

14. CAMPANIAN TO MAESTRICHIAN DINOFLAGELLATE CYSTS FROM THE UNITED STATES ATLANTIC MARGIN, DEEP SEA DRILLING PROJECT SITE 612¹

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ABSTRACT

Fifty-nine samples from the basal 110 m of DSDP Hole 612 (United States Atlantic Margin) were analyzed for palynomorph content. In total, 84 species and subspecies of dinoflagellate cysts were recorded which, on comparison with published data and shipboard analyses, indicate a Campanian to Maestrichtian age for this part of the succession. The Campanian/Maestrichtian contact is taken to occur in the upper part of Core 612-69.

INTRODUCTION

Leg 95 of the Deep Sea Drilling Project (DSDP) drilled at two sites, 612 and 613, on the New Jersey middle slope and upper rise, respectively. Site 612 was selected to provide a stratigraphic section which would serve as a link between the COST B-3 Well on the upper slope and DSDP Site 605 on the upper rise (Fig. 1). One of the primary aims was to provide a complete Upper Cretaceous and Cenozoic section for biostratigraphic analysis of this part of the margin. This chapter deals only with Upper Cretaceous material. A full report on the Cenozoic part of the section will follow at a later date.

There have been several previous studies of Campanian to Maestrichtian dinoflagellate cysts. In Europe, significant work was carried out by Deflandre (1935, 1936, 1937), Lejeune-Carpentier (1938, 1939), Alberti (1959, 1961), and, more recently, by Clarke and Verdier (1967), Kjellstrom (1973), Wilson (1971, 1974), and Hansen (1977). In Australia, there was a series of publications by Cookson and Eisenack (1958, 1960, 1962, 1968, 1970, 1974), and in New Zealand Wilson published a series (1976a, 1976b, 1983, 1984). Notable studies from the United States and Canada include those of Drugg (1967), Harland (1973), Williams (1975), Williams and Brideaux (1975), McIntyre (1975), Benson (1976), Bujak and Williams (1978), May (1980), and Whitney (1984).

In total, 59 samples were processed for this study using standard palynological techniques (Neves and Dale, 1963; Doher, 1980). Eighty-four species and subspecies of dinoflagellate cysts were recorded (see Appendix); their distribution is plotted in Figure 2.

BIOSTRATIGRAPHY

Site 612

The basal 25 to 26 m of the section (below Sample 612-69-2, 43–45 cm; Fig. 2) contains 48 species and subspecies of cysts, 19 of which are restricted to this inter-

val. These include the last occurrences of *Palaeohystri-chophora infusoroides* Deflandre, *Odontochitina costata* Alberti, *Trichodinium castaneum* (Deflandre) Clarke and Verdier, and *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson. Also, *Dinogymnium micro-granulosum* Clarke and Verdier, *D. digitus* (Deflandre) Evitt et al., *D. cf. euclaense* Cookson and Eisenack, *Kleithriasphaeridium truncatum* (Benson) Stover and Evitt, *Cannospaeropsis utinensis* O. Wetzel, and *Odontochitina porifera* Cookson have their first occurrences in this part of the section. A number of those occurrences compare closely with the zonation proposed by Bujak and Williams (1978) on the basis of studies of offshore eastern Canada. In particular, the last occurrences of *P. infusoroides*, *O. costata*, *O. operculata*, and *T. castaneum* and the first occurrence of *D. digitus* are indicative of Bujak and Williams's (1978) *O. operculata* Assemblage Zone of Campanian age. Furthermore, Williams (1975) and Wilson (1984) suggest that *C. utinensis* and *O. porifera*, respectively, first occur in the Campanian. The record most similar to the cyst distribution at Site 612, however, is that from the Atlantic Highlands, New Jersey (May, 1980). May (1980) suggests that the last occurrences of *P. infusoroides*, *O. costata*, and *Xenascus ceratioides* (Deflandre) Lentin and Williams, coinciding with the first occurrences of *Samlandia? angustivela* (Deflandre and Cookson) Eisenack and *C. utinensis*, indicate a latest Campanian to earliest Maestrichtian age. The close agreement of Site 612 results with these records therefore strongly suggests that the sediments below Sample 612-69-2, 43–45 cm (Fig. 2) are of late Campanian age.

The remaining 80 m of section examined here (from Sample 612-69-2, 43–45 cm to Sample 612-61-1, 40–42 cm; Fig. 2) contain 60 species and subspecies of cysts, 36 of these occurring for the first time. Stratigraphically significant occurrences include the last appearances of *Cyclonephelium distinctum* Deflandre and Cookson and *X. ceratioides* near the base of this interval, and the incoming of *S.? angustivela*, *Ceratiopsis diebelii* (Alberti) Vozzhennikova, *Cordosphaeridium fibrospinosum* Davy and Williams, *C. varians* May, *Spongodinium deltiense* (Ehrenberg) Deflandre, and *Dinogymnium westrålum* (Cookson and Eisenack) Evitt et al., and, high-

