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UPPER CARBONIFEROUS AND PERMIAN PALYNOLOGICAL STAGES AND THEIR DISTRIBUTION IN EASTERN AUSTRALIA.

by

P.R. Evans

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Blackwater
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ABSTRACT

A paper submitted to the First International Symposium on Gondwana stratigraphy and Palaeontology is reproduced with additional explanatory information. The uppermost Carboniferous and Permian of much of eastern Australia is divided between five palynological stages, in terms of which some of the main depositional events of the period are delineated.

FOREWORD

This paper incorporates a manuscript submitted to "I Simposio internacional sobre Estratigrafia y Paleontòlogia del Gondwana", to be held at Mar del Plata, Argentina in October 1967.

It briefly summarizes the relationship between palynological and depositional events in eastern Australia on the basis of current knowledge. Reference to the writer's customary nomenclature for palynological units has been purposely omitted to avoid burdening overseas readers with the code's now over-complicated format. However, a correlation of the old and the new schemes is added to this report in Table 1.

TABLE 1: COMPARISON OF PALYNOLOGICAL SCALES AND CORRELATION OF REPRESENTATIVE FORMATIONS AND GROUPS

ASSEMBLAGE (BALME)	PALYNOLOGICAL UNIT (BMR)	STAGE (THIS PAPER)	DENNISON TROUGH (BMR)	SYDNEY BASIN	COOPER BASIN	GALILEE BASIN
Dulhuntyspora	P4	5	Blackwater	Newcastle	Gidgealpa	Bett's Creek
	P3d		Black Alley	Tomago		*Upper Permian*
	P3c			Mulbring		
	P3b		Peawaddy Catherine Ingelara	Muree		*Colinlea*
			Aldebaran*			
Vittatina	P2-P3a	4	Cattle Creek	Branxton Greta		
	Plc	3	Reids Dome	Farley Rutherford		Reids Dome
Nuskoi sporites	C2-Plb	2		Allandale Lochinvar	"Merrimelia"	Boonderoo *UNNAMED*
	C1	1		Seaham		Joe Joe

* Stage 5 commences within the Freitag Member of the Aldebaran Formation, as defined by P.E. Power (Qld Govt. Min. J., 1966, 67, 109-116).

The manuscript also avoids reference to several unpublished B.M.R. Records and appendices to subsidized well completion reports, which would not be available to readers in other countries, and a list of the relevant reports is appended to this Record.

To avoid undue wastage of the 5000 words allowed for a contribution to the symposium, no references to descriptions of formations were mentioned in the MS, although cross reference was made to bibliographies compiled by M.R. Banks, K.S.W. Campbell, J.M. Dickins, N.J. de Jersey and other interested workers, who constructed a series of correlation charts of Australian Carboniferous, Permian, Triassic and Jurassic formations, which will also be presented to the symposium.

As shown in Table 1, the opportunity was taken to change both the units and the nomenclature of the palynological scale. The first of the writer's investigations of the eastern Australian Permian concerned the southern Bowen Basin, where the marine sequences were divisible according to the distribution of spinose acritarchs. As studies were extended to sediments on the Springsure Shelf and in the Galilee Basin, where the marine facies, and hence the spinose acritarchs, are not present, only the spore/pollen sequence was of value to stratigraphic correlation. In order to be consistent with previous usage, new, but clumsy groupings of palynological units, such as P3b-4, became necessary: a by-product of the bad stratigraphic practice of deriving a common scale from the distribution of entirely different biological groups. In spite of continued attempts to be independent, it became progressively clearer that Balme's Assemblages within the Striatites Microflora (figure 4) were major, widespread units applicable to the eastern Australian states as well as to Western Australia. Nevertheless, the independent approach led to recognition of useful subdivisions of both the "Nuskoisporites" and "Vittatina" Assemblages.

