Acta Palaeontologica Polonica
Vol. 33 No. 4 pp. 343—352; pls. 13—14 Warszawa, 1988

N. M. ABOUL ELA and M. F. ALY

PRELIMINARY INVESTIGATION OF MARINE PHYTOPLANKTON FROM THE MIDDLE JURASSIC COAL DEPOSITS OF EL-MAGHARA, CENTRAL SINAI, EGYPT

ABOUL ELA, N. M. and ALY, M. F.: Preliminary investigation of marine phytoplankton from the Middle Jurassic coal deposits of El-Maghara, Central Sinai, Egypt. Acta Palaeont. Polonica, 33, 4, 343—352, 1988 (issued 1989).

Nineteen species of Dinoflagellate have been found in the coal deposits of El-Maghara, Safa Formation, north central Sinai. The dominant recorded species are: *Lithodinia jurassica*, *Leptodinium antigonium*, *Gonyaulacysta* sp., *Chytroeisphaeridia* cf. *mantellii*, *Sentusidinium echinatum*, *Cassiculosphaeridia magna* and *Exiguisphaera* cf. *phragma*. Bajocian-Bathonian age of the coal deposits of El-Maghara could be confirmed. The data suggest a paralic origin for the coal of El-Maghara.

Key words: Dinoflagellate, coal deposits, Sinai, Egypt, Middle Jurassic.

N. M. Aboul Ela and M. F. Aly, Geology Department, Faculty of Science, Cairo University, Cairo, Egypt. *Received: January 1988.*

INTRODUCTION

A number of marine phytoplankton taxa has been recorded for the first time in the coal deposits of El-Maghara. The purpose of this work is to provide the main characteristics of this phytoplankton. The study is based on analysis of twelve samples collected from the coal-mine at El-Maghara, which is located at the north central Sinai (fig. 1).

Gabal El-Maghara consists mainly of Jurassic sediments, attaining a thickness of about 1900 m (Al Far 1964), and forming the core of a major anticlinal structure.

Much attention has been paid to the study of the macrofossil contents of the Jurassic deposits of El-Maghara. The most comprehensive work was carried out by Farag (1941) and Farag and Omara (1955). The latter authors concluded that most of the recovered brachiopods from Gabal El-Maghara are of Bathonian age. Said and Barakat (1958), on the basis of microfaunal contents, assumed that the Jurassic of El-Maghara was deposited in shallow marine environment. Al Far (1964), was first to pay much attention to the coal of El-Maghara. He subdivided the Jurassic of El-Maghara into six formations: Mashaba, Rajabiah, Shusha, Bir Maghara, Safa and Masajid Formations. Al Far suggested a Bathonian age for the whole section of the Safa Formation including the coal deposits.