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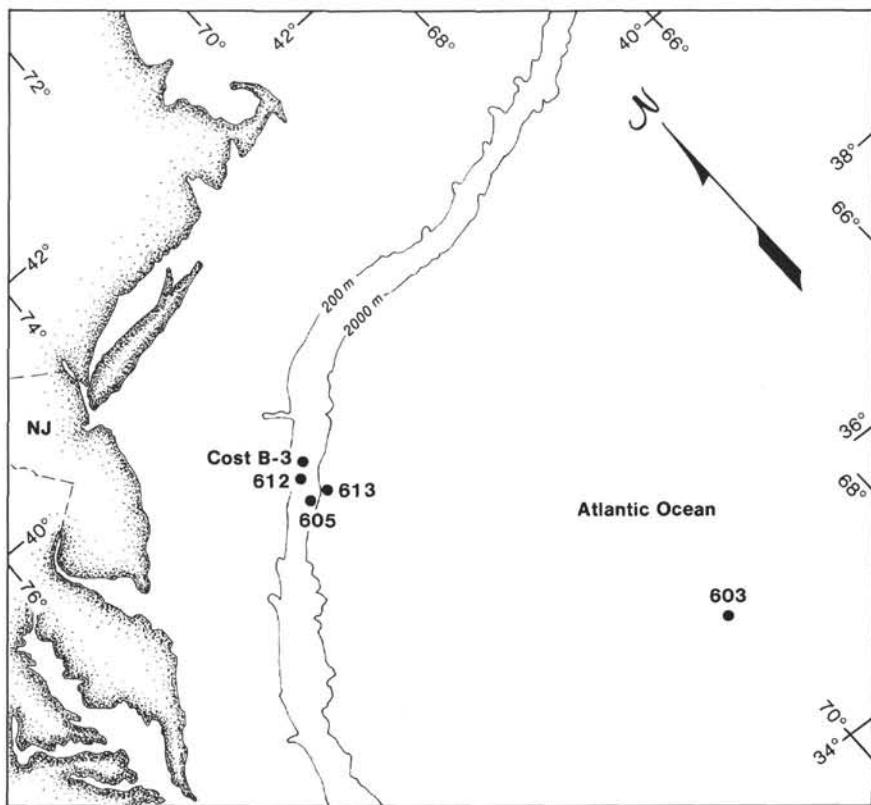


Figure 1. Location of Site 612, offshore New Jersey (NJ), on the western Atlantic margin, U.S.A.

er in the section, *Phelodinium tricuspidis* (O. Wetzel) Stover and Evitt, *Spiniferites cornutus* (Gerlach) Sarjeant, and *Palaeocystodinium australinum* (Cookson) Lentin and Williams. Several of these forms, in particular *C. fibrospinosum*, *C. diebelii*, *P. tricuspidis*, *P. australinum*, and *S. delitiense*, are recorded by Bujak and Williams (1978) as being characteristic of their *D. euclaense* Assemblage Zone of Maestrichtian age (although May [1980] records *C. fibrospinosum* as first appearing the late Campanian). Both Wilson (1974) and May (1980) record the incoming of *S. angustivela* and *S. delitiense* as occurring in the lower Maestrichtian, and the latter author also regards the first occurrences of *C. diebelii* and *D. westrallum* as indicating a similar age. It has been suggested (Wilson, 1984; Hansen, 1977) that *P. australinum* and *S. cornutus* are upper Maestrichtian indicators. However, May (1980) records the former species from the lower Maestrichtian of New Jersey, and it is suggested that the range of *S. cornutus* can likewise be extended down to this level. The absence of any definite upper Maestrichtian species suggests that the sediments are most reliably assigned to the lower Maestrichtian, and this is in agreement with the shipboard analyses based on foraminifers and nannofossils.

The Campanian/Maestrichtian contact is taken to occur in the upper part of Core 612-69, and it is associated with a sharp lithologic break from dark gray foraminiferal shale (below) to marly foraminiferal nannofossil chalk.

SUMMARY

In total, 84 species and subspecies of dinoflagellate cysts are recorded from the basal 110 m of DSDP Hole 612. On comparison with published dinoflagellate cyst records, these are taken to indicate a late Campanian to early Maestrichtian age for this part of the section. This conclusion is further strengthened by shipboard analyses based on foraminifers and nannofossils (site chapters, this volume). The Campanian/Maestrichtian contact is placed in the upper part of Core 612-69 and is associated with a sharp lithologic break.

ACKNOWLEDGMENTS

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APPENDIX

List of Taxa

- Achomosphaera crassipellis* (Deflandre and Cookson, 1955) Stover and Evitt, 1978
- Achomosphaera ramulifera* (Deflandre, 1937) Evitt, 1963
- Achomosphaera sagena* Davey and Williams, 1966
- Alterbia acutula* (Wilson, 1967) Lentin and Williams, 1976
- Andalusia spicata* (May, 1980) Lentin and Williams, 1981
- Areoligera senonensis* Lejeune-Carpentier, 1938
- Bacchidinium* sp.?
- Cannosphaeropsis uitensis* O. Wetzel, 1933; emend. Duxbury, 1980
- Ceratiopsis diebelii* (Alberti, 1959) Vozzhennikova, 1967
- Ceratiopsis* sp. A
- Ceratiopsis* sp. B
- Chlamydophorell discreta* Clarke and Verdier, 1967
- Cordosphaeridium fibrospinosum* Davey and Williams, 1966
- Cordosphaeridium varians* May, 1980
- Coronifera oceanica* Cookson and Eisenack, 1958
- Coronifera striolata* (Deflandre, 1937) Stover and Evitt, 1978
- Cribroperidinium edwardii* (Cookson and Eisenack, 1958) Stover and Evitt, 1978
- Cribroperidinium* sp.
- Cyclonephelium distinctum* Deflandre and Cookson, 1955
- Cyclonephelium expansum* Corradini, 1973
- Dapsilidinium? pumilum* (Davey and Williams, 1966) Lentin and Williams, 1981
- Dinogymnium digitus* (Deflandre, 1935) Evitt et al., 1967
- Dinogymnium* cf. *euclaense* Cookson and Eisenack, 1970
- Dinogymnium lanceolatum* May, 1977
- Dinogymnium microgranulosum* Clarke and Verdier, 1967
- Dinogymnium westrallum* (Cookson and Eisenack, 1958) Evitt et al., 1967; emend. May, 1977
- Dinogymnium* sp. A
- Dinogymnium* sp. B
- Dinopterygium* sp.?
- Eurydinium ingramii* (Cookson and Eisenack, 1970) Stover and Evitt, 1978
- Eurydinium* sp.
- Exochosphaeridium bifidum* (Clarke and Verdier, 1967) Clarke et al., 1968
- Glaphrocysta ordinata* (Williams and Downie, 1966) Stover and Evitt, 1978
- G. retiintexta* (Cookson, 1965) Stover and Evitt, 1978
- Gonyaulacysta? wetzeli* (Lejeune-Carpentier, 1939) Sarjeant, 1969
- Hystrichokolpoma unispinum* Williams and Downie, 1966a
- Hystrichokolpoma* sp.
- Hystrichodinium pulchrum pulchrum* Deflandre, 1935
- Hystrichosphaeridium palmatum* (White, 1842) Downie and Sarjeant, 1965
- Hystrichosphaeridium tubiferum* (Ehrenberg, 1838) *brevispinum* (Davey and Williams, 1966) Lentin and Williams, 1973
- Hystrichosphaeridium tubiferum tubiferum* (Ehrenberg, 1838) Deflandre, 1937; emend. Davey and Williams, 1966
- Hystrichosphaeridium* sp.
- Hystrichostrogylon membraniphorum* Agelopoulos, 1964

