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BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN

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INHOUDSTAFEL

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A restudy of Pastiels' (1948) dinoflagellate cysts from the Early Eocene of Belgium

by William Antony S. SARJEANT*
(With five plates and one table)

Résumé

L'assemblage de cystes de Dinoflagellates du début de l'Eocène (Yprésien), décrit par PASTIELS (1948) est réexaminé d'après les types subsistants. Vingt-huit taxa au moins sont reconnus. Une nouvelle espèce, *Cannosphaeropsis williamsii* est fondée et deux nouvelles combinaisons, *Nematosphaeropsis reticulensis* (PASTIELS, 1948) et *Tityrosphaeridium exilimurum* (DAVEY et WILLIAMS, 1966a) sont proposées. Les diagnoses des familles Deflandreaceae EISENACK, 1954 et Wetzeliellaceae VOZZHENNIKOVA, 1961 et des espèces *Nematosphaeropsis reticulensis, Glaphyrocysta exuberans* (DEFLANDRE et COOKSON, 1955) et *G. pastielsi* (DEFLANDRE et COOKSON, 1955) sont amendées. Le néotype de *G. exuberans* et le lectotype de *Nematosphaeropsis reticulensis* sont désignés. La morphologie de *Polysphaeridium belgicum SARJEANT in* DAVEY *et al.*, 1969 et les conséquences de la distinction des genres *Polysphaeridium* DAVEY et WILLIAMS, 1966a emend. BUJAK *et al.*, 1980b et *Dapsilidinium* DAVEY et WILLIAMS, 1966b sont discutées. Au début de l'Eocène, les assemblages du nord-ouest de l'Europe sont très semblables à ceux des «Grand Banks», au large du Canada oriental. Par contre, les assemblages de cette dernière région se sont que partiellement comparables à ceux des plates-formes continentales du Labrador et de la Nouvelle-Ecosse (ici respectivement appelés «Association Bujak» et «Association Brideaux») et diffèrent nettement de ceux connus dans d'autres parties du monde.

Abstract

The Early Eocene (Ypresian) dinoflagellate cyst assemblage described by PASTIELS (1948) is reassessed, on the basis of an examination of surviving type material. At least twenty-eight different taxa are recognized. The new species *Cannosphaeropsis williamsii* and the new combinations *Nematosphaeropsis reticulensis* (PASTIELS, 1948) and *Tityrosphaeridium exilimurum* (DAVEY and WILLIAMS, 1966a) are proposed. Emended diagnoses are formulated for the families Deflandreaceae EISENACK, 1954 and Wetzeliellaceae VOZZHENNIKOVA, 1961 and for the species *N. reticulensis, Glaphyrocysta exuberans* (DEFLANDRE and COOKSON, 1955) and *G. pastielsii* (DEFLANDRE and COOKSON, 1955). A neotype is selected for *G. exuberans* and a lectotype for *N. reticulensis*. The morphology of *Polysphaeridium belgicum* SARJEANT *in* DAVEY *et al.*, 1969, and the problems presented by the generic separation of *Polysphaeridium* and *Dapsilidinium*, as comprehended by BUJAK *et al.*, 1980b, are discussed. It is shown that, whereas there is great uniformity in Early Eocene assemblages between northeast Europe and the Grand Banks, offshore eastern Canada, the assemblages of the latter region differ in detailed composition from those of the Labrador and Scotian Continental Shelves (herein termed the "Bujak" and "Brideaux" Associations) and vary markedly from those recorded in other parts of the world.

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Acknowledgements

The author's visit to Brussels in 1979, was made possible by financial support from the National Research Council of Canada. I am indebted also to Dr. P. SARTENAER, Head of the Department of Palaeontology, the Institut Royal des Sciences Naturelles, for his courteous permission to restudy PASTIELS' material. Both during and after that visit, the assistance of Dr. Francine MARTIN, who granted me the use of her Leitz photomicroscope, has been invaluable. Thanks are offered to the staff of the Photographic Unit, Audio-Visual Services, University of Saskatchewan, for assistance in the preparation of the plates. I am grateful also to Dr. Jonathan P. BUJAK (Petro-Canada, Calgary, Alberta) for an exceptionally helpful referee's report on the manuscript.

I. - Introduction

A brief history of the study of Eocene dinoflagellate cysts has been given in an earlier paper (SARJEANT, 1981, p. 99). Although Eocene dinoflagellate cysts were first reported in 1892 and several times noted in subsequent papers, the earliest reasonably full account of an Eocene assemblage did not come until more than fifty years later, with the work of the Belgian stratigrapher and micropalaeontologist André Pastiels (1919-1970).

PASTIELS' paper, published in 1948, was an attempt to stimulate interest in Eocene microfossils in general; it embraced not merely dinoflagellate cysts, but also diatoms, spores and pollen, "internal moulds" of foraminifera and fungal remains. Microfossils from Landenian (late Palaeocene; Thanetian) strata were examined, but no dinoflagellates were reported from those strata; all PASTIELS' fossil dinoflagellates were extracted from Early Eocene (Ypresian) horizons. Since the cyst nature of fossil dinoflagellates had not then been appreciated and the dino-

flagellate affinity of the hystrichospheres was not recognized, PASTIELS dealt with the majority of the forms he observed under two headings — "Hystrichosphaeridés" and "Dinoflagellates". Moreover, he followed O. WETZEL (1933) in considering the genus *Cannosphaeropsis* to be a radiolarian and he did not perceive, in some other specimens, any indication of affinity, listing them merely as "spores incertae sedis". In consequence, accounts of dinoflagellate cysts are to be found in his paper under four different headings.

PASTIELS was reluctant to formulate new names and, although the majority of the forms he was seeing were yet undescribed, he proposed three new species only, one of which (*Hystrichosphaeridium geometricum*) was a junior homonym. Of the two others, one (*Nematosphaeropsis* [ex: *Cannosphaeropsis*] *recticulensis*) is now known to be a dinoflagellate cyst, not a radiolarian as PASTIELS supposed, whilst the other (*Micrhystridium multispinosum*), in contrast, is considered now to be an acritarch and is not treated here. The majority of the twenty-one morphotypes were either placed into existing species — some Late Cretaceous, some Palaeozoic — or identified to generic level only.

Many of these taxonomic placements were, even at that time, clearly inappropriate. Moreover, the morphological boundaries drawn by PASTIELS were (as we may now perceive, though he could not) too broad. However, his photographs and (in particular) his drawings were sufficiently good to permit other authors to use them as a basis for new taxa. DEFLANDRE and COOKSON (1955) began this process when, incidentally in a study of Mesozoic and Tertiary assemblages from Australasia, they elevated two of PASTIELS' forms to specific status, the forms he had attributed to *Membranilarnax pterospermoides* O. WETZEL becoming *Cyclonephelium* (now *Glaphyrocysta*) *exuberans* and those he had termed *Membranilarnax* cf. *liradiscoides* becoming *Cyclonephelium* (now *Glaphyrocysta*) *pastielsii.* Subsequently, DAVEY and WILLIAMS (1966a) used the specimens PASTIELS had attributed to *Hystrichosphaeridium pseudhystrichodinium* DEFLANDRE as conceptual basis for their new species *Polysphaeridium* (now *Dapsilidinium*) *pastielsii,* though choosing an English specimen as holotype. Three years later, the forms attributed by PASTIELS to the Palaeozoic species *Hystrichosphaeridium fluctuans* were elevated by me to specific status, as *Polysphaeridium? belgicum* SARJEANT *in* DAVEY *et al.,* 1969.

Thus the PASTIELS type material, now lodged in the Institut Royal des Sciences Naturelles, Brussels, contains the holotypes and paratypes of five valid species and one that is invalid. Moreover, this material furnished the foundation for modern studies of Eocene dinoflagellate cysts. For these reasons, its restudy seemed to me highly desirable; and, with that object, I visited Brussels in September 1979. The slides were well labelled and adequately curated, but their contents proved to be in extremely poor condition. Glycerine had been used as mountant and the slides, improperly sealed, had partially or completely dried out. Many figured specimens could not be located at all; others had moved or rotated, making their confident recognition impossible. In some instances, either debris (e.g. Pl. III, fig. 5) or clusters or streams of bubbles in the mountant (e.g. Pl. V, fig. 4) obscured the specimen in varying degree. There were fungal growth on some specimens (e.g. Pl. III, fig. 5). In other instances, the only remaining mountant was a mass held by, and obscuring, the specimen's processes (e.g. Pl. I, fig. 5; Pl. III, fig. 2). Remounting of this material is contemplated but, though possible, will certainly be hazardous. By the reillustration (and, where necessary, redescription) of the surviving specimens, it is hoped that a fuller understanding of this classic material will be rendered possible. In addition, PASTIELS' specimens are reattributed to the taxa recognized today; full synonymies are presented wherever appropriate; and the stratigraphical significance of his assemblage is assessed.

II. - Systematics

Class Dinophyceae PASCHER
Subclass Diniferophycidae BERGH
Family Spiniferitaceae SARJEANT, 1970,
emend. SARJEANT and DOWNIE, 1974
Genus *Spiniferites* MANTELL, 1850,
emend. SARJEANT, 1970
Spiniferites ramosus (EHRENBERG, 1838)
MANTELL, 1854
Spiniferites ramosus (EHRENBERG) var. *ramosus*
(DAVEY and WILLIAMS, 1966a)
DAVEY and VERDIER, 1971

[A partial synomymy to 1981 for this long-ranging variety, showing the different names applied to it, is given by SARJEANT, 1983, p. 91. The following entry should be added].

1948. — *Hystrichosphaeridium ramuliferum* DEFLANDRE — A. PASTIELS, p. 39, pl. 3, figs. 17-19.

DISCUSSION

The form attributed by PASTIELS to the Late Cretaceous species *Hystrichosphaeridium ramuliferum* DEFLANDRE (now *Achomosphaera ramulifera*) was noted as having "small crests irregularly disposed on its surface and at the points of origin of the appendages" (1948, p. 39, new transl.). Since the genus *Achomosphaera* and, in particular, its type species *A. ramulifera* are distinguished by the *lack*

of such crests, PASTIELS' identification cannot be maintained. Though none of the three specimens he figured could be located on the dried-out slides, his illustrations make it evident that they are attributable to *Spiniferites ramosus* and, in particular, to its variety *ramosus*.

Paradoxically, however, *Achomosphaera ramulifera* is indeed present in PASTIELS' assemblages, specimens of it having been misattributed to the Silurian species *Hystrichosphaeridium* (now *Baltisphaeridium*) *triangulatum,* an acritarch, as discussed later in this paper.

It should be noted that the blanket elevation of all fossil dinoflagellate cyst varieties to subspecific status by LENTIN and WILLIAMS (1973) is unacceptable to me, for reasons set forth earlier (see SARJEANT, 1976, p. 10, and 1983, p. 93).

Spiniferites ramosus (EHRENBERG) var. *reticulatus* (DAVEY and WILLIAMS, 1966a) DAVEY and VERDIER, 1971.
(Plate I, Figures 3-4).

1948. — *Hystrichosphaera furcata* (EHRENBERG). — A. PASTIELS, p. 36-37, pl. 3, fig. 11.

1966a. — *Hystrichosphaera ramosa* (EHRENBERG) var. *reticulata* DAVEY & WILLIAMS. — R.J. DAVEY and G.L. WILLIAMS, p. 38, pl. 1, figs. 2-3.

1969. — *Hystrichosphaera ramosa* (EHRENBERG) var. *reticulata* DAVEY & WILLIAMS. — R.J. DAVEY, p. 173.

1971. — *Hystrichosphaera ramosa* (EHRENBERG) var. *reticulata* DAVEY & WILLIAMS. — A. EISENACK and G. KJELLSTRÖM, p. 585.

1971. — *Spiniferites ramosus* (EHRENBERG) var. *reticulatus* (DAVEY & WILLIAMS). — R.J. DAVEY and J.P. VERDIER, p. 34.

1973. — *Spiniferites ramosus* (EHRENBERG) var. *reticulatus* (DAVEY & WILLIAMS). — R.J. DAVEY and J.P. VERDIER, text-fig. 9.

1973. — *Spiniferites ramosus reticulatus* (DAVEY & WILLIAMS) LENTIN & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 130.

1974. — *Spiniferites ramosus reticulatus* (DAVEY & WILLIAMS). — R.J. DAVEY and J.P. VERDIER, text-figs. 6-8.

1975. — *Spiniferites ramosus reticulatus* (DAVEY & WILLIAMS). — S.D. HARKER and W.A.S. SARJEANT, charts 3 (p. 236), 10 (p. 243).

1977b. — *Spiniferites ramosus reticulatus* (DAVEY & WILLIAMS). — J.K. LENTIN and G.L. WILLIAMS, p. 154.

1981. — *Spiniferites ramosus reticulatus* (DAVEY & WILLIAMS). — J.K. LENTIN and G.L. WILLIAMS, p. 266.

DISCUSSION

The two species *Hystrichosphaera ramosa* and *H. furcata* are now considered to be synonyms (see LEJEUNE-CARPENTIER, 1937 and DAVEY and WILLIAMS, 1966a). The specimen figured as *Hystrichosphaera furcata* by PASTIELS, was found on re-examination definitely to belong to the variety *reticulatus*; its surface ornament of reticulations may be seen clearly (Pl. I, fig. 4). This species has been reported hitherto only from the Middle to Late Cretaceous (Early Albian — Late Cenomanian).

The recognition of this variety in the Early Eocene (Ypresian) represents a considerable extension to its known stratigraphical range. However, this should occasion no surprise, for *Spiniferites ramosus* is so long-ranging a species as to be virtually without stratigraphical value and few palynologists trouble to discriminate its subordinate taxa, even though the latter might prove stratigraphically significant.

Spiniferites ramosus (EHRENBERG) var. *multibrevis* (DAVEY and WILLIAMS, 1966a) DAVEY and VERDIER, 1971.

[A full synonymy for this variety to 1981 is given in SARJEANT, 1983, p. 94-95. The following citation should be added].

(pars) 1948. — *Hystrichosphaeridium trifurcatum* EISENACK. — A. PASTIELS, p. 39-40, pl. 3, figs. 9-10.

(pars) 1975. — *Hystrichosphaeridium trifurcatum* EISENACK [of PASTIELS]. — S.D. HARKER and W.A.S. SARJEANT, chart 22 (p. 255).

DISCUSSION

Among the forms illustrated and described by PASTIELS were three which he misattributed to a Silurian species, *Hystrichosphaeridium* (now *Peteinosphaeridium*) *trifurcatum* EISENACK. He noticed that their appendages arose "either from tegumentary crests, or directly from the shell" (1948, p. 39, new transl.). Though two of the specimens he illustrated (*ibid.*, Pl. 3, figs. 9-10) were not found, as a consequence of drying out of the mountant, his illustrations indicate that they are attributable to the variety *multibrevis* of the species *Spiniferites ramosus*. Since the recorded range of this variety is Early Cretaceous (Valanginian) to Middle Miocene, its presence in the Early Eocene (Ypresian) occasions no surprise.

Genus *Achomosphaera* EVITT, 1963
Achomosphaera ramulifera (DEFLANDRE, 1937) EVITT, 1963
(Plate II, Figure 6).

[A full synonymy for this species to 1981 is given by SARJEANT, 1983, p. 97. The existing citation for

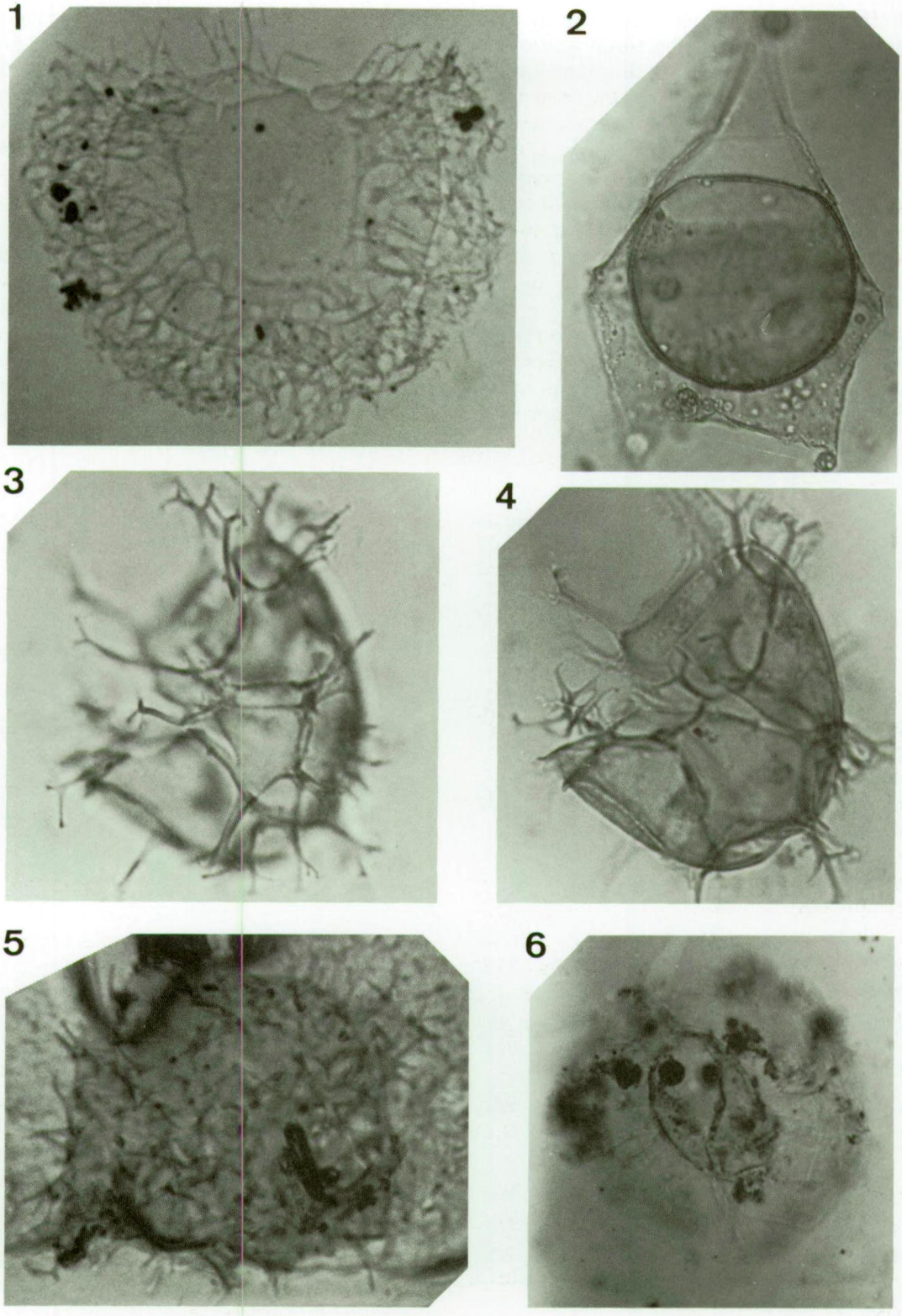

PLATE I

Fig. 1. – Glaphyrocysta divaricata *(WILLIAMS and DOWNIE) STOVER and EVITT, 1978. I.R.Sc.N.B. N° b 1529, dorsal view originally illustrated by PASTIELS (1948, Pl. 5, fig. 12) as* "Membranilarnax pterospermoides *O. WETZEL". × 1300.*

Fig. 2. – Deflandrea oebisfeldensis *ALBERTI, 1959. I.R.Sc.N.B. N° b 1530, dorsal view originally illustrated by PASTIELS (1948, Pl. 5, fig. 16) as* "Peridinium *cf.* galeatum *LEJEUNE-CARPENTIER". × 500.*

Figs. 3, 4. – Spiniferites ramosus *(EHRENBERG) var.* reticulatus *(DAVEY and WILLIAMS) DAVEY and VERDIER, 1971. I.R.Sc.N.B. N° b 1531, originally illustrated by PASTIELS (1948, Pl. 3, fig. 11) as* "Hystrichosphaera furcata *(EHRENBERG)". Fig. 3: in slightly oblique right lateral view. Fig. 4: in slightly oblique left lateral view. × 1000.*

Fig. 5. – Kisselovia tenuivirgula *(WILLIAMS and DOWNIE) LENTIN and WILLIAMS, 1976. I.R.Sc.N.B. N° b 1532, originally illustrated by PASTIELS (1948, Pl. 4, fig. 9) as* "Hystrichosphaeridium geometricum *nov. sp.". × 750.*

Fig. 6. – Thalassiphora delicata *WILLIAMS and DOWNIE emend. EATON, 1976. I.R.Sc.N.B. N° b 1533, slightly oblique dorsal view, originally illustrated by PASTIELS (1948, Pl. 6, figs. 35, 36) as "Spore inc. sed. Type-specimen n° 3". × 600.*

PASTIELS, 1948, should be deleted from, and the following citations added to, that list]:

(pars) 1948. — *Hystrichosphaeridium trifurcatum* EISENACK. — A. PASTIELS, p. 39-40, pl. 3, fig. 8.

(pars) 1975. — *Hystrichosphaeridium trifurcatum* EISENACK [of PASTIELS]. — S.D. HARKER and W.A.S. SARJEANT, chart 22 (p. 255).

1980. — *Achomosphaera ramulifera* (DEFLANDRE). — J.J. CHÂTEAUNEUF, p. 132, 256, text-fig. 346.

non 1948. — *Hystrichosphaeridium ramuliferum* DEFLANDRE. — PASTIELS, p. 39, pl. 3, figs. 17-19. [Shown herein to be *Spiniferites ramosus* var. *ramosus*].

DISCUSSION

As noted above, the specimens described and illustrated by PASTIELS under this name are not, in fact, attributable to this species. However, one of the three specimens which he misattributed to the Silurian acritarch species *Hystrichosphaeridium* (now *Peteinosphaeridium*) *trifurcatum* proved, on re-examination, to be a specimen of *Achomosphaera ramulifera* in slightly oblique antapical view (Pl. II, fig. 6).

PASTIELS' opinion (quoted above, p. 7) that there is intergradation between individuals with and without crests has been echoed by REID (1974) and MAY (1980), both of whom have proposed the abandonment of the genus *Achomosphaera* and the transfer of *A. ramulifera* to *Spiniferites*. This proposal was not accepted by LENTIN and WILLIAMS (1977b, p. 2; 1981, p. 3). It has been discussed by SARJEANT (1983, p. 99) and requires no fuller treatment here. The stratigraphic range of *A. ramulifera,* as presently defined, is extremely long, from Early Cretaceous (Valanginian) to Recent. Moreover, it is of almost world-wide occurrence in Late Cretaceous and Tertiary marine sediments (see summary in SARJEANT, 1983, p. 99).

Cf. *Achomosphaera alcicornu* (EISENACK, 1954) DAVEY and WILLIAMS, 1966a.

(pars) 1948. — *Hystrichosphaeridium salpingophorum* DEFLANDRE. — A. PASTIELS, p. 37, pl. 3, fig. 5.

DISCUSSION

Under the name of the Upper Cretaceous species *Hystrichosphaeridium salpingophorum* DEFLANDRE, PASTIELS (1948, Pl. 3, fig. 5) described and illustrated what we may now recognise as a variety of different morphotypes sharing the characteristic that they have tubular, intratabular processes. Among them is a form having relatively broad intratabular processes of tubiform, infundibular, buccinate or bifurcate shape, with aculeate to scutellate distal margins.

In the style of their terminations, these processes are reminiscent of those of the long-ranging species *Achomosphaera alcicornu.* However, they cannot be considered definitely to occupy gonal and sutural situations; moreover, they are both broader and shorter than those of typical *A. alcicornu.* Unfortunately the specimen could not be located, so that its affinity must remain a matter for speculation.

Genus *Nematosphaeropsis* DEFLANDRE and COOKSON, 1955, emend. WILLIAMS and DOWNIE, 1966c.

Nematosphaeropsis reticulensis (PASTIELS, 1948) comb. nov., emend. (Plate III, Figure 6).

(pars) 1948. — *Cannosphaeropsis reticulensis* PASTIELS. — A. PASTIELS, 1948, p. 49, pl. 5, figs. 7-8, 10.

?1961. — *Cannosphaeropsis reticulensis* PASTIELS. — G. ALBERTI, p. 36, pl. 9, fig. 15.

1967b. — *Cannosphaeropsis reticulensis* PASTIELS. — W.A.S. SARJEANT, p. 327.

?1968. — *Cannosphaeropsis reticulensis* PASTIELS. — J.J. CHÂTEAUNEUF and C. GRUAS-CAVAGNETTO, p. 130.

(pars) 1968. — *Adnatosphaeridium reticulensis* (PASTIELS). — J. DE CONINCK, p. 40, pl. 11, figs. 19, 20; pl. 12, figs. 2-5.