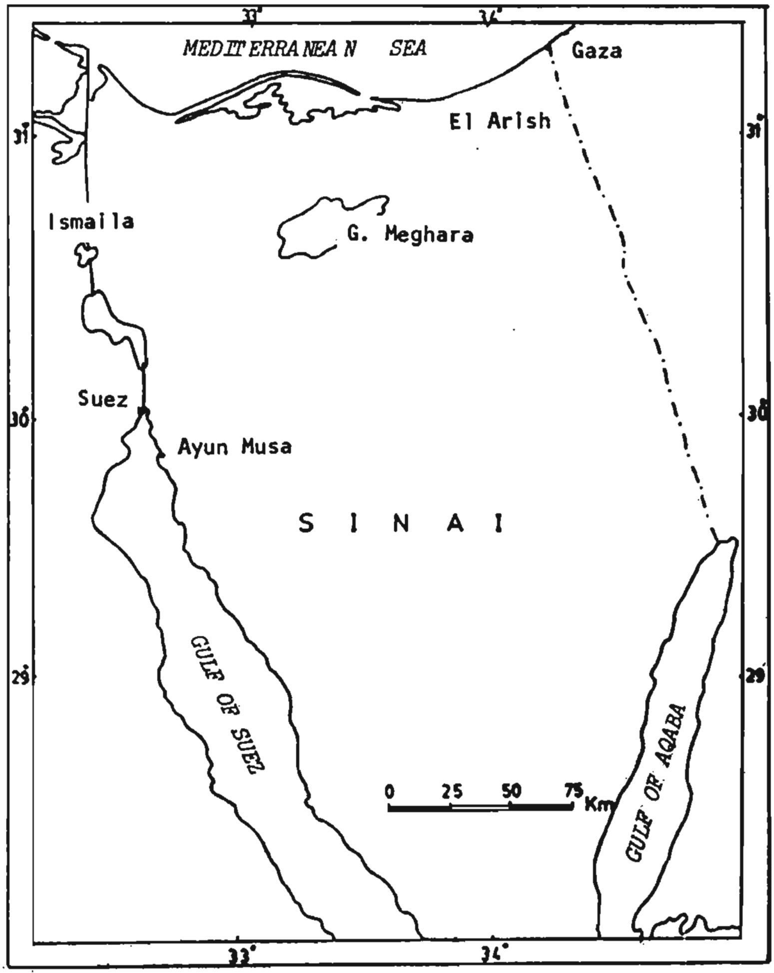


Fig. 1. Location map of Gabal El-Maghara.

More recently, a detailed palynological analysis (pollen and spores) has been carried out by Aboul Ela and Aly (in press) on the coal deposits of El-Maghara. They assigned a Bajocian-Bathonian age to the studied sediments.

The lower part of the Safa Formation contains economic coal deposits. The stratigraphical column of the Safa Formation is illustrated in fig. 2.

MATERIAL AND METHODS

Twelve samples were collected from the coal deposits of El-Maghara. The lower ten samples were collected from the coal-mine, while, the remaining two samples were taken outside the mine. Out of twelve