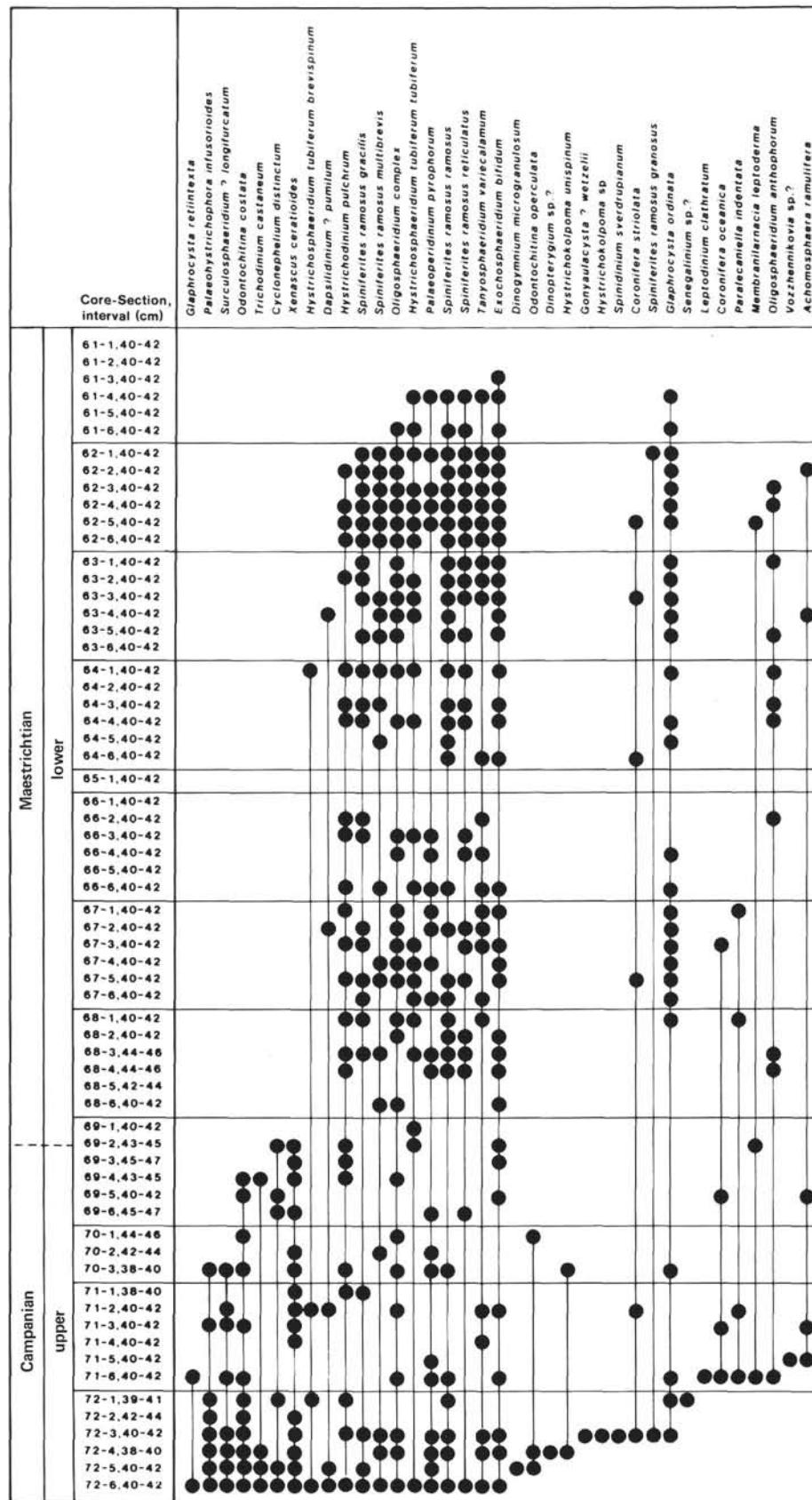


Figure 2. Range and distribution chart of dinoflagellate cysts recovered from Campanian to Maestrichtian sediments of Hole 612.

