Journal and Proceedings, Royal Society of New South Wales, Vol. 115, pp. 79-86, 1982
ISSN 0035-9173/82/0201 — 08 $4.00/1

Late Permian Acritarchs from the Northern Sydney Basin

A. McMinn

ABSTRACT. Five species of spinose acritarchs were encountered in the Late Permian coal measure sequences of the northern Sydney Basin. They occur both in those units previously thought to be marine, such as the Denman Formation, and occasionally in those directly associated with coal seams, e.g. the Middle River Coal. *Mehlisphaeridium* sp. cf. *M. fibratum* Segroves 1967 has a restricted stratigraphic range and is useful in correlating coal bores throughout the basin; the other species are either uncommon or range throughout the Late Permian sequence. *Ulanisphaeridium* is described as a new genus and *U. berryense* is described as a new species.

INTRODUCTION

Because of the need to evaluate the huge coal reserves of the northern Sydney Basin, this area has become the most densely drilled area in New South Wales. In spite of the resulting large volume of drill core, correlations within the sequence remain difficult. Rapid lateral variations in facies and frequent coal seam splitting hamper all but local interseam correlations based on lithology alone. Dulhunty (1945, 1946) aimed to use spore-pollen types to characterise individual coal seams and thus enable interseam correlations on a local and regional basis. Unfortunately, thirty-five years later, his original aspirations remain unrealised.

A palynological zonation for the Permian System in eastern Australia was first developed by Evans in a series of unpublished records (Evans 1964, 1966a, b, c, 1967a, b) and later published (Evans 1969). This framework of five stages was further developed and modified in part by Paten (1969) and Price (1976). The most recent developments in this zonation are presented by Kemp et al. (1977). This latter publication divides Evans' original five stages into eleven subzones. In the northern Sydney Basin almost the entire coal measure sequence, in some areas over 1500m thick, is contained within a single subzone, i.e. Upper Stage 5. Therefore there is a need to find biostratigraphically useful palynomorphs within this interval. In this initial investigation seven sections (see fig. 1) from the Singleton, Ulan and Lithgow areas are studied; these are:

DM Doyles Creek DDH 10
DM Doyles Creek DDH 11
DM Warkworth DDH 1
JDP Ulan DDH 6
JDP Ulan DDH 13
Elecom Lithgow-Newnes DDH 31
Browns Gap Road Section

Illustrated specimens are stored in the Mining Museum Micropalaeontology Collection (MMMC) of the Geological Survey of N.S.W.

PALYNOSTRATIGRAPHY

Traditionally, spinose acritarchs have been considered to indicate marine influence in sedimentation. In the northern and western coalfields of the Sydney Basin they are found in those units usually associated with marine sedimentation such as the Maitland Group, Berry Siltstone, Denman Formation and Bulga Formation and also in some units associated with coal deposition. Recent investigation of the depositional environments of many of these coal units in the western and northern coalfields indicates that they often had a deltaic origin (Herbert 1980) with some degree of marine influence evident.

Most acritarch species encountered during this investigation are long ranging and thus of only limited use in biostratigraphy. It was found however, that at least one species, *Mehlisphaeridium* sp. cf. *M. fibratum*, had its first local occurrence within the sequence. The level of this first local occurrence was found to be at stratigraphically and biostratigraphically equivalent positions within six of the seven sections investigated. The first local occurrence of *M.* sp. cf. *M. fibratum* was between the Bayswater Coal and the Denman Formation of the Singleton Super-Group and between the Irondale Coal and a unit equivalent to the Denman Formation in the Illawarra Coal Measures. This species only occurs above the first occurrence of the spore *Dulhuntyispora parvithola* (Balme & Hennelly) Potonie 1960. The first occurrence of *M.* sp. cf. *M. fibratum* in the Sydney Basin is thus a valuable biostratigraphic datum and can be used in regional correlation between bores. It should be noted that although *M.* sp. cf. *M. fibratum* is useful in regional correlations, *M. fibratum* s.s. occurs in considerably older strata in Western Australia and central Queensland.

