Spinidinium boydii Morgan
Pl. 44, figs. 6-9

1975 *Spinidinium boydii* Morgan, p. 159, pl. 1, figs. 3a-d

Dimensions: Length (26 specimens) 42-(52)-66 μm, width 34-(43)-52 μm; apical horn 1-6 μm long, paracingulum 4-8 μm wide; ornamental elements 1-2 μm high.

Distribution: A rare to common species in the upper part of the *Odontochitina operculata* Zone, and the *Pseudoceratium turneri* Zone. Morgan described the species from the early Albian of New South Wales.

Comments: The archaeopyle is usually equidimensional, circular to six-sided, formed by the loss of a single intercalary paraplate (see Pl. 44, fig. 9), but occasionally elongated by the (accidental?) loss of all intercalaries (Pl. 44, fig. 6).

Morgan (1975) separated this form from *S. styloniferum* Cookson & Eisenack, 1962b sensu stricto, on account of the smaller horns, the shallower paracingulum, and the less pronounced ornament. Genuine *styloniferum* forms have not been observed in the Surat Basin assemblages.

The species differs from *Wetzeliella pilata* Stanley, 1965, and *Spinidinium densispinatum* Stanley, 1965, in having shorter ornamental elements. *Wetzeliella rugosa* Stanley, 1965, has a consistently crumpled periphragm and develops 2 short antapical horns.

DIVISION CATEGORIES incertae sedis

The dinoflagellates described below are of unknown affinity. The following suprageneric groupings are used here for convenience only.

SUBDIVISION CATEGORIES ?-G

This group includes those forms in which the archaeopyle is seemingly formed by the loss of the entire dorsal part of the cyst.

SECTION CATEGORIES ?-G-1

Here incorporated are all forms which dehisce equatorially and have a non-tabular arrangement of structural elements. This section includes the genus *Nummus*.

Genus **Nummus** Morgan, 1975

Type species (by original designation): *Nummus monoculatus* Morgan, 1975; Aptian, New South Wales.

Nummus monoculatus Morgan
Pl. 46, fig. 4

1975 *Nummus monoculatus* Morgan, p. 163, pl. 3, figs. 1a-d, 4a-c

Description: Cyst spherical or dorso-ventrally compressed, without horns. Cyst wall thin, unstratified, dorsal membrane smooth or rarely covered with small, low, discrete elevations. Ventral membrane rarely preserved. An uninterrupted, low, thin list separates ventral and dorsal portions of the cyst, and seems to mark a line of dehiscence along which the entire dorsal part appears to be removed. A paracingulum is indicated in many specimens as a weak fold of the dorsal membrane. A circular, triangular, or six-sided aperture with thickened rim occurs mid-dorsally, about half-way between apex and paracingulum, imitating an 'intercalary archaeopyle'.

Dimensions: Length (12 specimens) 40-59 μm, width 35-58 μm; aperture diameter 8-12 μm.

Distribution: A rare to common species in many assemblages from the lower interval of the *Odontochitina operculata* Zone. Occasional (probably recycled) specimens also occur in some of the younger assemblages. Morgan (1975) described the species from the late Neocomian and early Aptian of New South Wales.

Comments: Morgan (op. cit.) referred to the mid-dorsal aperture as the pylome, and classified *monoculatus* as an acritarch, but the presence of a cingular structure and the suggested mode of dehiscence imply possible affinity of the species to the dinoflagellates. The dorsal aperture has no typical archaeopyle appearance and may have had no function in the excystment of the nucleus.

Nummus monoculatus is smaller than *Leiosphaeridia similis* Cookson & Eisenack, 1960b. *Cyclopsiella vieta* Drugg & Loeblich, 1967, has a bilamellate, crumbled, pseudoreticulate cyst wall, but develops a flange in an identical position as in *monoculatus*, and dehisces in a similar fashion, as according to the authors some specimens 'appear to have split around the circumference into two halves'.

SUBDIVISION & SECTION CATEGORIES unspecified

Genus **Rhombodella** Cookson & Eisenack, 1962b

Type species (by original designation): *Rhombodella natans* Cookson & Eisenack, 1962b; (late?) Albian, Western Australia.

Rhombodella natans Cookson & Eisenack
Pl. 46, figs. 3, 5, 6

1962b *Rhombodella natans* Cookson & Eisenack, p. 496, pl. 7, figs. 12, 13

Description: Cyst untabulated, initially in the shape of a four-sided pyramid, with rounded edges and corners and sunken sides, but usually compressed, with an irregularly diamond-shaped outline, and compression folds connecting the corners. Cyst wall very thin, transparent, psilate, with up to a dozen tiny, simple spinules 0.5-3 μm high in each of the corner areas. In several specimens a portion of the cyst including one, and occasionally two, of the corners of the pyramid has been removed along a straight and smooth line of detachment.

Dimensions: Diameter of 11 specimens 40-72 μm.

Distribution: An uncommon species in marine assemblages from the Surat Basin. Present in the Albian-Cenomanian of Western Australia (Cookson & Eisenack, 1962b), the Cenomanian of Bathurst Island (Norvick, 1975), and the Albian of France (Davey & Verdier, 1971, 1973).

Comments: Pyramid-shaped cysts are very rare in literature; *Palaeotetradinium silicorum* Deflandre, 1934, includes a similar type of cyst but, as in *natans*, lacks any features which would indicate the polarity of the specimen. The portion of the cyst which is sometimes missing may perhaps represent the operculum, dislodged in archaeopyle formation. In a few complete specimens one of the corners bears a blunt (apical?) spinule slightly thicker and larger than average (Pl. 46, fig. 3), but in most specimens no such process is present.

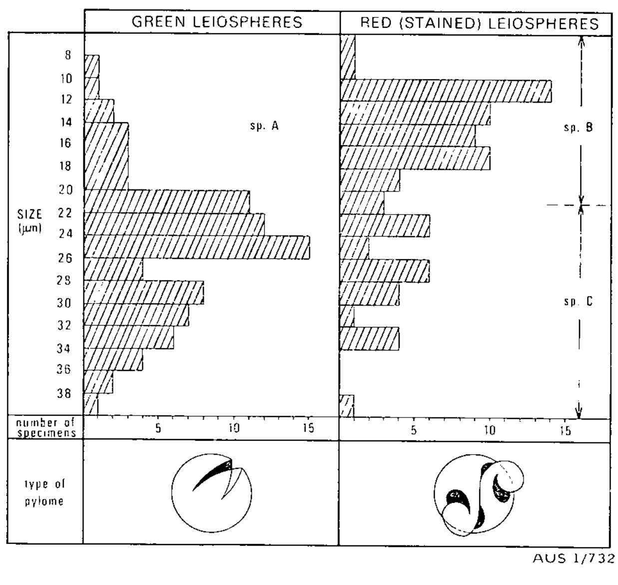


Fig. 24. Size/frequency distribution of red and green leiospheres.

3. SYSTEMATIC STUDY OF ACRITARCHS AND UNCLASSIFIED PALYNOMORPHS

The group of acritarchs occurring in the Early Cretaceous of the Surat Basin includes 14 morphological units here classified as species, assigned to 6 form-genera. They are classified according to the scheme designed by Downie, Evitt & Sarjeant (1963), as follows:

Group	*Subgroup*	*Genus*
ACRITARCHA	SPHAEROMORPHITAE	Palaeostomocystis Leiosphaeridia Fromea
	ACANTHOMORPHITAE	Micrhystridium Baltisphaeridium
	POLYGONOMORPHITAE	Veryhachium
	PTEROMORPHITAE	Pterospermella

Group ACRITARCHA Evitt, 1963
Subgroup SPHAEROMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus **Palaeostomocystis** Deflandre, 1937

Type species (by monotypy?): *Palaeostomocystis reticulata* Deflandre, 1937; Late Cretaceous?, France.

Remarks: The specimens from the Surat Basin here provisionally assigned to *Palaeostomocystis* have the form of a spherical to eggshaped sac, with a thin, single-layered, more or less intensely folded wall, and a smooth-edged pylome at the narrow end. Unlike the type species they are unsculptured and fit well into the Downie & others (1963) definition of the SPHAEROMORPHITAE. The type species *P. reticulata* appears to fit better into the Subgroup HERKOMORPHITAE Downie, Evitt & Sarjeant, and with continued use of the scheme proposed by those authors the species *fragilis* and *pergamentaceus* sp. nov. will probably have to be transferred to a different genus (*Fromea*?).

Palaeostomocystis fragilis Cookson & Eisenack
Pl. 46, fig. 7; Pl. 47, fig. 1

1962b *Palaeostomocystis fragilis* Cookson & Eisenack; p. 496, pl. 7, figs. 10, 11

Description: Outline of shell oval to circular, shape irregularly prolate. Wall single-layered, psilate to minutely punctate-granulate, 1-2 μm thick, arranged into broad, randomly orientated folds. No sign of paratabulation or paracingulum observed. In most specimens a small pylome with smooth edge is developed at the narrow end.

Dimensions: Length (= apical diameter) of sac (48 specimens) 52-(78)-130 μm, maximum width (44 specimens) 42-(68)-110 μm.

Distribution: A common species in the *Osmundacidites dubius* Zone, slightly less frequently present in the *Crybelosporites striatus* Zone; rarely present in the *Coptospora paradoxa* Zone. Comparable specimens have also been found in the *Murospora florida* Zone.

Comments: The specimens here described are comparable with *Palaeostomocystis fragilis* on general appearance but differ in certain aspects. Firstly, the holotype of the species displays transverse folding of the wall which Norvick (1975), who re-examined it in the National Museum of Victoria, Melbourne, where it is permanently deposited, regards as a cingulate structure. No such folding occurs in the Surat Basin specimens. Secondly, the wall of the species is described as 'finely and faintly granular' (Cookson & Eisenack, 1962b) whereas the large majority of the Surat Basin specimens have a psilate wall. Finally, the size range of the Surat Basin specimens only partly overlaps that which the authors gave for *P. fragilis* (82-157 μm).

Fromea amphora Cookson & Eisenack, 1958, differs from the above described specimens by its larger, rimmed aperture and the smoother (less crumpled) wall.

Palaeostomocystis pergamentaceus sp. nov.
Pl. 47, figs. 2, 3

Holotype: BMR Roma 1, depth 30.9 m (101 ft 6 in); Bungil Formation, Minmi Member. Cretaceous, early Aptian (MFP 4322-1, 422/1148; CPC 16471. Pl. 47, fig. 3).

Description: Shell in the form of an oval to spherical sac, with a small aperture (pylome?) at one end. In some specimens an operculum is still attached. Wall very probably single-layered, thin, psilate to punctate, usually folded, with a minutely and densely wrinkled, almost corrugate surface.

Dimensions: Length of sac (= apical diameter) of 19 specimens 52-(63)-82 μm.

Distribution: An uncommon species in many marine assemblages from the Surat Basin.

Comments: P. pergamentaceus sp. nov. differs from other species of *Palaeostomocystis* by its extremely thin, and characteristically wrinkled wall. The presence of an inner membrane, indicating that the species would be cavate, was suggested in only a few species but not confirmed in most others. If an endophragm is present, the species will probably have to be transferred to the genus *Hexagonifera.*

Genus **Leiosphaeridia** Eisenack, 1958a emend. Downie & Sarjeant, 1963

Type species (by original designation): *Leiosphaeridia baltica* Eisenack, 1958a; Ordovician, Germany.

Remarks: Smooth-walled, spherical, unicellular objects with a single organic wall membrane, ranging in diameter from 7 to 40 μm have been found in every preparation examined during the present study. In attempting a systematic approach to this unrewarding group of organisms it was noted that there are two different modes of pylome-formation. In one type (see *Leiosphaeridia* spp. B and C) a pylome may be formed by detachment of one or two round opercula along a winding, S-shaped line of weakness in the wall which is invisible with the light microscope when the opercula are still wholly in place. In the second type (see *Leiosphaeridia* sp. A) the pylome is formed by partial or near-complete detachment of a segment of the wall along a closed circular line of weakness (cryptosuture) which coincides or nearly coincides with the equator.

The difference between the two types of fossils is enhanced by the fact that, although having undergone identical chemical treatment, specimens of the first type readily absorb dye in the saffranine-stained residues and have a pale red colour in the preparations. Those of the second type cannot be stained and retain the greyish green colour which they have in unstained preparations.

It is interesting to note that Eisenack (1969) also reported consistent colour differences between *Leiosphaeridia baltica* (light yellow), *L. leptotheca* (brownish), and *L. voigti* (reddish brown). Although Eisenack commented that these colour differences did not necessarily have systematic value it may prove to be a consistent feature in the group of *Leiosphaeridia,* and should be further investigated on its (taxonomic?) significance.

The three types sp. A, sp. B, and sp. C have been assigned to *Leiosphaeridia,* as Eisenack's diagnosis of the genus specifies the presence of a pylome (sensu lato). *Leiosphaeridia* sp. A resembles forms of *Schizosporis* Cookson & Dettmann, 1959b, but they are smaller; they also have a different (spherical-prolate) shape, and unlike *Schizosporis* may be divided into two unequal portions, the operculum being the smaller.

Broad subdivisions seem to be apparent on the basis of size/frequency distribution (Text-fig. 24). These subdivisions, here ranked as form-species, are given only provisional designation as it is quite impracticable to establish synonymy between them and those species described in the literature. The holotype of the species *L. baltica* is different in that it measures 86 μm in diameter (Eisenack, 1958a, pl. 2, fig. 5) and has a relatively thick and apparently completely closed wall.

Leiosphaeridia sp. A
Pl. 47, figs. 4, 5

Description: Shape spherical, prolate, rarely oblate; shell wall single-layered, psilate to faintly punctate, 0.5-2 μm thick, in many specimens crumpled owing to shrinkage of the specimen, or broadly folded. A pylome, if present, is formed by partial or complete detachment of a relatively large segment of the shell along a smooth, circular line of weakness. Colour greenish grey to green.

Dimensions: Longest diameter (82 specimens) 7-(25)-40 μm.

Distribution: A common to abundant form in nearly every preparation examined.

Comments: The species differs from *Schizosporis parvus* Cookson & Dettmann, 1959b, by its smaller dimensions, spherical to prolate shape, and the single-layered shell wall. *Schizosporis spriggii* Cookson & Dettmann, 1959b, is also larger and has an oblate rather than prolate shape.

Leiosphaeridia sp. B
Pl. 47, fig. 10

Description: Shape spherical to prolate, shell wall very transparent, single-layered, psilate, 0.5-1.5 μm thick. Pylome formed by detachment of one or two circular opercula along an S-shaped line of which each leg describes approximately one full whorl. Opercula usually remain attached by a narrow neck. Size of opercula variable in relation to shell diameter. Colour pink to full red in stained preparations.

Dimensions: Long axis of shell (51 specimens) 9-(14)-21 μm.

Distribution: Present in all preparations examined; rare to common in the *Osmundacidites dubius* Zone, common to abundant in the *Crybelosporites striatus* Zone and the *Coptospora paradoxa* Zone.

Comments: The spiral line of detachment describes whorls of varying size and is only seen when the operculum is dislodged. The opercula are never larger in diameter than one-fifth of the entire body.

Leiosphaeridia sp. C
Pl. 47, figs. 6-9

Description: Shape prolate, shell wall single-layered, transparent, 1-1.5 μm thick, in many specimens broadly folded. Pylome formed by detachment of one, occasionally two, circular, small opercula along an S-shaped line of weakness of which each leg describes a spiral line of approximately one full whorl. Opercula, if dislodged, always attached by a narrow neck. Colour pale pink to red in stained preparations.

Dimensions: Long axis of shell (24 specimens) 21-(27)-38 μm.

Distribution: A rare form in the Early Cretaceous of the Surat Basin.

Comments: Graphic presentation of size/frequency distribution of the group of stained leiospheres suggests that two morphological units are included; sp. C is here separated from sp. B at the value of 21 μm (Text-fig. 24).

Leiosphaeridia sp. C is distinguished from certain dinoflagellates of comparable shape by its type of pylome. It differs from *Fromea amphora* Cookson & Eisenack, 1958, by the presence of an operculum and the spiral shape of the pylome margin. Hedlund (1965) described as *Sigmopollis hispidus* similar forms from the Miocene of Nevada, USA.

Genus **Fromea** Cookson & Eisenack, 1958

Type species (by original designation): *Fromea amphora* Cookson & Eisenack, 1958; Albian, South Australia.

Fromea cf. **F. amphora** Cookson & Eisenack
Pl. 46, figs. 1, 2

?1958 *Fromea amphora* Cookson & Eisenack, p. 56, pl. 5, figs. 10, 11

Dimensions: Length (3 specimens) 60-72 μm, width (7 specimens) 47-88 μm; diameter of aperture 20-27 μm. Wall less than 1 μm thick.

Distribution: A rare species in a number of marine assemblages from the Surat Basin. Also present in the Aptian of Queensland and New South Wales, and the Albian of South Australia and Western Australia (Cookson & Eisenack, 1958). Outside Australia, the species has been reported from the Barremian to Cenomanian of England (Cookson & Hughes, 1964; Sarjeant, 1966b; Davey, 1969), the Albian and Cenomanian of France (Davey, 1969; Davey & Verdier, 1971), the late Albian of Romania (Baltes, 1967b), and the Albian of Alberta, Canada (Singh, 1971).

Comments: The holotype of the species displays a paracingulum and is thicker-walled than the Surat Basin specimens, and, unlike those specimens, has a wall of variable thickness. But this is perhaps not sufficient reason to regard the Surat Basin specimens as a different species. Because of the consistent lack of typical dinoflagellate features they are here provisionally included in acritarchs.

Subgroup ACANTHOMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus **Micrhystridium** Deflandre, 1937 emend. Sarjeant, 1967

Type species (by original designation): *Micrhystridium* (al. *Hystrichosphaera*) *inconspicuum* (Deflandre, 1935) Deflandre, 1937; Late Cretaceous, France.

Remarks: Specimens from the Surat Basin assemblages incorporated into the genus *Micrhystridium* have a main body ranging in diameter from 8 to 30 μm, with a psilate wall without tabulation, in some specimens opened by partial detachment of an operculum. Wall evenly covered with uniform, short, thin, distally closed, and unbranched spinose processes. As in *Leiosphaeridia,* some of these organisms absorb the dye with which the residues are stained, others do not. Subdivision of this group of organisms is here primarily based on relative height and numbers of spines, and each subdivision is classified as a species. No attempt has been made to compare these groups with the myriad species of the genus described in literature, and no formal name is proposed for them at this stage.

Micrhystridium sp. A
Pl. 47, fig. 18

Description: Main body spherical, wall closed, semitransparent, psilate, less than 1 μm thick, evenly covered with about 100 uniformly shaped, discrete, thin, curved spines 1-3 μm high, with unbranched tips. Colour pale pink to red in stained preparations.

Dimensions: Diameter of main body (14 specimens) 8-24 μm.

Distribution: A rare to uncommon form in many assemblages from the Surat Basin.

Micrhystridium sp. B
Pl. 47, fig. 17

Description: Main body spherical, wall closed, semitransparent, up to 1.5 μm thick, covered with 50-150 evenly distributed, uniform, discrete, unbranched, thin and pointed processes 2-4 μm high. Colour greyish green.

Dimensions: Diameter of main body (27 specimens) 16-(21)-30 μm.

Distribution: Present in many assemblages examined; common to abundant in the *Osmundacidites dubius* Zone, rare to common in the *Crybelosporites striatus* Zone and the *Coptospora paradoxa* Zone.

Comments: The specimens are larger than *Micrhystridium* sp. A, and do not absorb the staining agent (saffranine) added to the microfossil residues.

Micrhystridium sp. C
Pl. 47, figs. 11-13

Description: Main body spherical to prolate; pylome commonly formed by partial or complete detachment of an operculum along a smooth circular line of detachment not coinciding with equator. Wall up to 0.5 μm thick, transparent, psilate, covered with well over 500 uniform, tiny, slender spinules or coni less than 1 μm high and implanted in a more or less regular (hexagonal or diamond) configuration. Colour pink in stained preparations.

Dimensions: Diameter of main body (17 specimens) 10-(15)-20 μm.

Distribution: A rare to common species in many assemblages from the Surat Basin.

Comments: This species is distinguished by its small diameter and large number of minute, regularly implanted spinules.

Micrhystridium sp. D
Pl. 47, figs. 14-16

Description: Shape spherical, wall unopened, less than 0.5 μm thick. Surface of shell psilate and covered with 10-20 unconnected, uniform, tiny, slender, and curving processes 2-4 μm long, with pointed, unbranched tips. Colour pale pink to pale red in stained preparations.

Dimensions: Diameter of main body (13 specimens) 10-15 μm.

Distribution: A rare to uncommon species in a number of assemblages from the Surat Basin.

Comments: This form differs from the other species of the genus here described by its smaller average dimensions and fewer processes.

Genus **Baltisphaeridium** Eisenack, 1958b

Remarks: Specimens with unopened shells and regularly distributed spinules occur in several assemblages and are here referred to as *Baltisphaeridium.* They probably represent more than 1 species but are too rare to be discussed adequately.

Subgroup POLYGONOMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus **Veryhachium** Deunff, 1958 emend. Downie & Sarjeant, 1963

Type species (by original designation): *Veryhachium trisulcum* Deunff, 1958; Ordovician, France.

Veryhachium reductum (Deunff) Jekhowsky
Pl. 48, fig. 5

1958 *Veryhachium trisulcum* var. *reductum* Deunff, p. 27, pl. 1, figs. 1, 3, 8, 10-12, 14, 15, 17, 22, 23
1961 *Veryhachium reductum* (Deunff) Jekhowsky, p. 210, pl. 2, figs. 33-37

Dimensions: Diameter of main body (9 specimens) 19-30 μm, appendices 12-27 μm long.

Distribution: A rare species in many marine assemblages from the Surat Basin. The known geological distribution of the species in Australia extends from the Aptian to the Cenomanian (Cookson & Eisenack, 1962a, 1968, 1970; Norvick, 1975).

Comments: The appendices, mostly three, sometimes four, occasionally two in number, are often hollow; the appendix cavity may or may not be separated from the main cavity by the shell wall.

Veryhachium singulare (Firtion) nov. comb.
Pl. 48, figs. 1-3

1952 *Micrhystridium singulare* Firtion, p. 160, pl. 8, figs. 1, 2
1970 *Veryhachium* sp. Cookson & Eisenack, p. 152, pl. 13, fig. 12
?1971 *Baltisphaeridium crameri* Singh; p. 393, pl. 73, figs. 1-3

Description: Main body oblong, pear-shaped, or spherical. Shell wall thin, transparent, psilate, bearing 5-9 thin, hollow, unbranched processes 10-23 μm high, with pointed tips. Process cavity in many specimens not in direct contact with interior of shell.

Dimensions: Maximum diameter of main body (5 specimens) 14-24 μm.

Distribution: A rare species in a number of marine assemblages from the Surat Basin.

Comments: In many specimens the body is not radially symmetrical as in *Micrhystridium,* and the processes are not evenly distributed. In some specimens 3 processes seem to occur in one (the equatorial?) plane and separated 120° as in *V. reductum;* the other processes are distributed at random. The species is here transferred from the genus *Micrhystridium* as it resembles other forms of *Veryhachium* with comparable numbers of spines, such as *Veryhachium* sp. B (see Davey, pl. 7, fig. 19), *V. rhomboidium* Downie, 1959, and *V.* sp. (see Cookson & Eisenack, 1970, pl. 13, fig. 12).

Subgroup PTEROMORPHITAE Downie, Evitt & Sarjeant, 1963

Genus **Pterospermella** Eisenack, 1972

Type species (by original designation): *Pterospermella* (al. *Pterospermopsis*) *aureolata* (Cookson & Eisenack, 1958) Eisenack, 1972; Early Cretaceous, Western Australia.

Pterospermella australiensis (Deflandre & Cookson) Eisenack & Cramer
Pl. 47, figs. 19, 20

1955 *Pterospermopsis autraliensis* Deflandre & Cookson, p. 286, pl. 3, fig. 4; text-figs. 52, 53
1973 *Pterospermella australiensis* (Deflandre & Cookson) Eisenack & Cramer, pp. 959-960

Dimensions: Diameter of main body (35 specimens) 9-(14)-20 μm, maximum overall diameter (37 specimens 16-(33)-55 μm.

Distribution: A rare species in many marine assemblages from the Surat Basin.

Comments: The specimens from the Surat Basin are thought to be identical to Cookson & Eisenack's species, with which they share the general appearance, although they have a more extended size range. They are considerably smaller than *Pt. aureolata* (Cookson & Eisenack, 1958) and *Pt. euryteris* (Cookson & Eisenack, 1958), both reported from the Early Cretaceous of Australia.

UNCLASSIFIED PALYNOMORPHS

Genus **Schizosporis** Cookson & Dettmann, 1959b

Type species (by original designation): *Schizosporis reticulatus* Cookson & Dettmann, 1959b; ?Cenomanian, South Australia.

Schizosporis reticulatus Cookson & Dettmann
Pl. 48, fig. 4

1959b *Schizosporis reticulatus* Cookson & Dettmann; p. 213, pl. 1, figs. 1-4

Dimensions: Maximum equatorial diameter (3 specimens) 78-112 μm; diameter of lumina 6-9 μm.

Distribution: A very rare species in the Early Cretaceous of the Surat Basin. Also present in the Aptian to ?Cenomanian of South Australia and Victoria.

Schizosporis spriggii Cookson & Dettmann
Pl. 48, figs. 8, 9

1969b *Schizosporis spriggi* Cookson & Dettmann; p. 216, pl. 1, figs. 10-14

Dimensions: Maximum equatorial diameter (3 specimens) 100-132 μm, wall 1.5-2 μm thick.

Distribution: Very rarely present in some mid-Albian assemblages. Also present in the Albian and ?Cenomanian of South Australia.

Schizosporis sp. A
Pl. 48, figs. 6, 7

Description: Shell large, spherical, wall thin, transparent, psilate to punctate, with a narrow to widely gaping median slit of varying length, which is only visible when the margins have separated; the wall is then usually folded back along its edges.

Dimensions: Maximum diameter of shell (7 specimens) 54-67 μm, length of opened slit 2-20 μm.

Distribution: A rare species in some late Aptian and early Albian assemblages.

Comments: These specimens are provisionally assigned to *Schizosporis* on account of their size, and the presence of a median slit. Pollen grains of *Concentrisporites* Wall have comparable slits which divide the body into two equal portions, but they are enveloped in an outer layer, and *Schizosporis* sp. A. is not. The species is smaller than *S. spriggii* and has a thinner wall; *S. parvus* is ellipsoidal and not spherical.

ACKNOWLEDGEMENTS

The author expresses his gratitude to Dr R. J. Davey, of Robertson Research International Ltd in North Wales, who critically read the manuscript, commented in detail on taxonomic and descriptive treatment of the dinoflagellates, and made many valuable suggestions regarding debatable points on morphology. He is also grateful to Dr D. Wall, of Amoco Production Co., Denver, who checked and commented upon the discussion of dinoflagellate taxonomy and gave valuable advice on the dinoflagellate classification here used.

He is indebted to Mr R. Morgan, formerly of the Geological Survey of New South Wales, and Mr D. W. Haig, formerly of the University of Queensland, for discussions and exchange of very helpful (and as yet unpublished) information based on their own studies on dinoflagellates and foraminifera in the Cretaceous of the Great Artesian Basin.

Discussions on lithostratigraphy, palaeo-environments, and log interpretation of well sections, with Drs N. F. Exon and B. R. Senior of the Bureau of Mineral Resources were very helpful in clarifying stratigraphic problems.

The author wishes in particular to express his sincere gratitude to Messrs J. T. Woods and R. A. Allen, of the Geological Survey of Queensland, for their most generous approval to examine large amounts of core material from Survey drilling projects, which were indispensable for this and other studies, and for the facilities kindly provided during collection of the samples.

Special appreciation is due to the BMR Cartography Section for drawing the figures and correlation diagrams.

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APPENDIX A: Composition of microfloral assemblages.

Sample number (MFP)	*Spores and pollen*	*Dino-flagellates*	*Acritarchs, Chlorophytae*	*Other microfossils*	*Total specimen count*
Griman Creek Formation					
5385	160	—	33	7	200
5340	181	—	13	6	200
5324	124	—	69	7	200
4704	169	1	25	5	200
5382	197	—	—	3	200
5322	159	—	32	9	200
6423	162	—	37	1	200
5387	188	—	5	7	200
6426	121	2	69	8	200
6422	160	—	36	4	200
4634	196	—	2	2	200
5013	193	—	4	3	200
4635	187	—	7	6	200
5008	176	—	19	5	200
4636	177	1	15	7	200
5017	166	—	29	5	200
5023	175	—	22	3	200
6428	176	—	19	5	200
5223	180	—	19	1	200
4706	180	—	17	3	200
4705	183	—	16	1	200
5222	175	—	19	6	200
6468	140	—	59	1	200
6450	141	—	57	2	200
4611	183	—	16	1	200
6435	167	—	32	1	200
Surat Siltstone					
5004	143	6	41	10	200
5012	156	3	31	10	200
4671	168	1	28	3	200
4535	183	2	8	7	200
5021	117	5	75	3	200
5321	169	—	27	4	200
4763	148	—	44	8	200
4612	171	5	18	6	200
6451	120	—	79	1	200
5216	166	3	23	8	200
4623	134	1	58	7	200
5221	144	5	46	5	200
5005	25	25	147	3	200
4266	162	9	21	8	200
1208	94	71	25	10	200
4624	164	3	28	5	200
6425	59	9	126	6	200
4625	140	4	48	8	200
Coreena Member					
4536	187	—	7	6	200
4537	189	2	2	7	200
5383	167	—	30	3	200
4538	178	4	11	7	200
4244	56	74	54	16	200
4615	117	40	34	9	200
4255	95	38	51	16	200
5821	172	2	23	3	200
4616	27	77	84	12	200
5022	186	—	13	1	200
6238	26	55	112	7	200
905	128	40	8	24	200
5014	146	6	31	17	200
4638	168	—	28	4	200
5209	170	—	18	12	200
4267	118	24	47	11	200
Doncaster Member					
4251	52	63	77	8	200
6239	83	24	138	5	250
5384	179	3	2	16	200
5006	87	45	57	11	200

APPENDIX A (contd): Composition of microfloral assemblages.

Sample number (MFP)	*Spores and pollen*	*Dino-flagellates*	*Acritarchs, Chlorophytae*	*Other microfossils*	*Total specimen count*
906	81	47	60	12	200
4675	113	8	73	6	200
5015	99	27	64	10	200
5800	132	10	53	5	200
5789	88	14	90	8	200
4676	103	16	80	1	200
5007	31	39	126	4	200
5801	114	18	62	6	200
Bungil Formation					
4276	129	21	46	4	200
4320	100	6	82	12	200
5790	182	2	13	3	200
3966	105	65	25	5	200
773	191	—	4	5	200
5208	177	1	20	2	200
5802	180	—	13	7	200
5975	184	1	14	1	200
5791	187	2	11	—	200
5154	132	16	43	9	200
4322	125	8	65	2	200
4325	138	—	61	1	200

APPENDIX B: Composition of spore and pollen assemblages.

Sample number (MFP)	*Cyathidites*, *Dictyophyllidites*, *Biretisporites*	*Cyathidites rafaeli*	*Baculatisporites comaumensis*, *Osmundacidites wellmanii*	*Osmundacidites dubius*	*Ceratosporites*	*Cepulina truncata*	*Cicatricosisporites*	*Lycopodiumsporites*	Other trilete azonate spores	*Gleicheniidites circinidites*	*Foraminisporis*	*Stereisporites*	*Crybelosporites*	Remainder of trilete spores	Monoletes, Hilates, Aletes & Inaperturates, Monosulcates	*Alisporites-Vitreisporites*	Podocarpoid pollen grains	*Microcachryidites antarcticus*, *Trisaccites microsaccatus*	*Classopollis*	*Clavatipollenites hughesii*, *Liliacidites* spp. *Asteropollis asteroides*	Total specimen count
Griman Creek Formation																					
5385	59	24	17	—	1	—	4	6	12	14	1	24	1	1	10	13	1	8	—	4	200
5340	73	30	19	—	—	—	4	5	8	9	—	18	1	—	9	19	—	4	—	1	200
5324	89	35	2	—	1	—	13	4	5	6	1	5	—	—	7	24	2	6	—	—	200
4704	63	25	34	—	1	—	12	5	5	2	—	14	—	1	8	20	3	4	—	3	200
5382	68	7	11	2	—	—	42	2	17	16	1	9	1	1	7	11	—	5	—	—	200
5322	67	9	17	—	—	—	2	—	11	2	—	23	—	—	15	42	2	9	1	—	200
6423	54	23	14	—	—	—	4	1	3	3	1	14	2	—	5	48	—	18	1	9	200
5387	39	20	29	—	4	—	2	7	6	4	3	42	—	—	3	27	2	9	—	3	200
6426	65	17	9	2	1	—	—	1	15	7	3	6	7	1	6	24	—	11	1	24	200
6422	50	18	24	—	—	—	—	4	7	5	5	8	4	1	4	46	6	12	—	6	200
4634	40	12	3	—	1	—	1	—	6	16	1	—	—	—	1	70	6	40	—	3	200
5013	54	19	34	1	—	—	13	5	16	14	1	10	1	1	2	24	2	3	—	—	200
4635	54	27	16	2	1	—	10	1	8	11	1	11	3	1	7	29	3	14	—	1	200
5008	89	19	15	—	—	—	3	2	9	14	2	5	—	1	5	24	4	6	—	2	200
4636	51	3	30	—	5	5	2	5	8	1	—	8	2	1	19	40	3	17	—	—	200
5017	104	6	1	—	—	—	—	—	5	2	—	—	2	—	3	45	1	30	—	1	200
5023	59	16	32	—	1	—	3	2	8	6	—	25	—	1	8	21	3	14	—	1	200
6428	28	16	19	8	1	—	1	4	10	2	2	41	1	—	9	34	4	19	—	1	200
5223	64	35	22	—	—	—	1	—	8	19	1	18	3	1	4	15	1	7	—	1	200
4706	76	19	26	—	—	—	1	1	8	3	3	18	3	1	7	16	1	7	—	10	200
4705	86	20	18	—	—	—	—	—	6	6	3	3	6	—	9	27	2	13	—	1	200
5222	101	11	40	—	1	—	4	2	12	2	—	5	3	—	5	11	—	1	—	2	200
6468	89	15	17	—	1	—	—	6	5	5	—	5	14	3	7	17	1	9	—	6	200
6450	59	8	1	—	1	—	—	3	8	4	5	1	4	—	4	58	6	34	—	4	200
4611	63	9	24	1	2	—	2	2	2	1	1	21	4	—	14	25	1	10	—	18	200
6435	59	24	6	—	—	—	—	—	5	—	—	20	3	—	5	45	5	28	—	—	200

APPENDIX B (contd): Composition of spore and pollen assemblages.

Sample number (MFP)	*Cyathidites, Dictyophyllidites, Biretisporites*	*Cyathidites rafaeli*	*Baculatisporites comaumensis, Osmundacidites wellmanii*	*Osmundacidites dubius*	*Ceratosporites*	*Cepulina truncata*	*Cicatricosisporites*	*Lycopodiumsporites*	Other trilete azonate spores	*Gleicheniidites circinidites*	*Foraminisporis*	*Stereisporites*	*Crybelosporites*	Remainder of trilete spores	Monoletes, Hilates, Aletes & Inaperturates, Monosulcates	*Alisporites-Vitreisporites*	Podocarpoid pollen grains	*Microcachryidites antarcticus, Trisaccites microsaccatus*	*Classopollis*	*Clavatipollenites hughesii, Liliacidites* spp. *Asteropollis asteroides*	Total specimen count
Surat Siltstone																					
5004	65	14	38	1	2	—	1	7	6	5	1	37	—	2	7	12	—	2	—	—	200
5012	52	11	31	1	1	1	6	2	11	2	1	63	—	1	8	7	—	2	—	—	200
4671	58	9	79	—	1	—	5	4	9	2	—	8	3	1	6	10	—	4	—	1	200
4535	45	10	75	1	2	1	8	11	10	1	1	8	2	—	2	17	—	3	1	2	200
5021	60	9	59	1	3	1	2	3	12	2	—	40	—	—	4	3	1	—	—	—	200
5321	77	14	57	—	—	—	3	5	7	1	—	11	3	—	3	10	—	4	—	5	200
4763	73	16	31	—	1	—	6	3	6	1	1	8	9	4	3	11	3	7	—	17	200
4612	58	16	33	1	1	—	2	2	6	3	5	15	9	—	7	18	1	4	—	19	200
6451	38	15	1	—	—	—	—	—	10	3	1	2	—	—	3	30	2	85	—	10	200
5216	55	29	2	—	—	—	1	4	22	15	1	16	1	6	3	33	—	8	—	4	200
4623	61	22	56	—	—	—	6	2	8	2	2	16	4	1	7	5	—	1	—	7	200
5221	61	24	2	—	2	—	—	2	11	9	—	29	1	3	9	36	—	10	—	1	200
5005	80	20	10	—	6	2	—	4	15	29	1	16	2	3	5	3	—	3	—	1	200
4266	56	14	53	1	4	1	4	6	6	8	1	32	1	—	2	9	1	1	—	—	200
1208	38	5	65	1	9	3	4	4	9	4	—	45	1	1	—	8	1	1	1	—	200
4624	60	21	62	—	1	—	5	3	3	2	1	20	1	1	8	6	—	2	—	4	200
6425	47	13	38	4	4	1	4	7	10	1	—	46	—	—	4	14	1	4	1	1	200
4625	27	21	38	1	3	—	1	2	9	3	—	72	—	—	7	13	1	1	—	1	200
Coreena Member																					
4536	52	8	20	2	2	2	2	4	16	2	1	6	2	—	14	54	2	9	—	2	200
4537	36	12	31	6	2	1	8	3	11	2	—	20	6	1	6	26	—	18	—	11	200
5383	80	18	45	—	1	—	8	—	11	5	1	18	1	1	3	6	—	1	—	1	200
4538	58	14	72	—	4	—	1	8	7	3	3	9	8	—	7	2	—	2	—	2	200
4244	17	7	15	1	2	1	1	2	5	7	—	17	—	1	6	11	1	5	1	—	100
4615	34	21	28	1	2	—	3	3	16	9	—	33	2	1	8	33	1	5	—	—	200
4255	49	27	13	15	3	1	3	1	13	10	1	44	—	—	3	10	3	4	—	—	200
5821	55	15	20	1	4	2	1	5	4	3	1	63	1	—	3	17	—	4	—	1	200
4616	44	9	4	2	5	1	2	3	7	6	—	10	—	1	1	4	1	—	—	—	100
5022	122	59	—	—	—	—	—	2	8	—	—	1	—	—	2	3	—	2	—	1	200
6238	21	25	—	9	—	—	—	—	11	19	1	—	—	1	5	3	—	5	—	—	100
905	31	13	35	1	10	5	6	6	10	2	—	32	—	2	9	29	3	6	—	—	200

APPENDIX B (contd): Composition of spore and pollen assemblages.

