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Eocene Dinoflagellate Cysts of Taiwan

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ABSTRACT: Forty-one Eocene dinoflagellate taxa from offshore Keelung, northern Taiwan are reported, thirty-two of which are described for the first time in Taiwan. They belong to one class, one order, four suborders, twelve families and twenty genera; namely 10 taxa (*Spinidinium taiwanianum sp. nov.*; *Apectodinium homomorphum* (Deflandre & Cookson) Lentin & Williams; *Apectodinium raritubiformium* Shaw; *Kisselovia coleothrypta* (Williams & Downie) Lentin & Williams; *K. taiwaniana* Shaw in Taiwania; *K. pengchiahsuensis* Shaw; *Wetzeliella symmetrica* Weiler var. *taiwaniana* Shaw; *W. symmetrica* Weiler var. *scabrata* Shaw; *W. articulata* Eisenack var. *taiwaniana* Shaw; *W. articulata* Eisenack var. *scabrata* Shaw), two Families for the Deflandreineae; 14 taxa (*Aireiana taiwaniana sp. nov.*; *Cordosphaeridium cordium* sp. nov.; *C. fibrospinosum* Davey & Williams; *C. taiwanianum sp. nov.; Turbiosphaera filosa* (Wilson) Archangelsky; *Impagidinium gracilium* sp. *nov.; I. taiwanianum sp. nov.; I. pengchiahsum sp. nov.; Ochetodinium taiwanianum sp. nov.; Operculodinium taiwanianum sp. nov.; Achomosphaera taiwaniana sp. nov.; Spinferites formosus sp. nov.*; *S. ramosus* subsp. *multibrevis* (Davey & Williams) Lentin; *S. scabrosus* (Clarke & Verdier) Lentin & Williams), 4 Families for the Gonyaulacystineae; 16 taxa (*Areoligera taiwaniana sp. nov.; Batiacasphaera microreticulata sp. nov.; B. microreticulata Shaw minima var. nov.; B. setulosa sp. nov.; B. setulosa Shaw minima var. nov.; B. extravermiculata sp. nov.; B. granulata sp. nov.; Homotryblium taiwanianum sp. nov.; Hystrichokolpoma cinctum Klumpp; H. taperinia sp. nov.*; *Oligosphaeridium complex* Davey & Williams in Davey *et al.*; *Systematophora taiwaniana sp. nov.*; *S. placacantha* (Deflandre & Cookson) Davey *et al.*; *Eisenackia circumtabulata* Drugg; *E. formosana sp. nov.*; *E. taiwaniana* sp. nov.), 5 Families for the Hystrichosphaeridiineae and one taxon (*Thalassiphora pelagica* (Eisenack) Eisenack & Gocht), one Family for the Incertae.

KEY WORDS: Eocene, Dinophyceae, Taxonomy, Taiwan area.

INTRODUCTION

Organic walled dinoflagellate cysts were first reported from Taiwan's Tertiary by Huang (1981) dealing with Miocene cysts. Taiwan's Eocene palynology was first investigated by this author in 1988. A total of forty-nine cores from offshore Keelung in northern Taiwan were collected for that study. The samples were brought to Chinese Petroleum Corporation Micropaleontological Laboratory and many dinoflagellate cysts were identified. Three papers have been published from that study (Shaw, 1997; Shaw, 1998; Shaw, 1999). This is the fourth paper and the second on fossil dinoflagellate cysts. This work is still continuing and more papers will be ready for publication and several questionable palynomorphs

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will require for further study. In the final complete report the author will include a checklist of the Eocene fossil flora and biostratigraphy offshore, Keelung area.

This paper includes extensive discussion of fossil dinoflagellate cysts of Dinophyceae found from offshore Keelung, on their morphology, taxonomy, and stratigraphic occurrences.

MATERIALS AND METHODS

Side-wall core samples from OK-1, OK-2 and OK-3 wells were made available to the author (Shaw, 1999). Forty-nine samples were prepared by Chinese Petroleum Corporation Micropaleontological Laboratory for a palynological study.

Shaw(1990)'s methed was adapted for palynomorph extraction, including 10% KOH treatment for dissolution of humic material, heavy solution of $ZnCl_2$ for floatation (S. G. 1.8-2.2), and 30% HCl and 52% HF for dissolution of the laterite pebble samples, which had been collected from the exploration well.

Photomicrographs were taken with a Zeiss Axiophot microscope equipped with an automatic camera using Kodacolor Gold (ASA 100) film. For fossil identification, the standard references used by Eisenack (1967), Eisenack and Kjellstrom (1971), Williams, Sarjeant, and Kidson (1978), Wilson and Clowes (1980) were adopted. The fossil slides are catalogued and stored at the Micropaleontology Laboratory, Chinese Petroleum Corporation.

RESULT

Forty-one taxa are reported in this paper, thirty-two of which are described for the first time in Taiwan. They belong to one class, one order, four suborders, twelve families and twenty genera; namely 10 taxa, two families for Deflandreineae; 14 taxa, four families for Gonyaulacystineae; 16 taxa, five families for Hystrichosphaeridiineae and one taxon, one family for Incertae. They are listed below:

Class Dinophyceae Fritsch
Order Peridiniales Haeckel
Suborder Deflandreineae Eisenack emend. Norris
Family **Deflandreaceae** Eisenack emend. Sarjeant and Downie
Genus *Spinidinium* Cookson & Eisenack emend. Lentin & Williams .
Spinidinium taiwanianum sp. nov.
Family **Wetzeliellaceae** Vozzhennikova
Genus *Apectodinium* Costa & Downie *ex* Lentin & Williams
Apectodinium homomorphum (Deflandre & Cookson) Lentin & Williams
Apectodinium raritubiformium Shaw
Genus *Kisselovia* Vozzhennikova
Kisselovia coleothrypta (Williams & Downie) Lentin & Williams
Kisselovia taiwaniana Shaw
Kisselovia pengchiahsuensis Shaw

Genus *Wetzeliella* Eisenack emend Lentin & Williams
Wetzeliella symmetrica Weiler *taiwaniana* Shaw
Wetzeliella symmetrica Weiler *scabrata* Shaw
Wetzeliella articulata Eisenack *taiwaniana* Shaw
Wetzeliella articulata Eisenack *scabrata* Shaw

Suborder Gonyaulacystineae Eisenack emend. Norris
Family **Cordosphaeridiaceae** Sarjeant and Downie emend. Norris
Genus *Aireiana* Cookson & Eisenack
Aireiana taiwaniana sp. nov.
Genus *Cordosphaeridium* Eisenack emend. Davey
Cordosphaeridium cordium sp. nov.
Cordosphaeridium fibrospinosum Davey & Williams
Cordosphaeridium taiwanianum sp. nov.
Genus *Turbiosphaera* Archangelsky
Turbiosphaera filosa (Wilson) Archangelsky
Family **Gonyaulacystaceae** Sarjeant and Downie emend. Sarjeant and Downie
Genus *Impagidinium* Stover & Evitt
Impagidinium gracilium sp. nov.
Impagidinium taiwanianum sp. nov.
Impagidinium pengchiahsum sp. nov.
Genus *Ochetodinium* Damassa
Ochetodinium taiwanianum sp. nov.
Family **Lingulodiniaceae** Sarjeant and Downie
Genus *Operculodinium* Wall
Operculodinium taiwanianum sp. nov.
Family **Spiniferitaceae** Sarjeant and Downie emend. Norris
Genus *Achomosphaera* Evitt
Achomosphaera taiwaniana sp. nov.
Genus *Spiniferites* Mantell emend. Sarjeant
Spinferites formosus sp. nov.
Spiniferites ramosus subsp. *multibrevis* (Davey & Williams) Lentin & Williams
Spiniferites scabrosus (Clarke & Verdier) Lentin & Williams

Suborder Hystrichosphaeridiineae Norris
Family **Areoligeraceae** Evitt emend. Sarjeant and Downie
Genus *Areoligera* Lejeune-Carpentier emend. Williams & Downie
Areoligera taiwaniana sp. nov.
Family **Batiacasphaeraceae** Dorhofer and Davies
Genus *Batiacasphaera* Drugg
Batiacasphaera microreticulata sp. nov.
Batiacasphaera microreticulata Shaw *minima* var. nov.
Batiacasphaera setulosa sp. nov.
Batiacasphaera setulosa Shaw *minima var. nov.*
Batiacasphaera extravermiculata sp. nov.
Batiacasphaera granulata sp. nov.

Family **Florentiniaceae** Harker and Sarjeant emend. Norris
Genus *Homotryblium* Davey & Williams
Homotryblium taiwanianum sp. nov.
Family **Hystrichosphaeridiaceae** Evitt emend. Norris
Genus *Hystrichokolpoma* Klumpp emend. Williams & Downile
Hystrichokolpoma cinctum Klumpp
Hystrichokolpoma taperinia sp. nov.
Genus *Oligosphaeridium* Davey & Williams
Oligosphaeridium complex Davey & Williams
Genus *Systematophora* Klement
Systematophora taiwaniana sp. nov.
Systematophora placacantha (Deflandre & Cookson) Davey *et al.*
Family **Lithodiniaceae** Norris
Genus *Eisenackia* Deflandre & Cookson emend, Stover & Evitt
Eisenackia formosana sp. nov.
Eisenackia circumtabulata Drugg
Eisenackia taiwaniana sp. nov.

Suborder Incertae

Family **Ceratocoryaceae** Stein
Genus *Thalassiphora* Eisenack & Gocht emend. Gocht
Thalassiphora pelagica (Eisenack) Eisenack & Gocht

SYSTEMATIC TAXONOMIC TREATMENT

Class Dinophyceae Fritsch, 1929
Order Peridiniales Haeckel, 1894
Suborder 1 Deflandreineae Eisenak emend. Norris, 1974

Family 1 **Deflandreaceae** Eisenack emend. Sarjeant and Downie, 1974
Genus 1 *Spinidinium* Cookson & Eisenack, 1962 emend. Lentin & Williams, 1976.

Type species *Spinidinium styloniferum* Cookson &, 1962.

Remarks: This genus differs from *Vozzhennikovia* in having the ornamentation arranged in penitabular rows or intratabular clusters, or both, rather than being nontabular. (Wilson and Clowes, 1980).

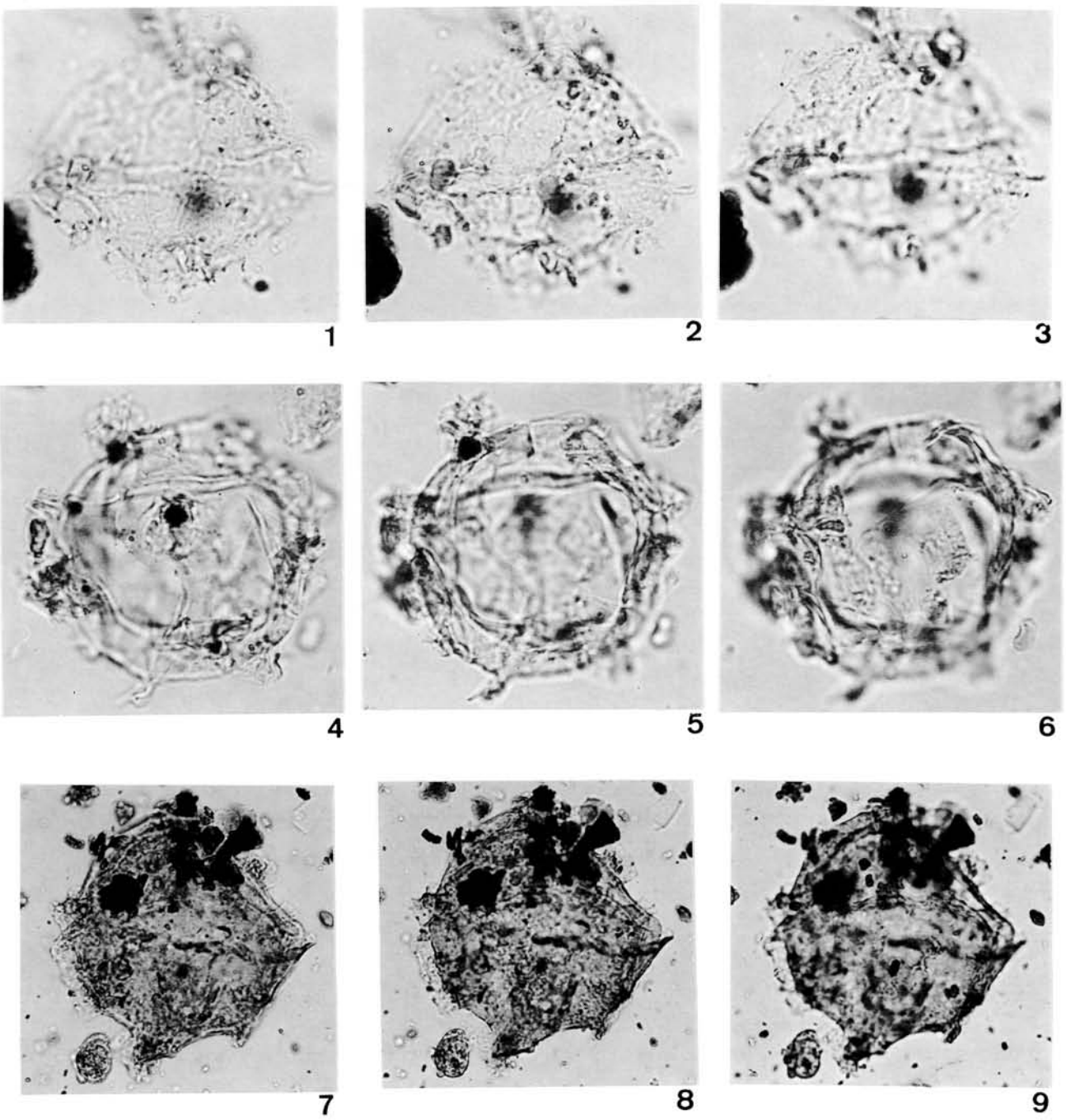
Stratigraphic range: Aptian – Eocene (Wilson and Clowes, 1980).

Spinidinium taiwanianum Shaw, *sp. nov.* Figs. 1-3

Holotype: Sample slide OK-1 1788bl- (1); film PF31-28, PF31-29, PF31-30; Figs. 1-3; CPC Micropaleontology Lab.

Description: Outer cyst sub-quadragonal in dorso-ventral view, 39 μm long, 46 μm wide. Outer cyst membrane thin; ornamented with short rodlike, clublike, spinelike or grapple-like appendages. Apical horn weakly developed and antapical horn indistinct. Innercyst indistinct. Archeopyle intercalary type, operculum free or attached.

Dimensions Holotype: Overall 39 μm long, 46 μm wide.



Figs. 1-3. *Spinidinium taiwanianum* Shaw, *sp. nov.* (OK-1 1788bl- (1); film PF31-28, PF31-29, PF31-30) Figs 4-6. *Aireiana taiwaniana* Shaw *sp. nov.* (OK-1 1638-(2); film WA60-32, WA60-33, WA60-34) Figs. 7-9. *Turbiosphaera filosa* (Wilson, 1967) Archangelsky (OK-1 1480-(1); film WA72-6, WA72-7, WA72-8) (Figures 1-6, x1000; Figures 7-9, x400).

Derivation of name: The specific epithet *taiwanianum* is derived from the name of the type locality.

Stratigraphic occurrence: Eocene (OK-1 well, 1788 m).

Remarks: The species differs from the type species *Spinidinium styloniferum* in having weakly developed indistinct apical and antapical horns and in having smaller size.

Family 2 **Wetzeliellaceae** Vozzhennikova, 1961
Genus 1 **Apectodinium** Costa & Downie, 1976 *ex* Lentin & Williams, 1977

Type species: *Apectodinium homomorphum* (Deflandre & Cookson, 1955) Lentin & Williams, 1977 emend. Harland, 1979.

Remarks: This genus differs from *Wetzeliella* in having nontabular processes and an endophragm which is always in very close contact with periphragm. Forms with developed lateral horns are rare (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p. 95).

Stratigraphic range: Late Paleocene – Eocene (Wilson and Clowes, 1980).

Apectodinium homomorphum (Deflandre & Coookson, 1955) Lentin & Williams, 1977 emend. Harland, 1979; Shaw in Taiwania 44(1): 31-48; Figs. 2-4, 1999.

1948 *Hystrichosphaeridium geometricum* Pastiels (pars): 41,pl.4, fig.3,5,6,7,9,10.
1955 *Wetzeliella homomorpha* Defiandre & Cookson: 254, pl. 5, fig. 7, text-fig. 19.
1977 *Apectodinium homomorphum* (Deflandre & Cookson) Lentin & Williams: 8.
1979 *Wetzeliella* (*Apectodinium*) *homomorpha* (Deflandre & Cookson) Harland: 63, pl. 1, figs. 1-8.

Slide: OK-3 1808-(2); film PF50-34, PF50-35, PF50-36; Figs. 2-4; CPC Micropaleontology Lab.

Description: Cysts intermediate; outline polygonal or more or less rounded; the wall of cyst thin and well-covered with appendages; processes numerous, tubiform, with bifid or entire tips, up to 8.5 μm long, surface view smooth. Endophragm is always in close contact with periphragm. Intercalary archeopyle, sometimes indistinct.

Stratigraphic occurrence: Eocene (OK-3 well, 1808 m).

Dimensions: Overall 99 μm long, 98 μm wide; endocyst 81 μm long, 79 μm wide (n=1).

Remarks: Intraspecific variations exist, especially in the degree of horns development, which are sometimes not developed, and shorter tubiform appendages. The species was recorded from the Waipawa Section (Wilson, 1967) and it was used as a zone index for the New Zealand Late Teurian and Early Waipawan (Wilson, 1984; 1988).

Previous records: This species has a world-wide distribution in Late Paleocene and Early Eocene.

Apectodinium raritubiformium Shaw in Taiwania 44(1): 31-48; Figs. 11-13, 1999.

Holotype: Slide OK-2 1875- (1); film WA68-31, WA68-31, WA68-33 (Holotype at three focus levels); Figs. 11-13; CPC Micropaleontology Lab.

Description: Cysts intermediate, outline polygonal or more or less rounded; the wall of cyst thin and scattered with appendages; processes tubiformed, with bifid or entire tips, fairly long (up to 18 μm long), surface view smooth. Endophragm is always in close contact with periphragm. Intercalary archeopyle, sometimes indistinct.

Stratigraphic occurrence: Eocene (OK-2 well, 1875m)

Dimensions: Overall 95 μm long, 72 μm wide, endocyst 85 μm long, 68 μm wide, surface features with tubiform processes, tubiforms 10-18 μm long (n=1).

Derivation of name: The specific epithet, *raritubiformium* refers to the scattered and

tubiformed appendages.

Remarks: The new species resembles *Apectodinium homomorphum* in having a roughly similar outline; however, it differs in having scattered and longer tubiform appendages.

Genus 2 **Kisselovia** Vozzhennikova, 1963

Type species: *Kisselovia ornata* Vozzhennikova, 1967

Remarks: This genus differs from *Wetzeliella* in having all or some of the intratabular groups of processes covered by pieces of ectophragm whose outlines approximate the shapes of paraplates (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p.111).

Stratigraphic range: Eocene –Early Oligocene (Wilson and Clowes, 1980).

Kisselovia coleothrypta (Williams & Downie, 1966) Lentin & Williams 1976 in Taiwania 44(1): 31-48; Figs. 16-18, 1999

1966 *Wetzeliella* (*Wetzeliella*) *coleothrypta* Williams & Downie: 185-186, pl. 18, fig. 8-9; text-fig. 47.
1976 *Kisselovia coleothrypta* (Williams & Downie) Lentin & Williams: 136.

Description: Cysts pentagonal with apical, two lateral and two normal to well-developed antapical horns and with endophragm, periphragm and ectophragm; intercalary archeopyle; about 142 μm wide. Pericoel totally enclosing endophragm. Ectocoel between periphragm and ectophragm. Parasuture with gonal tubiform processes. Processes arising from periphragm, hollow, connnecting with pericoel., surface features with tubiform processes, tubiforms 7.5-11 μm long.

Slide: OK-2 1700- (4); Film: WA70-25, WA70-26, WA70-27; Figs. 16-18; CPC Micropaleontology Lab.

Dimensions: Overall 163 μm long, 142 μm wide; endocyst 93 μm long, 101 μm wide, processes 7.5 μm -11 μm long (n=1).

Stratigraphic occurrence: Eocene (OK-2 well, 1700m)

Distribution: Recorded from upper Mangaorapan Stage and lower Heretaungan Stage. The species is the index for the Early Eocene *K. coleothrypta* Zone of Wilson (1984).