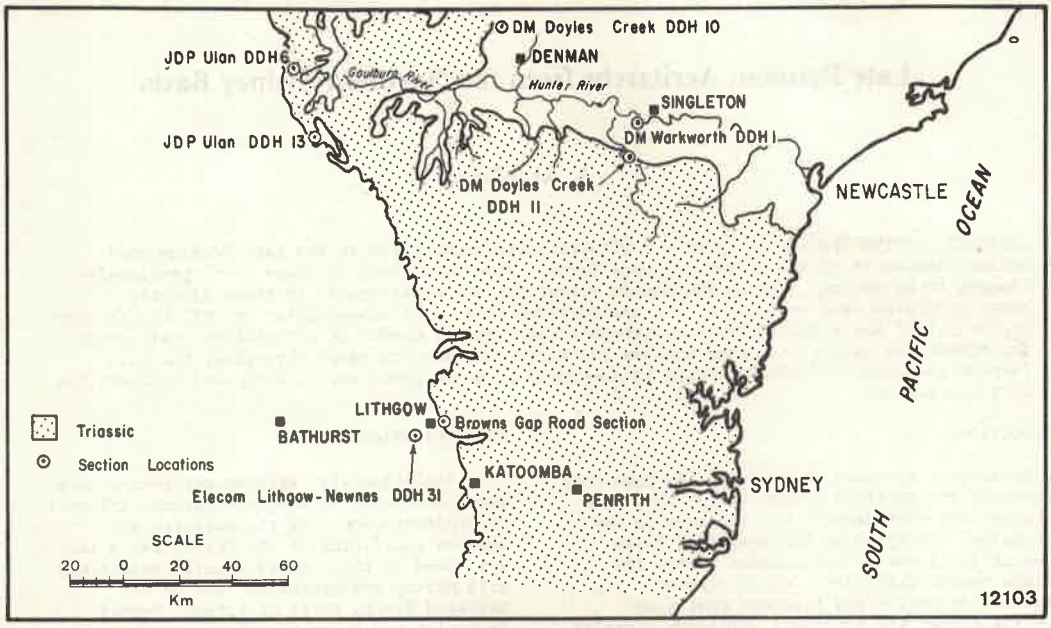


Fig. 1. Location of coal sequences

Figure 2 shows the correlations between the northern and western coalfields based on the first local occurrence of *M.* sp. cf. *M. fibratum*. In each bore the first occurrence of this species is slightly lower than the base of the marine to marginal marine Denman Formation and its western equivalents. The Denman Formation is composed of fine grained, grey to black siltstone and mudstone. It frequently shows burrows and other evidence of bioturbation; a marine microfauna is sporadically present (Scheibnerova pers. comm.). The burrow structures, microfauna and acritarch assemblages of the Denman Formation suggest a shallow marine environment of deposition.

The geographical distribution of acritarchs in the Late Permian of the northern Sydney Basin is apparently uneven. Acritarchs appear to be more common in the Illawarra Coal Measures than in the Singleton Super-Group. This greater abundance of acritarchs in the western areas may relate to environmental differences as there is also a higher ratio of spores to pollen in the Illawarra Coal Measures. An unusual abundance of acritarchs occurs in association with the Middle River Coal of the Illawarra Coal Measures. Acritarchs are found in clay bands actually within the coal seam. The Middle River Coal of the western Illawarra Coal Measures is usually correlated with the Wongawilli Coal of the south-western Illawarra Coal Measures. Byrnes et al. (1981) reported inarticulate brachiopods in clay-bands of the latter seam and suggested a possible marine influence on its deposition. The acritarch assemblages of the Middle River Coal are dominated by *M.* sp. cf. *M. fibratum*.

Two other species of acritarchs occur commonly in the Late Permian coal measures sequence and these are *Micrhystridium karamurzae* Sarjeant 1970 and *Ulanisphaeridium berryense* gen. et sp. nov. Both range throughout the Late Permian coal sequence and have also been recorded from both older and younger strata in other areas. The species *Quadrisporites horridus* Hennelly 1958, although common in sequences of similar age elsewhere, was found in only two samples in this study and these were both from high in the sequence. This species is not further discussed here. A fifth species, *Micrhystridium* sp. cf. *M. inconspicuum* (Deflandre) occurs only in the Berry Siltstone. The rarity of this species however reduces its usefulness as a biostratigraphic datum.

SYSTEMATIC PALAEONTOLOGY

ALGAE INCERTAE SEDIS
Genus MEHLISPHAERIDIUM Segroves 1967

Type species *Mehlisphaeridium fibratum* Segroves 1967

MEHLISPHAERIDIUM sp. cf. M. FIBRATUM Segroves
(Plate 1, figs 3, 4, Plate 2, figs 3, 5)

Description: This form has a spheroidal, two-layered vesicle bearing between 8 and 30 hollow, conical processes (average 15). These processes, which are between 2 µm and 6 µm long, emanate from the outer wall only and often display a coarse, granular structure of anastomosing fibres. Some of these processes open distally. A definite excystment aperture has not been identified on any specimen.

