ABSTRACT

Cutinized microfossils which lack haptotypic features are described from the Permian of Western Australia. It is suggested that these forms be classified as acritarchs, and the new acritarch Subgroup Schizomorphitae is introduced to accommodate forms which tend to rupture equatorially. Four new genera, Haplocystia, Mehlisphaeridium, Pyramidosporites *and* Spongocystia, *and eight new species are instituted.*

Cutinized microfossils of probable nonvascular origin from the Permian of Western Australia

KENNETH L. SEGROVES
Department of Geology
University of Western Australia
Nedlands, Western Australia

INTRODUCTION

Permian sediments in Western Australia often contain rich and well-preserved microfloras, the gross characters of which have been briefly discussed by Balme (1964). More detailed palynological studies of these Permian sediments are now proceeding, and these show that the assemblages sometimes contain large numbers of cutinized microfossils which lack the typical morphographic features of the spores or pollen grains of vascular plants. The purpose of this paper is to describe, from the Permian of the Perth and Canning Basins of Western Australia, certain of those forms lacking haptotypic features, and to consider the most appropriate systematic approach to adopt towards them.

Although these forms are usually present in only small numbers, they are collectively, in some samples, important components of the assemblages. It seems reasonable to suspect that this is a reflection of depositional environment and that their occurrence may have paleoecological significance. Although these microfossils are present in both marine and nonmarine sediments, they are more common in the latter with high concentrations in coals and coal measure sediments.

Microfossils with a general morphology similar to that of some described in this paper occur in sediments of all periods of the geologic column from the Cambrian onwards and have been subjected to a variety of systematic treatments. To consider some of the more recent papers, Balme and Hennelly (1956) described *Pilasporites* Balme and Hennelly and a form resembling *Tetraporina* Naumova as alete sporomorphs, but declined to place them in any system of classification. *Retialetes* Staplin and *Radialetes* Playford are classified under Turma Aletes Ibrahim by Playford (1963). In describing *Schizocystia*, Cookson and Eisenack (1962) stated that the microfossil is of unknown nature and affinity, and left open the question of its taxonomic position.

A satisfactory solution to the problem of the taxonomic treatment of cutinized microfossils which lack haptotypic features and bear no evidence of angiosperm affinities lies in the classification of the acritarchs proposed by Downie, Evitt and Sarjeant (1963). These authors did in fact incorporate *Concentricystes* Rossignol, *Lecaniella* Cookson and Eisenack, and *Schizocystia* Cookson and Eisenack under their "Subgroup Uncertain". Furthermore, Norris (1965) assigned *Circulisporites* de Jersey emend. Norris to the acritarch subgroup Sphaeromorphitae. It appears that most of the forms under consideration may quite appropriately be placed in the Acritarcha.

In the Permian sediments of the Perth and Canning Basins, Western Australia, a number of the cutinized microfossils are characterized by an equatorial line of weakness along which rupture often occurs. Rupture is frequently complete, with the result that detached symmetrical halves are produced. To accommodate those microfossils with a tendency to complete equatorial rupture, the new subgroup Schizomorphitae is introduced.

The occurrence of the microfossils is briefly discussed, but detailed investigation of their stratigraphic distribution is still going on and will be dealt with in a subsequent account.

SOURCE OF SAMPLES

Numbers indicating the sample from which each type and illustrated specimen came are given in the list of illustrations. Sample numbers used below refer to the general collections of the Department of Geology, University of Western Australia. Details of these samples are as follows:

Sample No. 44088
Lithology: Carbonaceous shale.
Stratigraphic information: Poole Sandstone, Lower Permian, lower Artinskian.
Source: Frome Rocks Bore No. 2 (West Australian Petroleum Pty., Ltd.) at 1500–1510 feet.
Locality: 18° 15′ 15″ S., 123° 39′ 35″ E., Canning Basin, Western Australia.

Sample No. 55645
Lithology: Silty sandstone.
Stratigraphic information: Poole Sandstone or lowermost part of Noonkanbah Formation, Lower Permian, Artinskian.
Source: Dampier Downs Stratigraphic Bore No. 1 (West Australian Petroleum Pty., Ltd.) at 1080–1090 feet.
Locality: 18° 18′ 0″ S., 123° 6′ 0″ E., Canning Basin, Western Australia.

Sample No. 55644
Lithology: Grey sandstone.
Stratigraphic information: Holmwood Shale, Lower Permian, upper Sakmarian.
Source: Abbarwardoo Bore No. 1 (West Australian Petroleum Pty., Ltd.) at 1040–1050 feet.
Locality: 28° 35′ 10″ S., 115° 9′ 35″ E., Indarra district, Perth Basin, Western Australia.

Sample No. 43315
Lithology: Grey siltstone.
Stratigraphic information: Lower Permian, Artinskian.
Source: Kockatea Creek Bore No. 21 at 46–66 feet.
Locality: 28° 32′ 31″ S., 115° 12′ 3″ E., Indarra district, Perth Basin, Western Australia.

Sample No. 11948
Lithology: Coal.
Stratigraphic information: Wagina Sandstone, Upper Permian.
Source: Greenough River Bore, depth unknown.
Locality: Near Eradu, northern Perth Basin, Western Australia. The precise locality is unknown.

Sample No. 43290
Lithology: Grey siltstone.
Stratigraphic information: Wagina Sandstone, Upper Permian.
Source: Public Works Department Bore X49 at 367–373 feet.
Locality: 28° 41′ 9″ S., 114° 59′ 38″ E., Wicherina district, Perth Basin, Western Australia.

Sample No. 55642
Lithology: Coal.
Stratigraphic information: Wagina Sandstone, Upper Permian.
Source: Eradu Shaft at 144 feet.
Locality: 28° 41′ 44″ S., 115° 2′ 4″ E., Eradu district, Perth Basin, Western Australia.

Sample No. 43283
Lithology: Coal.
Stratigraphic information: Wagina Sandstone, Upper Permian.
Source: Eradu Coal Bore No. 5 at 135–157 feet.
Locality: 28° 41′ 34″ S., 115° 2′ 0″ E., Eradu district, Perth Basin, Western Australia.

Sample No. 55641
Lithology: Grey siltstone.
Stratigraphic information: Fossil Cliff Formation, Lower Permian, upper Sakmarian or lower Artinskian.
Source: University of Western Australia Bore No. 5 at 48–49 feet.
Locality: 28° 41′ 34″ S., 115° 2′ 0″ E., Irwin River district, Perth Basin, Western Australia.

Sample No. 49741
Sample No. 55643
Lithology: Inferior canneloid coal.
Stratigraphic information: Wagina Sandstone, Upper Permian.
Source: University of Western Australia Bore No. 4 at 91–95 feet and at 97 feet, respectively.
Locality: 29° 10′ 36″ S., 115° 40′ 24″ E., Woolaga Creek, Irwin River district, Perth Basin, Western Australia.

PREPARATION OF SAMPLES

Clastic sediments were first treated with hydrofluoric acid to remove the silicates. Acid insoluble microfossils were then concentrated with the addition of Schulze solution followed by an alkali. The maceration procedure is outlined in detail by Balme and Hassell (1962). Coals were oxidized with sodium hypochlorite followed by sodium hydroxide.

STORAGE OF SPECIMENS

All types and illustrated specimens were stained with safranin O in the course of their preparation and are preserved as single mounts in glycerine jelly sealed with beeswax and clear varnish. The slides have been placed in the collections of the Department of Geology, University of Western Australia. The numbers used in the text refer to the catalogue of specimens in that repository.

ACKNOWLEDGMENTS

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SYSTEMATIC DESCRIPTIONS

Division CHLOROPHYTA
Class CHLOROPHYCEAE
Family BOTRYOCOCCACEAE
Genus BOTRYOCOCCUS Kützing, 1849

Botryococcus sp.
Plate 3, figure 20

Illustrated specimen: U. W. A. 55606.

Remarks: Botryococcus, a cosmopolitan colonial alga present in both salt and fresh water, has received attention from a number of paleobotanists. The best known accounts are those of Blackburn (1936), who considered the chemical constituents of the alga, and Temperley

(1936), who dealt with its structure. *Botryococcus* is most abundant in boghead coal but is known to occur also in a wide range of other sediments. An alga believed identical with the living *B. braunii* has existed since Ordovician times (Harris, 1938, p. 13). *Botryococcus* sp. is a common form in Upper Permian sediments of the Perth Basin and is also often abundant in the late Sakmarian part of the Grant Formation in the Canning Basin (Balme, unpublished data).