Previous records: Eocene, England (Williams & Downie, 1966); Eocene, Canada (Williams 1975); Abbotsford Mudstone, Dunedin, New Zealand (Mangaorapan and Heretaungan Stages) as outlined by Wilson (1967, 1984).

Kisselovia taiwaniana Shaw in Taiwania 44(1): 31-48; Figs. 8-10 and Figs. 19-21, 1999

Holotype: Slide OK-2 1700- (4); Figs. 8-10; film WA70-17, WA70-18, WA70-19 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Cysts pentagonal with apical, two lateral and two relatively reduced antapical horns and with endophragm, periphragm and ectophragm; intercalary archeopyle; 125-143 μm wide. Pericoel totally enclosing endophragm. Ectocoel between periphragm and ectophragm. Parasuture with gonal tubiform processes. Processes arising from periphragm, hollow, connnecting with pericole., surface features with tubiform processes, tubiforms 9-13 μm long.

Dimension Holotype: 112 μm long , 125 μm wide , endocyst 88 μm long , 94 μm wide, surface features with tubiform processes, tubiforms 10-13 μm long.

Dimensions: Overall 92-112 μm long, 105-143 μm long, endocyst 65-93 μm long , 76-101 μm wide , processes 9-19 μm long (n=6).

Stratigraphic occurrence: Eocene (OK-2 well, 1700m).

Derivation of name: The specific epithet *taiwaniana* is derived from the type locality.

Remarks: The new species most closely resembles *Kisselovia coleothrypta* (Williams & Downie) Lentin & Williams in having a roughly similar outline; however it differs both in having two relative-reduced antapical horns, and in having smaller size and longer tubiform appendages.

Kisselovia pengchiahsuensis Shaw in Taiwania 44(1): 31-48; Figs. 5-7 and Figs. 14-15, 1999

Holotype: Slide OK-2 1700- (4); Figs. 5-7; film WA70-4, WA70-5, WA70-6 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Cysts quardragonal with apical, two lateral and two antapical horns and with endophragm, periphragm and ectophragm; intercalary archeopyle; 93-100 μm wide. Pericoel totally enclosing endophragm. Ectocoel between periphragm and ectophragm. Parasuture with gonal tubiform processes. Processes arising from periphragm, hollow, connecting with pericoel, surface features with tubiform processes, tubiforms 6-11 μm long.

Dimensions Holotype: 72 μm long, 100 μm wide, endocyst 52 μm long, 62 μm wide, surface features with tubiform processes, tubiforms 6-10 μm long.

Dimensions: Overall 72-89 μm long, 93-100 μm wide, endocyst 52-53 μm long, 60-62 μm wide, processes 6-11 μm long (n=3).

Stratigraphic occurrence: Eocene (OK-2 well, 1700m)

Derivation of name: The specific epithet, *pengchiahsuensis* is derived from the type locality, Pengchiahsu Basin.

Remarks: The new species most closely resembles *Kisselovia coleothrypta* (Williams & Downie) Lentin & Williams in having a roughly similar outline, however it differs both in having four horns, and in having smaller size and shorter tubiform appendages.

Genus 3 **Wetzeliella** Eisenack, 1938 emend, Lentin & Williams, 1976

Type species *Wetzeliella articulata* Eisenack, 1938

Remarks: The genus differs from *Apectodinium* in having distinct paratabulation and generally a more distinct endocyst, and from *Wilsonnidium* in having intratabular rather than parassutural features (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p.131).

Stratigraphic range: Paleocene – Oligocene (Wilson and Clowes, 1980).

Wetzeliella symmetrica Weiler **taiwaniana** Shaw in Taiwania 44(1): 31-48; Figs. 22-30, 1999

Holotype: Slide OK-1 1788bl- (2); film W52-9, W52-10, W52-11 (Holotype at three

focus levels); Figs. 22-24; CPC Micropaleontology Lab.

Description: Cyst intermediate to large, compressed peridinioid, with four prominent horns (one apical, two lateral and one antapical). The wall of cyst thin and well-covered with appendages; processes numerous, tubiform, with bifid or entire tips, fairly long (up to 15 μm), relatively small and closely clustered on distal part of horns (2-5 μm), surface view smooth; endocyst smooth, thin-walled and broadly elliptical in outline. Intercalary archeopyle, operculum sometimes attached along anterior margin, generally free.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimension Holotype: 120 μm long, 95 μm wide, endocyst 80 μm long, 75 μm wide, processes 2-15 μm long.

Dimensions: Overall 103-120 μm long, 95-103 μm wide, endocyst 80 μm long, tubiformed processes, the tubiformed processes up to 15 μm long (n=4).

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

Remarks: The new variety resembles *Wetzeliella symmetrica* Weiler in having a roughly similar outline; however, it differs in having smaller size and in having shorter tubiform appendages.

Wetzeliella symmetrica Weiler **scabrata** Shaw in Taiwania 44(1): 31-48; Figs. 31-36, 1999

Holotype: Slide OK-1 1788- (1); film PF36-37, PF36-38, PF36-39 (Holotype at three focus levels); Figs. 31-33; CPC Micropaleontology Lab.

Description: Cyst intermediate to large, compressed peridinioid, with four prominent horns (one apical, two lateral and one antapical). The wall of cyst thin and well-covered with appendages, processes numerous, tubiform, with bifid or entire tips, fairly long (up to 16 μm), relatively small and closely clustered on distal part of horns (2-5 μm), surface view with scabrate ornamentation; endocyst smooth, thin-walled and broadly elliptical in outline. Intercalary archeopyle, operculum sometimes attached along anterior margin, generally free.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m).

Dimension Holotype: 147 μm long, 125 μm wide, endocyst 85 μm long , 80 μm wide, processes 3 μm –16 μm long.

Dimensions: Overall 112-147 μm long, 66-125 μm wide, endocyst 75-85 μm long, 70-80 μm wide, surface features with tubiform processes, tubiform processes up to 16 μm long (n=3).

Derivation of name: Latin, *scabrata* refers to the scabrate ornamentation of the cyst.

Remarks: The new variety resembles *Wetzeliella symmetrica* Weiler in having a roughly similar outline; however, it differs in having a smaller size and in having scabrate ornamentation.

Wetzeliella articulata Eisenack **taiwaniana** Shaw in Taiwania 44(1): 31-48; Figs. 37-48, 1999

Holotype: Slide OK-2 1875- (4); film WA69-17, WA69-18, WA69-19 (Holotype at three focus levels); Figs. 37-39; CPC Micropaleontology Lab.

Description: Cyst intermediate to large, compressed peridinioid, with one apical, two

lateral and two well-developed to relatively reduced antapical horns. The wall of cyst thin and well-covered with appendages; processes numerous, tubiform, with bifid or entire tips, fairly long (up to 15 μm), relatively small and closely clustered on distal part of horns (2-4 μm), surface view smooth; endocyst smooth, thin-walled and broadly elliptical in outline. Intercalary archeopyle, operculum sometimes attached along anterior margin, generally free.

Dimensions Holotype: 145 μm long, 127.5 μm wide, endocyst 93 μm long, 80 μm wide, processes 5 -21 μm long.

Dimensions: Overall 107-145 μm long, 87-131 μm wide, endocyst 75-93 μm long, 70-82.5 μm wide, surface features with tubiform processes, tubiform processes up to 21 μm long (n=11).

Stratigraphic occurrence: Eocene (OK-2 well, 1875m; OK-1 well, 1788m).

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

Remarks: The new variety resembles *Wetzeliella articulata* Eisenack in having a roughly similar outline and virtually no development of a right antapical horn. However, it differs in having a smaller size and shorter tubiform appendages.

Wetzeliella articulata Eisenack **scabrata** Shaw in Taiwania 44(1): 31-48; Figs. 49-57, 1999

Holotype: Slide OK-1 1788- (1); film PF34-6, PF34-7, PF34-8 (Holotype at three focus levels); Figs. 49-51; CPC Micropaleontology Lab.

Description: Cyst intermediate to large, compressed peridinioid, with apical, two lateral and two normal to relatively reduced antapical horns. The wall of cyst thin and well-covered with appendages; processes numerous, tubiformed, with bifid or entire tips, fairly long (up to 15 μm), relatively small and closely clustered on distal part of horns (2-4 μm), surface view with scabrate ornamentation; endocyst smooth, thin-walled and broadly elliptical in outline. Intercalary archeopyle, operculum sometimes attached along anterior margin, generally free.

Dimensions Holotype: 127 μm long, 113 μm wide, endocyst 78 μm long, 80 μm wide, surface features with tubiform processes, tubiform processes up to 11 μm long.

Dimensions: Overall 85-162 μm long , 90-113 μm wide, endocyst 78-92 μm long, 78-95 μm wide, surface features with tubiform processes, tubiformed processes up to 12 μm long (n=6).

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Derivation of name: Latin, **scabrata** refers the ornamentation of the cyst.

Remarks: The new variety resembles to *Wetzeliella articulata* Eisenack in having a roughly similar outline; however, it differs both in having smaller size and in having granulate ornamentation.

Class Dinophyceae Fritsch, 1929
Order Peridiniales, 1894
Suborder 2 Gonyaulacystineae Eisenak emend. Norris, 1974

Family 1 **Cordosphaeridiaceae** Sarjeant and Downie, emend. Norris, 1978

Genus 1 **AIREIANA** Cookson & Eisenack 1965

Remarks: This genus differs from *Conosphaeridium, Cordosphaeridium* and *Kleithriasphaeridium* mainly in lacking paracingular processes. (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p.139).

Stratigraphic range: Eocene Wilson and Clowes, 1980)

Type species: *Aireiana verrucosa* Cookson & Eisenack 1965

Aireiana taiwaniana Shaw, sp. nov. Figs 4-6

Holotype: Slide OK-1 1638-(2); Figs 4-6 (Holotype at three focus levels); film WA60-32, WA60-33, WA60-34; CPC Micropaleontology Lab.

Description: Cyst spherical and composed of two appressed wall layers. Periphragm less than 1 μm thick, smooth, elevated locally to form 14 or more crumpled-cylindrical to conate intratabular processes that are closed distally. Processes about seven μm high. Paracingulum usually poorly defined. Archeopyle indistinct.

Stratigraphic occurrence: Eocene (OK-1 well 1638m).

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

Dimensions Holotype: overall diameter 51 μm , diameter of cyst 40 μm, surface features with crumpled-cylindrical to conate intratabular processes that are closed distally, the processes up to 7 μm long.

Remarks: The new species most closely resembles *Aireiana verrucosa* Cookson & Eisenack in having a roughly similar outline; however, it differs both in having smooth periphragm and in having smaller size.

Genus 2 **Cordosphaeridium** Eisenack, 1963 emend. Davey, 1969

Type species *Cordosphaeridium inodes* (Klumpp, 1953) Eisenack, 1963.

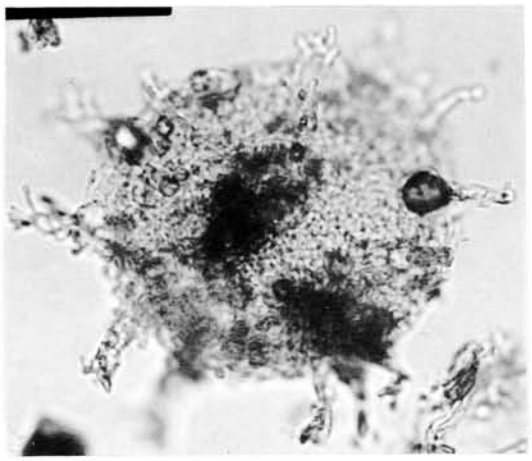
Remarks: The genus differs from *Kleithriasphaeridium* in having fibrous rather than smooth or faint straight processes. *Fibrocysta* has a more elongate body than *Cordosphaeridium* and has a larger number of paracingular processes generally; *Kenleyia* normally has fewer processes than *Cordosphaeridium* and the processes may be gonal rather than intratabular; *Turbiosphaera* is more elongate, the processes are typically wide and flat, and the paracingulum is represented by a shelf-like projection. A modified generic description is given by Stover and Evitt (1978, p.146).

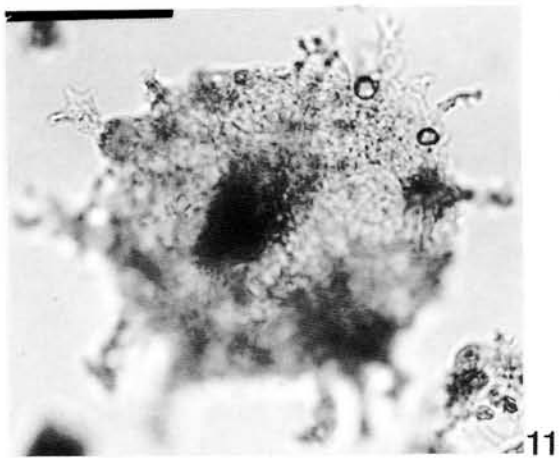
Stratigraphic range: Senonian – Oligocene (Wilson and Clowes, 1980)

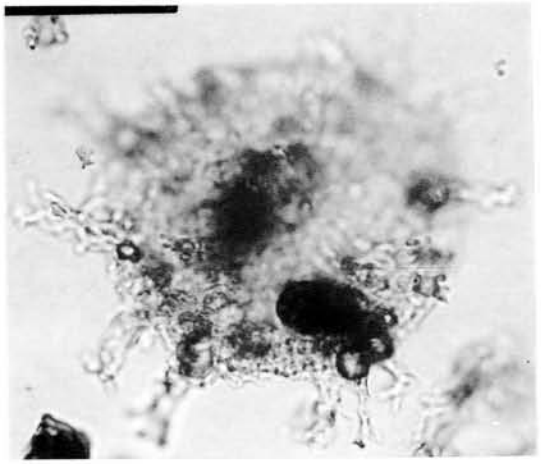
Cordosphaeridium cordium Shaw, sp. nov. Figs. 10-15

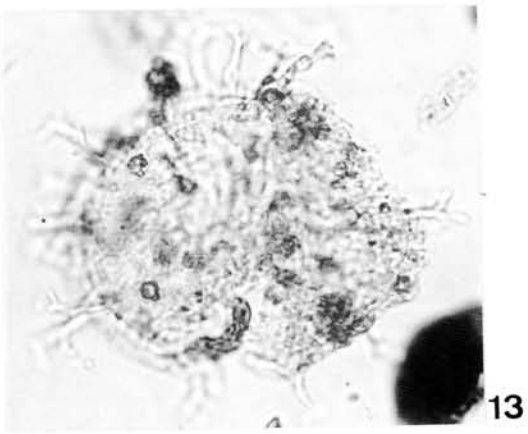
Holotype: slide OK-1 1788bl-(1); film PF32-15, PF32-16, PF32-17; Figs. 10-15 (Holotype at three focus levels); CPC Micropaleontology Lab.

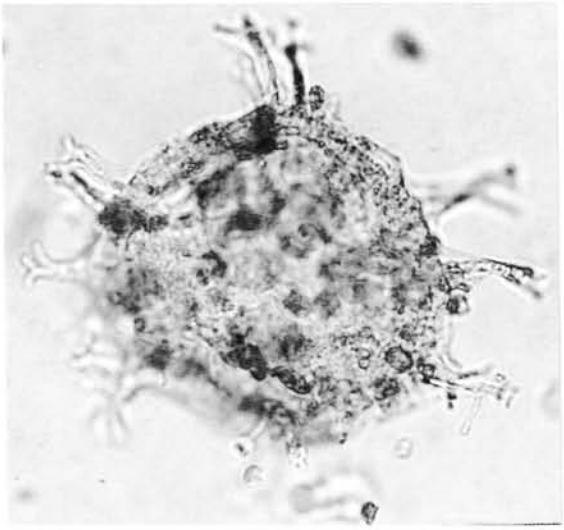
Description: Cysts spherical to subspherical, 41-47μm wide, surface view microreticulate or microgranulate; surface features with cord-like processes, the process up to 14 μm long; precingular archeopyle, indistinct.

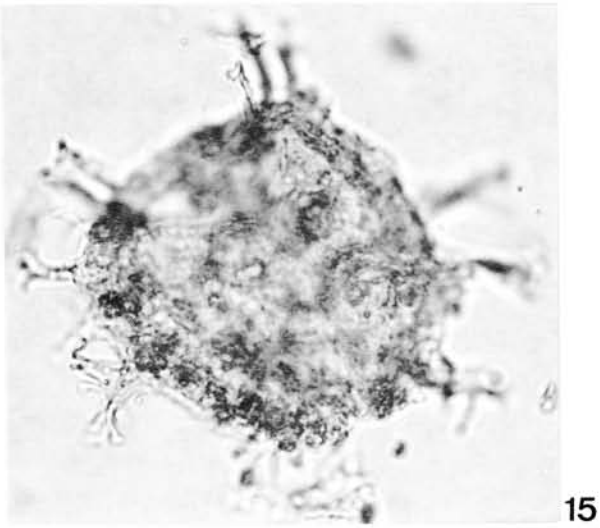












Figs. 10-15. *Cordosphaeridium cordium* Shaw, *sp. nov.* (OK-1 1788bl- (1); film PF32-15, PF32-16, PF32-17; OK-1 1788- (3); film W56-11; OK-1 1788- (3); film W56-14, W56-15) (All figures x1000).

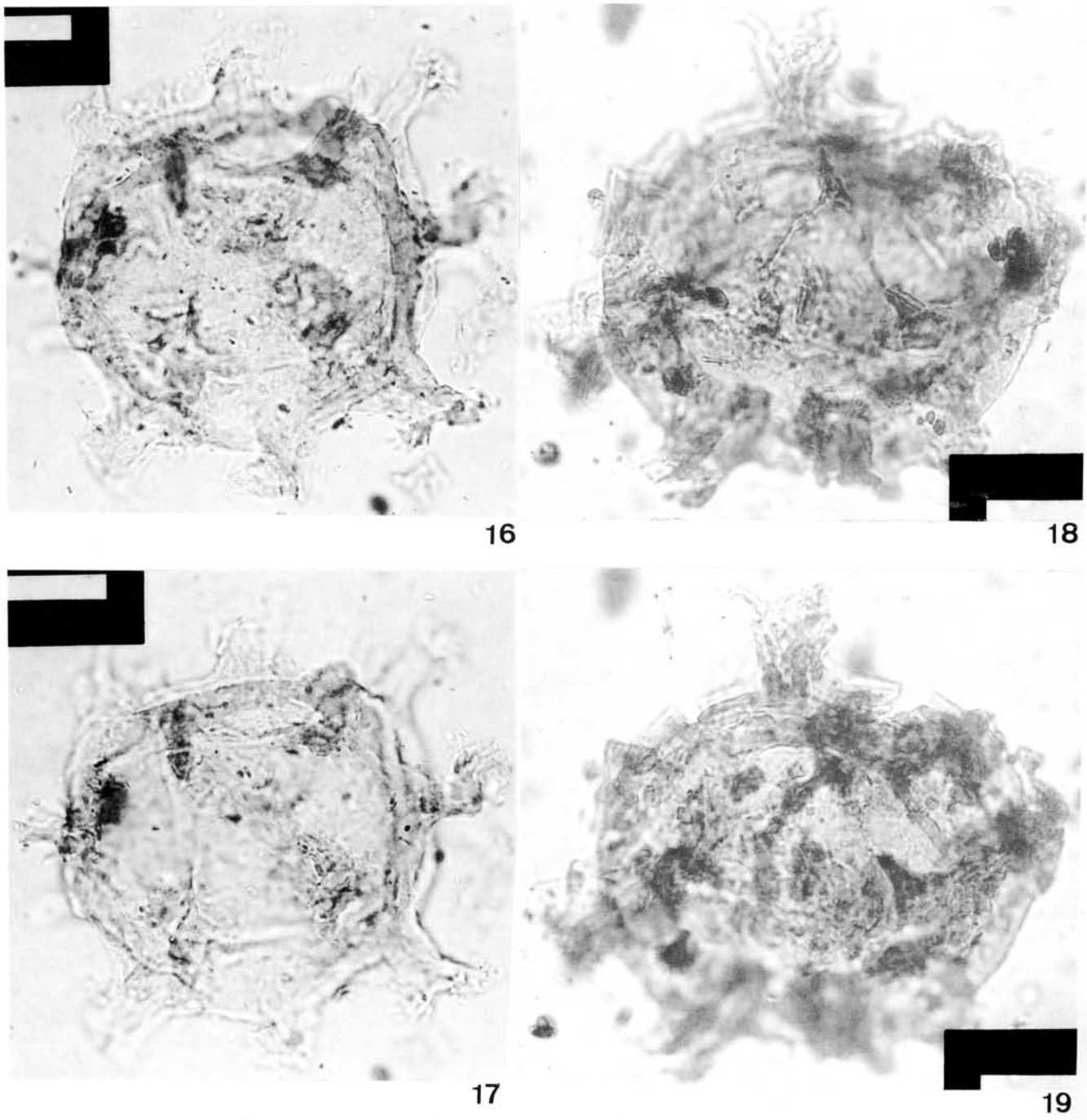
Stratigraphic occurrence: Eocene (OK-1 well, 1788 m).

