

Eocene Acritarchs of Taiwan

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ABSTRACT: Four new taxa (*Multiplicisphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Trichosphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Tylosphaeridium taiwanianum* C. L. Shaw *sp. nov.*, and *Cymatiosphaera taiwaniana* C. L. Shaw *sp. nov.*) of the fossil acritarchs obtained from Eocene sediments from offshore of the Keelung area in northern Taiwan are reported. They belong to two subgroups, four genera.

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

INTRODUCTION

The acritarchs (Downie *et al.*, 1963) comprise unicellular or apparently unicellular microfossils that consist of a test, which is composed of organic substances, enclosing a central cavity. They are morphologically variable and often abundant. Their affinities cannot be precisely determined at present. Downie *et al.* (1961) recommended that dinoflagellates, hystrichospheres, and other organic microfossils of uncertain affinities (including acritarchs in the sense used here) can be treated under the Botanical Code. Evitt (1963) accepted this recommendation and started putting the appropriate biological affinities and taxonomic hierarchy under the appropriate nomenclatural code whenever an acritarch genus is determined. In reviewing here some of the more common morphological types represented among the acritarchs the morphological classification of Downie *et al.* (1963) is followed. In this classification acritarch genera are considered to be form genera and are arranged in subgroups that are named and defined outside the jurisdiction of the Botanical Code, in a manner analogous to the turmae, etc., of the widely used form classification of sporomorphs developed by Potonié (1956) and others.

This paper is the ninth 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), and gymnospermous palynomorphs (Shaw, 2000a).

MATERIALS AND METHODS

Core samples from the OK-1, OK-2 and OK-3 wells from offshore Keelung in northern Taiwan were made available to the author (Shaw, 1999a). A total of 49 side-wall cores were prepared by the Chinese Petroleum Corporation Micropaleontological Laboratory for a palynological study.

1. National Museum of Prehistory Planning Bureau, Taitung 950, Taiwan, Republic of China.

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 $ZnCl_2$ for floatation (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.

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 Cramer (1973), Eisenack, Cramer and Diez (1976, 1979a, 1979b) were adopted. The fossil slides are catalogued and stored at the Micropaleontology Laboratory, Chinese Petroleum Corporation.

RESULTS

As an on-going effort in documenting the Eocene microflora of Taiwan, four new taxa (*Multiplicisphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Trichosphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Tylosphaeridium taiwanianum* C. L. Shaw *sp. nov.*, and *Cymatiosphaera taiwaniana* C. L. Shaw *sp. nov.*) of the fossil acritarchs are obtained and described from Eocene sediments from offshore Keelung in northern Taiwan. They belong to two subgroups, four genera.

Incertae Sedis

Group Acritarcha Evitt, 1963

Subgroup 1 Acanthomorphitae Downi, *et al.*, 1963

Genus 1 *Multiplicisphaeridium* Staplin, 1961, restricted Staplin, *et al.*, 1965

Generitypus: *Multiplicisphaeridium ramispinosum* Staplin, 1961

Original diagnosis (Staplin, 1961): Vesicle ellipsoidal to spherical; processes separate, narrow-based, tips multifurcate, expanded, dissected, or otherwise modified but not open; processes all of one type or variations of one type, not differentiated into distinctive orders or kinds of processes; wall surface exclusive of processes laevigate to finely granulose.

Restricted diagnosis (Staplin *et al.*, 1965): Vesicle ellipsoidal, subspherical to spherical; processes separate, proximately slender, distally multifurcate, expanded, dissected, or otherwise modified, with closed tips; processes on one vesicle all of one kind or variations of one type, not differentiated into more orders or kinds of processes; wall smooth or with minor ornamentation; no differentiation between vesicle wall and processes; spine cavity in open connection with vesicle interior.

1. *Multiplicisphaeridium taiwanianum* C. L. Shaw *sp. nov.* Figs. 1-3

Holotype: Sample slide: OK-3 1760-(2); films PF60-5, PF60-6, PF60-7; Figs. 1-3 (Holotype at three focus levels); CPC Micropaleontology Lab.