The problem of nomenclature of the resultant five palynological divisions has been shelved and will there remain until the character of each division is elaborated elsewhere. However, the non-committal phrases "palynological units", "divisions" and "zones" have been dropped in favour of the term "stage". This step has been taken because each "division" is characterized by a number of ranges of a variety of species and genera, each of which constitutes a zone. If a stage is composed of a series of zones, each "division" may be regarded as a stage. Balme's Assemblage names are not continued because of their less specific definitions, because of the now questionable nomenclature of the nominate forms (e.g. Nuskoisporites = ?Parasaccites = ?Cordaitina) and because the "Assemblages" appear to resemble stages on the basis of the reasoning given above. Further explanation and more specific definition of these stages will be set down elsewhere.

INTRODUCTION

Balme (1964) distinguished the Australian Permian by means of the Striatites Microflora, comprising the Nuskoisporites, Vittatina and Dulhuntyispora Assemblages. Subsequent investigations in eastern Australia have further resolved the Nuskoisporites and Vittatina Assemblages into two divisions each. This paper briefly indicates the palynological character of the resulting five stages, which for purposes of discussion are numbered upwards from one to five (to be formally named and fully described elsewhere). Only fossils and sections in South Australia, Victoria, New South Wales, Queensland and the Northern Territory are considered. Although some palynological data are available from the Permian of Tasmania (Newton, 1875; Dulhunty & Dulhunty, 1949; Balme, 1964; Spry & Banks, 1962), they have not yet been analysed in terms of these five stages. Several of the stages are recognizable in the Bonaparte Gulf Basin, where they are insufficiently understood to warrant description. The orogenically disturbed Carboniferous and Permian of the eastern margin of the continent are unsuitable subjects for palynological study and are excluded from discussion.

Full acknowledgement is given to members of the Bureau of Mineral Resources and the oil exploration companies whose geological and geophysical information is used in this summary.

LIMITS OF THE PERMIAN SYSTEM

Existing approximations to the limits of the Permian System in Australia (David, 1950) are retained, although the microfloral evidence may eventually contribute to modifications of these boundaries. The change from the Rhacopteris Flora to the Glossopteris Flora (Walkom, 1945) is taken as marking the base of the Permian. Balme (1961, 1964) tentatively correlated the first appearance of spermatophyte pollen at the commencement of the Nuskoisporites Assemblage with this macrofloral event, and regarded it as a palynological expression of the base of the Permian. However, the Nuskoisporites Assemblage first appears within the upper part of the range of the Rhacopteris Flora and the interval between the introduction of monosaccate pollen and the appearance of the Glossopteris Flora is accordingly thought of here as part of the Upper Carboniferous. Extinction of the Glossopteris Flora is regarded as the end of the Permian and is readily expressable in microfloral terms. Balme (1963) discussed this question and the matter is under active investigation (Evans, 1966).

