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TAXONOMY OF UPPER JURASSIC — LOWER CRETACEOUS MICROPLANKTON FROM THE RICHARDSON MOUNTAINS, DISTRICT OF MACKENZIE, CANADA

W. W. Brideaux

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PREFACE

This report describes the occurrence and taxonomy of Late Jurassic and Early Cretaceous dinoflagellate cysts and acritarchs from two subsurface sections along the east flank of the Richardson Mountains west and southwest of Aklavik, District of Mackenzie. Two new genera and sixteen new species or new combinations are introduced.

Such detailed taxonomic studies form the foundation upon which is based the precise dating and correlation of rocks that make up the geological framework of Canada. Their ultimate effect is to contribute toward the inventory of energy resources available to Canada through their application to surface and subsurface stratigraphy.

Ottawa
September 30, 1976

D.J. McLaren,
Director General,
Geological Survey of Canada.

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Abstract

This paper describes the taxonomy and gives the known geologic ranges and distribution of 108 dinoflagellate and acritarch species in uppermost Jurassic and Lower Cretaceous rocks of northern Canada. The taxonomy is based on material from two subsurface sections located along the eastern flank of the Richardson Mountains, southwest of Aklavik and west-southwest of Fort McPherson, respectively, in the District of Mackenzie.

The following new taxa or new combinations are proposed: *Leptodinium modicum* subsp. *denticulatum* subsp. nov., *Canningia palliata* sp. nov., *Canningia spumosa* sp. nov., *"Canningia" turrita* sp. nov., *Tenua brevispinosa* (Pocock) comb. nov., *Fromea complicata* sp. nov., *Mendicodinium caperatum* sp. nov., *Palaeostomocystis expolita* sp. nov., *Palaeostomocystis triquetra* sp. nov., *Cleistosphaeridium araneosum* sp. nov., *Operculodinium? spinigerum* sp. nov., *Glabridinium apatelum* (Cookson and Eisenack) gen. et comb. nov., *Dimidiadinium dangeardii* (Sarjeant) gen. et comb. nov., *Dimidiadinium sphaerocephalum* (Vozzhennikova) gen. et comb. nov., *Dimidiadinium uncinatum* gen. et sp. nov. (type species), and *Muderongia asymmetrica* sp. nov.

Résumé

Cette étude décrit la taxonomie de 108 espèces de dinoflagellés et acritarques (acritarch) provenant des roches du Jurassique tout à fait supérieur et du Crétacé inférieur dans le nord du Canada; sont également indiqués, les emplacements géographiques et les niveaux stratigraphiques où ces espèces ont été reconnues. La taxonomie est établie à partir d'échantillons provenant de deux coupes du sous-sol situées respectivement le long du flanc est des chaînons Richardson, au sud-ouest d'Aklavik et à l'ouest-sud-ouest de Fort MacPherson, dans le district de Mackenzie.

Les nouveaux taxons ou nouvelles combinaisons proposées sont les suivants: *Leptodinium modicum* subsp. *denticulatum* subsp. nov., *Canningia palliata* sp. nov., *Canningia spumosa* sp. nov., *"Canningia" turrita* sp. nov., *Tenua brevispinosa* (Pocock) comb. nov., *Fromea complicata* sp. nov., *Mendicodinium caperatum* sp. nov., *Palaeostomocystis expolita* sp. nov., *Palaeostomocystis triquetra* sp. nov., *Cleistosphaeridium araneosum* sp. nov., *Operculodinium? spinigerum* sp. nov., *Glabridinium apatelum* (Cookson et Eisenack) gen. et comb. nov., *Dimidiadinium dangeardii* (Sarjeant) gen. et comb. nov., *Dimidiadinium sphaerocephalum* (Vozzhennikova) gen. et comb. nov., *Dimidiadinium uncinatum* gen. et sp. nov. (espèce type), et *Muderongia asymmetrica* sp. nov.

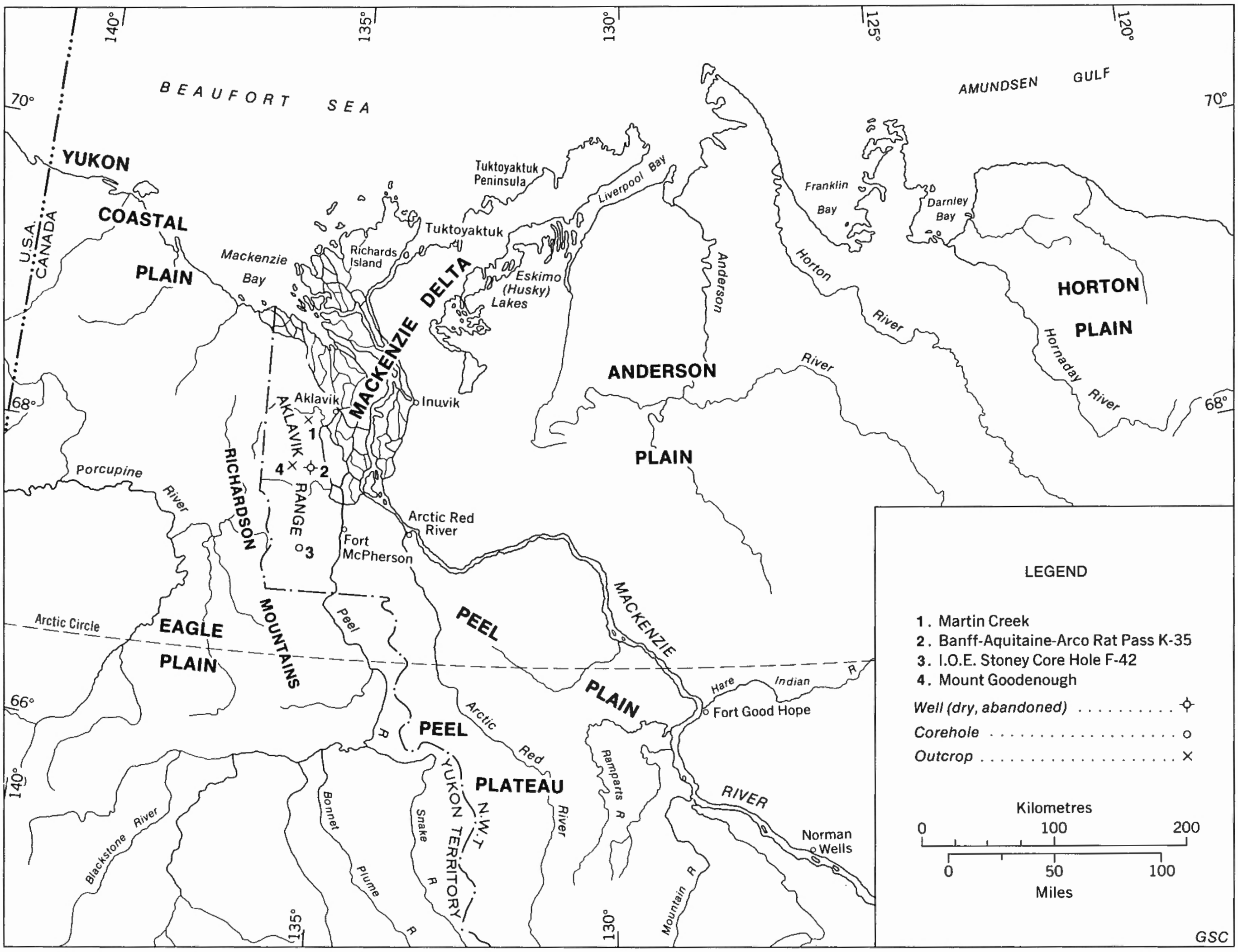

Figure 1. Location of sampled sections, Richardson Mountains region, District of Mackenzie.

TAXONOMY OF UPPER JURASSIC-LOWER CRETACEOUS MICROPLANKTON FROM THE RICHARDSON MOUNTAINS, DISTRICT OF MACKENZIE, CANADA

INTRODUCTION

The purpose of this paper is to make available a substantial body of taxonomy dealing with Upper Jurassic and Lower Cretaceous dinoflagellate cysts and acritarchs from the northern Canadian mainland. This taxonomy is basic to the development of a dinoflageliate zonation for the Upper Jurassic and Lower Cretaceous rocks of northern Canada. The taxonomy is based on material from two subsurface sections on the eastern flank of the Richardson Mountains in the northern District of Mackenzie (Fig. 1).

Stratigraphic ranges and occurrences in terms of lithologic units in the two sections are included for each species. The stratigraphic ranges are based on analyses of data to be published in a later paper (Brideaux, in prep.). That paper will relate the biostratigraphy of the species described herein to other published information on Upper Jurassic-Lower Cretaceous dinoflagellate assemblages from northern Canada (Johnson and Hills, 1973; Brideaux, 1975a, 1976b; Brideaux and Myhr, 1976; Brideaux and McIntyre, 1976; Brideaux and Fisher, 1976; Pocock, in press). Charts detailing the occurrences of species in the two sections are available in preliminary form (Brideaux, 1977).

The two subsurface sections sampled for this study are located along the eastern flank of the Richardson Mountains in the northern District of Mackenzie. The more northerly section is that penetrated by the Banff-Aquitaine-Arco Rat Pass K-35 well (Lat. 67°54'42.55"N, Long. 135°21'56.83"W) located 9.6 km (6 miles) southeast of Mount Goodenough and about 48 km (30 miles) southwest of Aklavik (Fig. 1). This well was drilled in 1970 to a total depth of 6004 feet (1830 m) and penetrated 1920 feet (585 m) of strata assigned a late Jurassic-Early Cretaceous age (Brideaux *in* Barnes *et al.*, 1974; Brideaux and Fisher, 1976), bottoming in rocks of Paleozoic age. The Mesozoic part of the section comprises the following lithologic units: the Albian shale-siltstone division equivalent (?0-?150 ft; ?0-?46 m); the Upper sandstone division equivalent (?150-?480 ft; ?46-?146 m); the Upper shale-siltstone division equivalent (?480-1690 ft; ?146-515 m); the Husky Formation (1690-1890 ft; 515-575 m); and an unnamed Upper Jurassic sandstone unit (1890-1920 ft; 576-585 m). These units probably are time and lithologic correlatives of surface lithologic divisions established by Jeletzky (1958, 1960, 1967).

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The samples from the Rat Pass K-35 well comprise cuttings and sidewall cores. The cuttings samples were processed by the Institute of Sedimentary and Petroleum Geology in Calgary, Alberta. Sidewall cores were processed by Atlantic Richfield Company (ARCO) in Dallas, Texas and slides made available for this investigation through the courtesy of Atlantic Richfield Canada Ltd. (ARCAN), Calgary. Sample intervals examined in this investigation and their positions relative to the lithologic units named above are given in Appendix 1.

The more southerly subsurface section is that penetrated by the IOE Stoney Core Hole F-42 well (Lat. 67°21'23"N, Long. 135°38'43"W) located along Stony Creek about 29 km (18 miles) west-southwest of Fort McPherson. This conventionally cored structure test hole was drilled in 1967 to a total depth of 1020 feet (311 m) and penetrated only Mesozoic (Upper Jurassic-Lower Cretaceous) strata. The section comprises the following units: the Albian shale-siltstone division equivalent (?0-?420 ft; ?0-?128 m); the Upper sandstone division equivalent (?420-?680 ft; ?128-?207m); the Upper shale-siltstone division equivalent (?680-940 ft; ?207-287 m); and the Husky Formation (940-1020 ft; 287-311 m). As in the Rat Pass K-35 well, these lithologic units probably are time and lithologic correlatives of surface divisions established by Jeletzky (1958, 1960, 1967). In both sections, uncertainty about the lithostratigraphic contacts is reflected in the queried depths for contacts between units.

CURATION OF MATERIALS

Cuttings samples and conventional core samples from sections used in this study are stored at the Institute of Sedimentary and Petroleum Geology. Palynologic slides prepared by the Institute and slides from sidewall cores prepared by ARCO (Dallas) that do not contain holotypes or figured specimens are stored in the collection of the Institute, 3303 - 33rd Street N.W., Calgary, Alberta, Canada T2L 2A7. Slides containing holotypes or figured specimens are stored in the collection of the Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8. All samples have been assigned Geological Survey of Canada location numbers (C-numbers).

ACKNOWLEDGMENTS

The writer thanks Atlantic Richfield Canada Ltd. (ARCAN) for the provision of slides prepared from sidewall cores from the Banff-Aquitaine-Arco Rat Pass K-35 well and acknowledges the kind permission of ARCAN and the Aquitaine Company of Canada to publish data from the study of that material. Discussions about the morphology and taxonomy of the species described, with J.K. Lentin (Dome Petroleum Limited, Calgary) and D.J. McIntyre (Union Oil of Canada Ltd., Calgary) were greatly appreciated.

The writer especially thanks E.J. Kidson (Amoco Production Company, Research Center, Tulsa, Oklahoma), T.T. Uyeno, W.A.M. Jenkins (I.S.P.G., Calgary) and G.L. Williams (Atlantic Geoscience Centre, Darmouth, Nova Scotia) for constructive reviews and critiques of the original manuscript and D.W. Myhr (formerly of I.S.P.G., Calgary, now with Husky Oil, Calgary) for provision of lithostratigraphic data. The excellent preparations of S. Pickering, E. O'Keefe and H. Johnson are the foundation for this work.

AGE DETERMINATIONS ON INVESTIGATED STRATA

The ages of the strata penetrated by these two wells have been discussed by Brideaux (*in* Barnes *et al.*, 1974) and Brideaux and Fisher (1976); both papers summarize earlier reports on age determinations in the two wells. Recent studies have resulted in revised age determinations which are given below.

Banff-Aquitaine-Arco Rat Pass K-35 well

0-70 ft (0-21 m)	Unknown; no samples
70-150 ft (21-46 m)	Early Cretaceous, Albian
150-630 ft (46-192 m)	Aptian
630-1530 ft (192-466.3 m)	Barremian
1530-1690 ft (466.3-515 m)	?Hauterivian
1690-1920 ft (515-585 m)	Late Jurassic, Late Oxfordian-Late Kimmeridgian

IOE Stoney Core Hole F-42

0-20 ft (0-6 m)	Unknown; no samples
20-420 ft (6-128 m)	Early Cretaceous, Early and Middle Albian
420-680 ft (128-207 m)	Aptian
680-860 ft (207-262 m)	Barremian
860-940 ft (262-286 m)	Hauterivian
940-970 ft (286-296 m)	Late Jurassic (samples unproductive)
970-1020 ft (296-311 m)	Late Jurassic, Late Oxfordian to Late Kimmeridgian

SYSTEMATIC PALYNOLOGY

The fossil dinoflagellate cysts described or recorded in this systematic treatment are grouped into the major gonyaulacacean, pseudoceratiacean and peridiniacean lineages and those of unknown lineage. Each of these lineages is treated in turn under the general headings of proximate, chorate and cavate cysts. Within these headings, taxa are treated in alphabetical order. The reasons for organizing the taxonomic section in this manner are discussed at length in Brideaux and McIntyre (1976, p. 18). The descriptive terminology employed in this paper is that used by Lentin and Williams (1976) and discussed and amplified by Evitt *et al.* (in press).

The following taxa are treated in this paper. They are in alphabetical order within the lineages and headings mentioned above, and follow in that order in the text. The numbers assigned to the taxa correspond to numbers on occurrence charts (Brideaux, 1977). For cuttings samples, first occurrence refers to the first appearance of a species below the top of the section.

LIST OF SPECIES

Division PYRRHOPHYTA Pasher

Class DINOPHYCEAE Pasher

Order PERIDINTALES Schütt

Proximate gonyaulacacean cysts

86 *Acanthaulax* sp. of Brideaux, this paper.

62 *Cribroperidinium muderongensis* (Cookson and Eisenack) Davey, 1969.

36 *Cribroperidinium orthoceras* (Eisenack) Davey, 1969.

79 *Gonyaulacysta* sp. cf. *G. cladophora* (Deflandre) Dodekova, 1967.

67 *Gonyaulacysta cretacea* (Neale and Sarjeant) Sarjeant, 1969.

64 *Gonyaulacysta episoma* Sarjeant, 1966.

65 *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant, 1966b.

100 *Gonyaulacysta hyalodermopsis* (Cookson and Eisenack) Sarjeant, 1969.

88 *Gonyaulacysta jurassica* (Deflandre) Norris and Sarjeant, 1965.

73 *Gonyaulacysta* sp. A of Brideaux, this paper.

104 *Leptodinium delicatum* (Davey) Sarjeant, 1969.

16 *Leptodinium modicum* subsp. *modicum* Brideaux and McIntyre, 1976.

71 *Leptodinium modicum* subsp. *denticulatum* subsp. nov.

4 *Lunatadinium dissolutum* Brideaux and McIntyre, 1973.

13 *Microdinium opacum* Brideaux, 1971.

23 *Microdinium spinosum* Brideaux and McIntyre, 1976.

105 *Prionodinium alaskense* Leffingwell and Morgan, 1976.

95 *Prionodinium alveolatum* Leffingwell and Morgan, 1976.

Proximate pseudoceratiacean cysts

2 *Batioladinium jaegeri* (Alberti) Brideaux, 1975b.

35 *Batioladinium micropodum* (Eisenack and Cookson) Brideaux, 1975b.

14 *Canningia aspera* Singh, 1971.

34 *Canningia* sp. cf. *C. colliveri* Cookson and Eisenack, 1960b.

40 *Canningia palliata* sp. nov.

25 *Canningia spumosa* sp. nov.

48 "*Canningia*" *turrita* sp. nov.

97 *Cyclonephelium compactum* Deflandre and Cookson, 1955.

46 *Cyclonephelium distinctum* Deflandre and Cookson, 1955.

57 *Eopseudoceratium* sp. cf. *E. gochtii* (Neale and Sarjeant) Lentin and Williams, 1973

51 *Pseudoceratium nudum* Gocht, 1957.

43 *Pseudoceratium retusum* sp. nov.

31 *Tenua brevispinosa* (Pocock) comb. nov.

91 *Tenus echinata* Gitmez and Sarjeant, 1972.

24 *Tenua hystrix* Eisenack, 1958.

81 *Tenua* sp. cf. *T. rioultii* Sarjeant, 1968.

39 *Tenua?* sp. B of Brideaux, this paper.

Proximate peridiniacean cysts

58 *Pareodinia* (spp.) Deflandre emend. Gocht, 1970.

90 *Pareodinia borealis* Brideaux and Fisher, 1976.

83 *Pareodinia capillosa* Brideaux and Fisher, 1976.

77 *Pareodinia ceratophora* Deflandre emend. Gocht, 1970.

Proximate unassigned cysts

12 *Dictyopyxidia imperfecta* Brideaux and McIntyre, 1976.

54 *Fromea amphora* Cookson and Eisenack, 1958.

93 *Fromea complicata* sp. nov.

26 *Mendicodinium caperatum* sp. nov.

89 *Hologinella spinosigibberosa* Brideaux and Fisher, 1976.

37 *Palaeostomocystis fragilis* Cookson and Eisenack, 1962a.

50 *Palaeostomocystis expolita* sp. nov.

56 *Palaeostomocystis triquetra* sp. nov.

Chorate gonyaulacacean cysts

94 *Achomosphaera neptunii* (Eisenack) Davey and Williams, 1966.

66 *Adnatosphaeridium* sp. A of Brideaux, this paper.

98 *Callaiosphaeridium asymmetricum* (Deflandre and Courteville) Davey and Williams, 1966.

45 *Cleistosphaeridium? aciculare* Davey, 1969.

15 *Cleistosphaeridium araneosum* sp. nov.

3 *Cleistosphaeridium multispinosum* (Singh) Brideaux, 1971.

41 *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey, 1969 subsp. *polypes*

22 *Cleistosphaeridium polypes* (Cookson and Eisenack) Davey subsp. *clavulum* Lentin and Williams, 1973.

107 *Cleistosphaeridium?* sp. BE of Brideaux, this paper.

106 *Conosphaeridium* sp. B of Brideaux, this paper.

75 *Cordosphaeridium eoinodes* (Eisenack) Eisenack, 1963.

78 *Coronifera oceanica* Cookson and Eisenack, 1958.

55 *Heslertonia heslertonensis* (Neale and Sarjeant) 1966a.

68 *Hystrichodinium* sp. of Brideaux, this paper.

74 *Hystrichokolpoma ferox* (Deflandre) Davey, 1969.

42 *Hystrichosphaeridium cooksonii* Singh, 1971.

108 *Hystrichosphaeridium costatum* Davey and Williams, 1966.

52 *Hystrichosphaeridium* sp. AE of Brideaux, this paper

61 *Hystrichosphaeridium* sp. BE of Brideaux, this paper.

82 *Lanterna saturnalis* Brideaux and Fisher, 1976.

28 *Oligosphaeridium albertense* (Pocock) Davey and Williams, 1966.

21 *Oligosphaeridium asterigium* (Gocht) Davey and Williams, 1966.

11 *Oligosphaeridium complex* (White) Davey and Williams, 1966.

96 *Oligosphaeridium* sp. cf. *Oligosphaeridium complex* (White) Davey and Williams, 1966.

76 *Oligosphaeridium nannum* Davey, 1974.

30 *Oligosphaeridium totum* Brideaux, 1971 subsp. *totum*

101 *Operculodinium? spinigerum* sp. nov.

69 *Prolixosphaeridium parvispinum* (Deflandre) Davey *et al.*, 1966.

8 *Spiniferites ramosus* (Ehrenberg) Mantell, 1854.

102 *Systematophora* sp. cf. *Systematophora complicata* Neale and Sarjeant, 1962.

44 *Systematophora schindewolfi* (Alberti) Downie and Sarjeant, 1965.

70 *Systematophora* sp. AE of Brideaux, this paper.

59 *Tanyosphaeridium* sp. A of Brideaux, 1971

103 *Tanyosphaeridium* sp. C of Brideaux and McIntyre, 1976.

60 *Tanyosphaeridium* sp. DE of Brideaux, this paper.

10 *Imbatodinium* sp. A of Brideaux and McIntyre, 1976.

Cavate gonyaulacacean cysts

9 *Chlamydophorella nyei* Cookson and Eisenack, 1958.

99 *Chlamydophorella* sp. AE of Brideaux, this paper.

18 *Endoscrinium campanula* (Gocht) Vozzhennikova, 1967.

87 *Endoscrinium luridum* (Deflandre) Gocht, 1970

20 *Gardodinium eisenackii* Alberti, 1961

Glabridinium apatelum (Cookson and Eisenack) comb. nov.

85 *Tubotuberella rhombiformis* Vozzhennikova, 1967 emend.

80 *Psaligonyaulax dualis* Brideaux and Fisher, 1976.

Dimidiadinium dangeardii (Sarjeant) gen. et comb. nov.

Dimidiadinium sphaerocephalum (Vozzhennikova) comb. nov.

49 *Dimidiadinium uncinatum* sp. nov.

84 *Scriniodinium crystallinum* (Deflandre) Klement, 1960.

72 *Sirmiodinium grossii* Alberti emend. Warren, 1973.

Cavate pseudoceratiacean cysts

33 *Muderongia asymmetrica* sp. nov.

38 *Muderongia tetracantha* (Gocht) Alberti, 1961.

5 *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson, 1955.

92 *Odontochitina* sp. of Brideaux, this paper.

19 *Senoniasphaera microreticulata* Brideaux and McIntyre, 1976.

Cavate peridiniacean cysts

6 *Palaeoperidinium cretaceum* (Pocock ex Davey) Lentin and Williams, 1976.

47 *Subtilisphaera perlucida* (Alberti) Jain and Millepied, 1973.

Unassigned cavate cysts

53 *Dingodinium cerviculum* Cookson and Eisenack, 1958.

63 *Wallodinium luna* (Cookson and Eisenack) Lentin and Williams, 1973.

Group ACRITARCHA

17 *Micrhystridium* sp. A of Brideaux and McIntyre, 1976.

7 *Pterospermopsis australiensis* Deflandre and Cookson, 1955

PROXIMATE GONYAULACEAN CYSTS

Genus *Acanthaulax* Sarjeant

1968 *Acanthaulax* Sarjeant, p. 227.

Acanthaulax sp. (86)

Plate 1, figure 1

Description.

Shape. Pericyst ambitus subcircular; maximum width at mid-line of cyst; apices rounded, with a short apical horn; slight dorso-ventral compression. Endocyst closely appressed.

Phragma. Periphragm 0.8μ thick, produced to form a dense spine cover, the spines simple and 1.0 to 2.5μ long, except up to 7.0μ long along the pericingulum.

Endophragm smooth, thin, less than 0.5μ thick.

Paratabulation. Paratabulation not observed.

Archeopyle/operculum. Archeopyle not developed.

Pericingulum/perisulcus. Pericingulum indicated indistinctly by two rows of longer spines flanking a strip devoid of spines; perisulcus not observed.

Dimensions. (1 specimen) - Cyst length, 95μ; cyst width, 85μ; apical horn length, 12.5μ.

Comparison. The specimen is similar to *Acanthaulax* sp. 2 of Johnson and Hills, 1973, reported from Lower Oxfordian rocks in the Sverdrup Basin, but lacks the spine tuffs on the apical horn. The apical horn on the specimen, however, is not well preserved.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Genus *Cribroperidinium* Neale and Sarjeant emend. Davey

1962 *Cribroperidinium* Neale and Sarjeant, p. 443.

1969 *Cribroperidinium* Neale and Sarjeant emend. Davey, p. 125.

Cribroperidinium muderongensis (Cookson and Eisenack) Davey (62)

Plate 1, figure 5

1958 *Gonyaulax muderongensis* Cookson and Eisenack, p. 32, Pl. 3, figs. 3, 4.

1969 *Gonyaulacysta muderongensis* (Cookson and Eisenack) Davey, p. 128.

Discussion. Specimens recorded during this investigation compare favourably with those described by Cookson and Eisenack (1958). The northern Canadian specimens possess an apical cap on the apical horn (likely a pre-apical paraplate), an intratabular sculpture on the periphragm composed of small, spiny processes and low, irregular apiculate ridges, a laevorotatory pericingulum displaced about two pericingular widths, and a size range that compares closely with material described by Cookson and Eisenack (1958).

Dimensions. (20 measured specimens, many more observed) - Pericyst length, 95-150μ; pericyst width, 70-110μ; length of apical horn, 20-37μ.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores (Barremian) and cuttings (first occurrence, Barremian).

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Hauterivian of Roumania (Baltes, 1965) and the Aptian and ?Neocomian of Australia (Cookson and Eisenack, 1958).

Cribroperidinium orthoceras (Eisenack) Davey (36)

1958 *Gonyaulax orthoceras* Eisenack, p. 388, Pl. 21, figs. 3-11, Pl. 24, fig. 1.

1969 *Cribroperidinium orthoceras* (Eisenack) Davey, p. 128.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian to Aptian.

Recorded previously from Valanginian to Turonian rocks of England, Europe, Australia and Canada by many authors including Eisenack (1958), Gocht (1959), Alberti (1961), Baltes (1965, 1967) and Singh (1971).

Genus *Gonyaulacysta* Deflandre ex Norris and Sarjeant emend. Sarjeant

1964 *Gonyaulacysta* Deflandre, p. 5.

1965 *Gonyaulacysta* Deflandre; Norris and Sarjeant, p. 65.

1969 *Gonyaulacysta* Deflandre ex Norris and Sarjeant emend. Sarjeant *in* Davey *et al.*, p. 7.

Gonyaulacysta sp. cf. *G. cladophora* (Deflandre) Dodekova (79)

cf. 1938 *Gonyaulax cladophora* Deflandre, p. 173, Pl. 7, figs. 1-5, Textfigs. 5, 6.

cf. 1967 *Gonyaulacysta cladophora* (Deflandre) Dodekova, p. 17, Pl. 2, figs. 2-8.

1976 *Gonyaulacysta* sp. cf. *G. cladophora* (Deflandre) Dodekova; Brideaux and Fisher, p. 18, Pl. 1, figs. 1-3, 7.

Occurrence. Rat Pass K-35: unnamed Upper Jurassic sandstone, sidewall core; Upper Oxfordian to Lower Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Middle to Upper Kimmeridgian.

Closely comparable species (*see* Brideaux and Fisher, 1976) (as *Gonyaulacysta cladophora*) recorded from strata of Bajocian to Kimmeridgian age (Deflandre, 1938; Valensi, 1953; Klement, 1960; Sarjeant, 1961; Dodekova, 1967).

Gonyaulacysta cretacea (Neale and Sarjeant) Sarjeant (67)

Plate 1, figure 3

1962 *Gonyaulax cretacea* Neale and Sarjeant, p. 441, Pl. 19, figs. 1, 2, Textfig. 2.

1969 *Gonyaulacysta cretacea* (Neale and Sarjeant) Sarjeant, p. 9

Discussion. The writer finds considerable difficulty in distinguishing *Gonyaulacysta cretacea* from *G. helicoidea*. The two species may be synonymous; further comment on this is reserved for a later paper (McIntyre and Brideaux, in prep.).

Dimensions. (3 measured specimens) - Pericyst length, 58-65μ; pericyst width, 43-55μ.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Hauterivian of England (Neale and Sarjeant, 1962).

Gonyaulacysta episoma Sarjeant (64)

Plate 1, figure 2

1966a *Gonyaulacysta episoma* Sarjeant, p. 118, p. 13, figs. 9, 10, Textfig. 27.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Barremian of England (Sarjeant, 1966b) and the Middle and Upper Albian of central Alberta, Canada (Singh, 1971).

Gonyaulacysta helicoidea (Eisenack and Cookson) Sarjeant (65)

Plate 1, figure 6

1960 *Gonyaulax helicoidea* Eisenack and Cookson, p. 2, Pl. 1, figs. 4, 9.

1966a *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant, p. 116.

Dimensions. (7 measured specimens) - Pericyst length, 49-60μ; pericyst width, 40-46μ.

Occurrence. Banff-Aquitaine-Arco Rat Pass K-35 well: Upper shale-siltstone division equivalent, sidewall cores; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Lower Barremian of England (Sarjeant, 1966a), the Aptian of Australia (Eisenack and Cookson, 1960), the Middle Albian of west-central Alberta (Singh, 1971) and the Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Gonyaulacysta hyalodermopsis (Cookson and Eisenack) Sarjeant (100)

Plate 1, figure 4

1958 *Gonyaulax hyalodermopsis* Cookson and Eisenack, p. 34, Pl. 3, figs. 11, 12, Textfigs. 5, 6.

1966a *Gonyaulacusta hyalodermopsis* (Cookson and Eisenack) Sarjeant, p. 131 (*non. nud.*)

1969 *Gonyaulacysta hyalodermopsis* (Cookson and Eisenack) Sarjeant, p. 10.

Dimensions. (3 measured specimens) - Pericyst length, 60-68μ; length of apical horn, 8-16μ; pericyst width, 55-58μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores; Barremian.

Recorded previously from the upper Neocomian and Aptian of West Australia (Cookson and Eisenack, 1958), from the Berriasian to Hauterivian of the Sacramento Valley, California, U.S.A. (Warren, 1967), and from the Middle Albian of the Anderson Plain, northern Canadian mainland (Brideaux and McIntyre, 1976).

Gonyaulacysta jurassica (Deflandre) Norris and Sarjeant (88)

1938 *Gonyaulax jurassica* Deflandre, p. 168, Pl. 6, figs. 2-5, Textfigs. 1, 2.

1965 *Gonyaulacysta jurassica* (Deflandre) Norris and Sarjeant, p. 65.

Dimensions. (1 measured specimen) - Pericyst length, 100μ; pericyst width, 55μ.

Discussion. One poorly preserved specimen was observed in a population of generally well preserved cysts. This suggests that the specimen is derived.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Recorded previously from Bathonian to Upper Kimmeridgian rocks in England, Europe, European Russia, Greenland, the U.S.A., India and Australasia (*see* Sarjeant, 1972) and from Callovian to Oxfordian rocks in the Canadian Arctic Archipelago (Johnson and Hills, 1973; Brideaux and Fisher, 1976).

Gitmez and Sarjeant (1972) record only a few specimens from Middle and Upper Kimmeridgian zones, the last appreciable numbers occurring in the Lower Kimmeridgian *autissiodoriensis* zone. Brideaux and Fisher (1976) report the species as rare occurrences from the Middle and Upper Kimmeridgian *Buchia-mosquensis-Buchia piochii* sensu lato zones on the northern Canadian mainland. The latter occurrence probably is derived as may be the occurrence recorded by Gitmez and Sarjeant (1972). It is probable that the upper limit of the range of this species is Lower Kimmeridgian, possibly basal Middle Kimmeridgian (cf. Brideaux and Fisher, 1976, Fig. 13).

Gonyaulacysta sp. A

Plate 1, figure 7

Description.

Shape. Pericyst ambitus subcircular to ovoid; the apex produced to form a short, notched apical horn; antapex rounded; dorso-ventral compression slight. Endocyst closely appressed to pericyst. Pericoel not developed.

Phragma. Periphragm about 1μ thick, punctate, bearing small, scattered intratabular apiculate sculptural elements about 0.5μ high and densely spaced, parasutural apiculate elements.

Endophragm of similar thickness; surface smooth.

Paratabulation. Parasutural apiculate elements on the periphragm denote a paratabulation of ?4', 6'', 6c, 5'''-?6''', ?1p, 1''''; paratabulation determined with difficulty on a given specimen, particularly in apical and antapical regions. Evidence for paratabulation on endophragm not noted.

Archeopyle/operculum. Archeopyle formed by loss of the third precingular paraplate. Operculum simple, free, rounded-trapezoidal in shape and longer than broad.

Formula. P.

Pericingulum/perisulcus. Pericingulum helicoid, displaced one pericingular width (5-7μ); six cingular paraplates denoted by densely spaced parasutural rows of apiculate elements. Perisulcus visible as a shallow, S-shaped depression, narrow anteriorly on the epicyst, broadening posteriorly on the hypocyst, widest just before termination at the antapex.

Other features. Periphragm of an amorphous consistency, affected by maceration; often degraded, obscuring details of paratabulation.

Dimensions. (7 measured specimens) - Pericyst length, 70-85μ; pericyst width, 62-70μ; length of apical horn, 6-8μ.

Comparison. *Gonyaulacysta nuciformis* (Deflandre) Sarjeant, 1968, p. 227 is very coarsely granular and thick walled. *Gonyaulacysta palla* Sarjeant, 1966a, p. 113, Plate 13, figures 3, 4, Textfigure 24, has paraplates denoted by very short spines arising from low ridges and, as well, seven postcingular paraplates. *Gonyaulacysta episoma* Sarjeant, 1966a, p. 118, Plate 13, figures 9, 10, Textfigure 27, has thin parasutural spinelets connected distally by trabeculum.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian and ?Aptian; cuttings (first occurrence, Barremian).

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Leptodinium* Klement
emend. Sarjeant *in* Davey *et al.*

1960 *Leptodinium* Klement, p. 45.

1966a *Leptodinium* Klement emend. Sarjeant, p. 133.

