

Eocene Areoligeraceous Dinoflagellate Cysts of Taiwan

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(Manuscript received 10 April, 2004; accepted 27 May, 2004)

ABSTRACT: Three genera *Areoligera*, *Cyclonephelium* and *Glaphyrocysta*, the fossil dinoflagellate cysts of Areoligeraceae, obtained from Eocene sediments offshore of Keelung area in northern Taiwan are reported. One species of the genus *Areoligera* (*Areoligera taiwaniana* C. L. Shaw), two species of the genus *Cyclonephelium* (*Cyclonephelium pengchiahsun* C. L. Shaw sp. nov. and *Cyclonephelium taiwanianum* C. L. Shaw sp. nov.) and One species of the genus *Glaphyrocysta* (*Glaphyrocysta microfenestrata* (Bujak) Stover & Evitt) are described.

KEY WORDS: Eocene, Areoligeraceae, Taxonomy, Taiwan.

INTRODUCTION

Organic walled dinoflagellate cysts were first reported from Taiwan Tertiary formations by Huang (1981) in *Taiwania* dealing with Miocene dinoflagellate cysts. Eocene palynology of Taiwan was investigated by the present author in 1988. A total of forty-nine cores of Eocene from offshore of Keelung area in northern Taiwan were collected. These samples were brought to the Chinese Petroleum Corporation Micropaleontological Laboratory for the preparation of pollen slides. This paper is the tenth installment reporting the palynological flora from wells drilled in offshore Keelung in northern Taiwan. The previous installments include reporting tiliaceous palynomorphs (Shaw, 1997), ephedraceous palynomorphs (Shaw, 1998), wetzeliellaceous dinoflagellates (Shaw, 1999a), fossil dinocysts (Shaw, 1999b), pteridophytic spores (Shaw, 1999c), angiospermous palynomorphs (Shaw, 1999d, 2000b), gymnospermous palynomorphs (Shaw, 2000a), and acritarchs (Shaw, 2001). This paper is part of a more extensive discussion of the fossil dinoflagellate cysts of Areoligeraceae, in which the morphology, taxonomy, and stratigraphic occurrence of this group have been found from the area offshore Keelung in northern Taiwan.

MATERIALS AND METHODS

Core samples from the OK-1, OK-2 and OK-3 Wells from the area offshore Keelung in northern Taiwan were studied (Shaw, 1999a). A total of forty-nine side-wall cores were prepared at the Chinese Petroleum Corporation Micropaleontological Laboratory for a palynological study. The extraction of fossil palynomorphs was made by using the method of the author (Shaw, 1990), including the treatment of 10% KOH for the dissolution of humic material. Heavy solution of ZnCl₂ for flotation (S. G. 1.8-2.2) and also 30% of HCl, 52% of HF were used for maceration of the laterite pebble samples, which were collected from the exploration well.

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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 and Kjellstrom (1975 & 1981), 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.

RESULTS

Areoligera, *Cyclonephelium* and *Glaphyrocysta* are distributed sporadically in the Eocene formations, but have not been studied in Taiwan and may therefore have significance as marker species of Eocene. Three genera *Areoligera*, *Cyclonephelium* and *Glaphyrocysta*, the fossil dinoflagellate cysts of Areoligeraceae, obtained from Eocene sediments from offshore Keelung area in northern Taiwan are reported. One species of the genus *Areoligera* (*Areoligera taiwaniana* C. L. Shaw), two species of the genus *Cyclonephelium* (*Cyclonephelium pengchiahsun* C. L. Shaw sp. nov. and *Cyclonephelium taiwanianum* C. L. Shaw sp. nov.) and one species of the genus *Glaphyrocysta* (*Glaphyrocysta microfenestrata* (Bujak) Stover & Evitt) are described from the OK-1, OK-2 and OK-3 wells.

TAXONOMIC TREATMENT

Class Dinophyceae Fritsch, 1929

Order Peridiniales, 1894

Suborder Hystrichosphaeridiineae Norris, 1978

Family Areoligeraceae Evitt, emend. Sarjeant and Downie, 1966

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

Type species: *Areoligera senonensis* 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 surfaces reduced in size and number, or lacking altogether (Wilson and Clowes, 1980).

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

Areoligera taiwaniana C. L. Shaw in *Taiwania* 44(2): 155-201; Figs. 70-71, 1999

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 raises from low dissected and incomplete thin septa, form more or less arcuate to rectilinear distal 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; about 37 x 54 μm wide. No indications of paratabulation, paracingulum, or parasulcus.

