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DINOFLAGELLATE CYSTS AND ACRITARCHS FROM THE UPPER VARDEKLØFT FORMATION (JURASSIC) OF JAMESON LAND, EAST GREENLAND

BY

WILLIAM A. S. SARJEANT

WITH A

SUPPLEMENT: POLLEN GRAINS AND SPORES FROM THE UPPER VARDEKLØFT FORMATION (JURASSIC), JAMESON LAND, EAST GREENLAND

BY

Marjorie D. Muir

WITH 12 FIGURES AND 1 TABLE IN THE TEXT AND 9 PLATES

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Abstract

Two assemblages of dinoflagellate cysts and acritarchs are described, from horizons in the Upper Vardekløft Formation of central Jameson Land. 44 species of dinoflagellate cysts are discussed: seven of those (*Gonyaulacysta whatleyi*, *Pareodinia groenlandica*, *P. apotomocerastes*, *Meiourogonyaulax callomonii*, *M. strongylos*, *?M. cantrellii* and *Chytroeisphaeridia dictydia*) are described for the first time. In addition, one new variety (*Pareodinia ceratophora* var. *scopaeus*) is distinguished and two new combinations (*?Acanthaulax spinosissima* and *Tenua varispinosa*) are proposed. Five species of acritarchs are also mentioned. The assemblages indicate a Bathonian date for the lower horizon (greater precision being scarcely possible in terms of present knowledge of dinoflagellate ranges) and a Middle Callovian (Jason to Athleta) date for the upper horizon.

In a supplement, Dr. M. D. Muir presents a brief study of the spores and pollen grains in the two horizons of the Upper Vardekløft Formation. She shows them to consist dominantly of long-ranging forms, not capable of providing close stratigraphic dates. 15 species are recognised.

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INTRODUCTION

In the summer of 1964, an expedition, organised and led by Dr. R. MARRIS and supported by a grant from the Royal Society, visited Jameson Land, East Greenland. A suite of samples was collected for micropalaeontological study by Dr. R. C. WHATLEY and Mr. D. C. BROWN: these included sequences through the Jurassic Neill Klinter and Vardekløft Formations.

On his return to England, Dr. WHATLEY contacted me to see whether I would be willing to undertake a palynological study of the samples; on my expressing interest, he sent me fourteen samples. These were duly processed and mostly yielded rich assemblages of dinoflagellates and acritarchs; their study was commenced early in 1966, but was suspended during my year as Visiting Professor at the University of Oklahoma (1966–1967) and was not resumed until 1969.

Unfortunately, when the work was well launched, the micropalaeontological laboratories of the University of Nottingham were destroyed by fire in March, 1970. All the remaining unprocessed material was destroyed and all but one of the prepared residues, together with all notes of work done up to that time. Two sets of strewmounts were recovered, one of them from the same horizon as the surviving prepared residue (from which supplementary mounts were subsequently made). The assemblages from the two horizons represented by these mounts are here described.

STRATIGRAPHICAL DETAILS

The assemblages studied were obtained from a section collected in central Jameson Land, at 71°5′N., 23°5′W. The section measured (R. I. WHATLEY, *in litt.*) is given below all measurements refer to height above sea-level, as determined by altimeter. The two horizons which yielded the assemblages here described are indicated by asterisks.

[830 feet (252.98 m.) Top of plateau].
[730 feet (222.50 m.) Base of slope, plateau gravel].
730–560 feet (222.50–170.68 m.) Massive yellow and grey sandstone.
[560.480 feet (170.68–146.30 m.) Obscured by scree].
480–440 feet (146.30–134.11 m.) Black sandstone.
*440–370 feet (134.11–112.77 m.) Black, very weathered micaceous shale, having the consistency of clay and containing irregular doggers. Becoming bluegrey to buff at base.
370–367 feet (112.77–111.86 m.) Blue and yellow paper shales.
367–366 feet (111.86–111.55 m.) Extremely micaceous, silty clay.
366–360 feet (111.55–109.72 m.) Light brown, friable sand.
360–356 feet (109.72–108.50 m.) Light brownish yellow, unconsolidated sand.
[356–300 feet (108.50–91.44 m.) Obscured by scree, but bands of black sand visible].
300–297 feet (91.44–90.52 m.) Purple sand.
297–294 feet (90.52–89.61 m.) Micaceous sand with 6″ (15.24 cm.) brown shaly sandstone at base.
294–291 feet (89.61–88.69 m.) Dark grey, rather clayey sand.
291–285 feet (88.69–86.86 m.) Light buff-yellow, unconsolidated sand.
285–283 feet (86.86–86.25 m.) Purple, rather shaley sand.
283–281.5 feet (86.25–85.79 m.) Light-coloured sand.
281.5–280.5 feet (85.79–85.49 m.) Purple sand.
280.5–278.5 feet (85.49–84.88 m.) Brown, unconsolidated sand.
278.5–277.5 feet (84.88–84.57 m.) Fissile, buff sandstone.
277.5–273.5 feet (84.57–83.36 m.) Grey, very hard siliceous sandstone, poorly bedded.
273.5–270 feet (83.36–82.29 m.) Loose, unconsolidated sandstone with severely weathered doggers.

270–269 feet (82.29–81.99 m.) Brown, earthy sandstone.
269–267 feet (81.99–81.38 m.) Red-black very fine, hard sandstone.
267–263 feet (81.38–80.16 m.) Loose greyish yellow sand interbedded with a 3″ (7.62 cm.) black, micaceous, clayey layer.
263–250 feet (80.16–76.20 m.) Grey-blue, very fissile sandstone with weathered yellow ironstone nodules.
250–247 feet (76.20–75.28 m.) Hard, buff sandstone.
*247–246 feet (75.28–74.08 m.) White, siliceous sandstone, with a 2″ (5.08 cm.) black micaceous shale, which when wet has the consistency of clay at base.
246–243 feet (74.98–74.06 m.) Coarse, friable yellow sandstone.
243–237 feet (74.66–72.23 m.) Soft, grey to buff sandstone and sand.
237–236 feet (72.23–71.93 m.) Red-black, very hard sandstone containing fossil wood.
[236–230 feet (71.93–70.10 m.) obscured by scree].
230–220 feet (70.10–67.05 m.) Blue-brown, shaly sand, becoming increasingly shaly towards base.

The younger sample studied, no. Y32 of WHATLEY (my no. GR426), was collected from a level approximately 430 feet (131.06 m.) below the top of the plateau. It consisted of black, micaceous shale which, when wet, had the consistency of clay.

The older sample studied, no. Y31 of WHATLEY (my no. GR425), was collected from a level about 584 feet (177.85 m.) below the top of the plateau. It consisted of black, very weathered and unconsolidated micaceous shale, the mica-flakes up to a centimeter in length — a most unpromising lithology, so that its rich dinoflagellate assemblages came as a particular surprise to me.

The stratigraphical interpretation of this sequence presents problems, since no ammonites have so far been located, nor have foraminifera and ostracoda been forthcoming from samples examined to date. In consequence, the exact position of the base of the Koch Fjeld Formation, which overlies the Vardekløft Formation unconformably in southern Jameson Land and in Milne Land, is currently uncertain. WHATLEY (*in litt.*) considers that the samples represent horizons in the Upper Vardekløft Formation, i.e. in the range from Variabile to Calloviense Zones (Upper Bathonian to Lower Callovian). As will be seen, the stratigraphical results of this study are in broad accord with WHATLEY's judgement.

SYSTEMATIC SECTION

All figured specimens are lodged in the Mineralogical Museum of the University of Copenhagen, Denmark. (The specimens are numbered here according to the author's own system and not that of the Museum). For the sake of brevity, "plate" is used instead of "plate-equivalent" and "tabulation" instead of "reflected tabulation".

Class **DINOPHYCEAE** Pascher

Subclass **Diniferophycidae** Bergh

Family Gonyaulacystaceae Sarjeant and Downie, 1966.

Genus *GONYAULACYSTA* Deflandre ex Norris and Sarjeant, 1965, emend. Sarjeant 1969.

Gonyaulacysta jurassica (Deflandre, 1938b) Norris and Sarjeant, 1965.

Plate 1, figs 2, 3, 4.

1938a *Gonyaulax jurassica* Deflandre, p. 688, text-fig. 2, *nomen nudum.*
1938b *Gonyaulax jurassica* Deflandre, pp. 168–170, pl. 6, figs. 2–5, text-figs. 1–2.
1952a *Gonyaulax jurassica* Defl. Deflandre, fig. 101.
1952b *Gonyaulax jurassica* Defl. Deflandre, fig. 303 B-C.
1957 *Gonyaulax jurassica* Defl. Downie, p. 420, text-fig. 3b.
1958 *Gonyaulax jurassica* Defl. Cookson & Eisenack, 1958, pp. 29–30, pl. 2, figs. 9–10.
1960 *Gonyaulax jurassica* Defl. Klement, pp. 27–28, pl. 2, figs. 3–5, text-fig. 6.
1960 *Gonyaulax jurassica* Defl. Sarjeant, pp. 393–4, pl. 13, figs. 1, 14, text-fig. 6.
1961 *Gonyaulax jurassica* Defl. Sarjeant, pp. 91–92, pl. 13, fig. 1, text-fig. 1–3.
1961 *Gonyaulax jurassica* Defl. Evitt, pl. 1, fig. 5, pl. 2, fig. 5.
1962a *Gonyaulax jurassica* Defl. Sarjeant, pp. 257–8, pl. 1, figs. 1–2, tab. 4.
1962b *Gonyaulax jurassica* Defl. Sarjeant, tabs. 2–3.
1964a *Gonyaulax jurassica* Defl. Sarjeant, tab. 2.
1964 *Gonyaulacysta jurassica* (Defl.) Deflandre, p. 5, *nom. nud.*
1964 *Gonyaulax jurassica* Defl. Downie & Sarjeant, p. 115.
1965 *Gonyaulacysta jurassica* (Defl.). Sarjeant, text-fig. 2B, *nom. nud.*
1965 *Gonyaulax jurassica* Defl. Vozzhennikova, text-fig. 33 H-I.
1965 *Gonyaulacysta jurassica* (Defl.). Deflandre ex Norris & Sarjeant p. 65.
1965 *Gonyaulacysta jurassica* (Defl.). Gorka, pp. 298–9, pl. 1, fig. 4a–b.
1965 *Gonyaulacysta jurassica* (Defl.). Dupin, p. 6.
1966 *Gonyaulacysta jurassica* (Defl.). Loeblich & Loeblich, p. 33.

1966 *Gonyaulax jurassica* Defl. Schulz & Mai, Tab. 1.
1966b *Gonyaulacysta jurassica* (Defl.). Sarjeant *in* Davey, Downie, Sarjeant & Williams, p. 111.
1967 *Gonyaulacysta jurassica* (Defl.). Dodekova, pp. 16–17, pl. 2, fig. 1.
1967 *Gonyaulax jurassica* Defl. Eisenack, pp. 367–9.
1967b *Gonyaulax jurassica* Defl. Vozzhennikova, Text-fig. 33 H–I. (English translation of Vozzhennikova, 1965).
1967a *Gonyaulacysta jurassica* (Defl.). Sarjeant, tab. 1.
1968 *Gonyaulacysta jurassica* (Defl.). Sarjeant, pl. 1, fig. 14, tab. 2A.
1968 *Gonyaulax jurassica* Defl. Venkatachala & Kar, pp. 408–9, figs. 1–2.
1969a *Gonyaulacysta jurassica* (Defl.). Sarjeant *in* Davey, Downie, Sarjeant & Williams, p. 8.
1970 *Gonyaulacysta jurassica* (Defl.). Gorka, pp. 482–3, pl. 1, fig. 3a–b, text-fig. 1.
1970 *Gonyaulacysta jurassica* (Defl.). Gitmez, tab. 4A.
1970 *Gonyaulacysta jurassica* (Defl.). Sarjeant, p. 676.
1972 *Gonyaulacysta jurassica* (Defl.).. Gitmez & Sarjeant, tabs. 3–6.
1972 *Gonyaulacysta jurassica* (Defl.). Riley & Sarjeant (in press).

Remarks: This is perhaps the best-known and most widely documented of Jurassic dinoflagellate cysts; the synonymy published above is the most comprehensive yet attempted. Recorded occurrences are not only from European countries (England, Scotland, France, Germany, Poland, Bulgaria and European Russia), but also the U.S.A. (Utah), India (Kutch), Australia and Papua.

It occurs at both studied levels of the Upper Vardekløft Formation. In the lower horizon, 24 specimens were observed, of which only 5 proved measurable: their dimensions were overall length 67–76 μ (mean 72 μ), length of apical horn 9–13 μ (mean 12.4 μ), breadth 44–58 μ (mean 50.3 μ). In the upper horizon, this is the most abundant dinoflagellate cyst, 32 specimens being observed [of which 4 were attributable to var. *longicornis* (see below)]. Their size is markedly larger: of 10 measurable specimens, overall length ranged from 69 to 98 μ (mean 83 μ), horn length from 8.5 to 24 μ (mean 18 μ), breadth from 33 to 70 μ (mean 54.4 μ). Both ranges fall within the total range which I quoted in my detailed morphological review of this species (1961).

Some specimens encountered exhibit an unusually broad-based apical horn (e.g. pl. 1, fig. 2), in one instance showing an opening in line with the archaeopyle (pl. 1, fig. 4).

Gonyaulacysta jurassica var. *longicornis* Deflandre 1938b

Plate 2, fig. 3.

1938b *Gonyaulax jurassica* var. *longicornia* Deflandre, p. 171, pl. 6, fig. 6.
1958 "Péridinien" Lantz, pl. 7, fig. 74.
1960 *Gonyaulax jurassica* subsp. *longicornis* Defl. Klement, pl. 2, figs. 6–8.
1961 *Gonyaulax jurassica* var. *longicornis* Defl. Sarjeant, pp. 92–4, text-fig. 2, 3, 15.
1962a *Gonyaulax jurassica* var. *longicornis* Defl. Sarjeant, p. 258, pl. 1, fig. 3.
1964 *Gonyaulax jurassica* var. *longicornis* Defl. Sarjeant, tab. 2.

1964 *Gonyaulax jurassica* var. *longicornis* Defl. DOWNIE & SARJEANT, p. 115.
1964 *Gonyaulacysta jurassica* var. *longicornis* (Defl.). DEFLANDRE, p. 5.
1967a *Gonyaulax jurassica* var. *longicornis* Defl. VOZZHENNIKOVA, p. 85, pl. 19, fig. 5, tabs. 2, 11.
1970 *Gonyaulacysta jurassica* var. *longicornis* Defl. GITMEZ, pp. 260–1, pl. 5, fig. 11, tab. 4A.
1971 *Gonyaulax jurassica* var. *longicornis* Defl. VOZZHENNIKOVA, pp. 128–9, pl. 19, fig. 5. (English translation of VOZZHENNIKOVA, 1967).
1972 *Gonyaulacysta jurassica* var. *longicornis* Defl. GITMEZ & SARJEANT, tabs. 3–6.
1972 *Gonyaulacysta jurassica* var. *longicornis* Defl. RILEY & SARJEANT (in press).

Remarks: One specimen from the lower horizon and four from the upper were allocated to this variety; their dimensions are included within the range quoted for the species since, as I have stated earlier (1961), it merely represents an extreme in the dimensional spread of *Gonyaulacysta jurassica* and cannot be considered of great significance.

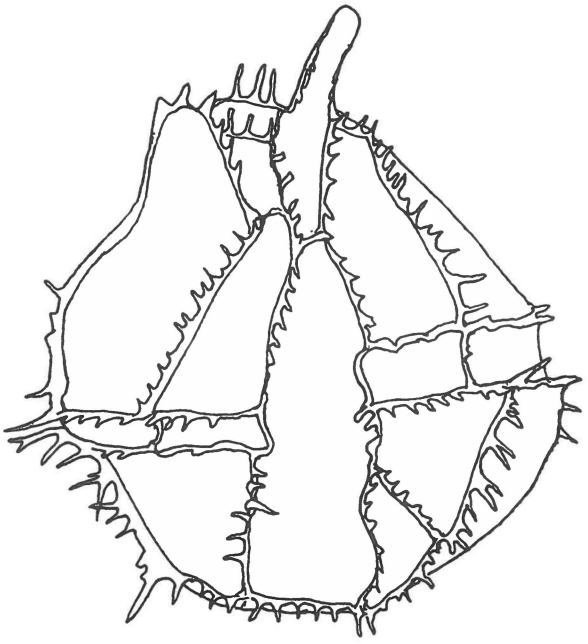


Figure 1. *Gonyaulacysta* aff. *jurassica* (DEFL.). Ventral view of specimen GR425/3/24 Xc. 1250.

Gonyaulacysta aff. *jurassica* (DEFLANDRE 1938b), NORRIS & SARJEANT 1965

Fig. 1; Plate 4, fig. 1.

Description: Cyst ovoidal to subpolygonal, with a broad sulcus, widest at its posterior end, and the tabulation 4′, 1a, 6″, 6c, 5‴, 1p, 1⁗. Crests in the form of low ridges ornamented by denticles of extremely variable

form, length and spacing (most often simple, sometimes bifid distally, sometimes deeply furcate, the branches sometimes having secondary outgrowths). Apical horn of moderate length, rounded at the distal end.

Figured Specimen: GR425/3/24, lower horizon, Upper Vardekløft Formation, Jameson Land, Greenland. *Dimensions.* Figured specimen: overall length 62 μ, length of apical horn 8 μ, overall breadth 54 μ, height of crests c. 4.5 to 6.5 μ. Three other specimens seen, none of them suitable for detailed measurements.

Remarks: The forms here described correspond in general morphology with *Gonyaulacysta jurassica*, but differ in the character of the apical horn (typically square-ended in the latter species), the lack of any indication of a sixth post cingular plate (plate 1′ of *G. jurassica*), and the detail of the crests, in which they resemble more closely *Gonyaulacysta cladophora*. It is possibly they represent an intermediate stage of evolution between *G. jurassica* and *G. cladophora;* further specimens must be awaited before this can be elucidated.

Gonyaulacysta cladophora (Deflandre, 1938b) Dodekova, 1967

1938a *Gonyaulax cladophora* Deflandre, p. 688, fig. 4 *nomen nudum.*
1938b *Gonyaulax cladophora* Deflandre, pp. 173–6, pl. 7, fig. 1–5, text-figs. 5–6.
1941 *Gonyaulax cladophora* Defl. Deflandre, p. 9, pl. 3, figs. 4–5.
?1953 *Gonyaulax cladophora* Defl. Valensi, pp. 25–27, pl. 1, figs. 3, 6, pl. 13, figs. 2–3, text-figs. 2b–c
1960 *Gonyaulax cladophora* Defl. Klement, pp. 33–38, pl. 3, figs. 1–12, pl. 4, figs. 1–9, text-figs. 11–17.
1960 *Gonyaulax cladophora* Defl. Sarjeant, tab. II.
1961 *Gonyaulax cladophora* Defl. Sarjeant, p. 94, pl. 13, fig. 2, pl. 14, figs. 1–2.
1962a *Gonyaulax cladophora* Defl. Sarjeant, tabs. 3–4.
1962b *Gonyaulax cladophora* Defl. Sarjeant, tabs. 2–3.
1964a *Gonyaulax cladophora* Defl. Sarjeant, tab. 2.
1964 *Gonyaulax cladophora* Defl. Downie & Sarjeant, p. 114.
1966 *Gonyaulax cladophora* Defl. Schulz & Mai, tab. I.
1966b *Gonyaulacysta cladophora* (Defl.). Sarjeant *in* Davey, Downie, Sarjeant & Williams, p. 130 *nom. nud.*
1967 *Gonyaulax cladophora* Defl. Vozzhennikova, pp. 78–9, pl. 19, figs. 1–4.
1967 *Gonyaulax cladophora* Defl. Eisenack, pp. 329–337.
1967 *Gonyaulacysta cladophora* (Defl.) Dodekova, pp. 17–18, pl. 2, figs. 2–8.
1967a *Gonyaulacysta cladophora* (Defl.) Sarjeant, tab. I, *nom. nud.*
1968 *Gonyaulacysta cladophora* (Defl.) Sarjeant, pl. 1, fig. 6, tab. 2A.
1969a *Gonyaulacysta cladophora* (Defl.) Sarjeant *in* Davey, Downie, Sarjeant & Williams, p. 9.
1970 *Gonyaulacysta cladophora* (Defl.) Gorka pp. 483–4, pl. 1, fig. 4, pl. 2, fig. 1a–c, 2a–b, text-figs. 2a-b.
1970 *Gonyaulacysta cladophora* (Defl.) Gitmez, pls. 4A–B.
1971 *Gonyaulax cladophora* Defl. Vozzhennikova, pp. 117–120, pl. 19, figs. 1–4. (English translation of Vozzhennikova, 1967).