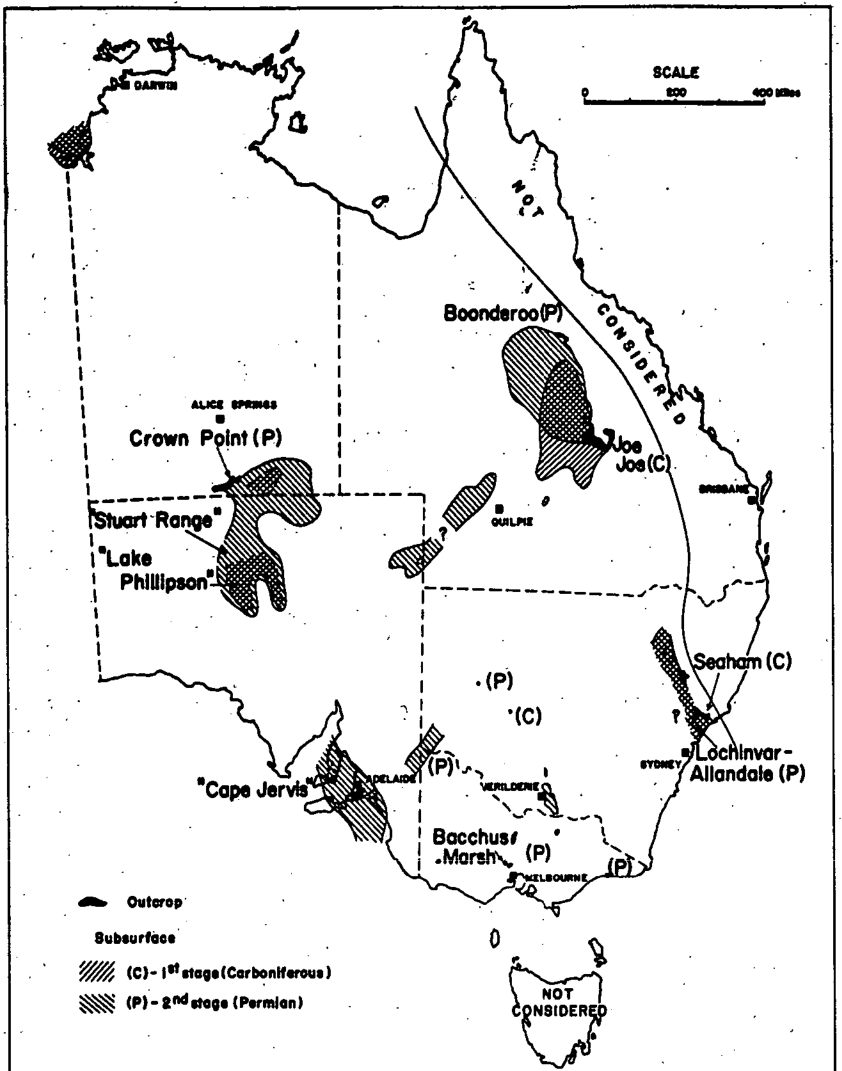

Fig. I. Distribution of stages I and 2

STAGE 1 (UPPER CARBONIFEROUS)

The Rhacopteris Flora is characteristic of the Kuttung Facies of New South Wales (Engel, 1965). Monosaccate pollen first appear in the youngest formations of the Kuttung Facies, for example the Seaham Beds*, where they are associated with spores of Retusotriletes diversiformis, Punctatisporites spp., including P. gretensis, and characteristic species of Verrucosisporites and aff. Vallatisporites. The same assemblage with forms of Dictyotriletes, cingulate mesoporoids, and rare monolpate pollen occurs in the glacigene Joe Joe Formation in the Galilee Basin+ (Lindner, 1966), where it is associated with Cardiopteris polymorpha (White, in Mollan, Dickins, Exon, & Kirkegaard, in press). No striate disaccate pollen have yet been

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* Consult the correlations of Carboniferous and Permian sequences in Australia (Banks, Campbell, Dickins & de Jersey, in press) for references to formations mentioned in the text.

\+ Positions of basins named in text are plotted in figure 3.

observed in these assemblages, which are characteristic of stage 1. Stage 1 constitutes a lower portion of Balme's Nuskoisporites Assemblage.

Stage 1 occurs below the Simpson Desert area* and was probably encountered in the "Stuart Range Beds" in the Lake Phillipson Bore, which Balme (1957) thought might be Upper Carboniferous in age.

Stage 1 is everywhere represented by glacigene deposits. It is apparently conformable with the underlying Carboniferous in the Sydney Basin, but elsewhere it rests unconformably upon older sediments. Except in the Sydney and Bonaparte Gulf Basins, the underlying Devonian - (?) Lower Carboniferous comprises red beds. Commencement of stage 1 therefore appears to be the product of marked changes in both structural configuration and climate.