Sample number (MFP)	*Cyathidites, Dictyophyllidites, Biretisporites*	*Cyathidites rafaeli*	*Baculatisporites comaumensis, Osmundacidites wellmanii*	*Osmundacidites dubius*	*Ceratosporites*	*Cepulina truncata*	*Cicatricosisporites*	*Lycopodiumsporites*	Other trilete azonate spores	*Gleicheniidites circinidites*	*Foraminisporis*	*Stereisporites*	*Crybelosporites*	Remainder of trilete spores	Monoletes, Hilates, Aletes & Inaperturates, Monosulcates	*Alisporites-Vitreisporites*	Podocarpoid pollen grains	*Microcachryidites antarcticus, Trisaccites microsaccatus*	*Classopollis*	*Clavatipollenites hughesii, Liliacidites* spp. *Asteropollis asteroides*	Total specimen count
5014	47	11	5	—	3	—	8	8	10	1	1	79	—	4	5	14	1	1	1	1	200
4638	26	27	15	4	5	1	1	3	8	1	—	86	—	2	4	10	3	4	—	—	200
5209	23	29	2	1	—	—	—	3	14	3	3	4	1	5	3	59	6	43	—	1	200
4267	36	44	13	2	5	4	7	4	9	6	—	42	—	1	7	16	1	3	—	—	200
Doncaster Member																					
4251	10	10	15	—	3	2	—	3	5	4	—	41	—	—	1	6	—	—	—	—	100
6239	42	28	10	3	4	—	—	7	11	43	—	36	—	2	4	5	—	5	—	—	200
5384	50	10	17	17	3	1	7	4	19	4	18	19	—	8	4	9	1	9	—	—	200
5006	51	34	15	7	3	2	2	10	16	9	1	40	1	2	3	3	—	1	—	—	200
906	47	23	38	11	15	4	5	9	10	6	—	19	—	1	2	8	—	2	—	—	200
4675	46	20	22	6	20	2	1	8	13	17	—	29	—	—	2	8	2	4	—	—	200
5015	51	35	13	4	8	2	1	8	20	38	—	10	—	—	3	6	—	1	—	—	200
5800	89	12	40	6	9	—	1	4	11	7	—	15	—	1	4	—	1	—	—	—	200
5789	81	20	28	5	5	2	2	4	10	12	—	15	—	—	6	8	1	1	—	—	200
4676	50	8	27	5	21	7	3	15	17	9	—	20	—	6	—	10	—	2	—	—	200
5007	103	20	11	1	2	2	—	3	9	34	—	9	—	—	2	3	—	1	—	—	200
5801	66	19	29	4	5	2	1	4	19	22	—	16	—	2	3	4	—	4	—	—	200
Bungil Formation																					
4276	45	21	10	1	14	1	1	22	14	8	—	26	—	5	6	18	1	7	—	—	200
4320	40	30	10	1	7	2	—	13	13	5	—	54	—	3	6	11	1	4	—	—	200
5790	62	6	15	1	13	3	6	18	18	8	—	30	—	5	7	5	1	2	—	—	200
3966	52	17	42	6	11	—	—	8	9	2	—	17	—	—	9	20	5	2	—	—	200
773	44	15	14	—	4	3	—	26	37	11	—	15	—	—	5	16	3	6	1	—	200
5208	51	31	6	—	1	2	2	17	27	14	—	14	—	2	15	13	2	3	—	—	200
5802	52	18	1	—	9	1	1	10	9	23	—	36	—	—	6	24	2	8	—	—	200
5975	80	11	29	—	3	1	—	17	13	5	—	12	—	—	8	16	2	3	—	—	200
5791	93	11	9	—	12	6	3	18	11	16	—	6	—	1	3	8	1	2	—	—	200
5154	58	29	9	—	8	5	2	18	26	13	1	18	—	—	5	8	—	—	—	—	200
4322	42	29	19	2	8	3	—	14	18	3	—	34	—	6	6	13	1	2	—	—	200
4325	34	12	29	—	18	5	—	30	21	4	—	31	1	—	5	8	—	1	1	—	200

APPENDIX C: Composition of dinoflagellate assemblages.

BMR Sample number (MFP)	*Canningia colliveri*	*Canninga minor* (sensu lato)	*Hexagonifera*	*Dingodinium cerviculum*	*Tenua aptiense*	*Tenua pilosa*	*Chlamydophorella nyei*	*Membranosphaera norvickii*	*Membranosphaera romaensis*	*Membranosphaera coninckii*	*Cleistosphaeridium*	*Cassiculosphaeridia ?reticulata*	*Apteodinium*	*Trichodinium eisenackii*	*Coronifera*	*Cribroperidinium* + *Gonyaulacysta*	*Leptodinium*	*Spiniferites*	*Diconodinium paucigranulatum*	*Diconodinium davidii*	*Spinidinium boydii*	*Vozzhennikovia villosa*	*Muderongia*	*Odontochitina*	*Rhombodella natans*	Other dinoflagellates	Total specimen count
SURAT SILTSTONE																											
5005	—	1	1	—	—	17	38	—	7	7	18	—	1	—	3	2	—	5	—	—	19	3	1	1	14	62	200
1208	3	6	4	1	—	9	39	—	2	3	8	8	6	11	7	3	6	4	—	—	11	—	7	9	—	53	200
WALLUMBILLA FORMATION																											
Coreena Member																											
4244	2	2	1	2	—	9	7	2	1	—	13	2	9	2	8	1	2	12	—	9	4	—	—	1	—	61	150
4615	5	5	2	—	—	6	6	—	7	4	5	1	1	—	—	—	—	—	—	—	4	—	10	11	5	28	100
4255	1	8	1	—	—	3	4	2	2	—	3	—	4	2	—	2	1	1	—	—	2	—	—	1	2	61	100
4616	3	12	2	—	—	13	28	6	7	2	9	—	1	5	3	2	1	7	—	—	38	—	3	5	6	47	200
6238	1	7	1	1	—	9	16	—	5	—	2	—	3	—	—	—	1	7	—	—	101	—	—	—	9	37	200
905	12	4	5	—	—	2	8	2	3	—	1	2	—	1	1	1	—	5	—	4	—	—	3	7	1	38	100
4267	1	2	3	2	—	1	9	3	—	—	—	—	1	1	—	—	2	1	—	3	—	—	—	2	—	19	50
Doncaster Member																											
4251	—	—	3	1	—	3	9	—	10	—	1	—	—	—	2	—	—	1	6	25	3	—	2	1	2	31	100
6239	1	8	5	2	—	3	4	—	19	—	—	—	—	—	—	—	2	2	5	—	—	—	—	7	5	37	100
5006	1	2	4	—	—	3	7	—	13	3	1	5	—	—	1	1	2	4	—	4	—	—	—	—	6	43	100
906	2	1	2	9	—	9	18	—	18	—	—	—	—	1	—	4	1	1	—	—	—	—	1	—	—	33	100
5007	—	7	6	—	4	14	45	—	13	2	7	2	—	1	3	3	3	6	—	—	4	7	1	10	8	54	200
BUNGIL FORMATION																											
3966	24	8	6	16	6	2	25	—	33	—	1	—	—	1	—	3	2	2	—	—	1	—	6	8	1	55	200

APPENDIX D: Composition of acritarch assemblages.

Sample number (MFP)	*Leiosphaeridia* sp. A	*Leiosphaeridia* sp. B	*Leiosphaeridia* sp. C	*Leiosphaeridia* spp.	*Micrhystridium* sp. A	*Micrhystridium* sp. B	*Micrhystridium* sp. C	*Micrhystridium* sp. D	*Micrhystridium* spp.	*Baltisphaeridium*	*Veryhachium*	*Palaeostomcystis*	Total specimen count	*Pterospermella australiensis*
Griman Creek Formation														
5385	5	45	—	—	—	—	—	—	—	—	—	—	50	—
5324	3	96	—	—	1	—	—	—	—	—	—	—	100	—
4704	9	41	—	—	—	—	—	—	—	—	—	—	50	—
6423	23	55	2	—	—	12	—	7	—	—	—	1	100	—
6426	17	43	—	—	1	4	4	23	—	—	2	1	100	—
6422	20	56	3	—	5	2	2	9	3	—	—	—	100	—
5008	—	50	—	—	—	—	—	—	—	—	—	—	50	—
5023	—	50	—	—	—	—	—	—	—	—	—	—	50	—
6428	1	53	3	—	—	—	4	9	5	—	—	—	75	—
5223	—	50	—	—	—	—	—	—	—	—	—	—	50	—
4705	17	32	—	—	—	—	—	—	—	—	1	—	50	—
6468	21	72	1	—	—	3	1	1	1	—	—	—	100	—
6450	9	79	1	—	—	2	—	3	6	—	—	—	100	—
4611	5	41	2	—	—	1	—	1	—	—	—	—	50	—
6435	7	85	4	—	—	—	—	—	4	—	—	—	100	—
Surat Siltstone														
5004	20	60	—	2	—	1	6	8	1	1	—	1	100	1
5012	8	71	—	—	—	—	9	8	2	—	2	—	100	—
4671	29	60	2	—	—	1	1	3	4	—	—	—	100	—
5021	8	64	—	—	—	—	17	11	—	—	—	—	100	—
5321	2	80	1	—	1	—	3	11	2	—	—	—	100	—
4763	57	34	2	4	—	—	1	—	2	—	—	—	100	—
4612	5	75	5	—	—	2	5	5	2	—	1	—	100	—
6451	6	180	5	—	1	—	1	2	4	—	1	—	200	—
5216	25	50	—	—	—	—	7	13	3	—	2	—	100	—
4623	8	64	2	—	—	—	13	11	—	—	1	1	100	—
5221	8	79	—	—	—	—	10	—	3	—	—	—	100	—
5005	2	81	—	—	1	—	95	16	—	—	4	1	200	—
4266	26	54	5	—	—	—	2	7	1	—	3	2	100	—
1208	30	21	1	1	—	—	35	4	2	—	1	5	100	1
4624	9	74	1	—	—	1	1	11	2	—	1	—	100	—
6425	46	40	—	—	—	—	97	14	2	1	—	—	200	—
4625	15	59	2	—	—	—	10	9	2	—	1	—	98	—
Coreena Member														
5383	7	82	—	—	—	—	4	5	1	—	1	—	100	—
4244	42	4	—	15	1	—	1	2	2	3	28	2	100	1
4615	19	40	3	—	1	—	19	7	3	—	2	5	99	—
4255	30	46	3	—	—	6	3	4	1	—	2	4	99	1
4616	14	34	—	—	1	1	39	2	2	—	6	1	100	4
5022	—	46	1	—	3	—	—	—	—	—	—	—	50	—
6238	22	51	—	—	2	5	8	16	—	8	1	—	113	2
5014	3	43	2	—	1	—	—	—	—	—	—	1	50	—
4638	45	41	—	—	—	12	1	—	—	—	—	1	100	—
5209	3	44	—	2	—	—	—	—	1	—	—	—	50	—
4267	34	51	1	—	—	2	—	1	1	—	10	—	100	1
Doncaster Member														
4251	21	4	—	47	1	8	—	1	7	—	8	2	99	2
6239	28	50	—	—	2	37	10	1	—	—	9	1	138	1
5006	11	65	4	—	2	—	4	3	—	1	7	3	100	1
906	28	14	—	—	—	20	20	—	12	2	4	—	100	1
4675	47	12	—	—	—	34	6	—	—	—	1	—	100	3
5015	23	25	—	—	—	38	8	—	—	4	1	1	100	1
5800	41	32	1	—	—	15	9	—	—	—	2	—	100	1
5789	16	36	1	—	2	12	21	2	—	—	9	1	100	—
4676	23	10	1	—	—	62	3	—	—	—	1	—	100	1
5007	—	45	—	—	—	—	60	15	—	—	4	2	126	—
5801	26	29	—	—	8	26	9	1	—	—	1	—	100	1
Bungil Formation														
4276	19	8	—	—	1	64	—	—	—	—	1	1	94	—
4320	27	14	—	—	—	47	2	—	—	—	5	5	100	8
3966	44	15	6	—	—	27	4	—	—	—	2	2	100	—
5154	44	14	—	—	—	41	1	—	—	—	—	—	100	—
4322	22	12	2	—	—	49	1	—	—	—	4	10	100	2
4325	14	5	1	—	—	74	6	—	—	—	—	—	100	1

APPENDIX E: Derivation of proposed new specific names.

APTIENSE (*Tenua*): based on the age of the stratum from which the selected holotype of the species has been recovered.

CONINCKII (*Membranosphaera*): named after Dr J. de Coninck, of the Institute of Geology, Ghent, Belgium.

DETTMANNAE (*Lycopodiacidites*): named after Dr Mary E. Dettmann, of the University of Queensland, Brisbane, Australia.

DUBIUS (*Osmundacidites*): from L. for doubtful, uncertain.

EISENACKII (*Trichodinium*): named after Prof. Albert Eisenack, of the University of Tübingen, Germany.

GRANULATUM (*Cleistosphaeridium*): from L. *granum*, grain or kernel.

NORVICKII (*Membranosphaera*): named after Dr M. S. Norvick, of B.P. Petroleum Development Ltd, Aberdeen; formerly of the Bureau of Mineral Resources, Canberra.

PAUCIGRANULATUM (*Diconodinium*): from L. *paucus*, few, and *granum*, grain or kernel.

PERGAMENTACEUS (*Palaeostomocystis*): from L. *pergamentum*, parchment; based on the minutely wrinkled appearance of the cyst membrane.

POCOCKII (*Stereisporites*): named after Dr S. A. J. Pocock, of Imperial Oil Ltd, Calgary, Alberta, Canada.

ROMAENSIS (*Membranosphaera*): named after the Roma 1:250 000 Sheet area from where the selected holotype has been recovered.

SIMPLEX (*Leptodinium*): from L. for simple, plain.

SOLIDUS (*Lycopodiumsporites*): from L. for massive, dense.

PLATE 1
all figures x750

Figs. 1, 2, 6 **Cyathidites australis** Couper. p. 48

Figs. 3, 7 **Cyathidites australis** var. **rimalis** Balme, showing typical exine thickenings along trilete laesurae. p. 48

Figs. 4, 5 **Cyathidites minor** Couper. p. 48

Figs. 8, 9 **Cyathidites rafaeli** (Burger). p. 48

Fig. 10 **Cyathidites punctatus** (Delcourt & Sprumont). p. 48

1. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 355/1185. CPC 16092.
2. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 400/1068. CPC 16093.
3. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-2, 452/1120. CPC 16094.
4. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-1, 413/1079. CPC 16095.
5. Same sample as Fig. 4; MFP 6451-1, 458/1109. CPC 16096.
6. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 417/1038. CPC 16097.
7. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 363/1152. CPC 16098.
8. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-1, 425/1044. CPC 16099.
9. BMR Surat 3, 15.9 m, Griman Creek Formation; MFP 4611-1, 443/1165. CPC 16100.
10. Same sample as Fig. 2; MFP 6426-2, 462/1059. CPC 16101.

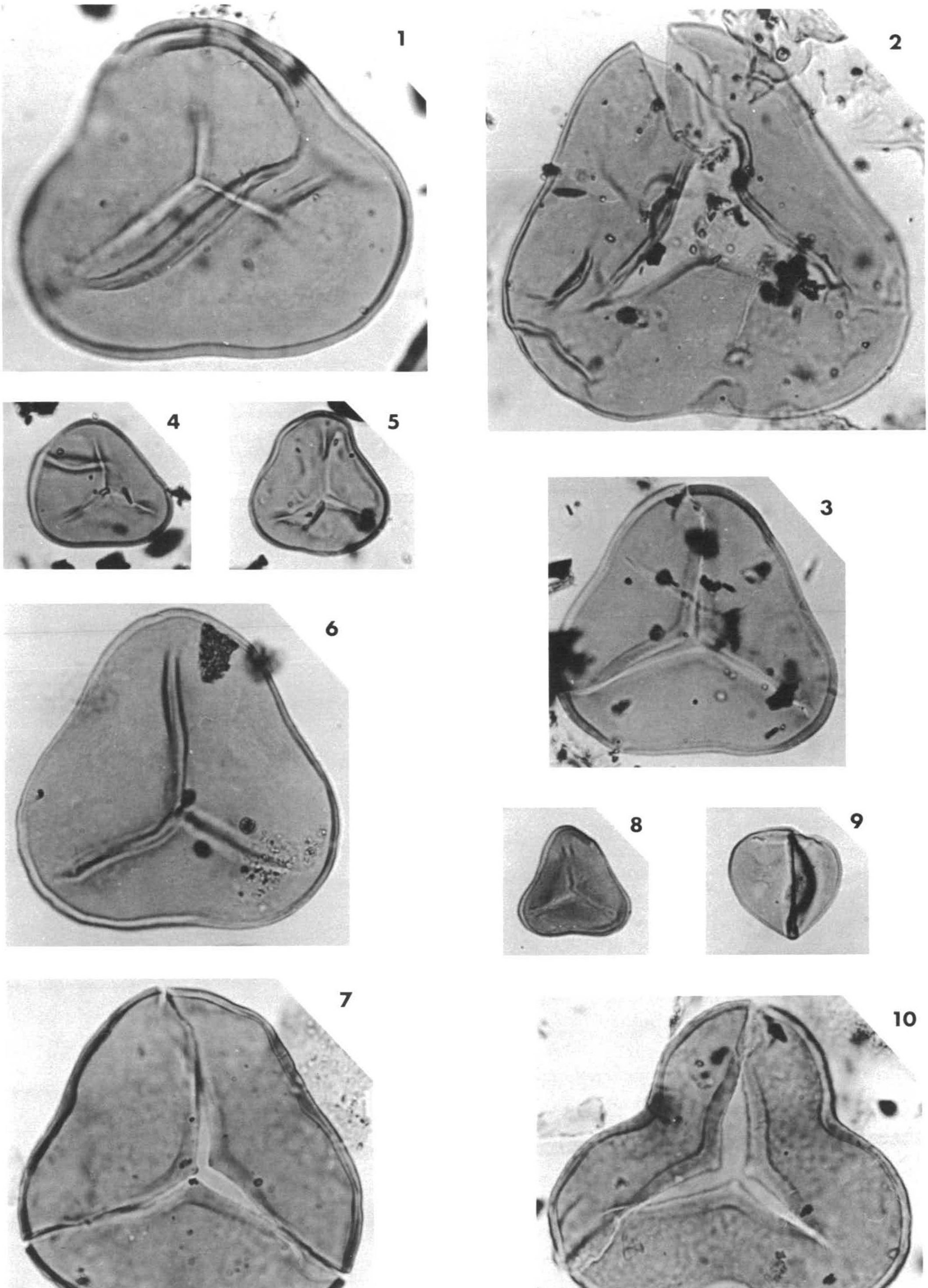
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PLATE 2
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Figs. 1, 2	**Cyathidites punctatus** (Delcourt & Sprumont). Fig. 2 shows a specimen with unusually thin, psilate exine.	p. 48
Figs. 3, 6	**Cyathidites asper** (Bolchovitina). Fig. 6a shows proximal face with details of the trilete laesurae, and the finely sculptured exine.	p. 48
Figs. 4, 7, 8	**Dictyophyllidites crenatus** Dettmann. Crenulation of laesurate margins clearly visible.	p. 50
Figs. 5, 9	**Dictyophyllidites crenatus** Dettmann. Specimens with accentuated laesurate margins, but no crenulation apparent.	p. 50

1. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 282/1096. CPC 16102.
2. Same sample as Fig. 1; MFP 6426-1, 384/1052. CPC 16103.
3. BMR Homeboin 3, 89.1 m, Griman Creek Formation; MFP 5382-1, 372/1068. CPC 16104.
4. BMR Surat 4, 92.3 m, Griman Creek Formation; MFP 4636-5, 277/1192. CPC 16105.
5. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 406/1091. CPC 16106.
6. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-1, 276/1101. CPC 16107.
7. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-1, 403/1067. CPC 16108.
8. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 298/1128. CPC 16109.
9. Same sample as Fig. 5; MFP 4266-5, 333/1191. CPC 16110.

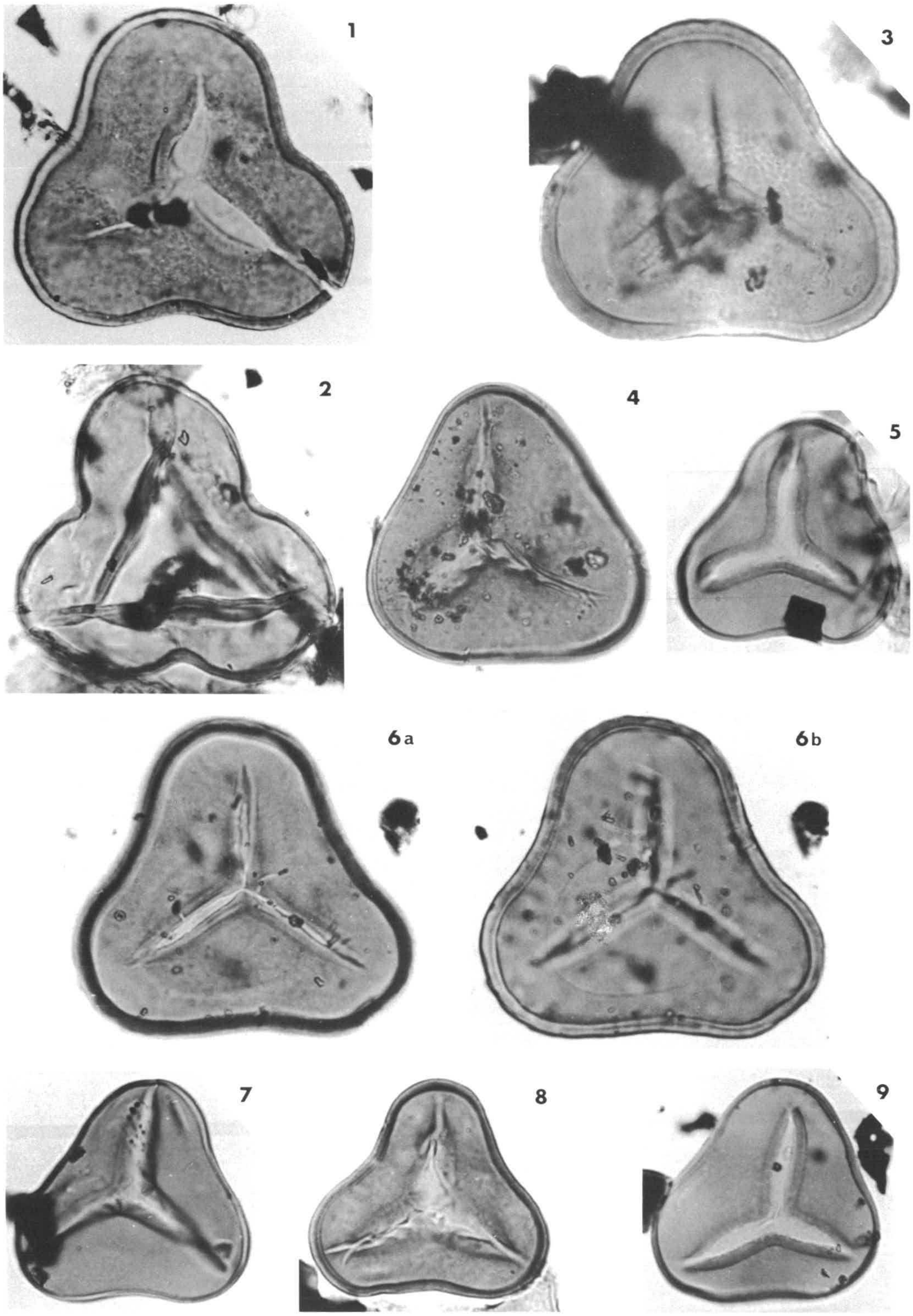
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PLATE 3

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Figs. 1-3, 5 **Biretisporites spectabilis** Dettmann. No laesurate lips are developed in the specimens of Figs. 1 and 3; initial lips (although not as pronounced as in holotype) are developed in the specimens of Figs. 2 and 5. p. 50

Fig. 4 **Biretisporites?, Cyathidites?** Specimen poorly preserved, smaller and with a thinner exine than **B. spectabilis.** p. 48

1. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 376/1049. CPC 16111.
2. Same sample as Fig. 1; MFP 6426-2, 426/1138. CPC 16112.
3. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 357/1098. CPC 16113.
4. GSQ Roma 3, 60.7 m, Minmi Member; MFP 5791-2, 439/1149. CPC 16114.
5. UKA St George 1, 152-156 m, Griman Creek Formation; MFP 4704-2, 443/1076. CPC 16115.

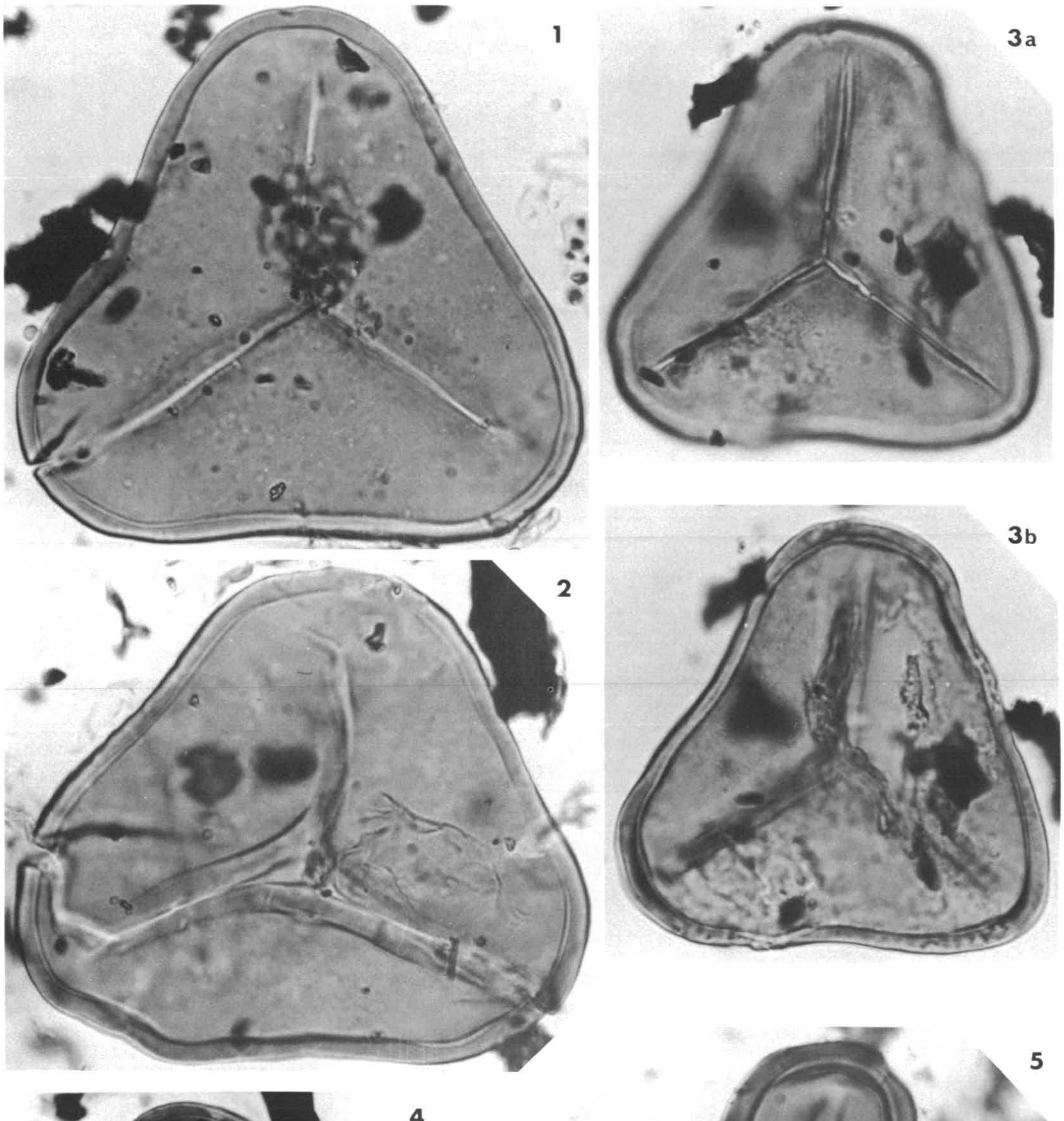
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PLATE 4
all figures x750

Figs. 1, 2	**Osmundacidites wellmanii** Couper.	p. 50
Figs. 3-5	**Osmundacidites dubius** sp. nov. Figs. 3 and 4 show typically dense and minute exine granulation. Fig. 4 holotype, specimen compressed. Fig. 5 corroded specimen, trilete laesurae faintly developed.	p. 50
Figs. 6, 8, 9	**Baculatisporites comaumensis** (Cookson), showing circular amb, distinct aperture, and more or less densely distributed, coarse granules typical of the species.	p. 50
Fig. 7	**Leptolepidites verrucatus** Couper.	p. 51

1. UKA Flinton 1, 314-317 m, Griman Creek Formation; MFP 6425-1, 404/1181. CPC 16116.
2. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 300/1070. CPC 16117.
3. BMR Roma 1, 16.0 m, Minmi Member; MFP 4320-1, 300/1075. CPC 16118.
4. Holotype of the species.
5. Same sample as Fig. 2; MFP 4624-1, 443/1053. CPC 16120.
6. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 407/1139. CPC 16121.
7. BMR Roma 1, 30.9 m, Minmi Member; MFP 4322-1, 366/1098. CPC 16122.
8. BMR Surat 3, 75.1 m, Surat Siltstone; MFP 4623-2, 398/1020. CPC 16123.
9. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-2, 442/1115. CPC 16124.

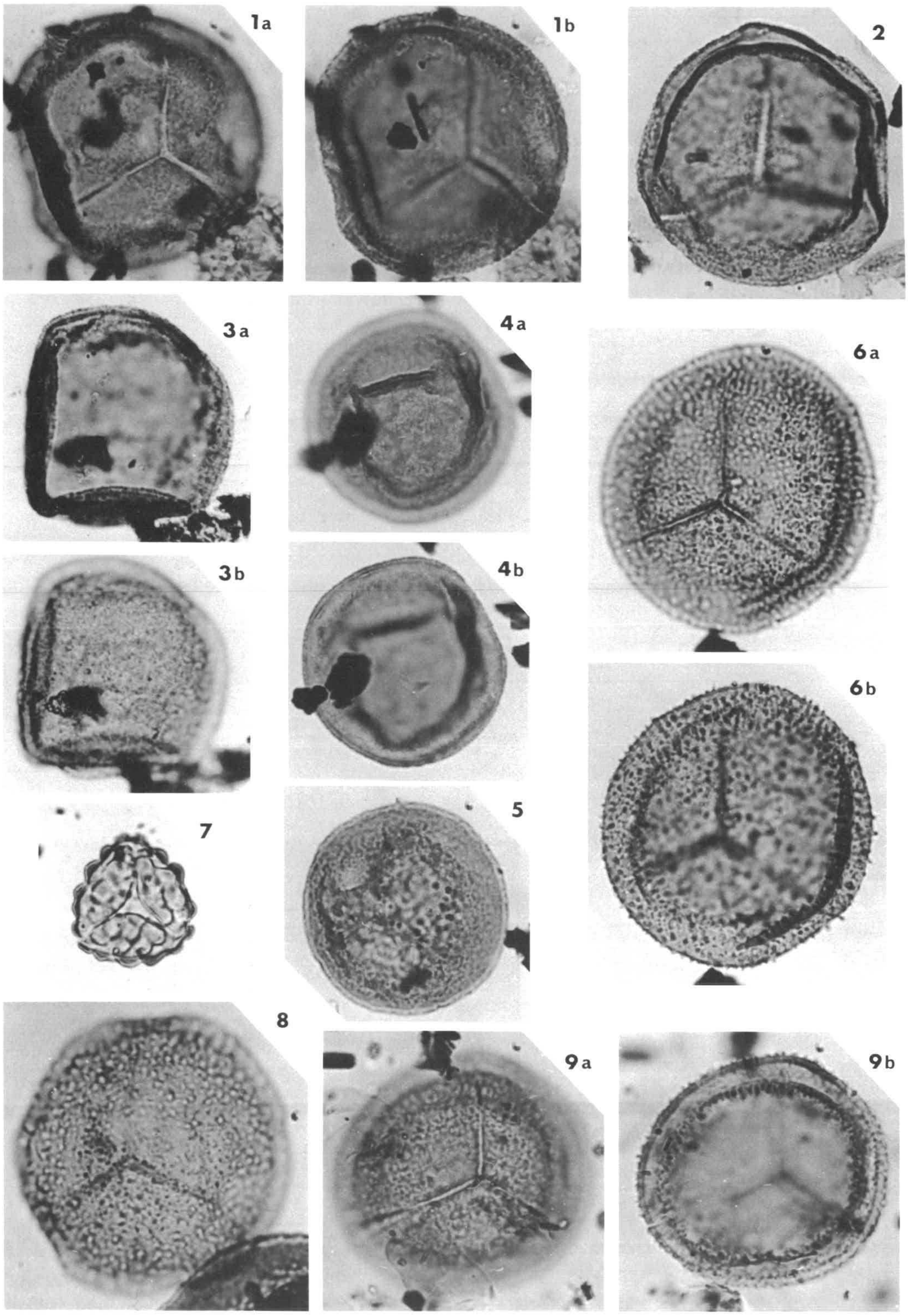
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PLATE 5
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Figs. 1-3	**Ceratosporites equalis** Cookson & Dettmann, showing considerable variations in size, the typical distal sculpture, lipped trilete laesurae, and psilate, sharply delineated proximal face.	p. 51
Fig. 4	**Lycopodiacidites asperatus** Dettmann.	p. 52
Fig. 5	**Leptolepidites major** Couper. Specimen compressed, focus on distal verrucae.	p. 51
Figs. 6-8	**Lycopodiacidites dettmannae** sp. nov. Figs. 6 and 7 show indistinct aperture; Fig. 6b focused on partly reduced sculptural elements at proximal face. Fig. 8 holotype; Fig. 8a, trilete laesurae split open, sculptural elements slightly smaller than at distal face; Fig. 8b focused on distal exine, showing typical verrucate-rugulate sculpture.	p. 52
Fig. 9	**Pilosisporites parvispinosus** Dettmann.	p. 52

1. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 421/1037. CPC 16125.
2. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 380/1117. CPC 16126.
3. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 424/1077. CPC 16127.
4. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-1, 375/1058. CPC 16128.
5. GSQ Surat 3, 165.5 m, Griman Creek Formation; MFP 5023-1, 242/1188. CPC 16129.
6. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-2, 345/1039. CPC 16130.
7. Same sample as Fig. 4; MFP 6422-2, 449/1050. CPC 16131.
8. Holotype of the species.
9. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-2, 444/1110. CPC 16133.

