1965/192.

019656*

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECENT ADVANCES IN MESOZOIC STRATIGRAPHIC PALYNOLOGY IN AUSTRALIA

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ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST
COMMITTEE ON INDUSTRY AND NATURAL RESOURCES

Symposium on the Development of Petroleum Resources of Asia and the Far East

Third Session: 10th—20th November 1965

TOKYO, JAPAN

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ABSTRACT

Publications on Australian palynology since the second ECAFE symposium on petroleum resources, held in Teheran in 1962, are listed; those concerning the Mesozoic are reviewed. Ways of subdividing the Australian Mesozoic by palynological criteria are presented: eight divisions of the Triassic, five, possibly six of the Jurassic, and eleven of the Cretaceous are recognized. Areas where some of these divisions have been identified are briefly indicated. Palynological subdivision of and correlations within the Triassic and Jurassic in eastern Australia show how some of the major eastern Australian sedimentary basins developed in time, a necessary adjunct to understanding the history of hydrocarbon generation and emplacement in that area.

INTRODUCTION

The writer presented two papers (Evans, 1963a,b) to the second ECAFE petroleum congress held in Teheran in 1962, outlining palynological research in Australia up to the time of the conference, and the approach taken to stratigraphic palynology, particularly in connection with the search for oil. Since then the number of palynologists has increased a little: the South Australian Mines Department has commenced palynological investigations in its state, the Western Australian Geological Survey undertook some palynological work for a period; one oil exploration company has recruited its own palynologist; and one consultant palynologist practices in Melbourne*. French exploration companies with their own palynological staffs have also contributed to knowledge of the country's microfloras.

Advances in knowledge have been gained from both academic workers and government surveys, both groups using material from oil search wells (many of them subsidized by the Commonwealth government), coal exploration drill holes, seismic shotholes, shallow drill holes specifically sited for palynological material, and a limited amount from outcrop.

The object of this paper is to outline palynological work completed since 1962. Only studies on the Mesozoic are discussed, although many advances in Upper Palaeozoic palynology have been made.

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* Other than palynologists on University staffs who also consult.

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REVIEW OF PUBLISHED LITERATURE

A list of Australian literature published on spores, pollens and microplankton since the previous ECAFE conference is included in the references at the end of the paper, but only those concerning the Mesozoic are reviewed here.

Triassic

Balme (1963) published a unique contribution to Triassic palynology in which he described microfloras (with Taeniae-sporites and Lundbladispora) associated with a Lower Triassic (Scythian) ammonoid fauna (Dickins & McTavish, 1963), a matter of great importance to any consideration of the palynological version of the Permian/Triassic boundary in the southern hemisphere.

De Jersey (1962) completed the first of a series of taxonomic studies of Queensland Mesozoic microfloras. This paper concerns spores and pollens from the Ipswich Coal Measures in the Clarence-Morton Basin*, which have been regarded from macrofloral evidence to be of Middle or Upper Triassic age (Jones & de Jersey, 1947). The microflora described differs from the Scythian assemblages described by Balme, and contains

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* A location map of the sedimentary basins of Australia accompanies the paper on "The sedimentary basins of Australia and the stratigraphic occurrence of hydrocarbons" submitted by M.A. Reyholds to this conference.

probable microfloral equivalents (*Alisporites*) of *Dicroidium* (Townrow, 1962), which is so abundant in the Ipswich macrofloral assemblages.

De Jersey (1964) continued with a description of spores and pollens in the Triassic Bundamba Sandstone which overlies the Ipswich Coal Measures in the Clarence-Morton Basin. *Alisporites* continues in abundance, but new forms of probable stratigraphic significance, *Circulina meyerina*, *Lycopodiumsporites antiquus* and *Discisporites verrucosus* appear. De Jersey refers to an as yet unpublished paper by Playford and Dettmann on a spore sequence in the Leigh Creek Coalfield, South Australia.

Jurassic

The point of introduction of a *Classopollis* microflora in eastern Australian rocks was previously discussed (Evans, 1963a, 1964a) as evidence that correlations of sediments between the Great Artesian and Clarence-Morton Basins (Whitehouse, 1955) were probably in error. De Jersey and Paten (Whitehouse, 1955) were probably in error. De Jersey and Paten (1964) have now described components of the basal Jurassic *Classopollis* microflora in the Surat Basin, following de Jersey's earlier description (1963) of what now is clearly a still younger microflora from the Marburg Sandstone in the Clarence-Morton Basin. The relative ages and correlations between these once problematic early Mesozoic sediments in the Surat and Clarence-Morton Basins are now fairly well resolved.

