

GÖRAN KJELLSTRÖM

ORDOVICIAN MICROPLANKTON  
(BALTISPHAERIDS)  
FROM THE GRÖTLINGBO  
BOREHOLE NO. 1 IN GOTLAND, SWEDEN



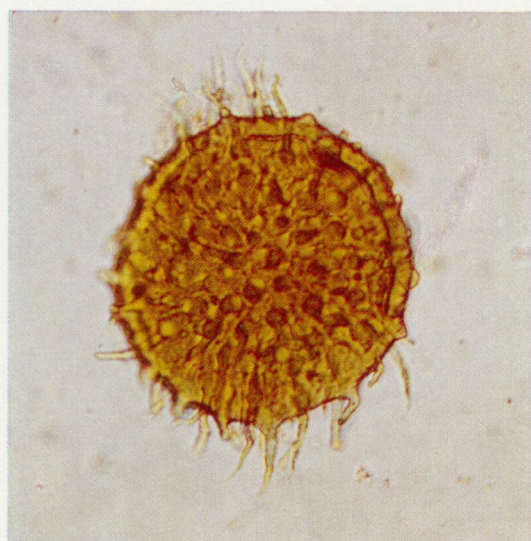
STOCKHOLM 1971

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C. DAVIDSONS BOKTRYCKERI AB, VÄXJÖ



## CONTENTS

|   |    |
|---|----|
| Abstract .....  | 6  |
| Резюме .....  | 6  |
| Acknowledgements .....  | 7  |
| Introduction .....  | 7  |
| Material and methods .....  | 8  |
| Terminology .....   | 9  |
| Taxonomy .....  | 13 |
| Systematics .....   | 16 |
| Group Acritarcha EVITT, 1963 .....  | 16 |
| Sub-group Acanthomorphae DOWNIE, EVITT & SARJEANT, 1963 .....                                     | 16 |
| Genus <i>Baltisphaeridium</i> EISENACK, 1958 emend. EISENACK, 1969 .....                          | 16 |
| <i>B. brevifilicum</i> n. sp. ....  | 17 |
| <i>B. brevispinosum</i> (EISENACK, 1931) .....  | 18 |
| <i>B. bulbosum</i> n.sp. ....   | 20 |
| <i>B. calicispinae</i> GÓRKA, 1969 .....  | 21 |
| <i>B. constrictum</i> n. sp. ....   | 22 |
| <i>B. aff. constrictum</i> .....  | 23 |
| <i>B. echinatum</i> n. sp. ....   | 23 |
| <i>B. filosum</i> n. sp. ....   | 24 |
| <i>B. flagellicum</i> n. sp. ....   | 25 |
| <i>B. granosum</i> n. sp. ....  | 25 |
| <i>B. hirsutoides</i> (EISENACK, 1951) .....  | 26 |
| <i>B. latiradiatum</i> (EISENACK, 1959) .....   | 28 |
| <i>B. longispinosum</i> (EISENACK, 1931) .....  | 29 |
| <i>B. macropylum</i> (EISENACK, 1959) .....   | 31 |
| <i>B. microspinosum</i> (EISENACK, 1954) .....  | 32 |
| <i>B. multipilosum</i> (EISENACK, 1931) .....   | 33 |
| <i>B. nanninum</i> EISENACK, 1965 .....   | 35 |
| <i>B. nanum</i> (DEFLANDRE) STOCKMANS & WILLIÈRE, 1962 .....                                      | 35 |
| <i>B. pachyacanthum</i> (EISENACK, 1963) n. nom., 1965 .....                                      | 37 |
| <i>B. paucispinum</i> n. sp. ....   | 38 |
| <i>B. psilatatum</i> n. sp. ....  | 39 |
| <i>B. ritvae</i> n. sp. ....  | 39 |
| <i>B. trichophorum</i> (EISENACK, 1965) n. comb. ....   | 40 |
| <i>B. triradiatum</i> n. sp. ....   | 41 |
| <i>B. verrucatum</i> n. sp. ....  | 41 |
| <i>B. sp. A</i> .....   | 42 |
| Genus <i>Goniosphaeridium</i> EISENACK, 1969 emend. ....  | 43 |
| <i>G. conjunctum</i> n. sp. ....  | 43 |
| <i>G. connectum</i> n. sp. ....   | 44 |
| Genus <i>Multiplicisphaeridium</i> STAPLIN, 1961 restit. STAPLIN, JANSONIUS & POCKOCK, 1965 ..... | 45 |
| <i>M. bifurcatum</i> STAPLIN, JANSONIUS & POCKOCK, 1965 .....                                     | 46 |
| <i>M. continuatum</i> n. sp. ....   | 46 |
| <i>M. corallinum</i> (EISENACK, 1959) .....   | 47 |
| <i>M. digitatum</i> (EISENACK, 1938) .....  | 48 |
| Genus <i>Orthosphaeridium</i> EISENACK, 1968 emend. ....  | 49 |
| <i>O. rectangulare</i> (EISENACK, 1963) .....   | 50 |
| <i>O. trabeculatum</i> n. sp. ....  | 50 |

|   |    |
|---|----|
| Genus <i>Peteinosphaeridium</i> STAPLIN, JANSONIUS & POCK, 1965 emend. EISENACK, 1969 ..... | 51 |
| <i>P. aequifurcatum</i> n. sp. ....   | 51 |
| <i>P. groetlingboensis</i> n. sp. ....  | 52 |
| <i>P. heteromorphicum</i> n. sp. ....   | 53 |
| <i>P. majorfurcatum</i> n. sp. ....   | 54 |
| <i>P. majorvesiculum</i> n. sp. ....  | 54 |
| <i>P. nanofurcatum</i> n. sp. ....  | 55 |
| <i>P. nudum</i> (EISENACK, 1959) .....  | 56 |
| <i>P. trifurcatum</i> (EISENACK, 1931) .....  | 57 |
| <i>P. velatum</i> n. sp. ....   | 58 |
| Stratigraphy .....  | 59 |
| References .....  | 64 |
| Plates .....  | 68 |

### ABSTRACT

The present study deals with a group of Ordovician phytoplankton with organic tests, baltisphaerids, derived from a continuous core drilled at Grötlingbo in Gotland. Forty-three species belonging to genera *Baltisphaeridium*, *Goniosphaeridium*, *Multiplicisphaeridium*, *Orthosphaeridium*, and *Peteinosphaeridium* are described and biostratigraphically analyzed. Twenty-three new species are proposed, i. e.: *Baltisphaeridium brevifilicum* n. sp., *Baltisphaeridium bulbosum* n. sp., *Baltisphaeridium constrictum* n. sp., *Baltisphaeridium echinatum* n. sp., *Baltisphaeridium filiosum* n. sp., *Baltisphaeridium flagellicum* n. sp., *Baltisphaeridium granosum* n. sp., *Baltisphaeridium paucispinum* n. sp., *Baltisphaeridium psilatum* n. sp., *Baltisphaeridium ritvae* n. sp., *Baltisphaeridium triradiatum* n. sp., *Baltisphaeridium verrucatum* n. sp., *Goniosphaeridium conjunctum* n. sp., *Goniosphaeridium connectum* n. sp., *Multiplicisphaeridium continuatum* n. sp., *Orthosphaeridium trabeculatum* n. sp., *Peteinosphaeridium aequifurcatum* n. sp., *Peteinosphaeridium groetlingboensis* n. sp., *Peteinosphaeridium heteromorphicum* n. sp., *Peteinosphaeridium majorfurcatum* n. sp., *Peteinosphaeridium majorvesiculum* n. sp., *Peteinosphaeridium nanofurcatum* n. sp., and *Peteinosphaeridium velatum* n. sp. Two genera, *Goniosphaeridium* and *Orthosphaeridium*, are emended.

### РЕЗЮМЕ

В данной статье рассматривается важная в стратиграфическом отношении группа балтосферидов, относимая к микропланктону. Исследование проведено на примере отложений ордовика из глубокой скважины Гротлингбу на острове Готланд в Швеции. Выполнен биостратиграфический анализ. Описано 43 вида, в том числе 23 новых.

## ACKNOWLEDGEMENTS

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## INTRODUCTION

During the past decade research into the stratigraphical distribution of fossil unicellular microplankton with organic tests, *Acritarcha*, has rapidly increased giving extensive records of species, now well established on a world-wide basis. These cosmopolitan microfossils with probable phytoplanktonic affinities hold great promise as biostratigraphical indicators, mainly owing to their presence in a great variety of sediments (shales, marls, limestones, sandstones, flints) from all parts of the geological column (Pre-Cambrian – Quaternary), their considerable abundance per volume of sediment, their complex morphology and their chemical resistance to different geological agencies.

The present investigation is a study of these phytoplankton and concentrates upon a group known as baltisphaerids, i. e. genera *Baltisphaeridium*, *Goniosphaeridium*, *Multiplicisphaeridium*, *Orthosphaeridium* and *Peteinosphaeridium*. It is the first contribution to a biostratigraphical analysis of baltisphaerids from the Ordovician portion of a continuous core drilled in Gotland and forms part of planned series of publications dealing with organic-walled microplankton derived from continuously cored wells of Balto-Scandia.

Research into the baltisphaerids with reference to the Ordovician System was initiated by Eisenack, whose extensive studies were originally based on glacial erratics from Sweden (Gotland and Öland), Estonia and along the coasts of East Prussia (1931, 1934, 1937, 1938, 1939, 1951, 1954, 1955, 1958 a, 1958 b, 1959, 1961, 1962 a, 1962 b, 1965 a, 1965 b, 1967, 1968 a, 1968 b, 1969). Baltisphaerids from Baltic erratics of Lower Ordovician age have also been investigated by W. Wetzel (1967). From the Ordovician of France baltisphaerids have been described by Le Corre & Deunff (1969), Deunff (1958), Deflandre & Ters (1966) and Henry (1969). From North Africa, Deunff (1961, 1964) and Combaz (1967) have given accounts of Tremadocian baltisphaerids. In England, work on Ordovician baltisphaerids was commenced by Downie (1958), studying Tremadocian samples from the Shineton Shale. Continued studies of Lower Ordovician baltisphaerids from the Skiddaw Slates in the Cross Fell Inlier, Teesdale Inlier and from Kent in England have been carried out by Lister, Burgess & Wadge (1969), Lister & Holliday (1970) and Lister, Cocks & Rushton (1969). A great number of baltisphaerids from the Ordovician of Russian provinces has been reported by Timofeev (1959, 1966). Investigations of Ordovician baltisphaerids from Belgium have been treated by Martin (1965, 1968, 1969). In Canada Staplin, Jansonius & Pocock (1965) have recorded Ordovician assemblages. Lower Ordovician species from Czechoslovakia have been described by Vavrdová (1965, 1966). Baltisphaerids from the Ordovician of Bohemia and Poland have been dealt with by Konzalová-Mazaneková (1969) and Górka (1969), respectively. Illustrations of Ordovician baltisphaerids from Oklahoma have been presented by Cramer & Diez Cramer (1968).

#### MATERIAL AND METHODS

The present study is based on material derived from the Ordovician part of a fairly complete Lower Palaeozoic continuous core drilled during a survey in 1968 under the auspices of the Geological Survey of Sweden. The drill-site was situated at Grötlingbo in the south-eastern part of Gotland (Fig. 1). The lithology and stratigraphy of the core will be described by Skoglund (in press, 1971). The material comprised in total 83 rock samples (one meter sample interval with the exception of level 459 m which was also investigated at 459.50 m). The sediments, each sample weighing 25 g, consisted of grey oolitic limestones, grey, green or red limestones, grey marly limestones, and grey clay shales. All lithologies but the red sediments yielded an abundant microplankton flora characterized by an exquisite state of preservation. In total about 15.000 specimens were recorded. A statistical study of this material will be dealt with in a subsequent paper. A preliminary range of the test dimensions for each species is, however, presented in this contribution. The specimen number given refers to the number of specimens upon which the diagnosis was based.

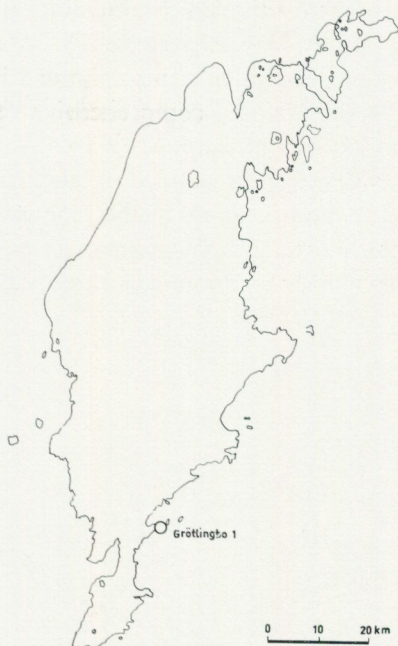


Fig. 1. Map of Gotland.

Standard chemical techniques similar those described by Funkhouser & Evitt (1959) were employed for processing the samples. The specimens were examined under the magnification of 420 X. A magnification of 1200 X (oil immersion) was used in order to determine the nature of the cell wall. The photomicrographic work was carried out partly by means of a Zeiss Ultraphot, partly with a Leitz Ortholux fitted with a Leitz Leica III g. The illustrations (enlargement: 280 X if not otherwise stated) were processed from Kodak Kodachrome II colour slides. The slides, labelled SGU Grötlingbo-1, are stored in the Department of Research and Applied Geology, the Geological Survey of Sweden, Stockholm.

#### TERMINOLOGY

The description of fossil organic-walled microplankton has often presented great difficulties due to the lack of a terminology with specifications of precise meanings. During the Second International Conference on Palynology in Utrecht (1966) a resolution concerning the establishment of an adequate terminology was therefore passed by the Commission Internationale des Microflores du Paléozoïque (CIMP). Proposals for a concise terminology given in an unpublished report by Downie, Cramer, Evitt, Jansonius, Staplin & Pocock were

presented in 1968 to members of the Subcommission on Acritarcha (CIMPA). As a complement to the terminology suggested, CIMPA distributed an English-French-German glossary of descriptive terms compiled in 1964 by Van Oyen. This glossary is now the subject of a comprehensive revision undertaken by Sarjeant (Sarjeant, personal communication, 1970).

The baltisphaerid terminology as defined in the CIMPA contribution is adopted with some minor modifications in the diagnosis and descriptions of this paper. The following morphographical terms of fundamental importance when treating the baltisphaerids taxonomically are used.

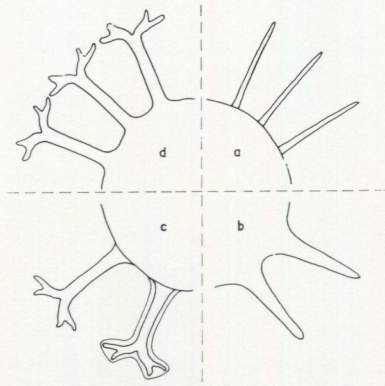


Fig. 2. Schematic drawing of test morphography of *Baltisphaeridium* (a), *Goniosphaeridium* (b), *Petemosphaeridium* (c), and *Multiplicisphaeridium* (d). *Orthosphaeridium* schematically included in *Baltisphaeridium*.

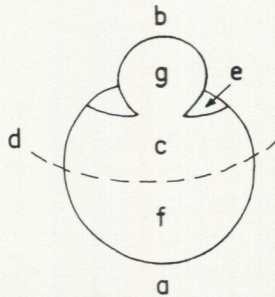


Fig. 3. Vesicle morphography of baltisphaerid. Antapex (a), apex (b), epicyst (c), equator (d), excystment opening (e), hypocyst (f), operculum (g).

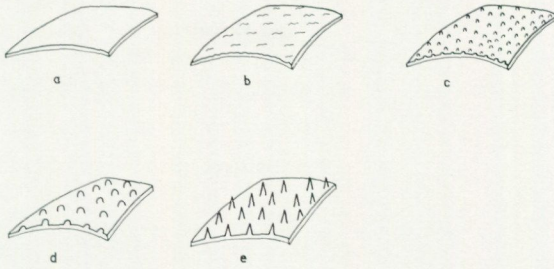


Fig. 4. Vesicle ornamentation of baltisphaerids. Psilate (a), shagrinate (b), granulate (c), verrucate (d), echinate (e).

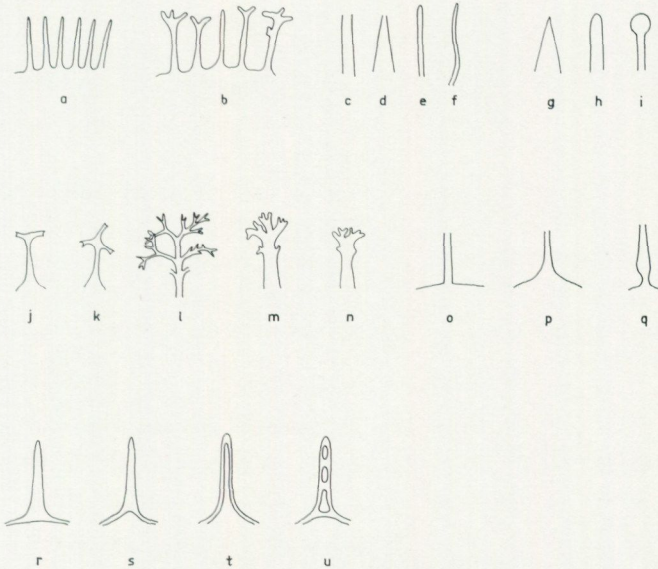


Fig. 5. Process morphography of baltisphaerids. Homomorphic process arrangement (a), heteromorphic process arrangement (b), cylindrical process (c), conical process (d), filiform process (e), flagelliform process (f), acuminate process termination (g), evexate process termination (h), bulbous process termination (i), bifurcate process termination (j), trifurcate process termination (k), arborescent process (l), digitate process termination (m, n), angular proximal process contact (o), curved proximal process contact (p), constricted proximal process contact (q), simple process termination (r, s, t), trabeculate process structure (u).