INCERTAE SEDIS

Genus Spheripollenites Couper, 1958; emend. Jansonius, 1962

Generic characters: Body circular to oval in outline, with or without an indistinct rupture. Wall sculptured or structured, and tending to possess an irregular partial rupture in the absence of any well-defined equatorial line of weakness.

Type species: Spheripollenites scabratus Couper, 1958 (p. 158, pl. 31, figs. 12–14) by original designation.

Distribution: Forms with the broad morphology of *Spheripollenites* occur from the Ordovician onward and have been reported from various parts of the world, including Canada, Great Britain and Australia.

Remarks: Schizosporis Cookson and Dettmann differs from *Spheripollenites* in its possession of a visible straight equatorial line of weakness along which complete or nearly complete rupture occurs. In the original diagnosis Couper (1958) considered *Spheripollenites* to be probably a monoporate pollen grain. The Western Australian specimens under consideration appear very similar to Couper's illustrations and hence are tentatively assigned to that genus. They do not, however, show any trace of pores and may not be the spores or pollen of vascular plants.

Spheripollenites sp. cf. S. psilatus Couper
Plate 1, figure 7

cf. *Spheripollenites psilatus* COUPER, 1958, p. 159, pl. 31, figs. 4–8.

Description: Body circular to oval in outline. Wall often ruptured along a somewhat uneven line. Wall about 1μ thick, psilate or punctate, frequently with secondary pitting, and usually folded.

Dimensions: Twenty specimens, longitudinal axis 25–75μ (mean 38μ), transverse axis 20–60μ (mean 33μ).

Illustrated specimen: U. W. A. 55610.

Occurrence: Forms resembling *Spheripollenites psilatus* are widely distributed and have been reported from Western Canada, Great Britain, Antarctica, Hungary, Western Australia, South Australia and Victoria. However, the species seems useful only as a broad form category and is unlikely to have any precise stratigraphic value.

Genus Quadrisporites Hennelly, 1958; emend. Potonié and Lele, 1961

Generic characters: Square or rhomboidal obligate tetrad. Individual spores apparently alete, and sculptured with grana, pila or bacula.

Type species: Quadrisporites horridus Hennelly, 1958 (p. 364, pl. 5, figs. 6–7) by original designation.

Distribution: Lower Permian of the Talchir Beds, South Rewa, India, and of the former Belgian Congo. Upper Sakmarian of Western Australia. Upper Permian Middle *Productus* Limestone, Warcha, West Pakistan. Uppermost Permian – basal Triassic, New South Wales.

Quadrisporites sp. cf. Q. horridus Hennelly
Plate 1, figure 8

cf. *Quadrisporites horridus* HENNELLY, 1958, p. 364, pl. 5, figs. 6–7. – POTONIÉ and LELE, 1961, p. 26, pl. 1, figs. 26–36.

Description: Obligate tetrad having rhomboidal or square arrangement. Spores lacking any apparent germinal aperture. Wall less than 1μ thick. Distal face of spores punctate and bearing bacula and spines 3–9μ long, 1.5–3μ in basal diameter, and 1–2μ apart.

Dimensions: Five specimens, tetrad diameter 53–65μ (mean 58μ), equatorial diameter of members 28–35μ (mean 31μ).

Illustrated specimen: U. W. A. 55597.

Occurrence: Lower Permian of the Talchir Beds, South Rewa, India, and of the Congo. Upper Sakmarian of Western Australia. Uppermost Permian – basal Triassic, New South Wales.

Remarks: Although this form may be accommodated in *Quadrisporites horridus*, a possible distinction lies in its abundance of spines. It is rare in the sediments examined, and only five specimens have been found.

Genus Pyramidosporites Segroves, new genus

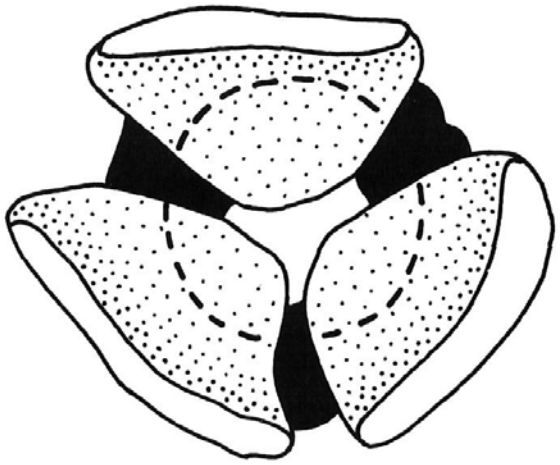
Diagnosis: Obligate tetrahedral tetrad. No clear evidence of a germinal mechanism. Each member of tetrad unsculptured and bound to each of the other three by a prominent, heavy thickening.

Type species: Pyramidosporites cyathodes Segroves, n. sp.

Distribution: Upper Permian of Western Australia.

Derivation of name: Greek πυραμίς – pyramid, plus σπορά – spore, referring to the tetrahedral arrangement of the spores.

Remarks: Quadrisporites Hennelly differs from *Pyramidosporites* in its lack of interspore thickenings, in its rhomboidal or square tetrad arrangement, and in its possession of grana, pila or bacula. *Tetradites* Cookson (1947) bears spines on the distal face. Spore 6 of Virkki (1946) may resemble *Pyramidosporites*, but the degree of similar-



TEXT-FIGURE 1

Pyramidosporites cyathodes Segroves, n. gen., n. sp. Diagrammatic reconstruction of tetrad as seen in equatorial view, *ca.* × 680.

ity is difficult to determine because her description indicates that the tetrad seems to be composed of "four large and four small lobes". In *Ricciisporites* Lundblad (1954), a distal sulcus is present and the exine is clavate.

Pyramidosporites cyathodes Segroves, new specie
Plate 1, figures 13–15; text-figure 1

Diagnosis: Obligate tetrahedral tetrad. No clear evidence of a germinal mechanism. Members of tetrad linked to each other by means of a prominent heavy thickening. Spores originally spheroidal, but their distal faces now usually invaginated. Exine 2–4μ thick, sometimes punctate, often with secondary pitting, and bearing many folds.

Types: Holotype, U. W. A. 55598. Paratypes, U. W. A. 55599 and 55600.

Type locality: University of Western Australia Bore No. 4, 93 feet, Woolaga Creek, Perth Basin, Western Australia. Upper Permian, Wagina Sandstone.

Derivation of name: Greek κυαθωδης – like a cup, in reference to the invaginated distal face of the spore.

Description: Obligate tetrahedral tetrad. No clear evidence of a germinal mechanism. Members of tetrad bound to each other by means of a heavy thickening. Spores 15–22μ apart where united by thickenings. In equatorial view, thickenings wedge-shaped with fullest development displayed by side most distant from the tetrad center. Thickenings subcircular to elongate oval in polar view, with diameter at points of attachment 30–40μ, while interspore diameter often somewhat less due to slight constriction. Spores of tetrad usually invaginated, resulting in concave distal faces. Exine 2–4μ thick, sometimes punctate, often with secondary pitting, and bearing many folds.

Holotype tetrad diameter 95μ, spores invaginated; exine punctate and with secondary pitting.

Paratype U. W. A. 55600, tetrad diameter 85μ; spores invaginated; exine punctate and with secondary pitting. Paratype U. W. A. 55599, tetrad diameter 83μ; spores invaginated.

Dimensions: Twenty specimens, tetrad diameter 74–105μ (mean 88μ), equatorial diameter of members 45–65μ (mean 52μ).

Group Acritarcha Evitt, 1963

Subgroup Schizomorphitae Segroves, new subgroup

Diagnosis: Acritarchs having a spherical, ellipsoidal, discoidal, elongate or polygonal body which possesses an equatorial line of weakness along which complete or incomplete rupture tends to occur. Rupture, when complete, produces two symmetrical halves.

Genus Schizosporis Cookson and Dettmann, 1959

Generic characters: Microfossil circular to oval in outline, with an equatorial line of weakness along which the body tends to split into two symmetrical halves. Body may be variously sculptured.

Type species: Schizosporis reticulatus Cookson and Dettmann, 1959 (p. 213, pl. 1, figs. 1–4) by original designation.

Distribution: Schizosporis has been reported from Permian to Cretaceous sediments from South Africa, Tanganyika, Western Australia, South Australia and western Canada.