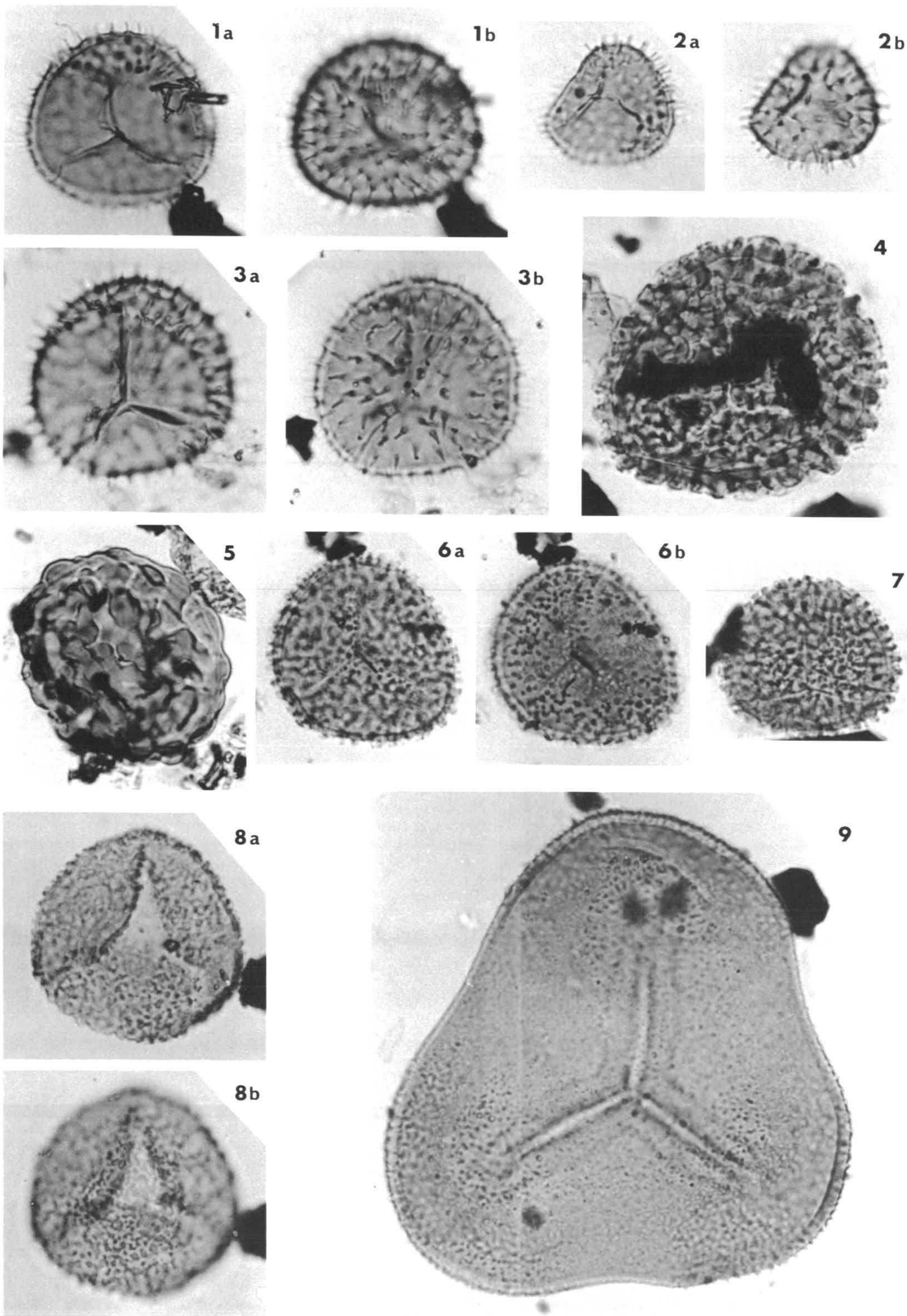
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PLATE 6

all figures (except Fig. 2) x500

Figs. 1-3	**Pilosisporites parvispinosus** Dettmann. Fig. 2 x750.	p. 52
Fig. 4	**Pilosisporites grandis** Dettmann, showing dense and regular distribution of spines on the exine.	p. 52
Fig. 5	**Pilosisporites notensis** Cookson & Dettmann, showing larger spines restricted to the proximal and distal apical regions.	p. 52

1. BMR Dirranbandi 5, 152.4 m, Surat Siltstone; MFP 5321-1, 355/1040. CPC 16134.

2. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-2, 298/1147. CPC 16135.

3. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 391/1060. CPC 16136.

4 BMR Surat 4, 59.7 m, Griman Creek Formation; MFP 4635-4, 320/1094. CPC 16137.

5. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-1, 261/1112. CPC 16138.

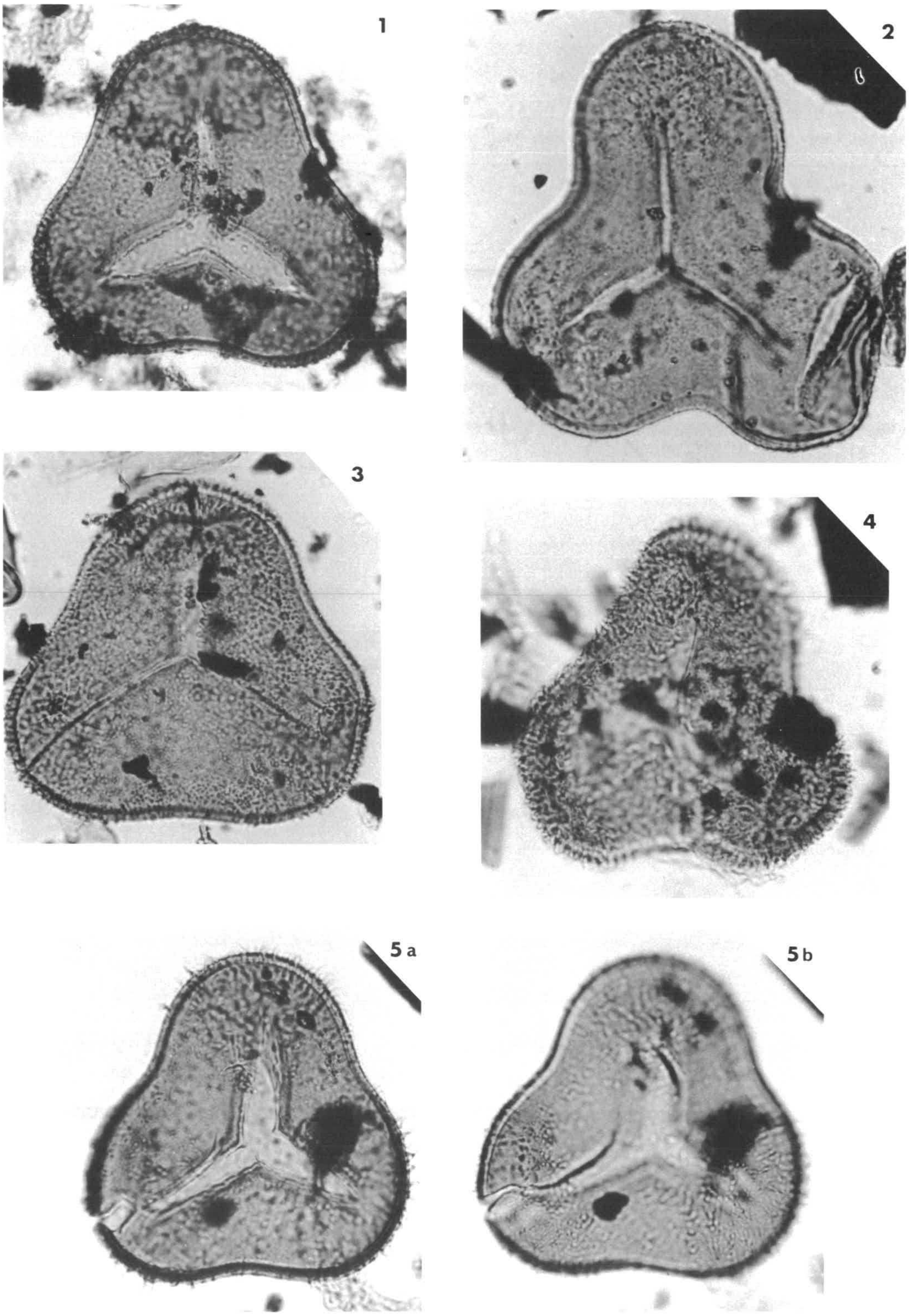
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PLATE 7
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Fig. 1	**Lycopodiumsporites austroclavatidites** (Cookson).	p. 52
Fig. 2	**Lycopodiumsporites circolumenus** Cookson & Dettmann.	p. 53
Figs. 3-5	**Lycopodiumsporites nodosus** Dettmann, showing lipped apertural grooves and typical granulation of the exine.	p. 53
Fig. 6	**Lycopodiumsporites eminulus** Dettmann.	p. 53
Fig. 7	**Lycopodiumsporites facetus** Dettmann. Poorly preserved specimen. Fig. 7a shows reticulate pattern on proximal exine and granulate appearance of outer exine layer; Fig. 7b shows bilamellate exine.	p. 53
Fig. 8	**Lycopodiumsporites** cf. **L. facetus** Dettmann. Fig. 8a shows tetrad mark; exine not visibly lamellated. Fig. 8b shows the typically wide-meshed distal reticulum.	p. 53

1. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 320/1034. CPC 16139.
2. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-1, 338/1192. CPC 16140.
3. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 287/1120. CPC 16141.
4. Same sample as Fig. 2; MFP 6468-2, 316/1112. CPC 16142.
5. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-5, 324/1125. CPC 16143.
6. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 378/1195. CPC 16146.
7. BMR Mitchell 8, 26.5 m, Coreena Member; MFP 4244-3, 339/1177. CPC 16144.
8. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-1, 337/1022. CPC 16145.

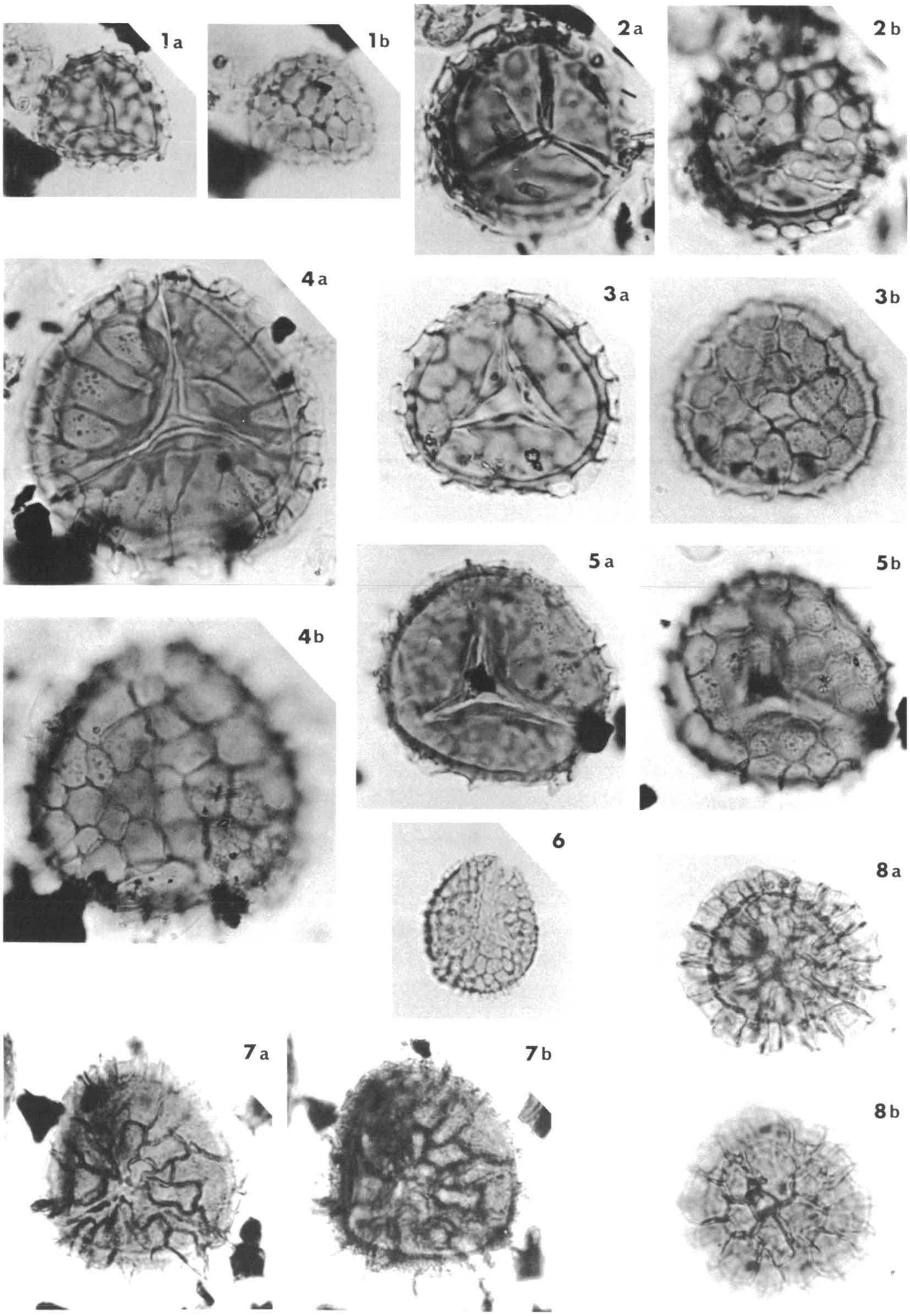
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PLATE 8
all figures x750

Fig. 1	**Lycopodiumsporites nodosus** Dettmann. Exine granulation minute and very weak, and locally absent.	p. 53
Fig. 2	**Lycopodiumsporites rosewoodensis** (De Jersey). Specimen shows simple tetrad mark and regular distal reticulum with typically low and thin muri.	p. 53
Fig. 3	**Reticulatisporites pudens** Balme.	p. 54
Figs. 4, 5, 7	**Lycopodiumsporites solidus** sp. nov. Fig. 4 shows the dense surface reticulum with the irregular lumina. Exine at upper part of specimen damaged and outer layers locally detached from inner layer. Fig. 5 shows the exine lamellation and the presence of a trilete mark. Fig. 7 holotype; Fig. 7a is focused on the highly refractive innermost exine layer, ruptured along the laesurae and partly collapsed; Fig. 7b shows the typical surface reticulum.	p. 53
Figs. 6, 9	**Foveosporites canalis** Balme. Specimen in Fig. 6 has slightly thickened exine in interradial equatorial areas. Specimen of Fig. 9 is azonate; Fig. 9b is focused on characteristic sculpture of distal face.	p. 54
Fig. 8	**Cyclosporites hughesii** (Cookson & Dettmann). Specimen relatively small; high, fin-like muri clearly shown in Fig. 8b; radial arrangement and bifurcation of proximal muri shown in Fig. 8a.	p. 54
Fig. 10	**Dictyotosporites filosus** Dettmann.	p. 54

1. UKA Boggo Creek 1, 201-210 m, Griman Creek Formation; MFP 6450-2, 377/1064. CPC 16147.
2. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 342/1160. CPC 16148.
3. BMR Dirranbandi 5, 152.4 m, Surat Siltstone; MFP 5321-1, 334/1142. CPC 16149.
4. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 242/1105. CPC 16150.
5. Same sample as Fig. 2; MFP 4266-5, 356/1044. CPC 16151.
6. BMR Surat 1, 42.4 m, Coreena Member; MFP 4536-1, 317/1059. CPC 16152.
7. Holotype of the species.
8. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 362/1122. CPC 16154.
9. BMR Surat 1, 65.0 m, Coreena Member; 4537-1, 358/1170. CPC 16155.
10. Same sample as Fig. 2; MFP 4266-5, 356/1044. CPC 16156.

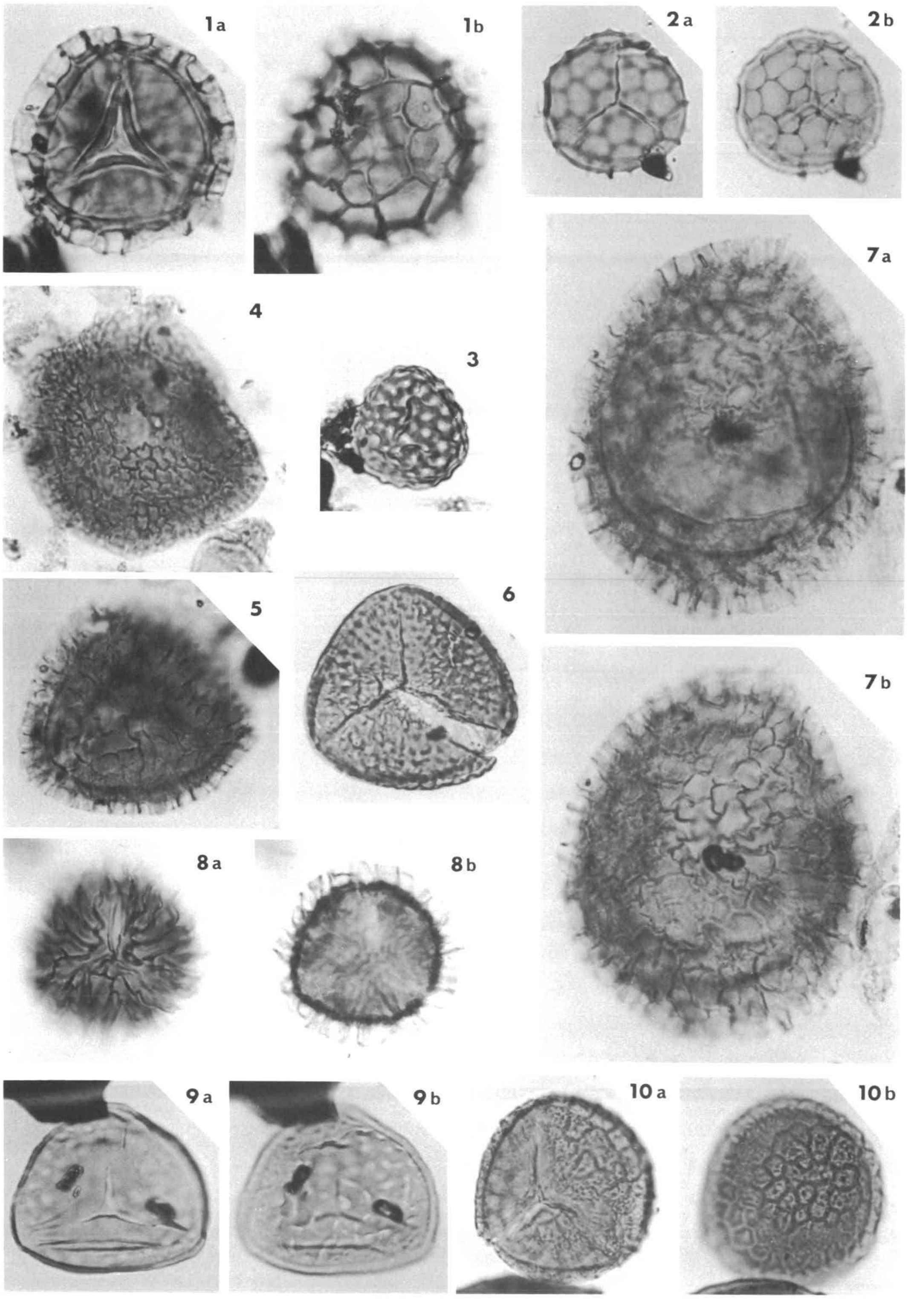
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PLATE 9
all figures x750

Fig. 1	**Klukisporites scaberis** (Cookson & Dettmann).	p. 54
Fig. 2	**Dictyotosporites speciosus** Cookson & Dettmann. Fig. 2b shows distal primary lumina and remains of coarser secondary network (partly out of focus).	p. 54
Fig. 3	**Cicatricosisporites pseudotripartitus** (Bolchovitina), showing the typically broad ribs and their arrangement on proximal and distal surface.	p. 55
Figs. 4, 7, 8	**Cicatricosisporites australiensis** (Cookson). Fig. 4 shows a small specimen with slender ribs; Fig. 4a shows the proximal arrangement of ribs: parallel to spore margin in one sector, and parallel to one of the laesurae and forming low angles with spore margin in another sector. Fig. 7 shows a specimen with broader ribs and intervening grooves.	p. 55
Figs. 5, 6	**Dictyotosporites complex** Cookson & Dettmann. Fig. 6a focused on central body of specimen, showing faint trilete mark.	p. 54
Figs. 9, 10	**Cicatricosisporites** cf. **C. australiensis** (Cookson). Specimens similar to the species but slightly larger, with more rounded triangular amb.	p. 55

1. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 343/1152. CPC 16157.
2. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-2, 331/1056. CPC 16158.
3. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-2, 463/1043. CPC 16159.
4. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-5, 429/1196. CPC 16160.
5. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 339/1170. CPC 16161.
6. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 267/1019. CPC 16162.
7. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 456/1091. CPC 16163.
8. Same sample as Fig. 5; MFP 6423-2, 282/1027. CPC 16164.
9. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 446/1137. CPC 16165.
10. Same sample as Fig. 4; MFP 4266-4, 310/1171. CPC 16166.

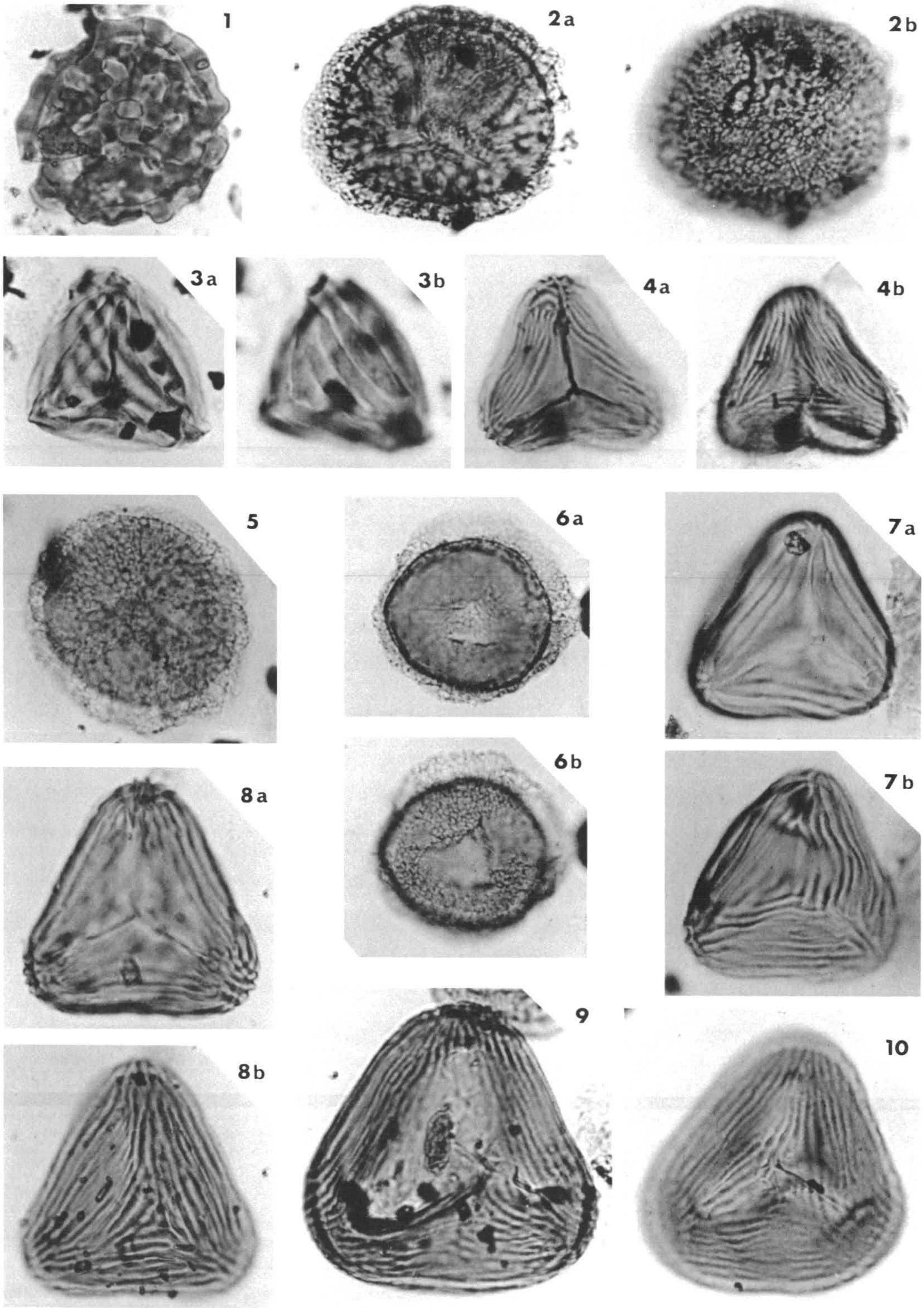
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PLATE 10

all figures (except Fig. 7) x750

Figs. 1, 2	**Cicatricosisporites** cf. **C. ludbrookiae** Dettmann. Oblique and irregular pattern of proximal ribs shown in Fig. 2.	p. 55
Figs. 3, 4	**Trilites** cf. **T. tuberculiformis** Cookson. Typical radial exine thickenings shown in specimen of Fig. 3; Fig. 4 shows a specimen in which no thickenings are apparent.	p. 56
Figs. 5, 6	**Cicatricosisporites ludbrookiae** Dettmann.	p. 55
Fig. 7	**Arcellites reticulatus** (Cookson & Dettmann). Dark-coloured specimen with laesurate lips well preserved. Half of main body at lower left shows the surface reticulum. Approximately x280.	p. 55

1. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 338/1146. CPC 16167.
2. BMR Roma 9, 108.1 m, Coreena Member; MFP 4638-2, 374/1183. CPC 16168.
3. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 338/1126. CPC 16169.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 364/1176. CPC 16170.
5. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-2, 336/1165. CPC 16171.
6. BMR Surat 2, 41.3 m, Surat Siltstone; MFP 4535-2, 447/1165. CPC 16172.
7. GSQ Surat 3, 321.8 m, Griman Creek Formation; MFP 5222-1, 345/1010. CPC 16173.

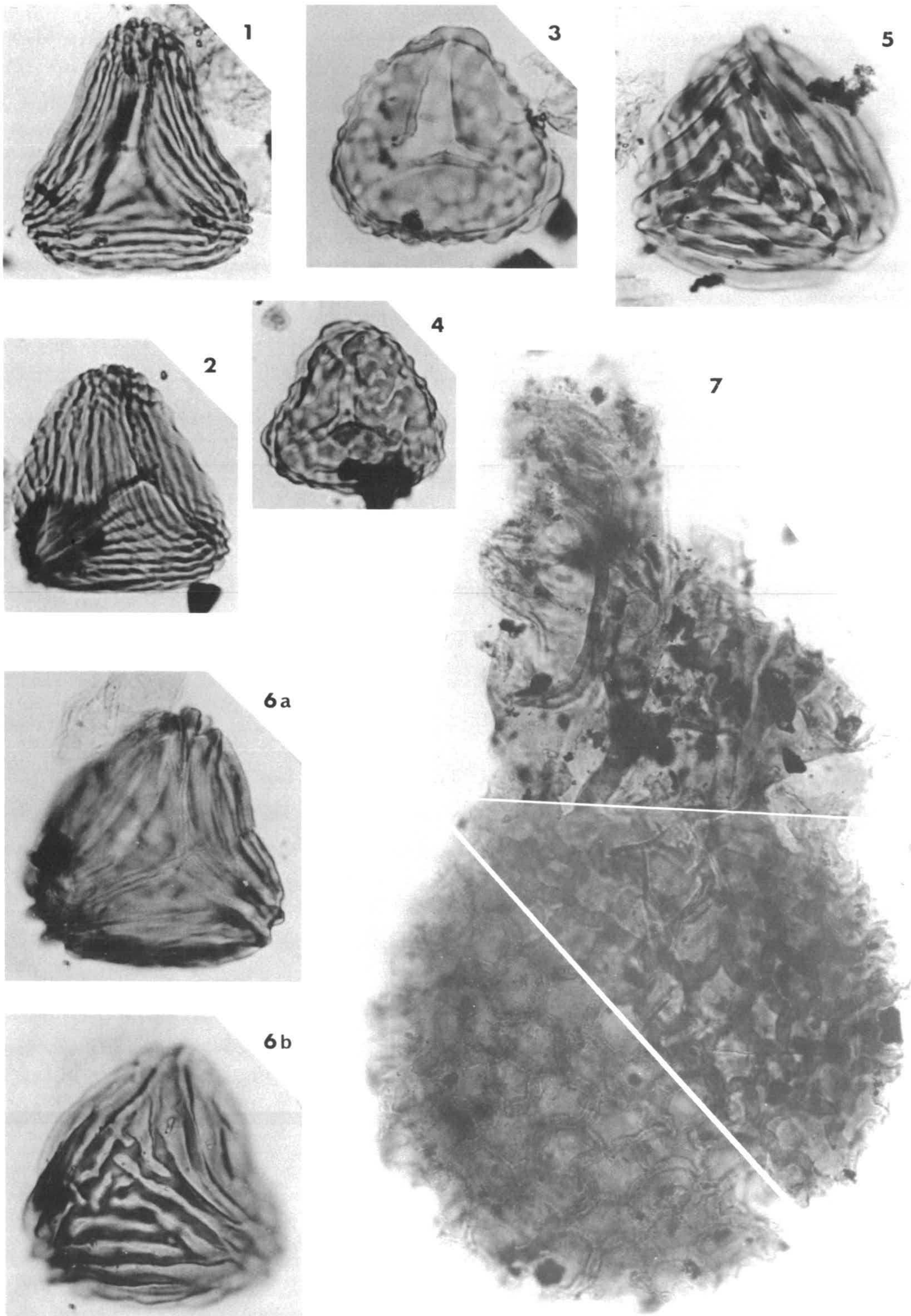
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PLATE 11

all figures (except Fig. 1) x750

Fig. 1	**Balmeisporites holodictyus** Cookson & Dettmann. Specimen with part of outer reticulate exine layer missing. Fig. 1a shows body with trilete laesurae; Fig. 1b focuses on wide-meshed reticulum and lateral outgrowths. Approximately x50.	p. 55
Figs. 2, 3	**Matonisporites cooksonae** Dettmann.	p. 56
Fig. 4	**Trilobosporites tribotrys** Dettmann.	p. 56
Fig. 5	**Trilobosporites trioreticulosus** Cookson & Dettmann.	p. 56

1. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 353/1148. CPC 16174.
2. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-2, 355/1195. CPC 16175.
3. GSQ Surat 3, 454.1 m, Coreena Member; MFP 5022-2, 406/1155. CPC 16176.
4. BMR Surat 2, 41.3 m, Surat Siltstone; MFP 4535-1, 326/1177. CPC 16177.
5. Same sample as Fig. 2; MFP 6423-1, 369/1031. CPC 16178.

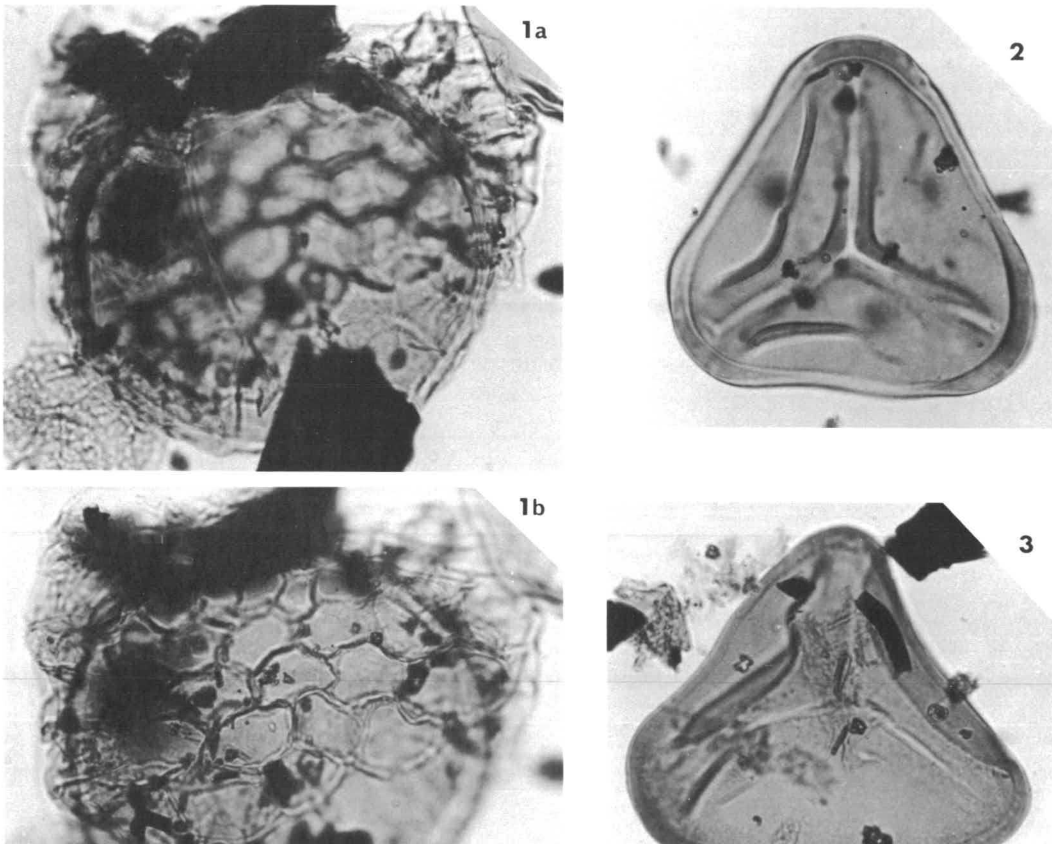
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PLATE 12
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Fig. 1	**Trilobosporites tribotrys** Dettmann.	p. 56
Fig. 2	**Ischyosporites punctatus** Cookson & Dettmann.	p. 56
Fig. 3	**Sestrosporites pseudoalveolatus** (Couper). Specimen without variation in width of the equatorial exine.	p. 57
Figs. 4-6	**Gleicheniidites circinidites** (Cookson).	p. 57
Fig. 7	**Polycingulatisporites densatus** (De Jersey).	p. 58
Fig. 8	**Trilobosporites antiquus** Reiser & Williams.	p. 56
Figs. 9-12	**Stereisporites antiquasporites** (Wilson & Webster). The figures show an array of specimens ranging from azonate to initially cingulate. The species lacks a distal circumpolar band of exine thickening.	p. 58
Figs. 13, 18	**Polycingulatisporites clavus** (Balme), showing distal polar exine thickening and typical circumpolar ring of verrucae.	p. 57
Figs. 14-17	**Stereisporites pocockii** sp. nov. Specimens show typically broad cingulum. Fig. 15 shows a specimen with the exine markedly thickened in the distal polar area, and radially striped cingulum. Fig. 17 holotype; distal exine only weakly thickened in polar region.	p. 58

1. GSQ Surat 3, 165.5 m, Griman Creek Formation; MFP 5023-1, 261/1115. CPC 16179.
2. BMR Surat 2, 30.5-33.5 m, Surat Siltstone; MFP 4671-2, 418/1158. CPC 16180.
3. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 264/1048. CPC 16181.
4. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 355/1066. CPC 16182.
5. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-2, 440/1018. CPC 16183.
6. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-1, 415/1018. CPC 16184.
7. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-2, 377/1115. CPC 16185.
8. GSQ Surat 1, 336.0 m, Minmi Member; MFP 5208-1, 367/1120. CPC 16186.
9. Same sample as Fig. 7; MFP 4537-2, 377/1067. CPC 16187.
10. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 317/1027. CPC 16188.
11. Same sample as Fig. 7; MFP 4537-1, 346/1143. CPC 16189.
12. Same sample as Fig. 7; MFP 4537-1, 448/1190. CPC 16190.
13. BMR Roma 1, 30.9 m, Minmi Member; MFP 4322-2, 333/1063. CPC 16191.
14. BMR Roma 9, 108.1 m, Coreena Member; MFP 4638-2, 329/1167. CPC 16192.
15. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 288/1087. CPC 16193.
16. Same sample as Fig. 7; MFP 4537-1, 303/1137. CPC 16194.
17. Holotype of the species.
18. Same sample as Fig. 13; MFP 4322-1, 375/1026. CPC 16196.

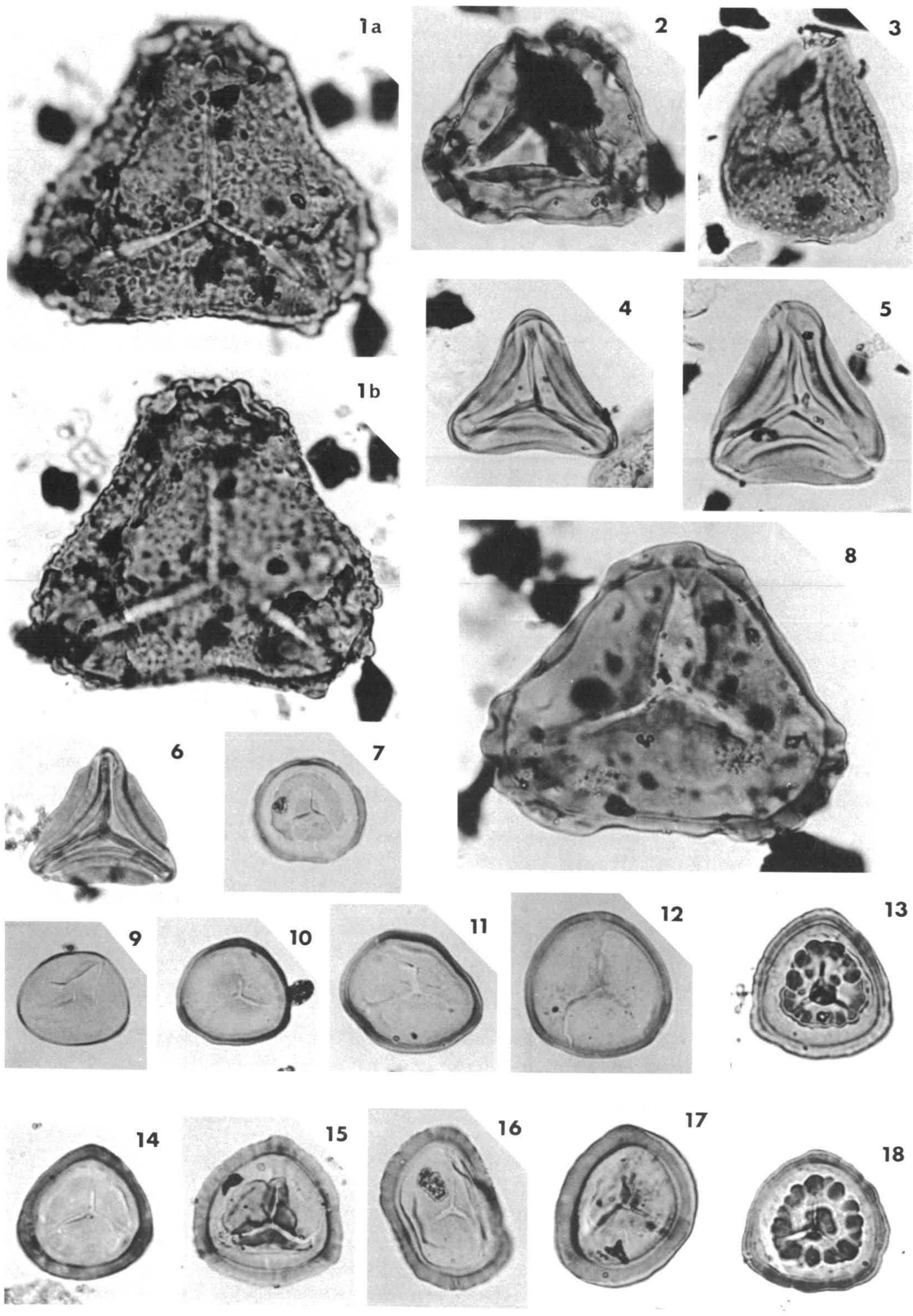
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PLATE 13
all figures x750

Figs. 1, 2	**Foraminisporis wonthaggiensis** (Cookson & Dettmann).	p. 59
Figs. 3, 4	**Foraminisporis asymmetricus** (Cookson & Dettmann).	p. 59
Figs. 5-7	**Foraminisporis dailyi** (Cookson & Dettmann). Figs. 5 and 7 show aspects of distal exine; it can be virtually psilate, with compressional folding (Fig. 5), to sparsely and irregularly verrucate. Fig. 6 shows the proximal interradial clusters of small verrucae.	p. 59
Fig. 8	**Contignisporites fornicatus** Dettmann, showing verrucae on proximal exine and the typically broad ribs. (not described)	—
Fig. 9	**Contignisporites** cf. **C. fornicatus** Dettmann. Fig. 9a shows the aperture, verrucae, and one set of ribs of the proximal surface; Fig. 9b shows the regularly arranged, moderately wide ribs.	p. 59
Fig. 10	**Contignisporites cooksonae** (Balme). Fig. 10a shows the aperture, one set of ribs located near outer margin, and additional low undulating relief of proximal exine.	p. 59
Fig. 11	**Contignisporites multimuratus** Dettmann. Fig. 11a focuses on the proximal exine; Fig. 11b shows the numerous distal ribs distinctive of the species.	p. 59

1. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-2, 356/1025. CPC 16197.
2. BMR Surat 1, 42.4 m, Coreena Member; MFP 4536-1, 295/1113. CPC 16198.
3. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-2, 370/1110. CPC 16199.
4. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 445/1169. CPC 16200.
5. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-1, 374/1115. CPC 16201.
6. Same sample as Fig. 5; MFP 6451-2, 253/1110. CPC 16202.
7. Same sample as Fig. 5; MFP 6451-1, 366/1153. CPC 16203.
8. HONL Werrina 1, 58-61 m, Griman Creek Formation; MFP 6428A-5, 408/1125. CPC 16204.
9. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-1, 337/1139. CPC 16207.
10. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-5, 406/1025. CPC 16205.
11. BMR Roma 8, 31.1 m, Doncaster Member; MFP 4676-1, 425/1097. CPC 16206.