1972 *Gonyaulacysta cladophora* (Defl.) GITMEZ & SARJEANT, tabs. 3–6.
1972 *Gonyaulacysta cladophora* (Defl.) RILEY & SARJEANT (in press).

Remarks: The most detailed study of this species was by KLEMENT (1960), who differentiated four subspecies, on morphological criteria alone. In the assemblages I have examined, there have never been sufficient well-preserved specimens of *Gonyaulacysta cladophora* for me to form a meaningful judgement on his proposals; DEFLANDRE's original comment that "Although plentiful . . . this species is most often in a bad state of preservation" (transl.) is entirely valid. It is represented by fourteen specimens in the lower horizon; none of these was adequate for accurate measurement. In the upper horizon, seventeen specimens were recognised; only one of these (specimen GR425/7/41) was suitable for measurement — overall length 127 μ, length of apical horn 17 μ, overall breadth 91 μ, breadth of central body 87 μ. These dimensions are quite typical for the species.

Gonyaulacysta aff. *cladophora* (DEFLANDRE, 1938b)
Fig.2; Plate 2, fig. 6

Description: Cyst moderately thick-walled, with a small, blunt apical horn: ambitus rounded-pentagonal. Tabulation: 3–?4′, 1a, 6″, ?6c, 6‴, 1p, 1⁗. Crests in the form of raised flanges, giving rise to simple or (less commonly) bifid spinelets: the length and spacing of these spinelets is extremely variable, but the longest are at crest nodes at the antapex.

Plate 1′ is extremely elongate, extending almost to the cingulum. (The sulcus is therefore unusually short: it is also quite broad). The number of other apical plates was not determined accurately, but it should be noted that a small circular plate appears to occupy the tip of the apical horn. Plate 1a is especially large and plate 6″, in consequence, reduced, the other precingular plates being of constant size and shape.

Plate 3″ forms the operculum. In the figured specimen, it remains in place, attached laterally to plate 4″. Probably as a consequence of crushing, a split has extended from the archaeopyle along the junction of plate 2″ with the cingulum; the figured specimen is slightly distorted as a consequence of folding along this line of weakness.

The cingulum is laevorotatory, its two ends differing in antero-posterior position by almost twice its breadth. The number of cingular plates was not determined. The first two postcingular plates are reduced to accommodate the posterior intercalary plate. Plate 1″ is especially small, but its boundary crests are quite clear. A large polygonal plate occupies the antapex.

Figured Specimen: Specimen GR426/11/11, upper horizon, Upper Vardekløft Formation, Jameson Land. Dimensions: Figured specimen; overall length 98 μ, length of horn 8 μ, overall breadth 96 μ (this is slightly

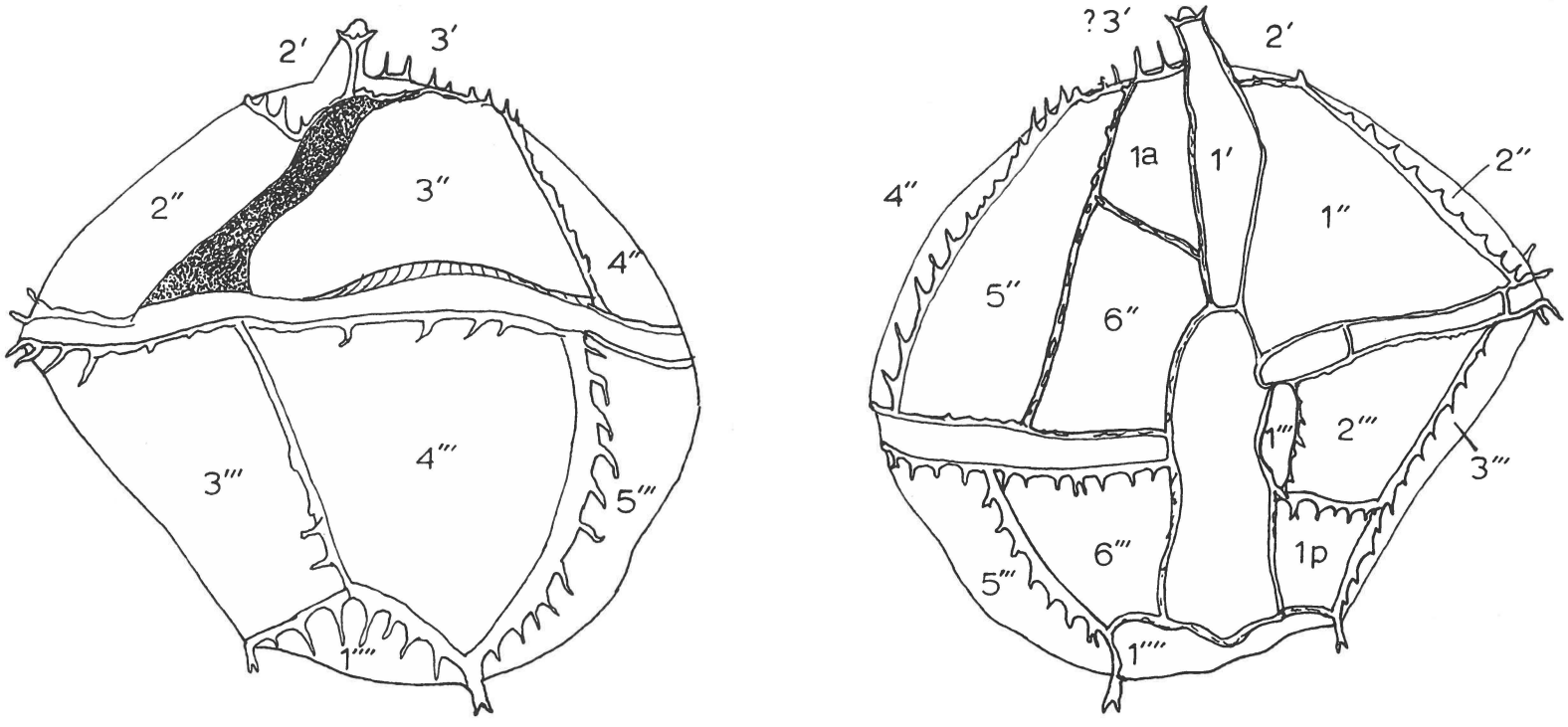


Figure 2. *Gonyaulacysta* aff. *cladophora* (DEFL.). Specimen GR 426/11/11. Left: in dorsal view. Right: in ventral view. Xc. 900.

exaggerated by crushing), height of crests up to 5.5 μ. Five other specimens were encountered in the upper horizon, none of them suitable for accurate measurement. In addition, a single specimen from the lower horizon may be of the same type.

Remarks: The specimens here discussed are extremely typical members of the genus *Gonyaulacysta*. They resemble *G. cladophora* in the general features of the tabulation, but differ in detail. (Comparing these forms with the various subspecies of *G. cladophora* differentiated by KLEMENT, 1960, in *G. cladophora cladophora* the placement of plate 1'' is different, *G. cladophora hemipolyedrica* apparently lacks an apical horn but has a closely similar tabulation, whilst *G. cladophora extensa* and *G. cladophora isovalvata* have much longer apical horns. A consistent difference is in the form of the sutural ornamentation, which in *G. cladophora* consists of lines of isolate, simple to capitate or bifurcate spines.

There is a broad correspondence in tabulation with *Gonyaulacysta filapicata* GOCHT, 1970, but the placement of plate 1'', the presence of plate 1a, and the lack of a general scatter of spinelets over the shell surface enables ready differentiation. *Gonyaulacysta ambigua* (DEFLANDRE, 1939) is similar in tabulation and proportions, but lacks plate 1p and has an even shorter apical horn. All other described species are even more markedly dissimilar.

In consequence, it appears that this is an undescribed species: however, the specimens studied were inadequate to serve as types for the erection of a new taxon.

Gonyaulacysta eisenacki (DEFLANDRE, 1938b) DODEKOVA, 1967

1938b *Gonyaulax eisenacki* DEFLANDRE, pp. 171–3, pl. 6, figs. 7–10, text-figs. 3–4.
1952 *Gonyaulax eisenacki* Defl. DEFLANDRE, fig. 300c.
1953 *Gonyaulax* cf. *eisenacki* Defl. VALENSI, p. 25, pl. 1, fig. 5, pl. 13, fig. 1.
1960 *Gonyaulax eisenacki* Defl. KLEMENT, pp. 29–30, pl. 2, figs. 9–10.
1962a *Gonyaulax eisenacki* Defl. SARJEANT, p. 258, pl. 1, fig. 4, tab. 3.
1962b *Gonyaulax eisenacki* Defl. SARJEANT, tabs. 2–3.
1964a *Gonyaulax eisenacki* Defl. SARJEANT, tab. 2.
1964 *Gonyaulax eisenacki* Defl. DOWNIE & SARJEANT, p. 114.
1965 *Gonyaulax eisenacki* Defl. GORKA, pp. 299–300, pl. 1, figs. 5a–c
1966c *Gonyaulacysta eisenacki* (Defl.) SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 131, *nom. nud.*
1967 *Gonyaulax eisenacki* (Defl.) EISENACK, pp. 353–4.
1967 *Gonyaulacysta eisenacki* (Defl.) DODEKOVA, pp. 18–19, pl. 2, figs. 9–11.
1967a *Gonyaulacysta eisenacki* (Defl.) SARJEANT, tab. I.
1968 *Gonyaulacysta eisenacki* (Defl.) SARJEANT, p. 227, pl. 3, fig. 14, tab. 2A.
1969a *Gonyaulacysta eisenacki* (Defl.) SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 9.
?1970 *Endoscrinium eisenacki* (Defl.) GOCHT, pp. 146–7, pl. 33, figs. 9–12, text-fig. 15f.
1972 *Gonyaulacysta eisenacki* (Defl.) GITMEZ & SARJEANT, tabs. 3, 5–6.
1972 *Gonyaulacysta eisenacki* (Defl.) RILEY & SARJEANT (in press).

Remarks: This species was originally described from the Oxfordian, where it is represented by forms having pronouncedly denticulate crests, an apical horn somewhat comparable to that of *Gonyaulacysta jurassica* but more in the form of a low-angle cone with blunt tip (thus midway bestween "horn" and "apical pericoel") and an antapical pericoel, more pronounced in KLEMENT's South German material (1960, pl. 2, figs. 9–10) than in the French and English specimens studied by DEFLANDRE and myself. [Note: the form which I figured, as *G. eisenacki*, from the Ampthill Clay of South Yorkshire (1962b, pl. 69, fig. 3), is attributable to the species *Gonyaulacysta dangeardi* SARJEANT, 1968: however, *G. eisenacki* is also present in the Ampthill Clay assemblages.].

GOCHT (1970, pp. 146–7)) has recently proposed the reattribution of this species to the genus *Endoscrinium* KLEMENT, 1960, emend. VOZZHENNIKOVA, 1965, on the basis of its antapical pericoel. It is indeed true that *G. eisenacki* does not accord with the typical members of the genus *Gonyaulacysta* in prssessing this particular feature; however, in my opinion it accords no better with the genus *Endoscrinium*. The typical members of this latter genus have an ambitus varying from oval to almost lozenge-shaped; they have six postcingular plates and lack a posterior intercalary plate, the sulcus widening posteriorly and seemingly occupying the antapex, no boundary between sulcus and antapical plate being discernible. Denticulate crests are not exhibited by any other member of this genus, nor are high crests. *G. eisenacki*, in contrast, has a tabulation typical of the *Gonyaulax*-pattern, and the its ambitus is more polygonal, modified by the crests. It is arguable that a new genus should be erected to accommodate this species: for the moment, however, I see no merit in transferring it to *Endoscrinium* and prefer to retain it in *Gonyaulacysta*.

GOCHT comments (1970, p. 146) that the majority of his forms accord with the subspecies *oligodentata* (see below). None of the forms he illustrates correspond with the typical subspecies.

Gonyaulacysta eisenacki was present in both examined horizons of the Upper Vardekløft Formation. In the lower horizon, 11 specimens were noted: in the upper, only 5. The best-preserved (unfortunately, slightly obscured) was no. GR426/4/8: its dimensions (overall length 125 μ, apical horn length 5 μ, antapical pericoel length 17 μ, overall breadth 60 μ) are larger than is usual for the species.

Gonyaulacysta eisenacki (DEFLANDRE, 1938b) subsp. *oligodentata* COOKSON and EISENACK, 1958

Fig. 2; Plate 2, fig. 1

1958 *Gonyaulax eisenacki oligodentata* COOKSON & EISENACK, p. 30, pl. 2, fig. 11.
1964 *Gonyaulax eisenacki oligodentata* COOKSON & EISENACK, DOWNIE & SARJEANT, p. 114.

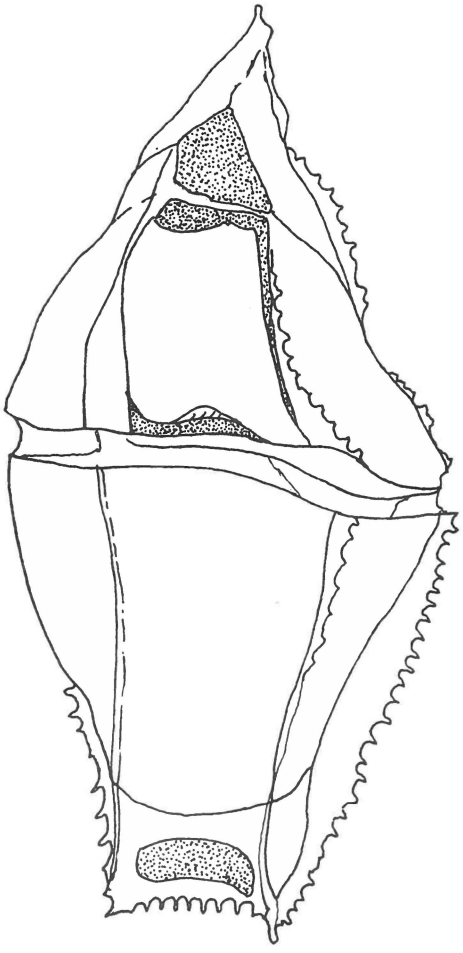


Figure 3. *Gonyaulacysta eisenacki oligodentata* COOKSON & EISENACK. Specimen GR426/6/16 in dorsal view, showing the archaeopyle and antapical opening. Xc. 900.

1967 *Gonyaulax eisenacki oligodentata* COOKSON & EISENACK, EISENACK, p. 355.
1970 *Gonyaulacysta eisenacki oligodentata* COOKSON & EISENACK, GOCHT, pp. 146–7, pl. 33, figs. 9–12, text-fig. 15f.
1972 *Gonyaulacysta eisenacki oligodentata* COOKSON & EISENACK, RILEY & SARJEANT (in press).

Remarks: Only two specimens, both from the upper horizon in the Upper Vardekløft Formation, were attributable to this subspecies. The better preserved specimen, GR426/6/16, is illustrated: its dimensions are overall length 140 μ, length of horn 8 μ, length of antapical pericoel 17 μ, overall breadth 64 μ, height of crests 3.5 to 6.5 μ. It exhibits the precingular archaeopyle typical of the species, with (unexpectedly) an apex-ward

extension apparently formed by partial or complete loss of plate 3′. In addition, there is an antapical opening of the type mentioned by KLEMENT, 1960 (p. 146). The functional significance of these additional openings remains to be ascertained.

Gonyaulacysta cf. *transparens* (SARJEANT, 1959) SARJEANT *in* DAVEY, DOWNIE, SARJEANT and WILLIAMS, 1969.

Discussion. Three specimens encountered in the lower horizon of the Upper Vardekløft Formation accord with *?Gonyaulacysta transparens* in shape, the extreme thinness and transparency of the cyst, the possession of a tabulation weakly marked by extremely low ridges on the sutures and the proportionate breadth of the cingulum. They have a clear single-plate precingular archaeopyle formed by loss of plate 3″. However, all were distorted and the extremely small apical horn characteristic of *G. transparens* was not observed, perhaps as a consequence of unfavourable orientation. Their assignment to this species is, in consequence, very tentative.

?Gonyaulacysta whatleyi sp. nov.

Fig. 4; Plate 7, fig. 1

Derivation of Name: In honour of Dr. ROBIN IGNATIUS WHATLEY, micropalaeontologist of the University of Wales, Aberystwyth, who provided the specimens for examination.

Diagnosis: Cyst delicate and transparent. Ambitus a rounded and elongate pentagon. Endophragm and periphragm in general contact, but separating at either pole: at the apex is a "horn" or small apical pericoel, in the form of a rounded-tipped cone with thickened base, and at the antapex an antapical pericoel in the form a truncated cone. Tabulation marked by low ridges on the periphragm; 5′, 1a, 6″, 5 (or 6?)c, 6‴, 1p, 1pv, ?1⁗. Cingulum markedly laevorotatory, its two ends differing in anteroposterior position by almost 3 times its breadth. Archaeopyle precingular, reduced, formed by loss of plate 3″.

Holotype: Specimen GR425/8/1, lower horizon, Upper Vardekløft Formation, Jameson Land, Greenland; lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype: overall length 78.5 μ, length of apical "horn" 8.5 μ, length of antapical pericoel 8 μ, length of endoblast 62 μ, overall breadth 39 μ. Range of dimensions (4 specimens were measurable): overall length 66.5–88.5 μ (mean 80.66 μ), overall breadth c. 37–42 μ (mean 39.66 μ), length of endoblast 51–60.5 μ (mean 57.16 μ).

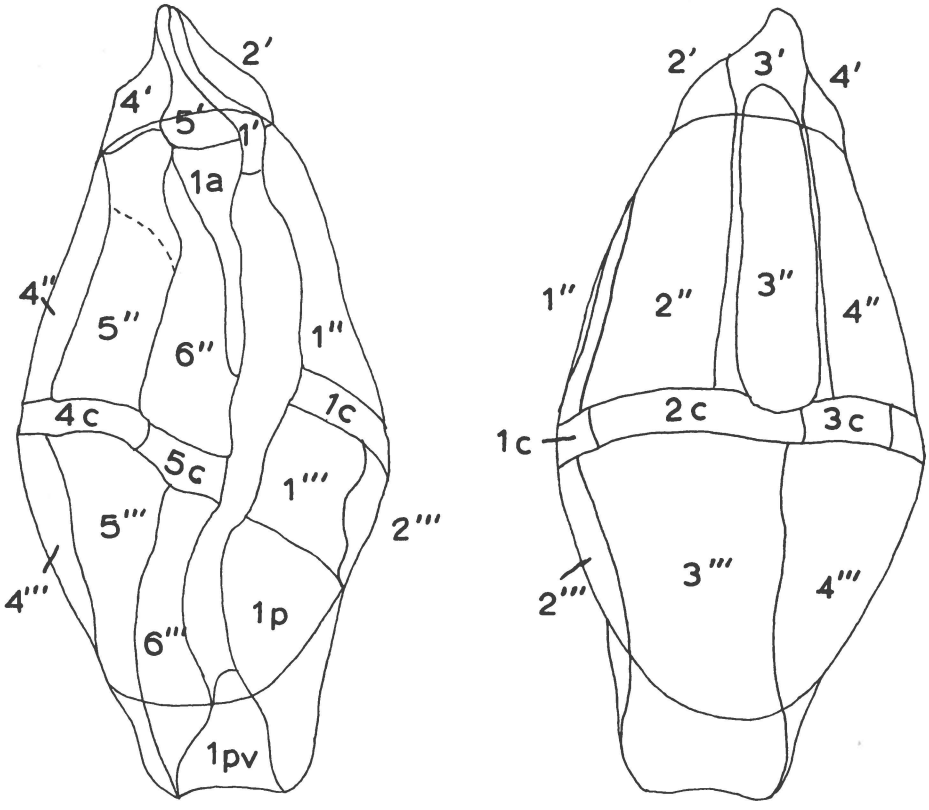


Figure 4. *?Gonyaulacysta whatleyi* sp. nov. The holotype; specimen GR425/8/1. Left: in ventral view. Right: in dorsal view Xc. 1250.