?1970a. — *Cannosphaeropsis reticulensis* PASTIELS. — C. GRUAS-CAVAGNETTO, p. 71.

?1970b. — *Cannosphaeropsis reticulensis* PASTIELS. — C. GRUAS-CAVAGNETTO, p. 131.

1971. — *Cannosphaeropsis reticulensis* PASTIELS. — A. EISENACK and G. KJELLSTRÖM, p. 135-136. [NOTE: The specimen they figure is not now considered attributable to this species].

1973. — *Cannosphaeropsis reticulensis* PASTIELS. — J.K. LENTIN and G.L. WILLIAMS, p. 12.

?1974. — *Adnatosphaeridium reticulensis* PASTIELS. — W.A.M. JENKINS, P. ASCOLI, F.M. GRADSTEIN, L.F. JANSA and G.L. WILLIAMS, p. 10.

1975. — *Adnatosphaeridium reticulense* (PASTIELS). — J. DE CONINCK, p. 23, 27, 47.

1975. — *Adnatosphaeridium reticulense* (PASTIELS). — S.D. HARKER and W.A.S. SARJEANT, chart 20 (p. 253).

?1976. — *Adnatosphaeridium* cf. *reticulense* (PASTIELS). — J. SCHUMACKER-LAMBRY and J.J. CHÂTEAUNEUF, p. 274.

1976. — *Adnatosphaeridium reticulense* (PASTIELS). — C. GRUAS-CAVAGNETTO, p. 44.

1977b. — *Adnatosphaeridium reticulense* (PASTIELS). — J.K. LENTIN and G.L. WILLIAMS, p. 4.

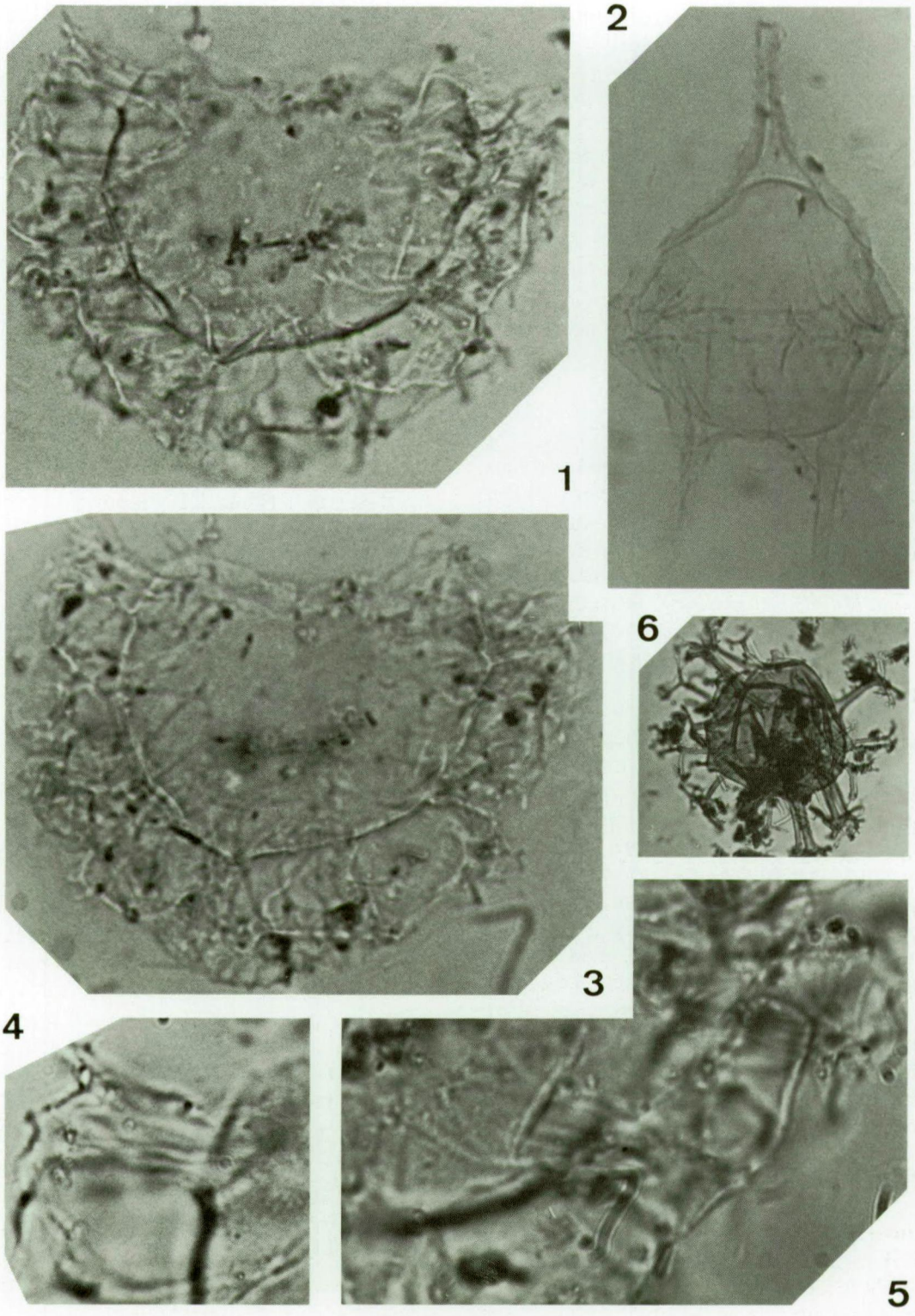

PLATE II

Figs. 1, 3-5. – Glaphyrocysta pastielsii *(DEFLANDRE and COOKSON) STOVER and EVITT, 1978 emend. nov. Holotype I.R.Sc.N.B. N° b 1534, originally figured by PASTIELS (1948, Pl. 5, fig. 15) as* "Membranilarnax *cf.* liradiscoides *O. WETZEL". Fig. 1: dorsal view, by transparency, × 900. Fig. 3: ventral view, × 900. Fig. 4: detail, showing the presumed paraplate 2", × 1800. Fig. 5: detail, showing the presumed paraplate 4"', × 1800.*

Fig. 2. – Ceratiopsis leptoderma *VOZZHENNIKOVA, 1963. I.R.Sc.N.B. N° b 1535, dorsal view, originally figured by PASTIELS (1948, Pl. 5, fig. 18) as* "Peridinium *cf.* galeatum *LEJEUNE-CARPENTIER". × 900.*

Fig. 6. – Achomosphaera ramulifera *(DEFLANDRE) EVITT, 1963. I.R.Sc.N.B. N° b 1536, slightly oblique antapical view, originally figured by PASTIELS (1948, Pl. 3, fig. 8) as* "Hystrichosphaeridium trifurcatum". *× 600.*

1978. — *Adnatosphaeridium reticulense* (PASTIELS). — L.E. STOVER and W.R. EVITT, p. 15.

?1980. — *Adnatosphaeridium reticulense* (PASTIELS). — M. LIENGJARERN, L.I. COSTA and C. DOWNIE, p. 478.

1980a. — *Adnatosphaeridium reticulense* (PASTIELS). — J. DE CONINCK, tabl. 1.

?1980a. — *Cannosphaeropsis reticulensis* (PASTIELS). — J.K. LENTIN and G.L. WILLIAMS, p. 6.

1981. — *Adnatosphaeridium reticulense* (PASTIELS). — J.K. LENTIN and G.L. WILLIAMS, p. 6.

non 1966. — *Cannosphaeropsis reticulensis* PASTIELS. — P. MORGENROTH, p. 19, pl. 4, figs. 2-3.

non 1966b. — *Cannosphaeropsis reticulensis* PASTIELS. — G.L. WILLIAMS and C. DOWNIE, p. 223, pl. 24, fig. 8.

non 1975. — *Adnatosphaeridium reticulense* (PASTIELS). — G.L. WILLIAMS and W.W. BRIDEAUX, p. 20, 22, pl. 21, fig. 11, folding figs. 8, 9, 11, 14, 15b.

non 1978. — *Adnatosphaeridium reticulense* (PASTIELS). — J. SCHUMACKER-LAMBRY, p. 35, pl. 1, fig. 8.

non 1980. — *Adnatosphaeridium reticulense* (PASTIELS). — J.J. CHÂTEAUNEUF, p. 132, 256, pl. 19, fig. 2, text-fig. 34b.

EMENDED DIAGNOSIS

Cyst spiniferate, trabeculate, hercotabulate. Central body spheroidal to broadly ovoidal. Processes gonal in situation, solid or hollow but always closed and furcate distally. Most processes are trifurcate, but the cingular processes are bifurcate. The process furcations are themselves bifurcate, giving rise to trabeculae connecting them to immediately adjacent processes. Length of processes between one-third and one-half the equatorial diameter of the cyst. Surface of phragma typically laevigate; septa between paraplates not marked. Paratabulation gonyaulacoid, indicated by the alignment of the trabeculae only; ?4′, 6″, 6c, 6‴, 1p, 1⁗. Archaeopyle single-plate precingular, type P (3″ only); operculum free.

HOLOTYPE

The specimen figured by PASTIELS, 1948, Pl. 5, fig. 10. (Not recognizable in his surviving material). Lectotype (here designated). — I.R.Sc.N.B. N° b 1541. This was figured as a paratype by PASTIELS (*ibid.*, Pl. 5, fig. 7).

DIMENSIONS

Holotype (in oblique polar view) [from PASTIELS' figure]: diameter overall 47-50 μm: diameter of central body c. 23-25 μm. Lectotype (in oblique dorsal view): overall length 65 μm. Length of central body 32 μm, overall beadth 61 μm, breadth of central body 25 μm.

TYPE HORIZON AND LOCALITY

Grey-blue clays, lower bed, Early Eocene (Early Ypresian), Blorquiau quarry of the Société Anonyme des Carrières de Quenast, Quenast, Belgium.

DISCUSSION

PASTIELS followed O. WETZEL (1933) in considering the genus *Cannosphaeropsis* to comprise radiolarians. This hypothesis was shown to be incorrect by G. DEFLANDRE (1947), who demonstrated instead that the genus comprises "hystrichospheres" — in current terminology, chorate dinoflagellate cysts.

Four of the specimens attributed by PASTIELS to his species *C. reticulensis* were illustrated, these being designated as holotype and three paratypes. Of these specimens, we were able to locate only one, a specimen which (though it has evidently shifted in the mountant) is considered to be that figured in his Pl. 5, fig. 7. A photograph of this specimen is here published for the first time. In lack of the holotype, it is designated lectotype for the species. It is indeed a more favourable reference specimen, being in dorso-ventral orientation, not polar orientation as was the holotype.

Its morphology proves to be markedly different from the concepts of this species that have resulted from the work of WILLIAMS and DOWNIE (1966b). Instead of having a general nontabulate scatter of processes, it has relatively few processes, all of them in gonal situations. Instead of having an overall surrounding trabecular meshwork, it has trabeculae which are aligned parallel to parasutures otherwise morphologically unexpressed. All in all, this specimen (and, therefore, this species) belongs not in the genus *Adnatosphaeridium,* as supposed hitherto, but in the genus *Nematosphaeropsis.* Examination of PASTIELS' illustrations of the holotype and one of the other paratypes shows them to be of comparable morphology. (The remaining paratype [1948, Pl. 5, fig. 9] has processes of dissimilar character and is compared on a later page, with a different species and genus).

The recognition that its morphology is so different from what has been believed hitherto casts doubt on most subsequent identifications of *N. reticulensis.* Only the specimens identified by DE CONINCK (1968) appear, in part at least, to correspond with this species, though those of ALBERTI (1961) may also do so. The specimens illustrated by WILLIAMS and BRIDEAUX (1975), by SCHUMACKER-LAMBRY (1978) and by CHÂTEAUNEUF (1980) instead correspond in morphology with that illustrated by WILLIAMS and DOWNIE (1966c); and unfortunately it was the illustration of their specimen, not of the holotype or a paratype, that was reproduced by EISENACK and KJELLSTRÖM (1971). It is highly

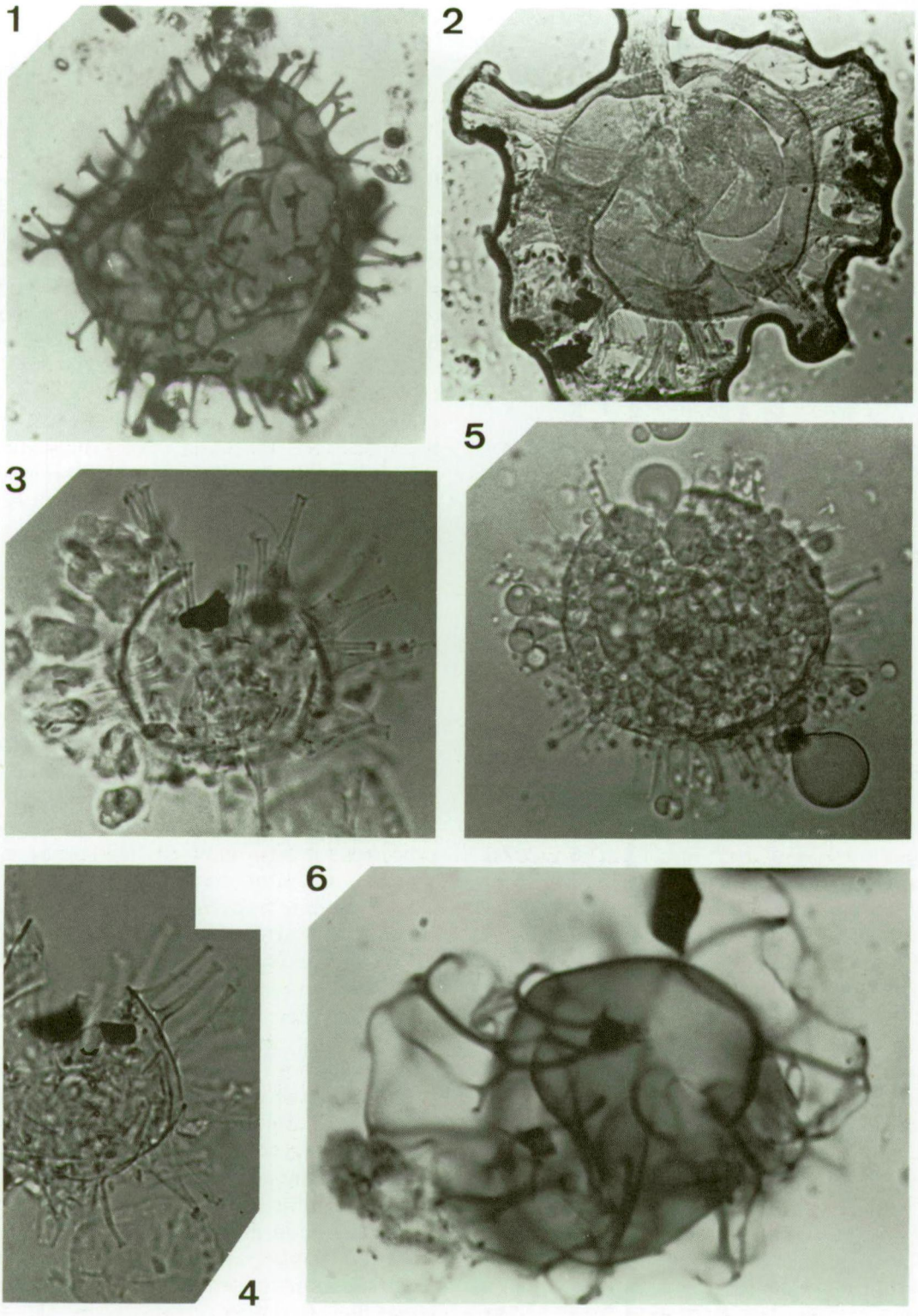

PLATE III

Fig. 1. – Apectodinium quinquelatum *(WILLIAMS and DOWNIE) COSTA and DOWNIE, 1979a. I.R.Sc.N.B. N° b 1537, dorsal view, with the displaced operculum within the cyst. Originally figured by PASTIELS (1948, Pl. 4, fig. 2) as* "Hystrichosphaeridium geometricum *sp. nov.". × 875.*

Fig. 2. – Tityrosphaeridium exilimurum *(DAVEY and WILLIAMS, 1966) comb. nov. I.R.Sc.N.B. N° b 1538, originally figured by PASTIELS (1948, Pl. 3, fig. 6) as* "Hystrichosphaeridium salpingophorum *DEFLANDRE". × 950.*

Figs. 3, 4. – Polysphaeridium *sp. I.R.Sc.N.B. N° b 1539, lateral view, originally figured by PASTIELS (1948, Pl. 3, fig. 14) as* "Hystrichosphaeridium pseudhystrichodinium *DEFLANDRE". Fig. 3: general view. Fig. 4: detail at a different focal plane, showing an opercular piece only partially attached. × 875.*

Fig. 5. – Polysphaeridium subtile *DAVEY and WILLIAMS emend. BUJAK* et al., *1980b. I.R.Sc.N.B. N° b 1540, lateral view, showing loose opercular pieces still in place. Originally figured by PASTIELS (1948, Pl. 5, fig. 5) as* "Hystrichosphaeridium *cf.* hirsutum *(EHRENBERG)". × 1000.*

Fig. 6. – Nematosphaeropsis reticulensis *(PASTIELS) comb. nov. emend. Lectotype I.R.Sc.N.B. N° b 1541, slightly oblique dorsal view, originally figured by PASTIELS (1948, Pl. 5, fig. 7) as* "Cannosphaeropsis reticulensis *sp. nov." × 1500.*

likely that many or all of the records of this species that are unaccompanied by illustrations refer to WILLIAMS and DOWNIE's form, not the true *N. reticulensis*. For this reason, they are marked with queries in the synonymy.

Nematosphaeropsis reticulensis is sufficiently closely similar to the type species *N. balcombiana* DEFLANDRE and COOKSON (1955, pp. 268-269, Pl. 8, fig. 5) as to raise the question whether it might be a senior synonym of the latter. However, its central body appears more rotund and its processes proportionately somewhat shorter. More importantly, it lacks the surficial ridges on parasutures characteristic of *N. balcombiana* (though these, indeed, are variably developed). It is likely that the two species will remain distinct.

For the moment, *N. reticulensis* (as here redefined) can be considered to have been recorded with confidence only from the Early to Middle Eocene (Ypresian to Lutetian) of Belgium. All other records appear open to question.

Family Cordosphaeridiaceae EISENACK, 1963, emend. SARJEANT, 1981

Genus *Tityrosphaeridium* SARJEANT, 1981

Tityrosphaeridium exilimurum (DAVEY and WILLIAMS, 1966b) comb. nov. (Plate III, Figure 2).

(pars) 1948. — *Hystrichosphaeridium salpingophorum* DEFLANDRE. — A. PASTIELS, p. 37-38, pl. 3, fig. 6.

1966b. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — R.J. DAVEY and G.L. WILLIAMS, p. 87-88, pl. 11, fig. 2.

1971. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — A. EISENACK and G. KJELLSTRÖM, p. 249.

1973. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 32.

1975. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — S.D. HARKER and W.A.S. SARJEANT, chart 21 (p. 254).

1977b. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 32.

1978. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — L.E. STOVER and W.R. EVITT, p. 147.

1979. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 51, 67.

1980 — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — S.K. DUTTA and K.P. JAIN, p. 66, pl. 2, fig. 18, pl. 6, figs. 47-48.

1981. — *Cordosphaeridium exilimurum* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 56.

1981. — *Hystrichosphaerina? exilimura* (DAVEY & WILLIAMS). — W.A.S. SARJEANT, p. 122.

DISCUSSION

As noted earlier, under the name of the Upper Cretaceous species *Hystrichosphaeridium salpingophorum* DEFLANDRE, PASTIELS (1948) described and illustrated a variety of morphotypes alike only in having tubular, intratabular processes. In the present condition of his slides, only one of these could be identified with any confidence. That specimen, figured originally in his Plate 3, fig. 6 (1948), appears to have rotated; moreover, it is contained in a slide so badly dried out that the residual mountant forms a coating about the processes (see Pl. 3, fig. 2). Because of its condition, its interpretation presents particular difficulties, and I am indebted to Dr. J.P. BUJAK for helpful discussions of these.

The archaeopyle appears, at first sight, to be so large and of such polygonal, scalloped outline as to be apical in character. However, the operculum within is much smaller and shield-shaped; moreover, it bears not more than two processes, rather than the four that normally might be expected on an apical operculum. Thus the archaeopyle must be considered, after all, to be single-plate precingular and its present outline a consequence of crushing and distortion.

The highly fibrous character of the processes suggests a comparison with the Cordosphaeridiaceae. The size of the processes is variable, but some are very broad and exhibit perforations or small fenestra. Their shape is tubiform to buccinate, their distal margins aculeate. In all these features, there is complete accord with the species *exilimurum* DAVEY & WILLIAMS. It may be noted, moreover, that the holotype of that species shows a similar orientation and crushing, its operculum having indeed been interpreted originally as apical.

In my revision of the Cordosphaeridiaceae (1981), I had difficulty in deciding to what genus this species should be allocated and finally placed it very tentatively into *Hystrichosphaerina,* since the processes were considered to be perhaps penitabular process clusters and the archaeopyle to be apical. Both these interpretations are now considered incorrect, following my discussions with Dr. J.P. BUJAK. Instead, the nature of the archaeopyle, the character of the processes and the presence of a series of cingular processes are all considered to justify its confident reassignment to the genus *Tityrosphaeridium.*

T. exilimurum, first reported from the Early Eocene of England, has been reported subsequently only from the Grand Banks, offshore eastern Canada, and the Palaeocene to Early Eocene of India.

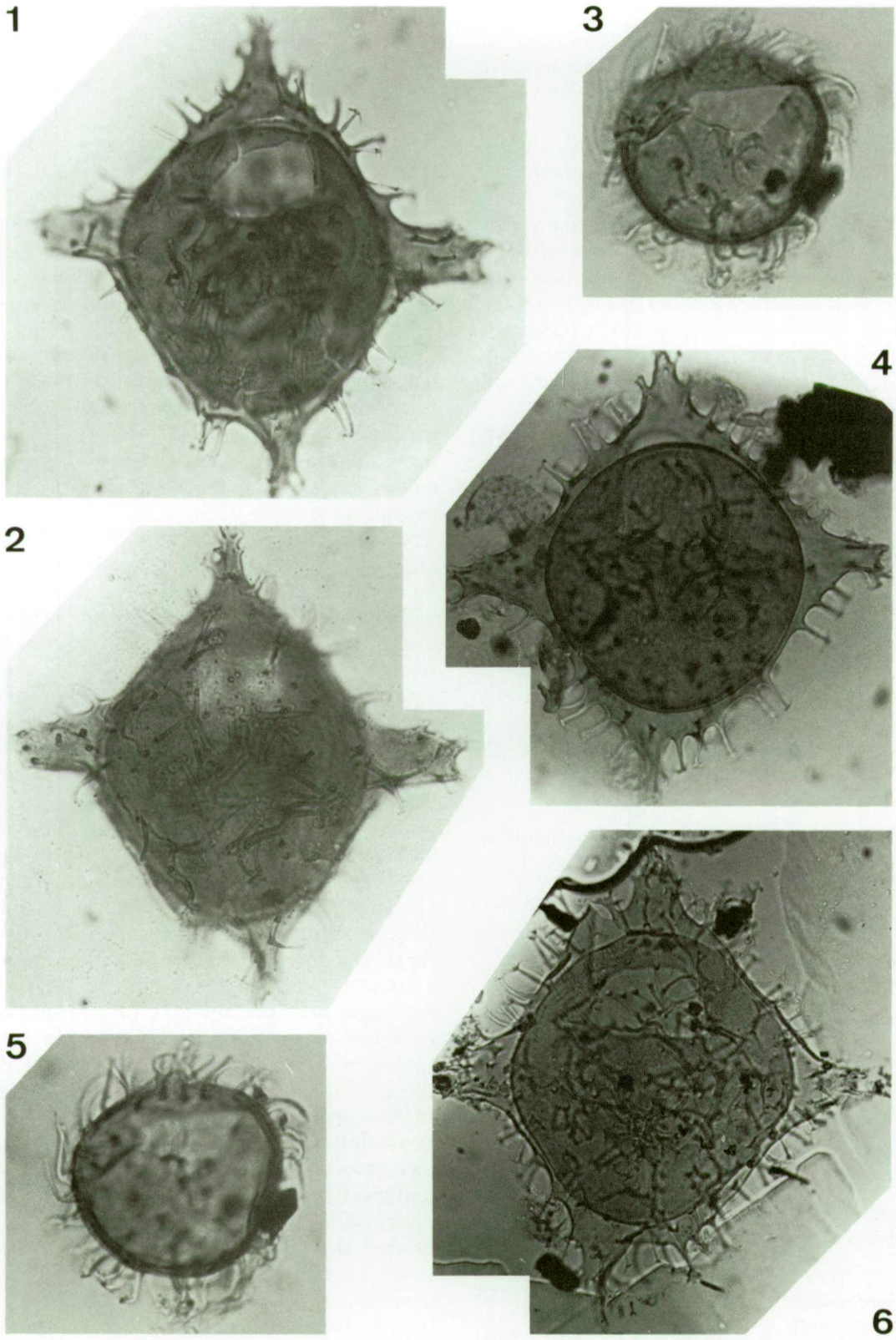

PLATE IV

Figs. 1, 2, 4. – Wetzeliella articulata *EISENACK emend. LENTIN and WILLIAMS, 1976. Fig. 1, 2: I.R.Sc.N.B. N° b 1542. Fig. 4: I.R.Sc.N.B. N° b 1544. Identified but apparently not illustrated by PASTIELS as* "Hystrichosphaeridium articulatum *(O. WETZEL) PASTIELS". Fig. 1: ventral view. Fig. 2: dorsal view, by transparency. Fig. 4: dorsal view. × 600.*

Figs. 3, 5. – Impletosphaeridium *cf.* transfodum *MORGENROTH, 1966. I.R.Sc.N.B. N° b 1543. Identified, but not figured, by PASTIELS (1948) as* "Hystrichosphaeridium fluctuans *EISENACK". Fig. 3: probably in slightly tilted apical view. Fig. 5: probably in slightly tilted antapical view, by transparency. × 600.*

Fig. 6. – Wetzeliella meckelfeldensis *GOCHT subsp.* lobisca *(WILLIAMS and DOWNIE) COSTA and DOWNIE, 1979a. I.R.Sc.N.B. N° b 1545, dorsal view originally figured by PASTIELS (1948, Pl. 4, fig. 17) as* "Hystrichosphaeridium articulatum *(O. WETZEL) PASTIELS". × 600.*

Tityrosphaeridium gracile (EISENACK, 1954, emend. DAVEY and WILLIAMS, 1966b), SARJEANT, 1981.

