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RESTUDY OF SOME LARGER DINOFLAGELLATE CYSTS AND AN ACRITARCH FROM THE UPPER CRETACEOUS OF BELGIUM AND GERMANY [1]

by

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(12 figures and 6 Plates)

RESUME.- Cette publication rend compte d'une révision des matériaux typiques de 13 espèces de kystes de dinoflagellés et d'une espèce d'acritarche des silex du Crétacé Supérieur de Belgique et d'Allemagne. Les combinaisons nouvelles *Amphorosphaeridium major* (Lejeune-Carpentier), *Hystrichokolpoma? crassipes* (Reade) et *Deflandrea damasi* (Lejeune-Carpentier) sont proposées. La sous-espèce décrite antérieurement comme *Exochosphaeridium spinosum* var. *deflandrei* est élevée au rang d'espèce sous l'appellation *Fibrocysta? deflandrei* (Lejeune-Carpentier). L'ancienne espèce *Hystrichosphaeridium cruciatum* doit être considérée comme un acritarche : la combinaison nouvelle *Veryhachium? cruciatum* (O. Wetzel) est proposée. Une remise à jour des diagnoses imposait de nombreuses modifications et précisions pour ces 5 espèces ainsi que pour les suivantes : *Gonyaulacysta wetzeli* (Lejeune-Carpentier), *Gonyaulacysta? obscura* (Lejeune-Carpentier) *Criboperidinium ventriosum* (O. Wetzel), *Leptodinium porosum* (Lejeune-Carpentier), *Deflandrea galeata* (Lejeune-Carpentier) et *Lejeunecysta tricuspis* (O. Wetzel). La liste synonymique complète est établie pour *Oligosphaeridium complex* (White) et *Areoligera senonensis* Lejeune-Carpentier, deux espèces dont la distribution stratigraphique et géographique est discutée. Sont également envisagés les problèmes de taxinomie posés par *Palaeoperidinium subconicoides*. Toutes les espèces citées ont été photographiées et leurs photos, reproduites ici, le sont en général pour la première fois. Des dessins dans le texte illustrent les nouvelles interprétations ; ils ont été pour la plupart exécutés sur les dessins originaux du premier auteur.

ABSTRACT.- An account is presented of a restudy of type material of 13 species of dinoflagellate cysts and one species of acritarch from Upper Cretaceous flints of Belgium and Germany. The new combinations *Amphorosphaeridium major* (Lejeune-Carpentier), *Hystrichokolpoma? crassipes* (Reade) and *Deflandrea damasii* (Lejeune-Carpentier) are proposed. The former *Exochosphaeridium spinosum* var. *deflandrei* is elevated to specific status, as *Fibrocysta? deflandrei* (Lejeune-Carpentier). The former *Hystrichosphaeridium cruciatum* is shown to be an acritarch ; the new combination *Veryhachium? cruciatum* (O. Wetzel) is proposed. Emended diagnoses are presented for these five species and for the following : *Gonyaulacysta wetzeli* (Lejeune-Carpentier), *Gonyaulacysta? obscura* (Lejeune-Carpentier), *Cribroperidinium ventriosum* (O. Wetzel), *Leptodinium porosum* (Lejeune-Carpentier), *Deflandrea galeata* (Lejeune-Carpentier) and *Lejeunecysta tricuspis* (O. Wetzel). Full synonymies are presented for the species *Oligosphaeridium complex* (White) and *Areoligera senonensis* Lejeune-Carpentier ; their stratigraphical and geographical distribution is discussed. The taxonomic problems presented by *Palaeoperidinium? subconicoides* are considered. Photographs of all species are presented, in most cases for the first time ; and interpretative drawings, most of them redrawn versions of the first author's original figures, supplement the text.

Around 1836, the great German microscopist Christian Gottfried Ehrenberg first observed microfossils enclosed within the translucent to transparent interiors of flakes of chert and flint. Among these were structures of two principal types. One group he immediately recognised as dinoflagellates ; though, as we now know, these were not fossilized motile forms, as Ehrenberg thought, but cysts. The others were spiny bodies which he misinterpreted as being zygospores of desmids and placed into the living genus *Xhanthidium* ; these also, as we now know, largely comprise

1 *Quatorzième note de la série "L'étude microscopique des silex". Manuscrit déposé le 30 novembre 1980.*

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dinoflagellate cysts, though a few remain of problematical affinity and are presently called "acritarchs".

The examination of these fossils enclosed in flakes of silica has continued from that time to this. The study flourished briefly in the mid-19th century and then faded, to be reactivated and brought to a fuller fruition in this century by four microscopists in particular ; Walter and Otto Wetzel, Georges Deflandre and the first author. Since that time the use of chemical techniques to extract the microfossils from enclosing sediments, initiated by Alfred Eisenack and others, has largely supplanted their examination *in situ* in silica ; but the latter method is still intermittently employed, e.g. by Foucher (1971, 1974). Moreover, some microfossils observed in flints (e.g. *Raphidodinium fucatum* Deflandre, 1936) have not yet been reported from chemically concentrated assemblages and may actually be destroyed by the reactions involved in the production of such concentrates.

Between 1937 and 1951, the first author reported the results of her researches, first, on the classic type material of Ehrenberg and later, on new material from the Chalk flints of Belgium and Germany, in papers mostly presented to the Société Géologique de Belgique and published in its **Bulletins** as a series of numbered notes under the collective title "L'étude microscopique des silex". Since that time, the morphological approach to the description of dinoflagellates has changed ; a redescription of the species recorded and illustrated in those notes has thus become necessary. This was undertaken jointly by the writers during a visit to Liège by the second author in November, 1979 (1). The results will be presented in two papers, of which this is the first.

To facilitate comparison with the earlier notes, the original drawings are here presented in modified form wherever necessary, and surfaces not originally illustrated are figured using the same conventions of lettering and shading. Other than the recognition of the archaeopyle in several specimens, it will be seen that the new observations are essentially confined to details not perceptible under the microscope initially used. In view of the vast advances in microscopic equipment that have taken place in the last thirty years, the original observations are shown to be of remarkable accuracy.

Class Dinophyceae Pascher
Order Peridiniales Schütt
Suborder Gonyaulacystineae Norris, 1978
Family GONYAULACYSTACEAE Sarjeant and Downie, 1966, *emend.* Sarjeant and Downie, 1974.

Note :

Because of difficulties encountered in employing the classification of acavate to bicavate cysts with a single-plate precingular archaeopyle proposed by Stover and Evitt (1978), the genus *Gonyaulacysta* is used in the wider sense in which it was employed before their studies and the generic name *Millioudodinium* is not utilised. A full study of this taxonomic problem is in preparation by the second author.

Genus *Gonyaulacysta* Deflandre, 1964, ex Norris and Sarjeant, 1965, emend. Sarjeant, *in* Davey *et al.*, 1969

Gonyaulacysta wetzeli (Lejeune-Carpentier, 1939) Sarjeant *in* Davey *et al.*, 1969, *emend.*

Plate 1 : 1-2 ; Plate 5 : 5-6 ; Text-fig. 1

1939 *Gonyaulax wetzeli* Lejeune-Carpentier, p. B526-B529, figs. 1-2.

1946 *G. wetzeli* Lej.-Carp., *emend.* Lejeune-Carpentier, p. B189-190, fig. 1.

?1952 *G. wetzeli* Lej.-Carp. W. Wetzel, p. 408, fig. 28.

1955 *G. wetzeli* Lej.-Carp. Deflandre and Cookson, p. 255, pl. 1. fig. 3.

1964 *G. wetzeli* Lej.-Carp. Eisenack and Klement, p. 413-414.

1964 *G. wetzeli* Lej.-Carp. Downie and Sarjeant, p. 116.

1966 *Gonyaulacysta wetzeli* (Lej.-Carp.) Sarjeant, p. 131, *nomen nudum.*

1967a *G. wetzeli* (Lej.- Carp.) Sarjeant, tab. II p. 328), *nomen nudum.*

1969 *G. wetzeli* (Lej.-Carp.) Sarjeant *in* Davey *et al.*, p. 11.

1973 *G. wetzeli* (Lej.-Carp.) Lentin and Williams, p. 64.

(1) Mme Lejeune-Carpentier apprécie infiniment la bienveillance du Prof. W.A.S. Sarjeant qui a pratiquement assumé tout le travail publié ici et a néanmoins voulu la placer comme premier auteur. Elle tient aussi à rendre hommage à cet éminent spécialiste dont elle a pu admirer l'immense talent, la rare érudition et l'extrême affabilité.

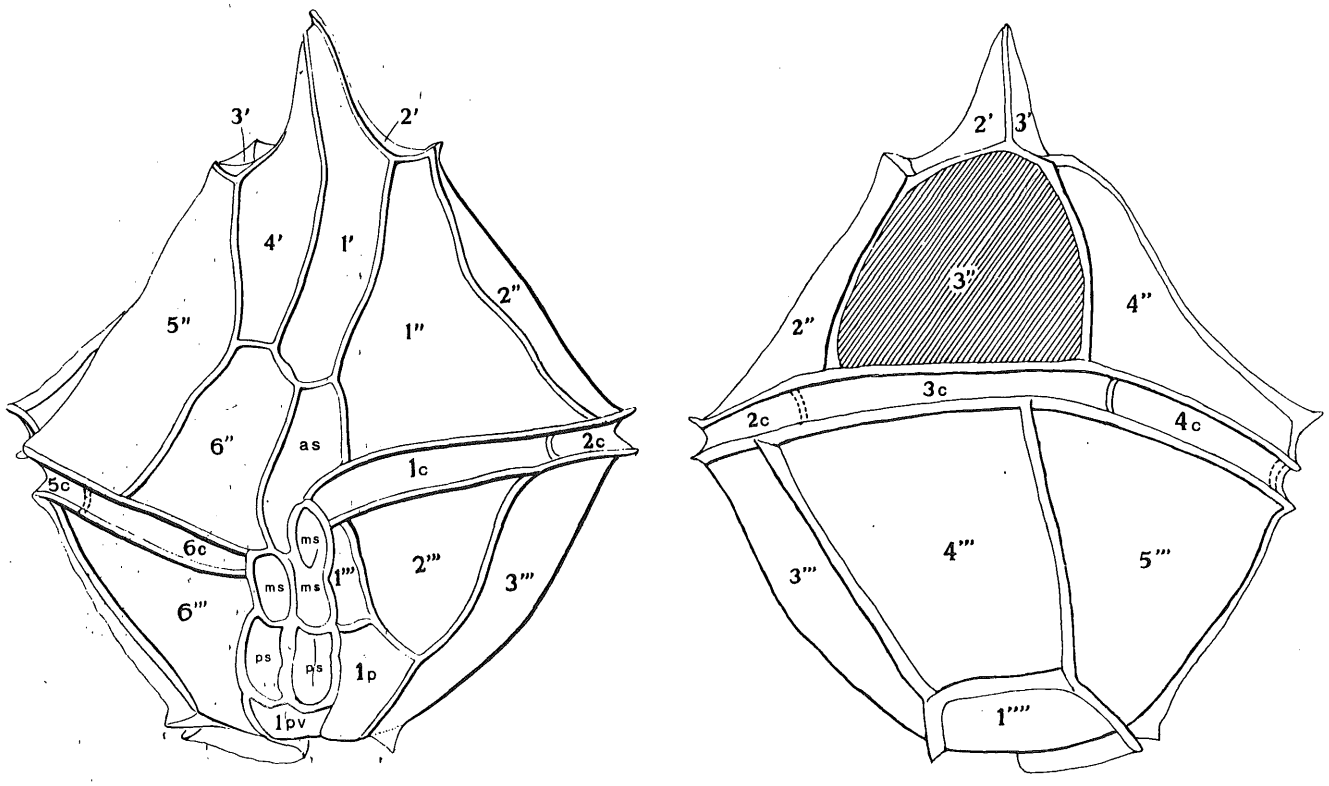

Figure 1. - Gonyaulacysta wetzeli *(Lejeune-Carpentier, 1939), emend. The paratype ; left, in ventral view and right, in dorsal view. The position of the archaeopyle is shaded.*

1975 *G. wetzeli* (Lej.-Carp.) Harker and Sarjeant, chart 8.

1977 *G. wetzelii* (Lej.-Carp.) Lentin and Williams, p. 70.

1978 *"G". wetzelii* (Lej.-Carp.) Stover and Evitt, p. 159.

Emended Diagnosis

Cyst rounded-polyhedral ; length slightly greater than breadth. The flanks of the epitract, as seen in ambital view, are flat to slightly concave ; those of the hypotract are convex. Apex surmounted by a strong apical horn of moderate length. Boundaries of paraplates, cingulum and sulcus are marked by raised crests of moderate height and simple, unornamented structure. Tabulation 4', 0a, 6", 6c, 6''', 1 p, 1pv, 1'''', 6s. Phragma finely and irregularly punctate, the punctations sometimes forming irregular lines. Cingulum deeply hollowed and markedly laevorotatory ; sulcus short, broad and divided into small paraplates, exhibiting clear flagellar marks. Paraplate 3" is lost in archaepyle formation.

Holotype

Specimen 495 (ex : O. Wetzel Collection) ; lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium and figured by Lejeune-Carpentier, 1939, figs. 1-2, and herein, Plate 5 : 5-6.

Paratype

Specimen 335 (ex : O. Wetzel Collection), same lodgement : figured by Lejeune-Carpentier, 1946, fig. 1 and herein, Plate 1 : 1-2 and Text-fig. 1.

Description and Dimensions

See Lejeune-Carpentier (1939, pp. B526-B529, and 1946, pp. B189-B190) for details.

Type Horizon and Locality

Upper Cretaceous flints in glacial drift, Eutin, Germany (FRG).

Remarks

The diagnosis is emended to clarify the cingular

paratabulation and to indicate the nature of the archaeopyle. The apical horn of the holotype is present but distorted (see Pl. 5 : 5-6), causing problems in its interpretation. The new observations are thus based essentially on the paratype, which is better preserved and presented. However, the same features (and, in particular, the same type of archaeopyle) are developed on both. It should be noted that the absence of paraplate 3" was recognised from the outset (see Lejeune-Carpentier, 1946, p. B189) but the significance of this observation was not originally appreciated.

Gonyaulacysta? obscura (Lejeune-Carpentier, 1946) Sarjeant *in* Davey *et al.*, 1969, *emend.*

Plate 2 : 3-5 ; Text. fig. 2

1936a *Palaeoperidinium ventriosum* (O. Wetzel). Deflandre, p. 58, fig. 100.

1936b *P. ventriosum* (O. Wetzel). Deflandre, p. 175-176, pl. 5 : 1-4.

1946 *Gonyaulax obscura* Lejeune-Carpentier, p. B191-192, figs 3-5.

1964 *G. obscura* Lej.-Carp. Downie and Sarjeant, p. 115.

1964 *G. obscura* Lej.-Carp. Eisenack and Klement, p. 387-388.

1966 *Gonyaulacysta obscura* (Lej.-Carp.) Sarjeant, p. 131, *nomen nudum.*

1967a *G. obscura* (Lej.-Carp.) Sarjeant, tab. I (p. 327), *nomen nudum.*

1969 *G. obscura* (Lej.-Carp.) Sarjeant *in* Davey *et al.*, p. 10.

1973 *G. obscura* (Lej.-Carp.) Lentin and Williams, p. 63.

1975 *G. obscura* (Lej.-Carp.) Harker and Sarjeant, chart 8.

1977 *G. obscura* (Lej.-Carp.) Lentin and Williams, p. 68.

1978 *G.? obscura* (Lej.-Carp.) Stover and Evitt, p. 158.

Emended Diagnosis

Cyst rounded-polyhedral, somewhat compressed dorsoventrally, with length markedly greater than breadth. Apical horn strong and acute, of moderate length. Epitract somewhat larger and more angular in outline than hypotract ; phragma thick and coarsely granular or punctate to reticulate. Strongly developed crests of moderate height, similarly ornamented, outline the paratabulation 4', 0a, 6-?7", ?7c, 6"', 1p, 1"". Cingulum broad, shallow, strongly laevorotatory, and subdivided by low crests into paraplates ; it exhibits the same ornamentation as the bulk of the cyst surface. Sulcus somewhat sigmoidal, relatively narrow, lacking obvious divisions and partially or entirely lacking ornamentation. A small paraplate of roughly the shape of a right-angled triangle abuts against paraplate 6" and the cingulum ; it may be regarded either as a sulcal paraplate or as a possible seventh precingular.

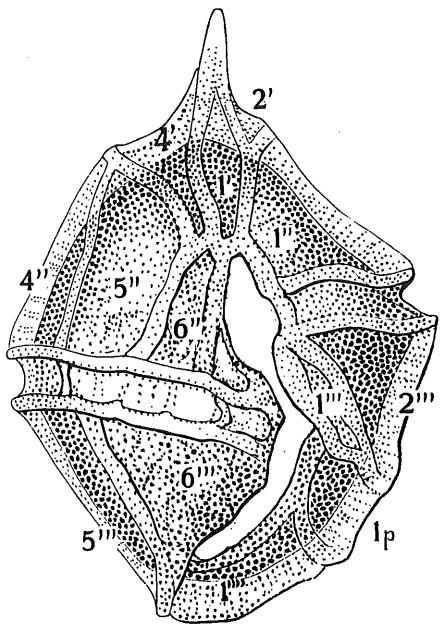

Figure 2.
Gonyaulacysta? obscura *(Lejeune-Carpentier, 1946), emend. The paratype, in slightly oblique ventral view.*

Holotype

Specimen CXII-420, lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by Lejeune-Carpentier, 1946, figs. 3-4 and herein, plate 2 : 3-4, text-fig. 2.