Remarks: A discussion comparing *Schizosporis* with *Ovoidites* Potonié ex Krutzsch and other similar forms is given by Cookson and Dettmann (1959) and Dettmann (1963). *Peltacystia* Balme and Segroves is distinct in that each hemisphere is divided into a polar zone and an equatorial zone by a circumpolar ridge or ring of sculptural processes. *Lecaniella* Cookson and Eisenack is a saucer-shaped microfossil, the outer surface of which is variously sculptured. However, it may represent the detached halves of an originally subspheroidal body. If so, the distinction between it and *Schizosporis* is questionable.

Schizosporis scissus (Balme and Hennelly) Hart
Plate 1, figures 5–6

Laevigatosporites scissus Balme and Hennelly, 1956, p. 56, pl. 1, figs. 6–9.
Spheripollenites scissus (Balme and Hennelly). – Jansonius, 1962, p. 82, pl. 16, fig. 8.
Schizosporis scissus (Balme and Hennelly). – Hart, 1965, p. 14.

Description: Microfossil circular to oval in outline, with a visible equatorial line of weakness along which the body tends to split into two symmetrical halves. Rupture may be either partial or complete. Wall 0.5–2.5μ thick, psilate or punctate, and frequently with secondary pitting.

Dimensions: Twenty specimens, equatorial diameter 25–70μ (mean 42μ), polar diameter 20–60μ (mean 34μ).

Illustrated specimens: U. W. A. 55611, 55612.

Occurrence: Permian of Western Australia, New South Wales, Tanganyika, Canada, Antarctica (Balme and Playford, unpublished data).

Remarks: Schizosporis parvus Cookson and Dettmann is distinct in its possession of a two-layered wall. *Spheripollenites psilatus* Couper differs in the fact that rupture is typically less complete than with *S. scissus* and occurs along an uneven line in the absence of any well-defined equatorial line of dehiscence. *S. scissus* is a common Permian form. The specimens considered in the present study extend the size range of the species.

Schizosporis dejerseyi Segroves, new species
Plate 1, figures 9–12

Diagnosis: Microfossil spheroidal to subspheroidal and tending to split along an equatorial line of weakness. Wall 3–6μ thick and bearing sparsely spaced rugulae and verrucae which do not merge to form a reticulum.

Types: Holotype, U. W. A. 55613. Paratypes, U. W. A. 55614 and 55615.

Type locality: University of Western Australia Bore No. 4, 97 feet, Woolaga Creek, Perth Basin, Western Australia. Upper Permian.

Derivation of name: After Dr. N. J. de Jersey, palynologist of the Geological Survey of Queensland.

Occurrence: Late Artinskian – Upper Permian, Perth Basin, Western Australia.

Description: Microfossil spheroidal to subspheroidal and tending to split along a straight equatorial line of weakness into two symmetrical halves. Intact specimens more common than detached halves. Wall 3–6μ (mean 4μ) thick, psilate to punctate, and bearing faint to well-developed rugulae and verrucae 0.5–2μ high, 3–10μ long, and about 4–10μ apart. Narrow, elongate exinal folds located at margins of rugulae and verrucae. Folds somewhat radially disposed, 0.25–0.5μ wide, 1–4μ long, and straight to sinuous.

Holotype diameter 57μ; rugulae and verrucae well developed. Paratype U. W. A. 55614, diameter 60μ; rugulae and verrucae poorly developed. Paratype U. W. A. 55615, diameter 53μ.

Dimensions: Twenty-five specimens, equatorial diameter 41–66μ (mean 54μ).

Remarks: Schizosporis rugulatus Cookson and Dettmann differs from *S. dejerseyi* in its larger size and finer ridges that may merge to form a reticulum. *S. dejerseyi* is an abundant form in certain samples from University of Western Australia Bore No. 4.

Genus Peltacystia Balme and Segroves, 1966

Generic characters: Microfossils spheroidal or oblate spheroidal and splitting along an equatorial line of weakness into two symmetrical halves. Each hemisphere divided into a polar zone and an equatorial zone by a circumpolar ridge or ring of sculptural processes. Additional circumpolar ridges or rings of processes may be present in the polar zones, and the remainder of the body wall may be laevigate or variously sculptured.

Type species: Peltacystia venosa Balme and Segroves, 1966, (p. 27, text-figs. 1a–b, 2a–f, 3f–k) by original designation.

Distribution: Late Artinskian and Upper Permian of Western Australia.

Remarks: In *Peltacystia* rupture is normally complete, and detached halves are much more common than intact specimens. Members of the genus are most abundant in coals and in clastic sediments associated with coals. On the basis of morphology, *Peltacystia* bears a resemblance to certain unicellular members of the Chlorococcales.

Peltacystia venosa Balme and Segroves
Plate 3, figures 1–2

Peltacystia venosa Balme and Segroves, 1966, p. 27, text-figs. 1a–b, 2a–f, 3f–k.

Description: Body subspheroidal, wall 1–2μ thick. Each hemisphere divided into a polar zone and an equatorial zone by a circumpolar ridge bearing processes. Additional circumpolar ridges may be present in the polar zone, which bears a complex reticulum. Equatorial zone characterized by muri extending from circumpolar ridge to line of equatorial rupture.

Dimensions: Twenty specimens, equatorial diameter 35–65μ (mean 45μ).

Illustrated specimens: U. W. A. 53992, 54005.

Occurrence: Upper Permian of Perth, Canning, and Collie-Muja Basins, Western Australia.

Remarks: Peltacystia venosa is the most common and widely distributed species of the genus. It may be distinguished from other species of *Peltacystia* by the reticulate sculpture of its polar zones.

Peltacystia monile Balme and Segroves
Plate 1, figures 3–4

Peltacystia monile Balme and Segroves, 1966, p. 28, text-figs. 3a–e, 4b.

Description: Body oblate spheroidal; wall about 1μ thick. Each hemisphere bearing a circumpolar ring of small verrucate or papillate processes lying about half way between the pole and equator. Bases of processes joined in some specimens to form a continuous subcristate ridge. Scattered processes sometimes present in polar zone. Remainder of surface laevigate or faintly punctate.

Dimensions: Twenty specimens, equatorial diameter 28–40μ (mean 33μ).

Illustrated specimens: U. W. A. 53996, 53997.

Occurrence: Upper Permian of Perth, Canning and Collie-Muja Basins, Western Australia.

Remarks: Peltacystia monile is smaller than *P. venosa* and lacks reticulate sculpture.

Peltacystia calvitium Balme and Segroves
Plate 1, figures 1–2

Peltacystia calvitium BALME and SEGROVES, 1966, p. 30, text-figs. 3l–o, 4a.

Description: Body oblate spheroidal. Wall 2–4μ thick, slightly thicker in the polar than in the equatorial zones. Each hemisphere bearing a circumpolar ridge 2–5μ high encircling the body about half way between the pole and equator. Top of ridge weakly undulate. Polar zones laevigate or faintly punctate. Equatorial zone bearing poorly defined striae extending from circumpolar ridge to line of equatorial rupture.

Dimensions: Twenty specimens, equatorial diameter 44–59μ (mean 50μ).

Illustrated specimen: U. W. A. 54002.

Occurrence: Upper Permian of Perth, Canning and Collie-Muja Basins, Western Australia.

Remarks: Unlike the previous two species, in *Peltacystia calvitium* intact specimens outnumber ruptured ones. *P. calvitium* differs from *P. venosa* in its well-defined circumpolar ridge which lacks heavy additional processes and in the absence of sculpture in the polar zone. *P. monile* is smaller and lacks the pronounced circumpolar ridge.

Peltacystia galeoides Segroves, new species
Plate 3, figures 3–5

Diagnosis: Microfossil helmet-shaped; wall 0.5–2μ thick. Body bearing circumpolar ridge lying somewhat nearer to the equator than to the pole. Ridge usually very thin, inconspicuous, and unevenly developed. Wall psilate to punctate, frequently folded and usually pitted.

Types: Holotype, U. W. A. 55607. Paratype, U. W. A. 55608.

Type locality: Eradu Coal Bore No. 5, 135–157 feet, Perth Basin, Western Australia, Upper Permian.

Derivation of name: Latin *galeoides* – like a helmet.

Occurrence: Late Artinskian – Upper Permian, Perth Basin, Western Australia.

Description: Microfossil helmet-shaped; wall 0.5–2μ thick. Body bearing circumpolar ridge lying somewhat nearer to the equator than to the pole. Thin, inconspicuous ridge 0.5–2μ high and unevenly developed. Ridge may be located on either convex of concave face of body. Wall often slightly thicker in the equatorial than in the polar zones. Wall psilate or punctate, frequently folded, and usually bearing evenly disposed pits 0.25–1μ in diameter, which are probably secondary. Specimens may be the detached halves of once spheroidal or oblate spheroidal bodies which possessed an equatorial line of weakness along which rupture occurred.