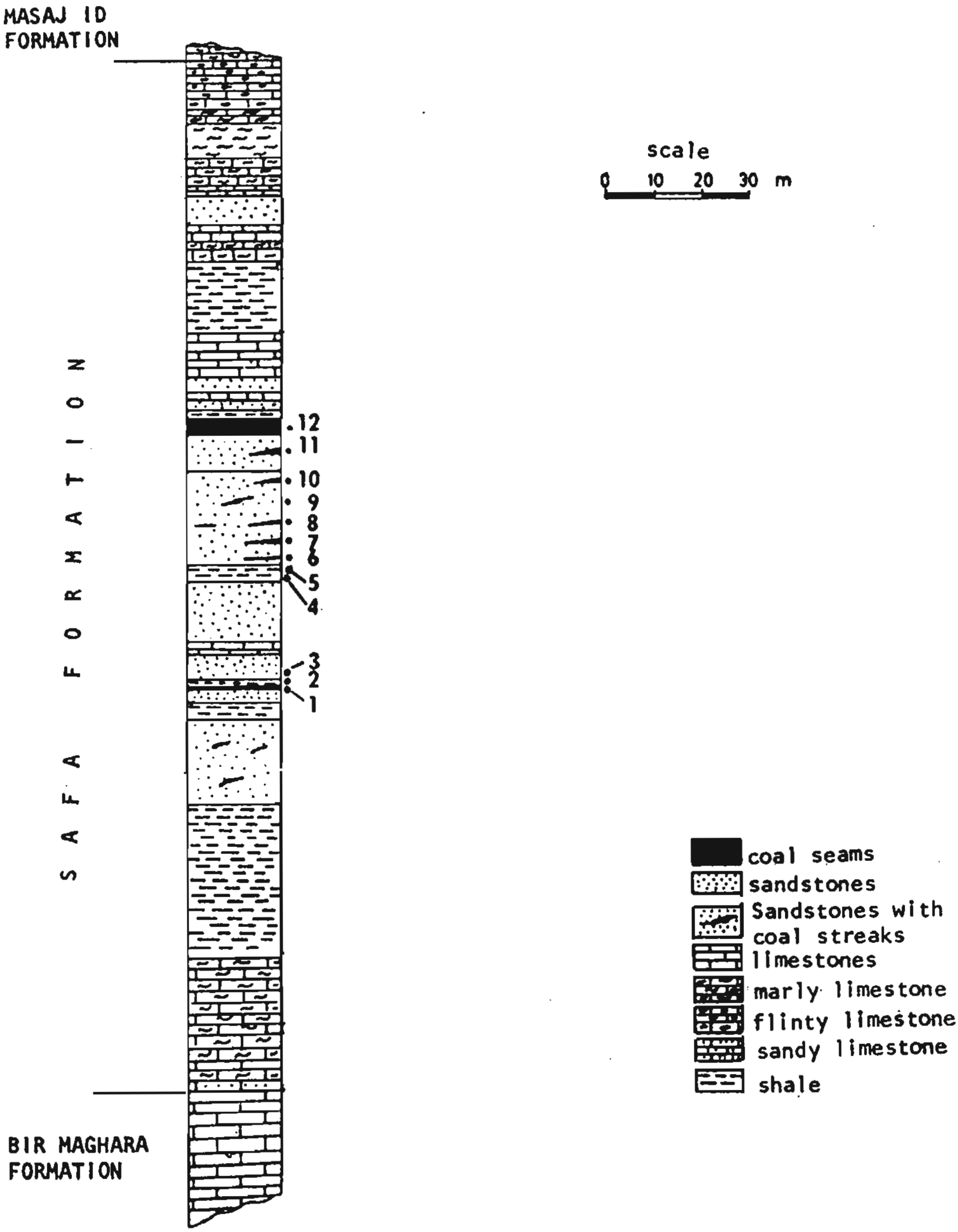


Fig. 2. Generalized section of the Safa Formation showing the stratigraphic position of the coal seams and the investigated samples.

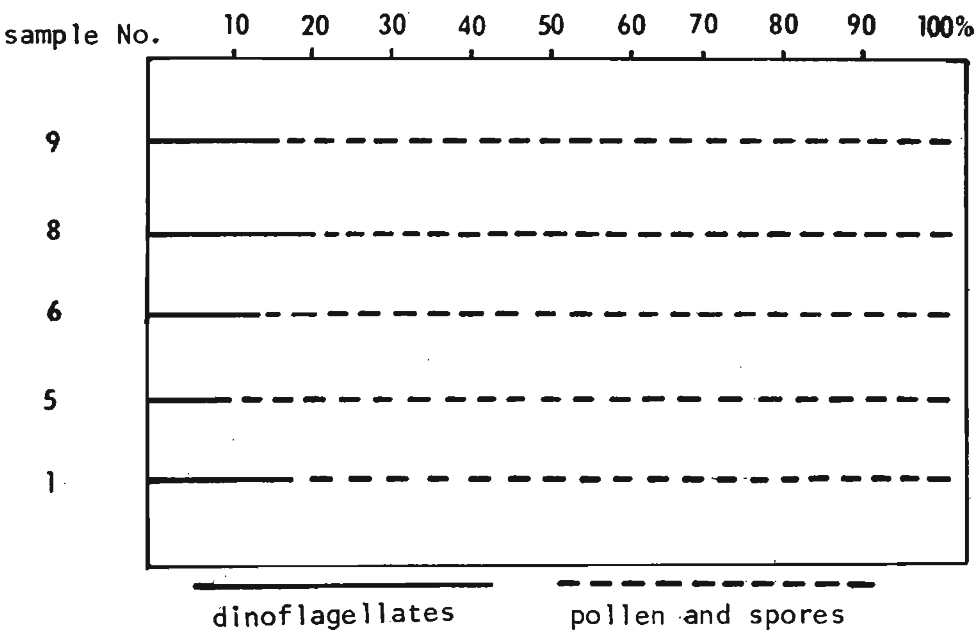
samples studied, only five yielded marine phytoplankton. These are samples 1, 5, 6, 8 and 9; the rest of the samples are barren (fig. 2). The samples were prepared following the routine palynological technique.