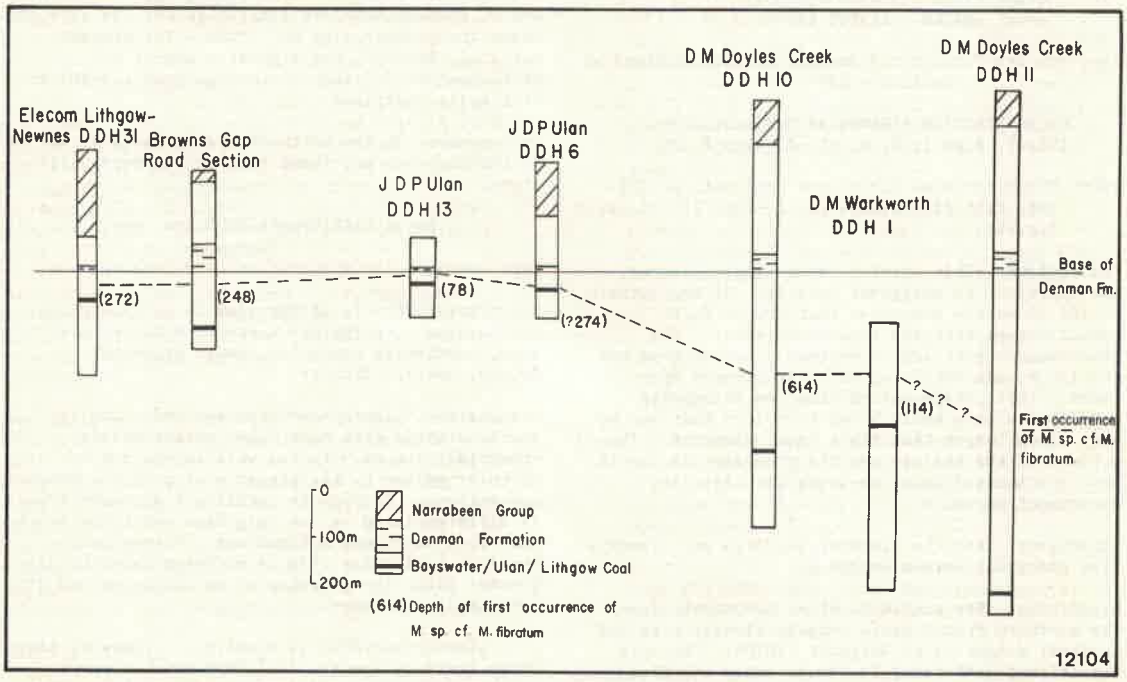


Fig. 2. Correlation of first occurrence of *Mehlisphaeridium* sp. cf. *M. fibratum*

Dimensions: Specimens from the Sydney Basin have a vesicle size range of 13(21)35 µm; 20 specimens were measured.

Discussion: There is a considerable size difference between *M. fibratum* and *M.* sp. cf. *M. fibratum*. Segroves (1967) described *M. fibratum* as having an equatorial diameter of between 37 µm and 94 µm and as having between 5 and 39 processes that were between 5 µm and 30 µm long. The Sydney Basin specimens vary in size between only 13 µm and 35 µm and have fewer, shorter processes.

Specimens in the larger size range have also been illustrated by Foster (1975) from the Early Permian Blair Athol Coal Measures. Specimens from the smaller size range have been illustrated by Rigby & Hekel (1977) from the Late Permian Black Alley Shale and Bandanna Formation of central Queensland. From the few scattered reports of these two forms it appears that the smaller forms, i.e. *M.* sp. cf. *M. fibratum*, may be restricted to the Late Permian. More information on the range of these two forms, particularly in the Early Permian, is needed before any division into separate species would be warranted. Further study of other Permian sequences may also reveal a possible relationship between the environment of deposition and the distribution of these two forms. At the present time the first local occurrence of *M.* sp. cf. *M. fibratum* provides a useful biostratigraphic horizon for correlating between bores in the northern Sydney Basin.

Occurrence: This species was originally described from the Early Permian Poole Sandstone or lowermost Noonkanbah Formation of the Canning Basin, Western Australia by Segroves (1967). It has been illustrated subsequently from the Springsure Anticline, Bowen Basin, central Queensland by Rigby & Hekel (1977) where it occurs probably only in the Late Permian. In their treatment of acritarchs Rigby & Hekel (1977) only distinguished between spinose and non-spinose acritarchs and made no attempts at specific identification. Of their five illustrations of specimens that can be assigned to *M.* sp. cf. *M. fibratum*, all occur in the Late Permian. *M. fibratum* was also recorded from the Early Permian Blair Athol Coal Measures (Foster 1975) and from the Late Permian Baralaba Coal Measures (Foster 1979).

