The Palaeobotanist, **26**(3): 307-313, 1980.

SUBATHUA—A NEW DINOFLAGELLATE GENUS AND ITS PALAEOECOLOGICAL SIGNIFICANCE IN THE SUBATHU FORMATION, SIMLA HILLS

A. K. KHANNA
Wadia Institute of Himalayan Geology, Dehra Dun-248 001, India

&

H. P. SINGH
Birbal Sahni Institute of Palaeobotany, Lucknow-226 007, India

ABSTRACT

A new dinoflagellate cyst genus *Subathua*, has been instituted from the Subathu Formation, Simla Hills consisting of two new species, viz., *S. sahnii* and *S. spinosa*. It has been observed that *Subathua* is distributed in high frequency in the upper part of the formation. Its palaeoecological significance has also been discussed.

Key-words — *Subathua*, Palaeoecology, Eocene, Subathu Formation (India).

सारांश

सुबाथुआ — सुबाथु शैल-समूह, शिमला पहाड़ियों से एक नई डाइनोफ्लेजैलेट प्रजाति तथा इसका पुरापारिस्थितिक महत्त्व — अशोक कुमार खन्ना एवं हरिपाल सिंह

सुबाथु शैल-समूह, शिमला पहाड़ियों से एक नई डाइनोफ्लेजैलेट पुटी प्रजाति **सुबाथुआ** एवं इसकी दो नई जातियाँ अर्थात् **सु० साहनाई** एवं **सु० स्पाइनोसा** बनाई गई हैं तथा यह प्रेक्षित किया गया है कि इस शैल-समूह के ऊपरी भाग में **सुबाथुआ** उच्च आवृत्ति में वितरित है। इस प्रजाति का पुरापारिस्थितिक महत्त्व भी विवेचित किया गया है।

INTRODUCTION

THE present paper deals with the detailed morphological and palaeoecological studies of a new dinoflagellate cyst, *subathua*. It is represented by two new species, viz., *S. sahnii* and *S. spinosa*. Of these, *S. sahnii* is very well distributed in the upper horizons of Subathu Formation in the Kalka-Simla area, Simla Hills, whereas *S. spinosa* is of rare occurrence. In morphological characters the *Subathua* cyst closely compares with that of *Thalassiphora* but its distinctive organization separates it from the latter. A study of the distributional pattern of *Subathua* in the area of investigation throws light on its palaeoecological and stratigraphical importance. The type material and the slides are housed at the Birbal Sahni Institute of Palaeobotany, Museum, Lucknow, India.

SYSTEMATIC DESCRIPTION

Class — DINOPHYCEAE Fritsch
Order — PERIDINIALES Haeckel
Family — THALASSIPHORACEAE Gocht emend. Sarjeant & Downie

Genus — *Subathua* gen. nov.

Diagnosis — Cavate cyst; central body with or without apical and/or antapical and/or lateral horn or horns or small protuberance; periphragm forming para-

chute-like wing lamella covering the body ventrally; archaeopyle precingular; reflected tabulation not evident; cingulum forming a raised ridge.

Generic Description — Cavate cyst, usually dorsoventrally flattened; endophragm smooth or granulose forming spherical to oval body with or without apical and/or antapical and/or lateral horn or horns or small protuberance; periphragmal strands arising either from the lateral or laterodorsal region, ramifying, inturning, uniting, forming coarse to fine reticulate parachute, covering the body ventrally; reflected tabulation not evident; cingulum forming a raised ridge; archaeopyle quadrate, precingular; periphragm may have an antapical keel.

Type Species — *Subathua sahnii* gen. et sp. nov.

Comparison — *Subathua* gen. nov. compares with *Thalassiphora* Eisenack & Gocht, 1960, *Catillopsis* Drugg, 1970 and *Pterospermopsis* Wetzel, 1952 but is distinguishable from all the three. *Subathua* differs from *Thalassiphora* by virtue of its attachment of wing lamella with the body. In the former case, the wing lamella is parachute-like and attached to the equatorial or subequatorial dorsal region of the body while in the latter the wing lamella envelopes the whole body. *Subathua* differs from *Catillopsis* by having a definite precingular, quadrate archaeopyle whereas *Catillopsis* has a simple subcircular to circular opening in the centre of the body. In *Pterospermopsis* the wing lamella extends outwards from the equatorial region of the body but does not cover the body on either side whereas in *Subathua* the wing lamella covers the body ventrally.