OBSERVATIONS ON THE DINOFLAGELLATE CONTENTS

Beside the marine phytoplankton, the investigated samples yielded remarkable amounts of land-derived pollen and spores. The average percentage of the marine phytoplankton reaches 17% against 82.5% for land-derived microflora. The percentage of the recovered marine phytoplankton *versus* the land-derived microflora in each sample is illustrated in table 1.

Table 1

Diagram showing the percentage of dinoflagellates *versus* pollen and spores in the studied samples



The marine phytoplankton is richly represented, especially in the lower coal seam and in the sandstone separating the two main coal seams (fig. 2), whereas it is lacking in the upper coal seam. Most of the studied samples contain abundant cuticular debris and fragments of wood tissues.

The general aspect of the marine phytoplankton associations of El--Maghara is almost total absence of acritarchs. Only a single form of the genus *Michrystridium* has been observed in sample 9. This, however, may be attributed to local changes in the environment of deposition as well as the effect of transportation and sorting of the microplankton.

The predominance of the proximate gonyaulacacean-type cysts is of particular interest in the dinoflagellate associations of El-Maghara. At the same time, the chorate and cavate cysts are virtually absent.

The following dinoflagellate cysts have been encountered in the coal deposits of El-Maghara. They are arranged in alphabetical order:

Canningia cf. *minor* (Cookson and Hughes, 1964) Stover and Evitt, 1978 (pl. 13: 1).
Cassiculosphaeridia cf. *magna* Davey, 1974 (pl. 13: 2).
Chlamydophorella sp. (pl. 13: 3).
Chytroeisphaeridia cf. *mantellii* Gitmez and Sarjeant, 1972 (pl. 13: 4).
Cribroperidinium sp. (pl. 13: 5).
Escharisphaeridia cf. *pocockii* (Sarjeant, 1968) Erkmen and Sarjeant, 1980 (pl. 13: 6).
Escharisphaeridia sp. (pl. 13: 7).
Exguisphaera cf. *phragma* Duxbury, 1979 (pl. 13: 8).
Gonyaulacysta sp. 1 (pl. 13: 9).
Gonyaulacysta sp. 2 (pl. 13: 10).
Kallosphaeridium sp. (pl. 13: 11).
Leptodinium antigonium Ioannides *et al.*, 1977, Stover and Evitt, 1978 (pl. 14: 1).
Leptodinium sp. (pl. 14: 2).
Lithodinia jurassica Eisenack, 1935, emend. Gocht, 1975b (pl. 14: 3).
Millioudodinium cf. *globatum* (Gitmez and Sarjeant, 1972) Stover and Evitt, 1978 (pl. 14: 4).
Saeptodinium sp. (pl. 14: 5).
Sentusidinium echinatum (Gitez and Sarjeant, 1972) Sarjeant and Stover, 1978 (pl. 14: 6).
Sentusidinium sp.? (pl. 14: 7).
Systematophora cf. S. sp. B Thusu and Vigran, 1985 (pl. 14: 8).

The recorded dinoflagellate species are distributed throughout the studied samples without showing any regular pattern. Three main genera of the dinoflagellate cysts are considered the most abundant and constitute more than 60% of the total identified dinocysts. These are: *Lithodinia jurassica* (36%), *Leptodinium antigonium* (15%) and *Gonyaulacysta* sp. 1 (10%). The less abundant species, constituting an average of 30%, include *Chytroeisphaeridia* cf. *mantellii* (12%), *Sentusidinium echinatum* (5%), *Cassiculosphaeridia* cf. *magna* (5%), *Exiguisphaera* cf. *phragma* (3%) and *Escharisphaeridia* cf. *pocockii* (2%). The rest of the cysts make less than 2%. A small number of indeterminate proximate dinocysts make about 0.5%.

