16. STRATIGRAPHIC PALYNOLOGY OF SELECTED MESOZOIC SAMPLES, DSDP HOLE 327A AND SITE 330

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INTRODUCTION

This paper presents the results of palynologic analyses of 13 selected samples from the sedimentary sequences cored at Hole 327A and Site 330 from Leg 36 of the Deep Sea Drilling Project (Figure 1). Core samples were analyzed from the following depths:
Hole 327A, at 341, 368, 396, 426, 453, and 463 meters
Site 330, at 271-281, 315, 317-318.5, 352, 377.5-379, 440, and 525 meters.

The six samples from Hole 327A and the upper five samples from Site 330 are within a sapropelic claystone sequence. The lower two samples from Site 330 are within an interbedded sandstone, clayey siltstone, and limestone sequence containing plant debris (Barker et al., 1974).

All samples yielded well-preserved palynomorph assemblages consisting of terrestrial spores and pollen grains, tasmanitids, and marine dinoflagellate cysts. The samples were prepared by pretreatment with dilute hydrochloric acid, followed by hydrofluoric acid digestion. No oxidation was necessary before strew-mounting the residues.

The distribution and relative frequencies of species are summarized in Figure 2 and are listed below. Selected species are illustrated in Plates 1 to 3. The spores and pollen are broadly classified in alphabetical order according to the system proposed by Potonié (1956, 1958, 1960) and modified by Dettmann (1963).

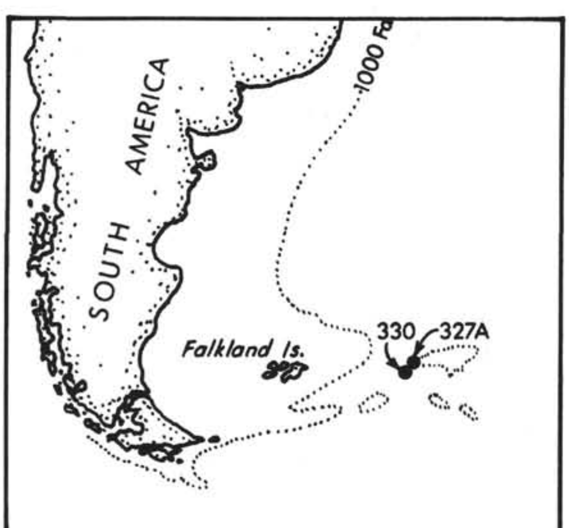

Figure 1. *Sample location map, Sites 327A and 330.*

Dinoflagellate cysts are listed with reference to two orders of presumed affinities: species within the Order Peridiniales are listed alphabetically. Slides and residues are housed in the Palynologic Collection of Amoco Production Company Research Center, Tulsa, Oklahoma. Examination and photography of specimens were with a Zeiss Universal microscope equipped with phase contrast and Nomarski differential interference contrast in the above institution.

TAXONOMIC LIST

Anteturma SPORITES
Turma TRILETES
Suprasubturma ACAVATITRILETES
Subturma AZONOTRILETES

Baculatisporites comaumensis (Cookson) Potonié, 1956
Ceratosporites equalis Cookson and Dettmann, 1958; Plate 1, Figure 5
Cicatricosisporites hallei Delcourt and Sprumont, 1955; Plate 1, Figure 7
Cicatricosisporites sp.; Plate 1, Figure 6
Concavisporites jurienensis Balme, 1957
Cyathidites australis Couper, 1953
Cyathidites minor Couper, 1953
Dictyophyllidites sp.
Ischyosporites crateris Balme, 1957; Plate 1, Figure 17
Lycopodiumsporites austroclavatidites (Cookson) Potonié, 1956
Neoraistrickia sp.
Rubinella major (Couper) Norris, 1969
Rubinella sp.; Plate 1, Figure 12
Todisporites minor Couper, 1958
Verrucosisporites sp.