Paratype

Specimen CXV-2 ; same lodgement ; figured by Lejeune-Carpentier, 1946, fig. 5 and herein, plate 2 : 5.

Type Horizon and Locality

Flints from Craie de Spiennes (Upper Cretaceous), quarry of Mortiau, Cuesmes, Belgium.

Description and Dimensions

See Lejeune-Carpentier (1946, p. B191-B192) for details.

Remarks

This species is distinguished by its thick phragma and dense ornament, which serve to obscure from casual view the crests, prominent though they in fact are. Its diagnosis is emended to include reference to the number of apical paraplates, the division into paraplates of the cingulum and the peculiar small "seventh precingular" paraplate. The holotype lacks all indication of an archaeopyle : and, though a precingular single-plate archaepyle, formed apparently by loss of paraplate 3", appears to be present in the paratype, the orientation of this specimen and its depth of burial in the flint preclude any certainty of recognition. For this reason, the generic assignation of this species must remain a matter for question.

Genus *Cribroperidinium* Neale and Sarjeant, 1962, *emend.* Davey, 1969

Note

The "Modified description" of Stover and Evitt (1968, p. 149) is not here considered to constitute, by intent or in practice, an emendation of the generic diagnosis.

Cribroperidinium ventriosum (O. Wetzel, 1933) Sarjeant, 1967b, *emend.*

Plate 1 : 3-4 ; Text-fig. 3

1933 *Peridinium ventriosum* O. Wetzel, p. 180, pl. 2 : 4-6, text-fig. 8.

1935 *Palaeoperidinium ventriosum* (O. We.) Deflandre, p. 228, pl. 5 : 5 ; Pl. 6 : 9-10.

1936a *P. ventriosum* (O. We.) Deflandre, p. 57, fig. 100.

1936b *P. ventriosum* (O. We.) Deflandre, p. 175-176, Pl. 5 : 4.

1940 *P. ventriosum* (O. We.) O. Wetzel, p. 135, pl. 4 : 4.

1946 *P. ventriosum* (O. We.) Lejeune-Carpentier, p. B190-B191, fig. 2.

1964 *P. ventriosum* (O. We.) Downie and Sarjeant, p. 115.

1964 *P. ventriosum* (O. We.) Eisenack and Klement, p. 681-682.

1967a *Cribroperidinium? ventriosum* (O. We.) Sarjeant, tab. I (p. 327), *nomen nudum.*

1967b *C. ventriosum* (O. We.) Sarjeant, p. 256-257.

1973 *C. ventriosum* (O. We.) Lentin and Williams, p. 35.

1975 *C. ventriosum* (O. We.) Harker and Sarjeant, chart 8.

1977 *C. ventriosum* (O. We.) Lentin and Williams, p. 35.

1978 *C. ventriosum* (O. We.) Stover and Evitt, p. 150.

Emended Diagnosis

Cyst rounded-pentagonal, almost as broad as long, with a short but strong, truncate apical horn. Epitract and hypotract of almost equal size ; epitract (as seen in lateral view) in the form of a truncated cone, hypotract more rounded. Low but well-marked crests, unornamented but distally irregular in form, outline the following paratabulation : 2pr, 4', 0a, 6", 7c, 6"', 1p, 2-?3"". Cingulum narrow, relatively weakly laevorotatory, divided by low ridges into paraplates ; sulcus narrow, without or only with weakly defined divisions. Surface of phragma irregularly granulate or punctate ; the precingular and postcingular paraplates are typically subdivided by accessory crests, which may constitute a penitabular simulation of the enclosing paraplate's shape or may be mere isolated ridges. Archaeopyle precingular, formed by loss of paraplate 3".

Holotype

Specimen 680 (ex : O. Wetzel Collection) ; lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium. Figured by O. Wetzel (1933, pl. 2 : 4), Lejeune-Carpentier (1946, fig. 2) and herein, pl. 1 : 3-4, text-fig. 3.

Other Specimens

Specimens 113 and 646, O. Wetzel Collection, Geologisches Institut der Universität, Kiel, Germany : and Ehrenberg Collection, flint XXVI n° 131, Alexander von Humboldt Universität, Berlin, Germany (DDR).

Type Horizon and Locality

Upper Cretaceous flints in glacial drift, Eutin, Germany (FRG).

Description

The apical horn is broad based, narrows abruptly

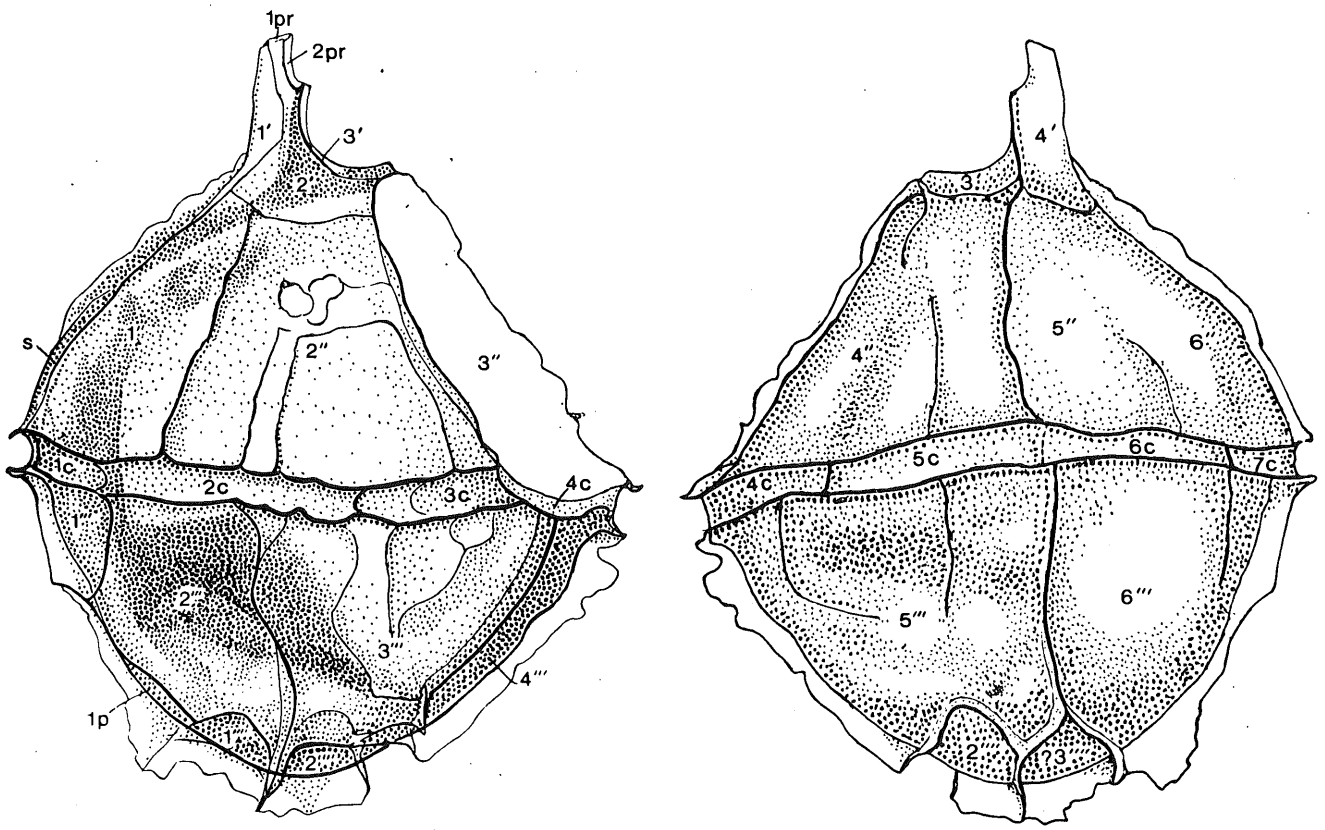

Figure 3.- Cribroperidinium ventriosum *(O. Wetzel, 1933), emend. The holotype ; left, in left lateral view and right, in right lateral view.*

at about two-thirds length and is blunt-tipped. The flattened tip is occupied by preapical paraplate 1pr, the incurved dorsal portion of the horn by preapical paraplate 2pr, which separates paraplate 3' from the horn tip. Paraplate 1' is elongate, occupying the ventral face of the horn and the anterior prolongation of the sulcus : the two lateral flanks of apex and horn are occupied by paraplates 2' and 4'.

Six large precingular paraplates are developed ; the boundary between 5" and 6" is, however, incompletely marked in the holotype. Paraplate 3", largest of the precingulars, is lost in archaeopyle formation.

The cingulum is narrow and weakly laevorotatory, its two ends differing in anteroposterior position by its width or less. The first and seventh cingular paraplates are smaller than the others, which are of relatively constant size and shape.

Postcingular paraplate 1''' is small and divided from the antapex by a somewhat larger posterior intercalary paraplate. The other paraplates of the postcingular series are all quite large. Both pre- and postcingular paraplates are in varying degree subdivided by accessory ridges, giving the impression of "plates within plates" so characteristic of this genus.

Davey, in his revision of *Cribroperidinium* (1969) specified "0'''' (-?2'''')" at the antapex ; Stover and Evitt (1978) however considered a single antapical paraplate to be developed. We must concur with Davey's judgement or differ from that of Stover and Evitt, for at least two, possibly three, small antapical paraplates are present in this species.

Dimensions

See Lejeune-Carpentier (1946, p. B191).

Remarks

Re-examination of the type material demonstrates that the earlier reassignment of this species to *Cribroperidinium* by one of us (Sarjeant, 1967b) was indeed correct. The diagnosis is emended to include a full

specification of the paratabulation and statement of the style of archaeopyle ; noteworthy is the presence of two preapical paraplates, a feature several times noted in species of *Gonyaulacysta* but not hitherto recognised in *Cribroperidinium*.

Genus *Leptodinium* Klement, 1960, *emend.* Stover and Evitt, 1978

Leptodinium porosum (Lejeune-Carpentier, 1946), Sarjeant *in* Davey *et al.*, 1969, *emend.*

Plate 3 : 1-2. Text-fig. 4.

1946 *Gonyaulax porosa* Lejeune-Carpentier, p. B193, B196, fig. 6.

1964 *G. porosa* Lej.-Carp. Downie and Sarjeant, p. 115.

1964 *G. porosa* Lej.-Carp. Eisenack and Klement, p. 399-400.

1966 *?Gonyaulacysta porosa* (Lej.-Carp.) Sarjeant, p. 132, *nomen nudum.*

1967a *G. porosa* (Lej.-Carp.) Sarjeant tab. I, *nomen nudum.*

1969 *Leptodinium porosum* (Lej.-Carp.) Sarjeant *in* Davey *et al.*, p. 13.

1973 *L. porosum* (Lej.-Carp.) Lentin and Williams, p. 88.

1977 *L. porosum* (Lej.-Carp.) Lentin and Williams, p. 99.

1978 *"L". porosum* (Lej.-Carp.) Stover and Evitt, p. 171.

Emended diagnosis

Cyst spheroidal to slightly subpolygonal in shape, without horns. Epitract and hypotract are of almost equal size and similar shape. Strong, short crests, striate or perforate and with undulose distal margins, demarcate the paraplates, those bounding the cingulum being especially prominent (though the cingulum itself is not much inset). Ventral region slightly sunken and sulcus narrow, especially in its hypotractal portion where it may be obscured from view by convergence of the crests on its boundaries. Paratabulation 4', 6", ?6c, 6"', 1p, 1"", ?s: paraplate 1"' small and elongate, it and the much larger paraplate 2"' being separated from the antapex by the large, subpentagonal posterior intercalary paraplate. Apical paraplate 4' is somewhat less long, and much broader, than the adjacent 1'. Phragma ornamented generally by large pustules and a finer granulation or punctation ; only the latter orna-

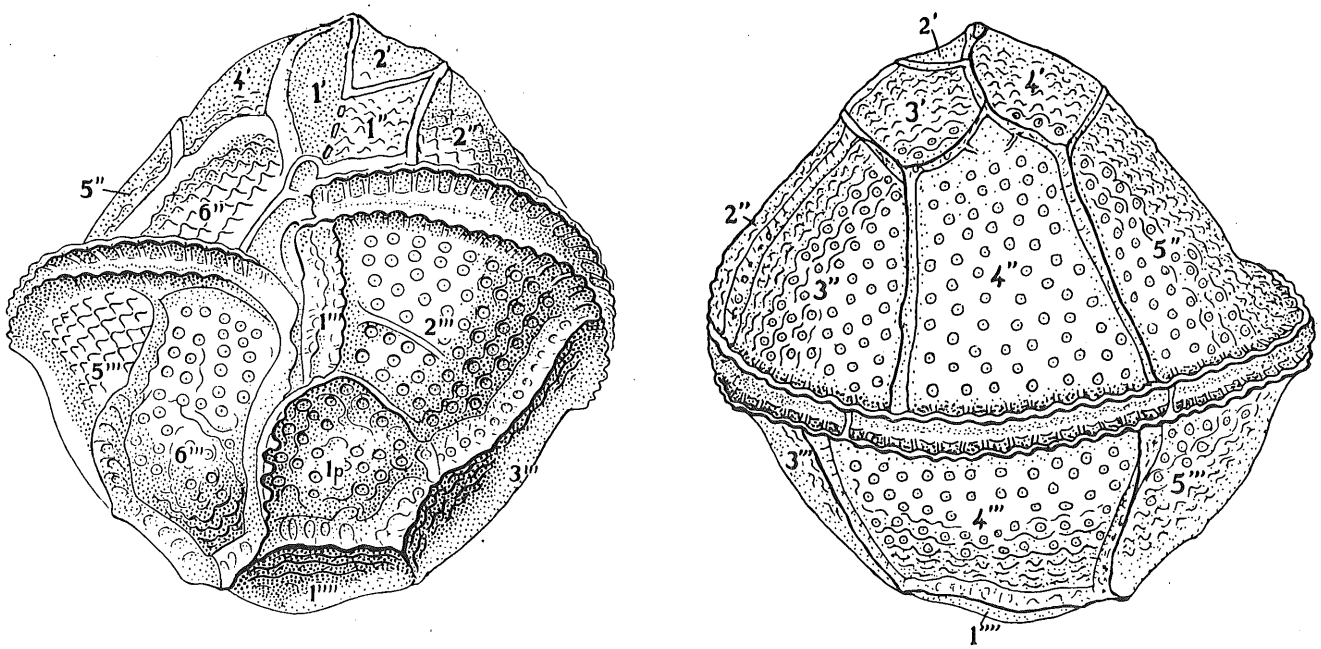

Figure 4.- Leptodinium porosum *(Lejeune-Carpentier, 1946), emend. The holotype : left, in slightly tilted ventral view and right, in slightly tilted dorsal view.*

ment, however, is developed on the surfaces of cingulum and sulcus.

Holotype

Specimen XIX-85, collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by Lejeune-Carpentier (1946, fig. 6) and herein, pl. 3 : 1-2, text-fig. 4.

Type Horizon and Locality

Flint filling the cavity of an echinoid test (*Echinocorys*), Upper Cretaceous (Upper Senonian), Hallembaye, Belgium (= Formatie van Gulpen, of Felder, 1975).

Description

Though the crests on this unique and distinctive specimen are quite prominent, they are masked by the undulose lines formed by adjacent pustules seen in profile. The posterior portion of the sulcus is masked also, by converging crests ; its central and wider portion, somewhat sunken, shows flagellar marks and may be subdivided into small sulcal paraplatelets. The sulcus scarcely extends onto the epitract, its anterior prolongation being occupied by the large apical paraplate 1'. The four apicals converge at the exact apex. Paraplates 2' and 3' are polygonal and of comparable size and shape, 4' somewhat larger, precingular paraplate 6" being concomitantly reduced. Paraplate 1" is also small and almost quadrate, its boundary with the sulcus poorly defined. The four remaining precingulars are all much larger. A small intercalary paraplate appears to be present at the junction of paraplates 3', 4', and 4", but its presence cannot be affirmed with complete confidence.

Paraplate 1"' occupies a narrow strip bulging out a little into the sulcus ; 2"' is much larger and of quadrate shape. 6"' is larger than either of these paraplates but somewhat smaller than the three other postcingulars. The posterior intercalary paraplate (1p) is unusually large, the antapical (1"") almost exactly hexagonal and of moderate size.

Dimensions

Holotype : length (in oblique view) 65 μm, maximum breadth 67 μm.

Remarks

The single specimen for which this species was erected remains the only one yet reported. It shows no indication of an archaeopyle and, in view of the pores penetrating the pustules in the wall, resembles living motile dinoflagellates so markedly that the possibility of its being a freak inclusion into flint of a motile form cannot be excluded. However, in all other instances, the dinoflagellates preserved in flints can be shown to be cysts and, if for no better reason, we consider it most likely that this also is a cyst. Since, in all features save the absence of an archaeopyle, this species accords with the generic diagnosis of *Leptodinium*, it is assigned to that genus with fair confidence. However, the discovery of future specimens must be awaited before the nature of this species can be finally decided.