|                             |  |
|-----------------------------|--|
| ACUMINATE                   | Pointed distal termination of the process: Fig. 5 g.   |
| ANGULAR PROCESS CONTACT     | Angular proximal process contact with the vesicle: Fig. 5 o.   |
| ANTAPEX                     | Polar region of the hypocyst: Fig. 3 a.  |
| APEX                        | Polar region of the epicyst: Fig. 3 b.   |
| ARBORESCENT                 | Multi-branched process: Fig. 5 l.  |
| BIFURCATE                   | Process split in the distal end into two tips: Fig. 5 j.   |
| BULBOUS                     | Bulbous distal termination of the process: Fig. 5 i.   |
| CENTRAL BODY                | The cyst minus the processes (synonym of vesicle): Fig. 3.   |
| CONICAL PROCESS             | Conical overall shape of the process: Fig. 5 d.  |
| CONSTRICTED PROCESS CONTACT | Constricted proximal process contact with the vesicle: Fig. 5 q.   |
| CURVED PROCESS CONTACT      | Curved proximal process contact with the vesicle: Fig. 5 p.  |
| CYLINDRICAL PROCESS         | Cylindrical overall shape of the process: Fig. 5 c.  |
| DIGITATE                    | Branched process: Fig. 5 m, n.   |
| DISTAL                      | Part of the process furthest away from the vesicle surface: Fig. 5 g-k.  |
| ECHINATE                    | Wall with spiny projections: Fig. 4 e.   |
| EPICYST                     | Part of the vesicle containing excystment opening if present: Fig. 3 c.  |
| EQUATOR                     | Zone of vesicle separating the epicyst from the hypocyst: Fig. 3 d.  |
| EVEXATE                     | Non-pointed distal termination of the process: Fig. 5 h.   |
| EXCYSTMENT OPENING          | Opening in the epicyst produced as pylome (see below), partial rupture, median split or epityche (cf. Loeblich & Tappan 1969). Fig. 3 e. |
| FILIFORME                   | Erect, slender process: Fig. 5 e.  |
| FLAGELLIFORME               | Curved, slender process: Fig. 5 f.   |
| FURCATE                     | See: Bifurcate, Trifurcate.  |
| GRANULATE                   | Wall with granulae less than 0.5 $\mu$ in diameter: Fig. 4 c.  |
| HETEROMORPHIC               | Process group exhibiting two orders of processes on the same vesicle (furcate and simple): Fig. 5 b.                                     |
| HOMOMORPHIC                 | Process group exhibiting one order of processes on the same vesicle (furcate or simple): Fig. 5 a.                                       |

|                       |  |
|-----------------------|--|
| HYPOCYST              | Opposite part of vesicle to the epicyst: Fig. 3 f.   |
| OPERCULUM             | Part of the epicyst formed as an excystment lid: Fig. 3 g.   |
| PETEINOS              | Veil structure outside the process stem: Fig. 2 c.   |
| PROCESS               | Excrescence of the vesicle formed as an appendage: Fig. 2, 5.  |
| PROXIMAL              | Basal part of the process at its origin in the vesicle: Fig. 2, 5 o-u.   |
| PSILATE               | Smooth wall without any structure: Fig. 4 a.   |
| PYLOME                | Circular excystment opening of the epicystal part of the vesicle: Fig. 3 e.  |
| SHAGRINATE            | Leather-like wall ornamentation: Fig. 4 b.   |
| SIMPLE PROCESS        | Non-furcate distal terminated process: Fig. 5 g-i.   |
| TEST                  | Central body including the process: Fig. 2.  |
| TRABECULATE           | Ladder-like structure inside the processes: Fig. 5 u.  |
| TRIFURCATE            | Process split in the distal end into three tips: Fig. 5 k.   |
| VERRUCATE             | Wall with warty projections greater than $0.5 \mu$ : Fig. 4 d.   |
| VESICLE               | Synonym of central body (= test minus processes): Fig. 3.  |
| VESICLE COMMUNICATION | Separation or non-separation of the process cavity from the interior of the vesicle: Fig. 2 a, c and 2 b, d, respectively. |

### TAXONOMY

The systematic relationships of fossil organic-walled microplankton have been a subject for much controversial speculation, resulting in a confusing taxonomy. Originally a zoological classification was used (O. Wetzel 1933), but this system was rejected by Deflandre (1936), who adopted a botanical classification. Unfortunately, both systems were widely used for a long time and as a consequence of employing two different taxonomical codes, International Code of Zoological Nomenclature (ICZN) and International Code of Botanical Nomenclature (ICBN), the classification work on fossil phytoplankton was severely inhibited.

In order to avoid further confusion Downie, Williams & Sarjeant (1961) suggested that fossil microplankton with organic tests should be classified as botanical objects and regarded as subjects to the rules of International Code of Botanical Nomenclature (ICBN). These recommendations, subsequently

formulated by Downie, Evitt & Sarjeant (1963), were given from certain practical considerations: 1. the precise biological affinities to different taxonomical groups (e. g. algae, plant spores, protozoans) and the interrelationships of these groups are uncertain, 2. the concept of a third Kingdom (Protista) including all unicellular organisms has not been generally accepted and consequently proposals of a third nomenclatural code have attracted little enthusiasm. The fossil microplankton were therefore attributed by Downie, Evitt & Sarjeant to a new botanical *Incertae Sedis* group, named Acritarcha (*akritos* + *arche* = uncertain + origin). The diagnosis of this group was formulated by Downie, Evitt & Sarjeant (1963):

"Unicellular or apparently unicellular microfossils consisting of a test composed of organic substances and enclosing a central cavity. Shape of the test spherical, ellipsoidal, discoidal, elongate or polygonal; test surface smooth, granular, punctate or perforate. Spines or other processes, raised ridges (crests), flanges, wings or other outgrowths present or absent; where present distributed regularly or irregularly. Inner capsule present or absent; where present, connected to the test by varied means or lacking such connection. Shell opens by rupture, splitting or formation of a simple circular pylome. Rarely, a number of tests loosely associated in a chain."

The Acritarcha group, comprising fourteen subgroups, was regarded by Downie, Evitt & Sarjeant as polyphyletic, possibly including various stages in the life cycle of algae, spores of higher plants, protozoans etc. As the biological criteria became more fully understood and the taxonomical affinities of the genera were established, it was intended that these genera should be removed from the subgroups and reallocated to appropriate families.

The baltisphaerids were provisionally included in the subgroup Acanthomorphae, diagnosed by Downie, Evitt & Sarjeant as: "Acritarchs having a spherical or ellipsoidal test, without an inner body and without crests. Processes isolate, simple or branching, solid or hollow, distributed arbitrarily or regularly. Without observed opening or with a simple circular pylome."

The Acritarcha classification has recently been criticized by Eisenack (1969), who takes issue with Downie, Evitt & Sarjeant on the ground that its artificiality separates morphologically similar forms on the basis of pure geometry. Contrary to Downie, Evitt & Sarjeant, Eisenack accepts an unity of these microplankton and regards them as monophyletic: "Bereits 1938:8,30 und später mehrfach habe ich aufgrund des chemischen Verhaltens der Membranzubstanz und des Auftretens der Pylome, die Ansicht vertreten, dass es sich bei den *Baltisphaeridium*-Arten (damals *Hystriochosphaeridium* genannt) und ihren Verwandten um Reste von einzelligen Algen (Phytoplanktonen) handelt."

Important criteria for Eisenack's monophyletic view are thus the uniform chemical composition of the cell walls (1969) and the excystment openings (pylome, partial rupture, median split, epityche), by which the cell contents

escape (Eisenack 1968 a, Loeblich & Tappan 1969, Staplin, Jansonius & Pockock 1965). Based on these morphological features Eisenack erects for the baltisphaerids a new botanical family ranked as belonging to the algae, i. e. *Baltisphaeridiaceae*, comprising eight genera: *Axisphaeridium*, *Baltisphaeridium* (type genus), *Estiastra*, *Goniosphaeridium*, *Multiplicisphaeridium*, *Orthosphaeridium*, *Peteinosphaeridium* and *Pulvinosphaeridium*.

It seems adequate to treat the excystment opening as an important monophyletic criterion. The chemical composition of the microplankton should, however, not be regarded at present as a sufficient criterion to justify a monophyletic view. In his chemical studies of cell walls, Kjellström (1968) has illustrated by means of infra-red microspectrometry that algae (*Tasmanites* and *Leiosphaeridia*) as well as spores of higher plants (*Lycopodium*) seem to be composed of identical functional groups of  $-\text{COOH}$ ,  $\text{CH}_2$  and  $\text{CH}_3$  similar those of fatty acids of stearic acid types,  $\text{C}_{17}\text{H}_{35}\text{COOH}$  (Fig. 6).

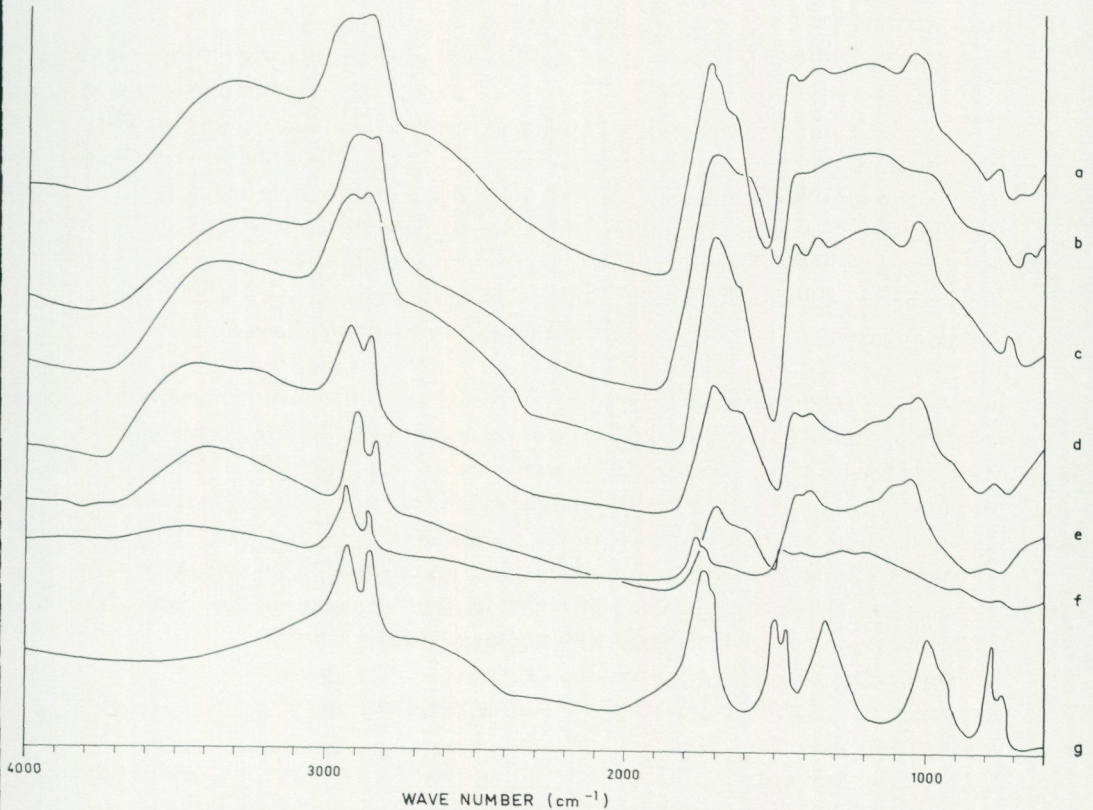


Fig. 6. Infra-red microspectra of the cell walls of fossil green algae, acritarchs and recent spores. *Tasmanites erraticus* (a, b), *Tasmanites punctatus* (c, d), *Leiosphaeridia* sp. (e), recent *Lycopodium* spores (f), stearic acid (g). After Kjellström 1968.

Therefore, until more substantial suprageneric characters of the baltisphaerids have been achieved, the present writer prefers to adopt the Acritarcha classification. The basic generic criteria of genera *Baltisphaeridium*, *Goniosphaeridium*, *Multiplicisphaeridium*, *Orthosphaeridium*, and *Peteinosphaeridium* are presented in Fig. 2.

## SYSTEMATICS

### *Incertae Sedis*

Group Acritarcha EVITT, 1963

Sub-group Acanthomorphae DOWNIE, EVITT & SARJEANT, 1963

Genus *Baltisphaeridium* EISENACK, 1958 emend. EISENACK, 1969

TYPE SPECIES. – Holotype (lost): *Baltisphaeridium* (*Ovum hispidum*) *longispinosum* EISENACK, 1931, p. 110, Pl. 5, fig. 10. Neotype: *Baltisphaeridium longispinosum* forma *filifera* EISENACK, 1959, p. 194, Pl. 15, fig. 1.

EMENDED DIAGNOSIS. – "Schale kugelförmig, ungefeldert, mit  $\pm$  zahlreichen, radial stehenden, meist gut abgesetzten und im allgemeinen gleichartigen und meist hohlen Anhängen versehen, die am Ende stets geschlossen sind. Meist sind die Anhängen unverzweigt, doch können am selben Exemplar neben solchen auch verzweigte Anhängen auftreten. Selten nur sind alle Anhängen gegabelt. Der Hohlraum der Anhängen steht mit dem der Zentralschale meist nicht in Verbindung. Die Anhängen sind gleichmässig (kugelsymmetrisch) verteilt, auch bei geringer Anzahl. Der Durchmesser der Schale liegt im allgemeinen über  $30 \mu$  (meist bei  $40\text{--}60 \mu$ ) und kann  $70 \mu$ , der Gesamtdurchmesser  $300 \mu$  überschreiten. Die (seltenen) Pyrome sind kreisförmig (Normalpyrome)."

REMARKS. – Originally Deflandre (1937) erected two collective genera, *Hystrichosphaeridium* and *Micrhystridium*, for microplankton having a test diameter greater than  $20 \mu$  and less than  $20 \mu$ , respectively. The genus *Hystrichosphaeridium* was subsequently split by Eisenack (1958 c), who referred to the profound differences in the character of the processes of the type species of *Hystrichosphaeridium*, *H. tubiferum*, and of *Micrhystridium*, *M. inconspicuum*. In the former species the processes are open at the tips while in the latter they are closed. Retaining the diagnosis of *Hystrichosphaeridium* for species like *H. tubiferum* Eisenack proposed a new genus, *Baltisphaeridium*, for species having a test diameter greater than  $20 \mu$  and possessing processes closed at their distal ends.

The size as a criterion for generic differentiation of *Baltisphaeridium* and *Micrhystridium* was not accepted by Staplin (1961), who suggested that the size limit of *Baltisphaeridium* and *Micrhystridium* should be abandoned. According to Staplin the genus *Micrhystridium* should include all globular forms with

simple, unbranched processes, closed at their distal ends. For species with branched processes, closed at their tips Staplin proposed a new genus *Multiplicisphaeridium*, regarding *Baltisphaeridium* as a junior synonym.

These proposals were criticized by Downie & Sarjeant (1963), who considered the size limit of *Baltisphaeridium* and *Micrhystridium* as a statistically sound expression of two size modes. Genus *Multiplicisphaeridium* was furthermore rejected by Downie & Sarjeant mainly due to the fact that many species possess both orders of processes (simple and branched or furcate) on a single vesicle. It was also emphasized by Downie & Sarjeant that "there is no evidence for the view that *Multiplicisphaeridium* constitutes an evolutionary chain of species; on the contrary, there is much evidence that the species with furcate or complex spine tips repeatedly arose, by a trend of increasing spine complexity, from forms with simple spines."

Later on Staplin, Jansonius & Pocock (1965) restricted the diagnosis of genus *Multiplicisphaeridium* as well as of the genus *Baltisphaeridium*. The free connection of the process cavity with the vesicle interior was defined as a generic criterion for genus *Multiplicisphaeridium*, and genus *Baltisphaeridium* – no longer treated as a junior synonym but incorporated in a new subgroup *Baltisphaeritae* – was characterized by a structural differentiation of the vesicle wall (granulate, scabrate, porate) and the process wall (hyaline).

The diagnosis of *Multiplicisphaeridium* as formulated by Staplin, Jansonius & Pocock was accepted in principal by Eisenack (1969). The diagnosis of *Baltisphaeridium* evoked, however, strong criticism from Eisenack, postulating that no such structural differentiation exists between the vesicle wall and the process wall among the baltisphaerids.

The material from Grötlingbo supports, however, Staplin, Jansonius & Pocock in the sense that structural differences exist between the vesicle wall and the process wall (cf. *Baltisphaeridium constrictum* n. sp. and *B. echinatum* n.sp. herein), but the present writer prefers not to consider them for the time being as a basis for generic differentiation.

Although much still remains to be clearly defined when it concerns genus *Baltisphaeridium*, the diagnosis as formulated by Eisenack (1969) is here adopted.

*Baltisphaeridium brevifilicum* n. sp.

Pl. 1, fig. 1.

DERIVATION OF NAME. – Latin: *brevi*, short; *filum*, thread. With reference to the short processes.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical to sub-spherical, shagrinated vesicle. Excystment structure with large operculum. Curved proximal process contact with the vesicle. Separation of the interior of the

process from the vesicle cavity. Numerous processes, in length about 1/10 of vesicle diameter, shagrinate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 80  $\mu$ ; process length: 8  $\mu$ ; process breadth (at the base): 1.5  $\mu$ ; process separation: 10  $\mu$ . Range: vesicle diameter: 77–86  $\mu$ ; process length: 8–10  $\mu$ ; process breadth: 1.5  $\mu$ . Specimen no.: 8.

REMARKS. – The large excystment opening and the great vesicle dimensions compared with the short, conical processes characterize this species.

HOLOTYPE. – SGU slide no. 450:1. Pl. 1, fig. 1.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 450.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 450.00–453.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium brevispinosum* (EISENACK, 1931)

Pl. 1, fig. 2.

- 1931 *Ovum hispidum brevispinosum* EISENACK. – Eisenack: Neue Mikrofossilien . . . , p. 111, Pl. 5, fig. 3–5.
- 1938 *Hystrichosphaeridium brevispinosum*. – Eisenack: Hystrichosphaerideen . . . , p. 12, Pl. 1, fig. 10.
- non 1942 *Hystrichosphaeridium brevispinosum* var. *nanum*. – Deflandre: Sur les Hystrichosphères . . . , p. 476, fig. 1.
- non 1944 *Hystrichosphaeridium brevispinosum* var. *nanum*. – Deflandre: Microfossiles . . . , p. 19, Pl. 1, fig. 5–7.
- non 1944 *Hystrichosphaeridium* cf. *brevispinosum* var. *nanum*. – Deflandre: Microfossiles . . . , Pl. 1, fig. 18.
- non 1947 *Hystrichosphaeridium brevispinosum*. – Deflandre: Le problème . . . , fig. 1, 16.
- ?1955 *Hystrichosphaeridium brevispinosum* subsp. *callosum*. – Sanne-mann: Hystrichosphaerideen . . . , p. 325, Pl. 1, fig. 1–4; Pl. 3, fig. 2–5, 10; Pl. 4, fig. 3–9; Pl. 6, fig. 11, 12; textfig. 2 a–d.
- ?1955 *Hystrichosphaeridium brevispinosum* subsp. *castaneoides*. – San-nemann: Hystrichosphaerideen . . . , p. 326, Pl. 4, fig. 13, 14; textfig. 3.