Subturma ZONOTRILETES

Cingulatisporites sp.; Plate 1, Figure 10
Clavifera triplex (Bolchovitina) Bolchovitina, 1968; Plate 1, Figure 4
Contignisporites glebulentus Dettmann, 1963; Plate 1, Figure 14
Coronatispora valdensis (Couper) Dettmann, 1963; Plate 1, Figure 13
Foraminisporis wonthaggiensis (Cookson and Dettmann) Dettmann, 1963
Gleicheniidites confossus Hedlund, 1966; Plate 1, Figure 3
Gleicheniidites senonicus Ross, 1949; Plate 1, Figure 1
Gleicheniidites sp.; Plate 1, Figure 2
Matonisporites crassiangulatus (Balme) Levet-Carette, 1964; Plate 1, Figure 16
Trilobosporites spp.

Suprasubturma PERINOTRILETES

Densoisporites velatus Weyland and Krieger, emend. Krasnova, 1961
Heliosporites sp.; Plate 1, Figure 8

Turma HILATES

Coptospora sp.; Plate 1, Figure 11

Anteturma POLLENITES
Turma SACCITES
Subturma MONOSACCITES

Cerebropollenites mesozoicus (Couper) Nilsson, 1958

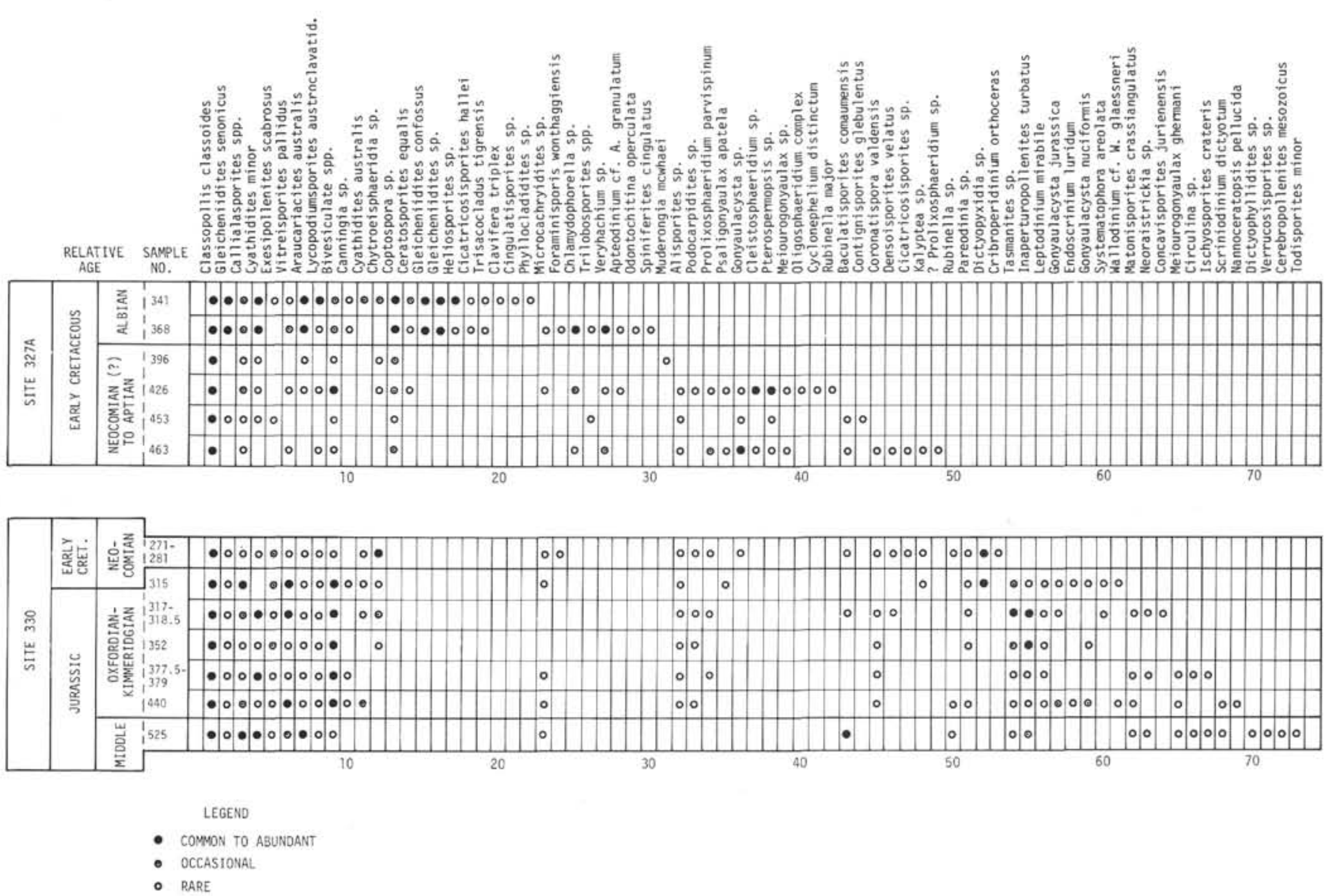

Figure 2. *Distribution and relative frequencies of palynomorph species.*

Subturma DISACCITES

Alisporites sp.; Plate 1, Figure 19
Microcachryidites sp.; Plate 1, Figure 20
Phyllocladidites sp.
Podocarpidites sp.; Plate 1, Figure 21
Vitreisporites pallidus (Reissinger) Potonié, 1960

Subturma POLYSACCITES

Callialasporites spp. includes
C. dampieri (Balme) Dev, 1961
C. trilobatus (Balme) Dev, 1961
Trisacocladus tigrensis Archangelsky, 1965; Plate 1, Figure 15

Turma ALETES

Araucariacites australis Cookson, 1947
Inaperturopollenites turbatus Balme, 1957; Plate 1, Figure 18

Turma POROSES

Exesipollenites scabrosus Norris, 1969; Plate 1, Figure 9

MIOSPORES INCERTAE SEDIS

Circulina sp.
Classopollis classoides Pflug, emend. Pocock and Jansonius, 1961

Class DINOPHYCEAE