CORRELATION AND AGE ASSIGNEMENT

Indeed, most if not all of the palynological studies of the Egyptian materials, are unfortunately directed towards investigating the pollen and spores and neglecting marine phytoplankton and its stratigraphic significance. Thus, the information on the local distribution of the index dinoflagellates in the territory of Egypt is not available. This, in turn, could not facilitate the biostratigraphic establishment of the present association. Especially, the investigated dinocyst are not diverse enough to help here.

However, there are some species in the associations examined which have been described from other regions. For example, the common species, *Lithodinia jurassica*, was recorded from the Bajocian-Bathonian of northern Europe (Fenton and Fischer 1978), from the Bathonian of the Netherlands (Herngreen *et al.* 1984), the Kimmeridgian of Dorset in England (Ioannides *et al.* 1976) and from the Kimmeridgian-Tithonian of Libya (Thusu and Virgan 1985). Furthermore, diverse species of the genus *Lithodinia* have been recorded also from the Late Bajocian of southern Germany and southern England (Fenton and Fischer 1978).

Two other species, *Sentusidinium echinatum* and *Escharisphaeridia* cf. *pocockii*, were reported from the Bathonian-Early Callovian of Libya (Thusu and Vigran 1985). In addition, Late Bathonian-Tithonian associations of Thusu and Vigran also contain dinocysts similar to those recorded from El-Maghara, e.g. determined at generic level *Millioudodinium*, *Systematophora* and *Exiguisphaera* cf. *phragma*.

Similarity could also be noticed between the examined association and a Bathonian assemblage of the northeastern Spain (Fenton and Fischer 1978) in the presence of *Systematophora*, *Lithodinia* and *Chytroeisphaeridia*. However, *Ctenidodinium* and *Tenua* are absent from the association of El-Maghara. Other common members of the El-Maghara associations, e.g. *Leptodinium* cf. *antigonium*, *Cassiculosphaeridia magna* and *Chrytroeisphaeridia* cf. *mantellii* are reported by Ioannides *et al.* (1976) from the Kimmeridgian of Dorset coast in England. Moreover, the genus *Chytroeisphaeridia* predominates in the Lower Bathonian of northwest Europe (Fenton and Fischer 1978), Greenland (Sarjeant 1972), Arctic Canada (Johnson and Hills 1973), Lower Bathonian of southern Spain (Fenton and Fischer 1978), Bulgaria (Dodekova 1975), northwest Negev (Conway 1976) and the Middle Bathonian of northwest Europe (Fenton and Fischer 1978).

It is noteworthy that, the Tethyan genus *Ctenidodinium* (Fenton and Fischer 1978) which is characteristic of most of south European Bathonian assemblages is completely absent from the associations of El-Maghara, the latter resembling in this respect assemblages of northeast Europe.

In addition, the widely distributed *Nannoceratopsis* which constitutes a conspicuous part of Bajocian-Bathonian assemblages of northwest Europe (Fenton and Fischer 1978), Late Malmian of the Netherlands (Herngreen *et al.* 1984) and Middle Jurassic ones of Libya (Guy-Ohlson 1982) is completely absent from El-Maghara associations.

As already seen, most of the recovered species are restricted mainly to Bajocian-Bathonian age, although, few are related to Bajocian-Kimmeridgian taxa. Accordingly, it could be possible to assign the association of El-Maghara a Bajocian-Bathonian age. This conclusion is in accordance with result recently obtained by Aboul Ela and Aly (in press) based on the study of pollen and spores.

REMARKS ON DEPOSITIONAL ENVIRONMENT

The presence of marine phytoplankton within the coal deposits of El-Maghara suggests an ingression of sea into coal depositionary basin. The sandstone separating the two coal seams yielded dinoflagellate cysts dominated by proximate gonyaulacyst type of dinocyst, known as being abundant in the marine environments (Downie *et al.*, 1971).