STAGE 2 (LOWER PERMIAN)

Figure 1

Gangamopteris is the first member of the Glossopteris Flora to appear in the Sydney Basin, about 390 metres above the base of the Lochinvar Formation of the Dalwood Group (= Lower Marine) (David, 1950; Booker, 1960), but the lowest horizon yet examined for spores lies near the top of the overlying Allandale Formation and is allocated to the base of stage 3. Stage 1 in the Galilee Basin and the Simpson Desert area is succeeded by beds with the earliest forms of disaccate striate and non-striate pollen, a greater abundance and variety of monosaccate pollen, and a significant number of monocolpate grains. The older assemblages are gradually replaced by new forms of (among others) Apiculatisporis, Lophotriletes, and cingulate mesosporoids. Plant fragments with glossopterid venation first appear in the Galilee Basin (White, 1964, 1965) with striatitid pollen of the Protohaploxypinus goraiensis type. This second palynological stage is therefore regarded as part of the Permian. It represents an upper portion of the Nuskoisporites Assemblage. Stage 2 sediments exceed 750 metres in thickness in both the Galilee and Sydney Basins and include the oldest sediments to be palynologically dated in the Cooper Basin (Kapel, 1966; Casey & Konecki, in press).

Stage 2 deposits near Jerilderie and Wentworth in western New South Wales and South Australia contain swarms of Leiosphaerids and occasional spinose acritarchs and foraminifera at several levels, indicative of at least ephemeral brackish or marine conditions. Ludbrook (1961) recognized similar palaeo-environments in the "Lake Phillipson Beds" of South Australia, although there is no evidence of their extension into the Simpson Desert area. In parts the glacigene "Cape Jervis Beds" near Adelaide also contain foraminifera (Ludbrook, 1957) and are tentatively referred to stage 2.

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* Several basins of Upper Palaeozoic sediments in the vicinity of the South Australia/Northern Territory border have been named (Wopfner, 1964; Kapel, 1966), but there is no satisfactory structural term for the entire region, which is referred to here as the Simpson Desert - Lake Phillipson area.

Because the stratigraphic positions of described spore bearing samples are uncertain, the palynological age of the glacigene sediments at Bacchus Marsh, Victoria, remains ill-defined (Virrki, 1939, 1945; Pant, 1949, 1955; Pant & Mehra, 1963; Kenley, 1952). Evidence suggests that they represent stage 2, but stage 1 could also be present (cf. David, 1950). The number of recycled Permian spores dispersed throughout the Mesozoic and Tertiary of western Victoria (Cookson, 1955) points to the previous existence of much greater deposits of Permian age in that region than are now preserved.

The suites of early Permian volcanics to the north of the Sydney Basin and east and north of the Bowen Basin cannot be adequately correlated with the palynological sequence, although limited microfloral evidence indicates that at least part of the Boggabri Volcanics of northern New South Wales could be referable to stage 2.

STAGE 3 (LOWER PERMIAN)

Figure 2

The prominence of monosaccate pollen begins to decline in assemblages succeeding stage 2, although the group continues to display diverse forms. Striate pollen become equally prominent and generally include forms of the *Protohaploxypinus amplus* and *P. sewardi* types and forms akin to *Vittatina*. *Marsupipollenites*, which appears extremely rarely in stage 2, rapidly becomes a major assemblage component. *Verrucosisporites pseudoreticulatus*, *Granulatisporites trisinus*, other varieties of *Apiculatisporis*, *Lophotriletes* and cingulate mesosporoids appear for the first time. The assemblages characterize stage 3 and correspond to a lower portion of Balme's *Vittatina* Assemblage.