- 1958 *Hystrichosphaeridium brevispinosum* (?). – Deunff: Microorganismes . . . , p. 25, Pl. 9, fig. 81, 84.
- 1958 *Hystrichosphaeridium* cf. *brevispinosum*. – Deunff: Microorganismes . . . , p. 25, Pl. 7, fig. 69.
- 1958 *Baltisphaeridium brevispinosum*. – Eisenack: Mikrofossilien . . . , p. 400.
- 1959 *Baltisphaeridium brevispinosum*. – Eisenack: Neotypen . . . , p. 197, Pl. 15, fig. 13–18.
- non 1959 *Baltisphaeridium brevispinosum* var. *wenlockensis*. – Downie: Hystrichospheres . . . , p. 59, Pl. 10, fig. 4.
- non 1959 *Hystrichosphaeridium brevispinosum*. – Timofeev: The ancient flora . . . , p. 55, Pl. 4, fig. 17.
- non 1959 *Baltisphaeridium brevispinosum* var. *granuliferum*. – Downie: Hystrichospheres . . . , p. 59, Pl. 10, fig. 5.
- non 1959 *Baltisphaeridium brevispinosum* var. *nanum*. – Downie: Hystrichospheres . . . , p. 59, Pl. 10, fig. 9.
- non 1964 *Baltisphaeridium brevispinosum* var. *granuliferum*. – Downie & Sarjeant: Bibliography . . . , p. 88.
- 1965 *Baltisphaeridium brevispinosum*. – Vavrdová: Ordovician acritarchs . . . , p. 351.
- 1965 *Baltisphaeridium pachyacanthum* EISENACK, 1965 n.nom. – Eisenack: Die Mikrofauna . . . , p. 134, Pl. 13, fig. 7.
- 1965 *Baltisphaeridium* cf. *brevispinosum*. – Staplin, Jansonius & Pocock: Evaluation . . . , p. 189, Pl. 19, fig. 13.
- ?1965 *Baltisphaeridium brevispinosum* subsp. *britannum*. – Deunff: Acritarches . . . , p. 163, fig. 1–3.
- non 1966 *Baltisphaeridium brevispinosum*. – Timofeev: Études . . . , Pl. 34, fig. 2, 7; Pl. 35, fig. 5; Pl. 41, fig. 6; Pl. 49, fig. 9; Pl. 64, fig. 4–6; Pl. 69, fig. 8; Pl. 82, fig. 11; Pl. 87, fig. 13; Pl. 89, fig. 6.
- 1967 *Ovum hispidum brevispinosum*. – Wetzell: Charakteristik . . . , p. 39, Pl. 2, fig. 7, 9, non 8.
- 1968 *Baltisphaeridium brevispinosum*. – Eisenack: Über die Fortpflanzung . . . , p. 7, Pl. 2, fig. 2.
- non 1968 *Baltisphaeridium* cf. *brevispinosum*. – Henry: Micro-organismes . . . , p. 77, Pl. 2, fig. 11, 15.
- 1969 *Baltisphaeridium brevispinosum*. – Górká: Microorganismes . . . , p. 30, Pl. 2, fig. 9, ?6 a, b.
- ?1969 *Baltisphaeridium* cf. *brevispinosum*. – Le Corre & Deunff: Sur la présence . . . , p. 46, fig. 12.
- 1969 *Baltisphaeridium brevispinosum*. – Eisenack: Zur Systematik . . . , p. 251.

DIAGNOSIS. – "Schale kugelförmig, im allgemeinen verhältnismässig dickwandig, mit zahlreichen kurzen Anhängen von der Länge des halben bis ganzen Kugelradius. Das Ende der Anhänge ist abgerundet, vielfach leicht knopfartig verdickt, sie erscheinen dadurch etwas gedrunken, fingerartig. Gabelung der Enden selten." (Eisenack 1959.)

DESCRIPTION. – *Baltisphaeridium* sp. with thick, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 25 in number, in length about 1/3 of vesicle diameter, shagrinated, conical, homomorphic, simple with evexate or bulbous distal terminations. Occasionally some processes possess bi- or trilobate, bulbous distal ends.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 20  $\mu$ ; process breadth (at the base): 4  $\mu$ ; process separation: 18  $\mu$ . Range: vesicle diameter: 63–70  $\mu$ ; process length: 20–25  $\mu$ ; process breadth: 4–5  $\mu$ ; process separation: 15–19  $\mu$ . Specimen no.: 11.

REMARKS. – According to the diagnosis and descriptions of Eisenack (1931: holotype, 1959: neotype) the distal terminations of *B. brevispinosum* always are evexate or bulbous in nature. Consequently a "non" has been attributed in the synonym list of this contribution to those specimens which were described to possess acuminate distal terminations and a question mark to those specimens which are difficult to interpret (mainly due to a bad preservation).

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 441.00–459.50 m. – Baltic erratics; Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. – Klabava, Czechoslovakia; Lower Ordovician, Arenig. – Veryhac'h, France; Ordovician.

*Baltisphaeridium bulbosum* n. sp.

Pl. 1, fig. 3.

DERIVATION OF NAME. – Latin: *bulbus*, knob. With reference to the bulbous distal terminations of the processes.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. Excystment structure formed as a partial rupture. Curved proximal process contact with the vesicle. Separation of the interior of the process from

the vesicle cavity. Processes, about 11 in number, in length about equal to the vesicle diameter, shagrinate, conical, broad bases, homomorphic, simple with bulbous distal terminations, sometimes bilobate.

DIMENSIONS. — Vesicle diameter: 63  $\mu$ ; process length: 56  $\mu$ ; process breadth (at the base): 20  $\mu$ . Range: vesicle diameter: 60–72  $\mu$ ; process length: 55–70  $\mu$ ; process breadth: 20–24  $\mu$ . Specimen no.: 7.

REMARKS. — The bulbous, occasionally bilobate terminations of the broad-based processes are prominent morphological features of this species.

HOLOTYPE. — SGU slide no. 450:1. Pl. 1, fig. 3.

TYPE LOCALITY AND TYPE STRATUM. — Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 450.00 m.

OCCURRENCE. — Grötlingbo Borehole No. 1, 450.00–455.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium calicispinae* GÓRKA, 1969

Pl. 1, fig. 4.

1969 *Baltisphaeridium calicispinae* GÓRKA. — Górká: Mikroorganismes . . . , p. 36, Pl. 6, fig. 3, 4; Pl. 8, fig. 1–3, 5; ?Pl. 10, fig. 3; textfig. 10.

DIAGNOSIS. — "Coque sphérique, munie de 6–14 appendices, dont les bases sont élargies en entonnoirs. Ils se rétrécissent vers les extrémités pointues et formées aussi en entonnoir. Ils sont pourvu sur toute leur surface de menues épines." (Górká 1969.)

DESCRIPTION. — *Baltisphaeridium* sp. with thick, single walled, spherical, echinate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 11 in number, in length not exceeding the vesicle diameter, echinate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. — Vesicle diameter: 66  $\mu$ ; process length: 60  $\mu$ ; process breadth (at the base): 6  $\mu$ ; process separation: 20  $\mu$ . Range: vesicle diameter: 62–71  $\mu$ ; process length: 57–62  $\mu$ ; process breadth: 6–7  $\mu$ ; process separation: 17–22  $\mu$ . Specimen no.: 6.

REMARKS. – This species has close affinities with *B. longispinosum* subsp. *uncinatum* DOWNIE, 1958 (textfig. 2 a, no longer within genus *Baltisphaeridium*) in the sense that the walls are echinate. It differs however, in having an angular proximal process contact freely communicating with the vesicle. *B. calicispinae* is also easily distinguished from *B. longispinosum* var. *klabavensis* VAJRDOVÁ, 1965, which latter possesses a constricted proximal process contact with the vesicle and is characterized by a verrucate ornamentation on the vesicle and process walls. In contrast to the holotype of Górká, no excystment structure is recorded (the holotype shows a cyclome).

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 440.00–445.00 m. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. Ketrzyn Borehole No. 1, Poland; Middle Ordovician, Lower Caradocian. Mielnik Borehole, Poland; Middle Ordovician, Lower Caradocian.

*Baltisphaeridium constrictum* n. sp.

Pl. 1, fig. 5, 6.

DERIVATION OF NAME. – Latin: *constringere*, constrict. With reference to the constricted proximal part of the process.

DIAGNOSIS. – *Baltisphaeridium* sp. with thick, single walled, spherical, granulate vesicle. Excystment structure formed as a median split. Constricted proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 8 in number, in length exceeding the vesicle diameter, psilate, broad above constricted proximal base area, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 90  $\mu$ ; process length: 120  $\mu$ ; process breadth (above constricted area): 18  $\mu$ . Range: vesicle diameter: 86–99  $\mu$ ; process length: 100–124  $\mu$ ; process breadth: 18–21  $\mu$ . Specimen no.: 11.

REMARKS. – The processes of *Baltisphaeridium constrictum* n. sp. have an outline approaching *B. latiradiatum* (EISENACK, 1959) EISENACK, 1969. It is clearly differentiated from the latter species by its thick, granulate vesicle.

HOLOTYPE. – SGU slide no. 459:5. Pl. 1, fig. 5, 6.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), Folkeslunda, 459.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 455.00–459.00 m.

*Baltisphaeridium* aff. *constrictum*

Pl. 1, fig. 7.

DESCRIPTION. — *Baltisphaeridium* sp. with thin, single walled, spherical to sub-spherical, granulate vesicle. No excystment structure recorded. Constricted proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 8 in number, in length exceeding the vesicle diameter, psilate, broad above constricted area, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. — Vesicle diameter: 65  $\mu$ ; process length: 72  $\mu$ ; process breadth (above constricted area): 21  $\mu$ . Range: vesicle diameter: 61–70  $\mu$ ; process length: 67–74  $\mu$ ; process breadth: 19–22  $\mu$ . Specimen no.: 4.

REMARKS. — *Baltisphaeridium* aff. *constrictum* differs from *B. constrictum* n. sp. by the presence of a much thinner vesicle wall and smaller vesicle and process dimensions.

OCCURRENCE. — Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 440.00–441.00 m.

*Baltisphaeridium echinatum* n. sp.

Pl. 1, fig. 8.

DERIVATION OF NAME. — Greek: *echinos*, hedgehog. With reference to the spinose ornamentation.

DIAGNOSIS. — *Baltisphaeridium* sp. with thin, single walled, spherical, echinate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 20 in number, in length less than vesicle diameter, psilate, filiforme, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. — Vesicle diameter: 54  $\mu$ ; process length: 30  $\mu$ ; process breadth (at the base): 3  $\mu$ ; process separation: 15  $\mu$ . Range: vesicle diameter: 49–58  $\mu$ ; process length: 29–32  $\mu$ . Specimen no.: 4.

REMARKS. — This species is reminiscent of *B. spinigerum* GÓRKA, 1969 (Pl. 11, fig. 2 b, 3). It differs by having an echinate vesicle ornamentation and a psilate process wall ornamentation. The process bases are also less broad in *B. echinatum* n. sp.

HOLOTYPE. – SGU slide no. 435:1. Pl. 1, fig. 8.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 435.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 433.00–438.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium filosum* n. sp.

Pl. 1, fig. 9.

DERIVATION OF NAME. – Latin: *filum*, thread. With reference to the thread-like processes.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, subspherical, shagrinated vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Numerous processes, in length about 1/3–1/4 of vesicle diameter, flagelliforme, homomorphic, simple with acuminate distal terminations. Process separation very small.

DIMENSIONS. – Vesicle diameter:  $63 \times 77 \mu$ ; process length:  $20 \mu$ ; process breadth:  $1 \mu$ . Range: vesicle diameter: 61 (70)–73 (84)  $\mu$ ; process length: 19–23  $\mu$ ; process breadth:  $1 \mu$ . Specimen no.: 4.

REMARKS. – The present species is characterized by the closely arranged flagelliform processes. Contrary to the distal terminations of the processes of *B. flagellicum* n. sp., the processes in *B. filosum* are always acuminate. It has not been possible to determine the nature of the processes whether they are solid or not, which is why this species has not been attributed to the genus *Filisphaeridium* STAPLIN, JANSONIUS & POCOCK, 1965. Furthermore, it seems – as has been pointed out by Sarjeant (Sarjeant in CIMPA report, 1969) – the criterion for *Filisphaeridium*, solid processes, is not sufficiently distinctive to be utilisable.

HOLOTYPE. – SGU slide no. 459:1. Pl. 1, fig. 9.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), Lasnamägi, Folkeslunda, 459.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 457.00–459.00 m, Middle Ordovician (Viruan), Lasnamägi, Folkeslunda.

*Baltisphaeridium flagellicum* n. sp.

Pl. 1, fig. 10.

DERIVATION OF NAME. – Latin: *flagellus*, whip. With reference to the flagelliforme processes.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical, psilate vesicle. Excystment structure formed as a partial rupture. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Numerous processes, in length about 1/5 of vesicle diameter, psilate, flagelliforme, homomorphic, simple with small bulbous distal terminations.

DIMENSIONS. – Vesicle diameter: 57  $\mu$ ; process length: 12  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 8  $\mu$ . Range: vesicle diameter: 58–67  $\mu$ ; process length: 11–14  $\mu$ . Specimen no.: 9.

REMARKS. – *Baltisphaeridium flagellicum* n. sp. differs from *B. brevispinosum* in the angular proximal process contact with the vesicle, greater number of processes, greater proportion of process length/vesicle diameter and smaller process base.

HOLOTYPE. – SGU slide no. 441:5. Pl. 1, fig. 10.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 441.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 441.00–443.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium granosum* n. sp.

Pl. 1, fig. 11.

DERIVATION OF NAME. – Latin: *granum*, grain (*granosum*, full of grains). With reference to the granulate vesicle wall.

DIAGNOSIS. – *Baltisphaeridium* sp. with thick, single walled, spherical, granulate vesicle. Large excystment structure formed as a partial rupture. Curved proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 25 in number, in length about 1/3 of vesicle diameter, echinate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 80  $\mu$ ; process length: 30  $\mu$ ; process breadth (at the base): 4  $\mu$ ; process separation: 12  $\mu$ . Range: vesicle diameter: 72–80  $\mu$ ; process length: 25–30  $\mu$ ; process breadth: 4  $\mu$ ; process separation: 10–12  $\mu$ . Specimen no.: 5.

REMARKS. – The marked features of this species are the great vesicle dimension, the granulate ornamentation of the vesicle, the echinate structure of the process wall and the large excystment opening.

HOLOTYPE. – SGU slide no. 475:1. Pl. 1, fig. 11.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Lower Ordovician (Oelandian), Volkhov, 475.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 472.00–475.00 m. Lower Ordovician (Oelandian), Kunda, Valaste – Hunderum; Volkhov, Langevoja – ?Lim-bata.

*Baltisphaeridium hirsutoides* (EISENACK, 1951)

Pl. 1, fig. 12.

- 1931 *Ovum hispidum* cf. *hirsutum* EHRENBERG. – Eisenack: Neue Mikro-fossilien . . . , p. 111, Pl. 5, fig. 19.
- 1938 *Hystrichosphaeridium* cf. *hirsutum* EHRENBERG. – Eisenack: Hystrichosphärideen . . . , p. 12, Pl. 1, fig. 11.
- 1951 *Hystrichosphaeridium hirsutoides* EISENACK. – Eisenack: Über Hyst-richtosphaerideen . . . , p. 189, Pl. 3, fig. 8.
- non 1958 *Hystrichosphaeridium hirsutoides*. – Downie: An assemblage . . . , p. 335, Pl. 16, fig. 2, 3, 11, 12; textfig. 2 f, g, i.
- non 1958 *Hystrichosphaeridium hirsutoides* var. *hamatum*. – Downie: An assemblage . . . , p. 335, Pl. 16, fig. 1; textfig. 2 j, k.
- 1959 *Baltisphaeridium hirsutoides*. – Eisenack: Neotypen . . . , p. 196.
- 1959 *Hystrichosphaeridium hirsutoides*. – Timofeev: The ancient flora . . . , p. 52, Pl. 4, fig. 5.
- 1962 *Baltisphaeridium hirsutoides*. – Eisenack: Mikrofossilien . . . , p. 359, Pl. 44, fig. 4–7.
- non 1964 *Baltisphaeridium hirsutoides*. – Downie & Sarjeant: Bibliogra-phy . . . , p. 91.
- 1965 *Baltisphaeridium hirsutoides*. – Eisenack: Die Mikrofauna . . . , p. 135.

- 1966 *Baltisphaeridium hirsutum*. – Timofeev: Étude . . ., Pl. 33, fig. 4; Pl. 83, fig. 17.
- ?1967 *Baltisphaeridium hirsutoides*. – Combaz: Un microbios . . ., Pl. 3, fig. 53, 54.
- 1968 *Baltisphaeridium hirsutoides*. – Eisenack: Über die Fortpflanzung . . ., Pl. 2, fig. 4.
- 1969 *Baltisphaeridium hirsutoides*. – Eisenack: Zur Systematik . . ., p. 250.
- 1969 *Baltisphaeridium hirsutoides*. – Lister, Burgess & Wadge: Microfossils . . ., p. 98.
- 1969 *Baltisphaeridium hirsutoides*. – Lister, Cocks & Rushton: The basement . . ., p. 602.

DIAGNOSIS. – "Zentralkörper kuglig. Anhänge zahlreicher als bei *H. longispinosum*, jedoch kürzer als bei dieser Art, etwa von der Länge des Halbmessers und darunter, meist dünn und borstenartig und in eine Spitze auslaufend. Im Vergleich mit *H. multipilosum* sind die Anhänge wesentlich geringer an Zahl und meist auch länger. Gegabelte Anhänge bisher nie beobachtet."

DESCRIPTION. – *Baltisphaeridium* sp. with thick, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 20 in number, in length about 1/3 of vesicle diameter, psilate, filiforme, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 68  $\mu$ ; process length: 28  $\mu$ ; process breadth (at the base): 3  $\mu$ ; process separation: 15  $\mu$ . Range: vesicle diameter: 59–68  $\mu$ ; process length: 20–25  $\mu$ ; process breadth: 3  $\mu$ ; process separation: 14–19  $\mu$ . Specimen no.: 11.

REMARKS. – Although *Baltisphaeridium hirsutoides* constitutes a great variety of transitional forms, the nature of the processes of *Baltisphaeridium hirsutoides* var. *hamatum* DOWNIE, 1958 merits this variety to be ranked at the specific level.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 433.00–438.00 m, Middle Ordovician (Viruan). – Baltic erratics; Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. – Tosna, Estland; Lower Ordovician. – Cross Fell Inlier, Teesdale Inlier and Kent, England; Lower Ordovician, Arenig-Llanvirn.

*Baltisphaeridium latiradiatum* (EISENACK, 1959)

Pl. 2, fig. 1.

- 1931 *Ovum hispidum longispinosum* EISENACK pars. – Eisenack: Neue Mikro-fossilien . . . , p. 110, Pl. 5, fig. 14, 15, non 16, 17.
- 1938 *Hystrichosphaeridium longispinosum* pars. – Eisenack: Hystrichosphäri-deen . . . , p. 12, Pl. 1, fig. 1–3.
- 1951 *Hystrichosphaeridium longispinosum* pars. – Eisenack: Über Hystricho-sphaerideen . . . , p. 188, Pl. 1, fig. 1, 2, 6.
- 1959 *Baltisphaeridium longispinosum* forma *latiradiata*. – Eisenack: Neoty-pen . . . , p. 195, Pl. 15, fig. 4.
- 1963 *Baltisphaeridium longispinosum* forma *latiradiata*. – Eisenack: Mittei-lung . . . , p. 209, Pl. 19, fig. 8.
- 1965 *Baltisphaeridium longispinosum* forma *latiradiata*. – Eisenack: Die Mik-rofauna . . . , p. 134.
- 1965 *Baltisphaeridium latiradiatum* STAPLIN, JANSONIUS & POCOCK, 1965 n. comb. – Staplin, Jansonius & Pocock: Evaluation . . . , p. 189, Pl. 20, fig. 3–5, 9, textfig. 13.
- 1966 *Baltisphaeridium longispinosum*. – Timofeev: Étude . . . , Pl. 84, fig. 5.
- 1967 *Ovum hispidum longispinosum*. – Wetzel: Charakteristik . . . , p. 38, Pl. 1, fig. 3, non 4, non 5, 6.
- 1968 *Baltisphaeridium longispinosum* forma *latiradiata*. – Eisenack: Über die Fortpflanzung . . . , Pl. 2, fig. 6.
- 1968 *Baltisphaeridium longispinosum* forma *latiradiata*. – Eisenack: Mikro-fossilien . . . , p. 90, Pl. 25, fig. 4.
- 1969 *Baltisphaeridium latiradiatum*. – Eisenack: Zur Systematik . . . , p. 250.

