TWO NEW EARLY CRETACEOUS DINOCYST SPECIES FROM THE NORTHERN NORTH SEA

by ROGER J. DAVEY

ABSTRACT. Two new species of dinocyst, Oligospheraeidi um abaculum and Sysematophora stybha, are described from a Barremian assemblage obtained from the northern North Sea north-east of the Shetlands. O. abaculum is the first-known hystichospore with plate-centred tubular processes on which a clearly defined paratabulation is present and this is described in detail. The paratabulation is of the Gonycaulos-type, and it is inferred that chorate cysts with similar morphology are also of this type.

During the routine dating of core samples from the Institute of Geological Sciences Offshore boreholes, a well-preserved and unusual dinocyst assemblage was recovered from the terminal depth sample (depth 78·95 m) of borehole 77/80B. Two new species from this assemblage are described below. The borehole was drilled during June 1977 and was located 30 km north-east of Unst, Shetlands in the northern North Sea licence block 1/4 (unallocated) at latitude 60° 56·7' N., longitude 0° 15·7' W. The water depth at this drilling site was 141 m. A sedimentary thickness of 78·95 m was penetrated which consisted of 33·60 m of Quaternary clay overlying 45·35 m of dark greenish-grey mudstone. The upper part of this mudstone is micropalaeontologically dated as being of Barremian–Aptian age and the lower part is of Barremian age.

All type and figured specimens having MPK numbers and the SEM stubs are housed in the collections of the Institute of Geological Sciences, Leeds.

ASSEMBLAGE DETAILS

After standard palynologic preparation, the core sample at 78·95 m yielded an assemblage composed almost entirely of dinocysts. Spores, pollen grains, and terrestrially derived plant debris are virtually absent. The dinocyst assemblage is very well preserved and dominated (97%) by Oligospheraeidi um abaculum sp. nov. It, however, contains many other species including Aethmosphaerae neptuni (Eisenack 1958) Davey and Williams 1965a, Avellodinium falsicum Duxbury 1977, Cassiculospheari um magna Davey 1974, Cyclonephelium hystrix (Eisenack 1958) Sarjeant and Stover 1978, Hystrichodinium velitii (Alberti 1961) Davey 1974, Kleithriasphe ridium corrugatum Davey 1974, Odomocystina operculata (Wetzel 1933) Deflandre and Cookson 1955, Pho berocysta noicomica (Gocht 1957) Millioud 1969, Pseudoceratium pelliferum Gocht 1957, and Systematophora stybha sp. nov. This assemblage, but for the new species, closely resembles those obtained from the Barremian part of the Speeton Clay in north-east England (Davey 1974; Duxbury 1977). The presence of O. operculata together with A. falsicum and K. corrugatum indicates that this core sample is of early Barremian age and assignable to the Cassiculospheari um magna Subzone, O. operculata Zone of Davey in press1.

The relatively rich dinocyst assemblage, associated with the paucity of land-derived plant remains, strongly suggests that deposition at this borehole site during the early Barremian took place during a marine transgressive phase.

SYSTEMATIC DESCRIPTIONS

Class DINOPHYCEAE Fritsch
Order PERIDINIALES Haeckel
Genus OLIGOSPHAERIDUM Davey and Williams 1966b

Remarks. *O. abaculum* sp. nov. is a tabulate dinocyst species, and by its inclusion in the previously non-tabulate genus *Oligosphaeridium* the concept of this genus, as envisaged by Davey and Williams 1966b, is widened. However, except for the para-tabulation, *O. abaculum* is so similar to the other members of this genus that it is undoubtedly closely related to them and the para-tabulation is considered to fall into the category of specific variation. The *Gonyaulax*-type para-tabulation and process formula determined for this species can undoubtedly be applied to the other members of *Oligosphaeridium*. In addition, it is probable that morphologically similar genera such as *Hystrichosphaeridium* Delanda 1937 emend. Davey and Williams 1966b, *Kleithriaosphaeridium* Davey 1974, and *Systematophora* Klement 1960 also have the same para-tabulation.

*Oligosphaeridium abaculum* sp. nov.
Plate 48, figs. 1–6; Plate 49, figs. 1–7, Plate 50, figs. 1, 4, 10, 11; text-figs. 1, 2

Derivation of name. Latin, *abacus*, small tile for mosaic work, with reference to the tabulate nature of the cyst wall.

Diagnosis. Shape: the pericyst, excluding processes, was originally spheroidal with only minor dorso-ventral flattening.