Order DINOPHYSIDALES

Nannoceratopsis pellucida Deflandre, emend. Evitt, 1961; Plate 3, Figure 6

Order PERIDINIALES

Apteodinium cf. *A. granulatum* Eisenack, 1958; Plate 2, Figure 4
Canningia sp.
Chlamydophorella sp.
Chytroeisphaeridia sp.
Cleistosphaeridium sp.; Plate 2, Figure 8
Cribroperidinium orthoceras (Eisenack) Davey, 1969; Plate 2, Figure 11
Cyclonephelium distinctum Deflandre and Cookson, 1955; Plate 2, Figure 10
Dictyopyxidia sp.
Endoscrinium luridum (Deflandre) Gocht, 1970; Plate 3, Figure 4
Gonyaulacysta jurassica (Deflandre) Norris and Sarjeant, 1965; Plate 3, Figure 1
Gonyaulacysta nuciformis (Deflandre) Sarjeant, 1968; Plate 3, Figure 8
Gonyaulacysta sp.; Plate 2, Figures 1, 2
Kalyptea sp.
Leptodinium mirabile Klement, 1960; Plate 3, Figures 2, 3
Meiourogonyaulax ghermani Beju, 1971; Plate 3, Figure 5
Meiourogonyaulax sp.; Plate 2, Figure 6
Muderongia mcwhaei Cookson and Eisenack, 1958; Plate 2, Figure 9
Odontochitina operculata (Wetzel) Deflandre and Cookson, 1955
Oligosphaeridium complex (White) Davey and Williams, 1966; Plate 2, Figure 13
Pareodinia sp.; Plate 3, Figure 11
Prolixosphaeridium parvispinum (Deflandre) Davey et al., 1969; Plate 2, Figure 7
?Prolixosphaeridium sp.; Plate 2, Figure 3
Psaligonyaulax apatela (Cookson and Eisenack) Sarjeant, 1969; Plate 2, Figure 5
Scriniodinium dictyotum Cookson and Eisenack, 1960; Plate 3, Figure 12
Spiniferites cingulatus (Wetzel) Sarjeant, 1970; Plate 2, Figure 12
Systematophora areolata Klement, 1960; Plate 3, Figures 9, 10

INCERTAE SEDIS and ACRITARCHS

Wallodinium cf. *W. glaessneri* (Cookson and Eisenack) Loeblich and Loeblich, 1968; Plate 3, Figure 7

Pterospermopsis sp.
Tasmanites sp.; Plate 3, Figures 13, 14
Veryhachium sp.