DIAGNOSIS. – "Die Schale ist meist etwas derber, daher dunkler und häufiger kugelförmig. Hingegen sind die Anhänge an der Basis recht breit und im ganzen dünnwandig und zart, daher oft zusammengefallen. Häufig sind Exemplar mit unverzweigten Anhängen, aber auch solche mit verzweigten Anhängen kommen vor." (Eisenack 1959.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, ellipsoidal, shag-rinate vesicle. No excystment structure recorded. Constricted proximal process contact with the vesicle. Separation of the interior of the process from the ve-sicle cavity. Processes, about 7 in number, in length almost equal but never less than vesicle diameter, psilate, broad above constricted proximal base area, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 75  $\mu$ ; process breadth (above constricted area): 18  $\mu$ ; process separation: too variable to be deter-

mined. Range: vesicle diameter: 60–87  $\mu$ ; process length: 68–90  $\mu$ ; process breadth: 15–18  $\mu$ . Specimen no.: 6.

REMARKS. – The processes with their constricted bases are similar those of *Baltisphaeridium constrictum* n. sp. *B. latiradiatum* differs however profoundly by its shagrinated vesicle wall (granulate in *B. constrictum* n. sp.).

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 450.00–452.00 m. – Baltic erratics; Ordovician.

*Baltisphaeridium longispinosum* (EISENACK, 1931)

Pl. 2, fig. 2.

- 1931 *Ovum hispidum longispinosum*. – Eisenack: Neue Mikrofossilien . . . , p. 110, Pl. 5, fig. 6–12.
- 1938 *Hystrichosphaeridium longispinosum* . – Eisenack: Hystrichosphaerideen . . . , p. 12, Pl. 1, fig. 4, 6, 7.
- 1951 *Hystrichosphaeridium longispinosum*. – Eisenack: Über Hystrichosphaerideen . . . , p. 188, Pl. 1, fig. 5.
- 1958 *Hystrichosphaeridium* cf. *longispinosum*. – Deunff: Ordovicien . . . , p. 24, Pl. 8, fig. 72.
- 1959 *Hystrichosphaeridium longispinosum*. – Timofeev: The ancient flora . . . , p. 51, Pl. 4, fig. 1.
- 1959 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Neotypen . . . , p. 195, Pl. 15, fig. 1, 6, non 7 (?*Goniosphaeridium*).
- 1962 *Baltisphaeridium longispinosum*. – Eisenack: Mitteilung . . . , p. 75.
- 1962 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Mikrofossilien . . . , p. 359.
- 1963 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Mitteilung . . . , p. 208, Pl. 19, fig. 1.
- 1964 *Baltisphaeridium longispinosum*. – Downie & Sarjeant: Bibliography . . . , p. 92.
- 1964 *Baltisphaeridium longispinosum*. – Cramer: Microplankton . . . , p. 297, textfig. 19:7.
- 1965 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Die Mikrofauna . . . , p. 134, Pl. 13, fig. 1–2.
- 1965 *Baltisphaeridium longispinosum* f. *longispinosum*. – Staplin, Jansonius & Pocock: Evaluation . . . , p. 190, Pl. 20, fig. 11, 15; textfig. 11.
- 1965 *Baltisphaeridium longispinosum*. – Vavrdová: Ordovician acritarchs . . . , p. 351.

- ?1965 *Baltisphaeridium longispinosum* var. *klabavensis*. – Vavrdová: Ordovician acritarchs . . . , p. 353, Pl. 2, fig. 1; textfig. 1.
- 1966 *Baltisphaeridium longispinosum*. – Timofeev: Étude . . . , Pl. 33, fig. 5, non fig. 6; ?Pl. 35, fig. 4; Pl. 42, fig. 6; ?Pl. 83, fig. 16; non Pl. 84, fig. 5; Pl. 89, fig. 5.
- 1968 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Über die Fortpflanzung . . . , p. 6, Pl. 1, fig. 8.
- 1968 *Baltisphaeridium longispinosum* f. *filifera*. – Eisenack: Mikrofossilien . . . , p. 90, Pl. 25, fig. 5.
- non 1968 *Baltisphaeridium* cf. *longispinosum* var. *uncinatum*. – Henry: Micro-organismes . . . , p. 77, Pl. 1, fig. 8, 10.
- 1968 *Baltisphaeridium* cf. *longispinosum*. – Henry: Micro-organismes . . . , Pl. 10, fig. 72.
- 1968 *Baltisphaeridium longispinosum* var. *klabavensis* (non *klabavense*). – Cramer & Diez Cramer: Consideraciones . . . , p. 16, textfig. 6 j.
- ?1969 *Baltisphaeridium longispinosum*. – Le Corre & Deunff: Sur la présence . . . , p. 46, fig. 13.
- 1969 *Baltisphaeridium longispinosum*. – Konzalová-Mazanková: Acritarcha . . . , p. 12, Pl. 15, fig. 20; textfig. 3.
- 1969 *Baltisphaeridium longispinosum*. – Stockmans & Willièrè: Acritarches . . . , p. 17, Pl. 4, fig. 15, 16.
- 1969 *Baltisphaeridium longispinosum*. – Lister, Cocks & Rushton: The basement . . . , p. 602.
- 1969 *Baltisphaeridium longispinosum*. – Eisenack: Zur Systematik . . . , p. 250.
- 1969 *Baltisphaeridium longispinosum* subsp. *longispinosum*. – Górka: Microorganismes . . . , p. 34, Pl. 6, fig. 2; Pl. 7, fig. 1–5; textfig. 9.

DIAGNOSIS. – "Schale kugelförmig, mit 4 bis etwa 20 dünnen, langen, spitz endigen, häufig unverzweigten, doch nicht selten auch mit einzelnen gegabelten oder verzweigten Anhängen, deren Länge im allgemeinen den Durchmesser übertrifft. Pylome selten." (Eisenack 1959.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinose or psilate vesicle. No excystment structure recorded. Faintly curved proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 7 in number, in length always exceeding the vesicle diameter, shagrinose or psilate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 60  $\mu$ ; process length: 71  $\mu$ ; process breadth (at the base): 5–8  $\mu$ ; process separation: 30  $\mu$ . Range: vesicle diameter: 58–85  $\mu$ ;

process length: 65–88  $\mu$ ; process breadth: 5–8  $\mu$ ; process separation: 26–32  $\mu$ .  
Specimen no.: 11.

REMARKS. – The specimen of *Baltisphaeridium longispinosum* figured in Eisenack (1959, Pl. 15, fig. 7) seems to possess no separation of the interior of the process from the vesicle cavity. It is therefore proposed here that in a future revision this specimen is treated as a species belonging to genus *Goniosphaeridium*. The specimen illustrated by Timofeev (1966, Pl. 5, fig. 6) has more close affinities to *Goniosphaeridium polygonale* than to *B. longispinosum*. The specimen shown in Pl. 84, fig. 5 (Timofeev 1966) is treated in the present contribution as *Baltisphaeridium latiradiatum* because of the constricted proximal process area.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 421.00–459.50 m, Middle Ordovician (Viruan) – Upper Ordovician (Harjuan), Vasagaard. – Baltic erratics; Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. Zbrza Borehole No. 1 and Goldap Borehole No. 1, Poland; Middle Ordovician, Caradocian. – Vologda and Voldai, Russia; Lower Ordovician. – Tosna, Estland; Lower Ordovician. – Klabava, Czechoslovakia; Lower Ordovician, Arenig. – Bohemia; Upper Ordovician, Ashgill. – Belgium; Devonian. – Oklahoma, USA; Upper Ordovician. – San Pedro, Spain; Silurian, Llandovery. – Veryhac'h, France; Ordovician. Presqu'île de Crozon, France; Ordovician. – Kent, England; Lower Ordovician.

*Baltisphaeridium macropylum* (EISENACK, 1959)

Pl. 2, fig. 3.

- 1938 *Hystriosphæridium* ex. aff. *multipilosum*. – Eisenack: *Hystriosphærideen* . . ., Pl. 3, fig. 9.  
1959 *Baltisphaeridium macropylum* EISENACK. – Eisenack: *Neotypen* . . ., p. 198, Pl. 16, fig. 3–5.  
1962 *Baltisphaeridium macropylum*. – Eisenack: *Mikrofossilien* . . ., p. 355, Pl. 44, fig. 8.  
1968 *Baltisphaeridium macropylum*. – Eisenack: *Über die Fortpflanzung* . . ., p. 7, Pl. 3, fig. 10.  
1969 *Peteinosphaeridium macropylum*. – Eisenack: *Zur Systematik* . . ., p. 254.

DIAGNOSIS. – "Schale kugelförmig, mit zahlreichen kurzen, meist dicklichen Anhängen ziemlich dicht bedeckt, die zum Teil in stumpfen Spitzen endigen, häufig aber auch schwach gegabelt sind. Pylome häufig, sehr weit, 35–40 % des Kugeldurchmessers." (Eisenack 1959.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, psilate vesicle. Excystment structure produced as a pylome, about 20  $\mu$  in diameter. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 25 in number, in length about 1/7 of vesicle diameter, conical, homomorphic, simple with evexate or bulbous distal terminations.

DIMENSIONS. – Vesicle diameter: 48  $\mu$ ; process length: 7  $\mu$ ; process breadth (at the base): 1  $\mu$ ; process separation: 8  $\mu$ . Range: vesicle diameter: 40–49  $\mu$ ; process length: 6–7  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 6–8  $\mu$ . Specimen no.: 8.

REMARKS. – According to Eisenack (1959) this species possesses not only processes with evexate distal terminations but also with furcae. For this reason Eisenack (1969) has proposed that *B. macropylum* should be transferred to genus *Peteinosphaeridium*. In the present material no furcate specimens of *B. macropylum* have been encountered, therefore this species is retained here within the genus *Baltisphaeridium* (cf. the diagnosis of *Baltisphaeridium*).

OCCURRENCE. – Grötlingbo Borehole No 1, Gotland; 471.00–472.00 m, Lower Ordovician (Oelandian), Kunda. – Baltic erratics; Lower Ordovician.

*Baltisphaeridium microspinosum* (EISENACK, 1954)

Pl. 2, fig. 4.

- 1954 *Hystrichosphaeridium microspinosum* EISENACK. – Eisenack: Hystrichosphären . . . , p. 209, Pl. 1, fig. 8.
- 1955 *Hystrichosphaeridium* cf. *microspinosum*. – Eisenack: Chitinozoen . . . , p. 178.
- 1958 *Hystrichosphaeridium microspinosum*. – Eisenack: *Tasmanites* . . . , Pl. 2, fig. 19.
- 1959 *Baltisphaeridium microspinosum*. – Downie: Hystrichospheres . . . , p. 60, Pl. 10, fig. 10.
- 1962 *Baltisphaeridium microspinosum*. – Eisenack: Mikrofossilien . . . , p. 359.
- 1963 *Lophosphaeridium microspinosum*. – Downie: Hystrichospheres . . . , p. 632, Pl. 92, fig. 11.
- 1964 *Lophosphaeridium microspinosum*. – Downie & Sarjeant: Bibliography . . . , p. 129.
- 1965 *Baltisphaeridium microspinosum*. – Eisenack: Mikrofossilien . . . , p. 259.
- 1969 *Baltisphaeridium microspinosum*. – Górká: Microorganismes . . . , p. 33, Pl. 5, fig. 1, 2, 4, 5, 7, 10, 11.

1969 *Baltisphaeridium microspinosum*. – Eisenack: Zur Systematik . . . , p. 250.

DIAGNOSIS. – "Zentralschale kugelförmig mit einem ziemlich dicken Besatz allerfeinster spitzer Stacheln." (Eisenack 1954.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. No communication between the interior of the process and the vesicle cavity can be seen. Numerous processes, in length about 1/10 of vesicle diameter, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 65  $\mu$ ; process length: 6  $\mu$ ; process breadth (at the base): 1  $\mu$ ; process separation: 7  $\mu$ . Range: vesicle diameter: 61–76  $\mu$ ; process length: 5–8  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 4–7  $\mu$ . Specimen no.: 15.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 440.00–444.00 m. Upper Visby Marl, Llandovery, Silurian. – Estonia; Upper Ludlow. – Wenlock Edge, England; Wenlock Shale, Silurian. – Podborowisko Borehole No. 1, Poland; Upper Arenig, Lower Ordovician. Ketrzyn Borehole No. 1, Poland; Lower Caradocian, Middle Ordovician. Erratics from Poland; Upper Tremadocian, Lower Ordovician.

*Baltisphaeridium multipilosum* (EISENACK, 1931)

Pl. 2, fig. 5.

1931 *Ovum hispidum multipilosum* EISENACK. – Eisenack: Neue Mikrofossilien . . . , p. 111, Pl. 5, fig. 20–22.

1938 *Hystrichosphaeridium multipilosum*. – Eisenack: Hystrichosphärideen . . . , p. 12, Pl. 1, fig. 12–13.

1955 *Hystrichosphaeridium multipilosum* subsp. *validum*. – Sannemann: Hystrichosphaerideen . . . , p. 330, Pl. 5, fig. 9, 10; textfig. 10.

1958 *Baltisphaeridium multipilosum*. – Eisenack: Mikrofossilien . . . , p. 400.

1958 *Hystrichosphaeridium* cf. *multipilosum*. – Deunff: Microorganismes . . . , p. 25, Pl. 10, fig. 99, 100, 102.

1959 *Baltisphaeridium multipilosum*. – Eisenack: Neotypen . . . , p. 197, Pl. 15, fig. 9–12.

1962 *Baltisphaeridium multipilosum*. – Eisenack: Mitteilung . . . , p. 75.

- 1962 *Baltisphaeridium multipilosum*. – Eisenack: Mikrofossilien . . . , p. 359, Pl. 44, fig. 10, 11.
- 1964 *Baltisphaeridium multipilosum*. – Downie & Sarjeant: Bibliography . . . , p. 93.
- 1965 *Baltisphaeridium multipilosum*. – Eisenack: Die Mikrofauna . . . , p. 135, Pl. 11, fig. 9; non Pl. 12, fig. 14; Pl. 13, fig. 9.
- 1965 *Baltisphaeridium* cf. *multipilosum*. – Eisenack: Mikrofossilien . . . , p. 259, Pl. 22, fig. 11.
- 1968 *Baltisphaeridium multipilosum*. – Eisenack: Über die Fortpflanzung . . . , p. 6, Pl. 1, fig. 10.
- 1969 *Baltisphaeridium multipilosum*. – Górká: Microorganismes . . . , p. 28, Pl. 2, fig. 8, 11.
- 1969 *Baltisphaeridium multipilosum*. – Eisenack: Zur Systematik . . . , p. 250.
- 1969 *Baltisphaeridium* cf. *multipilosum*. – Henry: Micro-organismes . . . , p. 78, Pl. 3, fig. 16–17, 19.
- 1969 *Baltisphaeridium multipilosum*. – Konzalová-Mazanková: Acritarcha . . . , p. 86.

DIAGNOSIS. – "Zentralkörper kugelförmig, mit zahlreichen haarförmigen Anhängen bedeckt, die höchstens die Länge des Durchmessers erreichen, meistens jedoch kürzer sind und schliesslich recht kurz werden können, aber auch bei schwächerer Vergrösserung noch deutlich sichtbar sind. Pylome vorhanden, verhältnismässig eng." (Eisenack 1959.)

DESCRIPTION. – *Baltisphaeridium* sp. with thick, single walled, spherical, shagrinated vesicle. Excystment structure formed as a partial rupture. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Numerous processes, in length about 1/10 of vesicle diameter, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 85  $\mu$ ; process length: 8  $\mu$ ; process breadth (at the base): 1  $\mu$ ; process separation: 2  $\mu$ . Range: vesicle diameter: 70–86  $\mu$ ; process length: 7–8  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 1–3  $\mu$ . Specimen no.: 8.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 440.00–446.00 m, Middle Ordovician (Viruan). – Baltic erratics; Ordovician. – Frankenwald, Germany; Silurian. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. – Veryhac'h, France; Ordovician. Presqu'île de Crozon, France; Ordovician. – Bohemia; Upper Ordovician, Ashgill.

*Baltisphaeridium nanninum* EISENACK, 1965

Pl. 2, fig. 6.

- 1965 *Baltisphaeridium nanninum* EISENACK. – Eisenack: Mikrofossilien . . . , p. 260, Pl. 22, fig. 6–8.
- 1968 *Baltisphaeridium nanninum*. – Eisenack: Über die Fortpflanzung . . . , p. 7.
- 1969 *Baltisphaeridium nanninum*. – Eisenack: Zur Systematik . . . , p. 250.

DIAGNOSIS. – "Schale kugelig (auch flachgedrückt), mit äusserst feinen Tuberkeln bedeckt. Pylome als kreisförmige Öffnung." (Eisenack 1965.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Numerous hair-like processes, in length less than  $1\ \mu$ , closely distributed over the entire vesicle surface, homomorphic, simple with small bulbous distal terminations.

DIMENSIONS. – Vesicle diameter:  $95\ \mu$ ; process length:  $<1\ \mu$ . Range: vesicle diameter:  $92\text{--}101\ \mu$ . Specimen no.: 9.

REMARKS. – This species, hitherto only known from the Silurian (Eisenack 1965), is characterized in having a large vesicle and small knob-like distal terminations of the processes, the latter less than  $1\ \mu$  in length.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 440.00–441.00 m. Lower and Upper Visby Marl, Llandoverly, Silurian. Slite Group, Wenlock, Silurian. Hemse Group, Ludlow, Silurian. – Estland; Silurian erratics.

*Baltisphaeridium nanum* (DEFLANDRE) STOCKMANS & WILLIÈRE, 1962

Pl. 2, fig. 7.

- 1942 *Hystrichosphaeridium brevispinosum* var. *nanum*. – Deflandre: Les Hystrichosphères . . . , p. 476, fig. 1.
- 1958 *Hystrichosphaeridium hirsutoides*. – Downie: An assemblage . . . , Pl. 16, fig. 3.
- 1962 *Baltisphaeridium nanum* STOCKMANS & WILLIÈRE. – Stockmans & Willièrè: Hystrichosphères . . . , p. 54, Pl. 1, fig. 21, 22, 25.
- 1964 *Baltisphaeridium nanum*. – Downie & Sarjeant: Bibliography . . . , p. 93.
- non 1965 *Baltisphaeridium nanum* COOKSON. – Cookson: Cretaceous and Tertiary . . . , p. 89, Pl. 10, fig. 5–8.