On the other hand, the increase in percentage of the land derived microflora against low percentage of dinoflagellates, indicates deposition in shallow marine environment. Moreover, the presence of terrestrial debris of wood tissues in the sandstones indicates that the deposition took place in close proximity of shoreline.

Thus, the results indicate a change in the environment of deposition from paralic swamp condition where the first coal seam was deposited, to shallow marine environment. This was followed by terrestrial swamp condition where the second coal seam was deposited.

SUMMARY

The investigation of the marine phytoplankton of the coal deposits of El-Maghara revealed the absence of acritarchs. Most of the recovered dinoflagellate cysts species represent mainly proximate gonyaulacacean type. The common dinocysts species confirm a Bajocian-Bathonian age of the association.

In general, Bajocian-Bathonian associations of El-Maghara differ from the Tethyan associations of Europe in the absence of the cosmopolitan elements *Ctenidodinium* and *Nannoceratopsis*.

The results of the present investigations give evidence of marine influence on coal deposits of El-Maghara. Thus, the coal of El-Maghara could be of a paralic type.

REFERENCES

ABOUL ELA, N. M. and ALY, M. F. (in press) Jurassic microflora from the coal deposits of El-Maghara North Central Sinai, Egypt. — *N. Jb. Geol. Paläont.*

AL FAR, D. 1964. A report on the discovery of coal in El. Maghara, North Sinai. — *Geol. Surv. Miner. Res. Dept.*, **114**.

CONWAY, B. H. 1976. Jurassic palynomorphs from Zohar 5, Yinnon 1 and Kidod 2 boreholes in southern Israel. M. Sc. Thesis, Univ. Sheffield (unpubl.).

DODEKOVA, L. 1975. New Upper Bathonian dinoflagellate cysts from north-eastern Bulgaria. — *Bulgarian Acad. Sci., Paleont. Strat. Lith.*, **2**, 17—34.

DOWNIE, C., HUSSAIN, M. A. and WILLIAMS, G. L. 1971. Dinoflagellate cysts and acritarch associations in the Paleogene of south-east England. — *Geosci. Man.*, **3**, 29—35.

DRUGG, W. 1978. Some Jurassic dinoflagellate cysts from England, France and Germany. — *Palaeontographica*, B, **168**, 69—79.

DUPIN, F. 1965. Contribution à l'étude paléontologique du Jurassique en Aquitaine occidentale. These Univ.

FARAG, I. A. M. 1941. The Jurassic Formation in Egypt. Ph. D. Thesis, Cairo University.

— and OMARA, S. 1955. On the occurrence of marine Middle Jurassic deposits of Gebel El-Minsherah (North Sinai, Egypt). — *Bull. Inst. Desert d'Egypt*, **1**, 165—178.

FENTON, J. P. G. and FISHER, M. J. 1978. Regional distribution of marine microplankton in the Bajocian and Bathonian of Northern Europe. — *Palinologia*, Numero extraordinario, **1**, 233—243.

GUY-OHLSON, D. 1982. Biostratigraphy of the Lower Jurassic-Cretaceous unconformity at Kullemolla, southern Sweeden. — *Sver. Geol. Unders Ser. Ca.*, **52**, 1—29.

HERNGREEN, C. F. W., DE BOER, K. F., ROMEIN, B. J., LISSENGERG, Th. and WIJKER, N. C. 1984. Middle Callovian beds in the Achterhoek, eastern Netherland. — *Meded. Rij. Geol. Dienst*, **37**, 1—29.

IOANNIDES, N. S., STAVINSON, G. N. and DOWNIE, C. 1976. Kimmeridgian microplankton from Clavell's Hard, Dorset, England. — *Micropaleontology*, **22**, 4, 443—478.

JOHNSON, C. D. and HILLS, L. V. 1973. Microplankton zones of the Savik Formation (Jurassic), Axel Heiberg and Ellesmere Islands, district Franklin. — *Bull. Can. Petrol. Geol.*, **21**, 178—218.