RESULTS

Figure 2 illustrates the distribution and relative frequencies of species in analyzed samples from Hole 327A and Site 330. Samples are listed as "meters below sea bottom" for each site and are not plotted to scale. The vertical relationships between the two sections are diagrammatic and do not indicate precise stratigraphic relationships. However, palynologic data suggest that the sample at 271-281 meters at Site 330 is somewhat older than the sample at 463 meters in Hole 327A.

Hole 327A

The sequence in Hole 327A consists of sediments ranging in age from Early Cretaceous to Recent. Only six samples from the Early Cretaceous sapropelic claystone were provided for this study (341 to 463 m).

341 to 368 meters

Samples from this interval are dated as Albian in age on the basis of palynologic comparisons with subsurface studies in the Austral Basin of Santa Cruz Province, Argentina (Hedlund, unpublished manuscript). The assemblage consists mainly of terrestrial palynomorphs, with rarely occurring dinoflagellate cysts. The following species are the more significant:

Classopollis classoides Pflug, emend. Pocock and Jansonius, 1961
Gleicheniidites senonicus Ross, 1949
Exesipollenites scabrosus Norris, 1969
Canningia sp.
Coptospora sp.
Gleicheniidites confossus Hedlund, 1966
Gleicheniidites sp.
Trisacocladus tigrensis Archangelsky, 1965
Cingulatisporites sp.
Cyathidites minor Couper, 1953
Heliosporites sp.
Chlamydophorella sp.

In addition, the sample at 368 meters contains *Spiniferites cingulatus* (Wetzel) Sarjeant, 1970, reported to occur in sediments no older than Albian in age (Millioud et al., 1975).

396 to 463 m

This interval contains both terrestrial and marine palynomorphs and is dated as Neocomian (?) to Aptian in age. The sample at 396 meters contains specimens of *Muderongia mcwhaei* Cookson and Eisenack, 1958, a dinoflagellate cyst presently known to range from the Neocomian through Aptian in Australasia (Harker and Sarjeant, 1975). Samples at 426, 453, and 463 meters yielded the following species:

Prolixosphaeridium parvispinum (Deflandre) Davey et al., 1969
Psaligonyaulax apatela (Cookson and Eisenack) Sarjeant, 1969
Oligosphaeridium complex (White) Davey and Williams, 1966
Cyclonephelium distinctum Deflandre and Cookson, 1955
Gonyaulacysta sp.
Kalyptea sp.
Cicatricosisporites sp.
Rubinella major (Couper) Norris, 1969
Contignisporites glebulentus Dettmann, 1963
Coronatispora valdensis (Couper) Dettmann, 1963
Densoisporites velatus Weyland and Krieger, emend. Krasnova, 1961

Prolixosphaeridium parvispinum and *Psaligonyaulax apatela* are known to range from the Late Jurassic to the Early Cretaceous (Sarjeant, 1975). *O. complex* and *C. distinctum* have not been reported from sediments older than Valanginian in age (Millioud et al., 1975).

SITE 330

The analyzed sequence at Site 330 ranges in age from Middle Jurassic to Neocomian. Seven samples were provided from this sequence. The upper five samples are from the sapropelic claystone, and the lower two are within the interbedded sandstone, clayey siltstone, and limestone sequence (Barker et al., 1974).

271 to 281 m

This interval contains both terrestrial and marine palynomorph species recovered from the lowest level (463 m) in Hole 327A. Specimens referred to *Cribroperidinium orthoceras* (Eisenack) Davey, 1969 also were found at this level. The occurrence of these taxa indicates a Neocomian age for the level, but lack of more numerous diagnostic species precludes a more precise age assignment.