Wall: the cyst wall is apparently two-layered, the two layers being closely appressed except where the periphrajm alone forms the processes. The wall is lightly to densely intraperforate, the surface is smooth to scabrate and sparsely pitted. The processes are smooth.

EXPLANATION OF PLATE 48

Figs. 1–6. *Oligosphaeridium abaculum* sp. nov. Note variation in cyst wall texture from smooth to scabrate. 1. offset ventral view with process arising from paraplate 6°. The wall is sparsely pitted and the parastutures very faintly indented, ×1500 (SEM). 2. lateral view; the precingular process has a strongly perforate base and on the adjacent paraplate (upper left) the precingular process has become completely detached at this point. Parasutures defined by very low ridges, ×1400 (SEM). 3. view of archaepyle margin and base of precingular process, ×5000 (SEM). 4. lateral view illustrating strong parasutural ridges and the distal spines of a precingular process, ×1000 (SEM). 5. view of base of a partially detached process, ×10,000 (SEM). 6. cyst fragment illustrating smooth internal wall, ×2000 (SEM).

Figs. 7, 8. *Systematophora siyiba* sp. nov. 7. lateral view of specimen with operculum remaining partially attached. Note the alignment of circular processes dividing the cyst into approximately equal halves. The pre- and postcingular annulate complexes are particularly noticeable because of the smooth periphraom surrounding, and within, each complex, ×1500 (SEM). 8. apical-lateral view of specimen with archaeopyle to illustrate the structure of a precingular annulate complex, ×2000 (SEM).
Paratabulation: the parasites may be defined by very low ridges or by an apparent change in the internal wall structure; the clarity of the parasites varies from poor to good with those in the parasilical region being the most poorly defined. The paratabulation formula is pr, 4', 6", 6c, 6", 1p, 5s, 1"'.

Processes: the processes are of tubiform shape, and flare distally typically giving rise to six slight flexuous spines; neighboring spines may be joined medially to each other. Process stem width varies according to position on the cyst, with the apical, posterior, intercalary, and parasilical processes being the most narrow. These processes are also the shortest but variation in length is not pronounced; process length is approximately equal to half the endocyst diameter. The process formula is 4', 6", 5", 1p, 1s, 1"'; the first postcingular paraplate (1") does not bear a process and the parasilical process occurs on the posterior sulcal paraplate (ps).

Archaeoepyle: an apical archaeoepyle always appears to be present, and is developed by the detachment of the apical paraplates as a unit (type A). It has a strongly zigzag margin with a deep parasilical notch.

**Holotype.** MPK 2145, slide CSC 1824/4, IGS borehole 77/80B, depth 78-95 m, northern North Sea, block 1/4, Barremian.

**Paratype.** MPK 2146, slide CSC 1824/4. IGS borehole 77/80B, depth 78-95 m, northern North Sea, block 1/4, Barremian.

**Dimensions**

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<th>Holotype (μm)</th>
<th>Paratype (μm)</th>
<th>Range (μm)</th>
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</thead>
<tbody>
<tr>
<td>Pericyst diameter (excluding processes) length (archaeoepyle developed)</td>
<td>54</td>
<td>—</td>
<td>51(56)62</td>
</tr>
<tr>
<td>width</td>
<td>57</td>
<td>52</td>
<td>52(57)64</td>
</tr>
<tr>
<td>Process stem length</td>
<td>28-36</td>
<td>22-38</td>
<td>16-38 (av. max. 31)</td>
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**Number of specimens measured 15.**

**Description.** Wall: the pericyst wall is approximately 0.5 μm thick and is not obviously two-layered. The density of the intraperforation varies only slightly with the individual and the consequent spongy appearance is obvious under the light microscope (Pl. 50, figs. 10, 11); under the SEM the wall surface is smooth to very lightly pitted (Pl. 48, figs. 1-6). The parasites are immediately obvious under the light microscope but under the SEM are difficult (Pl. 48, figs. 1, 2), and sometimes impossible, to discern. Rarely do they take the form of low ridges (Pl. 48, fig. 4). This lack of paucity of surface expression suggests that the parasutural markings may be mainly features formed by a change in wall structure such as a marked decrease in wall intraperforation.