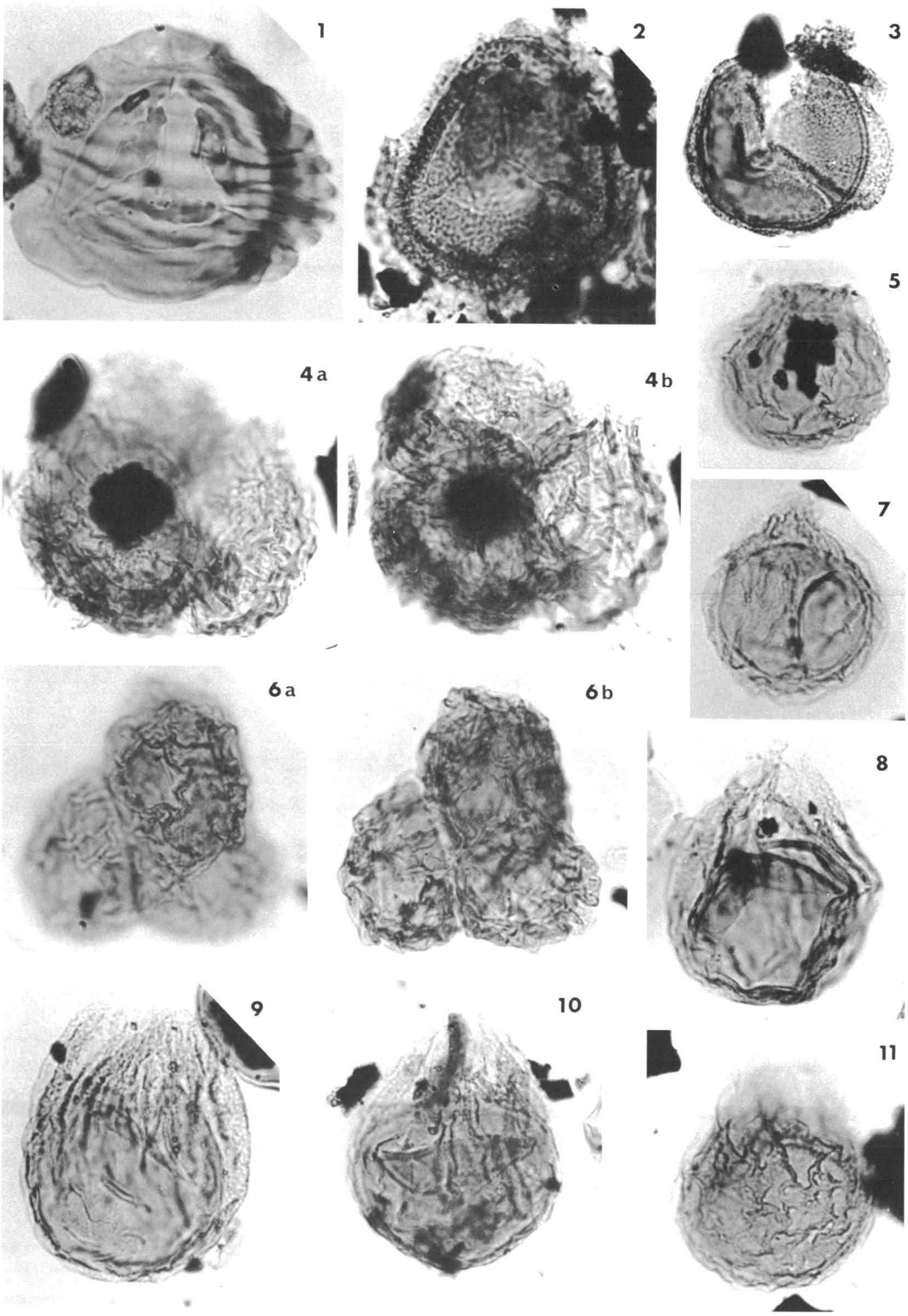
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PLATE 14

all figures x750

Fig. 1	**Contignisporites glebulentus** Dettmann. Relatively small specimen, showing wide cingulum typical of the species. (not described)	—
Figs. 2, 3	**Crybelosporites stylosus** Dettmann. Fig. 2 shows a slightly damaged specimen; Fig. 3 shows a specimen stripped of its outer sculptine layer.	p. 60
Figs. 4-6	**Crybelosporites berberioides** Burger. Figs. 4 and 6: specimens still united in the tetrad; trilete laesurae developed on inner body are shown in Fig. 6b, specimen at top. Fig. 5: free specimen, poorly preserved (proximal face upwards).	p. 60
Figs. 7-10	**Crybelosporites punctatus** Dettmann, showing pitted outer sculptine layer, psilate innermost body and (frequently opened) trilete laesurae. Inner sculptine layer not clearly visible.	p. 60
Fig. 11	**Crybelosporites** cf. **C. striatus** (Cookson & Dettmann). Specimen with anastomosing muroid folds (not arranged into a genuine reticulate pattern) of the outermost sculptine layer.	p. 60

1. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 331/1109. CPC 16208.
2. GSQ Roma 3, 60.7 m, Minmi Member correlate; MFP 5791-2, 270/1162. CPC 16209.
3. BMR Roma 1, 30.9 m, Minmi Member; MFP 4322-1, 318/1194. CPC 16210.
4. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-3, 407/1021. CPC 16211.
5. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 435/1185. CPC 16212.
6. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-1, 323/1073. CPC 16213.
7. Same sample as Fig. 1; MFP 4537-1, 448/1182. CPC 16214.
8. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-2, 381/1181. CPC 16215.
9. Same sample as Fig. 8; MFP 6423-1, 400/1009. CPC 16216.
10. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 391/1099. CPC 16226.
11. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 445/1066. CPC 16217.

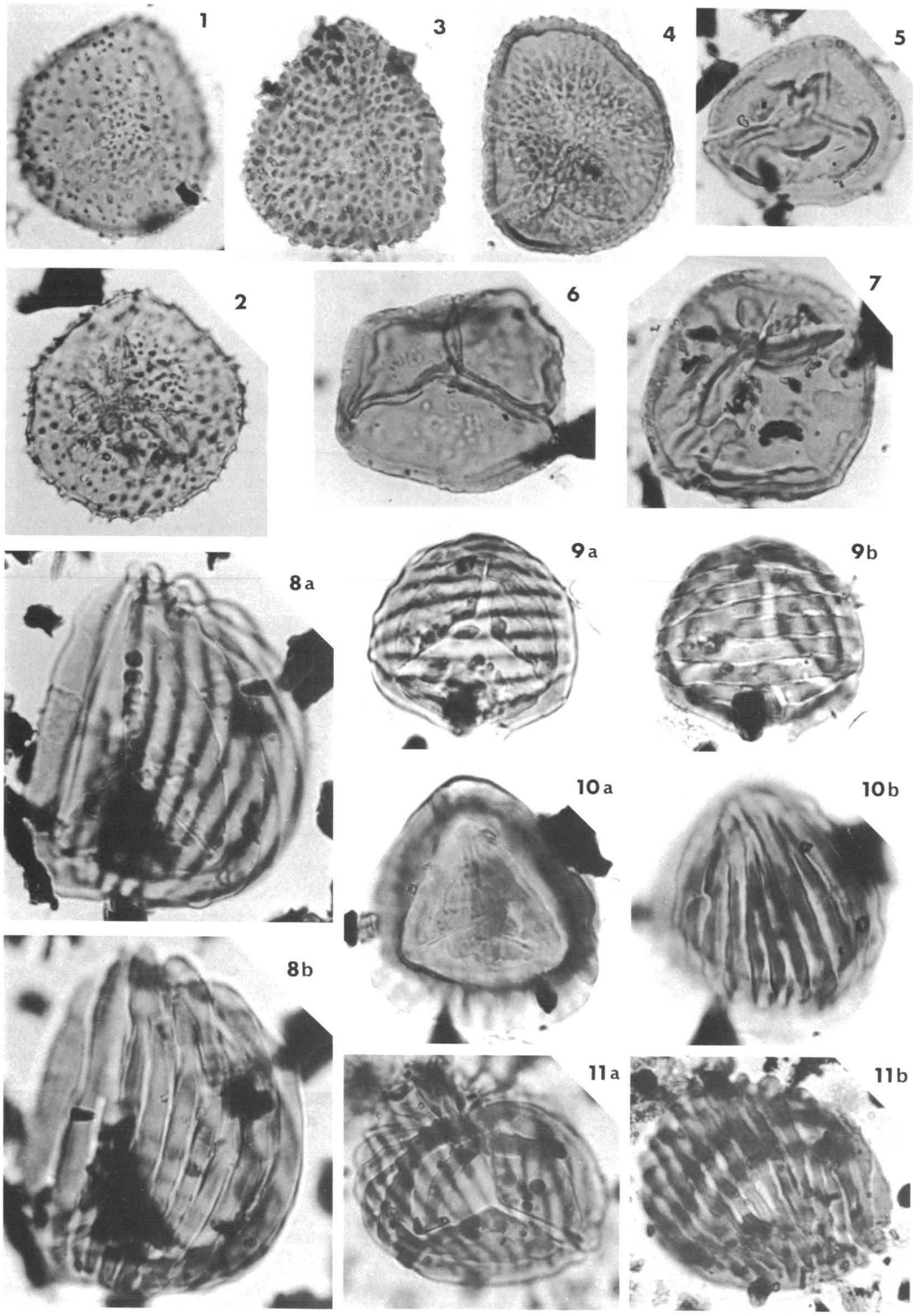
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PLATE 15

all figures (except Fig. 14a) x750

Figs. 1-8	**Crybelosporites striatus** (Cookson & Dettmann). Fig. 1: oblique view, specimen only with inner sclerine layer and inner sculptine layer preserved. Figs. 2, 5: lateral view, showing outer surface reticulum and gula-like projection of outer sculptine layer. Figs. 3, 4: lateral view, showing variations of sclerine thickness; Fig. 4a shows the striation of the proximal sculptine. Figs. 6, 7: oblique view, showing the aperture and thick, stratified sclerine. Fig. 8: polar view.	p. 60
Fig. 9	**Endoculeospora delicata** Burger. Holotype refigured.	p. 60
Figs. 10, 16	**Velosporites triquetrus** (Lantz). Specimens poorly preserved, minute perforations of zona caused by corrosion. Trilete mark extends beyond the margin of central body.	p. 61
Figs. 11, 12	**Punctatosporites scabratus** (Couper).	p. 61
Fig. 13	**Laevigatosporites ovatus** Wilson & Webster.	p. 61
Figs. 14, 15	**Tuberculatosporites** sp. A. Fig. 14a approximately x1260.	p. 61

1. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-1, 404/1133. CPC 16218.
2. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 377/1098. CPC 16219.
3. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 471/1058. CPC 16220.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-1, 339/1059. CPC 16221.
5. Same sample as Fig. 4; MFP 4615-2, 415/1140. CPC 16222.
6. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-1, 427/1152. CPC 16223.
7. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 388/1150. CPC 16224.
8. Same sample as Fig. 2; MFP 4266-4, 319/1151. CPC 16225.
9. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-1, 323/1158. CPC 13893.
10. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-2, 454/1038. CPC 16227.
11. Same sample as Fig. 7: MFP 6423-2, 432/1159. CPC 16228.
12. BMR Surat 4, 59.7 m, Griman Creek Formation; MFP 4635-3, 429/1134. CPC 16229.
13. BMR Surat 4, 28.4 m, Griman Creek Formation; MFP 4634-1, 255/1077. CPC 16230.
14. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 272/1154. CPC 16231.
15. Same sample as Fig. 10; MFP 6239-2, 312/1142. CPC 16232.
16. Same sample as Fig. 14; MFP 4624-2, 459/1179. CPC 16233.

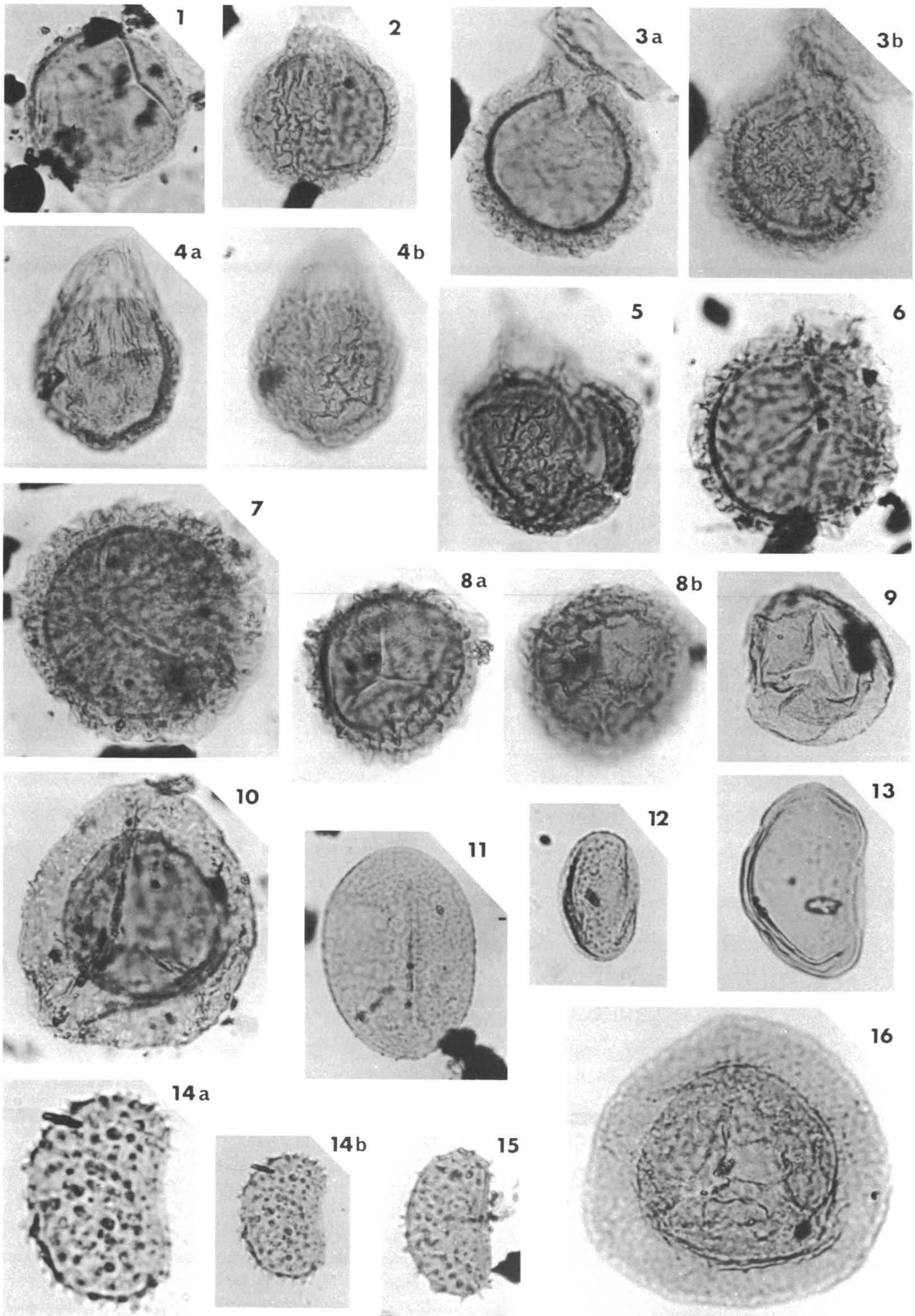
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PLATE 16
all figures x750

Figs. 1, 2	**Coptospora paradoxa** (Cookson & Dettmann). Specimens well preserved; traces of a trilete mark visible.	p. 62
Figs. 3, 4	**Aequitriradites verrucosus** (Cookson & Dettmann). Figs. 3a and 4a show the proximal aspect, a trilete mark is clearly visible. Figs. 3b and 4b are focused on distal face, showing sculpture, typical break-down of the exine, and thin zona.	p. 62
Fig. 5	**Aequitriradites spinulosus** (Cookson & Dettmann). Specimen damaged, much of distal exine missing.	p. 62
Fig. 6	**Aequitriradites** sp. A. Well-preserved specimen with evenly distributed sculptural elements. No hilum formed.	p. 62
Figs. 7-9	**Triporoletes radiatus** (Dettmann). Specimens with distinct, radial sclerinal ridges.	p. 62
Figs. 10, 11	**Triporoletes** cf. **T. laevigatus** (Pocock). Specimens show the anastomosing folds typical of the species.	p. 63

1. BMR Surat 1, 42.4 m, Coreena Member; MFP 4536-2, 190/1083. CPC 16234.
2. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 383/1141. CPC 16235.
3. BMR Roma 1, 30.9 m, Minmi Member; MFP 4322-2, 432/1044. CPC 16236.
4. BMR Surat 1, 130.5 m, Coreena Member; MFP 4538-1, 431/1066. CPC 16237.
5. Same sample as Fig. 4; MFP 4538-1, 365/1125. CPC 16238.
6. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-2, 387/1173. CPC 16239.
7. GSQ Surat 2, 73.2 m, Griman Creek Formation; MFP 5008-1, 255/1109. CPC 16240.
8. Same sample as Fig. 6; MFP 4537-2, 382/1027. CPC 16241.
9. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 365/1123. CPC 16242.
10. BMR Surat 3, 15.9 m, Griman Creek Formation; MFP 4611-1, 337/1023. CPC 16243.
11. GSQ Surat 2, 45.9 m, Griman Creek Formation; MFP 5013-1, 254/1145. CPC 16244.

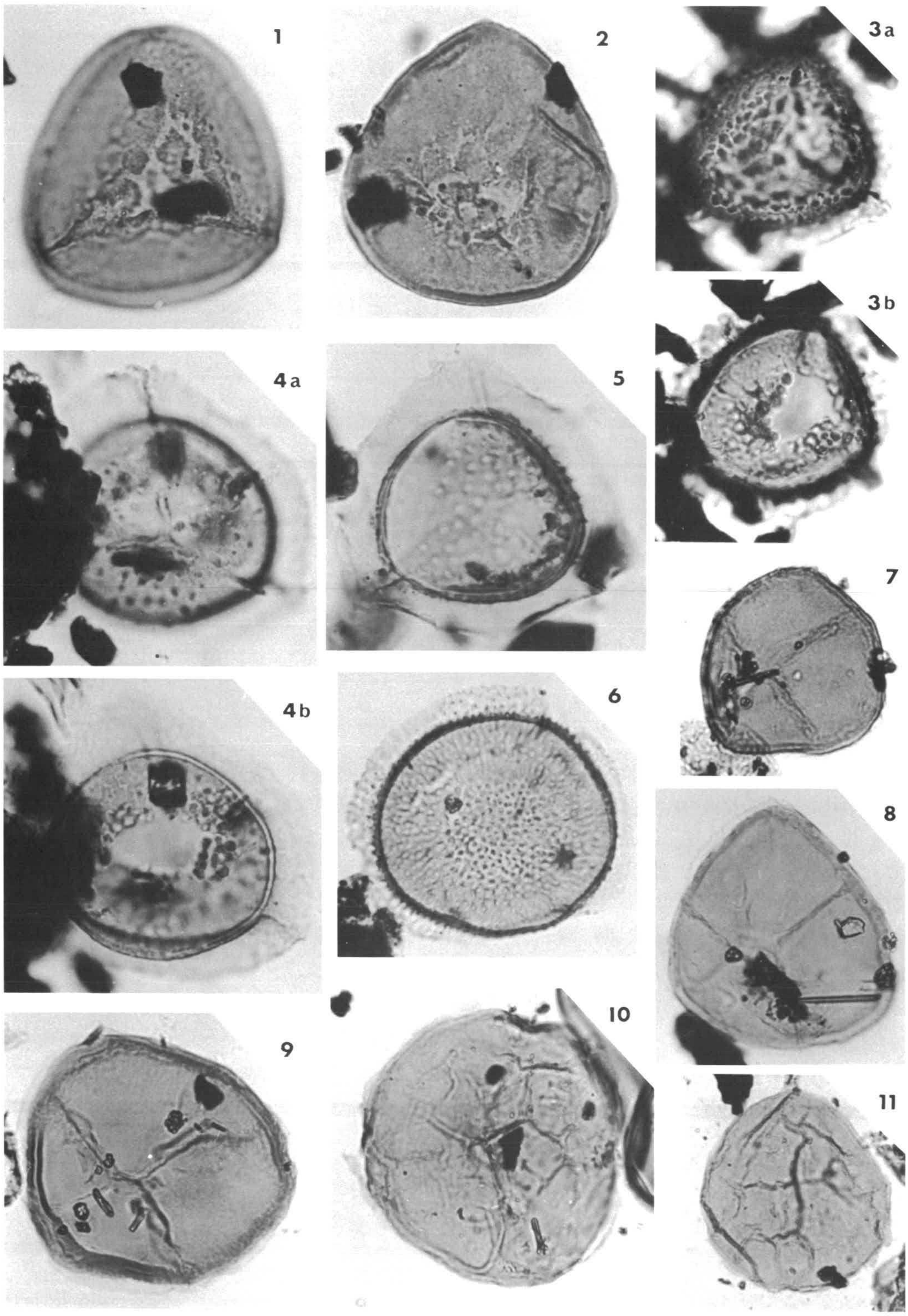
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PLATE 17

all figures x750

Figs. 1, 2, 5	**Triporoletes simplex** (Cookson & Dettmann). Specimens with distinctly developed triradiate ridges; no trilete mark apparent.	p. 62
Fig. 3	**Triporoletes** cf. **T. radiatus** (Dettmann). Specimen with distinct radiate ridges and additional minor folds (recycled specimen?).	p. 62
Fig. 4	**Araucariacites australis** Cookson.	p. 64
Figs. 6, 7	**Callialasporites dampieri** (Balme).	p. 63
Figs. 8, 12	**Alisporites grandis** (Cookson).	p. 63
Figs. 9, 10	**Alisporites similis** (Balme).	p. 63
Fig. 11	**Vitreisporites pallidus** (Reissinger).	p. 63

1. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-2, 349/1143. CPC 16245.
2. BMR Surat 2, 41.3 m, Surat Siltstone; MFP 4535-2, 332/1142. CPC 16246.
3. BMR Roma 9, 108.1 m, Coreena Member; MFP 4638-2, 309/1080. CPC 16247.
4. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 232/1013. CPC 16248.
5. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-2, 365/1087. CPC 16249.
6. BMR Homeboin 1, 145.4 m, Doncaster Member; MFP 5384-1, 243/1047. CPC 16250.
7. Same sample as Fig. 4; MFP 4276-2, 270/1094. CPC 16251.
8. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-2, 387/1137. CPC 16252.
9. Same sample as Fig. 4; MFP 4276-2, 270/1036. CPC 16253.
10. Same sample as Fig. 4; MFP 4276-2, 391/1193. CPC 16254.
11. BMR Surat 3, 15.9 m, Griman Creek Formation; MFP 4611-2, 333/1144. CPC 16255.
12. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 450/1110. CPC 16256.

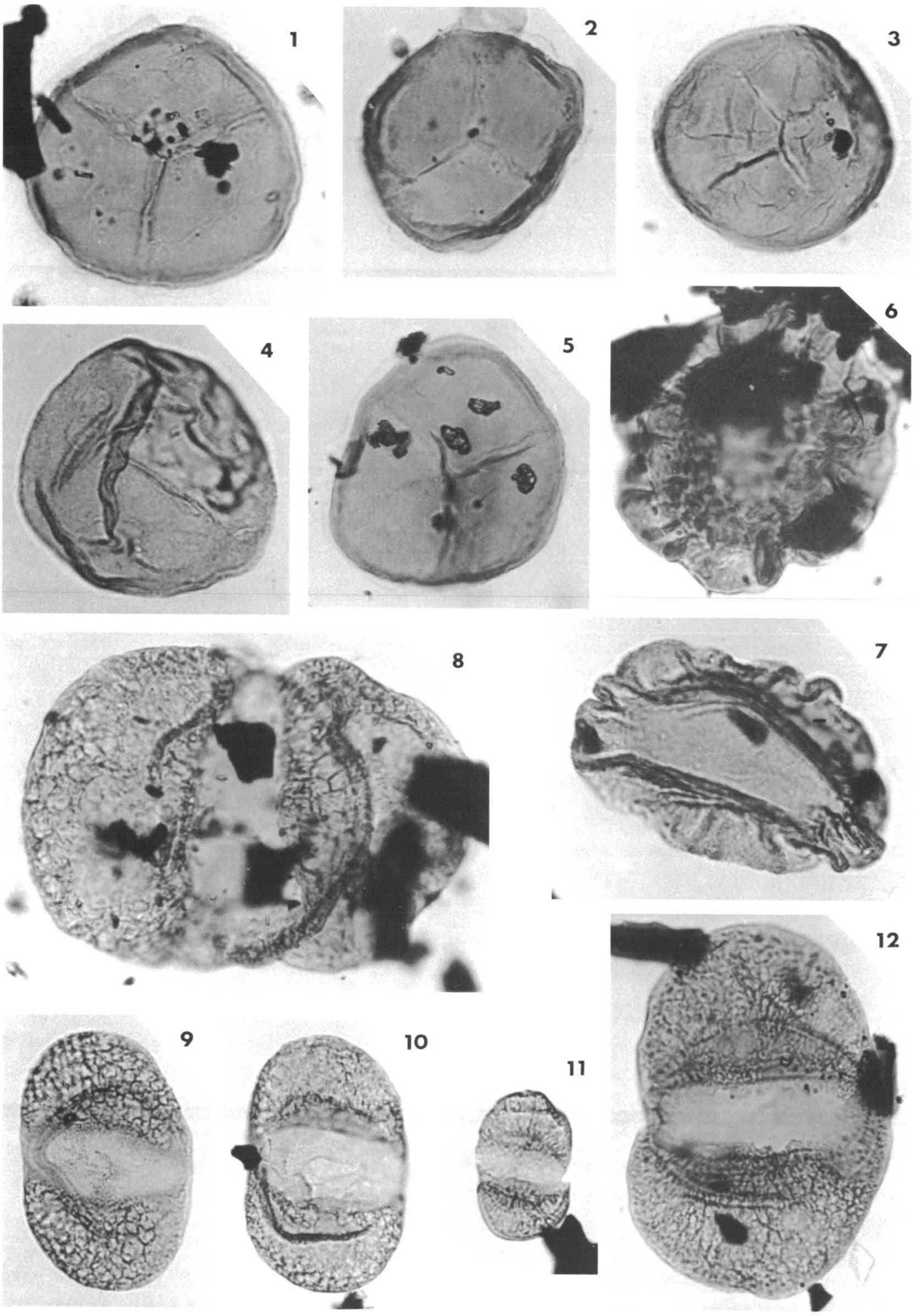
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PLATE 18

all figures (except Fig. 13a) x750

Figs. 1, 2 **Podocarpidites ellipticus** Cookson. p. 63

Fig. 3 **Podocarpidites multesimus** (Bolchovitina). p. 63

Figs. 4-6 **Rugubivesiculites** sp. A. p. 64

Figs. 7-9 **Microcachryidites antarcticus** Cookson. p. 64

Figs. 10-12, 14 **Trisaccites microsaccatus** (Couper). p. 64

Figs. 13, 15-17 **Classopollis** cf. **C. chateaunovi** Reyre. Fig. 13 shows the proximal hemisphere with equatorial belt of striae, the columellae and the region of the proximal pole, at which the columellate layer and tectum are dislodged in a triangular area. (Fig. 13a approximately x1500). Figs. 15 and 16 show specimens in polar view; Fig. 15 shows triangular area at proximal pole where sexine is missing; Fig. 16 shows distal hemisphere, with rimula and circular pore. Fig. 17 shows a compressed specimen, of which the proximal exine is differentiated in the proximal polar area, and clearly shows the columellate structure (Fig. 17b). p. 64

1. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 256/1030, CPC 16257.
2. UKA Boggo Creek 1, 201-210 m, Griman Creek Formation; MFP 6450-2, 405/1098. CPC 16258.
3. Same sample as Fig. 1; MFP 6423-2, 411/1109. CPC 16259.
4. BMR Surat 4, 28.4 m, Griman Creek Formation; MFP 4634-1, 312/1073. CPC 16260.
5. GSQ Surat 3, 125.3 m, Griman Creek Formation; MFP 5017-1, 417/1070. CPC 16261.
6. BMR Surat 1, 42.4 m, Coreena Member; MFP 4536-2, 275/1183. CPC 16262.
7. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-1, 303/1053. CPC 16263.
8. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-1, 412/1046. CPC 16264.
9. Same sample as Fig. 1; MFP 6423-1, 270/1069. CPC 16273.
10. Same sample as Fig. 1: MFP 6423-2, 401/1185. CPC 16265.
11. Same sample as Fig. 8; MFP 6426-1, 379/1103. CPC 16266.
12. Same sample as Fig. 8; MFP 6426-1, 398/1194. CPC 16267.
13. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 454/1029. CPC 16268.
14. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 368/1144. CPC 16269.
15. BMR Dalby 3, 61-64 m, Bungil Formation; MFP 5975-1, 309/1187. CPC 16270.
16. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 411/1141. CPC 16271.
17. Same sample as Fig. 15; MFP 5975-2, 400/1094. CPC 16272.

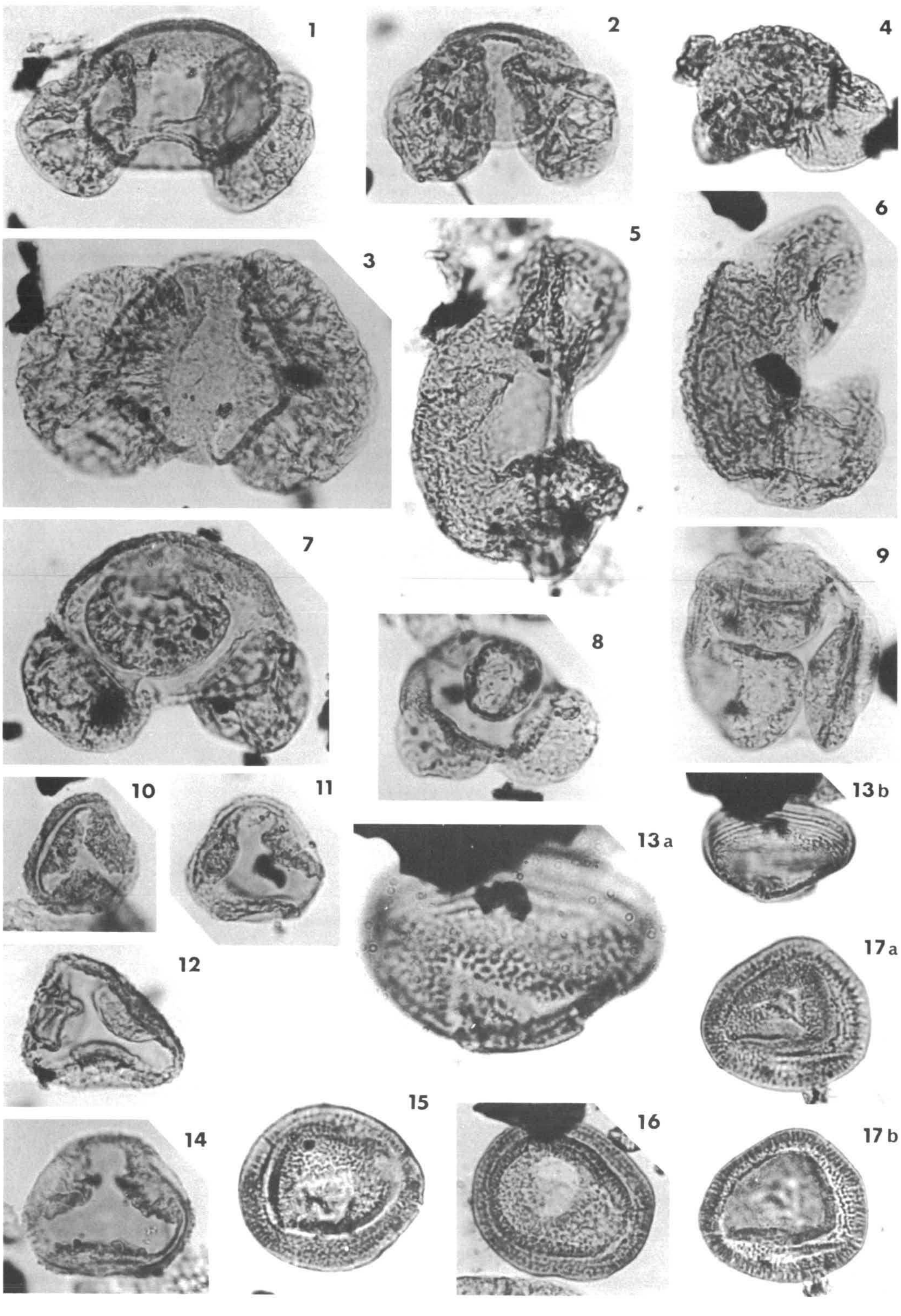
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PLATE 19

for magnifications, see individual figures

Fig. 1	**Ephedripites multicostatus** Brenner. (x750).	p. 65
Figs. 2-4	**Concentrisporites hallei** (Nilsson). Specimen of Fig. 3 split open along line of weakness. (x750).	p. 66
Figs, 5, 6	**Monosulcites minimus** Cookson. (x750).	p. 65
Figs. 7-9, 13, 14	**Clavatipollenites hughesii** Couper. Specimen of Fig. 7 with short sulcus; sulcal area covered with clusters of clavae; columellate structure of exine distinct (Fig. 7a x750, Fig. 7b photographed in interference contrast illumination, x1320). Figs. 8 and 13 show specimens with relatively coarse columellate structure (both x750). Figs. 9 and 14 show specimens with long sulci; sulcal area free of sexinal elements (Figs. 9 and 14a x750, Fig. 14b x1230).	p. 66
Fig. 10	**Clavatipollenites** sp. A. Extremely fine exine structure only visible at periphery of specimen in Fig. 10a (interference contrast photomicrograph, x1230; Fig. 10b x750).	p. 66
Figs. 11, 12	**Liliacidites** spp. Fig. 11a is focused on aperture; Fig. 11b shows the regular surface reticulum of the proximal exine (Fig. 11a x1300, Fig. 11b x750). Fig. 12 shows the reticulum reduced at apices of the grain (x750).	p. 66
Figs. 15-17, 19	**Asteropollis asteroides** Hedlund & Norris. Specimens depicted are characterised by a three-branch aperture. Fig. 19 shows a specimen with the columellate layer largely unbroken in sulcal areas. In Fig. 15 sulcal margins are marked by structural (clavate) elements larger than average (all figures x750).	p. 66
Fig. 18	**Retimonocolpites peroreticulatus** (Brenner). Poorly preserved specimen (x750).	p. 66
Fig. 20	**Asteropollis asteroides** Hedlund & Norris. Specimen with a four-branch aperture. Columellate layer initially fractured at extremities of apertural branches (Fig. 20a x750; Fig. 20b x1260).	p. 66

1. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-1, 377/1067. CPC 16274.
2. BMR Dirranbandi 5, 152.4 m, Surat Siltstone; MFP 5321-1, 262/1203. CPC 16275.
3. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 421/1150. CPC 16276.
4. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-2, 386/1067. CPC 16277.
5. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-2, 367/1130. CPC 16278.
6. UKA Boggo Creek 1, 201-210 m, Griman Creek Formation; MFP 6450-2, 280/1125. CPC 16279.
7. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 384/1184. CPC 16280.
8. Same sample as Fig. 5; MFP 6426-1, 386/1108. CPC 16281.
9. BMR Surat 3, 15.9 m, Griman Creek Formation; MFP 4611-1, 438/1168. CPC 16282.
10. Same sample as Fig. 9; MFP 4611-2, 352/1070. CPC 16283.
11. GSQ Surat 3, 165.5 m, Griman Creek Formation; MFP 5023-1, 320/1110. CPC 16284.
12. Same sample as Fig. 9; MFP 4611-1, 375/1190. CPC 16285.
13. HONL Werrina 1, 58-61 m, Griman Creek Formation; MFP 6428A-5, 424/1157. CPC 16286.
14. BMR Homeboin 2, 54.9 m, Surat Siltstone; MFP 6451-1, 436/1141. CPC 16287.
15. Same sample as Fig. 5; MFP 6426-1, 390/1055. CPC 16288.
16. Same sample as Fig. 5; MFP 6426-1, 331/1114. CPC 16289.
17. Same sample as Fig. 5; MFP 6426-2, 375/1043. CPC 16290.
18. Same sample as Fig. 5; MFP 6426-1, 278/1151. CPC 16291.
19. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 383/1096. CPC 16292.
20. Same sample as Fig. 4; MFP 4537-2, 307/1115. CPC 16293.