The specific diagnosis is emended to include reference to the apical paraplates and to specify more exactly the shape of the ventral hypotractal paraplates.

Suborder Hystrichosphaeridiineae Norris, 1978

Family HYSTRICHOSPHAERIDIACEAE Evitt, 1963, *emend.* Sarjeant and Downie, 1974

Genus *Oligosphaeridium* Davey and Williams, 1966

Oligosphaeridium complex (White, 1842) Davey and Williams, 1966

Plate 4 : 1--2 ; Text-fig. 5

1842 *Xanthidium tubiferum complex* White, p. 39, pl. 4 div. 3 : 11.

1844 *X. tubiferum complex* White, p. 83, pl. 8 : 10, 2 unnum. text-figs.

1848 *Xanthidium complexum* (White). Bronn, p. 1375.

1860 Sporangium of Desmidiacea. Griffith and Henfrey, pl. 19 : 25.

1940 *Hystrichosphaeridium elegantulum* Lejeune-Carpentier, p. B222, figs. 11-12.

1946 *Hystrichosphaeridium complex* (White). Deflandre, p. 111.

1952 *H. complex* (White). Firtion, p. 156, pl. 9 : 2, 4, 5; text-figs. 1A-F.

?1952 *Hystrichosphaeridium* cf. *elegantulum* Lejeune-Carpentier. W. Wetzel, p. 399, fig. 12.

?1953 *Hystrichosphaeridium* cf. *tubiferum* (Ehrenberg). Cookson, pl. 2 : 24.

1955 *Hystrichosphaeridium complex* (White). Deflandre and Cookson, p. 270, pl. 1 : 9-10.

?1955 *H.* cf. *complex* (White). W. Wetzel, p. 38, fig. 12.

?1958 *H. complex* (White). Cookson and Eisenack, p. 42, pl. 12 : 10.

1958 *H. complex* (White). Eisenack, p. 400, pl. 26 : 3-5, 16 ?

1959 *H. complex* (White). Gocht, p. 66, pl. 3 : 2-3, pl. 7 : 5-6.

1961 *H. complex* (White). Cookson and Eisenack, p. 73.

?1962 *Hystrichosphaeridium tubiferum* (Ehrenberg). Pocock, p. 83, pl. 15 : 230.

1962 *Hystrichosphaeridium complex* (White). Vachey and Jardiné, p. 103.

?1963 *Hystrichosphaeridium tubiferum* (Ehrenberg). Balteş, p. 586, pl. 2 : 1-3, 5-6.

1964 *Hystrichosphaeridium complex* (White). Cookson and Hughes, p. 46-47, pl. 9 : 6.

1964 *H. complex* (White). Vavrdova, p. 93.

1964 *H. complex* (White). Serpagli, p. 99-100, pl. 18 : 8.

?1964 *H. complex* (White). Varma and Dangwal, pl. 2 : 2-3.

1964 *H. complex* (White). Downie and Sarjeant, p. 120.

1965 *H. complex* (White). Balteş, p. 14, figs. 109-111.

1966 *Oligosphaeridium complex* (White). Davey and Williams, p. 71-74, pl. 7 : 1-2, pl. 10 : 3, text-fig. 14.

1967 *Hystrichosphaeridium complex* (White). Drugg. p. 26, pl. 4 : 14.

1967 *H. complex* (White). Clarke and Verdier, p. 53-54, pl. 11 : 10-11.

1967a *H. complex* (White). Millioud, p. 68.

1967b *H. complex* (White). Millioud, fig. 2.

1967a *Oligosphaeridium complex* (White). Sarjeant, tab. 6 (p. 332).

1969 *O. complex* (White). Davey, p. 146-147, pl. 5 : 6-7.

1969 *O. complex* (White). Millioud, p. 431.

1970 *Hystrichosphaeridium complex* (White). Deflandre and Cookson, p. 28, pl. 1 : 9-10.

?1970 *Oligosphaeridium cephalum* Sah, Kar and Singh, p. 147, pl. 2 : 22-23, pl. 4 : 5-7.

1970 *Oligosphaeridium complex* (White). Verdier, p. 10.

1971 *O. complex* (White). Davey and Verdier, p. 26.

1971a *O. complex* (White). Foucher, p. 7, pl. 2 : 7.

1971b *O. complex* (White). Foucher, p. 102, pl. 8 : 8-10.

1971 *O. complex* (White). Singh, p. 333-334, pl. 53 : 4-6, text-fig. 54, tab. 3.

1972 *O. complex* (White). Corradini, p. 140-141, pl. 20 : 4-5.

1973 *O. complex* (White). Lentin and Williams, p. 79.

1973 *O. complex* (White). Kjellström, p. 37-38, fig. 30.

1974 *O. complex* (White). Foucher, p. 27.

1974 *O. complex* (White). Gruas-Cavagnetto, p. 87.

1975 *O. complex* (White). Foucher, p. 15, pl. 4 : 8-11.

1975 *O. complex* (White). Playford, Haig and Dettmann, p. 354.

1975 *O. complex* (White). Verdier, fig. 45.

1975 *O. complex* (White). Williams and Brideaux, pl. 19 : 9, pl. 21 : 2.

1975 *O. complex* (White). Brideaux and McIntyre, p. 28, pl. 8 : 2.

1975 *O. complex* (White). Jain and Millepied, p. 134, 143, 163.

1975 *O. complex* (White). Harker and Sarjeant, charts 5, 12, 22.

1976 *O. complex* (White). Gruas-Cavagnetto, p. 45.

1976 *O. complex* (White). Brideaux and Myhr, fig. 43.3.

1976 *O. complex* (White). Wilson, p. 128.

1977 *O. complex* (White). Foucher and Robaszynski, p. 9.

1977 *O. complex* (White). Lentin and Williams, p. 113.

?1977 *O.* aff. *complex* (White). Boltenhagen, p. 45-46, pl. 4 : 7.

1978 *O. complex* (White). Davey, p. 892, pl. 5 : 13, fig. 3.

? *O.* cf. *complex* (White). Davey, p. 892, pl. 5 : 10.

1978 *O. complex* (White). Habib, fig. 3.

1979 *O. complex* (White). Fauconnier, p. 18.

1979 *O. complex* (White). Barss, Bujak and Williams, p. 29, 39, 76.

1979 *O. complex* (White). Davey, fig. 1.

1980 *O. complex* (White). Burger, p. 78, pl. 30 : 1-3.

? *O.* cf. *complex* (White). Burger, pl. 30 : 2.

1980 *O. complex* (White). May, p. 59-60, pl. 7 : 1-3, charts I-II.

1980 *O. complex* (White). Antonescu and Avram, pl. 12 : 1, 3; tab. 2.

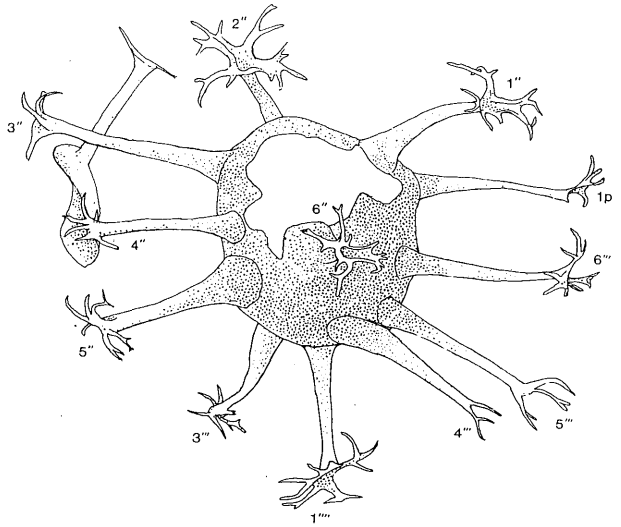

Figure 5.
Oligosphaeridium complex *(White). Specimen CVIII-4 (formerly the holotype of* Hystrichosphaeridium elegantulum *Lejeune-Carpentier) ; in oblique apical view. (The detached archaeopyle, seen at upper left, does not belong to this specimen !).*

Remarks

Our restudy of the holotype of *Hystrichosphaeridium elegantulum* Lejeune-Carpentier, 1940, shows an apical archaeopyle to be developed and confirms the reassignation of this species to *Oligosphaeridium.* The branching of the process extremities is somewhat more elaborate than in the neotype, and other specimens, of *Oligosphaeridium complex* illustrated by Davey and Williams (1966). However, the differences are too slight to warrant the maintenance of a differentiation at species level ; and, indeed, the many other published illustrations of this species show it to be exceptionally variable in the detail of process tip morphology. The treatment of *elegantulum* as a junior synonym of *complex,* originally proposed by Deflandre (1946), is thus confirmed by our observations.

This species is one of the most widely distributed and frequently reported of fossil dinoflagellate cysts, having been observed not only in France, Belgium, Germany and Britain, but also in Switzerland (Millioud, 1967a and b), Italy (Serpagli, 1964), Czechoslovakia (Vavrdova, 1964), Roumania (Balteş, 1965), Sweden (Kjellström, 1973), offshore western Atlantic sediments (Habib, 1978 ; Barss *et al.,* 1979) and assemblages from Canada (Singh, 1971, and others), the United States (May, 1980), Senegal (Jain and Millepied, 1975), the Ivory Coast (Vachey and Jardiné, 1962), questionably from Gabon (Boltenhagen, 1977) and India (Varma and Dangwal, 1964 ; Sah *et al.,* 1970), and even from Australia (Playford *et al.,* 1975 and others) and the Chatham Islands, near New Zealand (Wilson, 1976). Its stratigraphical range is also considerable, from Barremian to Paleocene and perhaps higher.

Genus *Hystrichokolpoma* Klumpp, 1953, *emend.* Williams and Downie, 1966
Hystrichokolpoma? crassipes (Reade, 1839). *comb. nov., emend.*

Plate 3 : 3 ; Text-fig. 6

1839 *Xanthidium crassipes* Reade, pl. 9 : 2.

1941 *Hystrichosphaeridium crassipes* (Reade). Lejeune-Carpentier, p. B79-B80, fig. 9.

1964 *H. crassipes* (Reade). Downie and Sarjeant, p. 120.

1966 *?Litosphaeridium crassipes* (Reade). Davey and Williams, p. 83, *nomen nudum.*

1967a *Litosphaeridium? crassipes* (Reade). Sarjeant, tab. 6, *nomen nudum.*

1969 *?Litosphaeridium crassipes* (Reade). Davey and Williams *in* Davey *et al.,* p. 5.

1973 *L.? crassipes* (Reade). Lentin and Williams, p. 89.

1975 *?L. crassipes* (Reade). Harker and Sarjeant, chart 12 (p. 245).

1978 *L.? crassipes* (Reade). Stover and Evitt, p. 62.

Emended Diagnosis

Cyst spheroidal to broadly ovoidal, the apex lost in archaeopyle formation. Intratabular processes of three types are developed :

1. Large processes, broad-based and tapering slightly towards their tips, closed proximally but open distally. These processes correspond in position to precingular, postcingular and antapical paraplates.
2. Smaller, spine-like processes, acuminate or oblate, closed or open proximally but consistently closed distally. These processes correspond in situation to cingulum and sulcus (and possibly to a second posterior intercalary plate).
3. A single broad, flat, blade-like process, closed distally and proximally, corresponds in situation to the posterior plate.

The antapical process is the longest, exceeding in length one-quarter of the cyst breadth. The length of all the other processes is less than one-quarter of the cyst breadth.

The processes reflect a paratabulation as follows : ?', 0a, 6", 6 or 7c, 5 or 6"', 1-?2p, 1 pv, 1"", 9-?11s. Rootlike ridges radiate out across the surface of the phragma from the bases of the larger processes and faint lines between adjacent processes, simulating paraplates, mark the limits of extension of these ridges. The phragma also exhibits a coarse granulation or punctation.

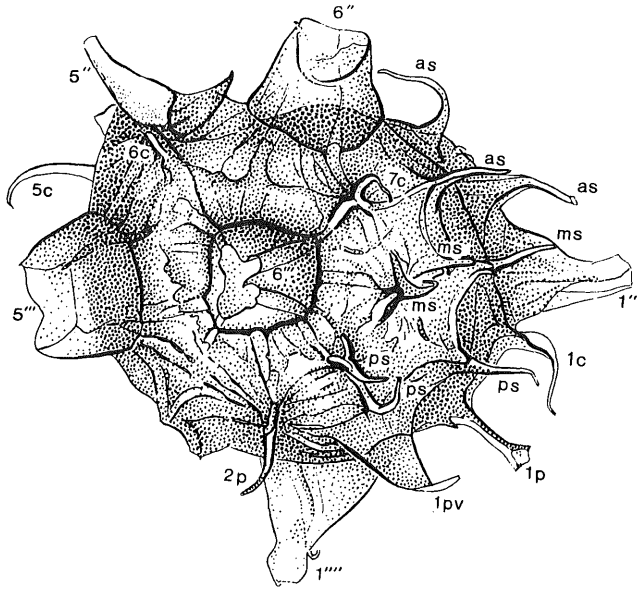

Figure 6.
Hystrichokolpoma? crassipes *(Reade, 1839), comb. nov., emend. The neotype, in oblique right lateral view.*

Neotype

Specimen CXII-43, collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by Lejeune-Carpentier (1941, fig. 9) and herein, pl. 3 : 3, Text-fig. 6.

Type Horizon and Locality (of Neotype).

Flint of Craie de Spiennes (= Formatie van Gulpen of Felder, 1975), Upper Cretaceous, (Senonian), Mortiau quarry, Cuesmes, Belgium.

Description

The neotype is seen in slightly oblique ventral view, so that the ventral and right lateral surfaces are well shown ; the morphology of the dorsal and left lateral surfaces is less easy to determine. Orientation is imposed on the basis (a.) of the archaeopyle, certainly essentially apical ; (b.) of an unusually large single process, here considered antapical in situation ; and (c.) of the single line of smaller processes separating the larger ones on both surfaces, considered to be cingular processes. On this basis, a striking feature of this specimen (and species) is the high number of sulcal processes : at least nine are present, perhaps eleven if the supposed seventh cingular and second posterior intercalary processes (see Text-fig. 6) are also sulcals.

The faint lines separating the convergences of rootlike extensions from adjacent processes may delimit paraplates ; but if so, the cingulum is not directly indicated and the limits of the sulcus are obscure.

Dimensions

Neotype : length of cyst 38 μm, breadth 46 μm, length of antapical process 13 μm, maximum length of other processes c. 10 μm.

Remarks

This species was first illustrated, without description, by Reade (1839) : despite prolonged enquiry by the second author in British museums and collections, the holotype has not come to light and must be presumed lost. The specimens attributed to this species by White (1842, 1844) differ too substantially in the morphology and proportionate length of their processes to be regarded nowadays as attributable even to the same genus, let alone to the same species ; in any case, they too are lost. Moreover, the locality and stra-

tigraphical horizon of Reade's specimens were not precisely stated, precluding the collection of new material from the same position. In consequence, the specimen described and illustrated earlier by one of us (Lejeune-Carpentier, 1941) is here selected as neotype and the revised diagnosis is based on that specimen.

The archeopyle is certainly essentially apical, though it may also involve a dorsal precingular paraplate ; the position of the neotype in the enclosing flint precluded confidence in this regard. Despite this uncertainty, the presence of processes of three distinct types, including cingular processes and a high number of sulcal processes, sufficently facilitates the identification of this species as to fully justify its retention.

Its generic placement must, however, be regarded as provisional. It is certainly **not** attributable to *Litosphaeridium,* which has fewer processes (16-19) and lacks cingulars and sulcals. Though similar in many respects, *Achilleodinium* has a precingular archaeopyle only. The archaeopyles of *Florentinia* and *Silicisphaera* likewise consistently involve (and may be entirely formed by) loss of a precingular paraplate ; however, the apical paraplates may also be lost. Placement in *Silicisphaera* is clearly inappropriate, since that genus lacks a distinctive antapical process and has equatorial (precingular and postcingular) processes with transversely elongate bases. Provisional attribution to *Hystrichokolpoma* is made on the basis that the archaeopyle appears exclusively apical ; if it proves otherwise, then reallocation to *Florentinia* may become appropriate. However, it should be noted that, in the typical species of both latter genera, the number of sulcals does not exceed five, so that placement of the species *crassipes* into a genus yet unnamed may well ultimately prove necessary.

Family EXOCHOSPHAERIDIACEAE Sarjeant and Downie, 1974

Genus *Amphorosphaeridium* Davey, 1969b

Amphorosphaeridium major (Lejeune-Carpentier, 1940) *comb. nov., emend.*

Plate 2 : 6-7 ; Text-fig. 7

?1837 Oeuf de Cristatelle. Turpin, p. 313, fig. B.

1940 *Hystrichosphaeridium major* Lejeune-Carpentier, p. B220-B221, fig. 13.

?1958 *Hystrichosphaeridium* cf. *major* Lej.-Carp. Deflandre and Deflandre-Rigaud, fiche 1416.

1964 *H. major* Lej.-Carp. Downie and Sarjeant, p. 121.

