UPPER MESOZOIC MICROPLANKTON FROM AUSTRALIA AND NEW GUINEA

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ABSTRACT. Thirty-one species of microplankton from Upper Jurassic deposits in north-western Australia are identified, six new genera are proposed and the following new species described: *Gonyaulax eumorpha, G. clathrata, G. bulloidea, Scriniodinium playfordi, S. dictyotum, S. ceratophorum, S. apatelum, Belodinium dysculum, Canningia reticulata, Hystrichosphaeridium pachydermum, H. torynum, H. capitatum, Cyclonephelium areolatum, C. densebarbatum, Cannosphaeropsis apiculata, Leiosphaeridia similis, Chlamydophorella wallala, Dictyopyxis areolata, Diplotesta glaessneri, Kalyptea diceras, K. monoceras, Komewuia glabra, Palaeostomocystis cylindrica, P. sinuosa.*

IN a previous paper (Cookson and Eisenack 1958) several microplankton species were described from the lower portion of the Jarlemai Siltstone at Broome in north-western Western Australia. The sample from which they were recovered came from between 1,405 and 1,427 ft. in the Broome No. 3 Artesian Bore and the age at this level is considered to be Oxfordian to Lower Kimeridgian (McWhae *et al.* 1958, p. 89).

The present paper is mainly concerned with the classification and distribution of a number of new forms recently isolated from upper portions of the Jarlemai Siltstone obtained from bores at Broome and other localities in the Canning Basin, Western Australia. The age of this part of the Siltstone is still uncertain but at present is taken as Lower Tithonian (McWhae *et al.* 1958, p. 89). In addition a few forms which are common to both uppermost Jurassic and lowermost Cretaceous sediments in Western Australia, Eastern Australia, and New Guinea are included.

Extraction methods were the same as those described in Deflandre and Cookson (1955).

Acknowledgements. We wish to express our indebtedness to Dr. Ross McWhae of West Australian Petroleum Pty. Ltd.; to Mr. B. E. Balme of the University of Western Australia; and to Mr. J. N. Montgomery of Australasian Petroleum Co. Ltd., for rock samples and information regarding their stratigraphical position and age. One of us (I. C. C.) has received considerable financial assistance from the Commonwealth Scientific and Industrial Research Organization.

LOCATION AND AGE OF SEDIMENTS

Most of the Western Australian samples were supplied by West Australian Petroleum Pty. Ltd. (to be referred to hereafter as 'Wapet'), those from Papua by Island Exploration Co. Ltd. (to be referred to hereafter as 'I.E.C.').

Western Australia, Canning Basin

1. Broome No. 3 Artesian Bore. Jarlemai Siltstone (lower portion) between 1,405 and 1,427 ft.; Oxfordian to Lower Kimeridgian (Teichert 1940; McWhae *et al.*, 1958, p. 89). Jarlemai Siltstone (upper portion 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; probably Tithonian (McWhae *et al.* 1958, p. 89).
2. Broome No. 1 Bore. Jarlemai Siltstone (upper portion) at 963 and 977 ft.; probably Tithonian (Authors).

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3. Wallal Core hole about 200 miles south-south-west of Broome. Alexander Formation between 560 and 575 ft.; Oxfordian to Lower Kimeridgian (J. R. H. McWhae pers. comm.). Jarlemai Siltstone at 350 ft. and between 305 and 320 ft.; probably Tithonian (Authors).

4. Roebuck Bay, 30 miles south-east of Broome, Wapet's No. 1 Well, core 11, between 972 and 982 ft.; base of Alexander Formation, Oxfordian to Lower Kimeridgian according to Wapet, probably Tithonian (Authors).

Western Australia, Exmouth Gulf area of Carnarvon Basin

1. Cape Range. Dingo Claystone (upper portion). Wapet's Well No. 1 between 3,825 and 3,840 ft. and Well No. 2 between 3,970 and 3,991 ft.; Oxfordian or Lower Kimeridgian (McWhae *et al.* 1958, p. 91).

2. Rough Range. Muderong Shale. Wapet's Well No. 8 between 3,863 and 3,883 ft.; Aptian (McWhae *et al.* 1958, p. 112).

Western Australia, south-west portion of Carnarvon Basin

Birdrong Formation (Grierson Member). Wapet's Meadow Station Bore No. 9; Upper Neocomian or Lower Aptian (McWhae *et al.* 1958, p. 111).

South Australia

South Australia Northern Territory Oil Search Ltd. ('Santos'), Oodnadatta Bore between 1,052 and 1,061 ft.; Lower Cretaceous, Aptian or older (Authors). Lake Phillipson Bore about 12 miles east of eastern margin of lake (Brown 1905, p. 6) at 87 ft. 10 in.; Lower Cretaceous, Aptian, or older (Authors).

Northern Queensland

1. Longreach Drill Co.'s Balmoral Well No. 1 on Padua property at 1,000 ft.; probably Aptian (Authors).

2. Roma Formation. Well on Batavia Downs Station, Cape York Peninsular, between 45 and 49 ft.; Aptian.

New Guinea

1. Omati River District, Western Papua. I.E.C.'s Well No. 1, sample 21 (Cookson and Eisenack 1958, fig. 2); late Upper Jurassic as determined by I.E.C.

2. Komewu, Papua. I.E.C.'s Well No. 1, core 15; probably late Upper Jurassic (Authors); Well No. 2, core 10; Neocomian (on faunal evidence, J. N. Montgomery, pers. comm.).

SYSTEMATIC DESCRIPTIONS

DINOFLAGELLATES

Family GONYAULACIDAE

Genus GONYAULAX Diesing 1866

Gonyaulax serrata Cookson and Eisenack

Gonyaulax serrata Cookson and Eisenack 1958, p. 34, pl. 3, fig. 2.

Occurrence. Upper Jurassic to? Neocomian: Omati, Papua, I.E.C.'s Well No. 1, samples 19, 20, 25 (Cookson and Eisenack 1958, fig. 2). Upper Jurassic probably Tithonian: Broome, W.A., No. 1 Bore at 977 ft. Neocomian, Komewu, Papua, I.E.C.'s Well No. 2, core 10.

Comments. The occurrence of *G. serrata* at Broome and Komewu, here recorded, suggests that the range in age of this species is from Tithonian to Neocomian.

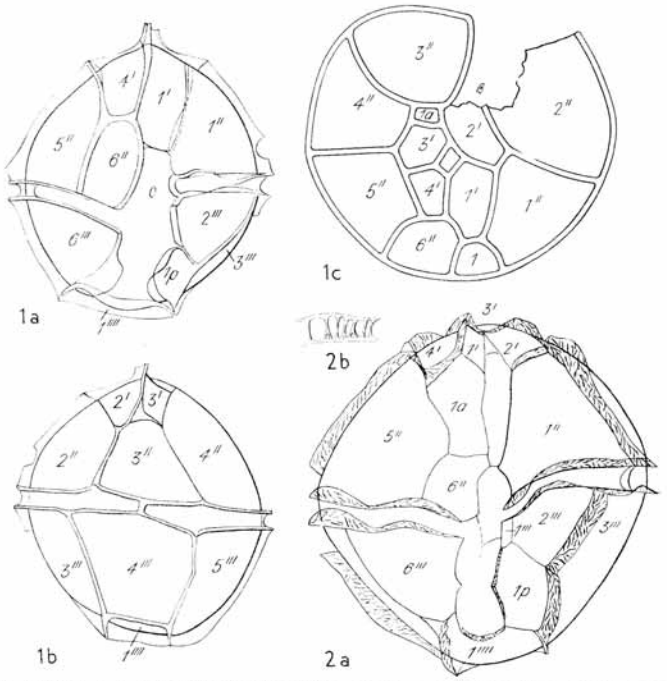
Gonyaulax cf. *ambigua* Deflandre

Plate 37, fig. 4; text-fig. 1

Gonyaulax ambigua Deflandre 1939, p. 144, pl. 1, fig. 2.

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Wapet's Wallal Core hole at 350 ft.

Comments. Shells having the main features of *G. ambigua* are fairly numerous in the Wallal deposit; they differ, however, from the description of the French examples, given by Deflandre, in the presence of plate 1p on the hypotheca. A funnel-shaped 'horn' is formed by the ledges of the four apical plates. Formula: 4′, (1a), 6″, 5‴, 1p, 1⁗. Sometimes 1a is present (text-fig. 1*c*), 1′ is long and narrow, 6″ small; longitudinal furrow short, 1‴ absent (text-fig. 1*a*).



TEXT-FIGS. 1, 2. 1, *Gonyaulax* cf. *ambigua* Defl.; *a*, ventral surface of specimen shown on Pl. 37, fig. 4; *b*, dorsal surface of same specimen; *c*, apical view of another specimen; ×*c*. 500. 2, *Gonyaulax clathrata* sp. nov.; *a*, ventral surface of specimen shown on Pl. 37, fig. 5; ×*c*. 500; *b*, portion of a ledge (schematic).