Material: 11 specimens in the lower horizon and 4 specimens in the upper horizon.

Description: Apex formed by five plates of varying shape, with plate 1′ occupying the anterior prolongation of the sulcus. The form of plate 1a was not established with complete certainty. Six precingular plates were present, plate 6″ reduced to accommodate the anterior intercalary plate: a boundary may be present separating a second anterior intercalary plate from plate 5″, but I consider it more likely to be a fortuitous appearance resulting from folding (examination of the other specimens was not conclusive). Only five cingular plates were recognised; this number is unusual and it is possible that the number should be six, the boundary of the sixth having escaped recognition.

Six postcingular plates are present, plate 1″ reduced to accommodate an unusually large posterior intercalary plate. The sulcus is of moderate and fairly constant breadth. The triangular plate, here numb-

ered as 1pv, may in fact represent an anterior extension of the antapical plate; no boundary enclosing the antapical plate could be distinguished.

Remarks: This species is characteristically thin-walled and delicate, very liable to damage: its tabulation was determined only by study by phase contrast and Nomarski interference contrast, in addition to examination under normal illumination.

Its generic attribution is provisional: there are strong arguments for allocation to *Psaligonyaulax* SARJEANT, 1967a, but the apical pericoel is considered insufficiently broad for this species to be termed "bicavate". For the moment, it is placed alongside *G. eisenacki* (whose systematic attribution is discussed above) into *Gonyaulacysta*. The most comparable species is, however, *G. dangeardi* SARJEANT, 1968, from which it differs in its more elongate outline, the antapical widening of the sulcus to form plate 1pv, and the different form of the apex (*G. dangeardi* has a narrower, square-ended horn).

Gonyaulacysta scarburghensis SARJEANT, 1964b

1961 *Gonyaulax areolata* SARJEANT, pp. 95–7, pl. 13, fig. 13, text-fig. 5, *nomen nudum*.
1964 *Gonyaulax areolata* SARJEANT, DOWNIE & SARJEANT, p. 113, *nom. nud.*
1964a *Gonyaulax areolata* SARJEANT, SARJEANT, tab. 2, *nom. nud.*
1964b *Gonyaulacysta scarburghensis* SARJEANT, pp. 472–3.
1966 *Gonyaulax areolata* SARJEANT, SCHULZ & MAI, tab. I, *nom. nud.*
1966b *Gonyaulacysta scarburghensis* SARJEANT, SARJEANT, *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 131.
1967a *Gonyaulacysta scarburghensis* SARJEANT, SARJEANT, tab. II.
1967 *Gonyaulax areolata* SARJEANT, EISENACK, pp. 321–2, *nom. nud.*
1968 *Gonyaulacysta scarburghensis* SARJEANT, SARJEANT, tab. 2A.
1969a *Gonyaulacysta scarburghensis* SARJEANT, SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 11.
1969b *Gonyaulacysta scarburghensis* SARJEANT, SARJEANT *in* ERDTMAN, fig. 45 no. 2.
1971 *Gonyaulacysta scarburghensis* SARJEANT, RILEY & SARJEANT (in press).

Remarks: Two poorly preserved specimens both from the upper horizon, appeared attributable to this species, agreeing in relative proporations and character of the periphragm.

Genus *LEPTODINIUM* KLEMENT, 1960, emend. SARJEANT, 1969a

Leptodinium cf. *millioudi* (SARJEANT, 1963) SARJEANT, 1969a

Remarks: A single specimen in the upper horizon resembled *Leptodinium millioudi* in proportions and form of crests, but the tabulation could not be confirmed in detail. No other specimen attributable to this genus were encountered.

Genus *HYSTRICHOGONYAULAX* SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1969

Hystrichogonyaulax cf. *cornigera* (VALENSI, 1953) SARJEANT 1969a

Plate 5, fig. 2.

Description: Cyst ovoidal, clearly tabulate, the tabulation broadly according with the *Gonyaulax* pattern but not determinable in detail in the specimens seen, in consequence of poor preservation and unfavourable orientation. Boundaries of plates are demarcated by lines of isolate spines; these spines are knobbed, capitate or briefly bifurcate at their distal ends. The average spine length is about one-twelfth of the shell breadth; however, the spines at the septal nodes surrounding the antapex are almost twice the average length. The surface is granular. A precingular single-plate archaeopyle is formed by loss of plate 3''.

Figured Specimen: Specimen GR425/6/22, lower horizon in the Upper Vardekløft Formation, Jameson Land.

Dimensions: Figured specimen; overall length 104 μ, overall breadth 88 μ, average length of spines c. 7 μ, length of antapical nodal spines c. 12.5 μ. Second specimen: overall length 115 μ, overall breadth 78 μ, spine length c. 10 μ.

Material: 5 specimens.

Genus *ACANTHAULAX* SARJEANT, 1968

?Acanthaulax spinosissima (DEFLANDRE, 1938b) comb. nov.

1938b *Palaeoperidinium spinosissimum* DEFLANDRE, p. 179, pl. 9, fig. 11.
1955 *Palaeohystrichophora spinosissima* (Defl.). DEFLANDRE & COOKSON, p. 258.
1960 *Palaeohystrichophora spinosissima* (Defl.) SARJEANT, p. 395, pl. 12, fig. 5, pl. 13, fig. 6.
1962b Cf. *Palaeohystrichophora spinosissima* (Defl.) SARJEANT, tabs. 2–3.
1964 *Palaeohystrichophora spinosissima* (Defl.) DOWNIE & SARJEANT, p. 137.
1967 *Palaeoperidinium spinosissimum* Defl. EISENACK, pp. 617–8.
1967c *Palaeohystrichophora spinossima* (Defl.) SARJEANT, tab. XI.
1962 *Palaeohystrichophora spinossima* (Defl.) RILEY & SARJEANT (in press).

Remarks: This species was described on the basis of fragmentary specimens from the Oxfordian of northern France and was originally placed into *Palaeoperidinium*, then a "waiting genus" without a specified type species and, as such, invalid under the international rules governing biological nomenclature. It was transferred by DEFLANDRE and COOKSON (1955) to the genus *Palaeohystrichophora* on the basis of its possession of a general spine cover: however, subsequent studies of the type species of the latter genus, *P. infusorioides* DEFLANDRE, 1935, have shown it to

be a cavate cyst, which the Jurassic species certainly is not. Accordingly, EISENACK (1957) returned it to the genus *Palaeoperidinium* which, as now circumscribed (SARJEANT, 1967), is an equally inappropriate placement.

Subsequent to DEFLANDRE's original description, the only observations of this species have been my own records from the Corallian (1960) and the Ampthill Clay (1962b) of Yorkshire, England. The assignment of the English forms (which like DEFLANDRE's original forms, were all severely damaged) to this species, originally tentative, may now be confirmed, following my examination of the holotype during visits to Prof. DEFLANDRE's laboratory in Paris: this also shows faint traces of a tabulation, the only point of apparent difference noted in the English forms. In view of the presence of tabulation traces and the general scatter of spines over the surface, it is here proposed that this species be provisionally reassigned to the genus *Acanthaulax* until such time as better specimens can be found and the tabulation determined.

Four fragmentary specimens in the upper horizon of the Upper Vardekløft Formation are assigned to this species, on the basis of general aspect, character of the spine cover, and presence of tabulation vestiges.

Family Pareodiniaceae GOCHT, 1957, emend. SARJEANT & DOWNIE 1966.

Remarks: EISENACK (1969) has pointed out that DOWNIE and I (1966) were inconsistent with our general thesis of classification, when proposing this cyst-family, in that we grouped forms with precingular and intercalary archaeopyles together. A full reconsideration of our scheme of classification is pending; in the meantime, EISENACK's recommendation (that the Family Apteodiniaceae be retained as a distinct entity from the Pareodiniaceae) is endorsed.

Genus *PAREODINIA* DEFLANDRE, 1947, emend. GOCHT, 1970

Pareodinia ceratophora DEFLANDRE, 1947

1947 *Pareodinia ceratophora* DEFLANDRE, p. 4, figs. 1–3.
1952a *Pareodinia ceratophora* Defl. DEFLANDRE, fig. 93.
1953 *Pareodinia ceratophora* Defl. VALENSI, pp. 29–30, pl. 13, fig. 4.
1953 Péridinien indéterminé VALENSI, p. 30, pl. 3, figs. 4, 7.
1958 *Pareodinia aphelia* (pars) COOKSON & EISENACK, p. 60, pl. 12, fig. 9.
1958 *Cryptomeriapollenites coralliensis* LANTZ, p. 927, pl. 5, figs. 55–56, pl. 6, fig. 7.
1958 Incertae sedis LANTZ, p. 927, pl. 6, figs. 58–59.
1959 *Pareodinia ceratophora* Defl. SARJEANT, p. 336, text-fig. 5b.
1960 *Pareodinia ceratophora* Defl. SARJEANT, pl. 12, fig. 11, tab. II.
?1960 *Kalyptea monoceras* COOKSON & EISENACK, p. 257, pl. 39, figs. 2–3.

1961 *Pareodinia ceratophora* Defl. SARJEANT, p. 99, pl. 13, fig. 16.
1961 *Pareodinia ceratophora* Defl. ALBERTI, p. 23, pl. 12, fig, 14.
1961 Peridinea (?) MALIAVKINA, SAMOILOVITCH *et al.*, pl. 16, figs. 1, ? 2.
1961 *Pareodinia* sp. EVITT, p. 4, pl. 8, fig. 19.
1962a *Pareodinia ceratophora* Defl. SARJEANT, p. 263, pl. 1, fig. 13.
1962b *Pareodinia ceratophora* Defl. SARJEANT, p. 483, pl. 69, fig. 8, text-fig. 5.
1963 *Pareodinia ceratophora* Defl. BALTES, p. 584, pl. 4, fig. 7. (Misspelt "*P. ceratophora*" in text).
1964 *Pareodinia ceratophora* Defl. SARJEANT, tab. 2.
1964 *Pareodinia ceratophora* Defl. DOWNIE & SARJEANT, p. 138.
?1964 *Kalyptea monoceras* COOKSON & EISENACK, DOWNIE & SARJEANT, p. 122.
1965 *Pareodinia ceratophora* Defl. NORRIS & SARJEANT, p. 47.
1965 *Pareodinia ceratophora* Defl. VOZZHENNIKOVA, fig. 32e.
1965b *Pareodinia ceratophora* Defl. SARJEANT, tab. I.
1966 *Pareodinia ceratophora* Defl. LOEBLICH & LOEBLICH, p. 46.
1966 *Pareodinia ceratophora* Defl. SCHULZ & MAI, tab. I.
1966c *Pareodinia ceratophora* Defl. SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, pp. 211–212, pl. 23, fig. 2.
1967 *Pareodinia ceratophora* Defl. EISENACK, p. 633.
1967a *Pareodinia ceratophora* Defl. VOZZHENNIKOVA, p. 58.
1967a *Pareodinia ceratophora* Defl. SARJEANT, tab. II.
1967 *Pareodinia* cf. *ceratophora* Defl. EVITT, p. 3, pl. 4, figs. 7, 28.
1967a *Pareodinia ceratophora* Defl. VOZZHENNIKOVA, p. 90, fig. 32E. (English translation of VOZZHENNIKOVA, 1965).
1968 *Pareodinia ceratophora* Defl. SARJEANT, p. 4, pl. 1, fig. 13, tab. 2a.
1970 *Pareodinia ceratophora* Defl. GITMEZ, p. 281, pl. 6, fig. 5, 6, pl. 14, fig. 6.
1970 *Pareodinia ceratophora* Defl. GOCHT, pp. 154–156, pl. 35, figs. 1–8, text-figs. 22–25.
1971 *Pareodinia ceratophora* Defl. VOZZHENNIKOVA, p. 86. (English translation of VOZZHENNIKOVA, 1967).
1972 *Pareodinia ceratophora* Defl. GITMEZ & SARJEANT, tabs. 3–6.
1972 *Perodinia certaophora* Defl. RILEY & SARJEANT (in press).

Remarks: This species has recently been discussed at length by GOCHT (1969), who proposes for it an emended diagnosis embodying a number of new features; this specifies the form of the archaeopyle (2-plate intercalary) and mentions the occasional presence of an antapical horn and the possession of an outer mantle of fleecy organic substance, for which the term "kalyptra" is proposed. Gocht comments that this outer mantle may be destroyed in preparation or handling, but that it is almost universal in his material.

Whilst I have occasionally encountered specimens of *Pareodinia ceratophora* partially sheathed in organic material (e.g. SARJEANT, 1962b, plate 69, fig. 8), I am by no means convinced that such an organic cloak is a universal feature of this species at all horizons, absent only as a result of laboratory treatment. In many horizons representatives of this species consistently lack such a cloak, whereas representatives of species of *Netrelytron* are consistently shrouded in a cloak of organic material. GOCHT's Bathonian specimens are geologically among the

earliest described: the type specimens, from the Callovian and the Callovian and Oxfordian specimens from England seem to typically lack this feature. It is conceivable that GOCHT may be correct in supposing the cloak to have been consistently present at all horizons until removed during natural weathering of the rocks or during laboratory treatment; it is equally possible that the "kalyptra" is a feature of early members of the lineage which is lacking in later forms, though retained in a second lineage leading to *Netrelytron* and *Paranetrelytron*. I do not consider that the stress which GOCHT gives to this feature in his emended diagnosis is justified at present.

I am equally doubtful as to whether the presence of a second antapical horn merits mention in the diagnosis. Whilst VALENSI has also described a form with an antapical horn (1953, p. 30; plate 3, fig. 11), this is certainly not a commonplace feature and may again be characteristic only of the early forms of this lineage. It is also arguable that the presence of such an important morphological feature as a second (antapical) horn is justification enough for taxonomic separation. GOCHT's inclusion of *Kalyptea diceras* COOKSON & EISENACK 1960 into the synonymy of this species, admittedly provisional, seems less justifiable than his inclusion of *K. monoceros;* the generic name *Kalyptea* might with advantage be retained for bicorn cysts lacking an endoblast.

Pareodinia ceratophora ceratophora DEFLANDRE, 1947

Plate 4, fig. 8.

Remarks: Typical forms are present at both horizons of the Upper Vardekløft Formation. 30 specimens were encountered in the lower horizon, of which 10 were well enough preserved and oriented for measurement: overall length ranged from 63 to 92 μ (mean 74.4 μ), breadth from 41 to 56 μ (mean 47.75 μ), length of the horn from 8.5 to 17 μ (mean 13.75 μ). In the upper horizon, 10 specimens were encountered of which six were measurable; their overall length ranged from 41 to 89 μ (mean 64.16 μ), breadth from 27.5 to 46 μ (mean 39.00 μ). The dimensional spread is thus greater than that quoted for the type material by DEFLANDRE (overall length 65–78 μ) or by GOCHT, 1970 (overall length 61–87 μ, breadth 31–42 μ).

Pareodinia ceratophora var. *pachyceras* SARJEANT, 1959

1959 *Pareodinia ceratophora* var. *pachyceras* SARJEANT, p. 337, pl. 13, fig. 10, text-fig. 5a.
1964a *P. ceratophora* var. *pachyceras* SARJEANT, SARJEANT, tab. 2.
1964 *P. ceratophora* var. *pachyceras* SARJEANT, DOWNIE & SARJEANT, p. 138.
1965 *P. ceratophora* var. *pachyceras* SARJEANT, EISENACK, p. 635.
1969b *P. ceratophora* var. *pachyceras* SARJEANT, SARJEANT *in* ERDTMAN, fig. 45 no. 4.
1972 *P. ceratophora* var. *pachyceras* SARJEANT, RILEY & SARJEANT (in press).

Remarks: Eleven specimens attributable to this variety were encountered in the lower horizon of the Upper Vardekløft Formation. Six of these were measurable: overall length ranged from 63.5 to 78 μ (mean 68.25 μ), breadth from 39 to 47 μ (mean 43.00 μ), length of horn from 10.5 to 16 μ (mean 13.75 μ). The outline of the horn was consistently as originally depicted (SARJEANT, 1959, text-fig. 5a), blunt-tipped and of rather constant breadth. The variety was not represented in the upper horizon.

Pareodinia ceratophora var. *scopaeus* nov.

Plate 2, fig. 4.

Derivation of Name: Gr. *skopaios* m., dwarf: with reference to the overall size.

Diagnosis: A variety of *Pareodinia ceratophora*, distinguished by its extremely small size.

Holotype: Specimen GR426/3/20, upper horizon, Upper Vardekløft Formation, Jameson Land: lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype: Overall length 39 μ, breadth 31 μ, length of horn 5.5 μ. Second specimen: overall length 47 μ, breadth 27 μ, length of horn 8 μ.

Remarks: Two specimens encountered in the upper horizon are comparable with *Pareodinia ceratophora* in all features but differ in their much more meagre dimensions, which fall outside any ranges quoted to date for this species. In view of their correspondence to *P. ceratophora* in all other features, it is considered that future studies will show them to fall within the extremes of variation of this very variable species; they are accordingly distinguished at varietal level only.

Pareodinia prolongata SARJEANT, 1959

Plate 4, fig. 9.

1959 *Pareodinia prolongata* SARJEANT, pp. 335–6, pl. 13, fig. 8, text-fig. 4.
1964a *Pareodinia prolongata* SARJEANT, SARJEANT, tab. 2.
1964 *Pareodinia prolongata* SARJEANT, DOWNIE & SARJEANT, p. 138.
1965 *Pareodinia prolongata* SARJEANT, EISENACK, p. 637.
1966 *Pareodinia prolongata* SARJEANT, SCHULZ & MAI, tab. I.
1967a *Pareodinia prolongata* SARJEANT, SARJEANT, tab. II.
1968 *Pareodinia prolongata* SARJEANT, SARJEANT, p. 228, pl. 3, fig. 2.
1972 *Pareodinia prolongata* SARJEANT, RILEY & SARJEANT (in press).

Remarks: This was the commonest single species in the lower horizon of the Upper Vardekløft Formation, 33 specimens being recognised. 22 of these were suitable for measurement; they ranged in overall length from

38 to 88 μ (mean 72.7 μ) and in breadth from 22.5 to 50 μ (mean 44.15 μ), the length of the apical horn varying from 16 to 27 μ (mean 20.3 μ). The dimensions are thus consistently smaller than in the type material from Yorkshire, England (overall length 90 to 120 μ). In the upper horizon, this species was questionably represented by a single, poorly preserved specimen.

Pareodinia groenlandica sp. nov.

Plate 2, fig. 2; Plate 5, fig. 1.

Derivation of Name: After the country of origin of the type material.

Diagnosis: A species of *Pareodinia* having an ovoid cyst, prolonged at the apex into a stout, blunt horn. The length of the horn is between one-quarter and one-third the length of the central body; it is formed from both wall layers, not by the periphragm only. The wall is relatively thick: the surface of the periphragm exhibits a dense network of areolae.

Holotype: Specimen GR425/3/10A, lower horizon of Upper Vardekløft Formation, Jameson Land: lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype: overall length 73 μ, breadth 44.5 μ, length of apical horn 17 μ. Range; overall length 64–84 μ (mean 73.8 μ), breadth 38–56 μ (mean 46.5 μ), length of apical horn 12–21 μ (mean 17.1 μ).

Material: 13 specimens (ten of these were measureable).

Description: The specimens seen were consistently thicker-walled and had a stronger body colour than specimens of *Pareodinia ceratophora* Deflandre or *P. prolongata* Sarjeant in the same assemblages. In some instances (e.g. in the holotype, plate 5, fig. 1, near the antapex), the periphragm is torn off, exposing the unornamented endophragm beneath. The two-plate intercalary archaeopyle forms a point of weakness and may be the position of folding; subsidiary tearing may occur from the corners of the archaeopyle. The operculum may be incompletely thrown off, and, in consequence, may be seen inside the cyst (cf. plate 5, fig. 1).