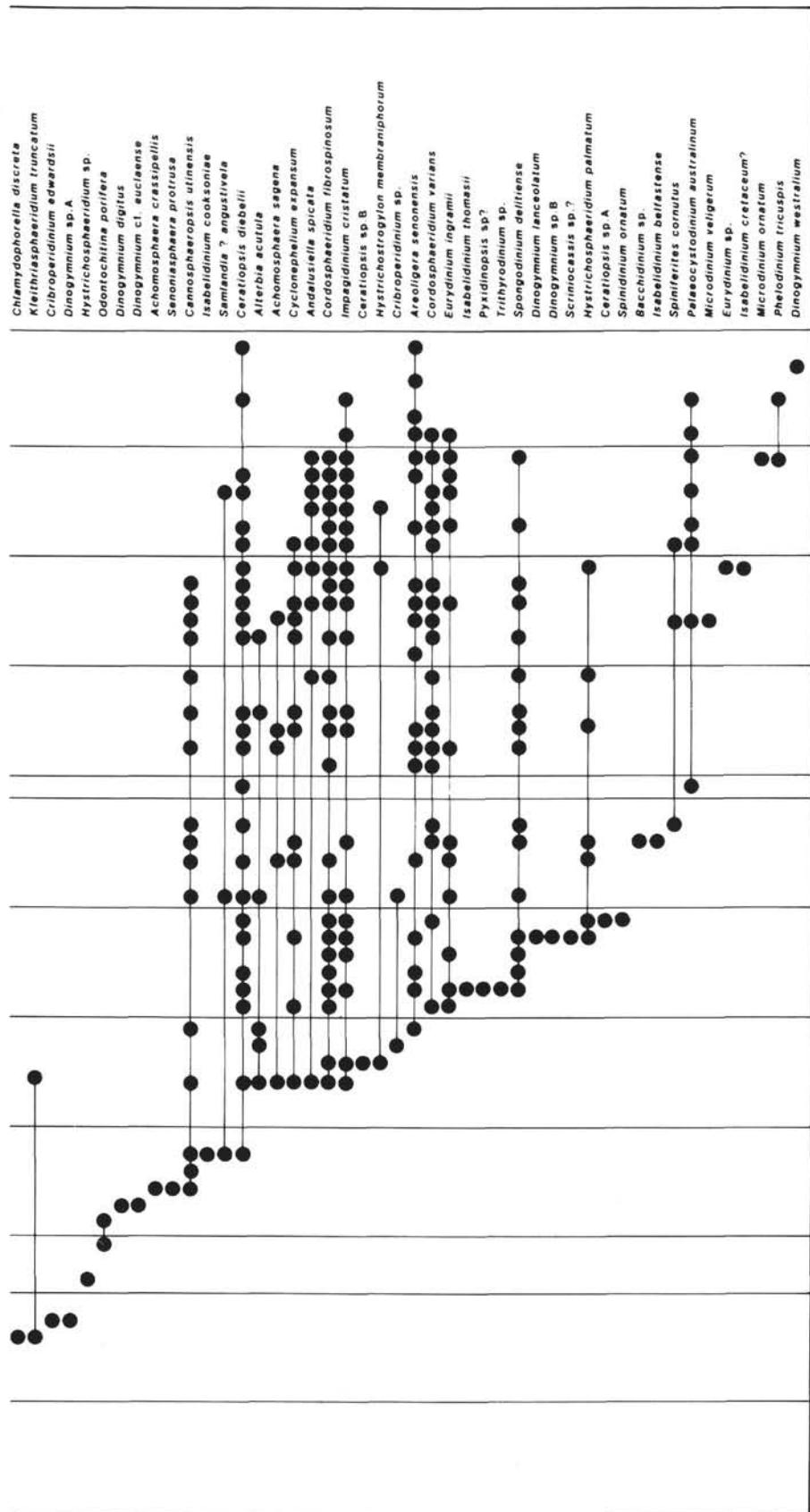


Figure 2 (continued).

- Impagidinium cristatum* (May, 1980) Lentin and Williams, 1981
Isabelidinium belfastense (Cookson and Eisenack, 1961) Lentin and Williams, 1977
Isabelidinium cooksoniae (Alberti, 1959) Lentin and Williams, 1977
Isabelidinium cretaceum? (Cookson, 1956) Lentin and Williams, 1977
Isabelidinium thomasi (Cookson and Eisenack, 1961) Lentin and Williams, 1977
Kleithriaspaeridium truncatum (Benson, 1976) Stover and Evitt, 1978
Leptodinium clathratum (Cookson and Eisenack, 1960) Sarjeant, 1969
Membranilarnacia leptoderma (Cookson and Eisenack, 1958) Eisenack, 1963
Microdinium ornatum Cookson and Eisenack, 1960
Microdinium veligerum (Deflandre, 1937) Davey, 1969
Odontochitina costata Alberti, 1961; emend. Clarke and Verdier, 1967
Odontochitina operculata (O. Wetzel, 1933) Deflandre and Cookson, 1955
Odontochitina porifera Cookson, 1956
Oligosphaeridium anthophorum (Cookson and Eisenack, 1958) Davey, 1969
Oligosphaeridium complex (White, 1842) Davey and Williams, 1966
Palaeocystodinium australinum (Cookson, 1965) Lentin and Williams, 1976
Palaeohystrichophora infusoriooides Deflandre, 1935
Palaeoperidinium pyrophorum (Ehrenberg, 1838) Sarjeant, 1967
Paralecaniella indentata (Deflandre and Cookson, 1955) Cookson and Eisenack, 1970; emend. Elsik, 1977
Phelodinium tricuspid (O. Wetzel, 1933) Stover and Evitt, 1978
Pyxidinopsis sp.?
Samlandia? angustivela (Deflandre and Cookson, 1955) Eisenack, 1963
Scrinicassis sp.?
Senegalium sp.?
Senoniasphaera protrusa Clarke and Verdier, 1967
Spinidinium ornatum (May, 1980) Lentin and Williams, 1981
Spindinium sverdrupianum (Manum, 1963) Lentin and Williams, 1973
Spiniferites cornutus (Gerlach, 1961) Sarjeant, 1970
Spiniferites ramosus (Ehrenberg, 1838) *gracilis* (Davey and Williams, 1966) Lentin and Williams, 1973
Spiniferites ramosus (Ehrenberg, 1838) *granosus* (Davey and Williams, 1966) Lentin and Williams, 1973
Spiniferites ramosus (Ehrenberg, 1838) *multibrevis* (Davey and Williams, 1966) Lentin and Williams, 1973
Spiniferites ramosus ramosus (Ehrenberg, 1838) Loeblich and Loeblich, 1966
Spiniferites ramosus (Ehrenberg, 1838) *reticulatus* (Davey and Williams, 1966) Lentin and Williams, 1973
Spongodinium delittense (Ehrenberg, 1838) Deflandre, 1936
Surculosphaeridium? longifurcatum (Firton, 1952) Davey et al., 1966
Tanyosphaeridium variecalatum Davey and Williams, 1966
Trichodinium castaneum (Deflandre, 1935) Clarke and Verdier, 1967
Trithyrodinium sp.
Vozzhennikovia sp.?
Xenascus ceratoides (Deflandre, 1937) Lentin and Williams, 1973