In most areas stage 3 is associated with non-marine carbonaceous sandstones, shales, and coal seams or volcanics. The Rutherford and Farley Formations represent the stage in the Sydney Basin and are considered to be marine. In the eastern and northern parts of the Bowen Basin it is probably represented by part of the Lizzie Creek Volcanics (= Lower Bowen Volcanics) and by part of the Camboon Andesite, because they underlie marine correlates of stage 4. The coal measures of the Reids Dome Beds in the Dennison Trough, along the south-western side of the Bowen Basin, exceed 1800 metres in thickness (Malone, 1964), but thinner coal measures overlie the glacigene beds of the Galilee Basin. An almost continuous sheet of freshwater sediments occupies the Cooper Basin (lower part of the Gidgealpa Formation) and similar deposits extend from Lake Phillipson to the Simpson Desert (Mount Toondina Beds). All these deposits include numerous occurrences of glossopterid remains.

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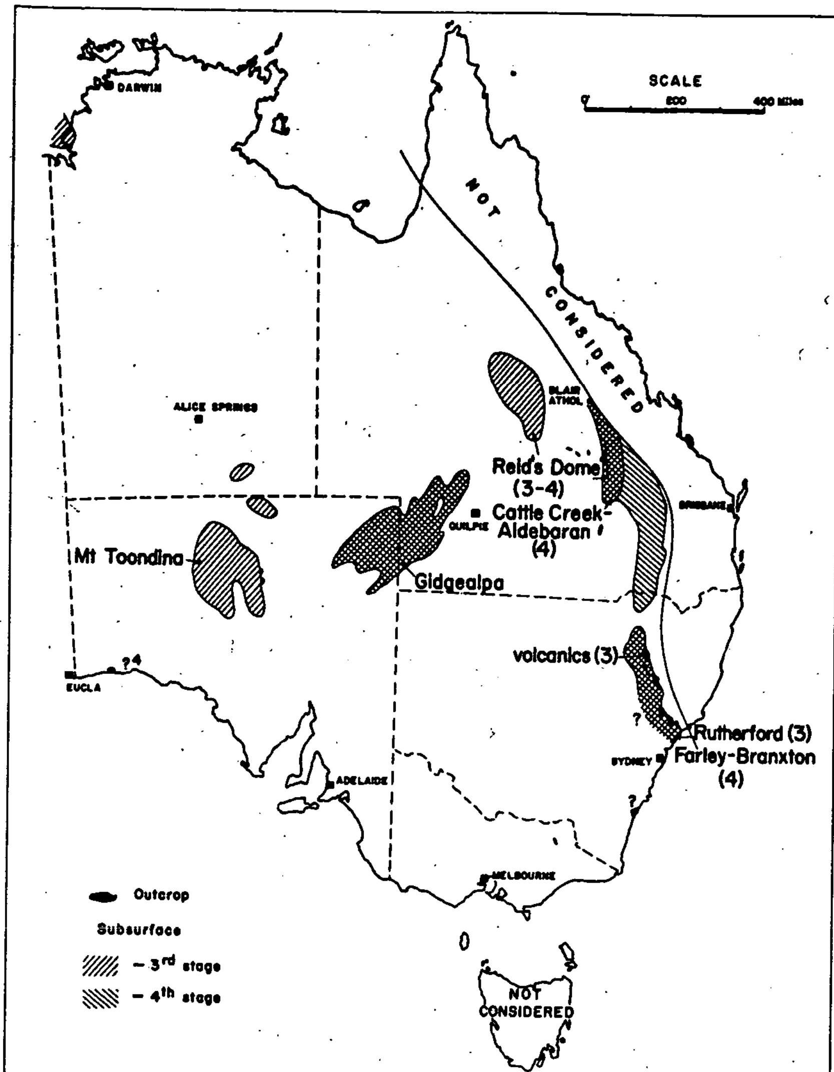

Fig. 2. Distribution of stages 3 and 4

STAGE 4 (LOWER PERMIAN)

Figure 2

The ratio of monosaccate to disaccate pollen declines further in stage 4. Monocolpate grains, particularly Marsupipollenites, become abundant at many levels. Polypodiitites cicatricosus, Apiculatisporis cornutus and Camptotriletes biornatus appear. Verrucosisporites parmatus and cingulate mesosporoids are common at intervals. A few ochinate forms with affinities to Didecitriletes ericianus appear high in the stage.