SAID, R. and BARAKAT, M. G. 1958. Jurassic microfossils from Gebel El-Maghara, N. Sinai, Egypt. — *Micropaleontology*, **4**, 231—272.

SARJEANT, W. A. S. 1972. Dinoflagellate cysts and acritarchs from the Upper Vardekloft Formation (Jurassic) of Jameson Land, East Greenland. — *Komm. Vid. Unders. Greenland*, **195**, 1—69.

THUSU, B. and VIGRAN, J. O. 1985. Middle-Late Jurassic (Late Bathonian-Tithonian) Palynomorphs, Libya In: Symposium on palynostratygraphy of North-East Libya (Arabian Gulf Company). — *J. Micropalaeontol.*, **4**, 1, 113—130.

N. M. ABOUL ELA i M. F. ALY

WSTĘPNE WYNIKI BADAŃ NAD MORSKIM FITOPLANKTONEM Z JURY ŚRODKOWEJ WĘGLONOŚNYCH OSADÓW Z EL-MAGHARA, CENTRALNY SYNAJ, EGIPT

Streszczenie

Wśród osadów węglonośnych w miejscowości El-Maghara w północnej części centralnego Synaju, należących do formacji Safa znaleziono obfite dinoflagellata. Niniejsze opracowanie wstępne przynosi listę oznaczonych i zilustrowanych 19 taksonów (pl. 13, 14). Dominującymi gatunkami są *Lithodinia jurassica*, *Leptodinium antigonium*, *Gonyaulacysta* sp., *Chytroeisphaeridia* cf. *mantellii*, *Sentusidinium echinatum*, *Cassiculosphaeridia magna* and *Exiguisphaera* cf. *phragma*. Dinoflagellata potwierdzają dotychczasowy pogląd, że osady węglonośne z El-Maghara są wieku bajosko-batońskiego. Obecność morskich ogranizmów, Dinoflagellata, w osadach węglonośnych świadczy o ingresjach morskich i pozwala na określenie węgli w El-Maghara, jako paralicznych.