G. ambigua was first described from Kimeridgian shales of Orbagnoux, France; since then it has been recorded from Kimeridge in England (Downie 1957) and from the Dingo Claystone (upper portion), Western Australia (Cookson and Eisenack 1958).

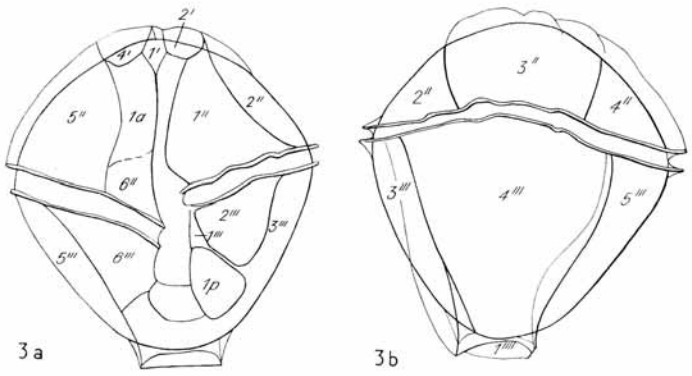
A certain identification of the Wallal specimens with *G. ambigua* will only be possible when better material of this species from the type locality is described.

Gonyaulax eumorpha sp. nov.

Plate 37, figs. 1–3; text-fig. 3; holotype fig. 1, Nat. Mus. Vic. P17767

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft.; Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft. Probably Tithonian, Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 977 ft.

Description. Shell rather large, ovoidal, flattened dorso-ventrally; epitheca broadly rounded, hypotheca narrowing somewhat towards the antapex. The girdle, which is equatorial, helicoid and broad, and the plates are bordered by thin, rather high ledges which may be perforated. The formula is 4′, 6″, 5‴, 1p, 1⁗, but it seems that 6″ is very small and a long intercalary plate, the transverse boundary of which is indistinct, is developed on the ventral surface (text-fig. 3*a*). Three of the four apical plates are always evident on the ventral surface (text-fig. 3*a*). Dimensions: holo type—112 μ long, 110 μ broad. Paratype (Pl. 37, fig. 3) 98 μ long, 93 μ broad. Range—length 86–112 μ, breadth 86–110 μ.



TEXT-FIG. 3. *Gonyaulax eumorpha* sp. nov.; *a*, ventral surface of specimen shown on Pl. 37, fig. 3; in this example plate 1‴ is faintly indicated; *b*, dorsal surface of same specimen; × *c.* 500.

Comments. G. eumorpha and *G.* cf. *ambigua* have the general shape and tabulation of the members of the genus *Gonyaulax*, however plate 1‴ seems to be missing. In spite of this fact we see no necessity for the creation of a new genus, since in some species of *Gonyaulax* (*G. polyedra* Stein) plate 1‴ is very considerably reduced.

Gonyaulax clathrata sp. nov.

Plate 37, fig. 5; text-fig. 2; holotype Nat. Mus. Vic. P17775

Occurrence. Probably Tithonian, Jarlemai Siltstone (upper portion), Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Bore between 972 and 982 ft.

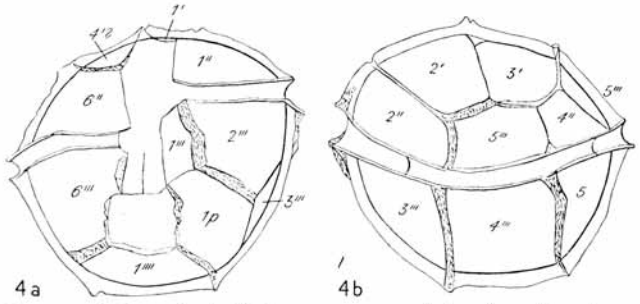
Description. Shell spherical to somewhat polygonal, approximately isodiametric. The transverse furrow is helicoid and divides the shell nearly equally. The plates and furrows are bordered by rather high ledges with radially arranged rectangular perforations which give them a palisade-like appearance. A large pylome is developed on the dorsal side (plate 3″). The formula is 4′, 1a, 6″, 6‴, 1p, 1⁗. Plates 1a and 1 of the longitudinal furrow are long and narrow, plates 6″ and 1‴ are small, especially the latter (text-fig. 2*a*). Dimensions: holotype—100 × 100 μ. Range in diameter—70–100 μ.

Gonyaulax bulloidea sp. nov.

Plate 37, fig. 11; text-fig. 4; holotype Nat. Mus. Vic. P17788

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), Broome No. 1 Bore at 977 ft.

Description. Shell spherical, rather thick-walled, epitheca and hypotheca nearly equal, separated by a rather broad, helicoid girdle. Longitudinal furrow broadened towards the antapex. Plates mostly squarish or broadly trapezoid; plates 2′ and 3′ especially large, plate 1‴ rather large, nearly rectangular. Formula 4′, 6″, 6‴, 1p, 1⁗. The girdle, longitudinal furrow, and plates are bordered by low but well-developed ledges; both plates



TEXT-FIG. 4. *Gonyaulax bulloidea* sp. nov., *a.* ventral surface of specimen shown on Pl. 37, fig. 11; *b.* dorsal surface of same specimen; × *c.* 500.

and ledges are ±granular, a feature which, when taken in conjunction with the spherical shape and squarish plates, gives the shell a very characteristic appearance. The apex is marked by a small pointed projection. In all the examples observed, plate 3″, which in many species of *Gonyaulax* becomes detached to form the pylome, has always been in position. On the other hand, in some specimens the apical plates have been missing (? Ekdysis). Dimensions: holotype—78 μ long, 83 μ broad. Range—60–88 μ × 57–83 μ.

Family DEFLANDREIDAE
Genus SCRINIODINIUM Klement 1957
Scriniodinium luridum (Deflandre)

Plate 37, fig. 10

Gymnodinium luridum Deflandre 1938, p. 166, pl. 5, fig. 4–6.
Scriniodinium luridum (Deflandre); Klement 1957, p. 410.
Gymnodinium luridum Deflandre; Cookson and Eisenack 1958, p. 24, pl. 1, figs. 3, 4.
Scriniodinium luridum (Deflandre); Ibid., p. 79.

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, Wapet's Wallal Core hole

between 560 and 575 ft.; Jarlemai Siltstone (lower portion), Broome No. 3 Bore between 1,405–27 ft. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 977 ft., Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001–42 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well, core 11, between 972 and 982 ft.

Scriniodinium playfordi sp. nov.

Plate 37, fig. 6; holotype Nat. Mus. Vic. P17233

Gymnodinium crystallinum Deflandre *in* Cookson and Eisenack 1958, p. 24, pl. 1, fig. 2.
Scriniodinium crystallinum (Deflandre); ibid., p. 79.

Occurrence. Oxfordian to Lower Kimeridgian: Dingo Claystone (upper part), W.A., Wapet's Cape Range Well No. 1 between 3,825 and 3,890 ft. and Well No. 2 between 3,970 and 3,991 ft.; Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft. Probably Tithonian: Wallal Core hole at 350 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well between 972 and 982 ft.

Description. Shell flat, somewhat arched, oval in outline, divided equally by a deep circular girdle; the hypotheca is rounded; the epitheca terminates in a rather short, stout horn the apex of which is truncate and carries a small median projection. The capsule fills the cavity of the shell and projects into the base of the apical horn, its wall is thin and ornamented either entirely or at the periphery only by a small-meshed reticulum of variable width. The shell-membrane is rather wide, smooth, and hyaline. A large pylome is developed. Dimensions: holotype—166 μ long, 147 μ broad. Range—108–166 $\mu \times 90$–147 μ. The species is named after Mr. P. E. Playford of West Australian Petroleum Pty. Ltd.

Scriniodinium dictyotum sp. nov.

Plate 37, figs. 8, 9; holotype fig. 9, Nat. Mus. Vic. P17768

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wallal Core hole between 560 and 575 ft. Probably Tithonian: Jarlemai Siltstone (upper portion) Wallal Core hole at 350 ft. and between 305 and 320 ft., and Broome No. 3 Bore between 1,001 and 1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well between 972 and 982 ft.