- 1965 *Baltisphaeridium nanum*. – Martin: Les Acritarches du sondage . . . , p. 2, Pl. 1, fig. 10.
- 1965 *Baltisphaeridium nanum*. – Martin: Les Acritarches de Sart Bernard . . . , p. 3.
- 1967 *Baltisphaeridium nanum*. – Martin: Les Acritarches du Parc . . . , p. 309.
- 1968 *Baltisphaeridium nanum*. – Martin: Les Acritarches . . . , p. 58, Pl. 4, fig. 189; Pl. 7, fig. 332.

DIAGNOSIS. – "Le nom de *Baltisphaeridium brevispinosum* (EISENACK) s'applique à des corps sphériques de grande taille, ayant 50–70  $\mu$  de diamètre, pourvus d'appendices également robustes (55 à 80  $\mu$  avec appendices). Pour des spécimens du Gothlandien de la Montagne Noir, G. Deflandre a créé une variété *nanum* qui, à notre avis, mérite d'être élevée au rang d'espèce. Le corps sphérique porte d'assez nombreux processus épineux dont la longueur dans l'holotype ne dépasse pas la moitié du diamètre du corps central et est dans l'ensemble un peu moindre." (Stockmans & Willièrè 1962.)

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Faintly defined separation of the interior of the process from the vesicle cavity. Processes, about 24 in number, in length about 1/3 of vesicle diameter, psilate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 50  $\mu$ ; process length: 15  $\mu$ ; process breadth (at the base): 3  $\mu$ ; process separation: 10  $\mu$ . Range: vesicle diameter: 41–52  $\mu$ ; process length: 12–16  $\mu$ ; process breadth: 3  $\mu$ ; process separation: 8–11  $\mu$ . Specimen no.: 14.

REMARKS. – Since the name of *Baltisphaeridium nanum* already was proposed in 1962 by Stockmans & Willièrè, the name of the species *Baltisphaeridium nanum* COOKSON, 1965 should be changed. This latter species from the Tertiary of Australia differs fundamentally from *Baltisphaeridium nanum* STOCKMANS & WILLIÈRE, 1962.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 450.00–455.00 m, Middle Ordovician (Viruan). – Shineton, England; Lower Ordovician, Tremadocian. – Montagne Noire, France; Silurian. – Flandres, Tournaisis, Massif du Brabant, Condroz, Belgium; Ordovician, Arenig-Llanvirn, Upper Caradocian and Silurian. Borehole l'Asile d'Aliénés; Upper Devonian.

*Baltisphaeridium pachyacanthum* (EISENACK, 1963) n. nom., 1965  
Pl. 2, fig. 8.

- 1938 *Hystrichosphaeridium longispinosum* pars. – Eisenack: Hystrichosphärideen . . . , p. 12, Pl. 1, fig. 8, 9.
- 1951 *Hystrichosphaeridium longispinosum* pars. – Eisenack: Über Hystrichosphaerideen . . . , p. 188, Pl. 1, fig. 3, 4.
- non 1955 *Hystrichosphaeridium robustum* SANNEMANN. – Sannemann: Hystrichosphaerideen . . . , p. 331, Pl. 1, fig. 6–8, 9; Pl. 6, fig. 7, 8; textfig. 13.
- 1959 *Baltisphaeridium longispinosum* f. *robusta*. – Eisenack: Neotyphen . . . , p. 195, Pl. 15, fig. 2, 3, 5, 8.
- 1962 *Baltisphaeridium longispinosum* f. *robusta*. – Eisenack: Mikrofosilien . . . , p. 359.
- 1963 *Baltisphaeridium robustum*. – Eisenack: Mitteilung . . . , p. 212, Pl. 19, fig. 6, 7.
- 1965 *Baltisphaeridium pachyacanthum* n. nom. EISENACK. – Eisenack: Die Mikrofauna . . . , p. 134, Pl. 13, fig. 6, 7.
- 1965 *Baltisphaeridium robustum*. – Staplin, Jansonius & Pocock: Evaluation . . . , p. 191, Pl. 20, fig. 10.
- 1968 *Baltisphaeridium pachyacanthum*. – Eisenack: Über die Fortpflanzung . . . , p. 6, Pl. 1, fig. 7.
- 1969 *Baltisphaeridium pachyacanthum*. – Eisenack: Zur Systematik . . . , p. 251.
- 1969 *Baltisphaeridium pachyacanthum*. – Górka: Microorganismes . . . , p. 31, Pl. 3, fig. 1–3; Pl. 6, fig. 1; textfig. 7.

DIAGNOSIS. – "Die Schale ist recht derb und dickwandig, daher meist dunkel und ausgezeichnet kugelförmig und dunkelrotbraun. Die Anhänge sind ebenfalls derb, im Querschnitt drehrund und von der Kugel scharf abgesetzt. Verzweigung bzw. Gabelung der Anhänge ist nicht selten." (Eisenack 1959).

DESCRIPTION. – *Baltisphaeridium* sp. with thick, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 8 in number, in length almost equal to the vesicle diameter, psilate, cylindrical with axial thread structure in the hollow stem, homomorphic, simple with evexate distal terminations.

DIMENSIONS. – Vesicle diameter: 85  $\mu$ ; process length: 80  $\mu$ ; process breadth (at the base): 5  $\mu$ ; process separation: 30  $\mu$ . Range: vesicle diameter: 70–85  $\mu$ ; process length: 65–82  $\mu$ ; process breadth: 3–5  $\mu$ ; process separation: 24–31  $\mu$ . Specimen no.: 9.

REMARKS. – The diagnosis refers to the neotype material of *Baltisphaeridium longispinosum* f. *robusta*, subsequently declared by Eisenack (1965) as *Baltisphaeridium pachyacanthum* n. nom., since the name of the forma was changed in 1963 to specific status (*Baltisphaeridium robustum*) and this latter name already was occupied for Sannemann's species (see synonym list herein).

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 439.00–444.00 m, Middle Ordovician (Viruan). – Baltic erratics; Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. Ketrzyn Borehole No. 1, Poland; Ordovician, Llandeilo. Goldap Borehole No. 1, Poland; Ordovician, Caradocian.

*Baltisphaeridium paucispinum* n. sp.

Pl. 2, fig. 9.

DERIVATION OF NAME. – Latin: *pauci*, few; *spina*, spine. With reference to the few, widely distributed processes.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 14 in number, in length about 1/3 of vesicle diameter, widely distributed, psilate, conical, homomorphic, simple with bulbous distal terminations.

DIMENSIONS. – Vesicle diameter: 65  $\mu$ ; process length: 21  $\mu$ ; process breadth (at the base): 1  $\mu$ ; process separation: 20  $\mu$ . Range: vesicle diameter: 63–70  $\mu$ ; process length: 20–25  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 20–23  $\mu$ . Specimen no.: 9.

REMARKS. – The bulbous terminations of the processes differentiate *B. paucispinum* n. sp. from *B. hirsutoides* (EISENACK) var. *hamatum* DOWNIE, 1958, which latter variety possesses acuminate distal terminations.

HOLOTYPE. – SGU slide no. 430:2. Pl. 2, fig. 9.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 430.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 430.00–435.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium psilatum* n. sp.

Pl. 2, fig. 10.

DERIVATION OF NAME. – Latinized, *psilatus*, smooth. With reference to the psilate surface.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Faintly defined separation of the interior of the process from the vesicle cavity. Processes, about 23 in number, in length about 1/4–1/5 of vesicle diameter, psilate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 60  $\mu$ ; process length: 12  $\mu$ ; process breadth (at the base): 5  $\mu$ ; process separation: 14  $\mu$ . Range: vesicle diameter: 55–61  $\mu$ ; process length: 11–14  $\mu$ ; process separation: 14–15  $\mu$ . Specimen no.: 13.

REMARKS. – The curved proximal process contact with the vesicle, the greater number of processes and the broader process bases distinguish *B. psilatum* n. sp. from *B. hirsutoides*.

HOLOTYPE. – SGU slide no. 437:1. Pl. 2, fig. 10.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 437.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 435.00–439.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium ritvae* n. sp.

Pl. 2, fig. 11.

DERIVATION OF NAME. – After Ritva Kjellström.

DIAGNOSIS. – *Baltisphaeridium* sp. with thick, single walled, spherical, shagrinated vesicle with short characteristic process plugs. No excystment structure recorded. Curved proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 40 in number, in length about 1/7 of vesicle diameter, psilate, broad bases, conical, homomorphic, simple with bulbous distal terminations.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 10  $\mu$ ; process breadth (at the base): 5  $\mu$ ; process separation: 7  $\mu$ . Range: vesicle diameter: 64–77  $\mu$ ; process length: 7–11  $\mu$ ; process breadth: 5  $\mu$ ; process separation: 5–7  $\mu$ . Specimen no.: 14.

REMARKS. – This species is clearly distinguishable through its combination of thick vesicle wall, process plugs, bulbous terminations of the processes and great number of processes.

HOLOTYPE. – SGU slide no. 441:5. Pl. 2, fig. 11.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 441.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 441.00–442.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium trichophorum* (EISENACK, 1965) n. comb.  
Pl. 2, fig. 12.

1965 *Baltisphaeridium multipilosum* forma *trichophora* EISENACK. – Eisenack: Die Mikrofauna . . . , p. 135, Pl. 12, fig. 14.

DESCRIPTION. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. Excystment structure formed as a pylome. Curved proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 35 in number, in length about 1/7 of vesicle diameter, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 50  $\mu$ ; process length: 7  $\mu$ ; process breadth (at the base): 1  $\mu$ ; process separation: 5  $\mu$ . Range: vesicle diameter: 48–58  $\mu$ ; process length: 7–8  $\mu$ ; process breadth: 1  $\mu$ ; process separation: 4–6  $\mu$ . Specimen no.: 14.

REMARKS. – *Baltisphaeridium trichophorum* was originally treated as a forma of *B. multipilosum*. However, the broader bases of the processes, the thinner vesicle wall, the curved proximal process contact to the vesicle merit the forma to be ranked at a specific level.

OCCURRENCE. – Grötlingbo Borehole No. 1, 472.00–475.00 m, Lower Ordovician (Oelandian), Kunda, Valaste – Hunderum; Volkhov, Langevoja. – Baltic erratics; Ordovician.

*Baltisphaeridium triradiatum* n. sp.

Pl. 3, fig. 1.

DERIVATION OF NAME. – Latin: *tri*, three; *radius*, ray. With reference to the triradiate ornamentation on the vesicle.

DIAGNOSIS. – *Baltisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Triradiate, psilate ornamentation on the vesicle wall, each ridge about 35  $\mu$  in length and 7  $\mu$  in breadth. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 10 in number, in length about 1/3 of vesicle diameter, psilate, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 22  $\mu$ ; process breadth: 3  $\mu$ ; processes distributed irregularly so that no process separation can be measured. 2 specimens recorded.

REMARKS. – The triradiate ornamentation of the vesicle wall characterizes this species. The few specimens recorded have not revealed sufficient information in order to determine whether this ornamentation has morphographical affinities with haptotypic structures of miospores. The structural differentiation of the triradiate ridges (psilate) and the vesicle wall (shagrinated) excludes accidental fold structures.

HOLOTYPE. – SGU slide no. 445:1. Pl. 3, fig. 1.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 445.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 445.00 m. Middle Ordovician (Viruan).

*Baltisphaeridium verrucatum* n. sp.

Pl. 3, fig. 2.

DERIVATION OF NAME. – Latin: *verruca*s, wart. With reference to the warty ornamentation on the vesicle and process wall.

DIAGNOSIS. – *Baltisphaeridium* sp. with thick, double walled, spherical, verrucate vesicle. Large excystment opening formed as a partial rupture. Angular proximal process contact with the vesicle. Separation of the interior of the

process from the vesicle cavity (= cavity between outer and inner vesicle wall). Processes, about 16 in number, in length exceeding the vesicle diameter, broad bases, verrucate, conical, homomorphic, simple with evexate distal terminations.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 68  $\mu$ ; process breadth (at the base): 6  $\mu$ ; process separation: 25  $\mu$ . 3 specimens recorded.

REMARKS. – This species bears resemblance to *Baltisphaeridium longispinosum* (EISENACK) var. *klabavensis* VAVRDOVÁ by having a verrucate ornamentation on the vesicle and process walls. It differs, however, fundamentally in possessing an angular proximal process contact with the vesicle compared with the constricted process contact in *B. longispinosum* var. *klabavensis* and by having a double vesicle wall structure.

HOLOTYPE. – SGU slide no. 459:1. Pl. 3, fig. 2.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), Lasnamägi, Folkeslunda, 459.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 459.00 m. Middle Ordovician (Viruan), Lasnamägi, Folkeslunda.

*Baltisphaeridium* sp. A

Pl. 3, fig. 3.

DESCRIPTION. – *Baltisphaeridium* sp. with thin, double walled, spherical, psilate outer vesicle wall and shagrinata inner vesicle wall. No excystment structure recorded. Curved proximal process contact with the outer vesicle wall. No separation of the interior of the process with the outer vesicle wall. Processes, projecting from outer vesicle wall, about 13 in number, in length equal to the vesicle diameter, psilate, more translucent in nature than inner vesicle wall, conical, homomorphic, trabeculate structure inside the process wall, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 42  $\times$  48  $\mu$ ; process length: 47  $\mu$ ; process breadth (at the base): 3  $\mu$ . Specimen no.: 1.

REMARKS. – The trabeculate structure inside the processes is similar that of *Baltisphaeridium trabeculaespiniae* GÓRKA, 1969. It differs, however, strongly by its acuminate distal terminations of the processes (bulbous in Górká's species, absence of structural ornamentation on the process walls and by having

a double walled vesicle arrangement (double walled (?)) in Górká 1969, p. 39, textfig. 12).

MATERIAL. – SGU slide no. 472.00 m. Pl. 3, fig. 3.

OCCURRENCE. – Grötlingbo Borehole No. 1, 472.00 m. Lower Ordovician (Oelandian), Kunda, Valaste.

Genus *Goniosphaeridium* EISENACK, 1969 emend.

TYPE SPECIES. – Holotype (lost): *Goniosphaeridium (Ovum hispidum) polygonale* EISENACK, 1931, p. 113, Pl. 4, fig. 19. Neotype: *Goniosphaeridium (Baltisphaeridium) polygonale* EISENACK, 1931 in Eisenack 1959, p. 199, Pl. 16, fig. 8.

DIAGNOSIS. – "Paläozoische Hystrichosphären (Acritarcha), mit hohlen, mit dem Schalen-Innenraum in Verbindung stehenden, unverzweigten und am Ende stets geschlossenen, zugespitzten Anhängen, deren Zahl von 3 bis zu vielen betragen kann. Gelegentlich sind ein oder wenige Anhänge gegabelt. Die Wand ist stets dünn und nahezu glatt; ein Unterschied in Dicke und Ausbildung zwischen einer Zentralschale und Anhängen ist nicht vorhanden. Das Öffnen der Hüllen ist noch unbekannt." (Eisenack 1969.)

EMENDED DIAGNOSIS. – Unicellular, organic-walled microplankton with spherical to polygonal vesicle greater than 20  $\mu$ , not divided into fields or plates. Process interior communicates freely with vesicle cavity, the distal terminations of the processes always simple and closed. Walls psilate or shagrinata.

REMARKS. – This genus was proposed by Eisenack (1969) for species, whose processes always terminate by simple non-furcate distal ends and communicate freely with the vesicle cavity. In analogy with the diagnosis of *Baltisphaeridium* and *Micrhystridium* a size limit is necessary to be defined for genus *Goniosphaeridium* in order to distinguish this genus from *Micrhystridium*, which latter genus also comprises species with a free-communicating process/vesicle cavity system. Consequently, the generic diagnosis herein is emended to include reference to a minimum size limit of 20  $\mu$ .

*Goniosphaeridium conjunctum* n. sp.

Pl. 3, fig. 4.

?1966 *Baltisphaeridium longispinosum* (EISENACK, 1931). – Timofeev: Étude . . ., Pl. 33, fig. 6.

DERIVATION OF NAME. – Latin: *conjungere*, join. With reference to the free communication of the process cavity with the vesicle interior.

DIAGNOSIS. – *Goniosphaeridium* sp. with thin, single walled, polygonal, shagrinate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 15 in number, in length exceeding the vesicle diameter, shagrinate, broad bases, conical, homomorphic, simple with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 53  $\mu$ ; process length: 55  $\mu$ ; process breadth (at the base): 15  $\mu$ ; process separation: 15  $\mu$ . Range: vesicle diameter: 42–53  $\mu$ ; process length: 47–68  $\mu$ ; process breadth: 12–19  $\mu$ ; process separation: 14–21  $\mu$ . Specimen no.: 11.

REMARKS. – The smaller test, the shagrinate surface and the acuminate distal process terminations readily distinguish *Goniosphaeridium conjunctum* n. sp. from *G. polygonale* (EISENACK) EISENACK, 1969. *B. longispinosum* in Timofeev 1966 seems to possess one of these criteria, i. e. the acuminate distal ends, but since there is no description of this specimen indicating the vesicle dimension, a question-mark has been attributed to it.

HOLOTYPE. – SGU slide no. 435:1. Pl. 3, fig. 4.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 435.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 433.00–435.00 m. Middle Ordovician (Viruan).

*Goniosphaeridium connectum* n. sp.

Pl. 3, fig. 5.

DERIVATION OF NAME. – Latin: *connectere*, connect. With reference to the free communication between the process and the vesicle cavities.

DIAGNOSIS. – *Goniosphaeridium* sp. with thin, single walled, polygonal, psilate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 10 in number, in length not exceeding the vesicle diameter, psilate, broad bases, conical, homomorphic, simple with evexate and/or bulbous distal terminations.

DIMENSIONS. – Vesicle diameter: 42  $\mu$ ; process length: 30  $\mu$ ; process breadth (at the base): 7  $\mu$ ; process separation: 18  $\mu$ . Range: vesicle diameter: 40–45  $\mu$ ; process length: 29–36  $\mu$ ; process breadth: 5–8  $\mu$ ; process separation: 15–19  $\mu$ . Specimen no.: 8.

REMARKS. – *Goniosphaeridium connectum* n. sp. has close resemblance to *Baltisphaeridium polygonale* subsp. *polyacanthum* EISENACK, 1965 in Górká (1969, Pl. 2, fig. 7) with respect to the test dimension and general outline. It differs from this variety, however, by lacking an echinate ornamentation on the process wall.

HOLOTYPE. – SGU slide no. 425:1. Pl. 3, fig. 5.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), Skagen, 425.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 425.00–426.00 m. Middle Ordovician (Viruan), Skagen, Dalby.

Genus *Multiplicisphaeridium* STAPLIN, 1961  
restr. STAPLIN, JANSONIUS & POCOCK, 1965

TYPE SPECIES. – Holotype: *Multiplicisphaeridium ramispinosum* STAPLIN, 1961, p. 411, Pl. 48, fig. 24.

RESTRICTED DIAGNOSIS. – "Vesicles ellipsoidal, subspherical or spherical; processes separate, proximally slender, distally multifurcate, expanded, dissected, or otherwise modified, with closed tips; processes on one vesicle all of one kind or variations of one type, not differentiated into more orders or kinds of processes; wall smooth or with minor ornamentation; no differentiation between vesicle wall and processes; spine cavity in open connection with vesicle interior." (Staplin, Jansonius & Pocock 1965.)