**Explanation of Plate 49**

Figs. 1-7. *Olgiaphoridium abaculum* sp. nov. All figures × 300. 1, ventral view of holotype. 2, view of posterior part of the parasilus. Note that processes have been detached from paraplates ps and lp. Slide CSC 1824/4, MPK 2160, phase contrast. 3, dorsal view of the holotype. 4, detached operculum; note centrally situated preapical paraplate. Slide CSC 1824/4, MPK 2161. 5, lateral view of specimen illustrating the shape of the circular paraplates. Slide CSC 1824/4, MPK 2162, phase contrast. 6, antapical view of paratype. 7, lateral view of specimen illustrating the spinose distal extremities of the processes. Slide CSC 1824/4, MPK 2163, interference contrast.
DAVEY. Cretaceous Dinocysts
Processes: the processes are smooth, without internal wall structure and the wall thickness is less than 0.5 \( \mu \text{m} \). Proximally, the bases of the processes typically have small to relatively large perforations (Pl. 48, figs. 2, 3). When these are well developed a definite weakness of the process wall is developed and the process easily becomes broken at this point (Pl. 48, fig. 5; Pl. 49, figs. 2, 5).

Paratabulation: the epicyst and hypocyst are of approximate equal size and are separated by a narrow paracingulum which on the ventral surface, is displaced by its own width (text-fig. 1A). The ends of the paracingulum do not overlap. The parasulcus is not sinusoidal but is rather displaced approximately half its width to the left at the paracingulum. The sulcal paraplates as, rs, ls, and ps are well defined; as is large and elongate, rs and ls are small and rectangular, and ps is relatively large and rectangular. The latter has a semi-circular boundary with paraplate 1'''. Paraplate ra lies above paraplates rs and ls and to the right of 1''; its boundary with cingular paraplate 6c is poorly defined. At the posterior end of paraplate as, abutting against paraplates 6c, ra and 1''', are two depressions which correspond to the thecal flagellar pores. The right depression is the smaller and more deeply indented.

A small ovoidal preapical paraplate (pr) occupies the centre of the apical series (text-fig. 2B). The apical paraplates 1' and 4' are essentially four-sided with 1' having an additional small side that abuts against paraplate as. Paraplates 2' and 3' are basically five-sided. The precingular paraplates are five-sided with 6'' being the smallest. The elongate cingular paraplates have arcuate long margins and are narrowest at the cingular paraplate boundaries and widest, particularly on the dorsal surface (text-fig. 1B), where the precingular parasutures abut against them. The postcingular paraplates are large and basically rectangular except for 1''' which is small, rectangular, and occurs beneath as and above 1p. The latter is five-sided. The
antapical paraplate (1′′′) is basically five-sided with paraplate ps indenting its ventral margin (text-fig. 2A).

Intraspecific variation: this is slight and involves details such as process length, width, and clarity of paratabulation. However, one rare distinctive variant exists in which the stems of the processes are very short or apparently absent (Pl. 50, figs. 1, 4). In the latter case, the stellate distal process terminations lie directly on the endocyst.

TEXT-FIG. 2. Drawing of Oligosphaeridium abaculum sp. nov. to illustrate the paratabulation and the position of the processes (process terminations omitted). a, antapical view of paratype, b, detached operculum (MPK 2161). Note small preapical paraplate occupying the centre of the apical series.

Remarks. The more or less clear paratabulation of O. abaculum sp. nov., which is defined by low ridges or, more usually, by internal wall structuring, differentiates this species from all previously described species. Davey, in press, erected a granular species of Oligosphaeridium, O. verrucosum, from the Aptian of the northern Bay of Biscay which sometimes possesses smooth parasutural areas. However, the granular nature of the periphragm and the form of the paratabulation differentiates O. verrucosum from O. abaculum. Evitt et al. (1977, p. 4) record that Wiggins and Engelhardt have found tabulate specimens of Oligosphaeridium in the Lower Cretaceous of Alaska; it may be that these are comparable to the present species.

GENUS SYSTEMATOPHORA Klement, 1960
Systematopora silyba sp. nov.
Plate 48, figs. 7, 8; Plate 50, figs. 2, 3, 5, 6, 7-9

Derivation of name. Latin, silyba, a kind of thistle— with reference to the spiny appearance of the cyst.

Diagnosis. Shape: the pericyst, excluding processes, is subspherical to ovoidal, the long axis being in the apical-antapical plane. Dorso-ventral flattening is minor.

Wall: the cyst wall is apparently two-layered, the two layers being closely appressed except where the periphragm alone forms the processes. The pericyst surface is rarely
smooth and is typically densely granular; the granules are concentrated in the para-
circular and pandasutural areas.

Processes: the processes are solid and smooth walled. Distally they terminate with
an irregular bifurcation; proximally they may divide several times before joining the
endocyst. Rarely neighbouring processes may be linked medially or distally. They
vary in width but are approximately of equal length—typically between one quarter
and one third the endocyst diameter. The processes are aligned along the paracingulum,
and in the pre- and postcircular and antapical regions tend to form annulate
complexes.