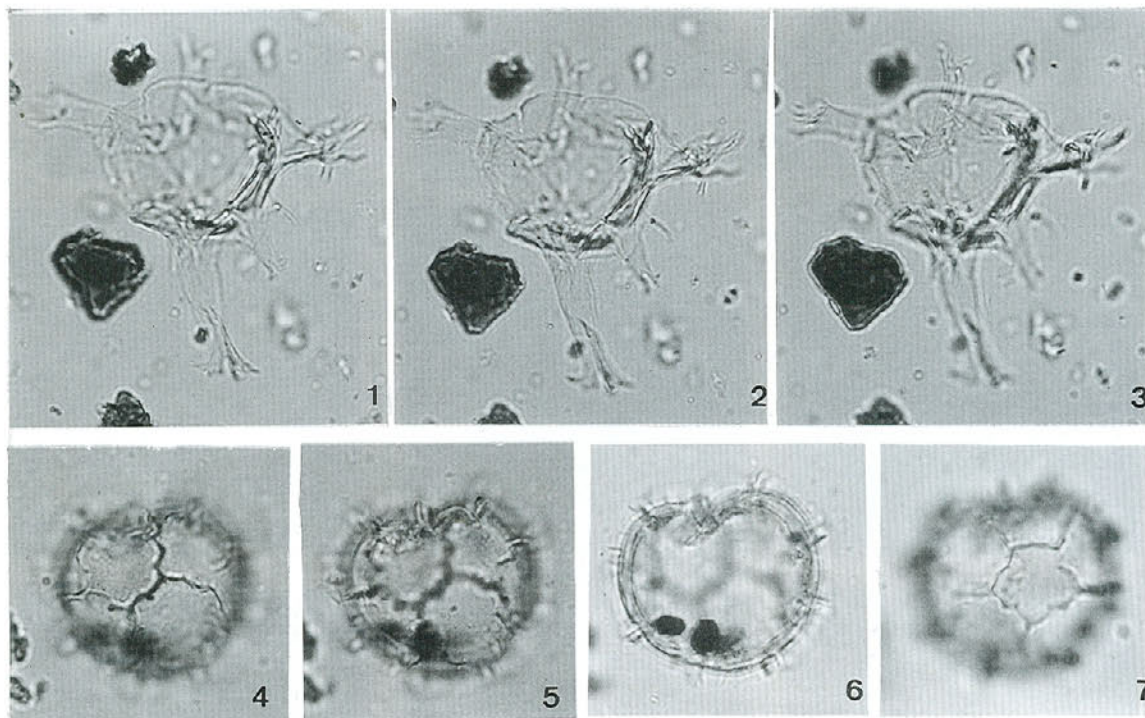
Description: Central body 24-28 μm in diameter, subspherical to spherical, smooth; conical processes, bases of the processes rounded, distally with aculeate or secate margin.

Dimensions Holotype: overall diameter 52-55 μm .

Stratigraphic occurrence: Eocene (OK-3 well, 1760 m); rare (n=1).

Derivation of name: The specific epithet *taiwanianum* refers to Taiwan Island, where the type locales are found.

Comment: This species differs from *M. ramispinosum* Staplin by having a simple process, the processes rounded, distally with aculeate or secate margin and smaller central body. It does not have a pinnae process or up to the fourth order as on *M. rramispinosum* Staplin.



Figs. 1-3: *Multiplicisphaeridium taiwanianum* C. L. Shaw (OK-3 1760-(2); Films PF60-5, PF60-6, PF60-7). Figs. 4-7: *Cymatiosphaera taiwaniana* C. L. Shaw (OK-1 1425-(1); Films PF65-37, PF65-38, PF66-1, PF66-) (All figures x1000).

Genus 2 *Trichosphaeridium* Timofeev, 1966

Generitypus: *Trichosphaeridium annolovaense* Timofeev, 1966

Original diagnosis: Envelopes 60-120 μm in diameter, spherical or compressed spherical, stout, often furrowed. Surface of envelope covered with fine hairs. Colour yellow, yellowish brown.

1. *Trichosphaeridium taiwanianum* C. L. Shaw *sp. nov.* Figs. 8-16

Holotype: Sample slide: OK-1 1400- (1); films PF65-24, PF65-25, PF65-26; Figs. 8-10 (Holotype at three focus levels); CPC Micropaleontology Lab.