Remarks — Morphologically *Subathua* is a very close ally of *Thalassiphora* and seems to have evolved from the same ancestral stock. Like *Thalassiphora*, thickenings and linear folds in the periphragm of *Subathua* indicate plate areas. A distinct pericoel has been found between the endophragm and periphragm on the ventral side. From the description and photographs of *Thalassiphora balcanica* as given by Baltes (1970) it is evident that this species has the same type of cyst organisation as in *Subathua*. Therefore, the aforesaid species has been transferred to the genus *Subathua* and a new combination has been instituted as *Subathua balcanica*.

Subathua (*Thalassiphora*) *balcanica* comb. nov.

Subathua sahnii gen. et sp. nov.

Pl. 1, figs 1-3, 5-9; Text-figs 1-2

Holotype — Pl. 1, fig. 2, slide no. 5865.

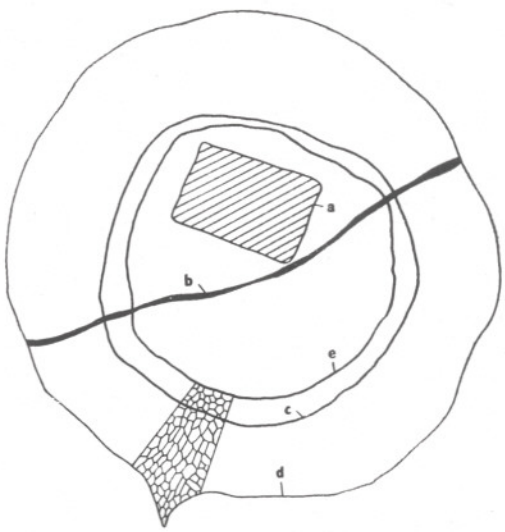
Type Locality — Jabli, Subathu Formation, Simla Hills.

Diagnosis — Cyst cavate, central body spherical to oval, smooth or granulose, without horns, periphragm forming parachute-like lamellar wing covering the body ventrally; archaeopyle precingular, quadrate.

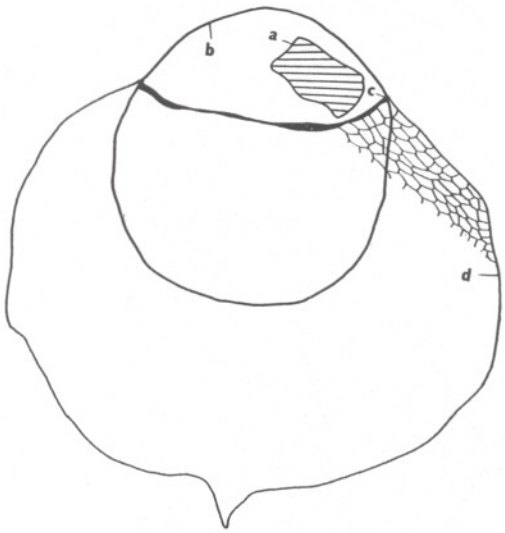
Description — Cyst cavate, endophragm forming spherical to oval body; body without horns; periphragmal strands arising from the lateral or latero-dorsal region, ramifying, uniting, forming a parachute-like fine to coarse reticulate wing lamella covering the body ventrally; archaeopyle precingular, reflected tabulation not evident; cingulum forming a raised ridge; a keel may be present.

Dimensions — Holotype; body diameter 65×58 μ; overall diameter 100×91 μ; observed range; body diameter 48×44-73 ×72 μ; overall diameter 80×72-119×104 μ.