Stage 4 is even more restricted in areal distribution than stage 3. Its microfloras occur in the Greta Coal Measures (Balme & Hennelly, 1955, 1956a, 1956b) and in the lower part of the marine Branxton Formation in the Sydney Basin; and in the top of the Reids Dome Beds and the overlying Cattle Creek Formation in the Bowen Basin. Stage 4 therefore marks a change from a regressive coal measure phase to the onset of transgressive marine conditions. The marine transgression did not extend into the Galilee and Cooper Basins. However, there is evidence of an at least limited transgression into the Eucla Basin in stage 3 or more probably stage 4 times (Harris & Ludbrook, 1966).

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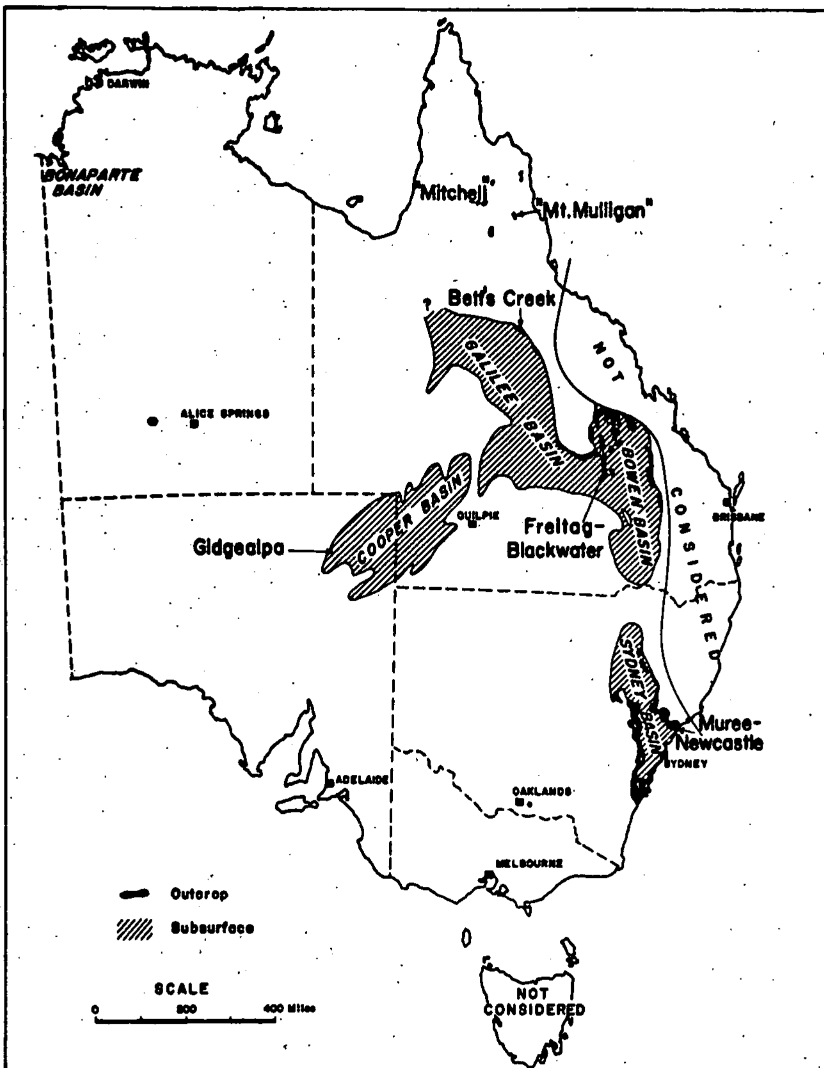

Fig. 3. Distribution of stage 5.