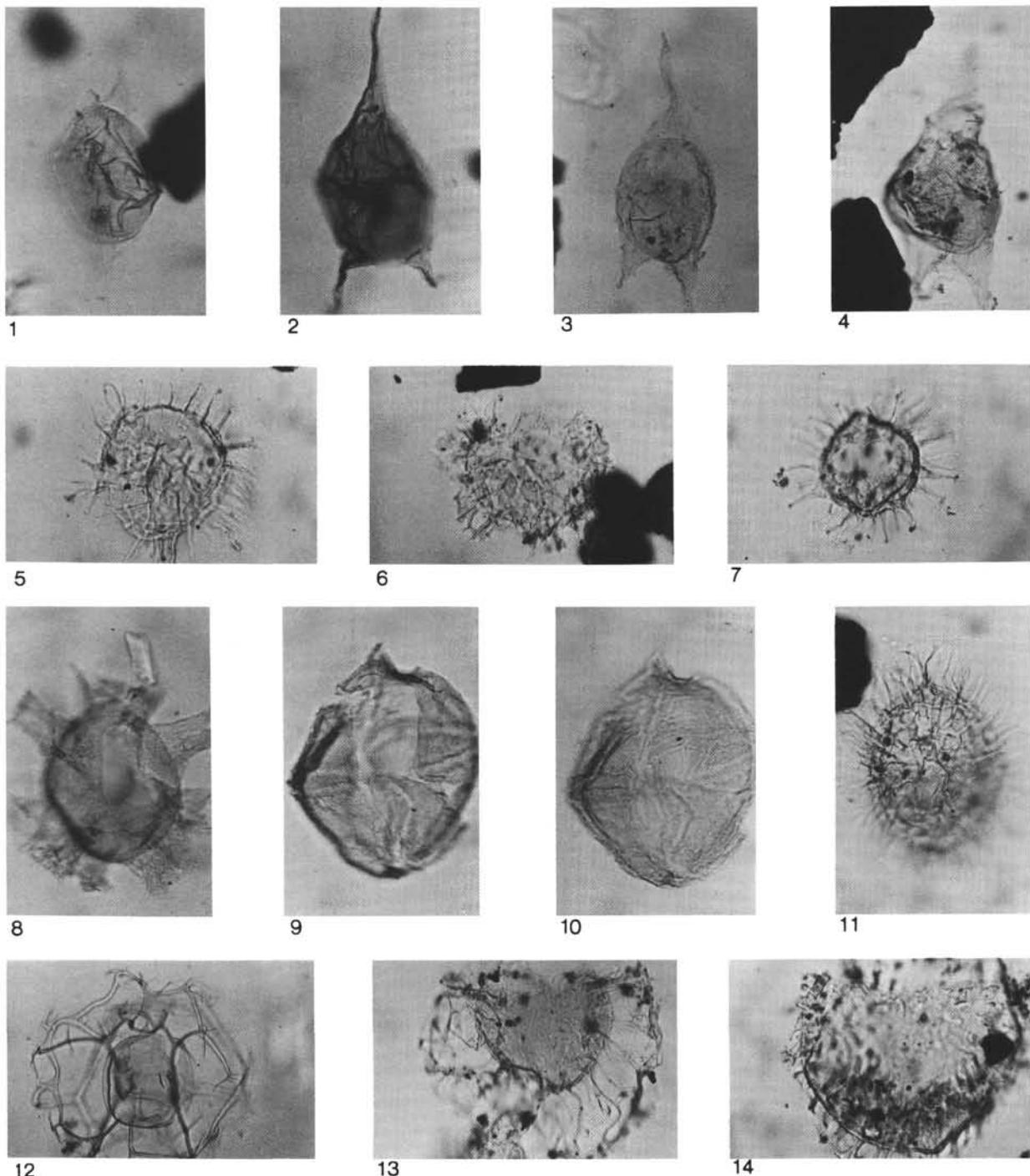


Plate 1. (Specimens photographed at $\times 400$ unless otherwise stated. All specimens photographed under normal transmitted light.) 1. *Andalusielia spicata* (May) Lentin and Williams, Sample 612-64-1, 40–42 cm. 2, 12. Sample 612-66-2, 40–42 cm, (2) *Ceratiopsis diebelii* (Alberti) Vozzhennikova, (12) *Cannosphaeropsis utinensis* O. Wetzel; emend. Duxbury. 3. *Ceratiopsis* sp. A, Sample 612-67-1, 40–42 cm. 4. *Ceratiopsis* sp. B, Sample 612-68-3, 44–46 cm. 5. *Coronifera oceanica* Cookson and Eisenack, Sample 612-67-5, 40–42 cm. 7. *Bacchidinium* sp.?, Sample 612-66-3, 40–42 cm, $\times 600$. 8. *Cordosphaeridium fibrospinosum* Davey and Williams, Sample 612-63-1, 40–42 cm. 9–10. *Cribroperidinium* sp. A, Sample 612-66-6, 40–42 cm. 11. *Coronifera striolata* (Deflandre) Stover and Evitt, Sample 612-71-2, 40–42 cm, $\times 600$. 13. *Gla phrocysta ordinata* (Williams and Downie) Stover and Evitt, Sample 612-61-1, 40–42 cm. 14. *Cyclonephelium distinctum* Deflandre and Cookson, Sample 612-69-5, 40–42 cm, $\times 600$.