Derivation of name: Latin, *cordium* refers to the surface feature which has cord-like processes.

Dimensions Holotype: Overall diameter 63 μm, diameter of cyst 46 μm, maximum length of processes 13 μm.

Dimensions: Overall diameter 48-66 μm, diameter of cyst 36-46 μm, maximum length of processes 14 μm (n=4).

Remarks: The species differs from *Cordosphaeridium fibrospinosum* Davey & Williams in having substantially smaller cyst body and in having cord-like processes surface features.



Figs. 16-19. *Cordosphaeridium taiwanianum* Shaw, *sp. nov.* (OK-3 1750- (3); film PF16-36, PF16-37; OK-2 1936- (5); film W47-38, W47-39) (All figures x1000).

Cordosphaeridium fibrospinosum Davey & Williams 1966 Figs. 20, 21

1966 *Cordosphaeridium fibrospinosum* Davey & Williams: 86, pl. 5, fig. 5

Sample slide: OK-1 1788- (5); film PF42-33, PF42-34; Figs. 20, 21 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts spherical to subspherical, about 61 μmwide, surface view rough pattern; surface features with cylindrical, fibrous processes, processes open distally, up to 23 μm long; precingular archeopyle, indistinct.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m).

Dimensions: Overall diameter 92 μm, diameter of cyst 61 μm, maximum length of processes 23 μm (n=1).

Previous records: Recorded originally from the Lower Eocene of England (Davey &Willians 1966). Also known from the Senonian of Natal, South Africa (Davey, 1969) and from European deposits ranging from Paleocene to Upper Oligocene (Eaton 1976). The species has recorded from the Late Teurian and, more abundantly, from the Waipawan from New Zealand (Wilson, 1988).

Cordosphaeridium taiwanianum Shaw, sp. nov. Figs. 16-19

Holotype: Slide OK-3 1750- (3); film PF16-36, PF16-37; Figs. 16, 17 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts spherical to subspherical, 57-68 μm wide, surface view rough pattern; surface features with cylindrical processes, process up to 18 μm long; precingular archeopyle, indistinct.

Stratigraphic occurrence: Eocene (OK-3 well, 1750; OK-2 well, 1936m)

Derivation of name: The specific epithet, *taiwanianum* is derived from the name of the type locality.

Dimensions Holotype: Overall diameter 76 μm, diameter 58 μm , surface features with cylindrical processes, the cylindrical about 18 μm long.

Dimensions: Overall diameter 72-83 μm, diameter of cyst 54-72 μm, maximum length of processes 20 μm (n=3).

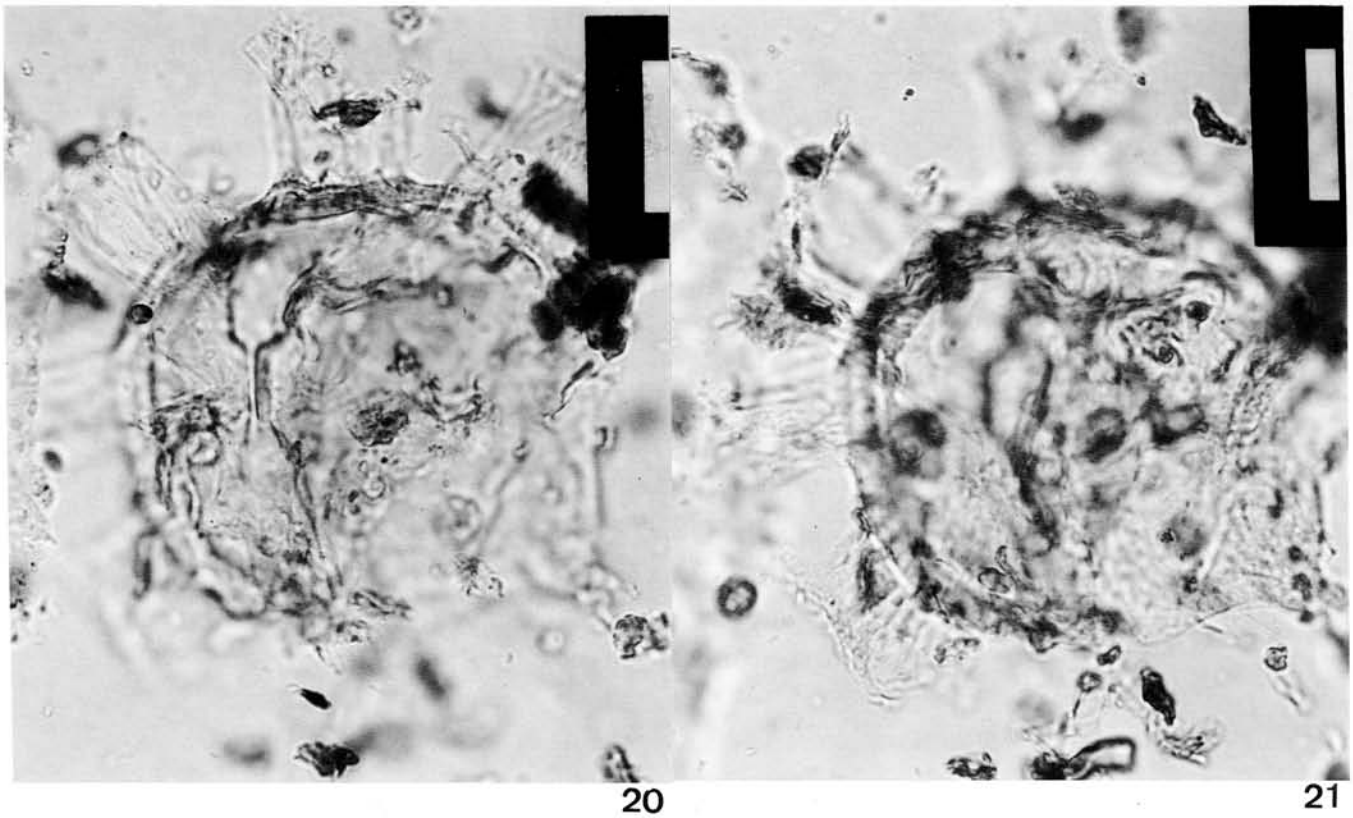
Remarks: The species differs from *Cordosphaeridium cordium* Shaw *sp. nov.* in being substantially larger cyst body and in having cylindrical processes surface features.

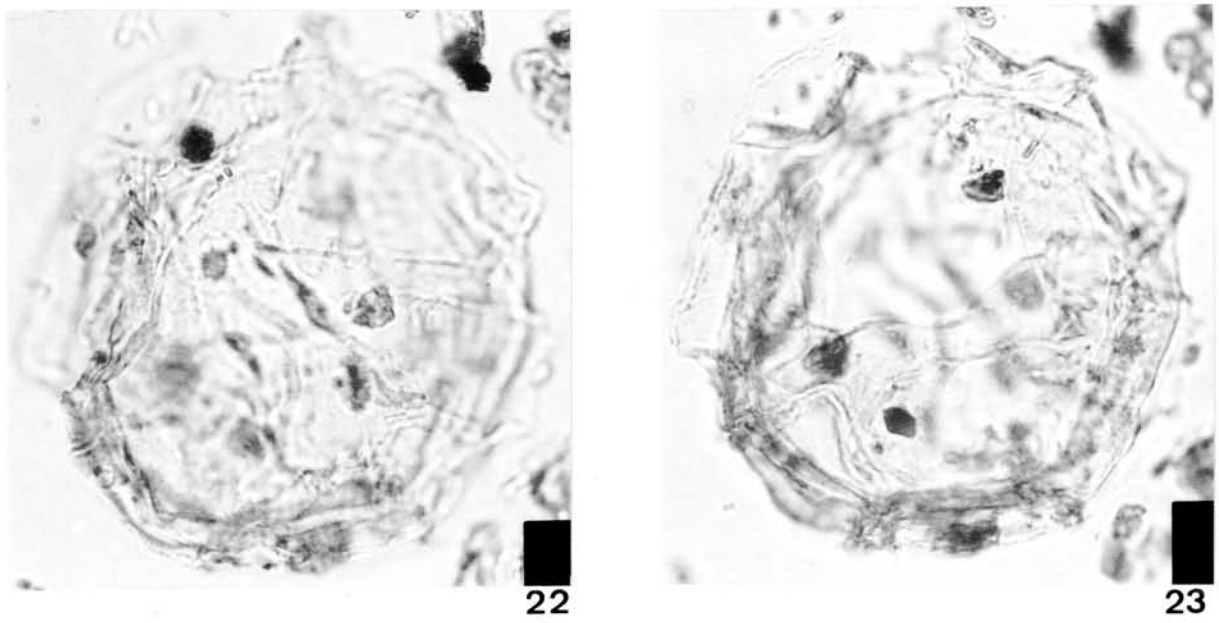
Genus 3 **Turbiosphaera** Archangelsky, 1969a

Remarks: The genus differs from *Fibrocysta* in having wider and flatter processes, especially in apical and antapical areas, in having its paracingulum expressed by a shelflike structure rather than tubular porcesses, and in having smaller processes and spines scattered among the larger precingular and postcingular processes. (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p.198).

Stratigraphic range: Paleocene – Oligocene (Wilson and Clowes, 1980).

Type species *Turbiosphaera filosa* (Wilson, 1967) Archangelsky, 1969





Figs. 20, 21. *Cordosphaeridium fibrospinosum* Davey & Williams (OK-1 1788- (5); film PF42-33, PF42-34) Figs. 22-23. *Impagidinium pengchiahsum* Shaw, *sp. nov.* (OK-1 1788- (1); film PF37-17, PF37-18) (All figures x1000).

Turbiosphaera filosa (Wilson, 1967) Archangelsky, 1969 Figs. 7-9

1967 *Cordosphaeridium filosum* Wilson: 66, Figs. 2, 31-32, 34.
1969 *Turbiosphaera filosa* (Wilson) Archangelsky: 408-411.

Slide: OK-1 1480-(1); film WA72-6, WA72-7, WA72-8; Fig. 7-9; CPC Micropaleontology Lab.

Description: Test bi-layered comprising fibrous outer cyst and smooth oval inner cyst; processes loosely fibrous with the antapical one being somewhat larger. Paracingulum indicated by a transverse shelflike ridge. Precingular archeopyle, large, located on dorsal epitheca.

Dimensions: Overall 105 μm long, 100 μm wide, endocyst 91 μm long, 89 μm wide, processes up to 25 μm long (n=1).

Stratigraphic occurrence: Eocene (OK-2 well, 1480m); fairly rare.

Previous records: Paleocene to Oligocene, Antarctica (Wilson, 1967); Mid to Late Eocene of Patagonia (Archangelsky, 1969; Archangelsky and Fasola, 1971); Late Eocene, Antarctica (Kemp, 1975); Eocene-Oligocene, Tasman Sea (Haskell & Wilson, 1975). Although the species has not been reported previously from New Zealand a closely related form, *T.* cf. *filosa*, has been listed from the Teurian to Kaiatan Stages (Wilson, 1984).

Family 2 **Gonyaulacystaceae** Sarjeant and Downie, emend. Sarjeant and Downie, 1974

Genus 1 **Impagidinium** Stover & Evitt, 1978

Type species *Impagidinium dispertitum* (Cookson & Eisenack, 1965) Stover & Evitt, 1978.

Remarks: This genus differs from *Leptodinium* in being less elongate, in lacking an apical projection, and in having reduced paratabulatin in some instances (Wilson and Clowes, 1980).

Stratigraphic range: Barremian – Recent (Wilson and Clowes, 1980).

Impagidinium gracilium Shaw, sp. nov. Figs. 37-42

Holotype slide: OK-1 1788bl- (1); film PF33-24, PF33-25, PF33-26; Figs. 37-39 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Cyst small size, subspherical; 33-45 μm long, 32-38 μm wide; autophragm thin, smooth, bearing low, smooth-crested parasutural septa. Precingular archeopyle, distinct. Second and third apical paraplates large, and comprise significant area of upper dorsal epicyst; first and fourth apical paraplates relatively narrow and elongate. Paratabulation well defined; no apparent subdivision into sulcal paraplates.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m; OK-3well, 1750m).

Derivation of name: Latin, *gracilium,* small; with reference to the smaller size.

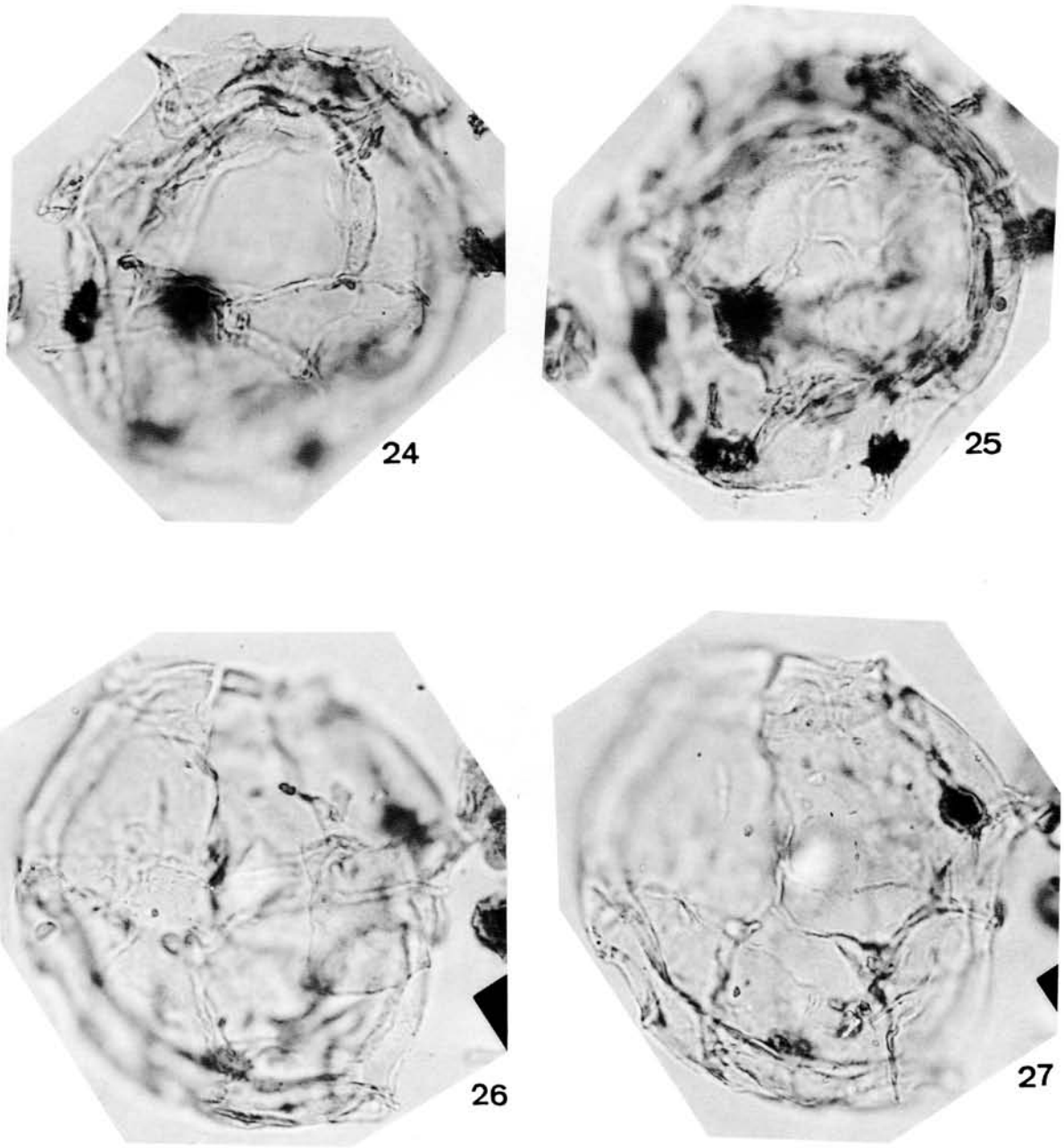
Dimensions Holotype: Overall 45 μm long, 38 μm wide, height of septa 2-3 μm.

Dimensions: Overall 33-45 μm long, 32-38 μm wide, height of septa 1.5-3 μm (n=3).

Remarks: The new species most closely resembles *Impagidinium crassimuratum* Wilson but differs from that species in having smaller size and in having thin autophragm.

Impagidinium taiwanianum Shaw, sp. nov. Figs. 28-36

Holotype slide: OK-1 1669- (1); film W54-16, W54-17, W54-18; Figs. 28-30 (Holotype at three focus levels); CPC Micropaleontology Lab.



Figs. 22-27. *Impagidinium pengchiahsum* Shaw, *sp. nov.* (OK-1 1788-bl- (1); film PF33-24, PF33-25, PF34-3, PF34-4) (All figures x1000).

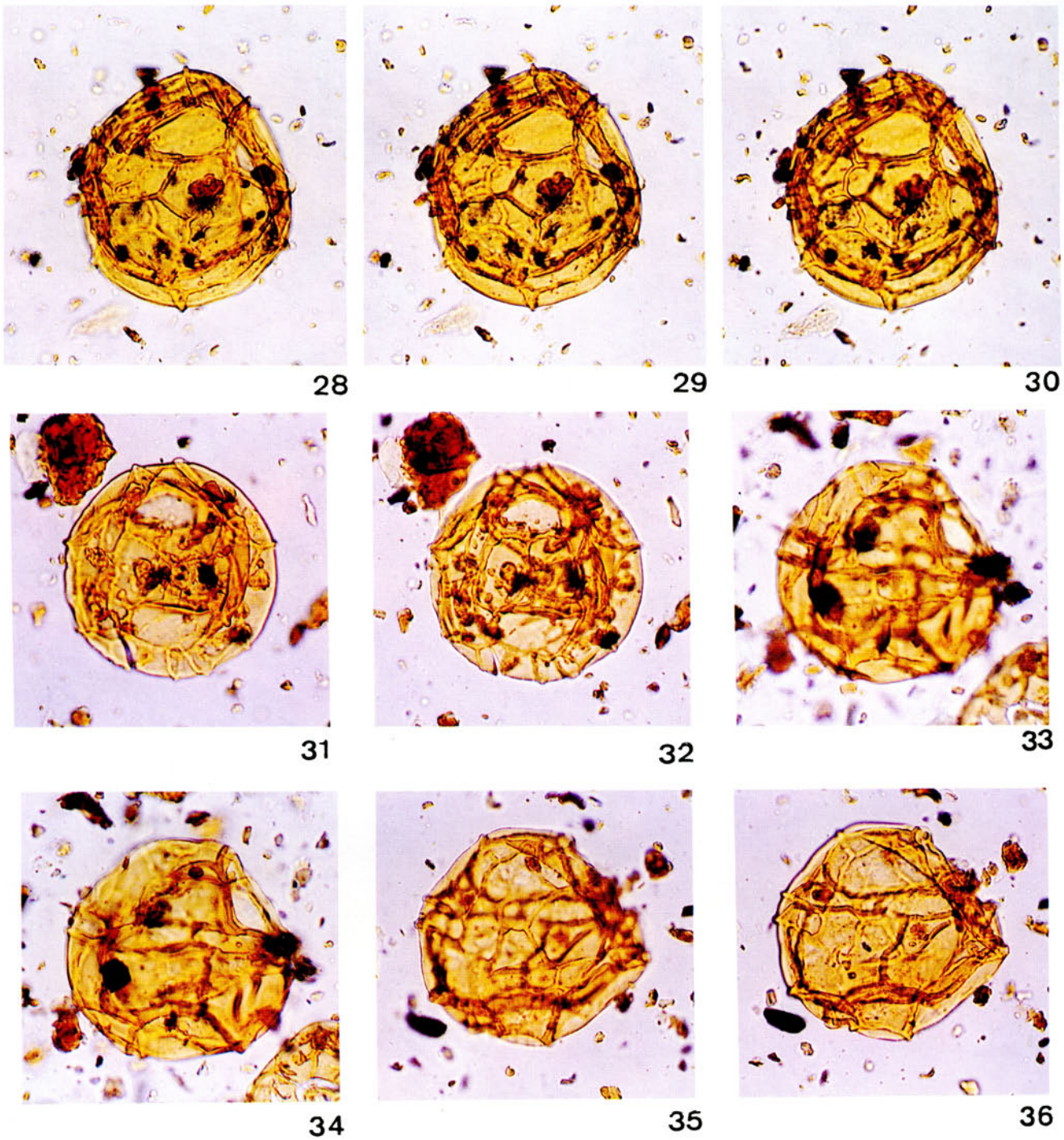
Description: Cyst of intermediate size, spherical to subspherical; 78-95 μm wide; autophragm thick (c. 2 μm) smooth, bearing low, solid straight parasutural septa. Precingular archeopyle, distinct, small, length and breadth usually less than one-third diameter of cyst. Second and third apical paraplates large; first and fourth apical paraplates relatively narrow and elongate. Paratabulation well defined; no apparent subdivision into sulcal paraplates.