In the Singleton Super-Group *M.* sp. cf. *M. fibratum* first occurs midway in the sequence between the Bayswater Coal and the Denman Formation, probably in the lower Malabar Formation. In the western Illawarra Coal Measures it first occurs between the Irondale Coal and the western equivalent of the Denman Formation. The species is not present in the type section of the Singleton Super-Group at DM Doyles Creek DDH 11 but is present in the nearby bores DM Doyles Creek DDH 10 and DM Warkworth DDH 1.

Genus MICRHYSTRIDIUM Deflandre 1937
emend. Lister 1970

Type species *Micrhystridium inconspicuum* (Deflandre) Deflandre 1937

MICRHYSTRIDIUM KARAMURZAE Sarjeant 1970
(Pl. 1, figs 1, 5, 6, pl. 2, figs 1, 2)

1970 *Micrhystridium karamurzae* Sarjeant, p. 282-283, text fig. 2, 3h, pl. 1, fig. 17, pl. 2, fig. 6.

Description: This species has a single layered, sub-spherical to polygonal vesicle. It has between 15 and 30 hollow processes that are in full communication with the vesicle interior. The processes vary in length between 2 µm and 8 µm and display a wide variation in shape between specimens. Their shape varies from low triangular projections with broad bases to spines that may be many times longer than their basal diameter. The surface of the vesicle and the processes is smooth. Most specimens display an irregular slit-like excystment aperture.

Dimensions: Vesicle diameter 11(20)24 µm. Twenty-five specimens were measured.

Discussion: The specimens of *M. karamurzae* from the northern Sydney Basin compare closely with the original diagnosis of Sarjeant (1970). The only significant difference is the presence of wider process bases in the Sydney Basin specimens. *M. karamurzae* is most similar to the early Palaeozoic species *Micrhystridium nanum* (Deflandre) Deflandre & Deflandre 1965 and *Micrhystridium stellatum* Deflandre 1945. These two species, which represent end members of a size distribution (Lister 1970), always have a relatively greater process length (i.e. always greater than one third vesicle diameter), than *M. karamurzae* (i.e. usually less than one third vesicle diameter).

Micrhystridium breve Jansonius 1962 has a similar size and shape but a greater number of processes (30-50). *Micrhystridium inconspicuum* (Deflandre) Deflandre 1937 has finer processes and is consistently smaller than *M. karamurzae*.

Occurrence: *Micrhystridium karamurzae* is present throughout the Late Permian Maitland Group and Denman Formation of the northern Sydney Basin. Foster (1979) has also recorded it from the Late Permian of Queensland. It was originally described by Sarjeant (1970) from the Late Permian Chhidru Formation of Pakistan.

MICRHYSTRIDIUM sp. cf. M. INCONSPICUUM (Deflandre)
(Pl. 1, fig. 2)

Description: The vesicle is spheroidal to ellipsoidal in shape, single layered and supports between 40 and 80, probably hollow, thin processes that are between 4 µm and 8 µm long. Many processes show slightly expanded bases. Slit-like excystment apertures were observed on many specimens.

Dimensions: Vesicle diameter 6(8)12 µm. Ten specimens were measured.

Discussion: *Micrhystridium* sp. cf. *M. inconspicuum* and *M. inconspicuum* are similar in vesicle size and shape and process size and shape. The present material, however, has a greater number of processes (40-80) than *M. inconspicuum* (15-40) as originally described.

Occurrence: In the northern Sydney Basin *M.* sp. cf. *M. inconspicuum* was found only in the Berry siltstone.

Genus ULANISPHAERIDIUM gen. nov.

Type species *Ulanisphaeridium berryense* sp. nov.

Diagnosis: Vesicle ellipsoidal to sub-spherical, two-layered. Periphragm supports a dense cover of fine, proximally connected, small processes. Pylome, small, circular.

Discussion: *Ulanisphaeridium* gen. nov. can be differentiated from most other approximately spheroidal genera with two wall layers and a circular pylome by the presence of proximal process connections. *Dasylapsis* Loeblich & Wicander 1976 is differentiated by its very fine processes which interlock to form a fibrous mat. *Nanocylopia* Loeblich & Wicander 1976 is differentiated by its greater size, the presence of an operculum and its very small processes.