REMARKS. – Genus *Multiplicisphaeridium*, first proposed by Staplin in 1961 for species with branched processes closed at their distal ends, was subsequently restricted by Staplin, Jansonius & Pocock (1965) to comprise species with processes, branched and closed at their distal ends, and whose cavities communicate directly with the vesicle interior. The restricted diagnosis is adopted in this contribution.

*Multiplicisphaeridium bifurcatum* STAPLIN, JANSONIUS & POCOCK, 1965  
Pl. 3, fig. 6.

1965 *Multiplicisphaeridium bifurcatum*. – Staplin, Jansonius & Pocock: Evaluation . . ., p. 182, Pl. 18, fig. 13.

1969 *Multiplicisphaeridium bifurcatum*. – Lister, Cocks & Rushton: The basement . . ., p. 602.

DIAGNOSIS. – "Vesicles subspherical, numerous semi-cylindrical spines, tapering at the distal end, branching into two tips (as a snake's tongue)." (Staplin, Jansonius & Pocock 1965.)

DESCRIPTION. – *Multiplicisphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 20 in number, in length about 1/3 of the vesicle, shagrinated, conical, homomorphic, bifurcate with acuminate distal terminations.

DIMENSIONS. – Vesicle diameter: 30  $\mu$ ; process length: 10  $\mu$ ; process breadth (at the base): 3  $\mu$ ; furca length: 1–3  $\mu$ ; process separation: 5  $\mu$ . Range: vesicle diameter: 28–31  $\mu$ ; process length: 10–11  $\mu$ ; process breadth: 2–3  $\mu$ ; furca length: 1–3  $\mu$ ; process separation: 4–5  $\mu$ . Specimen no.: 11.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 432.00–435.00 m, Middle Ordovician (Viruan). – Kent, England; Lower Ordovician, Arenig-Llanvirn. – Anticosti Island, Canada; Middle Ordovician.

*Multiplicisphaeridium continuatum* n. sp.

Pl. 3, fig. 7.

DERIVATION OF NAME. – Latin: *continuere*, continue. With reference to the free communication between the vesicle cavity and the process interior.

DIAGNOSIS. – *Multiplicisphaeridium* sp. with thin, single walled, polygonal, psilate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 8 in number, in length exceeding the vesicle dimension, psilate, cylindrical, homomorphic, furcate with acuminate distal terminations.

DIMENSIONS. – Vesicle dimension: 14  $\mu$ ; process length: 20  $\mu$ ; process breadth (at the base): 5  $\mu$ ; furca length: 6  $\mu$ ; process separation: 10  $\mu$ . Range: vesicle dimension: 13–19  $\mu$ ; process length: 20–25  $\mu$ ; process breadth: 5  $\mu$ ; furca length: 5–7  $\mu$ ; process separation: 9–12  $\mu$ . Specimen no.: 14.

REMARKS. – Although *Multiplicisphaeridium visbyense* (EISENACK, 1959) EISENACK 1969 constitutes a great number of variations, the small vesicle dimension of *M. continuatum* n. sp. merits this species to be separated from *M. visbyense*.

HOLOTYPE. – SGU slide no. 425:1. Pl. 3, fig. 7.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), Skagen, 425.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 425.00–427.00 m. Middle Ordovician (Viruan), Skagen, Dalby.

*Multiplicisphaeridium corallinum* (EISENACK, 1969)  
Pl. 3, fig. 8.

- 1959 *Baltisphaeridium corallinum* EISENACK. – Eisenack: Neotypen . . . , p. 201, Pl. 16, fig. 15, 16.
- 1964 *Baltisphaeridium corallinum*. – Downie & Sarjeant: Bibliography . . . , p. 89.
- 1965 *Baltisphaeridium corallinum*. – Eisenack: Mikrofossilien . . . , p. 263, Pl. 21, fig. 2; Pl. 24, fig. 7.
- 1968 *Baltisphaeridium corallinum*. – Martin: Les Acritarches . . . , p. 47, Pl. 3, fig. 158.
- 1969 *Baltisphaeridium corallinum*. – Martin: Sur l'âge . . . , p. 241.
- 1969 *Multiplicisphaeridium corallinum*. – Eisenack: Zur Systematik . . . , p. 259.

DIAGNOSIS. – "Zentralkörper kuglig, dünnwandig, mit  $\pm$  zahlreichen, weitlumigen, konisch-säulenförmigen Anhängen versehen, die sich mehrfach recht regelmässig dichotom, gelegentlich dreifach, in kurze, dickliche Zinken gabeln." (Eisenack 1959.)

DESCRIPTION. – *Multiplicisphaeridium* sp. with thin, single walled, spherical to subspherical, psilate vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 17 in number, in length less than vesicle diameter, psilate, cylindrical, homomorphic, furcate with evexate distal terminations.

DIMENSIONS. – Vesicle diameter: 63  $\mu$ ; process length: 30  $\mu$ ; process breadth (at the base): 15  $\mu$ ; furca length: 10  $\mu$ . Range: vesicle diameter: 58–65  $\mu$ ; process length: 30–33  $\mu$ ; process breadth: 12–15  $\mu$ ; furca length: 7–10  $\mu$ . Specimen no.: 9.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 439.00–444.00 m, Middle Ordovician (Viruan). – Baltic erratics; Silurian, Wenlock, Ludlow. – Belgium; Silurian, Upper Llandovery.

*Multiplicisphaeridium digitatum* (EISENACK, 1938)

Pl. 3, fig. 9.

- 1931 *Ovum hispidum* cf. *ramosum* EHRENBERG. – Eisenack: Mikrofossilien . . . , p. 112, Pl. 5, fig. 23, 24.
- 1938 *Hystrichosphaeridium digitatum* EISENACK. – Eisenack: Hystrichosphärideen . . . , p. 20, Pl. 4, fig. 3–5; textfig. 7.
- ? 1944 *Hystrichosphaeridium* cf. *digitatum*. – Deflandre: Microfossiles . . . , p. 19, Pl. 2, fig. 6 (incomplete specimen).
- 1959 *Baltisphaeridium digitatum*. – Eisenack: Neotypen . . . , p. 200, Pl. 16, fig. 10, 11.
- 1959 *Baltisphaeridium digitatum*. – Downie: Hystrichospheres . . . , p. 57, Pl. 11, fig. 1.
- 1964 *Baltisphaeridium digitatum*. – Downie & Sarjeant: Bibliography . . . , p. 89.
- 1965 *Baltisphaeridium digitatum*. – Eisenack: Mikrofossilien . . . , p. 262.
- 1965 *Baltisphaeridium digitatum*. – Eisenack: Die Mikrofauna . . . , p. 137, Pl. 13, fig. 5.
- 1967 *Baltisphaeridium digitatum*. – Martin: Les Acritarches du Parc . . . , p. 313, textfig. 4.
- 1968 *Baltisphaeridium digitatum*. – Eisenack: Mikrofossilien . . . , p. 91, Pl. 24, fig. 10, 11.
- 1968 *Baltisphaeridium digitatum*. – Martin: Les Acritarches . . . , p. 49, textfig. 6.
- 1968 *Baltisphaeridium digitatum*. – Cramer & Diez Cramer: Consideraciones . . . , p. 33, Pl. 16, fig. 57, 58.
- 1969 *Baltisphaeridium digitatum*. – Górká: Microorganismes . . . , p. 22, Pl. 1, fig. 2, 4, 6; textfig. 3.
- 1969 *Multiplicisphaeridium digitatum*. – Eisenack: Zur Systematik . . . , p. 259.

DIAGNOSIS. – "Schale dünnwandig, isodiametrisch, mit  $\pm$  zahlreichen Anhängen, die mit breiter Basis in die Schale übergehen und die am Ende 2 oder 3 kurze,

auseinandergespreizte Äste geteilt sind. Ab und zu kommt dichotome Verzweigung und auch nochmalige Gabelung vor. Die äussersten Spitze der Äste sind gelegentlich mit Schalensubstanz gefüllt." (Eisenack 1959.)

DESCRIPTION. – *Multiplicisphaeridium* sp. with thin, single walled, spherical to subspherical, shagrinated vesicle. No excystment structure recorded. Curved proximal process contact with the vesicle. Free communication between the process interior and the vesicle cavity. Processes, about 17 in number, in length about 1/3 of vesicle diameter, shagrinated, cylindrical, homomorphic, furcate with evexate distal terminations.

DIMENSIONS. – Vesicle diameter: 90  $\mu$ ; process length: 35  $\mu$ ; process breadth (at the base): 14  $\mu$ ; furca length: 7  $\mu$  (first order), 2–4  $\mu$  (second order). Range: vesicle diameter: 81–90  $\mu$ ; process length: 28–35  $\mu$ ; process breadth: 12–14  $\mu$ ; furca length: 5–7  $\mu$  (first order), 2–4  $\mu$  (second order).

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 434.00–435.00 m, Middle Ordovician (Viruan). – Baltic erratics; Ordovician and Silurian. – Estonia; Upper Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. – Belgium; Silurian, Upper Llandovery. – Wenlock Edge, England; Silurian, Wenlock. – Spain; Silurian, Lower Wenlock.

Genus *Orthosphaeridium* EISENACK, 1968 emend.

TYPE SPECIES. – Holotype: *Orthosphaeridium* (*Baltisphaeridium*) *rectangulare* EISENACK, 1963, p. 211, Pl. 20, fig. 1.

DIAGNOSIS. – "Zentralschale in der Aufsicht  $\pm$  rechteckig, im Querschnitt oval bis nahezu rechteckig, mit langen, divergierenden, hohlen und spitz zulaufenden, unverzweigten Fortsätzen, die verzugsweise an den Ecken sitzen und deren Hohlraum von dem der Schale abgeschlossen ist. Das Öffnen der Schale geschieht durch einen medianen Quer-Riss, der senkrecht zur langen Rechtecks-Seite steht." (Eisenack 1968.)

EMENDED DIAGNOSIS. – Unicellular, organic-walled microplankton with rectangular vesicles. Excystment structure always produced along a transversal suture line, median split, dividing the vesicle into two almost equal halves. Separation of the interior of the process from the vesicle cavity. Processes simple or furcate.

REMARKS. – The generic diagnosis is emended to include reference to furcate processes as indicated by *Orthosphaeridium trabeculatum* n. sp.

*Orthosphaeridium rectangulare* (EISENACK, 1963)

Pl. 3, fig. 10.

1963 *Baltisphaeridium rectangulare* EISENACK. – Eisenack: Mitteilung . . ., p. 211, Pl. 20, fig. 1–3, 10.

1968 *Orthosphaeridium rectangulare*. – Eisenack: Mikrofossilien . . ., p. 92, Pl. 25, fig. 1.

DIAGNOSIS. – "Zentralschale abgeflacht, in der Aufsicht nahezu rechteckig mit  $\pm$  ausgebauchten Seiten, mit 4 von den Ecken des Rechtecks ausgehenden, langen hohlen Anhängen versehen, die nahezu in einer Ebene liegen." (Eisenack 1963.)

DESCRIPTION. – *Orthosphaeridium* sp. with thick, single walled, rectangular, psilate vesicle. Transversel excystment structure (median split). Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, 4 in number, in length exceeding the vesicle dimension, psilate, conical, short interior basal plug structure in the process, homomorphic, simple with evexate distal terminations.

DIMENSIONS. – Vesicle dimension:  $40 \times 49 \mu$ ; process length:  $84 \mu$ ; process breadth (at the base):  $7 \mu$ ; process separation:  $40 \mu$  and  $49 \mu$ . Range: vesicle dimension:  $40 \mu$  ( $44 \mu$ )  $\times$   $45 \mu$  ( $53 \mu$ ); process length:  $71$ – $86 \mu$ ; process breadth:  $6$ – $7 \mu$ ; process separation: see vesicle dimensions.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 431.00–432.00 m, Middle Ordovician (Viruan). – Baltic erratics; Upper Ordovician.

*Orthosphaeridium trabeculatum* n. sp.

Pl. 3, fig. 11.

DERIVATION OF NAME. – Latin: *trabecula*, step. With reference to the step-like structure inside the processes.

DIAGNOSIS. – *Orthosphaeridium* sp. with thick, single walled, rectangular, psilate vesicle. Transversel excystment structure (median split). Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, 9 in number, in length not exceeding the vesicle dimension, psilate, trabeculate interior structure, conical, homomorphic, trifurcate.

DIMENSIONS. – Vesicle dimension:  $42 \times 48 \mu$ ; process length:  $40 \mu$ ; process breadth:  $3 \mu$ ; furca length:  $4 \mu$ . Range: vesicle dimension:  $36 \mu$  ( $43 \mu$ )  $\times$   $45 \mu$  ( $53 \mu$ ); process length:  $37\text{--}46 \mu$ ; process breadth:  $3 \mu$ ; furca length:  $2\text{--}4 \mu$ . Specimen no.: 7.

REMARKS. – The distinguishing features of *Orthosphaeridium trabeculatum* n. sp. are the trifurcate distal terminations of the processes and the trabeculate structure.

HOLOTYPE. – SGU slide no. 430:3. Pl. 3, fig. 11.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 430.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 430.00–431.00 m. Middle Ordovician (Viruan).

Genus *Peteinosphaeridium* STAPLIN, JANSONIUS & POCKOCK, 1965  
emend. EISENACK, 1969

TYPE SPECIES. – Holotype: *Peteinosphaeridium bergstromii* STAPLIN, JANSONIUS & POCKOCK, 1965, p. 194, Pl. 20, fig. 13.

EMENDED DIAGNOSIS. – "Schale kugelförmig, ziemlich fest, stets mit zahlreichen radialgestellten, langen, vollen oder hohlen, gleichartigen und gleichmässig verteilten Anhängen versehen, die am Ende geschlossen sind und sich dort in 2, 3 oder mehr  $\pm$  unregelmässig geformte und schräge nach aussen bis nahezu tangential gerichtete Gabelzinken verzweigen. Sekundär-Zinken kleineren Ausmasses können ebenfalls entwickelt sein. Zinken wie Radialstreben können mit  $\pm$  ausgedehnten Flügelsäumen versehen sein, die an den Streben herablaufen. Dock können die Säume bis zum Verschwinden reduziert sein, umgekehrt auch die Gabelung bei starker Entwicklung der Säume. Pylome (Normalpylome bzw. überhöhte Pylome) häufig." (Eisenack, 1969.)

*Peteinosphaeridium aequifurcatum* n. sp.  
Pl. 3, fig. 12.

DERIVATION OF NAME. – Latin: *aequus*, similar; *furca*, fork. With reference to the identical outline of the furcate distal ends of the processes.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, spherical to sub-spherical, psilate vesicle. No excystment structure recorded. Angular proximal

process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 10 in number, in length not exceeding the vesicle diameter, psilate, no peteinos, cylindrical, broader in the middle part of the process stem, homomorphic, bifurcate with acuminate furca-tips.

DIMENSIONS. – Vesicle diameter:  $53 \times 56 \mu$ ; process length:  $31 \mu$ ; process breadth (at the base):  $6 \mu$ ; furca length:  $10 \mu$  (large),  $7 \mu$  (small); Range: vesicle diameter:  $34 \mu$  ( $55 \mu$ )  $\times$   $45 \mu$  ( $60 \mu$ ); process length:  $26$ – $31 \mu$ ; process breadth:  $4$ – $6 \mu$ ; furca length:  $7$ – $10 \mu$ . Specimen no.: 6.

REMARKS. – This species is characterized by the large equal-sized furcae and the conspicuous broadening portion of the process stem.

HOLOTYPE. – SGU slide no. 432:2. Pl. 3, fig. 12.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 432.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 431.00–435.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium groetlingboensis* n. sp.

Pl. 4, fig. 1.

DERIVATION OF NAME. – After Grötlingbo. With reference to the locality Grötlingbo in Gotland.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 24 in number, in length about the radius of the vesicle, psilate, broad stem, cylindrical, homomorphic, furcate (bifurcate with two orders of furcae) with acuminate furca-tips.

DIMENSIONS. – Vesicle diameter:  $75 \mu$ ; process length:  $28 \mu$ ; process breadth:  $8 \mu$ ; furca length:  $12 \mu$  (first order),  $3 \mu$  (second order); process separation:  $10 \mu$ . Range: vesicle diameter:  $58$ – $77 \mu$ ; process length:  $26$ – $32 \mu$ ; process breadth:  $7$ – $10 \mu$ ; furca length:  $9$ – $12 \mu$  (first order),  $1$ – $3 \mu$  (second order); process separation:  $9$ – $12 \mu$ . Specimen no.: 14.

REMARKS. – The leading features of *Peteinosphaeridium groetlingboensis* n. sp. are the numerous broad, cylindrical processes and their furcate distal terminations of two orders.

HOLOTYPE. – SGU slide no. 432:4. Pl. 4, fig. 1.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 432.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 432.00–435.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium heteromorphicum* n. sp.

Pl. 4, fig. 2.

DERIVATION OF NAME. – Greek: *hetero*, dissimilar; *morphe*, body. With reference to the heteromorphic process arrangement.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, spherical, psilate vesicle. Excystment structure formed as a partial rupture. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 25 in number, in length about 1/3 of vesicle diameter, psilate, conical, heteromorphic, simple always with bulbous distal terminations and bifurcate with acuminate furca-tips.

DIMENSIONS. – Vesicle diameter: 74  $\mu$ ; process length: 20  $\mu$ ; process breadth (at the base): 6  $\mu$ ; furca length: 5  $\mu$ ; process separation: 13  $\mu$ . Range: vesicle diameter: 67–76  $\mu$ ; process length: 17–20  $\mu$ ; process breadth: 6  $\mu$ ; furca length: 4–6  $\mu$ ; process separation: 13–15  $\mu$ . Specimen no.: 9.

REMARKS. – A distinguishing quality of this species is the heteromorphic processes. The simple processes always are terminated by bulbous ends and the furcate processes possess acuminate tips.

HOLOTYPE. – SGU slide no. 454:2. Pl. 4, fig. 2.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 454.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 455.00–456.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium majorfurcatum* n. sp.

Pl. 4, fig. 3.

DERIVATION OF NAME. – Latin: *major*, large; *furca*, fork. With reference to the large furcae.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thick, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 18 in number, in length about 1/4 of vesicle diameter, psilate, cylindrical, homomorphic, bifurcate, the total length of the two furcae equal to the process stem length, acuminate furca-tips.

DIMENSIONS. – Vesicle diameter: 53  $\mu$ ; process length: 14  $\mu$ ; process breadth (at the base): 6  $\mu$ ; furca length: 7  $\mu$ ; process separation: 10  $\mu$ . Range: vesicle diameter: 53–61  $\mu$ ; process length: 13–15  $\mu$ ; process breadth: 6–7  $\mu$ ; furca length: 6–8  $\mu$ ; process separation: 10–12  $\mu$ . Specimen no.: 11.

REMARKS. – This species diverges from *Peteinosphaeridium nudum* (EISENACK, 1959) EISENACK, 1969 in having a thicker vesicle wall and larger bifurcation length.

HOLOTYPE. – SGU, slide no. 432:2. Pl. 4, fig. 3.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 432.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 426.00–432.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium majorvesiculum* n. sp.

Pl. 4, fig. 4.