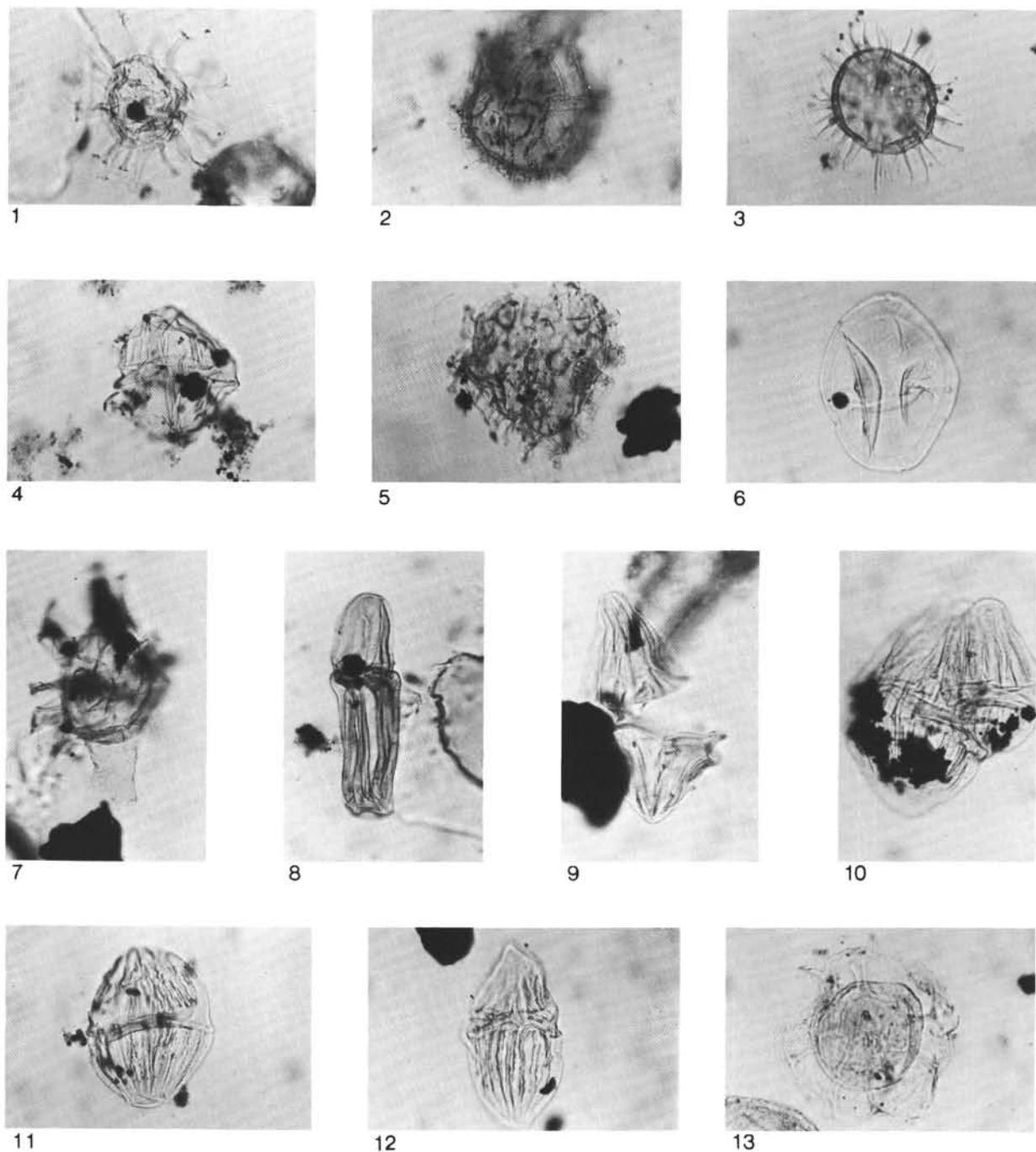


Plate 2. (Specimens photographed at $\times 600$ unless otherwise stated. All specimens photographed under normal transmitted light.) 1, 10. Sample 612-71-2, 40-42 cm, (1) *Dapsilidinium? pumilum* (Davey and Williams) Lentin and Williams, (10) *Dinogymnium* sp. B. 2. *Leptodinium clathratum* (Cookson and Eisenack) Sarjeant, Sample 612-71-6, 40-42 cm, $\times 400$. 3. *Exochosphaeridium bifidum* (Clarke and Verdier) Clarke et al., Sample 612-67-3, 40-42 cm, $\times 400$. 4, 8. Sample 612-69-2, 40-42 cm, (4) *Dinogymnium* cf. *euclaense* Cookson and Eisenack, (8) *Dinogymnium digitus* (Deflandre) Evitt et al. 5. *Glaophocysta retiintexta* (Cookson) Stover and Evitt, Sample 612-72-6, 40-42 cm $\times 400$. 6. *Eurydininium ingramii* (Cookson and Eisenack) Stover and Evitt, Sample 612-67-6, 40-42 cm. 7. *Hystrichokolpoma unispinum* Williams and Downie, Sample 612-72-3, 40-42 cm, $\times 400$. 9. *Dinogymnium microgranulosum* Clarke and Verdier, Sample 612-72-5, 40-42 cm. 11. *D. westralium* (Cookson and Eisenack) Evitt et al., emend. May, Sample 612-61-2, 40-42 cm. 12. *D. sp. A*, Sample 612-67-2, 40-42 cm. 13. *Membranilarnacia leptoderma* Cookson and Eisenack, Sample 612-69-2, 43-45 cm.