Ulanisphaeridium is monotypic. However, the Early Tertiary species '*Baltisphaeridium nanum*' Cookson 1965 described from the Browns Creek Clay, Victoria, Australia, fits the generic diagnosis. '*Baltisphaeridium nanum*' Cookson, however, is a junior homonym preoccupied by *Micrhystridium nanum* (Deflandre), which had previously been assigned to *Baltisphaeridium* by Downie (1959). As this paper discusses only Permian forms no new name is introduced for the Tertiary species at this stage.

Derivation of name: The name is derived from the type location at Ulan, N.S.W.

ULANISPHAERIDIUM BERRYENSE sp. nov.
(Pl. 1, figs 7-9, pl. 2, figs 4, 6)

1970 *Micrhystridium* sp. Grebe; pl. 6, fig. 7, 10.
1973 *?Micrhystridium* sp. Helby; pl. 3, fig. 10.
1979 *Micrhystridium* sp. B. Foster; p. 110, pl. 40, figs 2, 3.

Description: The vesicle is small and spheroidal to ellipsoidal. The vesicle wall is composed of two closely appressed layers; a thick (2 µm) smooth endophragm and a very thin (<1 µm) periphragm. The periphragm supports a dense network of proximally connected short, solid and sometimes bulbous, fibrous processes. The low connecting ridges between the processes form a poorly defined reticulation that can be detected only by S.E.M. (Pl. 2, figs 4, 6). The processes vary in thickness and length (1-3 µm) and occasionally bifurcate. A small circular pylome (2-4 µm) is usually present around which the ornament is often reduced. Oxidation and carbonisation readily removes the thin periphragm.

Dimensions: Vesicle diameter 13(19)22 µm (12 specimens from type location).

Discussion: *Ulanisphaeridium berryense* sp. nov. resembles the Tertiary species '*Baltisphaeridium nanum*' Cookson. This species has a similar vesicle size (23 µm - 34 µm), shape and pylome but can be differentiated by its very large number of longer (5 µm - 13 µm) extremely fine, hair-like processes. *Axisphaeridium tomentum* Colbath 1979 can be differentiated from *U. berryense* by its significantly thinner wall (<0.5 µm) and hollow processes. *Gorgonisphaeridium evexispinosum* Wicander 1974 and *Histopalla capillosa* Playford 1981 have similar ornament but lack the circular pylome of *Ulanisphaeridium*.

Occurrence: *Ulanisphaeridium berryense* occurs throughout the upper Maitland Group, Singleton Super-Group, Berry Siltstone, Illawarra Coal Measures and lower Narrabeen Group; Middle to Late Permian.

Type Material: The holotype is located on slide MMMC 01620, Palynology No. 3553. Length 22 µm, width 20 µm, processes 2 µm long, pylome diameter 2 µm. The paratype is located on slide MMMC 01622, Palynology No. 3553. Length 22 µm, width 21 µm, processes 3 µm long, pylome diameter 2 µm. The type location is at 268m, DM Ulan DDH 6, northern Sydney Basin, Illawarra Coal Measures. The name *berryense* is derived from the Berry Siltstone, a unit in which this species is common.

ACKNOWLEDGEMENTS

I would particularly like to thank Dr. R.J. Helby for the time he has spent reviewing the manuscript. This article is published with the permission of the Secretary, New South Wales Department of Mineral Resources.

REFERENCES

Byrnes, J., Scheibnerova, V. & Stutchbury, R., 1981. Evidence for marine influence during deposition of some coal measures sediments (Wongawilli Coal Seam). *Prog. Abst. 15th Symp. "Advances in the study of the Sydney Basin"*, 12.

Downie, C., 1959. Hystrichospheres from the Silurian Wenlock Shale of England. *Palaeontology, 2*, 56-71.

Dulhunty, J.A., 1945. Principal microspores types in the Permian coals of New South Wales. *Proc. Linn. Soc. N.S.W., 70*(3-4), 147-157.

Dulhunty, J.A., 1946. Distribution of microspore types in the Permian coals of New South Wales. *Proc. Linn. Soc. N.S.W., 71*, 239-251.

Evans, P.R., 1964. A correlation of some deep wells in the northwestern Eromanga Basin, central Queensland. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1964/197 (unpubl.).

Evans, P.R., 1966a. Palynological studies in the Longreach, Jericho, Galilee, Tambo, Eddystone and Taroom 1:250,000 sheet areas, Queensland. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1966/61 (unpubl.).