DERIVATION OF NAME. – Latin: *major*, large; *vesicula*, vesicle. With reference to the large vesicle.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, spherical, psilate vesicle. Excystment opening formed as a partial rupture. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 30 in number, in length about 1/7 of vesicle diameter, psilate, cylindrical, homomorphic, furcate (bifurcate with two orders of furcae) with acuminate furca-tips.

DIMENSIONS. – Vesicle diameter: 105  $\mu$ ; process length: 15  $\mu$ ; process breadth (at the base): 7  $\mu$ ; furca length: 7  $\mu$  (first order), 2–3  $\mu$  (second order); process separation: 15–20  $\mu$ . Range: vesicle diameter: 101–111  $\mu$ ; process length: 14–16  $\mu$ ; process breadth: 6–8  $\mu$ ; furca length: 5–8  $\mu$  (first order), 1–3  $\mu$  (second order); process separation: 15–22  $\mu$ . Specimen no.: 10.

REMARKS. – The main characteristics of *Peteinosphaeridium majorvesiculum* n. sp. are the great vesicle dimension and the short, broad, furcate processes.

HOLOTYPE. – SGU slide no. 441:2. Pl. 4, fig. 4.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 441.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 440.00–444.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium nanofurcatum* n. sp.

Pl. 4, fig. 5.

DERIVATION OF NAME. – Latin: *nanum*, small; *furca*, fork. With reference to the small furcae.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Numerous processes, in length about 1/12 of vesicle diameter, psilate, lambda-shaped, homomorphic, bifurcate with bulbous furca-tips.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 6  $\mu$ ; process breadth (at the base): 1  $\mu$ ; furca length: 3  $\mu$ ; process separation: 5  $\mu$ . Range: vesicle diameter: 60–71  $\mu$ ; process length: 4–6  $\mu$ ; process breadth: 1  $\mu$ ; furca length: 1–3  $\mu$ ; process separation: 4–5  $\mu$ . Specimen no.: 6.

REMARKS. – The small, lambda-shaped, bifurcate processes are the significant and distinctive morphological marks of this species.

HOLOTYPE. – SGU slide no. 441:1. Pl. 4, fig. 5.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Middle Ordovician (Viruan), 441.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 441.00 m. Middle Ordovician (Viruan).

*Peteinosphaeridium nudum* (EISENACK, 1959)

Pl. 4, fig. 6.

- 1938 *Hystrichosphaeridium trifurcatum* pars. – Eisenack: Hystrichosphärideen . . ., p. 16, Pl. 2, fig. 13.
- 1951 *Hystrichosphaeridium trifurcatum* pars. – Eisenack: Über Hystrichosphaerideen . . ., p. 188, Pl. 2, fig. 5.
- 1959 *Baltisphaeridium trifurcatum* subsp. *nudum* EISENACK. – Eisenack: Neotypen . . ., p. 203, Pl. 17, fig. 4–6.
- 1962 *Baltisphaeridium trifurcatum* subsp. *nudum*. – Eisenack: Mikrofossilien . . ., p. 359.
- 1965 *Baltisphaeridium trifurcatum* subsp. *nudum*. – Eisenack: Die Mikrofauna . . ., p. 139.
- 1965 *Baltisphaeridium nudum*. – Staplin, Jansonius & Pocock: Evaluation . . ., p. 190, Pl. 20, fig. 2, 6–8; textfig. 12.
- 1968 *Baltisphaeridium trifurcatum* subsp. *nuda*. – Eisenack: Über die Fortpflanzung . . ., p. 7, Pl. 2, fig. 1.
- 1968 *Baltisphaeridium nudum*. – Martin: Les Acritarches . . ., p. 59, Pl. 3, fig. 152; Pl. 4, fig. 163.
- 1969 *Baltisphaeridium nudum*. – Górka: Microorganismes . . ., p. 32, Pl. 4, fig. 1–8; textfig. 8.
- 1969 *Peteinosphaeridium nudum*. – Eisenack: Zur Systematik . . ., p. 255.

DIAGNOSIS. – "Grösse und Form, besonders auch die Anhänge, wie bei *Baltisphaeridium trifurcatum* f. *typica*, doch Anhänge ohne Flügelsäume." (Eisenack 1959.)

DESCRIPTION. – *Peteinosphaeridium* sp. with thin, single walled, spherical, psilate vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the vesicle cavity. Processes, about 18 in number, in length about 1/3 of vesicle diameter, psilate, cylindrical, homomorphic, furcate with acuminate distal terminations. No peteinos along the process stem or furcae.

DIMENSIONS. – Vesicle diameter: 70  $\mu$ ; process length: 22  $\mu$ ; process breadth (at the base): 8  $\mu$ ; furca length: 4–8  $\mu$ ; process separation: 20–25  $\mu$ . Range: vesicle diameter: 65–73  $\mu$ ; process length: 20–25  $\mu$ ; process breadth: 8  $\mu$ ; furca length: 4–8  $\mu$ ; process separation: 20–25  $\mu$ . Specimen no.: 14.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland; 434.00–439.00 m, Middle Ordovician (Viruan). – Baltic erratics; Middle Ordovician. – Estonia; Middle Ordovician. – Belgium; Silurian. – Zembrak Borehole, Mielnik Borehole, Poland; Middle Ordovician.

*Peteinosphaeridium trifurcatum* (EISENACK, 1931)

Pl. 4, fig. 7.

- 1931 *Ovum hispidum trifurcatum* . – Eisenack: Mikrofossilien . . . , p. 112, Pl. 4, fig. 22, 23.
- 1937 *Bion* cf. *ramosum*. – Eisenack: Mikrofossilien . . . , p. 231, Pl. 16, fig. 5.
- 1938 *Hystrichosphaeridium trifurcatum*. – Eisenack: Hystrichosphärideen . . . , p. 16, Pl. 2, fig. 3, 5, 8, 9, 10, 11, 14; Pl. 3, fig. 1; textfig. 5.
- 1951 *Hystrichosphaeridium trifurcatum*. – Eisenack: Über Hystrichosphaerideen . . . , p. 188, Pl. 2, fig. 1, 2, 7.
- 1959 *Baltisphaeridium trifurcatum* f. *typica*. – Eisenack: Neotypen . . . , p. 202, Pl. 17, fig. 1–3, 11, 12.
- 1964 *Baltisphaeridium trifurcatum*. – Downie & Sarjeant: Bibliography . . . , p. 97.
- 1965 *Baltisphaeridium trifurcatum* subsp. *typica*. – Eisenack: Die Mikrofauna . . . , p. 138.
- 1965 *Peteinosphaeridium bergstromii*. – Staplin, Jansonius & Pocock: Evaluation . . . , p. 194, Pl. 20, fig. 12–14, 16–18.
- 1968 *Baltisphaeridium trifurcatum* subsp. *typica*. – Eisenack: Über die Fortpflanzung . . . , p. 7.
- non 1969 *Baltisphaeridium trifurcatum* subsp. *typicum*. – Górka: Mikroorganismes . . . , p. 24, Pl. 1, fig. 1, 5; textfig. 4.
- 1969 *Peteinosphaeridium trifurcatum*. – Górka: Mikroorganismes . . . , p. 51, Pl. 14, fig. 3, 5; textfig. 19.
- 1969 *Baltisphaeridium trifurcatum nudum*. – Lister, Cocks & Rushton: The basement . . . , p. 602.
- 1969 *Peteinosphaeridium trifurcatum*. – Eisenack: Zur Systematik . . . , p. 254.

DIAGNOSIS. – "Zentralschale ziemlich dickwandig, kugelförmig, mit  $\pm$  zahlreichen (bis sehr vielen) radial stehenden und meist recht gleich langen Anhängen versehen, die am Ende in 2 bis 4 (meist 3) seitwärts abgebogene, vielfach hakenförmig gestaltete, oft auch sekundäre Abzweigungen besitzende Zinken gegabelt sind. Diese sind oft senkrecht zum Träger gestellt, können mit ihm aber auch stumpfe Winkel (bis etwa  $120^\circ$ ) bilden. Träger und Gabelzinken sind mit  $\pm$  entwickelten Flügelsäumen ausgerüstet. Pyrome sind häufig mit rund 22 bis 35 % des Diameters." (Eisenack 1959.)

DESCRIPTION. – *Peteinosphaeridium* sp. with thin, single walled, spherical, shagrinated vesicle. No excystment structure recorded. Angular proximal process contact with the vesicle. Separation of the interior of the process from the ve-

sicle cavity. Processes, about 10 in number, in length about 1/3 of vesicle diameter, composed of one slender stem enveloped by a psilate peteinos, homomorphic, furcate.

DIMENSIONS. – Vesicle diameter: 60  $\mu$ ; process length: 20  $\mu$ ; process breadth (at the base including the peteinos): 6  $\mu$ ; furca length: 5–10  $\mu$ ; process separation: 25–30  $\mu$ . Range: vesicle diameter: 59–68  $\mu$ ; process length: 18–22  $\mu$ ; process breadth: 5–6  $\mu$ ; furca length: 5–10  $\mu$ ; process separation: 25–30  $\mu$ . Specimen no.: 6.

OCCURRENCE. – Grötlingbo Borehole No. 1, Gotland, 434.00–437.00 m, Middle Ordovician (Viruan). – Baltic erratics; Middle Ordovician. – Podborowisko Borehole No. 1, Poland; Lower Ordovician, Upper Arenig. – Kent, England; Lower Ordovician, Arenig-Llanvirn.

*Peteinosphaeridium velatum* n. sp.

Pl. 4, fig. 8.

DERIVATION OF NAME. – Latin: *velum*, veil. With reference to the veil ornament outside the process.

DIAGNOSIS. – *Peteinosphaeridium* sp. with thin, single walled, ellipsoidal, shagrinated vesicle. No excystment structure recorded. Angular proximal process stem contact with the vesicle. Separation of the interior of the process stem from the vesicle cavity. Processes, about 17 in number, in length about 1/3–1/4 of vesicle diameter, psilate, peteinos ornament along the entire process stem, each velate process containing three stems, filiforme, homomorphic, trifurcate.

DIMENSIONS. – Vesicle diameter: 41  $\times$  50  $\mu$ ; process length: 12  $\mu$ ; process breadth (including velum ornamentation): 6  $\mu$ ; process distance: 6  $\mu$ . 3 specimens recorded.

REMARKS. – *Peteinosphaeridium velatum* n. sp. differs from *P. trifurcatum* by its shorter processes always consisting of three filiforme process stems.

HOLOTYPE. – SGU, slide no. 472:1. Pl. 4, fig. 8.

TYPE LOCALITY AND TYPE STRATUM. – Grötlingbo Borehole No. 1, Gotland; Lower Ordovician (Oelandian), Kunda, Valaste, 472.00 m.

OCCURRENCE. – Grötlingbo Borehole No. 1, 472.00–473.00 m. Lower Ordovician (Oelandian), Kunda, Valaste – Hunderum.

STRATIGRAPHY

The classification of the Ordovician System is in a confusing state. In his review on the series of the Ordovician System Jaanusson (1960) has drawn attention to the large number of different definitions of the terms Lower, Middle, and Upper Ordovician. The frequent use of identical terms for different parts of the system has consequently led to a confusion, so great that sometimes it is difficult to know what part of the Ordovician that was actually referred to.

In order to prevent misunderstandings concerning the boundaries of the Ordovician, these have been defined in the present paper according to the Balto-Scandian terminology given in Table 1 (through the courtesy of Dr. V. Jaanus-

| SERIES                       | BALTO-SCANDIAN STAGES | TOPO-STRATIGRAPHIC DIVISIONS OF THE CORE | LEVELS IN THE CORE            | CORRELATION WITH THE GRAPTOLITIC SEQUENCE IN SCANIA  |
|------------------------------|-----------------------|--|-------------------------------|--|
| UPPER ORDOVICIAN (HARJUAN)   | Tommarp               | Dalmanitina ?                            |                               |  |
|                              | Jerrestad             | Jonstorp                                 |                               | <i>Dicellograptus complanatus</i>  |
|                              | Vasagaard             | "Fjäckå"                                 | 420.62                        |  |
| Slandrom                     |                       | 421.62                                   | <i>Pleurograptus linearis</i> |  |
| MIDDLE ORDOVICIAN (VIRUAN)   | Macrourus             | Macrourus                                | 423.80                        | <i>Dicranograptus clingani</i>   |
|                              | Skagen                | HIATUS                                   | 424.85                        |  |
|                              |                       | Skagen                                   |                               | 424.85   |
|                              |                       |  | 425.21                        |  |
|                              | Dalby                 | Dalby                                    |                               | <i>Nemagraptus gracilis</i>  |
|                              | Uhaku                 | Uhaku                                    |                               | <i>Glyptograptus teretiusculus</i>   |
|                              | Lasnamägi             | Folkeslunda                              |                               | TRANSITIONAL BEDS  |
|                              |                       | Seby                                     | 459.40                        |  |
|                              |                       | Skärlov                                  | 459.56                        |  |
|                              | Aseri                 |  | 460.87                        | <i>Didymograptus murchisoni</i>  |
| Segerstad                    |                       |  | 465.12                        |  |
| LOWER ORDOVICIAN (OELANDIAN) | Kunda                 | Aluoja                                   |                               | <i>Didymograptus bifidus</i>   |
|                              |                       | Valaste                                  |                               |  |
|                              |                       | Hunderum                                 | 472.25                        |  |
|                              |                       | Langevoja                                | 473.44                        | <i>Didymograptus hirundo</i>   |
|                              | Volkhov               | Limbata                                  |                               |  |
|                              |                       |  | 478.06                        |  |
|                              | Latorp                | Latorp                                   |                               | <i>Phyllograptus angustifolius elongatus</i><br><i>Phyllograptus densus</i><br><i>Didymograptus balticus</i><br><i>Tetragraptus phyllograptoides</i> |
|                              |                       |  |                               | 479.04   |
|                              |                       |  |                               |  |
|                              | ? Ceratopyge ?        | 479.46                                   |                               |  |
|                              | HIATUS                |  |                               |  |

Table 1. Ordovician stratigraphy and correlation of the Grötlingbo Borehole No. 1, Gotland.

son and Dr. R. Skoglund). A correlation of the Balto-Scandian stages with the graptolitic sequence is also presented in this table.

The occurrence of the baltisphaerids from the Ordovician of the Grötlingbo Borehole No. 1 in Gotland is presented in Table 2. Four major baltisphaerid assemblages can be distinguished. These assemblages, in the following named ASS.I, ASS.II, ASS.III and ASS.IV, fall within 475.00–472.00 m, 459.00–450.00 m, 446.00–439.00 m and 439.00–425.00 m, respectively.

ASS.I. – This assemblage is characterized by the presence of *Baltisphaeridium granosum* n. sp., *Baltisphaeridium macropylum*, *Baltisphaeridium trichophorum* nov. comb., *Baltisphaeridium* sp. A, and *Peteinosphaeridium velatum* n. sp. At present it is not possible to indicate whether *Baltisphaeridium* sp. A can be regarded as a significant element of ASS.I, since only one specimen has been recorded (at 472.00 m). None of the species in ASS.I has been encountered in other baltisphaerid assemblages.

ASS.II. – After a microfloral break at 471.00–460.00 m, probably due to sedimentary conditions (oxidizing environments, Männil & Jaanusson, personal communication, 1970), a second major baltisphaerid assemblage is composed of representatives of genus *Baltisphaeridium* and genus *Peteinosphaeridium*, i. e.: *Baltisphaeridium brevifilicum* n. sp., *Baltisphaeridium brevispinosum*, *Baltisphaeridium bulbosum* n. sp., *Baltisphaeridium constrictum* n. sp., *Baltisphaeridium filiosum* n. sp., *Baltisphaeridium latiradiatum*, *Baltisphaeridium longispinosum*, *Baltisphaeridium nanum*, *Baltisphaeridium verrucatum* n. sp., and *Peteinosphaeridium heteromorphicum* n. sp. *Baltisphaeridium brevispinosum* and *Baltisphaeridium longispinosum* are the only species of those mentioned which also occur in other associations (*B. brevispinosum* in ASS.III and *B. longispinosum* in ASS.III and in ASS.IV).

ASS.III. – This assemblage is distinctly separated from previous baltisphaerid assemblages by the following species: *Baltisphaeridium brevispinosum*, *Baltisphaeridium calicispinae*, *Baltisphaeridium* aff. *constrictum*, *Baltisphaeridium flagellicum* n. sp., *Baltisphaeridium longispinosum*, *Baltisphaeridium microspinosum*, *Baltisphaeridium multipilosum*, *Baltisphaeridium nanninum*, *Baltisphaeridium pachyacanthum*, *Baltisphaeridium ritvae* n. sp., *Baltisphaeridium triradiatum* n. sp., *Multiplicisphaeridium corallinum*, *Peteinosphaeridium majorvesiculum* n. sp. and *Peteinosphaeridium nanofurcatum* n. sp.

ASS.IV. – This baltisphaerid assemblage is clearly differentiated from earlier by the following microfloral elements: *Baltisphaeridium echinatum* n. sp., *Baltisphaeridium hirsutoides*, *Baltisphaeridium longispinosum*, *Baltisphaeridium paucispinum* n. sp., *Baltisphaeridium psilatum* n. sp., *Goniosphaeridium conjunctum* n. sp., *Goniosphaeridium connectum* n. sp., *Multiplicisphaeridium bifurcatum*, *Multiplicisphaeridium continuatum* n. sp., *Multiplicisphaeridium digitatum*, *Orthosphaeridium rectangulare*, *Orthosphaeridium trabeculatum* n. sp., *Peteinosphaeridium aequifurcatum* n. sp., *Peteinosphaeridium*



Sandstone    
 Marlstone with limestone intercalations    
 Bentonite  
 Limestone    
 Clay shale    
 Glauconite

THE OCCURRENCE OF BALTISPHAERIDS FROM THE ORDOVICIAN OF THE GRÖTLINGBO BOREHOLE No.1

G. Kjellström, 1970

Table 2. The occurrence of baltisphaerids from the Ordovician of the Grötlingbo Borehole No. 1, Gotland.

*groetlingboensis* n. sp., *Peteinosphaeridium majorfurcatum* n. sp., *Peteinosphaeridium nudum*, and *Peteinosphaeridium trifurcatum*.

The occurrence trend of the baltisphaerids indicates a flourishing algae period in the Grötlingbo biotope during Middle Ordovician (Viruan). Compared with the Lower Ordovician part of the core where 5 species were recorded, 38 species in total were encountered in the Middle Ordovician. As was the case at 471.00–460.00 m an extensive phytoplanktonic break is prevalent with the entrance of the Upper Ordovician (Harjuan). In this series only one species has been met with, namely *Baltisphaeridium longispinosum*. Although it is beyond the scope of this contribution to explain the possible influence of oxidizing environments to organic-walled phytoplankton, it should be noted that comparative baltisphaerid studies of the same strata from a continuous core drilled in När (20 km NE of Grötlingbo) have revealed the same profoundly marked planktonic break with the entrance of Upper Ordovician. On the other hand, equivalent strata not influenced by oxidizing conditions in Scania and Östergötland (southern and middle part of Sweden, respectively) yield a rich and well preserved phytoplanktonic flora (unpublished data of the present writer).