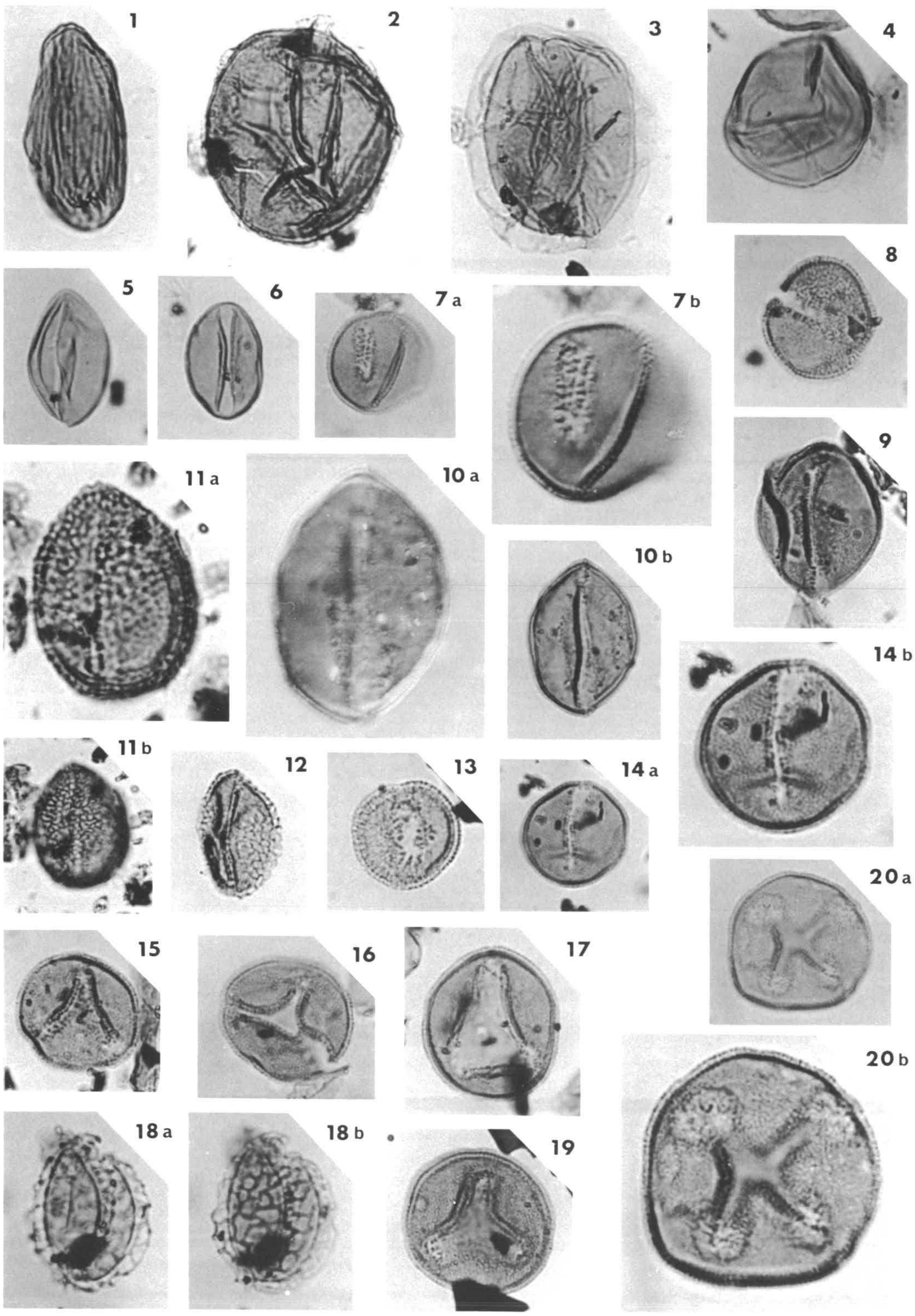
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PLATE 20

for magnifications, see individual figures

Figs. 1, 2, 4-6, 8 **Asteropollis asteroides** Hedlund & Norris. Specimens with four-branch apertures. The columellate layer shows varying degrees of breakdown in apertural areas. In Fig. 2 a specimen of which the sexine is unbroken; the aperture is difficult to locate. Apertural margins lined with columellae coarser than average in specimens of Figs. 1 and 4. Fig. 8 shows the nexinal body with aperture, columellate layer stripped off entirely; a sulcal membrane is not observed (Fig. 1b x1230, Fig. 4a photographed in interference contrast illumination, x1300; Fig. 6a x1140; other figures x750). p. 66

Fig. 3 **Asteropollis asteroides** Hedlund & Norris. Specimen with five-branch aperture. Columellate layer broken down near extremities of branches; areas of breakdown lined and partly covered with structural elements coarser than average (Fig. 3a x750; Fig. 3b interference contrast illumination micrograph, x1260). p. 66

Figs. 7, 9 **Rousea georgensis** (Brenner). Fig. 7 showing reticulate pattern reduced in polar regions and along aperture margins. Fig. 9 shows a poorly preserved specimen (both figures x750). p. 67

Fig. 10 **Tricolpites variabilis** Burger. Specimens united in tetrad. Figs. 10a-d represent successively lower levels of focus. Figs. 10a, e show the apertures joined two by two. Lumina of reticulum are slightly irregular, which is typical of the species, and remain constant in the polar regions and next to apertures (Figs. 10 a-d x750; Figs. 10 e-f x1240). p. 67

1. NAI Whyenbirra 1, 113-119 m, Griman Creek Formation; MFP 6422-2, 323/1163. CPC 16294.
2. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-2, 303/1142. CPC 16295.
3. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 287/1088. CPC 16296.
4. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 315/1170. CPC 16297.
5. BMR Surat 3, 75.1 m, Surat Siltstone; MFP 4623-1, 353/1120. CPC 16298.
6. Same sample as Fig. 4; MFP 6423-1, 281/1094. CPC 16299.
7. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-1, 479/1056. CPC 16300.
8. Same sample as Fig. 7; MFP 4612-2, 317/1149. CPC 16301.
9. Same sample as Fig. 7; MFP 4612-1, 419/1126. CPC 16302.
10. Same sample as Fig. 7; MFP 4612-2, 392/1081. CPC 16303.

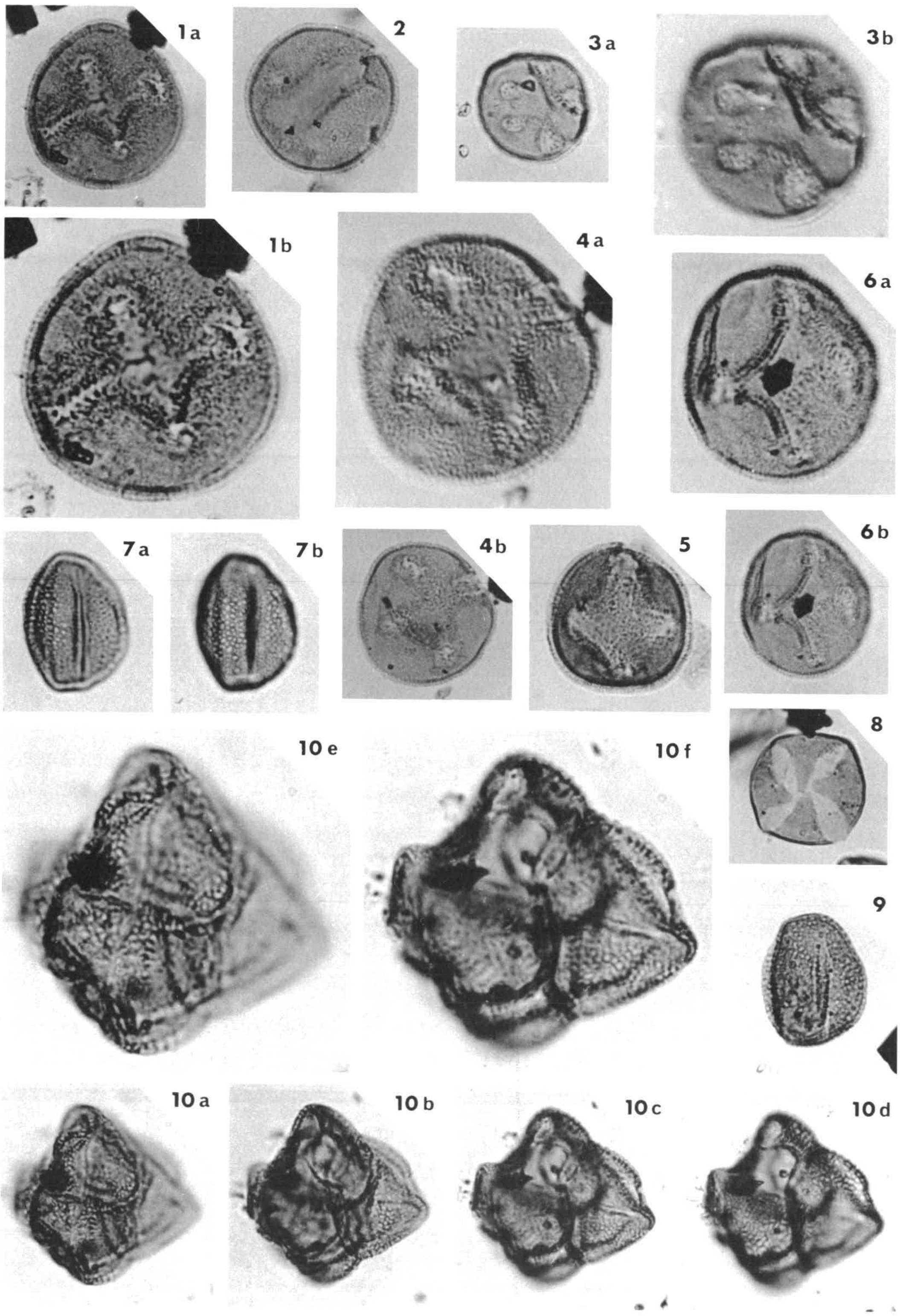
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PLATE 21
all figures x750

Figs. 1-3	**Canningia colliveri** Cookson & Eisenack. Figs. 1, 3 show dehisced specimens; positions of precingular paraplates shown in Fig. 1b. Fig. 2 shows a complete specimen; apical horn distinct.	p. 71
Fig. 4	**Canningia** sp. A. Specimen distinctly micro-echinate; precingular paraplate boundaries and parasulcal notch discernible.	p. 71
Fig. 5	**Hexagonifera** cf. **H. defloccata** Davey & Verdier. Specimen orientation obscure.	p. 72

1. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-1, 425/1067. CPC 16304.
2. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-1, 403/1070. CPC 16305.
3. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 373/1104. CPC 16306.
4. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 333/1048. CPC 16307.
5. Same sample as Fig. 2; MFP 4276-2, 243/1177. CPC 16308.

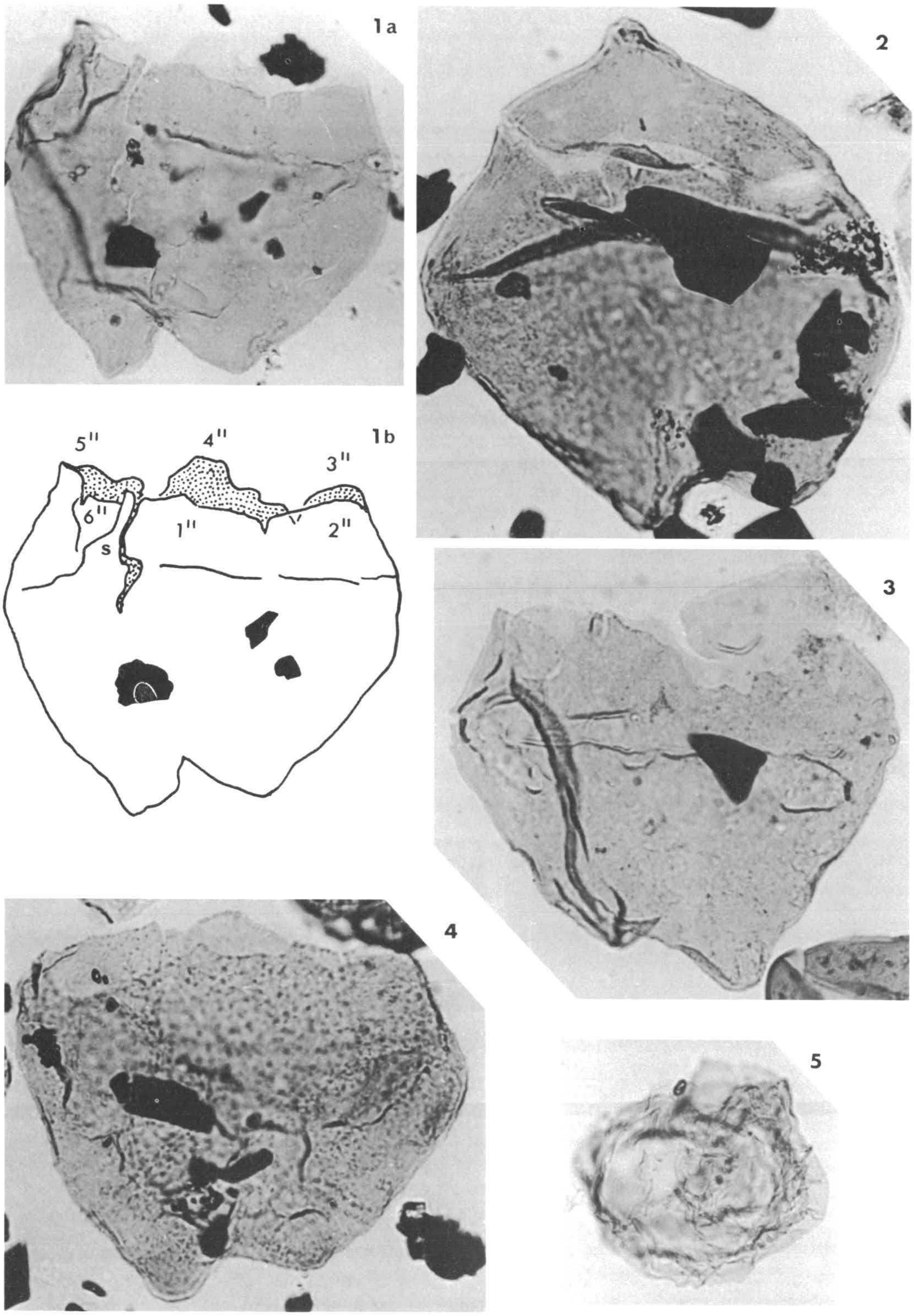
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PLATE 22
all figures x750

Fig. 1	**Hexagonifera** cf. **H. defloccata** Davey & Verdier, showing cavate nature of cyst. Archaeopyle developed in both endophragm and periphragm (type A/A).	p. 72
Figs. 2, 3	**Hexagonifera** sp. B. Specimen in Fig. 3 dehisced; archaeopyle present in both endophragm and periphragm.	p. 73
Fig. 4	**Hexagonifera** sp. A. Specimen shows small archaeopyle; periphragm narrowly enveloping endocyst.	p. 73
Figs. 5, 6	**Dingodinium cerviculum** Cookson & Eisenack. Specimen of Fig. 6 shows outline of precingular paraplates at archaeopyle margin and distinct parasutures on anterior surface.	p. 72
Fig. 7	**Prolixosphaeridium parvispinum** (Deflandre) Davey & others. Traces of paratabulation at archaeopyle margin; position of precingular paraplates shown in Fig. 7b.	p. 73
Figs. 8-10	**Tenua pilosa** (Ehrenberg). Thin autophragm and numerous short, pointed processes typical (Figs. 8 and 9 interference contrast illumination micrographs).	p. 76

1. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 424/1063. CPC 16309.
2. BMR Roma 1, 16.0 m, Minmi Member; MFP 4320-2, 469/1056. CPC 16310.
3. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 263/1208. CPC 16311.
4. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-2, 333/1037. CPC 16312.
5. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 329/1106. CPC 16313.
6. GSQ Surat 1, 305.3 m, Doncaster Member; MFP 5015-1, 327/1131. CPC 16314.
7. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 368/1167. CPC 16315.
8. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-2, 361/1124. CPC 16316.
9. Same sample as Fig. 8; MFP 6238-2, 424/1024. CPC 16317.
10. GSQ Surat 1, 91.4 m, Surat Siltstone; MFP 5005-1, 364/1120. CPC 16318.

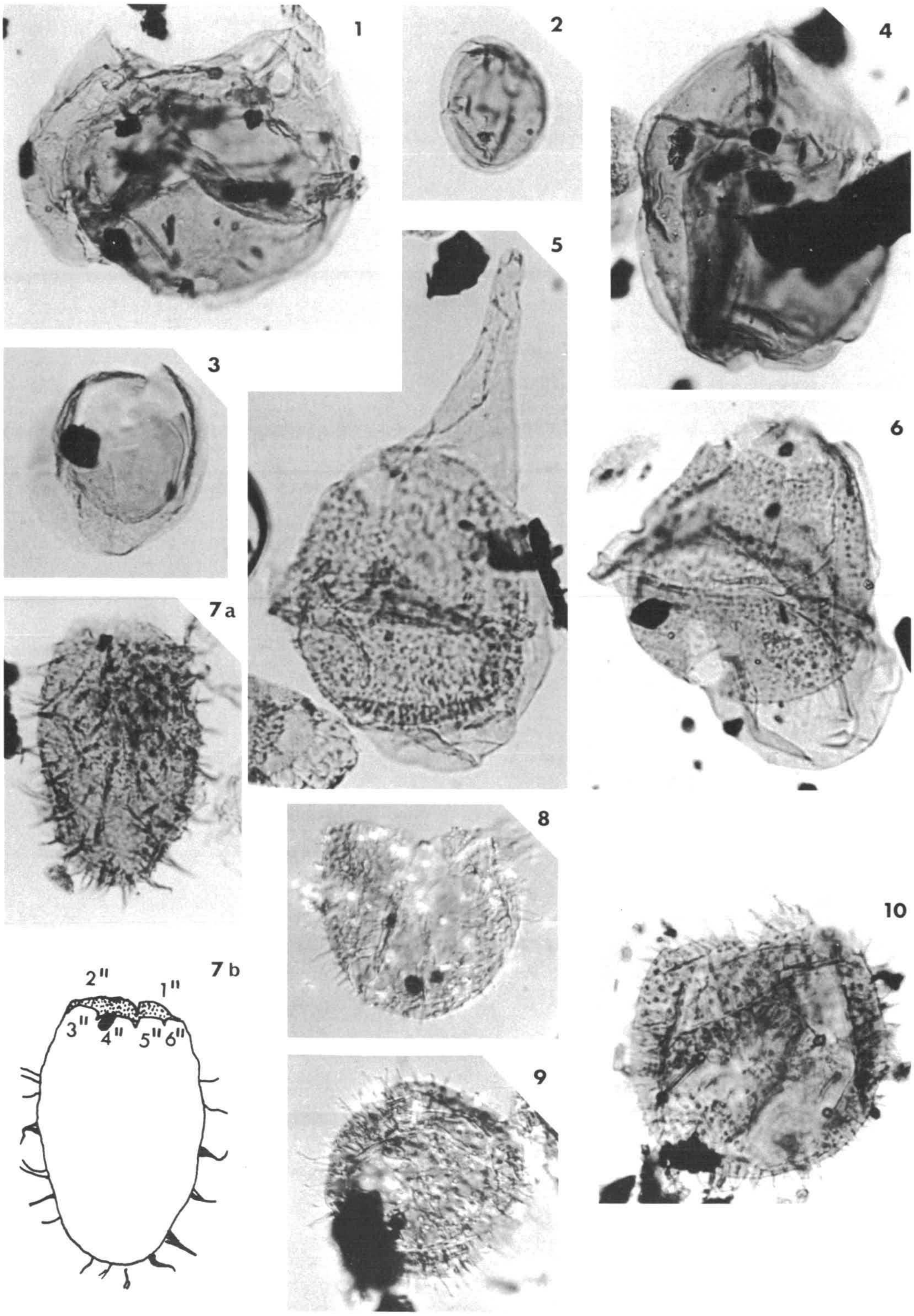
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PLATE 23

all figures (except Figs. 1b, c) x750

Figs. 1, 5	**Tenua aptiense** sp. nov. Fig. 1 holotype; dehisced specimen; Figs. 1 b, c show details of cyst granulation and short bifid processes. (Both figures approximately x2700). Fig. 5b shows outline of precingular paraplates along archaeopyle margin.	p. 76
Figs. 2, 3, ?4	**Tenua pilosa** (Ehrenberg). Fig. 4 represents a poorly preserved and broken (recycled?) specimen with an unusually high number of spines and therefore of uncertain affinity. (Fig. 2 taken in interference contrast illumination).	p. 76

1. Holotype of the species.
2. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 324/1102. CPC 16320.
3. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-1, 420/1081. CPC 16321.
4. AAO Pickanjinnie 1, 61-64 m, Minmi Member; MFP 773-2, 488/1190. CPC 16322.
5. GSQ Roma 3, 28.7 m, Doncaster Member; MFP 5789-1, 312/1076. CPC 16323.

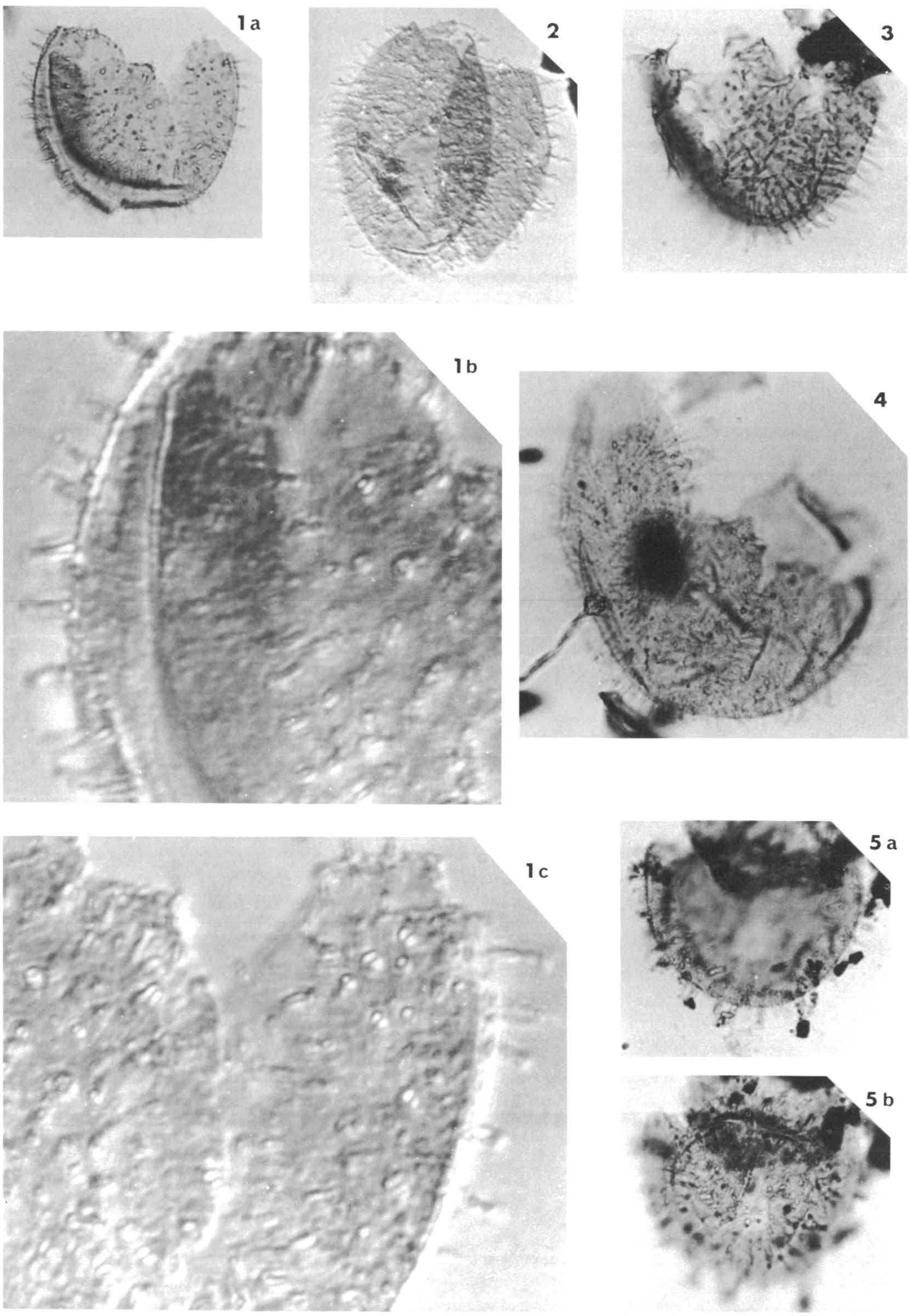
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PLATE 24
all figures x750

Fig. 1	**Tenua aptiense** sp. nov. Paratabulation apparent, positions of precingular paraplates shown in Fig. 1b. (Fig. 1a interference contrast illumination micrograph).	p. 76
Fig. 2	**Tanyosphaeridium** sp. A. Specimen illustrated in interference contrast illumination, showing the tubular processes with the trifid distal ends.	p. 80
Fig. 3	**Tanyosphaeridium isocalamus** (Deflandre & Cookson). Specimen indicating the presence of 5 precingular paraplates.	p. 79
Figs. 4-6	**Chlamydophorella nyei** Cookson & Eisenack. Fig. 4 with anterior portion of cyst partly detached. Apical horn distinct. Fig. 5: probably posterior part of cyst only. Fig. 6: free operculum without distinct horn.	p. 76
Figs. 7, 8	**Cleistosphaeridium polypes** (Cookson & Eisenack). Fig. 7 shows archaeopyle margin, operculum still in place. Fig. 8 shows a poorly preserved, possibly dehisced specimen.	p. 77

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 324/1102. CPC 16324.
2. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 325/1176. CPC 16325.
3. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-3, 318/1035. CPC 16326.
4. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 328/1034. CPC 16327.
5. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-2, 295/1111. CPC 16328.
6. GSQ Surat 1, 91.4 m, Surat Siltstone; MFP 5005-1, 320/1176. CPC 16329.
7. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-2, 495/1142. CPC 16330.
8. Same sample as Fig. 3; MFP 4616-4, 450/1081. CPC 16331.

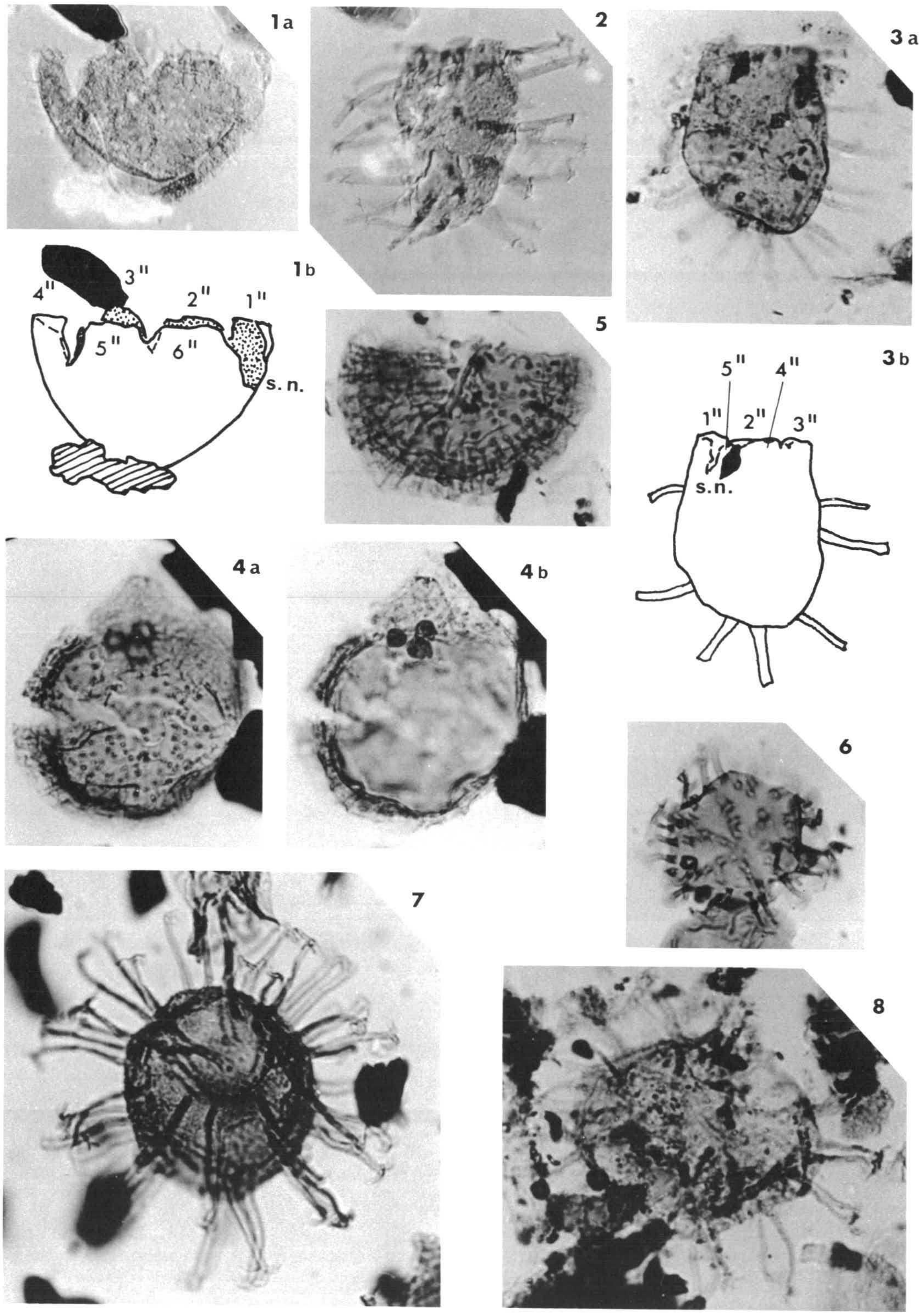
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PLATE 25

all figures x750

Figs. 1-4 **Chlamydophorella nyei** Cookson & Eisenack. Figs. 1, 4 represent dehisced specimens. Fig. 1: operculum with horn still attached; Fig. 1b (interference contrast illumination) shows remnants of the granulate outer enveloping membrane. Figs. 2 and 3 show undehisced specimens; Fig. 2: two precingular paraplates are removed by accidental breakdown of the cyst. Fig. 3: entire specimen, showing outer enveloping membrane intact. p. 76

Figs. 5-11 **Canningia minor** Cookson & Hughes var. **psilata** nov. Fig. 10 holotype. Fig. 8 with operculum (partly obscured) still attached. p. 71

1. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 316/1168. CPC 16332.
2. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-3, 473/1186. CPC 16333.
3. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-2, 335/1157. CPC 16334.
4. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 488/1112. CPC 16335.
5. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-2, 393/1083. CPC 16336.
6. Same sample as Fig. 2; MFP 4616-4, 388/1188. CPC 16337.
7. Same sample as Fig. 2; MFP 4616-4, 316/1002. CPC 16338.
8. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-2, 389/1155. CPC 16339.
9. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-2, 330/1082. CPC 16340.
10. Holotype of the variety.
11. Same sample as Fig. 5; MFP 6238-2, 269/1096. CPC 16342.

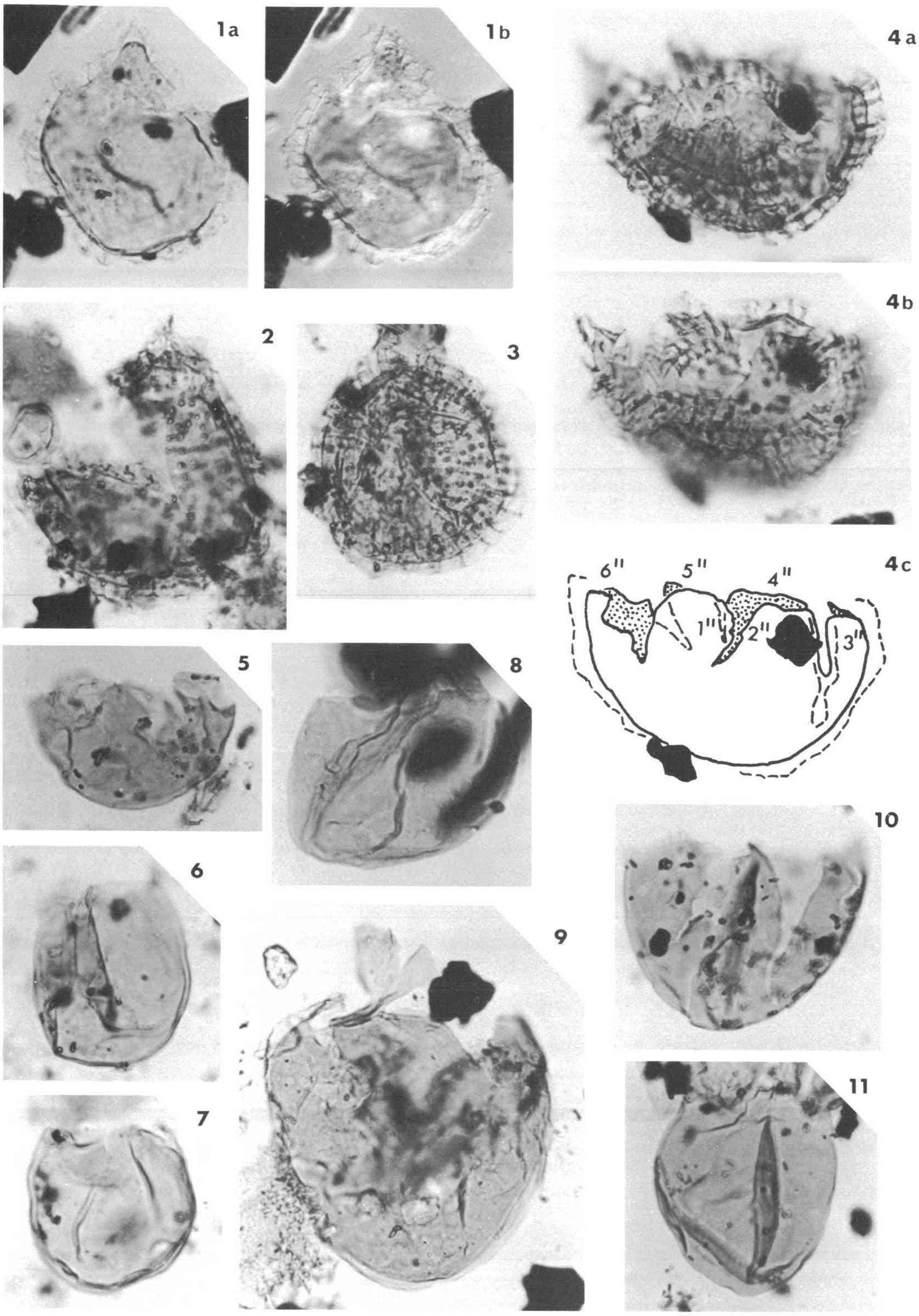
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PLATE 26
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Figs. 1-4	**Canningia minor** Cookson & Hughes.	p. 71
Figs. 5, 6	**Membranosphaera coninckii** sp. nov. Both specimens with opercula attached. Fig. 6 holotype; Fig. 6b indicates position of precingular paraplates and possible arrangement of apical paraplate series.	p. 74
Figs. 7, 8	**Membranosphaera norvickii** sp. nov. Fig. 7 holotype. Specimen in Fig. 8 with remnants of operculum still attached.	p. 73

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 279/1158. CPC 16343.
2. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 383/1205. CPC 16344.
3. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-2, 387/1067. CPC 16345.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 425/1092. CPC 16346.
5. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 350/1035. CPC 16347.
6. Holotype of the species.
7. Holotype of the species.
8. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 431/1042. CPC 16350.