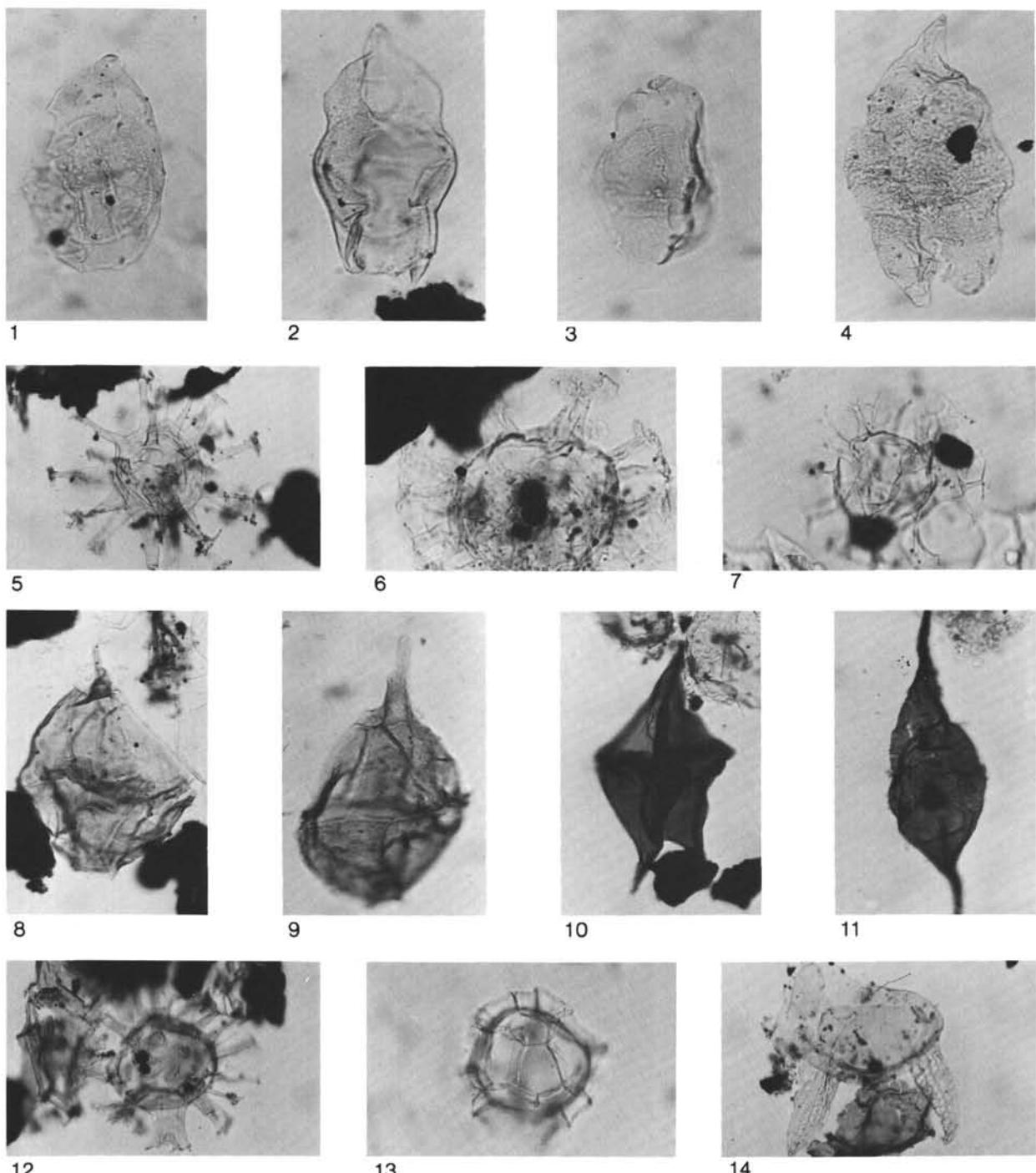


Plate 3. (Specimens photographed at $\times 400$ unless otherwise stated. All specimens photographed under normal transmitted light). 1. *Isabelidium belfastense* (Cookson and Eisenack) Lentin and Williams, Sample 612-66-3, 40–42 cm, $\times 600$. 2. *I. cooksoniae* (Alberti) Lentin and Williams, Sample 612-69-2, 43–45 cm, $\times 600$. 3, 13. Sample 612-63-1, 40–42 cm, $\times 600$, (3) *I. cretaceum?* (Cookson) Lentin and Williams, (13) *Impagidinium cristatum* (May) Lentin and Williams. 4. *I. thomasii* (Cookson and Eisenack) Lentin and Williams, Sample 612-67-2, 40–42 cm, $\times 600$. 5. *Hystrichosphaeridium tubiferum* (Ehrenberg) Deflandre; emend. Davey and Williams, Sample 612-72-6, 40–42 cm. 6. *H. sp.*, Sample 612-70-3, 38–40 cm. 7. *Hystrichostrogylion membraniphorum* Agelopoulos, Sample 612-68-3, 44–46 cm, $\times 600$. 8. *Gonyaulacysta?* *wetzelii* (Lejeune-Carpentier) Sarjeant, Sample 612-72-3, 40–42 cm. 9. *Cribroperidinium edwardsii* (Cookson and Eisenack) Stover and Evitt, Sample 612-71-2, 40–42 cm. 10, 12. Sample 612-61-2, 40–42 cm, (10) *Phelodinium tricuspidis* (O. Wetzel) Stover and Evitt, (12) *Kleithriaspheeridium truncatum* (Benson) Stover and Evitt. 11. *Palaeocystodinium australinum* (Cookson) Lentin and Williams, Sample 612-65-1, 40–42 cm. 14. *Odontochitina porifera* Cookson, Sample 612-69-6, 45–47 cm.