EXPLANATION OF PLATES 13 AND 14

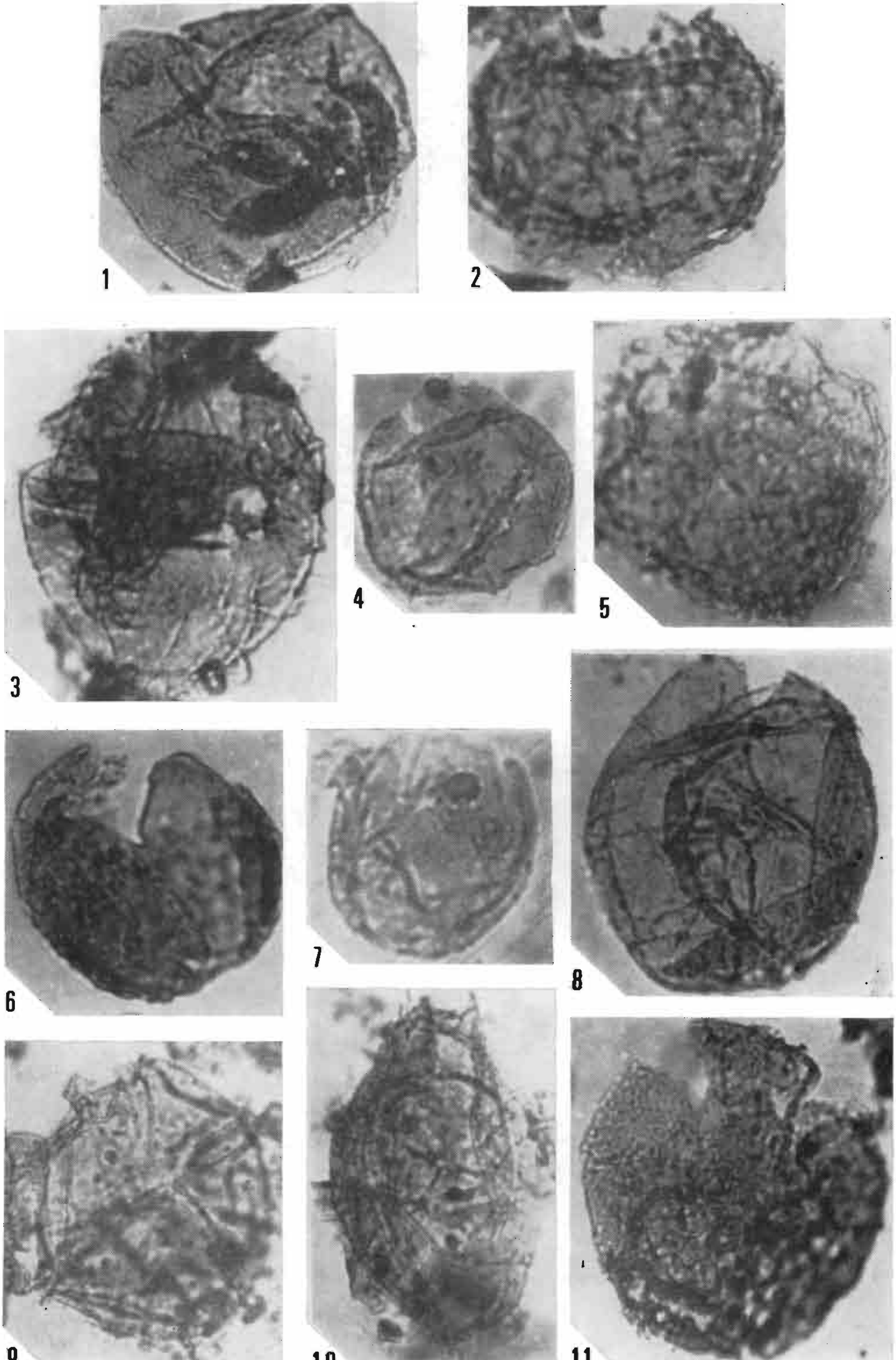
Plate 13

1. *Canningia* cf. *minor* Stover and Evitt, 1978, ×1000.
2. *Cassiculosphaeridia* cf. *magna* Davey, 1974, ×1000.
3. *Chlamydophorella* sp. ×1000.
4. *Chytroeisphaeridia* cf. *mantellii* Gitmez and Sarjeant, 1972, ×750.
5. *Cribroperidinium* sp., ×500.
6. *Eschaerisphaeridia* cf. *pocockii* Erkmen and Sarjeant, 1980, ×1000.
7. *Escharisphaeridia* sp., ×1000.
8. *Exiguisphaera* cf. *phragma* Duxbury, 1979, ×750.
9. *Gonyaulacysta* sp. 1, ×750.
10. *Gonyaulacysta* sp. 2, ×500.
11. *Kallosphaeridium* sp., ×750.

Plate 14

1. *Leptodinium antigonium* Ioannides *et al.*, 1977, Stover and Evitt, 1978, ×750.
2. *Leptodinium* sp., ×750.
3. *Lithodinia jurassica* Eisenack, 1935, emend. Gocht, 1975b ×1000.
4. *Millioudodinium* cf. *globatum* Stover and Evitt, 1978, ×750.
5. *Saeptodinium* sp., ×5000.
6. *Sentusidinium echinatum* Sarjeant and Stover, 1978, ×1000.

7. *Sentusidinium* sp.?, ×1000.
8. *Systematophora* cf. S. sp. B Thusu and Vigran, 1985, ×500.
9—11. Indeterminate dinoflagellate cysts, ×750.
12. *Michrystridium* sp., ×1000.


1
2
3
4
5
6
7
8
9
10
11