Remarks: In its general shape, with the unusually massive and blunt apical horn and style of surface ornamentation, *P. groenlandica* sp. nov. differs from all other described species. It was present in the lower horizon only.

Pareodinia apotomocerastes sp. nov.

Plate 3, fig. 4.

Derivation of Name: Gr. *apotomos*, cut off: *cerastes*, horned.

Diagnosis: A species of *Pareodinia* having a broadly ovoidal to almost spherical, thick walled central body, giving rise to a short, truncate apical

horn formed by the periphragm only. Length of horn typically less than one-quarter of the length of the central body. The surface of the periphragm generally has a roughened appearance; it bears rugae and granules, often so arranged as to suggest small areolae, though there is no clear overall areolate pattern. On the apical horn, the rugae and granules show some measure of alignment parallel to the long axis of the horn.

Holotype: Specimen GR425/2/15, lower horizon in Upper Vardekløft Formation, Jameson Land: lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype; overall length 64 μ, breadth 49 μ, length of horn 11 μ. Range; overall length 53–65 μ (mean 61.5 μ), breadth 30–49 μ (mean 42.5 μ), length of horn 5–13 μ (mean 9.07 μ).

Material: 12 specimens, seven of which were measurable.

Remarks: This species has a two-plate intercalary archaeopyle and lacks all indication of tabulation: it is therefore confidently assigned to *Pareodinia*, despite the fact that the formation of the apical horn by the periphragm only is exceptional among the species of the genus.

The endophragm is much thicker than the periphragm and, in some orientations, the apical horn may escape notice. *Pareodinia apotomocerastes* is present in the lower horizon only; a closely comparable form present in the upper horizon, *?Pareodinia* cf. *apotomocerastes* SARJEANT (discussed below), differs in its more elongate shape, clear cingulum, and retention of tabulation vestiges.

Pareodinia cf. *apotomocerastes* SARJEANT, herein
Plate 6, fig. 4.

?1959 *Apteodinium* sp. indet. SARJEANT, p. 338, plate 13, fig. 5.

Description: Cyst elongate ovoidal (almost ellipsoidal), prolonged into a truncate apical horn, which may show a cleft in the tip. It exhibits clear indication of a laevorotatory cingulum of moderate breadth: under phase contrast, vestiges of a tabulation may be seen (see pl. 6, fig. 4) which show broad accord with the *Gonyaulax* pattern. The surface of the central body is coarsely and irregularly granular: this granulation is absent from the apical horn, which is formed by the periphragm only. A two-plate intercalary archaeopyle is developed, the operculum remaining within the shell (still attached?).

Figured Specimen: Specimen GR426/8/4, upper horizon of Upper Vardekløft Formation, Jameson Land.

Dimensions: Figured specimen: overall length 67.5 μ, breadth 40 μ, length of apical horn 11 μ. The only other specimen seen was not suitable for measurement.

Remarks: This form shows close accord with that described by me in 1959 as "*Apteodinium* sp. indet.". Assignment of the latter to *Apteodinium* is no longer appropriate, since it has a two-plate intercalary, not a single plate precingular, archaeopyle. The assignment to *Pareodinia* is also disputable, in view of the presence of tabulation vestiges; however, as EISENACK states (1959, p. 22) "... one must not attribute to the peculiarity of tabulate and non-tabulate periphragm too great a significance. In resting cysts, it is clear that a constant and exact counter-reflection of the tabulate armour of the motile stage is not to be expected". (Transl.).

These forms differ from *Pareodinia apotomocerastes* in their more elongate outline, clear cingulum, and retention of traces of a tabulation. The specimen from the Jurassic of Yorkshire, England (SARJEANT, 1959) differs only in the more pointed shape of its apical horn and should be redesignated *?Pareodinia* aff. *apotomocerastes* SARJEANT.

Family Microdiniaceae EISENACK, 1964,
emend. SARJEANT & DOWNIE, 1966

Genus *MEIOUROGONYAULAX* SARJEANT, 1966a.

Meiourogonyaulax decapitata (W. WETZEL, 1966) SARJEANT, 1969a, emend.

Fig. 5; Plate 5, fig. 3.

1966 *Gonyaulax decapitata* W. WETZEL, p. 869, pl. 16, figs. 7a–b.
1969a *Meiourogonyaulax decapitata* (W. WETZEL). SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 14.
1972 *Meiourogonyaulax decapitata* (W. WETZEL). RILEY & SARJEANT (in press).

Original Diagnosis: "A species ... with the following tabulation pattern: number of apical plates unknown (polar cap thrown off). 6″, 6‴, p, ppl, 1⁗. The laevorotatory-spiral girdle-furrow is offset: its ends are set apart by a furrow breadth. The narrow longitudinal furrow shows a differentiated terminal plate. On the plate boundaries arise hollow membrane folds up to considerable height. Beneath the antapical pole is situated a blister-like envelope." (Transl.).

Emended Diagnosis: Cyst broadly ovoidal, with apex lost in archaeopyle formation. The "decapitated cyst" is almost exactly as broad as it is long. Tabulation ?′, 0a, 6″, 6c, 6‴, 1p, 1pv, 1⁗. Plate boundaries marked by crests of moderate height, often perforate and sometimes having the appearance of lines of spines linked distally by a trabecula. Cingulum of moderate breadth in the form of a weak laevorotatory spiral whose two ends differ in anteroposterior position by about the cingulum's breadth. The posterior intercalary plate is quite large, plate 1‴ is slightly larger. Both plates are almost quadrate in shape. The sulcus is quite broad; it is

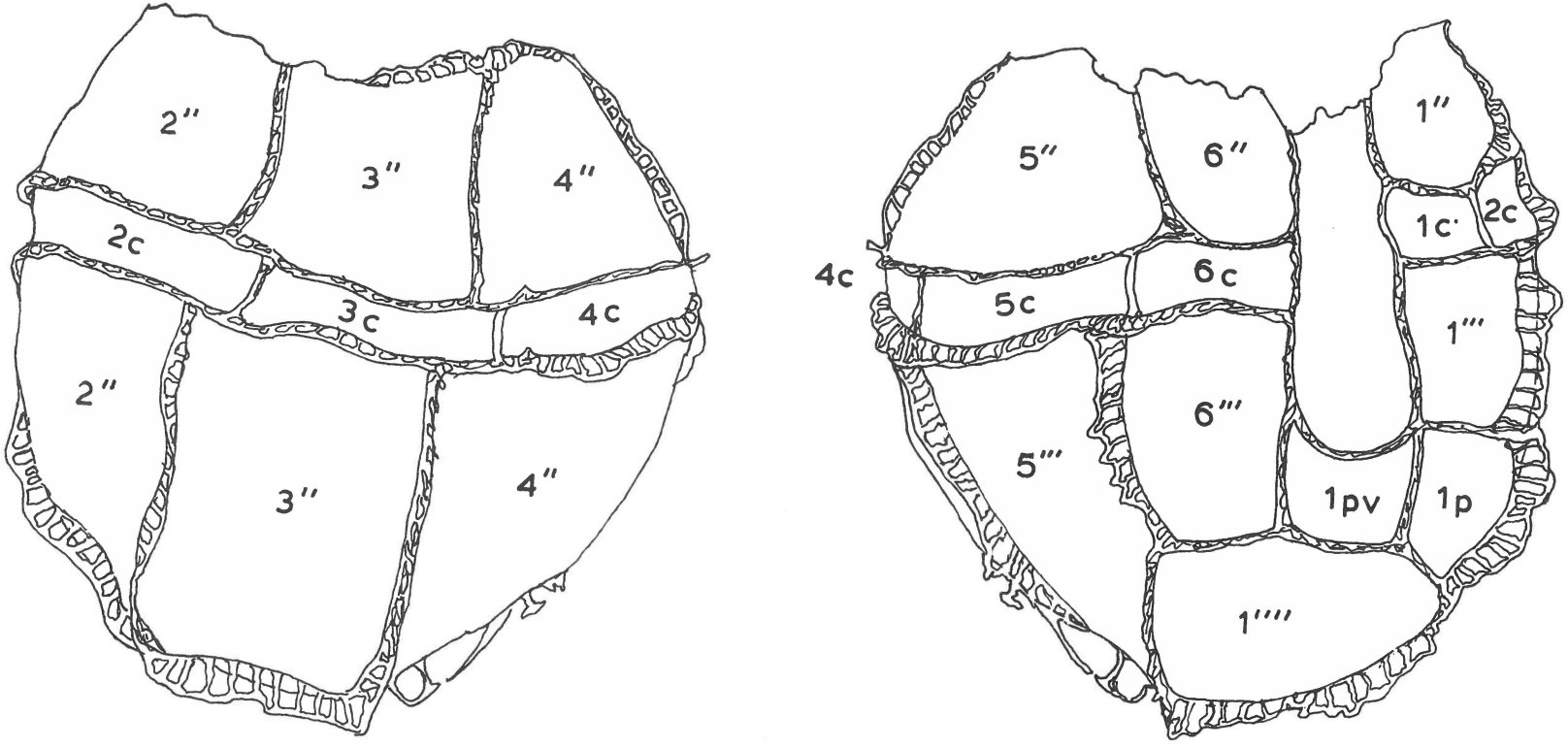


Figure 5. *Meiourogonyaulax decapitata* (W. WETZEL), emend. Specimen GR425/1/29. Left: in oblique dorsal view. Right: in oblique ventral view Xc. 1250.

separated from the antapex by a clearly marked posterior intercalary plate. The antapical plate is large.

Holotype: Specimen figured by W. WETZEL, 1966, plate 16, fig. 7a–b, from his preparation Bielefeld VII. Bajocian, Bielefeld, Germany. Lodgement: W. WETZEL collection, Kiel, Germany.

Figured Specimen: Specimen GR425/1/29, lower horizon in the Upper Vardekløft Formation, Jameson Land.

Dimensions: Holotype (Germany): "meridional diameter" 66 μ. Figured specimen (Greenland): length 72 μ, breadth 71.5 μ, height of crests c. 4 μ. Observed range (Greenland): length 62–72 μ (mean 63.14 μ), breadth 57–71.5 μ (mean 65.07 μ).

Material (Greenland): 17 specimens, of which only 7 were satisfactory for measurement.

Description: The Greenland cysts exhibit an apparently granular surface which, under phase contrast, has the aspect of an irregular, fine-meshed net. This may well be a preservational feature and is not considered diagnostic. The crests appear very variable in height, with an undulose "crest-line": this may also be in part due to preservation. Because of the height of the crests, the cyst has a polygonal appearance in certain orientations.

Remarks: The Greenland specimens correspond in all important particulars with WETZEL's diagnosis. His reference to a "blister-like envelope" beneath the antapical horn is puzzling, however, and may refer to some special feature of the specimen chosen as holotype; no such feature was detected in any specimen studied. The perforated crests, characteristic of the Greenland specimens, correspond with WETZEL's illustrations, though he does not mention this feature in the text.

This species is frequent in the lower horizon of the Upper Vardekløft Formation, but was not encountered in the upper horizon. It differs from *M. callomonii* in ventral tabulation and in the form of the cingulum.

Meiourogonyaulax callomonii sp. nov.

Fig. 6; Plate 5, fig. 5.

Derivation of Name: In honour of Dr. JOHN H. CALLOMON, chemist, Jurassic stratigrapher and ammonite specialist.

Diagnosis: Cyst ovoidal, with apex lost in archaeopyle formation. The "decapitated" cyst is typically broader than it is long. Tabulation ?′, 0a, 6″, 6c, 6‴, 1p, 1⁗. Plate boundaries marked by crests of very irregular form and height; when most fully developed, they are perforate, with continuous crests, and assume the appearance of branching spines

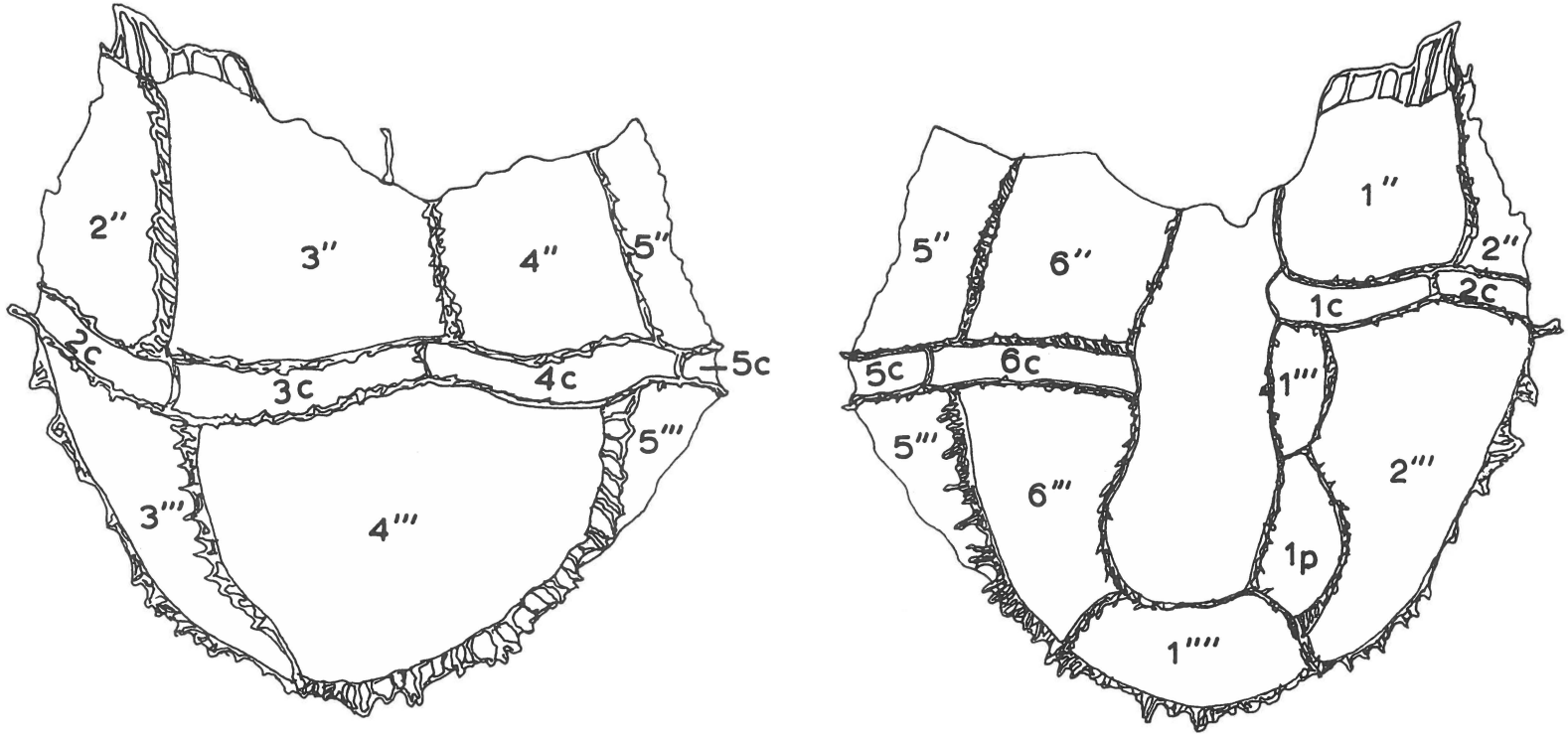


Figure 6. *Meiourogonyaulax callomonii* sp. nov. The holotype, specimen GR425/7/37. Left: in dorsal view. Right: in ventral view. Xc. 1250.

connected by trabeculae. Crests may be present on the margin of the apical archaeopyle. Cingulum relatively narrow, in the form of a laevorotatory spiral whose two ends differ in antero-posterior position by at least twice its breadth. The posterior intercalary plate is of moderate size; plate 1''' is quite small. Both plates are distinctly elongate. The sulcus is broad and extends to the antapex; the antapical plate is of moderate size.

Holotype: Specimen GR425/7/37, lower horizon in the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype: length 60 μ, breadth 67 μ. Range; length 50.5–70 μ (mean 59.25 μ), breadth 60–72 μ (mean 65.75 μ).

Material: 8 specimens from the lower horizon (six were measurable).

Description: The variable character of the crests is almost certainly partly due to preservation. In part, they resemble the crests of *Meiourogonyaulax decapitata* (W. Wetzel), but they were never seen to be so consistently well formed and are often so broken up as to have an irregularly denticulate appearance.

The surface of the periphragm appears coarsely and irregularly granular under ordinary illumination, but under phase contrast, like that of *M. decapitata*, it takes on the aspect of an irregular, fine-meshed net. This may be a consequence of preservation.

Remarks: This species occurs primarily in the lower horizon, though a single specimen may represent it in the upper horizon. It differs from *Meiourogonyaulax decapitata* in its ventral tabulation and the form of the cingulum. It resembles *Meiourogonyaulax cristulata* (Sarjeant, 1959) Sarjeant *in* Davey, Downie, Sarjeant & Williams, 1969 in the breadth of the sulcus but differs in the form of the crests and the presence of six postcingular plates.

Meiourogonyaulax cf. *callomonii* Sarjeant, herein

Plate 2, fig. 8; plate 5, fig. 6.

Description: Cyst ovoidal to subpolygonal, with apex consistently lost in archaeopyle formation. The relative proportions of the "decapitated" cyst are variable; it is quite often longer than broad, less frequently broader than long. Six precingular and six postcingular plates are present; the antapical plate is of moderate size. The ventral tabulation and number of cingular plates could not be determined accurately in any specimen studied, as a consequence of consistently unfavourable orientation and/or preservation. The cingulum is relatively narrow: the breadth of the sulcus could not be estimated accurately. The crests are very

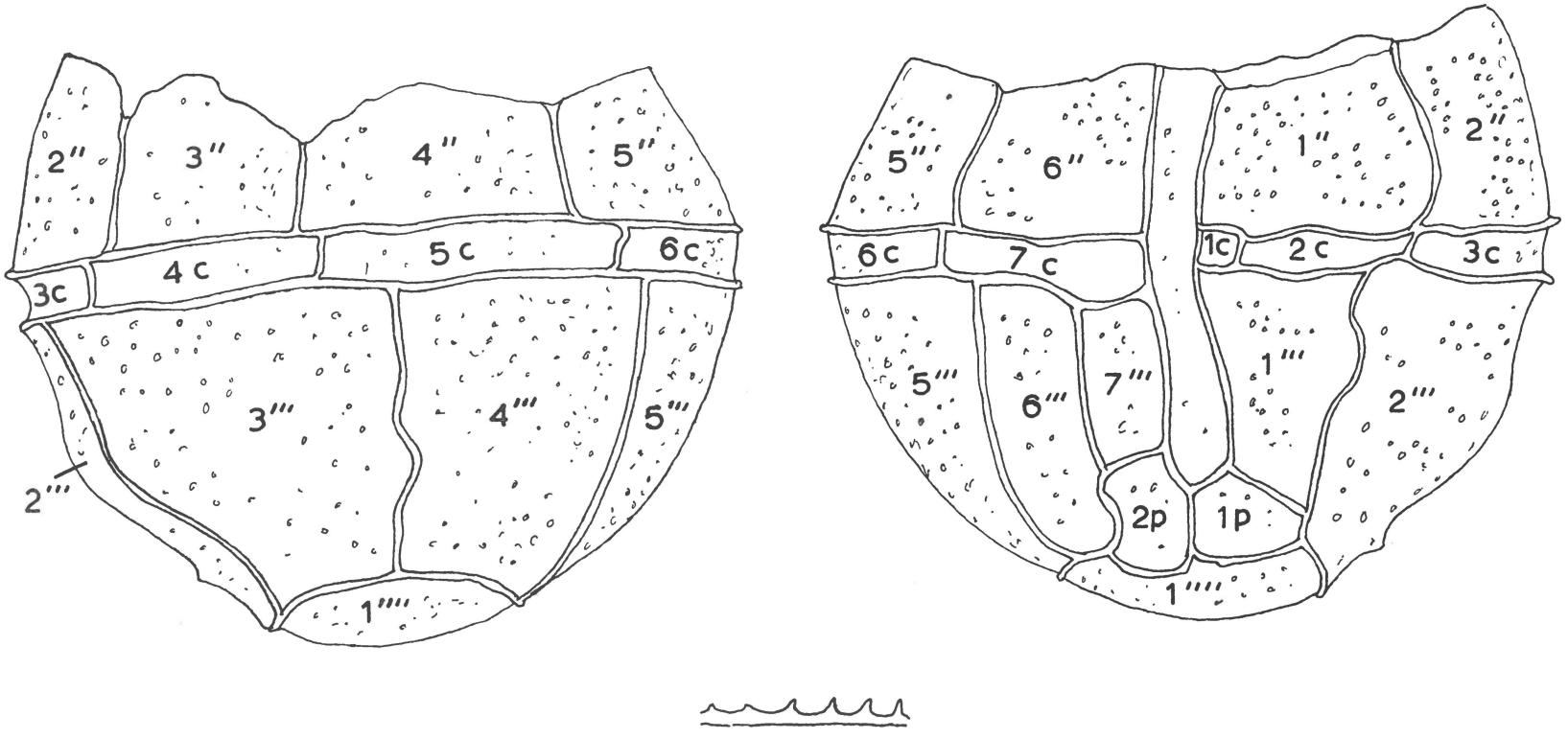


Figure 7. *Meiourogonyaulax strongylos* sp. nov. The holotype, specimen GR425/3/13 (slightly idealised: distribution of granules suggested, rather than drawn accurately, and damage not shown). Left: in dorsal view. Right: in ventral view. Centre: structure of crests. Xc. 1250.

variable, sometimes consisting of lines of denticles, which may be linked distally by trabeculae; but often the crests are of irregular form (as a consequence of preservation?). The appearance of the periphragm surface is as in *M. callomonii.*

Figured Specimens (i) GR426/7/17, upper horizon, Upper Vardekløft formation, Jameson Land (ii) GR425/6/25, lower horizon, same locality. Lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured specimens (i) length 55 μ, breadth 54 μ, height of crests c. 2 μ (ii) length 53 μ, breadth 70.5 μ. (These two specimens illustrate extremes in proportionate length/breadth variation). Range (lower horizon): length 55 to 73 μ (mean 61.88 μ), breadth 50 to 76.5 μ (mean 62.11 μ).