1966 *?Polysphaeridium major* (Lej.-Carp.) Davey and Williams, p. 95, *nomen nudum.*

1967a *P. ? major* (Lej.-Carp.) Sarjeant, tab. 6 (p. 332).

1969 *?P. major* (Lej.-Carp.) Davey and Williams *in* Davey *et al.*, p. 6.

1972 *Cordosphaeridium major* (Lej.-Carp.) Corradini, p. 149-150, pl. 22 : 6-8.

1973 *Polysphaeridium? major* (Lej.-Carp.) Lentin and Williams, p. 115.

1975 *Cordosphaeridium major* (Lej.-Carp.) Harker and Sarjeant, chart 11 (p. 244).

1977 *C. major* (Lej.-Carp.) Lentin and Williams, p. 33.

1978 *Polysphaeridium major* (Lej.-Carp.) Stover and Evitt, p. 147-148.

Emended Diagnosis

Cyst spheroidal to ovoidal, skolochorate. Processes tubular, often fibrous. They appear to be essentially intratabular in position and number around 60, being less than one-half the cyst diameter in length. The processes are typically broad-based but vary greatly in thickness and in style of distal termination, the latter including bifurcate, trifurcate, foliate, digitate and aculeate forms. Archaeopyle single-plate precingular, type P.

Holotype

Specimen XIX-133 : lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium : figured by Lejeune-Carpentier, 1940, fig. 13, and herein, Pl. 2 : 6-7 and Text-fig. 7.

Type Horizon and Locality

Flint filling of echinoid, Craie de Spiennes (= Formatie van Gulpen of Felder, 1975), Upper Cretaceous (Senonian), Hallembaye, Limbourg Basin, Belgium.

Dimensions

Holotype (in polar view) : diameter of cyst 64.5 μm, length of processes around 21.6 μm.

Range of Dimensions

Maximum cross-measurement of cyst 55-70 μm.

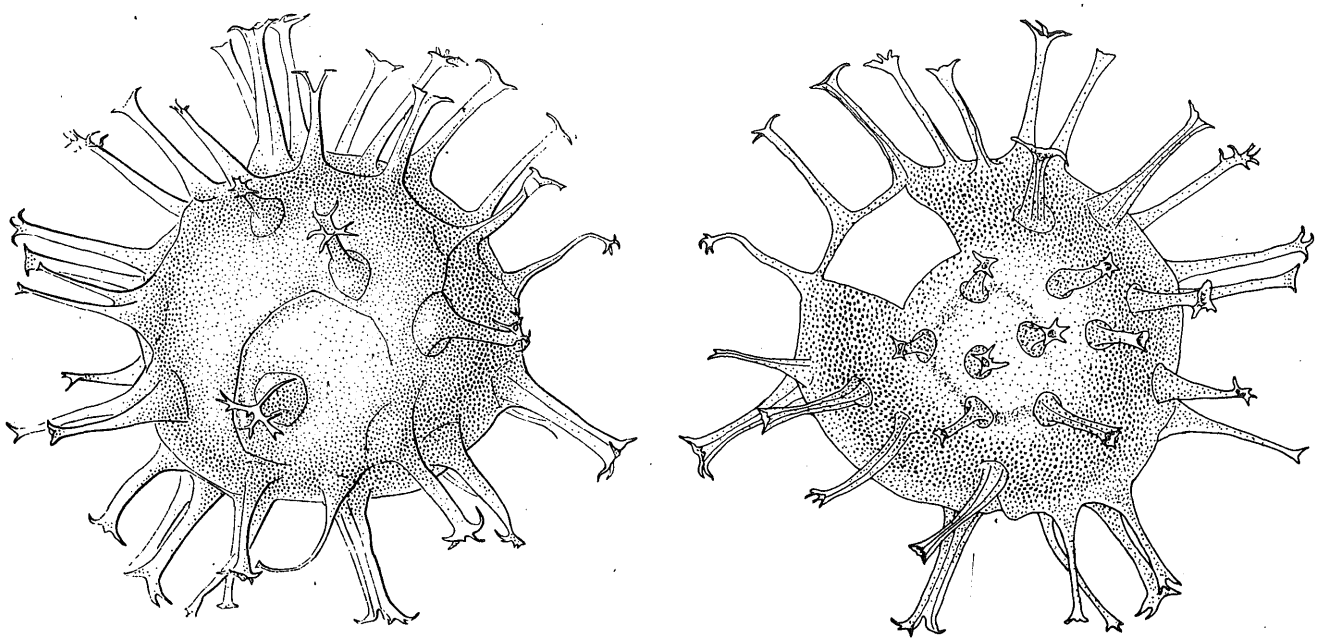

Figure 7.- Amphorosphaeridium major *(Lejeune-Carpentier, 1940), comb. nov., emend. The holotype : left, in slightly oblique antapical view and right, in slightly oblique apical view.*

Description

The holotype is seen in antapical view : the antapical process is surrounded by a groove of polygonal outline, simulating the shape of a single antapical paraplate. Many of the other, larger processes are considered to be likewise intratabular in positon, though in many instances there are clearly several processes per paraplate. The thinner processes appear to correspond to cingular and sulcal paraplates ; however, it is possible that some may be sutural in situation.

In view of the position of the holotype in the enclosing flint, the apical surface is hard to see and our reconstruction of it (Text-fig. 7, right) must certainly be inaccurate in detail. However, the size, shape and position of the archaeopyle make it clear that this was formed by loss of a single precingular paraplate (probably 3").

The surface of the phragma shows a dense ornament of granules and/or punctae. The processes, formed from periphragm only, have this ornament to a reduced degree but are commonly fibrous.

Remarks

Determination of the style of archaeopyle makes it impossible any longer to retain the species *major* in the genus *Polysphaeridium,* which characteristically has an apical archaeopyle. Nor can the attribution of it to *Cordosphaeridium* by Corradini (1972) be upheld, since the processes of that genus are much less numerous (22-30).

The diagnosis of *Amphorosphaeridium,* as defined by Davey (1969b) and "modified" by Stover and Evitt (1978, p. 140-141), specifies fibrous, hollow processes that are non-tabular (or "frequent intratabular") and a single-plate precingular archaeopyle. The apical process is distinctive ; in the type species it is "a broad, fibrous structure which gives rise medially to two to four subsidiary processes" (Davey, 1969, p. 31). The structure of the apical surface of the holotype of *major* proved difficult to determine : whilst no such strongly fibrous structure was noted, the five apical processes appear to arise from a ridge or boss, which may be a foreshadowing of the sort of structure Davey describes. The antapical process is not necessarily distinctive in *Amphorosphaeridium,* but (as in several other genera) may be unusually large. In the species *major,* though the outlining of the antapical paraplate identifies the antapical process, that process itself is in no way exceptional. In view of these difficulties, the species *major* cannot be considered to conform exactly to existing concepts of *Amphorosphae-*

ridium ; but the minor differences are, in our view, outweighed by the major similarities and it is allocated to that genus with fair confidence.

Despite the criticisms of Stover and Evitt (1978, p. 76), we consider that Corradini was correct when he recognised this species from the Upper Cretaceous flysch of the Appenines (1972) ; one of his figures (pl. 22 : 8) indeed accords particularly closely with our concept of this species. We trust this redescription will facilitate its future recognition from other Upper Cretaceous localities also.

Genus *Fibrocysta* Stover and Evitt, 1978
Fibrocysta? deflandrei (Lejeune-Carpentier, 1941) *stat. et comb. nov., emend.*

Plate 4 : 5-6 ; Text-fig. 8

1941 *Hystrichosphaeridium spinosum* (White) var. *deflandrei* Lejeune-Carpentier, p. B78-B79, fig. 6 (Styled *H.* cf. *spinosum* var. *deflandrei* in text-captions, p. B90).

1964 *Baltisphaeridium spinosum* var. *deflandrei* Lej.-Carp. Downie and Sarjeant, p. 96.

1969a *Exochosphaeridium spinosum* var. *deflandrei* Lej.-Carp. Davey, p. 166.

1973 *E. spinosum* subsp. *deflandrei* (Lej.-Carp.) Lentin and Williams, p. 56.

1975 *E. spinosum* var. *deflandrei* Lej.-Carp. Harker and Sarjeant, chart 12.

1977 *E. spinosum* subsp. *deflandrei* (Lej.-Carp.) Lentin and Williams, p. 60.

Emended Diagnosis

Cyst broadly ellipsoidal, with a short, strong apical horn and a much less prominent, rather flattened antapical mamelon. Surface of phragma irregularly areolate, the elongation of the areolations around some processes suggesting a root-like structure. Processes non-tabular (or apparently so) and thornlike, broad and flattened at the base but tapering to an acute point; their length shows some variation, but is always between one-third and one-half the shortest cyst diameter. Archaeopyle single-plate precingular (type P).

Holotype

Specimen CXII-33 ; lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium : figured by Lejeune-Carpentier, 1941, fig. 6, and herein, pl. 4 : 5-6, text-fig. 8.

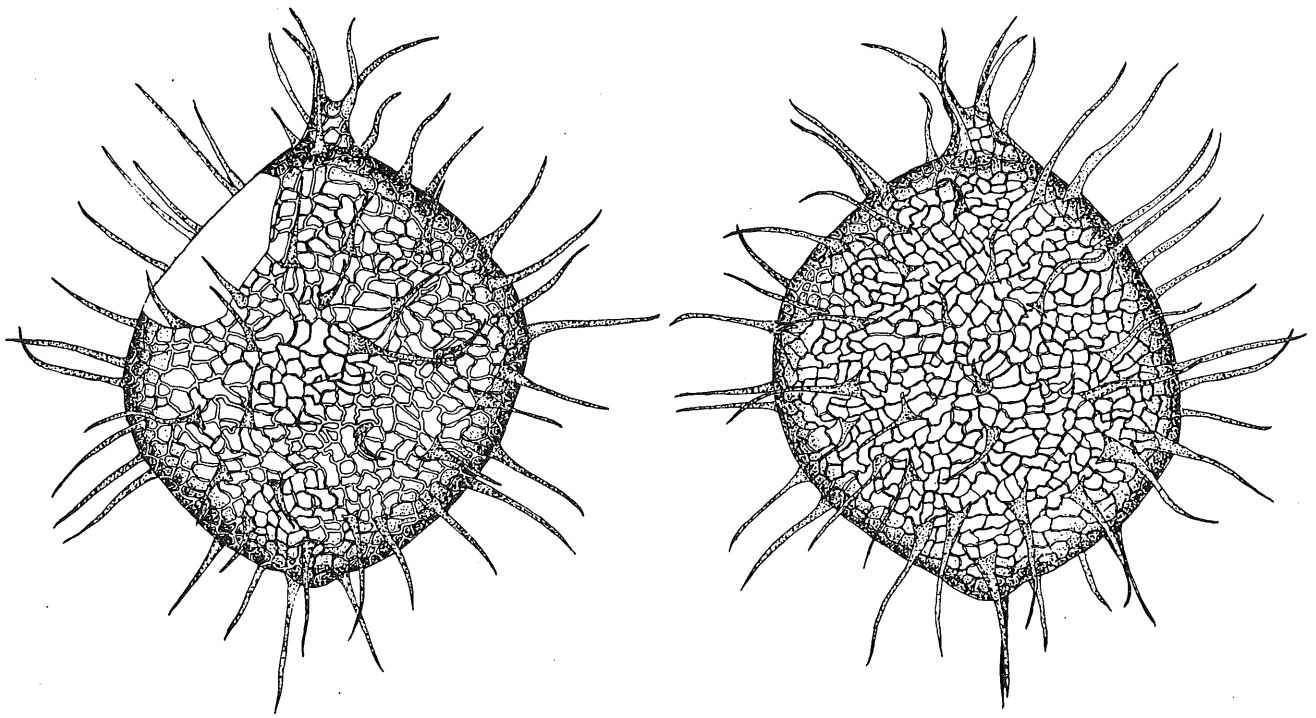

Figure 8.- Fibrocysta? deflandrei *(Lejeune-Carpentier, 1941), stat. et comb. nov., emend. The holotype ; left, in right lateral view and right, in left lateral view.*

Type Horizon and Locality

Flint from Craie de Spiennes (= Formatie van Gulpen of Felder, 1975), Upper Cretaceous, (Senonian), quarry of Mortiau, Cuesmes, (Hainaut), Belgium.

Dimensions

Holotype : overall length of cyst 48 μm, length of apical horn 5 μm, height of antapical mamelon c. 2 μm, breadth of cyst 39 μm, length of processes up to 19 μm.

Range of Dimensions

Overall length of cyst 36-49 μm, length of processes 14-21 μm.

Description

Our restudy showed that, instead of exhibiting the convergent web of rootlike extensions from process bases that the original figures (Lejeune-Carpentier, 1941) suggest, the surface of the phragma has an irregular overall areolation with meshes of very variable size and shape. In some instances, these are indeed elongate and seem to converge on particular processes, so that their boundaries simulate roots ; but in other instances, the meshes surrounding a process show no such relation to it, their shape instead appearing random.

The flattened bases of the spines are noteworthy, suggesting possible alignment along a reflected suture ; but no pattern of process distribution could be elucidated and they must for the moment be regarded as non-tabular. The spines arising on and about the apical horn give a bifid appearance to that structure in some specimens : but this varies according to position.

Remarks

White's illustrations of *Xanthidium (*now *Exochosphaeridium) spinosum* (1842) depict a more rotund form, with processes of dissimilar morphology and without apical or antapical protuberances. Our restudy makes it evident that the Belgian forms are certainly not conspecific, and indeed not even congeneric, with White's specimens. Since a survey of the literature has brought to light no species that is exactly comparable, the former variety *deflandrei* is here elevated to specific status.

In its overall shape, polar protrusions and possession of hollow, non tabular processes, this species accords with the diagnosis of *Fibrocysta* and in particular resembles *F. lappacea* (Drugg, 1970) Stover and Evitt, 1978. However, it lacks the fibrous processes, with expanded or branching tips, characteristic of that genus, instead having pointed processes that are not evidently fibrous. Moreover, though the overall shape is strikingly similar to that of *F. lappacea,* the processes are much longer and slimmer and the single-plate precingular archaeopyle appears less broad (though this may be a result of orientation). The species *deflandrei* is thus placed only tentatively into *Fibrocysta* and may shortly merit transfer to another genus yet undescribed.

Fibrocysta? cf. *deflandrei* (Lejeune-Carpentier, 1941), *emend.* Lejeune-Carpentier and Sarjeant, *herein.*

Plate 2 : 1-2

1941 *Hystrichosphaeridium spinosum* (White) var. *deflandrei* Lejeune-Carpentier, p. B90, fig. 7.

Remarks

The "fragment of a cyst" illustrated by the first author (1941, fig. 7) differs so substantially from the holotype of *Fibrocysta? deflandrei* that we cannot now assign it to the same taxon with any confidence. The spines are stronger, longer and more flexible, and somewhat fewer. Moreover, a system of radiating ridges about the process bases is much more clearly developed, though the surface remains essentially areolate ; and the cyst is either very severely damaged or else has developed a combination, rather that a single-plate precingular, archaeopyle. Both the generic and the specific assignment of this specimen must thus now be considered in the highest degree questionable.

Family AREOLIGERACEAE Evitt, 1963, *emend.* Sarjeant and Downie, 1966

Genus *Areoligera* Lejeune-Carpentier, 1938, *emend.* Williams and Downie, 1966

Areoligera senonensis Lejeune-Carpentier, 1938.

Plate 3 : 5-6 ; Plate 4 : 1-2

1938 *Areoligera senonensis* Lejeune-Carpentier, p. B164-B166, figs. 1-3.

1952 *A. danica* W. Wetzel, p. 396, pl. A : 5-6, text-fig. 8.

1961 *Areoligera* cf. *A. senonensis* Lej.-Carp. Evitt, pl. 8 : 11-15, pl. 9 : 3-7.

1964 *A. senonensis* Lej.-Carp. Downie and Sarjeant, p. 86.

?1965 *A.* cf. *senonensis* Lej.-Carp. Stanley, p. 228, pl. 26 : 1-8.

?1966 *A.* cf. *senonensis* Lej.-Carp. Williams and Downie, p. 230-231, pl. 25 : 6, text-fig. 64.

1967a *A. senonensis* Lej.-Carp. Sarjeant, tab. 7 (p. 333).

1969 *?Cleistosphaeridium danicum* (W. We.) Davey, Downie, Sarjeant and Williams, p. 15.

1969 *A. senonensis* Lej.-Carp. Gocht, p. 56-58, pl. 8 : 4-9, text-figs. 40-41.

1971 *A. senonensis* Lej.-Carp. Downie, Hussain and Williams, pl. 2 : 1.

1971 *A. senonensis* Lej.-Carp. Eisenack and Kjellström, p. 91-92.

1971 *A. senonensis* Lej.-Carp. Zaitzeff and Cross, pl. 4 : 33, tab. 1.

1973 *A. senonensis* Lej.-Carp. Lentin and Williams, p. 15.

Cleistosphaeridium? danicum (W. We.) Lentin and Williams, p. 28.

1975 *A. senonensis* Lej.-Carp. Harker and Sarjeant, charts 11, 20.

Cleistosphaeridium? danicum (W. We.) Harker and Sarjeant, chart 20.

