Taxonomic reconsideration of *Multiplicisphaeridium* Staplin, 1961 and other acritarch genera with branching processes

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ABSTRACT: The acritarch genus Multiplicisphaeridium, *originally proposed in 1961, has expanded in concept until it has come to embrace a great variety of morphologies. Its diagnosis is restricted herein to forms exhibiting at least two major orders of process branching. An emended diagnosis is proposed for the type species,* M. ramispinosum. *The other 262 species hitherto placed into this genus are reconsidered; 39 species are retained in* Multiplicisphaeridium *and 122 redistributed among 35 other acritarch genera. Seven other species are considered to be muellerisphaerids; two of these are formally transferred to the genus* Aldridgeisphaera, *the others being provisionally retained in* Multisplicisphaeridium. *The residue of species formerly placed in* Multiplicisphaeridium *have either been reattributed already to other acritarch genera, treated as taxonomic junior synonyms or shown to be invalid or of questionable validity.*

*As a consequence of this restudy, the diagnoses of eight other genera–*Ammonidium, Diexallophasis, Evittia, Lusatia, Petaloferidium, Tylotopalla, Unellium *and* Vogtlandia*–are emended and their species content critically reviewed. Three new genera–*Martinsphaeridium, Rhaetosphaeridium and Wicanderidium*–are proposed.*

This reorganization of species attributions is illustrated graphically; it gives a greater coherence to the stratigraphical ranges of the genera, those of Multiplicisphaeridium, Ammonidium *and* Martinsphaeridium *closely overlapping.*

1. Introduction

The genus *Multiplicisphaeridium* was erected by Staplin (1961, p. 411), primarily to accommodate elaborately spinose microfossils from the Upper Devonian oil-bearing strata of Alberta, Canada. Its diagnosis was broadly drawn: *Vesicle ellipsoidal to spherical; processes separate, narrow-based, tips multifurcate, expanded, dissected or otherwise modified but not open; processes all of one type or variations of one type, not differentiated into distinctive orders or kinds of processes; wall surface exclusive of processes laevigate to finely granulose.*

At this time, our knowledge of marine palynomorphs was still in its infancy and only a restricted number of genera of what were then styled 'hystrichospheres' had been described; indeed, Staplin listed only eight genera of Palaeozoic forms and commented that "it is fortunate that so few genera have been proposed" (1961, p. 403). Nevertheless, the breadth of Staplin's concept had the effect of eliminating one of those few genera. He wrote: *All species with simple unmodified spine tips are referred to* Micrhystridium.... *All species with broad-based processes that are an integral part of the vesicle shape are referred to* Veryhachium *Deunff. A new genus should be proposed for species with more than one order of processes, i.e., the different types of processes are distinct and have a constant spatial relationship to each other. (ibid.,* p. 410)

In consequence of the generic revision he was proposing, the genus *Baltisphaeridium* Eisenack (1958) was treated by Staplin as a junior synonym of the emended *Micrhystridium* (see Sarjeant and Stancliffe, 1994, p. 2, 23).

From the outset, Staplin's concepts attracted strong criticism. Eisenack (1962, p. 96) commented: *Now a partition of hystrichospheres with closed spine ends into those with unbranched and with branched appendages seems quite clear and straightforward, but Staplin has not allowed for their variability and overlooks the fact that he cannot hold the hystrichospheres to his 'scheme'.* [transl. in Norris and Sarjeant, 1965, p. 42]

After quoting examples of species that exhibited appendages partly unbranched, partly branched, Eisenack continued: *By division of the genus* Baltisphaeridium, *one also loses the contrast between it and the genus* Hystrichosphaeridium *[Deflandre, 1937]. This contrasts tube- to funnel-like appendages, open at the ends, with such as are closed at the ends. I see herein an important difference, which could relate to the question of the space which the enclosed protoplasm takes up. The behaviour of the appendages, whether divided or undivided, seems to be of secondary importance. (idem.)*

Downie and Sarjeant (1963, p. 85-86) criticized Staplin's concept of *Multiplicisphaeridium* at length and concluded: *There are thus a considerable number of species whose spine characters indicate a morphological position between forms having wholly simple spines and forms having multifurcate, expanded or dissected processes all of one type. The use of the structure of spine tips cannot be considered a satisfactory single criterion for determining generic assignment; the genus* Multiplicisphaeridium *would, if accepted, be an agglomeration of end members of numerous evolutionary trends rather than the focus of a morphological grouping. All, or nearly all, existing genera have been established in the view that they have generic meaning and express natural groupings: the discovery of overlap with other genera at the extreme limits of their morphological spread does not necessarily invalidate this view. In the case of* Multiplicisphaeridium, *such a view cannot be held even at the inception. We propose therefore that the genus be abandoned....*

However, a major change in the understanding of marine palynomorphs was taking place, even while their paper was in press. During that year, Evitt (1963) demonstrated that the typical hystrichospheres showed features proving that they were, in fact, cysts of dinoflagellates. For the spinose organic-walled microfossils not showing such features, he proposed the name 'acritarch' to indicate the continuing uncertainty concerning their affinity. This meant that a large number of the genera and species that had caused conceptual problems for the critics of Staplin's work were no longer threatened by it. However, when Downie, Evitt and Sarjeant (1963) proposed an informal classification of the acritarchs, the genus *Multiplicisphaeridium* was deliberately not listed.

Consequently, when Staplin, Jansonius and Pocock (1965) published an evaluation of what they termed 'acritarchous

hystrichospheres', they felt it necessary to defend Staplin's concept. They noted that several species, obviously not related to the type species of *Multiplicisphaeridium*, had nonetheless been assigned to the genus. However, they did not perceive this as a problem, writing (*ibid.*, p. 117): *...such forms eventually will be assigned to new genera. By this procedure* Multiplicisphaeridium... *will progress from a collective genus to a smaller but biologically more closely knit unit.* Staplin (1961) expressed his anticipation of this, and also stated clearly that another new genus ought to be erected "for those species with more than one order of processes". Eisenack seems to have overlooked these remarks and made objection–correctly–to a wholesale transfer of all species of *Baltisphaeridium* to either *Micrhystridium* or *Multiplicisphaeridium*.

Although endorsing Eisenack's objection, Staplin *et al.* defended the expanded concept of *Micrhystridium* and also criticized the views of Downie and Sarjeant (1963), writing that their objection to *Multiplicisphaeridium* was that: *...the diagnosis allows inclusion of obviously unrelated forms. This reflects an unfortunate misunderstanding. The type species,* Multiplicisphaeridium ramispinosum, *has complex ramose spines, the cavities of which communicate freely with the vesicle interior; the genus can stand on its name bearer, regardless of (anticipated) future changes in concepts. Classification of acritarchous hystrichospheres at present suffers from a need of valid genera based on properly described types, more than from too many inseparable genera. Virtually all genera now in the literature now may expect to be drastically restricted in future years.* (Staplin *et al.*, 1965, p. 177)

An inception for this process was their own proposal of a 'restricted' diagnosis for *Multiplicisphaeridium* itself: *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.* (*ibid.*, p. 180)

Moreover, they reversed their position on *Baltisphaeridium*, now accepting it under a diagnosis which was likewise 'restricted' (*ibid.*, p. 188).

In the years that have followed, the three genera *Baltisphaeridium*, *Micrhystridium* and *Multiplicisphaeridium* have continued to be employed by palynologists, but their diagnoses have undergone repeated revision. At the same time, many new genera of Palaeozoic acritarchs have been erected. The first two genera have been discussed at length by Eiserhardt (1989) and Sarjeant and Stancliffe (1994), but *Multiplicisphaeridium* remains a focus for controversy.

The first emendation of *Multiplicisphaeridium* was proposed by Eisenack himself (1969, p. 258): *Palaeozoic hystrichospheres (Acritarcha) with hollow appendages, their cavities linked to the shell interior, branching and having tips always closed, whose number ranges from four upwards. Sometimes one or a few appendages may be unbranched. The wall is always thin and nearly smooth; there are no differences in thickness and structure between a central shell and the appendages.* [new transl.]

A second emendation was proposed by Lister (1970, p. 83): *Vesicle hollow, spherical to ellipsoidal, single-walled; processes with closed tips, heteromorphic simple or compound branching, wall smooth or with minor ornamentation; no differentiation between vesicle wall and processes; process cavity in open connection with vesicle interior. Excystment by cryptosuture, apical or near-equatorial.*

The new feature here was the reference to the mode of excystment. Lister's diagnosis was accepted by Turner (1984) and quoted word-for-word; Fensome *et al.* (1990, p. 338) were incorrect in citing his work as constituting a further emendation. The content of *Multiplicisphaeridium* was discussed, and compared with that of other genera, by Le Hérissé (1989, p. 158-159) but he formulated no new proposals.

The most recent emendation was by Eiserhardt (1992, p. 49): *Acanthomorphic acritarchs with distally closed ramifying hollow processes, whose cavity is connected to the interior of the vesicle. Processes are sharply to sufficiently clearly distinct from the vesicle so that a definite central body* sensu strictu *is formed. The membrane of the processes and vesicle are–except for micro-ornamental differences–identical. Widening up to the occlusion, a polygonalmorphitic central region of the resultant bases is enclosed.* [new transl.]

This concept shows general accord with our own proposals; however, the morphology is defined in lesser detail and no reference is given to vesicle openings.

Over the years, a number of other genera have been described, only to be subsequently cited as junior synonyms of *Multiplicisphaeridium*; these are listed in full by Fensome *et al.* (*ibid.*, p. 339). Other genera have been set up which, though differing in definition from *Multiplicisphaeridium*, overlap the concepts embodied in its various diagnoses; some of these gain mention, and are given summary description, by Eiserhardt (1992, p. 49).

Presently some 164 species are retained in the genus, embracing a great variety of morphologies. During the second author's visit to Prague in June 1995, we considered together the possible redefinition of the genus to make it stratigraphically and morphologically more meaningful. Following this revision, 99 species formerly placed into *Multiplicisphaeridium* are reattributed to no less than 35 other genera. (Three species have been placed by earlier authors into *Multiplicisphaeridium* which do not even exhibit any branching of the processes!) The consequence is to make *Multiplicisphaeridium* a more coherent and stratigraphically meaningful taxonomic entity.

2. Systematics

In the following sections, the holotypes are distinguished not by citation of specimen number, but by indication of the illustration presented by the original authors or first revisers.Additional illustrations of the same species, even if provided by the original author or reviser, are not specified; details of these can be found in Fensome *et al.* 1990.

It should be noted that, according to Article 10.1 of the *International Code of Botanical Nomenclature* (Greuter *et al.* 1994): "The type of the name of a genus or of any subdivision of a genus is the type of a name of a species" but that "for purposes of designation or citation of a type, the species name alone suffices." In the text that follows, the words "type species" are used as short-hand for the purpose of typifying genera. In the few cases where the type of a genus has been transferred to a previously named species, of which the original species is considered a taxonomic junior synonym, the type of the genus is specified separately.

Group ACRITARCHA Evitt 1963
Subgroup ACANTHOMORPHITAE Downie, Evitt and Sarjeant 1963

Genus *Multiplicisphaeridium* Staplin 1961, p. 410, **emend. nov.**

Multiplicisphaeridium Staplin 1961, p. 410; Downie and

Sarjeant 1964, p. 173; Norris and Sarjeant 1965, p. 42; emend. Staplin, Jansonius and Pocock, 1965, p. 180; emend. Eisenack 1969, p. 258-259; Cramer 1970, p. 47; emend. Lister 1970, p. 83; Eisenack, Cramer and Díez Rodriguez 1973, p. 519-520; Turner 1984, p. 120; Le Hérissé 1989, p. 158-159; Fensome *et al.* 1990, p. 338-339; emend. Eiserhardt 1992, p. 49.

Original diagnosis: (Staplin 1961, p. 411) "Vesicle ellipsoidal to spherical; processes separate, narrow-based, tips multifurcate, expanded, dissected or otherwise modified but not open; processes all of one type or variations of one type, not differentiated into distinctive orders or kinds of processes; wall surface exclusive of processes laevigate to finely granulose."

Emended diagnosis: Vesicle hollow, spheroidal to broadly ellipsoidal, single-walled or apparently so. Processes hollow, ranging in number between six and twenty; the process cavity communicates directly with the vesicle interior. The processes are distributed uniformly on the vesicle, showing no topographic preference, and have stems arising at right-angles from the eilyma. The length of the processes typically exceeds 50% of the vesicle diameter; their morphology may be relatively uniform or highly variable, sometimes including one or a few unbranched processes. Process bases not normally inflated. Process stems of constant thickness or tapering only slightly between the base and the point of initial branching. First order branching occurs at half to three-quarters of the process length, the process typically dividing into two to four principal branches. These, in turn, undergo second order branching or ramification at their distal extremity. The secondary branches are short, but may display third order division into branchlets; however, they are not interconnected by trabeculae or enclosed by an ecteilymal cloak. Surface of eilyma laevigate or with reduced ornamentation, without septae, ridges or fine spinelets. Opening of vesicle by cryptosuture.

Remarks: The genus is emended to comprise forms with relatively long and elaborately branched processes, most often exhibiting two to three orders of branching; this revision accords with, but extends, that formulated by Eiserhardt 1992. Species having numerous processes that are hollow, but separated from the vesicle interior by a proximal plug, are attributable to *Excultibrachium* Loeblich Jr. and Tappan 1978; however, this feature may be difficult to discern in some specimens. Species having a thick eilyma composed of two layers, the processes formed only from the thin outer layer, are placed into *Leptobrachion* Dorning 1981 (**illustrated herein, Pl. II fig. 7**) or *Ordovicidium* Tappan and Loeblich 1971 (**illustrated herein, Pl. IV fig. 6**). If the process bases are plugged, the species are placed into *Oppilatala* Loeblich Jr. and Wicander 1976. If the eilyma is thin, but nevertheless separates the processes from the vesicle interior, and the processes taper to mid-point, then expand into an elaborately branched termination whose orders of branching are hard to distinguish, these features identify the genus *Paniculaferum* Miller 1991. Species having slender processes, branching only at a position very close to their distal extremities, are placed either into *Ammonidium* Lister 1970, as herein emended, or into a new genus, *Martinsphaeridium* proposed herein. Species exhibiting a positional arrangement of processes about an apical opening, may be attributable to *Cymbosphaeridium* Lister 1970 if few in number and showing a definite arrangement. Other species having shorter processes in limited number and of special character, are placed into appropriate genera later in this paper, as are forms whose processes exhibit distal linkage by trabeculae or an enclosing membrane.

Type species: Multiplicisphaeridium ramispinosum Staplin 1961, p. 411, pl. 48, fig. 24; text-figs. 9g-h, emend. Sarjeant and Vavrdová, herein. Late Devonian, Alberta, Canada.

Multiplicisphaeridium ramispinosum Staplin 1961, emend.
Pl. I figs. 1-4; Text-figs. 1, 2d

1961 *Multiplicisphaeridium ramispinosum* Staplin, p. 411, pl. 48, fig. 24, text-figs. 9g-h.
1964 *Baltisphaeridium ramispinosum* (Staplin) Downie and Sarjeant, p. 93.
1965 *Multiplicisphaeridium ramispinosum* Staplin - Staplin, Jansonius and Pocock, fig. 8.
1971 *Multiplicisphaeridium ramishinosum* [*sic*] Staplin - Pöthe de Baldis, p. 284, 286, pl. 1 fig. 2.
1974 *Multiplicisphaeridium ramusculosum* (Deflandre) - Anan-Yorke, p. 116-117, pl. 19 figs. 3, 4, 9; pl. 20 fig. 6.
1974 *Multiplicisphaeridium ramusculosum* (Deflandre) - Pöthe de Baldis, p. 314, pl. 4 figs. 3, 5.
1974 *Multiplicisphaeridium ramispinosum* Staplin - Pöthe de Baldis, p. 371, pl. 3 figs. 6-7.
1977 *Multiplicisphaeridium ramispinosum* Staplin - Nautiyal, p. 56, pl. 1 figs. 1, 9, 10.
1979 *Multiplicisphaeridium ramispinosum* Staplin - Eisenack, Cramer and Diéz, p. 35-36, figs. a-d.
1981 *Multiplicisphaeridium ramispinosum* Staplin - Martin, p. 25-26, pl. 7 figs. 5, 6, 11, 14 (non figs. 9, 12).
1981 *Multiplicisphaeridium ramusculosum* (Deflandre) - Deunff, p. 68, pl. 3 fig. 6.
1981 *Multiplicisphaeridium ramusculosum* (Deflandre) - Playford and Dring, p. 48, pl. 12 figs. 9-10.
1983 *Multiplicisphaeridium ramusculosum* (Deflandre) - Kimyai, p. 419, pl. 2-3.
1983 *Multiplicisphaeridium ramispinosum* Staplin - Wicander, p. 56.
1984 *Multiplicisphaeridium ramispinosum* Staplin - Amirie, p. 48-49, pl. 8 figs. 4-9.
1985 *Multiplicisphaeridium ramispinosum* Staplin - Wicander and Playford, p. 114, pl. 5 figs. 3-6.
1990 *Multiplicisphaeridium ramispinosum* Staplin - Colbath, p. 124-125, pl. 10 fig. 8.
1990 *Multiplicisphaeridium ramispinosum* Staplin - Fensome *et al.*, p. 353.
1993 *Multiplicisphaeridium ramispinosum* Staplin - Playford and McGregor, pl. 17, pl. 5 figs. 6-7.
non 1969 *Baltisphaeridium ramispinosum* (Staplin) - Martin, p. 61, pl. 6 fig. 280.

Original Diagnosis. "Vesicle subcircular: processes generally bifurcate, each branch again bifurcate or trifurcate, tips multiple: processes usually twelve in number (0-15 microns long; vesicle size 19-29 microns)." (Staplin 1961, p. 411)

Emended Diagnosis. A species of *Multiplicisphaeridium* having a low number of processes (9-14). Processes of varied form; some branch symmetrically or asymmetrically at around half length, thereafter again bifurcating and having irregularly bifid or trifid tips, while others are distally asymmetrically trifurcate, their branchlets ramifying in variable fashion. Surface of eilyma laevigate or with reduced ornamentation.

Holotype. Imperial Bistcho Lake No. 7-7, 7-7-124-2, now lodged in the collections of the Geological Survey of Canada, Calgary, Alberta. Staplin (1961, p. 48, fig. 24).

Type Horizon and Locality. Duvernay Member, Woodbend Formation (Upper Devonian) at 159-164 ft. depth, Imperial Bistcho Lake borehole, central Alberta, Canada.

Dimensions. Holotype: diameter of vesicle 29 m, length of processes ca. 12-14 m. Range: diameter of vesicle 19-29 m, length of processes 10-15 m.

Discussion. The emendation represents an expansion of the original diagnosis, stressing the variability in process form. The taxonomic distinctiveness of this species has been questioned by Playford and Dring (1981, p. 48) who, in describing forms from the Australian Late Devonian, wrote: *"The type species,* Multiplicisphaeridium ramispinosum... *might well be absorbed in a* sensu lato *interpretation of* M. ramusculosum *similar to that adopted here."*

The specimens they illustrated did indeed accord with Staplin's concept of *M. ramispinosum.* Their view was echoed by Lu Lichang and Wicander (1988, p. 125) who, in placing forms from the Late Devonian of China into *Multiplicisphaeridium* (al. *Hystrichosphaeridium*) *ramusculosum* Deflandre 1945, noted that: *A broad interpretation of* Multiplicisphaeridium ramusculosum *is adopted to include the type species* Multiplicisphaeridium ramispinosum *Staplin...."*

However, this was not a formal taxonomic proposal, nor has this concept been adopted by other authors. For example, Colbath (1990, p. 125) noted that: *"Deflandre's... drawings of the holotype clearly indicated lateral spines projecting from the processes. Such lateral spines are lacking in most specimens which have been assigned to* M. ramusculosum."

Moreover, other differences appear to separate the species, as discussed below.

The generic placement of *M. ramusculosum* has been questioned. Dorning (1981, p. 196) transferred that species to the genus *Oppilatala* Loeblich and Wicander 1976. However, though the transfer was correctly made (see Fensome *et al.* 1990, p. 353, 373), the combination *Oppilatala ramusculosa* has not been utilized by other authors and is not adopted herein, for two reasons: first, that the type material does not exhibit a distal tapering of the tubular processes; and secondly, that the eilyma does not show a clear division into two layers.

Nevertheless, Dorning's proposal may have some merit. Another characteristic of *Oppilatala* is that the bases of its processes are plugged and their cavities not linked directly with the vesicle interior. Utilizing information furnished by M.A. Miller, Colbath (1990, p. 125) suggested that the processes of Deflandre's species might have plugged bases and might properly belong in some other genus (presumably *Excultibrachium* Loeblich Jr. and Tappan 1978). Consequently, he expressed the view that: "Multiplicisphaeridium ramusculosum *sensu stricto may... be limited to a narrow stratigraphic interval within the Silurian, and the name should not be used for specimens such as those considered here."*

There is certainly a high degree of confusion in the application of the specific epithets *'ramusculosum'* and *'ramispinosum'*. If, upon re-examination of Deflandre's type material, the former species does indeed prove attributable to *Excultibrachium*, then the bulk of other records of *ramusculosum* will require rescrutiny. Presently, the two species appear capable of differentiation by four criteria:

i. The number of processes is lower in *M. ramispinosum.* Martin (1981, p. 25-26), on the basis of her examination of more than a thousand specimens, gives it as 9-14, typically 12, which accords with our own observations.
ii. The levels at which the processes begin to ramify in *M. ramispinosum* range from mid-length to extreme distal; in *M. ramusculosum*, ramification only occurs at a position closer to the distal extremity.
iii. The type material of *M. ramusculosum* exhibits some simple, pointed processes. These are not seen in *M. ramispinosum.*
iv. As stressed by Colbath (1990, p. 125), the processes of the type material of *M. ramusculosum* exhibit spines arising directly from the process trunk. These are not seen in *M. ramispinosum.*

Utilizing these criteria, the specimens illustrated as *M. ramusculosum* from Argentina by Pöthe de Baldis (1974a), from Ghana by Anan-Yorke (1974), from France by Deunff (1981), from Western Australia by Playford and Dring (1981) and from Bolivia by Kimyai (1983), accord in all particulars with our concept of *M. ramispinosum.* In contrast, as Martin (1981, p. 25) herself later recognized the Silurian form she had placed into *M. ramispinosum* in 1969 was misattributed; we believe also that two of the specimens she illustrated in her 1981 paper belong better in *M. ramusculosum.*

The present stratigraphical range of *Multiplisphaeridium ramusculosum* is long and incoherent; it must remain so until the type material has been restudied and its process characteristics elucidated. The range of *M. ramispinosum* is much more coherent; Colbath (1990) quoted it as late Mid to Late Devonian (Givetian-Famennian), an opinion we endorse. It is present in assemblages from Canada and the United States, Argentina, Bolivia and Paraguay, western Europe, Western Australia and Ghana. When the specimens presently placed into *M. ramusculosum* have been restudied, *M. ramispinosum* will surely prove to have an even wider distribution.

Accepted species:

Multiplicisphaeridium amitum Wicander and Loeblich Jr. 1977, p. 147, pl. 6, figs. 11-13. Late Devonian, Indiana, U.S.A.

Multiplicisphaeridium anastomosis Wicander 1974, p. 29, pl. 14, figs. 7-9. Late Devonian to Carboniferous (Early Mississippian), Ohio, U.S.A.

Multiplicisphaeridium arbusculum Dorning 1981, p. 194-195, pl. 1, fig. 7. Early Silurian (Wenlock), England.

Multiplicisphaeridium bifurcatum Staplin, Jansonius and Pocock 1965, p. 182, pl. 18, fig. 13. Middle Ordovician, Anticosti Island, Quebec, Canada. **Herein, Pl. IV fig. 1.**

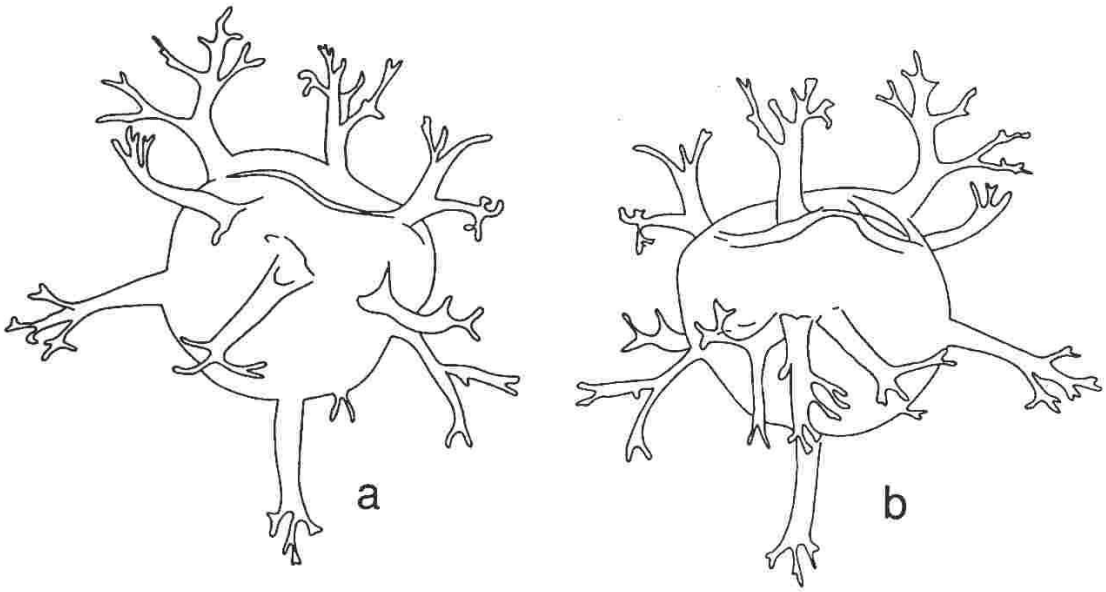
Multiplicisphaeridium? carnicum Priewalder 1987, p. 43-44, pl. 10, figs. 4-6; pl. 20, fig. 3; text-fig. 19. Early Silurian (Wenlock), Austria. [Note: The generic placement of this species is considered doubtful, since the processes are unusually short and broad, with somewhat conical bases].

Multiplicisphaeridium cladus (Downie 1963, 643-644, pl. 92, fig. 5; text-fig. 3a) Eisenack 1969, p. 260. Early Silurian (Wenlock), England. [Note: When he named this species, Downie gave no indication of the derivation of the name, which he spelled as *'cladum'*. This spelling has been adopted by subsequent authors, including Fensome *et al.* 1990, p. 342. However, the name clearly derives from the Greek *klados* a twig; it should thus be Latinized to *cladus* and treated as a noun in apposition, without modification according to gender. This change is made in accordance with Article 73, *I.C.B.N.*]

Multiplicisphaeridium cymula (Cramer and Díez 1972b, p. 149, pl. 31, fig. 7) Eisenack, Cramer and Díez Rodriguez 1973, p. 583-584. Silurian (Llandovery-Ludlow), Indiana, U.S.A. [Note: *cymula* is a noun in apposition; Fensome *et al.* 1990, p. 343 were therefore incorrect in modifying the trivial name to *'cymulum'*.]