No advances in knowledge of Middle and Upper Jurassic palynology have been published since 1962, although microfloras observed in rocks of that age have been listed in several Commonwealth Petroleum Search Subsidy Act publications (e.g. de Jersey & Dearne, and Evans in Union Oil Development Corporation, 1964).

Cretaceous

Dettmann completed (1963) a detailed taxonomic study of south-eastern Australian Lower Cretaceous spores and pollens, recognizing a sequence of three assemblages, the middle member of which seemed to her to be capable of further division.

Cookson (1964), Cookson & Balme (1962) and Cookson & Eisenack (1962) described some new types of Cretaceous microplankton and pollens from various parts of Australia, but offered few indications of the stratigraphic significance of these occurrences.

General

Balme (1964) briefly described the Australian Palaeozoic and Mesozoic sequence as known in 1960, dividing the fossil plexus into a number of assemblages.

Churchill & Sargeant (1962a,b) described fossil microplankton from Holocene fresh water deposits in south-western Western Australia, which must be considered carefully in any evaluation of the facies significance of these organisms (cf. Varma, 1964).

The scope of application of palynology to oil exploration has been discussed by Evans (1964) and de Jersey (1965). Evans referred to the problem of carbonization of spores in sediments other than coals and refers to an unpublished report (Evans, 1963c) in which a correlation between spore preservation and the likelihood of oil and gas occurrence is made.

PALYNOLOGICAL SUBDIVISIONS OF THE MESOZOIC

Evans, (1963a) indicated, but offered few comments on the relative order of occurrence of selected microfossils which permitted recognition of a sequence of "palynological units". Continued studies of eastern Australian Upper Palaeozoic - Mesozoic sedimentary basins have developed this scheme, and several of these units have now become accepted stratigraphic divisions of value to intra- and interbasinal correlations. The active search for oil in these basins has continually supplied new information with which the divisions are being more precisly defined. In the absence of other fossil groups it is impossible to apply existing time-rock nomenclatures with any sense of accuracy and the local nomenclature has been essential. The palynological units are akin to zones, some to stages and could be formally named, a step which will probably be taken in the future.

Other palynologists have taken different attitudes to the problem. Dettmann (1963) and Balme (1964) have described sequences of "assemblages". De Jersey, Cookson (and collaborators) refer to stratigraphic position in terms of the European nomenclature. However, whatever approach is taken, there is little doubt that palynology has already become the main source of biostratigraphic subdivisions of much of the eastern Australian Mesozoic, and eventually a number of stages based on this source will doubtless be accepted into Australian stratigraphy.

The remainder of this paper outlines the criteria for recognition of palynological units in Australian Mesozoic sediments today, with brief references to areas where they have been identified.

Triassic

The end of the *Glossopteris* flora in Australia has been generally accepted for many years as the base of the Triassic (viz. David, 1950). The *Glossopteris* and *Dicroidium* floras conveniently do not seem to overlap in this continent, in contrast to their ranges in South Africa (du Toit, 1954) and India (Pascoe, 1959). Hennelly (1958) showed that the end of the *Glossopteris* flora in the Sydney Basin corresponded to a change from the *Dulhuntyispora* assemblage (Balme, 1964) to a very different assemblage marked by the problematic fossil *Quadrisporites horridus*, with "*Nuskoisporites*" *radiatus* and gymnospermous pollens not recorded from the underlying Permian. Balme (1963) recorded an assemblage of striate bisaccate pollens (*Striatites* and *Taeniaesporites*) with distinctive spores (*Lundbladispora*) which bore little resemblance to Hennelly's forms. Evans (1963a) showed the relative occurrences in Lower Triassic palynological units "1-2" of a number of other genera. None of these reports gives a very clear picture of the Lower Triassic sequence, but results from the Triassic of the Bowen and Great Artesian Basins (Evans, 1965MS), supported by evidence from the Sydney Basin* shows the following.

* The writer's knowledge of microfloras from the Sydney Basin is limited to the content of only a few sections. Mr. R. Helby, N.S.W. Department of Mines, is making a detailed study of the basin, commenced while he was a research student at the University of Sydney.