1948. — *Hystrichosphaeridium tubiferum* (EHRENBERG). — A. PASTIELS, p. 38, pl. 3, figs. 1-2.

1954. — *Hystrichosphaeridium inodes* EISENACK var. *gracilis* EISENACK. — A. EISENACK, p. 66, pl. 8, fig. 7, pl. 10, figs. 3-8, pl. 12, figs. 7-21.

1964. — *Hystrichosphaeridium inodes* var. *gracilis* EISENACK. — C. DOWNIE and W.A.S. SARJEANT, p. 103.

1966b. — *Cordosphaeridium gracilis* (EISENACK). — R.J. DAVEY and G.L. WILLIAMS, p. 84-86, pl. 3, fig. 8, pl. 11, figs. 4, 6, 7, text-fig. 19.

1969. — *Cordosphaeridium inodes gracilis* (EISENACK). — H. GOCHT, p. 41, 72-81, 90, pl. 1, figs. 1-9.

1970a. — *Cordosphaeridium inodes gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 20.

1970b. — *Cordosphaeridium gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 70.

1971. — *Cordosphaeridium inodes gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 172.

1971. — *Cordosphaeridium gracilis* (EISENACK). — A. EISENACK and G. KJELLSTRÖM, p. 263.

1971. — *Cordosphaeridium gracilis* (EISENACK). — C. DOWNIE, M.A. HUSSAIN and G.L. WILLIAMS, p. 30, pl. 1, fig. 1, pl. 2, fig. 3.

1972. — *Cordosphaeridium inodes gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 66-72.

1972. — *Cordosphaeridium gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 72.

1973. — *Cordosphaeridium gracilis* (EISENACK). — J.K. LENTIN and G.L. WILLIAMS, p. 33.

1974. — *Cordosphaeridium gracilis* (EISENACK). — C. GRUAS-CAVAGNETTO, p. 87.

1974. — *Cordosphaeridium gracilis* (EISENACK). — W.A.M. JENKINS *et al.*, p. 5, 10.

1975. — *Cordosphaeridium gracilis* (EISENACK). — J.P. AUFFRET and C. GRUAS-CAVAGNETTO, p. 650.

1975. — *Cordosphaeridium gracilis* (EISENACK). — S.D. HARKER and W.A.S. SARJEANT, charts 21 (p. 254), 65 (p. 298).

1976. — *Cordosphaeridium gracilis* (EISENACK). — J. SCHUMACKER-LAMBRY and J.J. CHÂTEAUNEUF, p. 272, pl. 2, fig. 1, tab. 1.

1977a. — *Cordosphaeridium gracilis* (EISENACK). — G.L. WILLIAMS and J.P. BUJAK, text-fig. 8.

1977. — *Cordosphaeridium gracilis* (EISENACK). — J. DE CONINCK, encl. 1.

1977b. — *Cordosphaeridium gracile* (EISENACK). — J.K. LENTIN and G.L. WILLIAMS, p. 33.

1978. — *Cordosphaeridium gracile* (EISENACK). — J. SCHUMACKER-LAMBRY, p. 38, pl. 2, fig. 16.

1978. — *Cordosphaeridium gracile* (EISENACK). — L.E. STOVER and W.R. EVITT, p. 147.

1979. — *Cordosphaeridium gracile* (EISENACK). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 15, 18, 20, 25, 27, 29, 35, 44, 49, 52, 57, 58, 62, 63, 65, 67, 70, 73, 74, 76, 78, 81, 83, 84, 86, 90, 94, 98.

?1979. — *Cordosphaeridium* cf. *C. gracile* (EISENACK). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 13, 38, 40.

1979. — *Cordosphaeridium inodes gracilis* (EISENACK). — J.M. HANSEN, p. 90.

1979. — *Cordosphaeridium gracile* (EISENACK). — D.K. GOODMAN, tab. 1.

1980. — *Cordosphaeridium gracile* (EISENACK). — J.J. CHÂTEAUNEUF, p. 134, fig. 35b.

1981. — *Cordosphaeridium gracile* (EISENACK). — J. DE CONINCK, M. DE DECKER, J. DE HEINZELIN and W. WILLEMS, p. 127, 129.

1981. — *Cordosphaeridium gracile* (EISENACK). — J.K. LENTIN and G.L. WILLIAMS, p. 56.

1982. — *Cordosphaeridium gracile* (EISENACK). — N.O. FREDERIKSEN *et al.*, tabs. 2, 7.

1982. — *Tityrosphaeridium gracilis* (EISENACK). — W.A.S. SARJEANT, p. 121.

DISCUSSION

Following its emendation by R.J. DAVEY and G.L. WILLIAMS (1966b), the generic name *Hystrichosphaeridium* has been applied only to forms having tubular, intratabular processes, their arrangement corresponding to a gonyaulacacean tabulation, and an apical archaeopyle. Though the processes of the specimens illustrated by PASTIELS (1948) are of the correct form and distribution, their archaeopyles are not apical but single-plate precingular. This is apparent in his illustrations (in particular Plate 3, fig. 1) and is made explicit in his text description, which mentions that they exhibit "an orifice whose regular outline recalls that of a natural pore; this is the 'Pylome' of authors." (*ibid.*, p. 38, new transl.). Moreover, his second figure in particular (*ibid.*, Pl. 3, fig. 2) indicates that the processes are fibrous, with root-like proximal extensions.

In consequence, though his specimens appear not to have survived the drying-out of the mounts, it is evident that they were attributable to the genus *Tityrosphaeridium*. The form and proportionate length of their processes suggest that they are referable to *T. gracile*. This species has a known range from Late Cretaceous (Maastrichtian) to Early Oligocene (Rupelian). It has been recorded

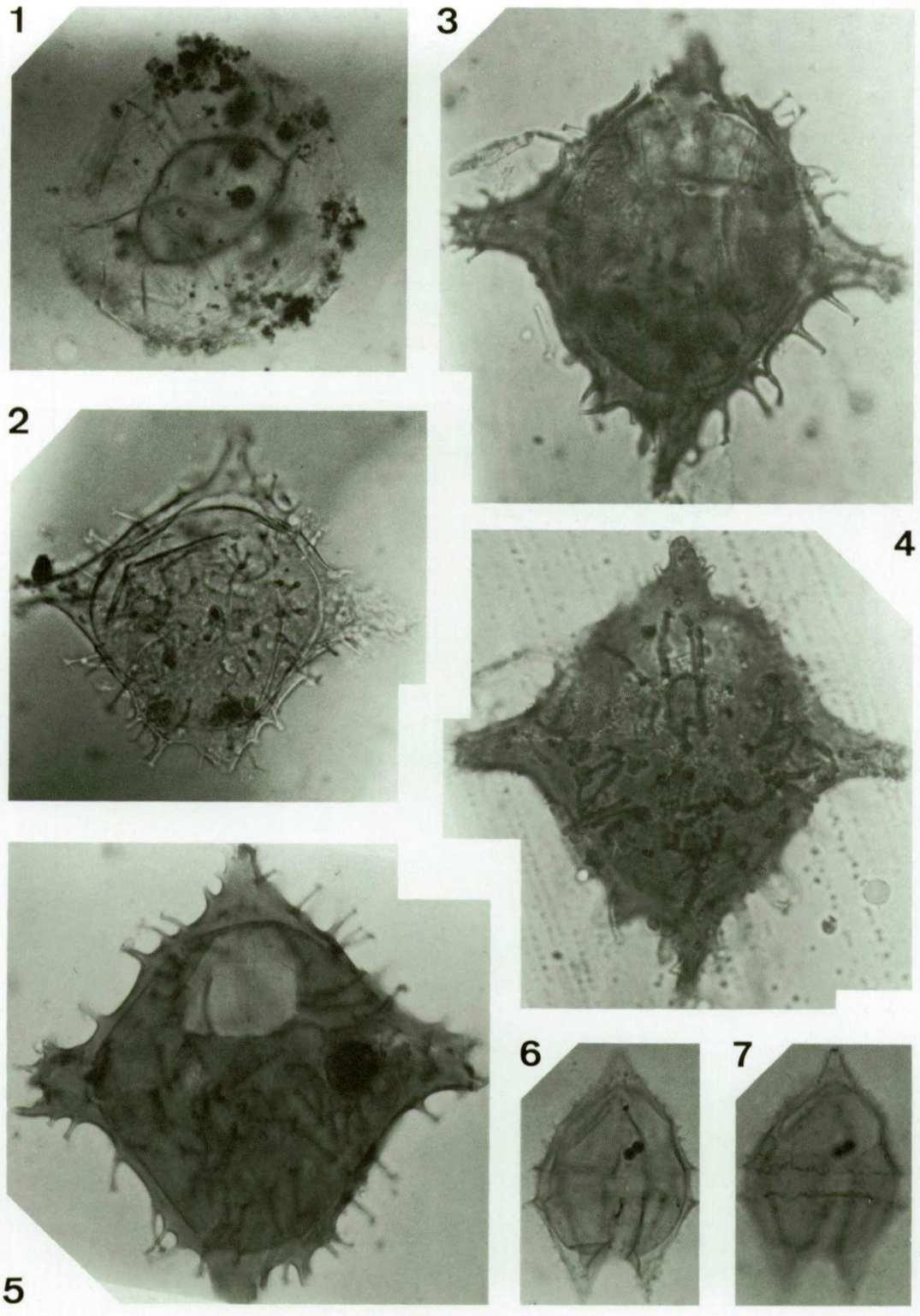

PLATE V

Fig. 1. – Thalassiphora delicata *WILLIAMS and DOWNIE emend. EATON, 1976. Same specimen as Pl. I, fig. 6.* × *600.*

Fig. 2-5. – Wetzeliella articulata *EISENACK emend. LENTIN and WILLIAMS, 1976. Fig. 2: I.R.Sc.N.B. N° b 1546, specimen in dorsal view with damaged antapex, operculum loose but in place,* × *600. Fig. 3, 4: I.R.Sc.N.B. N° b 1547,* × *700. Fig. 3: dorsal view. Fig. 4: ventral view, by transparency. Fig. 5: I.R.Sc.N.B. N° b 1548, dorsal view,* × *700. The specimen in Fig. 5 was originally figured by PASTIELS (1948, Pl. 4, fig. 13) and the two other specimens were identified by him as* "Hystrichosphaeridium articulatum *(O. WETZEL) PASTIELS".*

Figs. 6, 7. – Lentinia wetzelii *(MORGENROTH) BUJAK, 1980. I.R.Sc.N.B. N° b 1549, originally figured by PASTIELS (1948, Pl. 5, fig. 19) as* "Peridinium *cf.* galeatum *LEJEUNE-CARPENTIER". Fig. 6: ventral view, by transparency. Fig. 7: dorsal view.* × *630.*

from East Prussia (U.S.S.R.), Germany, France, Belgium, England, Denmark, Italy, Maryland and Missouri (U.S.A.) and from submarine cores from the English Channel and the Grand Banks, Scotian and Labrador Shelves, offshore eastern Canada.

Genus *Araneosphaera* EATON, 1976
Araneosphaera araneosa EATON, 1976

(pars) 1948. — *Hystrichosphaeridium salpingophorum* DEFLANDRE. — A. PASTIELS, p. 37, pl. 3, fig. 7.

1976. — *Araneosphaera araneosa* EATON. — G.L. EATON, pp. 240-242, pl. 2, figs. 5-8, text-fig. 6.

1977b. — *Araneosphaera araneosa* EATON. — J.K. LENTIN and G.L. WILLIAMS, p. 10.

1978. — *Araneosphaera araneosa* EATON. — L.E. STOVER and W.R. EVITT, p. 143.

1980a. — *Araneosphaera araneosa* EATON. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, p. 52, 57.

?1980 — *Araneosphaera* cf. *araneosa.* — S.K. DUTTA and K.P. JAIN, p. 66, pl. 7, fig. 64, tab. 2.

1981 — *Araneosphaera araneosa* EATON. — J.K. LENTIN and G.L. WILLIAMS, p. 18.

DISCUSSION

As noted earlier, PASTIELS' *"Hystrichosphaeridium salpingophorum"* embraces a variety of morphotypes. One of the forms he illustrated (1948, Pl. 3, fig. 7) has tubiform processes, flaring or buccinate distally and in part united by what is evidently a fenestrate ectophragm; indeed, PASTIELS noted that "some rare specimens ... show the remains of a velum extending between the extremities of the appendages" (*ibid.*, p. 37, new transl.). In addition, his illustration suggests the presence, at bottom right, of a precingular archaeopyle. (The specimen is considered to be in oblique polar orientation). The correspondence with *Araneosphaera araneosa* is sufficiently close that, even though the specimen itself could not be found, its identity appears clear.
The known stratigraphical range of *A. araneosa* is Early to Late Eocene. There is little information yet concerning its geographic range. To date, it is known in Europe only from southern England and Belgium and, though it is present in the subsurface of the Grand Banks, offshore eastern Canada, apparently it is absent from the Labrador and Scotian Shelves, a fact that may have palaeoecological or palaeogeographic significance. The record from India by DUTTA and JAIN (1980) must be regarded as doubtful, though their illustration indicates strong similarity to this species.

Family Homotrybliaceae
SARJEANT and DOWNIE, 1966,
emend. SARJEANT and DOWNIE, 1974
Genus *Polysphaeridium*
DAVEY and WILLIAMS, 1966b, emend.
BUJAK, DOWNIE, EATON and WILLIAMS, 1980b

DISCUSSION

In their emendation of this genus, BUJAK *et al.* (1980b) drew particular attention to its development of an epitractal archaeopyle shed, not as a unit, but as a series of up to ten opercular pieces. They noted also that its processes were sometimes "demonstrably intratabular", sometimes "forming ... linear, arcuate, soleate or annulate complexes". Species having an apical archaeopyle and having entirely intratabular processes were transferred to a new genus *Dapsilidinium,* for which the species *D. pastielsii* (earlier *Polysphaeridium pastielsii* DAVEY and WILLIAMS, 1966b), was chosen as type.
In their original description of *D. pastielsii,* DAVEY and WILLIAMS (*op. cit.*) stated that the specimens illustrated by *PASTIELS as Hystrichosphaeridium pseudhystrichodinium* "strongly resembled" their type assemblage. Though *D. pastielsii* has been recorded in a number of papers (e.g. by JENKINS *et al.,* 1974; AUFFRET and GRUAS-CAVAGNETTO, 1975; BARSS *et al.,* 1979; and BUJAK *et al.,* 1980a), only the single original illustration of it by DAVEY and WILLIAMS (1966b, Pl. 4, fig. 10) was available until recently, when the holotype was refigured, but not redescribed, by BUJAK (1980, Pl. 6, figs. 6, 9). Since the original illustration is not very clear, it is likely that the identification of this species has depended quite as much, if not to a greater extent, on PASTIELS' drawing (1948, Pl. 3, fig. 15).
My re-examination of PASTIELS' figured specimen makes it evident that this has an epitractal archaeopyle, lost not as a unit but as a series of opercular pieces; thus it is attributable to *Polysphaeridium* as recently redefined, and not to *Dapsilidinium.* For the moment, it is removed from the latter genus and from the species *D. pastielsii.*
A preliminary re-examination of the holotype of the latter species has shown it to differ in a number of significant details from PASTIELS' specimen and has cast doubt upon the nature of its archaeopyle. A fuller study of *D. pastielsii,* by Dr. J.P. BUJAK and the author, is in progress.

Polysphaeridium subtile DAVEY and WILLIAMS, 1966b, emend. BUJAK, DOWNIE, EATON and WILLIAMS, 1980b
(Plate III, Figure 5)

1948. — *Hystrichosphaeridium* cf. *hirsutum* (EHRENBERG) emend. DEFLANDRE. — A. PASTIELS, p. 44, pl. 5, fig. 5.

1966b. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — R.J. DAVEY and G.L. WILLIAMS, p. 92, pl. 11, fig. 1.

1967b. — *Polysphaeridium subtilum (sic)*. DAVEY & WILLIAMS. — W.A.S. SARJEANT, tab. 6 (p. 332).

1970a. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — C. GRUAS-CAVAGNETTO, p. 80.

1970. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — S.C.D. SAH, R.K. KAR and R.Y. SINGH, p. 147, pl. 2, fig. 24.

1971. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — A. EISENACK and G. KJELLSTRÖM, p. 927.

?1973. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — R. HARLAND, p. 687, pl. 86, figs. 3, 6.

1973. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 115.

1974. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — C. GRUAS-CAVAGNETTO, p. 87.

1975. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.P. AUFFRET and C. GRUAS-CAVAGNETTO, p. 650.

1975. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — S.D. HARKER and W.A.S. SARJEANT, charts 21 (p. 254), 32 (p. 265) and 61 (p. 294).

1976. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — G.L. EATON, p. 280, pl. 14, figs. 1-2.

1977b — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 133.

1978. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — L.E. STOVER and W.R. EVITT, p. 76.

1979. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, pp. 52, 83.

1980. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.J. CHÂTEAUNEUF, p. 147, 268, text-fig. 34e.

1980a. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, tab. 7B.

1980b. — *Polysphaeridium subtile* DAVEY & WILLIAMS emend. BUJAK *et al.* — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, p. 34, pl. 3, figs. 9, 12.

1981. — *Polysphaeridium subtile* DAVEY & WILLIAMS. — J.K. LENTIN and G.L. WILLIAMS, p. 232.

DISCUSSION

The specimen figured and described by PASTIELS as *Hystrichosphaeridium* cf. *hirsutum* (1948, Pl. 5, fig. 5) survives, but in an extremely poor state, having suffered intensive fungal attack (Pl. III, fig. 5). Nevertheless, the nature of the processes, the granulate character of the phragma surface and, most importantly, the fact that the epitract is breaking up into a number of opercular pieces may all be perceived, enabling its confident identification as *Polysphaeridium subtile*.

This species has been reported hitherto from the Early to Late Eocene (Late Ypresian to Bartonian) of Belgium, England, France, Italy and from submarine cores from the English Channel and two localities on the Grand Banks, offshore eastern Canada. The record from the Upper Cretaceous of Alberta, Canada, by HARLAND (1973) is, for the moment, treated as doubtful, pending determination of the character of the archaeopyle of his specimens.

Polysphaeridium belgicum SARJEANT *in* DAVEY *et al.*, 1969

(pars) 1948. — *Hystrichosphaeridium fluctuans* A. PASTIELS, p. 40, pl. 3, fig. 16.

1969. — *Polysphaeridium belgicum* SARJEANT. — W.A.S. SARJEANT *in* R.J. DAVEY *et al.*, p. 15.

1973. — *Polysphaeridium belgicum* SARJEANT. — J.K. LENTIN and G.L. WILLIAMS, p. 114.

1975. — *Polysphaeridium belgicum* SARJEANT. — A. EISENACK and G. KJELLSTRÖM, p. 391 (918b).

1977b. — *Polysphaeridium belgicum* SARJEANT. — J.K. LENTIN and G.L. WILLIAMS, p. 133.

1978. — *Polysphaeridium? belgicum* SARJEANT. — L.E. STOVER and W.R. EVITT, p. 76.

1981. — *Dapsilidinium? belgicum* (SARJEANT). — J.K. LENTIN and G.L. WILLIAMS, p. 69.

DISCUSSION

When this species was erected, the specimen illustrated by PASTIELS (1948, Pl. 3, fig. 16), and misattributed to the Silurian acritarch species *Hystrichosphaeridium* (later *Baltisphaeridium*) *fluctuans,* was specified as its holotype. Unfortunately this specimen could not be located in the PASTIELS collection, and the one other specimen given that name by PASTIELS, but unfigured hitherto, is of such markedly dissimilar morphology that it must be placed into another genus (see later discussion). Our understanding of the morphology of this species must continue, therefore, to depend wholly upon PASTIELS' original illustration. From this it may be seen that the archaeopyle is very large and involves the whole precingular paraplate series, the apical paraplates remaining attached, presumably at the position of the sulcus. Over 40 processes are present. Each is hollow and, according to PASTIELS, terminates "in a little bifid anchor, with centripetal hooks" (1948, p. 40, new transl.). However, his illustration suggests that the processes are distally open, with recurved margins, rather than of a truly bifid form. The small size of his specimens (diameter of central body 30 to 35 µm, length of processes 12 µm) may be noted also.

If the above interpretation of the distal morphology of the processes (i.e. open and recurved) is correct, this species exhibits close similarities to the Late Cretaceous *Polysphaeridium pumilum* R.J. DAVEY and G.L. WILLIAMS (1966b, p. 93-94, pl. 7, figs. 3-4) in all features. It is possible, then, that *P. belgicum* may come to be regarded as a subjective junior synonym of *P. pumilum*. However, the nature of the archaeopyle in the latter species remains to be elucidated and its presence in the Eocene needs to be confirmed.

Polysphaeridium sp.
(Plate III, Figures 3-4)

1948. — *Hystrichosphaeridium pseudhystrichodinium* DEFLANDRE. — A. PASTIELS, p. 43, pl. 3, figs. 12-15.

DISCUSSION

R.J. DAVEY and G.L. WILLIAMS (1966b, p. 92-93) recognized that the specimens attributed by PASTIELS to the Late Cretaceous species *Hystrichosphaeridium pseudhystrichodinium* DEFLANDRE, 1937, differed too markedly in process morphology properly to belong in that species. PASTIELS' specimens thus were considered to be attributable to a new species named after him by DAVEY and WILLIAMS, *Polysphaeridium pastielsii*. However, the holotype they chose and illustrated was not from Belgium, but from the London Clay (Ypresian) of the Isle of Sheppey, England. This species was considered by its authors to have an apical archaeopyle and, following the subsequent demonstration by J.P. BUJAK *et al.* (1980b) that the type species of *Polysphaeridium* had an epitractal archaeopyle, DAVEY and WILLIAMS' species was selected as type for a new genus, *Dapsilidinium,* into which the forms with apical archaeopyles were thenceforward to be placed.

Of the four specimens illustrated as *"Hystrichosphaeridium pseudhystrichodinium",* only one may still be identified in PASTIELS' type material; this is the specimen which he depicted (1948, Pl. 3, fig. 14), here refigured (Pl. III, figs. 3-4). From the illustrations here presented, it may be seen that the archaeopyle is epitractal, being cast off in the form of at least one apical piece and a series of precingular pieces; the specimen (Pl. III, fig. 5) shows one of the latter that is still attached. Another of the specimens figured by PASTIELS (1948, Pl. 3, fig. 12) clearly also had an epitractal archaeopyle; the morphology of the other two specimens he figured is less evident.

The processes of PASTIELS' specimens are oblate, tapering from their base to about two-thirds height and thereafter widening slightly. Their proximal diameter is about twice that of their narrowest diameter. The phragma is thin and delicate, without ornamentation discernible under the optical microscope. The processes are open distally but appear to be closed at the base.