Description. Shell flat, oval, divided by a $\pm$ distinct and relatively broad girdle into an epitheca and hypotheca of approximately equal size; epitheca prolonged into a broadly based, short, blunt apical projection. Capsule oval with a short apical prominence. The wall of the capsule bears numerous thin perpendicular ledges which form a small-meshed supporting reticulum for the thin outer membrane. The meshes of the reticulum

EXPLANATION OF PLATE 37

Figs. 1, 2. *Gonyaulax eumorpha* sp. nov. Broome No. 1 Bore, 977 ft. 1, $\times 400$. 2, $\times c.$ 500.
Fig. 3. *Gonyaulax eumorpha* dorsal surface. Wallal Core hole, 560-75 ft., $\times c.$ 500.
Fig. 4. *Gonyaulax* cf. *ambigua* Defl. Wallal Core hole, 350 ft., $\times c.$ 400.
Fig. 5. *Gonyaulax clathrata* sp. nov. Broome No. 3 Bore, 1001–42 ft., $\times c.$ 400.
Fig. 6. *Scriniodinium playfordi* sp. nov. Cape Range, W.A., Well 2, 3970–91 ft., $\times 400$.
Fig. 7. *Scriniodinium ceratophorum* sp. nov. Broome No. 3 Bore 1405–27 ft., $\times c.$ 400.
Figs. 8, 9. *Scriniodinium dictyotum* sp. nov. 8, Wallal Core hole, 560–75 ft., $\times 400$. 9, Wallal Core hole, 350 ft., $\times 400$.
Fig. 10. *Scriniodinium luridum* (Defl.). Broome No. 1 Bore, 977 ft., $\times 400$.
Fig. 11. *Gonyaulax bulloidea* sp. nov. Broome No. 1 Bore, 977 ft., $\times c.$ 400.
Figs. 12, 13. *Scriniodinium apatelum* sp. nov. Wallal Core hole, 560–75 ft., $\times c.$ 680.
Fig. 14. *Belodinium dysculum* sp. nov. Broome No. 1 Bore at 977 ft., $\times c.$ 400.

vary considerably in size and are usually widest towards the periphery. The pylome is broadly hoof-shaped and reaches the girdle. Dimensions: holotype—109 μ long, 95 μ broad, capsule 95 $\times$ 83 μ. Paratype (Pl. 37, fig. 8) 115 μ long, 100 μ broad, capsule 95 $\mu \times$ 83 μ. Range—109–135 $\mu \times$ 92 μ–112 μ.

Scriniodinium ceratophorum sp. nov.

Plate 37, fig. 7; holotype Nat. Mus. Vic. P17769

Occurrence. Oxfordian to Lower Kimeridgian: Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft.

Description. Shell flat, consisting of a larger triangular epitheca and a smaller rounded hypotheca which are separated by an apparently broad girdle with thin borders. Shell-membrane thin, either smooth or, as in the type, finely granular, prolonged into a well-developed apical horn having a truncate apex with a small median projection. The capsule has a small apical prominence and almost fills the shell. A large pylome is developed in the vicinity of the girdle. Dimensions: holotype—125 μ long, 94 μ broad, capsule 97 $\times$ 96 μ, horn 24 μ. Another example 110 μ long, 71 μ broad, capsule 70 $\times$ 67 μ, horn 33 μ.

Scriniodinium apatelum sp. nov.

Plate 37, figs. 12, 13; holotype fig. 12, Nat. Mus. Vic. P17770

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 578 ft.; Jarlemai Siltstone, W.A., Broome No. 3 Bore between 1,405 and 1,427 ft. Probably Tithonian: Jarlemai Siltstone, Wallal Core hole at 350 ft. between 305 and 320 ft., and Broome No. 3 Bore between 1,001 and 1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well between 972 and 982 ft.

Description. Shell flat, the main portion ovoidal to somewhat rhomboidal; epitheca with a small, thin-walled, cylindrical and truncate horn; hypotheca narrowing distally towards a square opening with a smooth or serrated edge and sometimes with a short spine-like projection at each angle. The girdle is circular, occasionally well marked but usually only indicated by narrow ledges on the two sides. Membrane of shell thin, smooth, perforate or serrate at the sides. The capsule, which fills the shell laterally and follows its outline in the middle region, terminates in a short apical prominence. A relatively large, hoof-shaped pylome extends from just beneath the apex to the level of the girdle. Dimensions: holotype—120 μ long, 58 μ broad, capsule 80 μ long and 58 μ broad. Paratype (Pl. 37, fig. 11) 95 μ long, 57 μ broad, capsule 62 μ long, 51 μ broad. Range—70–145 $\mu \times$ 42–72 μ.

Comments. S. apatelum has some of the features of *Gonyaulax jurassica* Defl. and *G. eisenacki* Defl., but none of the specimens have shown any sign of tabulation.

FAMILY INCERTA

Genus BELODINIUM gen. nov.

Description. Shell elongate, unequally divided by a circular girdle; main body marked into fields by delicate ledges; epitheca with a hollow membranous horn, hypotheca with a flattened membranous expansion. Type species *Belodinium dysculum* sp. nov.

Belodinium dysculum sp. nov.

Plate 37, fig. 14; Plate 39, fig. 10; holotype fig. 14, Nat. Mus. Vic. P1771

Occurrence. Probably Tithonian: Broome No. 1 Bore at 977 ft.; Broome No. 3 Bore between 1,200–1,211 ft., and between 1,001–1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well between 972 and 982 ft.

Description. Shell elongate, 2·5–4 times longer than broad, divided unequally by a conspicuous girdle into a longer epitheca and shorter hypotheca. The surface of the main body or capsule is divided by delicate, relatively high, sometimes undulate ledges into five to six nearly rectangular or trapezoid fields in the epitheca and into an unascertained number of ± isodiametric fields in the hypotheca; the ledges are supported by small spinules arranged in rows which arise from the surface of the capsule. The membrane which forms the ledges extends apically as a short, hollow, bluntly pointed horn and antapically as a hollow, rounded expansion which, in one example, appears to open terminally. A circle of rather strong spine-like processes is developed at the apical and antapical ends of the capsule. The shell apparently opens by the complete detachment of the apical part including the extreme anterior portion of the capsule. Dimensions: type—97 μ long, 42 μ broad, capsule 60 × 32 μ. Range—length 76–108 μ, breadth 24–42 μ, capsule 48–57 μ × 20–32 μ.

Comments. The shells of *Belodinium dysculum* are so delicate and transparent that the interpretation given above is to be regarded as both provisional and incomplete. *B. dysculum* is a readily distinguishable form and not uncommon in the Broome No. 3 Bore between 1,001 and 1,042 ft.

Genus BROOMEA Cookson and Eisenack 1958

Broomea simplex Cookson and Eisenack

Broomea simplex Cookson and Eisenack 1958, p. 42, pl. 6, fig. 9.

Occurrence. Late Upper Jurassic: Omati, Papua, I.E.C.'s Well No. 1, Sample 24 (Cookson and Eisenack 1958, fig. 2). Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 963 and 977 ft., and Bore No. 3 between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.

Comments. Previously *Broomea simplex* was known only from one of the uppermost samples in the Upper Jurassic section of the Omati bore, Papua. Its appearance in approximately the same stratigraphical position in Western Australia is therefore of interest.

Genus DINGODINIUM Cookson and Eisenack 1958

Dingodinium jurassicum Cookson and Eisenack

Dingodinium jurassicum Cookson and Eisenack 1958, p. 39, pl. 1, fig. 10.

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Dingo Claystone (upper part), W.A. (Cookson and Eisenack 1958, p. 39); Jarlemai Siltstone (lower part) Broome No. 3 Bore between 1,405 and 1,427 ft. Probably Tithonian: Jarlemai Siltstone (upper part) Wallal Core hole at 350 ft.; Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; Broome No. 1 Bore at 977 ft.

Comments. *D. jurassicum* appears to be restricted to deposits of Upper Jurassic age and to be replaced in the Lower Cretaceous by the closely related but distinct species

D. cerviculum Cookson and Eisenack. The occurrence of *D. jurassicum* in the upper portion of the Jarlemai Siltstone is therefore suggestive of an Upper Jurassic age.

Genus CANNINGIA gen. nov.

Description. Shell flattened, roughly five-sided to almost circular with a slight apical prominence and a broadly indented base. The basal projections (corresponding to antapical horns) are either equal or unequal and frequently differ slightly in shape. An equatorial girdle is either absent or faintly indicated both on the surface or by re-entrant angles at the sides. The shell opens by a proximal break which results in the complete detachment of the apical region. Type species *Canningia reticulata* sp. nov.

Canningia reticulata sp. nov.

Plate 38, figs. 1, 2; holotype fig. 1, Nat. Mus. Vic. P17778

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 977 and 963 ft.

Description. Shell with straight or rounded sides; apical projection not prominent, basal indentation clearly marked; a 'girdle' is usually present slightly above the equator. Shell-membrane densely and irregularly reticulate, the reticulum low, small-meshed and thick-walled. Dimensions: holotype—100 μ long and 86 μ broad. Paratype (Pl. 38, fig. 2) *c.* 95 μ long and 98 μ broad. Range—94–108 $\mu \times$ 74–98 μ.

Canningia colliveri sp. nov.