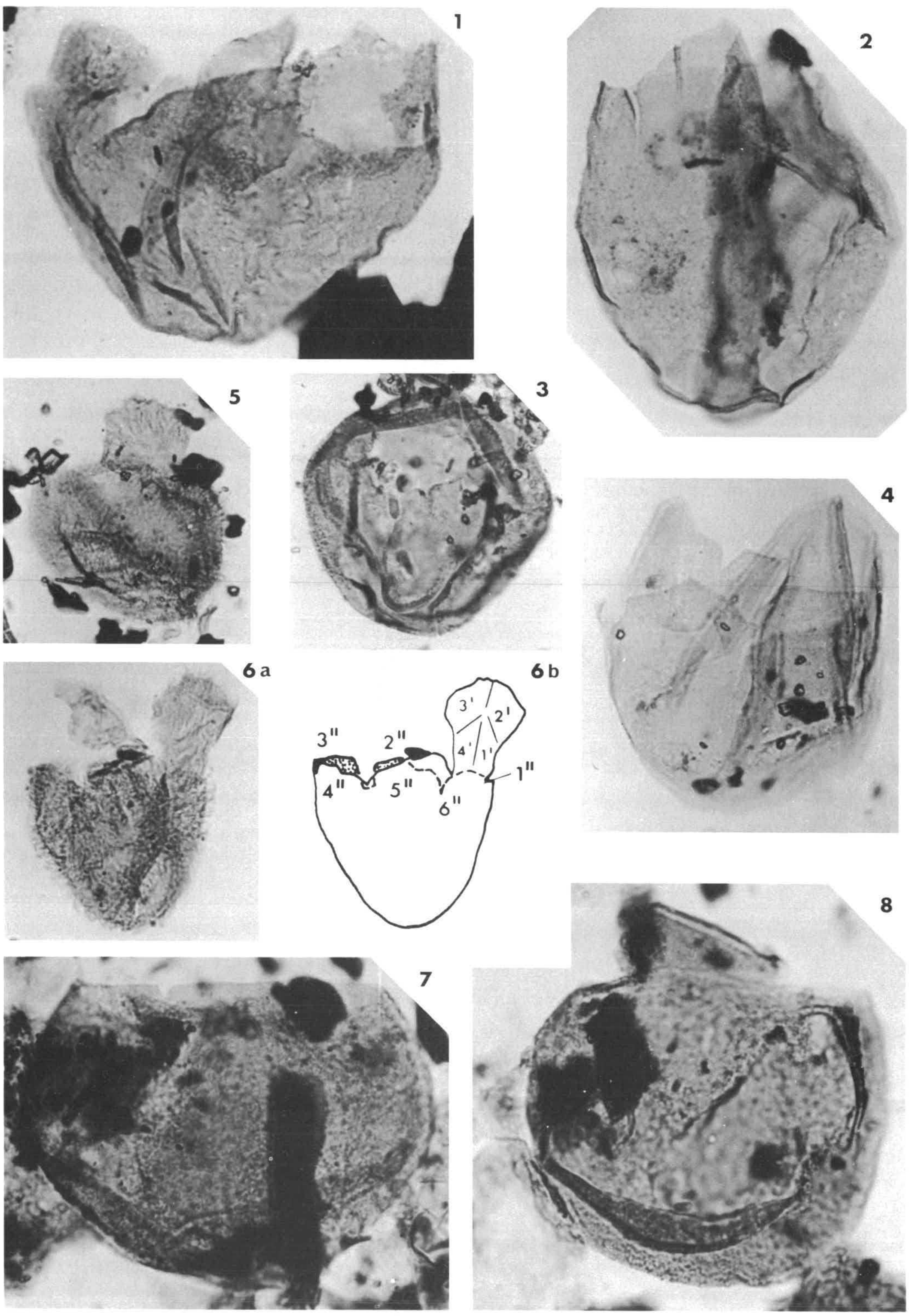
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PLATE 27
all figures x750

Figs. 1-3	**Membranosphaera romaensis** sp. nov. Fig. 1 taken in interference contrast illumination. Fig. 2 undehisced specimen (orientation uncertain). Fig. 3 holotype; operculum still attached. Operculate fragments represent 2-4' and 1' paraplate equivalents respectively.	p. 74
Fig. 4	**Membranosphaera granulata** Norvick. Surface granulation indistinct. Position of precingular paraplates shown in Fig. 4b.	p. 73
Figs. 5, 6	**Membranosphaera** sp. A. Fig. 5 shows a specimen in oblique view; precingular paraplates outlined at archaeopyle margin. Fig. 6 shows a specimen with the typical vermiculate pattern of the cyst wall ornament. Operculum partly dislodged.	p. 74
Figs. 7, 8	**Cassiculosphaeridia** cf. **C. reticulata** Davey. Illustrated specimens poorly preserved. Surface reticulum not well marked.	p. 72
Figs. 9, 10	**Oligosphaeridium nannum** Davey. Fig. 9: orientation of specimen unknown. Fig. 10: specimen probably in polar view. Aperture (archaeopyle?) circular, flanked by four or five processes.	p. 79

1. GSQ Surat 1, 305.3 m, Doncaster Member; MFP 5015-1, 347/1037. CPC 16351.
2. AAO Pickanjinnie 1, 61-64 m, Minmi Member; MFP 773-2, 481/1064. CPC 16352.
3. Holotype of the species.
4. BMR Roma 8, 31.1 m, Doncaster Member; MFP 4676-2, 264/1023. CPC 16354.
5. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 382/1044. CPC 16355.
6. Same sample as Fig. 5; MFP 4276-1, 292/1162. CPC 16356.
7. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-1, 404/1095. CPC 16357.
8. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-2, 440/1088. CPC 16358.
9. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-1, 442/1127. CPC 16359.
10. UKA Cabawin 1, 337.7 m, Doncaster Member; MFP 906-2, 350/1005. CPC 16360.

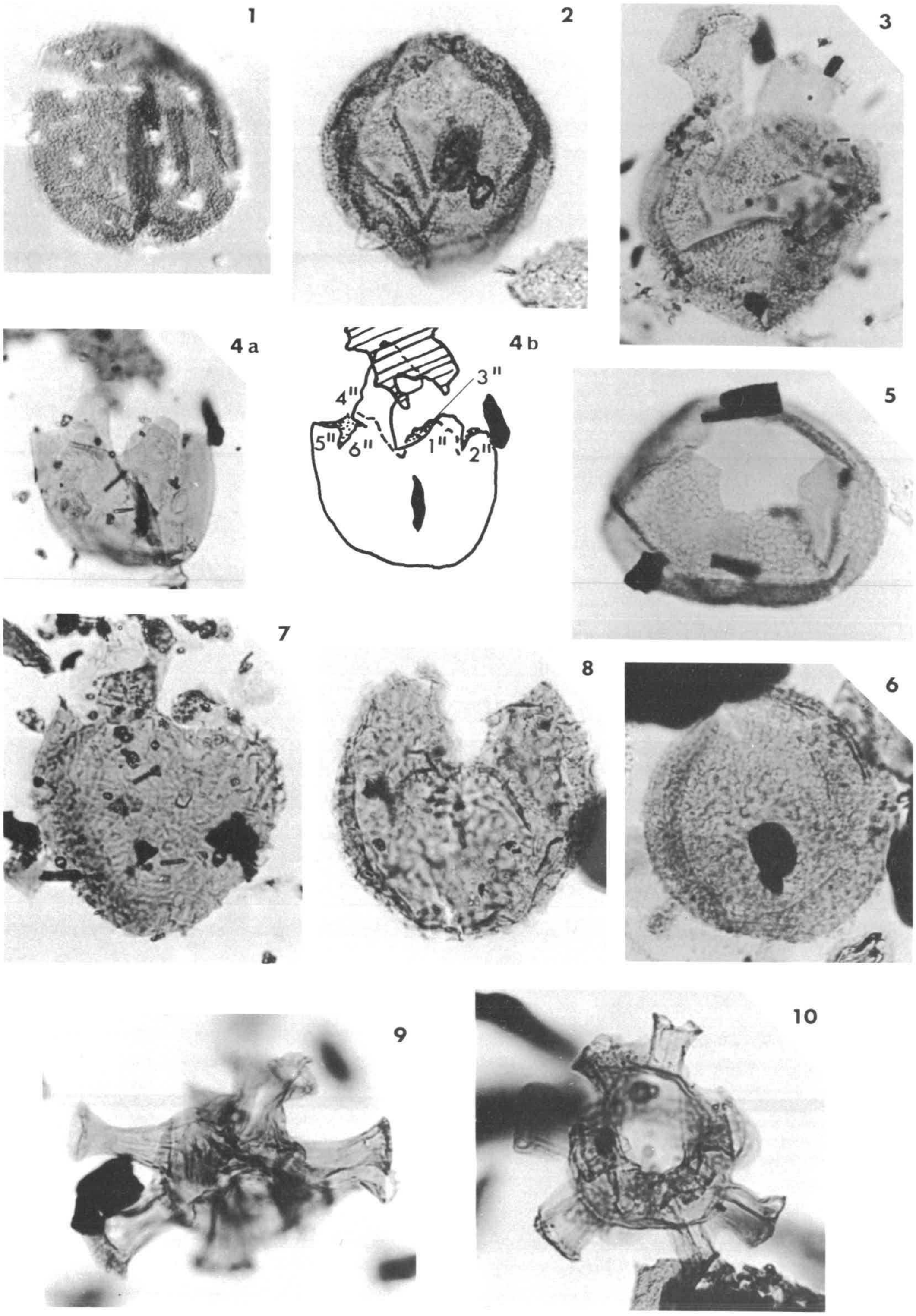
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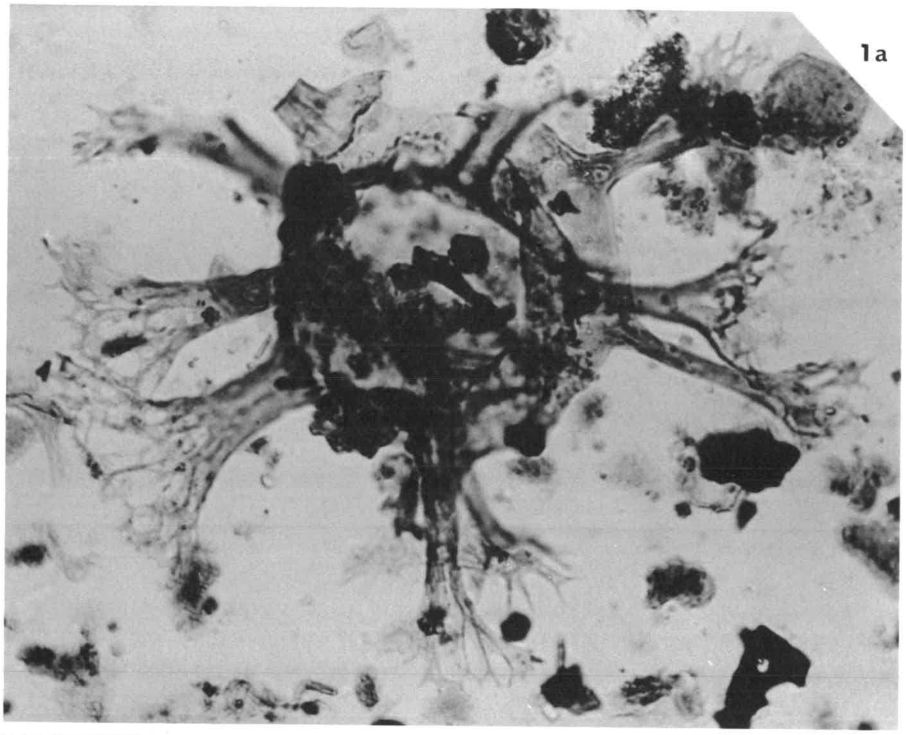
PLATE 28

for magnifications, see individual figures

Fig. 1	**Oligosphaeridium pulcherrimum** (Deflandre & Cookson). Specimen poorly preserved. Fig. 1b (interference contrast illumination) shows details of distal extremities of processes (Fig. 1a x750, Fig. 1b approximately x3000).	p. 78
Fig. 2	**Litosphaeridium** sp. A. Specimen photographed in interference contrast illumination (x750).	p. 78

1. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 283/1193. CPC 16361.
2. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 410/1183. CPC 16362.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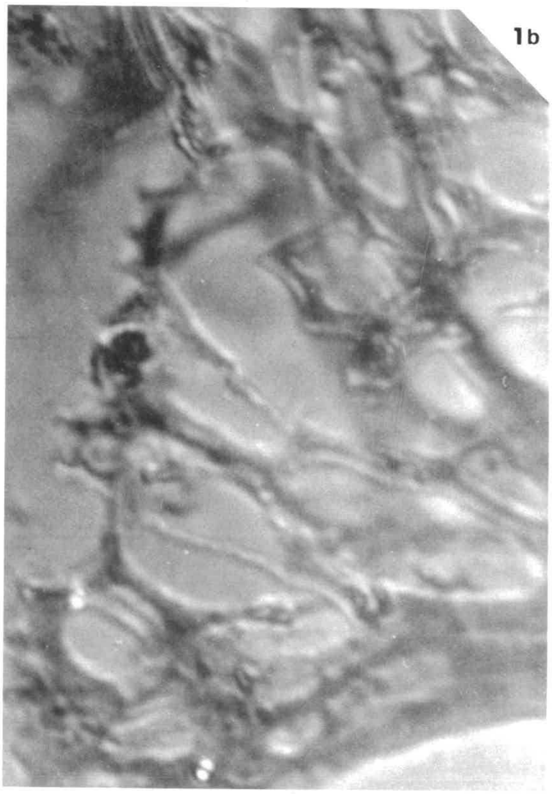
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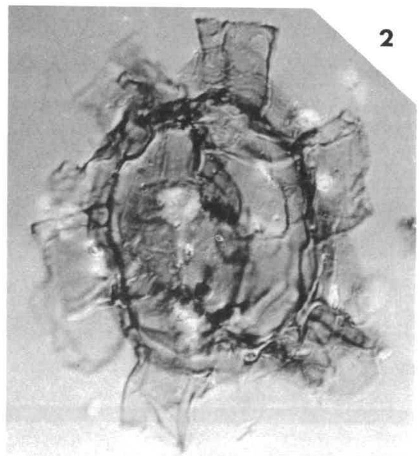
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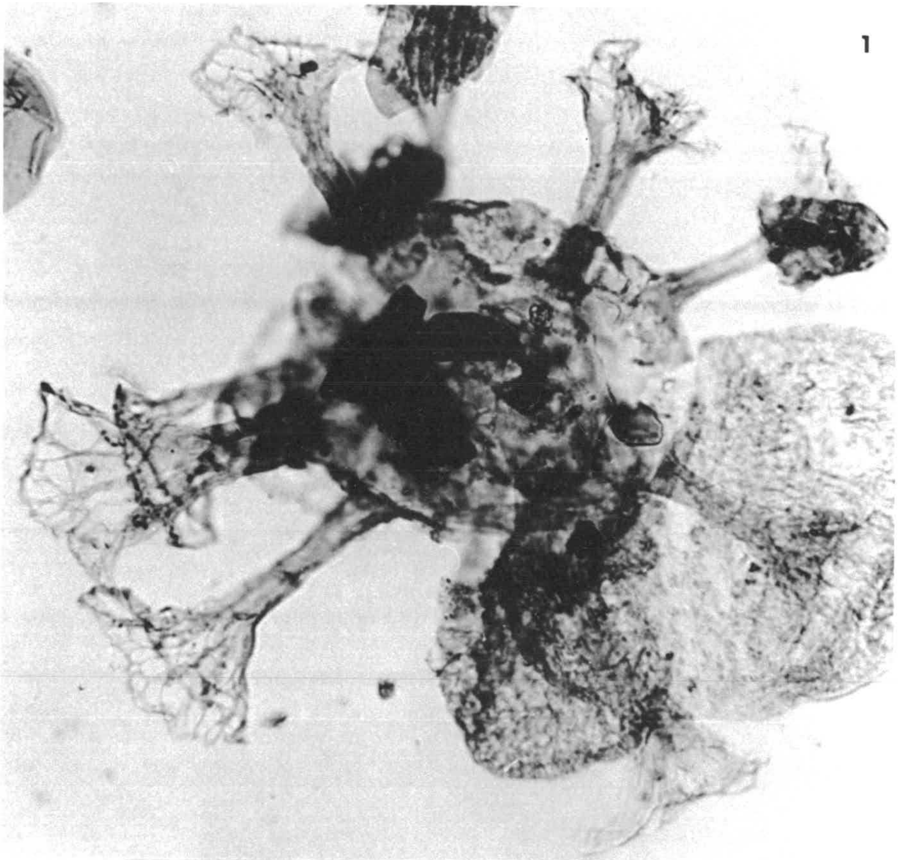
PLATE 29

all figures x750

Figs. 1?, 2 **Oligosphaeridium pulcherrimum** (Deflandre & Cookson). In view of the damaged cyst body and poorly preserved processes, Fig. 2 probably represents a specimen of secondary (recycled) origin. p. 78

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 374/1079. CPC 16363.
2. Same sample; MFP 3966-1, 352/1162. CPC 16364.



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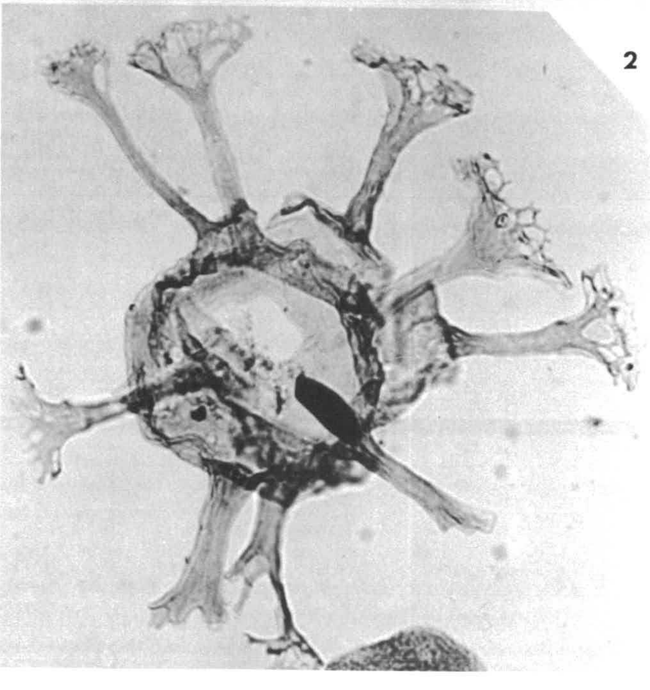

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PLATE 30

for magnifications, see individual figures

Figs. 1, 2?, 3 **Oligosphaeridium complex** (White). Fig. 1b taken in interference contrast illumination (Figs. 1, 2 x750). Fig. 3: free paraplate with plate-centred process (x750). p. 78

Fig. 4 **Hystrichosphaeridium** cf. **H. bowerbankii** Davey & Williams. Figs. 4b, c: details of processes (x3500 approximately, Fig. 4a x750). p. 78

1. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-4, 379/1074. CPC 16365.
2. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-1, 462/1024. CPC 16366.
3. BMR Surat 2, 41.3 m, Surat Siltstone; MFP 4535-2, 330/1133. CPC 16367.
4. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-2, 360/1107. CPC 16368.

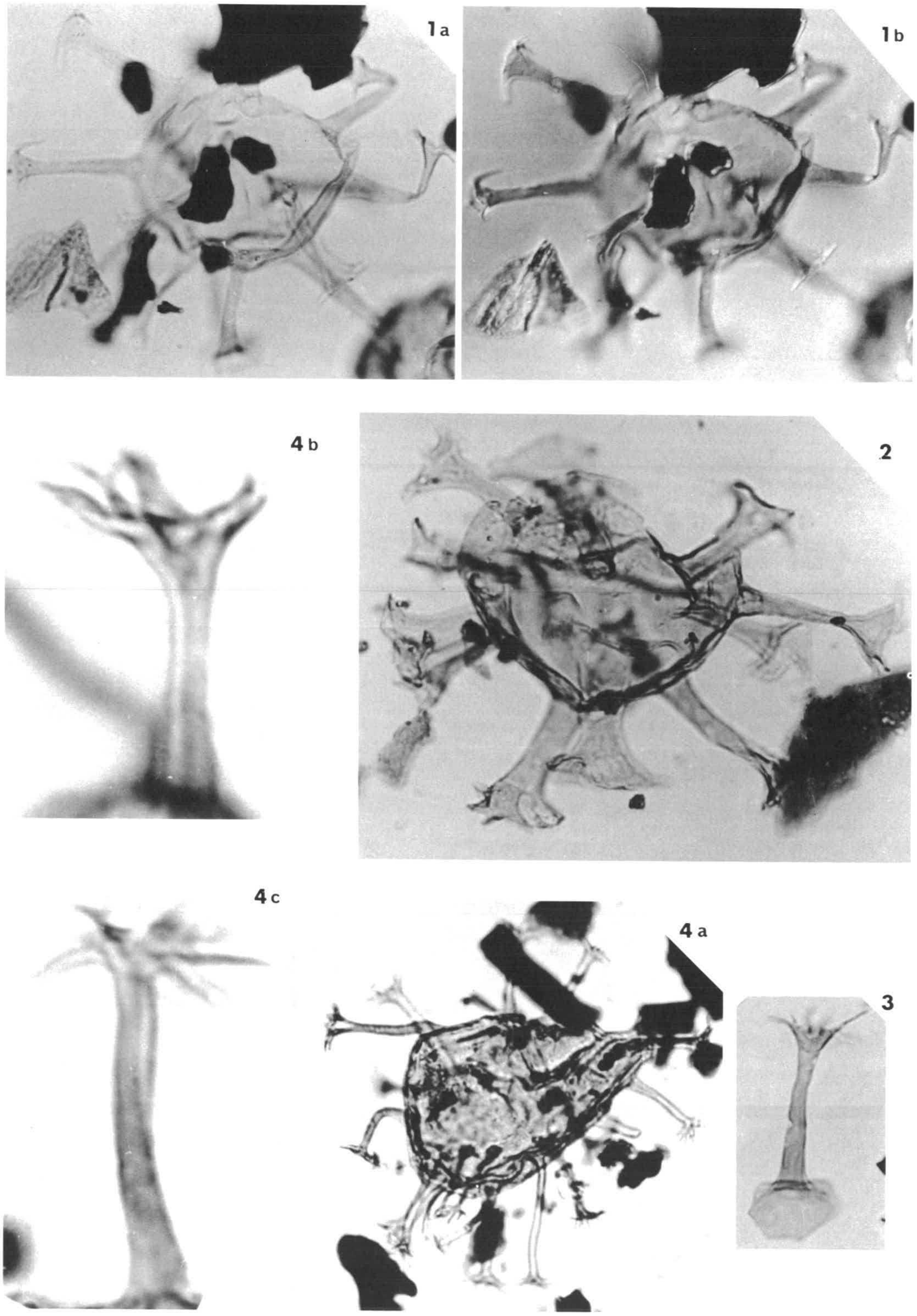
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PLATE 31

all figures (except Fig. 6b) x750

Figs. 1-3 **Cleistosphaeridium** cf. **C. polytrichum** (Valensi). Fig. 1 shows a probably dehisced specimen. p. 77

Figs. 4, 5 **Pseudoceratium turneri** Cookson & Eisenack. Fig. 4: operculum with apical horn, showing linear arrangement of sculptural elements. Fig. 5: dehisced specimen, lateral protuberance developed at left side; antapical horn folded back. Paracingulum vaguely indicated. p. 79

Fig. 6 **Cleistosphaeridium** sp. A. Fig. 6b shows processes in more detail (approximately x2800; taken in interference contrast illumination). p. 78

1. AAO Pickanjinnie 1, 61-64 m, Minmi Member; MFP 773-2, 488/1190. CPC 16369.
2. Same sample as Fig. 1; MFP 773-2, 453/1191. CPC 16370.
3. UKA Flinton 1, 314-317 m, Surat Siltstone; MFP 6425-2, 350/1061. CPC 16371.
4. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 381/1148. CPC 16372.
5. UKA Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-2, 412/1097. CPC 16373.
6. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-1, 404/1129. CPC 16374.

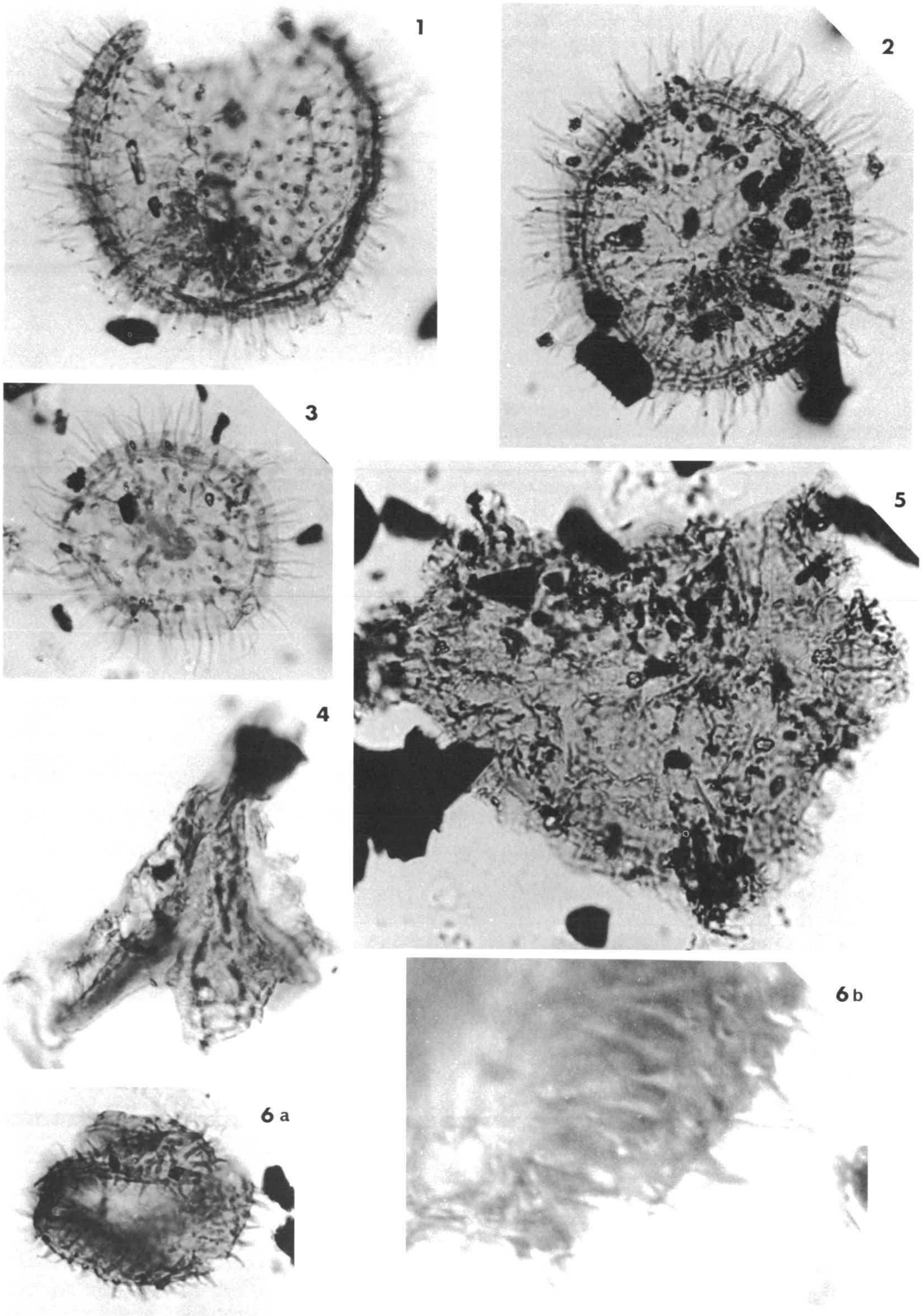

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PLATE 32

all figures x750

Figs. 1, 6	**Cleistosphaeridium** sp. A. Relatively small size and numerous, short, conical processes characteristic.	p. 78
Figs. 2, 3	**Pseudoceratium turneri** Cookson & Eisenack. Fig. 2: well-preserved specimen with short antapical and lateral protuberances. Ornamental elements trabeculate, arranged in linear patterns along parasutures. Fig. 3: free operculum.	p. 79
Figs. 4, 5, 7-9	**Cleistosphaeridium aciculare** Davey. Surface granulation of cyst membrane and long, simple, thin processes characteristic. Fig. 4: undehisced specimen. Figs. 5, 8: specimens showing archaeopyle, remains of the operculum still attached in specimen of Fig. 8a (taken in interference contrast illumination). Fig. 8b shows probable positions of precingular paraplates. Fig. 9: free operculum.	p. 77

1. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-2, 337/1025. CPC 16375.
2. Same sample as Fig. 1; MFP 905-2, 336/1061. CPC 16376.
3. UKA Flinton 1, 314-317 m, Surat Siltstone; MFP 6425-2, 327/1032. CPC 16377.
4. GSQ Surat 1, 29.9 m, Surat Siltstone; MFP 5004-1, 392/1102. CPC 16378.
5. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 426/1119. CPC 16379.
6. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 347/1095. CPC 16380.
7. Same sample as Fig. 5; MFP 1208-1, 405/1055. CPC 16381.
8. BMR Surat 1, 65.0 m, Coreena Member; MFP 4537-1, 438/1086. CPC 16382.
9. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 329/1095. CPC 16383.

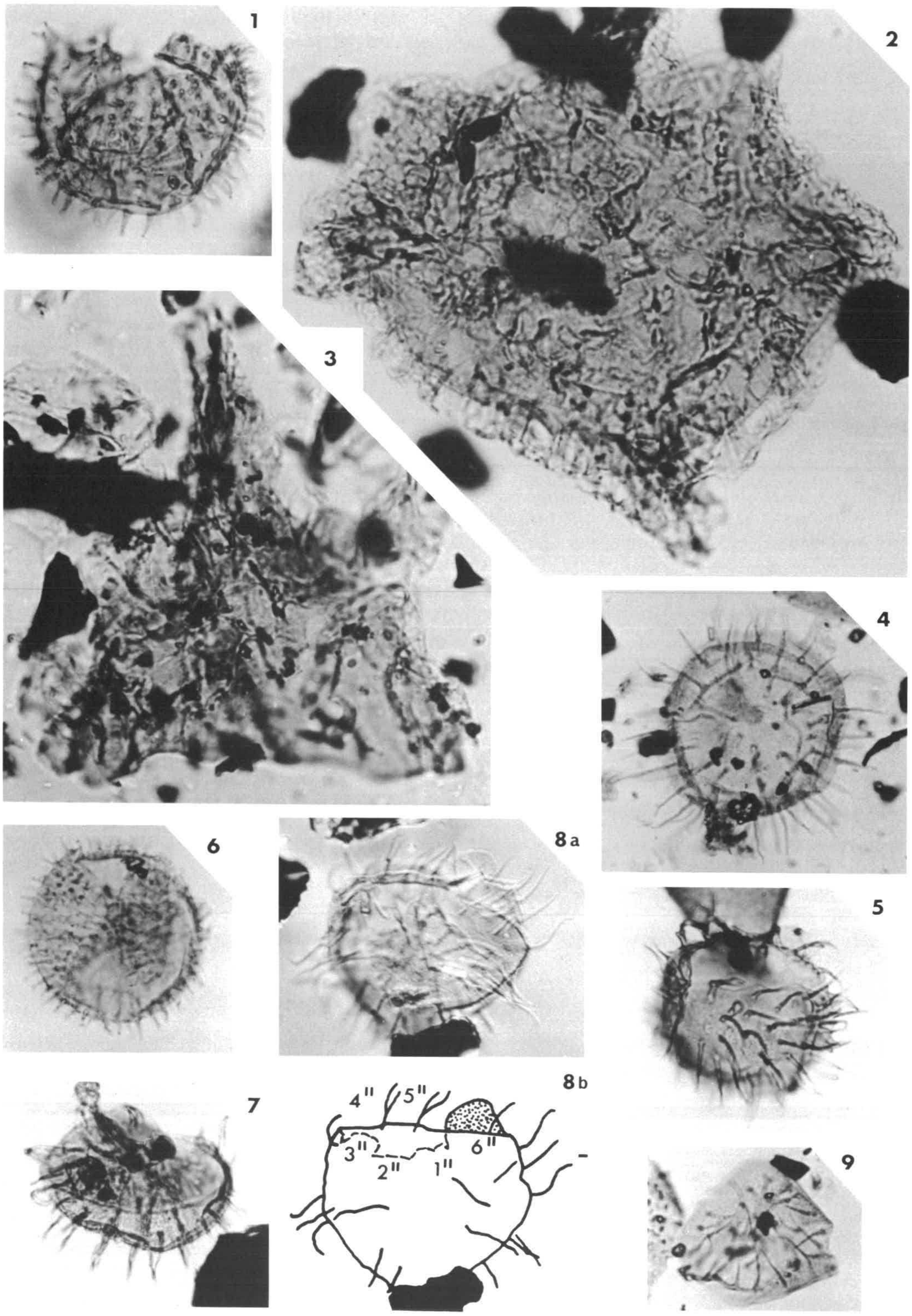
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PLATE 33

all figures (except Fig. 6) x750

Fig. 1 **Cleistosphaeridium aciculare** Davey. Specimen with operculum attached. Probable positions of precingular paraplates shown in Fig. 1b. p. 77

Fig. 5 **Cleistosphaeridium** cf. **C. aciculare** Davey. Undehisced specimen with relatively short processes. p. 77

Figs. 2-4, 6-10 **Cleistosphaeridium granulatum** sp. nov. Thin, granulate wall and relatively few, short, curving processes characteristic. Fig. 2 holotype; specimen dehisced. Figs. 3, 8 and 9 show specimens with damaged walls; archaeopyles (if formed) not well outlined. Fig. 6 shows details of cyst wall and processes (approximately x3000; taken in interference contrast illumination). Fig. 10: dehisced specimen well preserved. p. 77

1. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 421/1135. CPC 16384.
2. Holotype of the species.
3. Same sample as Fig. 1; MFP 4615-1, 343/1009. CPC 16386.
4. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 275/1085. CPC 16387.
5. Same sample as Fig. 1; MFP 4615-2, 325/1091. CPC 16388.
6. Same sample as Fig. 1; MFP 4615-2, 400/1178. CPC 16389.
7. GSQ Surat 1, 29.9 m, Surat Siltstone; MFP 5004-1, 280/1045. CPC 16390.
8. Same sample as Fig. 1; MFP 4615-1, 375/1038. CPC 16391.
9. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 326/1112. CPC 16392.
10. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-1, 290/1000. CPC 16393.

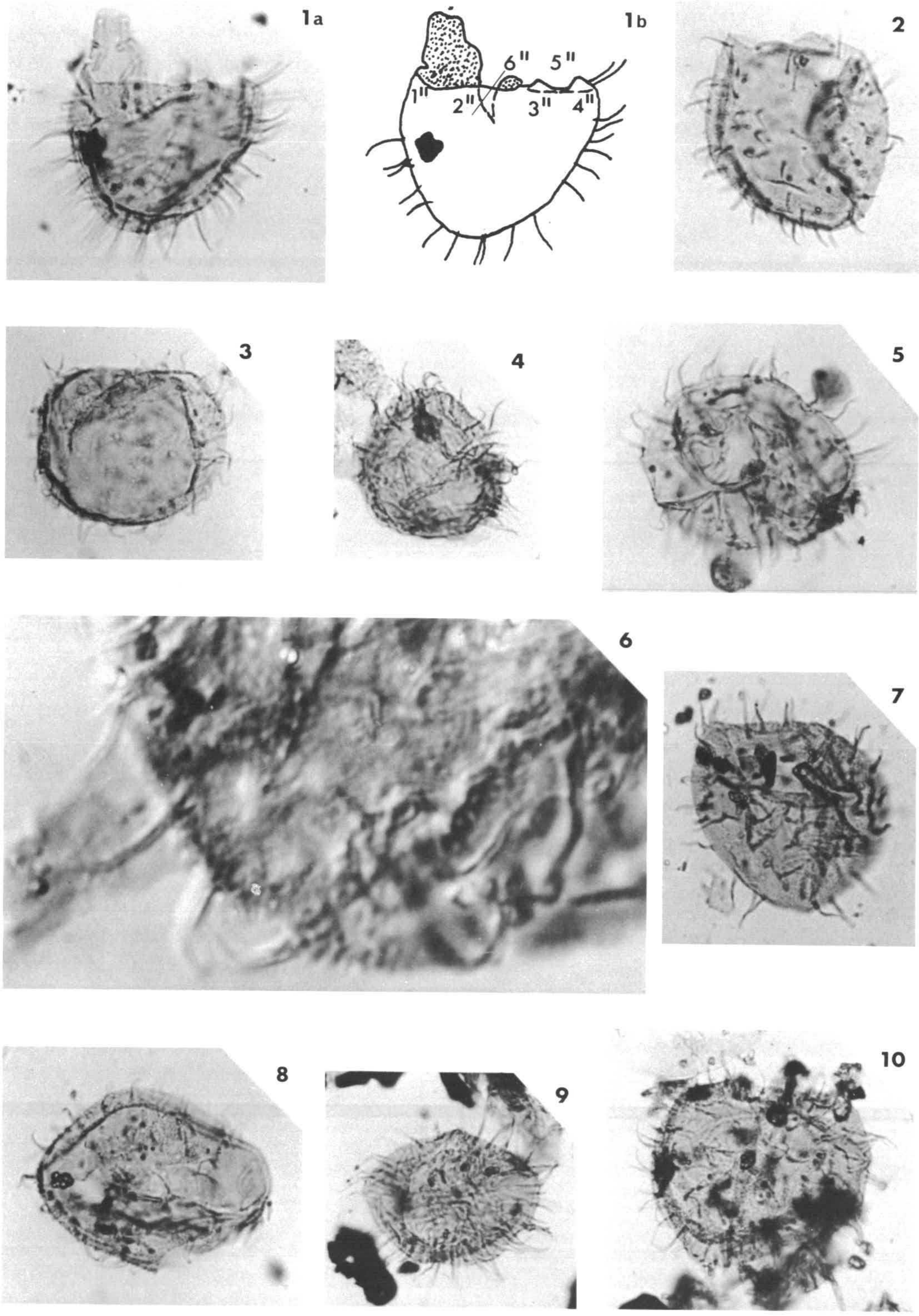
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PLATE 34
all figures x750

Figs. 1, 3, 4	**Odontochitina operculata** (O. Wetzel). Dehisced specimens; endophragm does not protrude into antapical horns. Fig. 1: archaeopyle margin asymmetrical. Fig. 3: specimen fractured, showing sulcal notch and partly attached precingular paraplate.	p. 75
Fig. 2	**Odontochitina** sp. A. Cyst considerably elongated, anterior part upwards, partly dislodged, presumably in archaeopyle formation.	p. 76

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 316/1201. CPC 16454.
2. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 2467-2, 388/1090. CPC 16455.
3. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 276/1174. CPC 16456.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 327/1095. CPC 16457.