315 to 440 m

Samples within this interval yielded high relative abundances of bivesiculate pollen grains, tasmanitids, and dinoflagellate cysts. The more stratigrapically significant species include the following:

Systematophora areolata Klement, 1960
Gonyaulacysta jurassica (Deflandre) Norris and Sarjeant, 1965
Gonyaulacysta nuciformis (Deflandre) Sarjeant, 1968
Leptodinium mirabile Klement, 1960
Meiourogonyaulax ghermani Beju, 1971
Scriniodinium dictyotum Cookson and Eisenack, 1960
Endoscrinium luridum (Deflandre) Gocht, 1970
Wallodinium glaessneri (Cookson and Eisenack) Loeblich and Loeblich, 1968
Nannoceratopsis pellucida Deflandre, emend. Evitt, 1961

Most of these species have a cosmopolitan geographic distribution in Late Jurassic sediments (Norris, 1975). Their occurrences have been reported from numerous areas of both northern and southern hemispheres and indicate an Oxfordian-Kimmeridgian age (Sarjeant, 1975). Of the dinoflagellate cyst species recovered from the highest samples in this interval (315 m, Figure 2), *S. areolata, G. jurassica, G. nuciformis,* and *E. luridum* are not known to occur in sediments younger than Kimmeridgian (Sarjeant, 1975). This indicates a probable hiatus representing Portlandian (and possibly a portion of Neocomian) time between samples at 271-281 meters and 315 meters. A slight change in the flora is marked by the highest occurrences of *N. pellucida* and *S. dictyotum* at 440 meters, and the lowest occurrences of *S. areolata, Kalyptea* sp., and *Dictyopyxidia* sp. at 315 to 318.5 meters, suggesting a gradual Oxfordian-Kimmeridgian transition. A somewhat similar distribution of dinoflagellate cysts has been reported by Cookson and Eisenack (1958, 1960) from the Late Jurassic of Australia and New Guinea.

525 m

The lowest stratigraphic sample contains a rich but relatively undiversified assemblage of land-derived palynomorphs that are known to have long stratigraphic ranges in upper Mesozoic sediments. However, the abundant occurrences of *Callialasporites dampieri* (Balme) Dev, 1961; *C. trilobatus* (Balme) Dev, 1961 (both included as *C.* spp. on Figure 2); and *Inaperturopollenites turbatus* Balme, 1957, together with the accessory species *Todisporites minor* Couper, 1958; *Ischyosporites crateris* Balme, 1957; *Baculatisporites comaumensis* (Cookson) Potonié, 1956; and *Cerebropollenites mesozoicus* (Couper) Nilsson, 1958 suggest a Middle Jurassic age for this sample. In the southern hemisphere this assemblage compares closely with Middle Jurassic microfloras previously reported from Argentina (Menendez, 1968; Volkheimer, 1969, 1971, 1972, 1973), Madagascar (de Jekhowsky and Goubin, 1964; Goubin, 1965), and Australia (Balme, 1957, 1964). In these areas the "Dampieri Assemblage" of Balme (1964) occurs in abundance in the Middle Jurassic, while the Early Jurassic is characterized by taxa that are absent from the Hole 330 assemblage.

CONCLUSIONS

Sedimentary sequences from Hole 327A and Site 330 have been palynologically dated as Middle Jurassic to Albian. Middle Jurassic sediments are dominated by land-derived palynomorphs, while Oxfordian-Kimmeridgian samples represent a shallow marine environment. A hiatus representing the Portlandian (and possibly a portion of the Neocomian) is indicated by the ranges of palynomorph taxa. Neocomian-Aptian sediments contain both terrestrial and marine fossils, but the Albian portion of Hole 327A is predominantly a terrestrial assemblage.

ADDENDUM

After completing this manuscript, the authors became aware of a recent reevaluation of the genus *Meiourogonyaulax* Sargeant, 1966, which is now regarded as a junior synonym of *Lithodinia* Eisenack, 1935 (Gocht, 1975). Therefore, forms referred to *Meiourogonyaulax ghermani* Beju, 1971 and *M.* sp. in this paper should be transferred to *Lithodinia.*