Plate 38, figs. 3, 4; holotype fig. 4, Nat. Mus. Vic. P17779

Occurrence. Aptian: Longreach Drill Co., Balmoral No. 1 Well at 1,000 ft.; Roma Formation, North Queensland, Well on Batavia Downs Station between 45 and 49 ft.; Muderong Shale, W.A., Wapet's Rough Range No. 8 Well between 3,863 and 3,883 ft.

Description. Shell somewhat longer than broad, widest at the equator; apex $\pm$ prominent, antapical projections short and blunt or only slightly indicated. Girdle if present only faintly showing at the sides. Wall thin, granular or closely to sparsely spinulate. Dimensions: holotype—107 μ long, 100 μ broad. Paratype (Pl. 38, fig. 3) 106 μ long, 90 μ broad. The species is named after Mr. F. S. Colliver of the University of Queensland.

HYSTRICHOSPHERES

Family HYSTRICHOSPHAERIDAE

Genus HYSTRICHOSPHAERIDIUM Deflandre 1936

Hystrichosphaeridium pachydermum sp. nov.

Plate 38, fig. 5; text-fig. 5; holotype Nat. Mus. Vic. P17772

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Wallal Core hole at 350 ft. and between 305 and 320 ft.; Broome No. 1 Bore at 963 ft.

Description. Shell spherical, thick-walled (*c.* 3–6 μ) with closely to sparsely arranged short, solid appendages of varying shape some being simple with $\pm$ capitate ends others flattened and equally or unequally bifurcate (text-fig. 5). Dimensions: holotype—

diameter 105 μ, diameter of shell 95 μ. Range—diameter 74–138 μ, diameter of shell 70–109 μ. Appendages 4–10 μ long.

Hystrichosphaeridium torynum sp. nov.

Plate 38, figs. 6, 15; holotype fig. 15, Nat. Mus. Vic. P17773

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 963 and 977 ft.; Broome No. 3 Bore between 1,001 and 1,042 ft. Neocomian: Komewu, Papua, I.E.C.'s No. 2 Well, core 10.

Description. Shell cylindrical with rounded ends and numerous short and apparently solid appendages of variable shape and size which are arranged in ± well-defined whorls around the circumference. The appendages are either narrow and simple with capitate ends or flattened and terminally branched. The opening of the shell appears to have been terminal (Pl. 38, fig. 6). Dimensions: holotype—shell 68 μ long, 33 μ broad; overall 81–56 μ. Appendages *c*. 10 μ long. Range of shell 64–78 $\mu \times$ 32–38 μ.

Hystrichosphaeridium capitatum sp. nov.

Plate 39, fig. 5; holotype Nat. Mus. Vic. P17774

Occurrence. Oxfordian to Kimeridgian: Alexander Formation, W.A., Wallal Core hole between 560 and 578 ft.; Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft.

Description. Shell cylindrical with rounded ends, densely covered with short, solid appendages with capitate or somewhat bifurcate ends and opening by the complete detachment of one end of the shell. Dimensions: holotype—shell 64 μ long, 42 μ broad, overall 72 $\times$ 50 μ. Range of shell 64–66 $\mu \times$ 28–44 μ.

Comments. *H. capitatum* seems distinct from all described species of *Hystrichosphaeridium* with elongate shells; the appendages show some similarity to those of *Hystrichosphaeridium* (*Hystrichosphaera*) *intermedia*? O. Wetzel 1933, but in the absence of a specific description and a satisfactory illustration a close comparison with this species is not possible.

EXPLANATION OF PLATE 38

Figs. 1, 2. *Canningia reticulata* sp. nov. Broome No. 1 Bore, W.A., at 977 ft., $\times c.$ 400.

Figs. 3, 4. *Canningia colliveri* sp. nov. 3, Muderong Shale, W.A., Wapet's Rough Range Well No. 8, 3863–83 ft., $\times$400. 4, Longreach Drill Co's Balmoral Well No. 1, Queensland, at 1,000 ft., $\times$400.

Fig. 5. *Hystrichosphaeridium pachydermum* sp. nov. Wallal Core hole, W.A., 560–75 ft., $\times c.$ 500.

Figs. 6, 15. *Hystrichosphaeridium torynum* sp.nov. Broome No. 1 Bore, W.A., at 977 ft. 6, $\times c.$ 430. 15, $\times c.$ 570.

Figs. 7, 8. *Cyclonephelium areolatum* sp. nov. Broome No. 1 Bore, W.A., at 977 ft. 7, $\times c.$ 400. 8. $\times c.$ 400.

Figs. 9, 10. *Cyclonephelium densebarbatum* sp. nov. 9, Wallal Core hole, W.A., at 305 ft., $\times c.$ 400. 10, Broome No. 1 Bore, W.A., at 963 ft., $\times c.$ 400.

Figs. 11, 12. Incertae sedis, Form A. 11, Komewu, New Guinea, No. 2 well core 10, $\times c.$ 400. 12, Broome No. 1 Bore at 977 ft., $\times c.$ 400.

Fig. 13. *Chlamydophorella wallala* sp. nov. Wallal Core hole, W.A., 560–75 ft., $\times c.$ 500.

Fig. 14. *Leiosphaeridia similis* sp. nov. Wapet's Roebuck Bay Well No. 1, 972–82 ft., $\times c.$ 400.

Figs. 16, 17. *Palaeostomocystis sinuosa* sp. nov. Broome No. 1 Bore at 977 ft., $\times c.$ 400.

Genus CYCLONEPHELIUM Deflandre and Cookson 1955

Cyclonephelium areolatum sp. nov.

Plate 38, figs. 7, 8; holotype fig. 8, Nat. Mus. Vic. P177791

Occurrence. Probably Tithonian; Broome No. 1 Bore at 963 and 977 ft.

Description. Shell flat, circular or slightly oval in outline with a peripheral sculptured zone (*c.* 15–20 μ broad) on both sides, in the form of a thin, finely vermiculate or areolate membrane; the unsculptured portion of the shell is generally smooth. A transverse 'girdle' is usually present. A pylome is formed by the detachment of the apical region. Dimensions holotype—70 μ long, 62 μ broad. Range—57–90 $\mu \times 62$–74 μ.

Cyclonephelium densebarbatum sp. nov.

Plate 38, figs. 9, 10; holotype fig. 10, Nat. Mus. Vic. P17776

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 963 ft. and 977 ft.; Wapet's Wallal Core hole between 305 and 320 ft., Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well, core 11 between 972 and 982 ft.

Description. Shell flat, circular to slightly polygonal with a broad (*c.* 16–24 μ) peripheral zone ornamented on both sides with short, densely arranged, rod-shaped bristles ranging from *c.* 2–12 μ in length, with simple, usually capitate or sometimes bifurcate ends, and inner areas without bristles but with granular surfaces. A transverse 'girdle' is sometimes evident; a large terminal pylome results from the complete detachment of the apical region. Dimensions: holotype—shell 95 μ long, 92 μ broad, overall 100 $\times$ 98 μ. Range—overall diameter 86–114 μ.

Comments. When the genus *Cyclonephelium* was created the number of examples of the genotype *C. compactum* Defl. and Cookson was insufficient for the exact orientation of the shell. Since then more specimens of this species have been seen and from them and particularly from the new species *C. areolatum* and *densebarbatum* it is clear that the shells of *Cyclonephelium* are bilaterally and not radially symmetrical as was originally thought. A bilateral construction is supported by the frequent presence of a transverse 'girdle', an apical pylome and the sometimes stronger development of the ornament at the apex. It follows therefore that the ornamented and unornamented portions of the shell of *Cyclonephelium* are neither 'equatorial' nor 'polar', respectively, as given in the generic description.

C. densebarbatum differs from *C. distinctum* Defl. and Cookson, the species of *Cyclonephelium*, to which it is most closely similar, in the stouter nature of the shell and the much denser arrangement of the bristles. The examples from the Wallal deposit on the whole have longer bristles, especially at the antapical region (Pl. 38, fig. 9), than those from the Broome and Roebuck Bay deposits.

Genus CANNOSPHAEROPSIS O. Wetzel 1933

Cannosphaeropsis mirabilis Cookson and Eisenack

Cannosphaeropsis mirabilis; Cookson and Eisenack 1958, p. 48, pl. 8, fig. 3.

Occurrence. Upper Jurassic to ?Neocomian: Omati, Papua, I.E.C.'s Well No. 1, samples 19, 20, 25,

26, 29 (Cookson and Eisenack 1958, fig. 2). Probably Tithonian: Broome No. 1 Bore at 963 and 977 ft. Neocomian: Komewu, Papua, I.E.C.'s Well No. 2, core 10.

Comment. From the above occurrences it seems likely that *C. mirabilis* ranged from late Upper Jurassic to Neocomian. The age of the Omati core samples 19 and 20 is still in doubt. The occurrence of *C. mirabilis* in Broome No. 1 Bore provides the first record of this species outside New Guinea.

Cannosphaeropsis apiculata sp. nov.