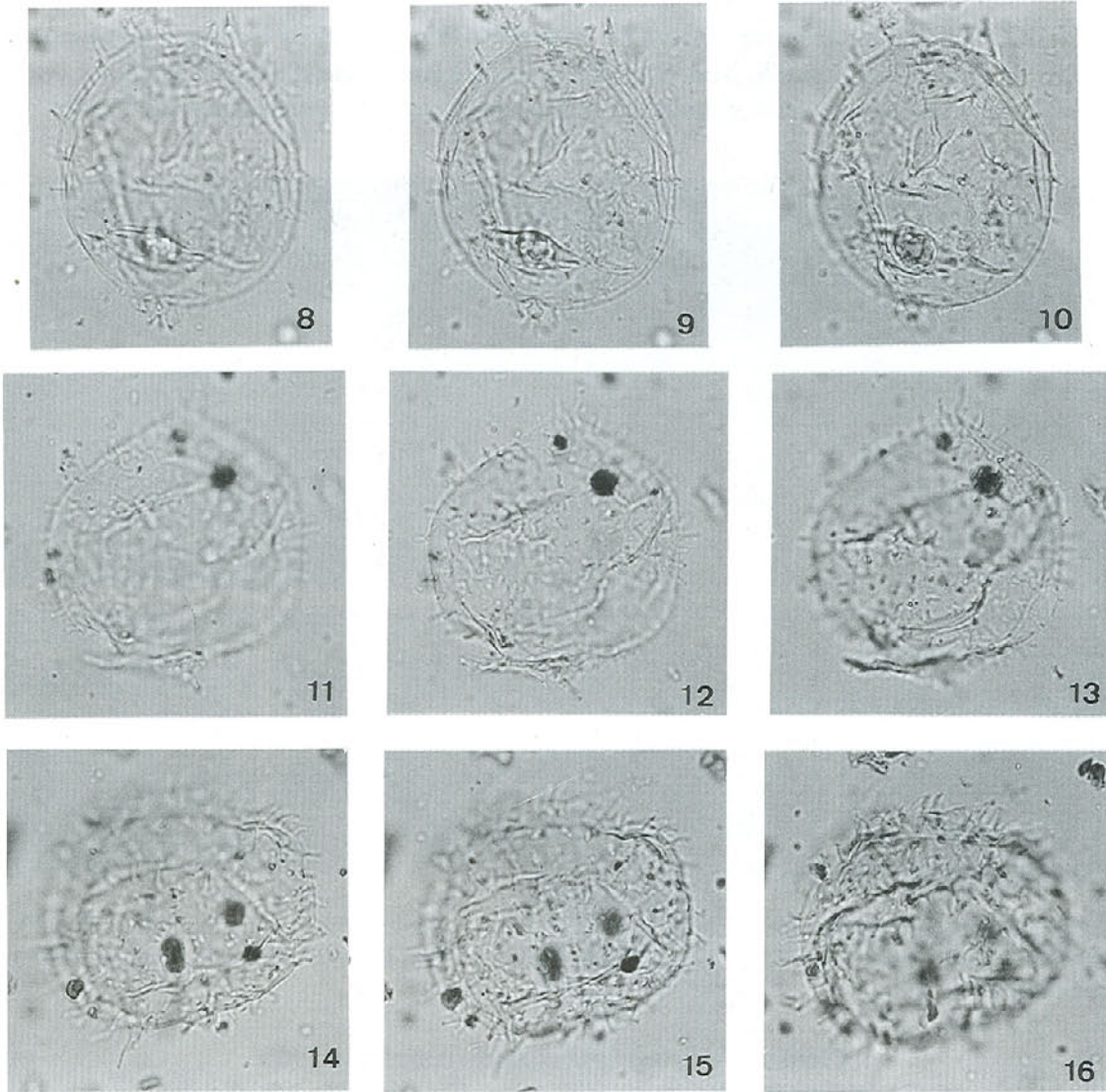
Description: Envelopes 32-41 μm in diameter, spherical. Surface of envelope covered with a few scanty short hairs.

Dimensions Holotype: overall diameter 35-39 μm .