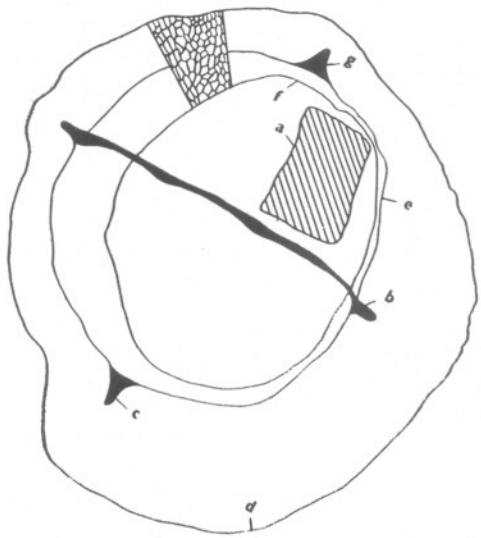
Remarks — Specimens have been found showing linear thickenings or folds in the periphragm indicating plate areas.



TEXT-FIG. 1 — *Subathua sahnii* sp. nov. in dorsal view. **A.** Archaeopyle, **B.** Equatorial girdle, **C.** Endophragm, **D.** Periphragm, **E.** Line of attachment of periphragm with the central body.



TEXT-FIG. 2 — *Subathua sahnii* sp. nov. in lateral view. **A.** Archaeopyle, **B.** Endophragm, **C.** Line of attachment of wing lamella with the central body, **D.** Periphragm.



TEXT-FIG. 3 — *Subathua spinosa* sp. nov. in dorsal view. **A.** Archaeopyle, **B.** Lateral horn, **C.** Antapical horn, **D.** Periphragm, **E.** Endophragm, **F.** Line of attachment of wing lamella with the central body, **G.** Apical horn.

When the specimens are laterally pressed, a distinct pericoel is seen between the endophragm and periphragm.

Occurrence — Lower-Upper Eocene.

Subathua spinosa sp. nov.

Pl. 1, figs 10-12; Text-fig. 3

Holotype — Pl. 1, fig. 10, slide no. 5865.

Type Locality — Jabli, Subathu Formation, Simla Hills.

Diagnosis — Cyst cavate, central body spherical to oval with apical and/or antapical and/or lateral horn or horns or protuberance; periphragm forming parachute-like wing lamella covering the body ventrally; archaeopyle precingular.

Description — Cyst cavate; usually dorsoventrally flattened; endophragm smooth or granulose forming spherical to oval body with apical and/or antapical and/or lateral horn/horns or protuberance; periphragmal strands arising either from the lateral or laterodorsal region, ramifying, inturning, uniting and forming a parachute-like coarse to fine reticulate wing lamella covering the body ventrally; reflected tabulation not evident; cingulum forming a raised ridge; archaeopyle quadrate, precingular.

Dimensions — Holotype; diameter of cyst body 72×59 μ; overall diameter 91×82 μ; observed range; diameter or cyst body $56 \times 47\text{-}72 \times 59$ μ; overall diameter $85 \times 75\text{-}91 \times 82$ μ.

Comparison — *Subathua spinosa* sp. nov. closely resembles *Subathua sahnii* sp. nov. but can be distinguished by the presence of apical and/or antapical and/or lateral horn or horns or protuberance on the central body.

Remarks — Though plate tabulation pattern is not completely evident in the present species, thickenings in the periphragm in some specimens indicate plate areas. A distinct pericoel is present on the ventral surface.

Occurrence — Middle Eocene.

DISCUSSION

The present exhaustive study of the newly established genus *Subathua* throws light both on its morphological characters/organisation and stratigraphical/palaeoecological significance in the Subathu Formation of Kalka-Simla area. A similar study dealing with the palaeoecology of *Pediastrum* in the Subathu Formation has already been done