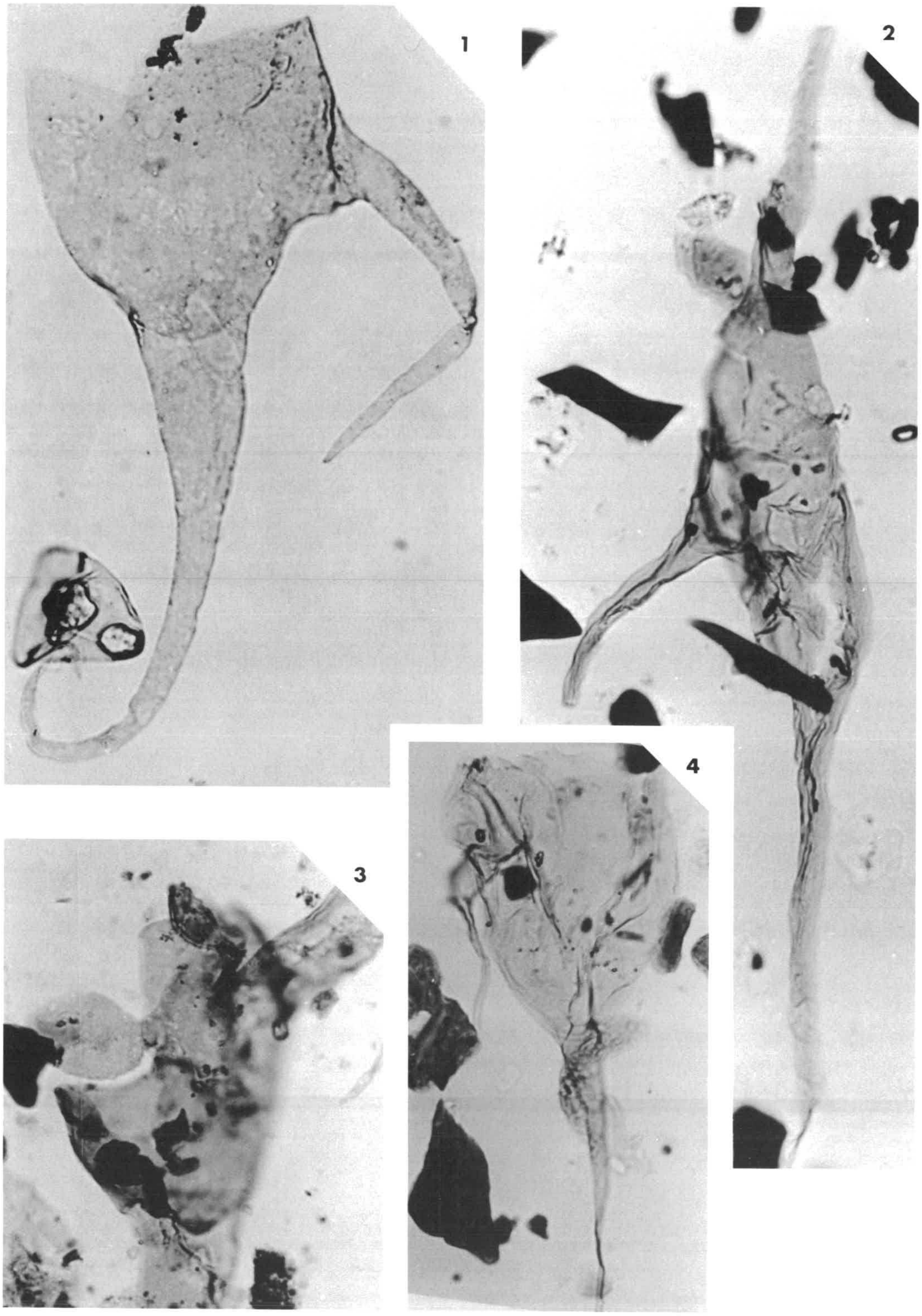
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PLATE 35
all figures x750

Figs. 1, 3 **Muderongia tetracantha** (Gocht). Fig. 1: showing apical archaeopyle and randomly distributed perforations in lateral and antapical horns. Fig. 3: entire specimen, apical portion of the cyst partly detached. p. 75

Figs. 2, 4 **Muderongia** cf. **M. staurota** Sarjeant. Specimens dehisced, showing abrupt curvature of lateral horns. Specimen of Fig. 4 shows parasulcal notch and fragment of the apical cyst wall still attached. p. 75

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 312/1107. CPC 16458.
2. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 420/1166. CPC 16459.
3. BMR Roma 1, 16.0 m, Minmi Member; MFP 4320-1, 275/1167. CPC 16460.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 423/1198. CPC 16461.

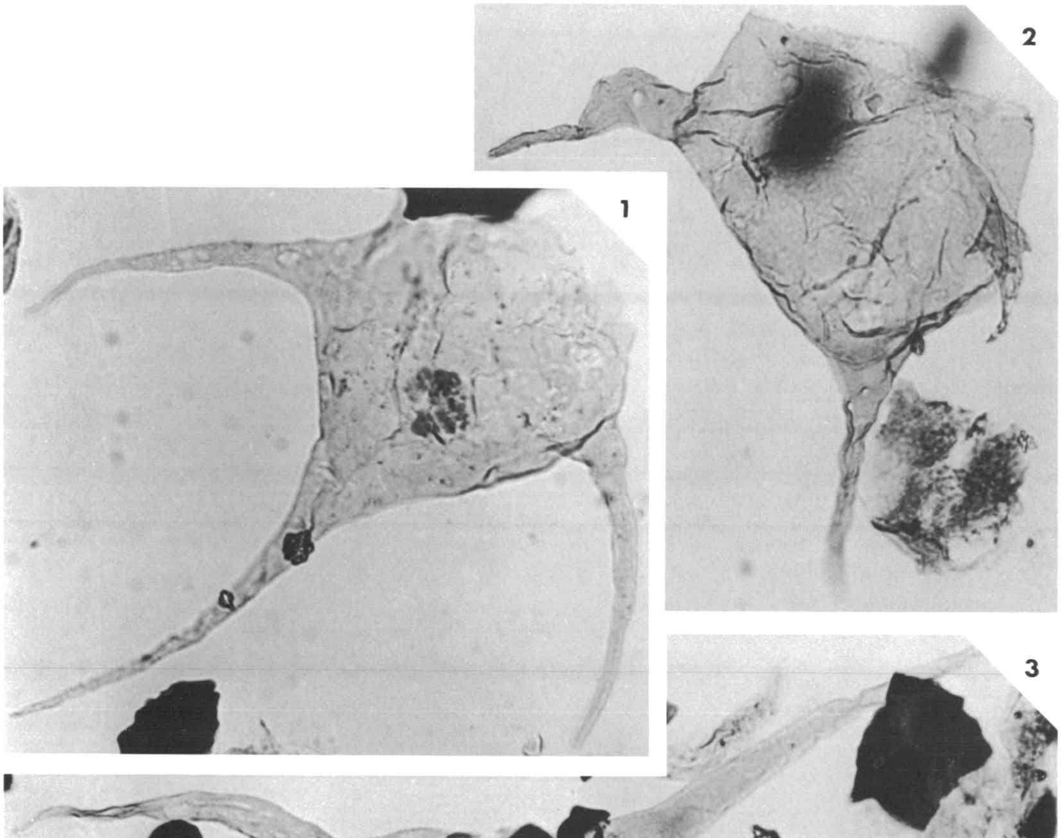
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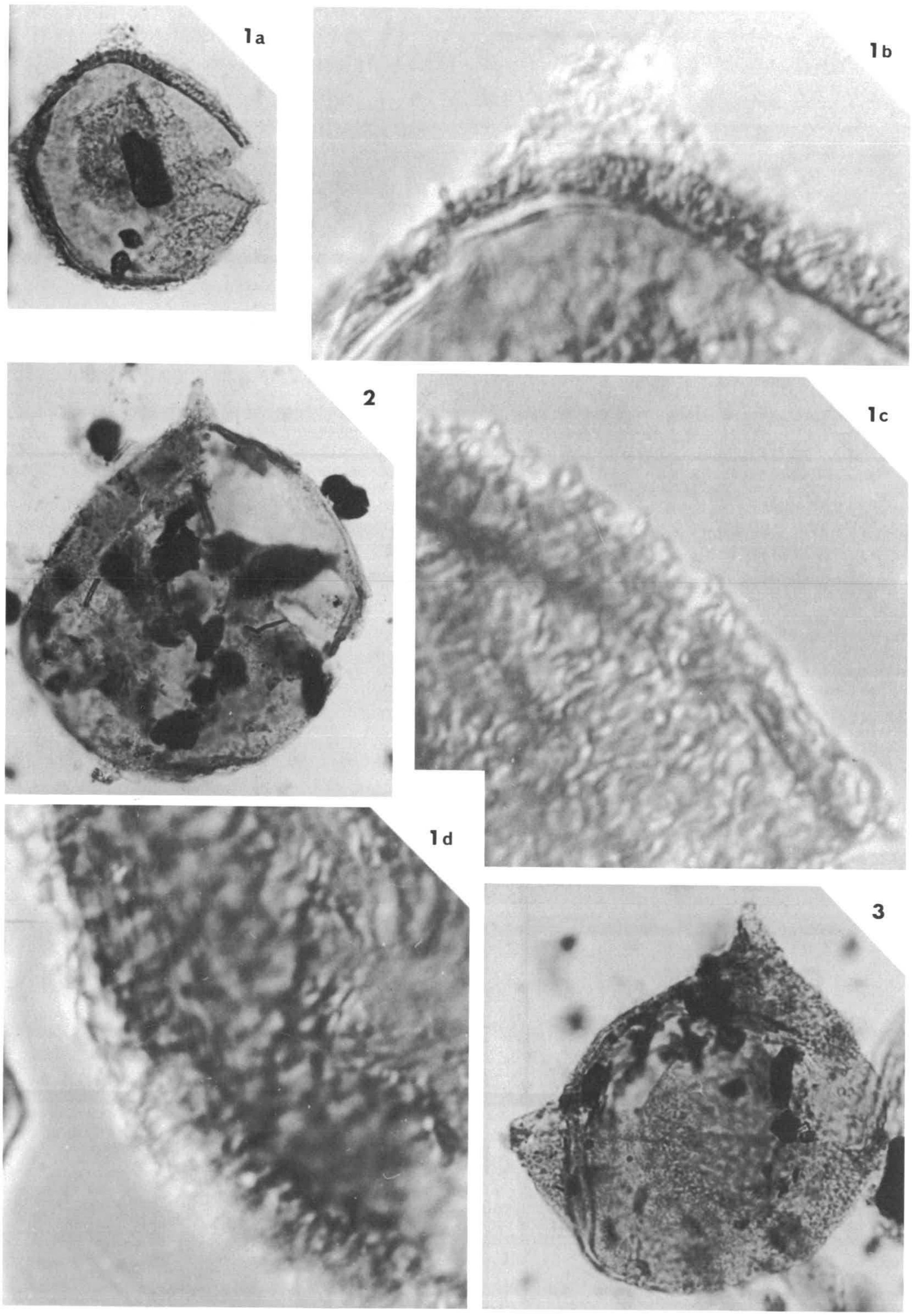
PLATE 36

for magnifications, see individual figures

Fig. 1	**Apteodinium conjunctum** Eisenack & Cookson. Dehisced specimen; large archaeopyle at right; Fig. 1b shows stratified cyst wall and hollow apical horn; Fig. 1c shows the typical vermiculate surface pattern; Fig. 1d shows the tiny, distally interwoven processes (Fig. 1a x750; Figs. 1b-d x2850, taken in interference contrast illumination).	p. 80
Figs. 2, 3	**Apteodinium maculatum** Eisenack & Cookson. Both specimens have characteristically large archaeopyles, and show a tiny, hollow apical horn. Fig. 3 shows traces of a paracingulum. (both x750).	p. 80

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 271/1074. CPC 16394.
2. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 426/1004. CPC 16395.
3. Same sample as Fig. 2; MFP 4616-4, 451/1165. CPC 16396.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1b
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1c
1d
3

PLATE 37

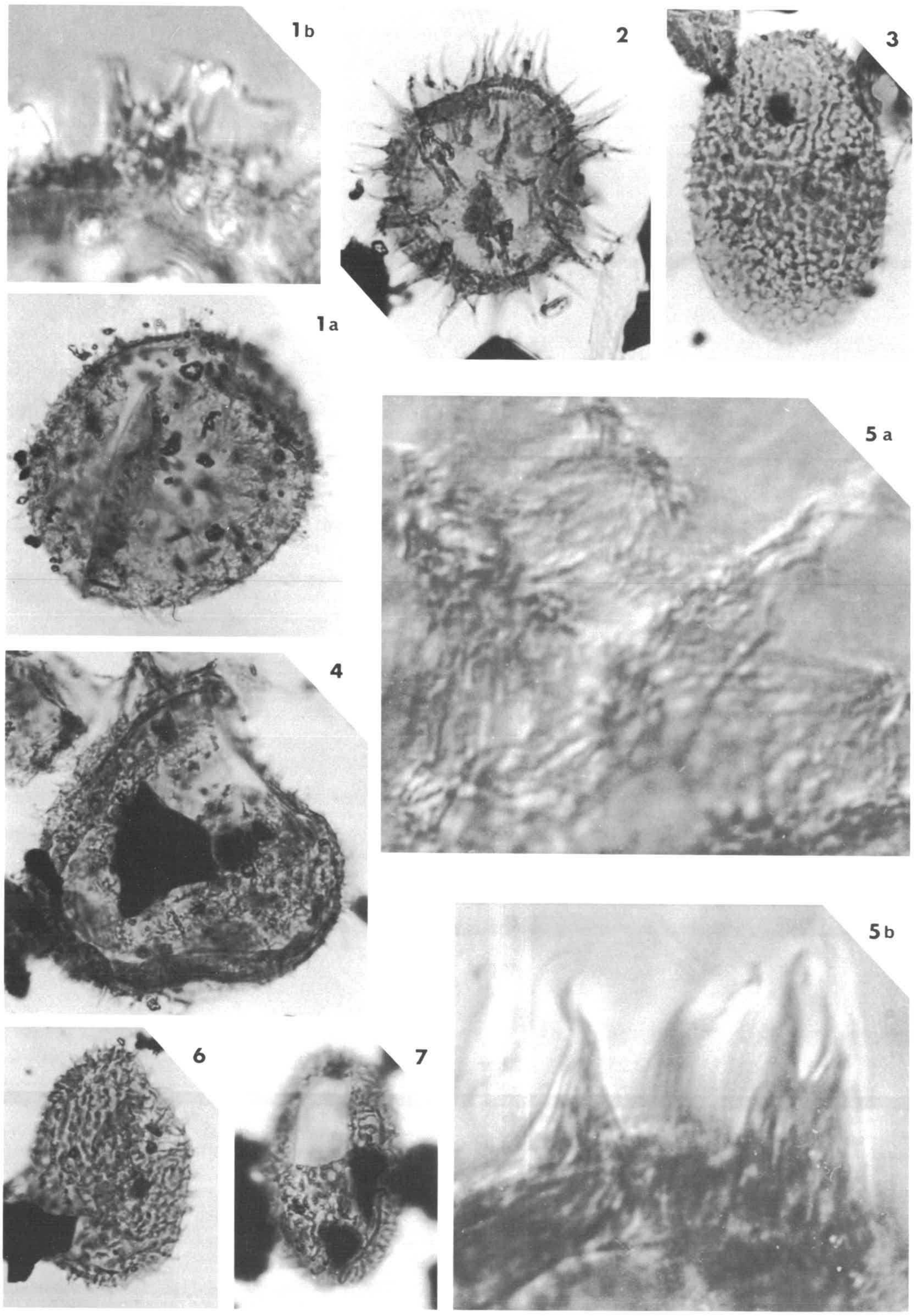
for magnifications, see individual figures

Figs. 1, 4 **Trichodinium eisenackii** sp. nov. Fig. 1: holotype; specimen undehisced; tiny apical horn developed at top and figured in detail in Fig. 1b. Fig. 4 shows a specimen with archaeopyle; position uncertain as no apical horn is apparent (Figs. 1a and 4 x750; Fig. 1b approximately x3000). p. 81

Figs. 2, 5 **Exochosphaeridium** cf. **E. phragmites** Davey & others. Fig. 2: specimen entire, showing granulate periphragm. Figs. 5a, b show details of periphragmic surface and conical, solid, fibrous processes (Fig. 2 x750; Figs. 5a, b approximately x3000, taken in interference contrast illumination). p. 81

Figs. 3, 6, 7 **Protoellipsodinium** sp. A. Fig. 3 undehisced; paracingulum and outline of archaeopyle marked, operculum still in place. Figs. 6, 7 show dehisced specimens, Fig. 6 with the archaeopyle at right (all figures x750). p. 81

1. Holotype of the species.
2. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 342/1045. CPC 16398.
3. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-1, 322/1063. CPC 16399.
4. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 306/1185. CPC 16400.
5. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-1, 315/1127. CPC 16401.
6. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 348/1159. CPC 16402.
7. NAI Whyenbirra 1, 304.8 m, Coreena Member, MFP 4267-1, 400/1159. CPC 16403.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1a
5 a
4
5b
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7

PLATE 38

all figures (except Fig. 4c) x750

Figs. 1, 2 **Exochosphaeridium** cf. **E. phragmites** Davey & others. Fig. 1 shows typically granulate periphragm and solid, fibrous processes. Archaeopyle present at left side, operculum dislodged but not entirely removed. Fig. 2: entire specimen, orientation uncertain. p. 81

Figs. 3, 4 **Coronifera oceanica** Cookson & Eisenack. Specimens undehisced, showing characteristically thin, high, branching and pointed processes. Tiny apical horn located in specimen of Fig. 4 only (detail see Fig. 4c, approximately x3000, taken in interference contrast illumination). Antapical horn not traced in either specimen. p. 82

1. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 346/1033. CPC 16404.
2. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 473/1038. CPC 16405.
3. Same sample as Fig. 1; MFP 4616-3, 344/1042. CPC 16406.
4. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 342/1177. CPC 16407.

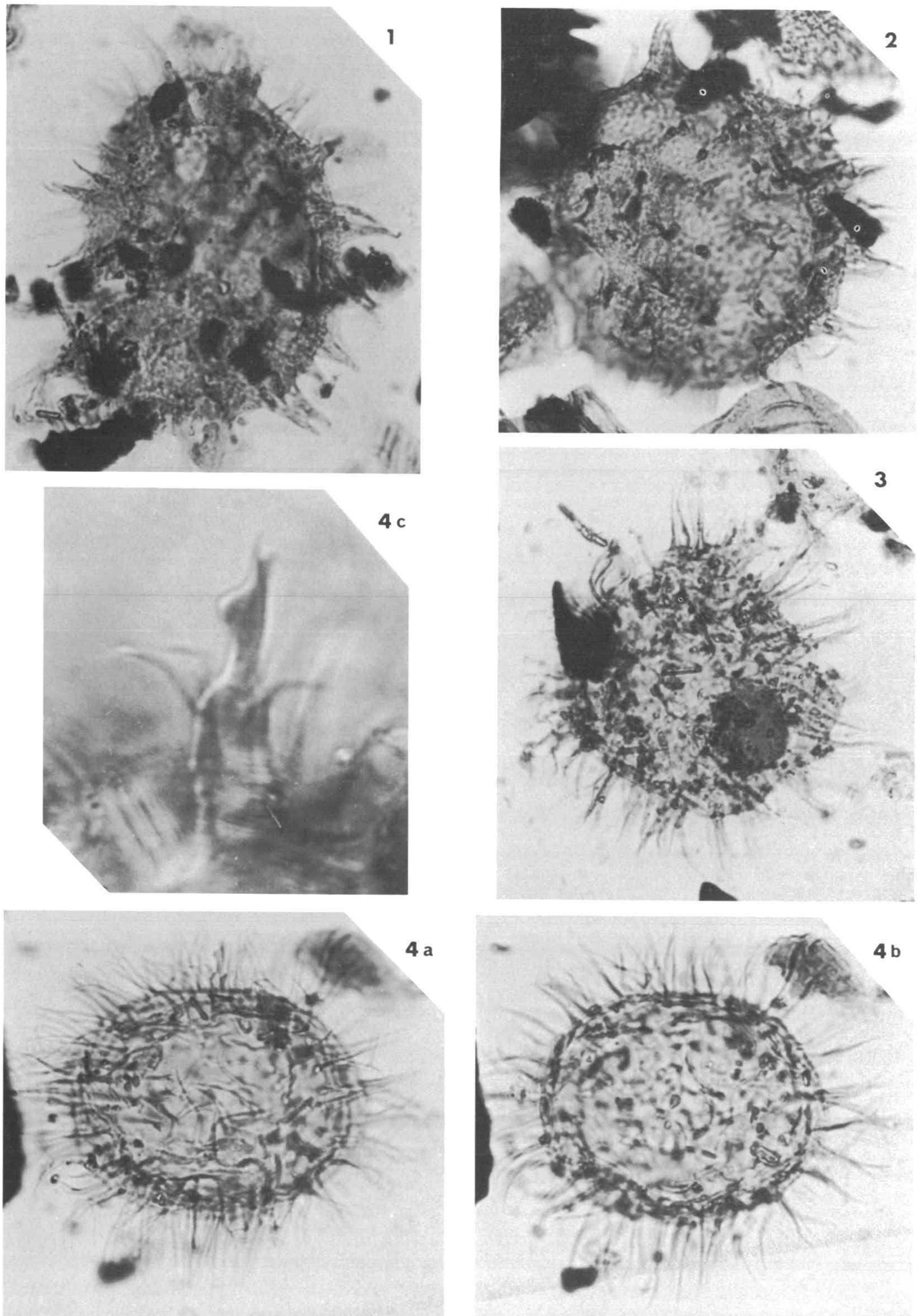
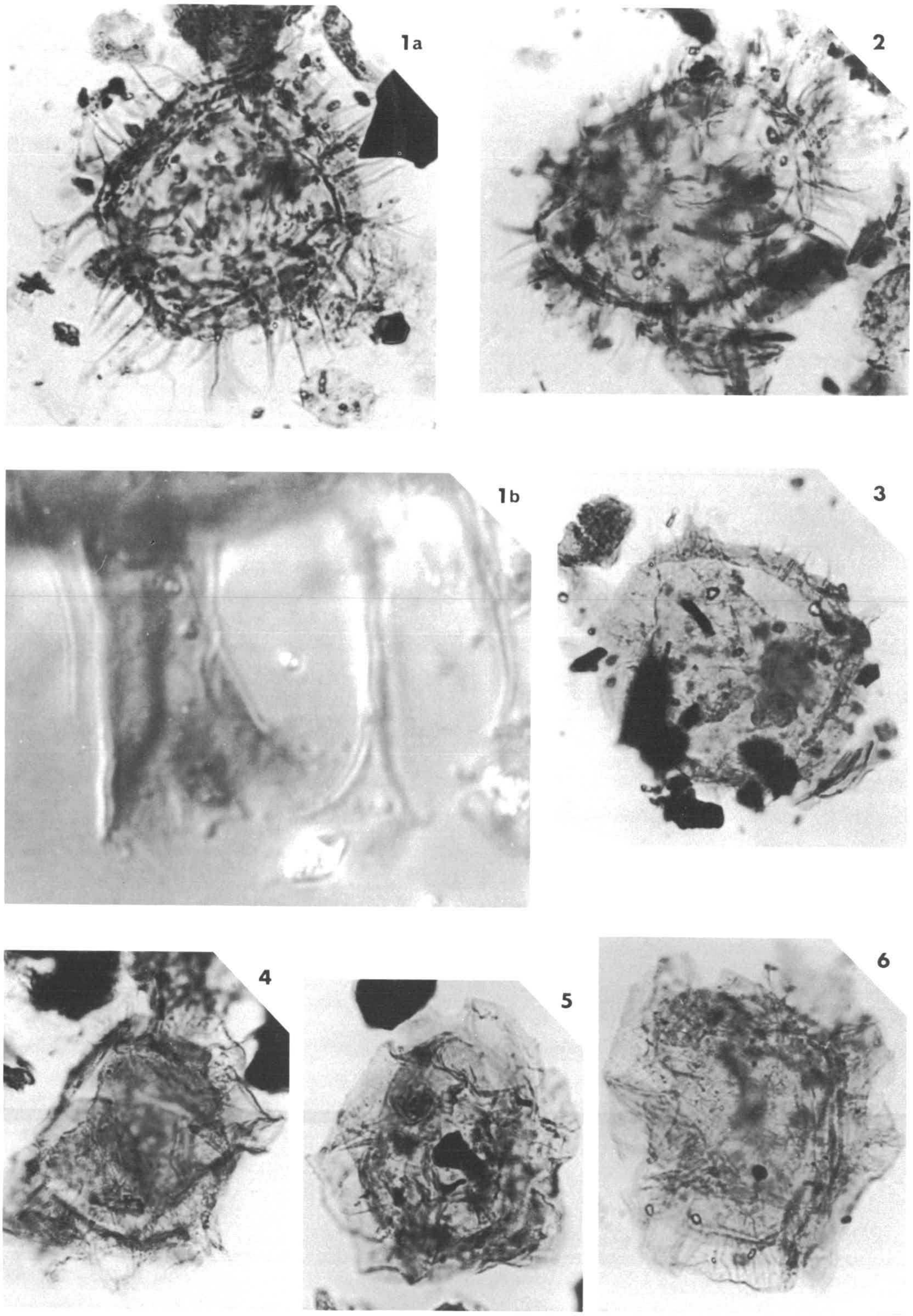

1
2
4c
3
4a
4b

PLATE 39

all figures (except Fig. 1b) x750

Figs. 1, 2	**Coronifera oceanica** Cookson & Eisenack. Fig. 1 shows distinct antapical horn, figured in detail in Fig. 1b (x2850, taken in interference contrast illumination). Fig. 2: specimen with archaeopyle and tiny apical horn at upper end.	p. 82
Fig. 3	**Coronifera** sp. A. Specimen shows archaeopyle, short apical horn, and typically short, pointed processes. Antapical horn obscured.	p. 82
Figs. 4-6	**Heslertonia striata** (Eisenack & Cookson). Specimens poorly preserved. Fig. 4: specimen with archaeopyle. Fig. 6 shows striation and granulation on sutural lists.	p. 83

1. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 354/1139. CPC 16408.
2. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 383/1205. CPC 16409.
3. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 435/1096. CPC 16410.
4. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 449/1018. CPC 16411.
5. Same sample as Fig. 4; MFP 1208-1, 406/1089. CPC 16412.
6. Same sample as Fig. 1; MFP 4616-2, 318/1150. CPC 16413.


1a
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6

PLATE 40
all figures x750

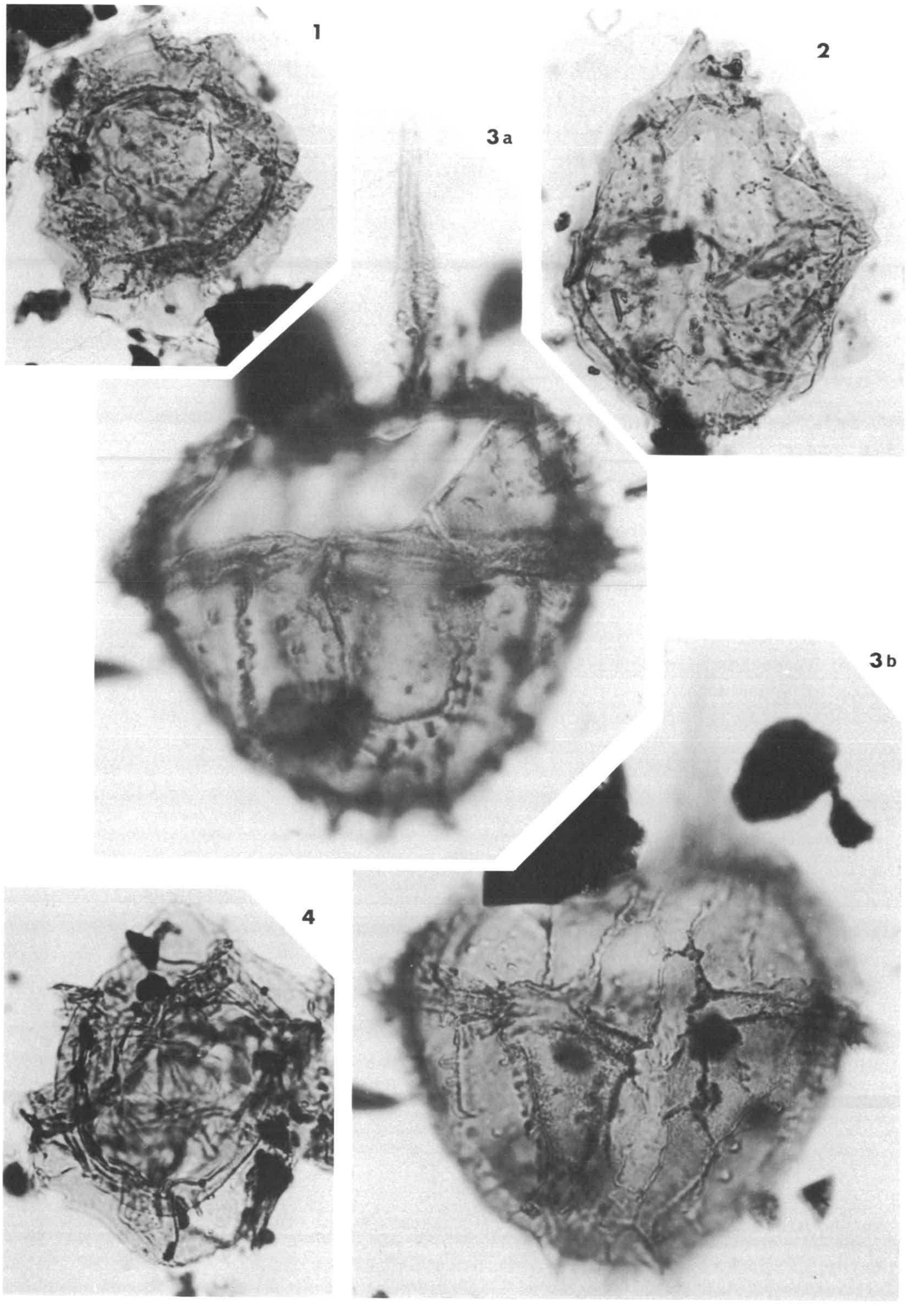
Fig. 1 **Heslertonia** cf. **H. striata** (Eisenack & Cookson). Specimen poorly preserved, undehisced. Lists faintly granulate instead of striate. p. 83

Fig. 2 **Gonyaulacysta** cf. **G. cassidata** (Eisenack & Cookson). Specimen with archaeopyle and small anterior (deflated) pericoel. p. 83

Fig. 3 **Cribroperidinium muderongensis** (Cookson & Eisenack). Specimen shows archaeopyle, sculpture on paraplate surfaces, parasutural lists and accessory crests. Paracingulum (slightly offset at the ends) and parasulcus shown in Fig. 3b. p. 82

Fig. 4 **Heslertonia striata** (Eisenack & Cookson). Specimen with faintly granulate lists. p. 83

1. GSQ Surat 1, 243.1 m, Doncaster Member; MFP 5006-1, 328/1169. CPC 16414.
2. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 470/1067. CPC 16415.
3. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-1, 398/1122. CPC 16416.
4. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-1, 327/1080. CPC 16417.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2
3a
3b
4

PLATE 41
all figures x750

Fig. 1	**Gonyaulacysta helicoidea** (Eisenack & Cookson). Dehisced specimen, operculum still attached. Fig. 1b shows the parasulcus and paracingulum with displaced ends.	p. 83
Fig. 2	**Cribroperidinium muderongensis** (Cookson & Eisenack).	p. 82
Fig. 3	**Cribroperidinium edwardsii** (Cookson & Eisenack). Specimen poorly preserved.	p. 82
Fig. 4	cf. **Leptodinium simplex** sp. nov. Poorly preserved, dehisced specimen with short apical horn.	p. 84

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 314/1078. CPC 16418.
2. BMR Mitchell 8, 26.5 m, Coreena Member; MFP 4244-4, 437/1106. CPC 16419.
3. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 399/1177. CPC 16420.
4. GSQ Surat 1, 91.4 m, Surat Siltstone; MFP 5005-1, 332/1067. CPC 16421.

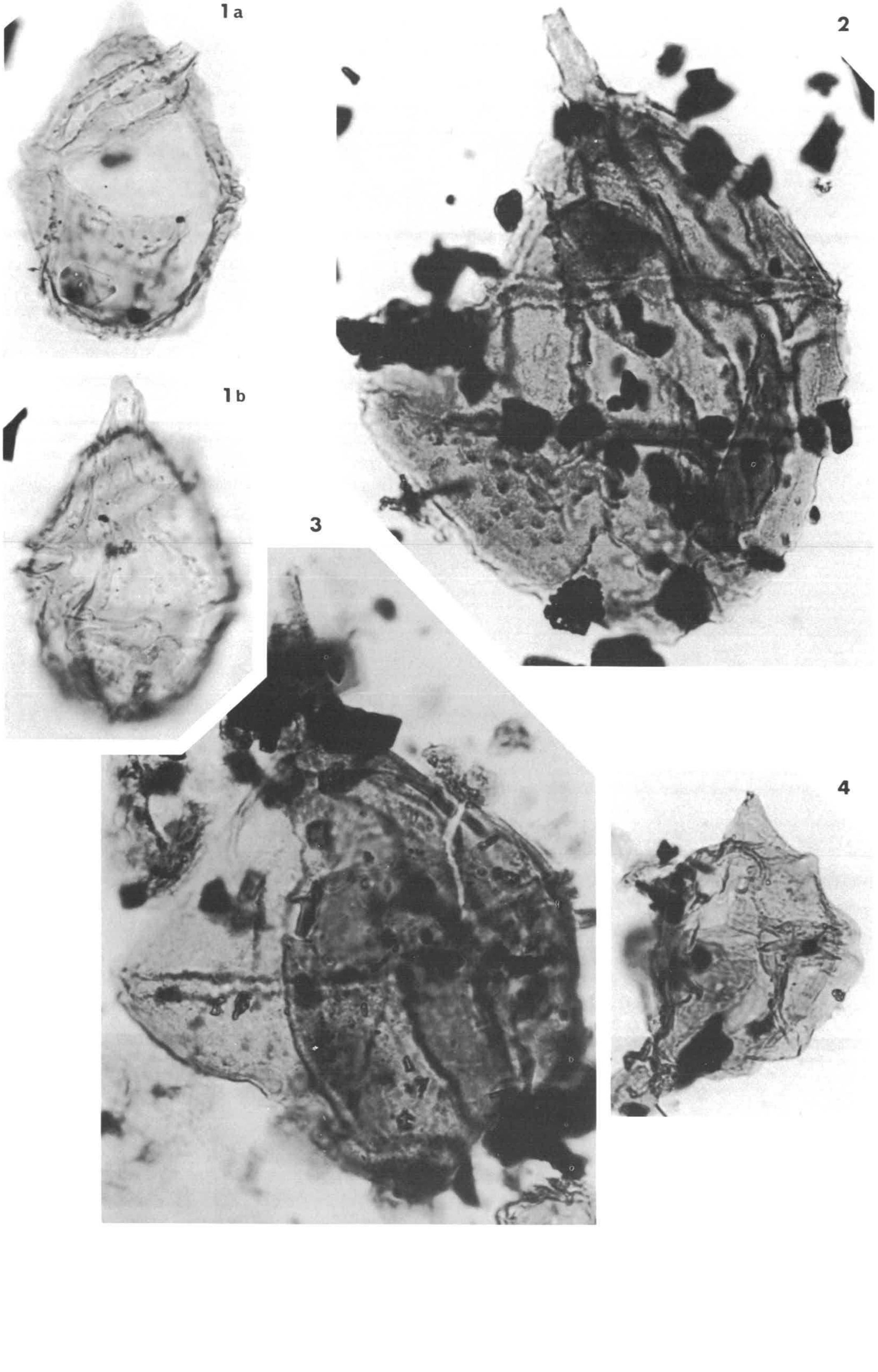
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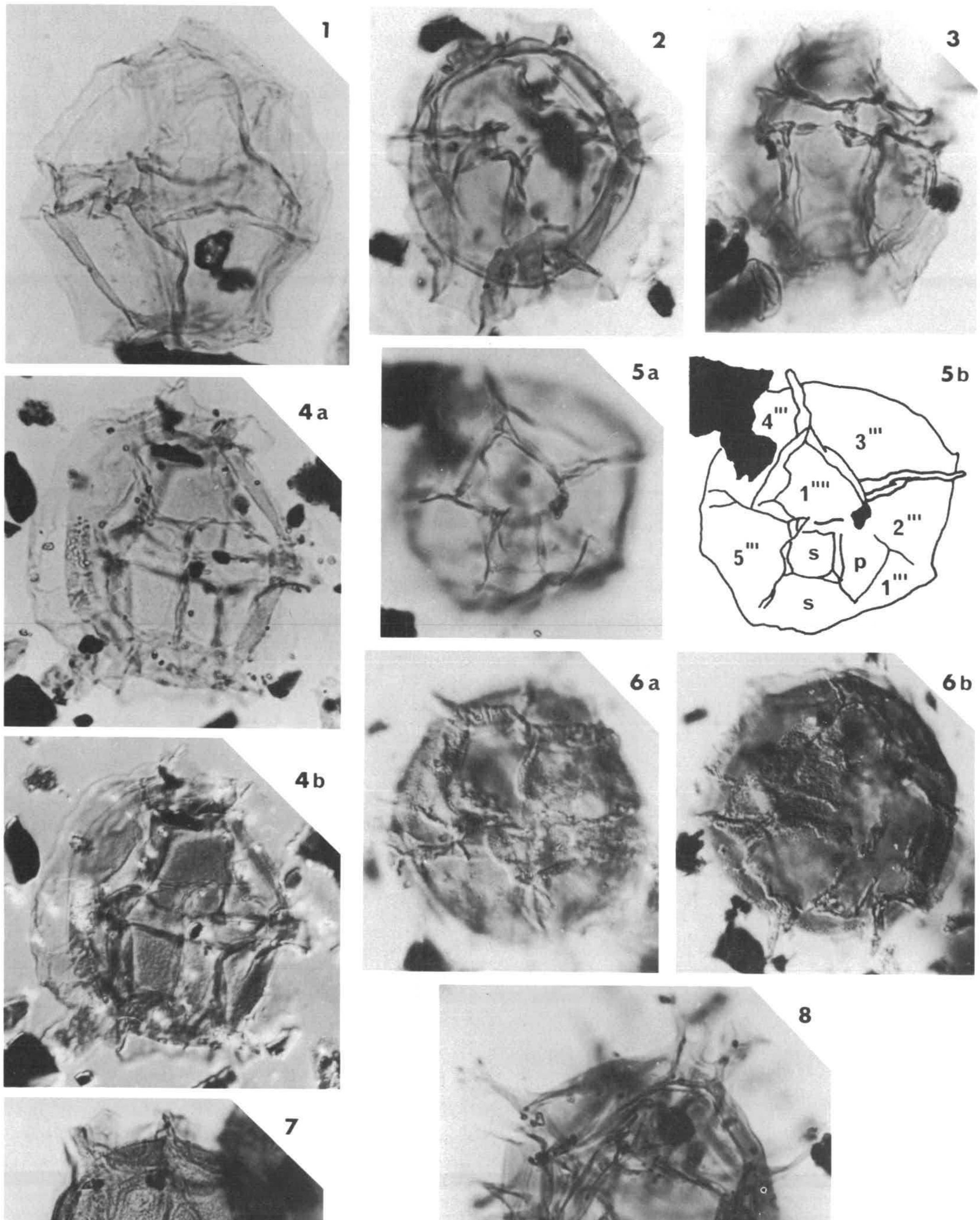
PLATE 42
all figures x750

Figs. 1-5	**Leptodinium simplex** sp. nov. Thin, psilate wall and lists characteristic of the species. Paratabulation well marked. Figs. 2, 3: slightly oblique view. Fig. 4: holotype, wall finely punctate, archaeopyle at right side (Fig. 4b interference contrast illumination micrograph). Fig. 5: polar view, posterior aspect of cyst; paraplate positions shown in Fig. 5b.	p. 84
Figs. 6, 7	**Leptodinium alectrolophum** Sarjeant. Fig. 6a shows archaeopyle and faintly striped lists; Fig. 6b shows parasulcal area and paracingulum with well displaced ends. Fig. 7: specimen with periphragm granulation and lists jutting out at gonal junctions. No archaeopyle formed.	p. 84
Fig. 8	**Spiniferites ramosus** (Ehr.) subsp. **ramosus** Lentin & Williams. Oblique view, anterior part of cyst.	p. 84

1. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-2, 406/1149. CPC 16422.
2. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-1, 430/1104. CPC 16423.
3. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-1, 349/1214. CPC 16424.
4. Holotype of the species.
5. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 304/1064. CPC 16426.
6. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 413/1153. CPC 16427.
7. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-2, 317/1133. CPC 16428.