1967 *Leptodinium* Klement emend. Wall, p. 104.

1969 *Leptodinium* Klement emend. Sarjeant *in* Davey *et al.*, p. 11.

Leptodinium delicatum (Davey) Sarjeant (104)

1969 *Gonyaulacysta delicata* Davey, p. 123, Pl. 1, figs. 7, 8, 10A, P.

1969 *Leptodinium delicatum* (Davey) Sarjeant *in* Davey *et al.*, p. 12.

Dimensions. (4 measured specimens) - Pericyst length, 46-50μ; pericyst width, 43-46μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Recorded previously from Cenomanian strata of Saskatchewan (Davey, 1969) and from Middle Albian rocks (Horton River Formation) of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Leptodinium modicum Brideaux and McIntyre
subsp. *modicum* (16)

Plate 1, figure 8

Holotype. GSC No. 34147, Slide 34147, Slide P851-2A, 32.6 x 117.0; Horton River Formation, Section CR14A-68, 6.1-9.1 m (20-30 ft), GSC loc. C-8533; Middle Albian.

Diagnosis. *See* Brideaux and McIntyre, 1976, p. 22.

Dimensions. (23 measured specimens) - Pericyst length, 38-55μ; pericyst width, 33-50μ. Known pericyst length, 38-65μ; known pericyst width, 33-58μ.

Occurrence. Banff-Aquitaine-Arco Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores; Barremian; cuttings (first occurrence, Barremian).

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Recorded previously from Middle Albian rocks (Horton River Formation) of the Anderson Plain, northern Canadian mainland (Brideaux and McIntyre, 1976).

Leptodinium modicum Brideaux and McIntyre subsp. *denticulatum* subsp. nov. (71)

Plate 1, figures 10, 11

Holotype. GSC No. 45967, ARCO slide 10612-A2, 26.3 x 123.7; Banff-Aquitaine-Arco Rat Pass K-35 well, Upper shale-siltstone division equivalent, sidewall core at 1445 feet (440.4 m) depth, GSC loc. C-12619; Barremian. Pericyst length, 52μ; pericyst width, 42μ (excluding parasutural septa).

Diagnosis.

Shape. Pericyst nearly equidimensional to slightly longer than broad, the outline subcircular, ovoid, occasionally somewhat pentagonal; apical and antapical horns lacking.

Endocyst as above, the two layers closely appressed; no pericoel development; compression dorso-ventral, if any.

Phragma. Periphragm about 1μ thick, smooth or scabrate, forming parasutural septa up to 5μ high; the septa entire-margined but with discrete distal marginal spinules 0.5 to 1.5μ high, or serrate and with or without spinules; occasional intratabular spinules present, up to 1μ high.

Endophragm about 1μ thick and smooth.

Paratabulation. Periphragm forming parasutural crests denoting a paratabulation of 4', 6'', 6c, 5''', ?1p, 1''''; folding of the phragma distorting the shape of the paraplates.

Endophragm showing no evidence of paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of precingular paraplate 3''. Operculum simple, free, somewhat horseshoe shaped, slightly longer than broad; the two layers closely appressed and separating as a unit.

Formula. P.

Pericingulum/perisulcus. Helicoid pericingulum about 5μ wide and displaced one to one and one-half pericingular widths; six cingular paraplates; perisulcal region in places obscured by folding of the phragma, perisulcus extending about halfway onto the epicyst and terminating posteriorly near the antapex, inclined to the left.

Dimensions. (20 measured specimens) - Pericyst length, 45-65μ; pericyst width, 42-57μ.

Comparison. *Leptodinium modicum* subsp. *denticulatum* nov. differs from *Leptodinium modicum* subsp. *modicum* in the possession of serrate or denticulate parasutural crests.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Lunatadinium* Brideaux and McIntyre

1973 *Lunatadinium* Brideaux and McIntyre, p. 396.

Lunatadinium dissolutum Brideaux and McIntyre (4)

1973 *Lunatadinium dissolutum* Brideaux and McIntyre, p. 396, Pl. 1, figs. 1-13.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents, Husky Formation and an unnamed Upper Jurassic sandstone unit; Upper Oxfordian to Middle Kimmeridgian (cuttings), Middle Kimmeridgian-Albian (sidewall cores and cuttings).

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Previously recorded from the Aptian to Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), from various surface and subsurface Hauterivian to Middle Albian strata from the northern Canadian mainland (Brideaux and McIntyre, 1973), from strata of the Valanginian Blue-grey shale division (Jeletzky, 1961, p. 13, 14; Brideaux, unpubl.), along Martin Creek, Aklavik Range, District of Mackenzie and from Tithonian to Valanginian strata of the Sacramento Valley, California, U.S.A. (Warren, 1967); known confirmed range, Upper Kimmeridgian to Middle Albian.

Genus *Microdinium* Cookson and Eisenack

1960a *Microdinium* Cookson and Eisenack, p. 6.

Microdinium opacum Brideaux (13)

1971 *Microdinium opacum* Brideaux, p. 76, Pl. 21, figs. 19-21, Textfig. 7d, e.

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, Upper shale-siltstone division equivalents, cuttings (first occurrence, Aptian) and Husky Formation and unnamed sandstone unit, cuttings (caved); Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Albian shale-siltstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from Aptian to Middle Albian rocks of central Alberta, Canada and the northern Canadian mainland (Brideaux, 1971; Brideaux and

McIntyre, 1976) and doubtfully from the Lower Cretaceous (Barremian to Aptian) of Czechoslovakia (Vavrdova, 1964).

Microdinium spinosum Brideaux and McIntyre (23)

1976 *Microdinium spinosum* Brideaux and McIntyre, p. 23, Pl. 6, figs. 3-5.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, cuttings; Barremian.

Stoney Core Hole F-42: Albian shale-siltstone division, conventional core; Middle Albian.

Recorded previously from the Middle Albian Horton River Formation of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Genus *Prionodinium* Leffingwell and Morgan

in press *Prionodinium* Leffingwell and Morgan.

Prionodinium alaskense Leffingwell and Morgan (105)

Plate 1, figures 9, 12, Plate 2, figures 1-3

in press *Prionodinium alaskense* Leffingwell and Morgan.

Description.

Shape. Pericyst ovoid, the length twice the width, the maximum width at the latitude of the paracingulum; apical and antapical horns absent. Endocyst shape as above, closely appressed to pericyst, no development of pericoel; lateral compression.

Phragma. Periphragm thin, about 0.5μ thick; smooth to microrugulate intratabularly, forming parasutural crests 3-5μ high; crests distally serrate, occasionally ragged and often bearing discrete spinules up to 1.0μ long, surface of crests microgranulate to microrugulate.

Endophragm smooth, about 1.0μ thick.

Paratabulation. Parasutural crests denote a paratabulation of 4', 6'', 6c, 5''', 1p, 1''''; of the apical paraplates, 1' is diamond-shaped and 2' is the largest; of the precingular paraplates, 1'' is triangular and 3'' is tongue-shaped and twice as long as broad; other precingular and postcingular paraplates are elongate, with 5''' being smaller and trapezoidal; paraplate 1p is quadrate.

Endophragm shows no evidence of paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of the third precingular paraplate. Operculum simple, free; tongue-shaped, occasionally found in endocoel; the two layers closely appressed and separating as a unit.

Formula. P.

Pericingulum/perisulcus. Helicoid pericingulum from 4-6μ wide and offset one width, with six cingular paraplates; perisulcus long and narrow, extending anteriorly halfway up the epicyst and posteriorly the length of the hypocyst; the lateral compression precluding observation of perisulcal details.

Dimensions. (7 measured specimens) - Pericyst length, 55-64μ; pericyst depth (lateral compression), 32-41μ.

Comparison. *Prionodinium alaskense* is superficially similar to *Herendeenia pisciformis* (Cookson and Eisenack) Wiggins, 1969 but lacks the apical horn of that species and differs in possessing four apical paraplates, six precingular paraplates and five postcingular paraplates. *Prionodinium alaskense* differs from another superficially similar form, *Clathroctenocystis elegans* Wiggins, 1972, p. 303, Plate II, figures A-C, Plate III, figures A-D, and Figure 3, in possession of a precingular archeopyle and absence of an apical horn.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores; ?Hauterivian to Barremian.

Prionodinium alveolatum Leffingwell and Morgan (95)

Plate 2, figures 4, 5

in press *Prionodinium alveolatum* Leffingwell and Morgan.

Description.

Shape. Pericyst outline distinctly longer than broad; maximum width at the latitude of the pericingulum; tapering little at apices; apical and antapical horns absent.

Endocyst outline as for the pericyst; pericoel absent; slight dorso-ventral compression.

Phragma. Periphragm smooth, thin, ±1μ thick, projecting to form parasutural septa; septa up to 10μ high with entire, serrate or strongly denticulate margins, perforated, the lumina varying from 1-5μ in maximum diameter and of irregular shape; confluence of septa in apical region producing an apical prominence but no true apical horn.

Endophragm smooth, thin, about 1μ thick, closely appressed to periphragm; no pericoel developed.

Paratabulation. Parasutural septa denote a paratabulation of ?4', 6'', 6c, 5'''-?6''', 1p, 1''''; precingular and postcingular paraplates elongate; folding of septa in apical region obscures apical paraplate series. Evidence of paratabulation on endocyst not noted.

Archeopyle/operculum. Peri- and endarcheopyle formed by the loss of the precingular paraplate 3''. Peri- and endoperculum simple and free, horseshoe-shaped, the layers separating as a unit.

Formula. P.

Pericingulum/perisulcus. Pericingulum 6-8μ wide, outlined by perforated parasutres displaced from one and one-half to two pericingular widths; six cingular paraplates. Perisulcus extending from the middle of the epicyst, terminating near the antapex; narrow anteriorly, widening posteriorly, assuming a sigmoid outline inclined to the left; bounded by perforated septa.

Dimensions. (5 measured specimens) - Pericyst length, 62-69μ; pericyst width, 36-40μ.

Comparison. *Carpodinium granulatum* Cookson and Eisenack, 1962a, p. 489, Plate 1, figures 6-10 and *C. obliquicostatum* Cookson and Hughes, 1964, p. 48, Plate 6, figures 1-6 differ in possessing granular or grooved intratabular ornamentation respectively. Both species possess a pronounced apical prominence and neither species possesses perforated parasutural crests. *Clathroctenocystis elegans* Wiggins, 1972, p. 303, Plate 2A-C, Plate 3A-D, and Figure 3 possesses an apical horn and apical archeopyle.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

PROXIMATE PSEUDOCERATIACEAN CYSTS

Discussion. The genera, *Batioladinium*, *Canningia*, *Cyclonephelium*, *Pseudoceratium* and *Tenua* are treated under this heading. *Muderongia*, *Odontochitina* and *Senoniasphaera* are treated later in this paper under the heading cavate pseudoceratiacean cysts. Wall and Evitt (1975) argue convincingly that *Canningia*, *Cyclonephelium* and *Tenua* do not belong to the ceratioid lineage, but rather to a gonyaulacinian lineage, an *Areoligera-Cyclonephelium* complex, closely realted to the ceratioid lineage. *Batioladinium* also does not belong to the ceratioid lineage, but Wall and Evitt (1975) do not postulate its position. Considering the characteristics outlined by Wall and Evitt (1975) for ceratioid genera, it is also likely that *Senoniasphaera* does not belong to the ceratioid lineage. However, the eight genera mentioned above are treated under the pseudoceratiacean grouping in this paper for convenience and in the absence of a more refined general classification. Development of such a classification is beyond the scope of this paper.

Genus *Batioladinium* Brideaux

1975b *Batioladinium* Brideaux, p. 1241 (June, 1975).

1975 *Necrobroomea* Wiggins, p. 111 (July, 1975)

(*See* Brideaux, 1975b for further synonymy).

Discussion. *Necrobroomea* Wiggins, 1975 appeared in Geoscience and Man, v. 11, the date of publication being given as April 25th, 1975. However, in a letter to the writer, acting editor, Ruth B. Hubert, established that no copies of this volume were available to the public before July 23rd, 1975, and that there was no prior distribution of the volume. Hence, under Article 29 of the International Code of Botanical Nomenclature (Stafleu *et al.*,1972), valid publication of *Necrobroomea* was effected after valid publication of *Batioladinium*. As the diagnoses of the two genera are essentially the same, *Batioladinium* has priority and *Necrobroomea* must be considered a junior synonym.

Batioladinium jaegeri (Alberti) Brideaux (2)

1961 *Broomea jaegeri* Alberti, p. 26, Pl. 5, figs. 1-7.

1975b *Batioladinium jaegeri* (Alberti) Brideaux, p. 1240, 1241, Figs. 1-3.

1975 *Necrobroomea jaegeri* (Alberti) Wiggins, p. 111.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Recorded previously from Hauterivian to Albian rocks of Germany, France and England (*see* Brideaux and McIntyre, 1976; Brideaux, 1975b), from the Upper Albian and? Lower Cenomanian of England (Cookson and Hughes, 1964), and as derived? material in Santonian and Campanian strata of the Anderson Plain region, northern Canadian mainland (McIntyre, 1974).

Batioladinium micropodum
(Eisenack and Cookson) Brideaux (35)

Plate 2, figure 7

1960 *Broomea micropoda* Eisenack and Cookson, p. 7, Pl. 2, figs. 8, 9.

1974 *"Broomea" micropoda* Eisenack and Cookson; Davey, p. 64, Pl. 7, figs. 6-8.

1975b *Batioladinium micropodum* (Eisenack and Cookson) Brideaux, p. 1240.

1975 *Necrobroomea micropoda* (Cookson and Eisenack) Wiggins, p. 111.

non Batioladinium jaegeri (Alberti) Brideaux (as *"Broomea" jaegeri*); Davey, 1974, p. 64.

Discussion. Davey (1974, p. 64) places *Batioladinium jaegeri* (Alberti) Brideaux (as *"Broomea" jaegeri* Alberti) in synonymy with *Batioladinium micropodum* (Eisenack and Cookson) Brideaux (as *"Broomea" micropoda*). The present author believes these species to be separate (*see* Brideaux, 1975b). Davey (1974) mentions a thick complex periphragm formed of fused granules joined to the endophragm by long rods. This structure does not occur in the periphragm of *Batioladinium jaegeri*.

Some specimens recovered from conventional core in the Stoney Core Hole F-42 possess an apical archeopyle of the type commonly observed in *B. jaegeri*. The operculum is simple and free, formed of the apical paraplate series, and includes the apical horn.

Dimensions. (12 measured specimens) - Pericyst length, 75-108μ; pericyst width, 32-48μ; apical horn (8 specimens), 12-17μ.

Occurrence. Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Aptian.

Recorded previously from the Barremian of England (Davey, 1974), the Aptian type sections in France (Davey and Verdier, 1974) and the Aptian and Albian of Australia (Eisenack and Cookson, 1960). The occurrence in the Albian of the Paris Basin, attributed to Davey and Verdier (1971) by Davey and Verdier (1974, Textfig. 8), refers to *Batioladinium jaegeri* and not *B. micropodum*.

Genus *Canningia* Cookson and Eisenack

1960b *Canningia* Cookson and Eisenack, p. 251.

Canningia aspera Singh (14)

Plate 2, figures 6, 8, 9

1971 *Canningia aspera* Singh, p. 322, Pl. 50, fig. 1.

Dimensions. (55 measured specimens) - Overall length (20 complete specimens), 83-110μ; overall width, 58-105μ.

Discussion. The specimens referred in this paper to *Canningia aspera* Singh show a wide variety of periphragm ornament, ranging from the irregularly shaped elevations topped with conical elements described by Singh (1971) to sculptural elements consisting of stout spines, bipartite spines and bacula to bifid elements, 1-5μ high, either discrete or arising from irregular non-tabular ridges. The size range of the species is considerably widened. The variation encountered is to be expected, as Singh (1971) based his species description on four specimens. Other features of the species are essentially as Singh (1971) described them.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents, sidewall cores and cuttings, Hauterivian to Albian; Husky Formation and unnamed Upper Jurassic sandstone unit, cuttings, probably caved, Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents, conventional core; Hauterivian-Middle Albian.

Recorded previously from the Middle Albian of west-central Alberta, Canada (Singh, 1971).

Canningia sp. cf. *C. colliveri* Cookson and Eisenack (34)

Plate 2, figure 10

cf. 1960b *Canningia coliveri* Cookson and Eisenack, p. 251, Pl. 38, figs. 3, 4.

1962 *Palaeoperidinium caulleri (sic)* Pocock, p. 80, Pl. 14, fig. 224 *auct. non Palaeoperidinium caulleryi* Deflandre [=*Diconodinium caulleryi* (Deflandre) Deflandre].

Dimensions. (13 measured specimens) - Pericyst length, 66-113μ; pericyst width, 58-87μ.

Discussion. The dimensions of specimens recorded in this study show greater variation and are generally less than those recorded by Cookson and Eisenack (1960b) and Singh (1971). Other morphological characters are similar.

Examination of the figured specimen, called *Palaeoperidinium caulleri* by Pocock (1962, p. 80, Pl. 14, fig. 224), has established that it is a specimen referrable to *Canningia* sp. cf. *C. colliveri* which is folded at the apex.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores and cuttings; Hauterivian? to Barremian.

Stoney Core Hole F-42: Albian shale-siltstone division and Upper sandstone division equivalents, conventional core; Aptian to Lower Albian.

Similar forms recorded previously (as *Canningia colliveri*) from the Aptian and ?older rocks of Australia (Cookson and Eisenack, 1960b; Eisenack and Cookson, 1960) and the Aptian of France (Davey and Verdier, 1974), the Lower Cretaceous (?Aptian and Albian) of Western Canada (Pocock, 1962), the Neocomian-Albian of Australia (Burger, 1973), the Albian of Alberta, Canada (Singh, 1971) and the Paris Basin (Davey and Verdier, 1971), the Albian and Cenomanian of France and Switzerland (Davey and Verdier, 1973), and a doubtful attribution from the Cenomanian to Santonian of the Isle of Wight (Clarke and Verdier, 1967).

Canningia palliata sp. nov. (40)

Plate 3, figures 1-8

Holotype. GSC No. 45976, Slide P770-42A, 13.5 x 119.2; Upper shale-siltstone division equivalent, I.O.E. Stoney Core Hole F-42, conventional core, 770-775 feet (234.7-236.2 m), GSC loc. C-10722; Barremian. Pericyst length, 77μ; pericyst width, 75μ.

Diagnosis.

Shape. Pericyst ambitus ovoid to ovoid-pentagonal; the apex produced into a short, rounded apical prominence; the antapex rounded or with development of one or two antapical prominences, of the two, the left one larger; maximum width occurring at the latitude of the pericingulum.

Endocyst closely appressed to the pericyst except at the antapex where expression of antapical endocyst prominences may be less strongly developed, forming one or two antapical pericoels; dorso-ventral compression.

Phragma. Periphragm discontinuous, consisting of a reticulate to imperfect rugulo-reticulate meshwork; the muri low, 0.5μ high and 1-2μ wide, and bearing baculate, bifid or simple projections, 1-3μ high; the lumina irregularly shaped, up to 5μ in maximum diameter.

Endophragm scabrate, 1.5-2.0μ thick.

Paratabulation. Operculum, archeopyle outline and development of accessory parasutures in the precingular paraplate series denotes a paratabulation of 4', 6'', c, x''', ?p on both pericyst and endocyst.

Archeopyle/operculum. Archeopyle formed by the loss of the four apical paraplates. Operculum simple and free, occasionally remaining partly attached ventrally, the two layers separating as a unit.

Formula. A.

Pericingulum/perisulcus. Pericingulum indistinctly represented by reduction of periphragm on some specimens, but generally not represented; perisulcal position indicated by reduction or absence of periphragm; perisulcus offset and inclined left to right, terminating at the antapex.

Dimensions. (14 measured specimens) - Overall length (2 complete specimens), 74-77μ; overall width, 65-95μ; length of incomplete specimens, 62-83μ.

Comparison. Canningia palliata sp. nov. differs from *Canningia reticulata* Cookson and Eisenack, 1960b, p. 258, Plate 38, figures 1, 2, in that the periphragm does not show evidence of paratabulation; it differs from *Cyclonephelium vannophorum* Davey, 1969, p. 168, Plate 9, figure 3, Plate 11, figures 11, 12 and Textfigure 16E, in that the periphragm is reduced only in the parasulcal region, and the processes arising from the reticulate periphragm are baculate to bifid rather than fan-shaped and complex.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Canningia spumosa sp. nov. (25)

Plate 3, figures 9-14

Holotype. GSC No. 45980, Slide P770-21C, 37.4 x 120.6, Albian shale-siltstone division equivalent, I.O.E. Stoney Core Hole F-42, 310-320 feet (94.6-97.6 m), conventional core, GSC loc. C-10703; Albian. Pericyst length, 63μ; pericyst width, 58μ.

Diagnosis.

Shape. Pericyst ambitus ovoid to rounded; pericyst profile ovoid, the apex produced into a short, rounded apical horn, 3-4μ long, the antapex rounded and without developed prominences.

Endocyst as above, the two layers closely appressed. Pericoel not developed; slight dorso-ventral compression.

Phragma. Periphragm from 1.0-1.5μ thick in optical section, fibrous structure formed of thin, rod-shaped pore canals and intervening solid periphragm, the pores opening as puncta on the surface; periphragm surface sculptured with discrete grana, cones, bacula or spines from 1-3μ high and about 1μ wide, sculpture set occasionally on low vermiculate or vermiculoreticulate ridges less than 0.5μ high and wide.

Endophragm thin, less than 0.5μ thick and smooth.

Paratabulation. Paratabulation of 4', 6'', 0c, ?''', ?p, denoted by shape of the archeopyle and the isolated opercula, and by development of accessory parasutures in the precingular paraplate series; other evidence for paratabulation lacking.

Endophragm showing no evidence of paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of four apical paraplates. Operculum simple, attached on the holotype specimen at the boundary of the parasulcal region and the posterior margin of the paraplate 1', otherwise apparently free; the two layers closely appressed and separating as one unit.

Formula. Aa? or A.

Pericingulum/perisulcus. No expression of pericingulum; perisulcal position indicated only by position of the perisulcal notch.

Dimensions. (8 measured specimens) - Pericyst length, 63μ (1 specimen); pericyst width, 40-70μ.

Discussion. The operculum was observed attached only on the holotype specimen. Other specimens may have strongly developed accessory parasutures in the precingular paraplate series. It is possible, therefore, that mechanical destruction of the tenuous connection between the operculum and the rest of the periblast has occurred.

Comparison. Canningia spumosa sp. nov. superficially resembles *Canningia circularis* Cookson and Eisenack, 1971, p. 219, Plate 8, figure 6, but differs in being smaller and in having a fibrous periphragm with variable sculpture of grana, coni, bacula, or spines.

Occurrence. Stoney Core Hole F-42: ?Upper sandstone division equivalent, conventional core; Aptian.

"*Canningia*" *turrita* sp. nov. (48)

Plate 4, figures 1-9

Holotype. GSC No. 45983, Slide P770-43B, 45.8 x 125.0, Upper shale-siltstone division equivalent, I.O.E. Stoney Core Hole F-42, conventional core, 780-785 feet (237.9-239.4 m), GSC loc. C-10723; Barremian. Overall length (archeopyle developed), 42μ; overall width, 50μ.

Diagnosis.

Shape. Pericyst apex not observed; antapex rounded or with left antapical prominence developed.

Endocyst as above, the two layers closely appressed and without pericoel development; dorso-ventral compression.

Phragma. Periphragm thin, less than 1.0μ thick; the surface scabrate, or with scattered grana or coni less than 1.0μ high.

Endophragm thin, less than 0.5μ thick and smooth.

Paratabulation. Paratabulation of 4?', ?(1-3)a, 7", 0c, ?"', ?"", ?p, denoted by the shape of the archeopyle and accessory parasutures in the precingular paraplate series; other evidence for paratabulation lacking.

Endophragm showing no evidence of paratabulation.

Archeopyle/operculum. Archeopyle interpreted as being formed by the loss of at least three apical paraplates (probably 2'-4') and one or three intercalary paraplates (1a or 1a-3a). Operculum free, never observed; the two layers probably separating as a unit.

Formula. 3A + ? I.

Pericingulum/perisulcus. Surface expression of pericingulum not observed on periphragm; some specimens possessing slight invaginations of the profile at mid-latitudes interpreted as representing the position of the pericingulum; no surface expression of perisulcus on periphragm.

Dimensions. (32 measured specimens) - Overall length, complete specimens not observed, 37-55μ; overall width, 34-55μ.

Discussion. The projecting tongue of the epicyst is interpreted as representing apical paraplate 1' because of its shape and position in relation to the shape of the archeopyle opening. Well-preserved and suitably oriented specimens (*see* Pl. 4, figs. 1-3, 7-9) indicate that seven precingular paraplates are present. The shape of the archeopyle opening indicates that intercalary paraplates are also present, possibly three in number. The operculum is thus formed of apical paraplates and probably includes one to three intercalary paraplates. The archeopyle of *Canningia* Cookson and Eisenack is formed by the loss of four apical paraplates. The new species, *turrita*, is, therefore, only provisionally assigned to *Canningia* until further information and confirmation of the interpreted paratabulation are discovered. Should the interpretation prove correct, then a new genus would have to be erected.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Cyclonephelium* Deflandre and Cookson emend. Cookson and Eisenack

1955 *Cyclonephelium* Deflandre and Cookson, p. 285.

1962a *Cyclonephelium* Deflandre and Cookson emend. Cookson and Eisenack, p. 493.

Cyclonephelium compactum Deflandre and Cookson (97)

1955 *Cyclonephelium compactum* Deflandre and Cookson, p. 285, Pl. 2, figs. 11-13.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Recorded previously from the Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), the Middle and Upper Albian of Alberta (Brideaux, 1971), and the Albian to Senonian? of Australia (Deflandre and Cookson, 1955; Cookson and Eisenack, 1958). Sarjeant (1967b, Table VII) cites a range of Aptian to Campanian, however Millioud *et al*. (1975, Chart 2) cite a range of Aptian to Cenomanian for this species.

Cyclonephelium distinctum Deflandre and Cookson (46)

1955 *Cyclonephelium distinctum* Deflandre and Cookson, p. 285, Pl. 2, fig. 14, Textfigs. 47, 48.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

Recorded previously from Aptian to Middle Albian strata from the Anderson Plain region, northern Canadian mainland, Cenomanian to Santonian strata of the Atlantic continental margin (Williams and Brideaux, 1975; Jenkins *et al*., 1974), and from Cretaceous and Lower Paleocene rocks in various parts of the world (*see* Brideaux and McIntyre, 1976).

Genus *Eopseudoceratium* Lentin and Williams

1973 *Eopseudoceratium* Lentin and Williams, p. 54.

Eopseudoceratium sp. cf. *E. gochtii* (Neale and Sarjeant) Lentin and Williams (57)

Plate 5, figure 4

1962 *Pseudoceratium (Eopseudoceratium) gochtii* Neale and Sarjeant, p. 446, Pl. 20, figs. 3, 4, Textfig. 4.

1973 *Eopseudoceratium gochtii* (Neale and Sarjeant) Lentin and Williams, p. 54.

Dimensions. (1 measured specimen) - Pericyst width, 55μ.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from putative Barremian rocks in the Gulf Mobil Parsons N-10 well (Brideaux and Myhr, 1976; Brideaux, 1976b), northern Canadian mainland.

Genus *Pseudoceratium* Gocht

1957 *Pseudoceratium* Gocht, p. 166.

Pseudoceratium nudum Gocht (51)

Plate 5, figure 3

1957 *Pseudoceratium? nudum* Gocht, p. 168, Pl. 18, figs. 3, 4, 6.

Discussion. Specimens observed in the northern Canadian mainland range in total length from 160 to 245μ, but are otherwise similar to those described by Gocht (1957).

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core, Barremian; cuttings (first occurrence, Barremian).

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

Pseudoceratium retusum sp. nov. (43)

Plate 4, figures 10-12;
Plate 5, figures 1, 2, 5-10

1962 *Pseudoceratium pelliferum auct. non* Gocht; Pocock, p. 79, Pl. 14, figs. 215-218.

1971 *Pseudoceratium pelliferum auct. non* Gocht; Singh, p. 374, Pl. 66, fig. 1

Holotype. GSC No. 45987, Slide P784-26d, 37.7 x 129.8; Upper shale-siltstone division equivalent, Banff-Aquitaine-Arco Rat Pass K-35 well, cuttings, 1140-1150 feet (347.5-350.5 m), GSC loc. C-12610; Barremian. Overall length, 100μ; overall width, 82μ; apical horn length, 25μ; postcingular horn length, 10μ.

Diagnosis.

Shape. Pericyst ambitus asymmetrical, the left-hand ambitus rounded and with a distinct apical horn and a less prominent antapical horn; the right-hand ambitus somewhat triangular and produced into a short, rounded post-cingular horn and, at the antapex, a faint right antapical bulge; pericyst length greater than width.

Endocyst closely appressed to periblast and of similar shape. Pericoel not developed; compression dorso-ventral.

Phragma. Periphragm less than 1.0μ thick, smooth or scabrate surface; periphragm produced to form variously shaped sculpture elements which are discrete or linked basally and/or distally, which are nonparatabular or occasionally distinctly parasutural in position, the basal linkages persistent enough to form what may be termed parasutures; intertabular sculpture commonly linked basally to form an anastomosing network, or passing into a reticulate pattern; where the reticulum is reduced in the interior of the paraplate, commonly assuming a penesutural position; individual sculpture elements are generally bifid or bifurcate, but may be spatulate, fan-shaped or acicular; distal linkage of elements at the apices of the horns in places forming a canopy-like structure; reduction of the sculpture elements may occur ventrally and dorsally on the central parts of the hypotract; sculpture element length typically 3-5μ but up to 8μ at the apices.

Paratabulation. Basal linkage of sculpture elements forming parasutural crests denoting the presence of four apical paraplates; archeopyle outline and occasional penesutural alignment of sculpture indicating presence of six precingular paraplates; paratabulation of hypocyst not determinable.

Archeopyle/operculum. Apical archeopyle formed by the loss of four apical paraplates; operculum simple, formed of the four apical paraplates, and free, but sometimes remaining partly attached or appressed to the remaining part of the cyst.

Formula. A.

Pericingulum/perisulcus. Pericingulum, on some specimens, indistinctly outlined by rows of sculpture flanking a barren area, position of sulcal notch and its relation to the ventral area of reduced or absent sculpture, indicating the approximate position of the perisulcus.

Variation. Greatest reduction of sculpture occurs in the interior of paraplates, especially on the precingular paraplates; sculpture remains most prominent at the anterior margins, less so at the lateral margins of these paraplates; the dorsal and ventral barren regions are variably developed and may be indicated only by slight reduction in the density of the sculpture; these barren areas are scabrate to granular in the absence of major sculptural elements.

Dimensions. (63 measured specimens) - Length of 17 complete specimens, 93-120μ; length of 46 specimens with archeopyle, 63-93μ width (including the post-cingular horn), 68-98μ; apical horn length, 14-25μ.

Discussion. The specimens illustrated by Pocock (1962, Pl. 14, figs. 215-218) and the specimen illustrated by Singh (1971, Pl. 66, fig. 1) belong to the newly proposed species, *Pseudoceratium retusum.* The material figured by Singh (1964, Pl. 20, figs. 5, 6) as *Pseudoceratium pelliferum auct. non* Gocht belongs neither to that species nor to *Pseudoceratium retusum* sp. nov., but rather to *Aptea eisenackii* (Davey) Davey and Verdier, 1974.

Comparison. Pseudoceratium retusum sp. nov. differs from *Pseudoceratium pelliferum* Gocht in possessing broader based and rounded apical, post-cingular and antapical horns, in development of dorsal and ventral reduction of ornament and in development on most specimens of the canopy-like fusion of sculpture at the apices of the horns.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores, Barremian; cuttings (first occurrence, Aptian).

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian to Aptian.

Recorded previously from the Aptian? and Lower and Middle Albian [*see* discussion under *Tenua brevispinosa* (Pocock) comb. nov.] of Alberta (Pocock, 1962), and a single reworked? specimen from the Middle Albian of central Alberta (Singh, 1971).

Genus *Tenua* Eisenack

1958 *Tenua* Eisenack, p. 410.

Discussion. See the comments on this genus in Brideaux and McIntyre (1976).

Tenua brevispinosa (Pocock) comb. nov. (31)

Plate 6, figures 1-5

1962 *Palaeohystrichophora brevispinosa* Pocock, p. 81, Pl. 14, figs. 222, 223.

1976 *Tenua* sp. A Brideaux and McIntyre, p. 25, Pl. 6, figs. 14-16.

Holotype. GSC Plant Type No. 14358, Imperial Oil Slide 3087-4, 40.0 x 131.3, McMurray Formation, "calcareous" member, Imperial Virginia Hills 6-36-63-12W5M, core, 5675-5676 feet (1729.7-1730.0 m); Middle or Lower Albian. Pericyst length, 122μ; pericyst width, 107μ. [Pocock (1962, p. 89) gives the age of the sample as Late Barremian. However, Mellon and Wall (1963) and Mellon (1967) give the age of the "calcareous" member as Middle Albian (*Beaudanticeras* zone). The dinoflagellate assemblage associated with the holotype was re-examined by the present writer (*see* Appendix 2). Based on data contained in Brideaux and McIntyre (1976) and this paper, the sample could be as old as late Aptian and as young as Early Albian. The evidence suggests that the age of the sample is younger than that given by Pocock (1962)].

Diagnosis.

Shape. Overall shape of pericyst pentagonal, but somewhat asymmetrical, the left side of the hypocyst being more prolonged than the right side; basic outline interrupted by prominent indentation at the antapex and pronounced prominences at the latitude of the pericingulum; apex on complete specimens produced into an apical prominence; antapical prominences equal or unequal in length, the left antapical prominence always the longer where unequal; the left cingular prominence more pronounced than the right.

Endocyst as above, the two layers closely appressed and without pericoel development; dorso-ventral compression.

Phragma. Periphragm thin, about 1μ thick, produced to form spines, pila and spatulate to bifid sculpture elements which, rarely, are connected basally; sculpture reduced in the perisulcal region and, on some specimens, the intratabular part of the precingular and apical paraplates; sculpture developed most strongly at the latitude of the paracingulum and penesuturally on the precingular and apical paraplates; variably developed otherwise; sculpture elements 3-6μ long and 1-2μ in maximum width.

Endophragm about 1-1.5μ thick and smooth.

Paratabulation. Paratabulation of 4', 6'', 0c, ?5''', ?1'''', ?p, denoted by the shape of the archeopyle, penesutural concentration of sculpture elements on the apical, precingular and to some extent post-cingular paraplates, and the development of accessory parasutures in the precingular paraplates.

Endophragm showing no evidence of paratabulation except development of accessory parasutures.