In their laevigate phragma surface and relatively slender processes, PASTIELS' specimens differ sufficiently markedly from *Dapsilidinium pastielsii* to deserve attribution to a different taxon. However, since the single surviving specimen is in too poor condition to serve as a holotype, no new name is proposed here.

Family Cleistosphaeridiaceae
SARJEANT and DOWNIE, 1974
Genus *Impletosphaeridium* MORGENROTH, 1966

DISCUSSION

In their comprehensive review of pre-Pleistocene dinoflagellate cysts, L.E. STOVER and W.R. EVITT (1978, p. 232) retained this genus for species with "essentially solid" processes "whose archaeopyle type is unknown or uncertain". The archaeopyle of the type species, *Impletosphaeridium transfodum* MORGENROTH, 1966, is not described in the text but is well shown in one of MORGENROTH's illustrations (1966, Pl. 10, fig. 4). It appears irregularly hexagonal in shape and may well be apical in situation, but (from the figure, at least) seems to lack both the accessory archaeopyle sutures and the sulcal notch typical of apical archaeopyles. Should the archaeopyle indeed prove to be apical and should no other differentiating characters become apparent, then *Impletosphaeridium* may prove to be a synonym of *Cleistosphaeridium* DAVEY *et al.*, 1966, with a seniority of rather more than one month. Pending re-examination of MORGENROTH's type material, however, I consider it preferable to retain both genera.

Impletosphaeridium cf. *transfodum*
MORGENROTH, 1966
(Plate IV, Figures 3, 5)

(pars) 1948. — *Hystrichosphaeridium fluctuans* EISENACK. — A. PASTIELS, p. 40 (unfigured).

DISCUSSION

A specimen in PASTIELS' collection, labelled by him *"Hystrichosphaeridium fluctuans* EISENACK" and, by implication, included in his published description of the forms so named, is here illustrated for the first time (Pl. 4, figs. 3, 5). It appears to be in slightly tilted apical view and has a polygonal archaeopyle, possibly apical but without conspicuous accessory sutures or a discernible sulcal

notch, which is very much reminiscent of that of *Impletosphaeridium transfodum* MORGENROTH. Moreover its processes, though much reflexed, are comparable in number, character and relative length to those of that species, though not exhibiting the minute pores upon with MORGENROTH (1966, p. 36) remarked. For that reason alone, PASTIELS' specimen is compared with, and not placed into, MORGENROTH's species, whose limits of variation remain to be determined.

Genus *Cleistosphaeridium*
DAVEY, DOWNIE, SARJEANT and WILLIAMS, 1966
? *Cleistosphaeridium* sp. plur. indet.

1948. — *Hystrichosphaeridium brevispinosum* (EISENACK). — A. PASTIELS, p. 43, pl. 4, figs. 18-21.

DISCUSSION

PASTIELS referred four specimens, of diverse morphological character, incorrectly to EISENACK's Silurian species *Hystrichosphaeridium brevispinosum* (now known to be an acritarch and styled *Baltisphaeridium brevispinosum*). None of these were located in PASTIELS' surviving material, nor are his figures adequate to enable their confident recognition. One of his drawings (Pl. 4, fig. 21) suggests a closed precingular archaeopyle, in which case its tentative allocation to this genus must be incorrect; but the uncertainties are so great that any other assignation would be equally speculative.

Family Deflandreaceae
EISENACK, 1954, emend. nov.

1954. — Family Deflandreidae EISENACK. — A. EISENACK, p. 305-307.

1961. — Family Deflandreidae EISENACK, *emend.* — T.F. VOZZHENNIKOVA, p. 1461.

1965. — Family Deflandreaceae EISENACK, *emend.* VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 179.

1966. — Cyst-Family Deflandreaceae, *emend.* SARJEANT & DOWNIE. — W.A.S. SARJEANT and C. DOWNIE, pp. 521-522.

1967. — Family Deflandreaceae EISENACK, *emend.* VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 134. Family Cooksoniellaceae VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 183. Family Chatangiellaceae VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 128.

(pars) 1967. — Group N. — C. DOWNIE and W.A.S. SARJEANT, p. 204.

(pars) 1968. — Deflandreoid lineage. — D. WALL and B. DALE, tab. 2.

1969. — Family Deflandreaceae EISENACK, *emend.* SARJEANT & DOWNIE. — A. EISENACK, p. 341.

(pars) 1974. — Family Deflandreaceae EISENACK, *emend.* SARJEANT and DOWNIE. — W.A.S. SARJEANT and C. DOWNIE, pp. 20-21.

1978. — Family Deflandreaceae EISENACK, *emend.* SARJEANT & DOWNIE. — G. NORRIS, pp. 17-18.

EMENDED DIAGNOSIS

Cysts organic-walled, proximate, cavate. Periblast spheroidal to ellipsoidal, polygonal or fusiform in shape, with or without an apical horn and one or two antapical horns but without lateral horns. Endoblast spheroidal to ovoidal or subpolygonal, without horns. Surface of periblast with or without a cover of short spines. Paratabulation clearly to feebly marked or absent; where determinable, its pattern accords exactly or approximately with the formula 4′, 3a, 7″, 5‴, 2⁗, the cingulum being divided into six or seven paraplates or undivided, and the sulcus divided into paraplates or (most often) undivided. When a paratabulation is not evident, the cingulum and sulcus may be marked clearly, feebly, or not at all. Archaeopyle intercalary, typically of hexa type. It is formed most often by loss of a single intercalary paraplate (2a) or, more rarely, of two or all three intercalary paraplates (2a plus 1a or 3a, or both).

TYPE GENUS

Deflandrea EISENACK, 1938, *emend.* LENTIN and WILLIAMS, 1976.

OTHER INCLUDED GENERA

Alterbia LENTIN and WILLIAMS, 1976; *Amphidiadema* COOKSON and EISENACK, 1960, emend. LENTIN and WILLIAMS, 1976; *Bulbodinium* O. WETZEL, 1960; *Ceratiopsis* VOZZHENNIKOVA, 1963, emend. BUJAK *et al.*, 1980b; *Chatangiella* VOZZHENNIKOVA, 1967, emend. LENTIN and WILLIAMS, 1976; *Diconodinium* EISENACK and COOKSON, 1960, emend. MORGAN, 1977; *Evittodinium* DEFLANDRE, 1964; *Hexagonifera* COOKSON and EISENACK, 1961, emend. STOVER and EVITT, 1978; *Isabelidinium* LENTIN and WILLIAMS, 1977a; *Lentinia* BUJAK, 1980; *Nelsoniella* COOKSON and EISENACK, 1960; *Palaeocystodinium* ALBERTI, 1961; *Smolenskiella* VOZZHENNIKOVA, 1967; *Spinidinium* COOKSON and EISENACK, 1962b, emend. LENTIN and WILLIAMS, 1976; *Svalbardella* MANUM, 1960; *Trithyrodinium* DRUGG, 1967, emend. LENTIN and WILLIAMS, 1976; *Uvatodinium* VOZZHENNIKOVA, 1963; *Vozzhennikovia* LENTIN and WILLIAMS, 1976; *Xenikoon* COOKSON and EISENACK, 1960.

DISCUSSION

In the emendation we proposed in 1974, DOWNIE and the author (1974) redefined the Deflandreaceae in such fashion as to incorporate VOZZHENNIKOVA's Family Wetzeliellaceae (1961). Subsequently, COSTA and DOWNIE (1979a) reinstated this family;

their view, read in manuscript, was endorsed in a paper published in advance of theirs by NORRIS (1978) and is accepted here. The diagnosis of the Family Deflandreaceae thus is emended to exclude forms possessing lateral horns. In addition, the nature of cingulum and sulcus is made more explicit and stress is laid on the fact that the intercalary archaeopyle is typically formed by loss of a single paraplate of hexa type.

Deflandrea oebisfeldensis ALBERTI, 1959
(Plate I, Figure 2)

(pars) 1948. — *Peridinium* cf. *galeatum* LEJEUNE-CARPENTIER. — A. PASTIELS, p. 50-51, pl. 5, fig. 16.

1959. G. ALBERTI, p. 95-96, pl. 8, figs. 10-13.

1964. — *Deflandrea oebisfeldensis* ALBERTI. — A. EISENACK and K.W. KLEMENT, p. 203-204.

1964. — *Deflandrea oebisfeldensis* ALBERTI. — C. DOWNIE and W.A.S. SARJEANT, p. 109.

1966b. — *Deflandrea oebisfeldensis* ALBERTI. — G.L. WILLIAMS and C. DOWNIE, p. 233, pl. 26, fig. 1.

1967. — *Deflandrea oebisfeldensis* ALBERTI. — N. BALTEŞ, p. 7, pl. 1, fig. 6.

1967a. — *Deflandrea oebisfeldensis* ALBERTI. — W.A.S. SARJEANT, tab. 9 (p. 335).

1972. — *Deflandrea oebisfeldensis* ALBERTI. — C. GRUAS-CAVAGNETTO, p. 222.

1973. — *Deflandrea oebisfeldensis* ALBERTI. — G.F.W. HERNGREEN, p. 130, pl. 1, fig. 1.

1973. — *Deflandrea oebisfeldensis* ALBERTI. — J.K. LENTIN and G.L. WILLIAMS, p. 43.

1975. — *Deflandrea oebisfeldensis* ALBERTI. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 23, pl. 4, fig. 5, folding fig. 14.

1975. — *Deflandrea oebisfeldensis* ALBERTI. — S.D. HARKER and W.A.S. SARJEANT, charts 24 (p. 257) and 67 (p. 300).

1976. — *Deflandrea oebisfeldensis* ALBERTI. — C. GRUAS-CAVAGNETTO, p. 70.

1976. — *Deflandrea oebisfeldensis* ALBERTI. — J.K. LENTIN and G.L. WILLIAMS, p. 42, pl. 3, fig. 40.

1977a. — *Deflandrea oebisfeldensis* ALBERTI. — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9.

1977b — *Deflandrea oebisfeldensis* ALBERTI. — J.K. LENTIN and G.L. WILLIAMS, p. 44.

1977b. — *Deflandrea oebisfeldensis* ALBERTI. — R.E. JAN DU CHÊNE, p. 149, tab. 1.

1978. — *Deflandrea oebisfeldensis* ALBERTI. — L.E. STOVER and W.R. EVITT, p. 101.

1979. — *Deflandrea oebisfeldensis* ALBERTI. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 27, 29, 65, 67, 69, 74, 91, 94.

1979b. — *Deflandrea oebisfeldensis* ALBERTI. — L.I. COSTA and C. DOWNIE, tabs. 1-2.

1980a. — *Deflandrea oebisfeldensis* ALBERTI. — J. DE CONINCK, tab. 1 (p. 202).

1980b. — *Deflandrea oebisfeldensis* ALBERTI. — J. DE CONINCK, tab. 1 (p. 314).

1980. — *Deflandrea oebisfeldensis* ALBERTI. — A.W. VAN ERVE, H. VISSCHER and V.J. GUPTA, p. 621, pl. 2, fig. 1.

1981. — *Deflandrea oebisfeldensis* ALBERTI. — J.K. LENTIN and G.L. WILLIAMS, p. 76.

1982. — *Deflandrea oebisfeldensis* ALBERTI. — C. HEILMANN-CLAUSEN, p. 58, 59, fig. 3c.

non 1972. — *Deflandrea oebisfeldensis* auct. non ALBERTI. — P.N. VON BENEDEK, p. 12, pl. 3, fig. 3.

non 1978. — *Deflandrea oebisfeldensis* auct. non ALBERTI. — JIABO, 83, pl. 2, fig. 12.

DISCUSSION

The six specimens figured by PASTIELS under the name *"Peridinium* cf. *galeatum"* represent a variety of morphological types, which nowadays would be assigned to at least four different species (and three different genera) of cavate cysts. PASTIELS recognized the cavate character of his specimens, implicitly at least for, whilst he treated EISENACK's species *Deflandrea phosphoritica* as a junior synonym of *P. galeatum* (1948, p. 50), at the same time he noted that his specimens included encysted specimens. However, scientific opinions have now much changed; the motile genus *Peridinium* is no longer considered to be represented directly by any fossils and LEJEUNE-CARPENTIER's species now is itself attributed to the genus *Deflandrea* (see LEJEUNE-CARPENTIER and SARJEANT, 1981, p. 18-19).

Of the six figured specimens, three remain recognizable. Among these is one of the two "encysted specimens" figured by PASTIELS (1948, Pl. 5, fig. 16). Its ambitus — in particular, the proportionate length of its three horns — and the shape of its archaeopyle show this form to be attributable to *Deflandrea oebisfeldensis*. The other "encysted" specimen figured by PASTIELS (Pl. 5, fig. 21) was not located but appears also referable to *D. oebisfeldensis*.

This species is known from the Late Palaeocene (Thanetion) to Lower Eocene (Ypresian) of north Germany, the Stalingrad region (U.S.S.R.), England, France, Belgium, the Netherlands and Switzerland, from the Palaeocene (Thanetian) of the English Channel, from the Late Palaeocene to Early Eocene of the Rockall Plateau, Atlantic Ocean, from the Early to Middle Eocene of the Grand Banks and the Scotian and Labrador Shelves, offshore eastern Canada, and from the Eocene of

the Simla Himalaya, India. The Oligocene specimens attributed to *D. oebisfeldensis* by BENEDEK (1972) and the Tertiary specimens figured by the three Chinese palynologists styling themselves JIABO (1978) differ too markedly in morphology to be included within this species.

Genus *Lentinia* BUJAK, 1980
Lentinia wetzelii (MORGENROTH, 1966) BUJAK, 1980
(Plate V, Figures 6-7)

(pars) 1948. — *Peridinium* cf. *galeatum* LEJEUNE-CARPENTIER. — A. PASTIELS, p. 50-51, pl. 5, figs. 17, 19.

1966. — *Deflandrea wetzeli* MORGENROTH. — MORGENROTH, p. 9, pl. 1, figs. 4-5.

1971. — *Deflandrea wetzeli* MORGENROTH. — A. EISENACK and G. KJELLSTRÖM, p. 9, pl. 1, figs. 4-5.

1973. — *Deflandrea wetzeli* MORGENROTH. — J.K. LENTIN and G.L. WILLIAMS, p. 45.

1975. — *Deflandrea wetzeli* MORGENROTH. — S.D. HARKER and W.A.S. SARJEANT, chart 24 (p. 257).

1976. — *Deflandrea wetzelii* MORGENROTH. — J.K. LENTIN and G.L. WILLIAMS, p. 45, pl. 2, fig. 27.

1976. — *Deflandrea wetzelii* MORGENROTH. — G.L. EATON, p. 292, pl. 17, fig. 4.

1977. — *Deflandrea wetzelii* MORGENROTH. — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9.

1977b. — *Deflandrea wetzelii* MORGENROTH. — J.K. LENTIN and G.L. WILLIAMS, p. 47.

1978. — *Deflandrea wetzelii* MORGENROTH. — L.E. STOVER and W.R. EVITT, p. 101.

1979. — *Deflandrea wetzelii* MORGENROTH. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 44, 58, 73, 81.

1980. — *Lentinia wetzelii* (MORGENROTH) BUJAK. — J.P. BUJAK, p. 72.

1981. — *Lentinia wetzelii* (MORGENROTH). — J.K. LENTIN and G.L. WILLIAMS, p. 171.

DISCUSSION

This species is represented among the four morphological types figured as *"Peridinium* cf. *galeatum"* by PASTIELS (1948, Pl. 5, figs. 17, 19). The former specimen could not be found, but the latter survives and is here reillustrated.
Lentinia wetzelii, originally described from the Late Eocene of Germany, has been reported subsequently from the Early to Late Eocene (Ypresian to Bartonian) of England and from submarine cores from the Early to Late Eocene of the Grand Banks and Scotian Shelf and the Middle Eocene of the Labrador Shelf, offshore eastern Canada.

Genus *Ceratiopsis* VOZZHENNIKOVA, 1963, emend. BUJAK, DOWNIE, EATON and WILLIAMS, 1980
Ceratiopsis leptoderma VOZZHENNIKOVA, 1963
(Plate II, Figure 2)

(pars) 1948. — *Peridinium* cf. *galeatum* LEJEUNE-CARPENTIER. — A. PASTIELS, p. 50-51, pl. 5, figs. 18, 20.

1963. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 180, text-fig. 8.

1967. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — A. EISENACK, p. 25 (132c).

1973. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — J.K. LENTIN and G.L. WILLIAMS, p. 24.

1975. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — S.D. HARKER and W.A.S. SARJEANT, charts 24 (p. 257) and 67 (p. 300).

1976. — *Deflandrea leptoderma* (VOZZHENNIKOVA). — J.K. LENTIN and G.L. WILLIAMS, p. 41, pl. 3, fig. 31.

1977a. — *Deflandrea leptoderma* (VOZZHENNIKOVA). — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9.

1977b. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — J.K. LENTIN and G.L. WILLIAMS, p. 21.

1978. — *Deflandrea leptoderma* (VOZZHENNIKOVA). — L.E. STOVER and W.R. EVITT, p. 101.

1979. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 62.

1981. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — J.K. LENTIN and G.L. WILLIAMS, p. 38.

non 1977. — *Ceratiopsis leptoderma* VOZZHENNIKOVA. — E. BOLTENHAGEN, p. 112-113, pl. 22, figs. 1-3.

DISCUSSION

This species also is represented among the types conjointly named *"Peridinium* cf. *galeatum"* by PASTIELS. The specimen he figured (1948, Pl. 5, fig. 18) survives and is here reillustrated. Though very pale, it may be seen to exhibit all the features that characterise *Ceratiopsis leptoderma.* A revision of the diagnosis of that species is overdue, but cannot be attempted on the basis of a single specimen of such mediocre quality.
C. leptoderma, first described from the Palaeocene of western Siberia (U.S.S.R.), has been reported subsequently only from the Late Palaeocene to Early Eocene of the Grand Banks, offshore eastern Canada. The specimens from the Late Cretaceous of Gabon, attributed to this species by BOLTENHAGEN (1977), differ so significantly in endoblast morphology that I consider them referable to a distinct species.

Family Wetzeliellaceae VOZZHENNIKOVA, 1961, emend. nov.

1961. — Family Wetzeliellaceae VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 1461.

1965. — Family Wetzeliellaceae VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 180.

(pars) 1967. — Group N. — C. DOWNIE and W.A.S. SARJEANT, p. 204.

1967. — Family Wetzeliellaceae VOZZHENNIKOVA. — T.F. VOZZHENNIKOVA, p. 160-161.

(pars) 1968. — Deflandreoid lineage. — D. WALL and B. DALE, tab. 2.

(pars) 1974. — Family Deflandreaceae EISENACK, emend. — W.A.S. SARJEANT and C. DOWNIE, p. 20-21.

1978. — Family Wetzeliellaceae VOZZHENNIKOVA. — G. NORRIS, p. 19.

1979a. — Family Wetzeliellaceae VOZZHENNIKOVA. — L. COSTA and C. DOWNIE, p. 34.

EMENDED DIAGNOSIS

Cysts organic-walled, proximate, cavate. Periblast of subpolygonal to kite-shaped, rhomboidal or pentagonal ambitus, with flanks convex to concave. An apical horn, two lateral horns and one or two antapical horns are developed. Endoblast spheroidal to ovoidal or subpolygonal, without horns. Surface or periblast laevigate or covered with short spines, simple or furcate, arranged along paraplate boundaries or forming a general cover. Paratabulation clearly to feebly marked or absent; where determinable, its pattern accords exactly or approximately with the formula 4′, 3a, 7″, 5‴, 2⁗, the cingulum being divided into six or seven paraplates or undivided and the sulcus divided into paraplates or (most often) undivided. When a paratabulation is not evident, the cingulum and sulcus may be marked clearly, feebly or not at all. Archaeopyle intercalary, typically formed by loss of a single anterior intercalary paraplate (2a) of quadra type, or, more rarely, of two or all three anterior intercalary paraplates.

TYPE GENUS

Wetzeliella EISENACK, 1938, emend. LENTIN and WILLIAMS, 1976.

OTHER INCLUDED GENERA

Apectodinium (COSTA and DOWNIE, 1976) LENTIN and WILLIAMS, 1977b; *Dracodinium* GOCHT, 1955, emend. BUJAK *et al.*, 1980b; *Gochtodinium* BUJAK, 1979; *Kisselovia* VOZZHENNIKOVA, 1963, emend. LENTIN and WILLIAMS, 1976; *Rhombodinium* GOCHT, 1955, emend. BUJAK, 1979; *Wilsonidium* LENTIN and WILLIAMS, 1976.

DISCUSSION

The diagnosis given here is much fuller than that of VOZZHENNIKOVA , incorporating details of the paratabulation, archaeopyle and surficial ornament. Essentially this family differs from the Deflandreaceae in having lateral horns, in possessing much more often a cover of spines and in having a quadra-type intercalery archaeopyle.

Genus *Wetzeliella* EISENACK, 1938, emend. LENTIN and WILLIAMS, 1976
Wetzeliella articulata EISENACK, 1938
(Plate IV, Figures 1, 2, 4; Plate V, Figures 2-5)

[An extensive synonymy for this species is given in SARJEANT, 1981, p. 118-119. The following references should be modified or added:]

(pars) 1948. — *Hystrichosphaeridium articulatum* EISENACK. — A. PASTIELS, p. 43-44, pl. 4, figs. 12-13.

1980a. — *Wetzeliella articulata* EISENACK. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7A.

1980. — *Wetzeliella articulata* EISENACK. — J.J. CHÂTEAUNEUF, p. 150, 272, text-fig. 34b.

1980. — *Wetzeliella* aff. *articulata* EISENACK. — J.J. CHÂTEAUNEUF, p. 150, 272, fig. 1, text-fig. 34b.

1981. — *Wetzeliella articulata* EISENACK. — J.K. LENTIN and G.K. WILLIAMS, p. 289.

DISCUSSION

The citation "*Hystrochosphaeridium articulatum* (O. WETZEL) PASTIELS", used in A. PASTIELS' plate captions and, in expanded form, in his text (1948, p. 42) is incorrect. Whilst he may have been right in believing that WETZEL (1935, p. 61-62, Pl. 10, figs. 1-2) was the first to figure and describe this species, the name was proposed, not by WETZEL, but by EISENACK (1938, p. 186-187). PASTIELS' reattribution of the species to the genus *Hystrichosphaeridium* was not appropriate. Neither in this nor in his considering *Wetzeliella clathrata* EISENACK, 1938 to be a junior synonym of this species has PASTIELS been followed by subsequent authors. PASTIELS figured five specimens under the name *"H. articulatum"*. Two at least of these (1948, pl. 4, figs. 12-13) accord with current concepts of the morphology of that species. The three others, however, now are attributable to other species (and in two instances, to other genera); these are discussed below. Of the several specimens identified by PASTIELS as belonging to this species, and according closely with its morphology, three are illustrated herein. The specimen here illustrated in Pl. V, fig. 5 appears to be one of those figured by PASTIELS (1948, pl. 4, fig. 13).

The recorded geographic and stratigraphic distribution of this species is summarised in my earlier paper (SARJEANT, 1981, p. 120).

Wetzeliella meckelfeldensis GOCHT, 1969
Wetzeliella meckelfeldensis GOCHT subsp. *lobisca*
(WILLIAMS and DOWNIE, 1966b)
COSTA and DOWNIE, 1979
(Plate IV, Figure 6)

(pars) 1948. — *Hystrichosphaeridium articulatum* (EISENACK. — A. PASTIELS, p. 42-43, pl. 4, fig. 17.

1966b. — *Wetzeliella (Wetzeliella) symmetrica* WEILER var. *lobisca* WILLIAMS & DOWNIE. — G.L. WILLIAMS and C. DOWNIE, p. 196, pl. 20, fig. 3.

1971. — *Wetzeliella (Wetzeliella) symmetrica* var. *lobisca* WILLIAMS & DOWNIE. — A. EISENACK and G. KJELLSTRÖM, p. 8 (195).

1973. — *Wetzeliella symmetrica lobisca* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 143.

1976. — *Wetzeliella symmetrica lobisca* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 133, pl. 17, fig. 266.

1977b. — *Wetzeliella symmetrica lobisca* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 170.

1979a. — *Wetzeliella meckelfeldensis* [*sic*] *lobisca* (WILLIAMS & DOWNIE). — L.I. COSTA and C. DOWNIE, p. 43.

1981. — *Wetzeliella meckelfeldensis* subsp. *lobisca* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 290.