Dimensions Holotype: 92 μm long, 83 μm wide, septa 2 μm thick.

Dimensions: Overall 78-95 μm long, 59-85 μm wide, septa 1.5-3 μm thick (n=14).

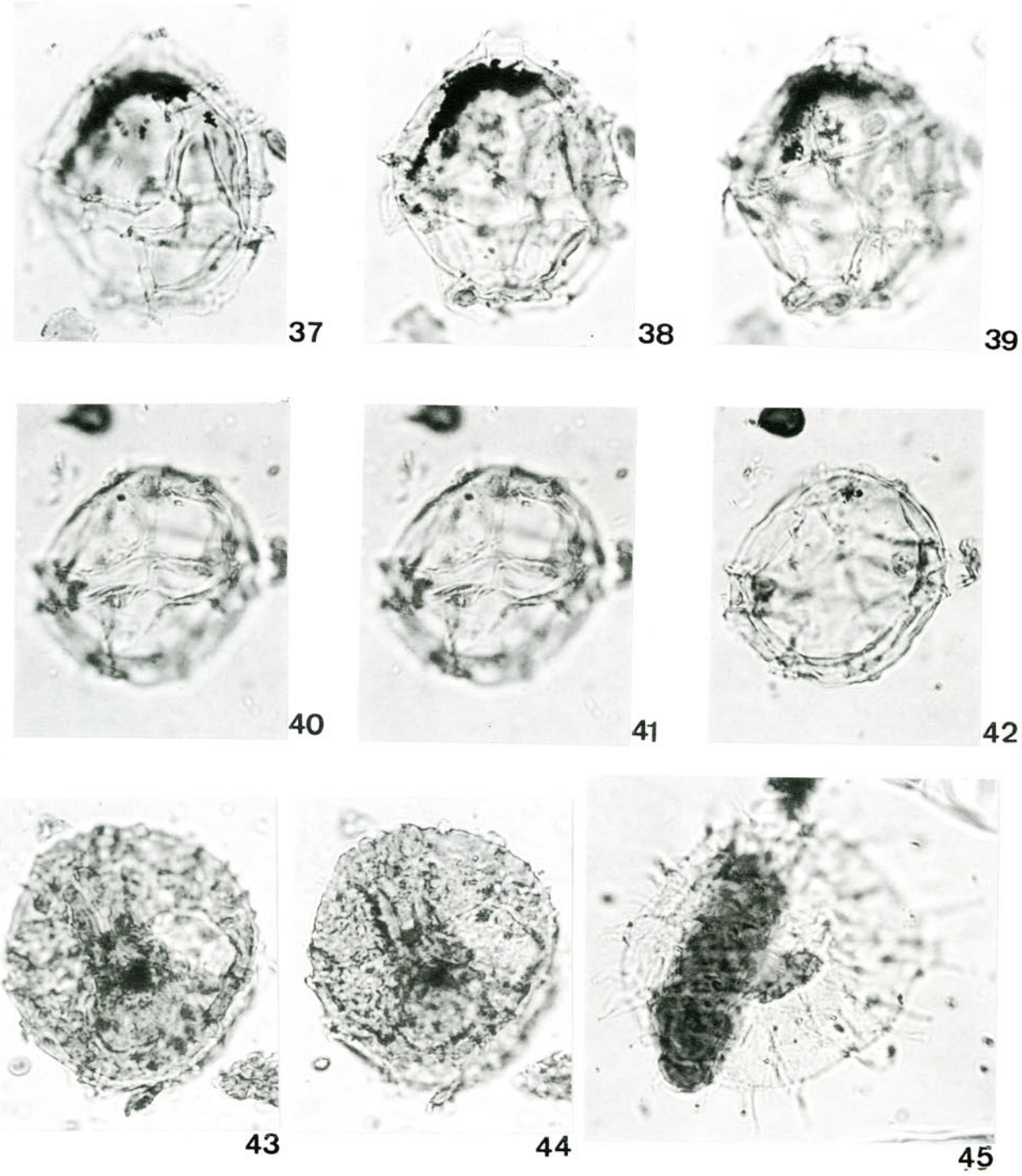
Stratigraphic occurrence: Eocene (OK-1 well, 1588m, 1669m, 1788m)

Derivation of name: The specific epithet *taiwanianum* is derived from the name of the type locality..



Figs. 28-36. *Impagidinium taiwanianum* Shaw, *sp. nov.*(OK-1 1669- (1); film W54-16, W54-17, W54-18; OK-1 1588- (1); film WA62-26, WA62-27; OK-1 1558- (1); film WA62-14, WA62-15; OK-1 1558- (1); film WA62-33, WA62-34) (All figures x400).

Remarks: This species resembles *I. crassimuratum* Wilson from the Lower Eocene of Australia (Wilson, 1988) but differs from that species in having a solid straight (not smooth-crested septa) septa.



Figs. 37-42. *Impagidinium gracilium* Shaw, *sp. nov.*(OK-1 1788bl- (1); film PF33-24, PF33-25, PF33-26; OK-3 1750- (3); film PF16-25, PF16-26, PF16-27) Figs. 43, 44. *Ochetodinium taiwanianum* Shaw, *sp. nov.*(OK-2 1916- (2); film W42-28, W42-29) Fig. 45. *Operculodinium taiwanianum* Shaw, *sp. nov.*(OK-3 1808- (1); film PF50-7) (All figures x1000).

Impagidinium pengchiahsum Shaw, sp. nov. Figs. 22-27

Holotype: Slide OK-1 1788-bl-(1); Figs. 22-23; film PF33-24, PF33-25; CPC Micropaleontology Lab.

Description: Cyst intermediate size, subspherical; about 60 μm wide; autophragm thin, smooth, bearing membranous parasutural septa. Pericingular archeopye, distinct. Second and

third apical paraplates large, and comprise significant area of upper dorsal epicyst; first and fourth apical paraplates relatively narrow and elongate. Paratabulation well defined.

Dimensions Holotype: Overall 60 μm long, 55 μm wide, height of septa 3-6 μm.

Dimensions: Overall 60-65 μm long, 55-65 μm wide, height of septa 3-9 μm (n=4).

Stratigraphic occurrence: Eocene (OK-1 well, 1788m).

Derivation of name: The specific epithet, *pengchiahsum* is derived from the name of the type locality.

Remarks: The species resembles *I. crassimuratum* Wilson from the Lower Eocene of Australia (Wilson, 1988) but differs from that species in having a membranous septa.

Genus 2 **Ochetodinium** Damassa 1979.

Type species: *Ochetodinium romanum,* Damassa 1979.

Remarks: This genus differs from *Leptodinium* in having parasutural elevations of the wall that are not simple septa, and in having intratabular ornamentation as well. It differs from *Trichodinium* in having a clear paratabulation and in the absence of an apical horn (Wilson and Clowes, 1980).

Stratigraphic range: Eocene (Wilson and Clowes, 1980).

Ochetodinium taiwanianum Shaw, sp. nov. Figs. 43, 44

Holotype: Slide OK-2 1916- (2); film W42-28, W42-29; Figs. 43, 44 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Spherical to subspherical cyst, diameter 39-41 μm. Thickness of autophragm exclusive of ornamentation 2 μm. Surface ornamented with extravermiculae; lateral view ornamented with coniculae. Paracingulum and parasulcus not generally indicated. Archeopyle precingular type, medium size, elongate; operculum free.

Stratigraphic occurrence: Eocene (OK-2 well, 1916m).

Derivation of name: The specific epithet, *taiwanianum* is derived from the name of the type locality.

Remarks: This species differs from the type species *O. romanum* Damassa in having extravermiculate ornament of the cyst and in having smaller size.

Family 3 **Lingulodiniaceae** Sarjeant and Downie, 1974

Genus 1 **Operculodinium** Wall 1967.

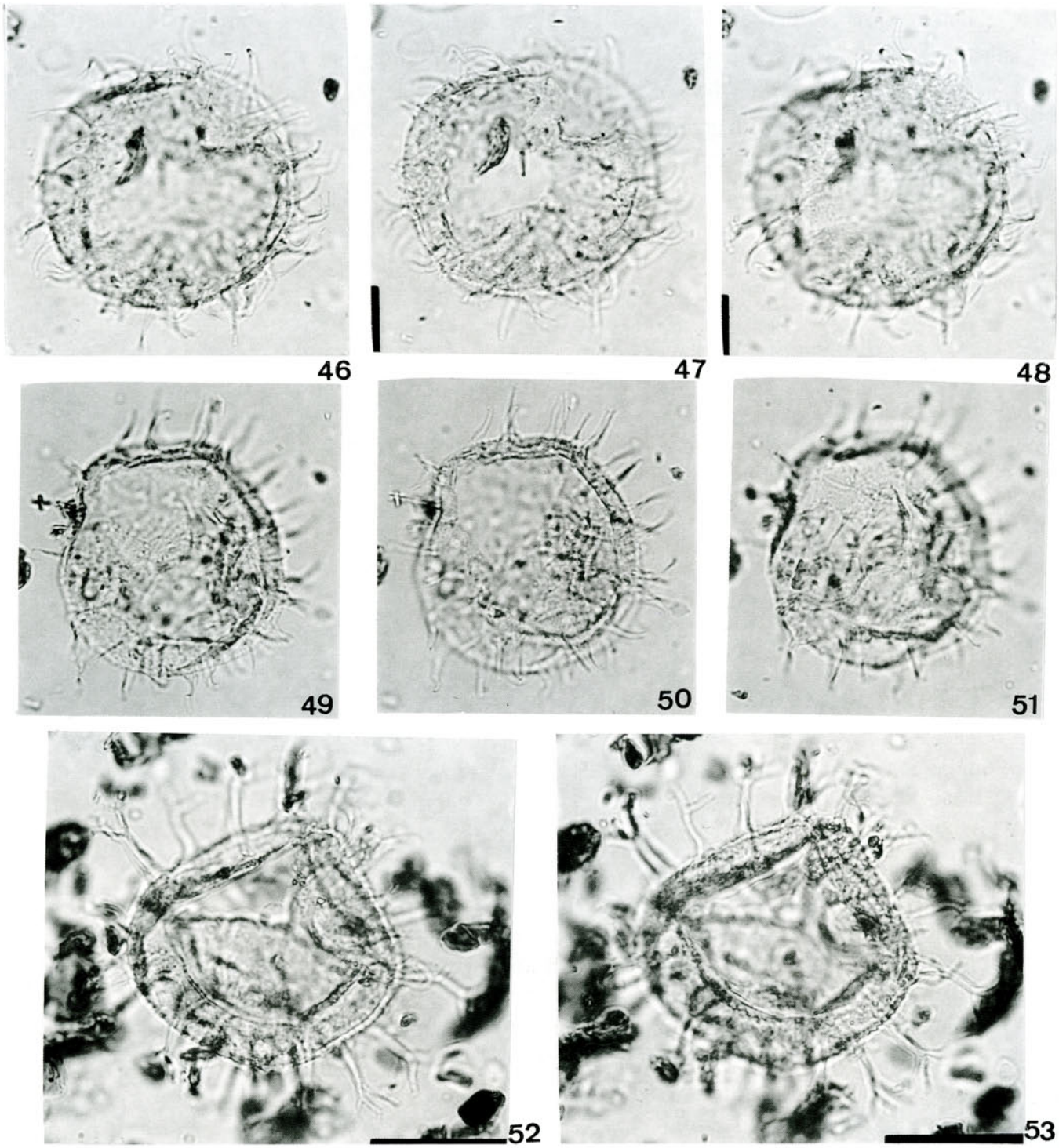
Type species: *Operculodinium centrocarpum* (Deflandre & Cookson 1955) Wall 1967.

Remarks: This genus differs from *Exochosphaeridium* and *Amphorosphaeridium* in not having fibrous processes and in lacking differentiated apical and/or antapical processes. It differs from *Lingulodinium* in having a precingular archeopyle formed by processes. (Wilson and Clowes, 1980).

Stratigraphic range: Hauterivian-Recent (Wilson and Clowes, 1980).

Operculodinium taiwanianum Shaw, sp. nov. Figs. 45-51

Holotype: Slide: OK-3 1750- (2); film PF14-7, PF14-8, PF14-9; Figs. 46-48 (Holotype at three focus levels); CPC Micropaleontology Lab.



Figs. 46-51. *Operculodinium taiwanianum* Shaw, *sp. nov.* (OK-3 1750- (2); film PF14-7, PF14-8, PF14-9; OK-3 1760- (2); film WA65-27, WA65-28, WA65-29) Figs. 52, 53. *Achomosphaera taiwaniana* Shaw, *sp. nov.* (OK-1 1825- (2); film WA60-2, WA60-3) (All figures x1000).

Description: Spherical to ellipsoidal cyst, diameter 38-46 μm, covered with numerous straight, slender processes placed irregularly or with a certain alignment. Processes solid, showing radiating fibrils at their point of insertion on the shell. Thickness of autophragm exclusive of ornamentation about 1 μm. Surface view of the cyst ornamented with finely granula. Precingular archeopyle type, operculum free.

Dimensions Holotype: Overall 53 μm long, 54 μm wide, cyst 37 μm long, 40 μm wide, surface features with acicular processes, acicular 7-9 μm long.

Dimensions: Overall 44-53 μm long, 43-54 μm wide, cyst 32-37 μm long, 34-40 μm wide, surface features with acicular processes, acicular 6-9 μm long (n=3).

Stratigraphic occurrence: Eocene (OK-3 well, 1750m, 1760m).

Derivation of name: The specific epithet, *taiwaniana* is derived from the name of the type locality.

Remarks: The species differs from the type species *O. centrocarpum* in having a finely granulate ornament of the cyst.

Family 4 Spiniferitaceae **Sarjeant and Downie, emend. Norris, 1978**

Genus 1 **Achomosphaera** Evitt, 1963

Type species *Achomosphaera ramulifera* (Deflandre, 1937) Evitt, 1963

Remarks: *Achomosphaera* differs from *Spiniferites* in lacking both prominent parasutural features and a well-defined paratabulation. A modified generic description if given by Stover & Evitt (1978, p.138)

Stratigraphic range: Late Cretaceous – Tertiary.

Achomosphaera taiwaniana Shaw, sp. nov. Figs. 52, 53

Holotype: Slide OK-1 1825-(2); Figs. 52,53 (Holotype at two focus levels); film WA60-2, WA60-3; CPC Micropaleontology Lab.

Description: Wall of central body thin, 1 μm thick, surface finely granulate (pseudo-reticulate); closed gonal processes hollow, bifurcate to trifurcate with bifurcate extremities. Processes sometimes branched, branching mainly confined to cingular zone. Characteristically shaped precingular archaeopyle free or present.

Dimensions Holotype: Diameter of central body 42-45 μm, processes 12 to 15 μm long (n=1).

Stratigraphic occurrence: Eocene (OK-1 well 1825m)

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

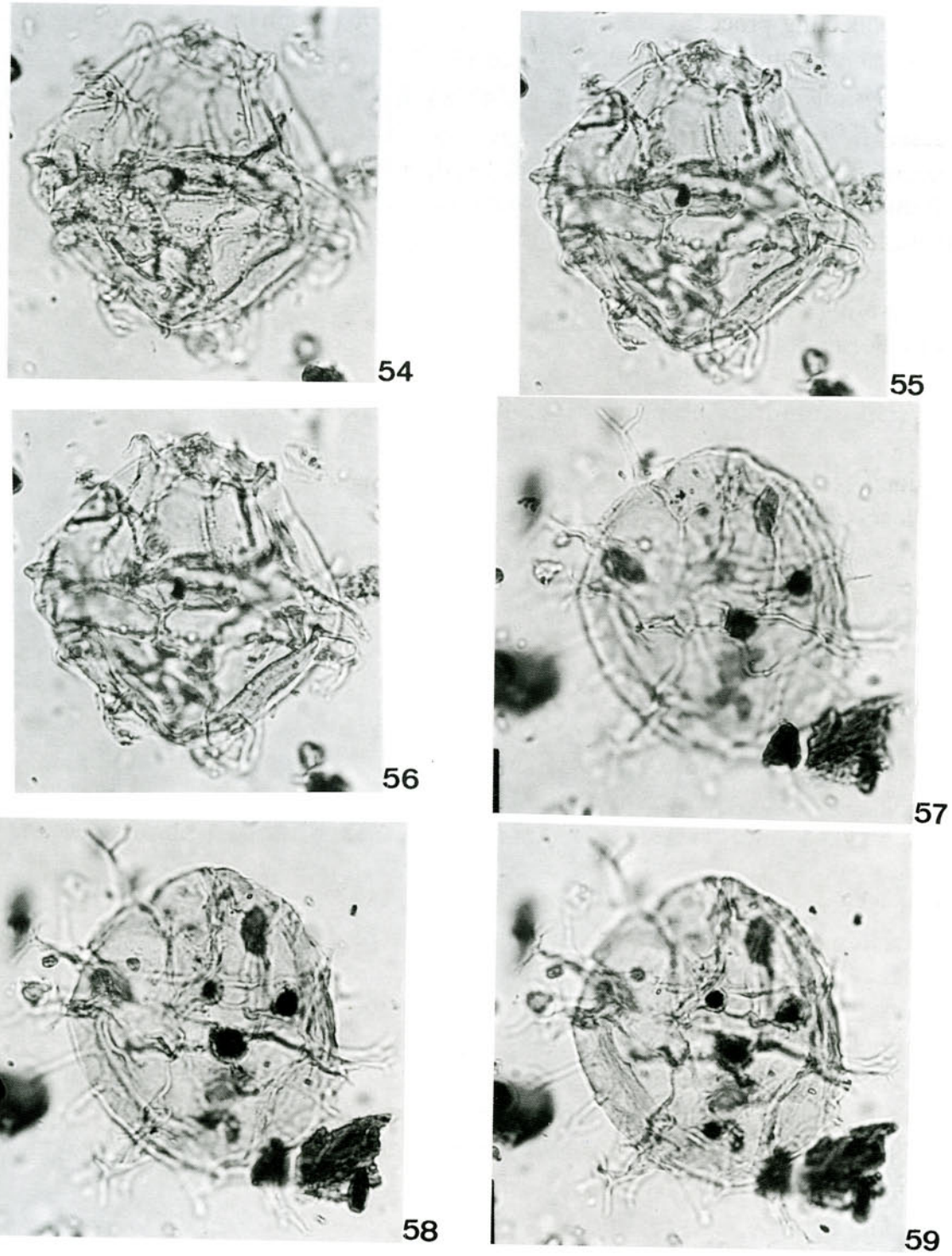
Remarks: The new species most closely resembles *Achomosphaera sagena* Davey & Williams in having a roughly similar outline; however, it differs from both in having finely granulate periphragm, and in having a thin cyst.

Genus 2 **Spiniferites** Mantell, 1850 emend. Sarjeant, 1970

Type species *Spiniferites ramosus* (Ehrenberg, 1838) Mantell, 1854

Stratigraphic range: Berriasian - Recent

Remarks: *Spiniferites* differs from *Achomosphaera* in having the bases of processes connected by parasutural ridges or septa. *Achomosphaera* may, however, have faint linear markings between processes, and forms intermediate between the two genera are known. A modified generic description is given by Stover & Evitt (1978, p.190).



Figs. 54-56. *Spiniferites formosus* Shaw, *sp. nov.* (OK-1 1788- (5); film PF42-26, PF42-27, PF42-28) Figs. 57-59. *Spiniferites ramosus* subsp. *multibrevis* (Davey & Williams) Lentin & Williams (OK-2 1875- (2); film WA69-8, WA69-9, WA69-10) (All figures x1000).