Multiplicisphaeridium delicatum Cramer and Díez 1977, p. 347, pl. 3, fig. 19. Early Ordovician (Early Arenig), Morocco. **Herein, Pl. II fig. 10.**

Multiplicisphaeridium eltonense Dorning 1981, p. 195, pl. 1, figs. 5, 8. Early Silurian (Wenlock), England.



text-figure 1
Multiplicisphaeridium ramispinosum Staplin 1961, emend. Sarjeant & Vavrdová, herein. Left: upper surface. Right: lower surface, by transparency. X ca. 125.

Multiplicisphaeridium fermosum Cramer 1970, p. 131-132, pl. 7, fig. 122; pl. 8, fig. 138; pl. 9, fig. 143; pl. 12, fig. 174; text-fig. 39c. Holotype pl. 7, fig. 122 (designated by Eisenack, Cramer and Díez Rodriquez 1973, p. 639-640). Early Silurian (Late Llandovery), Indiana, Ohio and Kentucky, U.S.A. [Note: In discussion with R.A. Fensome, he informs us that he now believes that Fensome *et al.* 1990, p. 346, were incorrect in considering the species to be invalid until 1973, since *I.C.B.N.* Article 7 requires that the holotype be illustrated but does not require that the illustration of it be identified.]

Multiplicisphaeridium fisheri (Cramer 1968, p. 65, pl. 1, fig. 1) Lister 1970, p. 89. Silurian (Late Llandovery to Early Ludlow), New York, U.S.A.

Multiplicisphaeridium fissile (Stockmans and Willière 1963, p. 458-459, pl. 1, fig. 6; text-fig. 14) Eisenack, Cramer and Díez Rodriguez 1973, p. 639-640. Early Silurian (Late Llandovery), Belgium.

Multiplicisphaeridium forquiferum (Cramer and Díez 1972b, p. 151, pl. 32, fig. 20) Eisenack, Cramer and Díez Rodriguez 1973, p. 641-642. Silurian (Llandovery to Ludlow), Kentucky, U.S.A.

Multiplicisphaeridium granulabrachium Eiserhardt 1992, p. 50, pl. 5, figs. 6-7, 10; text-fig. 7. Late Ordovician (Ashgill), Gotland, Sweden.

Multiplicisphaeridium illinoii (Cramer and Díez 1972b, p. 152-153, pl. 33, figs. 23-24) Eisenack, Cramer and Díez Rodriguez 1973, p. 659-660 Late Silurian (Ludlow), Illinois, U.S.A. **Herein, Pl. IV fig. 2.**

Multiplicisphaeridium inconstans Cramer and Díez 1977, p. 347, pl. 4, figs. 5, 8. Early Ordovician (Early Arenig), Morocco. **Herein, Pl. II fig. 12.**

Multiplicisphaeridium intonsurans (Lister 1970, p. 82-83, pl. 9, figs. 18-20; pl. 10, fig. 1) Sarjeant and Stancliffe 1994, p. 32. Late Silurian (Ludlow), England.

Multiplicisphaeridium irregulare Staplin, Jansonius and Pocock 1965, p. 183, pl. 18, figs. 17-18. Middle Ordovician, Anticosti Island, Quebec, Canada. [Note: placed into *Baltisphaeridium* by Martin 1969, p. 65, but retained in *Multiplicisphaeridium* by Eisenack, Cramer and Díez Rodriguez 1973, p. 633].

Multiplicisphaeridium leptaleoderos Loeblich Jr. and Wicander 1976, p. 18, pl. 5, fig. 5. Early Devonian (Late Gedinnian), Oklahoma, U.S.A.

Multiplicisphaeridium mergaeferum Loeblich Jr. 1970, p. 729, figs. 22A-E. Early Silurian (Wenlock), New York, U.S.A. [Note: transferred to *Micrhystridium* by Stockmans and Willière 1974, p. 27; returned to *Multiplicisphaeridium* by Sarjeant and Stancliffe 1994, p. 32].

Multiplicisphaeridium? micraulaxum Colbath 1979, p. 21, pl. 7, figs. 9-13. Late Ordovician, Indiana, U.S.A. Assignment questionable since the processes are usually simple or bifurcate, only rarely showing branching to third order.

Multiplicisphaeridium mingusii Le Hérissé 1989, p. 161-162, pl. 19, figs. 6-8, 13. Holotype pl. 19, figs. 7-8. Early Silurian (Early Llandovery), Gotland, Sweden.

Multiplicisphaeridium moccasinii (Cramer and Díez, 1972b, p. 153, pl. 33, fig. 25) Eisenack, Cramer and Díez Rodriguez 1973, p. 687-688. Silurian, Missouri, U.S.A.

Multiplicisphaeridium monkii Le Hérissé 1989, p. 162, pl. 19, figs. 9-11. Holotype pl. 19, fig. 11. Early Silurian (Early Llandovery), Gotland, Sweden.

Multiplicisphaeridium oblatum Sheshegova 1984, p. 75-76, pl. 12, figs. 2-3. Early Silurian (Late Llandovery), Siberia, Russia.

Multiplicisphaeridium osgoodense (Cramer and Díez 1972b, p. 153, pl. 33, fig. 26) Eisenack, Cramer and Díez Rodriguez 1973, p. 705-706. Early Silurian (Llandovery), Kentucky, U.S.A.

Multiplicisphaeridium paraguaferum (Cramer 1964, p. 300-301, pl. 2, figs. 3-4; text-fig. 22, nos. 2-3) Lister

1970, p. 92. Late Silurian (Late Ludlow)-Early Devonian (Emsian), Spain.

Multiplicisphaeridium pardaminum Díez and Cramer 1976, p. 127, pl. 3, figs. 3, 15. Late Silurian (Ludlow), Spain.

Multiplicisphaeridium pusillum Eiserhardt 1992, p. 56, pl. 6, figs. 7-8. Late Ordovician (Ashgill), Gotland, Sweden.

Multiplicisphaeridium ramusculosum (Deflandre 1945, p. 63, pl. 1, figs. 8-16; text-figs. 38-39) emend. Lister 1970, p. 92-93. Silurian, France. [Note: The transfer to *Oppilatala* by Dorning 1981, p. 196 is not accepted; see earlier discussion, pp. 11-15]. **Herein, Pl. II fig. 2.**

Multiplicisphaeridium robertinum (Cramer 1964, p. 301-302, pl. 2, figs. 9-10; text-fig. 22, no. 6) Lister 1970, p. 93-94. Late Silurian (Ludlow)-Early Devonian (Emsian), Spain.

Multiplicisphaeridium rochesterense (Cramer and Díez 1972b, p. 157, pl. 34, fig. 45; pl. 35, fig. 60) Eisenack, Cramer and Díez Rodriguez 1973, p. 785-786. Early Silurian (Late Llandovery), New York, U.S.A.

Multiplicisphaeridium? sylense Tynni 1975, p. 29, pl. 3, fig. 11. Middle Ordovician, Bothnian Sea, Finland. The single specimen on which the species is based, has ca. 10 processes of variable character, some exhibiting secondary branching; however, its morphology is obscure and this placement highly questionable.

Multiplicisphaeridium trunculum Wicander and Loeblich Jr. 1977, p. 148, pl. 6, fig. 7. Late Devonian, Indiana, U.S.A.

Multiplicisphaeridium variopinnum Cramer 1966, p. 244, pl. 1, fig. 4; text-fig. 3, no. 4 *ex* Eisenack, Cramer and Díez, - 1973, p. 823. Late Silurian (Ludlow)-Early Devonian (Early Gedinnian), Spain.

Multiplicisphaeridium variopinnum var. *lisum* Cramer 1966, p. 244, pl. 1, fig. 2; text-fig. 3, no. 4 *ex* Fensome, Williams, Barss, Freeman and Hill 1990, p. 357. Late Silurian (Ludlow)-Early Devonian (Emsian), Spain.

Multiplicisphaeridium variopinnum var. *variopinnum*. Autonym.

Multiplicisphaeridium verrucarum Wicander 1974, p. 29, pl. 14, figs. 10-12. Early Carboniferous (Early Mississippian), Ohio, U.S.A.

Multiplicisphaeridium wrensnestense Dorning 1981, p. 195, pl. 1, fig. 3. Early Silurian (Wenlock), England.

Multiplicisphaeridium wrightii Jacobson and Achab 1985, p. 186, 188, pl. 6, figs. 4, 7. Late Ordovician (Ashgill), Quebec, Canada.

Species formerly placed in *Multiplicisphaeridium*:

In 1955, Sannemann published a paper describing a group of exceptionally large forms from the Devonian (Late Givetian) of Germany which, from his photographs, appear also to have been unusually dark in colour. They were placed originally into the genus *Hystrichosphaeridium* and later into *Baltisphaeridium*. Subsequently, certain of these forms were shown by Kozur (1984) to be attributable to a new order of microfossils which he recognized, the muellerisphaerids. Unaware of this work, Fensome *et al.* (1990) retained all of Sannemann's species in the Acritarcha, seven being placed into *Multiplicisphaeridium*. Two of these seven species were considered by Kozur to be muellerisphaerids, but not validly transferred, since the basionyms were not fully referenced. Their transfer is validated below:

Aldridgeisphaera mutabilis (Sannemann 1955, p. 331, pl. 5, figs. 5-6; text-fig. 17a-d) comb. nov. Holotype pl. 5, fig. 5. Late Devonian, Germany. Note: transferred to this genus by implication by Kozur (1984, p. 131), but the new combination was not validly published.

Aldridgeisphaera? robusta (Sannemann 1955, p. 331, pl. 1, figs. 6, 8-9; pl. 6, figs. 7-9; text-figs. 13, 14a-c) comb. nov. Holotype pl. 6, fig. 7. Late Devonian, Germany. Note: tentatively transferred to this genus by implication by Kozur (1984, p. 131), but the new combination was not validly published.

Aldridgeisphaera? robusta subsp. *fissa* (Sannemann 1955, p. 331, pl. 6, fig. 9; text-figs. 14a-c) comb. nov. Late Devonian, Germany. Note: tentatively transferred to this genus by implication by Kozur (1984, p. 131), but the new combination was not validly published.

Aldridgeisphaera? robusta subsp. *robusta*. Autonym.

The remaining species introduced by Sannemann are all considered by us to be likewise muellerisphaerids but, since they have more complex processes than any of the three existing genera proposed by Kozur (1984), they cannot be reattributed without the erection of a new genus–an action we are unprepared to take without studying the type material. The species concerned are as follows:

Multiplicisphaeridium coniferum (Sannemann 1955, p. 327, pl. 4, fig. 2) Eisenack, Cramer and Díez Rodriguez 1973, p. 567.

Multiplicisphaeridium consonum (Sannemann 1955, p. 332, pl. 5, fig. 7) Eisenack, Cramer and Díez Rodriguez 1973, p. 569-570.

Multiplicisphaeridium eisenackii (Sannemann 1955, p. 327-328, pl. 4, figs. 10-12; text-figs. 8a-d) Eisenack, Cramer and Díez Rodriguez 1973, p. 615.

Multiplicisphaeridium integrum (Sannemann 1955, p. 329, pl. 5, fig. 12; text-fig. 12) Eisenack, Cramer and Díez Rodriguez 1973, p. 661.

Multiplicisphaeridium procerum (Sannemann 1955, p. 332, pl. 5, fig. 8; text-fig. 18) Eisenack, Cramer and Díez Rodriguez 1973, p. 743-744. [Originally *Hystrichosphaeridium trifurcatum* Eisenack 1931 subsp. *procerum* Sannemann].

Species considered to have vesicles of wholly organic composition, and thus unequivocally meriting retention as acritarchs, are listed below and their reassignment proposed wherever necessary.

Multiplicisphaeridium abnormisum Yin Leiming 1986, p. 350-351, pl. 83, figs. 9, 13-14; text-fig. 129. Provisionally transferred to *Micrhystridium* herein.

Multiplicisphaeridium absonum (Wicander 1974, p. 19, pl. 8, fig. 4) Eisenack, Cramer and Díez 1979b, p. 1. Transferred to *Stellechinatum* herein.

Multiplicisphaeridium acaciaense Playford and Martin 1984, p. 205, figs. 8A-F. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium actinospinosum Uutela and Tynni 1991, p. 87-88, pl. 20, fig. 206. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium aculeatum Díez and Cramer 1976, p. 126, pl. 3, figs. 8, 10. Transferred to *Piliferosphaera* herein.

Multiplicisphaeridium albanegum Cramer, Díez, Rodriguez and Fombella 1976, p. 446-447, pl. 1, figs. 4-5, 8-9, 13; text-fig. 2, no. 8. Transferred to *Timofeevia* herein.

Multiplicisphaeridium alloiteaui (Deunff 1955, p. 148, pl. 4, fig. 3) Eisenack, Cramer and Díez Rodriguez 1973, p. 521. Originally *Micrhystridium*; subsequently *Baltisphaeridium*. Transferred provisionally to *Ammonidium* by Deunff 1976, p. 63.

Multiplicisphaeridium almaradum Díez and Cramer 1976, p. 126, 127, pl. 3, figs. 13-14. Transferred to *Piliferosphaera* herein.

Multiplicisphaeridium amphitrae Deunff, Lefort and Paris

1971, p. 11, pl. 1, fig. 7; pl. 2, fig. 15. Transferred to *Evittia* herein.

Multiplicisphaeridium ancliforme Fombella 1978, p. 252, pl. 3, fig. 7. Transferred to *Vulcanisphaera* herein.

Multiplicisphaeridium ancorum Wicander and Loeblich Jr. 1977, p. 147, pl. 7, figs. 1-2, 6-7. Transferred to *Petaloferidium* herein.

Multiplicisphaeridium andrewsii (Stockmans and Willière 1962b, p. 88-89, pl. 2, fig. 16; text-fig. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 523. Originally *Baltisphaeridium*, subsequently *Micrhystridium*; transferred to *Gorgonisphaeridium* by Martin 1985, p. 21.

Multiplicisphaeridium arbusculiferum (Downie 1963, p. 644, pl. 91, fig. 5; text-fig. 3d) Staplin, Jansonius and Pocock 1965, p. 181. Originally *Baltisphaeridium*, subsequently invalidly placed into *Peteinosphaeridium*; transferred, as type species, to *Leptobrachion* by Dorning 1981, p. 193. [Note: illustrated herein as Text-fig. 4d]

Multiplicisphaeridium areolatum (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 120-121, pl. 3, figs. 2, 7, 10) Eisenack, Cramer and Díez 1979, p. 5. Originally *Baltisphaeridium*; transferred to *Acriora* herein.

Multiplicisphaeridium areolatum subsp. *areolatum*. Autonym; transferred to *Acriora* herein.

Multiplicisphaeridium areolatum subsp. *granulosum* (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 121, pl. 3, fig. 10) Eisenack, Cramer and Díez 1979, p. 5. Name not validly published; see Fensome *et al.* 1990, p. 340.

Multiplicisphaeridium areolatum subsp. *laevigatum* (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 121, pl. 3, figs. 2, 7) Eisenack, Cramer and Díez 1979, p. 5.Transferred to *Acriora* herein.

Multiplicisphaeridium asombrosum Cramer and Díez 1976, p. 85-86, pl. 2, figs. 10, 14-15. Transferred to *Dateriocradus* herein.

Multiplicisphaeridium asturiae (Cramer 1964, p. 313, pl. 13, figs. 14-15; text-fig. 30, no. 2) Eisenack, Cramer and Díez Rodriguez 1973, p. 529. Originally *Veryhachium*, subsequently *Baltisphaeridium*; also invalidly placed into *Evittia*. Transferred to *Dateriocradus* herein.

Multiplicisphaeridium barbarum (Deunff 1961, p. 41, pl. 1, fig. 7) Eisenack, Cramer and Díez Rodriguez 1973, p. 531. Combination illegitimate, since this is the type species of *Priscogalea*, a senior generic name; see Fensome *et al.* 1990, p. 341, for discussion.

Multiplicisphaeridium belmonte Cramer 1970, p. 145, pl. 14, figs. 196-201; text-fig. 47j *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 533-534. Transferred to *Ammonidium* herein.

Multiplicisphaeridium belmontiforme Tynni 1975, p. 28, pl. 3, fig. 8. Transferred to *Ammonidium* herein.

Multiplicisphaeridium bifurcatum (Thusu 1973a, p. 814, pl. 105, figs. 8, 12) Eisenack, Cramer and Díez 1976, p. 449 *non* Staplin, Jansonius and Pocock 1975. Junior homonym. Originally *Filisphaeridium*; subsequently renamed *Multiplicisphaeridium thusui* by Fensome *et al.* 1990, p. 341, 356; provisionally transferred to *Martinsphaeridium* herein, as *M.? bifurcatum*.

Multiplicisphaeridium bikidium (Lister 1970, p. 64-65, pl. 6, figs. 1-9; text-figs. 18a-e, f, 21) Eisenack, Cramer and Díez Rodriguez 1973, p. 537-538. Originally the type species of *Cymbosphaeridium*; returned to that genus by Deunff 1976, p. 62-63 and retained in it by Dorning 1981, p. 186.

Multiplicisphaeridium bipalmatum Uutela and Tynni 1991, p. 88, pl. 20, no. 207. Provisionally transferred to *Martinsphaeridium* herein.

Multiplicisphaeridium birminghamense Cramer 1970, p. 177-178, pl. 22, figs. 314, 316; text-fig. 55a *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 539-540. Originally invalidly published as *Baltisphaeridium*; transferred to *Hoegklintia* herein.

Multiplicisphaeridium bonitum Cramer 1970, p. 150-152, pl. 15, figs. 207-209, 213; text-fig. 47i. Holotype pl. 15, fig. 208 (designated by,Eisenack, Cramer and Díez Rodriquez 1973 p. 541-542). Senior synonym of *Thysanoprobolus* (*al. Multiplicisphaeridium*) *polykion* Loeblich Jr. and Tappan 1970, according to Eisenack *et al.*, *op. cit.*. [Note: In discussion with R.A. Fensome, he informs us that he now believes that Fensome *et al.* 1990, were incorrect in considering the species to be invalid until 1973, since *I.C.B.N.* Article 7 requires that the holotype be illustrated but does not require that the illustration of it be identified; accordingly, the trivial name *bonitum* can no longer be considered junior to *polykion* and, since the latter is the type species of *Thysanoprobolus*, '*bonitus*' becomes the type species of that genus.]

Multiplicisphaeridium borracherosum (Cramer 1964, p. 208, pl. 1, fig. 11; text-fig. 16, no. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 543-544. Originally *Baltisphaeridium*; also invalidly placed into *Hystrichosphaeridium*. Transferred to *Petaloferidium* herein.

Multiplicisphaeridium borracherosum forma *borracherosum*. Autonym; transferred to *Petaloferidium* herein.

Multiplicisphaeridium borracherosum forma *regulare* Uutela and Tynni 1991, p. 89, pl. 20, fig. 208. Transferred to *Petaloferidium* herein.

Multiplicisphaeridium brazodesnudum (Cramer 1964, p. 289, pl. 2, fig. 7; text-fig. 16, no. 8) Eisenack, Cramer and Díez Rodriguez 1973, p. 545-546. Originally *Baltisphaeridium*; transferred to *Excultibrachium* herein.

Multiplicisphaeridium brevidigitatum Uutela and Tynni 1991, p. 89, pl. 20, fig. 209. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium brevifurcatum (Eisenack 1954, p. 207-208, pl. 1, fig. 2; text-fig. 2) Eisenack, Cramer and Díez Rodriguez 1973, p. 547-548. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Visbysphaera*; returned to *Visbysphaera* by Priewalder 1987, p. 60.

Multiplicisphaeridium breviusculum (Burmann 1970, p. 292, pl. 2, fig. 2) Eisenack, Cramer and Díez, 1976, p. 451. Originally *Veryhachium*, subsequently *Frankea*. Jr. synonym of *Veryhachium* (now *Frankea*) *sartbernardense* Martin 1966b, according to Cramer and Díez 1977, p. 350.

Multiplicisphaeridium cacteum Uutela and Tynni 1991, p. 89-90, pl. 20, fig. 210a; pl. 21, fig. 210b. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium? canadense Staplin, Jansonius and Pocock 1965, p. 182-183, pl. 18, figs. 7-10; text-fig. 9. Transferred provisionally to *Comasphaeridium* herein.

Multiplicisphaeridium cannosphaeropsisoides (Stockmans and Willière 1962b, p. 90-91, pl. 1, fig. 17; text-fig. 9) Eisenack, Cramer and Díez Rodriguez 1973, p. 551. This species is based upon a single specimen of obscure morphology, with simple, unbranched processes and a network of bands on the vesicle surface. In view of the uncertainty concerning its morphological character, we consider that this taxon should be allowed to fall into disuse.

Multiplicisphaeridium caperoradiolum (Loeblich Jr. 1970, p. 714-715, figs. 7A-G) Eisenack, Cramer and Díez Rodriguez 1973, p. 553-556. Originally, and herein returned to, *Diexallophasis*.

Multiplicisphaeridium? cariniosum (Cramer 1964, p.284, pl. 1, fig. 13; text-fig. 14, nos. 7-8) Eisenack, Cramer and Díez Rodriguez 1973, p. 555-557. Originally *Baltisphaeri-*

dium; subsequently placed questionably into *Cymbosphaeridium* and confidently into *Priscogalea*; returned to *Baltisphaeridium* by Kiryanov 1978, p. 67.

Multiplicisphaeridium carrascum (Cramer 1966, p. 243, pl. 1, fig. 1) Eisenack, Cramer and Díez Rodriguez 1973, p. 563. Originally *Baltisphaeridium*; transferred to *Ammonidium* herein.

Multiplicisphaeridium carum (Cramer and Díez 1972b, p. 148-149, pl. 31, figs. 5-6) Eisenack, Cramer and Díez Rodriguez 1973, p. 561. Originally *Baltisphaeridium*; transferred to *Oppilatala* herein.

Multiplicisphaeridium? cazurrum (Cramer 1964, p. 315, pl. 13, fig. 1; text-fig. 30, no. 4) Eisenack, Cramer and Díez Rodriguez 1973, p. 563. Originally *Veryhachium*, subsequently *Baltisphaeridium*; transferred to *Villosacapsula* herein.

Multiplicisphaeridium cervinacornuum Welsch 1986, p. 61-62, pl. 6, figs. 7-10; text-fig. 21. Transferred to *Vogtlandia* herein.

Multiplicisphaeridium chagrinense (Wicander 1974, p. 17, pl. 5, figs. 3-4) Eisenack, Cramer and Díez 1979, p. 13. Originally the type species of *Barathrisphaeridium*, subsequently also *Gorgonisphaeridium*; returned to *Barathrisphaeridium* by Wicander 1983, p. 12, and retained in that genus by Sarjeant and Stancliffe 1994, p. 24.

Multiplicisphaeridium chakor Vanguestaine and van Looy 1983, p. 73-74, pl. 2, figs. 1-6; text-fig. 5. Provisionally transferred to *Micrhystridium* herein.

Multiplicisphaeridium chattonii (Stockmans and Willière 1962a, p. 59-69, pl. 1, fig. 19; text-fig. 17) Fensome, Williams, Barss, Freeman and Hill 1990, p. 342. Originally *Micrhystridium*; transferred to *Gorgonisphaeridium* by Sarjeant and Stancliffe 1994, p. 32.

Multiplicisphaeridium clarkii (Cramer and Díez 1972, p. 167, pl. 36, fig. 64-66; text-fig. 3a) Eisenack, Cramer and Díez 1976, p. 453. Jr. synonym of *Ammonidium* (*al. Caiacoryimbifer*) *waldronensis* Tappan and Loeblich Jr. 1971 according to Eisenack, Cramer and Díez 1976, p. 453, 487-488.

Multiplicisphaeridium clavatum Tynni 1978, p. 52, pl. 9, fig. 84. Early Cambrian, Finland. This species is based upon a single, ragged-looking specimen of obscure morphology; we recommend that the taxon be permitted to fall into disuse.

Multiplicisphaeridium concinnum (Loeblich Jr. and Tappan 1978, p. 1267-1268, pl. 9, figs. 3-6) Cramer and Díez 1979, p. 49. Originally, and now, *Excultibrachium*; combination not validly published: see Fensome *et al.* 1990, p. 343.

Multiplicisphaeridium consolator Cramer and Díez 1977, p. 347, pl. 3, fig. 17. Transferred to *Evittia* herein.

Multiplicisphaeridium continuatum Kjellström 1971, p. 46-47, pl. 3, fig. 7. Transferred to *Hoegklintia* herein.

Multiplicisphaeridium corallinum (Eisenack 1959, p. 201, pl. 16, figs. 15-16) Eisenack 1969, p. 259-260. Originally *Baltisphaeridium*; transferred to *Hoegklintia* herein.

Multiplicisphaeridium cornigerum Uutela and Tynni 1991, p. 90, pl. 21, fig. 211. Transferred to *Diexallophasis* herein.

Multiplicisphaeridium cortinulum (Deunff 1961, p. 41, pl. 1, figs. 8, 10) Eisenack, Cramer and Díez Rodriguez 1973, p. 577-578. Originally *Priscogalea*, subsequently *Baltisphaeridium* and *Stelliferidium*; returned to *Stelliferidium* by Deunff, Górka and Rauscher 1974, p. 14.

Multiplicisphaeridium cortracumense (Stockmans and Willière 1963, p. 468-469, pl. 2, fig. 11; text-fig. 29) Eisenack, Cramer and Díez Rodriguez 1973, p. 579. Originally *Micrhystridium* and returned to that genus herein.

Multiplicisphaeridium? crinitum (Grishina *in* Grishina and Klenina 1981, p. 31-32, pl. 1, fig. 10) Sarjeant and Stancliffe 1994, p. 22. Originally *Micrhystridium*; transferred to *Ammonidium* herein.

Multiplicisphaeridium cuspide (Wicander 1974, p. 19, pl. 8, fig. 5) Eisenack, Cramer and Díez 1979b, p. 15. Originally *Diexallophasis* and returned to that genus herein.

Multiplicisphaeridium cymoides Uutela and Tynni 1991, p. 91, pl. 21, fig. 212. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium cymosum (Loeblich Jr. 1970, p. 721-722, figs. 15A-C) Eisenack, Cramer and Díez Rodriguez 1973, p. 581-582. Originally *Evittia* and returned to that genus herein.

Multiplicisphaeridium dactilus Vidal *in* Moczydlowska and Vidal 1988, p. 8, pl. 2, figs. 1-7. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium dedosmuertos (Cramer 1964, p. 291, pl. 2, figs. 1-2; text-fig. 16, no. 7) Lister 1970, p. 84. Combination not validly published: see Fensome *et al.* 1990, p. 343. Originally *Baltisphaeridium*; now *Hemibaltisphaeridium*.

Multiplicisphaeridium dendroideum (Burmann 1970, p. 296, pl. 6, figs. 1-4) Eisenack, Cramer and Díez 1976, p. 455-456. Combination illegitimate: see Fensome *et al.* 1990, p. 343. Originally, and now, *Lusatia*.

Multiplicisphaeridium dendroideum (Yankauskas 1976, p. 189, pl. 25, fig. 19) Yankauskas and Kiryanov *in* Volkova *et al.* 1979, p. 6. Combination not validly published: see Fensome *et al.* 1990, p. 32. Now *Vogtlandia yankauskasii*.