Holotype equatorial diameter 40μ; ridge 0.5–1.5μ high; wall pitted. Illustrated specimen U. W. A 55609, equatorial diameter 45μ; ridge 0.5–2μ high; wall pitted. Paratype U. W. A. 55608, equatorial diameter 40μ; ridge 0.5–1.5μ high; wall pitted.

Dimensions: Thirty specimens, equatorial diameter 34–70μ (mean 43μ).

Remarks: Peltacystia venosa differs from *P. galeoides* in possessing a network of muri and a circumpolar ridge bearing processes. *P. monile* is distinct in its smaller size, and the presence of either a continuous subcristate ridge or a ring of small processes. In *P. calvitium*, the equatorial zone bears weakly defined, dichotomizing striae. *P. galeoides* is a common form in Upper Permian sediments of the Perth Basin.

Genus Circulisporites de Jersey, 1962; emend. Norris, 1965

Generic characters: Microfossil spheroidal to discoidal. Wall bearing circular striae extending in spiral arrangement from pole of spore to equator. Microfossil frequently splits along equator, yielding two symmetrical halves.

Type species: Circulisporites parvus de Jersey, 1962 (p. 15, pl. 5, figs. 13–15) by original designation.

Distribution: Upper Permian of Western Australia. Middle – Upper Triassic of Queensland. Upper Triassic of Antarctica.

Remarks: Chomotriletes Naumova, an Upper Devonian form from Russia, is said to be trilete and bears striae that are incomplete. *Concentricystes* Rossignol, a Pleistocene microfossil from Israel, is distinct in having three small equatorial orifices which are slightly elongate and surrounded by an aureole. Although they were not named, microfossils possessing the generic characters of *Circulisporites* were described from Permian coals of Queensland by de Jersey (1946), and from Queensland Triassic coals (de Jersey, 1949). Microfossil "P25A", described from the Permian of the Collie-Muja Basin, Western Australia, by Balme (1952) is also assignable to this genus. In the material under study, the rupture in *Circulisporites* is usually complete, and detached halves are more common than intact specimens. Although never abundant, *Circulisporites* is persistent in its occurrence in the Perth Basin and has been found only in Upper Permian sediments.

Circulisporites parvus de Jersey, emend. Norris
Plate 2, figure 7

Circulisporites parvus DE JERSEY, 1962, p. 15, pl. 5, figs. 13–15.
Circulisporites parvus de Jersey, emend. NORRIS, 1965, p. 262, text-figs. 71, 73–75.

Description: Microfossil discoidal, circular to subcircular in polar view. Wall bearing circular striae extending in spiral arrangement from pole of spore to equator. Striae consisting of alternating ridges and furrows. Ridges 0.5–1.5μ wide; furrows 0.3–0.6μ wide. Radius of body consisting of 7–10 ridges. Wall 0.5–1.5μ thick. Microfossils frequently split along equator, yielding two symmetrical halves.

Dimensions: Twenty specimens, equatorial diameter 14–27μ (mean 18μ).

Illustrated specimen: U. W. A. 55626.

Occurrence: Permian of Collie-Muja Basin, Western Australia. Upper Permian of Perth Basin, Western Australia. Middle – Upper Triassic of Ipswich Coalfield, Queensland. Upper Triassic of Antarctica.

Remarks: No equatorial orifices have been observed in *Circulisporites parvus*. However, the specimens are small, and interpretation of fine detail is difficult. If future work reveals the presence of such features in the type specimens, a recombination will be in order, as *Concentricystes* Rossignol (1962) has priority.

Subgroup ACANTHOMORPHITAE Downie, Evitt, and Sarjeant, 1963

Genus **Mehlisphaeridium** Segroves, **new genus**

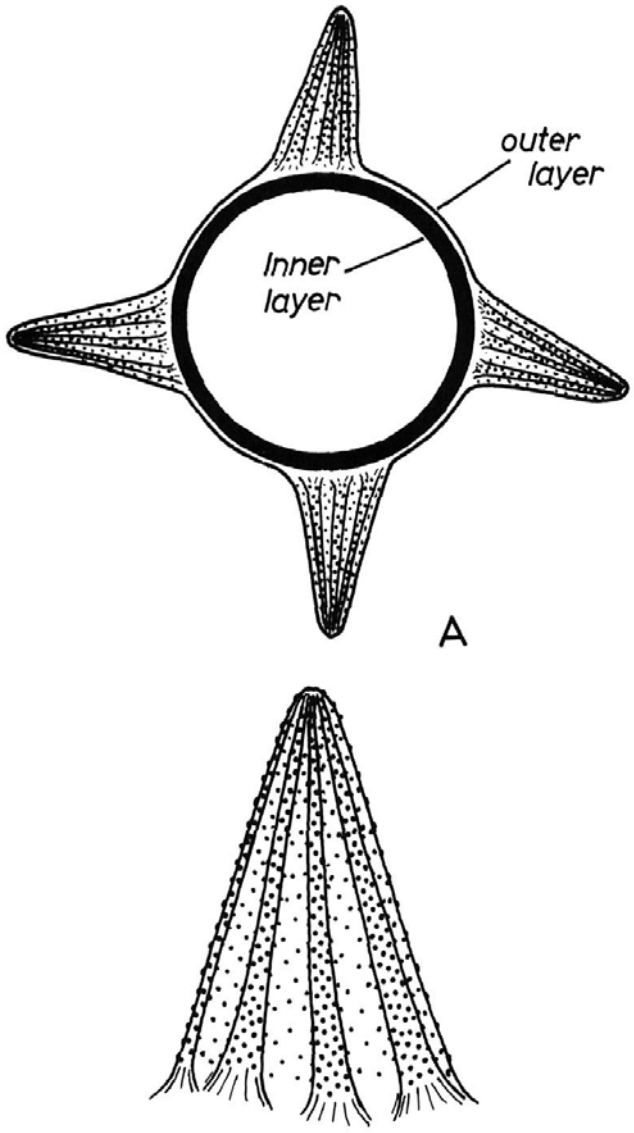
Diagnosis: Microfossil without any apparent dehiscence mechanism; body spheroidal; wall two-layered. Body bearing small to large, coarse, conical processes, which are hollow and are formed by the outer layer of the wall. Surface of processes differentially thickened to form fibers, which are confined to and traverse the length of the processes.

Type species: Mehlisphaeridium fibratum, Segroves, n. sp.

Distribution: Artinskian – ?Kungurian, Western Australia.

Derivation of name: After the late Dr. Maurice Mehl, paleontologist at the University of Missouri, plus Latin *sphaera* – sphere.

Remarks: Mehlisphaeridium is distinct from *Baltisphaeridium* Eisenack, emend. Downie and Sarjeant, in its possession of a wall of two layers, which are in contact. Forms superficially similar to *Mehlisphaeridium*, but apparently distinct in possessing an inner body and in lacking a two-layered wall, were described from the Lower Paleozoic of northwest Spain and tentatively assigned to *Baltisphaeridium* by Cramer (1964). *Hystrichosphaeridium* Deflandre, emend. Eisenack, has a wall of only one layer and bears processes with open ends.



TEXT-FIGURE 2

Mehlisphaeridium fibratum Segroves, n. gen., n. sp. A. Diagrammatic interpretation of microfossil as seen in optical section, *ca.* × 1,000. B. Diagrammatic reconstruction of a process, *ca.* × 3,000.

In *Cordosphaeridium* Eisenack the processes are not hollow, and the fibers diverge at the termini of the processes in a paintbrush-like manner, or are united together in netlike fashion. *Veryhachium* Deunff, emend. Downie and Sarjeant, is distinct in having a polygonal or subpolygonal body. The wall of *Hystrichosphaeridium striatoconus* Deflandre and Cookson appears to be one-layered and has a polygonal or rounded opening.

Mehlisphaeridium fibratum Segroves, new species
Plate 2, figures 8–14; text-figure 2

Diagnosis: Microfossil unruptured, body spheroidal, wall two-layered. Body bearing hollow, coarse, conical processes that are 5–30μ long and are composed of only the outer layer of the wall, which is differentially thickened to form elongate fibers 1–2μ in diameter and 1–11 in number per process. Fibers are confined to and traverse length of processes. Processes granulose or subgranulose. Remainder of outer layer psilate, punctate, scaly, or bearing small spines 0.5–2μ long.