Spiniferites formosus Shaw, sp. nov. Figs. 54-56

Holotype slide: OK-1 1788- (5); Figs. 54-56 (Holotype at three focus levels); film PF42-26, PF42-27, PF42-28 (Film at three focus levels); CPC Micropaleontology Lab.

Description: Rounded-rhomboidal central body, smooth to perforate, bearing short solid processes less than one fourth the diameter of central body in length. Parasutural features are

ridges connecting process bases. Gonal processes simple and short. Paracingulum indicated by parasutural features. Precingular archeopyle.

Dimensions Holotype: Overall diameter 50-52 μm, diameter of central body 44-46 μm, processes 8-9.5 μm long (n=1).

Stratigraphic occurrence: Eocene (OK-2 well, 1875m).

Remarks: The new species most closely resembles *Spiniferites ramosus* (Ehrenberg) Mantell in having a roughly similar outline; however, it differs in having simple and shorter gonal processes.

Derivation of name: The specific epithet *formosus* is derived from the name of of type locality Formosa Island.

Spiniferites ramosus subsp. **multibrevis** (Davey & Williams, 1966a) Lentin & Williams, 1973. Figs. 57-59

Slide: OK-2 1875- (2); Figs. 57-59; film WA69-8, WA69-9, WA69-10 (Film at three focus levels); CPC Micropaleontology Lab.

Description: Spherical central body, smooth, bearing short solid processes less than half the diameter of central body in length. Gonal processes bifurcate to trifurcate. Precingular archeopyle.

Dimensions: Overall diameter 59-68 μm, diameter of central body 39-45 μm, processes 11-14 μm long (n=1).

Stratigraphic occurrence: Eocene (OK-2 well, 1875m).

Previous records: *Spiniferites ramosus* subsp. *multibrevis* (Davey & Williams) Lentin & Williams has been reported from Lower Cretaceous to Eocene in England, from upper Cretaceous in France and from the Aptian of Germany (Eisenack and Kjellstrom, 1971: p. 581-582).

Spiniferites scabrosus (Clarkke & Verdier) Lentin & Williams Figs. 60-65

Slide: OK-2 1750- (2) and OK-1 1768- (1); Figs. 60-65; film PF49-4, PF49-5, PF49-6, (Film at three focus levels); W58-25, W58-26, (Film at two focus levels); CPC Micropaleontology Lab.

Description: Spherical central body, scabrate; processes arise from junction of the plates. Gonal processes trifurcate or bifurcate. Precingular archeopyle.

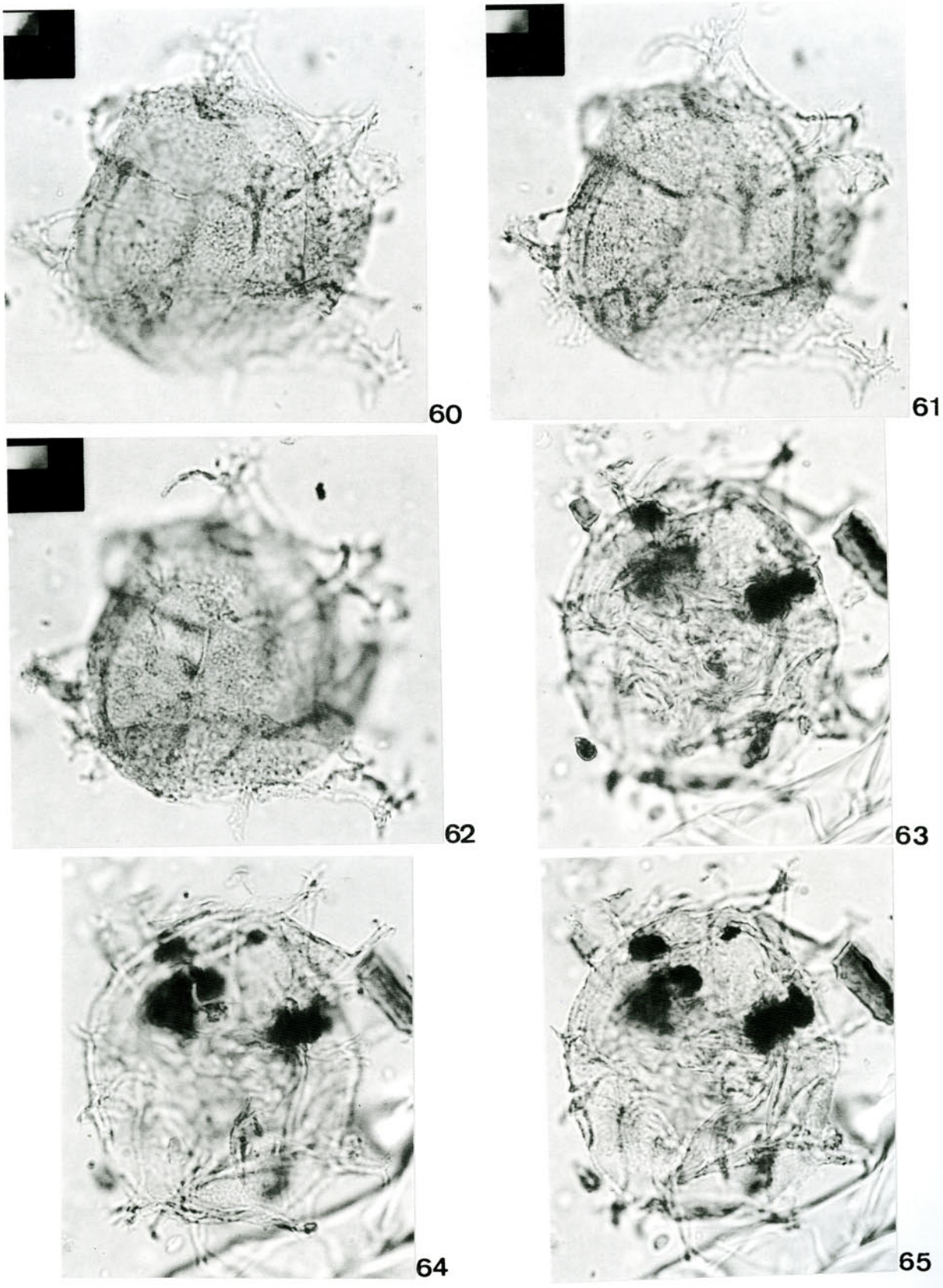
Dimensions: Overall diameter 47-66 μm, diameter of central body 44-52 μm, processes 11-17 μm long (n=2).

Stratigraphic occurrence: Eocene (OK-2 well, 1750m, OK-1 well, 1768m).

Previous records: *Spiniferites scabrosus* (Clarkke & Verdier) Lentin & Williams has been reported from Cenomanian in Isle of Wight (Eisenack and Kjellstrom, 1971: p. 593).

Class Dinophyceae Fritsch, 1929
Order Peridiniales, 1894
Suborder 3 Hystrichosphaeridiineae Norris, 1978

Family 1 **Areoligeraceae** Evitt, emend. Sarjeant and Downie, 1966



Figs. 60-65. *Spiniferites scabrosus* (Clarkke & Verdier) Lentin & Williams (OK-2 1750- (2) film PF49-4, PF49-5, PF49-6; OK-1 1768- (1); film W58-25, W58-26, W58-27). (All figures x1000).

Genus 1 **Areoligera** Lejeune-Carpentier, 1938 emend. Williams & Downie, 1966, pp. 227-228

Type species: *Areoligera senonenssis* Lejeune-Carpentier, 1938

Remarks: The genus differs from *Glaphyrocysta* in lacking a complex network of distal trabeculae between process complexes. It differs from *Systematophora* in being lenticular rather than subspherical, and in having the processes on the midventral and middorsal surface reduced in size and number, or lacking altogether. (Wilson and Clowes, 1980).

Stratigraphic range: Late Cretaceous – Early Tertiary (Wilson and Clowes, 1980)

Areoligera taiwaniana Shaw, sp. nov. Figs. 70, 71

Holotype: Slide OK-1 1638- (2); film WA60-38, WA60-339; Figs. 70-71 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts subspherical to elliptical; marginate cyst; surface feature with penitabular processes which rises from low disssected and incomplete thin septa, form more or less arcuate to rectilinear distally branched process groups; tips of some adjacent process groups may be connected by trabeculae. Paratabulation indicated by penitabular process groups; autophragm 1-1.5 μm thick; apical archeopyle, operculum sometimes indistinct; 37x54 μm. No indications of paratabulation, paracingulum, or parasulcus.

Dimensions Holotype: Overall 64 μm long, 51 μm wide, cyst 54 μm long, 37 μm wide, surface features with penitabular processes which rises from low disssected and incomplete thin septa, the processes 13-25 μm long.

Stratigraphic occurrence: Eocene (OK-1 well, 1638m); rare.

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

Family 2 **Batiacasphaeraceae** Dorhofer and Davies, 1979

Genus 1 **Batiacasphaera** Drugg, 1970

Remarks: The genus differs from *Kallosphaeridium* in having a free rather than attached operculum (Wilson and Clowes, 1980).

Stratigraphic range: Mid. Jurassic – Early Miocene (Wilson and Clowes, 1980).

Type species *Batiacasphaera compta* Drugg, 1970

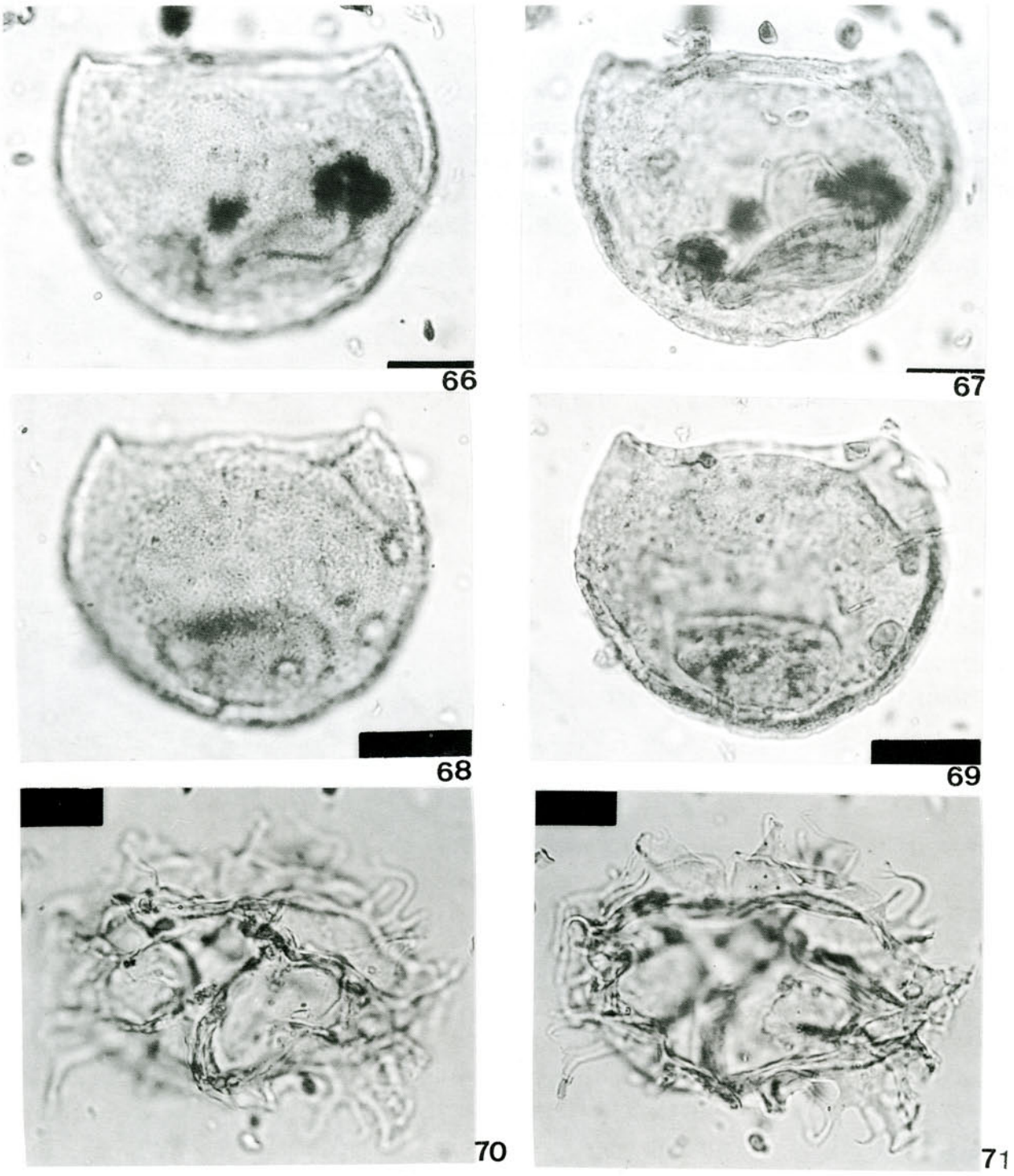
Batiacasphaera microreticulata Shaw, sp. nov. Figs. 66-69

Holotype: Slide OK-1 1669- (2); film W53-23, W53-24; Figs. 66-67(Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts subspherical or lenticular with a characteristic microreticulate (pseudo-granulate) surface and thick autophragm (2-2.5 μm thick); apical archeopyle, operculum generally free, occasionally remains in place; 33-54 μm wide. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1669m).

Dimensions Holotype: Overall 59 μm long, 45 μm wide, autophragm 2-2.5 μm thick, apical archeopyle 45 μm wide.



Figs. 66-69. *Batiacasphaera microreticulata* Shaw, *sp. nov.*; (OK-1 1669- (2); film W53-23, W53-24; OK-1 1669- (3); film W54-19, W54-20) Figs. 70, 71. *Areoligera taiwaniana* Shaw, *sp. nov.* (OK-1 1638- (2); film WA60-38, WA60-39) (All figures x1000).

Dimensions: Overall 55-59 μm long, 45 μm wide, autophragm 2-2.5 μm thick, apical archeopyle 40-45 μm wide (n=3).

Derivation of name: Latin, *microreticulata*; refers to the microreticulate surface.

Remarks: The species differs from *Batiacasphaera cassicula* Wilson 1988 in being substantially smaller and in having a microreticulate processes.

Batiacasphaera microreticulata Shaw **minima** Shaw, var. nov. Figs. 82, 83

Holotype: Slide OK-1 1788- (5); film W58-10, W58-11; Figs. 82,83 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts subspherical or lenticular with a characteristic microreticulate (pseudo-granulate) surface and thick autophragm (1-1.5 μm thick); apical archeopyle, operculum generally free, occasionally remains in place.; about 43 μm wide. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimensions Holotype: Overall 33 μm long, 43 μm wide, autophragm 1-1.5 μm thick, apical archeopyle 28 μm wide.

Derivation of name: Latin, *minima*, refers to the small size.

Remarks: The variety differs from *Batiacasphaera setulosa* Shaw in being substantially smaller size and in having thin autophragm.

Batiacasphaera setulosa Shaw, sp. nov. Figs. 72-77

Holotype: Slide OK-1 1788-bl-(2); film W52-18, W52-19; Figs. 72, 73 (Holotype at two focus levels); CPC Micropaleontology Lab.

Description: Cysts spherical, subspherical or lenticular with a characteristic setose surface, 2-3 μm long and thick autophragm (2-3 μm thick); apical archeopyle, operculum generally free, occasionally remains in place. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimensions Holotype: Overall 58 μm long, 51 μm wide; autophragm 2–3 μm thick, apical archeopyle 21 μm long.

Dimensions: Overall 43-58 μm long, 38-58 μm wide, autophragm 2-3 μm thick, apical archeopyle 20-25 μm wide (n=7).

Derivation of name: Latin, *setulosa*; refers to the spinule surface.

Remarks: The species differs from *Batiacasphaera cassicula* Wilson 1988 in being substantially smaller and in having a spinule processes.

Batiacasphaera setulosa Shaw **minima** Shaw, var. nov. Figs. 84-86

Holotype: Slide OK-1 1788-bl-(4); film PF41-23, PF41-24, PF41-25; Figs. 84-86 (Holotype at three focus levels); CPC Micropaleontology Lab.

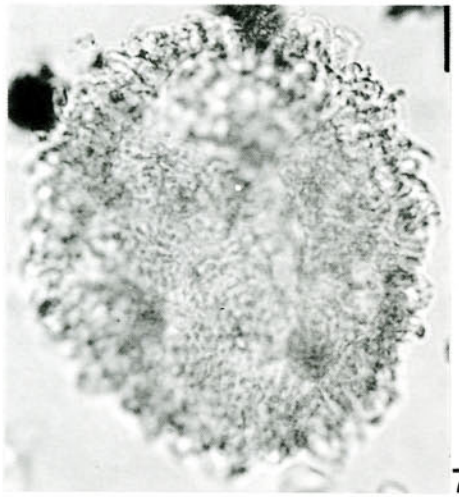
Description: Cysts spherical, subspherical or lenticular with a characteristic setose surface, 2-3 μm long and thin autophragm (1-1.5 μm thick); apical archeopyle, operculum generally free, occasionally remains in place. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimensions Holotype: Overall 35 μm long, 42 μm wide; autophragm 1–1.5 μm thick, apical archeopyle 15 μm wide.

Derivation of name: Latin, *minima,* refers to the small size.