Multiplicisphaeridium dendroidium Morbey 1975, p. 50-51, pl. 16, fig. 21. Transferred, as type species, to the new genus *Rhaetosphaeridium* herein.

Multiplicisphaeridium denticulatissimum (Cramer and Díez 1972b, p. 149, pl. 31, figs. 8-9) Eisenack, Cramer and Díez Rodriguez 1973, p. 585-586. Originally *Baltisphaeridium*; transferred to *Stellechinatum* herein.

Multiplicisphaeridium denticulatum (Stockmans and Willière 1963, p. 458, pl. 1, fig. 4; text-fig. 13) Eisenack, Cramer and Díez Rodriguez 1973, p. 587-591. Jr. synonym of *Veryhachium* (now *Diexallophasis*) *remotum* Deunff 1955, according to Playford 1977, p. 19.

Multiplicisphaeridium deunffii Jansonius 1962, p. 84, pl. 16, fig. 51; text-fig. 3c. Transferred successively to *Baltisphaeridium*, *Filisphaeridium* and *Micrhystridium*. Now again placed in *Filisphaeridium*; see Sarjeant and Stancliffe 1994, p. 29.

Multiplicisphaeridium dicrum (Loeblich Jr. and Drugg, 1968, p. 132-134, pl. 2, figs. 1-7) Eisenack, Cramer and Díez Rodriguez 1973, p. 605-606. Jr. synonym of *Veryhachium* (now *Ozotobrachion*) *furcillatum* Deunff 1955, according to Playford 1977, p. 31.

Multiplicisphaeridium digitatum (Eisenack 1938, p. 20-22, pl. 4, figs. 3-5; text-fig. 7) Eisenack 1969, p. 259. Originally *Hystrichosphaeridium*, subsequently *Baltisphaeridium*; transferred to *Hoegklintia* by Dorning 1981, p. 192.

Multiplicisphaeridium dilatispinosum (Downie 1963, p. 642, pl. 92, fig. 4) Eisenack, Cramer and Díez Rodriguez 1973, p. 611. Originally *Baltisphaeridium*; transferred to *Visbysphaera*, as type species, by Lister 1970, p. 98-99.

Multiplicisphaeridium diversispinosum Uutela and Tynni 1991, p. 91, pl. 21, fig. 213. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium dubitum (Lister 1970, p. 59, pl. 3, figs. 1-2, 4-6; text-figs. 17n, 19r, 20a) Eisenack, Cramer and Díez Rodriguez 1973, p. 613-614. Jr. synonym of *Baltisphaeridium arbusculiferum* Downie 1963, thereafter the type species of *Leptobrachion*, according to Dorning 1981, p. 193.

Multiplicisphaeridium ectynum Grishina *in* Grishina and Klenina 1981, p. 30, pl. 1, fig. 18. *Nomen nudum: err. cit.* for *Nucellosphaeridium* in Fensome *et al.* 1990, p. 345.

Multiplicisphaeridium elias Cramer, Díez Rodriguez and Fombella 1976, p. 447, pl. 1, fig. 19; text-fig. 2, no. 1. Transferred to *Visbysphaera* herein.

Multiplicisphaeridium ellipticum Cramer and Díez 1977, p. 348, pl. 3, figs. 12-13. Transferred to *Vulcanisphaera* herein.

Multiplicisphaeridium eodigitatum Fombella 1978, p. 253, pl. 1, fig. 4. Provisionally transferred to *Vulcanisphaera* herein.

Multiplicisphaeridium eopiriferum Fombella 1978, p. 253, pl. 3, fig. 20. Transferred to *Vulcanisphaera* herein.

Multiplicisphaeridium eoplanktonicum (Eisenack 1955, p. 178-179, pl. 4, fig. 14) Lister 1970, p. 89. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*. Transferred to *Oppilatala* by Dorning 1981, p. 196.

Multiplicisphaeridium erraticum (Eisenack 1954, p. 209, pl. 1, figs. 6-7; text-fig. 7) Eisenack, Cramer and Díez Rodriguez 1973, p. 621-622. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*. Transferred to *Visbysphaera* by Lister 1970, p. 98.

Multiplicisphaeridium escobaides (Cramer 1964, p. 294, pl. 2, fig. 16; text-fig. 19, no. 2) Eisenack, Cramer and Díez Rodriguez 1973, p. 623. Originally *Baltisphaeridium*; subsequently *Micrhystridium*. Provisionally transferred to *Evittia* herein.

Multiplicisphaeridium estrellaferum (Cramer 1966, p. 244-245, pl. 1, fig. 5; text-fig. 3, no. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 625-626. Originally *Baltisphaeridium*; transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium euernes (Cramer and Díez 1972b, p. 150, pl. 32, fig. 12) Eisenack, Cramer and Díez Rodriguez 1973, p. 627-628. Originally *Baltisphaeridium*; transferred to *Cymbosphaeridium* by Dorning 1981, p. 186.

Multiplicisphaeridium exasperatum (Deunff 1955, p. 146, pl. 3, fig. 4) Eisenack, Cramer and Díez Rodriguez 1973, p. 629. Originally *Veryhachium*; transferred to *Estiastra* herein.

Multiplicisphaeridium exornatum (Deunff 1967, p. 259, figs. 1, 3-4, 19) Eisenack, Cramer and Díez 1979b, p. 17. Originally *Baltisphaeridium*; subsequently *Hapsidopalla*, to which genus it is returned herein.

Multiplicisphaeridium exoticum Pöthé de Baldis 1974, p. 316, pl. 1, fig. 1. Transferred to *Excultibrachium* herein.

Multiplicisphaeridium ferum (Martin 1969, p. 52, pl. 1, figs. 13, 20, 22; text-fig. 8) Eisenack, Cramer and Díez Rodriguez 1973, p. 633. Originally *Baltisphaeridium*; subsequently *Priscogalea*. Returned to the latter genus by Martin 1975, p. 10-11.

Multiplicisphaeridium firmum (Burmann 1970, p. 295, pl. 5, figs. 3-4) Fensome, Williams, Barss, Freeman and Hill 1990, p. 346. Originally *Adorfia*; transferred to *Schizodiacrodium* herein.

Multiplicisphaeridium forquillum (Cramer and Díez 1972b, p. 152, pl. 32, fig. 15) Eisenack, Cramer and Díez Rodriguez 1973, p. 643-644. Originally *Baltisphaeridium*; transferred to *Lusatia* herein.

Multiplicisphaeridium fronde (Cramer and Díez 1972b, pl. 152, pl. 32, figs. 18-19) Eisenack, Cramer and Díez Rodriguez 1973, p. 645-646. Originally *Baltisphaeridium*; transferred to *Oppilatala* by Dorning 1981, p. 196.

Multiplicisphaeridium fui Fensome, Williams, Barss, Freeman and Hill 1990, p. 347, *nom. subst. pro M. robustum* Fu Jiayuan 1986b, p. 120, pl. 4, figs. 17, 25-26 *non M. robustum* (Sanneman 1955) Eisenack, Cramer and Díez Rodriguez 1973. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium furcatum (Deunff 1961, p. 41, pl. 1, fig. 11) Eisenack, Cramer and Díez Rodriguez 1973, p. 647. Originally *Priscogalea*, subsequently *Baltisphaeridium*; emended and transferred to *Stelliferidium* by Deunff, Górka and Rauscher 1974, p. 14.

Multiplicisphaeridium furcillatum (Deunff 1955, p. 146, fig. 18) Eisenack, Cramer and Díez Rodriguez 1973, p. 649. Originally *Veryhachium*; transferred to *Ozotobrachion* by Playford 1977, p. 31.

Multiplicisphaeridium ganglium (Wicander 1974, p. 18-19, pl. 8, figs. 6-8) Eisenack, Cramer and Díez 1979, p. 19-20. Originally the type species of *Diaphorochroa*; returned to that genus by Wicander 1983, p. 25.

Multiplicisphaeridium gotlandicum (Eisenack 1954, p. 209, pl. 1, fig. 5; text-fig. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 651-652. Originally *Hystrichosphaeridium*, subsequently *Baltisphaeridium*; transferred to *Visbysphaera* by Kiryanov 1978, p. 87-88.

Multiplicisphaeridium granulatispinosum (Downie 1963, p. 640-641, pl. 91, figs. 1, 7; text-fig. 3c) Eisenack, Cramer and Díez Rodriguez 1973, p. 653. Originally *Baltisphaeridium*, subsequently *Evittia* and *Diexallophasis*; also invalidly placed into *Peteinosphaeridium* by Piskun 1974. Jr. synonym of *Diexallophasis remota* Deunff 1955, according to Playford 1977, p. 19.

Multiplicisphaeridium grosjeanii (Stockmans and Willière 1962b, p. 87-88, pl. 2, fig. 17; text-fig. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 655. Originally *Baltisphaeridium*, subsequently *Micrhystridium*; transferred to *Ammonidium* by Martin 1981, p. 10-11.

Multiplicisphaeridium hamatum (Burmann 1970, p. 290, pl. 2, figs. 7, 9-10) Eisenack, Cramer and Díez 1976, p. 459. Originally the type species of *Frankea*; implicitly returned to that genus by Colbath 1986, p. 72-73 (see discussion in Fensome *et al.* 1990, p. 226).

Multiplicisphaeridium hamulatum (Burmann 1970, p. 291, pl. 2, figs. 5-6) Eisenack, Cramer and Díez 1976, p. 461. Originally *Frankea*; returned to that genus by Servais 1993, p. 84, 86.

Multiplicisphaeridium hoffmanense Cramer, Allam, Kanes and Díez 1974a, p. 185, pl. 27, fig. 10. Transferred to *Evittia* herein.

Multiplicisphaeridium hydraferum (Stockmans and Willière 1962b, pl. 93-94, pl. 2, fig. 15; text-fig. 13) Eisenack, Cramer and Díez Rodriguez 1973, p. 657. Jr. synonym of *Baltisphaeridium* (now *Ammonidium*) *grosjeanii* Stockmans and Willière 1962b, according to Martin 1981, p. 10.

Multiplicisphaeridium imitatum (Deflandre 1945, p. 67, pl. 3, figs. 1-4) emend. Lister 1970, p. 90-91. Originally *Micrhystridium*; provisionally transferred to *Gorgonisphaeridium* by Sarjeant and Stancliffe 1994, p. 32.

Multiplicisphaeridium imperfectum (Burmann 1970, p. 294, pl. 4, figs. 3-5) Eisenack, Cramer and Díez 1976, p. 463-464. Originally *Vogtlandia*; returned to that genus herein.

Multiplicisphaeridium jardinei Cramer 1970, p. 152, pl. 15, figs. 210, 213-214; text-fig. 47h. Jr. synonym of *Thysanoprobolus polykion* Loeblich Jr. and Tappan 1970, according to Loeblich Jr. and Wicander 1976, p. 25. [Note: In discussion with R.A. Fensome, he informs us that he now believes that Fensome *et al.* 1990, p. 348, were incorrect in considering the species to be invalid until the citation by Eisenack, Cramer and Díez Rodriguez 1973, p. 665-666, since *I.C.B.N.* Article 7 requires that the holotype be illustrated but does not require that the illustration of it be identified.]

Multiplicisphaeridium josefae (Cramer 1964, p. 316, pl. 12, figs. 9, 12; pl. 13, fig. 19; text-fig. 30, nos. 7-9) Eisenack,

Cramer and Díez Rodriguez 1973, p. 667-668. Originally *Veryhachium*, subsequently *Baltisphaeridium*; also placed invalidly in *Evittia*. Transferred to *Dateriocradus* herein.

Multiplicisphaeridium juliae (Cramer 1964, p. 296, pl. 1, fig. 4, text-fig. 19, nos. 5, 20) Eisenack, Cramer and Díez Rodriguez 1973, p. 669. Originally *Baltisphaeridium*; transferred to *Visbysphaera* herein.

Multiplicisphaeridium kahleri (Bachmann and Schmid 1964, p. 59-60, pl. 2, fig. 17; pl. 3, fig. 18; pl. 6, fig. 37) Eisenack, Cramer and Díez Rodriguez 1973, p. 671-672. Originally *Baltisphaeridium*; transferred provisionally to *Palacanthus* herein.

Multiplicisphaeridium lancariae Cramer and Díez 1972a, p. 42, pl. 1, figs. 1-4, 6, 8. Transferred, as type species, to *Timofeevia* by Vanguestaine 1978, p. 272.

Multiplicisphaeridium lewisii (Deunff 1954, p. 240, fig. 3) Elaouad-Debbaj 1978, p. 45. Originally *Hystrichosphaeridium*, subsequently *Baltisphaeridium*; also invalidly placed into *Ammonidium*. Provisionally transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium lichenoides Uutela and Tynni 1991, p. 93, pl. 21, fig. 214. Transferred to *Martinsphaeridium* herein.

Multiplicisphaeridium lindum Cramer and Díez 1976, p. 85, pl. 1, figs. 1-4, 6, 8; pl. 2, fig. 11. Transferred to *Dateriocradus* herein.

Multiplicisphaeridium lobeznum (Cramer 1964, p. 296, pl. 2, fig. 15; pl. 7, fig. 3; text-fig. 19, no. 6) Eisenack, Cramer and Díez Rodriguez 1973, p. 673-674. Jr. synonym of *Baltisphaeridium* (now *Multiplicisphaeridium*) *cladum* Downie 1963, according to Colbath 1979, p. 20-21.

Multiplicisphaeridium longistipitatum Cramer and Díez 1977, p. 348, pl. 1, fig. 12. Transferred to *Comasphaeridium* herein.

Multiplicisphaeridium longiusculum (Burmann 1970, p. 291-292, pl. 2, figs. 4, 12; pl. 3, figs. 1-2) Eisenack, Cramer and Díez 1976, p. 467-468. Originally *Frankea*; returned to that genus by Servais 1993, p. 86-87.

Multiplicisphaeridium loriferum (Deunff 1965, p. 163, figs. 6-8) Eisenack, Cramer and Díez Rodriguez 1973, p. 675. Originally *Baltisphaeridium*; also invalidly placed into *Ammonidium*; transferred to *Excultibrachium* herein.

Multiplicisphaeridium malum (Cramer 1964, p. 297, pl. 1, figs. 6, 8, 10; text-fig. 19, nos. 10-12) Eisenack, Cramer and Díez Rodriguez 1973, p. 677-678. Originally *Baltisphaeridium*; subsequently *Evittia*; also invalidly placed into *Hystrichosphaeridium*. Transferred, as type species, to *Rhachobrachion* by Dorning 1981, p. 198. [Note: The reattribution of this species to *Multiplicisphaeridium* by Le Hérissé 1989, p. 160-161, is not followed here, the placement into *Rhachobrachion* being instead retained.]

Multiplicisphaeridium maravillosum (Cramer 1969, p. 489-490, pl. 70, figs. 1-4; text-figs. 1A-C) Eisenack, Cramer and Díez Rodriguez 1973, p. 679. Originally *Baltisphaeridium*; transferred to *Ammonidium* by Thusu 1973b, p. 140.

Multiplicisphaeridium maroquense Cramer, Allam, Kanes and Díez 1974a, p. 185, pl. 27, figs. 3-5, 7-9. Transferred to *Hoegklintia* herein.

Multiplicisphaeridium martae Cramer and Díez 1972a, p. 42-43, pl. 1, figs. 5, 9; pl. 2, fig. 3. Transferred to *Timofeevia*, invalidly by Cramer and Díez 1979, p. 52, and validly by Fensome *et al.* 1990, p. 479.

Multiplicisphaeridium martiniae Priewalder 1987, p. 45, pl. 9, figs. 9-13; pl. 20, figs. 1-2; text-fig. 21. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium meson [Eisenack 1955, p. 179 *nom. subst. pro Hystrichosphaeridium intermedium* Eisenack 1954, p. 208, pl. 1, figs. 3, 9; text-figs. 3-4 *non Hystrichosphaeridium intermedium* (O. Wetzel 1933) Deflandre 1937] Eisenack, Cramer and Díez Rodriguez 1973, p. 681-682. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Visbysphaera*; returned to the latter genus by Priewalder 1987, p. 62.

Multiplicisphaeridium microcladum (Downie 1963, p. 546, pl. 91, fig. 3; pl. 92, fig. 6; text-fig. 3g) Eisenack, Cramer and Díez Rodriguez 1973, p. 683. Originally *Baltisphaeridium*; subsequently *Ammonidium*; returned to the latter genus by Wicander 1983, p. 7.

Multiplicisphaeridium micropilare Cramer 1970, p. 168, pl. 13, figs. 193-194; pl. 14, figs. 202-204; text-fig. 52o *ex* Eisenack, Cramer and Díez Rodriguez, 1973, p. 685-686. Jr. synonym of *Visbysphaera meson* (Eisenack 1955) Lister 1970 according to Ye Xiaorong 1984, p. 42.

Multiplicisphaeridium micropunctatum Uutela and Tynni 1991, p. 93-94, pl. 21, fig. 215. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium minutum Pöthé de Baldis 1974, p. 316-318, pl. 2, fig. 5. Transferred to *Micrhystridium* herein, as *M. baldisii* nom. nov.

Multiplicisphaeridium moharrum Cramer, Díez, Rodriguez and Fombella 1976, p. 447, pl. 1, fig. 7; text-fig. 2, nos. 6, 6a. Provisionally transferred to *Visbysphaera* herein.

Multiplicisphaeridium molinum (Cramer 1964, p. 297-298, pl. 6, fig. 5; pl. 7, fig. 9; text-figs. 21a, 21b [*pars*]) Lister 1970, p. 91. Originally *Baltisphaeridium*; provisionally transferred to *Evittia* herein.

Multiplicisphaeridium monterrosae (Cramer 1969, p. 490, pl. 70, figs. 5-7; text-fig. 10f) Eisenack, Cramer and Díez Rodriguez 1973, p. 693-694. Originally *Baltisphaeridium*; subsequently also *Evittia*; transferred to *Dateriocradus* by Pöthé de Baldis 1981, p. 238.

Multiplicisphaeridium mucronatum (Stockmans and Willière 1963, p. 456-457, pl. 1, fig. 20; pl. 3, fig. 6; text-figs. 10-11) Eisenack, Cramer and Díez Rodriguez 1973, p. 695-697. Originally *Veryhachium*; subsequently *Baltisphaeridium*; transferred provisionally to *Diexallophasis* by Priewalder 1987, p. 32.

Multiplicisphaeridium multipugiunculatum Cramer and Díez 1977, p. 348, pl. 3, figs. 14-16, 18. Transferred to *Vulcanisphaera* herein.

Multiplicisphaeridium multiradiale (Burmann 1970, p. 293, pl. 4, fig. 1) Eisenack, Cramer and Díez 1976, p. 473-474. Originally, and herein returned to, *Vogtlandia*.

Multiplicisphaeridium neahgae Cramer 1970, p. 134, pl. 9, figs. 139-142; text-fig. 39 *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 701-702. Jr. synonym of *Multiplicisphaeridium mergaeferum* Loeblich Jr. 1970, according to Eisenack, Cramer and Díez Rodriguez 1973, p. 701. [See discussion in Fensome *et al.* 1990, p. 350].

Multiplicisphaeridium oligofurcatum (Eisenack 1954, p. 208-209, pl. 1, fig. 4; text-fig. 5) Eisenack, Cramer and Díez Rodriguez 1973, p. 703-704. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Visbysphaera*; returned to the latter genus by Priewalder 1987, p. 63.

Multiplicisphaeridium olsztynense Górka 1979, p. 367, pl. 17, fig. 8. Transferred to *Ammonidium* herein.

Multiplicisphaeridium opimum Uutela and Tynni 1991, p. 94, pl. 21, fig. 216. Transferred to *Vogtlandia* herein.

Multiplicisphaeridium ornatum Pöthé de Baldis 1971, p. 284, pl. 2, fig. 2. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium pachymurum Hill 1978, p. 184, pl. 1,

figs. 5-12. Transferred to *Diexallophasis* by Dorning 1981, p. 188.

Multiplicisphaeridium paleozoicum (Stockmans and Willière 1962a, p. 56, pl. 1, fig. 12; text-fig. 13) Eisenack, Cramer and Díez Rodriguez 1973, p. 707. Originally *Baltisphaeridium*; subsequently invalidly placed into *Ammonidium*; validly transferred to *Ammonidium* herein.

Multiplicisphaeridium palidodigitatum (Cramer 1966, p. 247, pl. 1, fig. 8; text-fig. 3, no. 5) Eisenack, Cramer and Díez Rodriguez 1973, p. 709-711. Originally *Baltisphaeridium*; transferred to *Ozotobrachion* by Playford 1977, p. 31-32.

Multiplicisphaeridium palmitellum (Cramer and Díez 1972b, p. 153-154, pl. 33, figs. 27-30) Eisenack, Carmer and Díez Rodriguez 1973, p. 713-714. Originally *Baltisphaeridium*; transferred to *Ammonidium* by Dorning 1981, p. 183.

Multiplicisphaeridium parvipinnatum Uutela and Tynni 1991, p. 95, pl. 21, fig. 217. Transferred to *Martinsphaeridium* herein.

Multiplicisphaeridium parvirochesterense (Cramer and Díez 1972b, p. 154, pl. 33, fig. 32) Eisenack, Cramer and Díez Rodriguez 1973, p. 719. Originally *Baltisphaeridium*; jr. synonym of *Baltisphaeridium* (now *Multiplicisphaeridium?*) *cladum* Downie 1963, according to Colbath 1979, p. 20-21.

Multiplicisphaeridium parvispinosum Uutela and Tynni 1991, p. 95, pl. 21, fig. 218. Transferred to *Martinsphaeridium* herein.

Multiplicisphaeridium pequenhum (Cramer and Díez 1972b, p. 154-155, pl. 33, figs. 33-35) Eisenack, Cramer and Díez Rodriguez 1973, p. 721-722. Originally *Baltisphaeridium*; transferred provisionally to *Ammonidium* herein.

Multiplicisphaeridium perhamatum Eisenack, Cramer and Díez 1979, p. 23-24 *nom.subst.pro Ammonidium hamatum* Wicander 1974, p. 16, pl. 5, figs. 10-12 *non Multiplicisphaeridium hamatum* (Burmann 1970) Eisenack, Cramer and Díez 1976. Returned to *Ammonidium* herein, the original name *hamatum* regaining validity.

Multiplicisphaeridium perirregulare Eisenack, Cramer and Díez 1979, p. 25-26 *nom.subst.pro Exochoderma irregulare* Wicander 1974, p. 24-25, pl. 11, figs. 7-9 *non Multiplicisphaeridium irregulare* Staplin *et al*, 1965. Originally *Exochoderma*; returned to that genus by Wicander 1983, p. 37.

Multiplicisphaeridium petalum (Wicander 1974, p. 16, pl. 5, figs. 5-8) Eisenack, Cramer and Díez 1979b, p. 27. Originally *Acriora*; returned to that genus by Wicander 1983, p. 7.

Multiplicisphaeridium picorricum (Cramer 1964, p. 303-304, pl. 11, figs. 1-3; text-fig. 24) Lister 1970, p. 92. Originally *Micrhystridium*; also invalidly placed into *Hystrichosphaeridium*. Jr. synonym of *Baltisphaeridium* (now *Multiplicisphaeridium*) *cladum* Downie 1963, according to Colbath 1979, p. 20.

Multiplicisphaeridium pilar (Cramer 1964, p. 286, pl. 1, figs. 1-2; text-fig. 14, no. 1) Eisenack, Cramer and Díez Rodriguez 1973, p. 725-727. Originally *Baltisphaeridium*; subsequently *Cymbosphaeridium*; also invalidly placed into *Priscogalea*. Returned to *Cymbosphaeridium* by Miller 1987, p. 100.

Multiplicisphaeridium piriferum (Eisenack 1954, p. 206-207, pl. 1, figs. 1a-b; text-fig. 1) Eisenack, Cramer and Díez Rodriguez 1973, p. 737-739. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*; transferred to *Visbysphaera* by Kiryanov 1978, p. 89-90.

Multiplicisphaeridium pleniluniun (Wicander 1974, p. 30, pl. 15, figs. 4-6) Cramer and Díez 1979, p. 53. Originally *Naevisphaeridium*; returned to that genus by Wicander 1983, p. 58.

Multiplicisphaeridium polydactylum (Tappan and Loeblich Jr. 1971, p. 396, pl. 5, figs. 1-7) Cramer and Díez 1979, pl. 53. Originally *Dateriocradus*; combination not validly published [see Fensome *et al.* 1990, p. 352]. Jr. synonym of *Baltisphaeridium* (now *Dateriocradus*) *monterrosae* Cramer 1969, according to Eisenack, Cramer and Díez 1976, p. 185.

Multiplicisphaeridium polykion (Loeblich Jr. and Tappan 1970, p. 262-266, figs. 1-12) Eisenack, Cramer and Díez Rodriguez 1973, p. 741. Originally *Thysanoprobolus*; returned to that genus by Wicander 1983, p. 91.

Multiplicisphaeridium prolongatum (Burmann 1970, p. 295, pl. 5, figs. 1-2, 5) Fensome, Williams, Barss, Freeman and Hill 1990, p. 352. Originally *Adorfia*; transferred to *Schizodiacrodium* herein.

Multiplicisphaeridium pumilispinosum (Wicander 1974, p. 17, pl. 5, figs. 1-2) Eisenack, Cramer and Díez 1979, p. 31. Originally, and herein returned to, *Barathrisphaeridium*.

Multiplicisphaeridium? pustulatum (Schultz 1967, p. 180-181; pl. 1, fig. 11) Eisenack, Cramer and Díez Rodriguez 1973, p. 745. Originally *Baltisphaeridium*; transferred to *Buedingiisphaeridium* herein.

Multiplicisphaeridium rabiosum (Cramer 1964, p. 299, pl. 5, fig. 7, pl. 6, figs. 3, 8; pl. 7, figs. 5, 8-9; text-fig. 21b [*pars*]) Eisenack, Cramer and Díez Rodriguez 1973, p. 747-749. Originally *Veryhachium*; subsequently *Baltisphaeridium*; also invalidly placed into *Evittia*. Transferred to the latter genus herein.

Multiplicisphaeridium radicosum Loeblich Jr. 1970, p. 730, figs. 23A-E. Transferred to *Hoegklintia* by Jacobson and Achab 1985, p. 183.

Multiplicisphaeridium rakoae (Stockmans and Willière 1969, p. 20-21, pl. 4, figs. 1-3) Eisenack, Cramer and Díez Rodriguez 1973, p. 753. Originally *Baltisphaeridium*; transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium ramibrachium (Wicander 1974, p. 25, pl. 11, fig. 5) Eisenack, Cramer and Díez 1979, p. 33. Originally *Exochoderma*; returned to that genus by Wicander 1983, p. 37.

Multiplicisphaeridium ramidenticulatum (Cramer and Díez 1972b, p. 155, pl. 33, fig. 31)Eisenack, Cramer and Díez Rodriguez 1973, p. 755-756. Originally *Baltisphaeridium*; transferred to *Diexallophasis* herein.