1976 *Areoligera senonensis* Lej.-Carp. Eaton, p. 244, pl. 3 : 1, figs. 22, 30.

A. cf. *senonensis* Lej.-Carp. Eaton, p. 244, pl. 3 : 4-5, figs. 22, 30.

1977 *A. senonensis* Lej.-Carp. De Coninck, encl. 1.

1977 *A. senonensis* Lej.-Carp. Lentin and Williams, p. 11.

Cleistosphaeridium? danicum (W. We). Lentin and Williams, p. 27.

1978 *Areoligera senonensis* Lej.-Carp. Jain, p. 150, pl. 2 : 16.

1978 *A. senonensis* Lej.-Carp. Stover and Evitt, p. 18.

1979 *A. senonensis* Lej.-Carp. Barss *et al.*, p. 24, 25, 29, 40, 67, 93.

1979 *A. senonensis* Lej.-Carp. complex. Costa and Downie, tabs. 1, 3, 5.

Remarks

Photographs of the holotype of this species (pl. 3 : 5-6) and a paratype (pl. 4 : 1-2) are here published for the first time. Our restudy endorses the reinterpretation of this genus by Evitt (1962) and our observations fit well with the detailed study of its morphology by Gocht (1969). We further believe that the form poorly illustrated and described by Walter Wetzel (1952) as *Areoligera danica* falls within the range of variation of *A. senonensis* and should be treated as a subjective junior synonym (though this conclusion needs to be crosschecked by a re-examination of the holotype).

We consider the stratigraphical range of *A. senonensis*, as presently defined, to be from Upper Cretaceous (upper Campanian) to upper Eocene. Its geographic range is also known to be considerable ; it has been reported from northwest Europe (France, Germany, Belgium, England and Denmark), offshore Atlantic sediments (Barss *et al.*, 1978), doubtfully from South Dakota and confidently from Texas, U.S.A. (Stanley, 1965 ; Zaitzeff and Cross, 1971) and from southern India (Jain, 1978). However, this species - and, indeed, this genus - has not yet been recorded from Africa, Australia, or south America ; nor has it been encountered in Arctic and western Canada or the western United States. Its distribution may thus, in the future, help in the elucidation of past patterns of oceanic curculation.

Suborder Deflandreinaeae Eisenack, 1961, *emend.* Norris, 1978

Family DEFLANDREACEAE Eisenack, 1954, *emend.* Sarjeant and Downie, 1974.

Genus *Deflandrea* Eisenack, 1938, *emend.* Lentin and Williams, 1976

Deflandrea damasii (Lejeune-Carpentier, 1942) *comb. nov., emend.*

Plate 6 : 3 ; Text-fig. 9

1942 *Peridinium damasii* Lejeune-Carpentier, p. B185-B186, figs. 9-14.

1964 *P. damasii* Lej.-Carp. Eisenack and Klement, p. 669-670.

1964 *P. damasii* Lej.-Carp. Downie and Sarjeant, p. 139.

1967a *P. damasii* Lej.-Carp. Sarjeant, tab. 4 (p. 330).

1973 *Cooksoniella? damasii* (Lej.-Carp.) Lentin and Williams, p. 31.

1975 *C.? damasii* (Lej.-Carp.) Harker and Sarjeant, chart 14.

1976 *Palaeoperidinium damasii* (Lej.-Carp.) Lentin and Williams, p. 110.

1977 *P. damasii* (Lej.-Carp.) Lentin and Williams, p. 119.

1978 *P. damasii* (Lej.-Carp.) Stover and Evitt, p. 218.

Emended Diagnosis

Cornucavate to bicavate (or very narrowly circumcavate) cysts of small size, flattened dorsoventrally, with a broad-based, tapering and acute apical horn and two antapical horns, of shape and size similar to each other and to the apical horn, arising from the periblast. (The length of all horns approaches one-third of the length of the endoblast). Epitract of both periblast and endoblast convex, rounded anteriorly : hypotract slightly smaller, somewhat flattened posteriorly. Both layers of the phragma are thin and ornamented by a faint granulation or punctation. Strong ridges on the periblast demarcate a broad, almost planar to weakly laevorotatory cingulum. The sulcus and other elements of the paratabulation are less clearly defined by faint ridges. Paratabulation 4', 3a, 7", ?6c, 5"', 0p, 2"". Archaeopyle single-plate intercalary (type I/I), of broad-hexa type and formed by the loss of paraplate 2a.

Holotype

Specimen CXIII-83 ; lodged in the collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by Lejeune-Carpentier (1942, fig. 10) and herein, pl. 6 : 3, text-fig. 9a.

Type Horizon and Locality

Flint of Craie de Spiennes (= Formatie van Gulpen of Felder, 1975), Upper Cretaceous (Senonian), Mortiau quarry, Cuesmes, Belgium.

Dimensions

Holotype : overall length 64 μm, length of apical horn 13 μm, length of endoblast 38.5 μm, length of antapical horns c. 13 μm, overall breadth 39 μm,breadth of endoblast 34 μm.

Range of Dimensions

Overall length 58-78 μm, overall breadth 38-53 μm, dorsoventral thickness 22-31 μm.

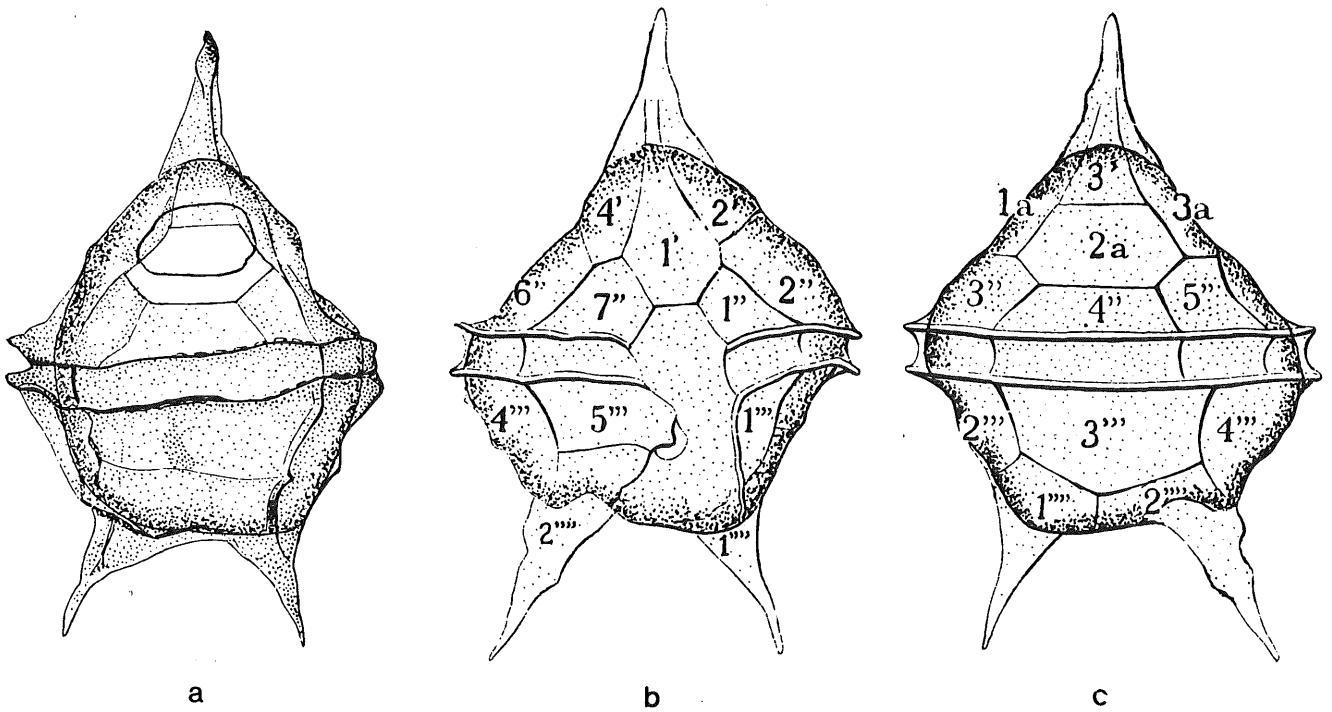

Figure 9.- Deflandrea damasii *(Lejeune-Carpentier, 1942), comb. nov., emend. a. The holotype, in dorsal view. b.-c. Specimen CXIII-31 (b. in ventral view ; c. in dorsal view).*

Description

The holotype and three of the other four figured specimens originally studied and illustrated by the first author (1942) were reexamined ; the fifth specimen then figured, specimen CXII-188, could not be examined since the flint fragment in which it is contained has come free from its slide and requires remounting before it can be again studied. The holotype shows the archaeopyle and dorsal paratabulation well ; specimen CXIII-31 (illustrated by Lejeune-Carpentier, 1942, figs. 13-14 and herein, Text-figs. 9b-c) shows the full paratabulation best - - and indeed, exceptionally well for a cavate cyst.

Apical paraplate 1' is approximately rhomboidal but broadest near its posterior margin and prolonged anteriorly to the horn tip ; 2' and 4' are almost symmetrical, narrower than 1' ; 3' is shorter and almost triangular. 2a is the largest of the anterior intercalary paraplates and of "broad hexa" type ; the two other anterior intercalaries are similar in size and shape and much narrower. The largest of the precingulars are paraplates 2" and 6", both asymmetrically pentagonal and elongate ; 3" and 5" are also asymmetrically pentagonal, but shorter : 4" is quadrate and laterally broad ; 7" and 1" are the smallest of the series, again pentagonal and symmetrical about the junction of 1' with the sulcus. The largest of the postcingulars is the broad, symmetrical paraplate 3"', occupying the median dorsal portion of the hypotract ; 2"' and 4"' are almost equally large and of similar shape ; 5"' appears almost quadrate and 1"' appears similar. Two large paraplates, symmetrical in size, shape and position, occupy the antapex.

Characteristic features are the three acute, quite long and almost symmetrical horns ; the meagre separation of the wall layers in lateral positions and at the antapex ; and the very broad cingulum.

Remarks

Our restudy makes clear the fact that this species is cavate, not proximate as hitherto supposed, and has a paratabulation and style of archaeopyle exactly typical of the genus *Deflandrea,* as emended by Lentin and Williams (1976, pp. 35-36). It is thus transferred to that genus with confidence.

The two most comparable species previously assigned to that genus are perhaps *Deflandrea wardenensis* Williams and Downie, 1966 and *D. sibirica* (Vozzhennikova, 1963) Lentin and Williams, 1976. However, the former species is distinguished by its less broad archaeopyle and both species by relatively poor expression of the paratabulation.

Deflandrea galeata (Lejeune-Carpentier, 1942) Lentin and Williams, 1973, *emend.*

Plate 5 : 1-2. Plate 6 : 1-2, Text-figs. 10-11

1933 *Peridinium* cf. *claudicans* Paulsen. O. Wetzel, p. 163-164, pl. 2 : 10.

1942 *Peridinium galeatum* Lejeune-Carpentier, p. B186-B188, figs. 15-20.

1964 *P. galeatum* Lej.-Carp. Downie and Sarjeant, p. 139.

1964 *P. galeatum* Lej.-Carp. Eisenack and Klement, p. 671-672.

1967a *P. galeatum* Lej.-Carp. Sarjeant, tab. 4 (p. 330).

1973 *Deflandrea galeata* (Lej.-Carp.) Lentin and Williams, p. 41.

1975 *D. galeata* (Lej.-Carp.) Harker and Sarjeant, chart 14.

1976 *D. galeata* (Lej.-Carp.) Lentin and Williams, p. 40, pl. 4 : 45.

1977 *D. galeata* (Lej.-Carp.) Lentin and Williams, p. 42.

1978 *D. galeata* (Lej.-Carp.) Stover and Evitt, p. 100.

Emended Diagnosis

Circumcavate cysts of relatively large size. Apical horn large, symmetrically tapering from a very broad base to a slightly blunt tip : the horn base is about three-quarters as wide as the horn length, which in turn is between one-third and one-half the length of the endoblast. The two antapical horns are only slightly smaller and almost equally broad-based, with lateral margins straight to slightly convex and inner margins concave. Epitract of periblast in the form of a truncated cone from which the apical horn arises : hypotract trapezoidal, its profile altered by the two horns. Endoblast spheroidal to broadly ovoidal. Cingulum well marked on the periblast by strong ridges but only slightly hollowed ; sulcal region quite deeply indented. Paraplate boundaries elsewhere indicated only by folds or low ridges on the periphragm ; paratabulation ?4', ?3a, 7", ?c, 5"', 0p, 2"". Surface of periphragm very irregularly papillate to echinate, the papillae and short spines corresponding in position to nodes on a fine polygonal network (not otherwise expressed). Archaeopyle single-plate intercalary (type I/I), of

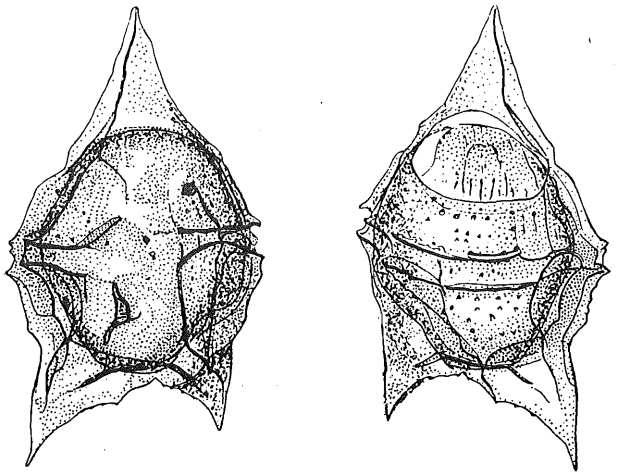

Figure 10.
Deflandrea galeata *(Lejeune-Carpentier, 1942), emend. The holotype ; left, in oblique ventral view and right, in oblique dorsal view.*

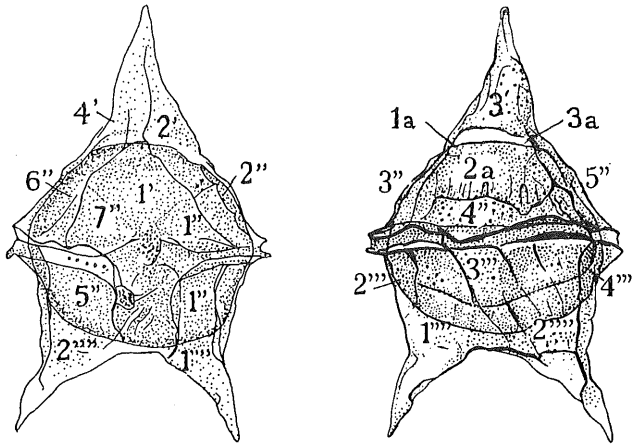

Figure 11.
Deflandrea galeata *(Lejeune-Carpentier, 1942), emend. Specimen CXIII-31 ; left, in ventral view and right, in dorsal view.*

broad-hexa type and formed by the loss of paraplate 2a.

Holotype

Specimen nº 407 (ex : O. Wetzel Collection), collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by O. Wetzel (1933, pl. 2 : 10), Lejeune-Carpentier (1942, figs. 15-16) and herein, pl. 5 : 1-2, text-fig. 10.

Type Horizon and Locality

Flint from the Upper Cretaceous, collected from drift at Holtenau, near Kiel, Germany.

Dimensions

Holotype (in slightly oblique dorsoventral view) : Maximum overall length 106 μm, length of apical horn 28 μm, length of endoblast 79.5 μm, length of antapical horns c. 27 μm, maximum overall breadth 64 μm, breadth of endoblast 53 μm.

Range of dimensions

Overall length 95-116 μm, overall breadth 52-72 μm, thickness (dorsoventral) 36-39 μm.

Description

All the specimens figured by the first author (1942) were re-examined ; and all are contained in the same flint flake (specimen no. 407). The slightly oblique position of the holotype gives a misleading impression of asymmetry to the horns and renders it less satisfactory for examination than another in the same flake (that figured by Lejeune-Carpentier, 1942, figs. 18-19, and herein, pl. 6 : 1-2, text-fig. 11). It is essentially from the latter that the paratabulation was determined. The shape of the apical and first and third anterior intercalary paraplates could not be elucidated with any certainty ; in all other respects, however, the shape and proportions of the paraplates are exactly as specified for *Deflandrea damasii* (see description above).

The ornament of papillae or short spines is more evident on the dorsal than on the ventral surface, but it is nowhere dense and is quite lacking from some parts of the periphragm. In addition, a very fine overall ornamentation of granules or punctae may be developed on endophragm and periphragm.

The divergence of the antapical horns forms an angle of approximately 60º.

Remarks

Our restudy of the type material of *D. galeata* shows it to correspond in all respects with the emended

diagnosis of the genus *Deflandrea*, as formulated by Lentin and Williams (1976), and thus confirms its assignation to that genus by those authors. The species is characterised by its large size, large and almost symmetrically developed horns, and periphragm ornament.

Deflandrea galeata has been reported also from Senonian flints of Belgium by the first author (1942) but has not yet been encountered in other localities. *Deflandrea speciosa* Alberti 1961, and in particular its subspecies *glabra* Gocht, 1969, is strikingly similar in most features but lacks the surficial ornament characteristic of *D. galeata* ; *Deflandrea subquadra* Corradini, 1973, is again similar but lacks that ornament and has a yet longer apical horn.