Archeopyle/operculum. Archeopyle formed by the loss of the four apical paraplates; the margin of the archeopyle strongly angular. Operculum simple and usually free, but partly attached ventrally on some specimens; the two layers separating as a unit.

Formula. A.

Pericingulum/perisulcus. Pericingulum outlined on many specimens by parallel rows of sculpture elements on the periphragm; pericingulum sinistral, displaced from one and one-half to two widths; the width 6-8μ; perisulcal position defined by a reduction or absence of sculpture elements on the hypocyst, the perisulcal path slanted from left to right below the offset perisulcal notch, and terminated at the antapex.

Variation. Development of the periphragm sculpture shows considerable variation from specimen to specimen. Similarly, indication of paratabulation by penetabular sculpture varies considerably. Pericingular prominences are considerably pronounced on some specimens compared to others.

Dimensions. (8 measured specimens) - Pericyst length (2 complete specimens), 120, 123μ, other specimens (with archeopyle developed), 77-93μ; pericyst width, 95-120μ. Known pericyst length, 120-130μ; known pericyst width, 77-115μ.

Comparison. *Tenua brevispinosa* (Pocock) comb. nov. is distinguished from all published species of the genus by its well-developed pericingular prominences together with the variable and distinctive periphragm sculpture and sculpture arrangement.

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, cuttings; Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division and Upper sandstone division equivalents, conventional core; Aptian to Lower Albian.

Pocock (1962, p. 81) lists the distribution of this species as the Garbutt Formation citing a late Barremian to Aptian age. However, Pocock (1962, Table, ad. p. 28) indicates that the species is common in the "quartz sand" (Ellerslie Member) and "calcareous" members of the McMurray Formation and in the Upper Mannville. The Garbutt Formation occurs stratigraphically below formations of Middle Albian age (*Gastroplites* zone) and is considered correlative with the lower part of the Buckinghorse Formation and with the Moosebar Formation (McLearn and Kindle, 1950; Stott, 1968) which are considered to be Middle Albian (Mellon, 1967). Stott (1968) notes that the Garbutt Formation does not yield macrofossils and may be older than Albian in its basal part. Mellon and Wall (1963) and Mellon (1967) indicate that the "quartz sand" and higher units and the Upper Mannville are of Early to Middle Albian age (*Cleoniceras* and *Beaudanticeras* zones). Hence, the range of this species as recorded by Pocock (1962) must be considered as Lower and Middle Albian, possibly Aptian. Brideaux and McIntyre (1976) record the species in Aptian to Middle Albian strata in the Anderson Plain region of the northern Canadian mainland. Williams (1975, Pl. 2, fig. 3 only) records this species as *Cyclonephelium attadalicum* from the Aptian of the Scotian Shelf, offshore eastern Canada.

Tenua echinata Gitmez and Sarjeant (91)

Plate 6, figure 6

1972 *Tenua echinata* Gitmez and Sarjeant, p. 190, Pl. 1, figs. 1, 9.

Dimensions. (1 measured specimen) - Length, 78μ (archeopyle present); width, 80μ; spines 2.5-4.0μ.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Recorded previously from Kimmeridgian rocks (Baylei to Pallasioides zones) of England and France (Gitmez and Sarjeant, 1972).

Tenua hystrix Eisenack (24)

1958 *Tenua hystrix* Eisenack, p. 410, Pl. 23, figs. 1-4.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Lower Albian.

Recorded previously from the Aptian (Eisenack, 1958; Eisenack and Kjellström, 1971) and the upper Hauterivian (Gocht, 1959) of northwest Germany, the Aptian and Lower Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976) and, probably reworked, from Middle Oligocene to Middle Miocene strata of northwest Germany (Gerlach, 1961).

Tenua sp. cf. *Tenua rioultii* Sarjeant (81)

Plate 6, figure 7

cf. 1968 *Tenua rioulti* Sarjeant, p. 231, Pl. 1, figs. 12, 22, Pl. 2, figs. 1-2, 4.

cf. 1972 *Tenua rioulti* Sarjeant, p. 43, Pl. 6, fig. 3, Pl. 7, fig. 2.

Description.

Shape. Overall shape of the pericyst elongate, as defined by the envelope of processes formed by the periphragm; the apex not present; antapex with left antapical extension and less prominent, or absent, right antapical extension.

Endocyst shape similar but with less pronounced antapical extensions. Pericoel not developed; compression dorso-ventral.

Phragma. Periphragm about 1.0μ thick and produced to form apiculate ornament, 5-17μ long, the longer elements present along the pericingulum and at the antapical prominences; apiculate ornament rarely simple distally, usually complex, bifid to bifurcate, or spatulate, thinner proximally and often set on expanded bases, sometimes connected by basal ridges, densely spaced.

Paratabulation. Outline of the apical archeopyle indicates the presence of four apical and six precingular paraplates; the ornament bears no relationship to paratabulation.

Archeopyle/operculum. Archeopyle apical, formed by the loss of four apical paraplates; operculum not observed.

Formula. A.

Pericingulum/perisulcus. Pericingulum outlined by rows of relatively longer apiculate elements; perisulcus not observed.

Dimensions. (3 measured specimens) - Endocyst length, 77-88μ (archeopyle present); endocyst width, 80-87μ.

Comparison. *Tenua* sp. cf. *T. rioultii* is similar to *T. rioultii* Sarjeant but the sculpture elements are somewhat longer and distally more complex and the overall dimensions are larger.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Middle to Upper Kimmeridgian.

A similar species recorded previously from the Bathonian and Callovian of Greenland (Sarjeant, 1972) and the Upper Callovian of France (Sarjeant, 1968).

Tenua? sp. B (39)

Plate 6, figures 8-10

Description.

Shape. Pericyst ovoid and elongate, the left antapex occasionally produced slightly to form an antapical prominence; apex rounded.

Endocyst as above, the two layers closely appressed and without pericoel development; dorso-ventral compression.

Phragma. Periphragm about 1μ thick and produced to form a surface sculpture of discrete but densely spaced elements, 8-12μ long, and about 1μ wide, consisting of simple, blunt elements, bifurcated and distally bifid elements, and asymmetrically distally furcated elements.

Endophragm less than 1μ thick and smooth.

Paratabulation. Apical archeopyle shape indicates the presence of four apical paraplates and six precingular paraplates; other evidence for paratabulation lacking.

Endophragm showing no evidence of paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of four apical paraplates; operculum simple and free, separating as a unit, occasionally partly attached ventrally on some specimens.

Formula. A.

Pericingulum/perisulcus. Pericingulum not distinguished; position of perisulcus indicated indistinctly by reduction of sculpture element size.

Dimensions. (22 measured specimens) - Pericyst length (5 specimens), 85-105μ; pericyst width, 58-98μ.

Discussion. *Tenua?* sp. B is referred doubtfully to that genus because of the nature of the sculpture elements. The species does not belong in *Pseudoceratium* because of its lack of ceratioid characters (Wall and Evitt, 1975), and cannot be assigned to *Cyclonephelium* because the sculpture elements are uniformly distributed.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division; Upper shale-siltstone division equivalents and Husky Formation, unnamed Upper Jurassic sandstone unit, cuttings, probably caved (first occurrence, Albian).

Stoney Core Hole F-42: Upper sandstone division equivalent; Aptian.

PROXIMATE PERIDINIACIAN CYSTS

Genus *Pareodinia* Deflandre emend. Gocht (58)

1947 *Pareodinia* Deflandre, p. 4.

1970 *Pareodinia* Deflandre emend. Gocht, p. 153.

Pareodinia borealis Brideaux and Fisher (90)

1976 *Pareodinia borealis* Brideaux and Fisher, p. 21, Pl. 3, figs. 3, 4, 6-9, Pl. 4, figs. 1-8.

Occurrence. Rat Pass K-35: Husky Formation, sidewall cores and cuttings; Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Middle to Upper Kimmeridgian.

Recorded previously from various surface and well sections on the northern Canadian mainland and the Canadian Arctic Archipelago in ?Lower and Upper Oxfordian to Valanginian strata (Brideaux and Fisher, 1976; Brideaux, 1976b; McIntyre and Brideaux, unpubl. data).

Pareodinia capillosa Brideaux and Fisher (83)

1976 *Pareodinia capillosa* Brideaux and Fisher, p. 20, Pl. 2, figs. 3-10, Pl. 3, figs. 1, 2, 5.

Occurrence. Rat Pass K-35: Husky Formation, sidewall core; Middle to Upper Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Kimmeridgian.

Recorded previously from various surface and well sections on the northern Canadian mainland and the Canadian Arctic Archipelago in Upper Oxfordian to Lower Berriasian strata (Brideaux, 1976b; cf. Brideaux and Fisher, 1976).

Pareodinia ceratophora Deflandre emend. Gocht (77)

1947 *Pareodinia ceratophora* Deflandre, p. 4, Text-figs. 1-3.

1960b *Kalyptea monoceras* Cookson and Eisenack p. 257, Pl. 39, figs. 1-8.

1970 *Pareodinia ceratophora* Deflandre emend. Gocht, p. 154, Pl. 35, figs. 1-8, Textfigs. 22-25.

1975 *Pareodinia ceratophora* Deflandre emend. Gocht; Wiggins, p. 103, Pl. 1, figs. 1-7.

Discussion. See Gocht (1970) and Wiggins (1975) for more complete synonymies and for discussions on the nature of the kalyptra.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalents, Husky Formation, conventional core; Middle Kimmeridgian to Hauterivian.

Recorded previously from Lower Jurassic (Toarcian) to Lower Cretaceous (Barremian) rocks from localities worldwide (Riley and Sarjeant, 1972; Harker and Sarjeant, 1975; Millioud *et al.*, 1975); from the Callovian to Kimmeridgian-Lower Volgian, Canadian Arctic Archipelago (Johnson and Hills, 1973).

PROXIMATE UNASSIGNED CYSTS

Genus *Dictyopyxidia* Eisenack

1961 *Dictyopyxidia* Eisenack, p. 316 (*nom. subst. pro Dictyopyxis* Cookson and Eisenack, 1960b).

Dictyopyxidia imperfecta
Brideaux and McIntyre (12)

1976 *Dictyopyxidia imperfecta* Brideaux and McIntyre, p. 25, Pl. 7, figs. 1-5.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall core and cuttings; Hauterivian to Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from Aptian to Middle Albian strata of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Genus *Fromea* Cookson and Eisenack

1958 *Fromea* Cookson and Eisenack, p. 55.

Fromea amphora Cookson and Eisenack (54)

1958 *Fromea amphora* Cookson and Eisenack, p. 56, Pl. 5, figs. 10, 11.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Aptian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Aptian to Cenomanian of Australia (Cookson and Eisenack, 1958), the Upper Cretaceous of the Canadian Arctic Archipelago (Manum and Cookson, 1964), the Upper Albian and? Lower Cenomanian (Cookson and Hughes, 1964) and Upper Barremian (Sarjeant, 1966b) of England, the Cenomanian of England and France (Davey, 1969), the Barremian of Germany (Alberti, 1961), the Upper Albian of Rumania (Baltes, 1967), the Middle and Upper Albian of central Alberta, Canada (Singh, 1971; Brideaux, 1971), the Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), the Albian of the Paris Basin, France (Davey and Verdier, 1971), and the Upper Cretaceous of the U.S.S.R. (Vozzhennikova, 1967).

Fromea complicata sp. nov. (93)

Plate 7, figures 1-6

Holotype. GSC No. 46000, Chevron Standard Slide 6894-2, 09.1 x 123.6, Horton River Formation, Section CR15A-68, 45.5-48.5 m (130-140 ft) from base of section, GSC loc. C-8555; Middle Albian. Autocyst length, 62μ; autocyst width, 42μ; archeopyle present.

Diagnosis.

Shape. Autocyst distinctly longer than broad, maximum width at the mid-line (usually the presumed position of the pericingulum), tapering and rounded at both apices; dorso-ventral compression.

Phragma. Autophragm about 1μ thick; smooth or scabrate; two major fold systems interpreted as related to position of the pericingulum and perisulcus; numerous other minor wrinkles and folds.

Paratabulation. Evidence for determinable paratabulation lacking.

Archeopyle/operculum. A subangular to irregular opening, presumably situated at the apex, is interpreted as an apical archeopyle; operculum free and simple, not observed separately.

Formula. A.

Pericingulum/perisulcus. A major transverse fold system present on all observed specimens, rarely (holotype) associated with a lateral invagination at the mid-line, interpreted as indicating presence of a pericingulum; a major longitudinal fold system, extending the length of the autocyst, appearing to be ventral to the pericingulum fold system, interpreted as indicating the presence of a perisulcus.

Variation. The pericingular fold system, on some specimens, appears offset and somewhat helicoid; on most specimens, however, it occurs only on one surface.

Dimensions. (2 measured specimens) - Autocyst length, 58-80μ; autocyst width, 43-60μ. (11 measured specimens, *see* holotype, and Brideaux, 1971) - Autocyst length, 41-96μ; autocyst width, 27-64μ.

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, cuttings; Aptian.

Recorded previously from Middle and Upper Albian rocks in central and west-central Alberta, Canada (Brideaux, 1971); holotype specimen recently observed in Middle Albian rocks from the Anderson Plain region, northern Canadian mainland (*see* Brideaux and McIntyre, 1976 for information on lithology and age of strata).

Genus *Hologinella* Cookson and Eisenack

1962b *Hologinella* Cookson and Eisenack, p. 271

Hologinella spinosigibberosa Brideaux and Fisher (89)

1976 *Hologinella spinosigibberosa* Brideaux and Fisher, p. 22, Pl. 4, fig. 9, Pl. 5, figs. 1-16.

1976a *Hologinella* sp. SP, Brideaux, p. 257.

Discussion. Brideaux and Fisher (1976, p. 23) present a detailed description on the morphology of this species and comment on the constituent species of the genus *Hologinella*.

Occurrence. Rat Pass K-35: Husky Formation, sidewall core; Upper Oxfordian to Upper Kimmeridgian (Brideaux and Fisher, 1976).

Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Recorded previously from putative Upper Oxfordian to ?Portlandian rocks of the northern Canadian mainland and Canadian Arctic Archipelago (Brideaux and Fisher, 1976), and from the Lower Berriasian *Buchia okensis* zone (Brideaux, 1976b).

Genus *Mendicodinium* Morgenroth

1970 *Mendicodinium* Morgenroth, p. 347.

Diagnosis (restated).

Shape. Autocyst subspherical to ellipsoid; length to width ratio approximately equal; apical and antapical horns absent; compression dorsoventral.

Phragma. Autophragm thin, constant thickness; surface sculpture variable and including scabrate, apiculate, and reticulate ornament.

Paratabulation. Evidence for determinable paratabulation lacking, except in the vicinity of the epicystal archeopyle and in the presumed perisulcal region where what is interpreted as an anterior sulcal paraplate is represented.

Archeopyle/operculum. Archeopyle formed by the presumed loss of the apical and precingular paraplate series; operculum simple, commonly free but attached on some specimens along the anterior parasuture of the presumed anterior sulcal paraplate, formed of the apical and precingular paraplate series.

Formula. $\overline{\text{AP}}$(?a).

Pericingulum/perisulcus. Pericingulum present or absent; when present, indicated by a slight invagination of the ambitus near the midlatitude of the autocyst. Perisulcus present or absent; when present, position indicated by a medial ventral invagination of the autocyst profile and the presumed anterior sulcal paraplate.

Type species. *Mendicodinium reticulatum* Morgenroth, 1970, p. 347, Plate 9, figures 5, 6 and Plate 10, figures 1-4 (Lower Jurassic, Lias delta, north Germany).

Other species. *Mendicodinium caperatum* sp. nov. (this paper).

Discussion. Pocock and Sarjeant (1972) have described three acritarch genera from Triassic and Jurassic rocks which have an ovoidal to spheroidal shape and exhibit regular division of the tests into distinct parts. These genera, however, do not possess the mode of division of *Mendicodinium*. Morgenroth (1970, p. 348) notes that the mode of archeopyle formation found in *Mendicodinium* occurs also in *Luehndea* Morgenroth, 1970 and *Ctenidodinium* Deflandre, 1938 emend. Sarjeant, 1966b. It occurs also in numerous other genera including *Hemicystodinium* Wall, 1967, to which species of *Mendicodinium* bear a remarkable resemblance in outline where archeopyle formation has occurred.

Mendicodinium caperatum sp. nov.

Plate 7, figures 7-11

1976b "*Hemicystodinium*" sp. CA Brideaux, p. 251, Pl. 44.a, fig. 10.

Holotype. GSC No. 46004, Slide P770-21C, 38.0 x 118.0, Albian shale-siltstone division equivalent, I.O.E. Stoney Core Hole F-42, conventional core, 310-320 feet (94.6-97.6 m), GSC loc. C-10703; Lower Albian. Autocyst width, 85μ; archeopyle present.

Diagnosis.

Shape. Autocyst subspherical to spherical; compression dorso-ventral.

Phragma. Autophragm about 0.5μ thick; surface scabrate, with scattered small grana less than 0.25μ in width and height; a few specimens with a fine pattern of vermiculate ridges, less than 0.25μ wide and high, anastomosing to form an irregular micro-reticulate surface pattern, the lumina as wide as 1.0μ; autophragm on most specimens wrinkled with numerous fine folds.

Paratabulation. Evidence of determinable paratabulation lacking; the shape of the operculum suggesting the presence of paratabulation, and the projecting part of the hypocyst appearing to represent the anterior sulcal paraplate.

Archeopyle/operculum. Archeopyle interpreted as forming by the loss of the apical and precingular paraplates; operculum interpreted as simple and free, consisting of the apical and precingular paraplates.

Formula. ?$\overline{AP}$.

Pericingulum/perisulcus. No evidence for presence of a pericingulum; anterior perisulcal position may be indicated by what is interpreted as the anterior sulcal paraplate.

Dimensions. (13 measured specimens) - Autocyst length (4 specimens), 65-70μ; autocyst width, 64-85μ.

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, cuttings; Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division and Upper sandstone division equivalents, conventional core; Aptian to Lower Albian.

Genus *Palaeostomocystis* Deflandre

1937 *Palaeostomocystis* Deflandre, p. 52.

Palaeostomocystis fragilis
Cookson and Eisenack (37)

1962a *Palaeostomocystis fragilis* Cookson and Eisenack, p. 496, Pl. 7, figs. 10, 11.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Hauterivian? to Barremian; Husky Formation, cuttings (caved); Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Aptian.

Recorded previously from the Aptian? to Cenomanian of Australia (Cookson and Eisenack, 1962a), the Upper Cretaceous of Graham Island and Ellef Ringnes Island, Canadian Arctic Archipelago (Manum and Cookson, 1964), the Middle and Upper Albian of central Alberta, Canada (Brideaux, 1971; Singh, 1971), and the Aptian and Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Palaeostomocystis expolita sp. nov. (50)

Plate 7, figures 12-14

Holotype. GSC No. 46006, Slide P770-40B, 43.4 x 131.4, Upper shale-siltstone division, I.O.E. Stoney Core Hole F-42, conventional core, 750-760 feet (228.8-231.9 m), GSC loc. C-10720; Barremian. Autocyst length, 93μ; oblique lateral view; operculum attached.

Diagnosis.

Shape. Autocyst length equal to or greater than maximum width; pear-shaped to trianguloid outline; autocyst narrowest apically, the sides straight or slightly convex, widening abruptly at about two thirds of the total length; straight or slightly invaginated in the median antapical part; lower third of the autocyst bilobed or at least expanded, the corners rounded; well-developed lobations commonly compressed and folded, rarely extended. Dorsoventral compression.

Phragma. Autophragm from 1.0-1.5μ thick; smooth or faintly scabrate.

Paratabulation. Evidence for determinable paratabulation lacking, the subangular outline of the apical archeopyle on many specimens indicating presence of apical paratabulation.

Archeopyle/operculum. Archeopyle apical, formed by the loss of a subcircular to subangular part of the apex, the archeopyle opening indistinctly to recognizably angular. Operculum flat, subrounded; generally detached, but occasionally in place (holotype) or lying in the autocoel.

Formula. A.

Pericingulum/perisulcus. Not observed.

Dimensions. (22 measured specimens) - Autocyst length, 65-100μ; maximum autocyst width, 70-86μ.

Comparison. *Palaeostomocystis expolita* sp. nov. differs from *Palaeostomocystis triquetra* sp. nov. in possessing a smooth or scabrate autophragm, and from other published species of the genus in its shape. *Horologinella* sp. indet. of Cookson and Eisenack, 1962b, p. 273, Plate 37, figure 14, possesses apiculate sculpture and is smaller. Other remarks made in the comparison section under *Palaeostomocystis triquetra* sp. nov. also apply here in part.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division, conventional core; Hauterivian to Barremian.

Palaeostomocystis triquetra sp. nov. (56)

Plate 8, figures 1-6

Holotype. GSC No. 46009, ARCO Slide 10606A-2, 17.0 x 116.4, Upper shale-siltstone division equivalent, Banff-Aquitaine-Arco Rat Pass K-35 well, sidewall core at 1025 feet (312.4 m), GSC loc. C-12606; Barremian. Autocyst length, 78μ; maximum autocyst width, 69μ; archeopyle present.

Diagnosis.

Shape. Autocyst length equal to or greater than maximum width, pear-shaped overall; epicyst more or less straight-sided in its upper part but widening abruptly in its lower part just before the pericingulum; hypocyst bilobed and forming marked antapical prominences; hypocyst straight to slightly invaginated between the prominences; the lobations commonly compressed and folded; dorso-ventral compression.

Phragma. Autophragm about 1.0-1.5μ thick; sculpture of variably shaped grana, short rows of fused grana, vermiculate ridges, and rarely, cones or spines; sculpture often longitudinally orientated, except transversely orientated in what is interpreted as the position of the perisulcus; sculpture in the perisulcal region consisting of fine, anastomosing striae; grana less than 1.0μ wide and high, vermiculate ridges less than 1.0μ high and about 0.5μ wide, striae less than 0.5 high and wide.

Paratabulation. Evidence for determinable paratabulation lacking; subangular outline of archeopyle pronounced on some specimens indicating the presence of apical paratabulation.

Archeopyle/operculum. Archeopyle apical, formed by the loss of a subcircular to subangular part of the apex, the archeopyle opening indistinctly to markedly angular. Operculum flat, rounded to subrounded and slightly angular in outline, generally detached, but occasionally in place or lying in the autocoel.

Formula. A.

Pericingulum/perisulcus. Position of the pericingulum marked indistinctly and discontinuously by parallel rows of larger and more widely spaced grana, 1.0-1.5μ wide and high; the pericingulum lying just below the point at which the autocyst widens abruptly. Position of perisulcus interpreted as lying between the two antapical prominences, and indicated by the trapezoidal-shaped region of autophragm bearing transversely orientated striae.

Variation/other features. Autophragm sculpture varies considerably, many specimens possessing only discrete grana without fusion or orientation; grana commonly rounded but in place trianguloid to rectanguloid in outline. Occasional specimens possess longitudinally orientated striae, the striae swinging around to a transverse orientation in the assumed perisulcal region.

Dimensions. (27 measured specimens) - Autocyst length, 68-100μ; maximum autocyst width, 50-77μ.

Comparison. Palaeostomocystis triquetra sp. nov. is distinguished from *Palaeostomocystis expolita* sp. nov. by its sculpture and from other published species of the genus by its trilobate shape and autophragm sculpture. *Hologinella* sp. indet. of Cookson and Eisenack, 1962b, p. 273, Plate 37, figure 15, is smaller, although superficially similar in shape and sculpture, but details of the apical region are difficult to determine on the published figure. *Trigonopyxidia ginella* (Cookson and Eisenack) Downie and Sarjeant, 1965 (*in* Cookson and Eisenack, 1960a, p. 11, Pl. 3, figs. 18-20) possesses a triangular shape and apical opening, but differs in having an internal body, more pronounced development of the antapical projections, a wider apical opening in both wall layers, and is three dimensionally a tetrahedron with a triangular base (E.J. Kidson, pers. com., 1976).

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

CHORATE GONYAULACACEAN CYSTS

Genus *Achomosphaera* Evitt

1963 *Achomosphaera* Evitt, p. 163.

Achomosphaera neptunii (Eisenack) Davey and Williams (94)

Plate 8, figure 7

1958 *Baltisphaeridium neptunii* Eisenack, p. 399, Pl. 28, figs. 7, 8, Textfig. 8.

1966 *Achomosphaera neptunii* (Eisenack) Davey and Williams, p. 51, Pl. 3, fig. 7, Pl. 9, fig. 11.

Dimensions. (3 measured specimens) - Pericyst length (1 specimen), 45μ; pericyst width, 42-56μ (excluding processes).

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall core and cuttings; Barremian to Aptian.

Recorded previously from Valanginian to Aptian strata of Germany, Switzerland and England (Eisenack, 1958; Gocht, 1959; Davey and Williams, 1966; Millioud, 1967, 1969; Davey and Verdier, 1974; Davey, 1974), and a single specimen from the Middle Albian (?derived) of central Alberta, Canada (Singh, 1964).

Genus *Adnatosphaeridium* Williams and Downie

1966 *Adnatosphaeridium* Williams and Downie, p. 215.

Adnatosphaeridium sp. A (66)

Plate 8, figures 10, 11

Description.

Shape. Pericyst projecting along the parasutures, the distal outline subcircular; closely appressed to endophragm intratabularly; without apical or antapical prominences.

Endocyst subcircular in outline, without apical or antapical prominences; closely appressed to the pericyst except along the parasutures. Pericoel not developed; compression dorso-ventral.

Phragma. Intratabular periphragm about 1.0-1.5μ thick, densely sculptured with low, narrow pila, up to 1.0μ high, and with scattered discrete acuminate processes up to 8.0μ high and up to 1.0μ wide; periphragm projecting along the parasutures to form thin, irregularly branched processes up to 16μ high and

1.0μ wide; processes may be discrete but more commonly are variously branched distally and linked by trabeculae.

Endophragm less than 0.5μ thick.

Paratabulation. Archeopyle outline and distally trabeculate parasutural processes denote a paratabulation of 4', 6'', xc, 5-6'''?, 1'''', ?p; compression of specimens renders observation of paratabulation difficult, especially on the hypocyst.

Archeopyle/operculum. Archeopyle formed by the loss of the four apical paraplates; operculum not observed separately but presumably free and simple.

Formula. A.

Pericingulum/perisulcus. Compression of distally trabeculate processes renders determination of pericingulum course difficult; several pericingular paraplates observed, but the course of pericingulum not clearly discernable; perisulcus imperfectly observed, apparently denoted by a narrow, longitudinal region bearing only isolated acuminate processes and bordered by aligned rows of projecting parasutural periphragm present on the hypocyst.

Dimensions. (3 measured specimens) - Maximum diameter, including processes, 65-83μ; maximum endocyst diameter, 54-70μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Callaiosphaeridium* Davey and Williams

1966 *Callaiosphaeridium* Davey and Williams, p. 103.

1967 *Hexasphaera* Clarke and Verdier, p. 42.

Callaiosphaeridium asymmetricum (Deflandre and Courteville) Davey and Williams (98)

Plate 8, figure 8

1966 *Callaiosphaeridium asymmetricum* (Deflandre and Courteville) Davey and Williams, p. 104.

Occurrence. Rat Pass K-35 well: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Recorded previously from Hauterivian to lower Santonian rocks in England, France and North America (Deflandre and Courteville, 1939; Davey and Williams, 1966; Clarke and Verdier, 1967; Davey, 1969; Brideaux, 1971; Davey and Verdier, 1971, 1973, 1974; Williams and Brideaux, 1975).

Genus *Cleistosphaeridium* Davey, Downie, Sarjeant and Williams

1966 *Cleistosphaeridium* Davey, Downie, Sarjeant and Williams, p. 166.

Cleistosphaeridium? aciculare Davey (45)

Plate 8, figure 9

1969 *Cleistosphaeridium? aciculare* Davey, p. 158, Pl. 6, figs. 11, 12.

Dimensions. (10 measured specimens) - Maximum diameter, 30-35μ; processes up to 20μ.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall core and cuttings; Barremian to Aptian.

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Aptian.

Recorded previously from the Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), and the Upper Albian to Lower Turonian of Saskatchewan (Davey, 1969).

Cleistosphaeridium araneosum sp. nov. (15)

Plate 9, figures 1-3

1971 *Cleistosphaeridium* sp. A of Brideaux, p. 94, Pl. 27, fig. 80.

1976 *Cleistosphaeridium?* sp. AE of Brideaux and McIntyre, p. 27, Pl. 7, figs. 13, 14.

Holotype. GSC No. 41501, Slide P851-2A, 17.4 x 122.8, Horton River Formation, Section CR14A-68, 6.0-9.2 m (20-30 ft), GSC loc. C-8533; Middle Albian. Pericyst length, 51μ; pericyst width, 52μ (excluding processes).

Diagnosis.

Shape. Pericyst subcircular; a short asymmetrical antapical prominence occurring on a few specimens.

Endocyst as above, closely appressed to the pericyst. Pericoel not developed; compression dorso-ventral.

Phragma. Periphragm less than 0.5μ thick, forming acuminate, distally pointed or weakly bifid processes up to 8μ long and 0.5 to 1.0μ wide, or flattened processes, wider basally and tapering distally, up to 10μ long and up to 2.0μ wide basally; process emplacement apparently non-paratabular; processes may or may not arise from a quasi-reticulate network of very low, narrow ridges formed of the periphragm, the ridges apparently also non-paratabular, process density highly variable, in places arranged in clusters. Surface ornamentation between processes scabrate to punctate.

Endophragm less than 1.0μ thick and unornamented.

Paratabulation. Archeopyle shape denotes four apical paraplates; other evidence for paratabulation lacking.

Archeopyle/operculum. Archeopyle formed by the loss of the four apical paraplates; operculum separating as a unit, simple and free, or lying in the archeopyle.

Formula. A.

Pericingulum/perisulcus. Pericingulum position determinable by parallel rows of widely spaced acuminate processes arising from a pair of narrow, low ridges formed from the periphragm; pericingulum positioned at the mid-latitude of the pericyst; pericingulum up to 7μ wide and offset about one half of pericingular width. Evidence for a discernible perisulcus lacking.

Dimensions. (15 measured specimens) - Pericyst length, 55-63μ; pericyst width, 48-55μ (maximum dimensions excluding processes). Maximum diameter on all reported specimens (*see* Brideaux, 1971; Brideaux and McIntyre, 1976), 37-78μ.

Comparison. *Cleistosphaeridium araneosum* sp. nov. is distinguished from the comparable species, *Cleistosphaeridium? aciculare* Davey, 1969 and *Cleistosphaeridium multispinosum* (Singh) Brideaux, 1971 by possession of acuminate to weakly bifid spines arising from a low quasi-reticulate meshwork on the periphragm and by the much lower density of processes arising from the periphragm. *Cleistosphaeridium multifurcatum* (Deflandre) Davey *et al*., 1969, p. 16, differs in having a preponderance of distinctly bifid spines with broad columns arising from an obvermiculate surface ornament. *Baltisphaeridium* sp. A of Singh, 1971, p. 397, Plate 73, figures 9, 10, appears very similar, but Singh (1971, p. 397) characterizes the processes as "... splitting into numerous, slender, pointed spines at their outer ends..."

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, sidewall cores and cuttings; Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from Middle and Upper Albian rocks of central and west-central Alberta, Canada (Brideaux, 1971) and from Middle Albian rocks on the Anderson Plain, northern Canadian mainland (Brideaux and McIntyre, 1976).

The suggestion of synonymy with *Cleistosphaeridium? aciculare* Davey (in part) is withdrawn and hence there is no confirmed Cenomanian record of *Cleistosphaeridium araneosum* sp. nov.

Cleistosphaeridium multispinosum (Singh) Brideaux (3)

1964 *Baltisphaeridium multispinosum* Singh, p. 141, Pl. 20, figs. 1, 2.

1971 *Cleistosphaeridium multispinosum* (Singh), Brideaux, p. 93, Pl. 27, figs. 77-79.

Discussion. The present writer now considers that *Cleistosphaeridium? aciculare* Davey, 1969, p. 158, Plate 6, figures 11, 12 and *C. multispinosum* (Singh) Brideaux, 1971 are separate species.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Recorded previously from Middle and Upper Albian rocks of Alberta (Singh, 1964, 1971; Brideaux, 1971), from Aptian to Middle Albian rocks of the Anderson Plain, northern Canadian mainland (Brideaux and McIntyre, 1976), and from the Albian of Maryland, U.S.A. (Brideaux, unpubl. data).

Cleistosphaeridium polypes (Cookson and Eisenack) Davey subsp. *polypes* (41)

For brief synonymy, *see* Brideaux and McIntyre (1976, p. 27).

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Aptian.

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Aptian.

Recorded previously from Barremian to Cenomanian strata (*see* Singh, 1971; Davey and Verdier, 1974; Brideaux and McIntyre, 1976).

Cleistosphaeridium polypes (Cookson and Eisenack) Davey subsp. *clavulum* Lentin and Williams (22)

For a brief synonymy, *see* Brideaux and McIntyre (1976, p. 27).

Occurrence. Stoney Core Hole F-42: Albian shale-siltstone division and Upper sandstone division equivalents, conventional core; Aptian to Middle Albian.

Recorded previously from Aptian to Lower Cenomanian strata from northern Canada, England and France (*see* Davey and Verdier, 1971, 1974; Brideaux and McIntyre, 1976).

Cleistosphaeridium? sp. BE (107)

Plate 9, figures 7, 8, 10, 11

Description.

Shape. Complete pericyst unobserved; remaining portion of pericyst more or less hemispherical.

Remaining endocyst of similar shape; closely appressed to pericyst. Pericoel not developed; dorso-ventral compression.

Phragma. Periphragm less than 0.5μ thick; sculpture of densely and finely granulate to echinulate elements less than 0.5μ high and non-paratabular; intratabular processes, closed and distally bifid to finely branched, 6-8μ long and up to 1μ wide arising from the periphragm, concentrated in the penesutural regions of paraplates and reduced in density to absent in the central parts of paraplates.

Endophragm less than 0.5μ thick.

Paratabulation. Penesutural arrangement of processes and development of principal archeopyle parasutures, denote an epiparatabulation of 4', 0a, 6'', ?c; penesutural arrangement of processes denotes a hypoparatabulation of 5-6?''', 1'''', ?p; paraplates on the epipericyst bearing 15 to 20 processes.

Endophragm lacking evidence for paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of four apical paraplates; operculum not observed, presumably free and simple, the two layers separating as a single unit.

Pericingulum/perisulcus. Evidence for discernible pericingulum lacking. Sulcal notch clearly visible on one specimen, perisulcal processes discrete and apparently paratabular in position denoting an anterior sulcal paraplate and one or more other sulcal paraplates; whether or not perisulcus is offset indeterminable because of compression.

Dimensions. (5 measured specimens) - Maximum pericyst width, excluding processes, 35-50μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Hauterivian.

Genus *Conosphaeridium* Cookson and Eisenack

1969 *Conosphaeridium* Cookson and Eisenack, p. 5.