Material: 17 specimens in the lower horizon (nine of them suitable for measurement), 7 specimens in the upper horizon (only one suitable for measurement).

Remarks: In absence of full knowledge of the tabulation, no new name can be proposed for these forms. The relatively narrow cingulum and proportionately small antapical plate suggest an affinity to *Meiourogonyaulax callomonii* sp. nov.; it is possible that they fall within the range of variation of this latter species, but the dissimilar overall aspect of the cyst makes it appear more probable that they represent an undescribed species.

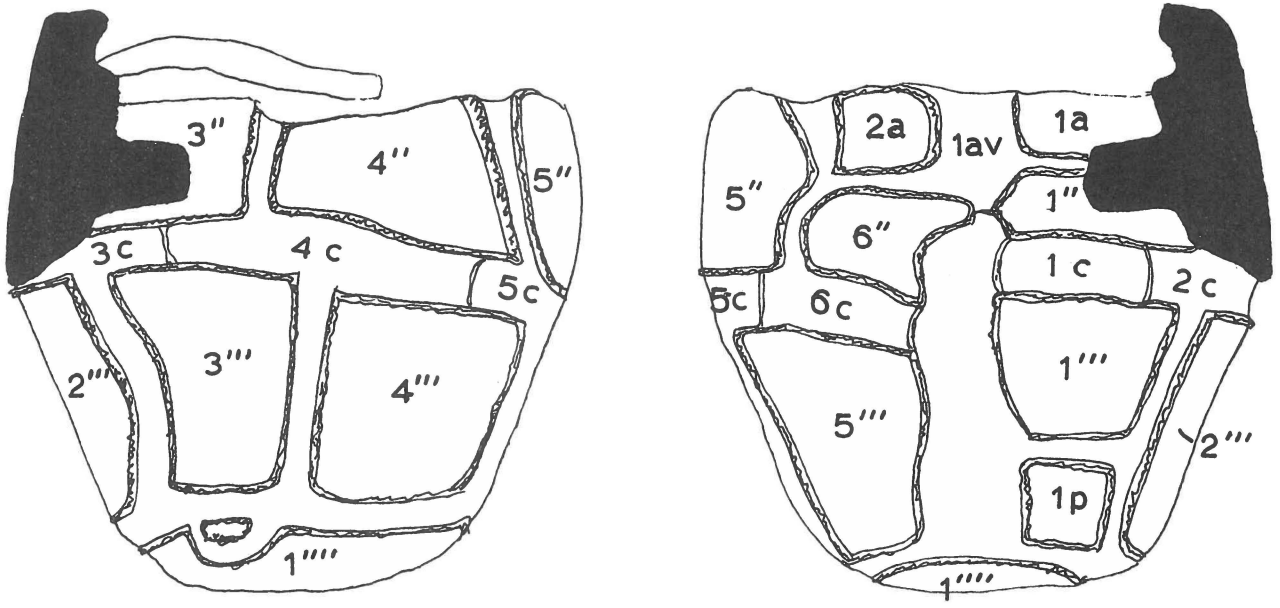
Meiourogonyaulax strongylos sp. nov.

Fig. 7; plate 4, fig. 7.

Derivation of name: Gr. *strongylos* ,round, rounded; with reference to the overall shape.

Diagnosis: Cyst spheroidal or very broadly ovoidal, with apex consistently lost in archaeopyle formation. Tabulation: ?', 6'', 0a, 7c, 7''', 2p, 1'''': plate boundaries are clearly demarcated by raised ridges bearing low denticles. The cingulum is narrow and forms a weakly laevorotatory spiral whose two ends scarcely differ in anteroposterior position. At its more anterior end, a small square plate is present (here numbered 1c): the other cingular plates are of more constant size. The sulcus is narrow: two plates (here numbered 1p and 2p) meet to separate it from the antapex. The first and seventh postcingular plates are reduced in size.

Holotype: Specimen GR425/3/13, lower horizon in the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum of the University of Copenhagen.



Figures 8. *?Meiourogonyaulax cantrellii* sp. nov. The holotype, specimen GR425/6/37, as seen partly masked by a wood fragment. Right: in dorsal view. (The partial "cap" may be a remnant of the operculum). Left: in ventral view. Xc. 1250.

Dimensions: Holotype: length 65 μ, breadth 75 μ. Range: length 54 to 74 μ (mean 63.3 μ) breadth 67 to 78 μ (mean 71.5 μ).

Material: 11 specimens (6 suitable for measurement), all from the lower horizon.

Description: The surface of the periphragm bears an irregular scatter of granules, reduced on the sulcus and absent from parts of the cingulum. The low crests bear small denticles (see text-fig. 7), spaced quite regularly and giving them a scalloped appearance.

The holotype is somewhat damaged dorsally: however, it was the most perfectly oriented of the specimens seen.

Remarks: This new species was present only in the lower horizon. It resembles *Meiourogonyaulax deflandrei* SARJEANT, 1968, in the nature of crests and cingulum, but differs in the possession of 7 postcingular plates and in its posterior ventral tabulation.

Meiourogonyaulax cf. *deflandrei* SARJEANT, 1968

Plate 1, fig. 5.

Remarks: A single specimen (GR426/6/19) observed in the upper horizon resembles *Meiourogonyaulax deflandrei* in shape, the character of cingulum and sulcus, and the general form of the crests, but was too poorly preserved to permit accurate determination of the tabulation.

?Meiourogonyaulax cantrellii sp. nov.

Fig. 8; plate 4, fig. 3; plate 6, figs 1–2.

Derivation of Name: In honour of the late HARRY CANTRELL, numismatist and amateur geologist of Sheffield, England, who gave me great encouragement in my early studies.

Diagnosis: Cyst ovoidal to subpolygonal, with apex thrown off in archaeopyle formation. Fields on the shell surface are demarcated by low, rather irregular septa; each of the fields of the epitract and hypotract is set apart from its neighbours, but septa along the line of the cingulum directly link the precingular and postcingular plates: plates 6″ and 1″ are also linked by a septum. The fields reflect a tabulation of ?′, 1av, 2a, 6″, 6c, 5‴, 1p, 1⁗. The cingulum is broad and forms a laevorotatory spiral whose two ends differ in antero-posterior position by the cingulum breadth. It is separated by septa from the sulcus, which is also broad, extending to the antapex but separated from the apex by the septum linking field 6″ to field 1″: the area of the surface anterior to this septum is here termed the "anterior ventral" field (lav.).

Holotype: Specimen GR425/6/37, from the lower horizon of the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Holotype: length 52 μ, breadth 52 μ. Range; length 52 to 75 μ (mean 65.58 μ), breadth 52 to 72.5 μ (mean 62.41 μ).

Material: 9 specimens, all from the lower horizon, six of which were suitable for measurement.

Description: The whole surface of the periphragm is densely ornamented by an irregular pattern of granules and low ridges: I consider it possible, but improbable, that this is a consequence of preservation. The character of the distal surfaces of the septa could not be accurately determined, but it is probable that they give rise to very short, well-spaced denticles.

The field here designated as "anterior ventral" may represent the posterior part of apical plate 1″, which may be split in two during excystment by the developing archaeopyle suture.

Remarks: The reflection of the original tabulation of the motile dinoflagellate by separate "fields" suggests a relationship with *Histiophora* KLEMENT, from the Upper Jurassic of Germany: however, the fields in that genus are both larger and fewer and the septa bounding them are much higher. *Lanterna bulgarica* DODEKOVA, 1961 from the Upper Jurassic of Bulgaria (the type species of that genus), has a pattern of "fields" comprised by densely packed appendages.

Placement in *Meiourogonyaulax* is not altogether appropriate, in view of the pattern of tabulation and the fashion in which it is represented. Erection of a new genus to accommodate this species may be considered appropriate at some future date.

?Meiourogonyaulax sp.

Fig. 9; plate 1, fig. 7; plate 5, fig. 4.

Description: Cyst broadly ovoidal, with apex thrown off in archaeopyle formation. Cyst wall of moderate thickness; its surface is roughened by granules and low ridges, but this ornament is much less dense than in other species of *Meiourogonyaulax* in these assemblages. Tabulation is almost wholly absent: however, traces remain around the apex (in the form of lines of well-spaced spines) and on the posterior margin of the poorly-marked cingulum, where a line of irregular outgrowths may be present; also a single process, or a few processes, may be present elsewhere on the cyst surface, in positions corresponding to plate boundaries.

Figured Specimens. (a) Specimen GR425/8/11, lower horizon in the Upper Vardekløft Formation, Jameson Land. (b) Specimen GR426/12/3,

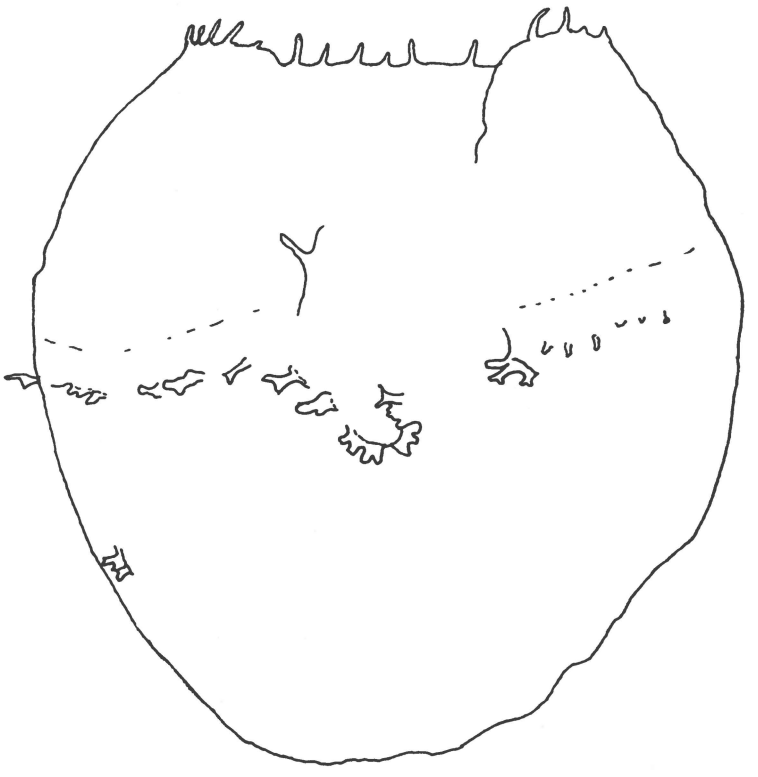


Figure 9. *?Meiourogonyaulax* sp. Dorsal surface of specimen GR425/8/11, showing the tabulation vestiges. Xc. 1250.

upper horizon in do. Lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Figured specimens: (a) length 74 μ, breadth 78 μ (b) length 72 μ, breadth 70 μ.

Material: One specimen in the lower horizon and two in the upper horizon.

Remarks: The vestigial nature of the tabulation traces in these forms makes their placement in *Meiourogonyaulax* provisional; all other described species of that genus are fully tabulate, even though the tabulation may in some instances be determinable only by phase contrast. The general proportions and the form of the archaeopyle are points of similarity.

These forms may be intermediate between *Meiourogonyaulax* and the non-tabulate genus *Chytroeisphaeridia* Sarjeant, 1962b emend. Downie, Evitt and Sarjeant, 1963.

Family Fromeaceae SARJEANT and DOWNIE, 1966

Genus *CHYTROEISPHAERIDIA* SARJEANT, 1962b, emend. DOWNIE EVITT and SARJEANT, 1963

Chytroeisphaeridia chytroeides (SARJEANT, 1962b) DOWNIE, EVITT & SARJEANT, 1963

Plate 2, fig. 5; plate 3, fig. 1.

1962b *Leiosphaeridia* (*Chytroeisphaeridia*) *chytroeides* SARJEANT, p. 492, pl. 70, figs. 13, 16, text-figs. 11, 12.
1963 *Chytroeisphaeridia chytroeides* (SARJEANT). DOWNIE, EVITT & SARJEANT, p. 9.
1964a *Leiosphaeridia chytroeides* SARJEANT, SARJEANT, tab. 3.
1964 *Chytroeisphaeridia chytroeides* (SARJEANT). DOWNIE & SARJEANT, p. 103.
?1965 *Leiosphaeridia wenlockia* DOWNIE, DUPIN, pl. 3A, no. 3.
1965b *Chytroeisphaeridia* cf. *chytroeides* (SARJEANT). SARJEANT, p. 182, pl. 1, fig. 12.
1967a *Chytroeisphaeridia chytroeides* SARJEANT, SARJEANT, tab. II.
1968 *Chytroeisphaeridia chytroeides* (SARJEANT). SARJEANT, pl. 3, fig. 10, tab. 2B.
1970 *Chytroeisphaeridia chytroeides* (SARJEANT). GITMEZ, pp. 242–3, pl. 14, fig. 5.
?1970 *Chytroeisphaeridia chytroeides* (SARJEANT). GOCHT, p. 152, pl. 34, figs. 20–24.
1972 *Chytroeisphaeridia chytroeides* (SARJEANT). GITMEZ & SARJEANT, pp. 185–6, pl. 1, fig. 2, tabs. 3–6.
1972 *Chytroeisphaeridia chytroeides* (SARJEANT). RILEY & SARJEANT (in press).

Remarks: This species was present in both studied horizons of the Upper Vardekløft Formation, being less numerous in the lower horizon (four specimens) than in the upper (17 specimens). The dimensional range exhibited was as follows: lower horizon-length 39 to 49 μ (mean 43.66 μ), breadth 45 to 62 μ (mean 54.5 μ); upper horizon — length 42.5 to 68 μ (mean 52.87 μ), breadth 42.5 to 70 μ (mean 54.83 μ). These dimensions compare quite well with the ranges quoted by SARJEANT (1962b) and GITMEZ (1970).

The specimen from the Upper Jurassic of Aquitaine, France, figured by DUPIN (1965) under the name *Leiosphaeridia wenlockia*, appears to be attributable to this species, though this cannot be confirmed in absence of any text description. The forms illustrated by GOCHT (1970) appear referable to *Chytroeisphaeridia pococki* SARJEANT, 1968: however, his mention of smooth-walled forms (p. 152) suggests that *C. chytroeides* is also present in the German Bathonian assemblages.

Chytroeisphaeridia pococki SARJEANT, 1968

1965 *Chytroeisphaeridia* sp. SARJEANT, p. 182, pl. 1, fig. 13.
1968 *Chytroeisphaeridia pococki* SARJEANT, p. 230, pl. 3, fig. 9.
1970 *Chytroeisphaeridia pococki* SARJEANT, GITMEZ, p. 243, pl. 9, figs. 7–8, pl. 10, fig. 3.
?1970 *Chytroeisphaeridia chytroeides* (SARJEANT). GOCHT, p. 152, pl. 34, figs. 20–24.
1972 *Chytroeisphaeridia pococki* SARJEANT, GITMEZ & SARJEANT, pp. 187–8, pl. 1, fig. 5, tabs. 3–6.
1972 *Chytroeisphaeridia pococki* SARJEANT, RILEY & SARJEANT (in press).

Remarks: This species was present at both horizons in the Upper Vardekløft Formation. Of six specimens in the upper horizon, four were suitable for measurement; length 45 to 60 μ (mean 51.75 μ), breadth 62 to 70 μ (mean 65.75 μ). These dimensions fall within the range quoted by GITMEZ (1970, p. 243). The four specimens in the lower horizon were unsuitable for measurement.

Chytroeisphaeridia dictydia sp. nov.

Plate 3, fig. 3; plate 6, fig. 6.

Derivation of Name: Gr. *diktydion* n. dim., a net; with reference to the surface patterning.

Diagnosis: Shell broadly oval to spheroidal, the apex lost in archaeopyle formation. The margin of the archaeopyle exhibits a sulcal notch and slits corresponding in position to sutures between precingular plates. The periphragm is densely and minutely reticulate, the reticulae formed by raised ridges and having an irregularly polygonal form.

Holotype: Specimen GR426/8/9, upper horizon in the Upper Vardekløft Formation; lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Holotype: length (without apex) 69 μ ,breadth 71.5 μ. Range: upper horizon — length (apex lacking) 54 to 74 μ (mean 65.14 μ), breadth 57 to 76 μ (mean 63.93 μ): lower horizon — length of single specimen measured 65 μ, breadth 70 μ.

Material: 16 specimens in the upper horizon (seven of them suitable for measurement), 15 specimens in the lower horizon.
Remarks: This new species is characterised by the nature of its surface ornamentation.

Genus *TENUA* EISENACK 1958 emend. SARJEANT 1968

Tenua pilosa (EHRENBERG 1843) emend. SARJEANT 1968

1843 *Xanthidium pilosum* EHRENBERG, pp. 61–3.
1854 *Xanthidium pilosum* EHRENBERG, EHRENBERG, pl. 37, fig. 8, no. 4.
1904 *Ovum hispidum* (*Xanthidium*) *pilosum* (EHRENBERG), LOHMANN, pp. 24–25.
1937 *Hystrichosphaeridium pilosum* (EHRENBERG). DEFLANDRE, p. 31.
1960 *Baltisphaeridium pilosum* (EHRENBERG), SARJEANT, pl. 13, figs. 11–12, tab. 2.
1961a *Baltisphaeridium pilosum* (EHRENBERG), SARJEANT, pp. 101–102, pl. 14, figs. 3–5.
1962a *Baltisphaeridium pilosum* (EHRENBERG), SARJEANT, pl. 20, figs. 7–10, tabs. 3–4.
1962b *Baltisphaeridium pilosum* (EHRENBERG), SARJEANT, tabs. 2–3.
1964a *Baltisphaeridium pilosum* (EHRENBERG), SARJEANT, tab. 3.
1964 *Baltisphaeridium pilosum* (EHRENBERG), DOWNIE & SARJEANT, p. 94.