DISCUSSION

In their first description of this variety, WILLIAMS and DOWNIE (1966a) recognised correctly that it had been figured earlier by PASTIELS. Both the figured specimens to which they made reference (PASTIELS, 1948, Pl. 4, figs. 16-17) have chanced to survive; one of them does indeed accord in morphology with this subspecies and is reillustrated here. PASTIELS referred to this specimen as his "Holotype" — an incorrect use of that term — of *"Hystrichosphaeridium articulatum"*.
The species *W. meckelfeldensis* has a known range from Late Palaeocene (Thanetian) to Middle Eocene. The range of the subspecies *lobisca* remains to be determined, but appears likely to prove identical. Indeed, it might more appropriately be accorded varietal status once again, since there is no evidence that it can be segregated geographically or stratigraphically.

Genus *Kisselovia* VOZZHENNIKOVA, 1963
Kisselovia tenuivirgula
(WILLIAMS and DOWNIE, 1966b)
LENTIN and WILLIAMS, 1976
(Plate I, Figure 5)

(pars) 1948. — *Hystrichosphaeridium geometricum* PASTIELS. — A. PASTIELS, p. 41, pl. 4, fig. 9.

1966b. — *Wetzeliella (Wetzeliella) tenuivirgula* WILLIAMS & DOWNIE. — G.L. WILLIAMS and C. DOWNIE, p. 188-189, pl. 19, figs. 2, 4.

1968. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — J.J. CHÂTEAUNEUF and C. GRUAS-CAVAGNETTO, p. 132.

1971. — *Wetzeliella (Wetzeliella) tenuivirgula* WILLIAMS & DOWNIE. — C. DOWNIE, M.A. HUSSAIN and G.L. WILLIAMS, p. 30.

1971. — *Wetzeliella (Wetzeliella) tenuivirgula* WILLIAMS & DOWNIE. — A. EISENACK and G. KJELLSTRÖM, p. 199-200 (856b-c).

1973. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — Y. CARO, p. 366, pl. 5, fig. 4.

1973. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — G.F.W. HERNGREEN, pl. 1, fig. 4.

1973. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 143.

?1975. — Aff. *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — W.R. EVITT and S.T. PIERCE, fig. 2, no. 5.

1975. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — J.P. AUFFRET and C. GRUAS-CAVAGNETTO, p. 651.

1975. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 21, 24.

1975. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — S.D. HARKER and W.A.S. SARJEANT, chart 25 (p. 258).

1976. — *Wetzeliella (Wetzeliella) tenuivirgula* (WILLIAMS & DOWNIE). — L.I. COSTA and C. DOWNIE, p. 600, text.-figs. 1, 3.

1976. — *Kisselevia* [*sic*] *tenuivirgula* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 136.

1976. — *Wetzeliella (Wetzeliella) tenuivirgula* WILLIAMS & DOWNIE. — G.L. EATON, p. 303, pl. 20, figs. 1-2, text-fig. 3.

1977a. — *Wetzeliella tenuivirgula* WILLIAMS & DOWNIE. — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9 (folding chart).

1977b. — *Kisselevia* [*sic*] *tenuivirgula* WILLIAMS & DOWNIE. — R.E. JAN DU CHÊNE, p. 151, tab. 1.

1977b. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 93.

1978. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — L.E. STOVER and W.R. EVITT, p. 111.

1978. — *Kisselevia* [*sic*] *tenuivirgula* (WILLIAMS & DOWNIE). — G. STAMPFLI, R.E. JAN DU CHENE and R. HERB, p. 389, pl. 31, figs. 1-4.

1979. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 20, 85, 88, 94.

?1979 — *Kisselovia* cf. *tenuivirgula* (WILLIAMS & DOWNIE). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 92.

1980. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — A.W. VAN ERVE, H. VISSCHER and V.J. GUPTA, p. 627-628, pl. 2, figs. 5-7.

1980a. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7B.

1981. — *Kisselovia tenuivirgula* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 164.

DISCUSSION

The forms placed by PASTIELS into his species *Hystrichosphaeridium geometricum* comprehend, in modern terms, several morphological types. One of the specimens surviving is that which he illustrated (1948, Pl. 4, fig. 9). Though it is now in lamentable condition, its ambitus and the character and distribution of its spines show it to be attributable to *Kisselovia tenuivirgula.*

This species appears to be confined to the Early and Middle Eocene (Late Ypresian to Lutetian) and thus serves as a useful stratigraphical marker. It has been recorded from sediments of these ages in England, France, Belgium, the Netherlands, Switzerland, Iran and the Simla Himalaya, India, from submarine cores from the English Channel, from the Grand Banks and Scotian and Labrador Shelves, offshore eastern Canada, and questionably from California.

Genus *Apectodinium* (COSTA and DOWNIE, 1976) LENTIN and WILLIAMS, 1977b *Apectodinium homomorphum* (DEFLANDRE and COOKSON, 1955) LENTIN and WILLIAMS, 1977b, emend. HARLAND, 1979

(pars) 1948. — *Hystrichosphaeridium geometricum* PASTIELS. — A. PASTIELS, p. 41, pl. 4, figs. 6, 11, *nomen nudum.* [Jr. homonym of *Hystrichosphaeridium geometricum* DEFLANDRE, 1942].

(pars) 1948. — *Hystrichosphaeridium articulatum* auct. non EISENACK. — A. PASTIELS, p. 42-43, pl. 4, fig. 14.

1953. — *Hystrichosphaeridium geometricum* PASTIELS *non* DEFLANDRE. — I.C. COOKSON, p. 114-115, pl. 2, fig. 25, *nomen nudum.*

1955. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — G. DEFLANDRE and I.C. COOKSON, p. 254, pl. 5, fig. 7, text-figs. 17-18.

1964. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — C. DOWNIE and W.A.S. SARJEANT, p. 154.

1964. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — A. EISENACK and K.W. KLEMENT, p. 829.

1965. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 11, 14, pl. 11, figs. 1, 2, 5, 6, 8, 9, 16.

1966. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, text-fig. 2, p. 216, 218.

1966. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 250, 252.

1966b. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — G.L. WILLIAMS and C. DOWNIE, p. 190-191.

?1966b. — *Wetzeliella (Wetzeliella) ovalis* auct. non EISENACK. — G.L. WILLIAMS and C. DOWNIE, p. 192-193, pl. 18, fig. 10.

1966. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — P. MORGENROTH, p. 10, pl. 1, figs. 8-9.

1967b. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — W.A.S. SARJEANT, tab. 10 (p. 336).

1968. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 91, pl. 13, figs. 1-3, 7.

1968. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J.J. CHÂTEAUNEUF and C. GRUAS-CAVAGNETTO, p. 71, 77, 78, fig. 3.

1968. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 8, 20, pl. 3, figs. 3-6.

1970b. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 70, 72, 74, pl. 1, fig. 9.

1971. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, fig. 3.

1971. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — C. DOWNIE, M.A. HUSSAIN and G.L. WILLIAMS, p. 31.

1971. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — A.S. GRIGOROVICH, p. 88.

1972. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 65.

1973. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — Y. CARO, p. 334, 336, 342, 363, pl. 5, fig. 10, text-fig. 2.

1973. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 141.

1975. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 11, 12, 13, 16, 18, 24, 25, 29, 63, pl. 6, fig. 11, pl. 7, fig. 1-2.

1975. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J.P. AUFFRET and C. GRUAS-CAVAGNETTO, p. 643, 646, 651.

1975. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — W.S. DRUGG and L.E. STOVER, pl. 7, fig. 9, chart 3.

1975. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 39, pl. 6, fig. 4, folding figs. 8-9, 11-12, 14, 15b.

1975. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — S.D. HARKER and W.A.S. SARJEANT, charts 25 (p. 258), 39 (p. 272), 55 (p. 288), 68 (p. 301).

1976. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 221, 222, 223, pl. 1, fig. 9.

1976. — *Wetzeliella (Apectodinium) homomorpha* DEFLANDRE & COOKSON. — L.I. COSTA and C. DOWNIE, p. 592-593, 600, 607, 608, text-figs. 1-3, 6.

1976. — *Wetzeliella homomorpha homomorpha* DEFLANDRE & COOKSON. — W.W. BRIDEAUX and D.W. MYHR, fig. 633.

1976. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 132, pl. 18, fig. 276.

1977a. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON. — G.L. WILLIAMS and J.P. BUJAK, p. 22, 29, pl. 3, fig. 6, text-fig. 9 (folding).

1977. — *Wetzeliella (Wetzeliella) homomorpha* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 38, fig. 3, encl. 1.

1977. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — R.E. JAN DU CHÊNE, p. 150, tabs. 1-2.

1977b. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J.K. LENTIN and G.L. WILLIAMS, p. 8.

1978. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J.J. CHÂTEAUNEUF and C. GRUAS-CAVAGNETTO, p. 71, 77, 78, fig. 3.

1978. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — L.E. STOVER and W.R. EVITT, p. 95.

1979a. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — L.I. COSTA and C. DOWNIE, p. 36, 43.

1979b. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — L.I. COSTA and C. DOWNIE, tabs. 1-2.

1979. — *Wetzeliella (Apectodinium) homomorpha* DEFLANDRE & COOKSON, emend. — R. HARLAND, p. 63-65, pl. 1, figs. 1-8.

1979. — *Wetzeliella (Apectodinium) homomorpha* DEFLANDRE & COOKSON. — R.W. O'B. KNOX and R. HARLAND, pl. 1, figs. 4-5.

1979. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 13, 20, 27, 29, 30, 37, 40, 42, 44, 49, 50, 51, 52, 57, 63, 65, 69, 70, 72, 73, 74, 76, 81, 86, 88, 89, 90, 91, 93, 94, 95, 97, 98.

1979. — *Wetzeliella homomorpha homomorpha* DEFLANDRE & COOKSON. — J.M. HANSEN, p. 90.

1980a. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J. DE CONINCK, tabs. 1, 3.

1980b. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J. DE CONINCK, p. 313, fig. 2, tab. 1.

1980. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — S.K. DUTTA and K.P. JAIN, p. 69, pl. 8, fig. 67, tab. 2.

1980. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J.J. CHÂTEAUNEUF, p. 149, 271, text-fig. 346.

1980a. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7a.

1981. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J. DE CONINCK, M. DE DECKER, J. DE HEINZELIN and W. WILLEMS, p. 126, 128, 129, pl. 3, figs. 8-9, tab. 2.

1981. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — J.K. LENTIN and G.L. WILLIAMS, p. 14.

1982. — *Apectodinium homomorphum* (DEFLANDRE & COOKSON). — C. HEILMANN-CLAUSEN, p. 58.

DISCUSSION

Two of the forms illustrated by PASTIELS as *Hystrichosphaeridium geometricum* (1948, Pl. 4, figs. 6, 11) were referred by R. HARLAND (1979, p. 63) to *Apectodinium homomorphum* and one of those illustrated by PASTIELS as *Hystrichosphaeridium articulatum* (1948, Pl. 4, fig. 14) seems to me to merit a similar attribution. These judgements cannot be confirmed, since the specimens figured were not among those still identifiable in PASTIELS' type material.

The synonymy presented above for this widely encountered species is the most extensive yet prepared. *Apectodinium homomorphum* appears in the Late Palaeocene (Thanetian) and ranges upward through the Eocene to the Early Oligocene (Rupelian). It has been recorded from Belgium, the Netherlands, France, Germany, Spain, Denmark, Switzerland, the Ukraine (U.S.S.R.), Italy, the eastern United States (McLEAN, unpublished data), the District of Mackenzie (Northwest Territories, Canada), Australia and India, and from submarine cores from the English Channel, the Rockall Plateau (North Atlantic Ocean), the Grand Banks and the Scotian and Labrador Shelves (offshore eastern Canada).

Apectodinium quinquelatum (WILLIAMS and DOWNIE, 1966b) COSTA and DOWNIE, 1979a (Plate III, Figure 1)

(pars) 1948. — *Hystrichosphaeridium geometricum* nov. sp. — A. PASTIELS, p. 41, pl. 4, figs. 1-5, 7-10, *nomen nudum*. [Jr. homonym of *Hystrichosphaeridium geometricum* DEFLANDRE, 1942).

1966b. — *Wetzeliella homomorpha* DEFLANDRE & COOKSON var. *quinquelata* WILLIAMS & DOWNIE. — G.L. WILLIAMS and C. DOWNIE, p. 191-192, pl. 18, fig. 7.

1968. — *Wetzeliella* sp. — J. DE CONINCK, pl. 3, figs. 13-14, 16-18.

1968. — *Wetzeliella homomorpha* var. *quinquelata* WILLIAMS & DOWNIE. — C. GRUAS-CAVAGNETTO, pl. 13, fig. 11.

1973. — *Wetzeliella homomorpha* var. *quinquelata* WILLIAMS & DOWNIE. — Y. CARO, p. 364, pl. 2, fig. 5, pl. 4, fig. 5.

1973. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 141.

1975. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — G.L. WILLIAMS and W.W. BRIDEAUX, p. 20, 23, pl. 6, fig. 5, folding figs. 8, 9, 15b.

1975. — *Wetzeliella homomorpha* var. *quinquelata* WILLIAMS & DOWNIE. — S.D. HARKER and W.A.S. SARJEANT, ch. 25 (p. 258).

1976. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 132, pl. 18, fig. 278.

1976. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — W.W. BRIDEAUX and D.W. MYHR, p. 241, fig. 43.3.

1977a. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9e.

1977b. — *Apectodinium homomorphum quinquelatum* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 8.

1977a. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — R.E. JAN DU CHÊNE, p. 56-57, *nomen nudum.*

1977b. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — R.E. JAN DU CHÊNE, p. 151, tab. 1, *nomen nudum.*

1979a. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — L.I. COSTA and C. DOWNIE, p. 43.

1979b. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — L.I. COSTA and C. DOWNIE, p. 515, tabs. 1-2.

?1979. — *Wetzeliella homomorpha quinquelata* (WILLIAMS & DOWNIE). — J.M. HANSEN, p. 90.

1979. — *Wetzeliella (Apectodinium) quinquelata* (WILLIAMS & DOWNIE). — R. HARLAND, p. 67-68, pl. 1, figs. 10-11, pl. 2, figs. 16, 20.

1979. — *Wetzeliella (Apectodinium) quinquelata* (WILLIAMS & DOWNIE). — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 88, 94, 95.

1981. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 14.

?1982. — *Apectodinium quinquelatum* (WILLIAMS & DOWNIE). — C. HEILMANN-CLAUSEN, p. 58.

DISCUSSION

The forms which PASTIELS described under the invalid name *"Hystrichosphaeridium geometricum"* are of two morphological types, both of which were encompassed within *Wetzeliella homomorpha* (now *Apectodinium homomorphum*) in its original, broad interpretation. However, as HARLAND (1979, pl. 2, fig. 4) has noted, the majority of PASTIELS' forms, including his holotype (1948, pl. 2, fig. 4), accord with the morphotype originally considered as variety *quinquelata* of *Wetzeliella homomorpha* but since elevated to specific status, as *Apectodinium quinquelatum.*

Of the nine specimens of *Apectodinium quinquelatum,* only one, apparently the "cotype" figured in his Pl. 2, fig. 2 (1948), could be identified in PASTIELS' type material. It is here illustrated photographically for the first time and may be seen to be an excellent specimen of this species.

The stratigraphical and geographical distribution of *A. quinquelatum* appears much more restricted than that of *A. homomorphum.* The former species is known only from the late Early to Late Eocene (Late Ypresian to Bartonian) of England, Belgium, France, Spain, Switzerland, the District of Mackenzie, Northwest Territories, Canada, and from submarine cores from the Labrador Shelf, offshore eastern Canada. The records by HANSEN (1979) and HEILMANN-CLAUSEN (1982), from the Late Palaeocene of Denmark, are unaccompanied by an illustration and cannot be assessed. The restricted geographical distribution of this species may suggest an association with cool marine waters.

Family Canningiaceae SARJEANT and DOWNIE, 1966, emend. SARJEANT and DOWNIE, 1974

Genus *Glaphyrocysta* STOVER and EVITT, 1978

Glaphyrocysta pastielsii (DEFLANDRE and COOKSON, 1955) STOVER and EVITT, 1978, emend. nov.

(Plate II, Figures 1, 3-5)

1948. — *Membranilarnax* cf. *liradiscoides* O. WETZEL. — A. PASTIELS, p. 47, pl. 5, fig. 15.

1952. — *Membranilarnax* cf. *liradiscoides* O. WETZEL. — H. GOCHT, pl. 2, fig. 22.

1955. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — G. DEFLANDRE and I.C. COOKSON, p. 285.

1964. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. DOWNIE and W.A.S. SARJEANT, p. 105.

1965. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 44, pl. 12, figs. 32, 35, 39.

1967. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 218.

1967. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 250, 252.

1967a. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — W.A.S. SARJEANT, tab. 8 (p. 334).

1968. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 83, 141, pl. 12, figs. 10-11, 15-16.

1969. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — H. GOCHT, p. 60-61, pl. 8, fig. 15.

1970a. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 71, pl. 2, fig. 4.

1970b. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 19.

1971. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — A. EISENACK and G. KJELLSTRÖM, p. 317.

1971. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 172.

?1973. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — Y. CARO, p. 352, pl. 1, fig. 8.

1973. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 37. [Considered incorrectly to be a *nomen nudum*].

1974. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 87.

1975. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 20, 22, 24, pl. 26, figs. 4, 8, folding figs. 8, 9, 11, 12, 14.

?1975. — *Cyclonephelium pastielsi?* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 11, 52, pl. 4, figs. 1-6.

1975. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — S.D. HARKER and W.A.S. SARJEANT, chart 20 (p. 253).

1976. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — J. SCHUMACKER-LAMBRY and J.J. CHÂTEAUNEUF, p. 274, tab. 1.

1976. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 45.

1976. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — G.L. EATON, p. 258-259.

1976. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — P.N. VON BENEDEK and C. MÜLLER, text-fig. 2.

1977b. — *Cyclonephelium pastielsii* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 38.

1977a. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9 (folding).

1977. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — J. DE CONINCK, encl. 1.

1978. — *Cyclonephelium pastielsii* DEFLANDRE & COOKSON. — J. SCHUMACKER-LAMBRY, p. 40, pl. 3, fig. 12.

1978. — *Cyclonephelium pastielsi* DEFLANDRE & COOKSON. — W.A.S. SARJEANT and L.E. STOVER, p. 52.

1978. — *Glaphyrocysta pastielsii* (DEFLANDRE & COOKSON). — L.E. STOVER and W.R. EVITT, p. 50.

1979. — *Cyclonephelium pastielsii* DEFLANDRE & COOKSON. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 29, 49, 65, 57.

?1980. — *Glaphyrocysta* aff. *pastielsii* (DEFLANDRE & COOKSON). — H. WEILER *in* F. DOEBL *et al.*, p. 53, ill. 10, fig. 2.

1980. — *Glaphyrocysta pastielsii* (DEFLANDRE & COOKSON). — J.J. CHÂTEAUNEUF, p. 139, 262, text-fig. 346.

1981. — *Glaphyrocysta pastielsii* (DEFLANDRE & COOKSON). — J.K. LENTIN and G.L. WILLIAMS, p. 111.

non 1966c. — *Cyclonephelium pastielsi* auct. non DEFLANDRE & COOKSON. — G.L. WILLIAMS and C. DOWNIE, p. 227, pl. 25, fig. 2 (see discussion, p. 2).

EMENDED DIAGNOSIS

Cyst lenticular, marginate and trabeculate. Ambitus broadly ovoidal, but with an asymmetrically situated antapical outbulge or broad, low horn (situated always to the left of the antapical pole in ventral view). Low surficial lines in the circumferential areas may mark the positions of parasutures or may be lacking; normally the cingulum can be seen clearly only in the lateral regions. The mid-ventral and mid-dorsal regions lack ornament. Processes arise primarily or entirely from paraplate boundaries, both in gonal and sutural positions. Their spacing is irregular, two to four parallel processes often arising close to a paraplate junction while the central sutural area lacks processes. They are short (in length, less than 1/3 the equatorial diameter of the cyst), very slender and apparently solid. The processes are linked distally by major trabeculae developed parallel to the paraplate boundaries. In addition, meshworks of minor trabeculae may develop from the processes, extending outward to join the major trabeculae and forming arch-like traceries beneath them. These meshworks are produced by the bifurcation or ramification of the processes at about one-third height, the resultant branches being complexly interconnected. Archaeopyle apical, type (tA); sulcal notch and accessory sutures well marked. Operculum free.

HOLOTYPE
(designated by EATON, 1976, p. 258)

Slide 35 (figured by PASTIELS, 1948, Pl. 5, fig. 15, and herein Pl. II, figs. 1, 3-5). I.R.Sc.N.B. N° b 1534.

DIMENSIONS

Holotype: overall length 181 µm, length of central body (apex lacking) 48 µm, overall breadth 93 µm, breadth of central body 57 µm.

TYPE HORIZON AND LOCALITY

Grey-blue clays, lower bed, Early Eocene (Early Ypresian), Blorquiau quarry of the Société Anonyme des Carrières de Quenast, Quenast, Belgium.

DISCUSSION

A re-examination of the specimen figured by PASTIELS (1948, Pl. 5, fig. 15) shows his interpretative drawing to be, though correct enough in its major features, somewhat misleading in detail, the shape

of the central body being less broad proportionately and the antapical prominence less evident than in reality. Moreover, the processes and the trabeculae are drawn too thick and their pattern of interconnexions is much simplified. The specimen illustrated as *C. pastielsii* by WILLIAMS and DOWNIE (1966b, Pl. 25, fig. 2) does not appear to belong to this species. Although the photograph presented by GOCHT (1969, Pl. 8, fig. 15) provides a better basis for the interpretation of the morphology of this species, it is questionable whether, with these very different illustrations to serve as bases, subsequent identifications of this species have been correct. Unfortunately, this is difficult to check since, in the majority of instances, no photographs are furnished in these later publications.

On the basis of these published records, *Glaphyrocysta pastielsii* appears to have a stratigraphic range from Late Palaeocene (Thanetian) to Late Eocene (Bartonian); the few later records all appear doubtful. It has been reported from Belgium, the Netherlands, England, France, Germany, Italy, and from submarine cores from the Grand Banks and Scotian Shelf, offshore eastern Canada. The specimen from Spain illustrated by CARO (1973) seems likely to prove attributable to a different species; and the systematic attribution of the specimens illustrated by DE CONINCK (1975) and WEILER (1980) was properly regarded as questionable from the outset.

In their diagnosis of *Glaphyrocysta,* STOVER and EVITT (1978, p. 69) noted that it has "No parasutural features." In the type species, *G. retiintexta* (COOKSON, 1965) STOVER and EVITT, 1978, this may well be the case. However, the processes of *G. pastielsii* furnish a direct expression of the paratabulation, for they arise from parasutures (feebly marked or not at all) whose position is paralleled by the major trabeculae. In combination, these features permit the determination of a ceratioid paratabulation comparable (for instance) with that illustrated for *Endoceratium ludbrookiae* by WALL and EVITT (1975, text-fig. 9 D-E). The clear delimitation of the antapical paraplate (1‴″) may be seen (Pl. II, figs. 1, 3) and the enlarged illustrations here provided show how the boundaries of paraplates 4‴ (Pl. II, fig. 5) and paraplate 2″ (Pl. II, fig. 4) can be distinguished without great difficulty. The displacement to the right of the bare midventral area (seen by transparency in Pl. II, fig. 3) should also be noted. All in all, though the interpretation of the paratabulation in this species is difficult, it is by no means impossible.

Since *G. pastielsii* thus has interconnected sutural processes rather than penitabular process complexes, its placement into the genus *Glaphyrocysta,* as presently defined, is clearly inappropriate. However, it is felt that a re-examination of the whole content of that genus is desirable before any proposals for taxonomic revisions are formulated.

Glaphyrocysta exuberans
(DEFLANDRE and COOKSON, 1955)
STOVER and EVITT, 1979, emend. nov.

(pars) 1948. — *Membranilarnax pterospermoides* auct. non O. WETZEL. — A. PASTIELS, p. 46, pl. 5, figs. 11, 13-14.

1955. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — G. DEFLANDRE and I.C. COOKSON, p. 285.

1964. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — C. DOWNIE and W.A.S. SARJEANT, p. 105.

1966b. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — G.L. WILLIAMS and C. DOWNIE, p. 225.

1966b. — *Cyclonephelium pastielsi* auct. non DEFLANDRE & COOKSON. — G.L. WILLIAMS and C. DOWNIE, p. 227, pl. 26, fig. 2.

1967a. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — W.A.S. SARJEANT, tab. 8 (p. 334).

1967. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 218.

1971. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. DE CONINCK, fig. 3.

1971. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — A. EISENACK and G. KJELLSTRÖM, p. 303.

1973. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 37. [Considered incorrectly to be a *nomen nudum*].

1974. — *"Cyclonephelium exuberans"* DEFLANDRE & COOKSON. — W.A.M. JENKINS, P. ASCOLI, F.M. GRADSTEIN, L.F. JANSA and G.L. WILLIAMS, p. 9.