Types: Holotype U. W. A. 55601. Paratypes, U. W. A. 55602–55604.

Type locality: Dampier Downs Stratigraphic Bore No. 1, 1080–1090 feet, Canning Basin, Western Australia. Poole Sandstone or lowermost part of Noonkanbah Formation, Artinskian.

Derivation of name: Latin *fibratum* – fibered, referring to the fiber-like thickenings of the processes.

Description: Microfossil unruptured; body spheroidal; wall two-layered. Inner layer dense and 1–2μ thick. Outer layer transparent and less than 1μ thick. Body bearing evenly or unevenly disposed, hollow, coarse, conical processes, which are 5–30μ long (mean 18μ), 4–16μ in basal diameter, 1–12μ apart, and 5–39 in number (mean 15). Processes composed of only the outer layer of the wall, which is differentially thickened to form elongate fibers 1–2μ in diameter and 1–11 in number per process. Fibers are confined to and traverse length of processes. Fibers often widest at base and, when two or more in number, are sometimes there united. Fibers usually converging toward and sometimes anastomosing near apex of each process. Processes bluntly to sharply rounded with terminal 1–2μ thickened and unsculptured. Grana or subgrana cover remainder of processes or may be restricted to fibers. Between bases of processes, outer wall psilate, punctate, scaly, or bearing small spines 0.5–2μ long.

Holotype diameter, exclusive of processes, 41μ. Total diameter 87μ. Processes evenly spaced, 20–26μ long, 7–15μ in basal diameter, and 20 in number. Fibers 2–4 in number per process, becoming wider near base and sometimes anastomosing there with other fibers of the same process. Processes subgranulose, with sculpture accentuated on fibers. Apices of processes sharply rounded.

Paratype U. W. A. 55602, total diameter 76μ. Processes 22–30μ long, 11–22μ in basal diameter, and 7 in number. Fibers 4–11 in number per process. Paratype U. W. A. 55603, total diameter 49μ. Processes 12μ long, 11–13μ in basal diameter, and 10 in number. Fibers 5–8 in number per process. Apices of processes bluntly rounded, their solid unsculptured termini well-developed. Paratype U. W. A. 55604, total diameter 62μ. Processes 9–13μ long, 6–9μ in basal diameter, and about 35 in number.

Dimensions: Thirty-six specimens, total diameter 37–94μ (mean 64μ).

Remarks: Veryhachium polygonale Eisenack differs from *Mehlisphaeridium fibratum* in having processes which lack fibers and are, in the terminal portions, filled with a prominent dark substance. Although an uncommon form in the Artinskian Carynginia Formation in the Perth Basin, *M. fibratum* is fairly abundant in the Artinskian of the Canning Basin.

Subgroup SPHAEROMORPHITAE Downie, Evitt and Sarjeant, 1963

Genus Leiosphaeridia Eisenack, 1958; emend. Downie and Sarjeant, 1963

Generic characters: Spheroidal to ellipsoidal bodies without processes, often collapsed or folded, with or without pylomes. Walls thin and granular, punctate or unornamented. Body without division into fields and without furrows or girdles.

Type species: Leiosphaeridia baltica Eisenack, 1958 (p. 8, pl. 2, fig. 5) by original designation.

Leiosphaeridia sp.
Plate 3, figure 19

Description: Microfossil without any apparent dehiscence mechanism. Body circular to oval in outline. Wall 0.5–1.5μ thick, psilate to punctate, and strongly folded.

Dimensions: Fifteen specimens, diameter 31–127μ (mean 60μ).

Illustrated specimens: U. W. A. 55632.

Remarks: Although never abundant, *Leiosphaeridia* sp. is a persistent form in Upper Permian sediments of the Perth Basin.

Genus Haplocystia Segroves, new genus

Diagnosis: Microfossil without any apparent dehiscence mechanism; body spheroidal to subspheroidal. Wall two-layered. Outer layer usually thick, translucent, and bearing a negative reticulum. Inner layer thick, and dark in colour.

Type species: Haplocystia pellucida Segroves, n. sp.

Distribution: Upper Permian of Western Australia.

Derivation of name: Greek απλοος – simple, plus κυστις – cyst, referring to the superficial appearance of the microfossil.

Remarks: Inderites Abramova and Marchenko, 1964, differs from *Haplocystia* in possessing a thicker outer wall, which is sometimes smooth. Although some members of the Tasmanaceae slightly resemble *Haplocystia*, they are here considered distinct because of their dark, homogeneous, one-layered wall. Furthermore, the family has rarely been assigned forms as small as *Haplocystia*.

Haplocystia pellucida Segroves, new species
Plate 2, figures 1–6

Diagnosis: Microfossil without any apparent dehiscence mechanism; body spheroidal to subspheroidal. Wall two-layered. Outer layer 1–4μ (mean 2μ) thick, translucent and channelled by a series of narrow grooves forming a negative reticulum. Inner layer 1–5.5μ (mean 3μ) thick, and dark in colour.

Types: Holotype, U. W. A. 55627. Paratypes, U. W. A. 55628 and 55629.

Type locality: Eradu Coal Bore No. 5, 135–157 feet, Perth Basin, Western Australia. Upper Permian.

Derivation of name: Latin *pellucidus* – transparent, or translucent, referring to the outer layer of the wall.

Description: Microfossil unruptured; body spheroidal to subspheroidal. Wall two-layered. Outer layer 1–4μ (mean 2μ) thick, translucent, and bearing narrow grooves that form a negative reticulum. Cavities about 0.25μ in size and about 0.25μ apart. Outer layer of wall fragile, often incomplete due to secondary removal and infrequently having the slight development of a polygonal pattern, due presumably to secondary fracturing. Inner layer of wall 1–5.5μ (mean 3μ) thick, with considerable variations in thickness in some specimens, and dark in colour. Inner layer often bearing tiny, closely spaced, concentric rugulae.

Holotype diameter 42μ. Outer layer of wall 1–3μ thick, incomplete due to secondary removal. Inner layer 3–4μ thick.

Paratype U. W. A 55628, diameter 40μ. Outer layer 1–4μ thick, and mechanically distorted. Inner layer 4–5.5μ thick. Paratype U. W. A 55629, diameter 36μ. Outer layer 1–3μ thick, with a slight development of secondary polygonal fracturing. Inner layer 2.5–5μ thick.

Dimensions: Twenty specimens, diameter 27–45μ (mean 37μ).

Remarks: Haplocystia pellucida is an abundant form in the Upper Permian coals of the Eradu district.

Subgroup Disphaeromorphitae Downie, Evitt and Sarjeant, 1963

Genus Spongocystia Segroves, new genus

Diagnosis: Microfossil without any apparent dehiscence mechanism; uncompressed specimens spheroidal; compressed specimens subspheroidal to nearly discoidal. Hollow, very thin-walled inner body enclosed by thick, dark-coloured, foveolate outer wall.

Type species: Spongocystia eraduica Segroves, n. sp.

Distribution: Artinskian of Western Australia.

Derivation of name: Greek σπογγος – spongy, from the foveolate outer layer of the wall, plus κυστις – cyst.

Remarks: Inderites Abramova and Marchenko (1964) differs from *Spongocystia* in possessing a smooth to reticulate outer layer 4–10μ thick and an inner layer 3.5–4.5μ thick. *Haplocystia* is distinct in lacking an inner body and in possessing a wall composed of thick inner and outer layers. Though slightly similar, previously described members of the Tasmanaceae are larger and have a homogeneous and usually pitted wall of one layer. It is impossible to assess the affinities of *Spongocystia.* However, the absence of morphological features that normally characterize the spores of vascular plants suggests a relationship with the lower plants.

Spongocystia eraduica Segroves, new species
Plate 3, figures 6–10

Diagnosis: Microfossil without any apparent dehiscence mechanism; uncompressed specimens spheroidal; compressed specimens subspheroidal to nearly discoidal. Wall of hollow inner body about 0.5μ thick and enclosed by foveolate outer wall, which is 2–6μ thick (mean 4μ).

Types: Holotype, U. W. A. 55616. Paratypes, U. W. A. 55617 and 55618.

Type locality: Kockatea Creek Bore No. 21, 46–66 feet, Perth Basin, Western Australia. Artinskian.

Derivation of name: After Eradu, village in northern Perth Basin, Western Australia.