Family PHTHANOPERIDINIACEAE Drugg and Loeblich, 1967, *emend.* Bradford, 1977.

Genus *Lejeunecysta* Artzner and Dörhöfer, 1978

Lejeunecysta tricuspis (O. Wetzel, 1933) Artzner and Dörhöfer, 1978, *emend.*

Plate 6 : 5

1922 *Peridinium* cf. *conicum* (Gran) Ostenfeld and Schmidt. W. Wetzel, p. 59, pl. 2 : 6.

1933 *Peridinium tricuspis* O. Wetzel, p. 166, pl. 2 : 14.

1942 *"Peridinium" tricuspis* O. We. Lejeune-Carpentier, p. B188-B189, figs. 21-22.

?1963 *Lejeunia* cf. *tricuspis* (O. We.) Górka, p. 40-41, pl. 5 : 1-3.

1964 *L. tricuspis* (O. We.) Downie and Sarjeant, 1964, p. 126.

1964 *"Peridinium" tricuspis* O. We. Eisenack and Klement, p. 679-680.

1967a *Lejeunia tricuspis* (O. We.) Sarjeant, tab. 4 (p. 330).

1970 *Astrocysta tricuspis* (O. We.) Davey, p. 360.

1973 *A. tricuspis* (O. We.) Lentin and Williams, p. 18.

1975 *A. tricuspis* (O. We.) Harker and Sarjeant, chart 9.

1976 *Lejeunia tricuspia (sic)* (O. We.) Lentin and Williams, p. 71, pl. 10 : 152.

1977 *Senegalinium tricuspis* (O. We.) Harland, p. 188.

1978 *Lejeunecysta tricuspis* (O. We.) Artzner and Dörhöfer, p. 1381-1382.

1978 *Phelodinium tricuspis* (O. We.) Stover and Evitt, p. 118.

Emended Diagnosis

Proximate cyst of relatively large size, dorsoventrally compressed and hollowed in the ventral region. Ambitus asymmetrically pentagonal, all flanks being strongly concave. Phragma apparently composed of a single layer (autophragm). Apical horn long, slender and pointed ; antapical horns of similar size and shape, long, pointed, slightly broader based than the apical horn. Cyst prolonged equatorially, at the line of the cingulum, into two hornlike extensions, imparting an overall five-horned appearance to the cyst. Cingulum narrow, only feebly laevorotatory, bordered by low but well-marked ridges. Ridges or folds of the autophragm partially outline a peridinioid paratabulation ; in addition, the cyst is ornamented by longitudinal striations.

Holotype

Specimen no. 473 (ex : O. Wetzel Collection), collections of the Laboratoire de Paléontologie, Université de Liège, Belgium ; illustrated by O. Wetzel (1933, pl. 2 : 14), Lejeune-Carpentier (1942, fig. 21) and herein, pl. 6 : 5.

Type Horizon and Locality

Flint of Upper Cretaceous, presumably from the drift of north Germany (provenance not indicated on slide and not stated by Otto Wetzel).

Dimensions

Holotype : overall length 116 μm, length of apical horn 28 μm, length of antapical horns c. 22.5 μm, maximum overall breadth 82 μm, thickness (dorsoventral) c. 22 μm.

Range of Dimensions

Overall length 100-160 μm, overall breadth 50-82 μm.

Description

The surface of the autophragm may exhibit a fine granulation or punctation, in addition to the marked striations. Here and there may also be seen dark spots of uncertain significance (possibly pyritic ?) The ridges or folds demarcating paraplates do so too poorly for the paratabulation to be determined in detail, though it is evidently peridinioid.

The five horns impart a pronounced and distinctive polygonality to the cyst ; the two antapical horns diverge from one another at about 45°, but the angle of divergence of the other adjacent horns is shallower (close to 70°). No archaeopyle could be discerned.

Remarks

This distinctive species has been much transferred but rarely encountered ; indeed, the records by the two Wetzels remain the only ones. Since the specimens do not exhibit a discernible excystment aperture, the possibility that they are fossil motile thecae cannot be entirely excluded ; but, since closely similar forms (most often without a visible archaeopyle) have been extracted from sediments and are demonstrably cysts, we regard these specimens as cysts also.

The transfer of this species to *Phelodinium* by Stover and Evitt was made on the basis of published illustrations, which do indeed suggest that *tricuspis* is cavate. This appearance results entirely from the surficial ridges and folds ; on close examination of the type specimens, this illusion vanishes and only one wall layer can be discerned. Thus we follow Artzner and Dörhöfer in assigning this species to *Lejeunecysta,* a genus with autophragm only in which not all individuals exhibit (or, indeed, appear to have developed) an excystment aperture.

Family PALAEOPERIDINIACEAE Vozzhennikova, 1961, *emend.* Sarjeant, 1967

Genus *Palaeoperidinium* Deflandre, 1937, *emend,* Lentin and Williams, 1976

Palaeoperidinium? subconicoides (Lejeune-Carpentier, 1942) Lentin and Williams, 1973.

Plate 6 : 4

1942 *Peridinium subconicoides* Lejeune-Carpentier, p. B183-B185, figs. 1-8.

1964 *P. subconicoides* Lej.-Carp. Downie and Sarjeant, p. 140.

1964 *P. subconicoides* Lej.-Carp. Eisenack and Klement, p. 677-678.

1967a *P. subconicoides* Lej.-Carp. Sarjeant, tab. 4 (p. 330).

1973 *Palaeoperidinium? subconicoides* (Lej.-Carp.) Lentin and Williams, p. 106.

1975 *P.? subconicoides* (Lej.-Carp.) Harker and Sarjeant, chart 9.

1976 *P.? subconicoides* (Lej.-Carp.) Lentin and Williams, p. 111, pl. 14 : 219.

1977 *P.? subconicoides* (Lej.-Carp.) Lentin and Williams, p. 121,

1978 *P.? subconicoides* (Lej.-Carp.) Stover and Evitt, p. 218.

Remarks

All specimens originally figured by the first author (1942) save one (XL1-3, whose containing flint has slipped too close to the edge of the mount for it to be visible) were re-examined. One specimen (XVIII-1, figured by Lejeune-Carpentier, 1942, fig. 8, and herein, pl. 6 : 4) shows an opening in the lateral and posterior surfaces of the hypotract, but this is considered to be random damage. None of the specimens gives any least indication of an archaeopyle.

Three principal possibilities thus exist. First, that we may be dealing with fossil motile thecae (highly improbable). Second, that we may be dealing with cysts from which excystment did not occur (possible but unusual). Third, that we are dealing with forms in which the aperture has closed up again after excystment.

Peridinioid forms are known which open by means of a transapical suture (see Norris and Hedlund, 1972 : Evitt, 1974) : they appear to intergrade with forms having a combination epitractal archaeopyle and are placed, together with those forms, into the genus *Palaeoperidinium.* Whether the species *subconicoides* has such an archaeopyle remains to be demonstrated when further specimens are recovered from other localities ; but it is sufficiently similar in general morphology to other species of *Palaeoperidinium* for its provisional placement into that genus to seem perfectly proper.

Group Acritarcha Evitt, 1963

Subgroup POLYGONOMORPHITAE Downie, Evitt and Sarjeant, 1968

Genus *Veryhachium* Deunff, 1959, *emend.* Loeblich and Tappan, 1969

Remarks

Whilst the second author continues to take issue with some of the taxonomic pronouncements enunciated by Loeblich and Tappan (1976), developing

knowledge of Palaeozoic acritarchs has rendered their restriction of the genus *Veryhachium* much more acceptable to him than it was earlier (see Sarjeant, 1973). Thus their concept of that genus, as embracing "forms with a lenticular, triangular or more rarely quadrangular body, with major processes in the plane of the body but occasional accessory procésses perpendicular to this" (Loeblich and Tappan, 1969, p. 56), is here provisionally accepted ; though our disagreement concerning the possible styles of opening continues unabated !

Veryhachium? cruciatum (O. Wetzel, 1933)
comb. nov., emend.

Plate 3 : 4 ; Text-fig. 12

1933 *Hystrichosphaera cruciata* O. Wetzel, p. 94-95, pl. 4 : 30.

1937 *Hystrichosphaeridium cruciatum* (O. We.) Deflandre, p. 79.

1940 *H. cruciatum* (O. We.) Lejeune-Carpentier, p. B223-B224, fig. 14.

1964 *H. cruciatum* (O. We.) Downie and Sarjeant, p. 120.

1966 *H. cruciatum* (O. We.) Davey and Williams, p. 70.

1967a *H. cruciatum* (O. We.) Sarjeant, tab. 6 (p. 332).

1973 *H. cruciatum* (O. We.) Lentin and Williams, p. 74.

1975 *H. cruciatum* (O. We.) Harker and Sarjeant, chart 12.

1977 *H. cruciatum* (O. We.) Lentin and Williams, p. 81.

1978 *H. cruciatum* (O. We.) Stover and Evitt, p. 56.

Emended Diagnosis

Vesicle elongate quadrangular in outline, the polar faces each giving rise to long processes whose points of origin impart to those faces a measure of triangularity. Certainly two, probably three, processes arise about one pole (at top in figure) : three processes arise about the opposite pole. The processes are extremely long, up to 2 1/2 times the longest dimension of the vesicle ; they are relatively broad-based, some tapering smoothly from base to tip, others flaring distally into bi-, tri- or quadrifurcations, the branches of equal to markedly unequal length. The vesicle opens at one pole (placed at the top in the sketch, Text-fig. 12) by epityche or cryptosuture.

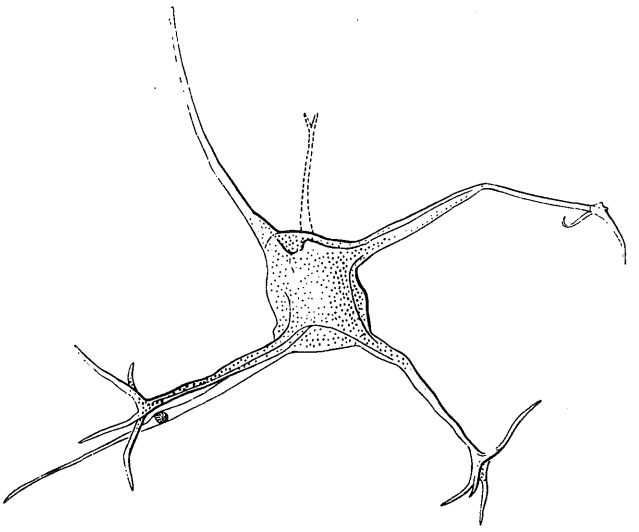

Figure 12.
Veryhachium? cruciatum *(O. Wetzel, 1933). The holotype.*

Holotype

Specimen 465, O. Wetzel Collection, Geologisches Institut der Universität, Kiel, Germany.

Figured Specimen.

Specimen LX-1, lodged in the Laboratoire de Paléontologie, Université de Liège, Belgium ; figured by Lejeune-Carpentier (1940, fig. 14) and herein, pl. 3 : 4, text-fig. 12.

Horizon and Locality

Holotype : Flint of Upper Cretaceous, presumably from the North German drift (locality not specified by the original author). Figured Specimen : Flint of Craie de Nouvelles (= Formatie van Gulpen of Felder, 1975), Upper Cretaceous (Senonian), Mons-Crotteux (Lez-Liège), Belgium.

Dimensions

Holotype : overall cross-measurement (between tips of processes) c. 92 μm ; cross-measurements of central body c. 20-24 μm, processes up to 40 μm long. Figured specimen : long axis of vesicle 20 μm, short axis 14.5 μm, length of processes up to 48.5 μm.

Description

Our observations are based, not on the holotype,

but on the specimen from the Upper Cretaceous of Belgium attributed to this species by the first author (1940). Insofar as the minute photograph published by Otto Wetzel (1933, pl. 4 : 30) can be relied upon, these specimens are closely comparable in all major features. The arbitrary orientation imposed in Text-fig. 12 is utilised in the following description.

Two processes arise from the corners of the upper face at the top. That at left is blunt-tipped and appears broken ; that at right is bent but unbroken, tapering from the base almost to the tip where it gives rise to two long branches (there is the suggestion that a third branch may have been broken off). A third process appears to arise from the lower face and to extend downwards into the enclosing silica (see Text-fig. 12) ; but its presence cannot be affirmed with complete confidence. An opening is evident at the junction between the upper face and the uppermost surface of the vesicle ; its form is not clear. (It may equally well be a cryptosuture or an epityche with infolded margin).

Three long processes surround the bottom surface, two on the upper and one on the lower face. That at upper left extends obliquely up through the flint and, in the drawing, appears foreshortened ; it gives rise distally to four branches of subequal length. That at right is similar, though the branches are more unequal ; but the process at lower left is unbranched and acute.

The surface of the vesicle is granular.

Remarks

In their survey of pre Quaternary dinoflagellate cysts, Stover and Evitt (1978) note that *cruciatum* is "probably an acritarch". Our restudy causes us to concur in this judgement and to firmly reject the earlier opinion by Davey and Williams (1966) that it is "probably the apical region of an otherwise undescribed species [of dinoflagellate]". Indeed, the specimen examined affords no least indication of dinoflagellate affinity.

The concept of *Veryhachium*, as emended by Loeblich and Tappan (1969), is that it should contain acritarchs whose principal processes all arise in the same plane. Those of *cruciatum* clearly do not ; its assignation to *Veryhachium* is thus questionable. However, since no other acritarch genus known to be represented in the Mesozoic affords a more suitable lodgement for this species, and since we are reluctant to erect a new genus on the inadequate foundation of two specimens, we propose its provisional attribution to *Veryhachium* until fuller information is forthcoming.

It should be noted that the spines are evidently both rigid and brittle ; it is possible, indeed, that the species has been so rarely observed-and only from flints-because it breaks up in the violence of reaction during chemical extraction of palynomorphs from sediments.

That these specimens were reworked from older sediments seems hardly likely, (a.) because no other reworked specimens are present in these flints and (b.) because exactly similar forms have not yet been recorded from more ancient sediments.

ACKNOWLEDGEMENTS

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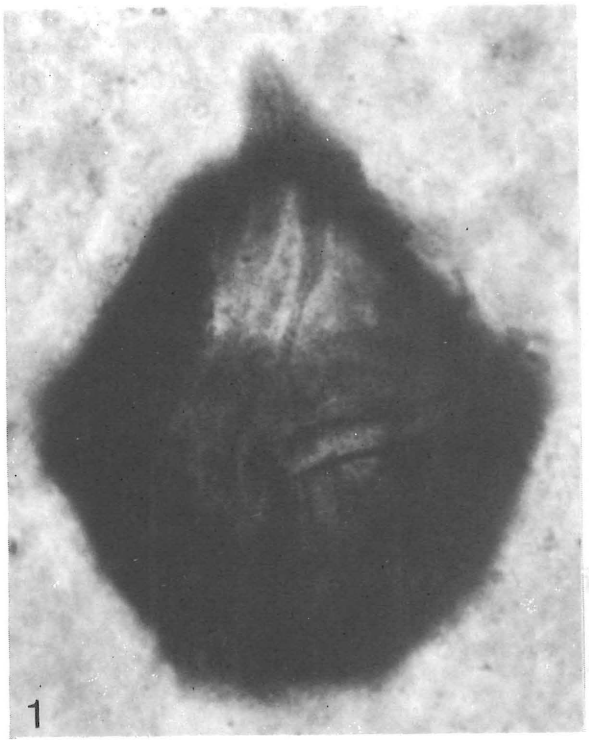
PLATE 1

1-2 *Gonyaulacysta wetzeli* (Lejeune-Carpentier, 1939), emend. The paratype (1. In ventral view. 2. In dorsal view, by transparency).

3-4 *Cribroperidinium ventriosum* (O. Wetzel, 1933), emend. The holotype (3. In left lateral view. 4. In right lateral view, by transparency).