Conosphaeridium sp. B (106)

Plate 9, figures 4-6

Description.

Shape. Pericyst subcircular, the width less than the overall length; apical and antapical processes lacking.

Endocyst subcircular, closely appressed to pericyst except at the base of processes arising from the pericyst, pericoel not developed; compression dorso-ventral.

Phragma. Periphragm less than 0.5μ thick, surface smooth between processes; periphragm produced to form numerous smooth, broad-based, latispinous, subconical or lagenate, tapering processes which are open distally; processes 4-5μ wide basally and 4-12μ long.

Endophragm smooth and up to 1.0μ thick.

Paratabulation. Shape of archeopyle and operculum denote four apical paraplates; processes appear non-paratabular, offering no information on paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of four apical paraplates; operculum free and simple, the two layers separating as a unit.

Pericingulum/perisulcus. Pericingulum and perisulcus absent.

Dimensions. (4 measured specimens) - Maximum width of pericyst excluding processes, 37-48μ.

Comparison. *Conosphaeridium* sp. B differs from *Conosphaeridium* sp. A of Brideaux and McIntyre, 1976, p. 28, Plate 7, figures 17, 18, in possessing a smooth periphragm and processes, and from published species of *Conosphaeridium* in possessing smooth and not striated processes.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Genus *Cordosphaeridium* Eisenack emend. Davey

1963 *Cordosphaeridium* Eisenack, p. 261.

1969 *Cordosphaeridium* Eisenack emend. Davey, p. 35.

Cordosphaeridium eoinodes (Eisenack) Eisenack (75)

Plate 9, figure 9

1958 *Hystrichosphaeridium eoinodes* Eisenack, p. 402, Pl. 27, figs. 3, 4.

1963 *Cordosphaeridium eoinodes* (Eisenack) Eisenack, p. 262.

Dimensions. (3 measured specimens) - Maximum diameter of pericyst excluding processes, 38-48μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

Recorded previously from Valanginian to Aptian strata of northwest Europe (Eisenack, 1958; Gocht, 1959); range reported as Berriasian to Albian *in* Millioud *et al.* (1975, Chart 2).

Genus *Coronifera* Cookson and Eisenack (78)

1958 *Coronifera* Cookson and Eisenack, p. 45.

Coronifera oceanica Cookson and Eisenack

1958 *Coronifera oceanica* Cookson and Eisenack, p. 45, Pl. 12, fig. 6.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian.

Recorded previously in Upper Hauterivian to Santonian rocks (*see* Davey and Verdier, 1974; Williams and Brideaux, 1975) from France, England, Australia and Canada.

Genus *Heslertonia* Sarjeant

1966a *Heslertonia* Sarjeant, p. 133.

Heslertonia heslertonensis (Neale and Sarjeant) Sarjeant (55)

Plate 10, figures 1-4

1962 *Gonyaulax heslertonensis* Neale and Sarjeant, p. 440, Pl. 19, fig. 5, Pl. 20, fig. 5, Text-fig. 1.

1966a *Heslertonia heslertonensis* (Neale and Sarjeant) Sarjeant, p. 133.

Discussion. The specimens observed by the present writer appear to fall within the circumscription of *Heslertonia heslertonensis* (Neale and Sarjeant) Sarjeant. However, their orientation and preservation do not permit the recognition of the paratabulation scheme outlined by Neale and Sarjeant (1962) and Sarjeant (1966a).

Dimensions. (7 measured specimens) - Maximum pericyst width, including parasutural crests, 48-75μ; maximum endocyst width, 35-50μ.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the Middle Hauterivian to Barremian of England (Neale and Sarjeant, 1962; Sarjeant, 1966a; Davey, 1974).

Hystrichodinium Deflandre emend. Clarke and Verdier

1935 *Hystrichodinium* Deflandre, p. 182.

1967 *Hystrichodinium* Deflandre emend. Clarke and Verdier, p. 37.

Hystrichodinium sp. (68)

Plate 10, figure 5

Discussion. *Hystrichodinium* sp. is represented by four poorly oriented, incomplete specimens. The species is characterized by a highly wrinkled periphragm, up to ten tapering processes, oval in section, that are parasutural and gonal in position, several defined postcingular paraplates and traces of a pericingulum and perisulcus outlined by low, narrow ridges formed from the periphragm. An archeopyle has not been observed. The poor preservation of these specimens does not merit a full description.

Dimensions. (4 measured specimens) - Maximum pericyst length, 30-42μ; maximum pericyst width, 30-37μ (excluding processes).

Distribution. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Hystrichokolpoma* Klumpp emend. Williams and Downie

1953 *Hystrichokolpoma* Klumpp, p. 388.

1966 *Hystrichokolpoma* Klumpp emend. Williams and Downie, p. 176

Hystrichokolpoma ferox (Deflandre) Davey (74)

1937 *Hystrichosphaeridium ferox* Deflandre, p. 72, Pl. 14, figs. 3, 4.

1969 *Hystrichokolpoma ferox* (Deflandre) Davey, p. 159, Pl. 9, figs. 5-7.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from upper Aptian (Eisenack, 1958) to Danian (Drugg, 1967) strata and from various localities in Britain, Europe, Australia and North America (Singh, 1971; Brideaux and McIntyre, 1976; Williams and Brideaux, 1975).

Genus *Hystrichosphaeridium* Deflandre emend. Davey and Williams

1937 *Hystrichosphaeridium* Deflandre, p. 68.

1966 *Hystrichosphaeridium* Deflandre emend. Davey and Williams, p. 55.

Hystrichosphaeridium cooksonii Singh (42)

Plate 10, figure 7

1971 *Hystrichosphaeridium cylindratum* Brideaux, p. 91, Pl. 26. figs. 69, 70, Pl. 27, fig. 74 (*non Hystrichosphaeridium cylindratum* Morgenroth, 1966, p. 30, Pl. 8, figs. 3, 4).

1971 *Hystrichosphaeridium brideauxii* Lentin and Williams, p. 74 (nom. nov., *nom. subst. pro. H. cylindratum* Brideaux, 1971).

Discussion. *Hystrichosphaeridium cylindratum* Brideaux, 1971 is a later homynym of *H. cylindratum* Morgenroth, 1966 and must be rejected under Art. 64

of the I.C.B.N. (Stafleu *et al.*, 1972). The name *Hystrichosphaeridium brideauxii* Lentin and Williams, 1973 was nomenclaturally superfluous when published (Art. 63, Art. 67) because *Hystrichosphaeridium cooksonii* Singh, 1971 is synonymous with the illegitimate taxon *H. cylindratum* Brideaux *non* Morgenroth (Singh, pers. com., 1974) and ought to have been adopted (Art. 72, I.C.B.N.) as the legitimate epithet.

Holotype. Research Council of Alberta Slide No. 3-S-4-Micro. 153, Carl Zeiss Photomicroscope coordinates 12.2 x 44.5, lower Shaftesbury Formation, section 3, sample no. 3-S-4, approximately 2 m (6 ft) above base of section, Upper Albian (*see* Singh, 1971, p. 330, Fig. 2).

Dimensions. (8 measured specimens) - Maximum diameter of pericyst, excluding processes, 45-63μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Aptian.

Recorded previously from Middle and Upper Albian strata of central and west-central Alberta (Brideaux, 1971; Singh, 1971).

Hystrichosphaeridium costatum
Davey and Williams (108)

Plate 10, figure 6

1966 *Hystrichosphaeridium costatum* Davey and Williams, p. 62, Pl. 10, fig. 4.

Dimensions. (1 measured specimen) - Maximum diameter, 40μ, excluding processes.

Discussion. The specimen agrees in all respects with the diagnosis and description given by Davey and Williams (1966, p. 62, 63), but is badly crushed.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Hauterivian.

Recorded previously from Oxfordian of England and Germany and doubtfully from the Oxfordian of France (as reported *in* Davey and Williams, 1966, p. 63). This specimen from the northern Canadian mainland is probably reworked.

Hystrichosphaeridium sp. AE (52)

Plate 10, figures 8-11

Description.

Shape. Pericyst subcircular to nearly circular.

Endocyst closely appressed to pericyst except at the loci of processes arising from the pericyst. Pericoel not developed; slight dorso-ventral compression.

Phragma. Periphragm less than 0.5μ thick, smooth to scabrate sculpture; produced to form paraplate-centred, hollow, distally open, in cross-section somewhat ovoid, processes; the processes mildly to markedly infundibular, widening abruptly at about half their length; the distal halves generally strongly fenestrate, the distal margins variously aculeate, secate or foliate, rarely serrate or entire; basal width of columns typically 5-10μ but up to 14μ; distal expansion of processes typically 15-30μ but reaching 45μ; the length of columns 20-30μ.

Endophragm less than 0.5μ thick, smooth.

Paratabulation. Process formula denoting a paratabulation of 5', 6'', 6c, 5''', 1'''', 1p, ?s; occasionally specimens have secondary parasutures developed about the archeopyle indicating four apical paraplates and six precingular paraplates; one of the apical series of processes may represent, therefore, a preapical paraplate; postcingular and antapical processes robust; pericingular processes reduced, in places strongly aculeate to foliate; posterior intercalary paraplate process strongly reduced; apical and precingular processes intermediate in size.

Endophragm bears no evidence of paratabulation.

Archeopyle/operculum. Archeopyle formed by the loss of the four apical paraplates; operculum simple and free, often lying in the archeopyle; operculum bearing five processes.

Formula. A.

Pericingulum/perisulcus. Pericingulum denoted by six reduced paraplate-centred processes, at the midline of the pericyst. Perisulcus not observed.

Variation/other features. Processes commonly fenestrate but may lack fenestrae on some specimens; distal terminations of such processes entire to serrate.

Dimensions. (5 measured specimens) - Maximum pericyst diameter, 52-60μ (excluding processes).

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Hystrichosphaeridium sp. BE (61)

Plate 11, figures 1, 2

Description.

Shape. Pericyst subcircular.

Endocyst closely appressed to pericyst except at loci of processes arising from the pericyst. Pericoel not developed, slight dorso-ventral compression.

Phragma. Periphragm less than 0.5μ thick; produced to form what are interpreted as paraplate-centred, hollow, tubiform processes, 12-25μ long, 2-3μ wide; processes open distally with strongly secate distal margins; secae acicular, or, less frequently, capitate or bifid; secae 8-15 in number and 3-7μ long, 0.5-1.0μ wide.

Paratabulation. Processes interpreted as paraplate-centred; absence of differentiation in processes and unfavourable orientation of observed specimens precludes a determination of process formula; 23-27 processes present.

Archeopyle/operculum. Archeopyle and operculum not observed.

Formula. ?A.

Pericingulum/perisulcus. Pericingulum and perisulcus not distinguishable on specimens available for study; processes representing the pericingulum presumably present.

Dimentions. (5 measured specimens) - Maximum pericyst diameter, 37-43μ, excluding processes.

Comparison. This form may be synonymous with the species *Hystrichosphaeridium arborispinum* Davey and Williams, 1966, p. 61, Plate 9, figure 10, which is characterized as possessing hollow, tubiform processes that have a complicated distal secate margin. However, the morphology of the secae on the illustrated specimen are difficult to determine from the photograph (Davey and Williams, 1966, Pl. 9, fig. 10).

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, cuttings (first appearance, Barremian).

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

Pending synonymy, doubtfully recorded from the Lower and Middle Barremian of England (Davey and Williams, 1966).

Genus *Lanterna* Dodekova

1969 *Lanterna* Dodekova, p. 16.

Lanterna saturnalis Brideaux and Fisher (82)

1976 *Lanterna saturnalis* Brideaux and Fisher, p. 24, Pl. 6, figs. 1-10; Pl. 7, figs. 1-13.

Occurrence. Rat Pass K-35: Husky Formation, sidewall cores; Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core, Upper Oxfordian to Kimmeridgian.

Recorded previously from Upper Oxfordian to Kimmeridgian rocks of the northern Canadian mainland and Canadian Arctic Archipelago (Brideaux and Fisher, 1976).

Genus *Oligosphaeridium* Davey and Williams

1966 *Oligosphaeridium* Davey and Williams, p. 71.

Oligosphaeridium albertense (Pocock) Davey and Williams (28)

Plate 11, figures 3-10, Plate 12, figures 1-3

1962 *Hystrichosphaeridium albertense* Pocock, p. 82, Pl. 15, figs. 226, 227.

1964 *Hystrichosphaeridium albertense* Pocock; Singh, p. 138, Pl. 18, figs. 6, 7.

1969 *Oligosphaeridium albertense* (Pocock) Davey and Williams, p. 5.

1976 *Oligosphaeridium* sp. AB of Brideaux and McIntyre, p. 29, Pl. 8, figs. 5, 8, 9.

1976 *Oligosphaeridium irregulare auct. non* (Pocock) Davey and Williams; Brideaux and McIntyre, p. 28, Pl. 8, figs. 3, 6.

Holotype. Illustrated by Pocock (1962, Pl. 15, fig. 226); holotype specimen from Imperial Kuroki 7-30-34-10W2M, slide (Staplin) 2, co-ordinates 32.7 x 121.8, Joli Fou Formation, 408.4-409.3 m (1340-1343 ft); Middle Albian.

Diagnosis (revised).

Shape. Pericyst, excluding processes, subcircular.

Endocyst closely appressed except at loci of processes arising from pericyst. Pericoel not developed; slight dorso-ventral compression.

Phragma. Pericyst less than 0.5μ thick, smooth or with scabrate sculpture; periphragm produced to form hollow, flared to tubiform processes, the processes open distally, the distal margins variably secate, occasionally aculeate or serrate; the distal third of some processes variably fenestrate; one process, probably sulcal in position, reduced, shorter, acuminate to foliate or with reduced distal secate margin; processes from 10-30μ long, 3-7μ wide basally (Pocock, 1962, p. 82 gives 25-40μ, 3-10μ respectively).

Endophragm less than 0.5μ thick, apparently smooth.

Paratabulation. Process formula determined as 4', 6", 0c, 5"', 1p, 1s, maximum of 17 processes observed on complete specimens, 13 on specimens with archeopyle developed; archeopyle outline denotes epiparatabulation of four apical paraplates and six precingular paraplates. Of the precingular processes, 6" smallest, 5" broadest and tubiform, 1"-4" intermediate in size; of the postcingular processes, 1"' often with a V-shaped extension of the distal opening down the column, 2"' broad-columned and tubiform, 3"' largest process on pericyst; antapical process often strongly secate, the secae broad and dissected; sulcal process variable, from an acuminate to foliate closed process to a reduced tubiform process, distally open; posterior intercalary process (1p) as large or larger than the process 6''.

Archeopyle/operculum. Archeopyle formed by the loss of four apical paraplates; the operculum simple, free, occasionally lying in the archeopyle, and bearing four apical processes little differentiated in size and structure.

Formula. A.

Pericingulum/perisulcus. Pericingular processes absent, the pericingular region defined by their absence; perisulcus represented by a single reduced process of variable morphology.

Dimensions. (40 measured specimens) - Maximum pericyst diameter, 52-70μ, excluding processes.

Comparison. The distally secate margins of the essentially similar flared to tubiform processes of *Oligosphaeridium albertense* distinguish this species from species with buccinate columns and entire to serrate distal margins (*Oligosphaeridium totum* Brideaux, 1971) and from species with highly variable columns and complex distal terminations [*Oligosphaeridium irregulare* (Pocock) Davey and Williams, 1969]. The species, *Oligosphaeridium reniforme* (Tasch) Davey, 1969, may be a synonym of *O. albertense*, but this cannot be determined from the original description and illustration (Tasch *et al.*, 1964, p. 193, Pl. 2, fig. 6). The same comments apply to *Oligosphaeridium? dispare* (Tasch) Davey and Williams, 1969.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Lower Albian.

Recorded previously from the Aptian? and Albian of Alberta [Pocock, 1962; Singh, 1964; *see* discussion of the age of the Garbutt Formation under *Tenua brevispinosa* (Pocock) nov. comb.], and the Aptian and Lower Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Oligosphaeridium anthophorum
(Cookson and Eisenack) Davey (29)

1958 *Hystrichosphaeridium anthophorum* Cookson and Eisenack, p. 43, Pl. 11, figs. 12, 13, Text-figs. 16-18.

1969 *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey, p. 147, Pl. 5, figs. 1-3.

Discussion. Lentin and Williams (1973, p. 99) ascribe the combination *Oligosphaeridium anthophorum* (Cookson and Eisenack) Davey to Eisenack and Kjellström (1971, p. 837). However, Davey (1969, p. 147) indicated the names were to be used in this combination and cited the basionym, thus fulfilling the requirements of Art. 33 (I.C.B.N., Stafleu *et al.*, 1972).

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Barremian to Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Lower Albian.

Recorded previously by numerous authors from Upper Jurassic to Albian rocks (Cookson and Eisenack, 1958; Eisenack, 1958; Alberti, 1961; Davey, 1969; Brideaux, 1971; Singh, 1971; Brideaux and McIntyre, 1976), and Coniacian to Santonian rocks of the Grand Banks, Atlantic continental margin (Williams and Brideaux, 1975).

Oligosphaeridium asterigium
(Gocht) Davey and Williams (21)

1959 *Hystrichosphaeridium asterigium* Gocht, p. 67, Pl. 3, fig. 1, Pl. 7, figs. 1-4.

1969 *Oligosphaeridium? asterigium* (Gocht) Davey and Williams

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall core and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent and Husky Formation conventional core; Middle Kimmeridgian to Middle Albian.

Recorded previously from the Valanginian and Hauterivian of Germany (Gocht, 1959) and the Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Oligosphaeridium complex
(White) Davey and Williams (11)

1966 *Oligosphaeridium complex* (White) Davey and Williams, p. 71, Pl. 7, figs. 1, 2, Pl. 10, fig. 3, Textfig. 14.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Widely distributed in Cretaceous and Tertiary rocks (Davey and Williams, 1966; Davey and Verdier, 1971, 1974; Brideaux, 1971; Singh, 1971; Brideaux and McIntyre, 1976; Williams and Brideaux, 1975).

Oligosphaeridium sp. cf. *Oligosphaeridium complex* (White) Davey and Williams (96)

Plate 12, figures 4, 5

1976a *Oligosphaeridium* sp. cf. *Oligosphaeridium complex* (White) Davey and Williams; Brideaux, p. 256, Pl. 44.2, fig. 14.

Discussion. This form differs from *Oligosphaeridium complex* (White) Davey and Williams in having clathrate, but markedly aculeate, distal terminations, or strongly dissected distal terminations of processes. The aculeate terminations are much more marked than those of *Oligosphaeridium asterigium* (Gocht) Davey and Williams. The short processes are sulcal in position; the longest processes appear to belong to the precingular paraplate series. Specimens encountered in this study are poorly preserved and may be derived, although this species was not observed in older rocks from the Rat Pass K-35 well.

Dimensions. (4 specimens) - Pericyst width, 43-58μ; process length, 9-58μ.

Occurrence. Rat Pass K-35 well: Upper shale-siltstone division equivalent, cuttings; Barremian.

Recorded previously from putative Valanginian to Hauterivian? strata in the Gulf Mobil Parsons N-10 well (Brideaux, 1976a).

Oligosphaeridium nannum Davey (76)

Plate 12, figures 6, 7

1971 *Oligosphaeridium?* sp. A of Brideaux, p. 91, Pl. 26, fig. 66.

1974 *Oligosphaeridium nannum* Davey, p. 59, Pl. 4, figs. 9, 10.

1976 *Oligosphaeridium?* sp. A of Brideaux; Brideaux and McIntyre, p. 29, Pl. 8, fig. 7.

Discussion. This species is characterized by an apical archeopyle, the small size of the central pericyst, and the tubiform to cylindrical ribbed processes. Some specimens (Brideaux and McIntyre, 1976) show a basal fusion of some of the precingular paraplate-centred processes.

Davey (1974, p. 59) suggests that this species may have affinities with *Kleithriasphaeridium* Davey, 1974. The type species of *Kleithriasphaeridium* appears, from the illustrations of Davey (1974, Pl. 5, figs. 1-5, Textfig. 3), to have an apical archeopyle, although Davey (1974) describes the species as possessing a precingular archeopyle. But the type species of *Kleithriasphaeridium* also possesses 20 or 21 processes plus 4 sulcal processes, compared to the 13 to 17 processes observed on *Oligosphaeridium nannum* Davey. If the genus *Kleithriasphaeridium* does possess an apical archeopyle, it would become indistinguishable from *Hystrichosphaeridium* Deflandre emend. Davey and Williams.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from Aptian strata of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), from Middle and Upper Albian strata of central and west-central Alberta (Brideaux, 1971), and from the Lower Barremian of England (Davey, 1974).

Oligosphaeridium pulcherrimum (Deflandre and Cookson) Davey and Williams (32)

1966 *Oligosphaeridium pulcherrimum* (Deflandre and Cookson) Davey and Williams, p. 75, Pl. 10, fig. 9, Pl. 11, fig. 5.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, cuttings (first occurrence, Aptian); Upper shale-siltstone division, sidewall cores; Barremian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents, and Husky Formation, conventional core; Middle Kimmeridgian to Lower Albian.

Recorded previously from Aptian strata of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976), Middle and Upper Albian strata in Alberta (Singh, 1971; Brideaux, 1971), Cenomanian to Coniacian strata of Alabama, U.S.A. (Leopold and Pakiser, 1964) and of England (Clarke and Verdier, 1967), Coniacian to Santonian strata of the Grand Banks, Atlantic continental margin (Williams and Brideaux, 1975), the Lower Cretaceous of Belgium (Delcourt and Sprumont, 1957) and Australia (Deflandre and Cookson, 1955), and the Cretaceous of France (Valense, 1955).

Millioud *et al.* (1975, Chart 5) give a range of Valanginian to Santonian.

Oligosphaeridium totum Brideaux subsp. *totum* (30)

1971 *Oligosphaeridium totum* var. *totum* Brideaux, p. 88, Pl. 25, figs. 53, 55 (October, 1971).

1971 *Oligosphaeridium diastema* Singh, p. 337, Pl. 55, figs. 4, 5, Pl. 56, figs. 1, 2 (December, 1971).

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Lower Albian.

Recorded previously from the Middle and Upper Albian of Alberta (Brideaux, 1971; Singh, 1971), and the Aptian, Lower and Middle Albian of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976).

Genus *Operculodinium* Wall

1967 *Operculodinium* Wall, p. 110.

Discussion. The genus, *Operculodinium* Wall, 1967, is characterized by processes that are penesutural in position and possess minutely striated bases. The species to be described below differs in these two respects and is, therefore, included only provisionally in this genus.

Operculodinium? spinigerum sp. nov. (101)

Plate 12, figures 8, 9, Plate 13, figures 1-11

Holotype. GSC No. 46035, ARCO Slide 10607-A-1, 19.0 x 124.2, Upper shale-siltstone division equivalent, Banff-Aquitaine-Arco Rat Pass K-35, sidewall core, 1130 feet (344.4 m), GSC loc. C-12609; Barremian.

Left lateral view at high focus, archeopyle present; pericyst length, 57μ; pericyst depth, 38μ (excluding processes); processes up to 15μ.

Diagnosis.

Shape. Pericyst longitudinally elongate, the length about one and one-half times the width, maximum width at the mid-latitude of the pericyst; apex and antapex rounded, apical and antapical prominences absent.

Endocyst closely appressed to the pericyst except at the loci of processes arising from the pericyst. Pericoel not developed; slight lateral compression.

Phragma. Periphragm less than 1.0μ thick; surface sculpture smooth; periphragm produced to form follow, smooth-columned, tubiform to cylindrical, distally closed processes; distal margins of processes highly variable, bifid, trifurcate with distal bifid tips, or quadrifurcate to multifurcate, the furcations produced into aculeate extensions of variable length, which may branch in a complex manner; periphragm also forms acicular or stout, spiny processes; distally complex processes 4-16μ long and 1-2μ wide; acicular and spiny processes, 4-8μ long and 0.5-1.0μ wide basally.

Endophragm less than 0.5μ thick, smooth; closed beneath loci of processes arising from the periphragm.

Paratabulation. Process formula and paratabulation details indeterminate; process position apparently related to paratabulation as evidenced by the operculum, which bears three to four ?penesutural aculeate processes; processes interpreted as representing other paraplates variable in number and location. Five to seven aculeate processes and two aciculate processes are associated with the apical part of the epicyst; using the archeopyle to orient the presumed position of the precingular paraplates, the interpretation may be made that each precingular paraplate bears from one to three aculeate processes; scattered spinose processes mark the position of the pericingulum; epipericyst bears, therefore, from 13 to 25 aculeate processes and two aculeate processes and up to four stout spines in the pericingular region.

Hypopericyst bearing from ten to fifteen aculeate processes and one to three reduced aculeate processes or aciculate processes; processes apparently related to paratabulation, often occurring in pairs, but varying from one to three per paraplate; exact process formula and paratabulation not determinable.

Archeopyle/operculum. Archeopyle formed by the loss of a single precingular paraplate; operculum free, occasionally lying in the archeopyle, and simple, consisting of a single horseshoe-shaped paraplate interpreted as the third precingular paraplate; operculum bearing three to four aculeate processes.

Formula. P.

Pericingulum/perisulcus. General position of pericingulum at the mid-latitude of the pericyst; indicated by the absence of processes or by the presence of scattered aciculate processes or stout spines, up to four in number; exact pericingular course not delineated. Perisulcus represented by one to three reduced aculeate processes or aciculate processes; exact perisulcal course not determinable.

Dimensions. (20 measured specimens) - Pericyst length, 44-57μ; pericyst depth (5 specimens), 29-38μ; pericyst width, 32-42μ (15 specimens); all measurements excluding processes.

Comparison. *Operculodinium? spinigerum* sp. nov. differs from all previously described species of *Operculodinium* in possessing smooth-columned processes which are not commonly situated penesuturally; *O.? spinigerum* sp. nov. differs from *O. centrocarpum* (Deflandre and Cookson) Wall in possessing processes with complexly furcate distal margins which are much less numerous and not located penesuturally. The genus *Bourkidinium* Morgan, 1975 possesses an apical archeopyle and cannot accomodate this species.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core, Barremian; cuttings, Hauterivian? to Barremian (first occurrence, Barremian).

Genus *Prolixosphaeridium*
Davey, Downie, Sarjeant and Williams

1966 *Prolixosphaeridium* Davey, Downie, Sarjeant and Williams, p. 171 (69)

Prolixosphaeridium parvispinum (Deflandre)
Davey, Downie, Sarjeant and Williams

Plate 14, figure 1

1966 *Prolixosphaeridium dierense* Davey, Downie, Sarjeant and Williams, p. 171, Pl. 3, fig. 2, Textfig. 45.

1969 *Prolixosphaeridium parvispinum* (Deflandre) Davey, Downie, Sarjeant and Williams, p. 17.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from the uppermost Lower Barremian to Lower Aptian of France (Millioud, 1969), the Middle Barremian (Davey *et al.*, 1966) and Middle and Upper Barremian of England (Davey, 1974), and the Albian of the Paris Basin (Davey and Verdier, 1971).

Genus *Spiniferites* Mantell emend. Sarjeant

1970 *Spiniferites* Mantell emend. Sarjeant, p. 75.

Spiniferites ramosus (Ehrenberg) Mantell (8)

1854 *Spiniferites ramosus* (Ehrenberg) Mantell, p. 239.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division, Upper shale-siltstone division equivalents and Husky Formation, conventional core; Upper Jurassic to Middle Albian.

Recorded previously from Upper Jurassic to Pleistocene strata.

Genus *Systematophora* Klement

1960 *Systematophora* Klement, p. 61.

Systematophora sp. cf. *S. complicata*
Neale and Sarjeant (102)

cf. 1962 *Systematophora complicata* Neale and Sarjeant, p. 455, Pl. 19, figs. 7, 8, Text-fig. 9.

Dimensions. (1 measured specimen) - Maximum width of cyst, excluding processes, 50μ.

Discussion. The specimen recovered from the northern Canadian mainland appears closely comparable to material described and illustrated by Neale and Sarjeant (1962). However, the single specimen available for comparison is preserved in an apical orientation and details of the paracingular processes cannot be determined. Therefore, definite synonymy is not indicated.

Occurrence. Rat Pass K-35 well: Upper shale-siltstone division, sidewall core; Barremian.

Closely comparable material recorded previously as *Systematophora complicata* from the Upper Hauterivian to Middle Barremian of England (Neale and Sarjeant, 1962).

Systematophora schindewolfii
(Alberti) Downie and Sarjeant (44)

Plate 14, figures 7, 9

1961 *Hystrichosphaerina schindewolfii* Alberti, p. 38, Pl. 10, figs. 1-3, 6, 7.

1965 *Systematophora schindewolfii* (Alberti) Downie and Sarjeant, p. 146.

1969 *Perisseiasphaeridium eisenackii* Davey and Williams *in* Davey *et al.*, p. 6.

Discussion. Davey and Verdier (1974, p. 640) discuss the synonymy of this species and indicate that the age of the type material of this species is Barremian-Aptian rather than Turonian as suggested by Alberti (1961).

Dimensions. (11 measured specimens) - Pericyst length (2 specimens), 62-69μ; pericyst width, 58-72μ; dimensions excluding processes.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Aptian.

Recorded previously from the Middle and Upper Barremian of England (Sarjeant, 1966a; Davey, 1974), and the Upper Barremian to Upper Aptian of Germany (Eisenack, 1958; Alberti, 1961).

Systematophora sp. AE (70)

Plate 14, figures 2, 3

Description.

Shape. Pericyst ambitus subcircular, apical and antapical prominences lacking.

Endocyst ambitus subcircular, closely appressed to the pericyst except at the loci of process clusters. Pericoels not developed; slight dorso-ventral compression.

Phragma. Periphragm less than 1.0μ thick; surface sculpture scabrate to granulate, on some specimens fibrous; periphragm forms penesutural crests or paraplate-centred annulate process clusters enclosing a rounded trapezoidal to polygonal area in the first instance and a smaller subcircular area in the second case; penesutural crests up to 15μ high, with thickened rims up to 1.5μ wide, generally entire but sometimes dissected, the crests variably fenestrate to reticulate, the maximum diameter of the lumina from 1-5μ, the muri of highly variable width; constriction of the penesutural crests and lengthening and widening of the fenestrae produce a more tubular process which is more paraplate-centred than penesutural in position, and which in the extreme may simulate a process cluster joined by a distal trabecula with various medial interconnections between the processes of the cluster; tubular clusters up to 20μ high and up to 20μ wide basally, cylindrical or flared to infundibular, the distal margins entire.

Endophragm thin, less than 0.5μ thick, smooth.

Paratabulation. Penesutural crests or paraplate-centred processes denoting a process formula of 4', 6'', 6c, 5''', 1'''', 1p, 1-2s; of the precingular paraplates, 4'' largest and 6'' smallest; of the postcingular paraplates, 1''' strongly reduced, 3''' and 4''' almost equally sized and the largest on the cyst, 2''' and 5''' and 1'''' of intermediate size; pericingular and perisulcal processes discussed below.

Archeopyle/operculum. Archeopyle apical, formed by the loss of the apical paraplates; operculum formed of the apical paraplates, not observed but presumably simple and free.

Formula. A.

Pericingulum/perisulcus. Six pericingular paraplates denoted by variably fenestrate to dissected penesutural crests, the dissected crests prolonged into broadly united and distally complex extensions; cingular paraplates markedly transversely elongated, their width up to five times their length. Perisulcal region denoted by one or two reduced, hollow, distally closed processes.

Dimensions. (7 measured specimens) - Pericyst length (1 specimen), 58μ; excluding processes.

Comparison. *Systematophora* sp. AE is closely comparable to *Systematophora turonica* (Alberti) Downie and Sarjeant as illustrated and described *in* Alberti (1961, p. 39, Pl. 10, fig. 4a, b). However, Alberti (1961, p. 39) does not mention the presence of cingular paraplates and it is impossible to discern from the published illustrations whether or not these paraplates are present.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Genus *Tanyosphaeridium* Davey and Williams

1966 *Tanyosphaeridium* Davey and Williams, p. 98.

Tanyosphaeridium sp. A of Brideaux (59)

1971 *Tanyosphaeridium* sp. A Brideaux, p. 93, Pl. 26, fig. 71.

1976 *Tanyosphaeridium* sp. A of Brideaux; Brideaux and McIntyre, p. 31, Pl. 9, fig. 11.

Occurrence. Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Recorded previously from Middle Albian rocks of the northern Canadian mainalnd (Brideaux and McIntyre, 1976), and Middle and Upper Albian rocks of central Alberta, Canada (Brideaux, 1971).

Tanyosphaeridium sp. C of Brideaux and McIntyre (103)

1976 *Tanyosphaeridium* sp. C of Brideaux and McIntyre, p. 32, Pl. 9, fig. 13.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Recorded previously from Middle Albian rocks of the Anderson Plain region, northern Canadian mainland (Brideaux and McIntyre, 1976). A similar form, as *T. variecalamum* Davey and Williams, 1966, is recorded from the Cenomanian of England.

Tanyosphaeridium sp. DE (60)

Plate 14, figure 5

Description.

Shape. Pericyst ambitus elongate, the length up to one and one-half times the width; complete specimens not observed.

Endocyst as above, closely appressed to pericyst, except at loci of processes arising from the pericyst. Pericoel not developed; slight dorso-ventral compression.

Phragma. Periphragm less than 1.0μ thick; surface sculpture granular; smooth processes formed of periphragm arising from the cyst, up to 50 or more in number, tubiform, hollow, open distally and with slightly flared and serrate, in places aculeate, margins; process length, 10-15μ; width, 1-2μ.

Endophragm thin, less than 0.5μ, smooth.

Paratabulation. Process distribution not indicative of a process formula or paratabulation; outline of archeopyle denoting presence of apical paraplates.

Archeopyle/operculum. Archeopyle apical and formed by the loss of the apical paraplates; operculum not observed, presumably free and simple.

Formula. A.

Pericingulum/perisulcus. Indications of pericingulum not observed; perisulcal position indicated at its anterior termination by a distinct sulcal notch.

Dimensions. (5 measured specimens) - Length, 37-50μ; width, 25-33μ (excluding processes; all specimens with archeopyle developed).

Comparison. *Tanyosphaeridium* sp. DE differs from *Tanyosphaeridium* sp. C of Brideaux and McIntyre, 1976 and *Tanyosphaeridium* sp. A of Brideaux, 1971, in the possession of a larger number of processes and in its slightly larger size, and from *Tanyosphaeridium* sp. B of Brideaux, 1971, in possession of tubiform rather than buccinate processes.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Previously recorded from Upper Berriasian rocks on the northern Canadian mainland (Brideaux, 1976b).

CHORATE UNASSIGNED CYSTS

Genus *Imbatodinium* Vozzhennikova

1967 *Imbatodinium* Vozzhennikova, p. 52.