Description: Microfossil unruptured, spheroidal to nearly discoidal. Outer wall of microfossil foveolate and 2–6μ thick with considerable variation in individual specimens. Diameter of foveolae 0.25–0.5μ, decreasing with depth until foveolae of outer surface occur as punctae on inner surface of wall. Foveolae 0.5–1μ apart. Infrequently, outer wall demonstrates slight development of a polygonal pattern due, presumably, to secondary fracturing. Wall of inner body 0.5μ thick, psilate, and usually folded.

Holotype diameter 42μ. Outer wall 3.5–5.5μ thick. Wall of inner body folded and unexpanded.

Paratype U. W. A. 55617 is 40μ in diameter. Outer wall 2–4μ thick. Wall of inner body folded and unexpanded. Paratype U. W. A. 55618 is 40μ in diameter. Outer wall 2–4.5μ thick with faint development of secondary polygonal pattern. Wall of inner body folded and unexpanded.

Dimensions: Twenty specimens, diameter 30–45μ (mean 38μ).

Remarks: Spongocystia eraduica is not an abundant form and has been found only in Artinskian sediments from Kockatea Creek Bore No. 21.

Subgroup uncertain
Genus Maculatasporites Tiwari, 1964

Generic characters: Microfossils without any apparent dehiscence mechanism; outline circular, oval, or round-

ed triangular. Wall reticulate, with lumina variable in shape and size.

Type species: Maculatasporites indicus Tiwari, 1964 (p. 257, pl. 1, figs. 11–12; text-fig. 7) by original designation.

Distribution: Carboniferous of Russia. Permian of India and Western Australia.

Remarks: Species assigned to *Reticulatasporites* (Ibrahim), emend. Potonié and Kremp, are characterized by extreme variations in width of muri. *Reticulatasporites* Leschik is invalid and appears to bear little resemblance to *Maculatasporites*. Forms resembling *Maculatasporites* were assigned to *Brochotriletes* by Naumova (1953). However, the type species of the latter genus is trilete. Carboniferous microfossils illustrated by Medvedeva (1960) and assigned to *Brochotriletes* appear to be identical with *Maculatasporites*. The legitimacy of *Maculatasporites* Tiwari and *Maculatisporites* Doring is in question, as the two names may be considered as orthographic variants. The question of priority is unclear, as both generic names were published in November, 1964. Although it has not been found in abundance, *Maculatasporites* is a persistent form in Artinskian sediments from the Perth and Canning Basins of Western Australia. Wide variation among forms possessing the generic characters of *Maculatasporites* suggests the presence of several species, but sufficient specimens for descriptive work have been found only of the two species described herein. *Maculatasporites* lacks any obvious features which suggest that it is the spore of a vascular plant, and it may be of fungal or algal origin.

Maculatasporites minimus Segroves, **new species**
Plate 3, figures 11–14

Diagnosis: Microfossils without any apparent dehiscence mechanism. Body spheroidal to nearly discoidal. Wall two-layered; inner and outer layers usually separated, hence most specimens have a hollow, thin-walled inner body. Outer layer of wall consisting of a heavy reticulum. Lumina of reticulum 1–7μ in diameter, and 30–100 in number. Outer layer structured.

Types: Holotype, U. W. A. 55619. Paratypes U. W. A. 55620 and 55621.

Type locality: Dampier Downs Stratigraphic Bore No. 1, 1080–1090 feet, Canning Basin, Western Australia. Artinskian.

Derivation of name: Latin *minimus* – smallest, referring to size of the microfossil.

Occurrence: Artinskian of Perth and Canning Basins, Western Australia.

Description: Microfossils without any apparent dehiscence mechanism. Uncompressed specimens spheroidal; compressed specimens subspheroidal to nearly discoidal. Wall two-layered; inner and outer layers usually separated, hence most specimens have a hollow inner body. Inner layer thin, psilate to punctate, and sometimes folded. Outer layer of wall coarsely reticulate; muri 2–5μ wide and 3–5μ high. Lumina circular to oval, 1–7μ in diameter, and 30–100 in number. Outer layer faintly to strongly intrapunctate; structure

PLATE 1

All photographs are from unretouched negatives and, unless otherwise stated, have a magnification of × 750.

1–2 *Peltacystia calvitium* Balme and Segroves
1, no. 54002, intact specimen in polar view; 2, no. 54003, intact specimen in equatorial view; sample 49741.

3–4 *Peltacystia monile* Balme and Segroves
3, no. 53996, intact specimen in oblique view; 4, no. 53997, ruptured specimen in polar view; sample 49741.

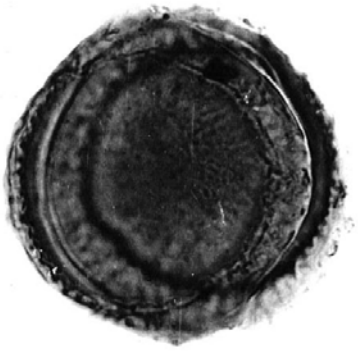
5–6 *Schizosporis scissus* (Balme and Hennelly) Hart
5, no. 55611, intact specimen showing equatorial line of dehiscence, sample 11948; 6, no. 55612, partly ruptured specimen, sample 55642.

7 *Spheripollenites* sp. cf. *S. psilatus* Couper
No. 55610, sample 11948.

8 *Quadrisporites* sp. cf. *Q. horridus* Hennelly
No. 55597, sample 55644.

9–12 *Schizosporis dejerseyi* Segroves, n. sp.
9, paratype, no. 55615; 10, holotype, no. 55613, surface view; 11, holotype, no. 55613, optical section; 12, paratype, no. 55614; sample 55643.

13–15 *Pyramidosporites cyathodes* Segroves, n. sp.
13, paratype, no. 55599; 14, holotype, no. 55598; 15, paratype, no. 55600; sample 49741, all magnifications × 600.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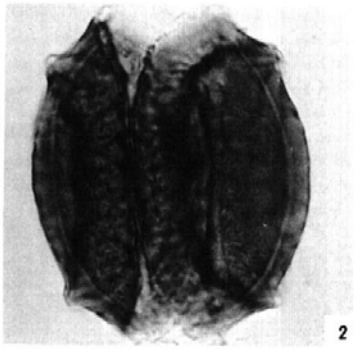
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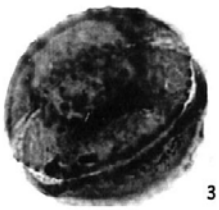
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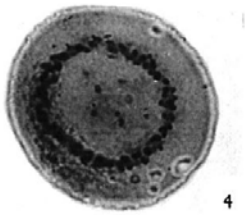
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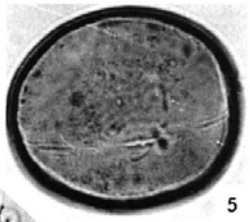
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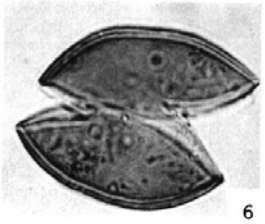
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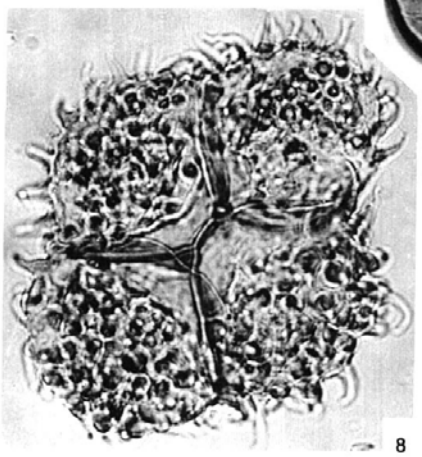
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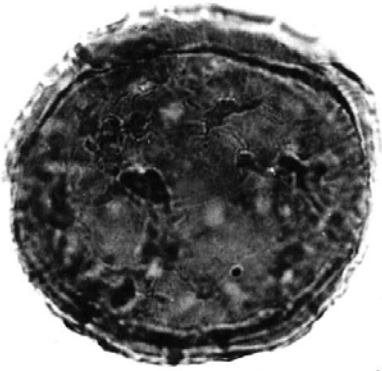
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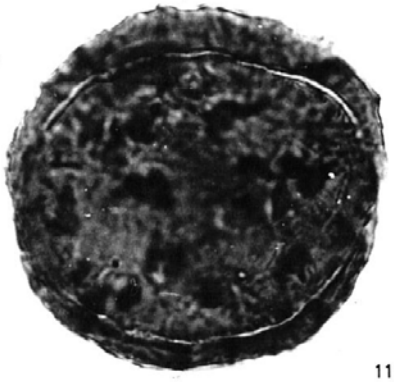
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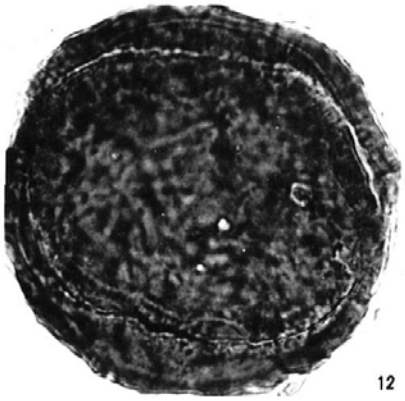
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usually most dense toward and sometimes restricted to the inner surface of the outer layer. Periphery of microfossil slightly undulating.