The Dulhuntyispora Assemblage of late Permian age ends in a great abundance of striate pollens (Protohaploxypinus limpidus, P. amplus, Striatopodocarpites cancellatus) with (among others) common Marsupipollenites triradiatus, Laevigatosporites vulgaris f. colliensis, Vesicaspora ovata and rare Dulhuntyispora parvithola. These comprise palynological unit P4 of Evans (1963a). The P4 assemblage is associated with an extensive suite of coal measures in the Bowen, Great Artesian and Sydney Basins.

Unit Trla. Unit P4 is rapidly replaced by a very different assemblage, unit Trla, in which Quadrisporites horridus is present in abundance, D. parvithola, M. triradiatus, Parasaccites spp., V. ovata, and Protohaploxypinus spp. are still in minor proportions, and in which new forms of monosaccate pollens - ("Nuskoisporites" radiatus, aff. Trizonaesporites-), and striate saccate pollens (Striatites, aff. Crustaesporites) make their first appearance.

The areal extent of rocks associated with unit Trla is unknown in the Sydney Basin, but includes Hennelly's transitional beds, and is restricted in the Bowen Basin by an onlapping unconformity within the Rewan Formation. Nothing has been recorded which resembles this unit in any other basin containing Triassic strata.

Unit Trlb. The succeeding unit Trlb contains no vestiges of the older, Permian microflora, but includes the first appearance of Taeniaesporites spp., a fairly abundant content of Alisporites (Pteruchus types), a continuance of the large monosaccate and striate pollens introduced in unit Trla, a relatively rare occurrence of Q. horridus, and the introduction of a number of undescribed pteridophytic spores.

Sediments mapped as part of the Rewan Formation and associated with unit Tr1b are widespread in the Bowen Basin, where they progressively onlap older sediments during the early stages of a final downwarp in the formation of the Bowen Basin. Sediments representing this stage occur in the north-eastern Eromanga Basin and are probably widespread in the Sydney Basin.

Unit Tr2a. A change in the gymnospermous pollen content of the microfloras occurred at the beginning of unit Tr2a, where the large monosaccate and striate forms almost disappear, and where *Taeniaesporites* types become prominent for the first time, associated with the appearance of *Lundbladispora*. Unit Tr2a is considered equivalent to the *Taeniaesporites* assemblage described by Balme (1963) from the Kockatea Shale of the Perth Basin. It is present in the Collaroy Claystone of the Narrabeen Group in the Sydney Basin, and in a thick upper section of the Rewan Formation in the Bowen Basin. Sediments associated with Unit Tr2a are of a more limited areal extent than those with Tr1b in the Bowen Basin, although they are widely developed under the north-eastern Eromanga Basin. They also contain in at least one locality an abundance of acritarchs (*Veryhachium reductum*) matching occurrences in the Kockatea Shale of the Perth Basin and the Blina Shale of the Fitzroy Basin.

Correlation of unit Tr2a with the *Taeniaesporites* assemblage of the Kockatea Shale raises again the question of the position of the Permian - Triassic boundary in Australia. Dickens & McTavish (1963) refer the Kocktea Shale macrofauna to the Otoceratan, the lowest division of the Lower Triassic

(Scythian), and yet sediments in eastern Australia, which in places exceed 3000 feet in thickness (with units Trla-b), and which underlie correlates of the Kockatea Shale and overlie the late Permian coal measures (unit P4), are also referred to the Triassic. It may be that Trla-b is of Permian age. The whole problem needs to be carefully appraised, as it involves definitions of the system boundary based on widely varied macro-and microfloral, vertebrate and invertebrate evidence, and its implications will generally affect the interpretation of the Gondwanaland geological scales.

The acritarchs in unit Tr2a in the Eromanga Basin are of palaeogeographical significance, as they imply that at least ephemeral marine incursions extended well over the present continental margin during this period of Triassic time. Although no supporting palynological data are available, there may be a correlation between unit Tr2a sediments in the Eromanga Basin and those in the Maryborough Basin which have yielded a marine Lower Triassic fauna comparable in certain respects to that in Kockatea Shale (Denmead, 1964).

Unit Tr2b. *Lundbladispora* spp. make their last appearance in Tr2b in association with the first appearance of *Aratrisporites* spp. *Taeniaesporites* spp. are a small component of the gymnospermous pollen content, but *Alisporites* spp. begin to be prominent at this level before they become the dominant constituent of the remaining Triassic (unit Tr3). Undescribed species of *Lundbladispora* are among spores known from this level.