Imbatodinium sp. A of Brideaux and McIntyre (10)

1976 *Imbatodinium* sp. A of Brideaux and McIntyre, p. 32, Pl. 9, figs. 14-16.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core, Barremian; Husky Formation, cuttings (caved).

Stoney Core Hole F-42: Albian shale-siltstone division equivalent, conventional core; Middle Albian.

Recorded previously from Middle Albian rocks in the Anderson Plain region, northern Canadian mainalnd (Brideaux and McIntyre, 1976).

CAVATE GONYAULACACEAN CYSTS

Genus *Chlamydophorella* Cookson and Eisenack

1958 *Chlamydophorella* Cookson and Eisenack, p. 56.

Chlamydophorella nyei Cookson and Eisenack (9)

1958 *Chlamydophorella nyei* Cookson and Eisenack, p. 56, Pl. 11, figs. 1-3.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Recorded previously from Barremian to Lower Turonian rocks at various localities (summarized *in* Singh, 1971; Brideaux, 1971; Davey, 1974), and from Coniacian rocks on the Scotian Shelf and western Grand Banks, Atlantic continental margin (Williams, 1975).

Chlamydophorella sp. AE (99)

Plate 14, figure 8

Description.

Shape. Ectocyst elongate, rounded antapically, produced apically to form an open, truncated apical prominence.

Autocyst elongate, rounded antapically, produced apically to form a short, rounded apical horn. Ectocoel developed; interrupted, except in the upper part of the epiectocoel, by processes supporting the ectocyst. Slight dorsoventral compression.

Phragma. Ectophragm about 0.5μ thick, reticulate; lumina 0.25-2.0μ in diameter, subcircular to polygonal in outline; muri about 0.25μ thick and wide; ectophragm in places discontinuous, the discontinuities possibly related to paratabulation, but the relation obscure and poorly understood.

Autophragm from 0.5-1.0μ thick, smooth, bearing discrete processes which support the ectophragm; processes with thin columns about 0.5μ wide, widening basally to about 1.0μ; columns 4-6μ long and distally bifid to bifurcate; process emplacement may reflect paratabulation but relationship is obscure and poorly understood.

Paratabulation. Paratabulation obscure, apparently present as indicated by process emplacement and discontinuities in the ectocyst.

Archeopyle/operculum. Archeopyle formation not observed; a slight suggestion of an incipient apical archeopyle involving both layers noted in material available.

Formula. ?A/?A.

Pericingulum/perisulcus. Not distinguished on available material.

Dimensions. (2 measured specimens) - Ectocyst length, 63-78μ; ectocyst width, 53-58μ; apical ectocyst prominence, 10-18μ; autocyst length, 50-53μ; autocyst width, 38-40μ; apical autocyst horn, 3-5μ.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core; Barremian.

Genus *Endoscrinium* Vozzhennikova

1967 *Endoscrinium* Vozzhennikova, p. 174.

Endoscrinium campanula (Gocht) Vozzhennikova (18)

1959 *Scriniodinium campanula* Gocht, p. 61, Pl. 4, fig. 6, Pl. 5, fig. 1

1967 *Endoscrinium campanula* (Gocht) Vozzhennikova, p. 175.

1971 *Gonyaulacysta fragosa* Brideaux, p. 83, Pl. 23, fig. 42, Pl. 24, figs. 44, 45, Textfig. 8c, d.

Occurrence. Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Middle Albian.

Recorded previously from Valanginian to Turonian rocks (*see* listing *in* Brideaux and McIntyre, 1976) and from the Senonian of the Grand Banks, Atlantic continental margin (Williams and Brideaux, 1975).

Endoscrinium luridum (Deflandre) Gocht (87)

Plate 14, figure 6

1938 *Gymnodinium luridum* Deflandre, p. 166, Pl. 5, figs. 4-6.

1960 *Scriniodinium (Endoscrinium) luridum* (Deflandre) Klement, p. 20, Pl. 1, figs. 2, 3, Textfigs. 2, 3.

1970 *Endoscrinium luridum* (Deflandre) Gocht, p. 144, Pl. 26, fig. 6, Pl. 28, figs. 5-7, Pl. 31, figs. 6-8, Textfigs. 2c, 12-14, 15a-d, 16-18.

Dimensions. (5 measured specimens) - Pericyst length, 75-110μ; pericyst width, 60-100μ. Endocyst length, 67-90μ; endocyst width, 55-77μ.

Occurrence. Rat Pass K-35: Husky Formation, sidewall core; Upper Oxfordian to Lower Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Recorded previously from Bathonian to Lower Kimmeridgian rocks in England, France, northwest Germany, Bulgaria (Deflandre, 1938; Klement, 1960; Dodekova, 1967; Riley and Sarjeant, 1972), from probable Middle and Upper Kimmeridgian rocks of Australia (Cookson and Eisenack, 1960b; Veevers and Wells, 1961), and Oxfordian and probable Kimmeridgian rocks of the Canadian Arctic Archipelago (Brideaux and Fisher, 1976; Brideaux and Myhr, 1976).

Genus *Gardodinium* Alberti

1961 *Gardodinium* Alberti, p. 18.

1967 *non Gardodinium* Alberti sensu Clarke and Verdier, p. 26.

Discussion. Brideaux and McIntyre (1976) discuss the treatment of the genus *Gardodinium* and present evidence to support the presence of an apical, rather than precingular, archeopyle, as proposed by Clarke and Verdier (1967).

Gardodinium eisenackii Alberti (20)

1961 *Gardodinium eisenackii* Alberti, p. 18, Pl. 3, figs. 8-13.

1971 *Gardodinium elongatum* Singh, p. 381, Pl. 68, figs. 3, 4.

Discussion. Davey (1974) synonymizes *Gardodinium eisenackii* Alberti with *Gardodinium trabeculosum* (Gocht) Alberti, 1961, p. 18. The writer prefers to use established nomenclature in the absence of a published comparative study of original material of Gocht (1959) and Alberti (1961).

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from Hauterivian to Aptian rocks of Germany (Alberti, 1961), Hauterivian to Barremian rocks at their type sections (Millioud, 1969), middle Hauterivian to lower Barremian rocks of England (Sarjeant, 1966b), and Aptian to Albian rocks of west-central Alberta and the northern Canadian mainland (Singh, 1971; Brideaux, 1971; Brideaux and McIntyre, 1976; Brideaux and Myhr, 1976).

Genus *Psaligonyaulax* Sarjeant, and related taxa

Discussion. Although genera in other parts of the paper have been arranged alphabetically, it is more convenient to discuss the genus *Psaligonyaulax* and related taxa as a group. New nomenclature and new taxa occasioned by this discussion will be documented following this section.

A number of species previously described in the literature, and assigned to the genera *Psaligonyaulax* Sarjeant, 1966a, *Tubotuberella* Vozzhennikova, 1967, *Scriniodinium* Klement, 1957, *Endoscrinium* (Klement) Vozzhennikova, 1967, *Gonyaulacysta* Deflandre ex Norris and Sarjeant, 1965 emend. Sarjeant, 1969, and *Leptodinium* Klement 1960 emend. Sarjeant, 1969, have these features in common: a well-defined pericyst and endocyst with distinct development of an apical and/or antapical pericoel; an elongate, often tubular or frustum shaped hypopericyst; and a pericingular archeopyle.

Within this larger group, three subgroupings of species may be recognized: the first with development of an apical and antapical pericoel; the second with development of an antapical pericoel only, the apical pericoel absent, or greatly reduced and formed essentially by extension of the pericyst into an apical prominence; and the third with development of an apical pericoel only.

Within the first subgroup, some species possess paratabulation denoted by smooth or spiny parasutures and are with or without apical horns (e.g. *Psaligonyaulax deflandrei* Sarjeant); others show little or no evidence of paratabulation and possess apical horns [e.g. *Glabridinium apatelum* (Cookson and Eisenack) comb. nov.]. Within the second subgroup, species possess paratabulation denoted by smooth or spiny parasutures and have apical horns (e.g. *Dimidiadinium uncinatum* gen. et sp. nov.). The single species in the third subgroup, *Gonyaulacysta cassidata* (Eisenack and Cookson) Sarjeant, 1966b, possesses an apical horn and paratabulation denoted by spiny parasutures. This latter subgroup is not discussed further in this paper.

The morphological characters of many of these species do not correspond to the diagnoses of the genera to which they are assigned. Consequently, some changes in the generic attributions of these species and some newly proposed taxa seem necessary. The reasons for these reallocations and newly proposed taxa are discussed in the following sections.

Genera of this group with apical and antapical pericoel:

Genus *Glabridinium* gen. nov.

Type species. *Glabridinium apatelum* (Cookson and Eisenack, 1960b, p. 249, Pl. 37, figs. 12, 13) comb. nov.

Diagnosis.

Shape. Pericyst ambitus elongate; the epipericyst produced to form an apical horn; the hypopericyst tapering slightly from the presumed latitude of the paracingulum, with a tubular to inverted frustum shape, quadrate in cross-section and open at the antapex to form an antapical breach.

Endocyst ambitus distinctly elongate; endocyst produced to form a short apical horn or prominence. Apical and antapical pericoels developed by separation of the pericyst and endocyst in the regions of the apical pericyst and the antapical pericyst. Ambital pericoel not developed; compression dorso-ventral.

Phragma. Periphragm of constant thickness, the exception being the possible presence of four thin longitudinal rib-like thickenings on the frustum shaped part of the hypoperiphragm; surface smooth or scabrate. No evidence of paratabulation.

Endophragm thin, of constant thickness; smooth, no evidence of paratabulation.

Paratabulation. Evidence for paratabulation lacking except in vicinity of periarcheopyle.

Archeopyle/operculum. Periarcheopyle formed by the loss of the third precingular paraplate; perioperculum simple, detached. Endoarcheopyle formed by the loss of the third precingular paraplate; endoperculum simple, detached.

Formula. P/P.

Pericingulum/perisulcus. Pericingulum generally indistinct or absent. Perisulcus present or absent.

Other features. Antapex of the hypopericyst bears a quadrate opening; the edges smooth or serrate, sometimes with short, spiny projections at each angle (prolongations of the longitudinal rib-like thickenings on the hypopericyst).

Comparison. *Glabridinium* gen. nov. differs from *Psaligonyaulax* Sarjeant in the absence of paratabulation, from *Tubotuberella* Vozzhennikova emend. in the presence of an apical horn and the absence of paratabulation, from *Dimidiadinium* gen. nov. in the absence of paratabulation and the presence of a distinct apical pericoel, and from *Hystrichosphaeropsis* (Deflandre) Sarjeant and *Rottnestia* Cookson and Eisenack in the absence of tabulation together with development of an apical horn and *Triblastula* O. Wetzel, 1933 emend. Morgenroth, 1966 in the absence of tabulation.

Glabridinium apatelum
(Cookson and Eisenack) comb. nov.

1960b *Scriniodinium apatelum* Cookson and Eisenack, p. 249, Pl. 37, figs. 12, 13.

1969 *Psaligonyaulax apatela* (Cookson and Eisenack) Sarjeant, p. 15.

(A more complete synonymy is given *in* Gitmez, 1970, p. 303).

Holotype. National Museum of Victoria P. 17770; Western Australian Petroleum Pty. Ltd. Wallal Core Hole, Alexander Formation, 560-575 feet (170.8-175.4 m); Oxfordian to Lower Kimmeridgian (Cookson and Eisenack, 1960b, p. 244).

Pericyst length, 120μ; pericyst width, 58μ; endocyst length, 80μ; endocyst width, 58μ.

Diagnosis. As for the genus with these particular features: pericyst length/width ratio approximately two to one, pericyst tapering gently at the apex; endocyst ovoid to subrhombic, the epiendocyst slightly longer than the hypoendocyst; peri- and endoperculum elongate, hoof-shaped; pericingulum indistinct, marked by narrow, thin cingular parasutures slightly below the mid-latitude of the pericyst; and perisulcus absent.

Dimensions. Pericyst length, 70-145μ; pericyst width, 30-72μ (compiled from Cookson and Eisenack, 1960b; Gitmez, 1970).

Comparison. The species is distinguished from *Tubotuberella rhombiformis* Vozzhennikova emend. by the absence of paratabulation and development of an apical horn.

Occurrence. Recorded previously from the Oxfordian to Kimmeridgian of Australia and New Guinea (Cookson and Eisenack, 1960b), and the Lower Kimmeridgian of France and England (Gitmez, 1970).

Cookson and Eisenack (1960b) also record this form from the "Tithonian", but Veevers and Wells (1961) suggest that the age of the rocks from which they record the species is not younger than Kimmeridgian. Specimens of *Glabridinium apatelum* in the Upper Cretaceous of the Canadian Arctic Archipelago (Manum and Cookson, 1964) probaly are derived from older rocks. Extension of the range of *Glabridinium apatelum* (Cookson and Eisenack) comb. nov., as *Psaligonyaulax apatela*, by Brideaux and Fisher (1976, Fig. 13) is erroneous and based on confusion in identification with *Dimidiadinium uncinatum* gen. et sp. nov., described later in this paper, and with *Tubotuberella rhombiformis* Vozzhennikova, 1967.

Genus *Tubotuberella* Vozzhennikova emend.

1967 *Tubotuberella* Vozzhennikova, p. 180.

Discussion. *Tubotuberella* Vozzhennikova, 1967 was diagnosed as possessing the following characteristics: an apical horn; precingular archeopyle; apical and antapical pericoels; and paratabulation denoted by smooth or spiny parasutures. The presence of an antapical breach was noted in the diagnosis. However, judged by the illustrations (Vozzhennikova, 1967, Pl. 101, figs. 1, 2, Pl. 102, figs. 1-3, Pl. 104, figs. 1-3), the type species of the genus, *T. rhombiformis*, possesses low, smooth parasutures and lacks an apical horn. The other species assigned to this genus, *T. sphaerocephalus*, judged by the drawings only (Vozzhennikova, 1967, Pl. 103, figs. 1-3), possesses an apical horn, a paratabulation of ?4', 6'', 6c, 5''', 1'''' denoted by spiny parasutures, and lacks an apical pericoel. These observations form the basis for restricting the genus to include species with developed epi- and hypopericoels and without an apical horn. The species *T. sphaerocephalus* is removed, therefore, to the genus *Dimidiadinium* gen. et sp. nov.

Type species. *Tubotuberella rhombiformis* Vozzhennikova (1967, p. 180, Pl. 101, figs. 1, 2, Pl. 102, figs. 1-3, Pl. 104, figs. 1-3) emend.

Diagnosis.

Shape. Pericyst ambitus elongate; the epipericyst tapering but not prolonged into an apical prominence or horn; the hypopericyst tapering sharply and then more gently, the posterior part in the shape of an inverted frustum, quadrate or tubular in cross-section, and open at the antapex, forming an antapical breach.

Endocyst ambitus slightly elongated, ovoid to rounded sub-rhombic; not produced to form an apical prominence. Apical and antapical pericoel developed by separation of the pericyst and endocyst in the regions of the anterior epipericyst and posterior hypopericyst respectively. Ambital pericoel not developed; compression dorso-ventral.

Phragma. Periphragm smooth, of constant thickness and raised into low, narrow parasutural ridges; parasutures smooth or variably ornamented.

Endophragm smooth.

Paratabulation. Paratabulation determined from published figures as ?4', 6'', 0c, 5'''-?6''', 1'''' (antapical breach present).

Archeopyle/operculum. Periarcheopyle formed by the loss of the third precingular paraplate; perioperculum simple, detached. Endoarcheopyle and endoperculum presumably similar but not observed.

Formula. P/P/

Pericingulum/perisulcus. Pericingulum denoted by low, smooth or ornamented parasutures, slightly helicoidal; cingular paratabulation present or absent. Perisulcus present wide anteriorly, the anterior termination commonly poorly delimited; narrowing posteriorly, terminating adjacent to the antapical breach; laterally delimited by low parasutural ridges; perisulcus slightly depressed relative to the rest of the pericyst outline.

Comparison. *Tubotuberella* Vozzhennikova emend. differs from *Glabridinium* gen. nov. in the possession of paratabulation and lack of an apical horn, from *Psaligonyaulax* in the lack of an apical horn, from *Dimidiadinium* gen. nov. in the possession of a distinct apical pericoel and lack of an apical horn, and from *Hystrichosphaeropsis*, *Rottnestia* and *Triblastula* in the shape of the hypopericyst. Individual species of these latter three genera also lack an antapical breach and may possess an apical horn.

Tubotuberella rhombiformis
Vozzhennikova emend. (85)

Plate 14, figures 10, 11, Plate 15, figure 1

1967 *Tubotuberella rhombiformis* Vozzhennikova, p. 180, Pl. 101, figs. 1, 2, Pl. 102, figs. 1-3, Pl. 104, figs. 1-3.

Holotype. IGiG SO AN prep. 308P-447/9, Upper Jurassic (Upper Volgian), well 50, Kuntsevo (Moscow region). Pericyst length, 121.5μ; pericyst width, 64.8μ.

Diagnosis. As for the genus with these particular features: the parasutural ridges smooth and unornamented; the epipericoel conical in outline.

Dimensions. (4 specimens) - Pericyst length, 82-95μ; pericyst width, 60-67μ; endocyst length, 52-67μ; endocyst width, 60-67μ. Combined observations (Vozzhennikova, 1967; this paper): pericyst length, 82-95μ; pericyst width, 40-67μ; endocyst length, 43-67μ; endocyst width, 38-67μ.

Occurrence. Rat Pass K-35: Husky Formation, sidewall core; Middle to Upper Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Kimmeridgian.

Recorded previously from the Upper Jurassic (Upper Volgian) of the Moscow region, U.S.S.R. (Vozzhennikova, 1967; *see also* Brideaux and Fisher, 1976, Fig. 12).

Genus *Psaligonyaulax* Sarjeant

1966a *Psaligonyaulax* Sarjeant, p. 136.

Discussion. The diagnosis of the genus, *Psaligonyaulax*, Sarjeant, 1966a includes the following characteristics: an apical horn; distinct apical and antapical pericoels; a precingular archeopyle; simple detached operculum; paratabulation denoted by smooth or spiny parasutures and determined as 4', 1a, 6'', 6c, 6''', 1p, 1''''; helicoid paracingulum; and distinct perisulcus. An antapical breach may be present or absent. Two published species conform to this diagnosis: *Psaligonyaulax deflandrei* Sarjeant, 1966a, p. 137, Plate 14, figures 7, 8, Textfigure 35 (Cenomanian); and *Psaligonyaulax dualis* Brideaux and Fisher, 1976, p. 18, Plate 1, figures 4-6, 8-12, Plate 2, figures 1, 2 (Upper Oxfordian to Middle ?and Upper Kimmeridgian).

A third species, based only on one specimen and assigned to *Psaligonyaulax* by Sarjeant (1969, p. 15) is provisionally retained: *Psaligonyaulax? simplicia* (Cookson and Eisenack, 1961, p. 42, Pl. 2, figs. 3, 4, Textfig. 1e-f) Sarjeant, 1969, p. 15 (Eocene).

Psaligonyaulax dualis Brideaux and Fisher (80)

1976 *Psaligonyaulax dualis* Brideaux and Fisher, p. 18, Pl. 1, figs. 4-6, 8-12, Pl. 2, figs. 1, 2.

Comparison. Brideaux and Fisher (1976, p. 19) offer a lengthy comparison with similar species.

Occurrence. Rat Pass K-35: Husky Formation and unnamed Upper Jurassic sandstone unit, sidewall core and cuttings; Upper Oxfordian to Kimmeridgian.

Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Kimmeridgian.

Recorded previously from Upper Oxfordian to Upper Kimmeridgian rocks of the northern Canadian mainland and the Canadian Arctic Archipelago [Brideaux and Fisher, 1976; closely comparable material (*see* Brideaux and Fisher, 1976, p. 19)] recorded from Oxfordian to Lower Kimmeridgian rocks of Germany (Klement, 1960), England (Sarjeant, 1962) and France (Gitmez, 1970).

Genera of this group with antapical pericoel only:

Genus *Dimidiadinium* gen. nov.

Type species. *Dimidiadinium dangeardii* (Sarjeant, 1968, p. 226, Pl. 1, fig. 21, Pl. 3, figs. 8, 15, Textfig. 3) comb. nov.

Diagnosis.

Shape. Pericyst ambitus elongate, the length up to twice the width; main portion of the ambitus rounded and subrhombic; epipericyst prolonged to form an apical horn or prominence; hypopericyst tapering gently then more sharply posteriorly and forming a frustum, subquadrate to quadrate in plan; hypopericyst open antapically forming an antapical breach, or closed. Endocyst ambitus subcircular to ovoid to subrhombic, slightly elongate, rounded apically or produced to form a small apical prominence. A distinct apical pericoel not present; antapical pericoel formed by separation of the hypopericyst and hypoendocyst; ambital pericoel not developed; slight dorso-ventral compression.

Phragma. Periphragm smooth or with minor surface ornamentation; of constant thickness; produced to form smooth or variably ornamented parasutural ridges, the ornament varying from small spines to large spines of variable length, or trifurcate spines, the ornament intergonal and/or gonal in position. Endocyst smooth or with minor sculpture and of constant thickness.

Paratabulation. Paratabulation denoted by smooth to ornamented parasutural ridges and determined as 4', ?a, 6'', 6c, 5'''-?6''', 0-1p, 1''''. Evidence of paratabulation not observed on the endocyst.

Archeopyle/operculum. Periarcheopyle formed by the loss of the third precingular paraplate; perioperculum simple, detached, somewhat gibbous to hoof-shaped. Endoarcheopyle and endoperculum similar.

Formula. P/P.

Pericingulum/perisulcus. Pericingulum slightly to moderately helicoid, denoted by smooth or ornamented parasutures which delineate six cingular paraplates. Perisulcus present; generally narrower anteriorly and terminating adjacent to the first apical paraplate, slightly to distinctly broader posteriorly, terminating adjacent to the antapical paraplate or antapical breach; laterally delineated by smooth or spiny parasutures; perisulcal region slightly to moderately depressed relative to the rest of the pericyst outline.

Comparison. *Dimidiadinium* gen. nov. differs from similar genera in the possession of an apical horn, paratabulation and absence of a well-defined apical pericoel. *Psaligonyaulax* and *Glabridinium* have apical and antapical pericoels; *Glabridinium* lacks paratabulation.

Dimidiadinium dangeardii
(Sarjeant) gen. et comb. nov.

1968 *Gonyaulacysta dangeardii* Sarjeant, p. 226, Pl. 1, fig. 21, Pl. 3, figs. 8, 15, Textfig. 3.

Holotype. Specimen V.52315/1, collections of British Museum (Natural History), London; Couches à *Cardioceras cordatum*, base of *C. cordatum* zone, Villers-sur-Mer (Calvados), France; Oxfordian.

Diagnosis. As for the genus with these particular features: short, blunt apical horn; hypopericyst tapering gently from latitude of pericingulum and then sharply to enclose a frustum-shaped antapical pericoel; endocyst ambitus ovoid; periphragm smooth with low, smooth or minutely spinate parasutural ridges defining a paratabultion of 4', ?0a, 6'', 6''', 1p, 1''''; archeopyle formed by the loss of the third precingular paraplate; operculum trapezoidal in shape, simple and detached; pericingulum helicoid, displaced twice its breadth, perisulcus narrow anteriorly and extending well onto the epipericyst, broader posteriorly; antapical breach present or absent. Sarjeant (1968, p. 226) gives further details about the shape and disposition of the paraplates.

Dimensions. Pericyst length, 70-89μ; pericyst width, 40-55μ; endocyst width, 38-53μ; apical horn length, 4-8μ.

Comparison. The species differs from *Dimidiadinium sphaerocephalum* (Vozzhennikova) gen. et comb. nov. and *Dimidiadinium uncinatum* gen. et sp. nov. in possessing smooth or minutely spinate parasutures.

Occurrence. Reported from the Upper Callovian and Lower Oxfordian of France (Sarjeant, 1968) and the Lower Oxfordian of England (Riley and Sarjeant, 1972, Table 3).

Dimidiadinium sphaerocephalum
(Vozzhennikova) comb. nov.

1967 *Tubotuberella sphaerocephalus* Vozzhennikova, p. 181, Pl. 103, figs. 1-3, Pl. 104, figs. 4, 5a, b.

Diagnosis. As for the genus with these particular features: short, conical apical horn surmounted with short spines; periphragm smooth and raised into parasutural ridges bearing simple, acuminate or capitate spines, the parasutures defining a paratabulation of ?4', ?0a, 6'', 6c, 5'''-?6''', ?p, 1''''; operculum hoof-shaped; pericingulum very slightly helicoid; anterior termination of perisulcus poorly defined and denoted by several rows of spinelets, posterior termination at the antapex; antapical breach present. Other details given by Vozzhennikova (1967, p. 181).

Dimensions. Pericyst length, 73-79μ; pericyst width, 50-60μ.

Comparison. This species differs from other species of the genus in possessing strongly spinate parasutures with gonal and intergonal spines.

Occurrence. Reported only from the Upper Jurassic (Upper Volgian) of the Moscow region, U.S.S.R. (Vozzhennikova, 1967).

Dimidiadinium uncinatum sp. nov. (49)

Plate 15, figures 2-5, 7, 8

Holotype. GSC No. 46050, ARCO Slide 10611A-2, 15.8 x 131.6, Upper shale-siltstone division equivalent, Banff-Aquitaine-Arco Rat Pass K-35 well, 1380 feet (420.6 m), GSC loc. C-12617; Barremian.

Pericyst length, 110μ; pericyst width, 68μ; endocyst length, 70μ. The small pericoel formed by the extension of the pericyst to form the apical horn is slightly larger than on most specimens; folding of the apical part of the pericyst accentuates this feature.

Diagnosis.

Shape. Pericyst ambitus broadly rhomboidal, the maximum width occurring at the latitude of the paracingulum; epipericyst tapering to form a short apical horn; hypopericyst tapering gently at first but then more abruptly to form a frustum, subquadrate in plan, and open antapically to form an antapical breach.

Endocyst ambitus subcircular to subrhombic. A small pericoel occurs only where the pericyst and endocyst separate to form an apical horn; antapical pericoel formed through the extension of the posterior hypopericyst and its separation from the posterior hypoendocyst; slight dorso-ventral compression.

Phragma. Periphragm thin, about 0.5μ thick, of constant thickness; surface sculpture smooth to scabrate; periphragm raised into low, thin parasutural ridges which bear thin-columned trifurcate processes at the junction of parasutural ridges and at the four corners of the quadrate to subquadrate antapical breach; parasutural ridges up to 3μ high but typically 1-2μ; processes up to 11μ, typically 8-10μ.

Endophragm thin, about 0.5μ thick, smooth.

Paratabulation. Paratabulation on the periphragm denoted by parasutural ridges and gonally positioned trifurcate processes, and determined as ?4', 6'', xc, 5''', 0-1p, 1''''.

Details of apical paraplates difficult to determine because of folding of the periphragm; of the precingular paraplates, 3'' is broadly pentagonal; of the post-cingular paraplates, all are broadly pentagonal, elongate and terminate adjacent to the antapical breach; 1''' and 5''' are the smallest; antapical breach occupying the position of the antapical paraplate, quadrate to subquadrate and flanked by four gonal processes. Evidence for paratabulation on endophragm lacking, except at the endoarcheopyle.

Archeopyle/operculum. Periarcheopyle formed by the loss of the third precingular paraplate; perioperculum simple, detached, broadly pentagonal and elongate in outline. Endoarcheopyle formed by the loss of the third precingular paraplate; endoperculum simple, detached, broadly pentagonal in shape, but slightly smaller in overall dimensions than the perioperculum.

Formula. P/P.

Percingulum/perisulcus. Parasutural ridges outline the course of the pericingulum on the pericyst; pericingulum slightly or not at all offset; six pairs of gonal trifurcate processes denote the presence of six cingular paraplates, other evidence for cingular paratabulation lacking. Perisulcus present, position outlined by a shallow, elongate depression, more prominent posteriorly, and by parasutural ridges; perisulcus terminated anteriorly against the first apical paraplate, and posteriorly by the antapical breach.

Variation. The apex of the pericyst sometimes bears several short spiny projections. Specimens vary greatly in the numbers of trifurcate processes present (possibly because of variable degree of mechanical damage). Along cingular parasutures, trifurcate processes may be reduced to broad-based, distally acuminate projections in gonal position. Occasional specimens, including the holotype, have a broader separation of the pericyst from the endocyst in the vicinity of the apical horn.

Dimensions. (22 specimens) - Pericyst length, 75-133μ; pericyst width, 53-75μ; endocyst length, 55-75μ.

Discussion. *Dimidiadinium uncinatum* sp. nov. has been confused (at least in part) with *Glabridinium apatelum* gen. et comb. nov. by Brideaux and Fisher (1976, Fig. 13) and by Pocock (in press). The species is listed as *Scriniodinium* sp. A var. A and B by Brideaux *in* Barnes *et al.* (1974, Fig. 4) and confused in part with *Tubotuberella rhombiformis* Vozzhennikova emend. The range of this species as indicated by Brideaux *in* Barnes *et al.* (1974, Fig. 4) is incorrect. The restricted range given below is based on a more complete understanding of the morphology of this and related species.

Comparison. *Dimidiadinium uncinatum* sp. nov. is distinguished from other species placed in this genus by possession of smooth parasutures bearing gonal trifurcate processes.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores and cuttings; Hauterivian to Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

The confirmed reported range of this species is Hauterivian to Barremian.

Taxa of doubtful attribution

Several other species possess morphological characteristics similar to the species assigned to the genera described in the previous sections. However, their taxonomic position remains doubtful.

Scriniodinium galeatum Cookson and Eisenack, 1960a, p. 3, Plate 1, figures 16-18, appears very similar in morphology to *Glabridinium apatelum* (Cookson and Eisenack) gen. et comb. nov. However, *S. galeatum* appears in places to possess indication of paratabulation denoted by parasutural granules on the periphragm, and thus possesses some characteristics in common with *Psaligonyaulax* Sarjeant.

Endoscrinium eisenackii subspecies *eisenackii* (Deflandre) Gocht, 1970, p. 146, and *E. eisenackii* subspecies *oligodentata* (Cookson and Eisenack) Gorka, 1965 appear, from published illustrations and descriptions (Deflandre, 1938; Cookson and Eisenack, 1958; Klement, 1960; Sarjeant, 1962, 1968, 1972; Gorka, 1965; Dodekova, 1967; and Gocht, 1970), to belong to the genus *Tubotuberella* Vozzhennikova emend. *Endoscrinium eisenackii* possesses paratabulation, apical and antapical pericoels and appears to lack an apical horn. However, it is difficult to determine definitely from illustrations whether an apical horn is absent or present. That is: whether the apparent prominence illustrated by many authors is formed from an apical extensions of the pericyst, or simulated by folding of parasutural crests in the apical region. The writer agrees with Sarjeant (1972, p. 17) that the species, *eisenackii*, does not belong in the genus *Endoscrinium* as indicated by Gocht (1970). Original material for these taxa need to be studied in order to support their present generic allocations.

Finally, two other species show some similarities to the taxa under discussion in that they exhibit paratabulation, an antapical pericoel, a slightly extended hypopericyst, often terminated against a quadrate antapical breach, and lack a distinct apical pericoel and an apical horn. The species, *Endoscrinium luridum* (Deflandre) Gocht, 1970 and *Leptodinium egemenii* Gitmez, 1970, are near in concept to the genus *Dimidiadinium* but lack apical horns. Their reallocation to this genus now would be premature.

Genus *Scriniodinium* Klement

1957 *Scriniodinium* Klement, p. 409.

Scriniodinium crystallinum (Deflandre) Klement (84)

Plate 15, figure 6

1960 *Scriniodinium crystallinum* (Deflandre) Klement, p. 18.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Upper Oxfordian to Lower Kimmeridgian.

Recorded previously from Upper Callovian to Kimmeridgian rocks of France, England, Australia, Germany, eastern Canada and the northern Canadian mainland and Arctic Archipelago (Deflandre, 1938; Sarjeant, 1961, 1968; Cookson and Eisenack, 1958; Klement, 1957; Williams, 1975; Brideaux and Fisher, 1976).

Genus *Sirmiodinium* Alberti emend. Warren

1961 *Sirmiodinium* Alberti, p. 22.

1973 *Sirmiodinium* Alberti emend. Warren, p. 104.

Sirmiodinium grossii Alberti emend. Warren (72)

Plate 15, figure 11

1961 *Sirmiodinium grossii* Alberti, p. 22, Pl. 7, figs. 5-7, Pl. 12, fig. 5.

1973 *Sirmiodinium grossii* Alberti emend. Warren, p. 104, Pl. 1, figs. 1-16, Pl. 2, figs. 1-10, Pl. 3, figs. 1-8, Textfigs. 3-6.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores, Kimmeridgian and Hauterivian to Barremian; cuttings, Upper Oxfordian to Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent and Husky Formation, conventional core; Middle Kimmeridgian and Barremian.

Recorded previously from the Upper Tithonian to Hauterivian of California (Warren, 1973), the Upper Kimmeridgian of Great Britain (Gitmez and Sarjeant, 1972), the Upper Hauterivian to Upper Barremian of Germany (Alberti, 1961), the Middle Hauterivian to Lower Barremian of England (Sarjeant, 1966b), the Barremian of England (Davey, 1974) and, in Canada, from the Middle? to Upper Kimmeridgian and Tithonian of the northern Canadian mainland and Arctic Archipelago (Brideaux and Fisher, 1976).

CAVATE PSEUDOCERATIACEAN CYSTS

Genus *Muderongia* Cookson and Eisenack

1958 *Muderongia* Cookson and Eisenack, p. 40.

Muderongia asymmetrica sp. nov. (33)

Plate 15, figures 9, 10, Plate 16, figure 1

1967 *Muderongia* sp. 1 Vozzhennikova, Pl. 115, Fig. 3 (no text reference).

1974 *Muderongia* sp. B Brideaux *in* Barnes *et al.*, Fig. 4.

1976 *Muderongia* sp. A Brideaux and McIntyre, p. 34, Pl. 11, figs. 4, 5.

Holotype. GSC No. 46054, Slide P770-25A, 25.8 x 133.8, Upper shale-siltstone division equivalent, I.O.E. Stoney Core Hole F-42, 390-400 feet (119-122 m), conventional core, GSC loc. C-10707; lower Albian.

Diagnosis.

Shape. Pericyst ambitus elongate, the main portion pentagonal to subrhombic; epipericyst prolonged into a long, tapering apical horn; hypopericyst prolonged antapically to form a longer tapering left antapical horn and a shorter, tapering to acuminate right antapical horn; laterally, hypopericyst produced to form a shorter right postcingular and longer left postcingular horn. Left antapical horn from one and one-half to three times the length of the right antapical horn; right postcingular horn distinctly longer and up to four times as long as the left postcingular horn; right postcingular horn broad at the base but tapering abruptly at about half its length.

Endocyst ambitus follows that of pericyst, but extends only slightly or not at all into the apical, postcingular and antapical horns. One apical, two lateral and two antapical pericoels formed in the broad sense; ambital pericoel not developed; dorso-ventral compression.