Holotype diameter 38μ; reticulum finely intrapunctate and forming about 65 lumina 2–7μ in diameter. Folded inner body present. In the photograph provided, the specimen appears faintly trilete. This effect is the result of the folding pattern of the inner body.

In paratype U. W. A. 55621, the reticulum is coarsely intrapunctate with about 90 lumina 1–6μ in diameter. Inner body present. Paratype U. W. A. 55620 has a coarsely intrapunctate reticulum with approximately 95 lumina almost uniformly 2μ in diameter.

Dimensions: Twenty-four specimens, diameter 24–40μ (mean 33μ).

Remarks: Maculatasporites minimus differs from *M. indicus* Tiwari in its larger size and possession of a structured outer layer.

Maculatasporites amplus Segroves, new species
Plate 3, figures 15–18

Diagnosis: Microfossils without any apparent dehiscence mechanism. Body spheroidal to nearly discoidal. Wall two-layered; inner and outer layers infrequently separated, hence a few specimens have a hollow, thin-walled inner body. Outer layer of wall consisting of a reticulum. Lumina of reticulum 1–3μ in diameter and 200–500 in number. Outer layer structured.

Types: Holotype, U. W. A. 55622. Paratypes, U. W. A. 55623 and 55624.

Type locality: University of Western Australia Bore No. 5, 48–49 feet, North Branch of Irwin River, Perth Basin, Western Australia. Fossil Cliff Formation, late Sakmarian.

Derivation of name: Latin *amplus* – large.

Occurrence: Late Sakmarian – Artinskian. Perth and Canning Basins, Western Australia.

Description: Microfossils without any apparent dehiscence mechanism. Uncompressed specimens spheroidal; compressed specimens subspheroidal to nearly discoidal. Wall two-layered; inner and outer layers occasionally separated, hence a few specimens have a hollow inner body. Inner layer thin, psilate to punctate, seldom folded. Outer layer of wall reticulate; muri 2–3μ wide and 3–7μ high. Lumina oval to elongate oval in outline, 1–3μ in diameter, and 200–500 in number. Outer layer faintly to strongly intrapunctate. Periphery of spore slightly undulating to even.

Holotype diameter 82μ; reticulum finely intrapunctate and forming about 450 lumina 2–3μ in diameter.

Paratype U. W. A. 55623 is 52μ in diameter, with about 240 lumina 1–2μ in diameter. Measuring 60μ in diameter, paratype U. W. A. 55624 bears approximately 250 lumina 1–3μ in diameter. Inner body present.

Dimensions: Twenty specimens, diameter 52–86μ (mean 68μ).

Remarks: Maculatasporites amplus is distinguished from *M. minimus* by its greater size, and its smaller and more numerous lumina. *M. indicus* Tiwari lacks a structured reticulum and possesses lumina that are more diverse in size and shape.

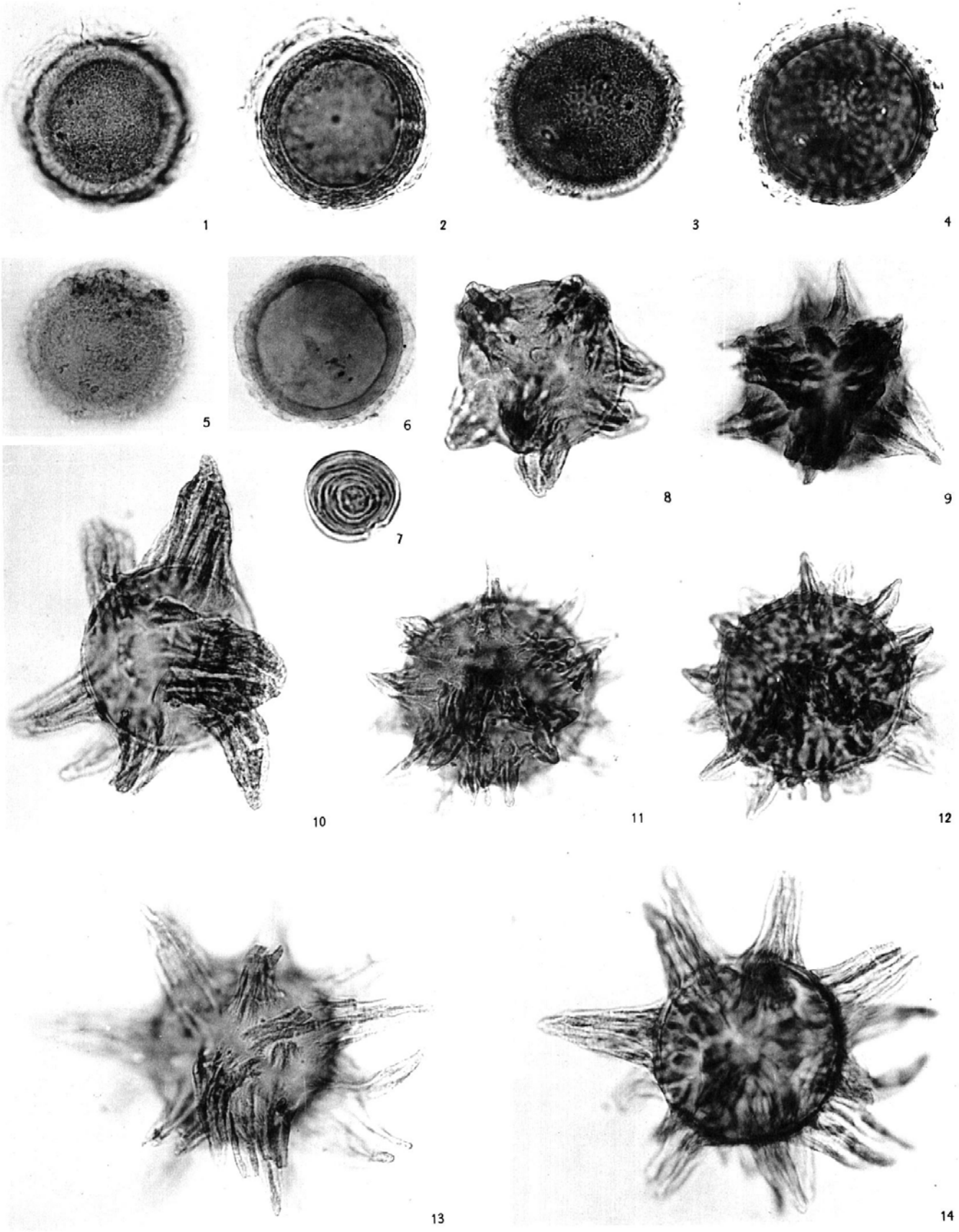
PLATE 2

All photographs are from unretouched negatives and have a magnification of × 750.

1–6 *Haplocystia pellucida* Segroves, n. sp.
1, paratype, no. 55628, surface view; 2, paratype, no. 55628, optical section; 3, holotype, no. 55627, surface view; 4, holotype, no. 55627, optical section; 5, paratype, no. 55629, surface view; 6, paratype, no. 55629, optical section; sample 43283.

7 *Circulisporites parvus* de Jersey, emend. Norris
No. 55626, intact specimen in polar view, sample 55642.

8–14 *Mehlisphaeridium fibratum* Segroves, n. sp.
8, paratype, no. 55603, sample 44088; 9, no. 55605; 10, paratype, no. 55602; 11, paratype, no. 55604, surface view; 12, paratype, no. 55604, optical section; 13, holotype, no. 55601, surface view; 14, holotype, no. 55601, optical section; sample 55645.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Genus **Tetraporina** Naumova, 1939; ex Naumova, 1950

Generic characters: Microfossil without any apparent dehiscence mechanism; wall unsculptured. Outline quadrilateral. Corners sometimes bearing arcuate folds.