Multiplicisphaeridium ramificatum (Burmann 1970, p. 292-293, pl. 3, figs. 4-5) Eisenack, Cramer and Díez 1976, p. 477-478. Originally placed, as type species, into *Vogtlandia*; implicitly returned to that genus by Dean and Martin 1978, p. 9-10 [see discussion in Fensome *et al.* 1990, p. 532].

Multiplicisphaeridium raplaense Uutela and Tynni 1991, p. 96, pl. 23, fig. 235. Transferred to *Martinsphaeridium* herein.

Multiplicisphaeridium raquelinae Cramer and Díez 1972a, p. 43-44, pl. 1, fig. 7. Transferred to *Timofeevia* by Cramer and Díez 1979, p. 53.

Multiplicisphaeridium raspum (Cramer 1964, p. 301, pl. 4, figs. 1-6, 11) Eisenack, Cramer and Díez Rodriguez 1973, p. 767-768. Originally *Baltisphaeridium*; subsequently *Micrhystridium*; transferred provisionally to *Gorgonisphaeridium* herein.

Multiplicisphaeridium ravum (Downie 1963, p. 643, pl. 91, fig. 6; text-fig. 3c) Eisenack, Cramer and Díez Rodriguez 1973, p. 769-771. Originally *Baltisphaeridium*; transferred to *Cymbosphaeridium* by Dorning 1981, p. 186.

Multiplicisphaeridium rayii Cramer, Allam, Kanes and Díez

1974a, p. 186, pl. 27, figs. 1, 2, 6. Transferred to *Lusatia* herein.

Multiplicisphaeridium rechonchum Cramer, Díez, Rodriguez and Fombella 1976, p. 447-448, pl. 1, fig. 2; text-fig. 2, no. 13. Transferred to *Barathrisphaeridium* herein.

Multiplicisphaeridium remotum (Deunff 1955, p. 146, pl. 4, fig. 8) Eisenack, Cramer and Díez Rodriguez 1973, p. 773. Originally *Veryhachium*; subsequently *Evittia*; emended, and transferred to *Diexallophasis*, by Playford 1977, p. 19-21.

Multiplicisphaeridium rigidum Deunff *in* Eisenack, Cramer and Díez Rodriguez 1973, p. 775. *Nomen nudum*: see discussion in Fensome *et al.* 1990, p. 354.

Multiplicisphaeridium robustum Fu Jiayuan 1986b, p. 120, pl. 4, figs. 17, 25-26. Jr. homonym of *Multiplicisphaeridium robustum* (Sanneman 1955) Eisenack, Cramer and Díez Rodriguez 1973. Renamed as *Multiplicisphaeridium fui* by Fensome *et al.* 1990, p. 347 and transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium rusticum Martin 1973, p. 11-12, pl. 1, figs. 28-29, 32; pl. 4, fig. 131; pl. 5, figs. 150-153, 156, 163, 166, 169-170. Transferred to *Piliferosphaera* by Martin 1978, p. 40.

Multiplicisphaeridium saharicum Lister 1970, p. 94, pl. 12, figs. 2-4. Transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium sanpetrense (Cramer 1964, p. 293-294, pl. 3, figs. 15-16; text-fig. 17, no. 3; text-fig. 18 *ex* Cramer 1970, p. 141) Eisenack, Cramer and Díez Rodriguez 1973, p. 789-790. Originally *Baltisphaeridium*; subsequently *Diexallophasis*; transferred to *Evittia* invalidly by Lister 1970, p. 67 and validly by Le Hérissé 1989, p. 130, but herein returned to *Diexallophasis*.

Multiplicisphaeridium sartbernardense (Martin 1966b, p. 434-435, text-figs. 11-13) Eisenack, Cramer and Díez Rodriguez 1973, p. 791-792. Originally *Veryhachium*; subsequently *Baltisphaeridium* and *Dateriocradus*; also invalidly placed into *Evittia*. Placed into *Frankea* by Colbath 1986, p. 73.

Multiplicisphaeridium scaber Díez and Cramer 1976, p. 128, pl. 2, figs. 4-6, 8-9. Transferred to *Villosacapsula* herein.

Multiplicisphaeridium selviellae (Cramer 1970, p. 190-191, text-fig. 62a) Eisenack, Cramer and Díez Rodriguez 1973, p. 793-794. Originally *Baltisphaeridium*; transferred to *Actipilion* herein.

Multiplicisphaeridium semipunctatum Pöthé de Baldis 1979, p. 165, pl. 1, figs. 12, 15. Transferred to *Villosacapsula* herein.

Multiplicisphaeridium septispinosum Lister 1970, p. 94-95, pl. 12, figs. 9-16. Jr. synonym of *Hystrichosphaeridium* (now *Oppilatala*) *eoplanktonicum* Eisenack 1955 according to Eisenack, Cramer and Díez Rodriguez 1973, p. 617.

Multiplicisphaeridium setosum (Loeblich Jr. 1970, p. 735-736, text-figs. 31A-C) Eisenack, Cramer and Díez Rodriguez 1973, p. 795-796. Originally the type species of *Piliferosphaera*; implicitly returned to that genus by Dorning 1981, p. 197 [see discussion in Fensome *et al.* 1990, p. 394].

Multiplicisphaeridium snigirevskaiae (Stockmans and Willière 1963, p. 459-460, pl. 1, fig. 5; text-fig. 15) Fensome *et al.* 1990, p. 355. Originally *Baltisphaeridium*; transferred to *Unellium* herein. [Note: The spelling of the trivial name as '*snigirevskae*' in Fensome *et al.* 1990, p. 355, is an error in citation.]

Multiplicisphaeridium solitarium Fombella 1978, p. 253-254, pl. 3, fig. 11. Transferred to *Estiastra* herein.

Multiplicisphaeridium sommeri (Brito 1967, p. 477-478, pl. 1, figs. 9-12) Eisenack, Cramer and Díez Rodriguez 1973, p. 799-800. Originally the type species of *Evittia*; subsequently also *Baltisphaeridium*; implicitly returned to *Evittia* by Deunff 1977, p. 143. [See discussion in Fensome *et al.* 1990, p. 216-217].

Multiplicisphaeridium spicatum Staplin 1961, p. 411-412, pl. 49, fig. 21. Subsequently *Baltisphaeridium*; emended and transferred to *Gorgonisphaeridium* by Staplin, Jansonius and Pocock 1965, p. 193.

Multiplicisphaeridium spiciferum (Deunff 1955, p. 146, pl. 3, fig. 1; text-fig. 26) Eisenack, Cramer and Díez Rodriguez 1973, p. 801. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*; also invalidly placed into *Evittia* and *Veryhachium*; transferred to *Stellechinatum* herein.

Multiplicisphaeridium spinosum Uutela and Tynni 1991, p. 97, pl. 23, fig. 237. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium? sprucegrovense Staplin 1961, p. 411, pl. 48, fig. 22; pl. 49, fig. 6; text-fig. 9. Subsequently *Baltisphaeridium* and *Hercyninia*; also invalidly placed in *Ammonidium*; emended and transferred to *Crateri-sphaeridium* by Turner 1986, p. 602-606.

Multiplicisphaeridium stockmansii (Martin 1966a, p. 363, pl. 1, fig. 17; text-fig. 9) Eisenack, Cramer and Díez Rodriguez 1973, p. 803. Originally *Baltisphaeridium*; transferred provisionally to *Gorgonisphaeridium* herein.

Multiplicisphaeridium striatum Uutela and Tynni 1991, p. 97-98, pl. 23, fig. 238. Transferred to *Diexallophasis* herein.

Multiplicisphaeridium subbifurcatum (Stockmans and Willière 1967) Eisenack, Cramer and Díez 1979b, p. 41. Originally *Micrhystridium*. Here considered to be a jr. synonym of *Multiplicisphaeridium bifurcatum* Staplin, Jansonius and Pocock 1965.

Multiplicisphaeridium succinum (Lister 1970, p. 75, pl. 8, figs. 1-4) Eisenack, Cramer and Díez Rodriguez 1973, p. 805-806. Originally *Gorgonisphaeridium*; returned to that genus by Kiryanov 1978, 55-56.

Multiplicisphaeridium temblorosum Fombella 1979, p. 2, 4. *Nomen nudum*: see Fensome *et al.* 1990, p. 356 for discussion.

Multiplicisphaeridium tenuatum (Burmann 1970, p. 293, pl. 3, fig. 3; pl. 4, fig. 2) Eisenack, Cramer and Díez 1976, p. 485-486. Originally *Vogtlandia*; transferred to *Lusatia* herein.

Multiplicisphaeridium tenuiramusculosum (Stockmans and Willière 1963, p. 457, pl. 3, fig. 9; text-fig. 12) Eisenack, Cramer and Díez Rodriguez 1973, p. 807. Originally *Baltisphaeridium*; subsequently *Micrhystridium* and *Oppilatala*; tentatively reattributed to *Oppilatala* by Priewalder 1987, p. 49.

Multiplicisphaeridium thusui Fensome, Williams, Barss, Freeman and Hill 1990, p. 356, *nom.subst.pro Multiplicisphaeridium bifurcatum* (Thusu 1973a) Eisenack, Cramer and Díez 1976, *non M. bifurcatum* Staplin, Jansonius and Pocock 1965. Provisionally transferred herein to *Martinsphaeridium*, as *M.? bifurcatum*.

Multiplicisphaeridium thyrae (Cramer 1964, p. 316-317, pl. 12, figs. 10, 13; text-fig. 30, nos. 5-6) Eisenack, Cramer and Díez Rodriguez 1973, p. 809-810. Originally *Veryhachium*; subsequently *Evittia* and *Baltisphaeridium*; returned to *Evittia* herein.

Multiplicisphaeridium titilator (Cramer and Díez 1972b, p. 158, pl. 34, fig. 42) Eisenack, Cramer and Díez Rodriguez 1973, p. 811-812. Originally *Baltisphaeridium*; transferred to *Oppilatala* herein.

Multiplicisphaeridium torrestionense (Cramer 1964, p. 317, pl. 15, fig. 1; tetx-fig. 30, no. 3) Eisenack, Cramer and Díez

Rodriguez 1973, p. 813. Originally *Veryhachium*; also transferred invalidly to *Evittia*. Jr. synonym of *Veryhachium* (now *Dateriocradus*) *asturiae* Cramer 1964 according to Cramer 1970, p. 171. [See discussion in Fensome *et al.* 1990, p. 356-357].

Multiplicisphaeridium? toyetae (Cramer 1964, p. 302, pl. 1, figs. 14-15; text-fig. 22, nos. 7-7a) Eisenack, Cramer and Díez Rodriguez 1973, p. 815-816. Originally *Baltisphaeridium*; subsequently also *Hystrichosphaeridium*; transferred to *Florisphaeridium* by Cramer and Díez 1976, p. 83-84.

Multiplicisphaeridium toyetaforme Uutela and Tynni 1991, p. 98, pl. 23, fig. 239. Transferred to *Diexallophasis* herein.

Multiplicisphaeridium triangulatum (Downie 1963, p. 631, pl. 92, fig. 1) Dorning 1981, p. 194. Originally *Lophosphaeridium*; transferred to *Gorgonisphaeridium* herein.

Multiplicisphaeridium tribrachiatum (Lister 1970, p. 71, pl. 5, fig. 5; text-fig. 20c) Eisenack, Cramer and Díez Rodriguez 1973, p. 817. Originally *Evittia*; transferred to *Dateriocradus* by Dorning 1981, p. 186.

Multiplicisphaeridium trispinoramosum (Stockmans and Willière 1962b, p. 83-84, pl. 1, fig. 1; text-fig. 1) Eisenack, Cramer and Díez Rodriguez 1973, p. 819. Originally *Veryhachium*; also placed invalidly into *Evittia*; transferred to *Frankea* herein.

Multiplicisphaeridium truncatum Staplin 1961, p. 411, pl. 48, fig. 23. Transferred to *Ammonidium* herein. [Note: A transfer to *Baltisphaeridium* was not accepted by Eisenack, Cramer and Díez 1979, p. 43].

"Multiplicisphaeridium trunculatum". A misspelling of the name *M. truncutum* Wicander and Loeblich Jr. 1977, p. 148, pl. 6, fig. 7 in Fensome *et al.* 1990, p. 357.

Multiplicisphaeridium turgidum Uutela and Tynni 1991, p. 98, pl. 23, fig. 240. Transferred to *Vogtlandia* herein.

Multiplicisphaeridium variabile (Lister 1970, p. 87-88, pl. 11, figs. 4-7, 9-10; text-figs. 25d, 26c) Dorning 1981, p. 194. Originally *Multiplicisphaeridium arbusculiferum* var. *variabile*; transferred provisionally to *Ammonidium* herein.

Multiplicisphaeridium varians (Stockmans and Willière 1963, p. 465-466, pl. 2, fig. 15; text-figs. 25-26) Eisenack, Cramer and Díez Rodriguez 1973, p. 821. Originally *Micrhystridium*; also invalidly placed into *Baltisphaeridium*; transferred to *Unellium* herein.

Multiplicisphaeridium? varipinnosum (Uutela and Tynni 1991, p. 86, pl. 20, fig. 202) Sarjeant and Stancliffe 1994, p. 32. Originally *Micrhystridium*; transferred to *Tylotopalla* herein.

Multiplicisphaeridium venustum (Sannemann 1955, p. 345, pl. 5, fig. 11; text-fig. 15) Eisenack, Cramer and Díez Rodriguez 1973, p. 827. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*; transferred to *Hapsidopalla* by Playford 1977, p. 25. [Note: Like the other species described by Sannemann, this may well be a muellerisphaerid; see comments, p. xx].

Multiplicisphaeridium verrucosum Uutela and Tynni 1991, p. 98-99, pl. 23, fig. 241. Transferred to *Diexallophasis* herein.

Multiplicisphaeridium vestitum (Deflandre 1938, p. 189-190, pl. 11, figs. 4-6) emend. Pocock 1972, p. 116. Late Jurassic (Oxfordian), France. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*; also placed into *Systematophora*. Transferred to *Surculosphaeridium* by Davey, Downie, Sarjeant and Williams 1966. A dinoflagellate cyst.

Multiplicisphaeridium vilnense (Yankauskas 1976, p. 188-189, pl. 25, figs. 1-3, 6) Yankauskas *in* Volkova, Kiryanov, Piskun, Paskeviciene and Yankauskas, 1979. Originally *Baltisphaeridium*; jr. synonym of *Multiplicisphaeridium* (now *Timofeevia*) *lancariae* Cramer and Díez 1972a, according to Martin *in* Martin and Dean 1981, p. 20.

Multiplicisphaeridium vinhuelae Cramer 1970, p. 158, pl. 15, fig. 219; text-fig. 47n *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 829-830. Originally invalidly placed in *Baltisphaeridium*; transferred to *Actipilion* herein.

Multiplicisphaeridium visbyense (Eisenack, 1959a, p. 200-201, pl. 16, figs. 12-14; text-fig. 7) Eisenack, 1969a, p. 259. Originally *Baltisphaeridium*; subsequently *Veryhachium*; transferred, as type species, to *Hoegklintia* by Dorning 1981, p. 192.

Multiplicisphaeridium waldronense (Tappan and Loeblich Jr. 1971, p. 392, pl. 3, figs. 1-8) Eisenack, Cramer and Díez 1976, p. 487-488. Originally *Caiacorymbifer*; transferred to *Ammonidium* by Dorning 1981, p. 183.

Multiplicisphaeridium? waltonii Downie 1982, p. 262, figs. 7g-i. Transferred to *Tylotopalla* herein.

Multiplicisphaeridium wenlockium (Thusu 1973a, p. 814-815, pl. 105, fig. 11) Eisenack, Cramer and Díez 1976, p. 489. Originally *Gorgonisphaeridium*; transferred to *Visbysphaera* by Dorning 1981, p. 176.

Multiplicisphaeridium winslowiae (Staplin, Jansonius and Pocock 1965, p. 192-193, pl. 19, figs. 11, 18-20; text-fig. 4) Eisenack, Cramer and Díez Rodriguez 1973, p. 835-836. Originally the type species of *Gorgonisphaeridium*; returned to that genus by Cramer and Díez 1979, p. 49.

Multiplicisphaeridium xianum Fombella 1977, p. 119, pl. 1, fig. 13; text-fig. 1, no. 10. Transferred to *Vogtlandia* herein.

Multiplicispheridium yankauskasii Fensome, Williams, Barss, Freeman and Hill 1990, p. 358, *nom.subst.pro Multiplicisphaeridium dendroideum* (Yankauskas 1976, p. 189, pl. 25, fig. 19) Yankauskas and Kiryanov in Volkova *et al.* 1979, p. 6. Transferred to *Vogtlandia* herein.

Genus ***Acriora*** Wicander 1974, p. 15-16.

Diagnosis: (Wicander 1974, p. 15-16). "Vesicle spherical, wall moderately thick, with corrugate-foveolate sculpture; numerous laevigate processes, hollow, but not opening into vesicle; processes furcate distally to form 4 to 6 aculeate branches; excystment by simple splitting of vesicle wall."

Remarks: This genus differs from *Multiplicisphaeridium* in the sculpture of its vesicle and in having processes with closed bases.

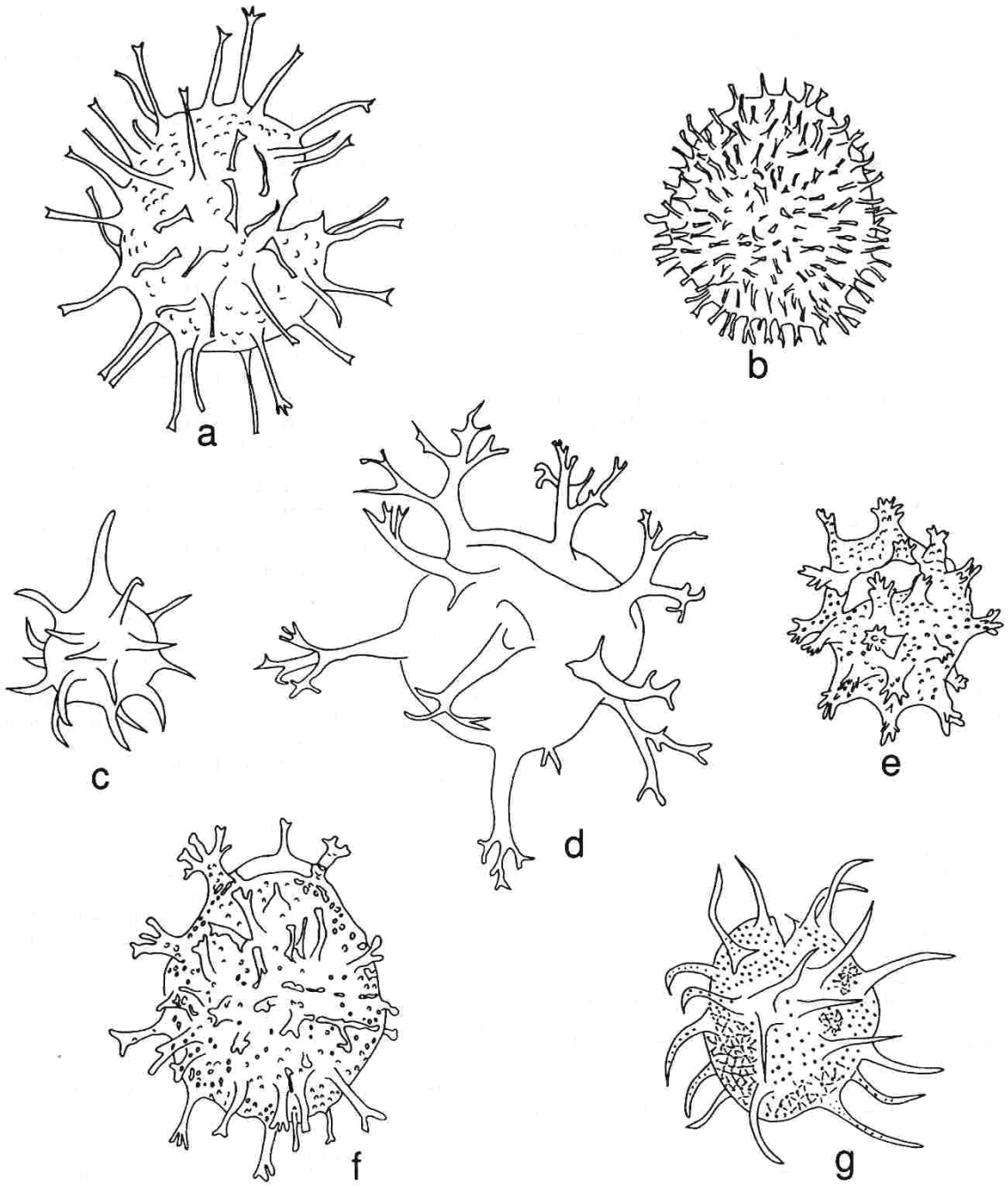
Type species: Acriora petala Wicander 1974 p. 16, pl. 5, figs. 5-8. Upper Devonian, Ohio, U.S.A.

Systematic reassignments:

Acriora areolata (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 120-121, pl. 3, figs. 2, 7, 10) comb. nov. Holotype pl. 3, fig. 10. Late Silurian, Saharan Algeria. Originally *Baltisphaeridium areolatum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the process cavities are not linked to the shell interior, and may be simple or may show only one order of branching.

Acriora areolata subsp. *areolata*. Autonym.

Acriora areolata subsp. *laevigata* (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 121, pl. 3, figs. 2, 7) comb. nov. Holotype pl. 3, fig. 7. Late Silurian, Saharan Algeria. Originally *Baltisphaeridium areolatum* subsp. *laevigatum*.



text-figure 2

Genera with processes in moderate to large number. a) *Ammonidium microcladum* (Downie): specimen illustrated by Lister 1970, pl. 1, fig. 9; b) *Martinsphaeridium macilentum* (Playford & Martin) comb. nov.: the holotype, after Playford & Martin, 1984, fig. 5B; c) *Unellium piriforme* Rauscher: specimen illustrated by Rauscher, 1969, pl. 1 fig. 2; d) *Tylotopalla digitifera* Loeblich Jr. 1970: the holotype, after Loeblich Jr. 1970, fig. 33E; f) *Rhaetosphaeridium dendroidium* (Morbey) comb. nov.: interpretative drawing based on Morbey 1975, pl. 16 fig. 22 and text-fig. 24; g) *Wicanderidinium invenustum* (Wicander & Wood) comb. nov.: the holotype, after Wicander and Wood, 1981, pl. 14 fig. 4. Sketches not to scale with one another.

Genus ***Actipilion*** Loeblich Jr. 1970, p. 710.

Diagnosis: (Loeblich Jr. 1970, p. 710). "Spherical to subspherical central body, apparently bilayered; processes formed from the outer layer and do not communicate with the central body; wall of central body dense and thick, variously sculptured, granulate, verrucate to rugulate, wall of processes thin, filmy and readily detached; excystment by simple splitting of the central body."

Remarks: This genus differs from *Multiplicisphaeridium* in the strong difference in appearance between the dense central body and the filmy, fragile processes, which do not branch distally.

Type species: *Actipilion druggii* Loeblich Jr. 1970, p. 711, figs. 3A-E. Holotype fig. 3A. Late Ordovician, Oklahoma, U.S.A.

Systematic reassignments:

Actipilion selviellae (Cramer 1970, p. 190-191, text-fig. 62a) comb. nov. Late Silurian (Ludlow)-Early Devonian (Early Gedinnian), Spain. Originally *Baltisphaeridium selviellae*; transferred from *Multiplicisphaeridium*, since the vesicle wall is thick, the processes being formed only from its outer layer; they are hollow and thin, highly flexible and numerous, their cavity sometimes or consistently separated from the vesicle cavity. Distally, the processes are usually, perhaps consistently, unbranched. Cramer's illustration does not support his contention that they sometimes anastomose.

Actipilion vinhuelae (Cramer 1970, p. 158, pl. 15, fig. 219; text-fig. 47n) comb. nov. Late Silurian (Ludlow)-Early Devonian (Lower Gedinnian), Spain. Originally *Baltisphaeridium vinhuelae*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle is thick and two-layered, the processes arising from the thin outer layer and unconnected to the vesicle interior. The processes are short, baculate to lobulate or of irregular form. [Note: In discussion with R.A. Fensome, he informs us that he now believes that Fensome *et al.* 1990, p. 358, were incorrect in considering the species to be invalid until the citation by Eisenack, Cramer and Díez Rodriguez 1973, p. 829-830, since *I.C.B.N.* Article 7 requires that the holotype be illustrated but does not require that the illustration of it be identified.]

Genus ***Ammonidium*** Lister 1970, p. 48-49 **emend.**

Ammonidium Lister 1970, p. 48-49; Loeblich Jr. and Wicander 1976, p. 6; Wicander 1983, p. 7; emend. Le Hérissé 1989, p. 80-81; Fensome *et al.* 1990, p. 58.

Junior synonym:

Caiacorymbifer Tappan and Loeblich Jr. 1971 [See Loeblich Jr. and Wicander 1976, p. 6]

Original diagnosis: (Lister 1970, p. 48). "Vesicle hollow, spherical to ellipsoidal, single-walled; vesicle wall smooth or sculptured. Processes numerous, evenly spaced, more or less rigid, hollow, tapering, communicating freely with the vesicle cavity; distally the processes have equifurcate terminations. Excystment by cryptosuture, apical or near-equatorial."

Emended diagnosis: (Le Hérissé 1989; p. 80-81; new transl.): "Vesicle spherical with circular or ellipsoidal outline with wall single, thin, smooth or lightly ornamented (microgranulate, scabrate, microrugulate), bearing numerous processes of variable length, equidistant, homomorphic, whose distal extremity is divided into a cluster of 3-5 short branches, extended in a single plane; the branches may be divided at tip; on each process the branches are of equal length and for a given specimen the branches appear identical; the stems of the processes may display a light granulation; the system of opening is of a simple slit type with slight ridges on the margins."

Emended diagnosis: Vesicle hollow, spherical to ellipsoidal, single-walled or apparently so. Processes moderately numerous to numerous (in excess of 20), their length typically exceeding 20% of the vesicle diameter. They are slender, showing only a slight proximal inflation, and hollow, their cavity communicating directly with the vesicle interior. The processes are usually homomorphic, but may show a restricted degree of variation; they are closed distally and exhibit a single order of branching confined to the distal extremity. Distal branching is usually uniform, into a low number of branches (2-6); occasionally a few processes may be acuminate. The branches are typically of equal or near-equal length and may show secondary division into branchlets; they show no linkage by trabeculae with other processes and are not enclosed within an ecteilyma. Eilyma and surfaces of processes laevigate or with inconspicuous ornamentation, but not striate or areolate and not exhibiting any pattern of indentations. Excystment by cryptosuture.

Remarks: The diagnosis of *Ammonidium* is here emended to allow for some variation in the distal process branching and to exclude species whose vesicle exhibits a strong ornamentation. The concepts of Le Hérissé (1989) in general accord with ours, save for minor differences and a requirement that the processes be relatively long. The concept of the genus expressed abovem accords with that of Eiserhardt (1992, p. 49) in that he conceives *Ammonidium* as only embracing species in which the branching is entirely distal and of lesser complexity than that of *Multiplicisphaeridium*. However, we differ from him in that we include forms in which a secondary division of the process branches into branchlets.