Dimensions Holotype: overall length 64 μm , breadth 51 μm , length of cyst 54 μm , breadth 37 μm , surface features with penitabular processes which raises from low dissected and incomplete thin septa, the processes about 13-25 μm long.

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

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

Genus 2 **Cyclonephelium** Deflandre & Cookson. 1955, p. 285 emend. Stover & Evitt 1978, pp. 35-6.

1958 *Tenua* Eisenack, p. 410.

Type species: *C. compactum* Deflandre & Cookson, 1955, p. 285, pl. 2, figs. 11-13, text-figs. 44-46.

Remarks: *Cyclonephelium* differs from *Canningia* mainly in having greatly reduced ornamentation, or none at all, on the midventral and middorsal areas, and from *Glaphyrocysta* in having relatively smaller processes which are only rarely connected distally. A modified generic description is given by Stover & Evitt (1978, p. 35).

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

Cyclonephelium pengchiahsu C. L. Shaw sp. nov.

Figs. 1 & 2

Holotype slide: OK-2 1750-(4); Figs. 1-2; film TL18-12, TL18-13; CPC Micropaleontology Lab.

Description: Cysts circular to subcircular, with a narrow continuous circumferential membrane in which ornament, in the form of irregular reticulate processes, are arranged; apical archeopyle, operculum generally free. No indications of paratabulation, paracingulum, or parasulcus.

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

Dimensions: Overall width 96 μm , cyst width 87 μm , apical archeopyle ($n = 1$).

Derivation of name: The specific epithet, "pengchiahsu" is derived from the name of Pengchiahsu basin of type locality.

Remarks: The species differs from *Cyclonephelium compactum* Deflandre & Cookson in being substantially larger size and in having a delicate irregular reticulate membranous process.

Cyclonephelium taiwanianum C. L. Shaw sp. nov.

Figs. 3 & 4

Holotype slide: OK-1 1588-(1); Figs. 3-4; film WA61-36, WA61-37; CPC Micropaleontology Lab.

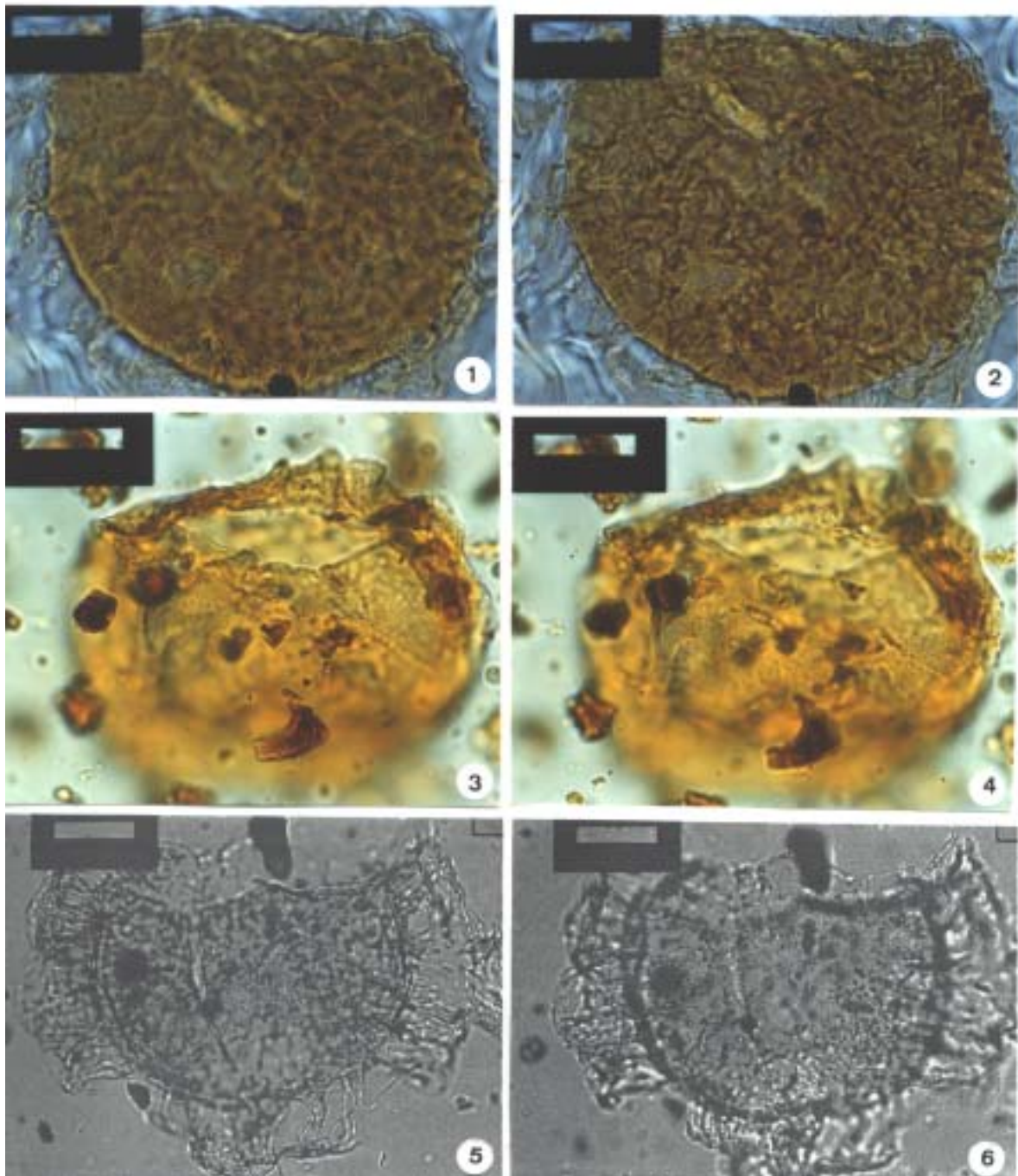
Description: Cysts circular to subcircular; apical archeopyle, operculum generally free; about 80 μm wide. No indications of paratabulation, paracingulum, or parasulcus. Surface view of cysts with finely granulate, lateral view of cysts scabrate.