Plate 39, fig. 15; holotype Nat. Mus. Vic. P17789

Occurrence. Probably Tithonian: Broome No. 1 Bore between 1,001 and 1,042 ft. Neocomian: Komewu Papua, I.E.C.'s Well No. 2, core 10.

Description. Shell small, spherical with a simple network composed of about eight to twelve solid and sometimes flattened supporting processes which branch distally and thin connecting threads which bear small spinules. Dimensions: holotype—shell 40 μ, overall 86 μ; other specimens shell 30–40 μ, overall 55–76 μ.

Family LEIOSPHAERIDAE
Genus LEIOSPHAERIDIA Eisenack 1958
Leiosphaeridia similis sp. nov.

Plate 38, fig. 14; holotype Nat. Mus. Vic. P17777

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; Broome No. 1 Bore at 977 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well, core 11, between 972 and 982 ft. Late Upper Jurassic: Omati, Papua, I.E.C.'s No. 1 Well, sample 21 (Cookson and Eisenack 1958, fig. 2).

Description. Shell relatively large, spheroidal but generally folded, with a circular pylome; the shell-membrane, which is thin and faintly granular, is somewhat thicker around the pylome. Dimensions: diameter of shell 70–100 μ, diameter of pylome 13–22 μ.

Comments. A form which appears close to, if not identical, with *Leiosphaeridia similis* has been recorded, without description, from the Kimeridge Clay of England by Downie (1957, fig. c 3) under the name *?Leiosphaera hyalina* Defl. However, since Deflandre's

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EXPLANATION OF PLATE 39

Fig. 1. *Kalyptea diceras* sp. nov. Broome No. 1 Bore at 977 ft., ×400.
Figs. 2, 3. *Kalyptea monoceras* sp. nov. Komewu, Papua, No. 1 Well, core 15. 2, ×500. 3, ×400.
Figs. 4–6. *Diplotesta glaessneri* sp. nov. 4, Broome No. 3 Bore, W.A., 1001–42 ft., ×*c.* 500. 5, Lake Phillipson Bore, S.A., 87 ft., ×500. 6, showing longitudinal striations, Broome No. 3 Bore, 1001–42 ft., ×680.
Figs. 7, 8. *Komewuia glabra* sp. nov. Broome No. 3 Bore, W.A., 1001–42 ft. 7, ×300. 8, showing 'lid' of pylome, ×*c* 300.
Fig. 9. *Hystrichosphaeridium capitatum* sp. nov. Broome No. 3 Bore, 405–27 ft., ×*c.* 500.
Fig. 10. *Belodinium dysculum* sp. nov. Broome No. 3 Bore, 1001–42 ft., ×470.
Fig. 11. *Chlamydophorella wallala* sp. nov. Wallal Core hole 560–575 ft., ×480.
Figs. 12–14. *Dictyopyxis areolata* sp. nov. Broome No. 3 Bore, 1405–27 ft., ×*c.* 400.
Fig. 15. *Cannosphaeropsis apiculata* sp. nov. Komewu, Papua, No. 2 Well, core 10, ×*c.* 400.
Fig. 16. *Palaeostomocystis cylindrica* sp. nov. Broome No. 1 Bore, 977 ft., ×*c.* 530.

description, based on material from the French Kimeridgian, gives no indication that a pylome is present, identification of the Australian form, of which a clearly defined pylome is a constant feature, with this species does not seem justifiable. *Leiosphaeridia similis* is distinct from *L. voigti* Eisenack 1958 from the Ordovician *Dictyonema* Shale of Esthonia in its smaller size and the less pronounced annular thickening around the pylome.

INCERTAE SEDIS

Genus CHLAMYDOPHORELLA Cookson and Eisenack 1958

Chlamydophorella wallala sp. nov.

Plate 38, fig. 13; Plate 39, fig. 11; holotype, fig. 13, Nat. Mus. Vic. P17780

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft. Probably Tithonian: Jarlemai Siltstone (upper part), Wallal Core hole at 350 ft.

Description. Shell approximately cylindrical in outline with rounded ends, covered with numerous short bifurcate processes which support a delicate external membrane; on one surface the processes tend to be linearly arranged especially in the equatorial region. An apical process is not developed; the shell opens by the detachment of the wall of one end. Dimensions: holotype—shell 57 μ long, 40 μ broad; overall 67 μ–50 μ. Paratype (Pl. 39, fig. 11) 52 $\mu \times 38\,\mu$, overall 57 $\mu \times 43\,\mu$. Overall range—57–81 $\mu \times 38$–62 μ. Processes *c.* 3–8 μ.

Comments. C. wallala is distinct from the type species, *C. nyei* Cookson and Eisenack, in its elongate form and in the absence of an apical projection.

Genus DICTYOPYXIS gen. nov.

Description. Shell elongate with rounded ends and a reticulate wall; a division into epitheca and hypotheca and the presence of a 'girdle' may be suggested by the more regular shape and arrangement of the meshes at or near the equator. The shell opens by the detachment of one of the ends. Type species *Dictyopyxis areolata* sp. nov.

Dictyopyxis areolata sp. nov.

Plate 39, figs. 12–14; holotype fig. 12, Nat. Mus. Vic. P17781

Occurrence. Oxfordian to Lower Kimeridgian: Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft.; Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft.

Description. Shell ellipsoidal to nearly cylindrical. Reticulum irregular, thin-walled with four- to six-sided meshes of varying size. In the equatorial region the meshes tend to be more regularly arranged and square to rectangular in shape giving the impression of a 'girdle'. A longitudinal row of elongate meshes is sometimes evident but the significance of this arrangement is not clear. Dimensions: holotype—*c.* 100 μ long, 66 μ broad. Range—86–124 $\mu \times 54$–66 μ.

Comments. D. areolata superficially resembles *Palaeoperidinium reticulatum* Valensi (1953, p. 28) from French Bajocian and Bathonian flints but shows no indication of the two superimposed reticula which characterize this species.

Genus DIPLOTESTA gen nov.

Description. Shell cylindrical or elongate-ellipsoidal, straight or curved, with rounded or bluntly pointed apices and partially filled with an elongate oval capsule. Membrane of shell smooth or finely and longitudinally striate; wall of capsule smooth. Type species *Diplotesta glaessneri* sp. nov.

Diplotesta glaessneri sp. nov.

Plate 39, figs. 4–6; holotype fig. 4, Nat. Mus. Vic. P17782

Occurrence. Upper Jurassic (Oxfordian to Lower Kimeridgian): Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft.; Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft. Probably Tithonian: Jarlemai Siltstone (upper portion), Wallal Core hole between 305 and 320 ft.; Broome No. 3 Bore between 1,200 and 1,211 ft. and between 1,001 and 1,042 ft.; Broome No. 1 Bore at 977 ft.; Roebuck Bay, W.A., Wapet's Well No. 1 between 972 and 982 ft. Lower Cretaceous (Aptian or older): Lake Phillipson Bore, S.A., at 87 ft. 10 in.; Santos Ltd., Oodnadatta Bore between 1,052 and 1,061 ft.; Wapet's Meadow Station Bore No. 9, W.A.

Description. Shell cylindrical, straight or curved, distal end bluntly pointed, proximal end not diminishing in size and apparently rounded. In all of the many examples observed the proximal end of the shell has been open and the edge clean-cut; in a number of them, including the type, and the example shown in Pl. 39, fig. 5, the proximal wall has separated off as a 'lid', seemingly along a preformed line of weakness, and is to be seen still attached at one side.

The capsule has a thin, smooth wall and extends laterally to or almost to the shell membrane, the latter is either smooth or longitudinally striate (Pl. 39, fig. 6). The capsule opens by means of a V-shaped apical split to one side of the middle line. Dimensions: holotype—length (without lid) 100 μ, breadth 24 μ, capsule 58 μ long, 24 μ broad. Paratype (Pl. 39, fig. 5) 80 $\mu \times 38\,\mu$, capsule 62$\mu \times 38\,\mu$. Range—length (without lid) 80–128 μ, breadth 24–38 μ. Capsule 53–84 μ long, 24–38 μ broad. The specific name is after Dr. M. F. Glaessner, University of Adelaide.

Comments. Although the Upper Jurassic and Lower Cretaceous representatives of *Diplotesta* have been included in one species slight differences between them exist. In the Upper Jurassic forms the shell is usually straight and the wall frequently longitudinally striate, whereas in the Lower Cretaceous examples observed the shells have all been curved and have unpatterned walls, moreover the latter are somewhat broader and shorter.

Genus KALYPTEA gen. nov.

Description. Shell spherical, oval to ellipsoidal, narrowing to an apical horn of variable length and either with or without an antapical horn; shell-membrane thin, smooth or finely granular. The shell, itself, is surrounded by a diaphanous veil-like external membrane. Type species *Kalyptea diceras* sp. nov.

Kalyptea diceras sp. nov.