Summing up, the Grötlingbo biotope shows a microplanktonic dominance during Middle Ordovician (Viruan). Diagram 1 presents the variation in the occurrence of species of different genera. Species of genus *Baltisphaeridium* occur in all assemblages and show a maximum frequency peak in ASS.III and a frequency decrease in ASS.IV. Species of *Goniosphaeridium* and genus *Orthosphaeridium* do not appear until in ASS.IV. *Multiplicisphaeridium* starts in ASS.III and expands somewhat in ASS.IV. Species of *Peteinosphaeridium* are present in ASS.I, ASS.II, ASS.III, and not until ASS.IV does this genus reach its maximum.

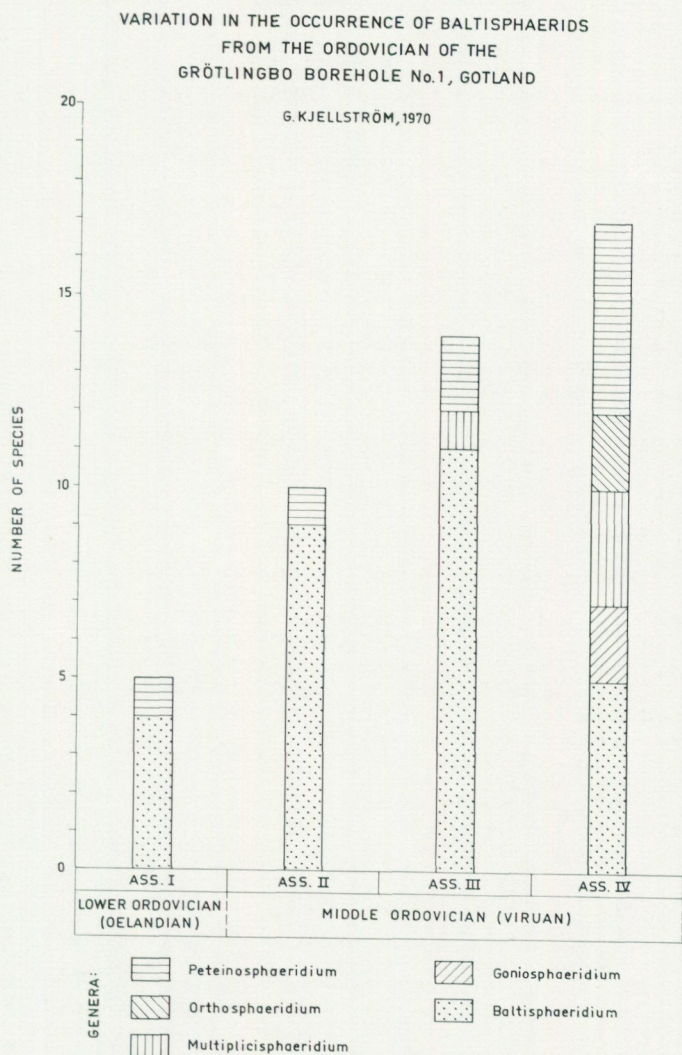


Diagram 1. Variation in the occurrence of baltisphaerids from the Ordovician of the Grötlingbo Borehole No. 1, Gotland.

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#### ADDENDUM

Recently, two publications have been issued dealing with baltisphaerids treated in the present contribution:

- MARTIN, F., MICHOT, P. & VANGUESTAINE, M., 1970: Le Flysch Caradocien d'Ombret. – Annales de la Société Géologique de Belgique, 93, II.
- PARIS, F. & DEUNFF, J., 1970: Le Paléoplancton Llanvirnien de la Roche-au-Merle. – Bull. Soc. géol. minéral. Bretagne, C, II, I.

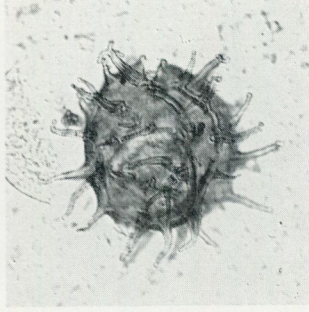
## Pl. 1

(280 X)

- Fig. 1. *Baltisphaeridium brevifilicum* n. sp., holotype  
Fig. 2. *Baltisphaeridium brevispinosum* (EISENACK, 1931)  
Fig. 3. *Baltisphaeridium bulbosum* n. sp., holotype  
Fig. 4. *Baltisphaeridium calicispinae* GÖRKA, 1969  
Fig. 5, 6. *Baltisphaeridium constrictum* n. sp., holotype (Fig. 6, 110×)  
Fig. 7. *Baltisphaeridium* aff. *constrictum*  
Fig. 8. *Baltisphaeridium echinatum* n. sp., holotype  
Fig. 9. *Baltisphaeridium filiosum* n. sp., holotype  
Fig. 10. *Baltisphaeridium flagellicum* n. sp., holotype  
Fig. 11. *Baltisphaeridium granosum* n. sp., holotype  
Fig. 12. *Baltisphaeridium hirsutoides* (EISENACK, 1951)



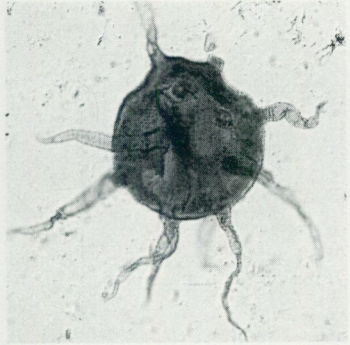
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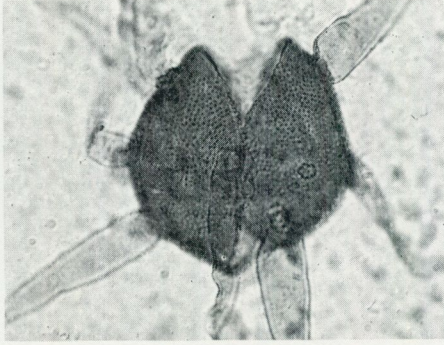
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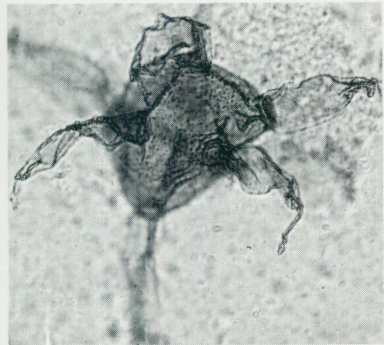
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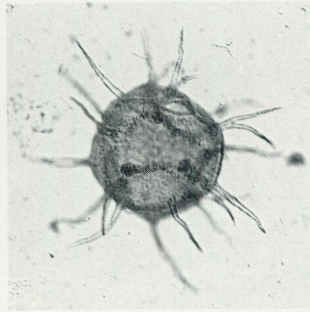
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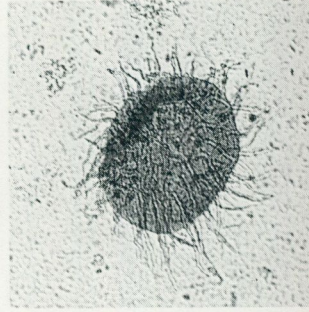
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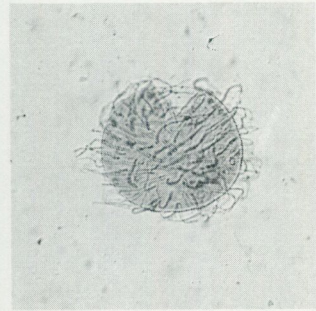
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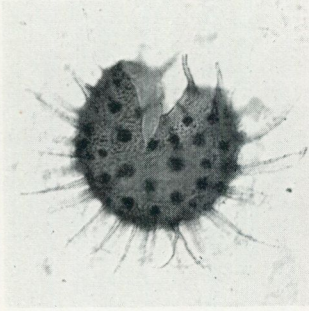
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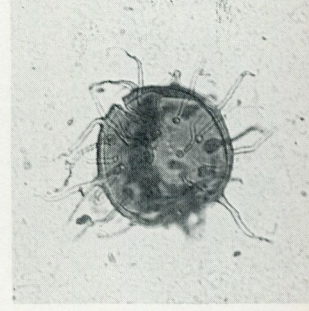
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## Pl. 2

(280 X)

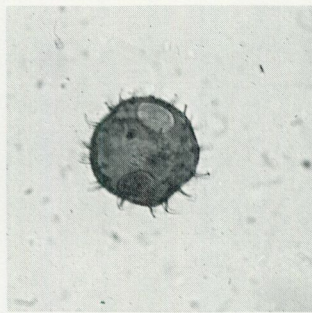
- Fig. 1. *Baltisphaeridium latiradiatum* (EISENACK, 1959)  
Fig. 2. *Baltisphaeridium longispinosum* (EISENACK, 1931)  
Fig. 3. *Baltisphaeridium macropylum* (EISENACK, 1959)  
Fig. 4. *Baltisphaeridium microspinosum* (EISENACK, 1954)  
Fig. 5. *Baltisphaeridium multipilosum* (EISENACK, 1931)  
Fig. 6. *Baltisphaeridium nanninum* EISENACK, 1965  
Fig. 7. *Baltisphaeridium nanum* (DEFLANDRE) STOCKMANS & WILLIÈRE, 1962  
Fig. 8. *Baltisphaeridium pachyacanthum* (EISENACK, 1963) n. nom., 1965  
Fig. 9. *Baltisphaeridium paucispinum* n. sp., holotype  
Fig. 10. *Baltisphaeridium psilatum* n. sp., holotype  
Fig. 11. *Baltisphaeridium ritvae* n. sp., holotype  
Fig. 12. *Baltisphaeridium trichophorum* (EISENACK, 1965) n. comb.



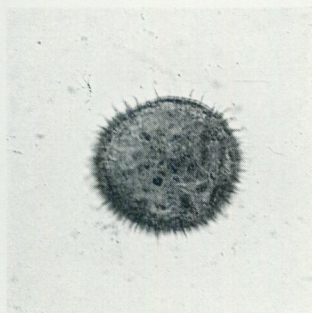
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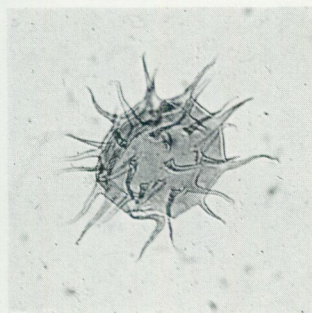
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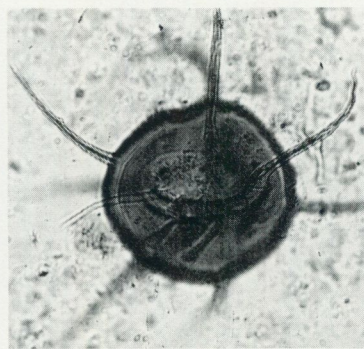
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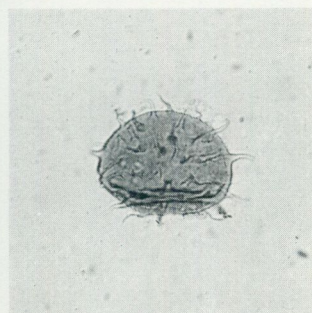
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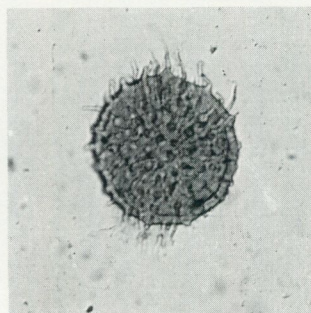
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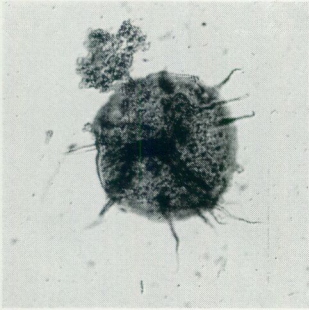


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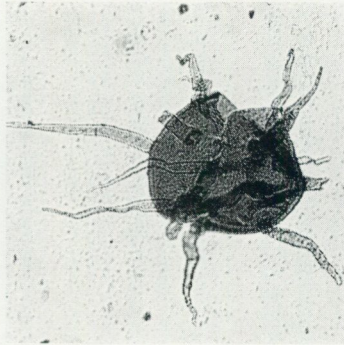
## Pl. 3

(280 X)

- Fig. 1. *Baltisphaeridium triradiatum* n. sp., holotype  
Fig. 2. *Baltisphaeridium verrucatum* n. sp., holotype  
Fig. 3. *Baltisphaeridium* sp. A  
Fig. 4. *Goniosphaeridium conjunctum* n. sp., holotype  
Fig. 5. *Goniosphaeridium connectum* n. sp., holotype  
Fig. 6. *Multiplicisphaeridium bifurcatum* STAPLIN, JANSONIUS & POCOCK, 1965  
Fig. 7. *Multiplicisphaeridium continuatum* n. sp., holotype  
Fig. 8. *Multiplicisphaeridium corallinum* (EISENACK, 1959)  
Fig. 9. *Multiplicisphaeridium digitatum* (EISENACK, 1938)  
Fig. 10. *Orthosphaeridium rectangulare* (EISENACK, 1963)  
Fig. 11. *Orthosphaeridium trabeculatum* n. sp., holotype  
Fig. 12. *Peteinosphaeridium aequifurcatum* n. sp., holotype



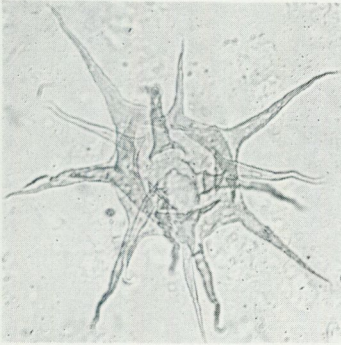
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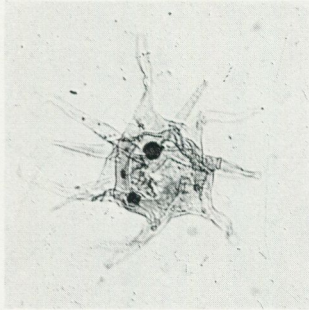
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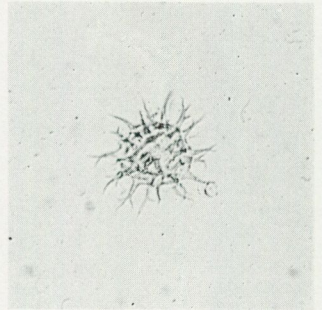
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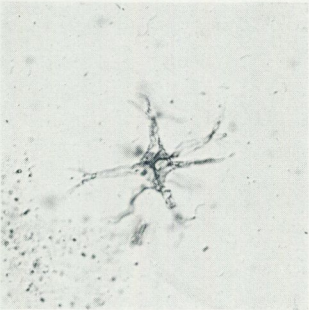
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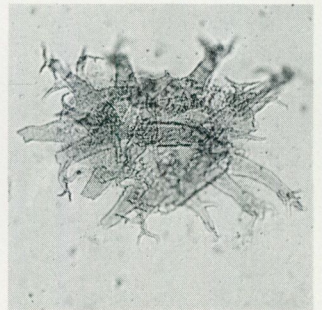
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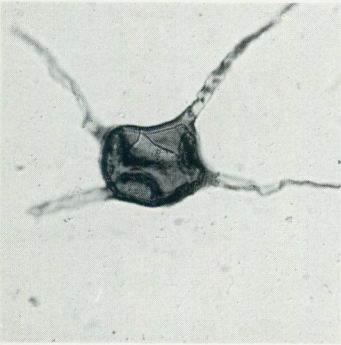
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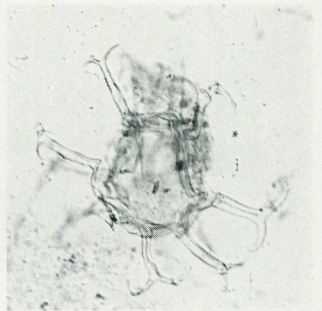
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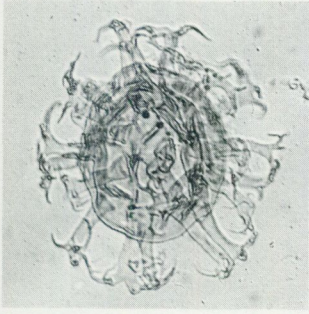


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Pl. 4

(280 X)

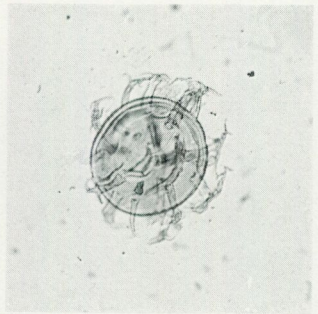
- Fig. 1. *Peteinosphaeridium groetlingboensis* n. sp., holotype  
Fig. 2. *Peteinosphaeridium heteromorphicum* n. sp., holotype  
Fig. 3. *Peteinosphaeridium majorfurcatum* n. sp., holotype  
Fig. 4. *Peteinosphaeridium majorvesiculum* n. sp., holotype  
Fig. 5. *Peteinosphaeridium nanofurcatum* n. sp., holotype  
Fig. 6. *Peteinosphaeridium nudum* (EISENACK, 1959)  
Fig. 7. *Peteinosphaeridium trifurcatum* (EISENACK, 1931)  
Fig. 8. *Peteinosphaeridium velatum* n. sp., holotype



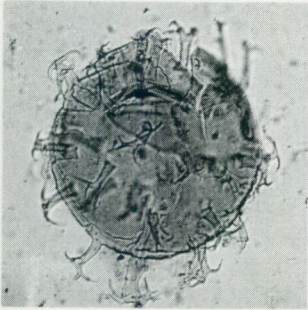
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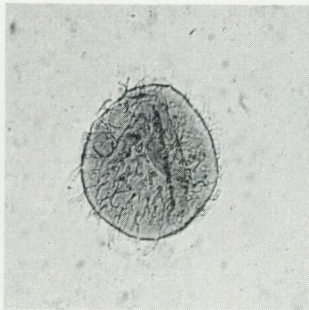
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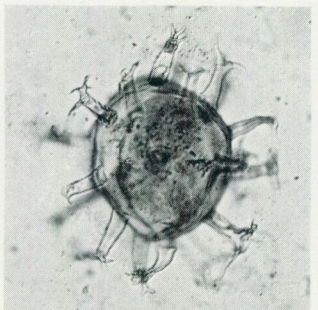
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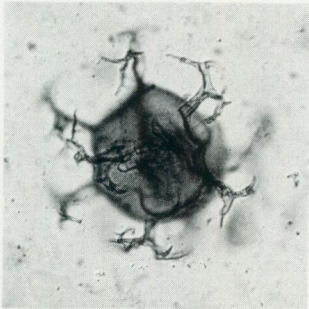
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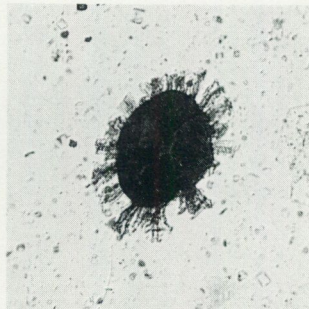
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