Evans, P.R., 1966b. Contribution to the palynology of the Permian and Triassic of the Bowen Basin. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1966/134 (unpubl.).

Evans, P.R., 1966c. Palynological comparisons in the Cooper and Galilee Basins. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1966/222 (unpubl.).

Evans, P.R., 1967a. Upper Carboniferous and Permian palynological stages and their distribution in eastern Australia. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1967/99, (unpubl.).

Evans, P.R., 1967b. Review of the Permian palynology of the Sydney Basin, New South Wales. *Rec. Bur. Miner. Resour. Geol. Geophys. Aust.* 1967/103 (unpubl.).

Evans, P.R., 1969. Upper Carboniferous and Permian palynological stages and their distribution in eastern Australia. *in* Gondwana Stratigraphy, IUGS. *1st Gondwana Symp., Buenos Aires, 1967*, 41-53.

Foster, C.B., 1975. Permian plant microfossils from the Blair Athol Coal Measures, Central Queensland, Australia. *Palaeontographica B, 154* (5-6), 121-171.

Foster, C.B., 1979. Permian plant microfossils of the Blair Athol Coal Measures, Baralaba Coal Measures, and basal Rewan Formation of Queensland. *Publs. Geol. Surv. Qd., 372, Palaeont. Pap. 45*, 1-244.

Grebe, H., 1970. Permian plant microfossils from the Newcastle Coal Measures/Narrabeen Group boundary, Lake Munmorah, New South Wales. *Rec. Geol. Surv. N.S.W., 12*(2), 125-136.

Helby, R., 1973. Review of Late Permian and Triassic palynology of New South Wales. *Spec. Publs. Geol. Soc. Aust., 4*, 141-155.

Herbert, C., 1980. Depositional development of the Sydney Basin, *in* Herbert, C., and Helby, R., A Guide to the Sydney Basin. *Bull. Geol. Surv. N.S.W., 26*, 11-52.

Kemp, E.M., Balme, B.E., Helby, R.J., Kyle, R.A., Playford, G. & Price, P.L., 1977. Carboniferous and Permian palynostratigraphy in Australia and Antarctica: a review. *BMR J. Aust. Geol. Geophys., 2*, 177-208.

Lister, T.R., 1970. The acritarchs and chitinozoa from the Wenlock and Ludlow Series of the Ludlow and Millichope areas, Shropshire. *Palaeontogr. Soc. Monogr., 1*, 1-100.

Paten, R.J., 1969. Palynologic contributions to petroleum exploration in the Permian formations of the Cooper Basin, Australia. *APEA J., 9*, 79-87.

Price, P.L., 1976. Permian palynology of the Bowen Basin. *in* Jensen, A.R., Exon, N.F., Anderson, J.C. & Koppe, W.H. (eds.), A guide to the geology of the Bowen and Surat Basins in Queensland. *Excursion Guide 3c, 25th Internat. Geol. Cong.*

Rigby, J.F. & Hekel, H., 1977. Palynology of the Permian sequence in the Springsure Anticline, central Queensland. *Publs. Geol. Surv. Qd., 363, Palaeont. Pap. 37*, 1-76.

Sarjeant, W.A.S., 1970. Acritarchs and tasmanitids from the Chhidru Formation, uppermost Permian of West Pakistan *in* Kummel, B. & Teichert, C., eds. Stratigraphic boundary problems: Permian and Triassic of West Pakistan. *Spec. Publ. Geol. Dept., Univ. Kansas, 4*, 221-253.

Segroves, K.L., 1967. Cutinized microfossils of probable nonvascular origin from the Permian of Western Australia. *Micropaleontology, 13*(3), 289-305.

Andrew McMinn
Geological Survey of New South Wales
Geological and Mining Museum
36 George Street
SYDNEY. N.S.W. 2000

(Manuscript first received 2.2.81)

(Manuscript received in final form 14.10.82)