Few sections with Tr2b assemblages have yet been found, but the distinctive transitional association of older and younger forms just below an important lithological change (to the Clematis Sandstone) in the Bowen Basin make the assemblage worthy of recognition as a separate unit. Sampling in the Sydney Basin has not yet been sufficient to determine where this zone might be found, but it could occur at the very top of the Collaroy Claystone of the Narrabeen Group.

Units Tr3a-d. A great abundance of *Alisporites* spp. (*Pteruchus* types) characterizes the remainder of the Triassic (Tr3a-d+) (de Jersey, 1962, 1964). This abundance in units Tr3a-b is associated with the presence, often in considerable numbers of several varieties of *Aratrisporites* and *Saturnisporites*: particular species of these genera distinguish Tr3a from Tr3b. A form comparable with *S. fischeri* Klaus in unit Tr3b is known to occur in the Bowen, Sydney and Perth Basins.

The point of first appearance of *Duplexisporites gyratus* Playford & Dettmann (de Jersey, 1964) is taken as the base of Unit Tr3d. An interval, termed Tr3c, lapses between the last appearance of *Aratrisporites*/ *Saturnisporites* and the first appearance of *Duplexisporites gyratus*.

Units Tr3a-d include the Clematis Sandstone and the Moolayember Formation in the Bowen Basin, and units Tr3a-b (+?c) the Gosford Formation, Hawkesbury Sandstone and Wianamatta Group in the Sydney Basin. Recognition of these units assists resolution of facies variations and unconformities in thsi younger Triassic in the Surat Basin.

D. gyratus appears with the *Alisporites* microflora in the Ipswich Coal Measures in the Clarence - Morton Basin and continues into the overlying

Bundamba Sandstone, where it becomes associated with Discisporites verrucatus and Circulina meyeri (de Jersey, 1964). The Ipswich Coal Measures and Bundamba Sandstone total about 5000 feet in thickness (Allen, Staines & Wilson in Hill & Denmead, 1960) and are thought to be represented at least in part by the major unconformity between the Moolayember Formation and Precipice Sandstone at the base of the Surat Basin.

Jurassic

The proposition that unconformity below the Surat Basin is represented by sediments in the Clarence - Morton Basin is partly supported by the existence, against the eastern side of a major subsurface ridge dividing these basins, of sediments which display both Triassic and ?Jurassic affinities, suggesting that overlap of this ridge began in latest Triassic times. Little is known of the microflora of this transitional zone, and no unit nomenclature for it is warranted at this stage.

Unit J1. The Precipice Sandstone, basal sandstone to the Surat Basin, is a reservoir of oil at Moonie and gas and oil in the Roma area. In consequence it has been subjected to fairly detailed palynological study (de Jersey & Paten, 1964; Evans, 1963a, 1964a, 1965MS). Its most obvious microfloral characteristic is a great abundance of Classopollis, while a suite of distinctive pteridophytic spores is established, including the genus Cardargasporites. These features characterize unit J1, which includes both the Precipice Sandstone and the lower half of the Evergreen Formation.

Unit J1 extends into the north-eastern Eromanga Basin where associated lithologies alter and where in subsurface the fossils are the best guide to recognition of the stage.

Representatives of unit J1 outside the Surat and Eromanga Basin have not yet been positively identified, except in the Yarrol Basin. Isopachs of the interval occupied by unit J1 in the Surat Basin imply that extension of sedimentation into the Clarence - Morton Basin occurred. Existing evidence from the latter basin, however, indicates that the Marburg Formation which immediately overlies the Triassic Bundamba Sandstone, is younger than J1 (de Jersey, 1963). Current drilling will probably show what happens to unit J1 in that region.

A thick sequence of sandstones in the Perth Basin, overlying the Lower Triassic Kockatea Shale and underlying the Bajocian Cadda Formation, is known to contain both the Alisporites and Classopollis microfloras, but more work on these sections is required in order to compare them in detail with the Surat Basin.