Ammonidium differs from *Martinsphaeridium* essentially in the greater proportionate length of its processess; this separation parallels that made between *Comasphaeridium* and *Filisphaeridium*, genera whose processes are uniformly simple and, for that reason, potentially more crowded in their placement on the vesicle. The processes of *Gracilisphaeridium* Eisenack, Cramer and Díez Rodriguez 1973 have pinnae linked together to form loops.

Ammonidium differs from *Palaiosphaeridium* Rasul 1977 and *Petaloferidium* Jacobson 1978 in the greater number and length of the processes and their more complex character; from *Paniculaferum* Miller 1991 in the lesser complexity of the distal branching; and from *Vandalosphaeridium* Vidal 1981 in not being enclosed with an ecteilyma. It differs from *Craterisphaeridium* Deunff 1981 in lacking ring-like ridges on the eilyma surface, from *Naevisphaeridium* Wicander 1974 in the absence of elliptical depressions in the eilyma surface and from *Piliferosphaera* in lacking "short spine-like pyla". It differs from *Filisphaeridium* and *Comasphaeridium* in having branched processes and from the former genus in the greater length and lesser number of the processes.

Type species: Ammonidium microcladum (Downie 1963, p. 645, pl. 91, fig. 3, pl. 92, fig. 6; text-fig. 3g) Lister 1970, p. 49-50. Holotype pl. 92, fig. 6. Early Silurian (Wenlock), England. Originally *Baltisphaeridium*. [Note: illustrated herein as Text-fig. 2a]

Accepted species:

Ammonidium belmonte (Cramer 1970, p. 145, pl. 14, figs. 196-201; text-fig. 47j *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 533-534) comb. nov. Holotype pl. 14, fig. 199. Late Silurian (Ludlow)-Early Devonian (Early Gedinnian), Spain. Originally *Multiplicisphaeridium belmonte*; transferred to *Ammonidium* since the processes show one order of palmate branching.

Ammonidium belmontiforme (Tynni 1975, p. 28, pl. 3, fig. 8) comb. nov. Middle Ordovician, Bothnian Sea, Finland. Originally *Multiplicisphaeridium belmontiforme*; transferred to *Ammonidium* since the numerous processes have a length of around one-fifth of the vesicle diameter and show one order of palmate branching.

Ammonidium carrascum (Cramer 1966, p. 243, pl. 1, fig. 1) comb. nov. Early Devonian (Gedinnian-Emsian), Spain. Originally *Baltisphaeridium carrascum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the processes are slender and have a length up to 25% of the vesicle diameter, dividing at their distal extremities into up to 6 branches.

Ammonidium cornuatum Loeblich Jr. and Wicander 1976, p. 6-7, pl. 1, figs. 4-6. Holotype pl. 1, fig. 4. Early Devonian (Late Gedinnian), Oklahoma, U.S.A.

Ammonidium crinitum (Grishina *in* Grishina and Klenina 1981, p. 31-32, pl. 1, fig. 10) comb. nov. Early Silurian (Late Wenlock), Kazakhstan. Originally *Micrhystridium crinitum*; subsequently, and transferred from, *Multiplicisphaeridium?*, since the processes are slender and numerous, sometimes simple and sometimes bifurcate, but never showing two orders of branching.

Ammonidium grosjeanii (Stockmans and Willière 1962b, p. 87-88, pl. 2, fig. 17; text-fig. 6) Martin 1981, p. 10-11. Late Devonian (Frasnian), Belgium. Originally *Baltisphaeridium*; subsequently *Micrhystridium* and *Multiplicisphaeridium*.

Ammondium hamatum Wicander 1974, p. 16, pl. 5, figs. 10-12. Holotype pl. 5, figs. 11-12. Late Devonian, Ohio, U.S.A. The transfer to *Multiplicisphaeridium* by Eisenack, Cramer and Díez 1976, p. 23-24 is not accepted, since the spheroidal vesicle bears 23-25 processes, distally furcate and showing an immediate secondary division into four small aculeate branches. The substitute trivial name *perhamatum*, proposed by those authors because of a synonymy occurring upon transfer, thus becomes superfluous.

Ammonidium inornatum Colbath 1990, p. 112, pl. 5, figs. 13-14, 23-24. Holotype pl. 5, figs. 13-14. Middle-Late Devonian (Givetian-Frasnian), Western Australia.

Ammonidium maravillosum (Cramer 1969, p. 489-490, pl. 70, figs. 1-4; text-figs. 1A-C) Thusu 1973b, p. 140. Holotype pl. 70, figs. 1-2. Early Silurian (Late Llandovery), Pennsylvania, U.S.A. Originally *Baltisphaeridium*; subsequently *Multiplicisphaeridium*. [Note: the microrugulate structure of the eilyma may justify eventual removal of this species into a separate genus].

Ammonidium maritimum Martin 1985, p. 16-17, pl. 8, figs. 1-2. Holotype pl. 8, fig. 1. Late Devonian (Early Famennian), Belgium.

Ammonidium microfurcatum (Deunff 1957, p. 6; fig. 2, p. 13; fig. 3, p. 14) Fensome, Williams, Barss, Freeman and Hill 1990, p. 59. Holotype fig. 2, p. 1. Middle Devonian, Canada. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium*; also invalidly attributed to *Veryhachium*.

Ammonidium olsztynense (Górka 1979, p. 367, pl. 17, fig. 8) comb. nov. Middle Ordovician (Llandeilo), Poland. Originally *Multiplicisphaeridium olsztynense*; transferred to *Ammonidium* since the appendages are numerous, slender and exhibit a single order of "plurifurcate" branching into five "tonguelets".

Ammonidium paleozoicum (Stockmans and Willière 1962a, p. 56, pl. 1, fig. 12; text-fig. 13) comb. nov. Early Carboniferous (Tournaisian), Belgium. Originally *Baltisphaeridium plaeozoicum*; subsequently *Multiplicisphaeridium*; also invalidly placed into *Ammonidium* [see Fensome *et al.* 1990, p. 60, 350]. Transfer validated herein, since the form and proportionate length of the processes accord with *Ammonidium*.

Ammonidium palmitellum (Cramer and Díez 1972b, p. 153-154, pl. 33, figs. 27-30) Dorning 1981, p. 183. Early Silurian (Llandovery-Wenlock), Kentucky, U.S.A. Originally *Baltisphaeridium palmitellum*; subsequently *Multiplicisphaeridium*. Retained in *Ammonidium*, since the processes are slender and flexible, palmately branched and in length exceeding 25% of the vesicle diameter. [Note: Cramer and Díez *op.cit.*, p. 154, indicate a process length of 30-75% of the vesicle diameter, but their illustrations do not support this].

Ammonidium? pequenhum (Cramer and Díez 1972b, p. 154-155, pl. 33, figs. 33-35) comb. nov. Holotype pl. 33, fig. 35. Early Silurian (Late Wenlock), Kentucky, U.S.A. Originally *Baltisphaeridium pequenhum*; provisionally transferred from *Multiplicisphaeridium*, since the spheroidal vesicle bears 30-40 processes exhibiting a single order of palmate branching. However, the illustrations of the type material indicate two different morphologies; the holotype has significantly thicker and more heteromorphic processes than the other illustrated specimens. A restudy of the type material will be necessary before confident generic placement is possible.

Ammonidium perhamatum (Eisenack, Cramer and Díez 1979, p. 23-24) comb. nov. Holotype Wicander 1974, pl. 5, figs. 11-12. Late Devonian, Ohio, U.S.A. [*nom. subst. pro Ammonidium hamatum* Wicander 1974, p. 16, pl. 5, figs. 10-12 *non Multiplicisphaeridium hamatum* (Burmann 1970) Eisenack, Cramer and Díez 1976]. Originally renamed *Multiplicisphaeridium perhamatum;* transferred to *Ammonidium* since the spheroidal vesicle bears ca. 40 relatively short processes, distally furcate and showing an immediate secondary division into four small aculeate branches.

Ammonidium truncatum (Staplin 1961, p. 411, pl. 48, fig. 23) comb. nov. Late Devonian, Canada. Originally *Multiplicisphaeridium truncatum*; transferred to *Ammonidium* since the numerous slender processes are acuminate to bifurcate, showing only one order of branching.

Ammonidium uncinum Loeblich Jr. and Wicander 1976, pl. 7, pl. 2, figs. 3-4. Early Devonian (Late Gedinnian), Oklahoma, U.S.A.

Ammonidium? variabile (Lister 1970, p. 87-88, pl. 11, figs. 4-7, 9-10; text-figs. 25d, 26c) comb. nov. Holotype pl. 11, fig. 10. Late Silurian (Ludlow), England. Originally *Multiplicisphaeridium arbusculiferum* var. *variabile*; elevated to specific status by Dorning 1981, p. 194; transferred provisionally from *Multiplicisphaeridium*, since the processes are unbranched or show only one order of branching. The presence of unbranched processes, the relatively low process number and the subangular vesicle shape suggest that this species may be intermediate to *Polygonium*.

Ammonidium waldronense (Tappan and Loeblich Jr. 1971, p. 392, pl. 3, figs. 1-8) Dorning 1981, p. 183. Early Silurian (Early Wenlock), Indiana, U.S.A. Originally *Caiacorymbifer*; subsequently *Multiplicisphaeridium*.

Species formerly placed in *Ammonidium*.

Ammonidium aduncum Playford and Martin 1984, p. 191, figs. 4C-H. Transferred to *Martinsphaeridium* herein.

Ammonidium? alloiteaui (Deunff 1955, p. 148, pl. 4, fig. 3) Deunff 1976, p. 63. Originally *Micrhystridium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; transferred to *Martinsphaeridium* herein.

Ammonidium ballistum Ottone in Ottone, Toro and Waisfeld 1992, p. 98, 100, pl. 2, figs. 1-3, 8. Transferred to *Martinsphaeridium* herein.

Ammonidium cladum (Downie 1963, p. 643-644, pl. 92, fig. 5; text-fig. 3a) Hill 1974, p. 11. Originally *Baltisphaeridium*; subsequently also *Multiplicisphaeridium* and invalidly placed into *Peteinosphaeridium*; reassigned to *Multiplicisphaeridium* by Colbath 1979, p. 20-21.

Ammonidium encantador (Cramer 1970, p. 189-190, pl. 19, figs. 296-299; text-fig. 61 *ex* Eisenack, Cramer and Díez Rodriquez 1973, p. 513-514) Hill 1974, p. 11. Originally the type species of *Gracilisphaeridium*; returned to that genus by Cramer, Díez and Kjellström 1979, p. 48.

Ammonidium exoticum Deunff *in* Lister 1970, p. 49. *Nomen nudum*: for discussion see Fensome *et al.* 1990, p. 58.

Ammonidium furtivum Playford and Martin 1984, p. 191-192, figs. 4I-M. Ordovician (Arenig-Llanvirn) Transferred to *Tylotopalla* herein.

Ammonidium hydraferum (Stockmans and Willière 1962b, p. 93-94, pl. 2, fig. 15; text-fig. 13) Lister 1970, p. 49. Combination not validly published: for discussion see Fensome *et al.* 1990, p. 59.

Ammonidium lewisii (Deunff 1954, p. 240, fig. 3) Lister 1970, p. 49. Combination not validly published: for discussion see Fensome *et al.* 1990, p. 59.

Ammonidium listeri Smelror 1986, p. 141-142, pl. 3, figs. 1-3. Transferred to *Martinsphaeridium* herein.

Ammonidium loriferum (Deunff 1965, p. 163, figs. 6-8) Lister 1970, p. 49. Combination not validly published: for discussion see Fensome *et al.* 1990, p. 59.

Ammonidium ludloviense Lister 1970, p. 50, pl. 1, figs. 6, 12-14 *ex* Dorning 1981, p. 183. Transferred provisionally to *Martinsphaeridium* herein.

Ammonidium macilentum Playford and Martin 1984, p. 192, figs. 5A-F. Holotype fig. 5B. Early-Middle Ordovician (Late Arenig-Llanvirn), Western Australia. Transferred, as type species, to *Martinsphaeridium* herein.

Ammonidium rigidum Deunff in Lister 1970, p. 49. *Nomen nudum*: for discussion see Fensome *et al.* 1990, p. 60.

Ammonidium sprucegrovense (Staplin 1961, p. 411, pl. 48, fig. 22; pl. 49, fig. 6; text-fig. 9) Lister 1970, p. 49. Combination not validly published: for discussion see Fensome *et al.* 1990, p. 60.

Genus ***Barathrisphaeridium*** Wicander 1974, p. 16.

Diagnosis: (Wicander 1974): "Vesicle spherical, wall single layered, foveolate, with numerous flexible, solid, laevigate processes not communicating with the vesicle interior; excystment by splitting of vesicle wall."

Remarks: This genus differs markedly from *Multiplicisphaeridium* in having very numerous, short, solid and laevigate processes.

Type species: Barathrisphaeridium chagrinense Wicander 1974, p. 17, pl. 5, figs. 3-4. Late Devonian, Ohio, U.S.A. **Herein, Pl. II fig. 1.**

Systematic reassignments:

Barathrisphaeridium pumilispinosum Wicander 1974, p. 17, pl. 5, figs. 1-2. Late Devonian, Ohio, U.S.A. Originally *Barathrisphaeridium*; subsequently *Multiplicisphaeridium*; returned to *Barathrisphaeridium*, since the vesicle is foveolate and the processes are well-spaced, closed and short.

Barathrisphaeridium rechonchum (Cramer, Díez, Rodriguez and Fombella 1976, p. 447-448, pl. 1, fig. 6; text-fig. 2, no. 13) comb. nov. Early Devonian (Middle Siegenian-Emsian), Spain. Originally *Multiplicisphaeridium reconchum;* transferred to *Barathrisphaeridium* since the processes are numerous and short, arising from a foveolate vesicle and having tips of varied style but showing only one order of branching.

Genus ***Buedingiisphaeridium*** Schaarschmidt 1963, p. 69-70 emend. Sarjeant and Stancliffe 1994, p. 24.

Diagnosis: (Sarjeant and Stancliffe 1994, p. 24): "Vesicle spherical, of small to moderate size. Eilyma ornamented by numerous low verrucae or conical tubercles closed at the tip, often thickened or solid, sometimes hollow, or partially so, and with cavities communicating with the vesicle interior. Height of verrucae or tubercles typically less than 2 m."

Remarks: The morphology of this genus, with its relatively small vesicle covered by verrucae or tubercles, differs markedly from the genera of the *Multiplicisphaeridium* group. [Note: *Buedingiisphaeridium tremadocum* Rasul is illustrated in **Pl. II fig. 3** herein.]

Type species: Buedingiisphaeridium permicum Schaarschmidt 1963, p. 70, pl. 20, figs. 4-6; text-fig. 26. Upper Permian, Germany.

Systematic reassignment:

Buedingiisphaeridium pustulatum (Schultz 1967, p. 180-181; pl. 1, fig. 11) comb. nov. Early Silurian (Llandovery), Sweden. Originally *Baltisphaeridium pustulatum*; subsequently and transferred from, *Multiplicisphaeridium?*, since the spheroidal test is ornamented only by extremely short conical tubercles, which show no indication of branching.

Genus ***Comasphaeridium*** Staplin, Jansonius and Pocock 1965, p. 192, emend. Sarjeant and Stancliffe 1994, p. 25.

Diagnosis: (Sarjeant and Stancliffe 1994, p. 25): "Vesicle spherical to ellipsoidal. Eilyma smooth to granular, thin, with a dense covering of spines. Spines solid or apparently so, thin and often hairlike and undulose. Proximally, the spines join the body at a sharp angle. Distally they are closed and normally do not branch. The spine length is over 25% of the body diameter and their number exceeds 35."

Remarks: The very numerous thin and hair-like processes, typically unbranched, differentiate this genus from the genera of the *Multiplicisphaeridium* group.

Type species: Comasphaeridium cometes (Valensi 1948, p. 547, fig. 5.6) Staplin, Jansonium and Pocock 1965, p. 192. Middle Jurassic, France. Originally *Micrhystridium*.

Systematic reassignments:

Comasphaeridium? canadense (Staplin, Jansonius and Pocock

1965, p. 182-183, pl. 18, figs. 7-10; text-fig. 9) comb. nov. Holotype pl. 18, figs. 7-8. Late Cambrian?, Canada. Originally *Multiplicisphaeridium? canadense*; transferred provisionally to Comasphaeridium since the vesicle is small and the short processes number between 35 and 45, but the processes divide distally into two to four very short branches. [Note: The number of processes is too low for oppropriate placement into *Martinsphaeridium*].

Comasphaeridium longistipitatum (Cramer and Díez 1977, p. 348, pl. 1, fig. 12) comb. nov. Early Ordovician (Early Arenig), Morocco. Originally *Multiplicisphaeridium longistipitatum*; transferred to *Comasphaeridium* since the numerous processes are long and flexuous, normally simple and only occasionally having tooth-like pinnae at the tip. **Herein, Pl. III fig. 1.**

Genus ***Dateriocradus*** Tappan and Loeblich Jr. 1971, p. 394-396.

Diagnosis: (Tappan and Loeblich Jr. 1971, p. 394): "Central vesicle subtriangular in outline, commonly with three long hollow processes in plane of vesicle, rarely a fourth arising from the broad face of the vesicle; processes distally bifurcating up to the fifth or sixth order; wall surface laevigate; excystment by development of an epityche, an arcuate splitting of the wall resulting in a flaplike opening between two processes similar to that in *Veryhachium*."

Remarks: The shape and symmetry of the vesicle, together with the low number of processes, differentiate this genus from the genera of the *Multiplicisphaeridium* group.

Type species: Dateriocradus polydactylus Tappan and Loeblich Jr. 1971, p. 396, pl. 5, figs. 1-7. Holotype pl. 5, fig. 1. Early Silurian (Late Wenlock), Indiana, U.S.A.

Systematic reassignments:

Dateriocradus asombrosus (Cramer and Díez 1976, p. 85-86, pl. 2, figs. 10, 14-15) comb. nov. Holotype pl. 2, fig. 15. Early Devonian (Late Emsian), Spain. Originally - *Multiplicisphaeridium asombrosum*; transferred to *Dateriocradus* since it has only 3 or 4 processes exhibiting three orders of branching, and opens by means of an epityche.

Dateriocradus asturiae (Cramer 1964, p. 313, pl. 13, figs. 14-15; text-fig. 30, no. 2) comb. nov. Holotype pl. 13, fig. 14. Late Silurian (Ludlow), Spain. Originally *Veryhachium asturiae*, subsequently *Baltisphaeridium*; also invalidly placed into *Evittia* by Britto 1967. Transferred herein from *Multiplicisphaeridium*, since it has 4 stout processes, irregularly branched.

Dateriocradus josefae (Cramer 1964, p. 316, pl. 12, figs. 9, 12; pl. 13, fig. 19; text-fig. 30, nos. 7-9) comb. nov. Holotype pl. 12, fig. 9. Late Silurian (Ludlow)-Early Devonian (Gedinnian), Spain. Originally *Veryhachium josefae*, subsequently *Baltisphaeridium* and *Multiplicisphaeridium* ; also placed invalidly in *Evittia* by Britto 1967. Transferred to *Dateriocradus*, since the processes may be simple or may show one order of irregular distal branching. [Note: Cramer's description admits a range of 3-6 or more processes, suggesting this may be a 'collective species'].

Dateriocradus lindus (Cramer and Díez 1976, p. 85, pl. 1, figs. 1-4, 6, 8; pl. 2, fig. 11) comb. nov. Holotype pl. 1, fig. 6. Early Devonian (Late Emsian), Spain. Originally *Multiplicisphaeridium lindum*; transferred to *Dateriocradus* since the vesicle bears only 3-4 processes, elaborately branched.

Genus ***Diexallophasis*** Loeblich Jr. 1970, p. 714, **emend.**

Diexallophasis Loeblich Jr. 1970, p. 714; Lister 1970, p. 66-67; Eisenack, Cramer and Díez Rodriguez 1973, p. 405; Cramer and Díez 1979, p. 76; Le Hérissé 1984, p. 220; Fensome *et al.* 1990, p. 196; **emend. nov.**

Original diagnosis: (Loeblich Jr. 1970, p. 714). "Central body inflated, in life probably spherical or subspherical, of variable outline when compressed; wall thin, no differentiation in wall between central body and processes except in ornamentation, surface of central body with grana and that of processes with small spines; the 4-10, commonly 6, hollow processes communicate freely with the central body, processes are of two types, one smaller, smooth and unbranched, and the other spinose, bifurcate or multifurcate and extremely variable in diameter; excystment by simple rupture of the central body."

Emended diagnosis: Vesicle hollow, spheroidal to subpolygonal; eilyma single-layered or apparently so. Surface of eilyma granulate to echinate. Number of processes low (ca. 4-10), their length typically exceeding the vesicle diameter. The processes taper from base towards tip; they may be acuminate or may divide at their distal extremities into one or more branches, these branches themselves sometimes secondarily branched but not showing ramification. Both styles of distal termination may be present on a single individual, in varying proportions, but the presence of at least one branched processes is a requirement for recognition of this genus. The processes are hollow, their cavities communicating directly with the vesicle cavity. Surfaces of processes covered by granae or echinae, irregularly or regularly arranged. Excystment by cryptosuture.

Remarks: Le Hérissé 1989, p. 125-126, discussed the problem of distinguishing this genus from *Evittia* and resolved it by treating *Diexallophasis* as a junior synonym of the latter genus. We consider that the two genera represent distinct morphologies and prefer to retain both, under emended diagnoses. The original diagnosis of *Diexallophasis* was, in some measure, ambiguous in that it implied that the "two types" of processes were more distinct than is truly the case. This is clarified and the differences from *Evittia* are emphasized. The presence of branched processes distinguishes this genus from *Stellechinatum*.

The question of the correct name for the type species of this genus is disputable. The holotype of the present type species, *Diexallophasis remota*, is a severely compressed specimen but definitely has bifurcate processes. The holotype of *D. denticulata*, originally selected by Loeblich as type species, in contrast has distally broken processes and may equally be assignable to *Stellechinatum*. For that reason, it is convenient to accept Playford's (1977) synonymizing of the two species, even though his judgement is incapable of proof. With this synonymization, the several subspecies of *D. denticulata* become subspecies of *D. remota* and will not be further discussed here.

Type species: Diexallophasis remota (Deunff 1955, p. 146, pl. 4, fig. 8) emend. Playford 1977, p. 19-21. Early Silurian (Wenlock)-Middle Devonian (Givetian), Canada. Originally *Veryhachium*; subsequently *Evittia* and *Multiplicisphaeridium*. [Note: *D. denticulata* (Stockmans and Willière 1963, p. 458, pl. 1, fig. 4, text-fig. 13) Loeblich Jr. 1970, p. 714, was selected as type species for this genus by Loeblich Jr. 1970, p. 714. Although this species was considered to be a nomenclatural synonym of *D. remota* by Playford 1977, p.

20–an opinion with which we concur–the holotype of *D. denticulata* remains the type of the genus *Diexallophasis*. [illustrated herein as Text-fig. 3c].

Accepted species:

Diexallophasis caperoradiola Loeblich Jr. 1970, p. 714-715, figs. 7A-7G. Middle Silurian, New York, U.S.A. Originally *Diexallophasis*; subsequently *Multiplicisphaeridium*; herein returned to *Diexallophasis*, since it has few long processes, simple and with echinate surfaces.

Diexallophasis cornigera (Uutela and Tynni 1991, p. 90, pl. 21, fig. 211) comb. nov. Late Ordovician (Early Ashgill), Estonia. Originally *Multiplicisphaeridium cornigerum*; transferred to *Diexallophasis* since the spherical vesicle bears only a low number (apparently 9 in the holotype) of long, furcate processes, their cavities apparently linked to the vesicle interior, though this is not stated.

Diexallophasis cuspidis Wicander 1974, p. 19, pl. 8, fig. 5. Early Carboniferous (Early Mississippian), Ohio, U.S.A. Originally *Diexallophasis*; subsequently *Multiplicisphaeridium*; herein returned to *Diexallophasis*, since the vesicle bears 9 long processes, simple or bifurcate, and those spines are either granulate or echinate.

Diexallophasis gotlandica Cramer 1970, p. 138-140, pl. 10, fig. 151; pl. 20, fig. 302; text-fig. 43b. Holotype, pl. 10, fig. 151. Silurian, Spain. Originally *Baltisphaeridium denticulatum* var. *gotlandicum*; subsequently *Multiplicisphaeridium*. [Note: In discussion with R.A. Fensome, he informs us that he now believes that Fensome *et al.* 1990, p. 346, were incorrect in considering the species to be invalid until their transfer in 1990, since *I.C.B.N.* Article 7 requires that the holotype be illustrated but does not require that the illustration of it be identified. The transfer, as a subspecies, to *Evittia* proposed by Le Hérissé 1989, p. 127 is not accepted.]

Diexallophasis granulosa (Cramer, Díez and Kjellström 1979, p. 50, fig. 18C) Fensome, Williams, Barss, Freeman and Hill 1990, p. 198. Early Silurian (Early Wenlock), Gotland, Sweden. Originally *Multiplicisphaeridium denticulatum granulosum*; invalidly transferred and elevated to specific status by Le Hérissé 1984, p. 220.

Diexallophasis ontariensis Cramer 1970, p. 140, pl. 10, figs. 152-153, 157-158; text-fig. 43c *ex* Fensome *et al.* 1990, p. 198. Holotype pl. 10, fig. 152. Silurian, Ontario, Canada. Originally invalidly published as *Baltisphaeridium denticulatum* var. *ontariensis*; subsequently invalidly termed *Multiplicisphaeridium denticulatum ontariense* by Eisenack *et al.* 1973, p. 599 and invalidly transferred to *Diexallophasis* and raised to specific rank as *D. ontariensis* by Le Hérissé 1984, p. 220.

Diexallophasis pachymura (Hill 1978, p. 184, pl. 1, figs. 5-12) Dorning 1981, p. 188. Holotype pl. 1, fig. 8. Early Silurian (Wenlock), England. Originally *Multiplicisphaeridium*.

Diexallophasis parvifurcata Priewalder 1987, p. 32-33, pl. 5, figs. 5-9; text-fig. 10. Holotype pl. 5, fig. 5. Early Silurian (Llandovery-Wenlock), Austria.

Diexallophasis ramidenticulata (Cramer and Díez 1972b, p. 155, pl. 33, fig. 31) comb. nov. Early Silurian (Late Wenlock), Indiana, U.S.A. Originally *Baltisphaeridium ramidenticulatum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the relatively few, long processes are granulate and the vesicle granulate to microechinate.

Diexallophasis sanpetrensis (Cramer 1964, p. 293-294, pl. 3, figs. 15-16; text-fig. 17, no. 3; text-fig. 18) Dorning 1981, p. 188. Holotype pl. 3, fig. 16. Late Silurian (Ludlow), Spain. Originally *Baltisphaeridium*; subsequently *Multiplicisphaeridium*; the transfer to *Evittia*, proposed invalidly by Lister 1970, p. 67 and validly by Le Hérissé 1989, p. 130, is here rejected following revision of *Diexallophasis*.