Stratigraphic occurrence: Eocene (OK-1 well, 1400 m); rare (n=4)

Derivation of name: The specific epithet *taiwanianum* refers to Taiwan Island, where the type locality are found.

Comment: This species differs from *T. annolovaense* Timofeev by having a conspicuous smaller envelope.



Figs. 8-16: *Trichosphaeridium taiwanianum* C. L. Shaw (OK-1 1400- (1); Films PF65-24, PF65-25, PF65-26; OK-2 1550- (5); Films TL17-12, 13, 14; OK-2 1600- (4); Films TL17-23, 24, 25) (All figures x1000).

Genus 3 *Tylosphaeridium* Timofeev, 1966
 Generitypus: *Tylosphaeridium tallanicum* Timofeev, 1966

Original diagnosis: Envelopes 60-70 μ m to 100-140 μ m in diameter, spherical, stout, with tuberculate surface, usually with large grooves. Tubercles abundant. Colour yellow to dark yellow.

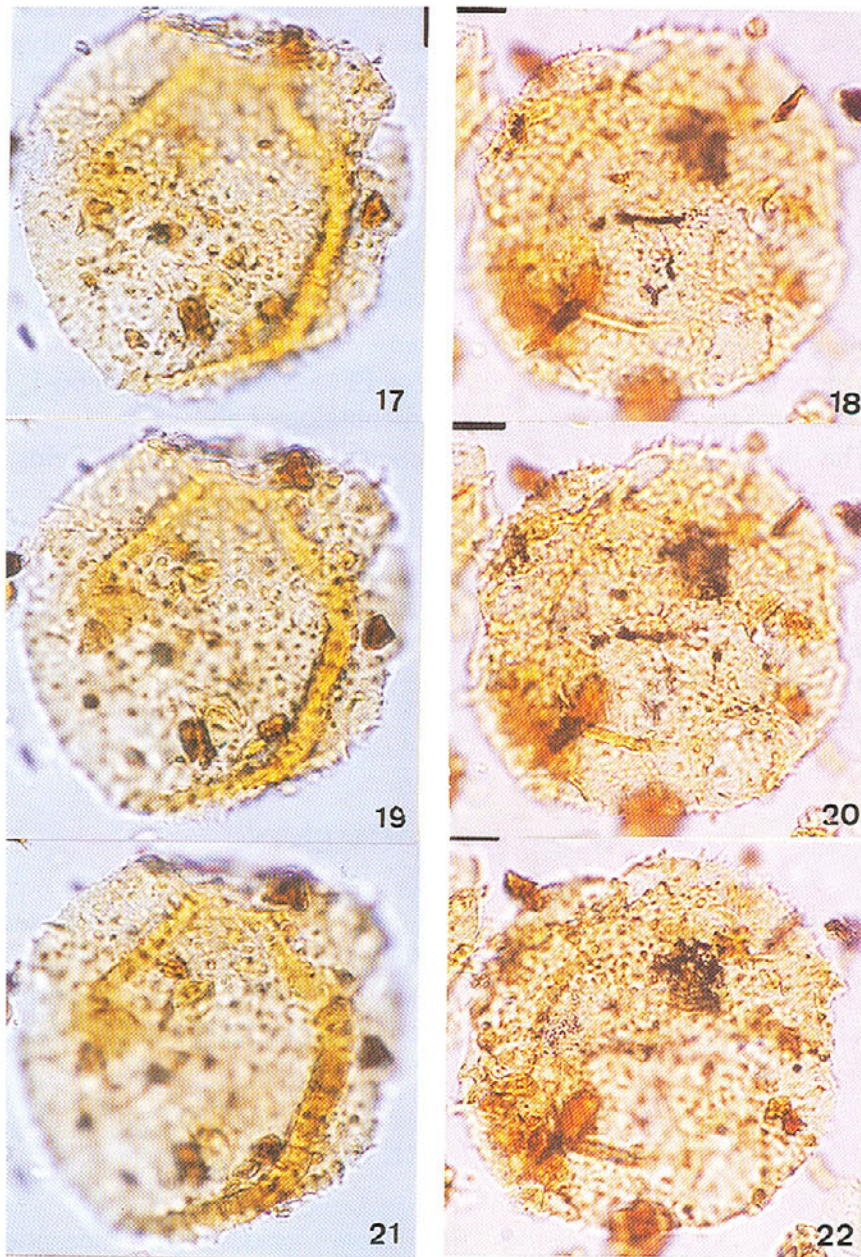
1. *Tylosphaeridium taiwanianum* C. L. Shaw *sp. nov.*

Figs. 17-22

Holotype: Sample slide: OK-1 1788- (5); film WA58-4, 5, 6; Figs. 20-22 (Holotype at three focus levels); CPC Micropaleontology Lab.