1975. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 26, pl. 27, fig. 3, folding figs. 7, 10A, 11, 12.

1975. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. DE CONINCK, p. 8, 12, 13, 20, 22, 51-52, pl. 3, figs. 8-9, 10-13, 14-16.

1975. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — S.D. HARKER and W.A.S. SARJEANT, chart 20 (p. 253).

1976. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — C. GRUAS-CAVAGNETTO, p. 45.

?1976. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. SCHUMACKER-LAMBRY and J.J. CHÂTEAUNEUF, p. 276, pl. 4, figs. 2-3.

1976. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — P.N. VON BENEDEK and C. MÜLLER, text-fig. 2.

1977a. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — G.L. WILLIAMS and J.P. BUJAK, text-fig. 9 (folding).

1977. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. DE CONINCK, encl. 1.

1977b. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — R.E. JAN DU CHÊNE, tab. 1.

1977b. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J.K. LENTIN and G.L. WILLIAMS, p. 37.

1978. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J. SCHUMACKER-LAMBRY, p. 40, pl. 3, fig. 7.

1978. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — W.A.S. SARJEANT and L.E. STOVER, p. 52.

1978. — *Glaphyrocysta exuberans* (DEFLANDRE & COOKSON). — L.E. STOVER and W.R. ' EVITT, p. 50.

1979. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 35, 78, 81.

1980a. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7B.

?1980a. — *Cyclonephelium* aff. *exuberans* DEFLANDRE & COOKSON. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7A.

1980a. — *Glaphyrocysta exuberans* (DEFLANDRE & COOKSON). — J. DE CONINCK, tab. 1.

1980. — *Glaphyrocysta exuberans* (DEFLANDRE & COOKSON). — S.K. DUTTA and K.P. JAIN, p. 69, pl. 2, figs. 7-8.

1981. — *Glaphyrocysta exuberans* (DEFLANDRE & COOKSON). — J.K. LENTIN and G.L. WILLIAMS, p. 10.

non 1963. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — M. BROSIUS, p. 46, pl. 8, fig. 3, tab. 1.

non 1966. — *Cyclonephelium exuberans* DEFLANDRE & COOKSON. — P. MORGENROTH, p. 27, pl. 6, fig. 6.

EMENDED DIAGNOSIS

Cyst lenticular, marginate and trabeculate. Ambitus spheroidal to ovoidal, but with one asymmetrically situated or two symmetrical but unequally developed antapical protuberances. If one only is present, it is situated to the left of the antapical pole in ventral view. Surface of phragma with or without a fine reticulation. Low ridges connect the bases of some processes to form annular or arcuate complexes; other processes lack such connexion. Paratabulation not directly indicated, though the presence of a cingulum may be indicated by alignment of processes or differences in surficial texture. Processes are lacking from the mid-ventral and mid-dorsal regions, but well developed elsewhere on the cyst. They appear solid and certainly are closed distally. Their length is variable, lateral processes having a length of around one-third of the cyst's equatorial diameter, polar processes approching one-half of that diameter. The processes are broad-based, tapering rapidly just above that base and thereafter maintaining a uniform thickness to about half their height, at which point they ramify elaborately, the branches being interconnected in mesh-like fashion by short trabeculae before combinding to form an overall network of larger trabeculae that surrounds the periphery of the cyst. This trabecular network may indeed simulate a minutely, but elaborately, fenestrate enclosing membrane. Occasionally, adjacent processes may exhibit also a trabecular connexion below half height; however, cysts seen in dorsal or ventral view characteristically have a spacious, open zone between the central body and the surrounding trabecular network. Archaeopyle apical (tA); sulcal notch and accessory sutures well marked. Operculum free or (rarely) attached.

HOLOTYPE
(designated by EATON, 1976, p. 255)

The specimen figured by PASTIELS (1948, pl. 5, figs. 11, 13). This specimen could not be located among PASTIELS' surviving material.

NEOTYPE
(here designated)

Specimen V.57742, British Museum (Natural History), London, England: illustrated by EATON, 1976, pl. 8, fig. 2.

DIMENSIONS

Holotype: overall length (apex lacking) 42 μm. Length of central body (apex lacking) 31 μm. Overall breadth 68 μm, breadth of central body 42 μm. Neotype: overall length (apex lacking) 102 μm, length of central body (apex lacking) 68 μm. Overall breadth 102 μm, breadth of central body 80 μm.

TYPE LOCALITIES AND HORIZONS

Holotype: grey-blue clays, lower bed, Early Eocene (Early Ypresian), Blorquiau quarry of the Société Anonyme des Carrières de Quenast, Quenast, Belgium. Neotype: Bracklesham Beds (Early-Late Eocene), Isle of Wight, southern England.

DISCUSSION

The two specimens illustrated, wrongly as *Membranilarnax pterospermoides* O. WETZEL, by PASTIELS (1948, Pl. 5, figs. 11-13) represent in modern terms two distinct species. EATON (1976) properly selected as holotype of *Cyclonephelium exuberans* the specimen most amply illustrated by PASTIELS, not only by a photograph and drawing (1948, Pl. 5, figs. 11, 13) but also by an idealized schematic drawing (*ibid.*, Pl. 5, fig. 14). Unfortunately, the holotype could not be discovered in the surviving slides and, as noted above, the second specimen figured by

PASTIELS (*ibid.*, Pl. 5, fig. 12) must now be considered to belong to another species.

The neotype here selected, although markedly larger than the lost holotype, was chosen because it is an excellent specimen which manifests, with particular clarity, all the special features that have come to be considered typical of *Cyclonephelium exuberans*. Moreover, it has the asset of being readily accessible for examination in a public collection. The emended diagnosis here presented takes into account the morphology of the neotype, as well as the features discernible in PASTIELS' illustrations.

In their account of *Cyclonephelium* (now *Glaphyrocysta*) *exuberans,* WILLIAMS and DOWNIE (1966b, p. 225) note that "*C. exuberans* has probably evolved from *C. pastielsi,* intermediate forms between the two being common". Their figure (*ibid.*, text-fig. 61) shows a specimen that is only in broadest terms comparable with *G. exuberans,* whereas their figure of *G. pastielsii* shows a specimen surely attributable to *G. exuberans*. I consider their comment to have been correct, *but* that their specimens all should be attributed to *Glaphyrocysta exuberans*. The Early Eocene specimen illustrated by MORGENROTH (1966, Pl. 6, fig. 6a) and the Late Oligocene specimen illustrated by BROSIUS (1963, Pl. 8, fig. 3) are each too different in morphology to be attributable to this species.

The known stratigraphical range of this species is from Late Palaeocene (Thanetian) to Early Oligocene (Rupelian). It has been reported from Belgium, England, France, Italy, Germany, Switzerland and India and from submarine cores from the English Channel and the Grand Banks, offshore eastern Canada.

Glaphyrocysta divaricata
(WILLIAMS and DOWNIE, 1966b)
STOVER and EVITT, 1978
(Plate I, Figure 1)

(pars) 1948. — *Membranilarnax pterospermoides* auct. non O. WETZEL. — A. PASTIELS, p. 46, pl. 5, fig. 12.

1966b. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — G.L. WILLIAMS and C. DOWNIE, p. 223-224, pl. 25, fig. 1, text-fig. 60.

1971. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — A. EISENACK and G. KJELLSTRÖM, p. 299.

1973. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 36.

?1975. — *Cyclonephelium divaricatum?* WILLIAMS & DOWNIE. — J. DE CONINCK, p. 50-51, pl. 3, figs. 6-7.

?1975. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 20, 21, 22, 42, pl. 25, fig. 3, pl. 26, fig. 1, folding figs. 8, 11, 12.

1975. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — S.D. HARKER and W.A.S. SARJEANT, chart 20 (p. 253).

1976. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — G.L. EATON, p. 255, pl. 7, fig. 5, text-figs. 29-30.

1977. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — J. DE CONINCK, encl. 1.

1977b. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 37.

1978. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — J. SCHUMACKER-LAMBRY, p. 39, pl. 3, fig. 8.

1978. — *Glaphyrocysta divaricata* (WILLIAMS & DOWNIE). — L.E. STOVER and W.R. EVITT, p. 50.

1979b. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — L.E. COSTA and C. DOWNIE, tab. 1.

1979. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 55, 89.

?1980b. — *Glaphyrocysta* aff. *divaricata* (WILLIAMS & DOWNIE). — J. DE CONINCK, tab. 1.

1980a. — *Cyclonephelium divaricatum* WILLIAMS & DOWNIE. — J.P. BUJAK, C. DOWNIE, G.L. EATON and G.L. WILLIAMS, text-fig. 7a.

1981. — *Glaphyrocysta divaricata* (WILLIAMS & DOWNIE). — J.K. LENTIN and G.L. WILLIAMS, p. 110.

1982. — *Glaphyrocysta divaricata* (WILLIAMS & DOWNIE). — J. DE CONINCK and J. SMIT, tab. 1.

DISCUSSION

The second of the specimens illustrated under the name *"Membranilarnax pterospermoides"* by PASTIELS (1948, Pl. 5, fig. 12) survives in good condition; a photograph of it is here published for the first time. Its processes are much more slender than those of *G. exuberans,* differing also by being more variable in level of branching or trabecular linkage and more evidently grouped into annulate complexes. The very fine-meshed net produced distally by the trabeculae has a more irregular, hummocky appearance and there is no sense of an open zone surrounding the central body. Clearly this specimen belongs in a distinct species.

In all features, it agrees with WILLIAMS and DOWNIE's diagnosis of *Cyclonephelium divaricatum,* now *Glaphyrocysta divaricata* (1966b, pp. 223-224). It displays also most of the supplementary features noted in their description. The autophragm is unusually delicate, its surface finely reticulate, and the trabecular meshwork exhibits what those authors termed "secae". However, processes do not surround the margin of the archaeopyle; they are lacking from its mid-dorsal margin and from its (asymmetrically positioned) sulcal region. In all crucial morphological features, therefore, PASTIELS'

specimen exhibits so completely the combination of morphological features specified for *G. divaricata* that it must be placed into that species.
Nevertheless, I view this attribution with some disquiet. The single photograph furnished by WILLIAMS & DOWNIE (1966b, Pl. 25, fig. 1) appears to have processes which are coarser and slightly longer: their Text-figure 60 emphasises this. The dorsal and ventral regions bare of processes appear to be smaller and the surrounding reticulum somewhat coarser-meshed. The specimen illustrated by EATON (1976, Pl. 7, fig. 5) resembles the holotype closely, whereas those illustrated by WILLIAMS & BRIDEAUX (1975, Pl. 25, fig. 3, Pl. 26, fig. 1) appear to have processes shorter even than those of PASTIELS' specimen; indeed, I view their attribution to this species with doubt. A redefinition of *G. divaricata,* providing more morphological detail, and an analysis of its morphological variability are desirable, in order to clarify its exact character.
This species has been recorded from Late Palaeocene (Thanetian) to Early Eocene (Ypresian) sediments of Belgium, England and Spain and from submarine cores from the Rockall Plateau, North Atlantic Ocean, and from the Grand Banks and Labrador Shelf, offshore eastern Canada.

Family Thalassiphoraceae GOCHT, 1968,
emend. SARJEANT and DOWNIE, 1974
Genus *Thalassiphora* EISENACK and GOCHT, 1960,
emend. BENEDEK and GOCHT, 1981
Thalassiphora delicata
WILLIAMS and DOWNIE, 1966b,
emend. EATON, 1976
(Plate I, Figure 6; Plate V, Figure 1)

1948. — Spore incertae sedis: Specimen no. 3. — A. PASTIELS, p. 59, pl. 6, figs. 35-36.

1966b. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — G.L. WILLIAMS and C. DOWNIE, p. 235, pl. 26, fig. 8.

1967. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — N. BALTEŞ, p. 11, pl. 4, fig. 1.

1968. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. DE CONINCK, p. 47-48, pl. 14, figs. 2-7.

1971. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — A. EISENACK & G. KJELLSTRÖM, p. 1053.

1971. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — C. DOWNIE, M.A. HUSSAIN and G.L. WILLIAMS, p. 30.

1971. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. DE CONINCK, p. 9, fig. 3.

1971. — *Thalassiphora* cf. *T. delicata* WILLIAMS & DOWNIE. — D. HABIB, pl. 4, fig. 2, tab. 1.

1973. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 136.

1974. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — W.A.M. JENKINS, P. ASCOLI, F.M. GRADSTEIN, L.F. JANSA and G.L. WILLIAMS, p. 6, 9.

1974. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — C. GRUAS-CAVAGNETTO, p. 87.

1975. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — G. AUFFRET and C. GRUAS-CAVAGNETTO, p. 651.

1975. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — S.D. HARKER and W.A.S. SARJEANT, chart 26 (p. 259).

1976. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. SCHUMACKER-LAMBRY and J.J. CHÂTEAUNEUF, p. 277, pl. 6, fig. 1, tab. 1.

1977b. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 162.

1978. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. SCHUMACKER-LAMBRY, p. 49, 87, 91, 92, 128, pl. 7, fig. 5, text-fig. 26.

1978. — *"Thalassiphora delicata"* WILLIAMS & DOWNIE. — R. HARLAND, chart 2, pl. 3, fig. 8.

?1979. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — L.I. COSTA and C. DOWNIE, pl. 3, fig. 9.

1979. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — M.S. BARSS, J.P. BUJAK and G.L. WILLIAMS, p. 13, 31, 35, 58, 66, 70, 81, 83.

1979. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — S. MANUM, fig. 2.

1979. — *"Thalassiphora delicata"* WILLIAMS & DOWNIE. — R. HARLAND, p. 531, pl. 2, fig. 15, text-fig. 1.

1980. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J.J. CHÂTEAUNEUF, fig. 38b.

1980a. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. DE CONINCK, tab. 1.

1980b. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. DE CONINCK, tab. 1.

1981. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J.K. LENTIN and G.L. WILLIAMS, p. 278.

?1982. — *Thalassiphora delicata* WILLIAMS & DOWNIE. — J. DE CONINCK and J. SMIT, tab. 1.

DISCUSSION

One of the specimens figured by PASTIELS as "Spores incertae sedis" may be seen, from his illustration (1948, Pl. 6, figs. 35-36), to exhibit evidences of paratabulation and to have a precingular archaeopyle. Since the specimen survives in fair condition, both features can be confirmed; the archaeopyle is seen particularly well (Pl. I, fig. 6). In view of its small size and the relative clarity with which the paratabulation may be seen, this specimen may be attributed confidently to *Thalassiphora delicata.*
This species has a stratigraphical range from Early Palaeocene (Danian) to Pliocene. It has been recorded from England, Germany, Belgium, France, Italy, Roumania and southern Spain, and from submarine cores from the English Channel, the Bay of Biscay and the Rockall Plateau (North Atlantic Ocean) and from the Grand Banks and Scotian Shelf, offshore eastern Canada.

Family Adnatosphaeridiaceae
SARJEANT and DOWNIE, 1966
Genus *Adnatosphaeridium*
WILLIAMS and DOWNIE, 1966b
Adnatosphaeridium cf. *vittatum*
WILLIAMS and DOWNIE, 1966b

(pars) 1948. — *Cannosphaeropsis reticulensis* PASTIELS. — A. PASTIELS, p. 49, pl. 5, fig. 9.

DISCUSSION

As noted earlier, four specimens attributed to his new species *Cannosphaeropsis reticulensis* were figured by PASTIELS. Three of these are retained by me in that species (now *Nematosphaeropsis reticulensis*). In contrast, the fourth — his third "paratype" — appears from PASTIELS' figure (1948, Pl. 5) to have, as well as slender processes, the distally open tubes that characterise *Adnatosphaeridium vittatum* WILLIAMS and DOWNIE. However, since this specimen could not be located, certainty is impossible and the specimen is merely compared with, not placed into, that species.

Family Cannosphaeropsitaceae
SARJEANT and DOWNIE, 1966
Cannosphaeropsis O. WETZEL, 1933,
emend. DUXBURY, 1980
Cannosphaeropsis williamsii sp. nov.

?1966. — *Cannosphaeropsis reticulensis* auct. non PASTIELS. — P. MORGENROTH, p. 19, pl. 4, figs. 2-3.

1966b. — *Cannosphaeropsis reticulensis* auct. non PASTIELS. — G.L. WILLIAMS and C. DOWNIE, p. 223, pl. 24, fig. 8.

(pars) 1968. — *Adnatosphaeridium reticulense* auct. non PASTIELS. — J. DE CONINCK, pl. 11, figs. 25-56.

1975. — *Adnatosphaeridium reticulense* auct. non PASTIELS. — G.L. WILLIAMS and W.W. BRIDEAUX, p. 20, 22, pl. 21, fig. 11, folding figs. 8, 9, 11, 14, 15b.

1975. — *Cannosphaeropsis reticulensis* (PASTIELS) sensu WILLIAMS and DOWNIE. — G.L. WILLIAMS and W.W. BRIDEAUX, folding fig. 12.

1978. — *Adnatosphaeridium reticulense* auct. non PASTIELS. — J. SCHUMACKER-LAMBRY, p. 35, pl. 1, fig. 8.

1980. — *Adnatosphaeridium reticulense* auct. non PASTIELS. — J.J. CHÂTEAUNEUF, p. 132, 256, pl. 19, fig. 2, text-fig. 34b.

DERIVATION OF NAME

In honour of the distinguished palynologist GRAHAM L. WILLIAMS, who has undertaken major studies of Tertiary dinoflagellate cysts.

DIAGNOSIS

Cyst chorate, skolochorate and trabeculate. Ambitus ovoidal to broadly ellipsoidal or elongate subpolygonal, without horns or antapical asymmetry. Processes nontabulate or in gonal or sutural situations. Each process tapers rapidly just above the base, thereafter maintaining constant thickness up to the position of branching. The processes may be hollow or solid, but they are always closed and bifurcate or trifurcate distally. The branches themselves bifurcate or trifurcate and give rise to an intricate, spider's-web-like meshwork of trabeculae which surrounds the whole cyst. Length of processes between one-third and one-half the equatorial diameter of the central body. Surface of phragma without, or with reduced, ornament; parasutures not indicated by ridges or lines. Archaeopyle precingular, type P; operculum free.

HOLOTYPE

Specimen V.51964(3), collections of the British Museum (Natural History), London (figured by WILLIAMS and DOWNIE, 1966b, Pl. 24, fig. 8).

DIMENSIONS

Holotype: overall length 46 μm, length of central body 30 μm, overall breadth 41 μm, breadth of central body 26 μm. Range: diameters of central body 26-43 μm, length of processes 9-18 μm.

TYPE LOCALITY AND HORIZON

London Clay, Early Eocene (Ypresian), England.

DISCUSSION

Though the position of the processes in this species could not be determined with complete confidence, they appear to be gonal (or gonal and sutural) rather than nontabulate. However, the enclosing trabecular network is elaborate and does not readily reveal the positions of parasutures, as does the simpler pattern of trabeculae in *Nematosphaeropsis reticulensis*. In consequence, since parasutural features are lacking, the paratabulation pattern (though probably gonyaulacacean) is not directly determinable and placement into the genus *Nematosphaeropsis*, even in the emended acceptation of STOVER and EVITT (1978, p. 176), would be inappropriate.

In view of past confusions in the identification of *N. reticulensis* and *Cannosphaeropsis williamsii* (see p. 11-13), any comment on the stratigraphical and geographical range of the latter species must be provisional. For the moment, its stratigraphic range appears to be from Early Palaeocene (Danian) to

Middle Eocene (Lutetian) and it is known at least from Germany, Belgium and England, and from cores from the Grand Banks, offshore eastern Canada.

Family Lingulodiniaceae
SARJEANT and DOWNIE, 1974
Genus *Lingulodinium* WALL, 1967,
emend. WALL and DALE, 1973
Cf. *Lingulodinium machaerophorum*
(DEFLANDRE & COOKSON, 1955) WALL, 1967

1948. — *Hystrichosphaeridium* cf. *hirsutum* (EHRENBERG) forma *minor* O. WETZEL. — A. PASTIELS, p. 45, pl. 5, figs. 4, 6.

DISCUSSION

The two specimens discussed and illustrated by PASTIELS as *Hystrichosphaeridium hirsutum* forma *minor* correspond, in the number and character of their processes, with *Lingulodinium machaerophorum,* though their dimensions are somewhat small for that species. Unfortunately, since neither specimen could be located, the character of the archaeopyles (not evident in PASTIELS' illustrations) could not be ascertained and the identification thus must remain uncertain.

Incertae Sedis
Proximate cysts, gen. et sp. indet.

1948. — *Palaeoperidinium* sp. — A. PASTIELS, p. 52, pl. 5, figs. 22-24.

DISCUSSION

The two specimens illustrated as *Palaeoperidinium* sp. by PASTIELS — appropriately enough at that time, since *Palaeoperidinium* was then a "sack" genus — were not relocated among the material still recognizable. Though his figures show proximate cysts on which a surficial pattern of paraplates is evident, it is not clear either if these specimens were cavate or what was their style of archaeopyle. The first specimen he illustrated (1948, Pl. 5, figs. 22, 23) might have either an intercalary or precingular archaeopyle; the second (Pl. 5, fig. 24) appears severely damaged. Under these circumstances, no taxonomic assignation can be suggested.

III. Conclusions

PASTIELS (1948) recognized nineteen dinoflagellate cyst morphotypes, variously as "hystrichospheres", "radiolaria", "dinoflagellates" and "spores incertae sedis". Because of the deterioration of his type material, only one-quarter of the specimens he illustrated can now be recognized. Three of his morphotypes cannot be reassigned, even at generic level, with any confidence. From among the remaining fifteen morphotypes, twenty-seven dinoflagellate cyst species are recognized with varying degrees of confidence; these are listed, and the known stratigraphical distribution indicated in Table I. An alphabetical, rather than a systematic, order is adopted, to facilitate ready reference. Also tabulated are the geographical occurrences within Belgium of the species in the Ypresian assemblages studied by PASTIELS (1948, pp. 30-33). These have been recorded in conservative fashion; where one of PASTIELS' morphotypes has been separated by me into two or several taxa, the resultant taxa are shown to be present only where text or plate captions make this reasonably certain.

Following this revision, none of the taxa remain in the genera to which PASTIELS assigned them. Moreover, only two (including the single valid new species he proposed) retain the specific epithets he applied to them — and then only in part, the contents of those taxa being now, in many cases, assigned to more than one species. The resultant picture thus is a very different one from that he presented. However, it furnishes no real surprises; all the taxa presently identified are eminently likely to be encountered in Early Eocene assemblages from northwest Europe, with the single exception of *Ceratiopsis leptoderma,* known hitherto only from Siberia (U.S.S.R.) and the Grand Banks, offshore eastern Canada.

The geographic picture that emerges is intriguing. Twenty species were identified with confidence. Of these, two *(Spiniferites ramosus* and *Achomosphaera ramulifera)* are very long-ranging and of world-wide occurrence, while two others *(Tityrosphaeridium gracile* and *Thalassiphora delicata)* are almost as long-ranging and widely distributed in the Northern Hemisphere. A fifth species *(Wetzeliella articulata)* was world-wide in the Eocene, while *Apectodinium homomorphum* may also prove to have been world-wide at that time.

The distribution of the remaining fourteen species, however, presents interesting features. Outside the area of northwest Europe and the north-eastern Atlantic Ocean, the strongest parallels are found in assemblages from the Grand Banks, where ten of these species have been recorded. However, only four have been reported from the Scotian Shelf; three of these four *(Deflandrea oebisfeldensis, Kisselovia tenuivirgula* and *Lentinia wetzelii)* occur also on the Labrador Shelf, whereas *Glaphyrocysta pastielsii* apparently does not. Two other species *(Glaphyrocysta divaricata* and *Apectodinium quinquelatum)* occur on the Labrador Shelf, the former being present in Grand Banks assemblages also, the latter

not. This suggests that, while environmental conditions on the Grand Banks in the Early Eocene were closely similar to those of northwest Europe, conditions on the Scotian Shelf to the south and the Labrador Shelf to the north were sufficiently different to affect markedly the composition of the microplankton flora.

Most of the papers on Tertiary assemblages from India contain descriptions and illustrations so poor that comparisons are difficult. Nevertheless, at least three of the species encountered *(Deflandrea oebisfeldensis, Kisselovia tenuivirgula* and *Glaphyrocysta exuberans)* do occur also in that region; the actual number probably is much higher. Only two of the Belgian species *(Ceratiopsis leptoderma* and *Apectodinium quinquelatum)* have been reported from Siberia and none from Australia, New Zealand, Argentina or Chile.