Plate 39, fig. 1; holotype Nat. Mus. Vic. P17783

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 1 Bore at 977 ft. and Broome No. 3 Bore between 1,001 and 1,042 ft.

Description. Shell ellipsoidal with apical and antapical horns of unequal length. The

apical horn is relatively long, straight or curved, and consists of a short hollow basal region and a longer and more slender solid apex. The antapical horn is considerably shorter but like the apical horn ends in a solid tip. The membrane of the shell is thin and finely granular; the external membrane in the type specimen is clearly attached to the tip of the apical horn. Dimensions: holotype—shell 152 μ long, 47 μ broad; apical horn 48 μ long, antapical horn about 15 μ. Another example 168 $\mu \times 33\,\mu$.

Comments. K. diceras is similar in general features to a specimen from the high Dogger described, in an unpublished thesis submitted to the University of Tübingen, by Mr. G. Alberti, the only apparent difference being the more circular shell outline of the latter. In the Australian specimens the amount of the outer membrane present seems to be dependent upon the state of preservation.

Kalyptea monoceras sp. nov.

Plate 39, figs. 2, 3; holotype fig. 2, Nat. Mus. Vic. P17784

Occurrence. Probably Tithonian: Jarlemai Siltstone (upper portion), Broome No. 1 Bore at 963 ft.; Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft. Late Upper Jurassic: Komewu, Papua, I.E.C.'s No. 1 Well, core 15.

Description. Shell oval to almost circular in outline narrowing distally towards a short, slender horn, the terminal half of which is solid. Shell-membrane thin and finely granular. Outer 'veil' typically strongly developed but sometimes only slightly preserved. Dimensions: holotype—75 μ long, 43 μ broad, overall length 80 μ, breadth 100 μ. Paratype (Pl. 39, fig. 4) 88 μ long, 52 μ broad, overall *c.* 100 $\mu \times 100\,\mu$.

Comments. It seems possible that the specimen referred to as *Pareodinia aphelis* by Cookson and Eisenack (1958, pl. 12, fig. 4) might be an imperfect example of *K. monoceras*.

Genus KOMEWUIA gen. nov.

Description. Shell ±flattened, rounded-rhombic in outline with relatively short apical and antapical horns and without tabulation, girdle, or furrows. A pylome is developed. Type species *Komewuia glabra* sp. nov.

Komewuia glabra sp. nov.

Plate 39, figs. 7, 8; holotype fig. 8, Nat. Mus. Vic. P17785

Occurrence. Late Upper Jurassic: Komewu, Papua, I.E.C.'s No. 1 Well, core 15. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well, core 11 between 972 and 982 ft.

Description. Shell flattened, rounded-rhombic in outline, longer than broad with rather strong, bluntly pointed apical and antapical horns of unequal length, the apical horn being the longer, and sometimes a relatively large pylome just below the apical horn. Shell-membrane faintly granular, smooth in optical section. Dimensions: holotype—132 μ long, 102 μ broad; lid of pylome 50 $\mu \times 40\,\mu$. Range 80–157 $\mu \times$ 66–104 μ.

Genus NANNOCERATOPSIS Deflandre 1938
Nannoceratopsis pellucida Deflandre

Nannoceratopsis pellucida Deflandre 1938, p. 183, pl. 8, fig. 10.

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wapet's Wallal Core hole between 560 and 575 ft.; Dingo Claystone (upper portion), W.A. (Cookson and Eisenack 1958, p. 52); Jarlemai Siltstone (lower portion), W.A., Broome No. 3 Bore between 1,405 and 1,427 ft.; Omati, Papua, I.E.C.'s Well No. 1, samples 31, 35. Probably Tithonian: Jarlemai Siltstone (upper portion), Wallal Core hole at 350 ft. and between 305 and 320 ft. Late Upper Jurassic: Komewu, Papua, I.E.C.'s Well No. 1, core 15.

Comments. The occurrence of *N. pellucida* in the upper portion of the Jarlemai Siltstone supports the Upper Jurassic (probably Tithonian) age suggested for this portion of the Siltstone. The Australian and New Guinea shells referred to *N. pellucida* have varied somewhat in the degree of ornamentation, some have been almost smooth, others densely and finely granular, while a few have been finely reticulate. These variations seem to us too inconstant for a subdivision of *N. pellucida* on this character.

Genus PALAEOSTOMOCYSTIS Deflandre 1935
Palaeostomocystis cylindrica sp. nov.

Plate 38, fig. 16; holotype Nat. Mus. Vic. P17786

Occurrence. Oxfordian to Lower Kimeridgian: Alexander Formation, W.A., Wallal Core hole between 560 and 575 ft. Probably Tithonian: Jarlemai Siltstone (upper portion), W.A., Broome No. 3 Bore between 1,200 and 1,211 ft., and 1,001 and 1,042 ft., Broome No. 1 Bore at 963 and 977 ft.; Wallal Core hole at 350 ft., and between 305 and 320 ft.; Roebuck Bay, W.A., Wapet's No. 1 Well between 972 and 982 ft. Neocomian: Komewu, Papua, I.E.C.'s Well No. 2, core 10.

Description. Shell cylindrical with rounded ends and a terminal, slightly sunken opening. Wall about 4 μ thick, finely granular, ornamented with a low, small-meshed, thick-walled reticulum. Dimensions: holotype—71 μ long, 48 μ broad, opening *c*. 14 μ. Range —76–86 $\mu \times$ 38–56 μ, opening 10–20 μ.

Palaeostomocystis sinuosa sp. nov.

Plate 38, figs. 16, 17; holotype fig. 16, Nat. Mus. Vic. P17787

Occurrence. Probably Tithonian: Broome No. 1 Bore at 977 ft.; Broome No. 3 Bore between 1,011 and 1,042 ft.

Description. Shell small, rather flat, outline squarish and $\pm$ deeply embayed with four to seven rounded prominences; a clearly marked circular opening occupies the greater part of one of the 'bays'. The shell-membrane is thin and finely granular, sometimes more pronouncedly so over the ends of the prominences. Dimensions: holotype—48 $\mu \times$ 48 μ, opening 16 μ. Range—38–54 μ, opening 12–24 μ.

Comments. *Palaeostomocystis cylindrica* and *P. sinuosa* have been placed in the genus *Palaeostomocystis* because the opening in the shells of both species appears to be a constant morphological feature.

Gen. et sp. indet. Form A

Plate 38, figs. 11, 12; Nat. Mus. Vic. P17790

Occurrence. Probably Tithonian: Broome No. 1 Bore at 977 ft.; Broome No. 3 Bore between 1,200 and 1,211, 1,001 and 1,042 ft. Neocomian: Komewu, Papua, I.E.C.'s Well No. 2, core 10.

Description. Shell hollow, always compressed and frequently damaged, usually longer than broad with one side convex, the other straight or slightly concave; the ends of the shell are generally broken but one appears to have been straight, the other rounded. A narrow girdle-like zone due to the uneven thickening of the wall sometimes encircles the middle part of the shell in much the same way as in *Fromea amphora* Cookson and Eisenack 1958. Dimensions: 43–86 μ long, 40–67 μ broad.

Comments. The interest of Form A lies in its occurrence in deposits that appear to be situated close to the Cretaceo–Jurassic boundary.

MICROPLANKTON ASSEMBLAGES

A. *Oxfordian to Lower Kimeridgian*

1. Jarlemai Siltstone (lower portion), Broome No. 3 Bore between 1,405 and 1,427 ft. In addition to the species already listed (Cookson and Eisenack 1958, p. 62) the following have been observed: Dinoflagellata: *Gonyaulax eumorpha*, *Scriniodinium apatelum*, *S. ceratophorum*. Hystrichosphaeridea: *Hystrichosphaeridium capitatum*. Incertae sedis: *Dictyopyxis areolata*, *Diplotesta glaessneri*.

2. Alexander Formation, Wapet's Wallal Core hole between 560 and 575 ft. The microplankton includes: Dinoflagellata: *Gonyaulax eumorpha*, *Scriniodinium apatelum*, *S. dictyodermum*, *S. luridum*, *Dingodinium jurassicum*, *Wetzeliella irregularis* Cookson and Eisenack. Hystrichosphaeridea: *Hystrichosphaeridium pachydermum*, *H. capitatum*, *Cannosphaeropsis aemula* (Defl.). *Cyclonephelium densebarbatum*, *Leiofusa jurassica* Cookson and Eisenack, *Pyxidiella pandora* Cookson and Eisenack. Incertae sedis: *Chlamydophorella wallala*, *Nannoceratopsis pellucida*, *Palaeostomocystis cylindrica*, *Wanaea clathrata* Cookson and Eisenack, *Pareodinia aphelia* Cookson and Eisenack, *Dictyopyxis areolata*.