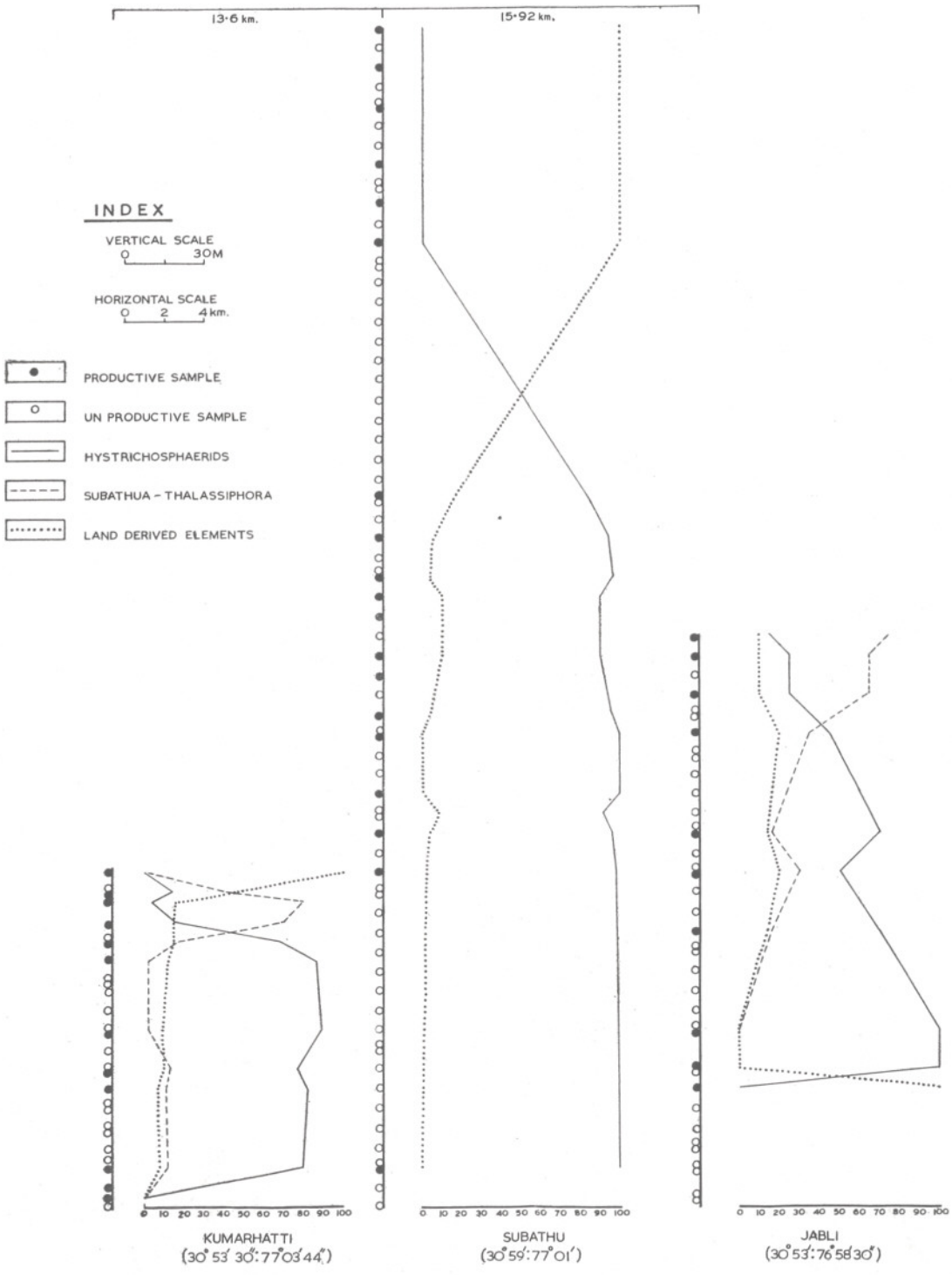

13·6 km.
15·92 km.
INDEX
VERTICAL SCALE
0 30M
HORIZONTAL SCALE
0 2 4 km.
PRODUCTIVE SAMPLE
UN PRODUCTIVE SAMPLE
HYSTRICHOSPHAERIDS
SUBATHUA – THALASSIPHORA
LAND DERIVED ELEMENTS
0 10 20 30 40 50 60 70 80 90 100
KUMARHATTI
(30° 53′ 30″: 77° 03′ 44″)
SUBATHU
(30° 59′: 77° 01′)
JABLI
(30° 53′: 76° 58′ 30″)

CHART 1

by Singh and Khanna (1978). These aspects of studies have been discussed below:

1. *Morphological Characters and Organisation of Subathua* — A comparative morphological study of the genera *Subathua* and *Thalassiphora* shows that both the genera have largely similar morphological characters yet each one of them can be distinguished by its distinct organisation. In *Subathua*, disposition of the wing lamella is limited to the equatorial or subequatorial dorsal region of the body and appears more or less like a parachute whereas it completely envelops the body in the case of *Thalassiphora*. This organisational distinction between the two seems to have some evolutionary significance. It seems most likely that the fully enveloped cyst of *Thalassiphora* in comparison to the partially covered cyst of *Subathua* is better equipped to withstand the rough environmental hazzards. Thus this feature, in our opinion, may be considered as an advanced character since it provides additional protection to the cyst during floatation. Equatorial disposition of the wing lamella in *Pterospermopsis*, obviously represents a similar organization among the three aforementioned genera.

2. *Stratigraphical and Palaeoecological Significance of Subathua* — *Thalassiphora* is abundantly distributed in the Middle-Upper Eocene sediments of Europe (Sarjeant, 1974) and usually inhabits marginal facies particularly with low saline contents. This feature of *Thalassiphora* seems to be in common with *Subathua*. During the course of palynological study of the Subathu Formation (Kalka-Simla area) it has been observed that *Subathua* appears in low frequency at the basal sediments of the succession and gradually increases in abundance in the Upper horizons where it attains its acme period and identifies a palynozone known as the *Subathua sahnii* Cenozone (Singh, Khanna & Sah, 1978).

The distributional relationship of *Subathua - Thalassiphora*/hystrichosphaerids/land derived elements has been worked out from three stratigraphical sections represented at Jabli, Subathu and Kumarhatti (Chart 1). The accruing palynological information from the Jabli and Kumarhatti sections shows that the *Subathua-Thalassiphora* cysts register an inverse ratio in relation to the cysts of hystrichosphaerids which are known to have relatively more salinity tolerance. These localities represent south-western and north-eastern flanks of the basin respectively.

The virtual absence of terrestrial elements and *Subathua-Thalassiphora* cysts from the lower part of the Subathu section, Subathu Formation strongly supports the lithological evidence that this part of the basin was relatively deeper and away from the margin having no direct connection with fresh water channels. The *Subathua* and *Thalassiphora* rich horizons which identify the upper part of Subathu Formation at the north-eastern and south-western margins of the basin have not been detected in the deeper part of the basin. To explain the absence of these two forms specially from the upper part of the Subathu section another argument may also be advanced that we might have missed to collect samples from the *Subathua-Thalassiphora* rich horizon. However, notwithstanding even with this argument and on the basis of our present study concerning the distributional pattern of *Subathua* at three different localities, viz., Jabli, Subathu and Kumarhatti and its abundant association with the marginal sediments of Upper Eocene (Subathu Formation) supported by a similar record of global distribution of *Thalassiphora*, it is evidently clear that the genus *Subathua*, besides being a low salinity marker has proved to be a dependable palaeoecological indicator and a useful stratigraphical tool.

REFERENCES

SARJEANT, W. A. S. (1974). *Fossil and Living Dinoflagellates*. Academic Press, London & New York.

SINGH, H. P. & KHANNA, A. K. (1978). Some fossil species of *Pediastrum* and their palaeoecological significance in the Subathu Formation of Himachal Pradesh. *Palaeobotanist*, **25**: 466-474.

SINGH, H. P., KHANNA, A. K. & SAH, S. C. D. (1978). Palynological zonation of the Subathu Formation in the Kalka-Simla area of Himachal Pradesh. *Him. Geol.*, **8** : 33-46

EXPLANATION OF PLATE

PLATE 1

(All photomicrographs are magnified ca.× 500 unless otherwise mentioned)

1-3. *Subathua sahnii* sp. nov.; Regd. negative nos 823/2, 826/19 (Holotype), 822/14.

4. *Thalassiphora velata* (Deflandre & Cookson) Cookson & Eisenack, 1961; Regd. negative no. 826/26.

5-9. *Subathua sahnii* sp. nov.; Regd. negative nos 822/29, 825/29, 825/26, 824/21, 825/22.