STAGE 5 (LOWER - UPPER PERMIAN)

Figure 3

The fifth and last stage is characterized by the establishment of disaccate striate pollen as the main assemblage component and by the appearance of Dulhuntyispora, Bascanisporites undosus, Gnetaceaepollenites sinuosus, Microreticulatisporites bitriangularis, and certain forms of Didecitriletes and Microbaculispora. The proportion of spores decreases considerably towards the top of the stage and Marsupipollenites once again becomes a major component, at about the level where Indospora and Vitreisporites are established.

Stage 5 corresponds to Balme's Dulhuntyispora Assemblage. Because of its appearance below the Artinskian Ingelara Formation in the Bowen Basin, it is thought to commence within the Lower Permian and not at the base of the Upper Permian as deduced by Balme (1964).

Stage 5 has the widest distribution of all. The marine conditions existing in both the Sydney and Bowen Basins prevailed into stage 5, but were no more than briefly established at the south-eastern end of the Galilee Basin. They did not affect the Cooper Basin. In all areas the stage ends with extensive coal measure development, although towards the east coarse clastics and detrital volcanics are evident.

The microfloras change rapidly at the end of stage 5 (Hennelly, 1959), to correspond with the end of the Glossopteris Flora. In parts of the Sydney and Bowen Basins the change is found within the last of the coal measures. Elsewhere stage 5 is succeeded disconformably or unconformably by red beds of the Lower Triassic in much the same configuration.