1966 *Cleistophaeridium pilosum* (EHRENBERG), DAVEY, DOWNIE, SARJEANT & WILLIAMS, p. 170, *nom. nud.*
1967a *Tenua pilosa* (EHRENBERG), SARJEANT, tab. 3, *nom. nud.*
1968 *Tenua pilosa* (EHRENBERG) emend. SARJEANT, p. 231, pl. 2, fig. 7.
1970 *Tenua pilosa* (EHRENBERG), GITMEZ, pp. 244–5, pl. 4, fig. 5.
1972 *Tenua pilosa* (EHRENBERG). RILEY & SARJEANT (in press).

Remarks: Forms corresponding exactly in morphology with this species were relatively numerous in the upper horizon of the Upper Vardekløft Formation. 14 specimens were encountered; their dimensional range was length (apex lacking) 30 to 47 μ (mean 36.33 μ), breadth 23 to 27.5 μ (mean 24.87 μ), length of spines 2 to 4 μ (mean 2.62 μ). These dimensions are rather more meagre than those quoted by Gitmez (1970, p. 245). This species is not represented in the lower horizon.

Tenua cf. *pilosa* (EHRENBERG, 1843) emend. SARJEANT 1968

Plate 4, fig. 4.

Description: Cyst oval, the apex lost in archaeopyle formation. The archaeopyle exhibits a sulcal notch and splits extending posteriorly, corresponding to the position of sutures between plates. Faint indications of a cingulum may be seen. The surface is minutely granular and bears quite widely spaced, simple spines of fair length, though these were uniformly recurved in the specimen seen and were thus not measureable.

Figured Specimen: Specimen GR425/6/52, lower horizon of Upper Vardekløft Formation, Jameson Land: lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured specimen: length (apex lacking) 38 μ, breadth 33 μ, length of spines (estimate only) c. 4 μ.

Remarks: A single specimen from the lower horizon resembled *Tenua pilosa* in shell shape and form of archaeopyle but differs in the wider spacing and greater proportionate length of its spines.

Tenua aff. *hystrix* EISENACK, 1958

Plate 1, fig. 6; plate 7, fig. 3.

Description: Shell spherical to broadly ovoidal, the apex lost in archaeopyle formation. The archaeopyle exhibits a sulcal notch and slits extending posteriorly, corresponding to the position of sutures between plates. A narrow cingulum is sometimes faintly suggested. The surface is minutely granular and bears a dense cover of conical spines with rounded tips, seen especially well under phase contrast (pl. 7, fig. 3).

Figured Specimens: (a) specimen GR425/3/8 (pl. 1, fig. 6), from the lower horizon in the Upper Vardekløft Formation, Jameson Land.

(b) specimen GR425/6/38, same locality and horizon (pl. 7, fig. 3); both lodged in the Mineralogical Museum of the University of Copenhagen.

Dimensions: Figured specimen (a) length 47.5 μ (apex lacking), breadth 60 μ, length of spines c. 0.33–0.5 μ (b) folded and unsuitable for measurement.

Material: Three specimens from the lower horizon, only one of them suitable for measurement.

Remarks: In outline and in spine number, these forms compare quite well with *Tenua hystrix* EISENACK, 1958, a species originally recorded from the Lower Cretaceous, subsequently from the Upper Jurassic (lowest Kimmeridgian) by GITMEZ, 1969. However, the shape of the spines is markedly dissimilar.

Tenua rioulti SARJEANT, 1968

Plate 6, fig. 3; plate 7, fig. 2.

1967a *Tenua rioulti* SARJEANT, tab. 3, *nom. nud.*
1968 *Tenua rioulti* SARJEANT, p. 231, pl. 1, figs. 12, 22, pl. 2, figs. 1–2, 4.
1972 *Tenua rioulti* SARJEANT, RILEY & SARJEANT (in press).

Remarks: This species was well represented in the upper horizon of the Upper Vardekløft Formation, 11 specimens being observed: in addition, two specimens were noted in the lower horizon. All of them exhibited a degree of damage and folding which rendered them unsuitable for meaningful measurement, but their dimensions fall within the range originally quoted (1968, p. 231) — overall length (apices lacking) 48 to 62 μ, overall breadth 50.5 to 69 μ, length of central body (apices lacking) 45 to 57 μ, breadth 44.5 to 57 μ.

Tenua varispinosa (SARJEANT, 1959) comb. nov.

1959 *Baltisphaeridium varispinosum* SARJEANT, pp. 338–340, pl. 13, fig. 7, text-fig. 6.
1964a *Baltisphaeridium varispinosum* SARJEANT, SARJEANT, tab. 3.
1964 *Baltisphaeridium varispinosum* SARJEANT, DOWNIE & SARJEANT, p. 98.
1972 *Baltisphaeridium varispinosum* SARJEANT, RILEY & SARJEANT (in press).

Remarks: This species is transferred to *Tenua* on the basis of the form of its spines and its possession of an apical archaeopyle, a feature which renders its attribution to an acritarch genus wholly inappropriate. Four specimens from the lower horizon were attributable to this species, hitherto recorded only from the lowest Callovian of Yorkshire, England. Two specimens proved measurable; their dimensions (length of central body 59.5 and 49 μ, breadth 61 and 50 μ, length of spines 7.5 and 6.5 μ) are more meagre than in the type material but the relative proportions of spines to central body are exactly comparable.

Family Uncertain

Genus *NANNOCERATOPSIS* DEFLANDRE, 1938b, emend. EVITT 1961

Nannoceratopsis pellucida DEFLANDRE, 1938b, emend. EVITT 1961

1938a *Nannoceratopsis pellucida* DEFLANDRE, fig. 5, *nom. nud.*
1938b *Nannoceratopsis pellucida* DEFL. DEFLANDRE, pp. 183–4, pl. 8, figs. 8–12.
1952a *Nannoceratopsis pellucida* DEFL. DEFLANDRE, fig. 81.
1952b *Nannoceratopsis pellucida* DEFL. DEFLANDRE, fig. 0.
1958 *Nannoceratopsis pellucida* DEFL. COOKSON & EISENACK, p. 52, pl. 10, fig. 5–6, text-fig. 19.
1960 *Nannoceratopsis pellucida* DEFL. SARJEANT, pl. 12, fig. 7, 10, tab. 2.
1961 *Nannoceratopsis pellucida* DEFL. ALBERTI, pp. 29–30, 42.
1961 *Nannoceratopsis pellucida* DEFL. emend. EVITT, p. 34, pl. 1, figs. 15–18, pl. 2, figs. 30–31.
1962a *Nannoceratopsis pellucida* DEFL. SARJEANT, tabs. 3, 4.
1962b *Nannoceratopsis pellucida* DEFL. SARJEANT, pl. 69, figs. 9–10, tabs. 2–3.
1964a *Nannoceratopsis pellucida* DEFL. SARJEANT, tab. 2.
1964 *Nannoceratopsis pellucida* DEFL. DOWNIE & SARJEANT, p. 134.
1965 *Nannoceratopsis pellucida* DEFL. VOZZHENNIKOVA, fig. 47H.
1965 *Nannoceratopsis pellucida* DEFL. NORRIS & SARJEANT, p. 43.
1966 *Nannoceratopsis pellucida* DEFL. SCHULZ & MAI, tab. I.
1966 *Nannoceratopsis pellucida* DEFL. LOEBLICH & LOEBLICH, p. 41.
1967 *Nannoceratopsis pellucida* DEFL. EISENACK, pp. 535–6.
1967b *Nannoceratopsis pellucida* DEFL. VOZZHENNIKOVA, fig. 47H. (English translation of VOZZHENNIKOVA, 1965).
1967a *Nannoceratopsis pellucida* DEFL. SARJEANT, tab. 4.
1968 *Nannoceratopsis pellucida* DEFL. SARJEANT, tab. 2B.
1970 *Nannoceratopsis pellucida* DEFL. GOCHT, p. 157, pl. 32, figs. 19–22, text-fig. 26.
1970 *Nannoceratopsis pellucida* DEFL. GITMEZ, p. 282, pl. 7, fig. 4.
1972 *Nannoceratopsis pellucida* DEFL. GITMEZ & SARJEANT tabs. 3, 6.
1972 *Nannoceratopsis pellucida* DEFL. RILEY & SARJEANT (in press).

Remarks: A single, excellently preserved representative of this species was present in the upper horizon of the Upper Vardekløft Formation.

Family Hystrichosphaeridiaceae EVITT 1963 emend. SARJEANT and DOWNIE 1966

Genus *HYSTRICHOSPHAERIDIUM* DEFLANDRE, 1937 emend. DAVEY & WILLIAMS 1966

Hystrichosphaeridium costatum DAVEY & WILLIAMS 1966

?1938 *Hystrichosphaeridium salpingophorum* (DEFL.) DEFLANDRE, p. 186, pl. 10, fig. 1–3.
?1947 *Hystrichosphaeridium salpingophorum* (DEFL.) DEFLANDRE, text-fig. 1, no. 6.
?1952a *Hystrichosphaeridium salpingophorum* (DEFL.) DEFLANDRE, text-fig. 10.
1960 *Hystrichosphaeridium salpingophorum* (DEFL.) SARJEANT, pl. 13, fig. 7, tab. 2.
1960 *Hystrichosphaeridium salpingophorum* (DEFL.) KLEMENT, p. 55, pl. 7, figs. 3–5, text-fig. 31.

1961 *Hystrichosphaeridium salpingophorum* (DEFL.) SARJEANT, p. 99, pl. 15, fig. 7.
1962a *Hystrichosphaeridium salpingophorum* (DEFL.) SARJEANT, tabs. 3–4.
1962b *Hystrichosphaeridium salpingophorum* (DEFL.) SARJEANT, tabs. 2–3.
1964a *Hystrichosphaeridium salpingophorum* (DEFL.) SARJEANT, tab. 3.
1966 *Hystrichosphaeridium costatum* DAVEY & WILLIAMS, pp. 62–3, pl. 10, fig. 4.
1967 *Hystrichosphaeridium salpingophorum* (DEFL.) DODEKOVA, pp. 22–3, pl. 3, fig. 4–5.
1970 *Cordosphaeridium costatum* (DAVEY & WILL.) GORKA, pp. 489–490, pl. 5, fig. 1a–b.
1972 *Hystrichosphaeridium costatum* DAVEY & WILL. RILEY & SARJEANT (in press).

Remarks: A revision of the generic diagnosis of *Cordosphaeridium* EISENACK, 1963 as emended by DAVEY & WILLIAMS (1967, p. 83) seems called for, since I have been assured by EVITT (*pers. comm.*) that the holotype of the type species, *Cordosphaeridium inodes* (KLUMPP, 1953) exhibits a precingular archaeopyle. If this is the case, GORKA's reattribution of *H. costatum* to *Cordosphaeridium* is inappropriate; for the present, therefore, the original generic attribution is retained.

This species was represented by two poorly preserved specimens in the upper horizon of the Upper Vardekløft Formation.

Genus *POLYSTEPHANEPHORUS* SARJEANT 1961b

Polystephanephorus cf. *speciosus* (ALBERTI 1961) RILEY & SARJEANT 1972

Plate 4, fig. 2.

Remarks: Two specimens in the lower horizon of the Upper Vardekløft Formation are broadly comparable with this poorly known species, originally described from the Middle Jurassic of Germany; however, their preservation was not good enough to permit confident assignment.

Genus *PROLIXOSPHAERIDIUM* DAVEY, DOWNIE, SARJEANT & WILLIAMS 1966

Prolixosphaeridium aff. *deirense* DAVEY, DOWNIE, SARJEANT and WILLIAMS 1966

Plate 7, fig. 6.

Description: Cyst elongate ovoidal, with the apex lost in archaeopyle formation. The whole of the surface of the periphragm bears a dense cover of extremely short spinelets. In addition, there are c. 55–65 much longer processes, of length equal to about $^1/_4$–$^1/_3$ the short diameter of the shell. These may be simple, but are typically blunt ended, capitate or very briefly bifurcate distally.

Figured Specimen: Specimen GR426/5/3, upper horizon in the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured specimen: length of central body 51.5 μ, breadth 30 μ, length of longer spines c. 7 μ, length of spinelets less than 0.5 μ.
Material: Two specimens, only one of which was measurable, from the upper horizon.

Remarks: The two forms here described resemble the Lower Cretaceous (Barremian) species *Prolixosphaeridium deirense* in most features, but differ in the nature of the process tips. This genus has an erratic stratigraphic distribution: when present, it is usually represented only by a handful of specimens. In consequence, it would be wholly inappropriate to propose a new name for them, not only because of inadequate representation but also because the relationships between the five existing species are so poorly understood.

Family Ctenidodiniaceae SARJEANT & DOWNIE 1966

Genus *WANAEA* COOKSON & EISENACK 1958

Wanaea digitata COOKSON & EISENACK 1958

Plate 7, fig. 5.

1958 *Wanaea digitata* COOKSON & EISENACK, p. 58, pl. 9, figs. 2–5.
1964a *Wanaea digitata* COOKSON & EISENACK, SARJEANT, tab. 4.
1964 *Wanaea digitata* COOKSON & EISENACK, DOWNIE & SARJEANT, p. 153.
1967a *Wanaea digitata* COOKSON & EISENACK, SARJEANT, tab. 9.
1968 *Wanaea digitata* COOKSON & EISENACK, SARJEANT, p. 233, pl. 1, fig. 2, tabs. 2B.
1972 *Wanaea digitata* COOKSON & EISENACK, RILEY & SARJEANT (in press).

Remarks: This species is represented by five specimens, all encountered in the assemblage from the upper horizon of the Upper Vardekløft Formation. Only one was suitable for measurement; diameter (in polar view) 80 μ, breadth of fringe c. 6.5 μ. These dimensions are comparable with the French specimens (diameter 68–82 μ, breadth of fringe 7–8 μ: SARJEANT, 1968) but markedly smaller than the type specimens from Western Australia (diameter 109–110 μ, breadth of fringe 9.5 μ).

Family Membranilarnaciaceae SARJEANT & DOWNIE 1966

Genus *VALENSIELLA* EISENACK, 1963

Valensiella ovula (DEFLANDRE, 1947) EISENACK, 1963

Plate 2, fig. 7.

1947 *Membranilarnax ovulum* DEFLANDRE, pp. 9–10, text-fig. 22–23.
1952a *Membranilarnax ovulum* DEFL. DEFLANDRE, fig. 32.
1953 *Membranilarnax ovulum* DEFL. VALENSI, p. 62, pl. 9, figs. 6, 12.
1955 *Membranilarnax ovulum* DEFL. VALENSI, p. 590, pl. 2, fig. 4, pl. 5, fig. 6.

1961 *Membranilarnax ovulum* DEFL. SARJEANT, p. 109, text-fig. 9c.
1962a *Membranilarnax ovulum* DEFL. SARJEANT, pl. 2, figs. 8–9, tab. 2.
1963 *Valensiella ovula* (DEFL.) EISENACK, pp. 100–101.
1963 *Favilarnax ovula* (DEFL.) SARJEANT, p. 720.
1964a *Membranilarnax ovulum* DEFL. SARJEANT, tab. 3.
1964c *Favilarnax ovula* (DEFL.) SARJEANT, pp. 172–3.
1964c *Valensiella ovula* (DEFL.) SARJEANT, pp. 172–3.
1964 *Valensiella ovula* (DEFL.) DOWNIE & SARJEANT, p. 150.
1966 *Ellipsoidictyum ovulum* (DEFL.) SCHULZ & MAI, tab. I, *nom. nud.*
1967a *Valensiella ovula* (DEFL.) SARJEANT, tab. 13.
1970 *Valensiella ovulum* (DEFL.) (*sic*) GOCHT, pp. 148–9, pl. 34, figs. 1–6, text-fig. 19b–c.
1972 *Valensiella ovula* (DEFL.) RILEY & SARJEANT (in press).

Remarks: Four specimens from the upper horizon of the Upper Vardekløft Formation correspond with the typical forms of the species *Valensiella ovula*, differentiated by GOCHT (1970) — on the basis of mesh-size of the reticulum — from his "Form A". Two of them were suitable for measurement; their dimensions (overall length, without apex, 57–62 μ and 69 μ, overall breadth 62 and 58 μ) differ little from the range he quotes from German Bathonian forms (overall length, without apex 47–63 μ, overall breadth 40–56 μ).

In addition, three poorly preserved specimens from the lower horizon are also referable to this species.

Aff. *Valensiella* sp.

Plate 6, fig. 5.

Description: Central body of cyst elongate ovoidal, with the apex lost in archaeopyle formation. A raised reticulum, supported by slender processes arising from the cyst surface, encloses the whole central body except for the narrow cingulum (the sulcus was not discerned). The reticulum seems to comprise finer meshes arranged into larger, roughly oval to rectangular, groups which may suggest a tabulation. The height of the reticulum above the surface of the central body is variable; it is least high at the antapex.

Figured Specimen: Specimen GR425/2/27, lower horizon of the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured specimen; length of central body 42 μ, breadth 30 μ, with reticulum raised up to 4.5 μ above the surface of the central body.

Remarks: Two specimens in the lower horizon have a high reticulum raised above the surface by slender processes. No true ectophragm is present, so that firm placement in *Valensiella* would be entirely inappropriate. Such genera as *Dictyopyxis* COOKSON & EISENACK, 1960 have

a surface reticulum whilst *Epiplosphaera* KLEMENT, 1960 has a double reticulum of entirely dissimilar form. It is clear that these are representatives of an undescribed genus, but fuller information must be awaited before any nomenclatural proposals can be made.

Family Endoscriniaceae VOZZHENNIKOVA, 1965 emend. SARJEANT & DOWNIE 1966

Genus *ENDOSCRINIUM* KLEMENT, 1960 emend. VOZZHENNIKOVA 1965

Endoscrinium luridum (DEFLANDRE, 1938b) VOZZHENNIKOVA 1967

1938 *Gymnodinium luridum* DEFLANDRE, p. 166, pl. 5, figs. 4–6.
1957 *Scriniodinium luridum* (DEFL.) KLEMENT, pp. 409–10.
1958 *Gymnodinium luridum* DEFL. COOKSON & EISENACK, p. 24, pl. 1, figs. 3–4.
1960 *Scriniodinium* (*Endoscrinium*) *luridum* (DEFL.) KLEMENT, pp. 20–22, pl. 1, figs. 2–3, text-fig. 2–3.
1960 *Scriniodinium luridum* (DEFL.) COOKSON & EISENACK, pp. 247–8, pl. 37, fig. 10.
1960 *Scriniodinium luridum* (DEFL.) SARJEANT, pl. 12, fig. 2, tab. 2.
1962a *Scriniodinium luridum* (DEFL.) SARJEANT, pl. 1, fig. 14, tabs. 3–4.
1962b *Scriniodinium luridum* (DEFL.) SARJEANT, pl. 69, fig. 7, tabs. 2–3.
1964a *Scriniodinium luridum* (DEFL.) SARJEANT, tab. 2.
1964 *Scriniodinium* (*Endoscrinium*) *luridum* (DEFL.) DOWNIE & SARJEANT, p. 144.
1965 *Scriniodinium luridum* (DEFL.) GORKA, p. 296, pl. 1, fig. 3.
1967 *Scriniodinium luridum* (DEFL.) DODEKOVA, pp. 12–13, pl. 1, fig. 3.
1967 *Scriniodinium luridum* (DEFL.) EISENACK, pp. 767–8.
1967a *Endoscrinium luridum* (DEFL.) VOZZHENNIKOVA, p. 175.
1967a *Endoscrinium luridum* (DEFL.) SARJEANT, tab. 11.
1968 *Endoscrinium luridum* (DEFL.) SARJEANT, tab. 2b.
1970 *Endoscrinium luridum* (DEFL.) GITMEZ, pp. 302–3, pl. 3, fig. 2, text-fig. 28.
1970 *Endoscrinium luridum* (DEFL.) GOCHT, pp. 144–6, pl. 27, fig. 6, pl. 28, figs. 5–7, pl. 31, figs. 6–8, text-figs. 2c, 12–14, 15a–d, 16–18.
1971 *Endoscrinium luridum* (DEFL.) VOZZHENNIKOVA, p. 271. [English translation of VOZZHENNIKOVA 1967a].
1972 *Endoscrinium luridum* (DEFL.) GITMEZ & SARJEANT, tabs. 3–6.
1972 *Endoscrinium luridum* (DEFL.) RILEY & SARJEANT (in press).