Type species: Tetraporina antiqua Naumova, 1950 (p. 106, pl. 1, fig. 25), designated by Potonié (1960, p. 130).

Distribution: Lower Carboniferous of Russia and Spitsbergen. Upper Mississippian of Alberta, Canada. Lower Permian of Victoria and New South Wales. Permian – Lower Triassic and Recent of Western Australia.

Remarks: Balme (personal communication) considers Sporomorph 'A', figured from the Permian of New South Wales by Balme and Hennelly (1956), to possess the generic characters of *Tetraporina*. There appears to be little doubt concerning the synonymy of *Balmeella* Pant and Mehra (1963), described from the Bacchus Marsh Tillite of Victoria. The monotypic genus is based on two specimens, and, according to Pant and Mehra, these are identical with Sporomorph 'A' of Balme and Hennelly. Although similar in form, *Schizocystia* Cookson and Eisenack tends to separate into two approximately equal halves along a straight line. While *Tetraporina* has, on the basis of its "porate structure", been assigned angiospermous affinity by some workers (Naumova, 1939, 1950; Teteriuk, 1956, 1958), this assessment has been doubted by several more recent authors (Staplin, 1960; Scott, Barghoorn and Leopold, 1960; Hughes, 1961). The presence of genuine pores is under question, although in some specimens pores are simulated by arcuate folds. Churchill (1960) considered *Tetraporina* to be very similar to an entity which he believed to be the aplanospore of a member of the Cyanophyceae.

Tetraporina horologia (Staplin) Playford
Plate 3, figure 21

Azonotetraporina? horologia STAPLIN, 1960, p. 6, pl. 1, figs. 4–6.
Tetraporina horologia (Staplin). – PLAYFORD, 1963, p. 659, pl. 95, figs. 14–15.

Description: Microfossil without any apparent dehiscence mechanism; outline quadrilateral. Sides straight to slightly convex or concave. Wall about 1μ thick, psilate to punctate, sometimes folded. Arcuate folds 8–10μ across often present at each corner of body.

Dimensions: Eighteen specimens, diagonal length 22–45μ (mean 27μ).

Illustrated specimen: U. W. A. 55630.

Occurrence: Lower Carboniferous of Canada and Spitsbergen. Permian and Lower Triassic of Western Australia.

Remarks: Balme (1963) extended the stratigraphic and geographic ranges of *Tetraporina horologia* beyond the

PLATE 3

All photographs are from unretouched negatives and, unless otherwise stated, have a magnification of × 750.

1–2 *Peltacystia venosa* Balme and Segroves
1, no. 53992, intact specimen in oblique view; 2, no. 54005, ruptured specimen in polar view; sample 49741.

3–5 *Peltacystia galeoides* Segroves, n. sp.
3, holotype, no. 55607; 4, no. 55609; 5, paratype, no. 55608; sample 43283.

6–10 *Spongocystia eraduica* Segroves, n. sp.
6, holotype, no. 55616, surface view; 7, holotype, no. 55616, optical section; 8, paratype, no. 55618, surface view; 9, paratype, no. 55618, optical section; 10, paratype, no. 55617; sample 43315.

11–14 *Maculatasporites minimus* Segroves, n. sp.
11, holotype, no. 55619, surface view; 12, holotype, no. 55619, optical section; 13, paratype, no. 55620; 14, paratype, no. 55621; sample 55645.

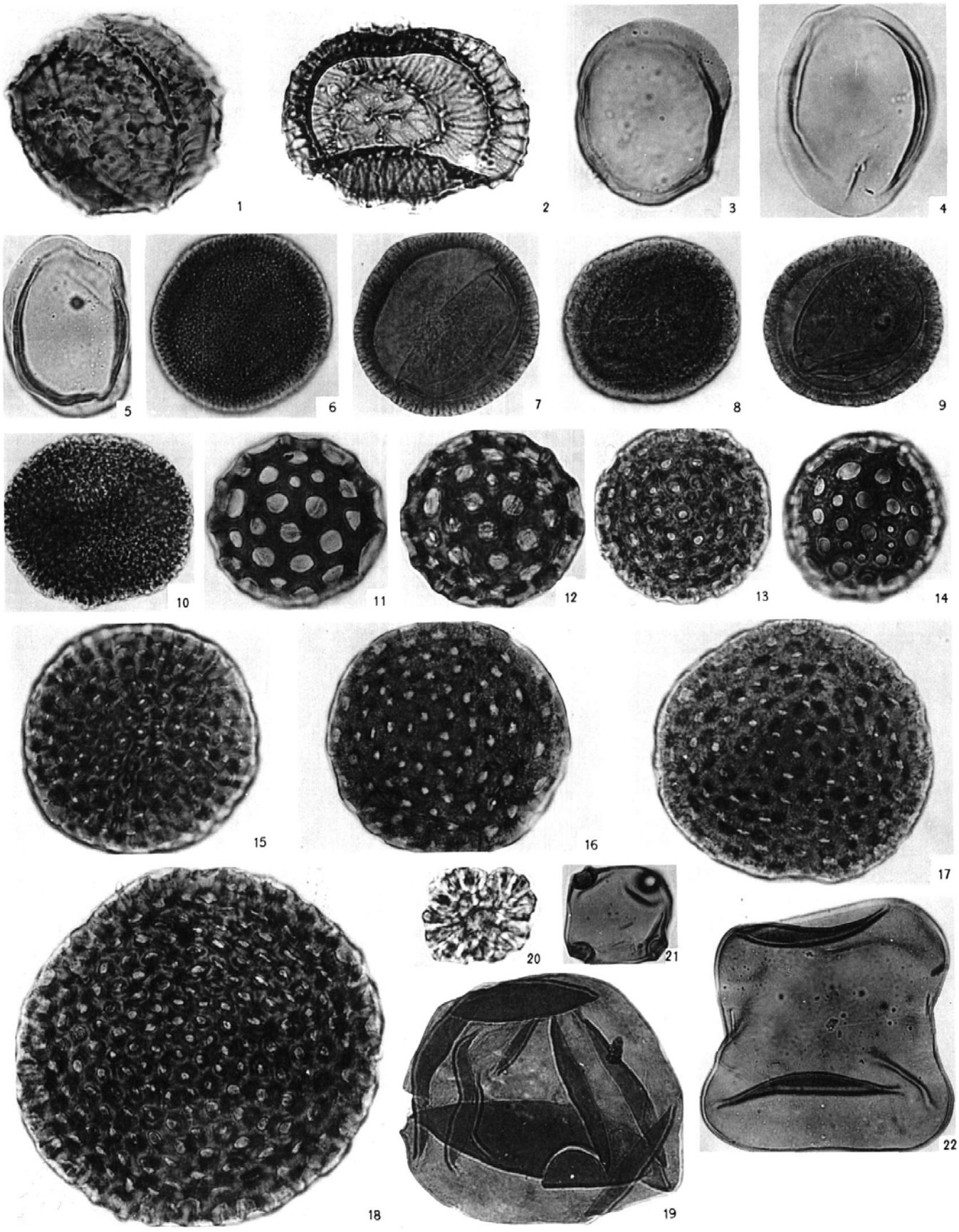
15–18 *Maculatasporites amplus* Segroves, n. sp.
15, paratype, no. 55623; 16, no. 55625; 17, paratype, no. 55624; 18, holotype, no. 55622; sample 55641.

19 *Leiosphaeridia* sp.
No. 55632, sample 11948.

20 *Botryococcus* sp.
No. 55606, sample 11948.

21 *Tetraporina horologia* (Staplin) Playford
No. 55630, sample 43290.

22 *Tetraporina* sp.
No. 55631, sample 43290, × 400.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Mississippian of Alberta, Canada, by reporting its limited occurrence in the Lower Triassic of Western Australia. In his study of the Permian sediments of the Perth Basin, the present author has found the species to be most common in, although not confined to, the Upper Permian.

Tetraporina sp.
Plate 3, figure 22

Description: Microfossils without any apparent dehiscence mechanism; outline quadrilateral. Sides straight to concave. Wall 2–4μ thick, psilate to punctate, frequently folded. On concave margins of microfossil, wall characterized by numerous fine fractures. Fractures lie normal to margin of microfossil and are of variable length. Body without arcuate folds.

Dimensions: Nine specimens, diagonal length 73–210μ (mean 117μ).

Illustrated specimen: U. W. A. 55631.

Occurrence: Upper Permian of Western Australia.

Remarks: With its characteristic fracturing of the wall, *Tetraporina* sp. is a rather distinctive form. It has not been formally named due to its rarity.

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