All figures X 1,000.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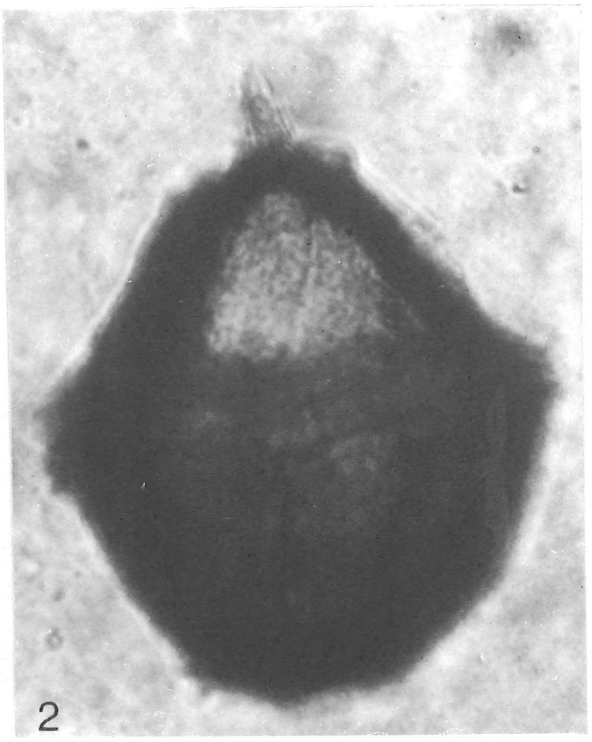
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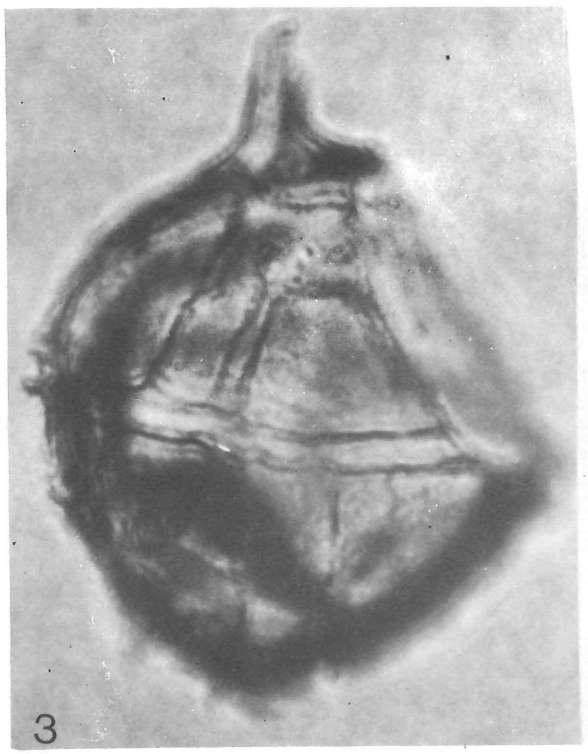
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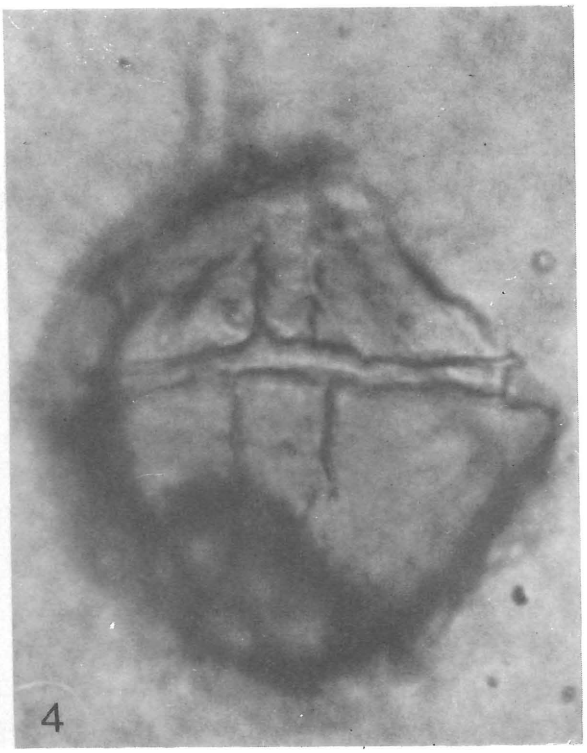
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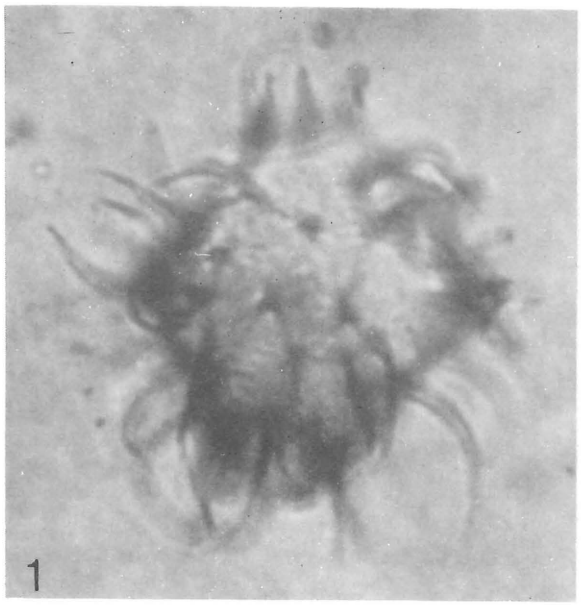
PLATE 2

1-2 *Fibrocysta?* cf. *deflandrei* (Lejeune-Carpentier, 1941), stat. et comb. nov., emend. Specimen CXII-53. (1. In presumed ventral view. 2. In presumed dorsal view). X c. 1,250.

3-5 *Gonyaulacysta? obscura* (Lejeune-Carpentier, 1946), emend. 3-4. The holotype (3. In ventral view. 4. In dorsal view, by transparency). 5. The paratype. X 1,000.

6-7 *Amphorosphaeridium major* (Lejeune-Carpentier, 1940), comb. nov., emend. The holotype. (6. In slightly oblique antapical view. 7. In slightly oblique apical view, by transparency). x 500.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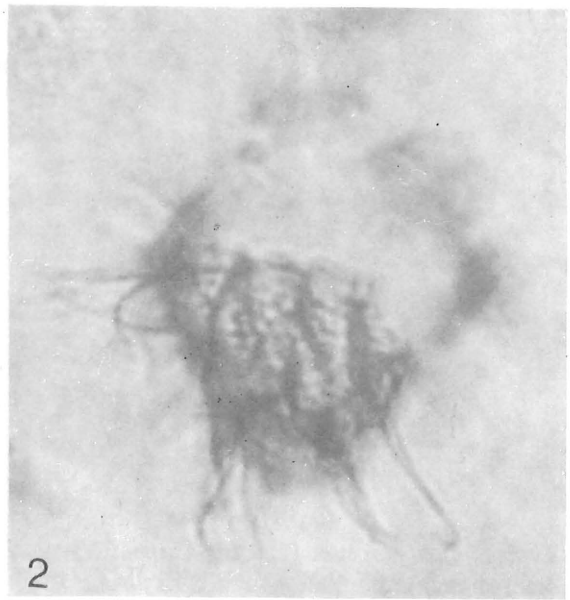
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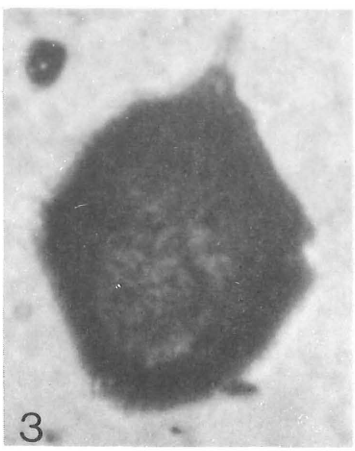
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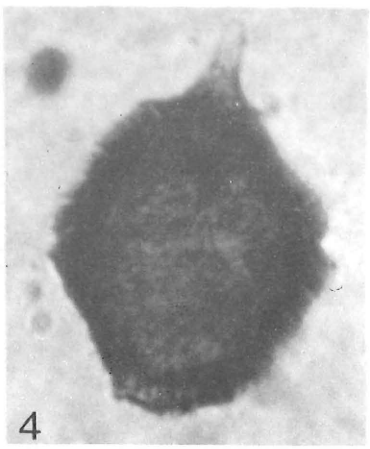
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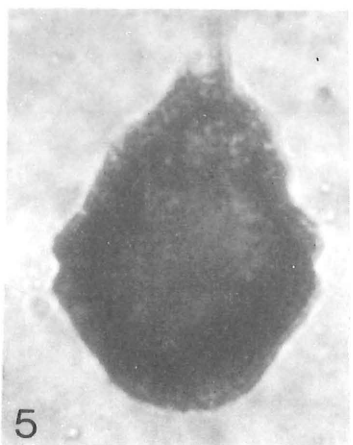
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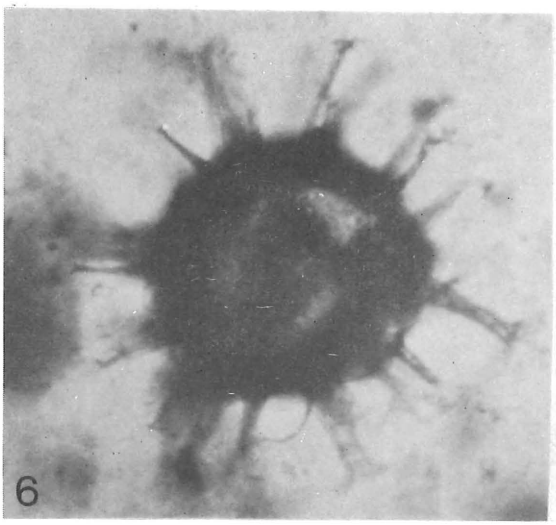
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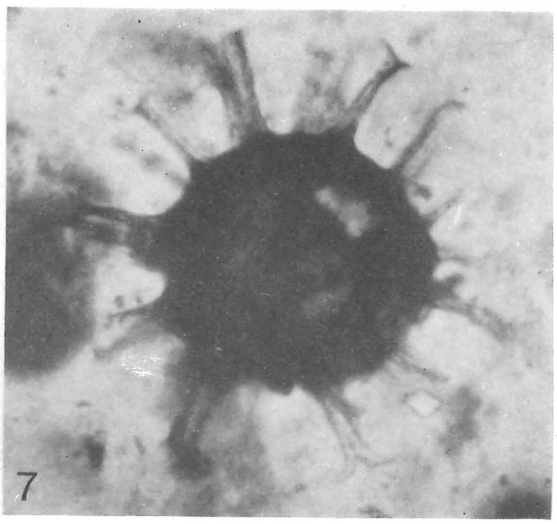
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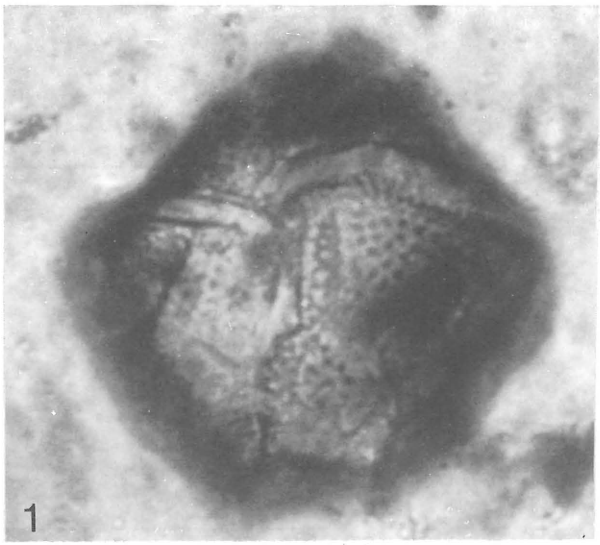
PLATE 3

1-2 *Leptodinium porosum* (Lejeune-Carpentier, 1946). The holotype (1. In ventral view. 2. In dorsal view, by transparency). x 1,000.

3 *Hystrichokolpoma? crassipes* (Reade, 1839), comb. nov., emend. The neotype, in oblique right lateral view. x 1,000.

4 *Veryhachium? cruciatum* (O. Wetzel, 1933). The holotype, x c. 660.

5-6 *Areoligera senonensis* Lejeune-Carpentier, 1938. The holotype. (5. In apical view, by transparency. 6. In antapical view). x c. 660.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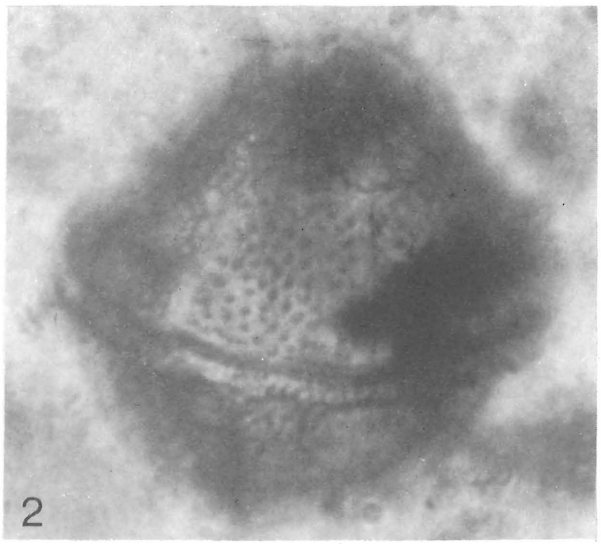
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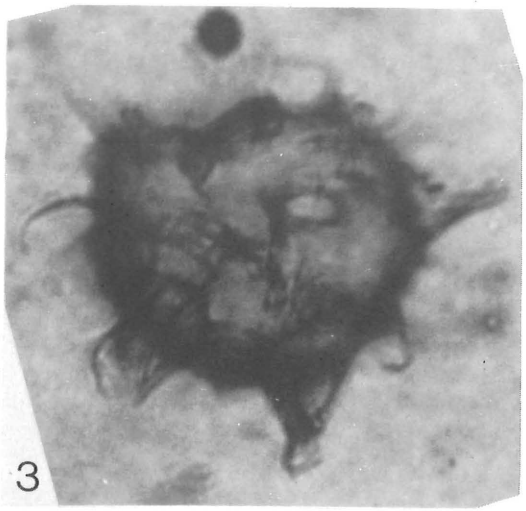
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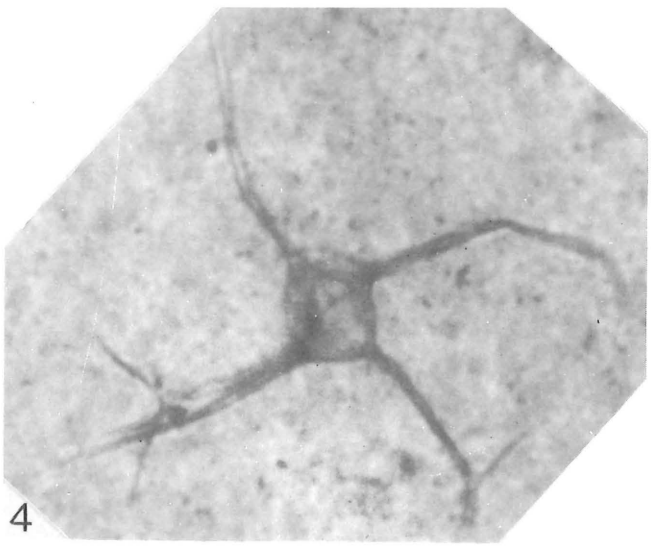
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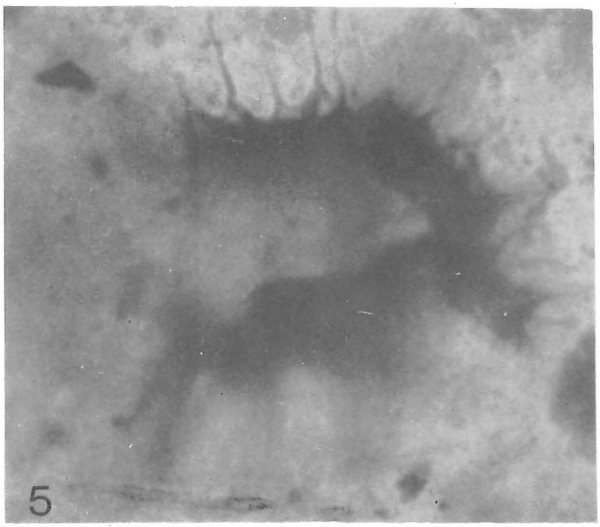
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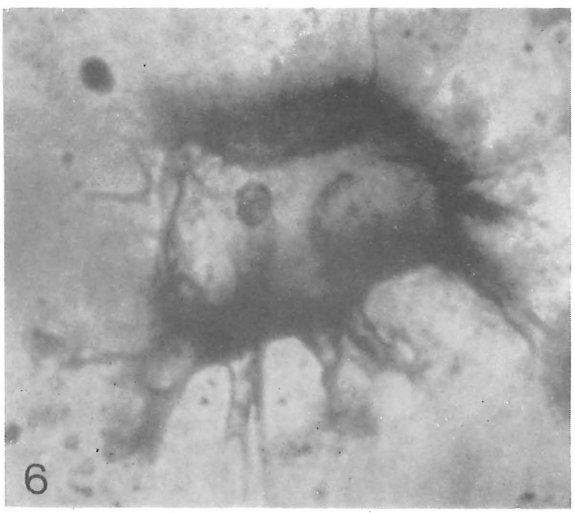
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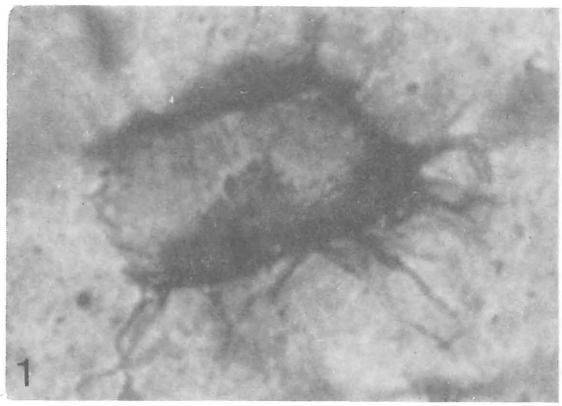
PLATE 4

1-2 *Areoligera senonensis* Lejeune-Carpentier, 1938. Paratype, specimen XXX-75. (1. In oblique apical view, by transparency. (2. In oblique antapical view). x c. 660.