Diexallophasis senarius (Colbath 1990, p. 115, pl. 5, figs. 15-20) comb. nov. Holotype pl. 5, figs. 19-20. Middle-Late Devonian (Givetian-Frasnian), Western Australia. Originally *Evittia senaria*; transferred to *Diexallophasis* since there are 4-7 processes, blunt-tipped or briefly furcate, whose length equals or exceeds the vesicle diameter.

Diexallophasis simplex Wicander and Wood 1981, p. 33-34, pl. 5, fig. 7; pl. 6. figs. 1-3. Holotype pl. 5, fig. 7. Middle Devonian (Givetian), Ohio, U.S.A.

Diexallophasis striatus (Uutela and Tynni 1991, p. 97-98, pl. 23, fig. 238) comb. nov. Late Ordovician (Middle Caradoc), Estonia. Originally *Multiplicisphaeridium striatum*; transferred to *Diexallophasis* since the vesicle bears only 6 branching processes, whose cavity (from the illustration) communicates directly with the vesicle interior.

Diexallophasis tappaniae (Kiryanov 1978, p. 87, pl. 13, fig. 7; pl. 14, fig. 1) Wicander 1986, p. 342. Holotype: pl. 13, fig. 7. Early Silurian (Late Llandovery-Wenlock), Ukraine. Originally *Tylotopalla*; subsequently *Evittia*.

Diexallophasis toyetaformis (Uutela and Tynni 1991, p. 98, pl. 23, fig. 239) comb. nov. Late Ordovician (Middle Caradoc), Estonia. Originally *Multiplicisphaeridium toyetaforme*; transferred to *Diexallophasis* since the spherical vesicle has a shagreenate eilyma and bears (in the holotype) 5 long processes with cauliflorate distal extremities.

Diexallophasis verrucosa (Uutela and Tynni 1991, p. 98-99, pl. 23, fig. 241) comb. nov. Late Ordovician (Middle Caradoc-Middle Ashgill), Estonia. Originally - *Multiplicisphaeridium verrucosum*; transferred to *Diexallophasis* since the vesicle is subspherical, ornamented with "bulbous tubercles" and bears 4-5 processes, exhibiting up to three orders of branching.

Diexallophasis virgulata (Le Hérissé 1989, p. 131, pl. 12, figs. 3-4) comb. nov. Holotype pl. 12, figs. 3-4. Early Ordovician (Early Llandovery), Gotland, Sweden. Originally *Evittia virgulata*; transferred to *Diexallophasis* since process length exceeds vesicle diameter, process division is at the distal extremity, and denticles arise from longitudinal striations on the processes.

Species formerly placed in *Diexallophasis:*

Diexallophasis absona Wicander 1974, p. 19, pl. 8, fig. 4. Subsequently *Multiplicisphaeridium*; transferred to *Stellechinatum* herein.

Diexallophasis cleopatra Deunff *in* Vanguestaine *in* Kimpe *et al.* 1978, p. 55-56; caption to pl. 13, fig. 10. *Nomen nudum:* see Fensome *et al.* 1990, p. 197.

Deixallophasis denticulata (Stockmans and Willière 1963, p. 458, pl. 1, fig. 4; text-fig. 13) Loeblich Jr. 1970, p. 715. Originally *Baltisphaeridium*; subsequently *Multiplicisphaeridium*, *Diexallophasis* (as type species) and *Evittia*. Jr. synonym of *Veryhachium* (now *Diexallophasis*) *remotum* Deunff 1955, according to Playford 1977, p. 19. Since Le Hérissé considered *Diexallophasis* to be a jr. synonym of *Evittia*, he transferred this species to that genus, without directly commenting on the synonymy. We retain *Diexallophasis* herein, under an emended diagnosis, and accept Playford's view concerning the synonymy.

Diexallophasis granulatispinosum (Downie 1963, p. 640-641, pl. 91, figs. 1, 7; text-fig. 3c) Hill 1974, p. 12. Originally

Baltisphaeridium, subsequently *Evittia* and *Multiplicisphaeridium*; also invalidly placed into *Peteinosphaeridium*. Jr. synonym of *Diexallophasis remota* Deunff 1955, according to Playford 1977, p. 19.

Diexallophasis? mucronata (Stockmans and Willière 1963, p. 456-457, pl. 1, fig. 20; pl. 3, fig. 6; text-fig. 10-11) Priewalder 1987, p. 32. Originally *Veryhachium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; transferred to *Villosacapsula* herein.

Genus ***Dorsennidium*** Wicander 1974, p. 20, emend. Sarjeant and Stancliffe 1994, p. 39.

Emended diagnosis: (Sarjeant and Stancliffe 1994, p. 39): "Acritarchs having a polygonal vesicle whose outline is determined by the number (4-10) and relative position of its spines. Eilyma single-layered or apparently so; surface laevigate to finely granular or shagreenate. The spines arise in more than one plane: proximally they merge so smoothly with the vesicle wall that no exact limit can be set to their bases; they are without linkage by ridges or crests to adjacent spines. Spines always hollow, the bases open to the vesicle interior, and without development of costae, striae or spinelets. The spines may have small pores in their wall, but are never branched and have tips that are always closed and pointed. A cryptosuture can be developed, but this is rarely observed."

Remarks: This genus is differentiated from members of the *Multiplicisphaeridium* group by its unbranched spines in low number.

Type species: Dorsennidium patulum Wicander 1974, p. 20, pl. 9, figs. 10-12. Holotype pl. 9, fig. 12. Late Devonian, Ohio, U.S.A.

Systematic reassignment:

Dorsennidium maracum (Díez and Cramer 1976, p. 130, pl. 1, figs. 3, 9, 14, 18; pl. 2, figs. 10, 12, 14) comb. nov. Holotype pl. 1, fig. 14. Late Silurian (Ludlow), Spain. Originally *Tylotopalla maraca*; transferred to *Dorsennidium* since the vesicle bears unbranched, acuminate processes, around 10 in number, and the vesicle surface has only a minor "irregularly pseudoscabrate" ornament. [Note: the variety of illustrated forms placed into this species by its authors is so great that this reassignment is based only upon the illustration of the holotype. A restudy of the type material is urgently necessary].

Genus ***Estiastra*** Eisenack 1959, p. 201, emend. Sarjeant and Stancliffe 1994, p. 50.

Emended diagnosis: (Sarjeant and Stancliffe 1994, p. 50): "Acritarchs of stellate aspect, composed of 4-10 processes arising in more than one plane. Processes very broad-based, conical to phalloid in outline; distally they may be acuminate, sometimes with a nipple-like prominence, or (rarely) briefly bifurcate, but they are never blunt or rounded and lack distinct branches. Central portion of vesicle formed by the confluence of process bases. Eilyma composed of one layer or of two layers in continuous contact; process tips may be solid or plugged. Surface psilate, punctate, granulate or pustulose, with or without ridges connecting the process bases. Opening, where observed, by cryptosuture; when fully open, a section of the eilyma including one or two processes may be lost."

Remarks: The low number of extremely broad-based processes, whose confluence determines the vesicle shape, distinguishes this genus from members of the *Multiplicisphaeridium* group.

Type species: Estiastra magna Eisenack 1959, p. 201-202, pl. 16, figs. 17-20. Holotype pl. 16, fig. 17. Early Silurian (Lower Llandovery), Estonia.

Systematic reassignments:

Estiastra exasperata (Deunff 1955, p. 146, pl. 3, fig. 4) comb. nov. Middle Devonian, Canada. Originally *Veryhachium exasperatum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the six to eight hollow processes are cushion-shaped and unbranched.

Estiastra solitaria (Fombella 1978, p. 253-254, pl. 3, fig. 11) comb. nov. Late Middle Cambrian, Spain. Originally *Multiplicisphaeridium solitarium*; transferred to *Estiastra* since the vesicle bears around 12 processes, very broad-based, the bases essentially determining the vesicle shape. Distally the processes are unbranched.

Genus ***Evittia*** Brito 1967, p. 477, **emend.**

Evittia Brito 1966, p. 78 *nomen nudum*; Brito 1967, p. 477; **emend.** Lister 1970, p. 66-67; Cramer and Díez 1979, p. 9; Le Hérissé 1989, p. 125-126; Colbath 1990, p. 114; Fensome *et al.* 1990, p. 216-217; **emend. nov.**

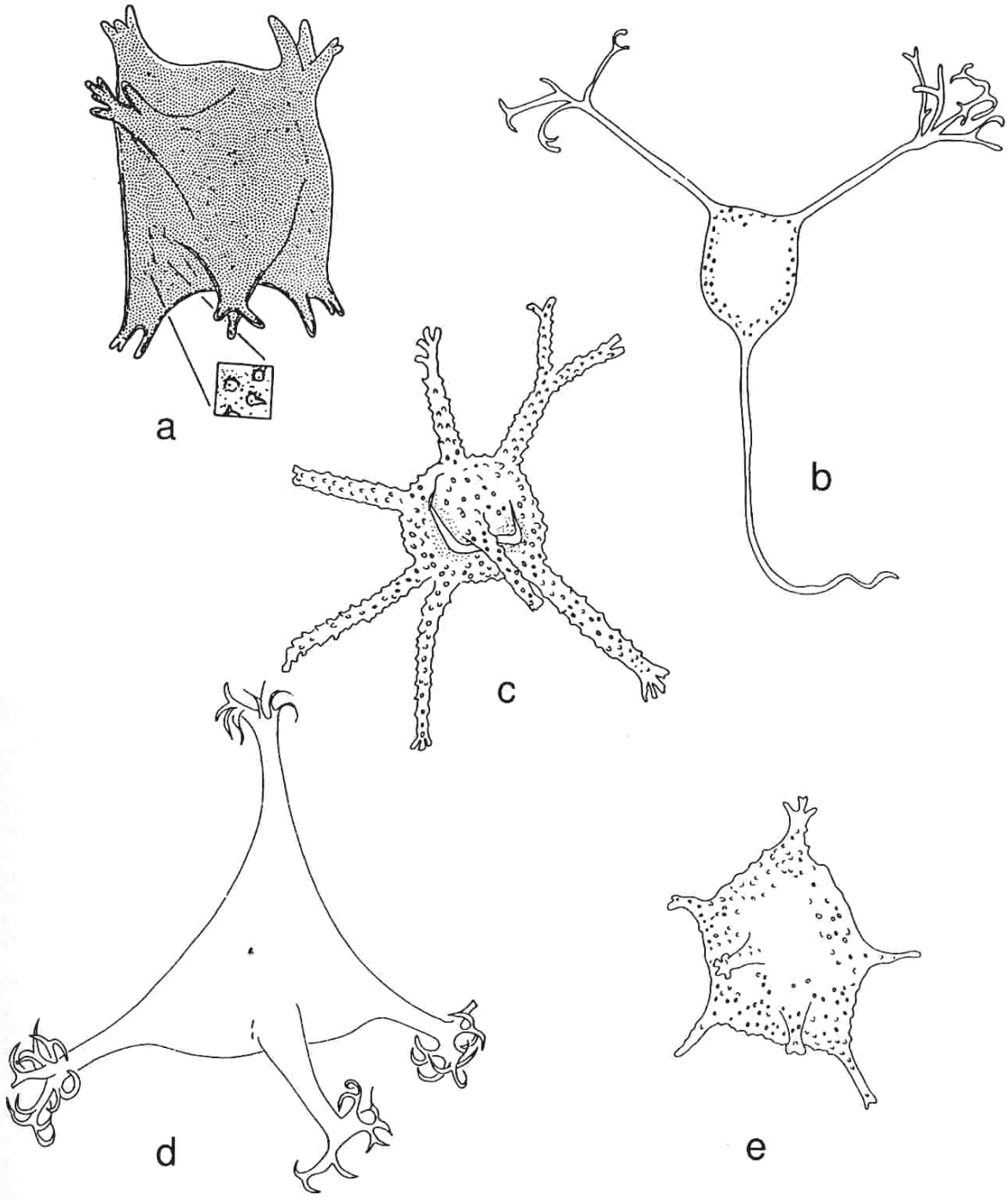
Original diagnosis: (Brito 1967, p. 477): "Acritarchs with triangular to polygonal vesicles having the general structure of *Veryhachium* but with the processes typically ramified, although some of the processes on a specimen may have simple tips."

Previously emended diagnosis: (Lister 1970, p. 66): "Vesicle hollow, subspherical to polygonal, single-walled; vesicle wall may be smooth or sculptured; processes are heteromorphic, hollow, invariably granulate to echinate, communicating with the vesicle cavity. Excystment by cryptosuture, apical or near equatorial."

Emended diagnosis: Vesicle hollow, subpolygonal to polygonal; eilyma single-layered or apparently so. Surface of eilyma laevigate, granulate to echinate. Number of processes low (ca. 4-12), their broad bases modifying but not controlling the vesicle outline. Processes always broad and short, dividing distally into a low number of rather blunt branches, sometimes secondarily branched but not showing ramification. The processes are hollow, their cavities communicating directly with the vesicle cavity. Excystment by cryptosuture, apical or near equatorial.

Remarks: As initially defined, *Evittia* embraced triangular forms with branching processes. Following the revision of the genus *Frankea* by Servais 1993 and of the *Veryhachium* group by Sarjeant and Stancliffe 1994, such species are now referred to *Frankea*, two further transfers to that genus being made herein. *Evittia* differs from the members of the *Veryhachium* and *Pulvinosphaeridium* groups in the form and number of its processes, their brevity and the fact that they do not modify the vesicle outline.

Evittia differs from *Vogtlandia* in having a vesicle whose outline may be modified, but is not determined, by the shape of the processes and in having processes whose distal extremities branch or ramify less elaborately. This genus differs from *Multiplicisphaeridium* in that the processes show essentially one order of branching and from *Martinsphaeridium* and *Ammonidium* in the much lower number and greater thickness



text-figure 3

Genera with processes in low number. a) *Evittia sommeri* Brito: specimen illustrated by Brito 1967, pl. 1 fig. 11; b) *Lusatia dendroidea* Burmann: the holotype, redrawn after Burmann 1970, pl. 6 fig. 3; c) *Diexallophasis remota* (Duenff): specimen illustrated by Loeblich Jr. 1969, fig. 8A; d) *Vogtlandia ramificata* Burmann: the holotype, redrawn after Burmann 1970, pl. 3 fig. 5; e) *Petaloferidium stigii* jacobson: the holotype, after Jacobson 1978, pl. 1 fig. 5. Sketches not to scale with one another.

of the processes. It differs from *Tylotopalla* in the lesser number of the processes and in the fact that the vesicle is not essentially spheroidal.

Type species: Evittia sommeri Brito 1967, p. 477-478, pl. 1, figs. 9-12. Holotype pl. 1, fig. 9. Early-Middle Devonian, Brazil. **Herein, Pl. IV fig. 5 and Text-fig. 3a.**

Accepted species:

Evittia amphitritae (Deunff, Lefort and Paris 1971, p. 11, pl. 1, fig. 7; pl. 2, fig. 15) comb. nov. Holotype pl. 1, fig. 7. Silurian (Late Ludlow), France. Originally *Multiplicisphaeridium amphitritae*; transferred to *Evittia* since the processes are few (13-15) and may be simple or show only one order of branching.

Evittia consolator (Cramer and Díez 1977, p. 347, pl. 3, fig. 17) comb. nov. Early Ordovician (Early Arenig), Morocco. Originally *Multiplicisphaeridium consolator*; transferred to *Evittia* since the number of processes is low and their bases determine the vesicle outline, the process stems are short and their tips aculeate.

Evittia cymosa Loeblich Jr. 1970, p. 721-722, figs. 15A-C. Early Devonian (Early Gedinnian), Oklahoma, U.S.A. Originally *Evittia*; subsequently *Multiplicisphaeridium*; herein returned to *Evittia*, since the bases of the short processes impose a polygonal shape on the central body and the processes branch only at their tips.

Evittia? escobaides (Cramer 1964, p. 294, pl. 2, fig. 16; text-fig. 19, no. 2) comb. nov. Holotype pl. 2, fig. 16. Early Devonian (Middle Siegenian-Emsian), Spain. Originally *Baltisphaeridium escobaides*, subsequently *Micrhystridium*; provisionally transferred from *Multiplicisphaeridium*, since the vesicle appears polygonal, with relatively few, very broad-based processes showing one order of distal branching. However, the development of a pylome, rather than a cryptosuture, makes this assignation doubtful.

Evittia florigera Vavrdová 1977, p. 116, pl. 4, figs. 1-10. Middle Ordovician (Early Llanvirn), Czech Republic. [Note: the transfer to *Petaloferidium*, proposed by Fensome, Williams, Barss, Freeman and Hill 1990, p. 388, is rejected, since the vesicle shape and low number of processes do not accord with the diagnosis of that genus, as revised herein.]

Evittia flosmaris Deunff 1977, p. 143, pl. 1, fig. 18; pl. 2, figs. 7, 9, 11, 14. Holotype pl. 2, fig. 11. Middle Ordovician (Llanvirn), Morocco. Transferred provisionally to *Vogtlandia* by Molyneux 1987, p. 355; here returned to *Evittia*, with whose diagnosis it accords in all features. [Note: the opinion of Martin, expressed as an addendum *in* Dean and Martin 1978, p. 19, that *Vogtlandia coalita* Martin *in* Dean and Martin 1978 is a jr. synonym of *E. flosmaris*, is not accepted since the processes of the former species are very much more elaborately branched].

Evittia geometrica Playford *in* Playford and Dring 1981, p. 29-30, pl. 6, fig. 13, pl. 7, figs. 3-8. Late Devonian (?Frasnian), Western Australia.

Evittia hoffmanensis (Cramer, Allam, Kanes and Díez 1974a, p. 185, pl. 27, fig. 10) comb. nov. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Morocco. Originally *Multiplicisphaeridium hoffmanense*; transferred to *Evittia* since the 15 to 25 processes are broad-based, modifying the vesicle outline, and show only one order of branching.

Evittia? molina (Cramer 1964, p. 297-298, pl. 6, fig. 5; pl. 7, fig. 9; text-figs. 21a, 21b [*pars*]) comb. nov. Holotype pl. 6, fig. 5. Early Devonian (Middle Siegenian), Spain. Originally *Baltisphaeridium molinum*; subsequently, and provisionally transferred from, *Multiplicisphaeridium*, since the vesicle is formed by the fusion of the bases of "three to twelve" processes, plumply cylindrical, showing one to two orders of branching, and with cavities opening directly to the vesicle interior. Attribution questionable, since Cramer notes there is "a tendency to equatorial splitting" in this species.

Evittia rabiosa (Cramer 1964, p. 299, pl. 5, fig. 7, pl. 6, figs. 3, 8; pl. 7, figs. 5, 8-9; text-fig. 21b [*pars*]) comb. nov. Holotype pl. 5, fig. 7. Early Devonian (Siegenian-Emsian), Spain. Originally *Veryhachium rabiosum*; subsequently *Baltisphaeridium*; also invalidly placed into *Evittia* by Brito 1967, p. 477 [see Fensome *et al.* 1990, p. 218]; subsequently, and transferred from, *Multiplicisphaeridium*, since it has only around 5 processes on a polygonal vesicle, the processes being quite long and showing only one order of branching.

Evittia thyrae (Cramer 1964, p. 316-317, pl. 12, figs. 10, 13; text-fig. 30, nos. 5-6) Brito 1967a, p. 477. Holotype pl. 12, fig. 10. Late Silurian (Ludlow), Spain. Originally *Veryhachium thyrae*; subsequently *Evittia*, *Baltisphaeridium* and *Multiplicisphaeridium*. Returned to *Evittia*, since the polygonal vesicle bears only 4 processes, dividing at their distal extremities.

Species formerly placed in *Evittia:*

Evittia antonius Deunff *in* Lister 1970, p. 67. *Nomen nudum*: for discussion see Fensome *et al.* 1990, p. 217.

Evittia asturiae (Cramer 1964, p. 313, pl. 13, figs. 14-15; text-fig. 30, no. 2) Brito 1967, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 217. Originally *Veryhachium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; transferred to *Dateriocradus* herein.

Evittia cleopatra Deunff *in* Lister 1970, p. 67. *Nomen nudum*: for discussion see Fensome *et al.* 1990, p. 217.

Evittia denticulata (Stockmans and Willière 1963, p. 458, pl. 1, fig. 4; text-fig. 13) Le Hérissé 1989, p. 126-127. Originally *Baltisphaeridium*; subsequently *Multiplicisphaeridium* and *Diexallophasis*, as type species. Jr. synonym of *Veryhachium* (now *Diexallophasis*) *remotum* Deunff 1955, according to Playford 1977, p. 19. Since Le Hérissé considered *Diexallophasis* to be a jr. synonym of *Evittia*, he transferred this species to that genus, without directly commenting on the synonymy. We retain *Diexallophasis* herein, under an emended diagnosis and accept Playford's view concerning the synonymy.

Evittia florigera Vavrdová 1977, p. 116, pl. 4, figs. 1-10. Originally *Evittia*; transferred to *Petaloferidium* by Fensome, Williams, Barss, Freeman and Hill 1990, p. 388.

Evittia granulatispinosa (Downie 1963, p. 640-641, pl. 91, figs. 1, 7; text-fig. 3c) Lister 1970, p. 67. Originally *Baltisphaeridium*; subsequently *Evittia*; then *Multiplicisphaeridium*, *Diexallophasis* and *Peteinosphaeridium*.

Evittia irregulare Downie 1982, p. 278, figs. 10q-u. Transferred to *Tylotopalla* herein.

Evittia josefae (Cramer 1964, p. 316, pl. 12, figs. 9, 12; pl. 13, fig. 19; text-fig. 30, figs. 7-9) Brito 1967, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 217. Originally *Veryhachium*, subsequently *Baltisphaeridium*; transferred to *Dateriocradus* herein.

Evittia mala (Cramer 1964, p. 297, pl. 1, figs. 6, 8, 10; text-fig. 19, nos. 10-12) Lister 1970, p. 70-71. Originally *Baltisphaeridium*; subsequently *Evittia* and *Multiplicisphaeridium*. Transferred, as type species, to *Rhachobrachion* by Dorning 1981, p. 198.

Evittia monterrosae (Cramer 1969, p. 490, pl. 70, figs. 5-7; text-fig. 10f) Thusu 1973a, p. 815. Originally

Baltisphaeridium; subsequently also *Multiplicisphaeridium* and *Evittia*; transferred to *Dateriocradus* by Pöthe de Baldis 1981, p. 238.

Evittia ramusculosa (Deflandre 1945, p. 63, pl. 1, figs. 8-16; text-figs. 38-39) Lister 1970, p. 67. Combination not validly published: see Fensome *et al.* 1990, p. 218. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; also invalidly placed into *Evittia* and *Peteinosphaeridium*; transferred to *Oppilatala* by Dorning 1981, p. 196.

Evittia remota (Deunff 1955, p. 146, pl. 4, fig. 8) Lister 1970, p. 69-70. Originally *Veryhachium*; subsequently *Evittia* and *Multiplicisphaeridium*; emended, and transferred to *Diexallophasis* by Playford 1977, p. 19-21, being considered by him to be a sr. synonym of the type species of that genus, *D. denticulata*.

Evittia robustispinosa (Downie 1959, p. 61, pl. 10, fig. 7) Lister 1970, p. 67. Combination not validly published: see Fensome *et al.* 1990, p. 218. Originally *Baltisphaeridium*; transferred to *Tylotopalla* by Eisenack, Cramer and Díez Rodriguez 1973, p. 1071-1072.

Evittia sanpetrensis (Cramer 1964, p. 293-294, pl. 3, figs. 15-16; text-fig. 17, no. 3; text-fig. 18) Le Hérissé 1989, p. 130. Originally *Baltisphaeridium*; subsequently *Multiplicisphaeridium*; transferred invalidly to *Evittia* by Lister 1970, p. 67 (see Fensome *et al.* 1990, p. 218). Placed in *Diexallophasis* by Dorning 1981, p. 188; this placement is accepted herein.

Evittia sartbernardensis (Martin 1966b, p. 434-435; tetx-figs. 11-13) Brito 1967, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 218. Originally *Veryhachium*; subsequently *Baltisphaeridium*, *Multiplicisphaeridium* and *Dateriocradus*; placed into *Frankea* by Colbath 1986, p. 73.

Evittia semispinosa Pöthé de Baldis 1981, p. 241, pl. 3, fig. 3. Transferred to *Frankea* herein.

Evittia senaria Colbath 1990, pl. 5, figs. 15-20. Transferred to *Diexallophasis* herein.

Evittia spicifera (Deunff 1955, p. 146, pl. 3, fig. 1; text-fig. 26) Lister 1970, p. 67. Combination not validly published: see Fensome *et al.* 1990, p. 219. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; also invalidly placed into *Veryhachium*; transferred to *Stellechinatum* herein.

Evittia tappaniae (Kiryanov 1978, p. 87, pl. 13, fig. 7, pl. 14, fig. 1) Le Hérissé 1989, p. 130 [incorrectly as *E. tappana*]. Originally *Tylotopalla*; transferred to *Diexallophasis* by Wicander 1986, p. 342, a placement with which we concur.

Evittia tolontola (Cramer 1964, p. 317, pl. 13, fig. 20; text-fig. 13, no. 1) Brito 1967, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 219. Originally *Veryhachium*; subsequently *Baltisphaeridium* and *Goniosphaeridium*; provisionally transferred to *Stellechinatum* by Sarjeant and Stancliffe 1994, p. 45.

Evittia torrestionensis (Cramer 1964, p. 317, pl. 15, fig. 1; text-fig. 30, no. 3) Brito 1967, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 219. Originally *Veryhachium*; subsequently *Multiplicisphaeridium*. Jr. synonym of *Veryhachium* (now *Dateriocradus*) *asturiae* Cramer 1964 according to Cramer 1970, p. 171.

Evittia tribrachiata Lister 1970, p. 71, pl. 5, fig. 5; text-fig. 20c. Subsequently *Multiplicisphaeridium*; transferred to *Dateriocradus* by Dorning 1981, p. 186.

Evittia trispinoramosa (Stockmans and Willière 1962b, p. 83-84, pl. 1, fig. 1; text-fig. 1) Brito 1967a, p. 477. Combination not validly published: see Fensome *et al.* 1990, p. 219. Originally *Veryhachium*; subsequently *Multiplicisphaeridium*; transferred to *Frankea* herein.

Evittia virgulata Le Hérissé 1989, p. 131, pl. 12, figs. 3, 4. Transferred to *Diexallophasis* herein.

Genus ***Excultibrachium*** Loeblich Jr. and Tappan 1978, p. 1264.

Diagnosis: (Loeblich Jr. and Tappan 1978, p. 1264). "Vesicle circular in outline, ornamented with numerous stiff hollow processes that do not communicate with the vesicle interior but are closed proximally by a short solid plug; processes divide distally into four to six flexible branches in a single plane, branches are hollow at point of branching, but distally are filled and solid, where they taper to a fine point; vesicle wall laevigate, process wall scabrate."

Remarks: Differs from *Multiplicisphaeridium* in having processes with plugged bases and only one level of branching.