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PLATE 1

Figure 1	*Gleicheniidites senonicus* Ross, 1949. Hole 327A (341 m), × ca. 1000.
Figure 2	*Gleicheniidites* sp. Hole 327A (341 m), × ca. 1000.
Figure 3	*Gleicheniidites confossus* Hedlund, 1966. Hole 327A (341 m), × ca. 1000.
Figure 4	*Clavifera triplex* (Bolchovitina) Bolchovitina, 1968. Hole 327A (341 m), × ca. 1000.
Figure 5	*Ceratosporites equalis* Cookson and Dettmann, 1958. Hole 327A (341 m), × ca. 1000.
Figure 6	*Cicatricosisporites* sp. Hole 327A (463 m), × ca. 1000.
Figure 7	*Cicatricosisporites hallei* Delcourt and Sprumont, 1955. Hole 327A (368 m), × ca. 1000.
Figure 8	*Heliosporites* sp. Hole 327A (341 m), × ca. 1000.
Figure 9	*Exesipollenites scabrosus* Norris, 1969. Site 330 (317 m), × ca. 1000.
Figure 10	*Cingulatisporites* sp. Hole 327A (463 m), × ca. 650.
Figure 11	*Coptospora* sp. Hole 327A (341 m), × ca. 1000.
Figure 12	*Rubinella* sp. Site 330 (440 m), × ca. 650.
Figure 13	*Coronatispora valdensis* (Couper) Dettmann, 1963. Site 330 (317 m), × ca. 1000.
Figure 14	*Contignisporites glebulentus* Dettmann, 1963. Hole 327A (463 m), × ca. 650.
Figure 15	*Trisacocladus tigrensis* Archangelsky, 1965. Hole 327A (368 m), × ca. 1000.
Figure 16	*Matonisporites crassiangulatus* (Balme) Levet-Carette, 1964. Site 330 (525 m), × ca. 650.
Figure 17	*Ischyosporites crateris* Balme, 1957. Site 330 (525 m), × ca. 1000.
Figure 18	*Inaperturopollenites turbatus* Balme, 1957. Site 330 (525 m), × ca. 400.
Figure 19	*Alisporites* sp. Site 330 (440 m), × ca. 650.
Figure 20	*Microcachryidites* sp. Site 330 (440 m), × ca. 650.
Figure 21	*Podocarpidites* sp. Site 330 (440 m), × ca. 650.