Description: Envelopes 52-58 μ m in diameter, spherical, stout, with tuberculate surface, usually with fold-like ridges. Tubercles abundant.

Dimensions Holotype: overall diameter 53-55 μ m.



Figs. 17-22 *Tylosphaeridium taiwanianum* C. L. Shaw (OK-1 1788bl- (1); Films F32-4, PF32-5, PF32-6; OK-1 1788- (5); Films WA58-4, 5, 6) (All figures x1000).

Stratigraphic occurrence: Eocene (OK-1 well, 1788 m); rare (n=4)

Derivation of name: The specific epithet *taiwanianum* refers to Taiwan Island, where the type locality are found.

Comment: This species differs from *T. tallanicum* Timofeev by having a conspicuous smaller envelope.

Subgroup 2 Herkomorphitae

Genus 1 *Cymatiosphaera* O. Wetzel 1933 emend. Deflandre and Cookson, 1954

Generitypus: *Cymatiosphaera radiata* O. Wetzel, 1933

Original diagnosis: Shell spherical with thick, smooth wall, its surface divided into number of subpolygonal areas by low membranes supported at corners of polygons by spines not extending beyond membrane. Membranes undulatory or wavy in plan view.

Amended diagnosis (Deflandre and Cookson, 1954): Shell globular, spherical or ellipsoidal, the external surface divided into polygonal fields by membranes perpendicular to the surface, without any equatorial differentiation of the fields or processes of any kind; the outer margins of the membranes straight or slightly concave, entire, serrated or somewhat corroded. Surface of shell smooth, punctate or granular.

1. *Cymatiosphaera taiwaniana* C. L. Shaw *sp. nov.*

Figs. 4-7

Holotype: Sample slide: OK-1 1425- (1); films PF65-37, PF65-38, PF66-1, PF66-2; Figs. 4-7 (Holotype at four focus levels); CPC Micropaleontology Lab.

Description: The shell spherical 26-31 μm in diameter, with 10 polygonal fields; the networks connect with the zigzag line; wall 2 μm thick.

Dimensions Holotype: overall diameter 26-31 μm .

Stratigraphic occurrence: Eocene (OK-3 well, 1760 m); rare (n=1)

Derivation of name: The specific epithet *taiwaniana* refers to Taiwan Island, where the type locality are found.

Comment: This species differs from *C. globulosa* Takahashi by having fewer polygonal fields and larger spherical shell.

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LITERATURE CITED

- Deflandre, G. 1954. Systématique des hystrichosphaeridés: sur l'acception du genre *Cymatiosphaera* O. Wetzel. *Compte rendu sommaire et bulletin de la Société géologique de France*, 4: 257-258.
- Deflandre, G. and I. C. Cookson. 1954. Sur le microplancton fossile conservé dans diverses roches sédimentaires australiennes s'étageant du Crétacé inférieur au Miocène supérieur. *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, 239: 1235-1238.
- Deflandre, G. and I. C. Cookson. 1955. Fossil microplankton from Australian Late Mesozoic and Tertiary sediments. *Australian Journal of Marine and Freshwater Research*, 6: 242-313.
- Downie, C., W. R. Evitt and W. A. S. Sarjeant. 1963. Dinoflagellate, hystrichospheres, and the classification of the acritarchs. *Stanford Univ. Publ., Geol. Sci.* 7: 1-16
- Downie, C., G. L. Williams and W. A. S. Sarjeant. 1961. Classification of the fossil microplankton. *Nature, Geol. Sci.* 192: 1-471.