B. *Probably Tithonian*

1. Jarlemai Siltstone (upper portion)

(*a*) Broome No. 3 Bore, 1,001 and 1,211 ft. Dinoflagellata: *Gonyaulax clathrata*, *Scriniodinium luridum*, *S. apatelum*, *S. dictyodermum*, *Dingodinium jurassicum*, *Broomea simplex*, *Belodinium dysculum*. Hystrichosphaeridea: *Cyclonephelium densebarbatum*, *Cannosphaeropsis apiculata*, *Leiosphaeridia similis*. Incertae sedis: *Diplotesta glaessneri*, *Kalyptea diceras*, *K. monoceras*, *Komewuia glabra*, *Palaeostomocystis cylindrica*, *P. sinuosa*.

(*b*) Wallal Core hole at 350 ft. Dinoflagellata: *Gonyaulax* cf. *ambigua*, *Scriniodinium dictyodermum*, *S. apatelum*, *S. playfordi*, *Dingodinium jurassicum*. Hystrichosphaeridea: *Hystrichosphaeridium pachydermum*. Incertae sedis: *Nannoceratopsis pellucida*, *Palaeostomocystis cylindrica*, *Chlamydophorella wallala*.

(*c*) Wallal Core hole between 305 and 320 ft. Dinoflagellata: *Scriniodinium luridum*, *S. dictyodermum*, *S. apatelum*. Hystrichosphaeridea: *Hystrichosphaeridium pachydermum*, *Cyclonephelium densebarbatum*. Incertae sedis: *Diplotesta glaessneri*, *Nannoceratopsis pellucida*, *Palaeostomocystis cylindrica*.

(*d*) Broome No. 1 Bore between 963 and 977 ft. Dinoflagellata: *Gonyaulax eumorpha*, *G. serrata*, *G. bulloidea*, *Scriniodinium luridum*, *Wetzeliella irregularis*, *Belodinium dysculum*, *Canningia reticulata*, *Broomea simplex*. Hystrichosphaeridea: *Hystrichosphaeridium pachydermum*, *H. torynum*, *Cyclonephelium areolatum*, *C. densebarbatum*, *Cannosphaeropsis mirabilis*. Incertae sedis: *Diplotesta glaessneri*, *Kalyptea diceras*, *Palaeostomocystis cylindrica*, *P. sinuosa*.

2. Roebuck Bay, Well No. 1 between 972 and 982 ft. Dinoflagellata: *Scriniodinium playfordi*, *S. apatelum*, *S. dictyodermum*, *S. clathratum*, *Belodinium dysculum*. Hystrichosphaeridea: *Cyclonephelium densebarbatum*, *Leiosphaeridia similis*. Incertae sedis: *Komewuia glabra*, *Palaeostomocystis cylindrica*.

STRATIGRAPHICAL CONCLUSIONS

This study of the microplankton obtained from the upper portion of the Jarlemai Siltstone has shown that:

1. Although the total microplankton population of different localities varies, sometimes considerably, there are a sufficient number of species in common to permit of an approximate correlation between them (see Table).

2. The microplankton content of the upper portion of the Jarlemai Siltstone is distinct from that of the lower portion both in the presence of species not occurring at the lower level (Broome No. 3 Bore between 1,405 and 1,427 ft.) and the apparent absence of such Oxfordian and Lower Kimeridgian types as: *Scriniodinium crystallinum* (Defl.), *Gonyaulax jurassica* Defl., and *Wanaea digitata* Cookson and Eisenack.

TABLE

Distribution of some of the microplankton occurring in the Upper Jurassic of the Canning Basin, Western Australia

Species	*Oxfordian to Lower Kimeridgian*		*Probably Tithonian*						
	Broome B. 3 1405–27 ft.	Wallal C.h. 560–75 ft.	Broome B. 1 963 ft.	Broome B. 1 977 ft.	Broome B. 3 1001–20 ft.	Broome B. 3 1200–11 ft.	Wallal C.h. 350 ft.	Wallal C.h. 305–20 ft.	Roebuck Bay 972–82 ft.
Gonyaulax eumorpha	+	+	−	+	−	−	−	−	−
Gonyaulax clathrata	−	−	−	−	+	+	−	−	+
Scriniodinium luridum	+	+	+	+	+	+	−	+	+
Scriniodinium dictyodermum	−	+	−	−	+	−	+	+	+
Scriniodinium apatelum	+	+	−	+	+	−	+	+	+
Dingodinium jurassicum	+	+	−	−	+	+	+	−	−
Nannoceratopsis pellucida	+	+	−	−	−	−	+	+	−
Diplotesta glaessneri	+	+	−	−	+	+	−	+	+
Leiosphaeridia similis	−	−	−	+	+	+	−	−	+
Komewuia glabra	−	−	−	−	+	+	−	−	+
Palaeostomocystis cylindrica	−	+	+	+	+	+	+	+	+
Cyclonephelium densebarbatum	−	+	+	+	+	+	−	+	+
Kalyptea monoceras	−	−	+	−	+	+	−	−	−

3. The age of the upper portion of the Jarlemai Siltstone in containing such Upper Jurassic types as *Scriniodinium luridum* (Defl.), *Dingodinium jurassicum* Cookson and Eisenack, and *Nannoceratopsis pellucida* Defl. is almost certainly Upper Jurassic and not Lower Cretaceous as at one time was suspected.

4. The deposit from the Roebuck Bay No. 1 Well between 972 and 982 ft. for which a Kimeridgian–Oxfordian age has been tentatively suggested by Wapet geologists, probably approximates to the age of the Broome No. 3 sample between 1,001 and 1,042 ft., i.e. probably Tithonian.

5. The microplankton content of the Wallal deposit between 560 and 575 ft. agrees well with that of the upper portion of the Dingo Claystone, W. A. (Oxfordian to Lower Kimeridgian). It seems probable, therefore, that the age of the sediments at this level is similarly Oxfordian to Lower Kimeridgian.

6. Seven of the species present in the upper portion of the Jarlemai Siltstone also occur in Upper Jurassic and/or Neocomian deposits in Papua, New Guinea, namely *Gonyaulax serrata*, *Hystrichosphaeridium torynum*, *Cannosphaeropsis apiculata*, *C. mirabilis*, *Komewuia glabra*, *Leiosphaeridia similis*, and *Palaeostomocystis cylindrica*.

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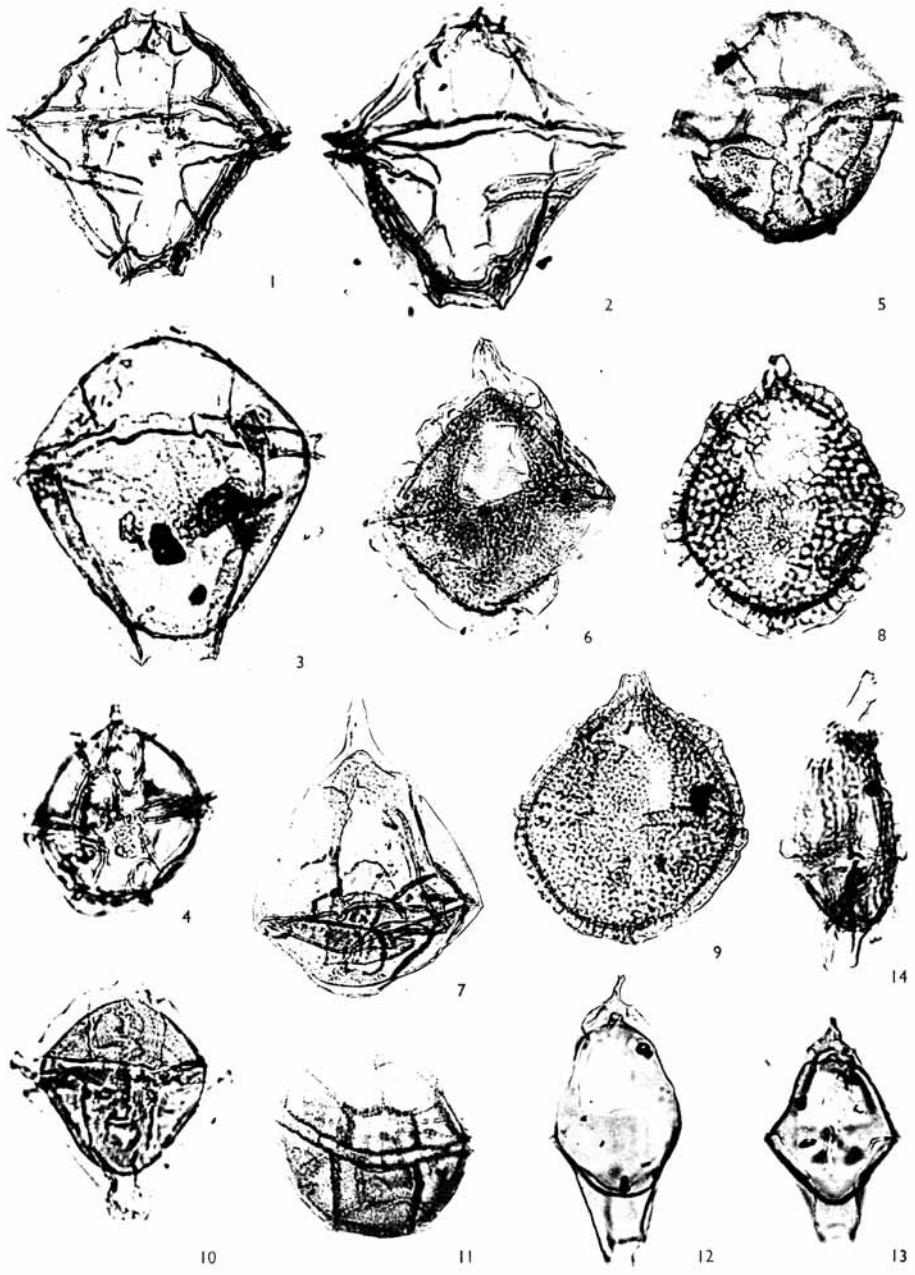