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

Dimensions: Overall width 80 μm , apical archeopyle ($n = 1$).

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

Remarks: The species differs from *Cyclonephelium compactum* Deflandre & Cookson in being substantially larger size and in having finely granulate (not punctoreticulate) cysts.



Figs. 1 & 2. *Cyclonephelium pengchiahsun* C. L. Shaw sp. nov. (Film TL18-12, TL18-13). Figs. 3 & 4. *Cyclonephelium taiwanianum* C. L. Shaw sp. nov. (Film WA61-36, WA61-37). Figs. 5 & 6. *Glaphyrocysta microfenestrata* (Bujak) Stover & Evitt, 1978 (Film PF61-19, PF61-20). (Hollow scale bar = 20 μ m).

Genus 3 **Glaphyrocysta** Stover & Evitt, 1978

Type species: *Glaphyrocysta retiintexta* (Cookson) Stover & Evitt, 1978

Remarks: *Glaphyrocysta* differs from *Cyclonephelium* in having longer and generally fewer projection, which are always connected distally by a trabecular ectophragm; from *Glaphyrocysta* in having relatively smaller processes which are only rarely connected distally.

It differs from *Adentosphaeridium* in having a lenticular rather than a subspherical body and usually with more complex processes. (Wilson and Clowes, 1980).

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

Glaphyrocysta microfenestrata (Bujak) Stover & Evitt, 1978 Figs. 5 & 6

1976 *Cyclonephelium microfenestratum* Bujak

Sample slide: OK-3 1790-(4); film PF61-19, PF61-20; Figs. 5-6 (at two focus levels); CPC Micropaleontology Lab.

Description: Central body dorsoventrally compressed, outline subcircular to subcircular. Processes fibrous, solid, arranged in annulate or soleate complexes. About eight processes comprising each apical, precingular, postcingular and antapical process complex. Apical archeopyle. Operculum simple and usually detached.

Stratigraphic occurrence: Eocene (OK-3 well, 1790 m) (n = 2).

Dimensions: Overall length 76-85 μm , breadth 120-130 μm . Central body length (without operculum) 48-55 μm , central body breadth 72-80 μm , process length 20-29 μm .

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台灣始新統甲藻類缺網紋化石藻科之化石藻

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(收稿日期：2004年4月10日；接受日期：2004年5月27日)

摘 要

本文描述在台灣基隆北方海域始新世地層中發現的甲藻類缺網紋化石藻科 (Areoligeraceae)。 *Areoligera* 屬共計一種：台灣缺網紋藻 (*Areoligera taiwaniana* C. L. Shaw), *Cyclonephelium* 屬共計二種：彭佳嶼雜紋架藻 (*Cyclonephelium pengchiahsun* C. L. Shaw sp. nov.) 以及台灣雜紋架藻 (*Cyclonephelium taiwanianum* C. L. Shaw sp. nov.) , *Glaphyrocysta* 屬共計一種：小窗紋聯刺胞囊藻 (*Glaphyrocysta microfenestrata* (Bujak) Stover & Evitt)。

關鍵詞：始新世地層、缺網紋化石藻科、分類、台灣。

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