PLATE 1

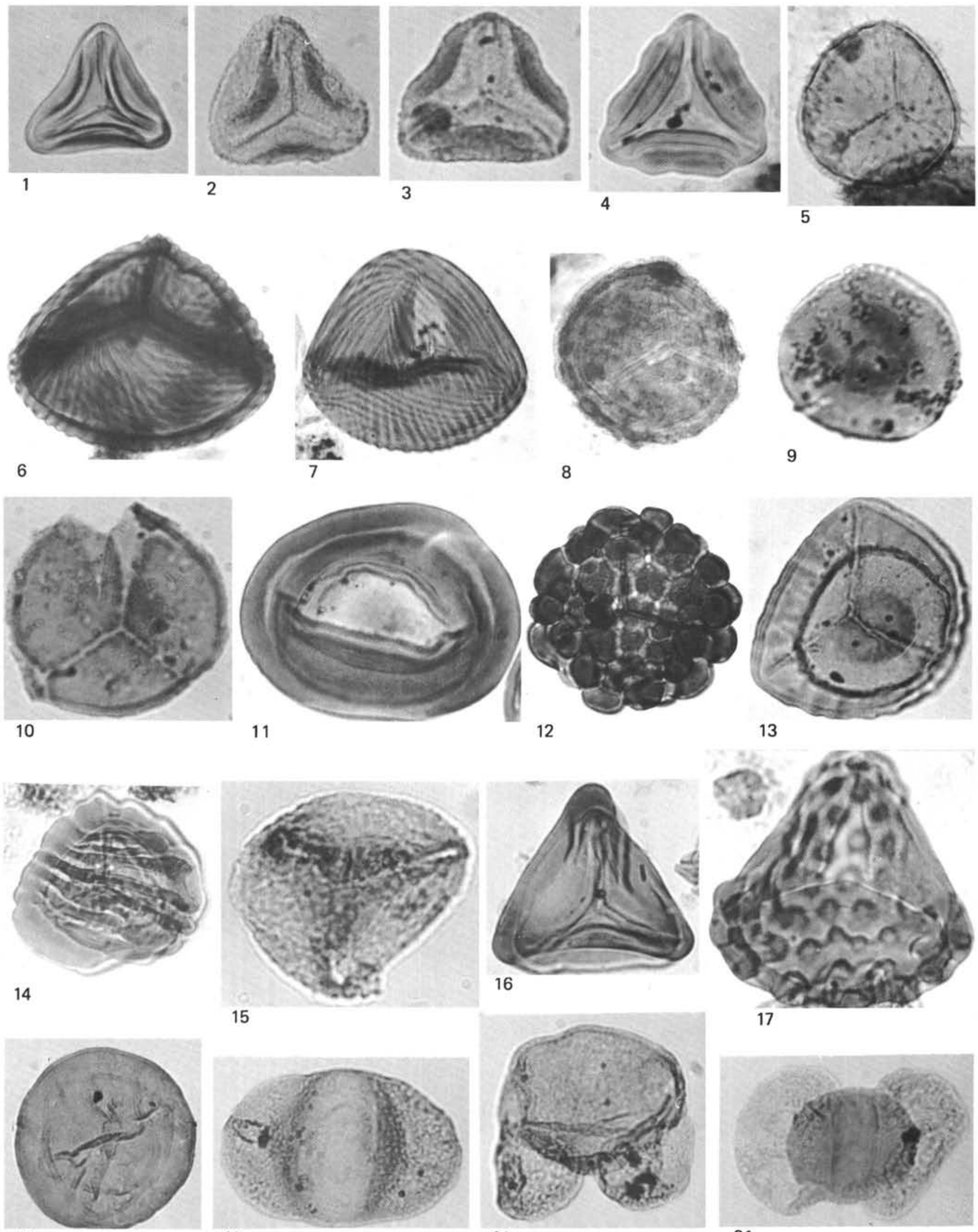

PLATE 2

Figures 1,2	*Gonyaulacysta* sp. Hole 327A (463 m), × ca. 650.
Figure 3	? *Prolixosphaeridium* sp. Hole 327A (463 m), × ca. 650.
Figure 4	*Apteodinium* cf. *A. granulatum* Eisenack, 1958. Hole 327A (426 m), × ca. 650.
Figure 5	*Psaligonyaulax apatela* (Cookson and Eisenack) Sarjeant, 1969. Site 330 (315 m), × ca. 650.
Figure 6	*Meiourogonyaulax* sp. Hole 327A (463 m), × ca. 650.
Figure 7	*Prolixosphaeridium parvispinum* (Deflandre) Davey et al., 1969. Hole 327 A (463 m), × ca. 650.
Figure 8	*Cleistosphaeridium* sp. Hole 327A (463 m), × ca. 650.
Figure 9	*Muderongia mcwhaei* Cookson and Eisenack, 1958. Hole 327A (396 m), × ca. 650.
Figure 10	*Cyclonephelium distinctum* Deflandre and Cookson, 1955. Hole 327A (396 m), × ca. 650.
Figure 11	*Cribroperidinium orthoceras* (Eisenack) Davey, 1969. Site 330 (271 m), × ca. 400.
Figure 12	*Spiniferites cingulatus* (O. Wetzel) Sarjeant, 1970. Hole 327A (386 m), × ca. 650.
Figure 13	*Oligosphaeridium complex* (White) Davey and Williams, 1966. Hole 327A (426 m), × ca. 400.