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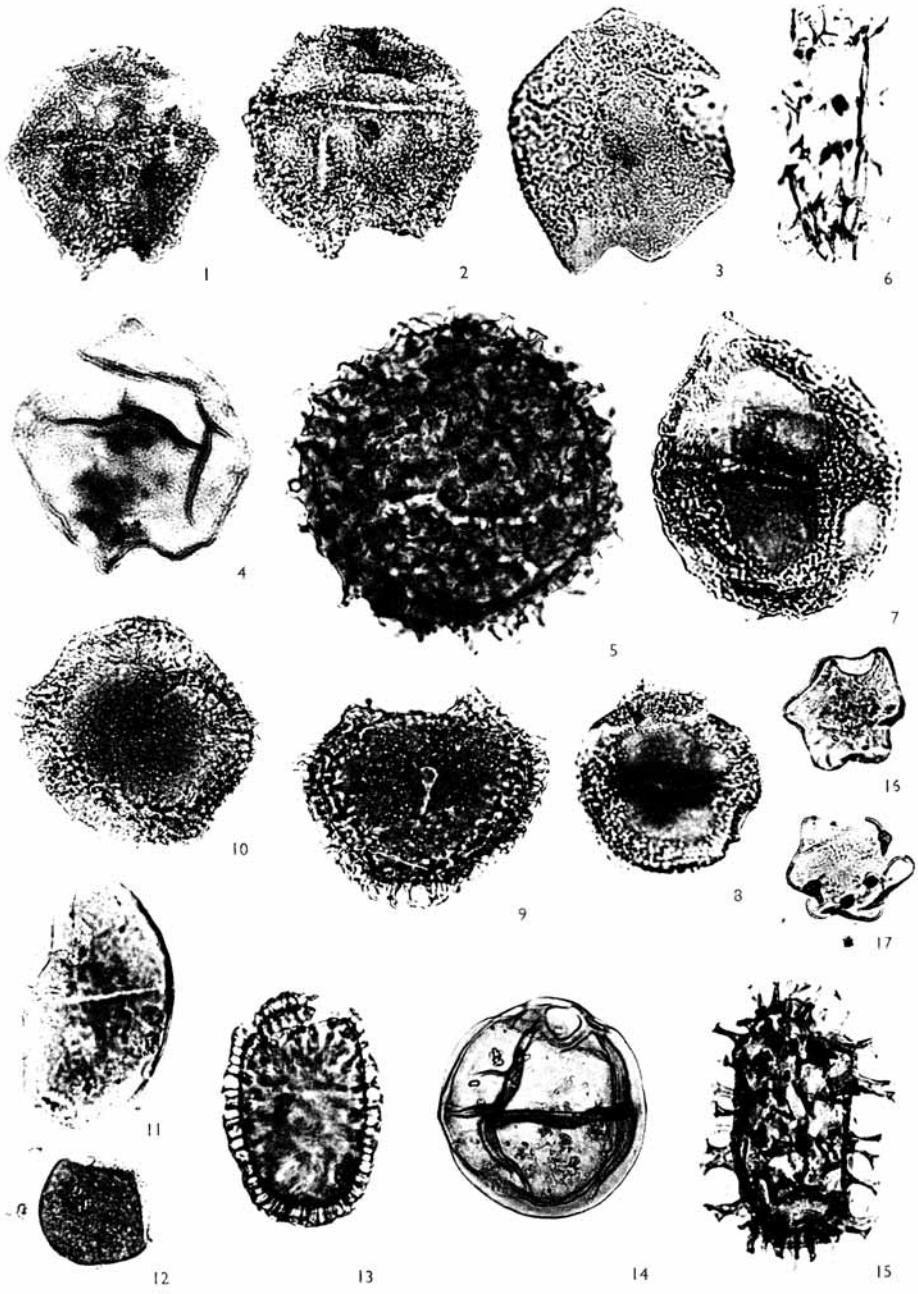

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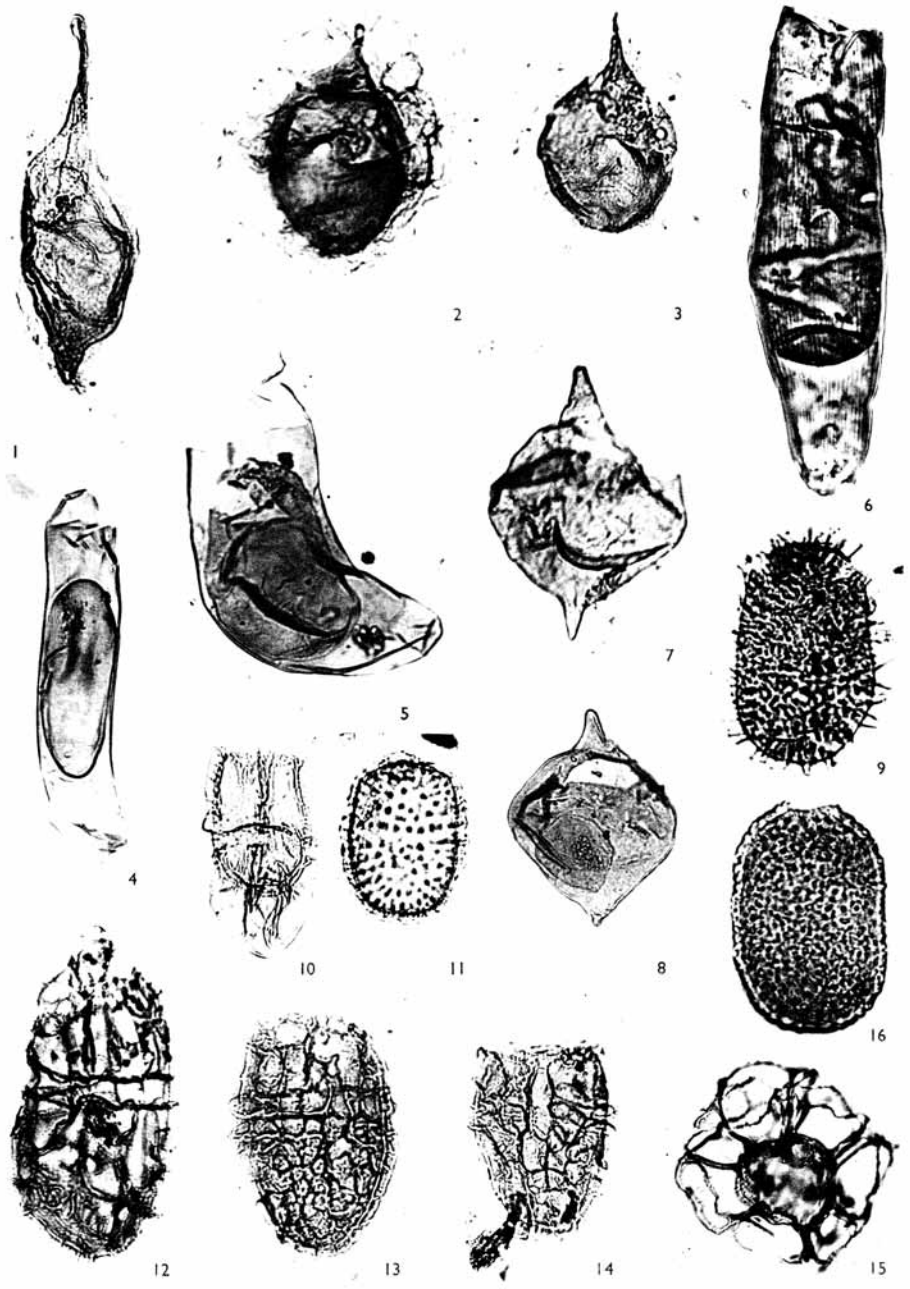

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