Phragma. Periphragm about 1.0μ thick, of constant thickness; surface smooth or granulate.

Endophragm thin, less than 0.5μ thick, of constant thickness.

Paratabulation. Evident only in the formation of the archeopyle, denoted by the zig-zag shape of the archeopyle outline; details of paratabulation not observed.

Archeopyle/operculum. Peri- and endoarcheopyle formed by the loss of the apical part of the peri- and endocyst; perioperculum presumably simple, detached, as is endoperculum; detached opercula not observed.

Formula. A/A.

Pericingulum/perisulcus. Not observed.

Dimensions. (17 specimens) - Pericyst width (2 complete specimens), 103, 118μ; pericyst width (excluding postcingular horns), 43-58μ; left postcingular horn, 12-38μ; right postcingular horn, 15-33μ; left antapical horn, 25-60μ; right antapical horn, 10-35μ.

Comparison. Muderongia asymmetrica sp. nov. is distinguished from other species of the genus by its possession of two developed antapical horns and by the pairing of long left antapical and short right postcingular horns and short right antapical and long left postcingular horns. "Pseudoceratium sp. A" of Davis (1963, p. 130, Pl. 10, figs. 9-12; unpubl. thesis) possesses a shorter and broader apical horn and postcingular and antapical horns in equal-sized pairs.

Occurrence. Rat Pass K-35: Upper sandstone division equivalent, cuttings; Aptian.

Stoney Core Hole F-42: Albian shale-siltstone division and Upper sandstone division equivalents, conventional core; Aptian and Lower Albian.

Recorded previously from Aptian and Lower Albian rocks of the northern Canadian mainland (Brideaux and McIntyre, 1976; Brideaux and Myhr, 1976); figured only by Vozzhennikova (1967, Pl. 115, fig. 3) and designated as coming from the Tyumensk region of western Siberia from rocks in Well 318P dated as Valanginian in age (Vozzhennikova, 1967, p. 15). Confirmed range of the species: Aptian to Lower Albian.

Muderongia tetracantha (Gocht) Alberti (38)

Plate 16, figure 2

1957 *Pseudoceratium? tetracanthum* Gocht, p. 168, Pl. 18, figs. 7-9.

1961 *Muderongia tetracantha* (Gocht) Alberti, p. 14, Pl. 2, figs. 14-18.

Dimensions. (6 measured specimens) - Total pericyst length, 140-175μ; pericyst width, excluding paracingular horns, 50-58μ; paracingular horn length, 35-55μ; antapical horn length, 60-70μ.

Occurrence. Stoney Core Hole F-42: ?Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Aptian.

Recorded previously from the Valanginian to Lower Barremian of Germany and Poland (Alberti, 1961), the Upper Hauterivian of Germany (Gocht, 1957), the Aptian of Australia (Cookson and Eisenack, 1958), and the Barremian and Aptian of the northern Canadian mainland (Brideaux and McIntyre, 1976; Brideaux and Myhr, 1976).

Genus *Odontochitina* Deflandre

1935 *Odontochitina* Deflandre, p. 234.

Odontochitina operculata (O. Wetzel) Deflandre and Cookson (5)

1955 *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson, p. 291.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from many localities worldwide (*see* Singh, 1971; Brideaux, 1971) in Hauterivian to Campanian rocks, and from Aptian, Middle Albian and Campanian rocks on the northern Canadian mainland (Brideaux and McIntyre, 1976; Brideaux and Myhr, 1976), and Barremian to Campanian rocks on the Canadian Atlantic continental margin (Williams and Brideaux, 1975; Williams, 1975).

Odontochitina sp. (92)

Plate 16, figure 3

Dimensions. (1 specimen) - Pericyst length, specimen broken, 175μ; endocyst length, 75μ; endocyst width, 58μ.

Discussion. The morphology of this specimen is similar to that of *Odontochitina operculata* (O. Wetzel) Deflandre and Cookson, except that the antapical horn does not taper uniformly but rather, bulges anteriorly and the outline of the archeopyle is not so clearly zig-zag. The endocyst is also more elongated.

Occurrence. Stoney Core Hole F-42: Husky Formation, conventional core; Upper Jurassic, Upper Oxfordian to Lower Kimmeridgian.

This specimen does not appear to be a contaminant; no other species with known ranges restricted to Cretaceous rocks occur in this sample. It appears, therefore, to be a confirmed report of the genus, *Odontochitina*, from the Upper Jurassic.

Genus *Senoniasphaera* Clarke and Verdier

1967 *Senoniasphaera* Clarke and Verdier, p. 61.

Senoniasphaera microreticulata Brideaux and McIntyre (19)

1976 *Senoniasphaera microreticulata* Brideaux and McIntyre, p. 35, Pl. 11, figs. 7-12, Pl. 12, figs. 1-8.

Occurrence. Stoney Core Hole F-42: Albian shale-siltstone division and Upper shale-siltstone division equivalents, conventional core; Barremian and Middle Albian.

Recorded previously from Lower and Middle Albian rocks of the northern Canadian mainland (Brideaux and McIntyre, 1976), and recently from the Upper shale-siltstone division exposed downstream from the I.O.E. Stoney Core Hole F-42, along Stoney Creek, associated with an upper Hauterivian to Barremian dinoflagellate cyst assemblage (W.W. Brideaux, GSC Paleontology Report No. 8-WWB-1974, unpubl.).

CAVATE PERIDINIACEAN CYSTS

Genus *Palaeoperidinium* Deflandre ex Sarjeant

1934 *Palaeoperidinium* Deflandre, p. 968 (*nom. nud.*).

1967a *Palaeoperidinium* Deflandre ex Sarjeant, p. 246.

Palaeoperidinium cretaceum (Pocock ex Davey) Lentin and Williams (6)

1962 *Palaeoperidinium cretaceum* Pocock, p. 80, Pl. 14, figs. 219-221 (invalid under ICBN, Art. 43).

1970 *Astrocysta cretacea* Pocock ex Davey, p. 359, Pl. 2, fig. 4.

1971 *Lejeunia? cretacea* (Pocock ex Davey) Brideaux, p. 86, Pl. 24, figs. 46, 47.

1976 *Palaeoperidinium cretaceum* (Pocock ex Davey) Lentin and Williams, p. 110.

Discussion. For a complete discussion, see the comments by Brideaux and McIntyre (1976, p. 36). In addition, it may be noted that Lentin and Williams (1976, p. 110) have transferred the valid species *cretaceum* to *Palaeoperidinium* Deflandre ex Sarjeant, 1967 and this represents the first effectively and validly published combination of these two names.

Occurrence. Rat Pass K-35: Albian shale-siltstone division, Upper sandstone division, and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian to Albian.

Stoney Core Hole F-42: Albian shale-siltstone division, Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Middle Albian.

Recorded previously from Barremian to Campanian rocks in eastern and western Canada (Pocock, 1962; Singh, 1964, 1971; Brideaux, 1971; Williams, 1975), Arctic Canada (Manum and Cookson, 1964; Brideaux and McIntyre, 1976) and the Atlantic Coastal Plain (Brideaux, unpubl.), and from the Lower Cenomanian of Montana and Wyoming (Burgess, 1971). *See also* Brideaux and McIntyre (1976, p. 36) for further information on these occurrences.

Subtilisphaera Jain and Millepied emend. Lentin and Williams

1973 *Subtilisphaera* Jain and Millepied, p. 27.

1976 *Subtilisphaera* Jain and Millepied, emend. Lentin and Williams, p. 117.

Subtilisphaera perlucida (Alberti) Jain and Millepied (47)

Plate 16, figures 4, 5

1959 *Deflandrea perlucida* Alberti, p. 102, Pl. 9, figs. 16, 17.

1973 *Subtilisphaera perlucida* (Alberti) Jain and Millepied, p. 27.

Discussion. Some new observations on this species, based on examination of several hundreds of specimens, are presented herein. The presence of a periarcheopyle involving formation by loss of one apical paraplate (3'), three intercalary paraplates (1a, 2a, 3a), and three precingular paraplates (3"-5") is confirmed, although its occurrence in the population is rare. Endoarcheopyle formation was not observed. A few very well preserved specimens exhibited evidence of paratabulation denoted by parasutural rows of minute granules. On these few specimens, the apical paraplate series is not visible. Only one intercalary plate (2a) was visible; on this specimen (Pl. 16, fig. 4), it is elongate in the longitudinal axis and belongs to the shape class called "attenuated hexa 2a" by Lentin and Williams (1976). Three precingular paraplates (3", 4", 5") are visible; paraplate 4" is subquadrate, the posterior parasuture being slightly longer than the anterior parasuture. Postcingular paraplates 3"', 4"' and 5"' are imperfectly visible. None of the specimens examined shows any evidence for pandasutural bands as in *Palaeoperidinium* (*see also* Lentin and Williams, 1976, p. 117-119).

Dimensions. (65 measured specimens, many hundreds observed) - Pericyst: length, 65-102μ; width, 35-70μ. Endocyst: length, 55-65μ; width, 35-42μ.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores; Barremian; cuttings (first occurrence, Aptian).

Stoney Core Hole F-42: Upper sandstone division and Upper shale-siltstone division equivalents, conventional core; Barremian to Aptian.

Recorded previously from the Upper Barremian of Germany (Alberti, 1959), the Barremian of England (Davey, 1974), the Aptian of France (Davey and Verdier, 1974), the Hauterivian to Aptian of the Canadian Atlantic continental margin (Williams, 1975, Fig. 5) and the (?)Barremian-Aptian of Czechoslovakia (Vavrdova, 1964).

Vavrdova (1964) records, but does not figure, specimens of *Subtilisphaera perlucida* from the Tesin-Hradiste series of Czechoslovakia (northwestern Moravia), and cites the age of the series as Valanginian to early Aptian (Vavrdova, 1964, p. 91). Harker and Sarjeant (1975, Chart 6) extend the range of *S. perlucida* based on this statement. However, Vavrdova (1964, p. 101) states that "The determined microplankton assemblage is to be correlated with those of the Barremian and Aptian series of Germany ...." The present writer observes also that samples studied by Vavrdova (1964) came only from some part of the Tesin-Hradiste series. Therefore, to cite a range of Valanginian-lower Aptian based on such information results only in confusion of poorly documented information with well-documented data.

UNASSIGNED CAVATE CYSTS

Genus *Dingodinium* Cookson and Eisenack

1958 *Dingodinium* Cookson and Eisenack, p. 39.

Dingodinium cerviculum Cookson and Eisenack (53)

1958 *Dingodinium cerviculum* Cookson and Eisenack, p. 40, Pl. 1, figs. 12-14.

1966b *Dingodinium albertii* Sarjeant, p. 210, Pl. 21, fig. 3, Pl. 23, fig. 1.

Discussion. Specimens encountered in this study and other studies (Brideaux, 1971; Brideaux and McIntyre, 1976) have an overall length intermediate between that quoted by Cookson and Eisenack (1958) of 81-109μ and Sarjeant (1966b) of 50-66μ. Singh (1971) describes material with an overall length closer to that of Sarjeant's (1966b) material but notes that, on many specimens, damage has occurred to the anterior part of the apical horn. The differentiation of the two species, *cerviculum* and *albertii*, on size range seems difficult to maintain and the two species are synonymized in this investigation.

Occurrence. Rat Pass K-35: Upper sandstone division and Upper shale-siltstone division equivalents, sidewall cores and cuttings; Hauterivian? to Barremian and Aptian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Barremian.

Reported previously from Upper Hauterivian to Albian rocks from Germany, France, England, Roumania, Australia and Canada (*see* Davey, 1974; Brideaux and McIntyre, 1976).

Genus *Wallodinium* Loeblich and Loeblich

1960a *Diplotesta* Cookson and Eisenack, p. 10 (*nom. nud.*) *non* Brongniart, 1874.

1960b *Diplotesta* Cookson and Eisenack, p. 256 *non* Brongniart, 1874.

1968 *Wallodinium* Loeblich and Loeblich, p. 212 (*nom. subst. pro Diplotesta* Cookson and Eisenack).

Wallodinium luna (Cookson and Eisenack) Lentin and Williams (63)

Plate 16, figures 6, 7

1960a *Diplotesta luna* Cookson and Eisenack, p. 10, Pl. 3, fig. 21.

1961 *Diplotesta krutzschii* Alberti, p. 21, Pl. 7, figs. 19-21, Pl. 12, figs. 6, 7.

1964 *Diplotesta anglica* Cookson and Hughes, p. 56, Pl. 11, figs. 1-5.

1972 *Wallodinium krutzschii* (Alberti) Habib, p. 378, Pl. 9, fig. 12, Pl. 13, fig. 2.

1973 *Wallodinium anglicum* (Cookson and Hughes) Lentin and Williams, p. 140.

1973 *Wallodinium luna* (Cookson and Eisenack) Lentin and Williams, p. 140.

1974 *Wallodinium luna* (Cookson and Eisenack) Lentin and Williams; Davey and Verdier, p. 645.

1974 *Wallodinium anglicum* (Cookson and Hughes) Lentin and Williams; Davey and Verdier, p. 645.

1974 *Wallodinium anglicum* (Cookson and Hughes) Lentin and Williams; McIntyre, p. 26, Pl. 9, figs. 1, 2.

Discussion. The name, *Diplotesta* Cookson and Eisenack *non* Brongniart is a junior homynym (Loeblich and Loeblich, 1968, p. 212) and, though effectively published, is illegitimate under the ICBN (Art. 64). All species, however, were effectively and validly published with that generic epithet and must be considered for purposes of priority (Art. 11). Davey and Verdier (1974, p. 645) suggested that the three species, *luna*, *krutzschii*, and *anglicum*, are, for practical purposes, inseparable. They indicated that the species, *luna*, would have priority should these three species be synonymized, and this view is embodied in the synonymy.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall core and cuttings; Barremian.

Stoney Core Hole F-42: Upper shale-siltstone division equivalent, conventional core; Hauterivian to Barremian.

Recorded previously from Lower Hauterivian to Cenomanian rocks of England, France, Germany, Australia and the Atlantic continental margin of the United States (Cookson and Eisenack, 1960b; Alberti, 1961; Cookson and Hughes, 1964; Habib, 1972; Davey and Verdier, 1974; Davey, 1974); a Santonian-Campanian occurrence from the northern Canadian mainland (McIntyre, 1974) may be derived.

GROUP ACRITARCHA EVITT

Genus *Micrhystridium* Deflandre

1937 *Micrhystridium* Deflandre, p. 79.

Micrhystridium sp. A of Brideaux and McIntyre (17)

1976 *Micrhystridium* sp. A Brideaux and McIntyre, p. 39, Pl. 14, figs. 12, 13.

Occurrence. Stoney Core Hole F-42: Albian shale-siltstone division equivalent, conventional core; Middle Albian.

Recorded previously from Lower and Middle Albian rocks of the northern Canadian mainland (Brideaux and McIntyre, 1976).

Genus *Pterospermopsis* W. Wetzel

1952 *Pterospermopsis* W. Wetzel, p. 411.

Pterospermopsis australiensis Deflandre and Cookson (7)

1955 *Pterospermopsis australiensis* Deflandre and Cookson, p. 286, Pl. 3, fig. 4, Figs. 52, 53.

Occurrence. Rat Pass K-35: Upper shale-siltstone division equivalent, sidewall cores, Barremian; cuttings (first occurrence, Aptian).

Stoney Core Hole F-42: Albian shale-siltstone division and Upper shale-siltstone division equivalents, conventional core; Hauterivian to Barremian and Middle Albian.

Recorded previously from Lower Cretaceous to Paleocene rocks (*see* Brideaux and McIntyre, 1976).

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APPENDIX 1

LIST OF SAMPLES

Banff-Aquitaine-Arco Rat Pass K-35 well

Sidewall cores

C-12602	945 ft	288.0 m	Upper shale-siltstone division equivalent
C-12606	1025 ft	312.4 m	
C-12609	1130 ft	344.4 m	
C-12611	1180 ft	359.7 m	
C-12613	1250 ft	381.0 m	
C-12615	1325 ft	403.9 m	
C-12617	1380 ft	420.6 m	
C-12619	1445 ft	440.4 m	
C-12622	1530 ft	466.3 m	
C-12624	1600 ft	487.7 m	
C-12626	1660 ft	506.0 m	
C-12628	1710 ft	521.2 m	Husky Formation
C-12630	1765 ft	538.0 m	
C-12635	1920 ft	585.2 m	Unnamed sandstone unit
C-12639	2025 ft	617.2 m	Paleozoic lithologic units
C-12640	2225 ft	678.2 m	
C-12641	2325 ft	708.7 m	

Cuttings samples

C-12582	70- 90 ft	21.3- 27.4 m	Albian shale-siltstone division equivalent
C-12583	110-130 ft	33.5- 39.6 m	
C-12584	150-170 ft	45.7- 51.8 m	Upper sandstone division equivalent
C-12585	190-210 ft	57.9- 64.0 m	
C-12586	230-250 ft	70.1- 76.2 m	
C-12587	280-300 ft	85.3- 91.4 m	
C-12588	330-350 ft	100.6-106.7 m	Upper sandstone division equivalent
C-12589	370-390 ft	112.8-118.9 m	
C-12590	410-430 ft	125.0-131.1 m	
C-12591	450-470 ft	137.2-143.3 m	
C-12592	500-520 ft	152.4-158.5 m	Upper shale-siltstone division equivalent
C-12593	550-570 ft	167.6-173.7 m	
C-12594	590-610 ft	179.8-185.9 m	

C-12595	630- 650 ft	192.0-198.1 m	
C-12596	690- 700 ft	210.3-213.4 m	
C-12597	750- 760 ft	228.6-231.6 m	
C-12598	780- 800 ft	237.7-243.8 m	
C-12599	830- 840 ft	253.0-256.0 m	
C-12600	910- 920 ft	277.4-280.4 m	
C-12601	930- 940 ft	283.4-286.5 m	
C-12603	960- 970 ft	292.6-295.7 m	
C-12604	990-1000 ft	301.7-304.8 m	
C-12605	1010-1020 ft	307.8-310.9 m	
C-12607	1040-1050 ft	317.0-320.0 m	
C-12608	1808-1090 ft	329.2-332.2 m	
C-12610	1140-1150 ft	347.5-350.5 m	
C-12612	1210-1220 ft	368.3-371.9 m	
C-12614	1280-1290 ft	390.1-393.2 m	
C-12616	1350-1360 ft	411.5-414.5 m	
C-12618	1410-1420 ft	429.8-432.8 m	
C-12620	1470-1480 ft	448.1-451.1 m	
C-12621	1500-1510 ft	457.2-460.2 m	
C-12623	1550-1560 ft	472.4-475.5 m	
C-12625	1620-1630 ft	493.8-496.8 m	
C-12627	1680-1690 ft	512.1-515.1 m	
C-12629	1710-1720 ft*	521.2-524.3 m*	Husky Formation
C-12631	1780-1800 ft	542.5-545.6 m	
C-12632	1810-1820 ft	551.7-554.7 m	
C-12633	1850-1860 ft	563.9-567.0 m	
C-12634	1880-1890 ft	573.0-576.1 m	
C-12636	1900-1910 ft	579.1-582.2 m	Unnamed sandstone unit
C-12637	1910-1920 ft	582.2-595.2 m	
C-12638	1930-1950 ft	588.3-591.3 m	Paleozoic lithologic units

* Samples lagged 20 ft (6.1 m) below 1690 ft (515.1 m)

I.O.E. Stoney Core Hole F-42

Conventional core

C-9152	20- 30 ft	6.1- 9.1 m	Albian shale-siltstone division equivalent
C-9153	40- 50 ft	12.2- 15.2 m	

C-9154	60- 70 ft	18.3- 21.3 m	
C-9155	80- 90 ft	24.3- 27.3 m	
C-10696	130-135 ft	39.6- 41.1 m	
C-10697	145-150 ft	44.2- 45.7 m	
C-10698	160-165 ft	48.4- 50.3 m	
C-10699	210-220 ft	64.0- 67.1 m	
C-10700	230-240 ft	70.3- 73.3 m	
C-10701	250-260 ft	76.4- 79.5 m	
C-10702	270-280 ft	82.6- 85.7 m	
C-10703	310-320 ft	94.5- 97.6 m	
C-10704	330-340 ft	100.7-103.8 m	
C-10705	350-360 ft	106.7-109.7 m	
C-10706	370-380 ft	112.8-115.8 m	
C-10707	390-400 ft	119.0-122.0 m	
C-10708	410-420 ft	125.0-128.0 m	
C-10709	430-440 ft	131.0-134.0 m	Upper sandstone division equivalent
C-9156	450-460 ft	137.1-140.2 m	
C-10710	470-480 ft	143.2-146.2 m	
C-10711	510-520 ft	155.4-158.4 m	
C-10712	530-540 ft	161.5-164.5 m	
C-10713	550-560 ft	167.6-170.6 m	
C-10714	610-620 ft	185.9-188.9 m	
C-10715	660-670 ft	201.2-204.2 m	
C-10716	680-690 ft	207.1-210.3 m	Upper shale-siltstone division
C-10717	690-700 ft	210.3-213.3 m	
C-10718	700-715 ft	213.3-217.9 m	
C-4343	725-730 ft	221.0-222.5 m	
C-10719	740-745 ft	225.7-227.1 m	
C-10721	760-765 ft	231.6-233.1 m	
C-10722	770-775 ft	234.6-236.2 m	
C-10723	780-785 ft	237.7-239.3 m	
C-10724	790-795 ft	240.8-242.3 m	
C-9157	795-800 ft	242.3-243.8 m	
C-10725	805-810 ft	245.4-246.9 m	
C-10726	815-820 ft	248.4-249.9 m	

C-10727	825- 830 ft	251.5-253.0 m	
C-10728	835- 840 ft	254.5-256.0 m	
C-10729	845- 850 ft	257.6-259.1 m	
C-10730	855- 860 ft	260.6-262 m	
C-10731	865- 870 ft	263.7-265.2 m	
C-10732	875- 880 ft	266.7-268 m	
C-10733	890- 900 ft	271 -274 m	
C-4344	900- 910 ft	274 -277 m	
C-10734	910- 920 ft	277 -280 m	
C-30190	920- 930 ft	280 -283 m	
C-30191	930- 940 ft	283 -286 m	
C-30192	970- 980 ft	296 -299 m	Husky Formation
C-30193	980- 990 ft	299 -302 m	
C-30195	1000-1010 ft	302 -305 m	
C-4345	1010-1020 ft	305 -308 m	
C-30196			

T.D. 1020 ft (311 m)

APPENDIX 2

List of species identified in: Imperial Oil Limited Slides 3087-4/3087-5
Imp. Virginia Hills 6-36-63-12W5M
5675-5676 ft (1730.9-1731.2 m)
(contains GSC Plant Type No. 14358)

Canningia aspera Singh, 1971

Canningia sp. cf. *C. colliveri* Cookson and Eisenack, 1960b

Tenua brevispinosa (Pocock) comb. nov.

Muderongia asymmetrica sp. nov.

Batioladinium jaegeri (Alberti) Brideaux, 1975b

Palaeoperidinium cretaceum (Pocock ex Davey) Lentin and Williams, 1976

Chlamydophorella nyei Cookson and Eisenack, 1958

Odontochitina operculata (O. Wetzel) Deflandre and Cookson, 1955

Oligosphaeridium complex (White) Davey and Williams, 1966

Oligosphaeridium albertense (Pocock) Davey and Williams, 1966

Oligosphaeridium totum Brideaux, 1971 subsp. *totum*

Oligosphaeridium irregulare (Pocock) Davey and Williams, 1966
[The paratype only on Imperial Oil Ltd. Slide 3087-5, 38.0 x 118.6; the holotype specimen cannot be located as of this writing (Pocock, pers. com., 1975)]

Pseudoceratium retusum sp. nov.

Gardodinium eisenackii Alberti, 1961

age: Early Cretaceous, late Aptian or early Albian.

PLATES 1 to 16

In the explanation of figures, the species name is followed by the GSC (ISPG) locality number, the slide number, the stage co-ordinates for Reichert Zetopan Microscope No. 56 395 at the Institute of Sedimentary and Petroleum Geology, Calgary, T2L 2A7, Alberta, Canada, an explanation (if necessary) of the focus level and orientation of the specimen, the GSC type Number, the magnification and page reference. IC refers to Interference Contrast; other figures are photographed in brightfield.

PLATE 1

Figure 1. *Acanthaulax* sp. C-30195, P770-63A, 10.7 x 119.3, mid-focus, GSC 45958, x500 (p. 2, 5).

Figure 2. *Gonyaulacysta episoma* Sarjeant. C-10724, P770-44B, 09.8 x 117.6, hi-focus on ventral surface, GSC 45959, x500 (p. 2, 6).

Figure 3. *Gonyaulacysta cretacea* (Neale and Sarjeant) Sarjeant. C-9157, P770-7f, 11.0 x 124.7, mid-focus and lateral orientation, GSC 45960, x500 (p. 2, 6).

Figure 4. *Gonyaulacysta hyalodermopsis* (Cookson and Eisenack) Sarjeant. C-12606, ARCO Slide 10606-A2, 34.4 x 123.2, mid-focus, GSC 45961, x500 (p. 2, 6).

Figure 5. *Cribroperidinium muderongensis* (Cookson and Eisenack) Davey. C-12606, ARCO Slide 10606-A2, 11.3 x 127.9, lo-focus on ventral surface, GSC 45962, x500 (p. 2, 5).

Figure 6. *Gonyaulacysta helicoidea* (Eisenack and Cookson) Sarjeant. C-12606, ARCO Slide 10606-A2, 18.9 x 134.4, hi-focus on ventral surface, GSC 45963, x500 (p. 2, 6).

Figure 7. *Gonyaulacysta* sp. A of Brideaux, this paper. C-12606, ARCO Slide 10606-A2, 15.4 x 119.9, lo-focus on ventral surface, GSC 45964, x500 (p. 2, 7).

Figure 8. *Leptodinium modicum* subsp. *modicum* Brideaux and McIntyre. C-12611, ARCO Slide 10608-A1, 22.3 x 117.3, lo-focus on dorsal surface, GSC 45965, x500 (p. 2, 7).

Figures 9, 12. *Prionodinium alaskense* Leffingwell and Morgan (p. 3, 9).

9. C-12617, ARCO Slide 10611-A2, 28.8 x 133.8, lateral orientation, mid-focus, IC, GSC 46064, x1000.

12. C-12617, ARCO Slide 10611-A1, 18.7 x 130.9, hi-focus on ventral surface, IC, GSC 45966, x1200.

Figures 10, 11. *Leptodinium modicum* subsp. *denticulatum* subsp. nov. Holotype. C-12619, ARCO Slide 10612-A2, 27.1 x 121.9. (10) hi-focus on dorsal surface, (11) lo-focus on ventral surface, IC, GSC 45967, x1000 (p. 2, 8).

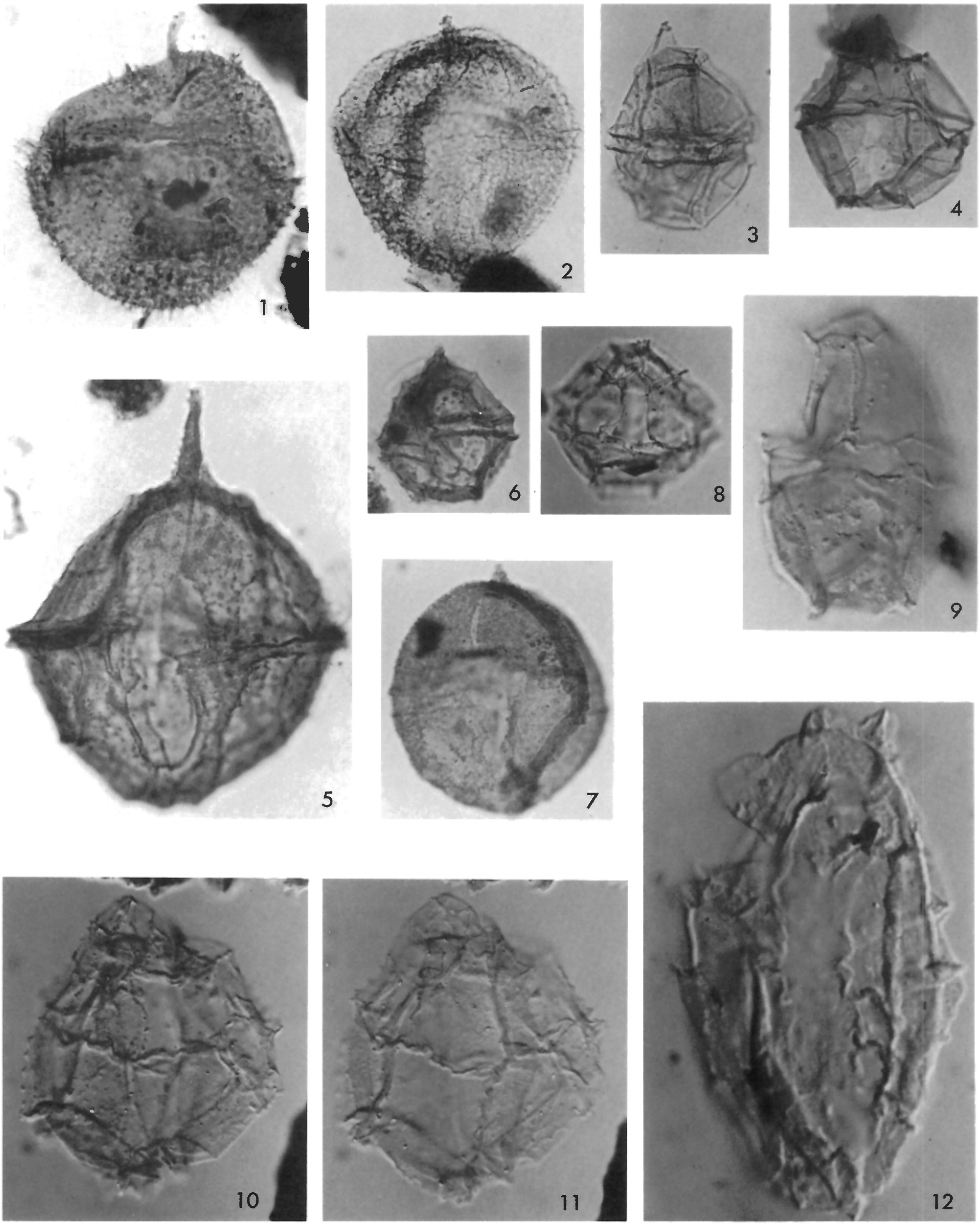
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PLATE 2

Figures 1-3. *Prionodinium alaskense* Leffingwell and Morgan (p. 3, 9).

1, 2. C-12619, ARCO Slide 10612-A2, 19.1 x 132.2. (1) lateral orientation, hi-focus, (2) lateral orientation, lo-focus, IC, GSC 45968, x1200.

3. C-12617, ARCO Slide 10611-A1, 18.7 x 130.9, lo-focus on dorsal surface, IC, GSC 45969, x1200.

Figures 4, 5. *Prionodinium alveolatum* Leffingwell and Morgan. C-12624, ARCO Slide 10614-A2, 23.2 x 119.2. (4) hi-focus on ventral surface, (5) mid-focus on peri-archeopyle, IC, GSC 45970, x1000 (p. 3, 9).

Figures 6, 8, 9. *Canningia aspera* Singh (p. 3, 11).

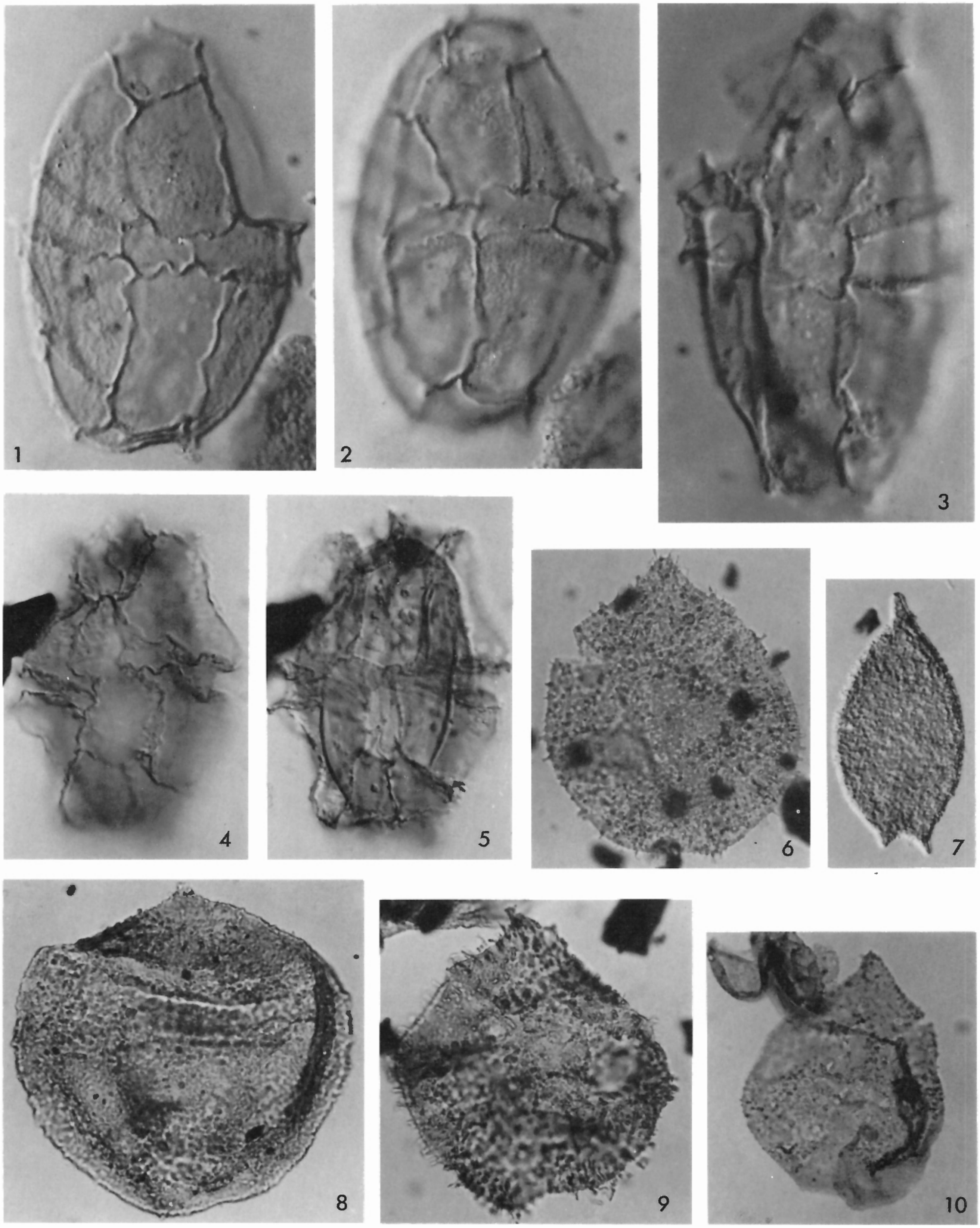
6. C-9157, P770-7f, 24.0 x 128.9, mid-focus, GSC 45971, x500.