Remarks: The variety differs from *Batiacasphaera setulosa* Shaw in being substantially smaller size and in having thin autophragm.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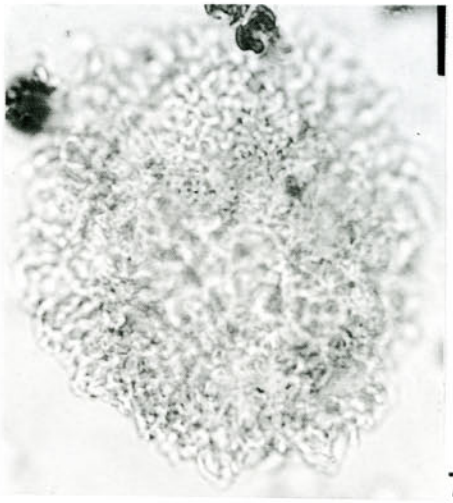
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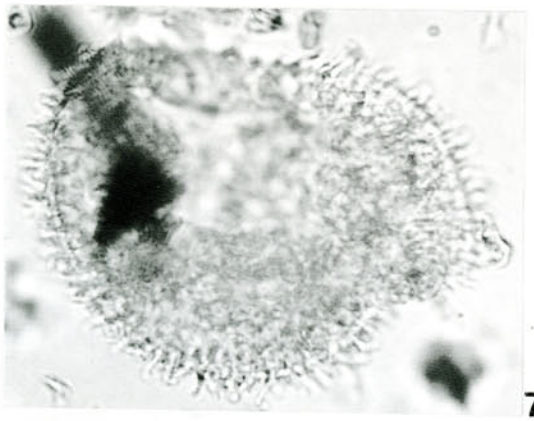
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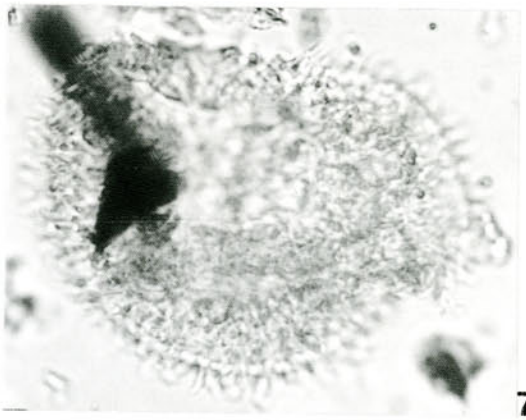
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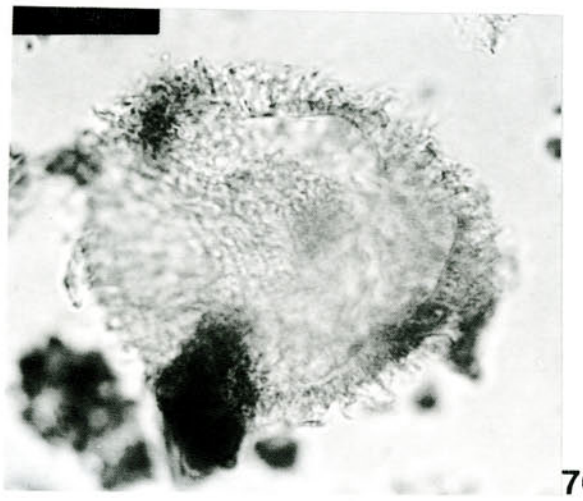
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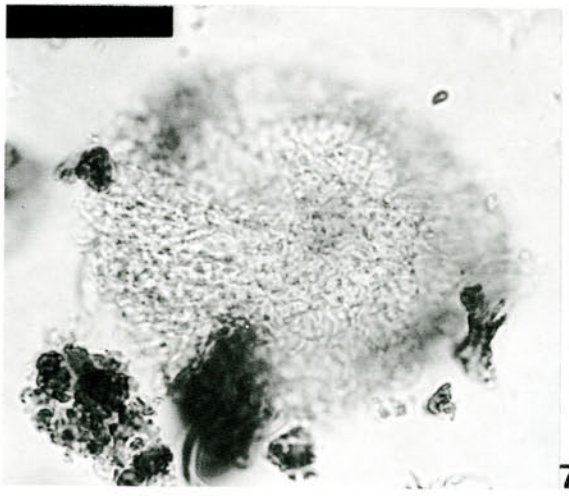
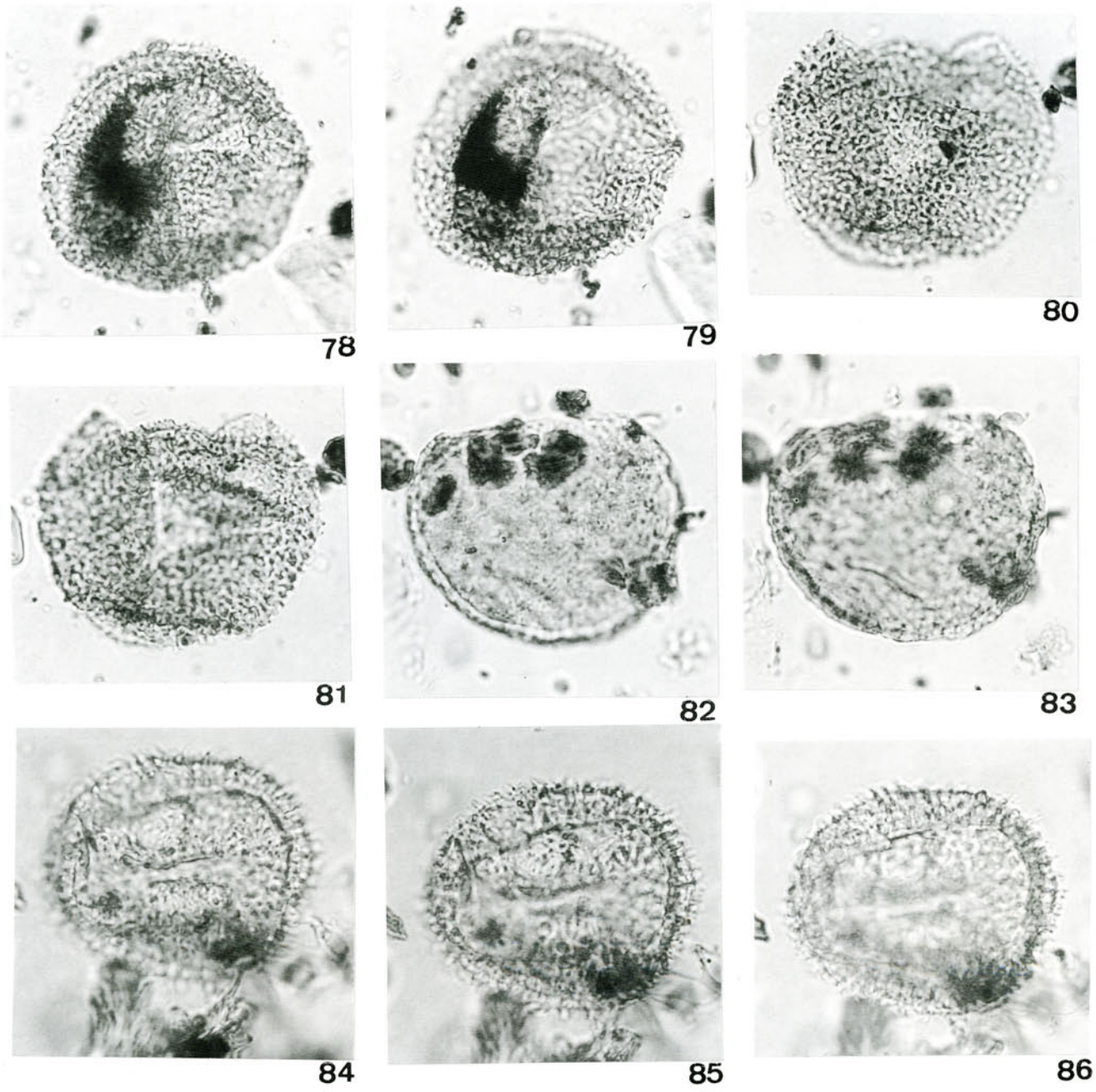

77

Figs. 72-77. *Batiacasphaera setulosa* Shaw, *sp. nov.* (OK-1 1788-bl-(2); film W52-18, W52-19; OK-1 1788-(1); film PF34-16, PF34-17; OK-1 1788-bl-(1); film PF30-28, PF30-29) (All figures x1000).

Batiacasphaera extravermiculata Shaw, sp. nov. Figs. 87-95

Holotype: Sample slide OK-1 1788- (1); Figs. 87-89; film PF33-30, PF33-31, PF33-32; CPC Micropaleontology Lab.

Description: Cysts spherical, subspherical or lenticular with a characteristic condensed extravermiculate surface and thick autophragm (4 –5 μm thick); lateral view of the cyst

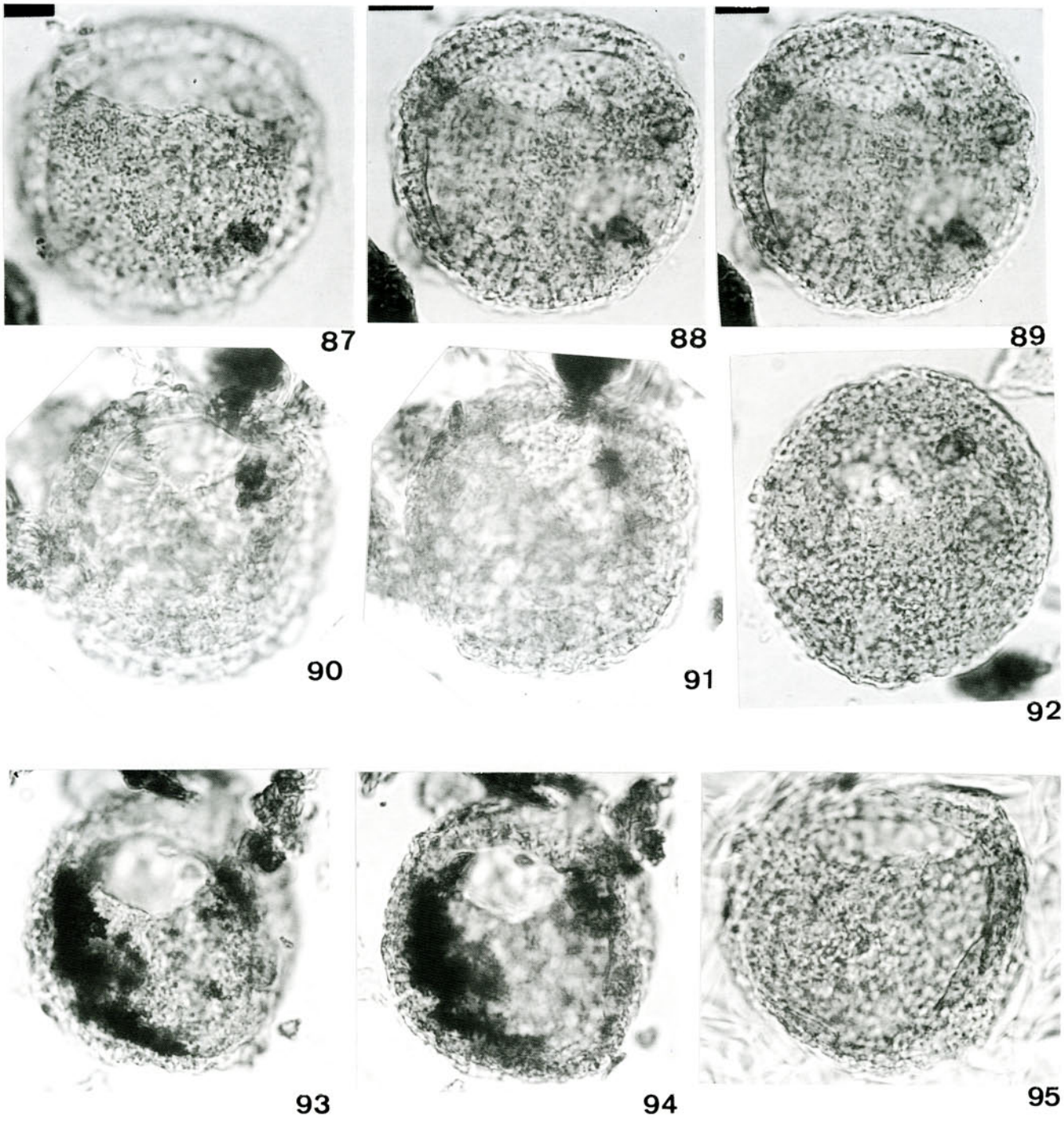


Figs. 78-81. *Batiacasphaera granulata* Shaw, *sp. nov.* (OK-2 1936- (1); film W45-25, W45-26; OK-2 1936-(1); film W46-24, W46-25) Figs. 82, 83. *Batiacasphaera microreticulata* Shaw, *minima* Shaw, *var. nov.*(OK-1 1788- (5); film W58-10, W58-11) Figs. 84-86. *Batiacasphaera setulosa* Shaw *minima* Shaw, *var. nov.*(OK-1 1788-bl-(4); film PF41-23, PF41-24, PF41-25) (All figures x1000).

scabrate; apical archeopyle, operculum generally free, occasionally remains in place.; about 26 μm wide. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimension Holotype: Overall diameter 50 μm, autophragm 4–5 μm thick, apical archeopyle 26 μm wide.



Figs. 87-95. *Batiacasphaera extravermiculata* Shaw, *sp. nov.*(OK-1 1788- (1); film PF33-30, PF33-31, PF33-32, PF34-36, PF34-37, PF35-3, PF35-10, PF35-11, PF35-17) (All figures x1000).

Dimensions: Overall diameter 38-52 μm, autophragm 2.5-5 μm thick, apical archeopyle 16-28 μm wide (n=22).

Derivation of name: Latin, *extravermiculata*; refers to the condensed extravermiculate surface.

Remarks: The species differs from *Batiacasphaera cassicula* Wilson 1988 in being substantially smaller and in having an extravermiculate processes.

Batiacasphaera granulata Shaw, sp. nov. Figs. 78-81

Holotype: Slide OK-2 1936- (1); Figs. 78,79; film W45-25, W45-26; CPC Micropaleontology Lab.

Description: Cysts spherical, subspherical or lenticular with a characteristic condensed granulate surface and thin autophragm (about 1–1.5 μm thick); lateral view of the cyst baculate to papillate; apical archeopyle, operculum generally free, occasionally remains in place; 17-22 μm wide. No indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-2 well, 1936m).

Dimension Holotype: Overall diameter 40 μm, autophragm 1.5 μm thick, apical archeopyle 17 μm wide.

Dimensions: Overall diameter 40-43 μm, autophragm 1-1.5 μm thick, apical archeopyle 17-22 μm wide (n=3).

Derivation of name: Latin, *granulata*; refers to the condensed granulate surface.

Remarks: The species differs from *Batiacasphaera cassicula* Wilson 1988 in being substantially smaller and in having granulate processes.

Family 3 **Florentiniaceae** Harker and Sarjeant, emend. Norris, 1978

Genus 1 **Homotryblium** Davey & Williams, 1966

Type species *Homotryblium tenuispinosum* Davey & Williams, 1966b

Remarks: The genus differs from *Hemicystodinium* and *Eocladopyxis,* which have a similar archeopyle, in having intratabular rather than nontabular processes (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p. 210).

Stratigraphic range: Middle Paleocene – Oligocene (Wilson and Clowes, 1980).

Homotryblium taiwanianum Shaw sp. nov. Figs. 96-98

Holotype slide: OK-2 1480- (5); Figs. 96-98; film WA72-28, WA72-29, WA72-30 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Subspherical to oval central body, inner endophragm thin, and surrounding periphragm smooth to obscure which gives rise to processes. Processes intratabular, tubiform to buccinate, with recurved tips, up to 13 μm long.; archeopyle indistinct.

Dimensions Holotype: Overall diameter 49-55 μm , diameter of central body 37-44 μm, processes 9-13 μm long, 2.5-5 μm wide (n=1).

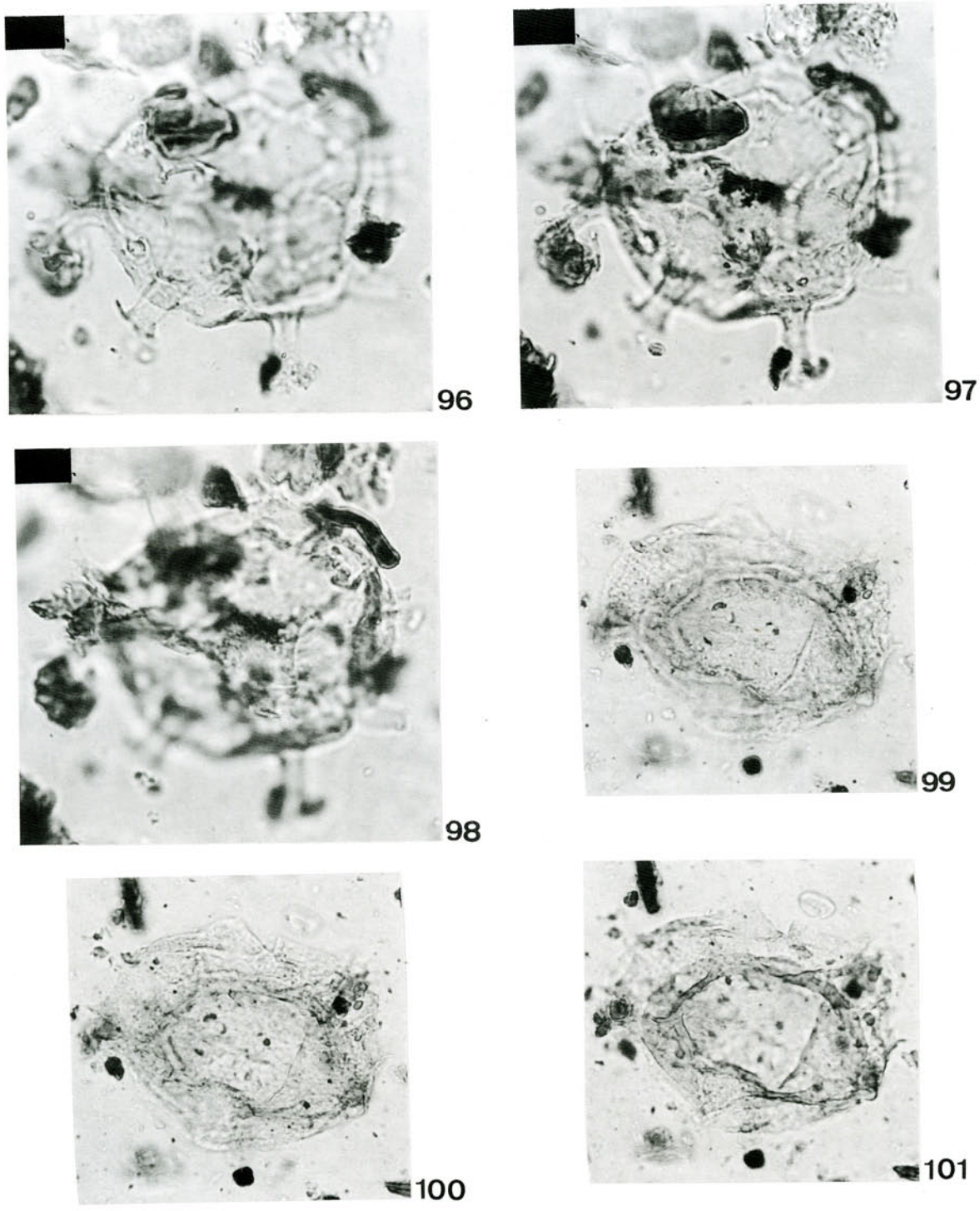
Stratigraphic occurrence: Eocene (OK-2 well, 1480m), rare.

Derivation of name: The specific epithet, *taiwanianum* is derived from the name of the type locality.

Remarks: The new species most closely resembles *Homotryblium tenuispinosum* Davey & Williams in having a roughly similar outline; however, it differs both in having smooth to obscure periphragm, and in having a smaller size and shorter tubiform to buccinate appendages processes.

Family 4 **Hystrichosphaeridiaceae** Evitt, emend. Norris, 1978

Genus 1 **Hystrichokolpoma** Klumpp, 1953 emend. Williams & Downile 1966.



Figs. 96-98. *Homotryblium taiwanianum* Shaw, *sp. nov.* (OK-2 1480- (5); Figs. 96-98; film WA72-28, WA72-29, WA72-30) Figs. 99-101. *Thalassiphora pelagica* (Eisenack) Eisenack & Gocht (OK-1 1365-(2); film WA65-12, WA65-13, WA65-14) (Figures 96-98, x1000; Figures 99-101 x400).

Remarks: The genus differs from *Florentinia* and *Achilleodinium* in having an apical rather than a precingular or combination archeoplyle (Wilson and Clowes, 1980).

Stratigraphic range: Late Paleocene – Early Pleistocene (Wilson and Clowes, 1980).

Type species *Hystrichokolpoma cinctum* Klumpp, 1953.

Hystrichokolpoma cinctum Klumpp 1953 Figs. 102-107

Slide: OK-1 1788-bl- (1); Figs. 102-107; film PF30-8, PF30-9, PF30-10, PF32-36, PF32-37, PF32-38; CPC Micropaleontology Lab.

Description: Cyst of intermediate size, bilayered, with moderately thick, smooth endophragm and periphragm, both layers in close contact. Precingular and postcingular intratabular processes 14-21 μm long, somewhat cyclindrical, with broad subpolygonal or rounded bases (12-15 μm wide), smooth, or occasionally bearing rare short spinules. Antapical process distinctive, hollow, relatively long (23 to 45 μm) distally narrower with blunt tip, 18-22 μm wide; paracingular processes simple or bifurcate, narrow, hollow, pointed, apparently two per paraplate. Apical archeopyle with subrounded margin, operculum free. Paracingulum indicated by simple or bifurcate processes.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Dimensions: Overall diameter 57-80 μm, diameter of endocyst 38-56 μm (n=26).

Previous records: *Hystrichokolpoma cinctum* has a worldwide distribution in the Lower to Middle Eocene. (William & Bujak, 1977).

Hystrichokolpoma taperinia Shaw, sp. nov. Figs. 108-113

Holotype: Slide OK-1 1788-bl-(2); Figs. 108-110 (Holotype at three focus levels); film W52-24, W52-25, W52-26; CPC Micropaleontology Lab.

Description: Spherical to subspherical cyst with moderately thick smooth endophragm and periphragm, both layers in close contact, diameter 51-52 μm; parasutural features are relatively narrow, linear and low ridges between raised intratabular areas. Precingular and postcingular intratabular with crumpled-conical penitabular processes 4-9 μm long. Antapical process indistinctive. Paracingulum indicated by simple tapering processes (n>10), the processes up to 7 μm long. Apical archeopyle with subrounded margin, operculum free.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m).

Derivation of name: Latin, *taperinia* refers to the tapering processes on the paracingulum.

Dimensions Holotype: Overall 52 μm long, 48 μm wide, cyst 46 μm long, 46 μm wide, surface features with crumpled-conical penitabular processes, processes up to 4-9 μm long. Paracingulum indicated by tapering processes (n>10), the processes up to 7 μm long.