10-12. *Subathua spinosa* sp. nov.; Regd. negative nos 824/2 (Holotype) 835/24, 835/18.

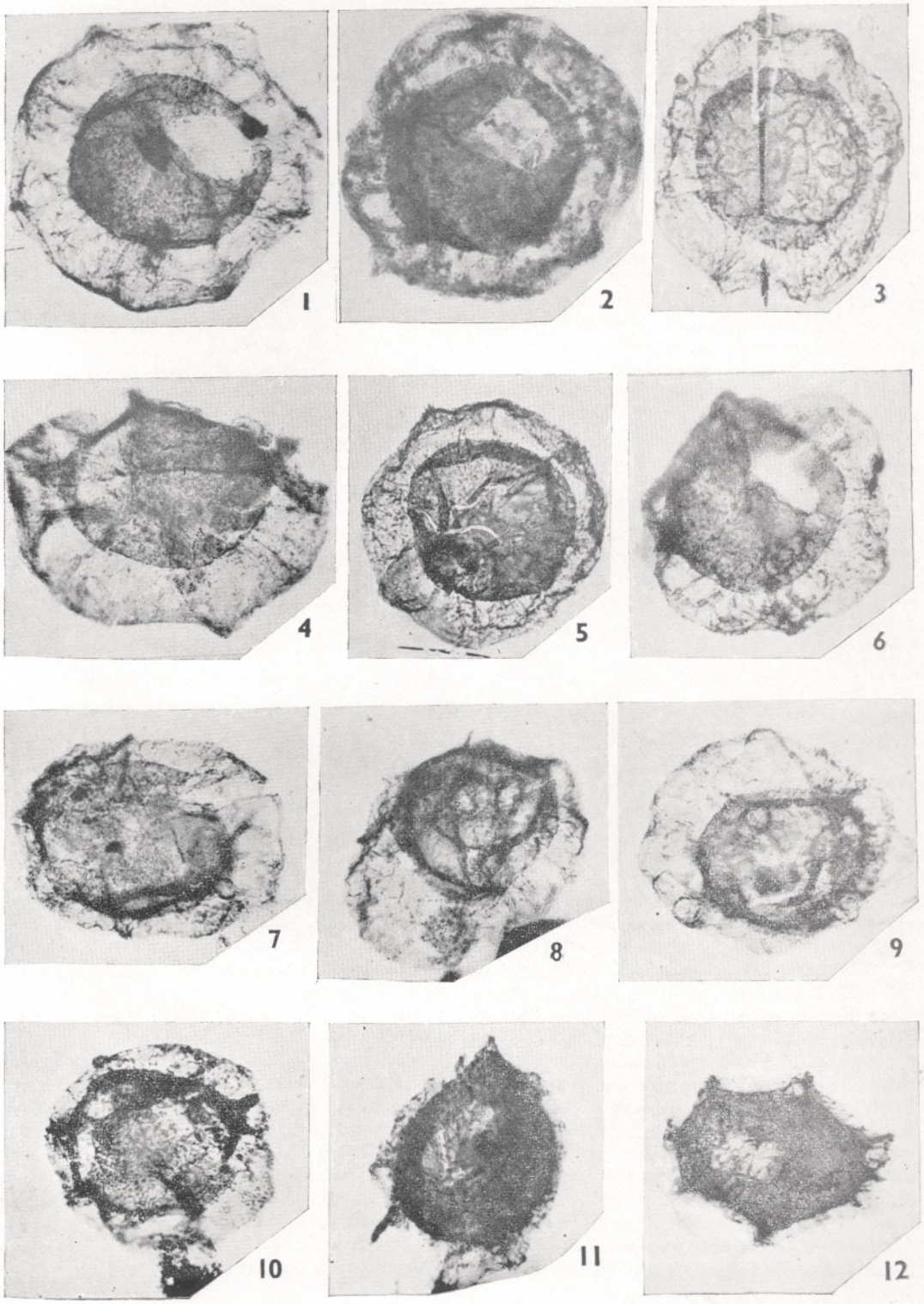


PLATE 1