8. C-10697, P770-12A, 41.4 x 125.0, mid-focus, GSC 45972, x500.

9. C-10703, P770-21C, 28.2 x 123.4, mid-focus, GSC 45973, x500.

Figure 7. *Batioladinium micropodum* (Alberti) Brideaux. C-10724, P770-44B, 09.6 x 120.8, mid-focus, IC, GSC 45974, x500 (p. 3, 10).

Figure 10. *Canningia* sp. cf. *C. colliveri* Cookson and Eisenack. C-12602, ARCO Slide 10605-A2, 13.4 x 123.1, mid-focus, GSC 45975, x500 (p. 3, 11).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<u>PLATE 3</u>

Figures 1-8. *Canningia palliata* sp. nov. (p. 3, 11).

1-4. Holotype. C-10722, P770-42A, 13.5 x 119.2. (1) hi-focus on ventral surface, (2) lo-focus on dorsal surface, x5000, (3, 4) detail of periphragm, IC, x1200, GSC 45976.

5. C-9157, P770-7b, 22.8 x 127.2, ventral surface at lo-focus, GSC 45977, x500.

6, 7. C-10722, P770-42A, 40.5 x 117.1. (6) hi-focus on dorsal surface, (7) lo-focus on ventral surface, the operculum attached, GSC 45978, x500.

8. C-10714, P770-34A, 27.7 x 131.7, hi-focus on dorsal surface, GSC 45979, x500.

Figures 9-14. *Canningia spumosa* sp. nov. C-10703, P770-21C (p. 3, 12).

9, 14. Holotype. 37.4 x 120.6. (9) mid-focus on periphragm detail, IC, x1200, (14) mid-focus on complete specimen and operculum, IC, x500. GSC 45980.

10, 11. 33.8 x 119.5. (10) lo-focus on dorsal surface, (11) hi-focus on ventral surface, IC, GSC 45981, x500.

12, 13. 42.3 x 123.8. (12) lo-focus on apical archeopyle, (13) hi-focus on antapex, IC, GSC 45982, x500.

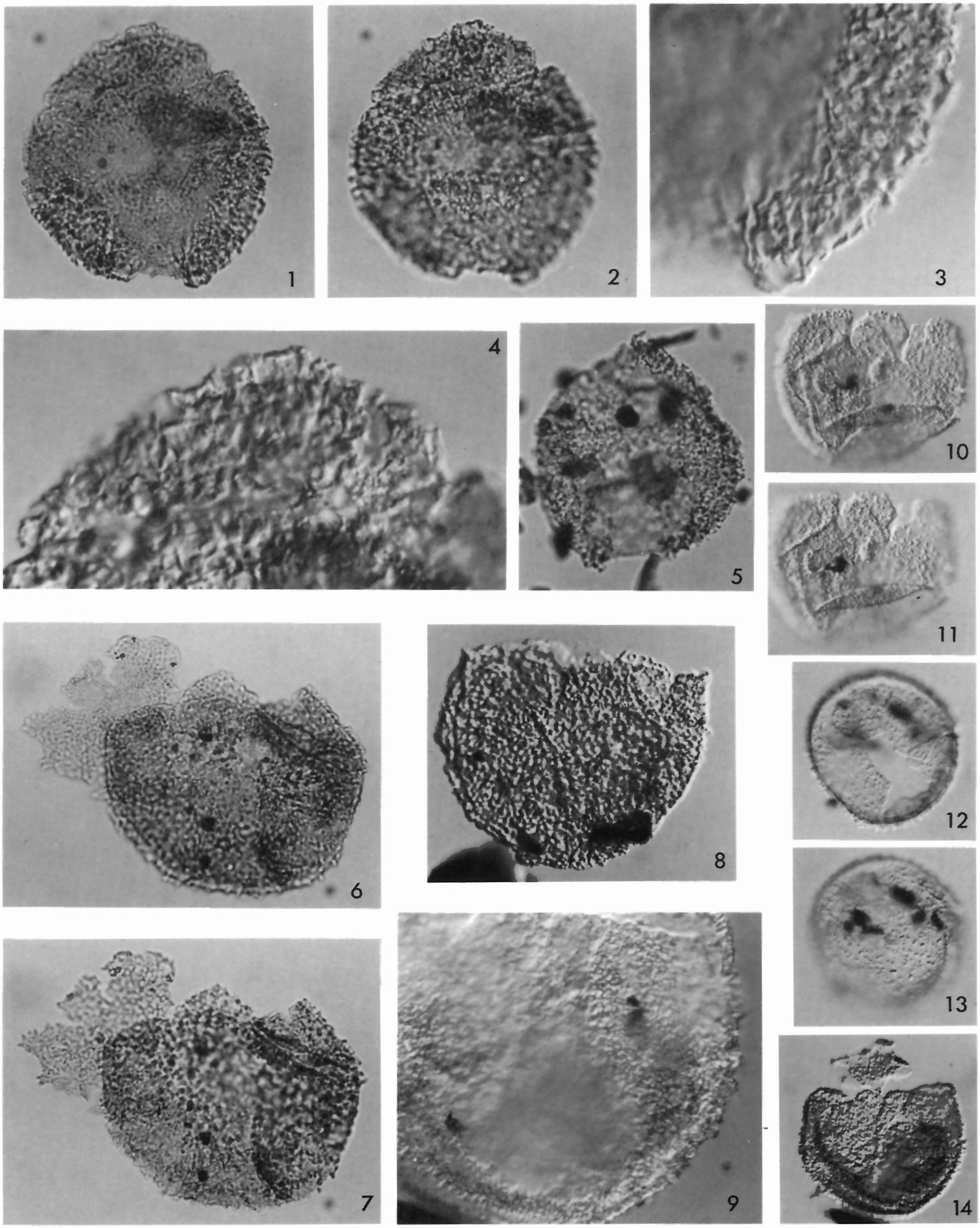
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PLATE 4

Figures 1-9. *"Canningia" turrita* sp. nov. (p. 3, 13).

1-3. Holotype. C-10723, P-70-43B, 45.8 x 125.0. (1) hi-focus on ventral surface, (2) mid-focus, (3) lo-focus on dorsal surface, IC, GSC 45983, x1000.

4, 5. C-10722, P770-42A, 37.5 x 131.2. (4) hi-focus on dorsal surface, (5) lo-focus on ventral surface, IC, GSC 45984, x1000.

6. C-10719, P770-39B, 17.3 x 129.3, mid-focus, IC, GSC 45985, x1000.

7-9. C-10729, P770-49D, 30.3 x 127.3. (7) hi-focus on dorsal surface, (8) mid-focus, (9) lo-focus on ventral surface, IC, GSC 45986, x100.

Figures 10-12. *Pseudoceratium retusum* sp. nov. Holotype. C-12610, P784-26D, 37.7 x 129.8. (10) hi-focus on dorsal surface, x500, (11) lo-focus on ventral surface, x500, (12) detail of periphragm on postcingular horn, x1200, GSC 45987 (p. 3, 14).

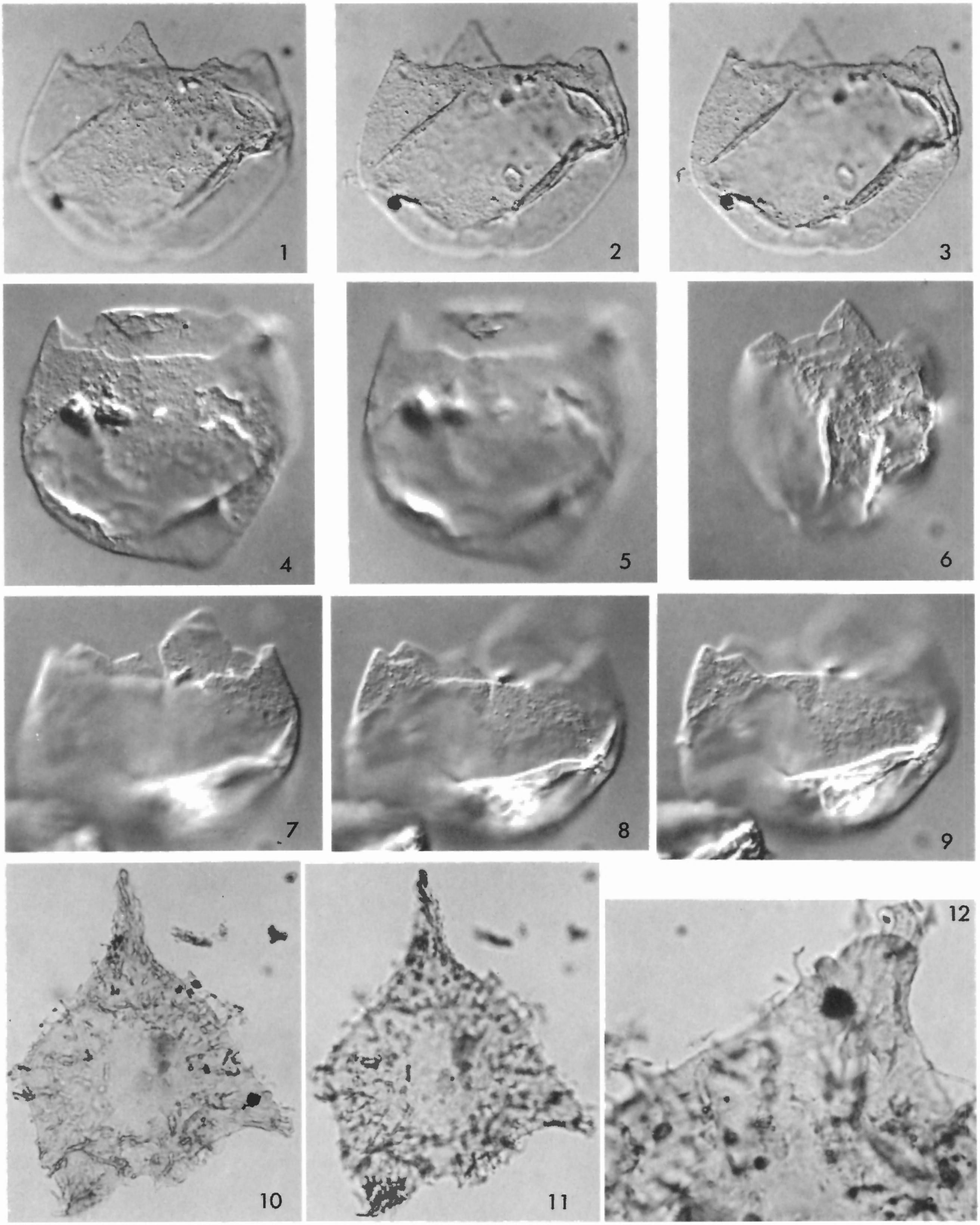
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PLATE 5

Figures 1, 2, 5-10. *Pseudoceratium retusum* sp. nov. (p. 3, 14).

1, 2. C-12605, P770-23A, 29.4 x 123.4. (1) hi-focus on ventral surface, (2) lo-focus on dorsal surface, GSC 45988, x500.

5, 6. C-9157, P770-7f, 24.0 x 132.1. (5) hi-focus on dorsal surface, (6) lo-focus on ventral surface, GSC 45989, x500.

7. C-12606, ARCO Slide 10606-A2, 08.4 x 123.2, mid-focus, GSC 45990, x500.

8. C-10727, P770-47B, 25.2 x 135.0, mid-focus, GSC 45991, x500.

9, 10. C-12606, ARCO Slide 10606-A2, 13.1 x 121.4. (9) hi-focus on ventral surface, (10) lo-focus on dorsal surface, GSC 45992, x500.

Figure 3. *Pseudoceratium nudum* Gocht. C-9157, P770-7f, 09.2 x 126.2, mid-focus, GSC 45993, x300 (p. 3, 14).

Figure 4. *Eopseudoceratium* sp. cf. *E. gochtii* (Neale and Sarjeant) Lentin and Williams. C-10720, P770-40B, 38.1 x 127.3, antapical view at mid-focus, GSC 45994, x500 (p. 3, 14).

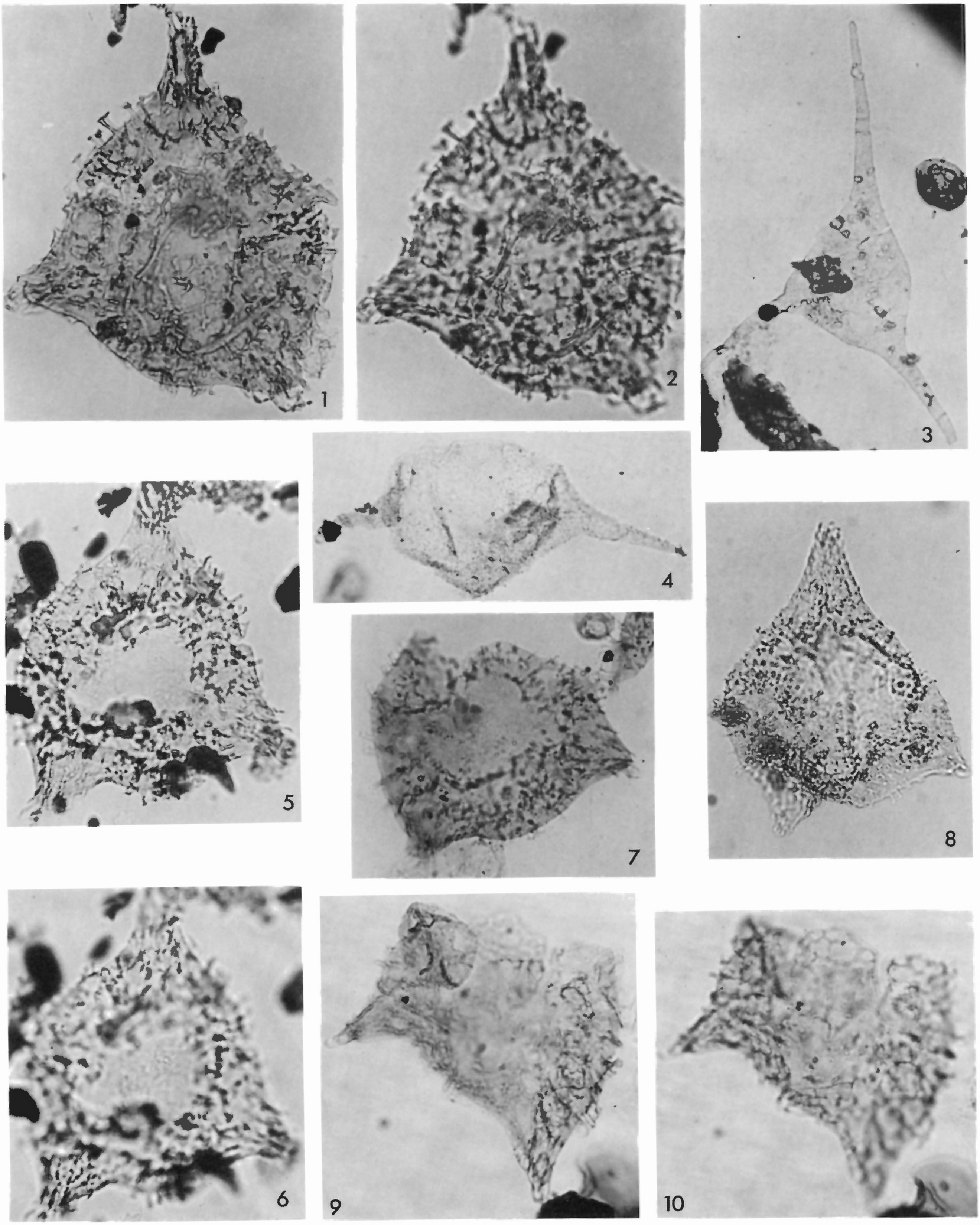
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PLATE 6

Figures 1-5. *Tenua brevispinosa* (Pocock) comb. nov. (p. 3, 15).

1. Holotype refigured. Imperial Oil Slide 3087-4, 40.0 x 131.3, mid-focus, GSC Plant Type No. 14358, x500.

2, 3. C-10713, P770-33B, 14.2 x 130.5. (2) hi-focus on ventral surface, (3) lo-focus on dorsal surface, GSC 45995, x500.

4, 5. C-13589, P784-8A, 32.4 x 124.9. (4) hi-focus on ventral surface, (5) lo-focus on dorsal surface, GSC 45996, x500.

Figure 6. *Tenua echinata* Gitmez and Sarjeant. C-30195, P770-63A, 16.2 x 118.8, mid-focus, GSC 45997, x500 (p. 3, 16).

Figure 7. *Tenua* sp. cf. *T. rioultii* Sarjeant. C-30193, P770-61D, 17.7 x 115.6, mid-focus, GSC 45998, x500 (p. 3, 16).

Figures 8-10. *Tenua?* sp. B of Brideaux, this paper. C-12582, P784-1B, 30.4 x 126.6. (8) mid-focus, (9) mid-focus, IC, x500, (10) detail of periphragm, x1200, GSC 45999 (p. 3, 17).

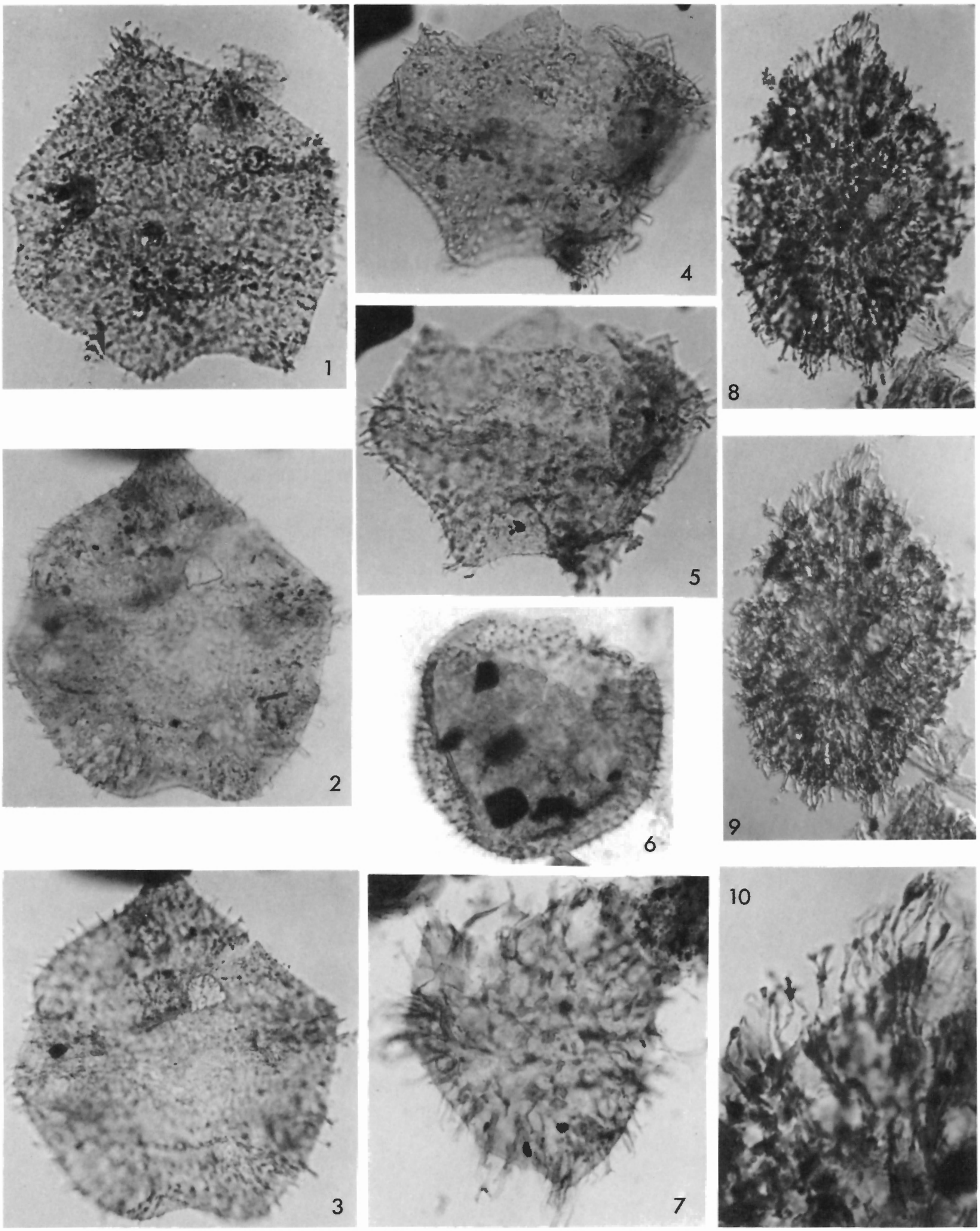
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PLATE 7

Figures 1-6. *Fromea complicata* sp. nov. (p. 3, 18).

1, 2. Holotype. C-8555, Chevron Standard Slide 6894-2, 09.1 x 123.6, hi- and lo-focus respectively, IC, GSC 46000, x1000.

3, 4. C-64762, Slide BW 76/2 (Imperial Battle Lake No. 1 well, Joli Fou Formation, Upper Albian, 5447-5452 ft, 1661.3 - 1662.8 m), 23.5 x 118.8, mid- and lo-focus respectively, IC, GSC 46001, x1000.

5, 6. C-12585, P784-4D, 36.9 x 125.9, hi- and lo-focus respectively, IC, GSC 46002, x500.

Figures 7-11. *Mendicodinium caperatum* sp. nov. (p. 3, 19).

7. C-10703, P770-21C, 05.0 x 130.0, mid-focus, the operculum still partly attached, GSC 46003, x500.

8, 9. Holotype, C-10703, P770-21C, 38.0 x 118.0. (8) hi-focus on ventral surface, (9) lo-focus on dorsal surface, GSC 46004, x500.

10, 11. C-10703, P770-21C, 38.3 x 118.7, mid- and lo-focus respectively, GSC 46005, x500.

Figures 12-14. *Palaeostomocystis expolita* sp. nov. (p. 3, 20).

12. Holotype. C-10720, P770-40B, 43.4 x 131.4, mid-focus, IC, GSC 46006, x1000.

13. C-10720, P770-40B, 38.2 x 132.7, mid-focus, GSC 46007, x300.

14. C-10724, P770-44B, 09.6 x 123.8, focus on operculum in autocoel, GSC 46008, x500.

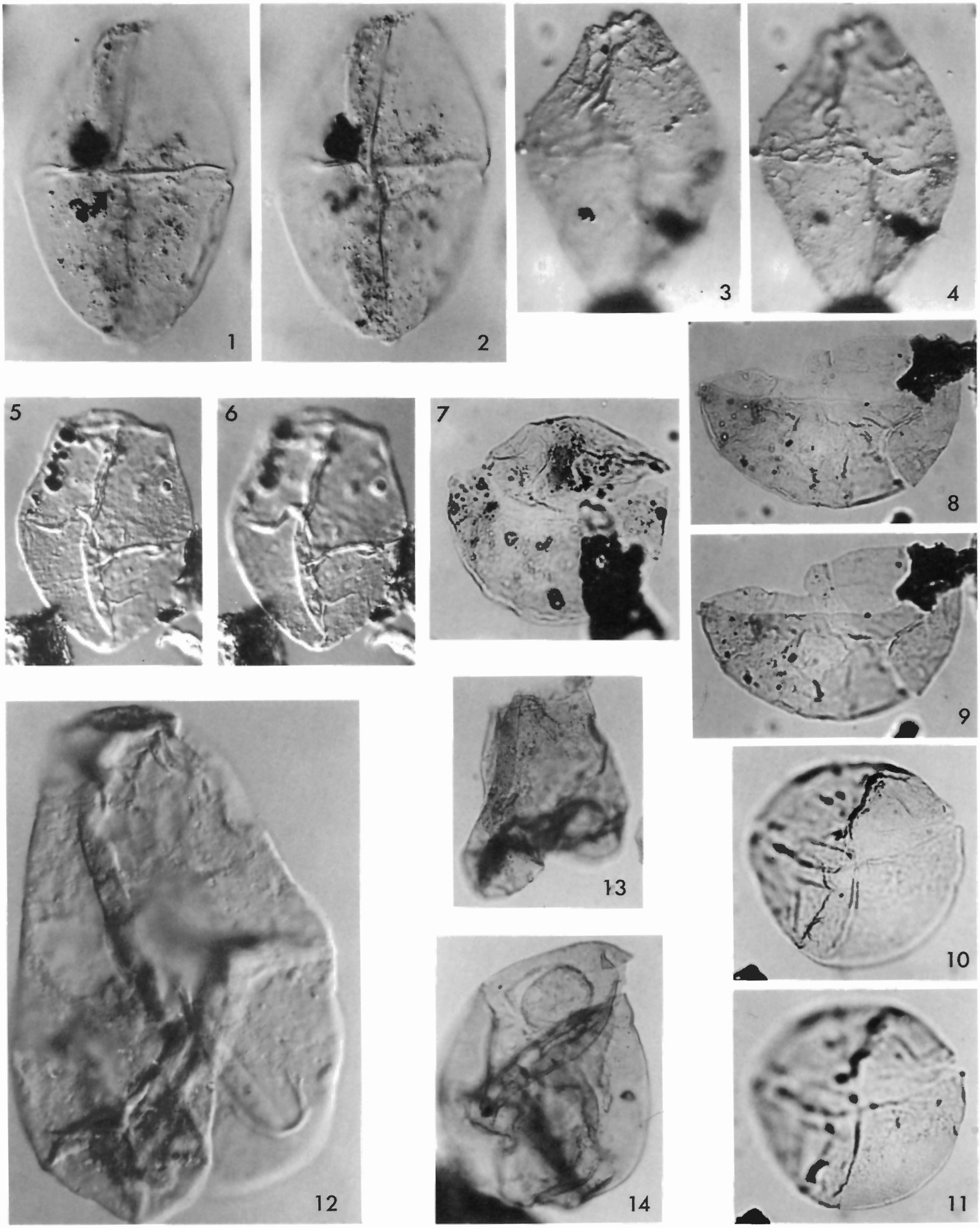
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PLATE 8

Figures 1-6. *Palaeostomocystis triquetra* sp. nov. (p. 3, 20).

1, 2. Holotype. C-12606, ARCO Slide 10606-A2, 17.0 x 116.4. (1) hi-focus on ventral surface, (2) lo-focus on dorsal surface, IC, GSC 46009, x1000.

3. C-12606, ARCO Slide 10606-A2, 19.1 x 118.4, mid-focus, IC, GSC 46010, x1000.

4, 5. C-12605, P784-23A, 21.8 x 116.0. (4) mid-focus on archeopyle, IC, x1200, (5) mid-focus, complete specimen, IC, x500, GSC 46011.

6. C-12604, P784-22B, 26.4 x 126.2, mid-focus, IC, GSC 46012, x500.

Figure 7. *Achomosphaera neptunii* (Eisenack) Davey and Williams. C-12606, ARCO Slide 10606-A2, 23.2 x 117.8, hi-focus on dorsal surface, IC, GSC 46013, x1000 (p. 3, 21

Figure 8. *Callaiosphaeridium asymmetricum* (Deflandre and Courteville) Davey and Williams. C-12606, ARCO Slide 10606-A2, 12.7 x 117.7, mid-focus, GSC 46014, x500 (p. 3, 22).

Figure 9. *Cleistosphaeridium? aciculare* Davey. C-9157, P770-7f, 29.3 x 120.2, mid-focus, GSC 46015, x500 (p. 3, 22).

Figures 10, 11. *Adnatosphaeridium* sp. A of Brideaux, this paper. C-12606, ARCO Slide 10606-A2, 16.1 x 115.9, lo- and mid-focus respectively, GSC 46016, x500 (p. 3, 21).

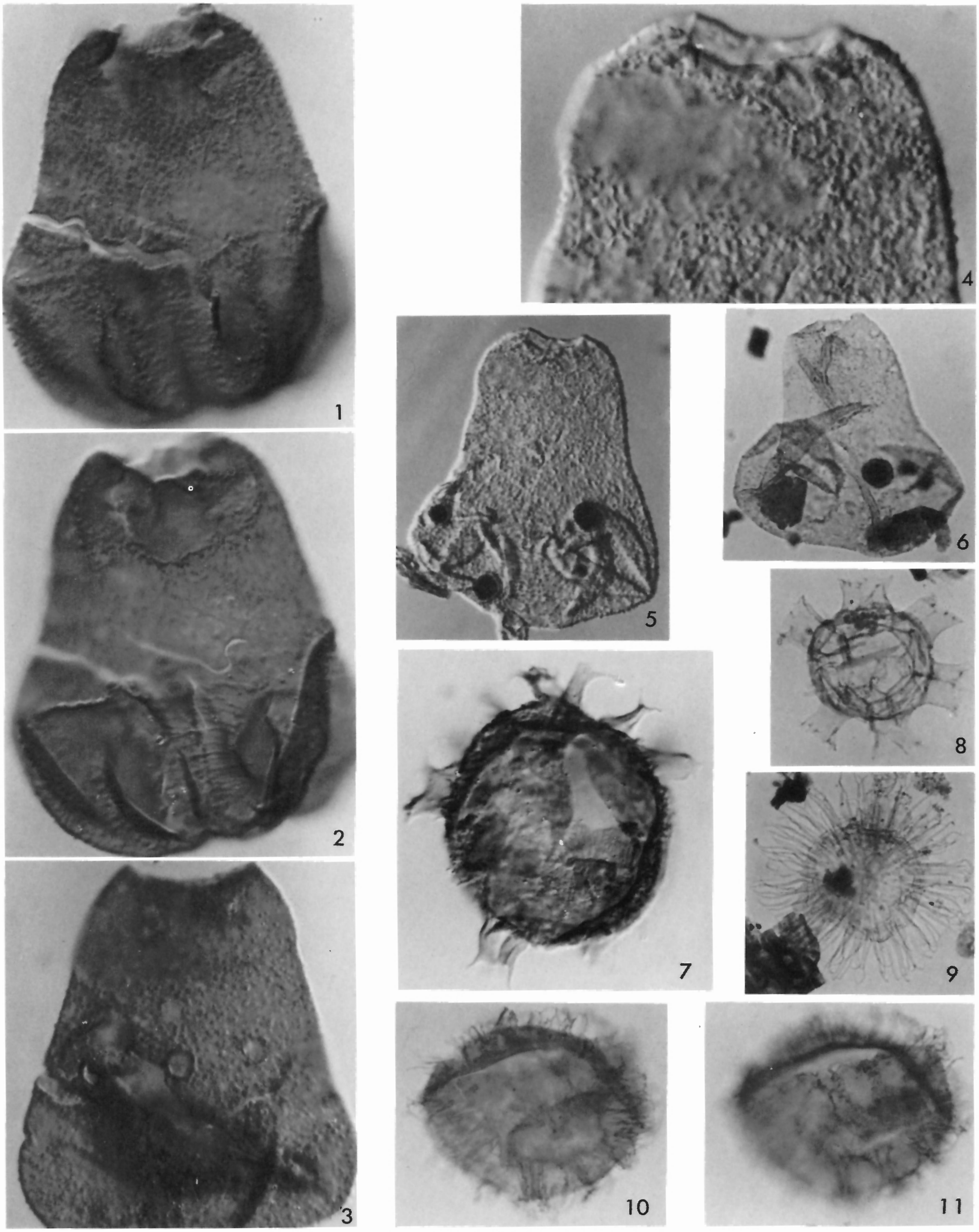
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PLATE 9

Figures 1-3. *Cleistosphaeridium araneosum* sp. nov. (p. 3, 22).

1, 2. Holotype. C-8533, P851-2A, 17.4 x 122.8. (1) hi-focus on dorsal surface, (2) lo-focus on ventral surface, GSC 41501, x1000.

3. C-12611, ARCO Slide 10608-A2, 19.4 x 131.6, hi-focus on dorsal surface, IC, GSC 46017, x1000.

Figures 4-6. *Conosphaeridium* sp. B of Brideaux, this paper. C-12619, ARCO Slide 10612-A2, 18.0 x 124.3. (4) hi-focus on operculum, IC, (5) lo-focus, IC, x1000, (6) detail of processes, IC, GSC 46018, x1200 (p. 3, 24).

Figures 7, 8, 10, 11. *Cleistosphaeridium?* sp. BE of Brideaux, this paper (p. 3, 24).

7, 8. C-12624, ARCO Slide 10614-A2, 26.8 x 128.7. (7) hi-focus on apical archeopyle, (8) lower hi-focus on archeopyle, GSC 46019, x1200.

10, 11. C-12624, ARCO Slide 10614-A2, 17.1 x 125.7. (10) hi-focus, right oblique orientation, paraplates 5'', 6'' and 1'' in focus, (11) lo-focus, right oblique orientation, focus on paraplates 3''-5'', GSC 46020, x1200.

Figure 9. *Cordosphaeridium eoinodes* (Eisenack) Eisenack. C-12609, ARCO Slide 10607-A1, 27.4 x 113.4, hi-focus, GSC 46021, x500 (p. 3, 24).