Unit J2. The base of Unit J2 is recognised by the first appearance of Applanopsis spp. Brief mention was made by Evans (1963a) of microplankton (acritarchs only) occurring in the early Jurassic in the Surat Basin. The course of this occurrence has now been traced across the basin and in outcrop: it lies within the Evergreen Formation, consists of upper and lower zones, which are found respectively above and below the Boxvale Sandstone, where that member is developed, and elsewhere is associated with a ferruginous pellet and oolite horizon. The geographic distribution of these elements and their isopachs lead to a picture of a shallow water, briefly "marine" area, bordered in the west by sand deposits of limited distribution. There appears to be no eastern barrier to the unit in the Surat Basin, and it is expected to continue eastwards into the Clarence - Morton and Maryborough Basins, although proof of this theory is still wanting. The term "marine" is used with caution as only acritarchs (Veryhachium and Micrhystridium) have been found, no open sea macrofaunas have yet been discovered in this interval and only a few arenaceous foraminifera have been found within it at one locality. The presence of acritarchs alone as marine markers is treated with special caution, particularly in view of comments by Churchill & Sargeant (1962a,b). However, the unit may be of considerable commercial significance as the associated sandstones at Alton, Trinidad and Annabranch are oil producers.

Units J3-4. The characters of units J3-4 are still vaguely determined. Classopollis becomes a very minor constituent, but Applanopsis segmentatus, A. dampieri, Araucariacites, Laricoidites, disaccate pollens, Cyathidites, Lycopodiumsporites, Osmundacidites, and Baculatisporites predominate. Species of Lycopodiumsporites and rare spores appear to be of value in subdividing this sequence. It certainly warrants more attention as it probably includes the most widely spread Jurassic sediments in the continent, occurring in the Clarence - Morton, Great Artesian, Laura, Canning, Carnarvon and Perth Basins.

At least one marine incursion into the Laura Basin occurred in J3-4 times, as dinoflagellates, (cf. Apteodinium) have been found there. Acritarchs have been discovered in relative abundance in a few sections in the north-eastern Eromanga Basin.

Isopachs and facies changes in the J3-4 interval indicate western and southern margins of deposition, but, as with J2, sediments are thought to have once been laid down eastwards and northwards of the present limits of the Surat Basin.

Unit J5. Evans (1963a) commenced unit J5 with the introduction of Contignisporites (al. Cicatricosisporites) cooksonii, which Balme (1957) records from beds as old as the Callovian in the Carnarvon Basin, and commenced the basal Cretaceous unit K1 at the first appearance of Cicatricosisporites australiensis, Dictyotosporites speciosus and Lycopodiumsporites circolumenus. This sequence now must be modified. Studies in the Surat Basin show that C. cooksonii, L. circolumenus and Murospora florida first appear at a lithologically distinctive horizon in the Injune Creek Beds, which is taken as the base of Unit J5. Locally at least this corresponds to an environmental change from assemblages with a (?) bryophytic Annulispora, Rogalskasporites, and Antiquasporites content to be found in underlying coal measures to a dominantly gymospermous assemblage with abundant Applanopsis dampieri, A. trilobatus, Laricoidites spp. and podocarpoid pollens. There is no sign at this horizon of C. australiensis or Dictyotosporites. Forms referrable to the latter genus and comparable with D. complex appear higher up, possibly distinguishing another unit, which could be termed J6. Evans (in Henderson et al., 1963) reports D. cf. complex and D. cf. speciosus in association with Dingodinium jurassicum and other Upper Jurassic microplankton in the Canning Basin. He also reports Cicatricosisporites australiensis higher in the same borehole sequence in what might be either Jurassic or Cretaceous strata, so that the position of the Jurassic - Cretaceous boundary is apparently still unsatisfactorily determined. Additional work is obviously required on this interval before palynological units might be recognized in it.

Cretaceous

Evans (1963a) subdivided the Cretaceous of the Great Artesian Basin on combined spore and microplankton criteria. In the light of more recent work, considerable modification to that scheme is needed and the code nomenclature discarded. Dettmann (1963) recognized in ascending order the Stylosa, Speciosus and Paradoxa Assemblages in south-eastern Australian Lower Cretaceous sediments. Of these divisions, the Speciosus Assemblage is the most clearly marked. The Stylosa Assemblage appears to be based on insufficient data to warrant its complete acceptance as a workable stratigraphic unit at this time, as it seems possible that D. speciosus ranges downwards further than Dettmann supposes. Dettmann notes that the Speciosus assemblage may be split into a lower unit with Murospora florida and an upper unit with Crybelosporites striatus. Studies in the Otway, Great Artesian and Papuan Basins confirm this proposition, and in the Otway Basin at least, if Cyclosporites hughesi is also considered, four divisions of the Speciosus Assemblage may be traced. Continuing for the moment the assumption that the first appearance of C. australiensis corresponds with the base of the Cretaceous, the following units may be recognized:

Unit K1a. First appearance of C. australiensis, C. hughesi, continued appearance of D. speciosus, last appearance of M. florida.