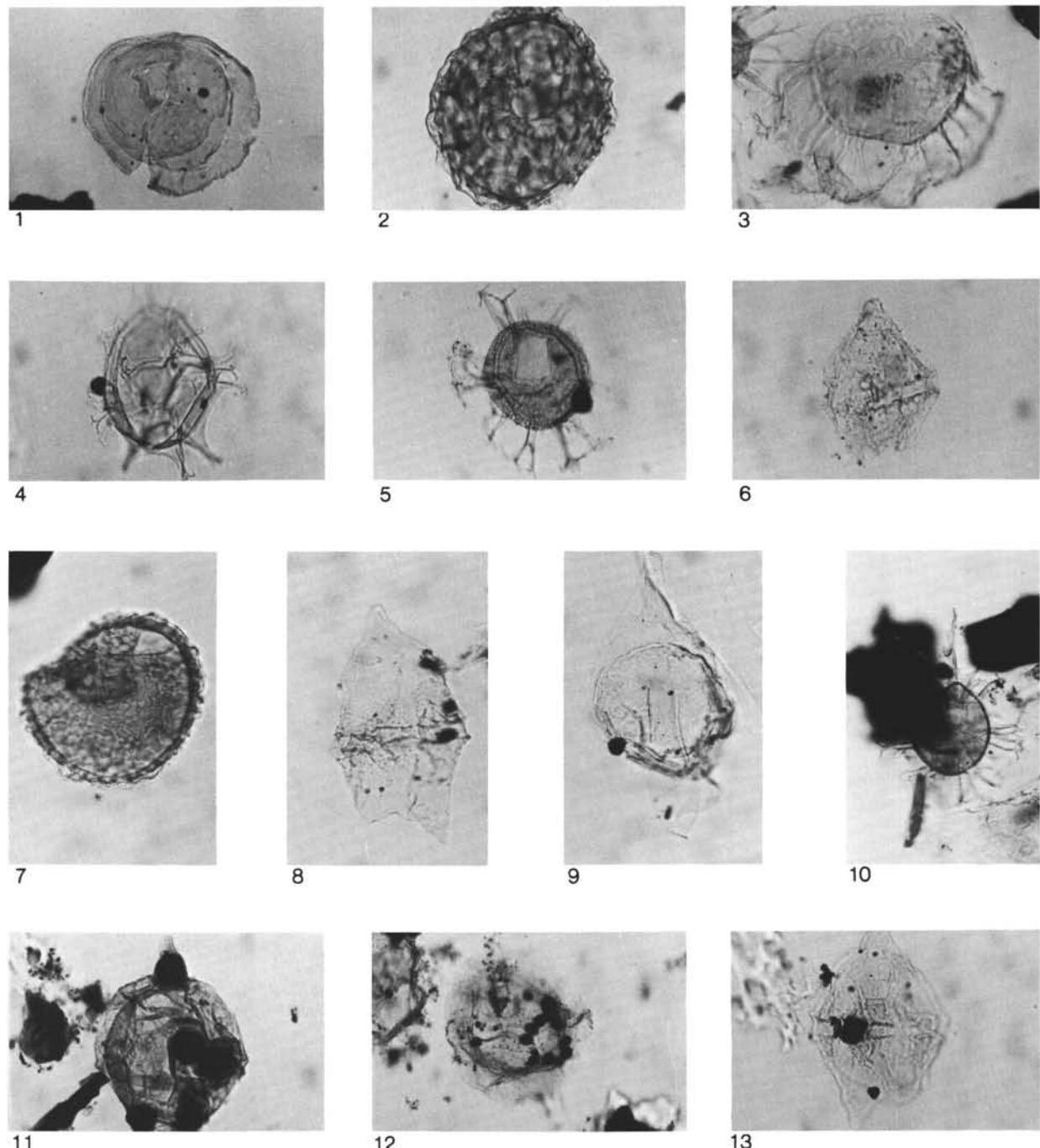


Plate 4. (Specimens photographed at $\times 600$ unless otherwise stated. All specimens photographed under normal transmitted light). 1. *Paralecaniella indentata* (Deflandre and Cookson) Cookson and Eisenack; emend. Elsik, Sample 612-71-2, 40–42 cm, $\times 400$. 2. *Samlandia? angustivela* (Deflandre and Cookson) Eisenack, Sample 612-69-2, 43–45 cm. 3. *Cyclonephelium expansum* Corradini, Sample 612-66-4, 40–42 cm, $\times 400$. 4, 7, 9. Sample 612-67-5, 40–42 cm, (4) *Spiniferites ramosus* (Ehrenberg) *multibrevis* (Davey and Williams) Lentin and Williams, (7) *Pyxidinopsis* sp.? (9) *Trityrodinium* sp. 5. *S. ramosus* (Ehrenberg) *reticulatus* (Davey and Williams) Lentin and Williams, Sample 612-69-1, 40–42 cm, $\times 400$. 6. *Spinidinium ornatum* (May) Lentin and Williams, Sample 612-67-1, 40–42 cm. 8. *Vozzhennikovia* sp.?, Sample 612-71-5, 40–42 cm. 10. *Spiniferites cornutus* (Gerlach) Sarjeant, Sample 612-63-4, 40–42 cm, $\times 400$. 11. *Senegaliniump* sp.?, Sample 612-72-1, 39–41 cm. 12. *Dinopterygium* sp.?, Sample 612-72-4, 38–40 cm. 13. *Spinidinium sverdrupianum* (Manum) Lentin and Williams, Sample 612-72-2, 42–44 cm.