PLATE 9

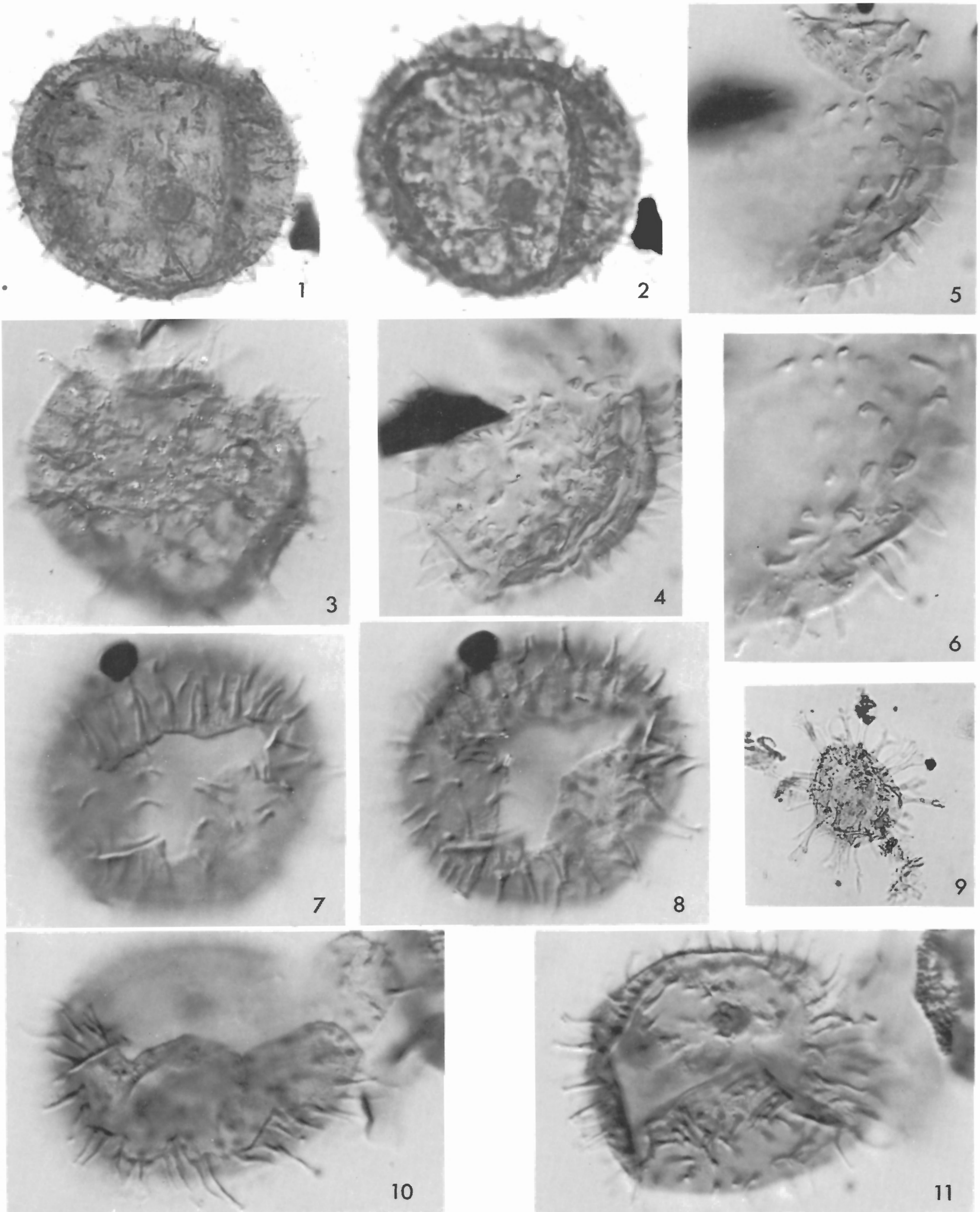

PLATE 10

Figures 1-4. *Heslertonia heslertonensis* (Neale and Sarjeant) Sarjeant (p. 3, 25).

1, 2. C-10723, P770-43A, 40.1 x 135.2. (1) hi-focus on antapical surface, (2) lo-focus on apical surface, IC, GSC 46022, x500.

3, 4. C-10725, P770-45A, 22.6 x 127.9, hi- and lo-focus respectively, GSC 46023, x500.

Figure 5. *Hystrichodinium* sp. of Brideaux, this paper. C-10703, P770-21C, 40.4 x 128.8, hi-focus on ventral surface, IC, GSC 46024, x1000 (p. 3, 25).

Figure 6. *Hystrichosphaeridium costatum* Davey and Williams. C-12624, ARCO Slide 10614-A1, 11.7 x 124.5, mid-focus on archeopyle, IC, GSC 46025, x1200 (p. 3, 26).

Figure 7. *Hystrichosphaeridium cooksonii* Singh. C-12608, P784-25B, 16.7 x 131.0, mid-focus, IC, GSC 46026, x500 (p. 3, 25).

Figures 8-11. *Hystrichosphaeridium* sp. AE of Brideaux, this paper (p. 4, 25).

8, 9. C-10727, P770-47B, 25.5 x 118.1, hi- and lo-focus respectively, IC, GSC 46027, x500.

10, 11. C-12606, ARCO Slide 10606-A2, 27.2 x 115.7. (10) hi-focus on processes, (11) mid-focus on archeopyle, IC, GSC 46028, x1000.

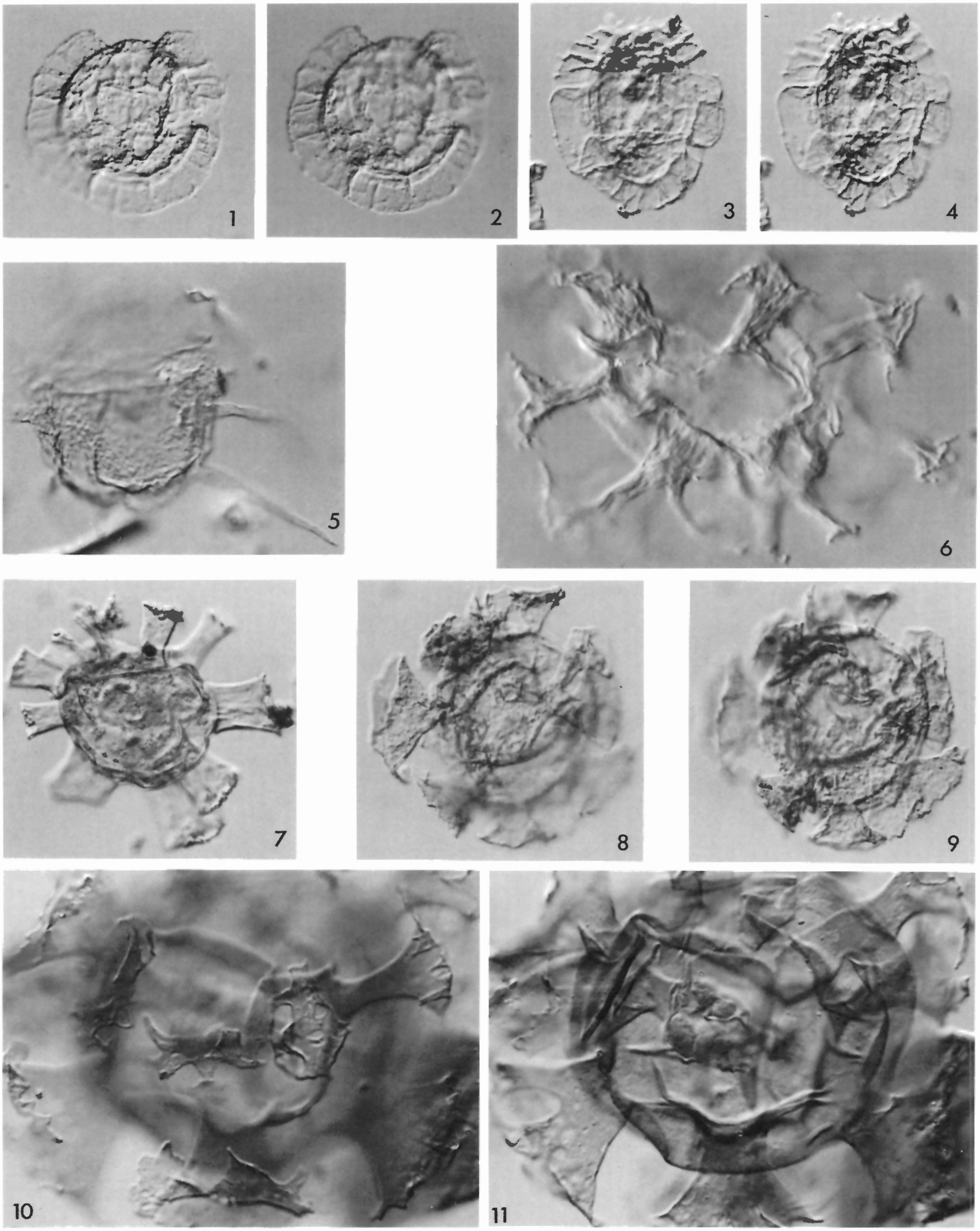
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PLATE 11

Figures 1, 2. *Hystrichosphaeridium* sp. BE of Brideaux, this paper (p. 4, 26).

1. C-12608, P784-25D, 32.1 x 125.2, mid-focus, IC, GSC 46029, x1000.

2. C-12620, P784-31C, 15.5 x 115.6, mid-focus, IC, GSC 46030, x1000.

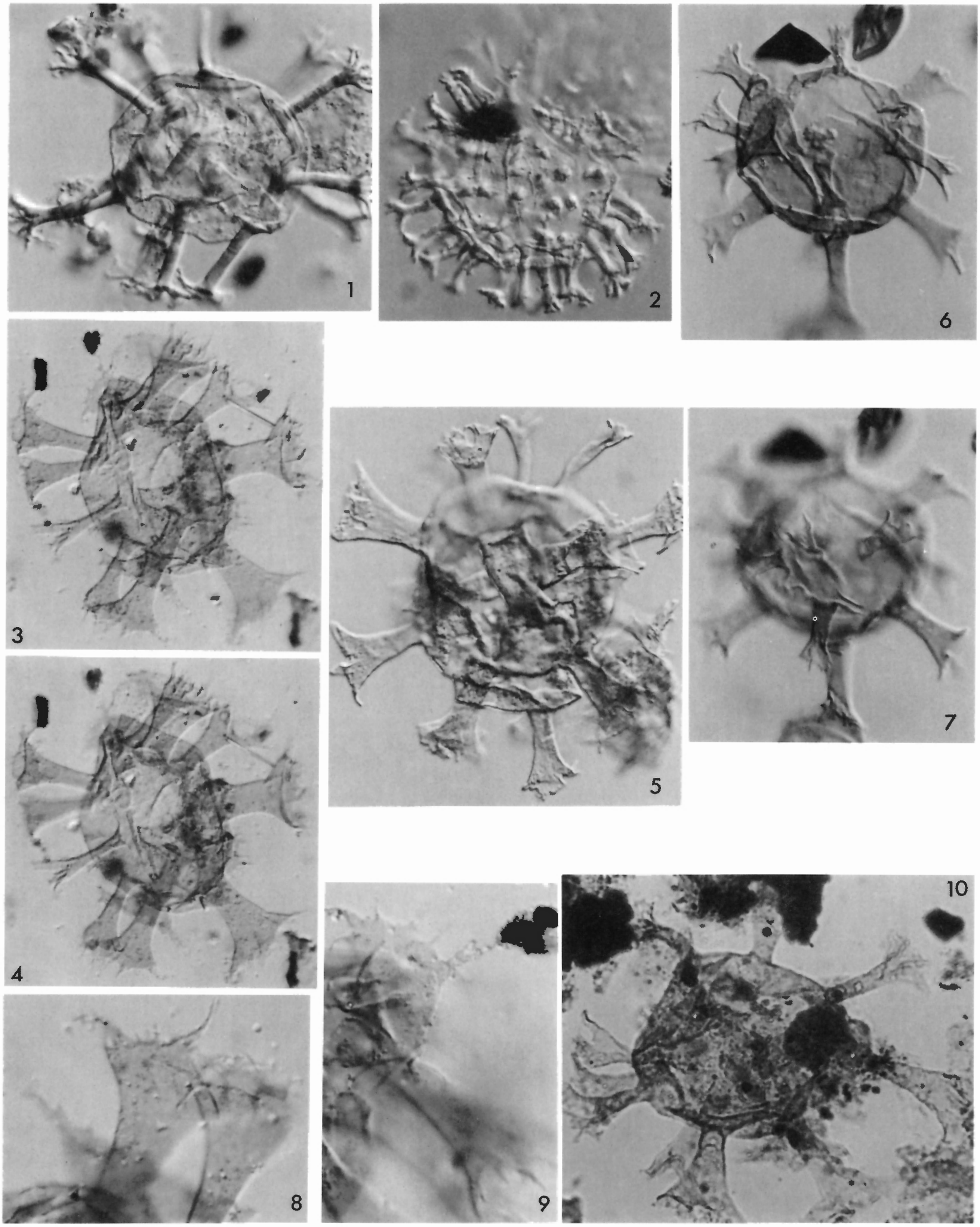
Figures 3-10. *Oligosphaeridium albertense* (Pocock) Davey and Williams (p. 4, 27).

3, 4, 8, 9. Holotype refigured. Imperial Kuroki 7-30-34-10W2M, slide (Staplin) 2, 32.7 x 1 1.8, 1340-1343 ft (408.4-409.3 m) depth, IC. (3) hi-focus, (4) mid-focus, x500, (8, 9) detail of processes, GSC Plant Type No. 14358, x1200.

5. C-10721, P770-41B, 09.6 x 134.8, mid-focus, IC, GSC 46031, x500.

6, 7. C-12606, ARCO Slide 10606-A2, 08.1 x 124.8, specimen slightly tilted to observer. (6) hi-focus on archeopyle, (7) lo-focus on ventral and antapical processes, IC, GSC 46032, x500.

10. Paratype refigured. Imperial Virginia Hills 6-36-63-12W5, Imperial Oil Ltd. Slide 3087-4, 38.4 x 122.4, 5675-5676 ft (1730.9-1731.2 m), GSC Plant Type No. 14358, x500.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<u>PLATE 12</u>

Figures 1-3. *Oligosphaeridium albertense* (Pocock) Davey and Williams. C-12606, ARCO Slide 10606-A2, 08.1 x 124.8. (1) hi-focus on precingular paraplate 3'', x1000, (2) lo-focus on sulcal process, northeast of picture centre, x1200, (3) lo-focus on several postcingular and antapical processes, x1000, IC, GSC 46032. (Specimen figured also on Pl. 11, figs. 6, 7). (p. 4, 27).

Figures 4, 5. *Oligosphaeridium* sp. cf. *O. complex* (White) Davey and Williams. (4) P784-15B, 18.1 x 125.5, hi-focus on archeopyle, GSC 46033, x300, (5) focus on processes arising from hypopericyst, x500 (p. 4, 29).

Figures 6, 7. *Oligosphaeridium nannum* Davey. C-12609, ARCO Slide 10607-A2, 25.4 x 133.2. (6) hi-focus, IC, (7) lo-focus, GSC 46034, x1200 (p. 4, 29).

Figures 8, 9. *Operculodinium? spinigerum* sp. nov. Holotype. C-12609, ARCO Slide 10607-A1, 19.0 x 124.2. (8) hi-focus, left ventrolateral orientation, (9) mi-lo-focus, archeopyle edge in focus, IC, GSC 46035, x1000 (p. 4, 30).

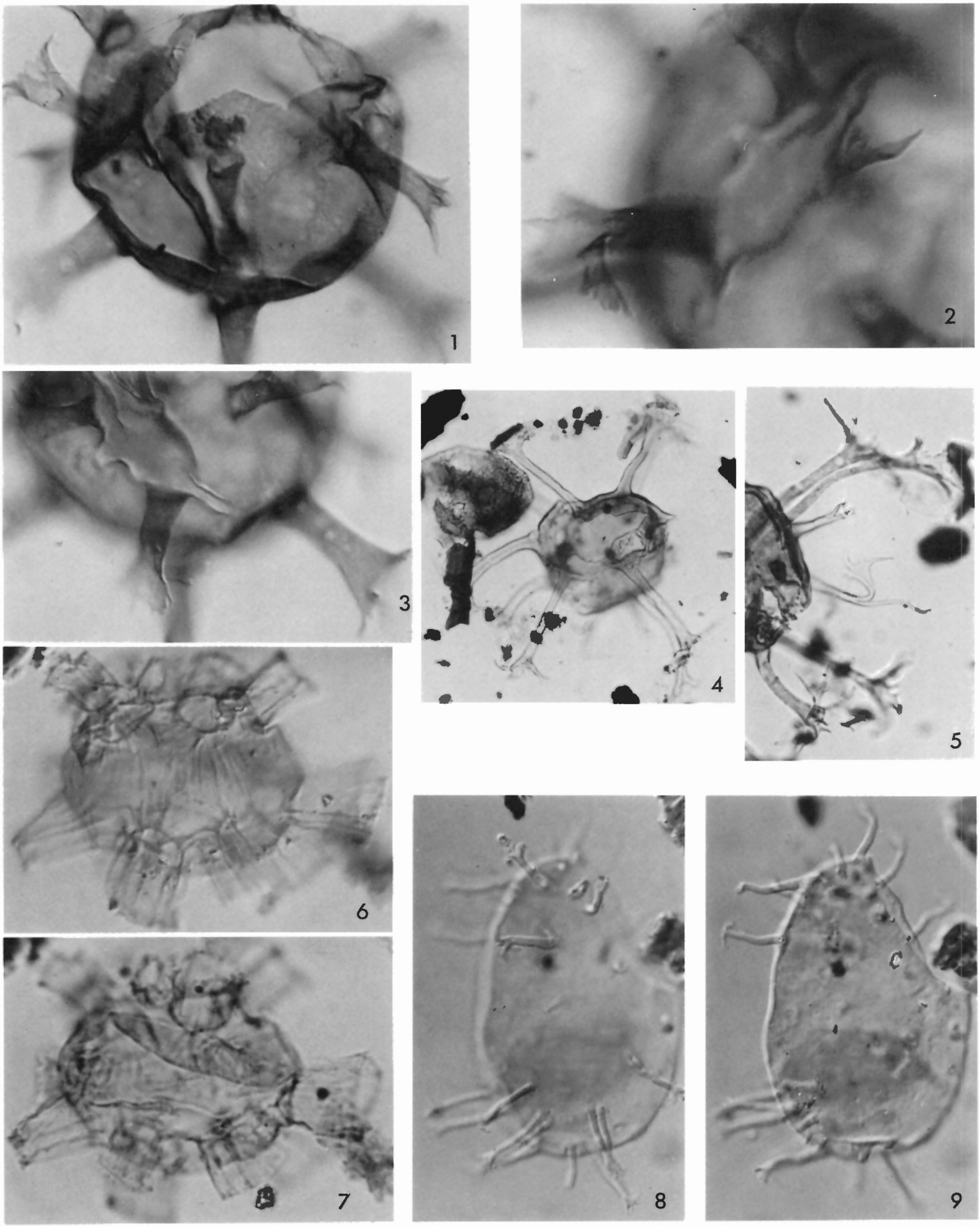
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PLATE 13

Figures 1-11. *Operculodinium? spinigerum* sp. nov. (p. 4, 30).

1-4. Holotype. C-12609, ARCO Slide 10607-A1, 19.0 x 124.2, hi-focus, hi-mid-focus, lo-mid-focus and lo-focus respectively on the pericyst and pericingular region, IC, GSC 46035, x1200.

5, 6. C-12609, ARCO Slide 10607-A2, 31.5 x 127.6. (5) complete specimen, mid-focus, x1000, (6) detail of archeopyle, mid-focus, x1200, IC, GSC 46036.

7. C-12609, ARCO Slide 10607-A2, 09.1 x 133.7, lo-focus on ventral hypopericyst, IC, GSC 46037, x1000.

8. C-12609, ARCO Slide 10607-A1, 11.4 x 125.8, hi-focus on antapical processes, IC, GSC 46038, x1250.

9-11. C-12609, ARCO Slide 10607-A1, 11.3 x 119.1, oblique right ventro-lateral orientation. (9) hi-focus, (10) mid-focus, (11) lo-focus, GSC 46039, x1000.

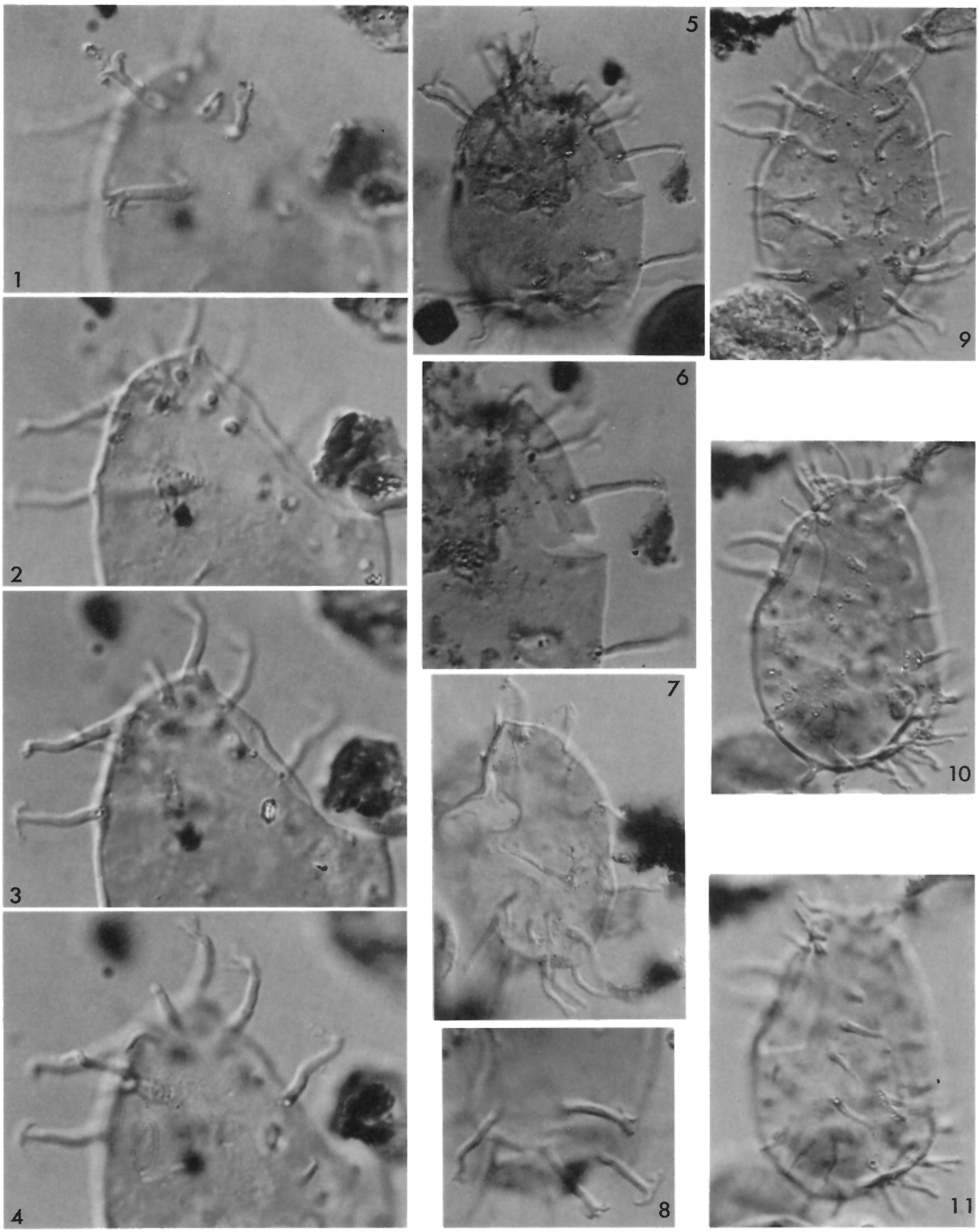
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PLATE 14

Figure 1. *Prolixosphaeridium parvispinum* (Deflandre) Davey, Downie, Sarjeant and Williams. C-12609, ARCO Slide 10607-A1, 19.1 x 117.4, mid-focus, IC, GSC 46040, x500 (p. 4, 31).

Figures 2, 3. *Systematophora* sp. AE. C-12605, P784-23A, 11.3 x 128.0. (2) complete specimen, lo-focus on ventral surface, x500, (3) hi-focus on dorsal surface, x1000, IC, GSC 46041 (p. 4, 31).

Figure 4. *Systematophora* sp. cf. *S. complicata* Neale and Sarjeant. C-12609, ARCO Slide 10607-A2, 17.5 x 116.2, mid-focus on apical archeopyle, GSC 46042, x500 (p. 4, 31).

Figure 5. *Tanyosphaeridium* sp. DE of Brideaux, this paper. C-12609, ARCO Slide 10607-A2, 35.2 x 121.5, mid-focus, IC, GSC 46043, x500 (p. 4, 32).

Figure 6. *Endoscrinium luridum* (Deflandre) Gocht. C-30195, P770-63A, 30.5 x 123.1, mid-focus, GSC 46044, x500 (p. 4, 34).

Figures 7, 9. *Systematophora schindewolfii* (Alberti) Downie and Sarjeant. C-12609, ARCO Slide 10607-A2, 36.6 x 126.5. (7) hi-focus on dorsal surface, (9) lo-focus on ventral surface, IC, GSC 46045, x500 (p. 4, 31).

Figure 8. *Chlamydophorella* sp. AE of Brideaux, this paper. C-12606, ARCO Slide 10606-A2, 32.3 x 126.5, mid-focus, GSC 46046, x500 (p. 4, 33).

Figures 10, 11. *Tubotuberella rhombiformis* Vozzhennikova emend. (10) C-30195, P770-63c, 31.0 x 114.2, hi-focus on ventral surface, IC, GSC 46047, x500, (11) C-31094, P770-62B, 21.7 x 130.7, hi-focus on dorsal surface and precingular archeopyle, IC, GSC 46048, x1000 (p. 4, 36).

PLATE 14

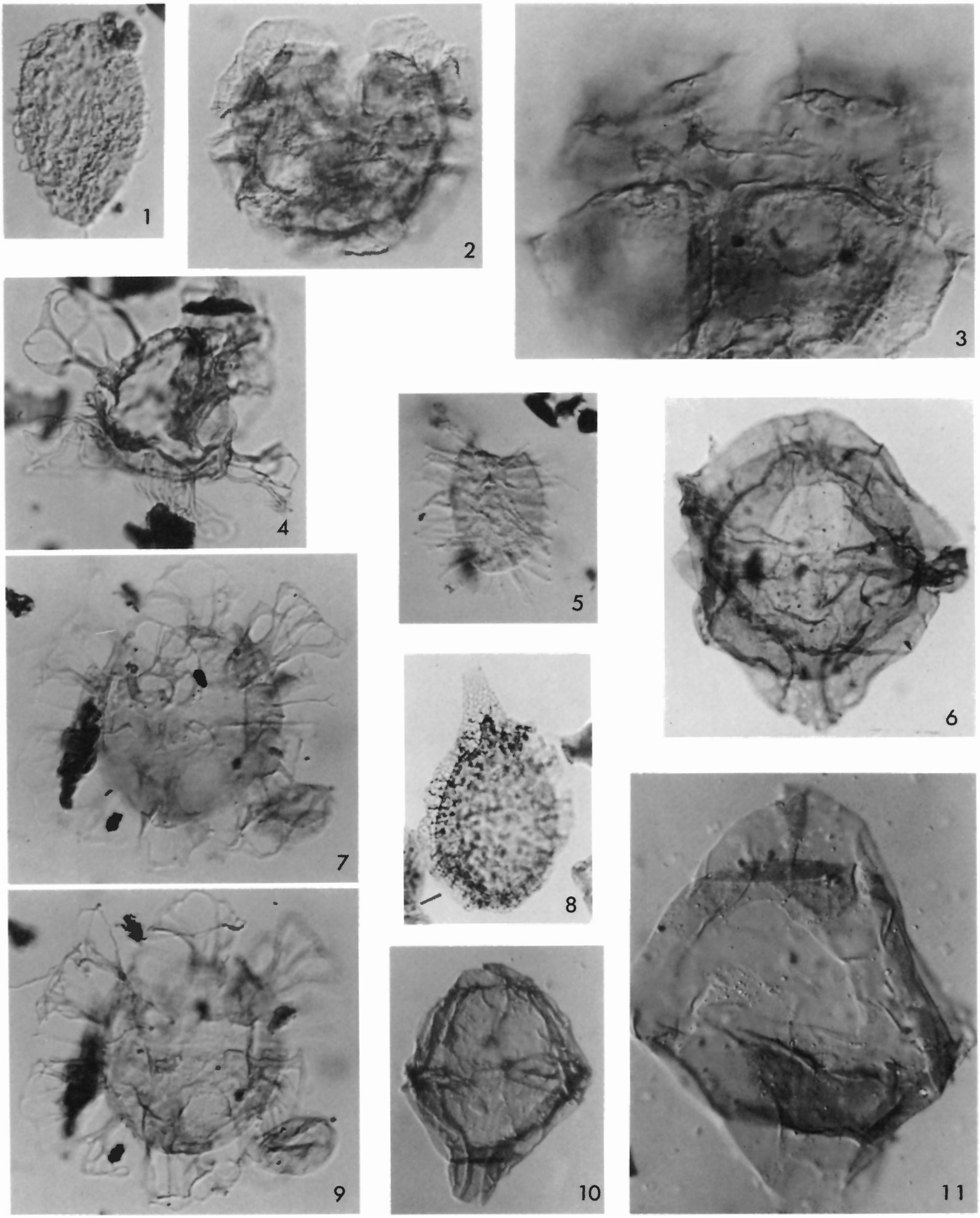

PLATE 15

Figure 1. *Tubotuberella rhombiformis* Vozzhennikova emend. C-12628, ARCO Slide 10616-A2, 29.3 x 134.3, mid-focus, IC, GSC 46049, x500 (p. 4, 36).

Figures 2-5, 7, 8. *Dimidiadinium uncinatum* gen. et sp. nov. (p. 4, 38).

2-5. Holotype. C-12617, ARCO Slide 10611-A2, 15.8 x 131.6. (2) hi-focus on ventral surface, (3) mid-focus, (4) lo-focus on dorsal surface, (5) ventral epipericyst at hi-focus, IC, GSC 46059, (2-4, x500; 5, x1000).

7. C-12611, ARCO Slide 10608-A2, 10.2 x 125.2, hi-focus on ventral surface, IC, GSC 46051, x500.

8. C-10729, P770-49D, 33.8 x 118.5, mid-focus, IC, GSC 46052, x1000.

Figure 6. *Scriniodinium crystallinum* (Deflandre) Klement. C-30195, P770-63A, 24.3 x 128.2, mid-focus, IC, GSC 46053, x500 (p. 4, 39).

Figures 9, 10. *Muderongia asymmetrica* sp. nov. (p. 4, 40).

9. Holotype. C-10706, P770-25A, 25.8 x 133.8, mid-focus, IC, GSC 46054, x1000.

10. C-10711, P770-31B, 29.0 x 118.0, mid-focus, GSC 46055, x500.

Figure 11. *Sirmiodinium grossii* Alberti emend. Warren. C-12626, ARCO Slide 10615-A2, 27.7 x 122.5, mid-focus, IC, GSC 46056, x500 (p. 4, 40).

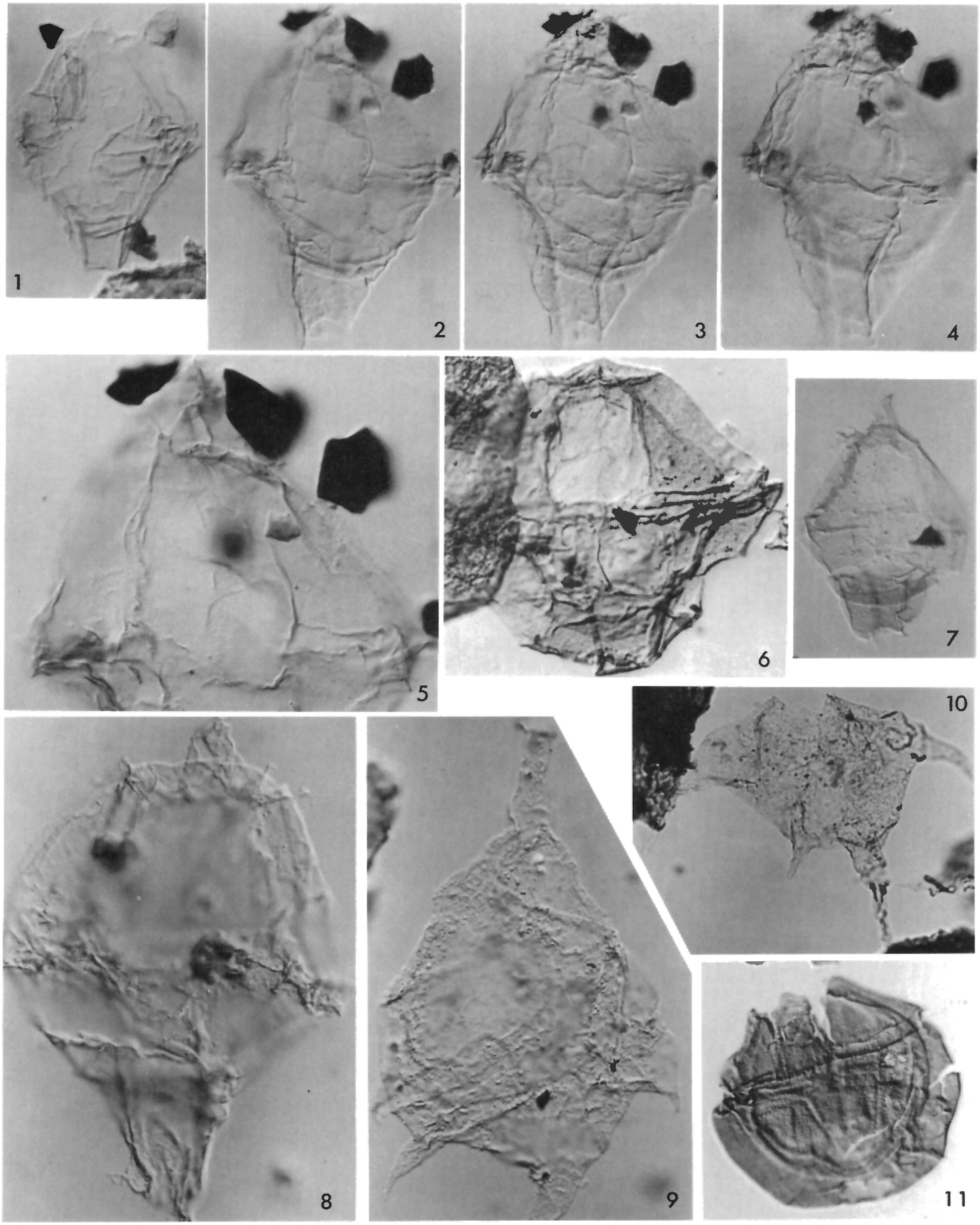
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PLATE 16

Figure 1. *Muderongia asymmetrica* sp. nov. Holotype. C-10706, P770-25A, 25.8 x 133.8, mid-focus, GSC 46054, x500 (p. 4, 40).

Figure 2. *Muderongia tetracantha* (Gocht) Alberti. C-10732, P770-52A, 16.1 x 129.4, mid-focus, IC, GSC 46057, x500 (p. 4, 41).

Figure 3. *Odontochitina* sp. of Brideaux, this paper. C-30195, P770-63C, 13.9 x 131.2, mid-focus, IC, GSC 46058, x500 (p. 4, 41).

Figures 4, 5. *Subtilisphaera perlucida* (Alberti) Jain and Millepied. (4) C-12616, P784-29A, 31.4 x 128.9, focus on dorsal intercalary paraplate 2a, IC, GSC 46059, x1000, (5) C-12604, P784-22B, 31.8 x 125.0, hi-focus on peri-archeopyle ("transapical" archeopyle) and attached peri-operculum, IC, GSC 46060, x1000 (p. 4, 42).

Figures 6, 7. *Wallodinium luna* (Cookson and Eisenack) Lentin and Williams (p. 4, 43).

6. C-12620, P784-31C, 23.7 x 120.2, mid-focus, IC, GSC 46061, x500.

7. C-10723, P770-43A, 11.6 x 130.5, mid-focus, IC, GSC 46062, x500.

PLATE 16