Though monographic inequalities are surely a partial cause for these disparities, nevertheless there is strong suggestion that, in the Early Eocene as in the Late Cretaceous, there were three major dinoflagellate cyst realms, each divisible into distinct provinces and suites. Northwest Europe and the Grand Banks, it appears, continued to form part of the North Atlantic Province and of what LENTIN and WILLIAMS (1980) call the "Williams Suite". The Labrador Shelf and Scotian Shelf, however, appear to have been distinct, not only in terms of the species treated in this paper but also in the distribution of other species, as indicated by BARSS, BUJAK and WILLIAMS (1979) and WILLIAMS and BUJAK (1977b). It is here proposed that they be termed respectively the "Bujak Association" and the "Brideaux Association", after two palynologists, J.P. BUJAK and W.W. BRIDEAUX, who have been concerned in the study of the dinoflagellate cysts of Canadian offshore cores. The Bujak Association may well reflect cool-water conditions. Predictably, few species are held in common with the Early Eocene microflora of the Tethyan and South Temperate Realms as proposed by LENTIN and WILLIAMS (1980); in the Early Eocene, at least, there seems no indication that the Williams Suite was present in the South Atlantic Province.

References (compiled in 1983)

ALBERTI, G., 1959. Zur Kenntnis der Gattung *Deflandrea* EISENACK (Dinoflag.) in der Kreide und im Alttertiär Nord- und Mitteldeutschlands — *Mitt. Geol. Staatsinst. Hamburg,* no. 18, pp. 93-105.

ALBERTI, G., 1961. Zur Kenntnis mesozoischer und alttertiärer Dinoflagellaten und Hystrichosphaerideen von Nord- und Mittel Deutschlands sowie einigen anderen europäischen Gebieten. — *Palaeontographica,* Abt. A, Bd. 116, pp. 1-58.

ASCOLI, P., 1974. Cf. JENKINS, W.A.M.

AUFFRET J.-P. et GRUAS-CAVAGNETTO, C., 1975. Les Formations Paléogènes sous-marines de la Manche Orientale; données palynologiques. — *Bull. Soc. géol. Fr.,* vol. XVII, no. 5, pp. 641-655.

BALTEŞ, N., 1967. Distribution stratigraphique des Dinoflagellés et Acritarches Tertiaires en Roumanie. — *Planktonic Conference, Geneva, Switzerland,* pp. 1-24.

BARSS, M.S., BUJAK, J.P. et WILLIAMS, G.L., 1979. Palynological zonation and correlation of sixty-seven wells, Eastern Canada. — *Geol. Surv. Can.,* Paper 78-24, 118 p.

BENEDEK, P.N., 1972. Phytoplanktonten aus dem Mittel- und Oberoligozän von Tönisberg (Niederrheingebiet). — *Palaeontographica,* Abt. B, Bd. 137, pp. 1-71.

BENEDEK, P.N. et GOCHT, H., 1981. *Thalassiphora pelagica* (Dinoflagellata, Tertiär): Elektronenmikroskopische Untersuchung und Gedanken zur Paläobiologie. — *Palaeontographica,* Abt. B, Bd. 180, pp. 39-64.

BENEDEK, P.N. et MÜLLER, C., 1976. Die Grenze Unter-Mittel-Oligozän am Doberg bei Bünde Westfalen. I. Phyto- und Nannoplankton. — *N. Jb. Geol. Paläont. Mh.,* no. 3, pp. 129-144.

BOLTENHAGEN, E., 1977. Microplancton du Crétacé Supérieur du Gabon. — *Cahiers de Paléontologie,* 151 p.

BRIDEAUX, W.W., 1975. Cf. WILLIAMS, G.L.

BRIDEAUX, W.W. et MYHR, D.W., 1976. Lithostratigraphy and dinoflagellate cyst succession in the Gulf Mobil Parsons N-10 well, District of Mackenzie. — *Geol. Surv. Can.,* Paper 76-1B, pp. 235-249.

BROSIUS, M., 1963. Plankton aus dem nordhessischen Kasseler Meeressand (Oberoligozän). — *Deutsch . Geol. Gesell. Zeitschr.,* vol. 114, pp. 32-56.

BUJAK, J.P., 1977a. Cf. WILLIAMS, G.L.

BUJAK, J.P., 1977b. Cf. WILLIAMS, G.L.

BUJAK, J.P., 1979. Cf. BARSS, M.S.

BUJAK, J.P., 1979. Proposed phylogeny of the dinoflagellates *Rhombodinium* and *Gochtodinium.* — *Micropaleontology,* vol. 25, pp. 308-324.

BUJAK, J.P., 1980. Dinoflagellate cysts and acritarchs from the Eocene Barton Beds of southern England; *in* BUJAK, J.P., DOWNIE, C., EATON, G.L. and WILLIAMS, G.L., Dinoflagellate cysts and acritarchs from the Eocene of southern England. — *The Palaeont. Ass. Sp. Pap. in Palaeontol.,* no. 24, pp. 36-91.

BUJAK, J.P., DOWNIE, C., EATON, G.L. et WILLIAMS, G.L. 1980a. Dinoflagellate cyst zonation of the Eocene, southern England; *in* BUJAK, J.P., DOWNIE, C., EATON, G.L. and WILLIAMS, G.L., Dinoflagellate cysts and acritarchs from the Eocene of southern England. — *Ibid.,* no. 24, pp. 15-26.

BUJAK, J.P., DOWNIE, C., EATON, G.L. et WILLIAMS, G.L. 1980b. Taxonomy of some Eocene dinoflagellate cyst species from southern England; *in* BUJAK, J.P., DOWNIE, C., EATON, G.L. and WILLIAMS, G.L., Dinoflagellate cysts and acritarchs from the Eocene of southern England. — *Ibid.,* no. 24, pp. 26-36.

BYBELL, L.M., 1982. Cf. FREDERIKSEN, N.O.

CARO, Y., 1973. Contribution à la connaissance des Dinoflagellés du Paléocène-Eocène inférieur des Pyrénées espagnoles. — *Rev. esp. Micropaleont.,* vol. 5, no. 3, pp. 329-372.

CHÂTEAUNEUF, J.J., 1976. Cf. SCHUMACKER-LAMBRY, J.

CHÂTEAUNEUF, J.J., 1980. Palynostratigraphie et Paléoclimatologie de l'Eocène supérieur et de l'Oligocène du Bassin de Paris. — *Bull. Bur. Rech. géol. min. Paris,* Mém. 116, pp. 1-360.

CHÂTEAUNEUF, J.J. et GRUAS-CAVAGNETTO, C., 1968. Étude palynologique du Paléogène de quatre Sondages du Bassin Parisien (Chargnes, Montjavault, Le Fellet, Lude). — *Bull. Bur. Rech. géol. min. Paris,* no. 59, pp. 114-158.

CHÂTEAUNEUF, J.J. et GRUAS-CAVAGNETTO, C., 1978. Les zones de Wetzeliellaceae (Dinophyceae) du Bassin de Paris. — *Bull. Bur. Rech. géol. min. Paris,* (2ème ser.), Section IV, no. 2, pp. 59-93.

CHRISTOPHER, R.A., 1982. Cf. FREDERIKSEN, N.O.

COOKSON, I.C., 1953. Records of *Botryococcus braunii, Pediastrum* and the Hystrichosphaeridae in Cainozoic deposits of Australia. — *Mém. Nat. Mus. Melbourne,* no. 18, pp. 107-123.

COOKSON, I.C., 1955. Cf. DEFLANDRE, G.

COOKSON, I.C., 1965. Cretaceous and Tertiary microplankton from southeastern Australia. — *Proc. Roy. Soc. Victoria,* vol. 78, pp. 85-93.

COOKSON, I.C. et EISENACK, A., 1960. Upper Mesozoic microplankton from Australia and New Guinea. — *Palaeontology,* vol. 2, part 2, pp. 243-261.

COOKSON, I.C. et EISENACK, A., 1961. Tertiary microplankton from the Rottnest Island bore, Western Australia. — *J. Roy. Soc. Western Aust.,* vol. 44, part 2, pp. 39-47.

COOKSON, I.C. et EISENACK, A., 1962. Additional microplankton from Australian Cretaceous sediments. — *Micropaleontology,* vol. 8, pp. 485-507.

COSTA, L.I. et DOWNIE, C. 1976. The distribution of the dinoflagellate *Wetzeliella* in the Palaeogene of northwestern Europe. — *Palaeontology,* vol. 19, part 4, pp. 591-614.

COSTA, L.I. et DOWNIE, C. 1979a. The Wetzeliellaceae; Palaeogene dinoflagellates. — *Proc. IV Int. Palynol. Conf., Lucknow,* vol. 2, pp. 34-46.

COSTA, L.I. et DOWNIE, C. 1979b. Cenozoic dinocyst stratigraphy of sites 403 to 406 (Rockall Plateau), IPOD, LEG 48. — *Initial Reports of the Deep Sea Drilling Project,* vol. XLVIII, pp. 513-529.

COSTA, L.I. et DOWNIE, C. 1980. Cf. LIENGJAREN, M.

CRONE, A.J., 1982. Cf. FREDERIKSEN, N.O.

DALE, B., 1968. Cf. WALL, D.

DAVEY, R.J., 1969. Non-calcareous microplankton from the Cenomanian of England, northern France and North America, Part I. — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* vol. 17, pp. 103-180.

DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. et WILLIAMS, G.L., 1966. Fossil dinoflagellate cysts attributed to *Baltisphaeridium*; *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Studies on Mesozoic and Cainozoic dinoflagellate cysts. — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* Suppl. 3, pp. 157-175.

DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. et WILLIAMS, G.L., 1969. Generic reallocations; *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Appendix to "Studies on Mesozoic and Cainozoic dinoflagellate cysts". — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* Appendix to Suppl. 3, pp. 15-17.

DAVEY, R.J. et VERDIER, J.-P., 1971. An investigation of microplankton assemblages from the Albian of the Paris Basin. — *Verh. k. ned. Akad. Wet.,* Ser. 1, vol. 26, no. 2, pp. 1-58.

DAVEY, R.J. et VERDIER, J.-P., 1973. An investigation of microplankton from latest Albian (Vraconian) sediments. — *Rev. esp. Micropaleont.,* vol. V, no. 2, pp. 173-212.

DAVEY, R.J. et VERDIER, J.-P., 1974. Dinoflagellate cysts from the Aptian type sections at Gargas and La Bédoule, France. — *Palaeontology,* vol. 17, part 3, pp. 623-653.

DAVEY, R.J. et WILLIAMS, G.L., 1966a. The genera *Hystrichosphaera* and *Achomosphaera, in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Studies on Mesozoic and Cainozoic dinoflagellate cysts. — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* Suppl. 3, pp. 28-52.

DAVEY, R.J. et WILLIAMS, G.L., 1966b. The genus *Hystrichosphaeridium* and its allies, *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Studies on Mesozoic and Cainozoic dinoflagellate cysts. — *Ibid.,* pp. 53-106.

DE CONINCK, J., 1965. Microfossiles planctoniques du Sable Yprésien à Merelbeke. Dinophyceae et Acritarcha. — *Mém. Acad. Roy. Belg. (Sci.),* vol. 36, part 2, pp. 1-64.

DE CONINCK, J., 1967. Het Fossielhoudend Ieperiaan van Merelbeke II. Hystrichospheren en Dinoflagellaten. — *Nat. Tijdschrift,* vol. 48, pp. 215-218.

DE CONINCK, J., 1968. Dinophyceae et Acritarcha de l'Yprésien du Sondage de Kallo. — *Bull. Inst. r. Sci. nat. Belg.,* no. 161, 67 p.

DE CONINCK, J., 1971. Application stratigraphique des microfossiles organiques dans l'Yprésien du Belge. — *Bull. Soc. belge Géol., Paléont., Hydrol.,* vol. 81, nos. 1-2, pp. 1-11.

DE CONINCK, J., 1975. Microfossiles à paroi organique de l'Yprésien du Bassin Belge. — *Serv. Géol. Belg.,* Prof. Paper no. 12, pp. 1-151.

DE CONINCK, J., 1977. Organic walled microfossils from the Eocene of the Woensdrecht borehole, southern Netherlands. — *Meded. Rijks. Geol. Dienst,* n.s., 28 (3), pp. 33-64.

DE CONINCK, J., 1980a. Organic walled microfossils in the clay of Ieper in the Overijse Borehole. — *Bull. Soc. belge Géol., Paléont., Hydrol.,* vol. 89, part 4, pp. 201-215.

DE CONINCK, J., 1980b. Espèces indicatrices de microfossiles à paroi organique des dépôts de l'Yprésien Supérieur et du Lutétien dans le sondage de Kallo. — *Bull. Soc. belge Géol., Paléont., Hydrol.,* vol. 89, part 4, pp. 309-317.

DE CONINCK, J., DE DECKER, M., DE HEINZELIN, J. et WILLEMS, W., 1981. L'âge des faunes d'Erquelines. — *Bull. Soc. belge Géol., Paléont., Hydrol.,* vol. 90, no. 2, pp. 121-154.

DE CONINCK, J. et SMIT, J., 1982. Marine organic-walled microfossils at the Cretaceous Tertiary boundary in the Barranco Del Gredero (S.E. Spain). — *Geologie Mijnb.,* vol. 61, pp. 173-178.

DE DECKER, M., 1981. Cf. DE CONINCK, J.

DE HEINZELIN, J., 1981. Cf. DE CONINCK, J.

DEFLANDRE, G., 1937. Microfossiles des silex crétacés II. Flagellés incertae sedis. Hystrichosphaeridées. Sarcodinés. Organismes divers. — *Ann. Paléont.,* vol. 26, pp. 51-103.

DEFLANDRE, G., 1942. Sur les Hystrichosphères des calcaires siluriens de la Montagne Noire. — *Acad. Sci. Paris, C.R.,* vol. 215, no. 20, pp. 475-476.

DEFLANDRE, G., 1947. Sur une nouvelle Hystrichosphère des silex crétacés et sur les affinités du genre *Cannosphaeropsis* O. We. — *Acad. Sci. Paris, C.R.,* vol. 224, pp. 1574-1576.

DEFLANDRE, G., 1937. Remarques sur la classification des Dinoflagellés fossiles, à propos d'*Evittodinium,* nouveau genre crétacé de la famille des Deflandreaceae. — *Acad. Sci. Paris, C.R.,* vol. 258, pp. 5027-5030.

DEFLANDRE, G. et COOKSON, I.C., 1955. Fossil microplankton from Australian Late Mesozoic and Tertiary sediments. — *Aust. J. Mar. Freshw. Res.,* vol. 6, no. 2, pp. 242-313.

DOWNIE, C., 1966. Cf. DAVEY, R.J.

DOWNIE, C., 1966. Cf. SARJEANT, W.A.S.

DOWNIE, C., 1966a. Cf. WILLIAMS, G.L.

DOWNIE, C., 1966b. Cf. WILLIAMS, G.L.

DOWNIE, C., 1969. Cf. DAVEY, R.J.

DOWNIE, C., 1974. Cf. SARJEANT, W.A.S.

DOWNIE, C., 1976. Cf. COSTA, L.I.

DOWNIE, C., 1979a. Cf. COSTA, L.I.

DOWNIE, C., 1979b. Cf. COSTA, L.I.

DOWNIE, C., 1980. Cf. LIENGJARERN, M.

DOWNIE, C., 1980a. Cf. BUJAK, J.P.

DOWNIE, C., HUSSAIN, M.A. et WILLIAMS, G.L., 1971. Dinoflagellate cyst and acritarch associations in the Paleogene of southeast England. — *Geoscience and Man,* vol. 3, pp. 29-35.

DOWNIE, C. et SARJEANT, W.A.S., 1964. Bibliography and index of fossil dinoflagellates and acritarchs. — *Geol. Soc. Amer., Memoir* 94, pp. 1-180.

DOWNIE, C. et SARJEANT, W.A.S., 1967. Class Dinophyceae Pascher; *in* BLACK, M., DOWNIE, C., ROSS, R. and SARJEANT, W.A.S., Chapter 2. Thallophyta - 2. — *Geol. Soc./Palaeont. Assoc.,* "The Fossil Record: a symposium with documentation", pp. 195-209.

DRUGG, W.S., 1967. Palynology of the Upper Moreno Formation (Late Cretaceous-Paleocene), Escarpado Canyon, California. — *Palaeontographica,* Ser. B., vol. 120, pp. 1-71.

DUTTA, S.K. et JAIN, K.P., 1980. Geology and Palynology of the area around Lumshnong, Jaintia Hills, Meghalaya, India. — *Biol. Mem.,* vol. 5, no. 1, pp. 56-81.

DUXBURY, S., 1980. Barremian phytoplankton from Speeton, east Yorkshire. — *Palaeontographica,* ser. B, vol. 173, pp. 107-146.

EATON, G.L., 1976. Dinoflagellate cysts from the Bracklesham Beds (Eocene) of the Isle of Wight, Southern England. — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* vol. 26, no. 6, pp. 228-332.

EATON, G.L., 1980a. Cf. BUJAK, J.P.

EATON, G.L., 1980b. Cf. BUJAK, J.P.

EDWARDS, L.E., 1982. Cf. FREDERIKSEN, N.O.

EHRENBERG, C.G., 1838. Über das Massenverhältniss der jetzt lebenden Kiesel-Infusorien und über ein neues Infusorien-Conglomerat als Polirschiefer von Jastraba in Ungarn. — *Abh. Preuss. Akad. Wiss.,* 1836, pp. 109-135.

EISENACK, A., 1938. Die Phosphoritknollen der Bernsteinsformation als Überlieferer tertiären Planktons. — *Schr. phys.-ökon. Ges. Königsb.,* vol. 70, pp. 181-188.

EISENACK, A., 1954. Hystrichosphären aus dem baltischen Gotlandium. — *Senckenbergiana,* vol. 34, no. 4/5, pp. 205-211.

EISENACK, A., 1960. Cf. COOKSON, I.C.

EISENACK, A., 1961. Cf. COOKSON, I.C.

EISENACK, A., 1962. Cf. COOKSON, I.C.

EISENACK, A., 1963. *Cordosphaeridium* n.g. *ex Hystrichosphaeridium,* Hystrichosphaeridea. — *N. Jb. Geol. Paläont., Abh.,* vol. 118, pp. 260-265.

EISENACK, A., 1967. Katalog der fossilen Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien. Band I. Dinoflagellaten. 1. Erganzungslieferung. — *E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart,* 241 p.

EISENACK, A., 1969. Bemerkungen zur Systematik der fossilen Dinoflagellaten. — *N. Jb. Geol. Paläont., Mh.,* vol. 6, pp. 337-343.

EISENACK, A. et GOCHT, H., 1960. Neue Namen für einige Hystrichosphären der Bernsteinformation Ostpreussens. — *N. Jb. Geol. Paläont., Mh.,* pp. 511-518.

EISENACK, A. et KJELLSTRÖM, G., 1971. Katalog des fossilien Dinoflagellaten. Hystrichosphären und verwandten Mikrofossilien. Band II. Dinoflagellaten. — *E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart,* 1130 p.

EISENACK, A. et KJELLSTRÖM, G., 1975. Katalog der fossilien Dinoflagelatten, Hystrichosphären und verwandten Mikrofossilien. Vol. I. Dinoflagellaten. 3. Ergänzungslieferung. — *E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart,* 254 p.

EISENACK, A. et KLEMENT, K.W., 1964. Katalog der fossilien Dinoflagellaten, Hystrichosphären und verwandten Mikrofossilien. Vol. I. Dinoflagellaten. — *E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart,* 888 p.

EVITT, W.R., 1963. A discussion and proposals concerning fossil dinoflagellates, hystrichospheres and acritarchs. — *Proc. Nat. Acad. Sci.,* vol. 49, nos. 2, 3, pp. 158-164.

EVITT, W.R., 1975. Cf. WALL, D.

EVITT, W.R., 1978. Cf. STOVER, L.E.

EVITT, W.R. et PIERCE, S.T., 1975. Early Tertiary ages from the coastal belt of the Franciscan complex, northern California. — *Geology,* vol. 3, no. 8, pp. 433-436.

FREDERIKSEN, N.O., BYBELL, L.M., CHRISTOPHER, R.A., CRONE, A.J., EDWARDS, L.E., GIBSON, T.G., HAZEL, J.E., REPETSKI, J.E., RUSS, D.P., SMITH, C.C. et WARD, L.W., 1982. Biostratigraphy and paleoecology of Lower Paleozoic, Upper Cretaceous and Lower Tertiary rocks in U.S. Geological Survey New Madrid Test Wells, southeastern Missouri. — *Tulane Stud. Geol. Paleont.,* vol. 17, no. 2, pp. 23-45.

GIBSON, T.G., 1982. Cf. FREDERIKSON, N.O.

GOCHT, H., 1955. *Rhombodinium* und *Dracodinium,* zwei neue Dinoflagellaten-Gattungen aus dem norddeutschen Tertiär. — *N. Jb. Geol. Paläont., Mh.,* no. 2, pp. 84-92.

GOCHT, H., 1968. Zur Morphologie und Ontogenie von *Thalassiphora* (Dinoflagellata). — *Palaeontographica,* Abt. A, vol. 129, pp. 149-156.

GOCHT, H., 1969. Formengemeinschaften alttertiären Mikroplanktons aus Bohrproben des Erdölfeldes Meckelfeld bei Hamburg. — *Palaeontographica,* Abt. B, vol. 126, pts. 1-3, pp. 1-100.

GOCHT, H., 1981. Cf. BENEDEK, P.N. VON.

GOODMAN, D.K., 1979. Dinoflagellate "communities" from the Lower Eocene Nanjemoy Formation of Maryland, U.S.A. — *Palynology,* vol. 3, pp. 169-190.

GRADSTEIN, F.M. 1974. Cf. JENKINS, W.A.M.

GRIGOROVICH, A.S., 1971. Mikrofitoplankton melov'ix i paleogenov'ix otlozhenii severnogo sklona ukrainskix Karpat. — *Byull. Mosk. Obschch. Ispyt. Priir.,* vol. 46, no. 2, pp. 83-98.

GRUAS-CAVAGNETTO, C., 1966. Complexes sporo-polliniques du Sparnacien du Bassin de Paris. — *Rev. Palaeobot. Palynol.,* vol. 5, pp. 243-261.

GRUAS-CAVAGNETTO, C., 1968. Étude palynologique des divers gisements du Sparnacien du bassin de Paris. — *Mém. Soc. géol. France,* n.s., vol. 47, no. 110, pp. 1-144.

GRUAS-CAVAGNETTO, C., 1968. Cf. CHÂTEAUNEUF, J.J.

GRUAS-CAVAGNETTO, C., 1970a. Aperçu sur la microflore et le microplancton du Paléogène anglais. — *C. r. somm. Séances Soc. géol. France,* no. 1, p. 19.

GRUAS-CAVAGNETTO, C., 1970b. Microflore et microplancton des Woolwich Beds (Swanscombe, Kent). — *Pollen et Spores,* vol. 8, no. 1, pp. 71-82.

GRUAS-CAVAGNETTO, C., 1971. Présence de microplancton et de pollens dans le Lutétien du Bassin de Paris. — *C. R. somm. Séances Soc. géol. France,* no. 24, pp. 172-173.

GRUAS-CAVAGNETTO, C., 1972. Étude palynoplanctologique de deux gisements du Thanétien des environs de Reims. — *Rev. Micropaléont.,* vol. 15, no. 2, pp. 63-74.

GRUAS-CAVAGNETTO, C., 1974. La palynoflore et le microplancton du Priabonien dans sa localité-type (Prov. Vicenza, Italie). — *Bull. Soc. géol. France,* Sér. 7, vol. 16, no. 1, pp. 86-90.

GRUAS-CAVAGNETTO, C., 1975. Cf. AUFFRET, J.-P.

GRUAS-CAVAGNETTO, C., 1976. Les marqueurs stratigraphiques (Dinoflagellés) de l'Éocène du Bassin de Paris et de la Manche Orientale. — *Rev. Micropaléont.,* vol. 18, no. 4, pp. 221-228.

GRUAS-CAVAGNETTO, C., 1978. Cf. CHÂTEAUNEUF, J.J.

GUPTA, V.J., 1980. Cf. VAN ERVE, A.W.

HABIB, D., 1971. Dinoflagellate stratigraphy across the Miocene-Pliocene boundary, Tubiano stratotype section. — *Proc. II Plank. Conf., Roma 1970,* pp. 591-598.

HANSEN, J.M., 1979. Age of the Mo-Clay Formation. — *Bull. geol. Soc. Denmark,* vol. 27, pp. 89-91.

HARKER, S.D. et SARJEANT, W.A.S., 1975. The stratigraphic distribution of organic-walled dinoflagellate cysts in the Cretaceous and Tertiary. — *Rev. Palaeobot. Palynol.,* vol. 20, pp. 217-315.