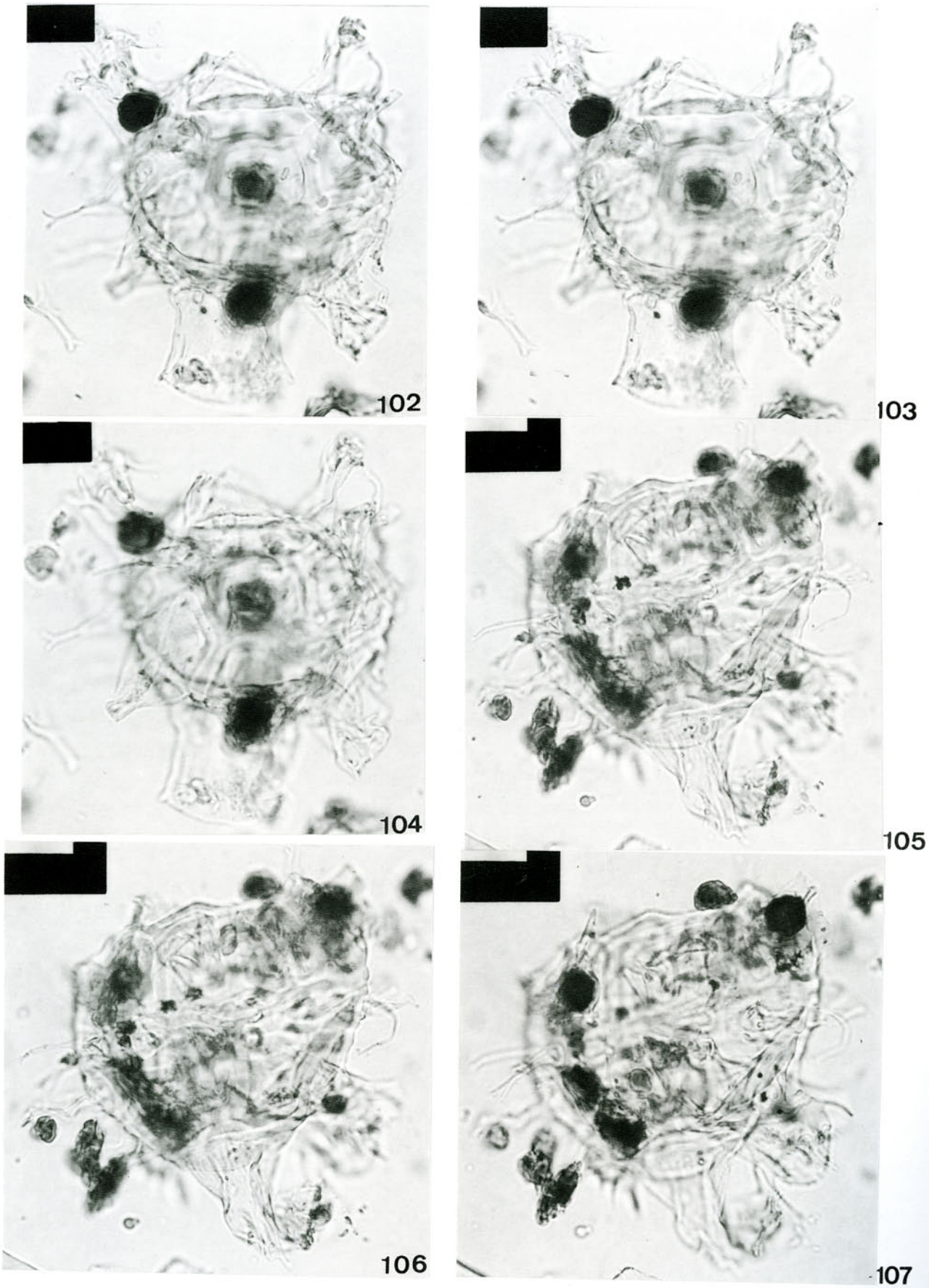
Remarks: The new species resembles *Hystrichokolpoma cinctum* Klumpp in having a roughly similar outline; however, it differs both in having crumpled-conical penitabular processes, and in lacking a long antapical process. The new species also closely resembles *Eisenackia crassitabulata* Deflandre & Cookson emend. McLean in having a roughly similar outline; however, it differs in having a tapering processes on the paracingulum.

Genus 2 **Oligosphaeridium** Davey & Williams in Davey *et al.*, 1966, pp. 70-1

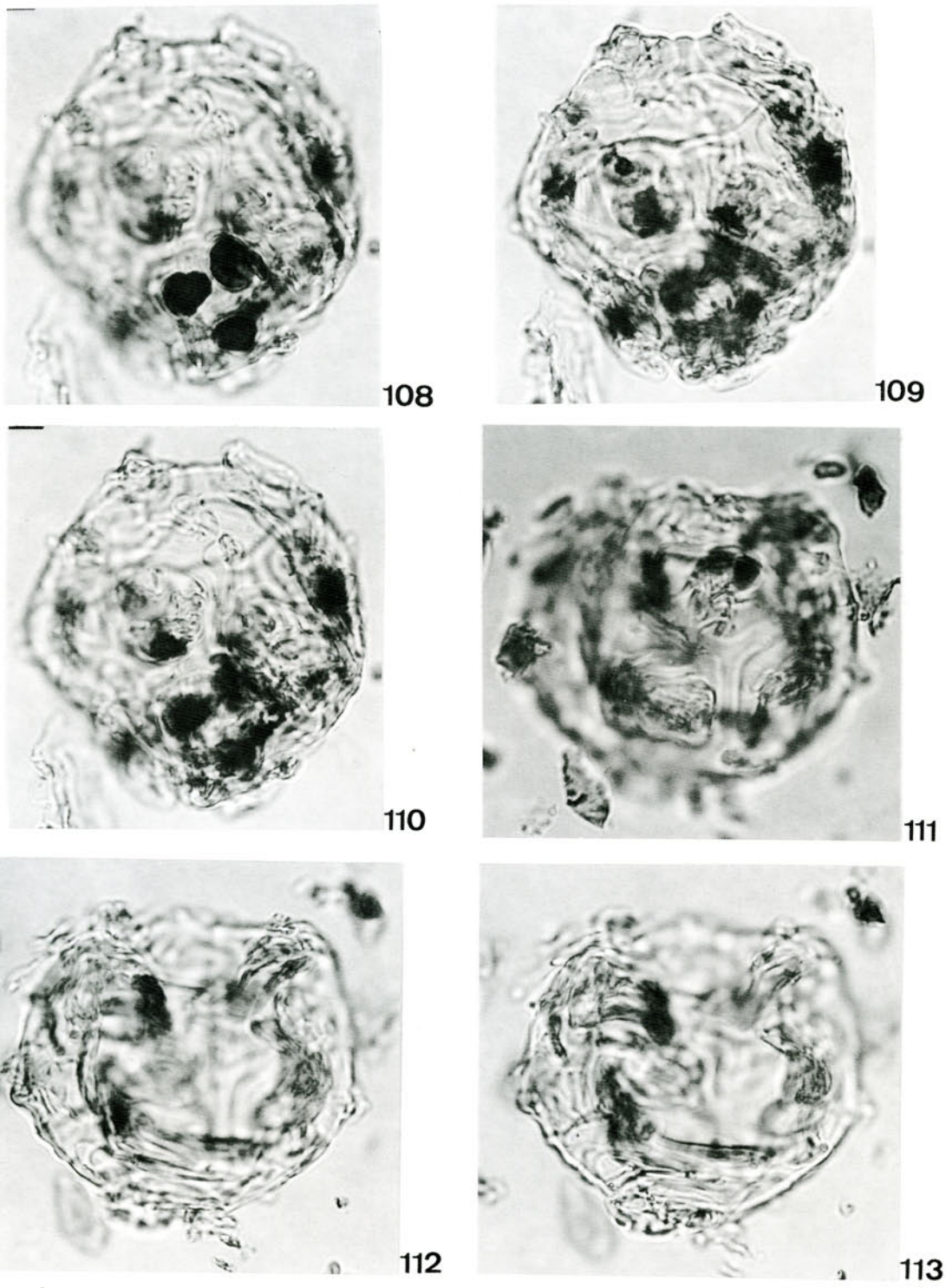
Type species: *O. complex* Davey & Williams in Davey *et al.*, 1966, pp.71-4

Remarks: *Oligosphaeridium* differs from *Hystrichosphaeridium* and *Perisseiasphaeridium* in lacking paracingular processes, from *Kaiwaradinium* in having a subspherical rather than an elongate ellipsoidal body, and from *Areosphaeridium* in having tubiform rather than solid processes. A modified generic description is given by Stover & Evitt (1978, p. 68).

Stratigraphic range: Late Jurassic - ? Paleocene



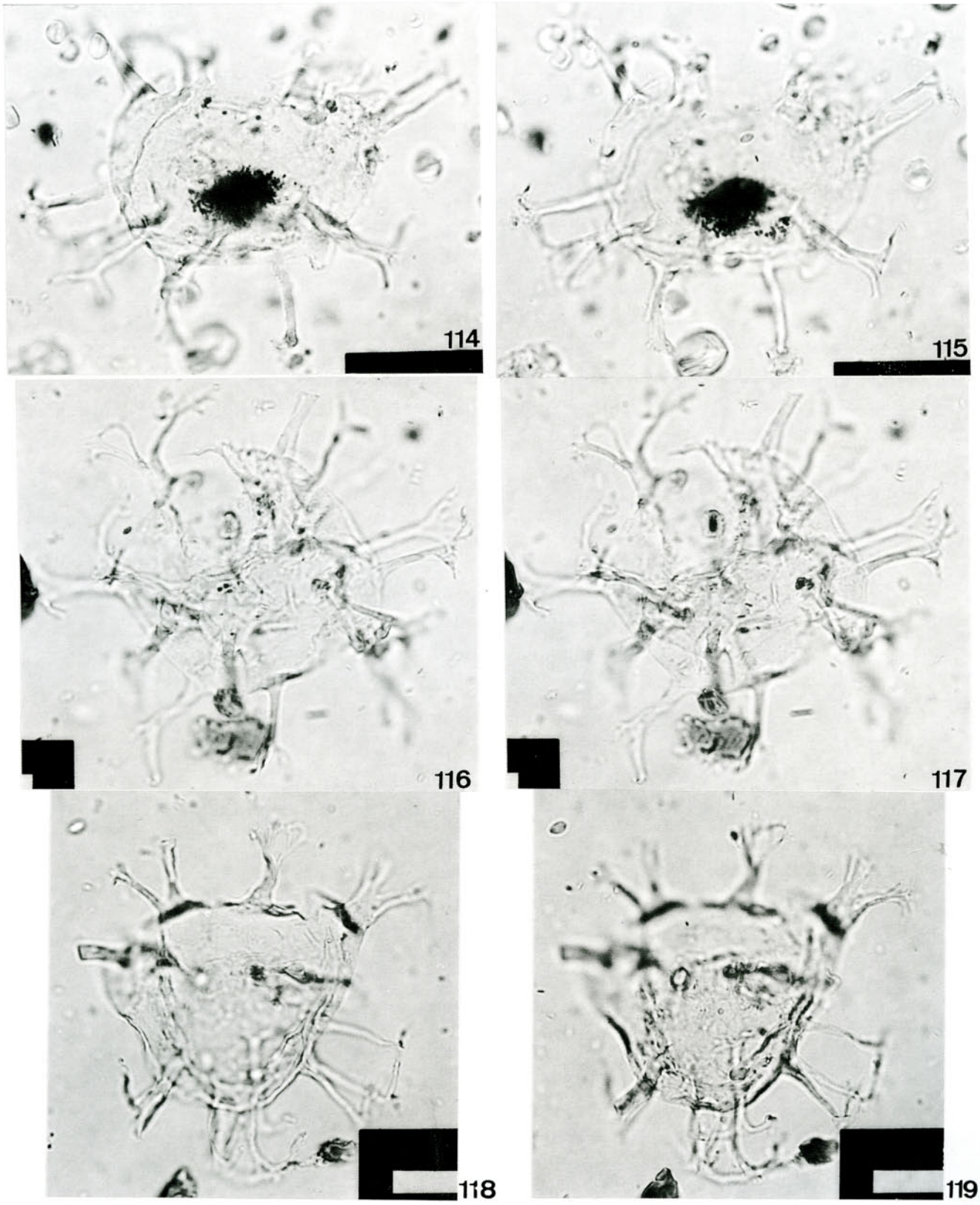
Figs. 102-107. *Hystrichokolpoma cinctum* Klumpp (OK-1 1788-bl- (1); film PF30-8, PF30-9, PF30-10, PF32-36, PF32-37, PF32-38) (All figures x1000).



Figs. 108-113. *Hystrichokolpoma taperinia* Shaw *sp. nov.* (OK-1 1788-bl-(2); film W52-24, W52-25, W52-26; OK-1 1788-bl- (3); film PF38-38, PF39-1, PF39-2) (All figures x1000).

Oligosphaeridium complex Davey & Williams in Davey *et al.*, 1966 Figs. 114-119

1842 *Xanthidium tubiferum complex* White, p.39, pl.4, div. 3, fig. 11.
1848 *Xanthidium complexum* (White) Bronn, p. 1375.
1940 *Hystrichosphaeridium elegantulum* Lejeune--Carpentier, p. 22, Textfigs. 11,12.
1952 *Hystrichosphaeridium complex* (White) Firtion, P. 156, Pl. 9, figs. 2.4.5, Textfigs. 1A-F.
1962 *Oligosphaeridium tubiferum* (Ehrenberg) Pocock, p. 83, Pl. 15, fig. 230.



Figs. 114-119. *Oligosphaeridium complex* Davey & Williams in Davey *et al.* (OK-3 1750- (5), 1750- (2); film PF27-6, PF27-7, PF29-26, PF29-27, PF14-26, PF14-27) (All figures x1000).

Slide: OK-3 1750- (5), 1750- (2); Figs. 114-119; film PF27-6, PF27-7, PF29-26, PF29-27, PF14-26, PF14-27; CPC Micropaleontology Lab.

Description: Central body subspherical to ovoidal. Wall composed of thin endophragm and periphragm, the latter giving rise to processes. Processes simple or branched, cylindrical for most of their length, open and expanded distally with aculeate or secate margin. Apical archaeopyle usually present. Processes in complete specimen more than 14.

Dimensions: Maximum overall diameter 55-77 μm, diameter of central body 34-48 μm, processes 12-19 μm long (n=4).

Stratigraphic occurrence: Eocene (OK-3 well, 1750m)

Previous records: The species has been recorded world-wide from deposits ranging from Cretaceous to top of the Middle Eocene (Williams & Bujak, 1977).

Genus 3 **Systematophora** Klement, 1960.

Type species: *Systematophora areolata* Klement, 1960.

Remarks: The genus differs from *Areoligera* in being subspherical rather than lenticular, and in having the well-developed process complexes in midventral and middorsal surface (Wilson and Clowes, 1980).

Stratigraphic range: Middle Oxfordian – Miocene (Wilson and Clowes, 1980).

Systematophora taiwaniana Shaw, sp. nov. Figs. 120-125

Holotype: slide OK-1 1788bl- (4); film PF40-33, PF40-34, PF40-35; Figs. 123-125 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Cysts spherical to subspherical, 43-51 μm wide, surface features with annulate complex of processes which are distally free, processes cylindrical to tapering with evexate tip, up to 18 μm long; apical archeopyle, operculum generally free, occasionally remains in place; no indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m).

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

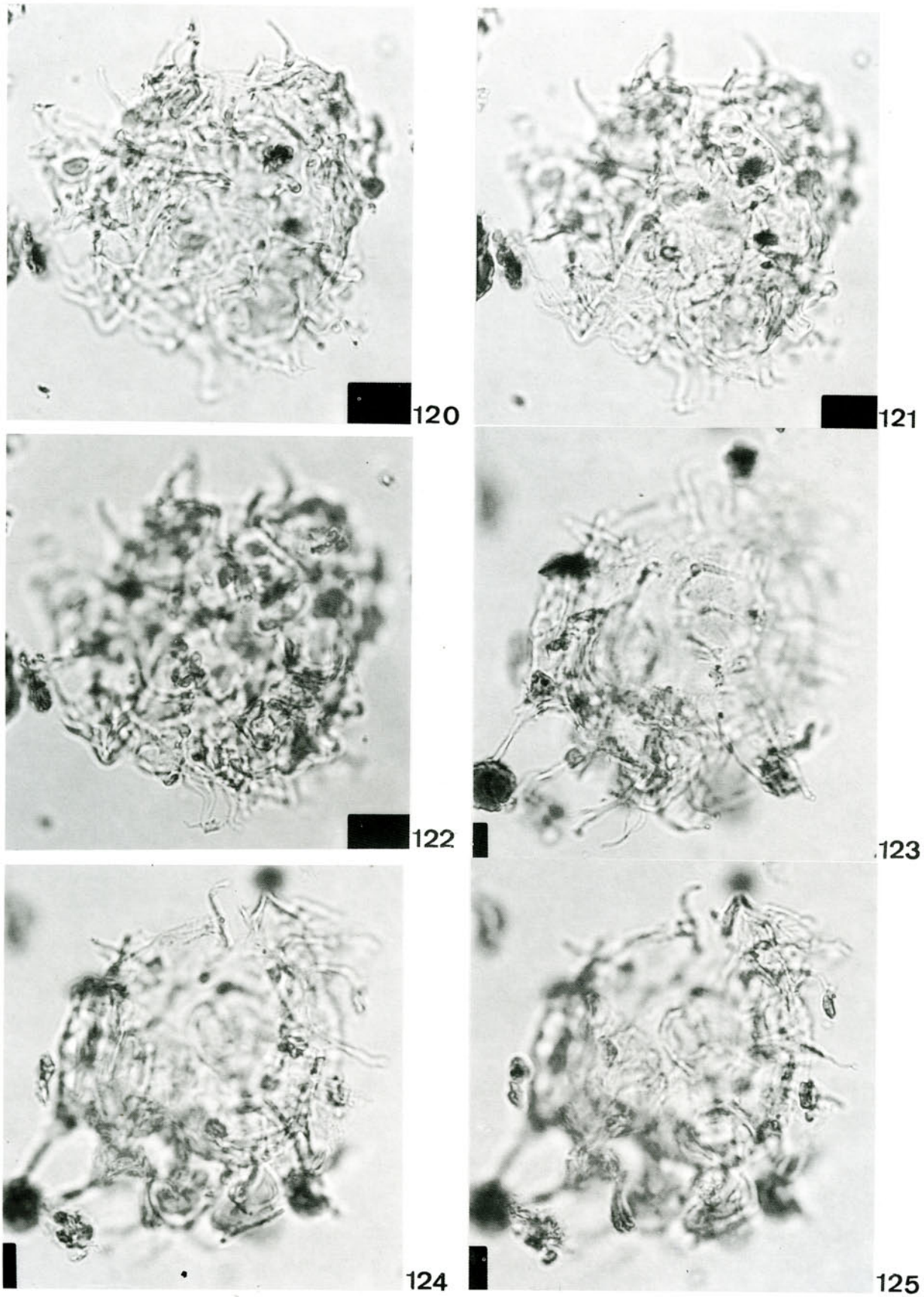
Dimensions Holotype: Overall 42 μm long, 51 μm wide, processes 11-18 μm long.

Remarks: The new species differs from *Systematophora placacantha* (Cookson & Eisenack) Davey *et al.* in having the surface features with annulate complex of processes which are distally free, processes cylindrical to tapering with evexate tip.