Type species. Excultibrachium concinnum Loeblich Jr. and Tappan 1978, p. 1267-1268, pl. 9 fig. 3-6. Late Ordovician (Caradoc), Indiana, U.S.A. [Note: illustrated herein as Text-fig. 4a]

Systematic reassignments:

Excultibrachium? brazodesnudum (Cramer 1964, p. 289, pl. 2, fig. 7; text-fig. 16, no. 8) comb. nov. Late Silurian (Ludlow), Spain. Originally *Baltisphaeridium brazodesnudum*; subsequently, and transferred provisionally from, *Multiplicisphaeridium*, since there are 5 to 10 long processes, distally pinnate or with more complex first order branching. However, though distal closure of the processes is suggested by Cramer's photograph, it is not mentioned in his text or illustrated in his drawing, casting some doubt upon this reassignment.

Excultibrachium exoticum (Pöthé de Baldis 1974, p. 316, pl. 1, fig. 1) comb. nov. Late Silurian (Ludlow), Paraguay. Originally *Multiplicisphaeridium exoticum*; transferred to *Excultibrachium* since the vesicle bears only five to six long processes with plugged but unconstricted bases, exhibiting one order of branching.

Excultibrachium loriferum (Deunff 1965, p. 163, figs. 6-8) Eisenack, Cramer and Díez Rodriguez 1973, p. 675. Holotype fig. 8. Late Devonian (Frasnian), France. Originally *Baltisphaeridium loriferum*; invalidly placed into *Ammonidium* by Deunff 1965; subsequently, and transferred from, *Multiplicisphaeridium*, since the 10 processes are plugged proximally, but unconstricted, and show only one order of branching.

Genus ***Frankea*** Burmann 1970, p. 290, emend. Servais 1993, p. 80.

Emended diagnosis: (Servais 1993, p. 80). "Triangular central body, with triradially arranged processes, which are hollow at the base and split distally at one point into unbranched pinnae. The number of the terminal pinnae (2 or more) and the ratio of process length to central body diameter are variable but constant for each specimen. The wall texture of the central body is smooth to finely granulate or shows over all the vesicle a striate ornament parallel to the vesicle sides."

Remarks: The triangular vesicle, extended into only three processes, distinguishes this genus from the members of the *Multiplicisphaeridium* group. [Note: *Frankea breviuscula* Burmann 1970 is illustrated herein by **Pl. II fig. 8.**]

Type species: Frankea hamata Burmann 1970, p. 290-291, pl. 2, fig. 7, 9-10. Middle Ordovician (Late Llanvirn), Germany.

Systematic reassignments:

Frankea longispinosa (Pöthé de Baldis 1975b, p. 510, pl. 1, figs. 1-2; pl. 2, figs. 5-6) comb. nov. Holotype pl. 2, fig. 5. Late Silurian, Argentina. Originally *Evittia longispinosa*; transferred to *Frankea* since the vesicle is triangular, with a long, birfurcate spine extending out from each corner.

Frankea semispinosa (Pöthé de Baldis 1981, p. 241, pl. 3, fig. 3) comb. nov. Late Silurian (Early Ludlow), Argentina. Originally *Evittia semispinosa*; transferred to *Frankea* since the vesicle is triangular and gives rise to only 3 branching spines.

Frankea trispinoramosa (Stockmans and Willière 1962b, p. 83-84, pl. 1, fig. 1; text-fig. 1) comb. nov. Late Devonian (Frasnian), Belgium. Originally *Veryhachium trispinoramosum*; also placed invalidly into *Evittia*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle extends into 3 long processes, each distally bifurcating and sometimes showing a secondary division into branchlets.

Genus ***Gorgonisphaeridium*** Staplin, Jansonius and Pocock 1965, p. 192-193.

Diagnosis: (Staplin, Jansonius and Pocock 1965, p. 192): "Vesicles spherical; wall firm, relatively thick, smooth or with minute sculpture; spines numerous, solid, usually sinuous, slender or broad, of the same material as vesicle wall. Tips simple, or distally branched, flexible, bases may be slightly bulbous; vesicle size of known species relatively large."

Remarks: This genus has come to include both small and large species, in which the spines are at least in part solid, or apparently so, and whose morphology may be uniform or quite highly variable. Typically, however, it has come to comprise forms having relatively broad processes (see discussion in Sarjeant and Stancliffe 1994, p. 31).

Type species: Gorgonisphaeridium winslowii Staplin, Jansonius and Pocock 1965, p. 193, pl. 19, figs. 11, 18-20; text-fig. 4. Holotype pl. 19, fig. 20. Carboniferous (Early Mississippian; Tournaisian), Alberta, Canada.

Systematic reassignments:

Gorgonisphaeridium acaciaense (Playford and Martin 1984, p. 205, figs. 8A-F) comb. nov. Holotype fig. 8E. Early-Middle Ordovician (Arenig to Llanvirn), Western Australia. Originally *Multiplicisphaeridium acaciaense*; transferred to *Gorgonisphaeridium* since the processes are short, sometimes solid and showing distal division into up to five branchlets.

Gorgonisphaeridium cacteum (Uutela and Tynni 1991, p. 89-90, pl. 20, fig. 210a; pl. 21, fig. 210b) comb. nov. Early-Middle Ordovician (Arenig-Llanvirn), Estonia. Originally *Multiplicisphaeridium cacteum;* transferred to *Gorgonisphaeridium* since the processes are solid, basally costate and distally furcate.

Gorgonisphaeridium diversispinosum (Uutela and Tynni 1991, p. 91, pl. 21, fig. 213) comb. nov. Middle-Late Ordovician (Llandeilo-Ashgill), Estonia. Originally *Multiplicisphaeridium diversispinosum*; transferred to *Gorgonisphaeridium* since the short, furcate processes have cavities that do not communicate with the vesicle interior.

Gorgonisphaeridium estrellaferum (Cramer 1966, p. 244-245, pl. 1, fig. 5; text-fig. 3, no. 6) comb. nov. Late Silurian (Ludlow)-Early Devonian (Emsian), Spain. Originally *Baltisphaeridium estrellaferum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle is spherical and bears numerous short, stout processes, broad-based and distally palmate.

Gorgonisphaeridium fui (Fensome, Williams, Barss, Freeman and Hill 1990, p. 347) comb. nov. Holotype: Fu Jiayuan 1986b, pl. 4, fig. 26. Early-Middle Ordovician, China. Originally *Multiplicisphaeridium robustum* Fu Jiayuan 1986b, p. 120, pl. 4, figs. 17, 25-26 *non M. robustum* (Sanneman 1955) Eisenack, Cramer and Díez Rodríguez 1973; transferred to *Gorgonisphaeridium*, since the numerous processes are very short, bifurcate or with brief branches and apparently solid.

Gorgonisphaeridium? lewisii (Deunff 1954, p. 240, fig. 3) comb. nov. Middle Devonian, France. Originally *Hystrichosphaeridium lewisii*, subsequently *Baltisphaeridium* and *Multiplicisphaeridium* ; also invalidly placed into *Ammonidium* by Lister 1970, p. 49. Transfer provisional, since the numerous short, sometimes bifurcate processes may be solid or hollow.

Gorgonisphaeridium martiniae (Priewalder 1987, p. 45, pl. 9, figs. 9-13; pl. 20, figs. 1-2; text-fig. 21) comb. nov. Holotype pl. 9, fig. 13. Early Silurian (Llandovery), Austria. Originally *Multiplicisphaeridium martiniae*; transferred to *Gorgonisphaeridium* since the numerous short processes are of variable thickness and character but show only one order of principal branching.

Gorgonisphaeridium rakoae (Stockmans and Willière 1969, p. 20-21, pl. 4, figs. 1-3) comb. nov. Holotype pl. 4, fig. 3. Late Devonian (Famennian), Belgium. Originally *Baltisphaeridium rakoae*; subsequently, and transferred from, *Multiplicisphaeridium*, since the processes are quite short and heteromorphic (simple, bifurcate or branching into rosettes).

Gorgonisphaeridium? raspum (Cramer 1964, p. 301, pl. 4, figs. 1-6, 11) comb. nov. Holotype pl. 4, fig. 1. Early Devonian (Middle Siegenian-Emsian), Spain. Originally *Baltisphaeridium raspum*; subsequently *Micrhystridium* and *Multiplicisphaeridium*; transferred provisionally from the latter genus, since the processes are quite short and strongly heteromorphic. [Note: this reassignment presents particular problems since Cramer included two distinct morphotypes into this species–the typical forms with very numerous, short processes, probably solid, and forms with relatively long processes, fewer in number and certainly hollow, opening to the vesicle interior. Only the former can be attributed with any confidence to *Gorgonisphaeridium*.]

Gorgonisphaeridium saharicum (Lister 1970, p. 94, pl. 12, figs. 2-4) comb. nov. Holotype pl. 12, fig. 4. Late Silurian (Ludlow), England. Originally *Multiplicisphaeridium saharicum*; transferred to *Gorgonisphaeridium* since the processes are extremely short, perhaps solid, "tapering distally and dichotomizing irregularly".

Gorgonisphaeridium triangulatum (Downie 1963, p. 631, pl. 92, fig. 1) comb. nov. Early Silurian (Wenlock), England. Originally *Lophosphaeridium triangulatum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle bears numerous short, solid spines which do not exhibit distal branching.

Genus ***Hapsidopalla*** Playford 1977, p. 25

Original diagnosis: (Playford 1977, p. 25): "Vesicle hollow,

apparently single-layered, originally spherical to ellipsoidal; outline circular to subcircular or oval, clearly differentiated from processes. Numerous, ± evenly spaced, hollow, essentially homomorphic and smooth processes project from vesicle wall and branch distally; tips closed. Though discrete from one another, adjacent processes are interconected proximally by muri that form a distinct ± uniform reticulum sculpturing the vesicle surface; processes characteristically project from junctions of muri, never from lacunae. Lacunae typically triangular to polygonal. Interior of processes in free communication with vesicle cavity. Excystment by splitting of vesicle wall."

Remarks: The emendation proposed by Wicander and Wood 1981, p. 43 would incorporate into this genus forms with acuminate processes and a rosette-like vesicle sculpture. It is not accepted here, since the branching of the processes is considered a crucial feature in the definition of *Hapsidopalla* and since the difference in eilyma ornamentation, between a reticulate and a rosette pattern, is regarded as too major for containment within a single genus. The two species assigned by Wicander and Wood to this genus, on the basis of their proposed emendation, are herein transferred to the new genus *Wicanderidium*.

Type species: Hapsidopalla sannemannii (Deunff 1957, p. 6, fig. 1 {p. 13}; figs 5-9 {p. 14}) emend. Playford 1977, p. 26. Holotype fig. 1 {p. 13}. Middle Devonian, Belgium. Originally *Micrhystridium*; subsequently *Baltisphaeridium*; also invalidly placed into *Veryhachium*.

Systematic reassignments:

Hapsidopalla exornata (Deunff 1967, p. 259, figs. 1, 3-4, 19) emend. Playford 1977, p. 25-26. Early Devonian, Canada. Originally *Baltisphaeridium*; subsequently *Hapsidopalla* and *Multiplicisphaeridium*. Herein returned to *Hapsidopalla* since the vesicle surface bears a network of small crests and the hollow appendages branch only at the distal extremities.

Hapsidopalla? venusta (Sannemann 1955, p. 345, pl. 5, fig. 11; text-fig. 15) Playford 1977, p. 25. Middle Devonian (Late Givetian), Germany. Originally *Hystrichosphaeridium*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*. This generic assignation is considered questionable since, like the other species described by Sannemann, this may well be a muellerisphaerid [see comments].

Transferred species:

Hapsidopalla chela Wicander and Wood 1981, p. 43, pl. 10, fig. 8; pl. 11, figs. 1-2. Transferred to *Wicanderidium* herein.

Hapsidopalla invenusta Wicander and Wood 1981, p. 44-45, pl. 11, figs. 4-6; pl. 12, fig. 1. Transferred, as type species, to *Wicanderidium* herein.

Hapsidopalla reticulata (Pöthé de Baldis 1975a, p. 500, 503, pl. 2, figs. 4, 6) Playford 1977, p. 25. Originally *Tylotopalla*; transferred to *Hoegklintia* herein.

Genus ***Hoegklintia*** Dorning 1981, p. 192.

Diagnosis: (Dorning 1981, p. 192): "Vesicle subsphaerical to polygonal in outline, large, ill defined from processes, wall thin, laevigate, 3 to several processes, broad ill defined base, distally branched, bifurcate to multifurcate in one to three orders; the distal termination is sharp to somewhat blunt, often with some darkening of the process wall at the tip."

Remarks: The large vesicle, not clearly distinct from the processes, and the form of those processes distinguishes this genus from *Multiplicisphaeridium*.

Type species: Hoegklintia visbyensis (Eisenack 1959, p. 200-201, pl. 16, figs. 12-14; text-fig. 7) Dorning 1981, p. 192. Holotype pl. 16, fig. 12. Silurian (Late Llandovery-Early Ludlow), Gotland, Sweden. Originally *Baltisphaeridium*; subsequently *Veryhachium* and *Multiplicisphaeridium*.

Systematic reassignments:

Hoegklintia birminghamensis (Cramer 1970, p. 177-178, pl. 22, figs. 314, 316; text-fig. 55a *ex* Eisenack, Cramer and Díez Rodriguez 1973, p. 539-540) comb. nov. Holotype pl. 22, fig. 314. Early Silurian (Late Llandovery), Alabama, U.S.A. Originally invalidly published as *Baltisphaeridium birminghamense*; validly published as, and transferred from, *Multiplicisphaeridium*, since the processes are broadly conical and heteromorphic, the union of their bases giving shape to the vesicle.

Hoegklintia continuata (Kjellström 1971a, p. 46-47, pl. 3, fig. 7) comb. nov. Middle Ordovician, Sweden. Originally *Multiplicisphaeridium continuatum*; transferred to *Hoeglintia* since the seven large spines converge at their bases to form the vesicle and their branching is homomorphic.

Hoegklintia corallina (Eisenack 1959, p. 201, pl. 16, figs. 15-16) comb. nov. Holotype pl. 16, fig. 15. Silurian (Early Wenlock-Early Ludlow), Baltic region. Originally *Baltisphaeridium corallinum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the few massive processes coalesce proximally to form the central body.

Hoegklintia maroquensis (Cramer, Allam, Kanes and Díez 1974a, p. 185, pl. 27, figs. 3-5, 7-9) comb. nov. Holotype pl. 27, fig. 9. Early Ordovician (Late Arenig)-Early Silurian (Late Llandovery), Morocco. Originally *Multiplicisphaeridium maroquense*; transferred to *Hoeglintia* since the low number of processes are extremely broad-based and show two orders of distal branching. **Herein, Pl. II fig. 6.**

Hoegklintia reticulata (Pöthé de Baldis 1975a, p. 500, 503, pl. 2, figs. 4, 6) comb. nov. Holotype, pl. 2, fig. 6. Early Silurian (Wenlock), Argentina. Originally *Tylotopalla reticulata*; subsequently, and transferred from, *Hapsidopalla*, since the briefly bifurcate to trifurcate processes are low and very broad based, modifying the vesicle outline.

Genus ***Lusatia*** Burmann 1970, p. 295-296 **emend.**

Lusatia Burmann 1970, p. 295-296; Eisenack, Cramer and Díez 1976, p. 437; Cramer and Díez 1977, p. 89; Fensome *et al.* 1990, p. 307.

Original diagnosis: (Burmann 1970, p. 296; translated by Eisenack, Cramer and Díez 1976, p. 437): "General form of the central body variable, often depending on the number of processes, hence in outline circular or triangular, also slightly stretched axially or with convex vaulting of the interprocessal sides. The number of the processes varies greatly (1, 2, 3 and more). The processes are in general long, thin and well differentiated from the central body. Some are unbranched [e.g. the axial process of *Lusatia* (*Multiplicisphaeridium*) *dendroidea*] and taper gradually, while others are branched dichotomously but irregularly to form a wide tree-like crown of long pinnae. The dichotomous branching is subject to considerable variation and as, generally, a consistent terminal focus of branching is

PLATE CAPTIONS

Plate I

figures 1-4

The holotype of *Multiplicisphaeridium ramispinosum* Staplin 1961, emend. Sarjeant and Vavrdová, herein. Seen at four different focal levels, from uppermost (figure 1) to lowermost (figure 4). (Photos: Jan Jansonius). X ca. 125.

Plate II

figure 1

Barathrisphaeridium chagrinense Wicander, 1974. Ashkidah Formation, latest Devonian. Sheet Sabha, Murzuq Basin, Libya. Slide D-1 A, coordinates: 14x123. (Photo: M. Vavrdová). X ca. 700.

figure 2

Multiplicisphaeridium ramusculosum (Deflandre) Lister, 1970. Kosov Formation, latest Ordovician. Hlásná Třebáň near Beroun, Czech Republic. Slide HT-4/11, coordinates: 8x105. (Photo: M. Vavrdová). X ca. 800.

figure 3

Oppilatala cara (Cramer & Díez 1972b) comb. nov. Kosov Formation, latest Ordovician. Hlásná Třebáň near Beroun, Czech Republic. Slide HT-4/11, coordinates: 8x105. (Photo: M. Vavrdová). X ca. 400.

figure 4

Vogtlandia multiradialis Burmann, 1970. Klabava Formation, late Arenig. Krušná Hora near Beroun, Gabriela mine. Slide KK-104, coordinates: 6.2x111. (Photo: M. Vavrdová). X ca. 1300.

figure 5

Lusatia dendroidea Burmann, 1970. Klabava Formation, late Arenig. Mýto near Rokycany, Czech Republic. Slide 106, coordingates: 13.7x115. (Photo: M. Vavrdová). X ca. 550.

figure 6

Hoegklintia maroquensis (Cramer *et al.*, 1974) comb. nov. Klabava Formation, latest Arenig. Mýto near Rokycany. Slide MV-2, coordinates: 15.5x130.5. (Photo: M. Vavrdová). X ca. 700

figure 7

Leptobrachion arbusculiferum (Downie) Dorning, 1981. Kosov Formation, latest Ordovician. Hlásná Třebáň near Beroun, Czech Republic. Slide HT-2/7, coordinates: 23x99. (Photo: M. Vavrdová). X ca. 1200.

figure 8

Frankea breviuscula Burmann, 1970. Šárka Formation, Early Llanvirn. Krušná Hora near Beroun. Czech Republic. Slide KH-53, coordinates: 9.6x110. (Photo: M. Vavrdová). X ca. 600.

figure 9

Martinsphaeridium aduncum (Playford & Martin, 1984) comb. nov. Klabava Formation, late Arenig. Mýto near Rokycany. Slide MÝ-3, coordinates: 12x134. (Photo: M. Vavrdová). X ca. 700.

figure 10

Multiplicisphaeridium delicatum Cramer & Díez, 1977. Kosov Formation, Late Ordovician. Hlásná Třebáň near Beroun. Slide HT-2/19, coordinates: 17x119.6. (Photo: M. Vavrdová). X ca. 800.

figure 11

Schizodiacrodium firmum (Burmann, 1970) comb. nov. Kosov Formation, Late Ordovician. Hlásná Třebáň near Beroun, Czech Republic. Slide HT-2/19, coordinates: 20x101. (Photo: M. Vavrdová). X ca. 500.

figure 12

Multiplicisphaeridium inconstans Cramer & Díez, 1977. Kosov Formation, Late Ordovician. Hlásná Třebáň near Beroun. Slide HT-2/7, coordinates: 23x102. (Photo: M. Vavrdová). X ca. 400.

Plate III

figure 1

Comasphaeridium longistipitatum (Cramer & Díez, 1977) comb. nov. Klabava Formation, late Arenig. Mýto near Rokycany. SEM 4565. (Photo: M. Vavrdová). X 1200.

figure 2

Buedingiisphaeridium tremadocum Rasul, 1979. Klabava Formation, late Arenig. Mýto near Rokycany. SEM 2017. (Photo: M. Vavrdová). X 2500.

figures 3 & 4

Athabascaella penika Martin & Leiming, 1988. Klabava Formation, late Arenig. Mýto near Rokycany. SEM 2203. (Photo: M. Vavrdová). X 3000 [figure 3]; X 6000 [figure 4].

Plate IV

figure 1

Multiplicisphaeridium bifurcatum Staplin *et al.*, 1965. Kosov Formation, Late Ordovician. Hlásná Třebáň near Beroun. Slide HT-4/11, coordinates: 2x119.2. (Photo: M. Vavrdová). X ca. 900.

figure 2

Multiplicisphaeridium illinoii (Cramer & Díez) Eisenack *et al.*, 1973. Kosov Formation, Late Ordovician. Hlásná Třebáň near Beroun. Slide HT-3/9, coordinates: 11.4x107. (Photo: M. Vavrdová). X ca. 600.

figures 3 & 4

Vogtlandia cervinacornua (Welsh 1986) comb. nov. Ladoga Formation, Late Cambrian. Outcrop 3, left bank of Izhora river, sample 6b (collected by N.A. Volkova), coordinates: 8x119.7. 2x119.2. (Photo: M. Vavrdová). X ca. 800.

figure 5

Evittia sommeri Brito, 1967. Tequeje Formation, latest Silurian. Pando X-1 core hole, Madre de Díos Basin, norther Bolivia. Slide P-38/11, coordinates: 8.3x91.2. 2x119.2. (Photo: M. Vavrdová). X 800.

figure 6

Ordovicidium groetlingboense (Kjellström) Loeblich & Tappan, 1978. Kosov Formation, latest Ordovician. Hlásná Třebáň near Beroun, Czech Republic. Slide HT-2/34, coordinates: 21.8x111.4. 2x119.2. (Photo: M. Vavrdová). X ca. 500.