HARLAND, R., 1973. Dinoflagellate cysts and acritarchs from the Bearpaw Formation (Upper Campanian) of southern Alberta, Canada. — *Palaeontology,* vol. 16, pp. 665-706.

HARLAND, R., 1979. The *Wetzeliella (Apectodinium) homomorphum* plexus from the Palaeogene / earliest Eocene of north-west Europe. — *IV. Int. Palynol. Conf., Lucknow (1976-77),* pp. 59-70.

HARLAND, R., 1979. Cf. KNOX, R.W. O'B.

HAZEL, J.E., 1982. Cf. FREDERIKSEN, N.O.

HEILMANN-CLAUSEN, C., 1982. The Paleocene-Eocene boundary in Denmark. — *Newsl. Stratigr.,* vol. 11, no. 2, pp. 55-63.

HERB, R., 1978. Cf. STAMPFLI, G.

HERNGREEN, G.F.W., 1973. The so-called Kuhfeld Beds in the eastern Netherlands. — *Meded. Rijksgeol. Dienst.,* N.S., vol. 24, pp. 127-137.

HUSSAIN, M.A., 1971. Cf. DOWNIE, C.

JAIN, K.P., 1980. Cf. DUTTA, S.K.

JAN DU CHÊNE, R.E., 1977a. — Nouvelles données sur la palynostratigraphie des Flyschs des Préalpes externes. — *Archs. Sci.,* Genève, vol. 30, no. 1, pp. 53-63.

JAN DU CHÊNE, R.E., 1977b. Palynostratigraphie (Maastrichtien-Eocène inférieur) des Flyschs du Schlieren (Canton d'Obwald, Suisse centrale). — *Rev. Micropaléont.,* vol. 20, no. 3, pp. 147-156.

JAN DU CHÊNE, R.E., 1978. Cf. STAMPFLI, G.

JANSA, L.F., 1974. Cf. JENKINS, W.A.M.

JENKINS, W.A.M., ASCOLI, P., GRADSTEIN, F.M., JANSA, L.F. et WILLIAMS, G.L., 1974. Stratigraphy of the Amoco Ioe A-1 Puffin B-90 Well, Grand Banks of Newfoundland. — *Geol. Surv. Can.,* Paper 74-61, pp. 1-12.

JIABO, 1978. On the Paleogene dinoflagellates and acritarchs from the coastal region of Bohai. — *Nanking Institute of Geology and Palaeontology, Academia Sinica,* pp. 1-190.

KAR, R.K., 1970. Cf. SAH, S.C.D.

KJELLSTRÖM, G., 1971. Cf. EISENACK, A.

KJELLSTRÖM, G., 1975. Cf. EISENACK, A.

KLEMENT, K.W., 1964. Cf. EISENACK, A.

KNOX, R. O'B. et HARLAND, R., 1979. Stratigraphical relationships of the early Palaeogene ash-series of NW Europe. — *J. Geol. Soc. London,* vol. 136, pp. 463-470.

LEJEUNE-CARPENTIER, M., 1937. L'étude microscopique des silex (2ième Note): Un fossile anciennement connu et pourtant méconnu; *Hystrichosphaera ramosa* Ehrbg. — *Ann. Soc. géol. Belg.,* vol. 60, no. 7, pp. 239-260.

LEJEUNE-CARPENTIER, M. et SARJEANT, W.A.S., 1981. Restudy of some larger dinoflagellate cysts and an acritarch from the Upper Cretaceous of Belgium and Germany. — *Ann. Soc. géol. Belg.,* pp. 1-39.

LENTIN, J.K. et WILLIAMS, G.L., 1973. Fossil dinoflagellates: Index to genera and species. — *Geol. Surv. Can.,* Paper 73-42, 176 p.

LENTIN, J.K. et WILLIAMS, G.L., 1976. A monograph of fossil peridinioid dinoflagellate cysts. — *Bed. Inst. Ocean.,* Report Series B1-R-75-16, pp. 1-237.

LENTIN, J.K. et WILLIAMS, G.L., 1977a. Fossil dinoflagellate genus *Isabelidinium nom. nov.* — *Palynology,* vol. 1, pp. 167-168.

LENTIN, J.K. et WILLIAMS, G.L., 1977b. Fossil dinoflagellates: Index to genera and species. — *Bed. Inst. Ocean.,* Report Series B1-R-77-8, pp. 1-209.

LENTIN, J.K. et WILLIAMS, G.L., 1980. Dinoflagellate provincialism with emphasis on Campanian peridiniaceans. — *Amer. Ass. Strat. Palynol.,* Contribution Series, no. 7, pp. 1-47.

LENTIN, J.K. et WILLIAMS, G.L., 1981. Fossil dinoflagellates: Index to genera and species, 1981 edition. — *Bed. Inst. Ocean.,* Report Series B1-R-81-12, pp. 1-345.

LIENGJARERN, M., COSTA, L.I. et DOWNIE, C., 1980. Dinoflagellate cysts from the Upper Eocene-Lower Oligocene of the Isle of Wight. — *Palaeontology,* vol. 23, part 3, pp. 475-499.

MANTELL, G.A., 1850. *A pictoral atlas of fossil remains, consisting of coloured illustrations selected from Parkinson's "Organic remains of a former World" and Artis's "Antediluvian Phytology".* — London: Bohn, 208 p.

MANTELL, G.A., 1854. *The medals of Creation; or, first lessons in Geology and the study of organic remains.* Second Ed. London: Bohn, 2 vols. 930 pp.

MANUM, S. 1960. Some dinoflagellates and hystrichosphaerids from the Lower Tertiary of Spitzbergen. — *Nytt. Mag. f. Bot.,* vol. 8, pp. 17-26.

MANUM, S. 1979. Two new Tertiary dinocyst genera from the Norwegian Sea: *Lophocysta* and *Evittosphaerula.* — *Rev. Palaeobot. Palynol.,* vol. 28, pp. 237-248.

MAY, F.E., 1980. Dinoflagellate cysts of the Gymnodiniaceae, Peridiniaceae, and Gonyaulacaceae from the Upper Cretaceous Monmouth Group, Atlantic Highlands, New Jersey. — *Palaeontographica,* vol. 172, ser. B, pp. 10-116.

MORGAN, R., 1977. Elucidation of the Cretaceous dinoflagellate *Diconodinium* Eisenack and Cookson, 1960, and related peridinoid species from Australia. — *Palynology,* vol. 1, pp. 123-138.

MORGENROTH, P., 1966. Mikrofossilien und Konkretionen des nordwesteuropäischen Untereozäns. — *Palaeontographica,* Abt. B, vol. 119, pp. 1-53.

MÜLLER, C., 1976. Cf. BENEDEK, P.N. VON.

MYHR, D.W., 1976. Cf. BRIDEAUX, W.W.

NORRIS, G., 1978. Phylogeny and a revised supra-generic classification for Triassic-Quaternary organic-walled dinoflagellate cysts (Pyrrhophyta). Part II. Families and suborders of fossil dinoflagellates. — *N. Jb. Geol. Paläont. Abh.,* vol. 156, no. 1, pp. 1-30.

PASTIELS, A., 1948. Contributions à l'étude des microfossiles de l'Eocène belge. — *Mém. Mus. Nat. Hist. Nat. Belg.,* mém. no. 109, 77 p.

PIERCE, S.T., 1975. Cf. EVITT, W.R.

REID, P.H., 1974. Gonyaulacacean dinoflagellate cysts from the British Isles. — *Nova Hedwigia,* vol. XXV, pp. 579-636.

REPETSKI, J.E., 1982. Cf. FREDERIKSEN, N.O.

SAH, S.C.D., KAR, R.K. et SINGH, R.Y., 1970. Fossil microplankton from the Langpar formation of Therriaghat, South Shillong Plateau, Assam, India. — *Palaeobotanist,* vol. 18, no. 2, pp. 143-150.

SARJEANT, W.A.S., 1964. Cf. DOWNIE, C.

SARJEANT, W.A.S., 1966. Cf. DAVEY, R.J.

SARJEANT, W.A.S., 1967a. Observations on the acritarch genus *Micrhystridium* Deflandre. — *Rev. Micropaléont.,* vol. 9, no. 4, pp. 201-208.

SARJEANT, W.A.S., 1967b. The stratigraphical distribution of fossil dinoflagellates. — *Rev. Palaeobot. Palyn.,* pp. 323-343.

SARJEANT, W.A.S., 1969. Taxonomic changes; *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S., and WILLIAMS, G.L., Appendix to "Studies on Mesozoic and Cainozoic dinoflagellate cysts". — *Bull. Brit. Mus. (Nat. Hist.) Geol.,* Appendix to Suppl. 3, pp. 7-15.

SARJEANT, W.A.S., 1970. The genus *Spiniferites* Mantell, 1850 (Dinophyceae). — *Grana Palyn.,* vol. 10, pp. 74-78.

SARJEANT, W.A.S., 1975. Cf. HARKER, S.D.

SARJEANT, W.A.S., 1976. English Jurassic dinoflagellate cysts and acritarchs: a re-examination of some type and figured specimens. — *Geoscience and Man,* vol. 15, pp. 1-24.

SARJEANT, W.A.S., 1981. A restudy of some dinoflagellate cyst holotypes in the University of Kiel collections. II. The Eocene holotypes of Barbara Klumpp (1953); with a revision of the genus *Cordosphaeridium* Eisenack, 1963. — *Meyniana,* vol. 33, pp. 97-132.

SARJEANT, W.A.S., 1981. Cf. LEJEUNE-CARPENTIER, M.

SARJEANT, W.A.S., 1983. A restudy of some dinoflagellate cyst holotypes in the University of Kiel collections. IV. The Oligocene and Miocene holotypes of Dorothea Maier (1959). — *Meyniana,* vol. 35, pp. 85-137.

SARJEANT, W.A.S. et DOWNIE, C., 1966. The classification of dinoflagellate cysts above generic level. — *Grana Palyn.,* vol. 6, no. 3, pp. 503-527.

SARJEANT, W.A.S. et DOWNIE C., 1974. The classification of dinoflagellate cysts above generic level: a discussion and revisions; *in* SAH, S.C.D., CROSS, A.T. (eds.), Symposium on Stratigraphical Palynology. — *Bir. Sah. Instit. Palaeobot.,* Spec. Publ., no. 3, pp. 9-32.

SARJEANT, W.A.S. et STOVER, L.E., 1978. *Cyclonephelium* and *Tenua*: a problem in dinoflagellate cyst taxonomy. — *Grana,* vol. 17, no. 1, pp. 47-54.

SCHUMACKER-LAMBRY, J., 1978. *Palynologie du Landenien inférieur (Paléocène) à Gelinden-Overbroek / Belgique. Relations entre les microfossiles et le sédiment.* — Laboratoire de Paléobotanique et de Paléopalynologie (ed.), Université de Liège, pp. 1-157.

SCHUMACKER-LAMBRY, J. et CHÂTEAUNEUF, J.J., 1976. Dinoflagellés et acritarches des Marnes heersiennes de Gelinden (Base du Landénien, Paléocène, Belgique). — *Rev. Palaeobot. Palynol.,* vol. 21, pp. 267-294.

SINGH, R.Y., 1970. Cf. SAH, S.C.D.

SMIT, J., 1982. Cf. DE CONINCK, J.

SMITH, C.C., 1982. Cf. FREDERIKSEN, N.O.

STAMPFLI, G., JAN DU CHENE, R. et HERB, R., 1978. Géologie et micropaléontologie (Nummulites et palynologie) de la Formation éocène de Ziarat, Elbourz Oriental (Iran). — *Riv. ital. Paleont.,* vol. 84, no. 2, pp. 383-402.

STOVER, L.E., 1975. Cf. DRUGG, W.S.

STOVER, L.E. et EVITT, W.R., 1978. Analyses of pre-Pleistocene organic-walled dinoflagellates. — *Stanford University Publications, Geological Sciences,* vol. 15, pp. 1-300.

VAN ERVE, A.W. VISSCHER, H. et GUPTA, V.J., 1980. — An Eocene phytoplankton assemblage from the Subathu Formation of the Simla Himalayas, India. — *Recent Resaerches in Geology,* vol. 6, pp. 614-630.

VERDIER, J.-P., 1971. Cf. DAVEY, R.J.

VERDIER, J.-P., 1973. Cf. DAVEY, R.J.

VERDIER, J.-P., 1974. Cf. DAVEY, R.J.

VISSCHER, H., 1980. Cf. VAN ERVE, A.W.

VOZZHENNIKOVA, T.F., 1961. A contribution to the problem of the taxonomy of fossil Peridinae. — *Dokl. Akad. Nauk. S.S.S.R.,* vol. 139, no. 6, pp. 582-583.

VOZZHENNIKOVA, T.F., 1963. Pirrofitovye Vodorosli. (Phylum Pyrrhophyta); *in* ORLOV, YU. A. (ed.) — *Osnovy Maleontologii* 14. (Fundamentals of Paleontology).

VOZZHENNIKOVA, T.F., 1965. Vvedenie v izuchenie iskopaemykh peridineevykh vodorosli. — *Akad. Nauk. S.S.S.R. Sib. Otd., Inst. Geol. Geofiz., Tr.,* 156 p. [Translation, 1967, edited by SARJEANT, W.A.S., *Introduction to the study of fossilized Peridinid algae.* Boston Spa, Yorks: National Lending Library, 231 p.]

VOZZHENNIKOVA, T.F., 1967. Iskopaemye peridinei yurskikh, melovykh i paleogenovykh otlozheniy S.S.S.R. — *Akad. Nauk. S.S.S.R., Sib. Otd., Inst. Geol. Geofiz., Tr.,* 374 p. [Translated, 1971, edited by SARJEANT, W.A.S., *Fossil peridinians of the Jurassic, Cretaceous and Paleogene deposits of the U.S.S.R.* Boston Spa, Yorks: National Lending Library, 453 p.]

WALL, D., 1967. Fossil microplankton in deep-sea cores from the Caribbean Sea. — *Palaeontology*, vol. 10, part I, pp. 95-123.

WALL, D. et DALE, B., 1968. Early Pleistocene dinoflagellates from the Royal Society borehole at Ludham, Norfolk. — *New Phytol.,* vol. 67, pp. 315-326.

WALL, D. et DALE, B., 1973. Paleosalinity relationships of dinoflagellates in the Late Quaternary of the Black Sea — a summary. — *Geoscience and Man,* vol. 8, pp. 95-102.

WALL, D. et EVITT, W.R., 1975. A comparison of the modern genus *Ceratium* Schrank, 1793 with certain Cretaceous marine dinoflagellates. — *Micropaleontology,* vol. 21, no. 1, pp. 14-44.

WARD, L.W., 1982. Cf. FREDERIKSEN, N.O.

WEILER, H., 1980. Phytoplankton; *in* DOEBL, F., MARTINI, E., SONNE, V. et WEILER, H., Mikrofauna und -flora des Unteren Meeressandes (Rupel). 2. Sandgrube am "Zeilstück" bei Alzey-Weinheim (Mainzer Becken). — *Mainzer geowiss. Mitt.,* vol. 8, pp. 48-62.

WETZEL, O., 1933. Die in organisher Substanz erhaltenen Mikrofossilien des Baltischen Kreide-Feuersteins. — *Palaeontographica,* vol. 77, pp. 141-188; vol. 78, pp. 1-110.

WETZEL, O., 1935. Die Mikropaläontologie des Heiligenhafner Kieseltones (Unter-Eozän). — *Niedersachs. Geol. Verein., Jb.,* no. 27, pp. 41-76.

WETZEL, O., 1960. Ein neue Dinoflagellaten-Gruppe aus dem baltischen Geschiebefeuerstein. — *Naturwiss. Vereins Schlesw.-Holstein. Schr.,* vol. 31, pp. 81-86.

WILLEMS, W., 1981. Cf. DE CONINCK, J.

WILLIAMS, G.L., 1966a. Cf. DAVEY, R.J.

WILLIAMS, G.L., 1966b. Cf. DAVEY, R.J.

WILLIAMS, G.L., 1969. Cf. DAVEY, R.J.

WILLIAMS, G.L., 1971. Cf. DOWNEY, C.

WILLIAMS, G.L., 1973. Cf. LENTIN, J.K.

WILLIAMS, G.L., 1974. Cf. JENKINS, W.A.M.

WILLIAMS, G.L., 1976. Cf. LENTIN, J.K.

WILLIAMS, G.L., 1977a. Cf. LENTIN, J.K.

WILLIAMS, G.L., 1977b. Cf. LENTIN, J.K.

WILLIAMS, G.L., 1979. Cf. BARSS, M.S.

WILLIAMS, G.L., 1980. Cf. LENTIN, J.K.

WILLIAMS, G.L., 1980a. Cf. BUJAK, J.P.

WILLIAMS, G.L., 1980b. Cf. BUJAK, J.P.

WILLIAMS, G.L., 1981. Cf. LENTIN, J.K.

WILLIAMS, G.L. et BRIDEAUX, W.W., 1975. Palynologic analysis of Upper Mesozoic and Cenozoic rocks of the Grand Banks, Atlantic Continental Margin. — *Geol. Surv. Can. Bull.*, 236, pp. 1-162.

WILLIAMS, G.L. et BUJAK, J.P., 1977a. Cenozoic palynostratigraphy of offshore eastern Canada; *in* ELSIK, W.C. (ed.) Contributions of Stratigraphic Palynology, vol. 1, Cenozoic Palynology. — *Amer. Assoc. Strat. Palynol., Contr. Ser.*, no. 5A, pp. 14-47.

WILLIAMS, G.L. et BUJAK, J.P., 1977b. Distribution patterns of some North Atlantic Cenozoic dinoflagellate cysts. — *Mar. Micropaleont.*, vol. 2, pp. 223-233.

WILLIAMS, G.L. et DOWNIE, C., 1966a. *Wetzeliella* from the London Clay; *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Studies on Mesozoic and Cainozoic dinoflagellate cysts. — *Bull. Brit. Mus. (Nat. Hist.) Geol.*, Suppl. 3, pp. 182-198.

WILLIAMS, G.L. et DOWNIE, C., 1966b. Further dinoflagellate cysts from the London Clay; *in* DAVEY, R.J., DOWNIE, C., SARJEANT, W.A.S. and WILLIAMS, G.L., Studies on Mesozoic and Cainozoic dinoflagellate cysts. — *Ibid.*, pp. 215-235.

Table I.
The present taxonomic assignations here proposed for PASTIELS' *Eocene species of dinoflagellate cysts and their known stratigraphical ranges.*

Present Name	Pastiels' Name	Localities and Horizons of Occurrence					Known Stratigraphical Range
		Quenast		Forest	Gand	Ostende	
		Lower	Upper				
Cf. *Achomosphaera alcicornu* (EIS.)	*Hystrichosphaeridium salpingophorum* DEFL. (*pars*)	X	–	–	–	–	[Late Cretaceous — Middle Miocene]
Achomosphaera ramulifera (DEFL.)	*Hystrichosphaeridium trifurcatum* EIS. (*pars*)	X	X	X	X	X	Early Cretaceous (Valanginian) — Recent
Adnatosphaeridium cf. *vittatum* (WILL. & DOWN.)	*Cannosphaeropsis reticulensis* (PAST. (*pars*)	–	–	X	–	–	[Early-Middle Eocene (Late Ypresian-Lutetian)]
Apectodinium homomorphum (DEFL. & COOKS.)	*Hystrichosphaeridium geometricum* PAST. (*pars*)	X	–	–	X	–	Late Palaeocene (Thanetian) – Early Oligocene (Rupelian)
Apectodinium quinquelatum (WILL. & DOWN.)	*Hystrichosphaeridium geometricum* PAST. (*pars*)	X	X	–	X	–	Early-Late Eocene (Late Ypresian — Bartonian)
Araneosphaera araneosa EATON	*Hystrichosphaeridium salpingophorum* DEFL. (*pars*)	–	X	–	–	–	Early-late Eocene (Ypresian-Bartonian)
Ceratiopsis leptoderma VOZZH.	*Peridinium* cf. *galeatum* LEJ.-CARP. (*pars*)	–	X	–	–	–	Late Palaeocene (Thanetian) — Early Eocene (Ypresian)
?Cleistosphaeridium sp. plur. indet.	*Hystrichosphaeridium brevispinosum* (EIS.)	X	X	X	–	–	—
Deflandrea oebisfeldensis ALBERTI	*Peridinium* cf. *galeatum* LEJ.-CARP. (*pars*)	–	X	–	–	–	Late Palaeocene (Thanetian) — Lower Eocene (Ypresian)
Glaphyrocysta divaricata (WILL. & DOWN.)	*Membranilarnax pterospermoides* O. WE. (*pars*)	–	X	–	–	–	Late Palaeocene (Thanetian) — Early Eocene (Ypresian)
Glaphyrocysta exuberans (DEFL. & COOKS.)	*Membranilarnax pterospermoides* O. WE. (*pars*)	X	–	–	–	–	Late Palaeocene (Thanetian) – Early Oligocene (Rupelian)
Glaphyrocysta pastielsii (DEFL. & COOKS.)	*Membranilarnax* cf. *liradiscoides* O. WE.	X	–	–	–	–	Late Palaeocene (Thanetian) — Late Eocene (Bartonian)
Impletosphaeridium cf. *transfodum* MORG.	*Hystrichosphaeridium fluctuans* EIS. (*pars*)	?	?	–	?	?	[Early Eocene (Ypresian)]
Kisselovia tenuivirgula (WILL. & DOWN.)	*Hystrichosphaeridium geometricum* PAST. (*pars*)	–	–	–	X	–	Early-Middle Eocene (Late Ypresian-Lutetian)
Lentinia wetzelii MORG.	*Peridinium* cf. *galeatum* LEJ.-CARP. (*pars*)	–	X	–	–	–	Early-Late Eocene (Ypresian-Bartonian)
Cf. *Lingulodinium machaerophorum* (DEFL. & COOKS.)	*Hystrichosphaeridium* cf. *hirsutum* forma *minor* O. WE.	–	–	–	X	X	[Early Palaeocene (Late Danian) — Recent]
Nematosphaeropsis reticulensis (PAST.)	*Cannosphaeropsis reticulensis* PAST. (*pars*)	X	–	–	–	–	Early-Middle Eocene (Ypresian-Lutetian)
Polysphaeridium belgicum SARJ.	*Hystrichosphaeridium fluctuans* EIS. (*pars*)	–	–	–	X	–	Early Eocene (Ypresian)
Polysphaeridium subtile DAV. & WILL.	*Hystrichosphaeridium* cf. *hirsutum* (EHR.)	X	–	–	–	X	Early-Late Eocene (Ypresian-Bartonian)
Polysphaeridium sp.	*Hystrichosphaeridium pseudhystrichodinium* DEFL.	X	X	–	X	–	—
Spiniferites ramosus var. *multibrevis* DAV. & WILL.	*Hystrichosphaeridium trifurcatum* EIS. (*pars*)	X	X	X	X	X	Early Cretaceous (Valanginian) — Middle Miocene
Spiniferites ramosus var. *ramosus* (EHR.)	*Hystrichosphaeridium ramulifera* DEFL.	X	X	X	X	X	Early Cretaceous — Recent
Spiniferites ramosus var. *reticulatus* (DAVEY)	*Hystrichosphaeridium furcata* (EHR.)	–	X	–	–	–	Middle Cretaceous (Early Albian) — Early Eocene (Ypresian)
Thalassiphora delicata WILL. & DOWN.	Spore incertae sedis: Specimen no. 3	–	X	–	–	–	Early Palaeocene (Danian) – Pliocene
Tityrosphaeridium exilimurum (DAVEY & WILL.)	*Hystrichosphaeridium salpingophorum* DEFL. (*pars*)	X	–	–	–	–	Late Palaeocene (Thanetian) — Early Eocene (Ypresian)
Tityrosphaeridium gracile (EIS.)	*Hystrichosphaeridium tubiferum* (EHR.)	X	X	X	–	–	Late Cretaceous (Maastrichtian) — Early Oligocene (Rupelian)

Present Name	Pastiels' Name	Localities and Horizons of Occurrence					Known Stratigraphical Range
		Quenast		Forest	Gand	Ostende	
		Lower	Upper				
Wetzeliella articulata EIS.	*Hystrichosphaeridium articulatum* (EIS.) (*pars*)	X	X	X	–	–	Early Eocene (Ypresian) — Middle Oligocene (Early Chattian)
Wetzeliella meckelfeldensis lobisca (WILL. & DOWN.)	*Hystrichosphaeridium articulatum* (EIS.) (*pars*)	X	–	–	–	–	Late Palaeocene (Thanetian) — Middle Eocene (Lutetian)
Proximate cysts gen. et sp. indet.	*Palaeoperidinium* sp. 1	–	X	–	–	X	—
Proximate cysts gen. et sp. indet.	*Palaeoperidinium* sp. 2	X	–	–	–	–	—