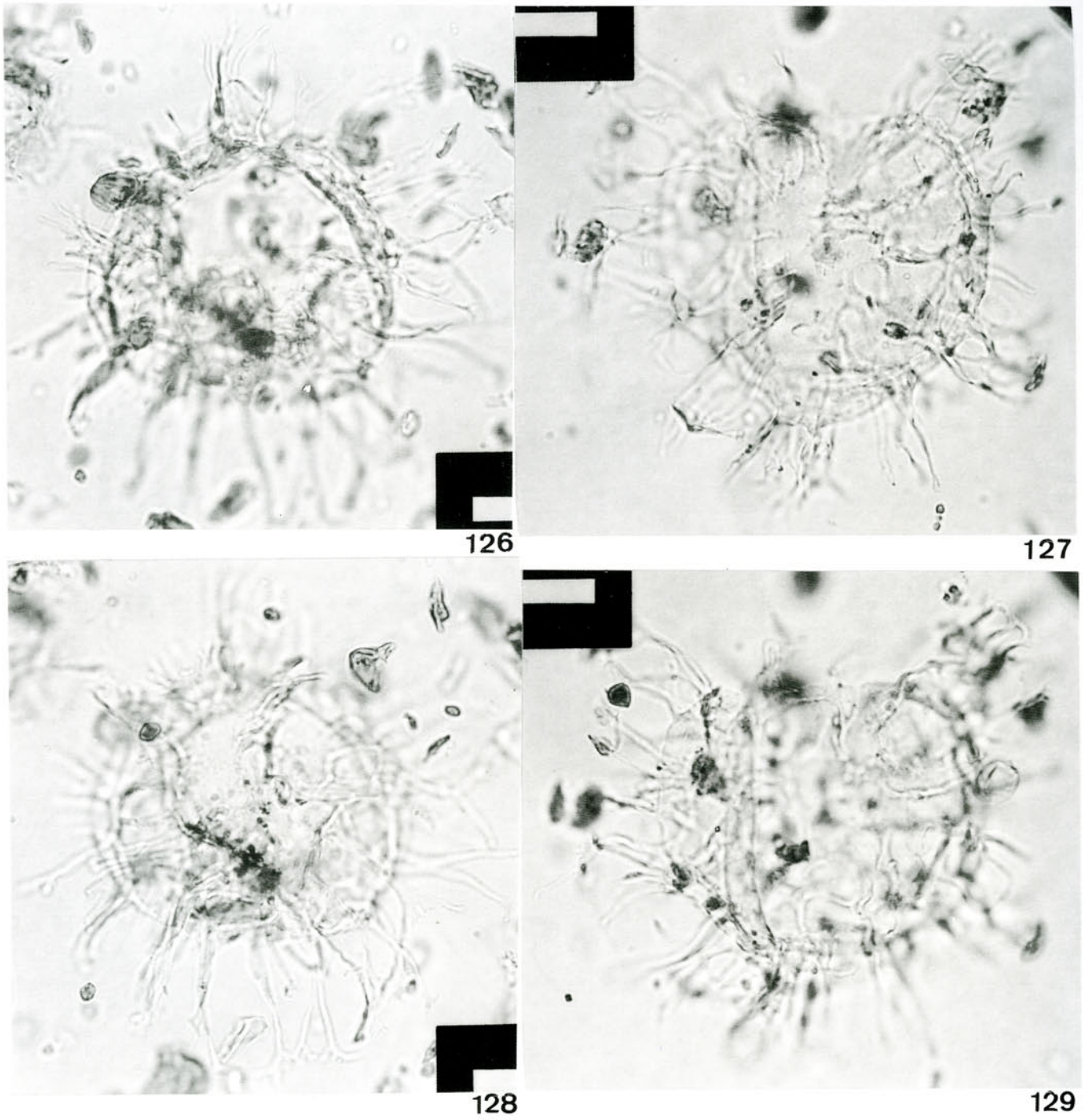
Systematophora placacantha (Deflandre & Cookson, 1955) Davey *et al.* 1969, emend, May, 1980 Figs. 126-129

1955 *Hystrichaosphaeridum placacanthum* Deflandre & Cookson: 276-227 pl. 9, figs 1-3.
1963 *Baltisphaeridum placacanthum* (Deflandre & Eisenack) Downie & Sarjeant: 92
1969 *Systematophora placacantha* (Cookson & Eisenack) Davey *et al.*: 17.
1980 *Systematophora placacantha* (Deflandre & Eisenack) Davey *et al.*; emend. May: 68.

Sample slide: OK-1 1788-bl- (1); film PF30-30, PF30-31, PF30-32, PF33-3, PF33-4, PF33-5; Figs. 126-129; CPC Micropaleontology Lab.



Figs. 120-125. *Systematophora taiwaniana* Shaw, sp. nov. (OK-1 1788bl- (4); film PF40-15, PF40-16, PF40-17, PF40-33, PF40-34, PF40-35) (All figures x1000).



Figs. 126-129. *Systematophora placacantha* (Deflandre & Cookson) Davey *et al.* emend, May (OK-1 1788-(1); film PF34-24, PF34-25; OK-1 1788-bl- (1); film PF30-30, PF30-31) (All figures x1000).

Description: Cysts spherical to subspherical, about 50-54 μm wide, surface features with annulate complex of processes which are distally free, process with entire or bifurcate tip, up to 25 μm long; apical archeopyle, operculum generally free, occasionally remains in place; no indications of paratabulation, paracingulum, or parasulcus.

Stratigraphic occurrence: Eocene (OK-1 well, 1788m)

Previous records: The species has been reported from deposits ranging from the Campanian-Maastrichtian of America (May, 1980) to the Miocene of Australia (Deflandre &

Cookson, 1955). It has not been reported previously from New Zealand although a closely related form, *S.* cf, *placacantha*, has been recorded from the Runangan Stage (Wilson, 1982).

Family 5 **Lithodiniaceae** Norris, 1978

Genus 1 **Eisenackia** Deflandre & Cookson, 1955 emend. Stover & Evitt, 1978.

Type species: *Eisenackia crassitabulata* Deflandre & Cookson, 1955 emend. McLean, 1973.

Remarks: The genus differs from *Cassidium* in having wider and generally deeper parasutural depressions, and in having paraplates expressed in thee parasulcus. *Alisocysta* has parasutural ridges or septa rather than depressions (Wilson and Clowes, 1980). A modified generic description is given by Stover and Evitt (1978, p.42.).

Stratigraphic range: Paleocene – Early Eocene (Wilson and Clowes, 1980).

Eisenackia formosana Shaw, sp. nov. Figs. 133-135

Holotype sample slide: OK-2 1916-(3); Figs. 133-135 (Holotype at three focus levels); film W43-23, W43-24, W43-25; CPC Micropaleontology Lab.

Description: Spherical to subspherical cyst, diameter 45-51 μm; parasutural features relatively narrow, linear and low ridges between raised intratabular areas, with crumpled-conical penitabular processes. Paracingulum indicated by transversely elongate penitabular ridges. Apical archeopyle.

Stratigraphic occurrence: Eocene (OK-2 well, 1916m)

Derivation of name: The specific epithet *formosana* is derived from the name of the type locality.

Dimensions Holotype: Overall 52 μm long, 48 μm wide, cyst 46 μm long, 46 μm wide, surface features with crumpled-conical penitabular processes, processes up to 4-9 μm long. Paracingulum indicated by tapering processes (n>10), the processes up to 7 μm long.

Remarks: The new species most closely resembles *Eisenackia crassitabulata* Deflandre & Cookson emend. McLean in having a roughly similar outline; however, it differs both in having crumpled-conical penitabular processes, and in having a tapering processes on the paracingulum.

Eisenackia circumtabulata Drugg, 1967 Figs. 130-132

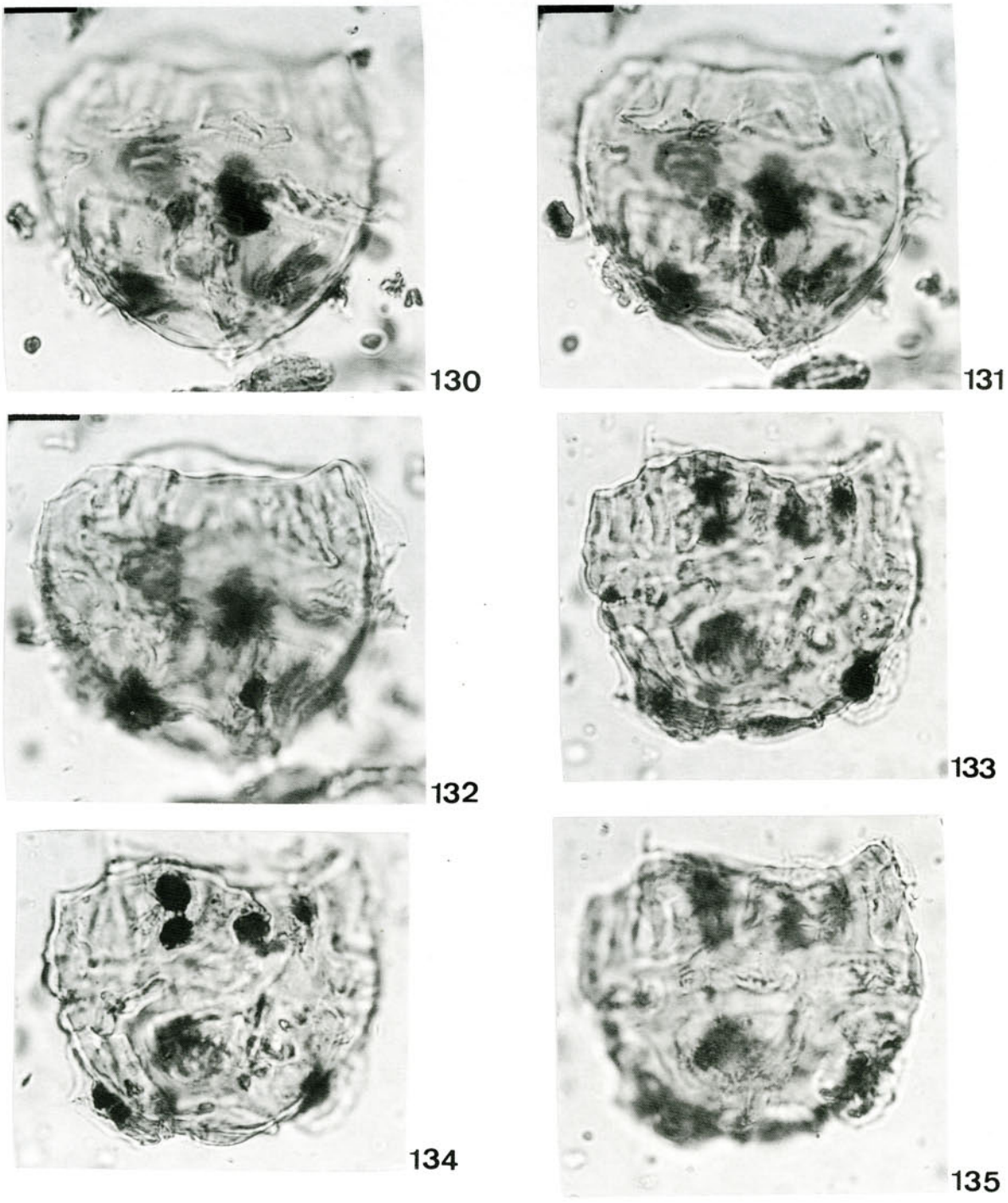
Sample slide: OK-1 1825- (4); film WA60-10, WA 60-11, WA 60-12; Figs. 130-132; CPC Micropaleontology Lab.

Description: Spherical to subspherical cyst, diameter 47-49 μm; parasutural features relatively narrow, linear and low ridges between raised intratabular areas, surface view of the cyst smooth, with low membrane wall-like penitabular crests. Paracingulum indicated by transversely elongate penitabular ridges. Apical archeopyle.

Stratigraphic occurrence: Eocene (OK-1 well, 1825m).

Dimensions: Overall 49 μm long, 58 μm wide, cyst 47 μm long, 49 μm wide, surface features with low membrane wall-like penitabular crests, the crests up to 4 μm long.

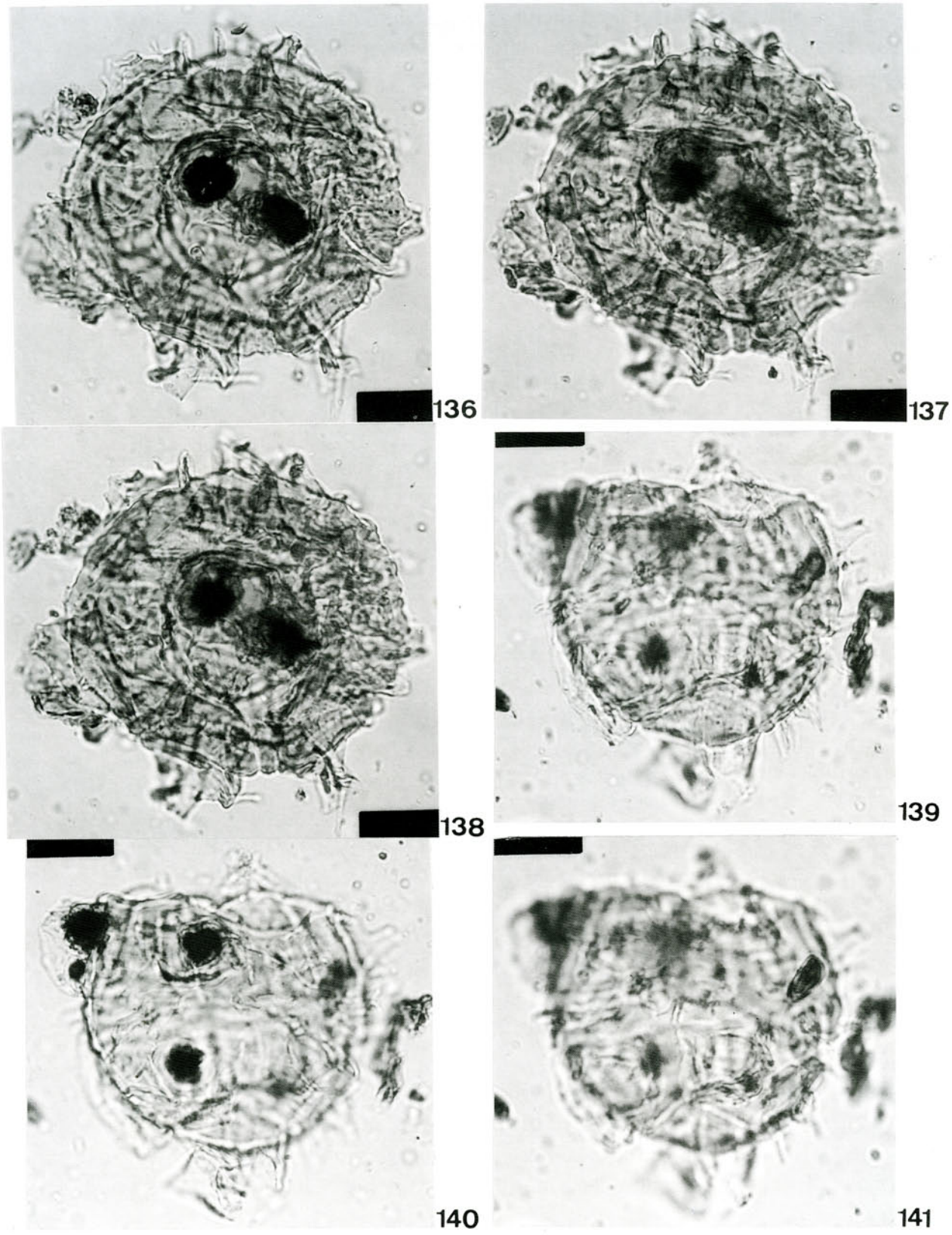
Previous records: The species was first described from the Danian of California (Drugg 1967) and it is also known from the Danian of Texas (Evitt, 1973). It has previously been reported from the Paleocene and Lower Eocene of New Zealand by Wilson (1984).



Figs. 130-132. *Eisenackia circumtabulata* Drugg (OK-1 1825- (4); film WA60-10, WA 60-11, WA 60-12); Figs. 133-135. *Eisenackia formosana* Shaw *sp. nov.*(OK-2 1916-(3); film W43-23, W43-24, W43-25) (All figures x1000).

Eisenackia taiwaniana Shaw, sp. nov. Figs. 136-141

Holotype slide: OK-2 1875- (5); film WA69-23, WA 69-24, WA 69-25; Figs. 136-138 (Holotype at three focus levels); CPC Micropaleontology Lab.



Figs. 136-141. *Eisenackia taiwaniana* Shaw, *sp. nov.* (OK-2 1875- (5); film WA69-23, WA69-24, WA69-25; OK-2 1916- (2); film W41-34, W41-35, W41-36) (All figures x1000).

Description: Spherical to ellipsoidal cyst without appendages, diameter 61-62 μm. Wall thick and smooth; parasutural features relatively narrow, linear and low ridges between raised intratabular areas, with high membrane wall-like penitabular processes. Paracingulum indicated by transversely elongate penitabular ridges. Apical archeopyle, operculum free.

Dimension Holotype: Overall 61 μm long , 62 μm wide, cyst 47 μm long, 49 μm wide, surface features delineated by high membranous walls, the walls up to 9-13 μm long.

Derivation of name: The specific epithet *taiwaniana* is derived from the name of the type locality.

Stratigraphic occurrence: Eocene (OK-2 well, 1875m, 1916m).

Remarks: The species differs from the type species *Eisenackia crassitabulata* in lacking a thick-walled mesh of the plates and in having a smaller size.

Class Dinophyceae Fritsch, 1929
Order Peridiniales, 1894
Suborder 4 Incertae

Family 1 **Ceratocoryaceae** Stein, 1883
Genus 1 **Thalassiphora** Eisenack & Gocht, 1960 emend. Gocht, 1968

Type species *Thalassiphora pelagica* (Eisenack, 1954) Eisenack & Gocht, 1960

Stratigraphic range: Albian - Pliocene

Remarks: *Thalassiphora* differs from *Stephodinium* in having endophragm and periphragm appressed dorsally and separated elsewhere, and in lacking a prominent paracingular bandlike protrusion. A modified generic description is given by Stover & Evitt (1978, p.194)

Thalassiphora pelagica (Eisenack, 1954) Eisenack & Gocht, 1960 Figs. 99-101

1938 *Bion pelagicum* Eisenack: 187 (nom. und.).
1954 *Pterospermopsis pelagica* Eisenack: 71, pl., 12, fig. 17-18.
1960 *Thalassiphora pelagica* (Eisenack) Eisenack & Gocht: 513; text-fig. 1-3.

Slide: OK-1 1365-(2); film WA65-12, WA65-13, WA65-14; Figs. 99-101; CPC Micropaleontology Lab.

Description: Central body ellipsoidal with a slightly thicken membrane; external membrane thin and relative wide; with finely reticulate ornament. Precingular archeopyle indistinct.

Dimensions: Overall 116x87 μm, endocyst 82x58 μm (n=1).

Stratigraphic occurrence: Eocene (OK-1 well, 1365m)

Remarks: The specimens have a finely reticulate periphragm, generally well-folded, with a relatively distinct raised ridge denoting the paracingulum. No indications of paratabulation are present.

Previous records: The species has been widely recorded from deposits ranging in age from Late Maastrichtian (Wilson, 1971) to Middle Miocene (Gerlach, 1961). Most documented records are from the Eocene and Oligocene (Wilson, 1982; 1984).

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台灣始新世溝鞭藻化石

蕭承龍[1]

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摘　　要

本文報導發現於台灣基隆北方海域始新世地層中，溝鞭藻化石共計四十一個分類群；並描述第一次出現於始新世地層中的溝鞭藻化石共計三十二個分類群，分別屬於壹綱，壹目，肆亞目，貳拾屬，其中Deflandreineae亞目計有貳科，拾個分類群 (*Spinidinium taiwanianum sp. nov.; Apectodinium homomorphum* (Deflandre & Cookson) Lentin & Williams; *A. raritubiformium* Shaw; *Kisselovia coleothrypta* (Williams & Downie) Lentin & Williams; *K. taiwaniana* Shaw; *K. pengchiahsuensis* Shaw; *Wetzeliella symmetrica* Weiler var. *taiwaniana* Shaw; *W. symmetrica* Weiler var. *scabrata* Shaw; *W. articulata* Eisenack var.*taiwaniana* Shaw; *W. articulata* Eisenack var. *scabrata* Shaw) ; Gonyaulacystineae亞目計有肆科，十四個分類群 (*Aireiana taiwaniana sp. nov.*; *Cordosphaeridium cordium sp. nov.*; *C. fibrospinosum* Davey & Williams; *C. taiwanianum sp. nov.; Turbiosphaera filosa* (Wilson) Archangelsky; *Impagidinium gracilium sp. nov.; I. taiwanianum sp. nov.; I. pengchiahsum sp. nov.; Ochetodinium taiwanianum sp. nov.; Operculodinium taiwanianum sp. nov.; Achomosphaera taiwaniana sp. nov.; Spinferites formosus sp. nov.; S. ramosus* subsp. *multibrevis* (Davey & Williams) Lentin; *S. scabrosus* (Clarke & Verdier) Lentin & Williams)；Hystrichosphaeridiineae亞目計有五科，十六個分類群 (*Areoligera taiwaniana sp. nov.; Batiacasphaera microreticulata sp. nov.; B. microreticulata Shaw minima var. nov.; B. setulosa sp. nov.; B. setulosa Shaw minima var. nov.; B. extravermiculata sp. nov.; B. granulata sp. nov.; Homotryblium taiwanianum sp. nov.; Hystrichokolpoma cinctum* Klumpp; *H. taperinia sp. nov.; Oligosphaeridium complex* Davey & Williams in Davey *et al.*; *Systematophora taiwaniana sp. nov. ; S. placacantha* (Deflandre & Cookson) Davey *et al.*; *Eisenackia circumtabulata* Drugg; *E. formosana sp. nov.; E. taiwaniana sp. nov.*)；Incertae亞目計有一科，一個分類群 (*Thalassiphora pelagica* (Eisenack) Eisenack & Gocht)。

關鍵詞: 始新世地層、溝鞭藻化石、分類、台灣。

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