Remarks: This species is moderately abundant in the lower horizon of the Upper Vardekløft Formation (17 specimens) and present in lower numbers in the upper horizon (4 specimens). The dimensional range exhibited in the lower horizon was length of periblast 58–88.5 μ (mean 68.50 μ), breadth 55–72 μ (mean 65.90 μ), length of endoblast 42 to 63 μ (mean 56.10 μ), breadth 37 to 63.5 μ (mean 47.37 μ). In the upper horizon, the single specimen suitable for measurement had a periblast of length 78 μ, breadth 83 μ, endoblast of length 56 μ, breadth 65 μ. The dimensions exhibited by the Greenland specimens accord well with the ranges quoted by GITMEZ (1970, pp. 302–3) and GOCHT (1970, p. 146) for specimens from England, France and Germany.

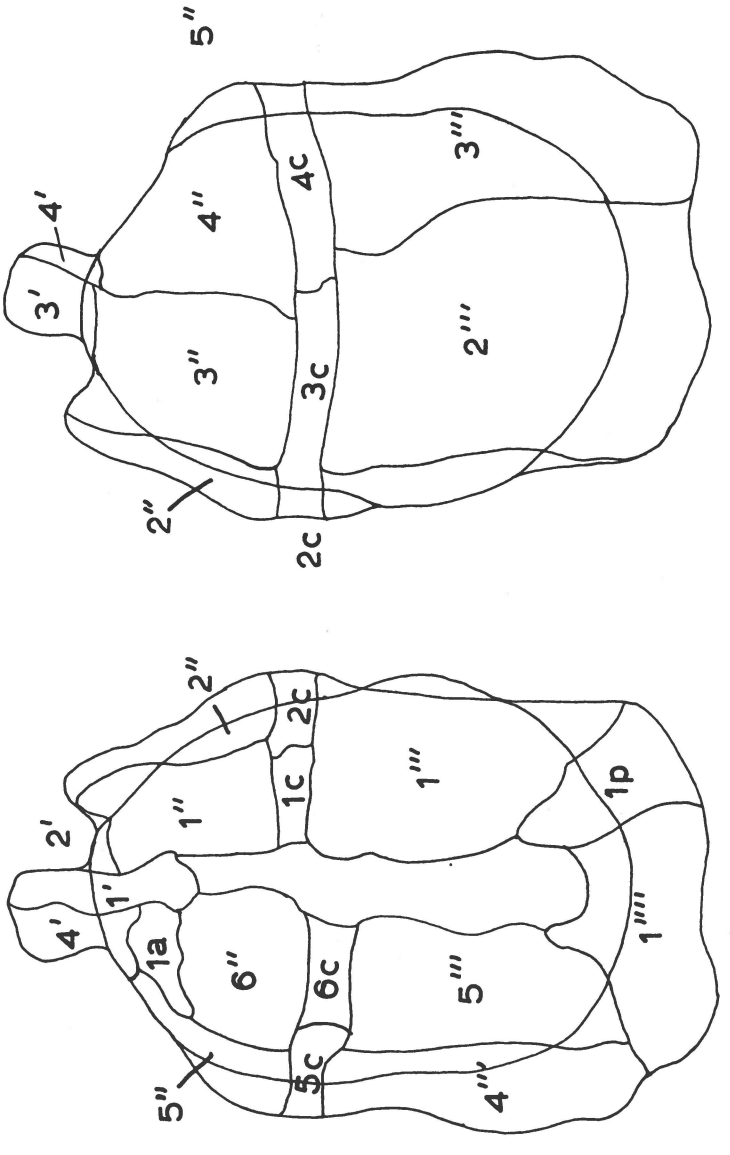


Figure 10. *?Endoscrinium* sp. Specimen GR425/13/6. Left: in ventral view. Right: in dorsal view. Xc. 1250.

Endoscrinium cf. *galeritum* (DEFLANDRE, 1938b) VOZZHENNIKOVA 1965

Plate 3, fig. 6.

Remarks: A single specimen (GR426/8/13) from the upper horizon showed general morphological accord with *Endoscrinium galeritum*, but the antapex was unfortunately obscured and its form not clear. The dimensions (length of periblast c. 50 μ, breadth 54 μ, length of endoblast 40 μ, breadth 43 μ) are smaller than is usual for that species. Three other, larger specimens, all extremely poorly preserved, may also represent this species.

?Endoscrinium sp.

Fig. 10.

Description: Periblast broadly ovoidal to subangular, with a horn-like, square-ended apical pericoel. Endoblast ovoidal. Tabulation discernible under phase contrast on the periblast, marked by lines along the sutures: 4′, 1a, 6″, 6c, 5‴, 1p, 1⁗. Cingulum narrow, forming an only slightly laevorotatory spiral whose two ends scarcely differ in antero-posterior position. The epitract of the periblast is markedly less large than the hypotract, the sulcus extending from mid-point on the epitract to the antapex. Surface of endoblast and periblast smooth: endophragm and periphragm are both thin and transparent.

Figured Specimen: Specimen GR425/13/6, lower horizon in the Upper Vardekløft Formation, Jameson Land: lodged in the Mineralogical Museum ,University of Copenhagen.

Dimensions: Figured specimen; length of periblast 70 μ, breadth 45.5 μ, length of endoblast 52.5 μ, breadth 36.5 μ.

Material: Three specimens from the lower horizon, only one of which was suitable for detailed study and measurement.

Remarks: The general form and tabulation of these specimens are distinctive, but (in view of its extremely thinness) it is possible that the appearance of the periblast has been modified by folding. It is therefore felt that further specimens must be studied before any firm taxonomic proposals can be made.

Genus *PSALIGONYAULAX* SARJEANT, 1967a

?Psaligonyaulax cf. *apaleta* (COOKSON & EISENACK, 1960), SARJEANT *in* DAVEY, DOWNIE, SARJEANT & WILLIAMS, 1969

Fig. 11; plate 4, fig. 6.

Description: Periblast extremely elongate, with blunt-pointed apex and almost flat antapex edged by denticles. Endoblast elongate-oval.

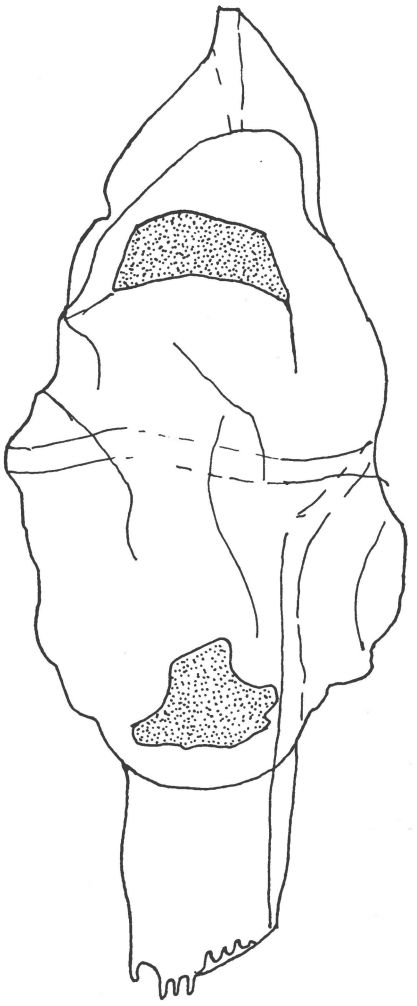


Figure 11. *?Psaligonyaulax* cf. *apaleta* (Cookson & Eisenack. Specimen GR425/3/99, in dorsal view, showing the archaeopyle and posterior dorsal opening. Xc. 1250.

The periblast exhibits traces of a cingulum and faint lines suggesting vestiges of a tabulation. It is penetrated by two dorsal openings, one in the epitract (possibly an intercalary archaeopyle, possibly a precingular archaeopyle that has incompletely opened) and one, more irregular, on the posterior flank of the hypotract (see fig. 11). The surface of the endoblast is granular; no traces of openings were discerned in it.

Figured Specimen: Specimen GR425/3/99, lower horizon of the Upper Vardekløft Formation, Jameson Land, lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured specimen: length of periblast 88.5 μ, breadth 39 μ, length of endoblast 61 μ, breadth c. 38 μ, (length of apical pericoel 11.5 μ, length of antapical pericoel 16.5 μ). Range: length of periblast 61.87 μ (mean 80.40 μ), breadth 39–48.5 μ (mean 42.50 μ), length of endoblast 47–64 μ (mean 59.10 μ), breadth 38–45 μ (mean 40.80 μ).

Material: Eight specimens in the lower horizon, five of which were suitable for measurement.

Remarks: In general characters, these forms resemble *?Psaligonyaulax apaleta*, from the Upper Jurassic of Western Australia. However, they differ in lacking a distinct, truncate apical horn: moreover, the character of the archaeopyle remains to be elucidated.

Family Nelsoniellaceae EISENACK 1961, emend. SARJEANT & DOWNIE 1966

Genus *SCRINIODINIUM* KLEMENT, 1957

Scriniodinium dictyotum COOKSON & EISENACK 1960

1960 *Scriniodinium dictyotum* COOKSON & EISENACK, pp. 248–249, pl. 27, figs. 8–9.
1962a *Scriniodinium dictyotum* COOKS. & EIS. SARJEANT, p. 262, pl. 1, fig. 9, tabs. 3–4.
1962b *Scriniodinium dictyotum* COOKS. & EIS. SARJEANT, pl. 69, fig. 11, tabs. 2–3.
1964a *Scriniodinium dictyotum* COOKS. & EIS. SARJEANT, tab. 2.
1964 *Scriniodinium dictyotum* COOKS. & EIS. DOWNIE & SARJEANT, p. 144.
1967 *Scriniodinium dictyotum* COOKS. & EIS. EISENACK, p. 755.
1967c *Scriniodinium dictyotum* COOKS. & EIS. SARJEANT, tab. 11.
1968 *Scriniodinium dictyotum* COOKS. & EIS. SARJEANT, p. 236, pl. 1, fig. 7, tab. 2b.
1970 *Scriniodinium dictyotum dictyotum* COOKS. & EIS. GITMEZ, p. 310.
1972 *Scriniodinium dictyotum dictyotum* COOKS & EIS. GITMEZ & SARJEANT, tabs. 3, 6.
1972 *Scriniodinium dictyotum dictyotum* COOKS. & EIS. RILEY & SARJEANT (in press).

Remarks: A single representative of the typical subspecies of *S. dictyotum* was present in the upper horizon of the Upper Vardekløft Formation. It was too poorly preserved to be suitable for measurement.

Scriniodinium cf. *parvimarginatum* (COOKSON & EISENACK 1958) EISENACK 1967

Plate 4, fig. 5.

Remarks: A single, damaged specimen from the lower horizon of the Upper Vardekløft Formation corresponds broadly with *Scriniodinium parvimarginatum*, originally described from the Upper Jurassic of Western Australia. However, its dimensions are markedly smaller (periblast length 67 μ, breadth 53.5 μ, as against a quoted range of 76–100 μ × 76–100 μ) and the attribution must be considered highly questionable.

Scriniodinium sp.

Plate 1, fig. 1.

Description: Periblast almost spindle-shaped, but widest and slightly asymmetrical in its equatorial region. Endoblast broadly ovate. Slight folds in the periphragm suggest a cingulum and (possibly) vestiges of a tabulation. The archaeopyle penetrates both membranes; in the endoblast, it is subapical in position, the operculum remaining attached. The position of the archaeoplye in the periblast is less clear, since it is incompletely open; it appears to be precingular, but may be intercalary. The endophragm is of moderate thickness, its surface minutely granular; the periphragm is thinner and lacks granulation.

Figured Specimen: Specimen GR426/12/21, upper horizon in the Upper Vardekløft Formation, Jameson Land; lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured Specimen — length of periblast 84 μ, breadth 54 μ, length of endoblast 54 μ, breadth c. 49 μ.

Remarks: This single specimen clearly represents an undescribed species, for fuller knowledge of which further specimens must be awaited.

Family Netrelytraceae Sarjeant & Downie 1966

Genus *NETRELYTRON* Sarjeant 1961, emend. Sarjeant 1966c

Netrelytron aff. *stegastum* Sarjeant 1961

Plate 3, fig. 5.

Description: Cyst spindle-shaped and enclosed in a cloak of adherent debris. Apical horn of periblast long and acute, antapical horn shorter and blunt; the central portion of the periblast is broadly ovate, almost spheroidal. Endoblast spheroidal (clearly visible only by phase contrast or Nomarski interference contrast). Archaeopyle present, intercalary and attached in the periblast, subapical and attached in the endoblast.

Figured Specimen: Specimen GR426/12/24, upper horizon in the Upper Vardekløft Formation; lodged in the Mineralogical Museum, University of Copenhagen.

Dimensions: Figured Specimen; length of periblast 110 μ, breadth 54 μ, length of apical horn 24 μ, length of antapical horn 13 μ, length of endoblast 65 μ, breadth 52.5 μ.

Remarks: In general shape and the acuteness of its apical horn, this specimen resembles *Kalyptea diceras* Cookson and Eisenack, 1960, individuals of which sometimes exhibit a debris cloak, and some of the

forms placed by GOCHT (1970) into *Pareodinia ceratophora* (e. g. the specimen illustrated in Plate 35, fig. 8, which is seemingly in inverse orientation). However, the genus *Kalyptea* is not known to be cavate and may represent a type (ancestral to *Netrelytron?*) in which the two membranes have not separated. The relationships of *Kalyptea* and *Pareodinia ceratophora* are considered on an earlier page.

Typical representatives of *Netrelytron stegastum* have a shorter, less acute apical horn, the central portion of the periblast being markedly less rotund.

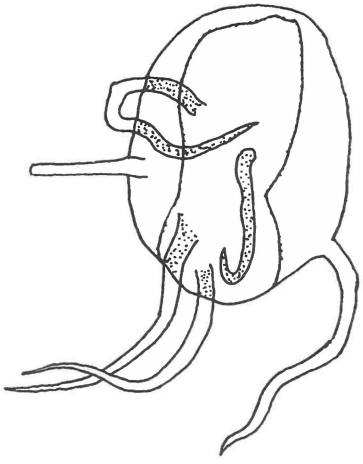


Figure 12. *Micrhystridium* sp., showing the opening in the shell and the character of the spines (spines on the underside are shaded), Xc. 1500.

GROUP ACRITARCHA EVITT 1963

Subgroup **Acanthomorphitae** DOWNIE, EVITT & SARJEANT 1963

Genus *MICRHYSTRIDIUM* DEFLANDRE 1937, emend. SARJEANT 1966

Micrhystridium sp.

Fig. 12.

Remarks: A single specimen from the lower horizon, lacking a portion of the shell (possibly as a result of excystment or hatching?) and with only six spines, one of them broken and all of them bent, is the sole representative of this genus encountered in the two horizons studied. In the character, number and proportionate length of its spines, it differs from all described species of this genus.

Subgroup **Sphaeromorphitae** Downie, Evitt & Sarjeant 1963

Genus *LEIOSPHAERIDIA* Eisenack, 1958, emend. Downie & Sarjeant 1963

Leiosphaeridia hyalina (Deflandre 1941) Eisenack 1958

Plate 3, fig. 2.

1941 *?Leiosphaera hyalina* Deflandre, p. 24, pl. 6, figs. 12–13.
1958 *Leiosphaeridia hyalina* Defl. Eisenack, p. 9.
1964a *Leiosphaeridia hyalina* Defl. Sarjeant, tab. 3.
1964 *Leiosphaeridia hyalina* Defl. Downie & Sarjeant, p. 124.
1972 *Leiosphaeridia hyalina* Defl. Riley & Sarjeant (in press).

Remarks: Four leiospheres were encountered in the lower horizon and eight in the upper horizon of the Upper Vardekløft Formation. They correspond in all important features with Deflandre's diagnosis. However, the greenish-yellow bodies ("corpuscles jeune verdâtre") which he refers to (1941, p. 24) are lacking and an opening, not regular enough to be considered an archaeopyle, is sometimes present. The figured specimen (GR426/12/4) is the best preserved; its dimensions (longest diameter 50 μ, shortest 41.5 μ) are typical.

It should be stressed that Jurassic leiospheres are so poorly known and the definition of leiosphere taxa so unsatisfactory that attribution of these forms to the Kimmeridgian species cannot be regarded as having any stratigraphic significance.

Subgroup **Pteromorphitae** Downie, Evitt & Sarjeant 1963

Genus *PTEROSPERMOPSIS* W. Wetzel 1952

Pterospermopsis helios Sarjeant 1959

1959 *Pterospermopsis helios* Sarjeant, p. 342, pl. 13, fig. 9.
cf. 1960 *Pterospermopsis* cf. *helios* Sarjeant, Sarjeant, p. 402, pl. 13, fig. 10, tab. 2.
1962b *Pterospermopsis helios* Sarjeant, Sarjeant, tabs. 2–3.
cf. 1962b *Pterospermopsis* cf. *helios* Sarjeant, Sarjeant, p. 492, p. 70, fig. 15, text-fig. 9b.
1964a *Pterospermopsis helios* Sarjeant, Sarjeant, tab. 3.
1964 *Pterospermopsis helios* Sarjeant, Downie & Sarjeant, p. 143.
aff. 1968 *Pterospermopsis* aff. *helios* Sarjeant, Sarjeant, tab. 2A.
1972 *Pterospermopsis helios* Sarjeant, Riley & Sarjeant (in press).

Remarks: A single, poorly preserved specimen in each horizon was attributed to this species.

Subgroup **Partitomorphitae** Pocock & Sarjeant 1972

Remarks: The Greenland representatives of this newly proposed subgroup are fully discussed by Pocock & Sarjeant (in press) and will not be again discussed here.

CONCLUSIONS

In both assemblages here described, dinoflagellate cysts predominate; they account for 97.66 % of the lower assemblage and 76 % of the upper. Among the dinoflagellates, proximate cysts are overwhelmingly predominant, accounting for 88.33 % of the lower assemblage, but dropping to 63 % of the upper. Details of the assemblages are presented in Table 1.

Proximate cysts with apical archaeopyles are almost equally numerous in either assemblage (24.66 % and 24.33 % respectively). This constancy is not paralleled at generic level, however; *Meiourogonyaulax*, abundant in the lower assemblage (of which it forms 16.33 %), becomes infrequent (4.33 %), whereas *Chytroeisphaeridia* and *Tenua* become more frequent (6.33 % to 11.33 % and 1.66 % to 8.33 %). [Note: Unidentifiable proximate cysts accounted for 12 % of the lower assemblage and 11.33 % of the upper. These are necessarily not taken into account in assessing the distribution of archaeopyle types, but it is improbable that they would greatly distort the picture].

Proximate cysts with intercalary archaeopyles (all members of the genus *Pareodinia*) are more abundant and varied in the lower assemblage than in any other yet described. In the upper assemblage they become markedly less numerous and varied, declining from 33 % to 3.66 %.

Proximate cysts with precingular archaeopyles, all of which exhibit a *Gonyaulax*-style tabulation, rise slightly in proportinate numbers from the lower (18.66 %) to the higher horizon (23.66 %). The dominant species is *Gonyaulacysta jurassica*, accounting for 8.33 % of the lower assemblage and 10.33 % of the upper.

Cavate cysts account for 14.66 % of the lower assemblage and decline to 9.66 % in the upper. Forms with precingular archaeopyles are extensively present in the lower assemblage and overwhelmingly predominant in the upper. A high proportion in both assemblages apparently represent undescribed species, whose poor preservation precluded accurate description. Chorate, proximochorate and membranate cysts play a very minor role in these assemblages, together accounting for 2.66 % in the lower horizon and 4 % in the upper.

Acritarchs are very poorly represented in the lower horizon, where they make up only 2.33 % of the assemblages; four subgroups are

Table 1. *The numerical distribution by horizon of species in the Jurassic of Jameson Land, compared with their previously recorded ranges.*

(*The figures in parenthesis are those used in determining percentages, where different from final totals*).