- Eisenack, A. 1967. Katalog der Fossilen Dinoflagellaten, Hystrichosphären und Verwandten Mikrofossilien. Band I. Dinoflagellaten. 1. Ergänzungslieferung. III + 241 p; E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, Germany.
- Eisenack, A. and F. H. Cramer. 1973. Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien, Band. III. Acritarcha. 1. Teil. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller) Stuttgart, pp. 1-1100.
- Eisenack, A., F. H. Cramer and M. del C. R. Diez. 1976. Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien, Band. IV. Acritarcha. 2. Teil. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller) Stuttgart, pp. 1-863.
- Eisenack, A., F. H. Cramer and M. del C. R. Diez. 1979a. Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien, Band. V. Acritarcha. 3. Teil. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller) Stuttgart, pp. 1-532.
- Eisenack, A., F. H. Cramer and M. del C. R. Diez. 1979b. Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien, Band. VI. Acritarcha. 3. Teil. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller) Stuttgart, pp. 1-533.
- Evitt, W. R. 1963. A discussion and proposals concerning fossil dinoflagellates, hystrichospheres, and acritarchs, I. National Academy of Sciences, Washington, Proceedings, v. 49, p. 158-164.
- Potonié, R. 1956. Synopsis der Gattungen der Sporae dispersae. (Hannover), Saccites, Aletes, Praecolpates, Polyplacates, Monocolpates. Beihefte Geologisches Jahrbuch, no. 23, p. 1-103.
- Shaw, C.-L. 1990. Pollen Analysis of the Cretaceous Sediments of Taiwan. Ph. D. Dissertation of National Taiwan University, Taiwan, 506 pp.
- Shaw, C.-L. 1997. Eocene Tiliaceous palynomorphs of Taiwan. *Taiwania* **42**: 267-273.
- Shaw, C.-L. 1998. Eocene Ephedraceous palynomorphs of Taiwan. *Bot. Bull. Acad. Sin.* **38**: 69-80.
- Shaw, C.-L. 1999a. Eocene Wetzeliellaceous cysts of Taiwan. *Taiwania* **44**: 31-48.
- Shaw, C.-L. 1999b. Eocene dinoflagellate cysts of Taiwan. *Taiwania* **44**: 155-201.
- Shaw, C.-L. 1999c. Eocene palynomorphs of Taiwan-Pteridophytic spores. *Taiwania* **44**: 230-258.
- Shaw, C.-L. 1999d. Eocene angiospermous palynomorphs of Taiwan. *Taiwania* **44**: 423-478.
- Shaw, C.-L. 2000a. Eocene gymnospermous palynomorphs of Taiwan. *Taiwania* **45**: 13-29.
- Shaw, C.-L. 2000b. Eocene angiospermous palynomorphs of Taiwan (II). *Taiwania* **45**: 167-180.
- Staplin, F. L. 1961. Reef-controlled distribution of Devonian microplankton in Alberta. *Palaeontology*, **4**: 392-424.
- Staplin, F. L., J. Jansonius and S. A. J. Pocock. 1965. Evaluation of some acritarchous hystrichosphere genera. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **123**: 167-201.
- Timofeev, B. V. 1966. Mikropaleofitologicheskoe issledovanie drevnikh svit. Akademiya Nauk SSSR, Isdatelskvo Nauka, Moskva, p. 1-147. (Published English translation dated 1974 by British Library - Lending Division, Yorkshire, England, 214 p.)
- Wetzel, O. 1933. Die in organischer Substanz erhaltenen Mikrofossilien des baltischen Kreide-Feuersteins mit einem sediment-petrographischen und stratigraphischen Anhang. *Palaeontographica, Abteilung A*, **77**: 141-186.

台灣始新世古難歸類群化石

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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，古難歸類群化石共計四個分類群 (*Multiplicisphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Trichosphaeridium taiwanianum* C. L. Shaw *sp. nov.*, *Tylosphaeridium taiwanianum* C. L. Shaw *sp. nov.* 和 *Cymatiosphaera taiwaniana* C. L. Shaw *sp. nov.*)，它們分別屬於貳亞群，肆屬。

關鍵詞：始新世地層、古難歸類群化石、台灣、分類。

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