EXPLANATION OF PLATE 1

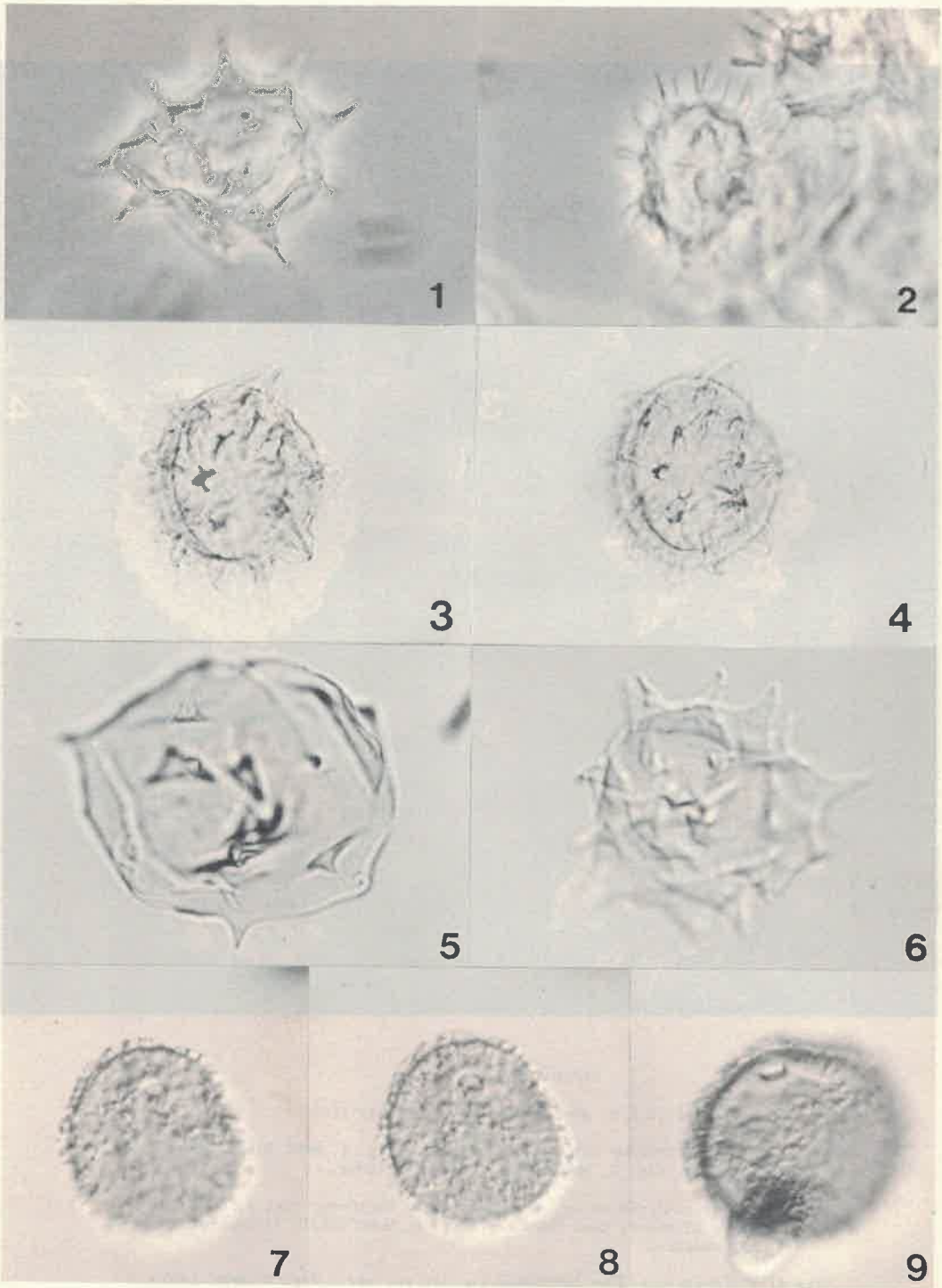
All photographs approximately X1200

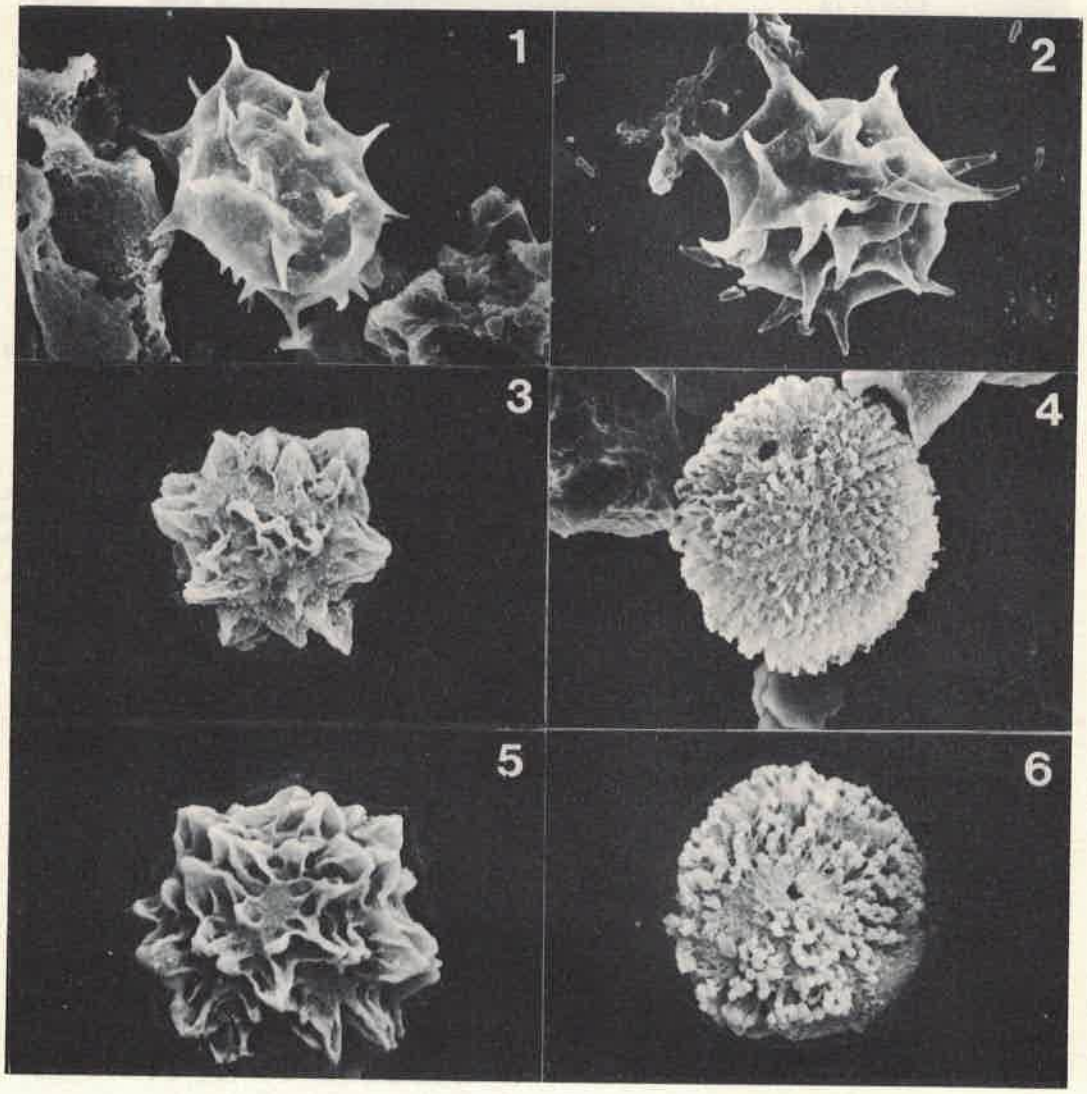
Figs 1, 5, 6 *Micrhystridium karamurzae* Sarjeant; fig. 1 MMMC 01614, Berry Siltstone, phase contrast; fig. 5. MMMC 01681, Denman Formation, showing pylome; fig. 6 MMMC 01619, Berry Siltstone, interference contrast.

Fig. 2 *Micrhystridium* sp. cf. *M. inconspicuum* (Deflandre), MMMC 01615, Berry Siltstone, phase contrast.

Figs 3, 4 *Mehlisphaeridium* sp. cf. *M. fibratum* Segroves; fig 3, 4, MMMC 01616, Illawarra Coal Measures.

Figs 7, 8, 9 *Ulanisphaeridium berryense* gen. et sp. nov.; figs 7, 8, Holotype, MMMC 01620, Illawarra Coal Measures, interference contrast; fig. 9, Paratype, MMMC 01622 Illawarra Coal Measures, interference contrast.


1
2
3
4
5
6
7
8
9



EXPLANATION OF PLATE 2

All S.E.M. photographs approximately X1200

Figs 1, 2 *Micrhystridium karamurzae;* Sarjeant; fig. 1, MMMC 01623 Berry Siltstone, fig. 2, MMMC 01624, Berry Siltstone.

Figs 3, 5 *Mehlisphaeridium* sp. cf. *M. fibratum* Segroves; fig. 3, MMMC 01625, Illawarra Coal Measures, fig. 5, MMMC 01627, Illawarra Coal Measures.

Figs 4, 6 *Ulanisphaeridium berryense* gen. et sp. nov.; fig. 4, MMMC 10626, Illawarra Coal Measures; fig. 6, MMMC 10628, Illawarra Coal Measures.