3-4 *Oligosphaeridium complex* (White). Specimen CVIII-4, formerly the holotype of *Hystrichosphaeridium elegantulum* Lejeune-Carpentier. (3. In oblique apical view. 4. In oblique antapical view, by transparency). x 700.

5-6 *Fibrocysta? deflandrei* (Lejeune-Carpentier, 1940), stat. et comb. nov., emend. The holotype (5. In right lateral view. 6. In left lateral view, by transparency). x 1,000.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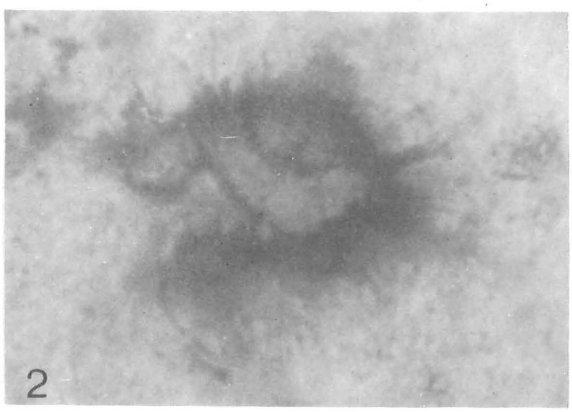
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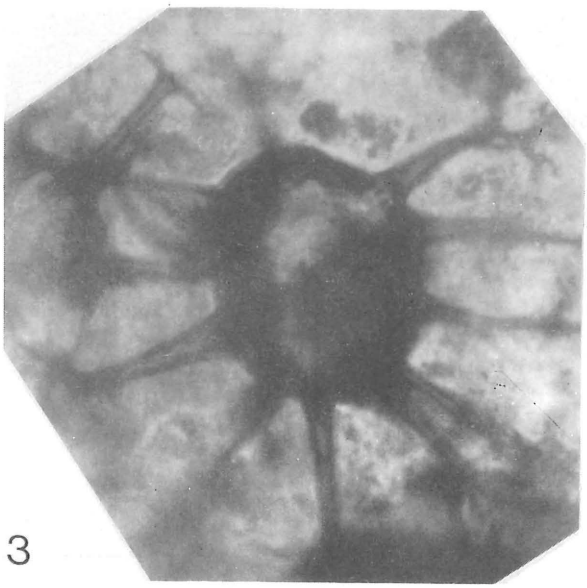
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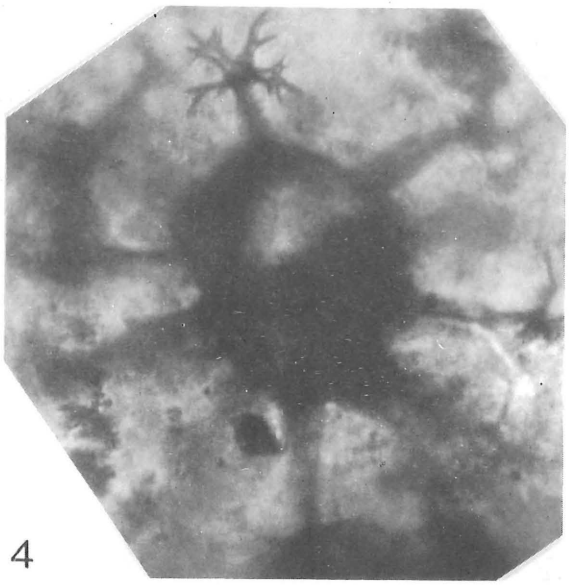
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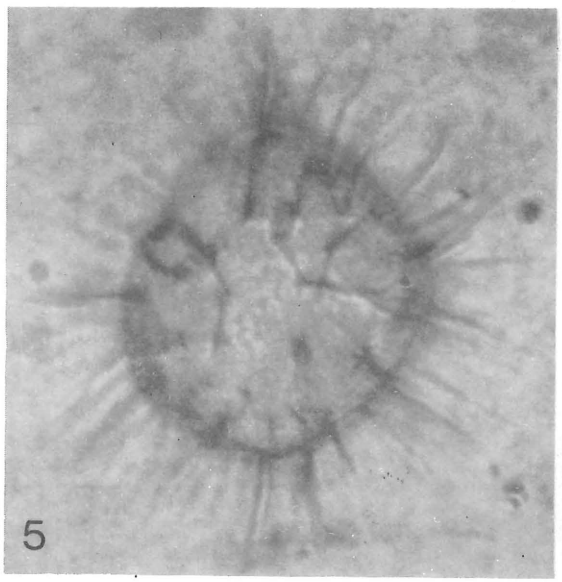
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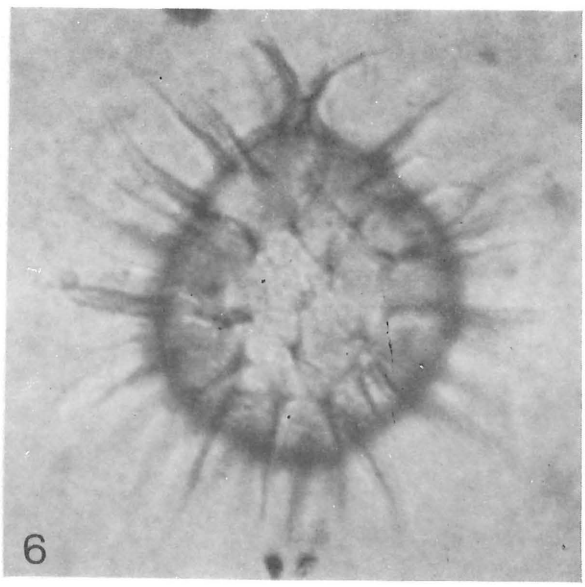
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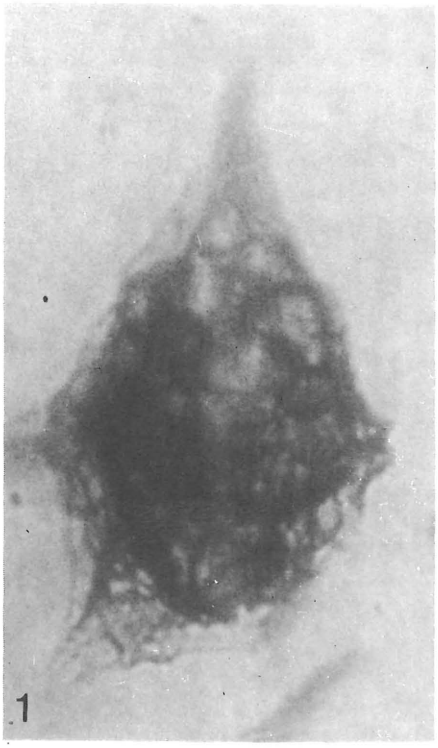
PLATE 5

1-2 *Deflandrea galeata* (Lejeune-Carpentier, 1942), emend. The holotype. (1. In oblique ventral view. 2. In oblique dorsal view, by transparency). x 700.

3-4 *Oligosphaeridium complex* (White). Specimen CVIII-5 (3. At lower focus, by transparency. 4. At upper focus). x 700.

5-6 *Gonyaulacysta wetzeli* (Lejeune-Carpentier, 1939), emend. The holotype. (5. In slightly oblique ventral view. 6. In slightly oblique dorsal view, by transparency). x 500.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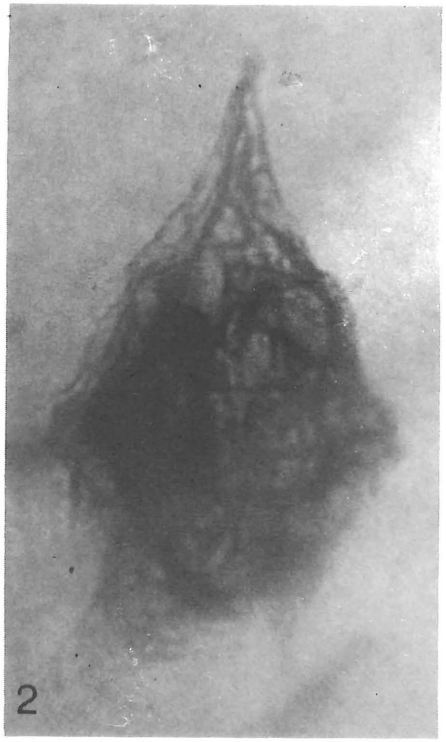
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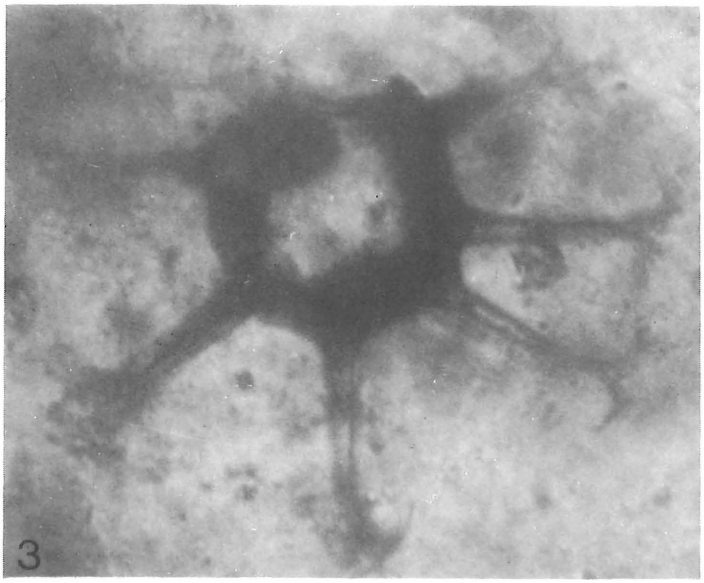
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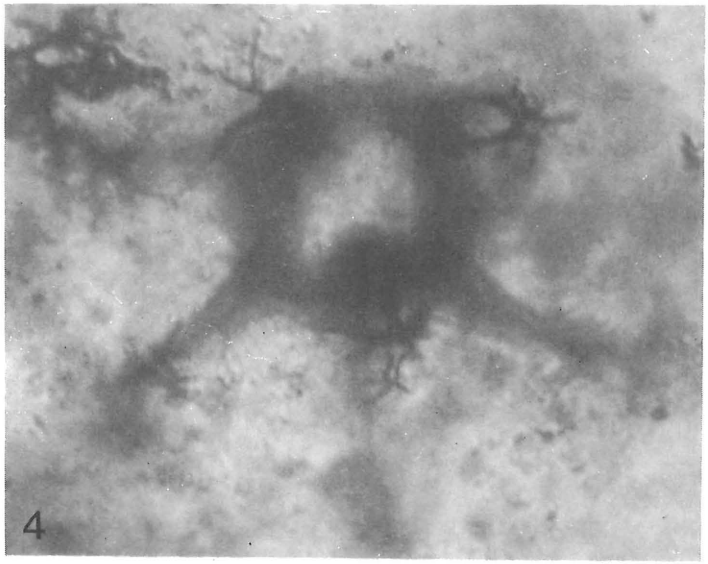
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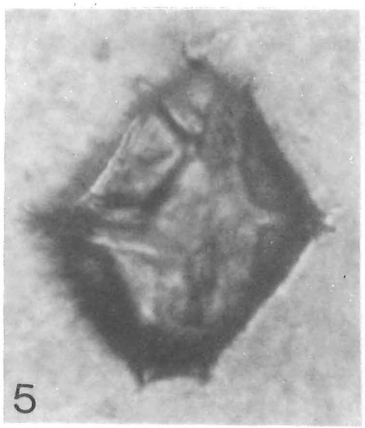
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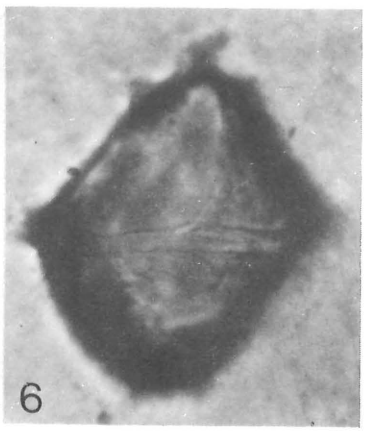
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PLATE 6

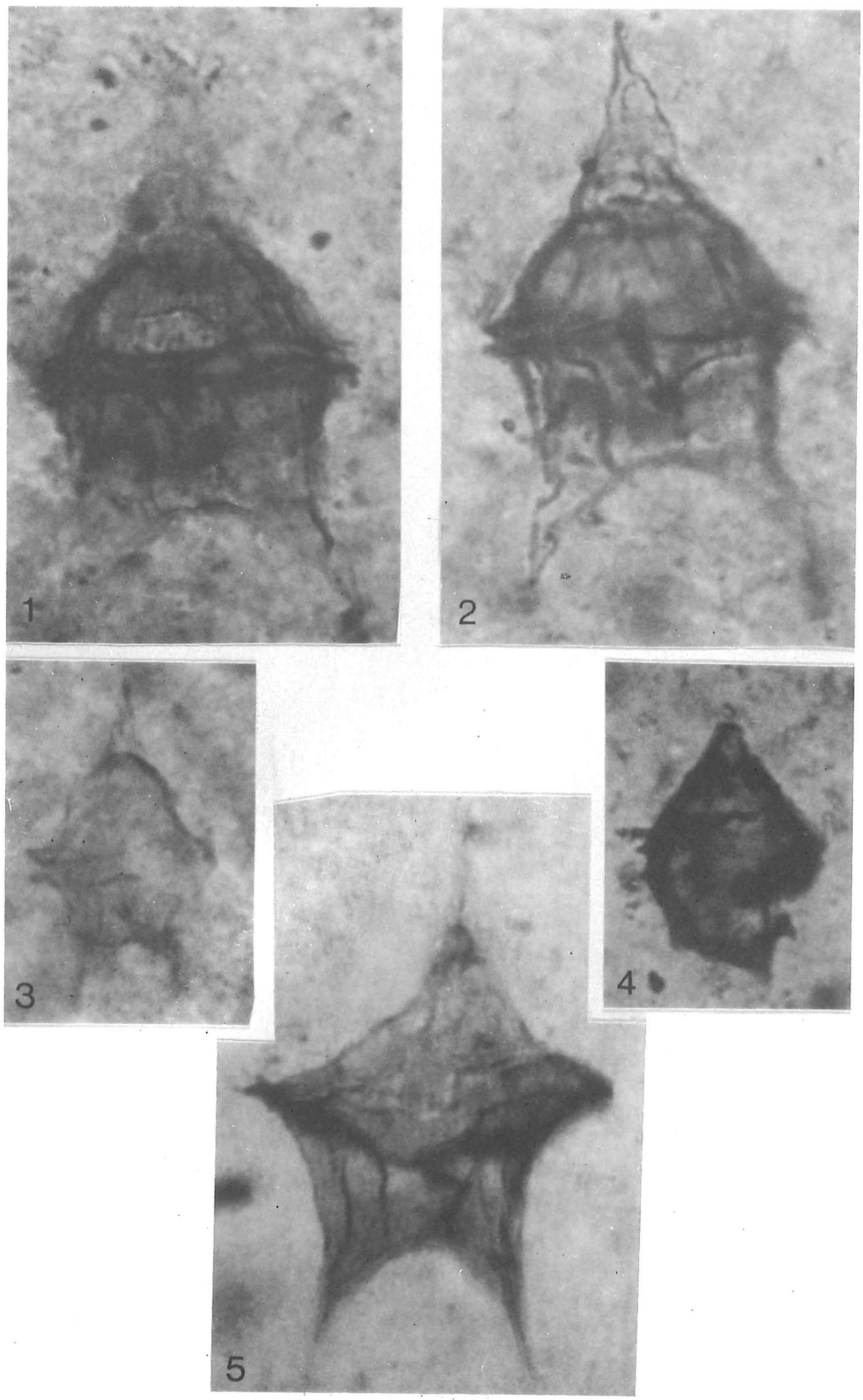
1-2 *Deflandrea galeata* (Lejeune-Carpentier, 1942), emend. Specimen CXIII-31 (1. In dorsal view, by transparency. 2. In ventral view).

3 *Deflandrea damasii* (Lejeune-Carpentier, 1942), comb. nov., emend. The holotype, in dorsal view.

4 *Palaeoperidinium? subconicoides* (Lejeune-Carpentier, 1942). Specimen XVIII-1.

5 *Lejeunecysta tricuspis* (O. Wetzel), emend. The holotype, in dorsal view.

All figures x 700.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2
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ANNALES DE LA SOCIETE GEOLOGIQUE DE BELGIQUE, T. 104, fascicule 1 (1981)

ERRATA

p. 1 : Résumé : 4ème ligne, au lieu de "*damasi*", lire "*damasii*"
9ème ligne, au lieu de "*Criboperidinium*", lire "*Cribroperidinium*"

p. 6, 2ème colonne, 9ème ligne, au lieu de "judgement or differ", lire "judgement and differ".

p. 26, 2ème colonne : STOVER, L.E. & EVITT, W.R., 1978. Au lieu de "Anayses", lire "Analyses".

p. 27, 2ème colonne : WILLIAMS, G.L. & DOWNIE, C., 1966. Au lieu de "Suties", lire "Studies".