PLATE 2

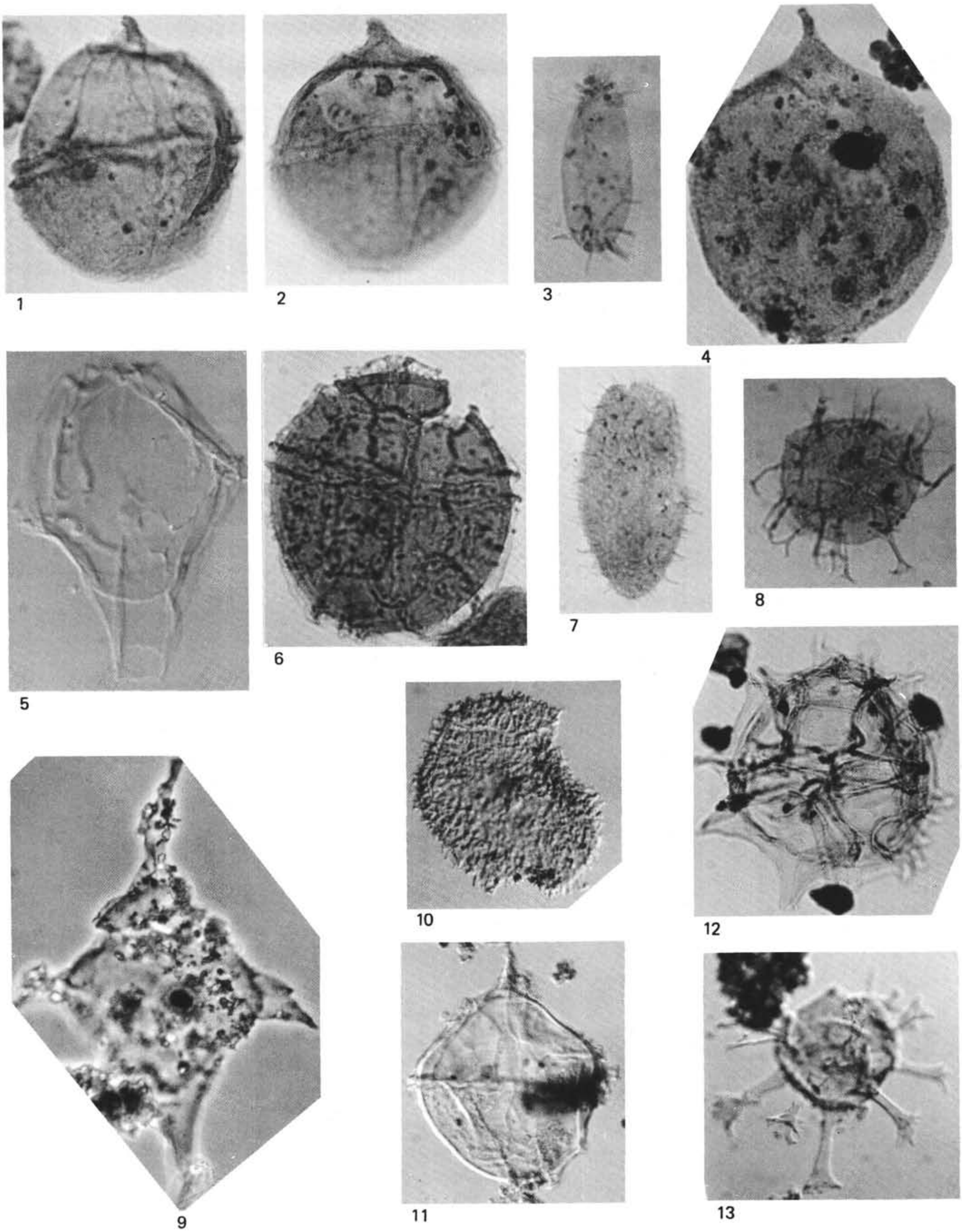

PLATE 3

Figure 1	*Gonyaulacysta jurassica* (Deflandre) Norris and Sarjeant, 1965. Site 330 (440 m), × ca. 650.
Figures 2, 3	*Leptodinium mirabile* Klement, 1960. Site 330 (440 m), × ca. 400.
Figure 4	*Endoscrinium luridum* (Deflandre) Gocht, 1970. Site 330 (440 m), × ca. 650.
Figure 5	*Meiourogonyaulax ghermani* Beju, 1971. Site 330 (440 m), × ca. 1000.
Figure 6	*Nannoceratopsis pellucida* Deflandre, emend. Evitt, 1961. Site 330 (440 m), × ca. 650.
Figure 7	*Wallodinium* cf. *W. glaessneri* (Cookson and Eisenack). Loeblich and Loeblich, 1968. Site 330 (440 m), × ca. 650.
Figure 8	*Gonyaulacysta nuciformis* (Deflandre) Sarjeant, 1968. Site 330 (440 m), × ca. 650.
Figures 9, 10	*Systematophora areolata* Klement, 1960. Hole 327A (426 m), × ca. 650.
Figure 11	*Pareodinia* sp. Site 330 (440 m), × ca. 650.
Figure 12	*Scriniodinium dictyotum* Cookson and Eisenack, 1960. Site 330 (440 m), × ca. 650.
Figures 13, 14	*Tasmanites* sp. Site 330 (440 m), × ca. 650.

PLATE 3