Archaeopyle: an apical archaeopyle (type A) always appears to be developed
although the operculum often remains attached. The archaeopyle has a strongly
zigzag margin with a moderately deep parasutal notch.

Holotype. MPK 2147, slide CSC 1824/3, IGS borehole 77/80B, depth 78-95 m, northern North Sea, block 1/4, Barremian.

Paratype. MPK 2148, slide CSC 1824/4, IGS borehole 77/80B, depth 78-95 m, northern North Sea, block 1/4, Barremian.

Dimensions

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<th>Holotype (μm)</th>
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<tbody>
<tr>
<td>Pericyst diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>length (complete)</td>
<td>36</td>
<td>36-38</td>
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</tr>
<tr>
<td>length (archaeopyle</td>
<td>33</td>
<td>30-32-36</td>
<td></td>
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<tr>
<td>developed)</td>
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<td></td>
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<tr>
<td>width</td>
<td>38</td>
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<td>29-34-38</td>
</tr>
<tr>
<td>Process length</td>
<td>8-14</td>
<td>7-10</td>
<td>7-14</td>
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<td></td>
<td>(av. max. 13)</td>
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</table>

Number of specimens measured 15.

Description. Wall: the pericyst wall is approximately 0.5 μm in thickness. Smooth
specimens are apparently present and although the majority of specimens are strongly
granular (Pls. 48, figs. 7, 8), the exact nature of the surface ornamentation is sometimes
difficult to discern under the light microscope. The granules, which measure less than
0.5 μm in diameter, vary somewhat in size and appear to be restricted to the portions
of the cyst surface outside the annulate complexes. This unusual distribution results

EXPLANATION OF PLATE 50

Figs. 1, 4, 10, 11. *Oligospaeridium abaculum* sp. nov. 1, ventral view to specimen with very faint parasutures and reduced process stets, ×2000 (SEM). 4, dorsal view of similar aberrant specimen with more clearly defined paracingulum, ×1500 (SEM). 10, 11, Slide CSC 1824/1, MPK 2164, Ventral views of specimen to illustrate wall texture and structure, ×100 (interference contrast); 11, ×800 (phase contrast).

Figs. 2, 3, 5, 6, 7-9. *Systematophora silyba* sp. nov. 2, dorsal view of holotype illustrating pre- and postcircular annulate complexes and aligned circular processes, ×640. 3, ventral view, Slide CSC 1824/4, MPK 2165, ×640. 5, medial view of paratype, ×640. 6, dorsal view of paratype, ×640. 7, detail of cyst surface to illustrate smooth processes and granular surface peripharynx, ×5000 (SEM). 8, lateral view of a particular granular specimen; operculum partially attached. Slide CSC 1824/4, MPK 2166, ×640. 9, lateral view of specimen illustrating process alignment and archaeopyle development. Slide CSC 1824/1, MPK 2167, ×640.
because the smooth walled processes tend to branch proximally to give root-like extensions over the cyst surface within the annulate complexes (Pl. 48, figs. 7, 8). A less well defined, non-annulate area sometimes surrounds the complexes and similarly results from the proximal branching of the processes. The processes vary in width from under 0.5 μm to 2 μm, are mainly either bifid distally or are broadly but irregularly capitulate.

Process distribution: the epicyst and hypocyst are of approximately equal size and are separated by a single alignment of processes that mark the position of the paracingulum. They are here distributed in pairs and triplets, each linear group being indicative of a single cingular paraplate. Annulate complexes occupy the pre- and postcingular and antapical regions and each indicates a single paraplate. There appear to be six precingular, five postcingular, and one antapical complex. Obvious annulate complexes or process alignments are absent in the apical and parasutal regions.

Remarks. The combination of apical archaeoepyle and annulate process complexes clearly indicate that S. silybu sp. nov. belongs to the genus Systematophora. The simple form of the processes, however, differentiates this species from most other members of the genus, which bear complexly branching and anastomosing processes. S. areolata Klement 1960, from the Upper Jurassic, is the most similar species but differs significantly in having fewer processes which are more orderly arranged; in particular, the annulate complexes are very obvious.

The specimen illustrated by Duxbury 1977 (pl. 11, fig. 3) as Cleistospheeridium polytype (Cookson and Eisenack 1962), from the Hauterivian and Barremian of north-east England, is similar to S. silybu and may be conspecific.

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REFERENCES


DAVEY: CRETACEOUS DINOCYSTS


R. J. DAVEY
Robertson Research International Ltd.
'Ty'n-y-Coed'
Llanrhos
Llandudno LL30 1SA
Gwynedd
Wales

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