8. Same sample as Fig. 2; MFP 6238-1, 315/1124. CPC 16429.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6a
6b
4b
7
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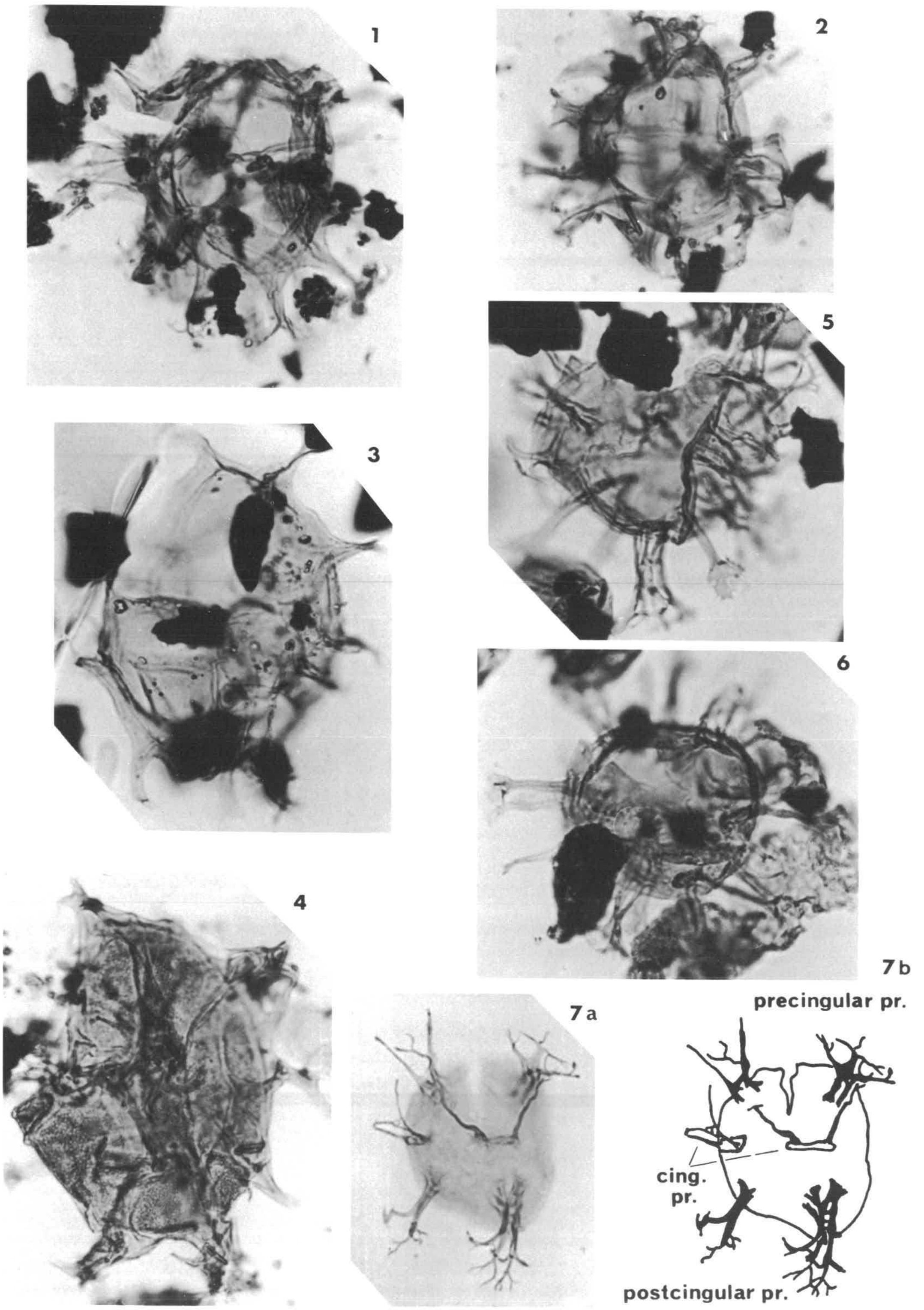
PLATE 43
all figures x750

Figs. 1-3	**Spiniferites ramosus** (Ehr.) subsp. **ramosus** Lentin & Williams. Fig. 3: dehisced specimen, poorly preserved.	p. 84
Fig. 4	**Spiniferites ramosus** subsp. **granomembranaceus** (Davey & Williams). Dehisced specimen, showing stratified cyst wall and granulate endophragm.	p. 84
Figs. 5-7	**Systematophora complicata** Neale & Sarjeant. Fig. 5: specimen with archaeopyle, clusters of processes visible on precingular paraplates (upper right and left) and antapex (bottom). Single processes visible in various undetermined positions. Fig. 6: dehisced specimen in oblique anterior view. Operculum partly detached. Fig. 7: part of cyst wall with precingular, sulcal, and postcingular processes. Wall fragment probably consists of paraplates 3" and 4", plus the adjoining sulcal and postcingular paraplates.	p. 79

1. GSQ Surat 1, 243.1 m, Doncaster Member: MFP 5006-1, 461/1199. CPC 16430.
2. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-1, 250/1163. CPC 16431.
3. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-1, 462/1130. CPC 16432.
4. Same sample as Fig. 2; MFP 5007-1, 300/1152. CPC 16433.
5. UKA Cabawin 1, 173.6 m, Coreena Member; MFP 905-1, 367/1152. CPC 16434.
6. Same sample as Fig. 5; MFP 905-1, 376/1061. CPC 16435.
7. Same sample as Fig. 5; MFP 905-1, 354/1015. CPC 16436.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7b
precingular pr.
7a
cing. pr.
postcingular pr.

PLATE 44

all figures x750

Figs. 1-3 **Diconodinium paucigranulatum** sp. nov. Fig. 1 shows the intercalary archaeopyle (operculum still attached) and the randomly granulated wall. Fig. 2: dehisced specimen, poorly preserved, paracingulum vaguely outlined. Fig. 3: holotype, specimen undehisced, showing random distribution of granules (Figs. 1 and 3 interference contrast illumination micrographs). p. 86

Figs. 4, 5 **Diconodinium davidii** Morgan. Fig. 4 shows the sulcal area, paracingulum, and relatively coarse granules. Fig. 5: undehisced specimen, antapical horn folded back; dorsal part of cyst to the left. p. 86

Figs. 6-9 **Spinidinium boydii** Morgan. Fig. 6: dehisced specimen; all three intercalaries are removed. Fig. 7: specimen poorly preserved; intercalaries and underlying precingular paraplates removed. Fig. 8: undehisced specimen, dorsal view; outline of paraplate 2a visible. Fig. 9: paraplate 2a broken and partly removed. p. 86

1. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 250/1201. CPC 16437.
2. Same sample as Fig. 1: MFP 6239-1, 348/1022. CPC 16438.
3. Holotype of the species.
4. NAI Whyenbirra 1, 304.8 m, Coreena Member; MFP 4267-1, 358/1076. CPC 16440.
5. BMR Mitchell 8, 26.5 m, Coreena Member; MFP 4244-4, 449/1048. CPC 16441.
6. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 320/1092. CPC 16442.
7. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 333/1095. CPC 16443.
8. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-1, 400/1033. CPC 16444.
9. Same sample as Fig. 8; MFP 6238-1, 402/1159. CPC 16445.

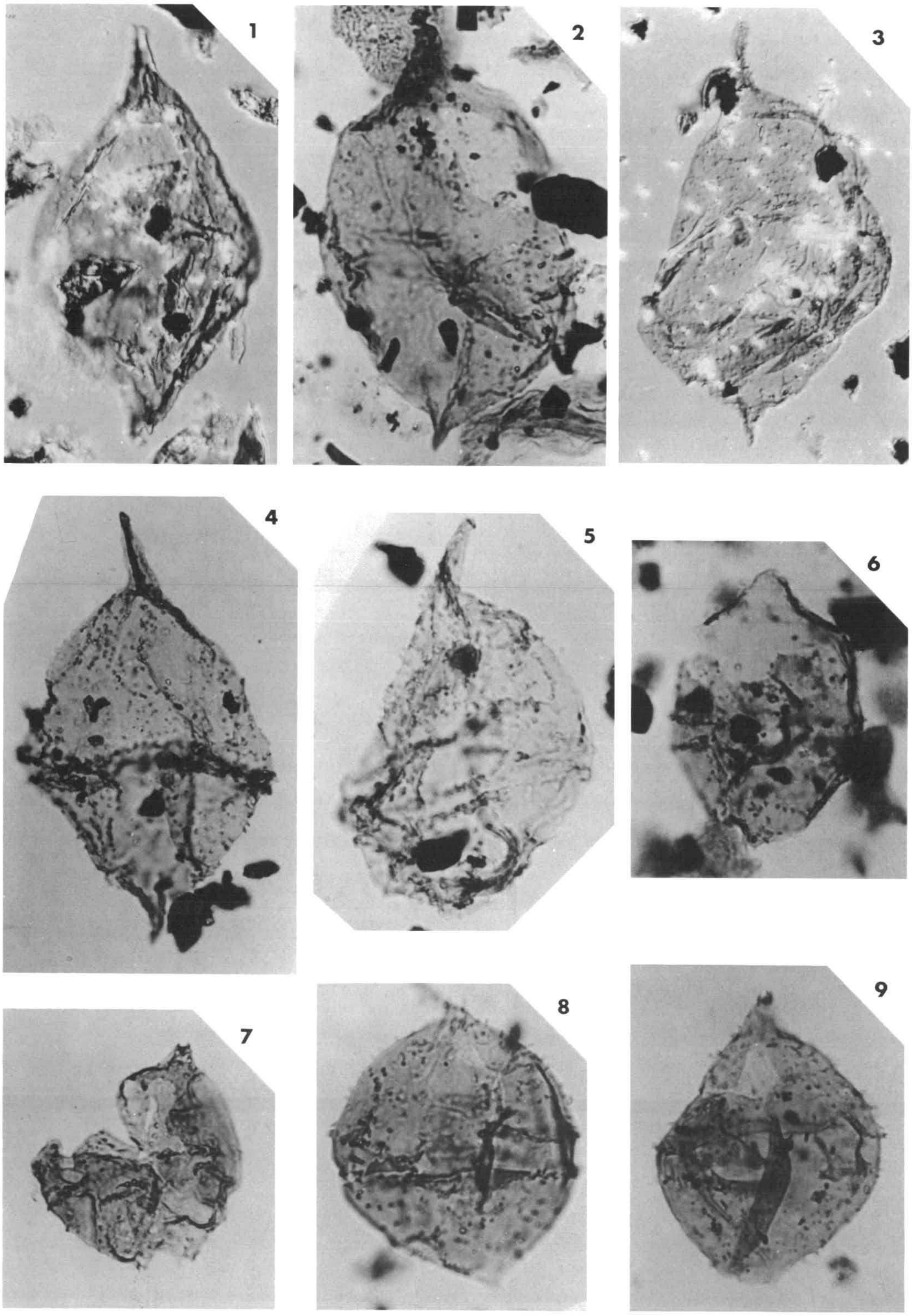
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PLATE 45

all figures x750

Figs. 1, 2 **Vozzhennikovia villosa** (Eisenack & Cookson). Fig. 1: ventral aspect, paracingulum and parasulcus vaguely outlined. Fig. 2: dorsal view, paracingulum and outline of archaeopyle visible, operculum not entirely removed (interference contrast illumination micrograph). p. 85

Fig. 3 **Necrobroomea micropoda** (Eisenack & Cookson). Undehisced specimen, apical part of cyst detached (accidental breakdown?, archaeopyle formation?). Wall layers separated at distal end of apical horn. Paracingulum vaguely indicated. p. 74

Figs. 4, 5, 8 **Pareodinia ceratophora** Deflandre. Fig. 4: lateral (equatorial) view; specimen poorly preserved, enveloped in a cloak of organic substance. Outline of archaeopyle visible at upper left; intercalary paraplate not entirely removed. Fig. 5: dorsal view, specimen wrapped in organic matter, outline of archaeopyle (operculum still in situ) visible (taken with interference contrast illumination). Fig. 8: oblique view; dehisced specimen, all three intercalaries removed. p. 85

Figs. 6, 7 **Broomea jaegeri** Alberti. Fig. 6: anterior part of specimen removed, possibly by accidental breakdown of the cyst (interference contrast illumination micrograph). Fig. 7: entire specimen, paracingulum vaguely indicated. p. 85

1. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-4, 385/1048. CPC 16446.
2. Same sample as Fig. 1; MFP 4616-3, 328/998. CPC 16447.
3. NAI Whyenbirra 1, 182.9 m, Surat Siltstone; MFP 4266-5, 305/1131. CPC 16448.
4. BMR Mitchell 1, 16.2 m, Minmi Member correlate; MFP 3966-1, 320/1081. CPC 16449.
5. Same sample as Fig. 4; MFP 3966-2, 330/1085. CPC 16450.
6. Same sample as Fig. 4; MFP 3966-2, 451/1178. CPC 16451.
7. Same sample as Fig. 4; MFP 3966-1, 389/1147. CPC 16452.
8. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 280/1186. CPC 16453.

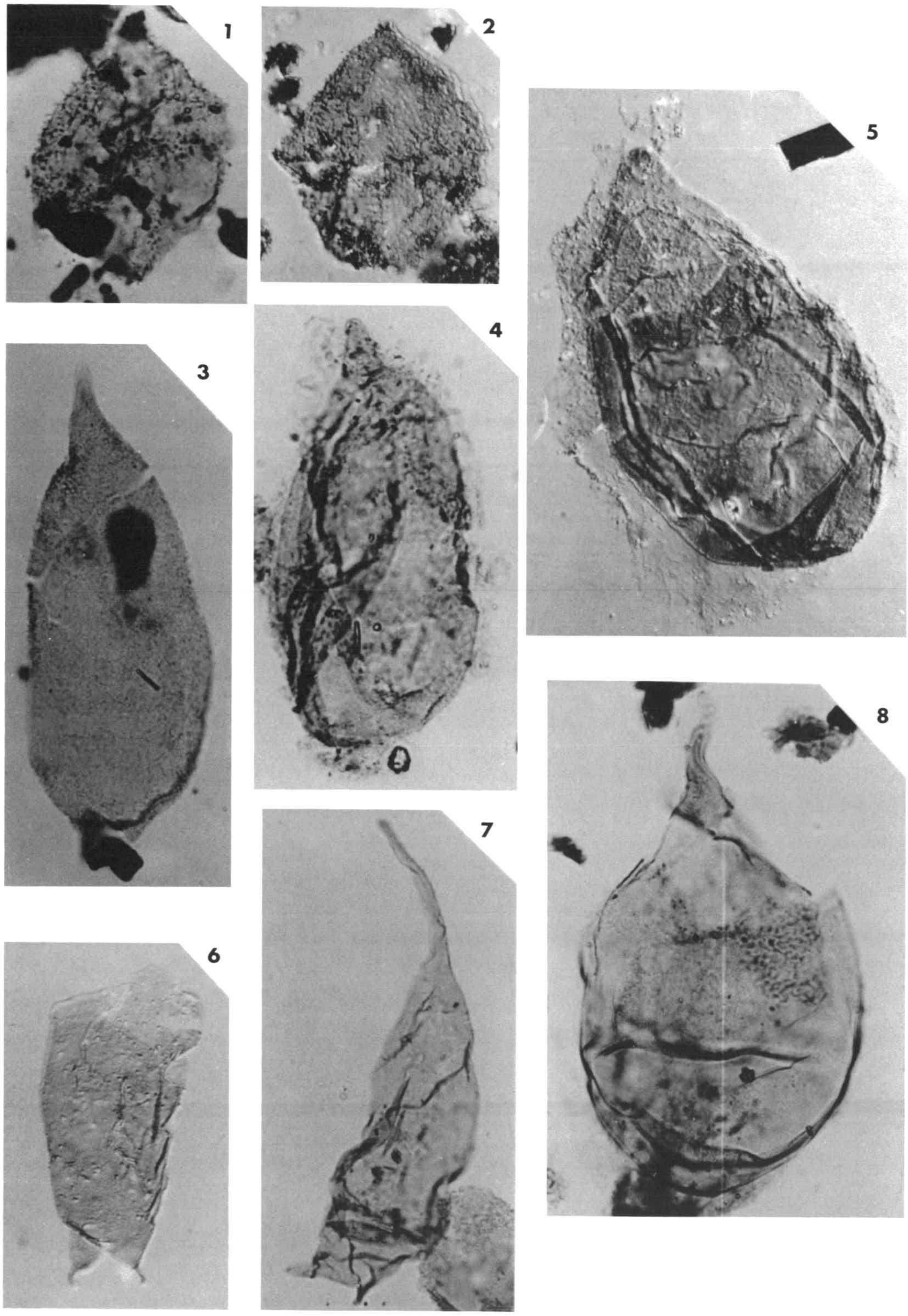
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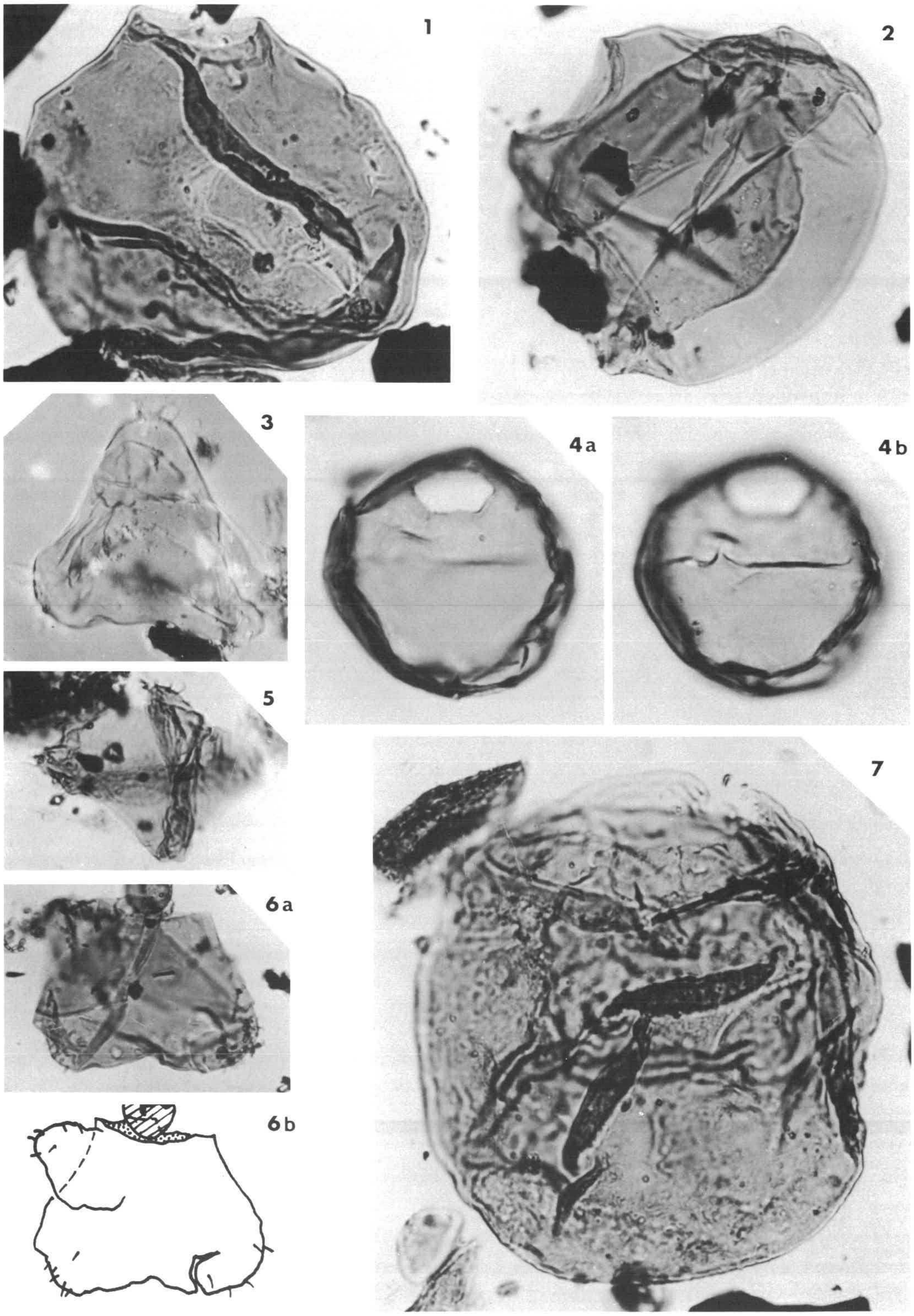
PLATE 46

all figures x750

Figs. 1, 2	**Fromea** cf. **F. amphora** Cookson & Eisenack. Specimens thin-walled, randomly folded, with rimmed, smooth-edged pylome.	p. 89
Figs. 3, 5, 6	**Rhombodella natans** Cookson & Eisenack. Fig. 3: specimen with tiny (apical?) horn at upper corner (fourth corner not in focus). Fig. 5: specimen compressed but still indicating initial pyramid shape of cyst. Fig. 6: specimen with one corner missing (in archaeopyle formation?), one corner is not in focus on account of pyramid shape of cyst (see Fig. 6b).	p. 87
Fig. 4	**Nummus monoculatus** Morgan. Dorsal part of cyst wall preserved. Fig. 4a: focus on irregular folding in equatorial region and mid-dorsal aperture. Fig. 4b: focus on paracingular fold.	p. 87
Fig. 7	**Palaeostomocystis fragilis** Cookson & Eisenack. Pylome visible at upper end.	p. 88

1. BMR Roma 1, 30.9 m, Minmi Member: MFP 4322-2, 475/1092. CPC 16462.
2. NAI Whyenbirra 1, 304.8 m, Coreena Member: MFP 4267-2, 393/1035. CPC 16463.
3. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 308/1058. CPC 16464.
4. AAO 1 (Roma), 67.1 m, Minmi Member; MFP 878-1, 329/1196. CPC 16465.
5. GSQ Surat 1, 243.1 m, Doncaster Member: MFP 5006-1, 296/1113. CPC 16466.
6. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-2, 329/1145. CPC 16467.
7. UKA Cabawin 1, 337.7 m, Doncaster Member; MFP 906-1, 412/1016. CPC 16468.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4a
4b
5
6a
6b
7

PLATE 47

all figures (except Figs. 13 and 14) x750

Fig. 1	**Palaeostomocystis fragilis** Cookson & Eisenack.	p. 88
Figs. 2, 3	**Palaeostomocystis pergamentaceus** sp. nov. Specimens show characteristic pattern of minute wrinkles. No pylome formed. Fig. 3: holotype (Fig. 3b interference contrast illumination micrograph).	p. 88
Figs. 4, 5	**Leiosphaeridia** sp. A. Specimens partly opened by a straight line of weakness (cryptosuture); (Fig. 4 taken with interference contrast illumination).	p. 89
Figs. 6-9	**Leiosphaeridia** sp. C. Figs. 6, 8 show winding, S-shaped line of weakness and partly dislodged opercula. Fig. 9: specimen closed, line of detachment not visible.	p. 89
Fig. 10	**Leiosphaeridia** sp. B. Specimen shows S-shaped line of detachment; opercula still in place.	p. 89
Figs. 11-13	**Micrhystridium** sp. C, showing minute spines and regular pattern of implantation of spines (Fig. 13 approximately x1300).	p. 90
Figs. 14-16	**Micrhystridium** sp. D. Specimens small, with typically few spines (Fig. 14 approximately x1200).	p. 90
Fig. 17	**Micrhystridium** sp. B, showing relatively long spines. Specimen opens along a straight line of weakness.	p. 90
Fig. 18	**Micrhystridium** sp. A. Large specimen, showing short, thin spines.	p. 90
Figs. 19, 20	**Pterospermella australiensis** (Deflandre & Cookson). (Both figures taken with interference contrast illumination).	p. 91

1. BMR Roma 9, 30.5 m, Coreena Member; MFP 4615-2, 322/1083. CPC 16469.
2. GSQ Surat 1, 320.0 m, Doncaster Member; MFP 5007-2, 455/1167. CPC 16470.
3. Holotype of the species.
4. UKA Bidgel 1, 215-224 m, Griman Creek Formation; MFP 6468-1; 448/1039. CPC 16472.
5. BMR Mitchell 11, 14.6 m, Minmi Member; MFP 4276-2, 377/1143. CPC 16473.
6. UKA Foyleview 1, 122-131 m, Griman Creek Formation; MFP 6426-2, 388/1161. CPC 16474.
7. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-2, 407/1080. CPC 16475.
8. Same sample as Fig. 2; MFP 5007-1, 454/1020. CPC 16476.
9. Same sample as Fig. 6; MFP 6426-2, 353/1102. CPC 16477.
10. BMR Surat 3, 106.7 m, Surat Siltstone; MFP 4624-1, 419/1082. CPC 16478.
11. Same sample as Fig. 2; MFP 5007-1, 299/1122. CPC 16479.
12. Same sample as Fig. 2; MFP 5007-2, 386/1070. CPC 16480.
13. Same sample as Fig. 2; MFP 5007-2, 292/1210. CPC 16481.
14. Same sample as Fig. 6; MFP 6426-1, 400/1176. CPC 16482.
15. UKA Cabawin 1, 30.5-33.5 m, Surat Siltstone; MFP 1208-2, 423/1109. CPC 16483.
16. Same sample as Fig. 2; MFP 5007-2, 376/1025. CPC 16484.
17. Same sample as Fig. 5; MFP 4276-2, 357/1181. CPC 16485.
18. GSQ Surat 3, 454.1 m, Coreena Member; MFP 5022-1, 242/1074. CPC 16486.
19. BMR Roma 1, 16.0 m, Minmi Member; MFP 4320-1, 391/1048. CPC 16487.
20. Same sample as Fig. 19; MFP 4320-2, 458/1043. CPC 16488.

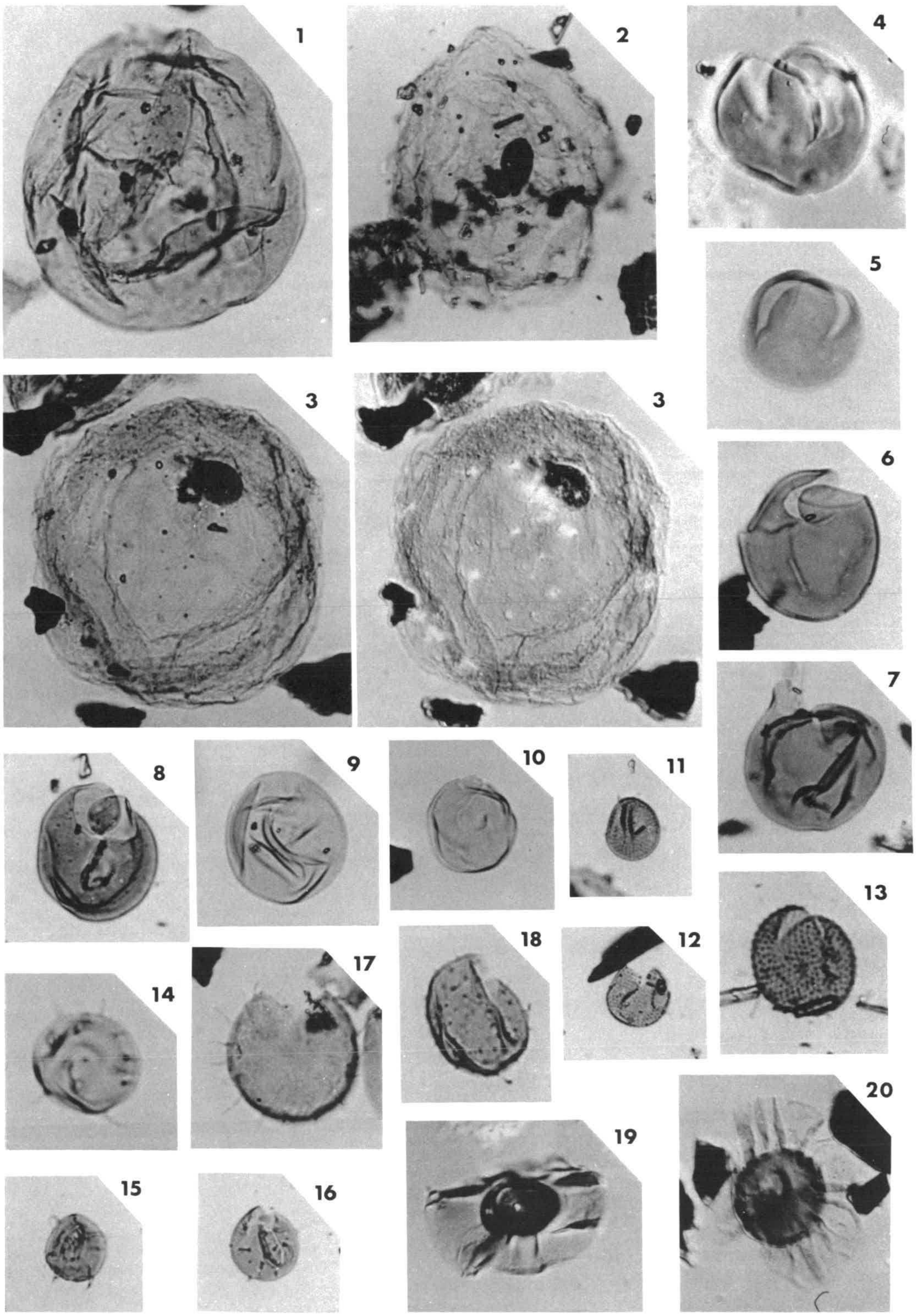
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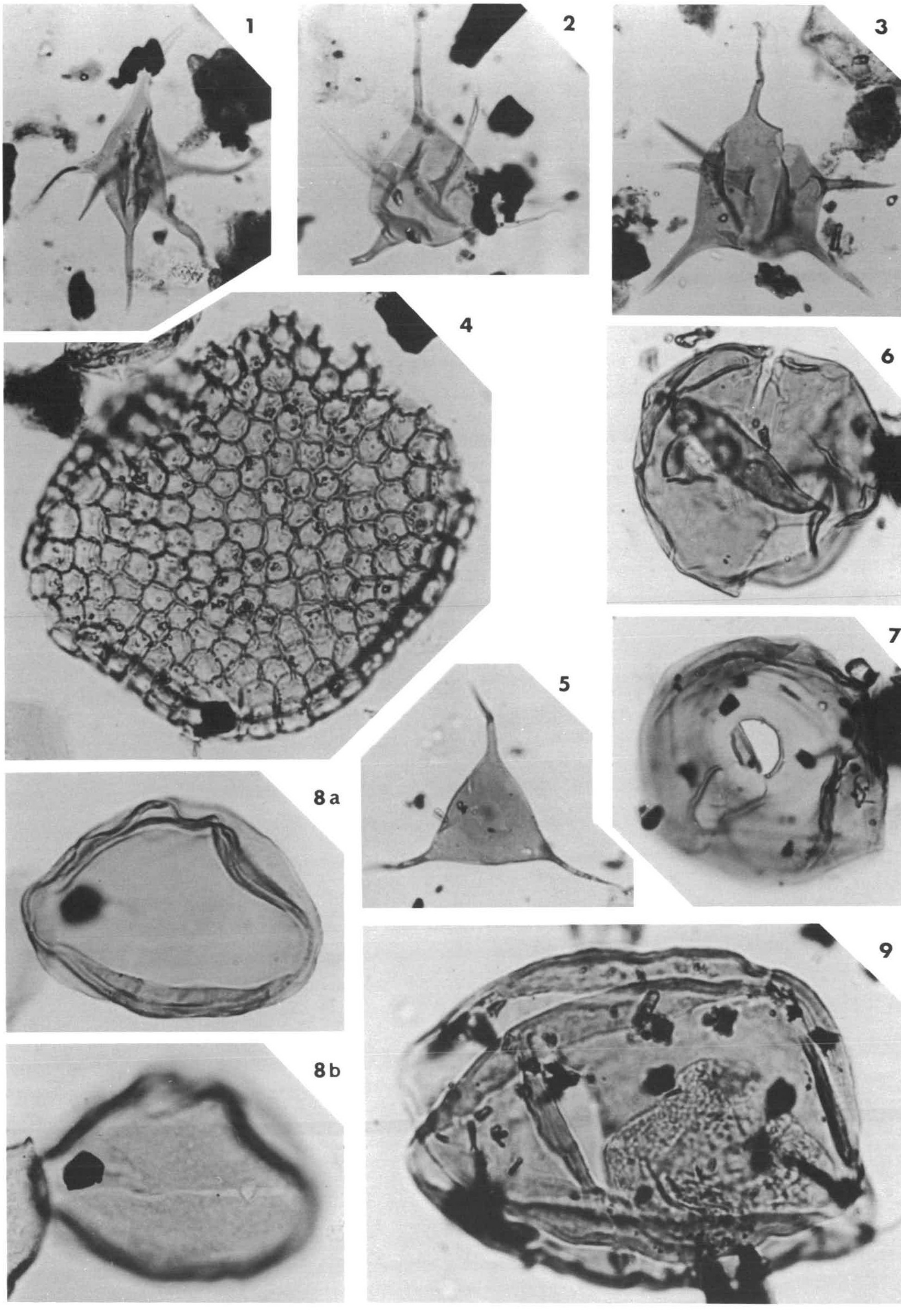
PLATE 48
all figures x750

Figs. 1-3	**Veryhachium singulare** (Firtion). Fig. 3: specimen with elongate slit in wall.	p. 91
Fig. 4	**Schizosporis reticulatus** Cookson & Dettmann. Specimen damaged, half of shell lost (recycled specimen?).	p. 91
Fig. 5	**Veryhachium reductum** (Deunff).	p. 90
Figs. 6, 7	**Schizosporis** sp. A. Fig. 6: specimen partly opened, suture at top part. Fig. 7: suture partly opened.	p. 91
Figs. 8, 9	**Schizosporis spriggii** Cookson & Dettmann. Fig. 8: deflated specimen; Fig. 8b focused on suture.	p. 91

1. BMR Roma 9, 61.0 m, Coreena Member; MFP 4616-3, 380/1063. CPC 16489.
2. BMR Roma 8, 31.1 m, Doncaster Member; MFP 4676-1, 362/1043. CPC 16490.
3. Same sample as Fig. 1; MFP 4616-4, 363/1091. CPC 16491.
4. BMR Surat 3, 49.2 m, Surat Siltstone; MFP 4612-2, 345/1034. CPC 16492.
5. BMR Mitchell 10, 120.1 m, Doncaster Member; MFP 6239-1, 254/1190. CPC 16493.
6. GSQ Surat 1, 91.4 m, Surat Siltstone; MFP 5005-1, 277/1021. CPC 16494.
7. BMR Roma 9, 78.8 m, Coreena Member; MFP 6238-1, 411/1088. CPC 16495.
8. BMR Surat 2, 41.3 m, Surat Siltstone; MFP 4535-2, 350/1045. CPC 16496.
9. DOA Hoolah 1, 46-55 m, Griman Creek Formation; MFP 6423-1, 399/1036. CPC 16497.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