Species	Lower horizon (GR425)	Upper horizon (GR426)	Previously known Range
PROXIMATE CYSTS			
Gonyaulacysta jurassica	24(17)	28	Bathonian-M. Kimmeridgian
G. jurassica var. longicornis	1(1)	4(3)	L. Callovian-L. Kimmeridgian
G. aff. *jurassica*	5(4)	–	–
G. cladophora	14(10)	17(16)	Bajocian-Kimmeridgian
G. aff. *cladophora*	1	4(2)	–
G. eisenacki	11(10)	5	Bathonian-U. Oxfordian
G. eisenacki oligodentata	–	2	Upper Jurassic
?G. whatleyi	7	4	–
G. scarburghensis	–	?2	U. Callovian-L. Oxfordian
Leptodinium cf. *millioudi*	–	1	–
Hystrichogonyaulax cf. *cornigera*	5(4)	–	–
?Acanthaulax spinosissima	–	4	L. Oxfordian
Acanthaulax sp. indet.	2	4	–
Pareodinia ceratophora	30	10(8)	Bajocian
P. ceratophora var. *pachyceras*	11(9)	–	Lowest Callovian
P. ceratophora var. *scopaeus*	–	2	–
P. prolongata	33(20)	?1	L.-U. Callovian
P. groenlandica	13(8)	–	–
P. apotomocerastes	12	–	–
Meiourogonyaulax decapitata	17(11)	–	–
M. callomonii	8(4)	7	–
M. cf. *callomonii*	17(14)	? 1	–
M. strongylos	11(8)	–	–
Mm cf. *deflandrei*	–	1	–
?M. cantrellii	9(6)	–	–
?M. sp.	1	2	–
M. sp. indet.	7(5)	2	–
Chytroeisphaeridia chytroeides	4	17(14)	L. Bathonian-U. Kimmeridgian
C. pococki	4(2)	6(5)	L. Callovian-U. Kimmeridgian
C. dictydia	15(13)	16(15)	–
Tenua pilosa	–	14	U. Callovian-L. Kimmeridgian
Tenua cf. *pilosa*	3(1)	–	–
T. rioulti	2(2)	11	U. Callovian-L. Oxfordian
T. varispinosa	4	–	Lowest Callovian
Nannoceratopsis pellucida	–	1	?Callovian-L. Kimmeridgian
Proximate cysts sp. indet.	40(36)	34	–

continued)

Table 1 (continued).

Species	Lower horizon (GR425)	Upper horizon (GR426)	Proviously known Range
CHORATE CYSTS			
Hystrichosphaeridium costatum	–	2	U. Callovian-Oxfordian
Polystephanephorus cf. *speciosus*	2(1)	–	–
Prolixosphaeridium aff. *deirense*	–	2	–
PROXIMOCHORATE CYSTS			
Wanaea digitata	–	5	U. Callovian-?Kimmeridgian
Ctenidodinium sp. indet.	2	–	–
MEMBRANATE CYSTS			
Valensiella ovula	3	4(3)	Bajocian-L. Oxfordian
Aff. *Valensiella* sp.	2	–	–
CAVATE CYSTS			
Endoscrinium luridum	17(14)	4(3)	L. Bathonian-L. Kimmeridgian
E. cf. *galeritum*	–	?4	L. Bathonian-L. Kimmeridgian
?E. sp.	3	–	–
?Psaligonyaulax cf. *apaleta*	8(7)	–	–
Scriniodinium cf *parvimarginatum*	1(1)	–	–
Scriniodinium dictyotum	–	1	U. Callovian-M. Kimmeridgian
S. sp.	–	1(–)	–
Netrelytron aff. *stegastum*	–	1(–)	–
Cavate cysts sp. indet.	25(19)	19(18)	–
ACRITARCHS:			
ACANTHOMORPHITAE			
Micrhystridium sp.	1	–	–
SPHAEROMORPHITAE			
Leiosphaeridia hyalina	4	8	Kimmeridgian
PTEROMORPHITAE			
Pterospermopsis helios	1	1	L. Callovian-U. Oxfordian
PARTITOMORPHITAE			
Rugidinium ornatum	1	–	U. Jurassic
Thuledinium groenlandicum	1	65(63)	–
TOTAL ASSEMBLAGE	382(300)	315(300)	

represented, among which the leiospheres account for 1.33 %. In the upper horizon, in contrast, the partitomorph acritarch *Thuledinium groenlandicum* is the most abundant single species, accounting for 21 % of the assemblage; but other acritarchs only amount to 1.99 % ,with the leiospheres forming 1.66 %.

Since no other palaeontological evidence is available, a probable age must be assigned for these assemblages wholly on the basis of their dinoflagellates. The expression of a stratigraphic opinion is rendered hazardous by the fact that no boreal Jurassic assemblages have yet been described, and that the only Middle and Upper Bathonian assemblages hitherto described from north west Europe have been from northern France (VALENSI, 1953), where small acritarchs of the genus *Micrystridium* are overwhelmingly predominant. (This is probably a consequence of the shallowness of the Middle Jurassic seas in that region). Only one relatively dinoflagellate-rich Bathonian assemblage has been described to date — from Germany, by GOCHT (1970); the assemblage is considered to be of Lower Bathonian date.

A further complication is that the dinoflagellates of the Middle Callovian have not yet been studied in detail, though accounts of Lower Callovian (Macrocephalus and Calloviense Zones) and uppermost Callovian (Lamberti Zone) have been published (SARJEANT, 1959, 1966a, 1968).

Nevertheless, the upper assemblage (GR426) can be confidently stated to be Callovian. The characteristic Oxfordian species are beginning to appear, but are not yet so predominant as they become by the Lamberti Zone; on the other hand, the dominant forms of the Middle Jurassic (particularly, species of *Meiourogonyaulax*, *Ctenidodinium* and *Pareodinia*) are no longer pre-eminent. In terms of the northwest European zonation, I believe a Middle Callovian date should provisionally be assigned to this assemblage, older than Lamberti and probably younger than Calloviense, i.e. in the range Jason to Athleta.

Similarly, it appears clear that the lower assemblage (GR425) must be considered as Bathonian, in view of the predominance of species of *Pareodinia* and *Meiourogonyaulax* (many of which have hitherto been undescribed). Greater accuracy is not possible, in terms of published data on dinoflagellate distribution; but, if I may venture an opinion, it seems probable that the date will prove to be lower Variabile or Kochi i.e. the middle to lower part of the Upper Bathonian — lower Discus or Aspidoides, in terms of the standard European zonation (CALLOMON, 1963) — or earlier, rather than from the uppermost Bathonian.

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REFERENCES

ALBERTI, G., 1961: Zur Kenntnis mesozoicher und alttertiärer Dinoflagellaten und Hystrichosphaerideen von Nord- und Mitteldeutschland sowie einigen anderen europaischen Gebieten. *Palaeontographica*, ser. A, **116**, 1–12.

BALTES, N., 1963: Dinoflagellate si Hystrichosphaeride cretacice din Platforma moesic'a. *Petrol Gaze, Bucuresti*, **14** 581–597.

CALLOMON, J. H., 1959: The ammonite zones of the Middle Jurassic beds of East Greenland. Geol. Mag., **96**, 505–513.

— 1961: The Jurassic System in East Greenland. *In* RAASCH, G. O. (editor), *Geology of the Arctic* **1**, 258–268. Toronto U. P.

— 1963: The Jurassic ammonite-faunas of East Greenland. *Experientia, Basel*, **19**, 289–294.

COOKSON, I. C. & EISENACK, A., 1958: Microplankton from Australian and New Guinea Upper Mesozoic sediments. *Proc. Roy. Soc. Victoria*, **70**, 19–29.

— 1960: Upper Mesozoic microplankton from Australia and New Guinea. *Palaeontology*, **2**, 243–61.

DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L., 1966: Fossil dinoflagellate cysts attributed to *Baltisphaeridium*. *In* DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L.: Studies on Mesozoic & Cainosoic dinoflagellate cysts, 157–175, *Bull. Brit. Mus. Nat. Hist.* (*Geol.*). Supplement 3.

— 1959: Appendix to "Studies on Mesozoic and Cainozoic dinoflagellate cysts". *Bull. Brit. Mus. Nat. Hist.* (*Geol.*). Appendix to Supplement 2: 24 pp.

DAVEY, R. J., & WILLIAMS, G. L., 1966: The genus *Hystrichosphaeridium* and its allies. *In* DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L. Studies on Mesozoic & Cainozoic dinoflagellate cysts, 53–106. *Bull. Brit. Mus. Nat. Hist.* (*Geol.*).

DEFLANDRE, G., 1935: Considérations biologiques sur les micro-organismes planctoniques conservés dans les silex de la craie. *Bull. biol. Fr. Belg.*, **69**, 213–244.

— 1938a: Sur les micro-organismes des mers jurassiques conservé à l' état de matière organique dans les marnes de Villers-sur-Mer. *C. r. Acad. Sci. Paris*, **206**, 687–9.

— 1938b: Microplancton des mers jurassiques conservé dans les marnes de Villers-sur-Mer (Calvados). Etude liminaire et considérations générales. *Trav. Stat. zool. Wimereux*, **13**, *Vol. jubilaire M. Caullery*, 147–200.

— 1947: Sur quelques micro-organismes planctoniques des mers jurassiques. *Bull. Inst. oceanogr. Monaco*, no. **921**, 1–10.

— 1952a: Protistes. Généralités. Sous-embranchement des Flagellés. Groupes Incertae Sedis. *In* PIVETEAU, J. (editor): *Traité de Paléontologie*, **1**, 89–95, 99–130. Masson, Paris.

— 1952b: Dinoflagellés fossiles. *In* GRASSÉ, P. P. (editor): *Traité de Zoologie*, **1**, 391–406. Masson, Paris.

DEFLANDRE, G., 1964: Quelques observations sur la systématique et la nomenclature des dinoflagellés fossiles. *Multicop. Lab. micropaléont. Ecole Pratique Hautes Etudes, Paris*, 1–8.

DODEKOVA, L., 1967: Les dinoflagellés et acritarches de l'Oxfordien. — Kiméridgien de la Bulgarie du nord-est. *Ann. Univ. Sofia Fac. Geol. Geogr.*, **60**, *Geol.* **1**, 9–30.

— 1969: Dinoflagellés et acritarches du Tithonique aux environs de Pleven, Bulgarie Centrale du nord. *Bulg. Acad. Sci., Bull. Geol. Inst., Ser. Paleobtology*, 18, 13–24.

DUPIN, F., 1965: Contribution à l'etude lapéoplanctologique du Jurassique en Aquitaine occidentale. *Actes. Soc. Linn. Bordeaux* **102** ser. B, 1–19.

EHRENBERG, C. G., 1843: Uber Jura-Infusorien Arten des Corallrags bei Krakau. *Mber. Akad. Wiss. Berlin* 61–3.

— 1854: *Mikrogeologie: das Erden und Felsen schaffende Wirken des unsichtbar kleinen selbständigen Lebens aus der Erde.* 374+3+88 pp. Voss, Leipzig.

ERDTMAN, G., 1969: *Handbook of Paylnology, Morphology-taxonomy-ecology.* 486 pp. Munksgaard, Copenhagen. /Includes an Appendix: Microfossils other than pollen and spores in palynological preparations, by W. A. S. SARJEANT (pp. 167–212).

EISENACK, A., 1958: Mikroplankton aus dem norddeutschen Apt, nebst einigen Bemerkungen über fossile Dinoflagellaten. *Neu. Jb. Geol. Paläeont, Abh.*, **106**, 383–422.

— 1963: Zur *Membranilarnax*-Frage. *Neu. Jb. Geol. Paläont, Mh.*, no. **2**, 98–103.

— 1967: *Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien I. Dinoflagellaten* 895 pp. Schweizerbart, Stuttgart.

— 1969: Bemerkungen zur Systematik der fossilen Dinoflagellaten. *Neu. Jb. Geol. Palaont., Mh.*, no. **6**, 337–343.

EVITT, W. R., 1961: The dinoflagellate *Nannoceratopsis* Deflandre: morphology, affinities and infraspecific variability. *Micropaleontol ogy* **7**, 305–316.

— 1963: A discussion and proposals concerning fossil Dinoflagellates, Hystrichospheres and Acritarchs. *Proc. Nat. Acad. Sci. Washington*, 158–64, 298–302.

— 1967: Dinoflagellate studies. II The archeopyle. *Stanford Univ. Publ. Geol. Sci.* **10**, no. 3, 1–61.

GITMEZ, G. U., 1970: Dinoflagellate cysts and acritarchs from the basal Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Brit. Mus.* (*Nat. Hist.*) *Geol.* **18**, 234–331.

GITMEZ, G. U. & SARJEANT, W. A. S., 1971: Dinoflagellate cysts and acritarchs from the Kimmeridgian (Upper Jurassic) of England, Scotland and France. *Bull. Brit. Mus.* (*Nat. Hist.*) *Geol.*, (in press).

GOCHT, H., 1970: Dinoflagellaten-Zysten aus dem Bathonium des Erdölfeldes Aldorf (N. W.-Deutschland). *Palaeontographica*, ser. B, **129**, 125–165.

KLEMENT, K. W., 1957: Revision der Gattungzugehörigkeit einge in die Gattung *Gymnodinium* eingestüfter Arten jurassischer Dinoflagellaten. *Neu. Jb. Geol. Paläont, Mh.*, no. **9**, 408–10.

— 1960: Dinoflagellaten und Hystrichosphaerideen aus dem Unteren und Mittleren Malm Südwestdeutschlands. Palaeontographica, ser. A, **114**, 1–104.

LANTZ, J., 1958: Etude palynologique de quelques échantillons mésozoiques de Dorset (Grand-Bretagne). *Rev. Inst. Pétrole*, **13**, 917–940.

LOEBLICH, A. R., JR., & LOEBLICH, A. R., III. 1966: Index to the genera, subgenera and sections of the Pyrrhophyta. *Univ. Miami Studies trop. Oceanogr.*, no. **3**, 94 pp.

LOHMANN, H., 1904: Eier und sogenannte Cysten der Plankton-Expedition. Anhang Cyphonautes. *Wissenschaft Ergebnisse der Plankton-Expedition Humboldt-Stiftung*, new ser., **4**, 1–62.

MALIAVKINA, V. S., SAMOILOVITCH, S. R., *et.al.*, 1961: Pollen and spores of Western Siberia: Jurassic-Paleocene. A symposium (in Russian). *Trudy Vses. Neft. Nauchno-Iss. Geol. Inst.* no. 177, 1–657.

NORRIS, G., & SARJEANT, W. A. S., 1965: A descriptive index of genera of fossil Dinophyceae and Acritarchs. *Palaeont. Bull. Wellington*, no. 40, 1–72.

POCOCK, S. A. J., & SARJEANT, W. A. S., 1972: The Partitomorphitae, a new subgroup of acritarchs from the Jurassic of Canada and Greenland. *Bull. geol. Soc. Denmark* (in press).

RILEY, L. A. & SARJEANT, W. A. S., 1971: Survey of the stratigraphical distribution of dinoflagellates, acritarchs and Tasmanitids in the Jurassic. *Geophytology* (in press).

SARJEANT, W. A. S., 1959: Microplankton from the Cornbash of Yorkshire. *Proc. Yorks. geol. Soc.*, **96**, 329–46.

— 1960: Microplankton from the Corallian rocks of Yorkshire. *Proc. Yorks. geol. Soc.* **97**, 137–44.

— 1961: Microplankton from the Kellaways Rock and Oxford Clay of Yorkshire. *Palaeontology*, **4**, 90–118.

— 1962a: Upper Jurassic microplankton from Dorset, England. *Micropaleontology*, **8**, 255–68.

— 1962b: Microplankton from the Ampthill Clay of Melton, South Yorkshire. *Palaeontology*, **5**, 478–97.

— 1963a: *Favilarnax*, new genus of Mesozoic hystrichospheres. *J. Paleont.* **37**, 719–21.

— 1963b: Two new Jurassic species of *Gonyaulax* (Dinophyceae). *Rev. Micropaléont.*, **6**, 85–8.

— 1964a: The stratigraphic application of fossil microplankton (Dinoflagellates and Hystrichospheres) in the Jurassic. *In* MAUBEUGE, P. L. (ed.) *Colloque du Jurassique, Luxembourg* **1962**, *Vol. C. R. et Mem.*, 441–448.

— 1964b: New name and diagnosis for an Upper Jurassic species of *Gonyaulacysta* (Dinophyceae). *Palaeontology*, **7**, 472–3.

— 1964c: Hystrichosphere synonyms: *Favilarnax* Sarjeant junior to *Valensiella* Eisenack. *J. Paleont*, **38**, 172–3.

— 1966a: Microplankton from the Callovian (*S. calloviense* Zone), of Normandy. *Rev. Micropaléont.*, **8**, 175–184.

— 1966b: Dinoflagellate cysts with a *Gonyaulax*-type tabulation, *in* DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS, G. L.: *Studies on Mesozoic and Cainozoic dinoflagellates cysts*, 107–156, Bull. Brit. Mus. Hist. (Geol.) Supplement 3.

— 1966c: Further dinoflagellate cysts from the Speeton Clay (Lower Cretaceous). *In* DAVEY, R. J., DOWNIE, C., SARJEANT, W. A. S., & WILLIAMS G. L.: *Studies on Mesozoic and Cainozoic dinoflagellate cysts*, 199–214. Bull. Brit. Mus. Nat. Hist. (Geol.) Supplement 3.

— 1967a: The stratigraphical distribution of fossil dinoflagellates. *Rev. Palaeobot. Palyn.*, **1**, 323–343.

— 1967b: The genus *Palaeoperidinium* DEFLANDRE (Dinophyceae). *Grana Palyn.*, **7**, 243–258.

— 1968: Microplankton from the Upper Callovian and Lower Oxfordian of Normandy. *Rev. Micropaléont.* **10**, 221–242.

— 1970: Recent developments in the application of fossilised planktonic organisms to problems of stratigraphy and palaeoecology. *Paläont, Abh., Berlin*, 669–682.

SARJEANT, W. A. S., & DOWNIE, C., 1966: the classification of dinoflagellate cysts above generic level. *Grana Palyn.*, **6**, 503–527.

SCHULZ, E., & MAI, D. H., 1966: Erläuterungen zur Tabelle der stratigraphischen Verbreitungs des Phytoplantons im Lias und Dogger. In Erlauterungen zu den sporenstratigraphischen Tabellen vom Zechstein bis zum Oligozän, *Zentral geol. Inst. Abh. Berlin*, **48**, 35–45.

VALENSI, L., 1953: Microfossiles des silex du Jurassique moyen. Remarques pétrographiques. *Mem. Soc. Géol. Fr.*, **68**, 1–100.

— 1955: Etude microscopique des silex du Magdalénien de Saint-Amand (Cher). *Bull. Soc. préhist. Fr.*, **52**, 584–596.

VENKATACHALA, B. S., & KAR, R. K., 1968: Dinoflagellate and hystrichosphaerid fossils from Katrol (Upper Jurassic) sediments of Kutch, W. India. *Curr. Sci.* **37**, 408–10.

VOZZHENNIKOVA, T. F., 1965: *Vvedenyie v izychenye iskopayemix peridineevix vodoroslei.* Izdatel. "Nauka", Moscow, 156 pp.

— 1967a: *Iskopaemye peridinei Yurskikh, Melovykhi Paleogenovykh otlozhenii S.S.S.R.* Izdatel. "Nauka", Moscow, 347 pp.

— 1967b: *Introduction of the study of fossilised peridinid algae.* (English transl. of VOZZHENNIKOVA, 1965, prepared by K. SYERS, edited by W. A. S. SARJEANT). Nat. Lend. Lib. for Sci. Tech., Boston Spa, Yorks 233 pp.

— 1971: Fossilised peridinid algae in the Jurassic, Cretaceous and Palaeogene deposits of the U.S.S.R. (English transl. of VOZZHENNIKOVA 1967a, prepared by E. LEES and edited by W. A. S. SARJEANT). N. V. Lend. Lib. for Sci. Tech., Boston Sp., Yorks. 2 vols., 453 pp.

WETZEL, W., 1966: Charakteristik des marinen Planktons und Pseudoplanktons der Amaltheen-Schichten Deutschlands und Lothringens. *Neues Jb. Geol. Paläont. Abh.*, **124**, 313–326.