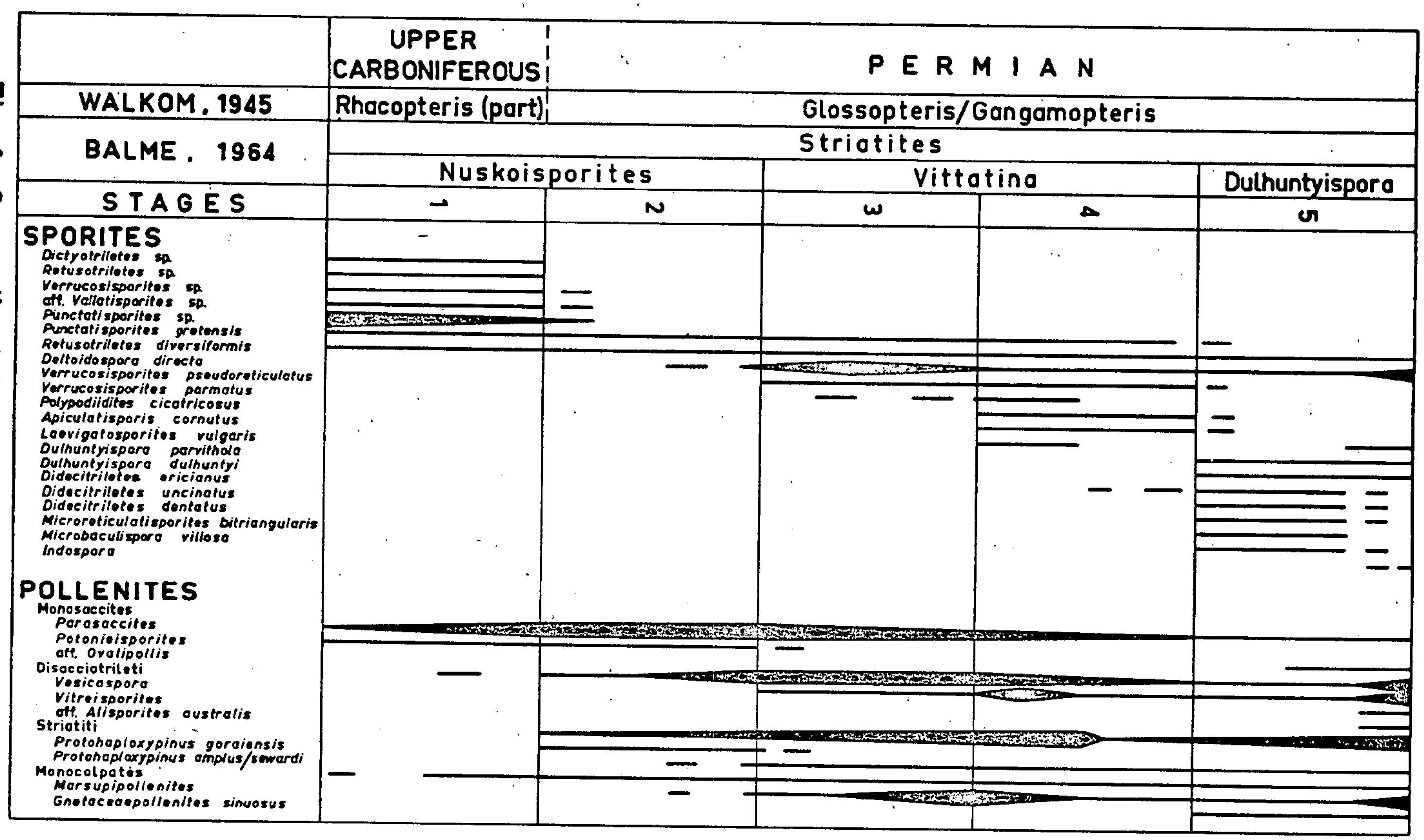

Fig. 4. Generalized flora distribution diagram

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APPENDIX: RELEVANT UNPUBLISHED REPORTS NOT LISTED AMONG THE REFERENCES

The following papers by the writer include data relevant to the palynological sequence discussed above, although they were not included in the MS submitted to the symposium.

Bureau of Mineral Resources Records

1962/4 - A palynological report on A.O.G. Wentworth No. 1, N.S.W. with observations on the Permian of the Oaklands - Coorabin area of the Murray Basin.

1962/139 - A revised palynological report on S.P.L. No. 1 (Birkhead) Well, Great Artesian Basin, Queensland.

1963/100 - Spore preservation in the Bowen Basin.

1964/91 - Some palynological observations on the Mesozoic of the Baralaba, Monto, Taroom, & Mundubbera 1:250,000 Sheet areas, Bowen-Surat Basin, Queensland.

1964/50 - (in collaboration with E.A. Hodgson) A palynological report on Arco-Woodside Duck Bay No. 1 Well.

1964/196 - Lower Permian microfloras from the Crown Point Formation, Finke area, Northern Territory.

1964/197 - A correlation of some deep wells in the north-eastern Eromanga Basin, central Queensland.

1964/76 - Some palynological observations on samples from the north-eastern Eromanga Basin, central Queensland.

1965/88 - (in collaboration with E.A. Hodgon) Palynological correlation of Plant Tooloombilla No. 1, Crystalbrook No. 1 & Warrong No. 1, Eddystone 1:250,000 Sheet area, Surat Basin, Queensland.

1966/61 - Palynological studies in the Longreach, Jericho, Galilee, Tambo, Eddystone & Taroom 1:250,000 Sheet areas, Queensland.

1966/134 - Contributions to the palynology of the Permian & Triassic of the Bowen Basin.

1966/222 - Palynological comparison of the Cooper and Galilee Basins.

1967 (in prep.) - Review of the Permian palynology of the Sydney Basin, New South Wales.

APPENDICES TO SUBSIDIZED WELL COMPLETION REPORTS

A.A.O. Westgrove No. 1:	Mines Administration Pty Ltd Rep.	Q55-56P/109.
A.A.O. Westgrove No. 2:	" " " " "	Q55-56P/110.
A.A.O. Westgrove No. 3:	" " " " "	Q55-56P/119.
A.A.O. Kildare No. 1:	" " " " "	Q55-56P/117.
A.A.O. Arbroath No. 1:	" " " " "	Q55-56P/131.
Plante Warrinilla No. 1:	Cundill, Meyers & Associates.	