Unit K1b. Continued appearance of C. australiensis, D. speciosus, last appearance of C. hughesi.

Unit K1c. Continued appearance of C. australiensis and D. speciosus.

Unit K1d. Continued appearance of C. australiensis, and D. speciosus, first appearance of C. striatus.

Unit K2. First appearance of Coptospora paradoxa. The last appearance of D. speciosus just overlaps the beginning of the range of C. paradoxa.

The Cretaceous microplankton in the Great Artesian Basin are being re-examined in the University of Queensland, but at least two divisions of these microfossils are known, the lower marked by Dingodinium cerviculum and Muderongia tetracantha and the upper by Gonyaulax edwardsi and Diconodinium spp. The D. cerviculum Zone includes the Roma Formation in the Surat Basin and the Doncaster Member of the Wilgunya Formation in the Eromanga Basin. Undetermined facies changes above the Doncaster Member and below the Toolebuc Member of the Wilgunya Formation, result in swarms of leiosphaerids and smooth walled dinoflagellates. The D. cerviculum Zone corresponds approximately to the spore/pollen units K1b-c. Correlations below K1b/D. cerviculum Zone in the Great Artesian Basin are at present uncertain, owing to revisional mapping in the pre-marine Roma Formation Upper Jurassic and Cretaceous (Day, 1964) and the recognition of probable gaps in sections previously referred to as the

Blythesdale Group. Dettmann's studies of sections in the southern Eromanga and Otway Basins highlight the existence of two differing depositional facies in Cretaceous times in eastern Australia. Although several sections representing units K1b–c (part of the Speciosus Assemblage) in the Otway Basin have been examined, no dinoflagellates have been found in them. Swarms of acritarchs, including Micrhystridium spp., and "gen. et sp. indet. Forma A" Eisenack & Cookson, 1960 occur in unit K1a in the Gippsland Basin (Evans & Hodgson, 1964) and in the Otway Basin. Eisenack & Cookson reported their problematica from Unit K1a–b horizons in the Great Artesian Basin. Rare acritarchs (Micrhystridium spp., Cymatiosphaera sp.) spasmodically occur in Unit K2 (Paradoxa Assemblage) in the Otway Basin, and at the top of this unit (in the top of the Merino-Otway "Group") Odontochitina operculata, Gonyaulax edwardsi and other microplankton are occasionally found. This lack of microplankton in general and of dinoflagellates in particular contrasts greatly with the microplankton content of units K1b–K2 (Wilgunya Formation) in the Great Artesian Basin. For this reason, Lower Cretaceous sediments in the northern Murray Basin, and which contain abundant microplankton, are to be linked with the Great Artesian Basin, not with sediments in the Otway Basin. Similar facies changes can be traced southwards from the Surat Basin into the Coonamble Basin in New South Wales.

Little progress in Upper Cretaceous stratigraphic palynology has been achieved since the previous congress. Dinoflagellate sequences recognized by Cookson & Eisenack (1960), Douglas (1962) and Evans (1962) are applicable across the Otway Basin, but study of the angiosperm content of these rocks is still required. Harris (1965) and Cookson (1965) described spore/pollen and microplankton assemblages from the Pebble Point Formation, which they accept as Palaeocene in age, thus providing comparitive data for the older, little studied sections.

CONCLUDING REMARKS

Although much of the evidence is still sketchy, and many results and observations have still to be published Australian palynologists have between them probably seen what amounts to an almost complete sequence of Mesozoic fossil palynomorphs. Although opinions on stratigraphic terminology and divisions understandably differ, the basic data are available by which the Mesozoic may be subdivided. In the absence of other fossil evidence these data and stratigraphic divisions in many cases must form the main support for correlations and time-scale concepts in analyses of depositional histories of several of the continent's sedimentary basins, in particular the Great Artesian, Otway, Murray and Clarence-Morton Basins. Palyno-biostratigraphic divisions in the Great Artesian Basin, for example, coupled with isopach maps of the divisions and sedimentary petrological evidence are already sufficient to show that the present day configuration of the basin does not reflect the original depositional configuration, that in fact most pre-Upper Jurassic deposits were "open" towards the north and east, margins of deposition occurring to the south and west only. Addition to this picture of occurrences of microplankton from Triassic times onwards which reflect spasmodic marine incursions, leads to the conclusion that the basin is filled with generally paralic sediments, rather than just freshwater sediments as previously supposed.

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