figure 7

Vogtlandia multiradialis Burmann, 1970. Klabava Formation, late Arenig. Mýto near Rokycany. Slide MÝ-6, coorddinates: 8.3x119.1. 2x119.2. (Photo: M. Vavrdová). X ca. 1100.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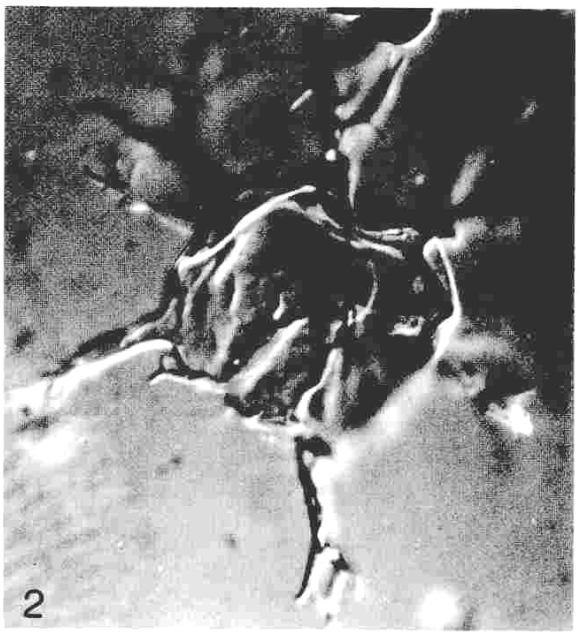
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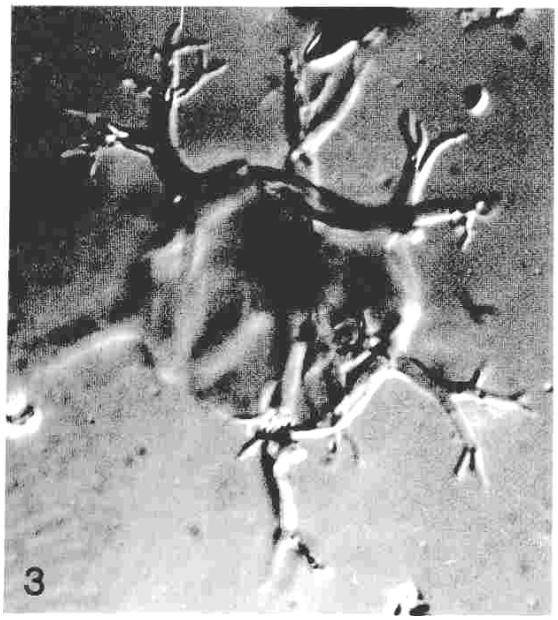
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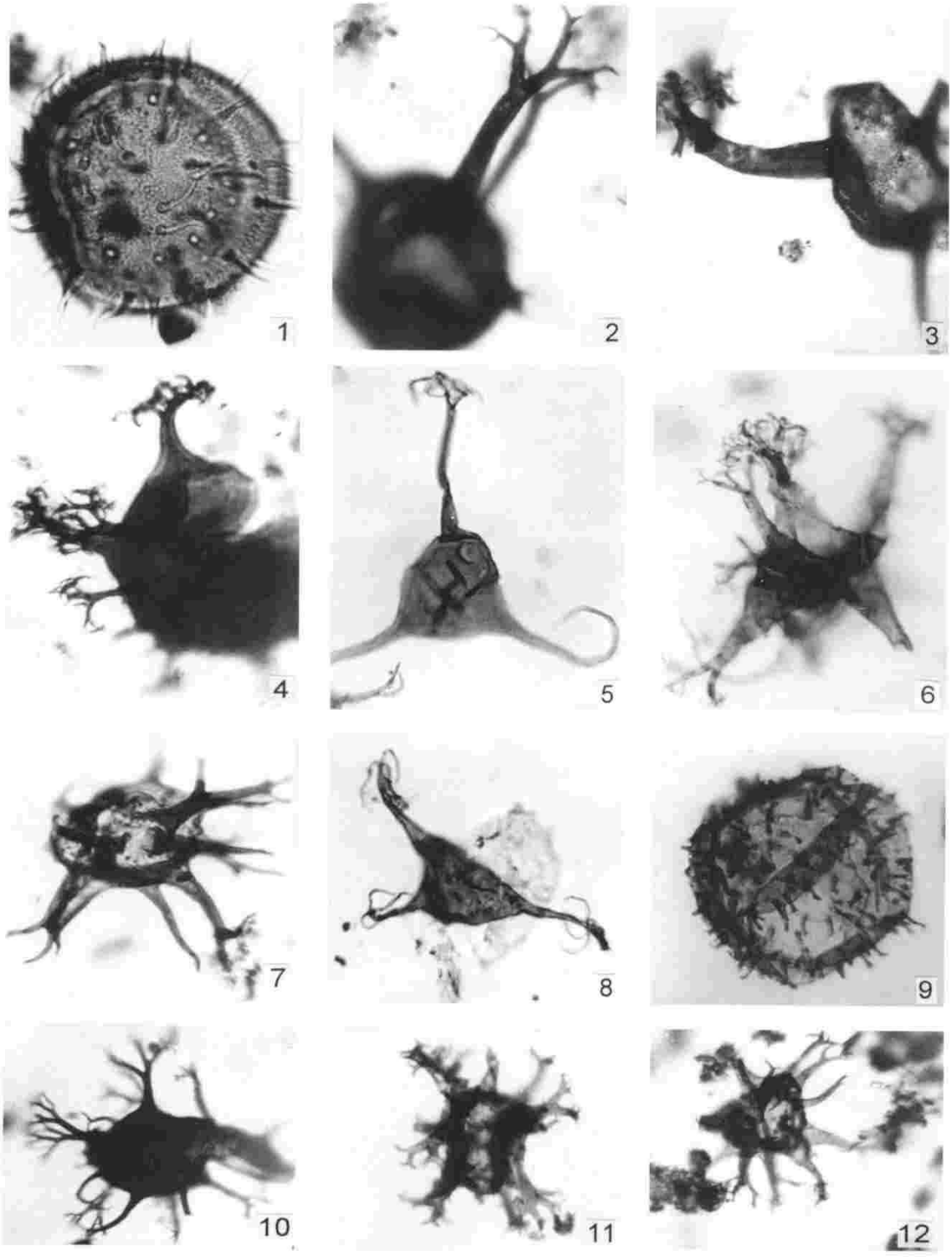
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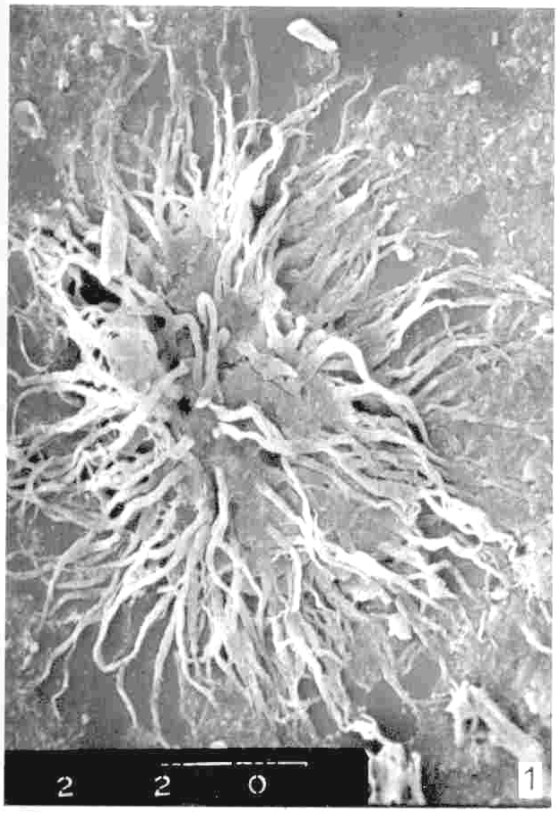
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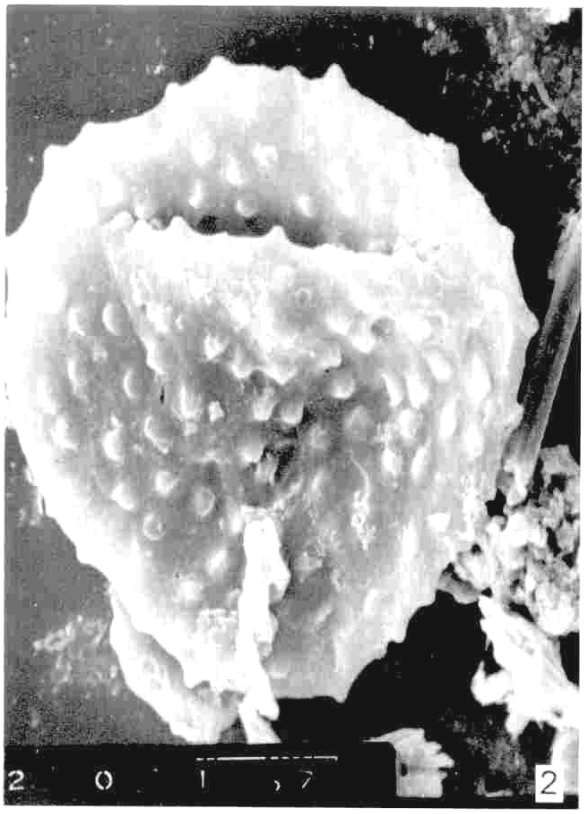
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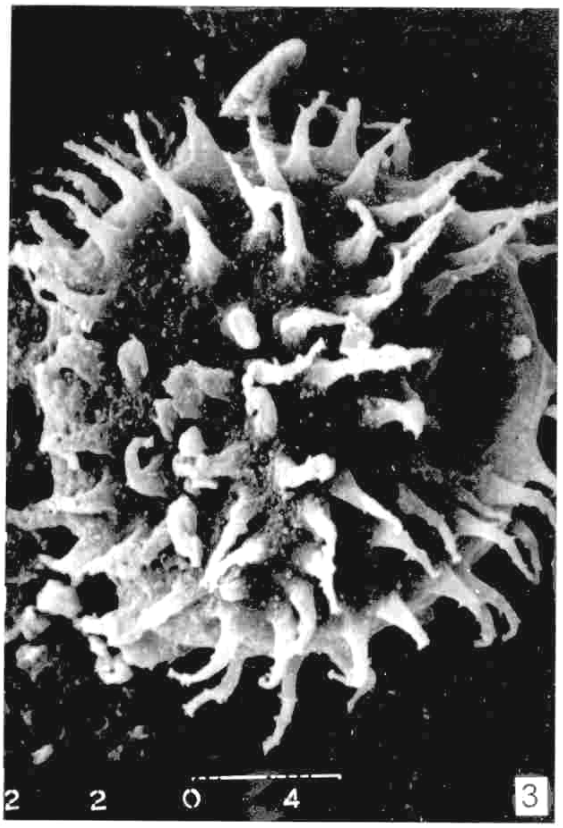
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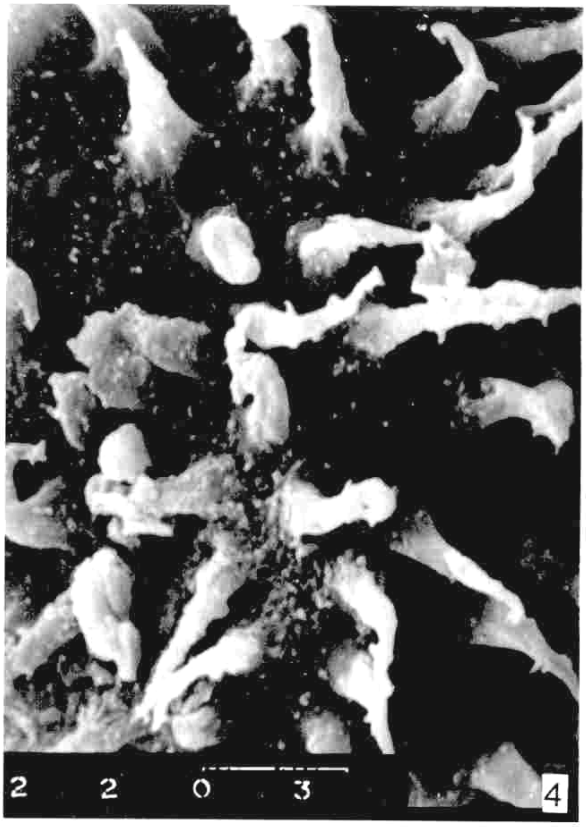
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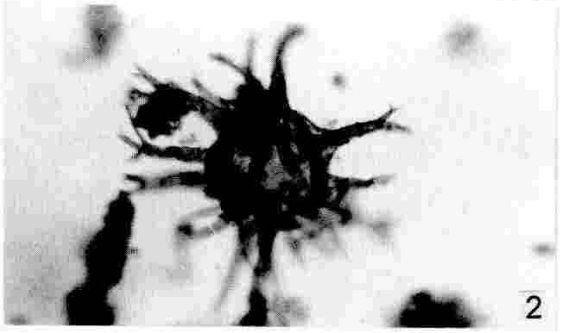
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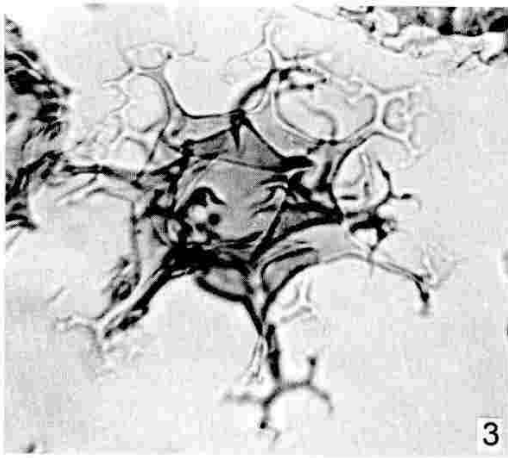
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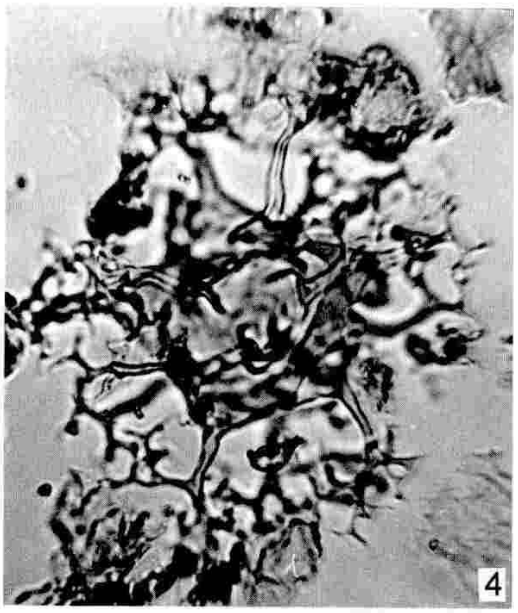
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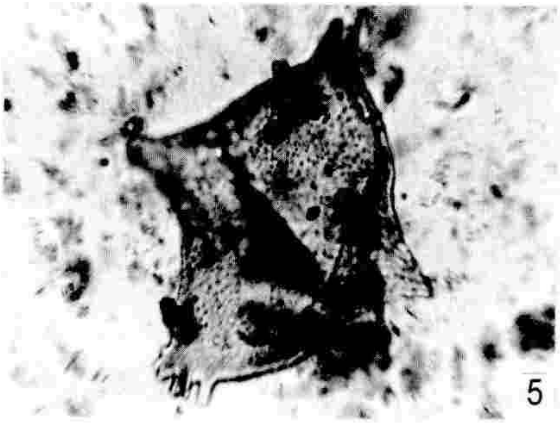
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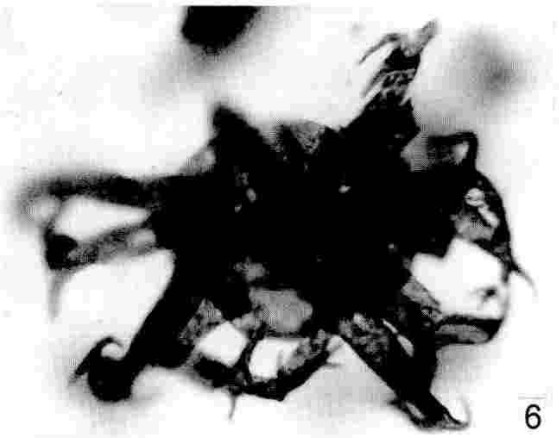
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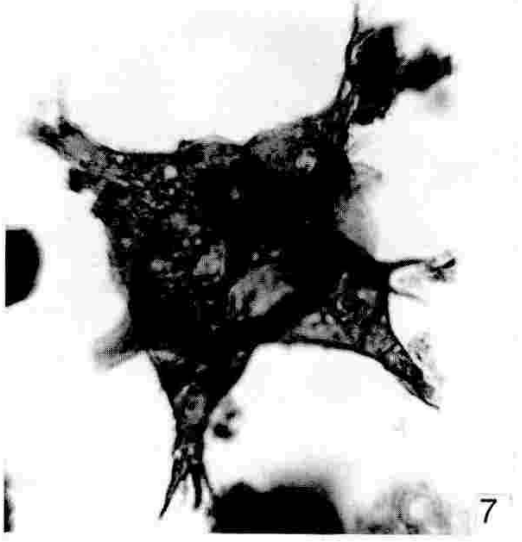
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lacking, the degree of branching is quite variable and furthermore the dichotomous branching takes place asymmetrically. The considerable length of the pinnae causes a wide crown in cases where the branching attains a high order."

Emended diagnosis: Vesicle triangular to quadrangular or tetrahedral, its angles prolonged into processes whose length typically exceeds the lengths of its sides. These processes typically arise at a sharp angle to the eilyma of the vesicle and taper only slightly to their distal extremities. Here they divide into 2-5 branches which, in turn, branch or ramify into a complex of branchlets, symmetrically or asymmetrically arranged and sometimes arborescent. The sides of the vesicle may be concave, flat or convex. Eilyma and processes laevigate or showing minor ornamentation, but not adorned by ridges or a reticulum and lacking granules, verrucae or spinelets. Opening by epityche.

Remarks: In their criticism of this genus, Eisenack *et al.* (1976, p. 437) note the overlap of the diagnosis with that of *Multiplicisphaeridium*. In practice, the genus *Lusatia* has been employed only for two species which have only three processes. As it stands, the diagnosis overlaps with that of *Vogtlandia*, two species of which, likewise have only three processes. To clarify the comprehension of both genera and enhance their usefulness, the diagnosis of *Lusatia* is here restricted to encompass only triangular to quadrangular or tetrahedral forms, while the genus *Vogtlandia* is redefined to encompass forms having more numerous spines and a vesicle of more complex shape.

Type species: Lusatia dendroidea Burmann 1970, p. 296, pl. 6, figs. 1-4. Holotype pl. 6, fig. 3. Lower Ordovician (?Tremadoc), Germany. [Note: a proposed transfer to *Multiplicisphaeridium* by Eisenack *et al.*, 1976 (p. 454-456) was illegitimate; see Fensome *et al.* p. 343. **Herein, Pl. II fig. 5 and Text-fig. 3b.**

Accepted species:

Lusatia forquilla (Cramer and Díez 1972b, p. 152, pl. 32, fig. 15) comb. nov. Early Silurian (Late Llandovery), Kentucky, U.S.A. Originally *Baltisphaeridium forquillum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle is spherical and bears only four processes showing a single order of distal branching.

Lusatia heteromorpha Vavrdová 1986, p. 351-352, pl. 3, figs. 4-6; text-fig. 3. Holotype pl. 3, fig. 4; text-fig. 3. Middle Ordovician (Early Llanvirn), Czech Republic.

Lusatia imperfecta (Burmann 1970, p. 294, pl. 4, figs. 3-5) comb. nov. Holotype pl. 4, fig. 3. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. Originally *Vogtlandia imperfecta*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle has only three long and elaborately branched processes.

Lusatia rayii (Cramer, Allam, Kanes and Díez 1974a, p. 186, pl. 27, figs. 1, 2, 6) comb. nov. Holotype pl. 27, fig. 1. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Morocco. Originally *Multiplicisphaeridium rayii*; transferred to *Lusatia* since the holotype exhibits only 4 symmetrically placed processes, long and branching distally. [Note: the material included into this species by the original authors appears to embrace several of the species differentiated by Burmann 1970 and merits careful restudy].

Lusatia tenuata (Burmann 1970, p. 293-294, pl. 3, fig. 3; pl. 4, fig. 2) comb. nov. Holotype pl. 3, fig. 3. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. Originally *Vogtlandia tenuata*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle is triangular and the form of the processes accords with that of *Lusatia*, as herein redefined.

Genus ***Martinsphaeridium*** Sarjeant and Vavrdová, **n. gen.**

Derivation of name: In tribute to the distinguished Belgian acritarch specialist, Francine Laure Martin (1937-1995).

Diagnosis: Vesicle hollow, spherical to ellipsoidal, single-walled or apparently so. Processes numerous, their length typically exceeding 2 m and less than one-quarter of the vesicle diameter. They are slender, showing only a slight proximal inflation, and normally hollow, their cavities communicating directly with the vesicle interior (though the slenderness of the processes may cause them to seem solid). The processes are usually homomorphic, but may show a restricted degree of variation; they are closed distally and exhibit a single order of branching confined to the distal extremity. Distal branching is usually uniform, into bifurcations, trifurcations or into a low number of branches; occasionally, acuminate processes may be present, but only in low number. The branches are typically of equal or near-equal length and without secondary division into branchlets; they show no linkage by trabeculae with other processes and are not enclosed within an ecteilyma. Eilyma and surfaces of processes laevigate or with inconspicuous ornamentation, but not striate or areolate and not exhibiting any pattern of indentations. Excystment by cryptosuture.

Remarks: Martinsphaeridium differs essentially from *Ammonidium* in the shorter length of processes; the processes also tend to be somewhat more numerous. It differs from *Tylotopalla* in the slenderness of its processes and their lesser complexity; and from *Barathrisphaeridium* in lacking a foveolate ornament of the eilyma. *Buedingiisphaeridium* has an ornament of verrucae or conical tubercles and *Gorgonisphaeridium* has processes of varied form and thickness, typically solid. *Tongzia* Li Jun 1987 has uniformly bifurcate processes with plugged bases. *Athabascaella* Martin 1984 emend. Martin and Yin Leiming 1988 (**illustrated herein, Pl. III figs. 3-4**) has ramifying processes, often linked by trabeculae; *Lua* Martin and Yin Leiming 1988 differs in having a prominent apical tubular extension (though this may not be visible in some orientations).

Type species: Martinsphaeridium macilentum (Playford and Martin 1984, p. 192, figs. 5A-F) comb. nov. Holotype fig. 5B. Early-Middle Ordovician (Late Arenig-Llanvirn), Western Australia. Originally *Ammonidium macilentum*. [Note: illustrated herein as Text-fig. 2b]

Accepted species:

Martinsphaeridium aduncum (Playford and Martin 1984, p. 191, figs. 4C-H) comb. nov. Holotype 4F. Early-Middle Ordovician (Late Arenig-Llanvirn), Western Australia. Originally *Ammonidium aduncum*; transferred to *Martinsphaeridium* since the numerous processes have a length of less than 20% of the vesicle diameter. **Herein, Pl. II fig. 9.**

Martinsphaeridium alloiteaui (Deunff 1955, p. 148, pl. 4, fig. 3) comb. nov. Middle Devonian, Canada. Originally *Micrhystridium alloiteaui*; subsequently *Baltisphaeridium* and *Multiplicisphaeridium*; transferred from *Ammonidium?*, since the numerous processes have a length of less than 20% of the vesicle diameter.

Martinsphaeridium ballistum (Ottone in Ottone, Toro and Waisfeld 1992, p. 98, 100, pl. 2, figs. 1-3, 8) comb. nov. Holotype pl. 2, fig. 1. Early Ordovician (Arenig), Argentina. Originally *Ammonidium ballistum*; transferred to *Martinsphaeridium* since the slender, branching processes are less than one-fifth of the vesicle diameter in length and are bifurcate to quadrifurcate.

Martinsphaeridium? bifurcatum (Thusu 1973a, p. 814, pl. 105, figs. 8, 12) comb. nov. Holotype pl. 105, fig. 8. Early Silurian (Wenlock), Ontario, Canada. Originally *Filisphaeridium bifurcatum*; subsequently *Multiplicisphaeridium*, becoming a jr. homonym of *M. bifurcatum* Staplin, Jansonius and Pocock 1965 and consequently renamed *M. thusui* by Fensome *et al.* 1990, p. 341, 356. Provisionally transferred to *Martinsphaeridium* herein, since it has 30 or more short, bifurcate processes; however, this number is low for the genus.

Martinsphaeridium? bipalmatum (Uutela and Tynni 1991, p. 88, pl. 20, no. 207) comb. nov. Middle Ordovician (Llanvirn)-Early Silurian (Llandovery), Estonia. Originally *Multiplicisphaeridium bipalmatum*; provisionally transferred to *Martinsphaeridium* since it accords with this genus in process length and number but differs in that the processes exhibit medial, as well as distal, stellate expansions, the former being larger. This may ultimately justify taxonomic separation at the generic or subgeneric level.

Martinsphaeridium lichenoides (Uutela and Tynni 1991, p. 93, pl. 21, fig. 214) comb. nov. Middle-Late Ordovician (Late Llandeilo-Middle Caradoc), Estonia. Originally *Multiplicisphaeridium lichenoides*; transferred to *Martinsphaeridium* since the processes are numerous and short (about one-tenth of the vesicle diameter), with stellate distal terminations.

Martinsphaeridium listeri (Smelror 1986, p. 141-142, pl. 3, figs. 1-3) comb. nov. Holotype pl. 3, fig. 2. Early Silurian (Llandovery), Norway. Originally *Ammonidium listeri*; transferred to *Martinsphaeridium* since the process length is less than one-sixth of the vesicle diameter.

Martinsphaeridium? ludloviense (Lister 1970, p. 50, pl. 1, figs. 6, 12-14 *ex* Dorning 1981, p. 183) comb. nov. Holotype pl. 1, fig. 14. Silurian (Wenlock-Ludlow), England. Originally described under the invalid name *Ammonidium rigidum* var. *ludloviensis* by Lister 1970; validly published as *Ammonidium ludloviense*, and here transferred provisionally from that genus, since the processes are quite short and bifurcate to trifurcate, but much fewer in number than is typical for this genus.

Martinsphaeridium parvipinnatum (Uutela and Tynni 1991, p. 95, pl. 21, fig. 217) comb. nov. Early Ordovician (Late Arenig)-Early Silurian (Early Llandovery), Estonia. Originally *Multiplicisphaeridium parvipinnatum*; transferred to *Martinsphaeridium* since the numerous processes are short and distally palmate. [Note: this species is the second smallest presently assigned to this genus–vesicle diameter 14-18 m–and stands close to *Micrhystridium*].

Martinsphaeridium parvispinosum (Uutela and Tynni 1991, p. 95, pl. 21, fig. 218) comb. nov. Middle-Late Ordovician (Early Llanvirn-Late Caradoc), Estonia. Originally - *Multiplicisphaeridium parvispinosum*; transferred to *Martinsphaeridium* since the numerous processes have a length of one-tenth of the vesicle diameter and show "slight palmate branching distally".

Martinsphaeridium raplaense (Uutela and Tynni 1991, p. 96, pl. 23, fig. 235) comb. nov. Ordovician (Late Arenig-Middle Ashgill), Estonia. Originally *Multiplicisphaeridium raplaense*; transferred to *Martinsphaeridium* since the vesicle is densely covered with distally furcate processes with a length only one-tenth of the vesicle diameter. [Note: this species is the smallest presently assigned to this genus–vesicle diameter 10-16 m–and stands close to *Micrhystridium*].

Genus ***Micrhystridium*** Deflandre 1937, p. 31-32, emend. Sarjeant and Stancliffe 1994, p. 12.

Emended diagnosis: (Sarjeant and Stancliffe 1994, p. 12): "Acritarchs with a spherical, oval to rounded-subpolygonal vesicle whose outline in optical section is not significantly modified by the bases of the spines. Vesicle size small, generally less than 20 m; larger species very rarely range above 27 m in diameter. Eilyma typically single-layered, rarely two-layered. Surface psilate to granulate or with other fine microstructure, but not divided into fields or plates. Arising from the vesicle, generally at right angles to the eilyma, are from 9 to 35 spines with closed tips, usually simple but rarely clavate. The spines may flare somewhat at their bases. Spines hollow to solid; if hollow, their central cavity may or may not communicate with that of the vesicle. A few spines may exhibit distal bifurcations or have small holes in their mid section. The spine length can range from ca. 1.5 m to greater than the vesicle diameter. Release of vesicle contents occurs by formation of a linear slit or a crescentic to horseshoe-shaped opening (epityche) or by opening of a cryptosuture, causing loss of an irregularly shaped portion of one surface: regularly formed circular to polygonal openings (pylomes) are not developed."

Remarks: The typically small vesicle size and simplicity of process morphology, separate this genus from the *Multiplicisphaeridium* group.

Type species: Micrhystridium inconspicuum (Deflandre 1935, p. 233, pl. 9, figs. 11-12) Deflandre 1937, p. 80, emend. Deflandre and Sarjeant 1970, p. 6-7. Holotype pl. 9, fig. 11. Late Cretaceous, France.

Systematic reassignments:

Micrhystridium? abnormisum (Yin Leiming 1986, p. 350-351, pl. 83, figs. 9, 13-14; text-fig. 129) comb. nov. Holotype pl. 83, fig. 14. Late Cambrian to Early Ordovician (Early Tremadoc), China. Originally *Multiplicisphaeridium abnormisum*; provisionally transferred to *Micrhystridium* since the vesicle size is small, the number of processes low (13-30) and the processes mostly simple, only a few bifurcating.

Micrhystridium baldisiae Sarjeant and Vavrdová, *nom.nov., nom.subst.pro Multiplicisphaeridium minutum* Pöthé de Baldis 1974, p. 316-318, pl. 2, fig. 5 which becomes upon transfer, a jr. synonym of *Micrhystridium minutum* Downie 1982 [now *Filisphaeridium downiei* Sarjeant and Stancliffe 1994]. Late Silurian (Ludlow), Argentina. This form is reattributed to *Micrhystridium* since the vesicle is very small, with numerous, very short conical processes, some simple and some briefly bifurcate.

Micrhystridium? chakor (Vanguestaine and van Looy 1983, p. 73-74, pl. 2, figs. 1-6; text-fig. 5) comb. nov. Holotype pl. 2, fig. 1. Middle Cambrian, Morocco. Originally *Multiplicisphaeridium chakor*; provisionally transferred to *Micrhystridium* in view of its small dimensions and process number; however, the presence of some ramified processes differentiates it from typical species of that genus.

Micrhystridium cortracumense Stockmans and Willière 1963, p. 468-469, pl. 2, fig. 11; text-fig. 29. Early Ordovician

(Late Llandovery), Belgium. Originally *Micrhystridium*; subsequently *Multiplicisphaeridium*, but now returned to *Micrhystridium* since the vesicle is small and globular and the majority of the spines are simple.

Genus ***Oppilatala*** Loeblich Jr. and Wicander 1976, p. 19.

Diagnosis: (Loeblich Jr. and Wicander 1976, p. 19): "Vesicle circular in outline, with variable number of processes clearly delineated from the vesicle and variously multifurcate; wall variously ornamented, double-layered, the processes formed by the outer layer, processes commonly constricted proximally and plugged for a short distance with material resembling the vesicle wall, processes do not communicate with the vesicle; excystment by a simple rupture of the vesicle wall."

Remarks: The double-layered eilyma and the processes, with their proximal constrictions and plugging, differentiate this genus from *Multiplicisphaeridium*.

Type species: Oppilatala vulgaris Loeblich Jr. and Wicander 1976, p. 20, pl. 6, figs. 11-13. Holotype pl. 6, fig. 13. Early Devonian (Late Gedinnian), Oklahoma, U.S.A. [Note: illustrated herein as Text-fig. 4b]

Systematic reassignments:

Oppilatala cara (Cramer and Díez 1972b, p. 148-149, pl. 31, figs. 5-6) comb. nov. Holotype pl. 31, fig. 5. Early Silurian (Late Wenlock), Kentucky, U.S.A. Originally *Baltisphaeridium carum* [*sic*]; subsequently, and transferred from, *Multiplicisphaeridium*, since it has few, long and broad processes, closed and constricted proximally. [Note: Cramer & Díez did not give any derivation for the trivial name. However, it appears to be based upon the Greek word 'kara', head; this would make it a noun in apposition and not requiring a change of suffix according to gender.] **Herein, Pl. II fig. 3.**

Oppilatala titilator (Cramer and Díez 1972b, p. 158, pl. 34, fig. 42) comb. nov. Early Silurian (Late Wenlock), Kentucky, U.S.A. Originally *Baltisphaeridium titilator*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle bears 4-10 long processes, dividing at their tips, and having plugged and constricted bases, and apparently unlinked with the vesicle interior.

Genus ***Palacanthus*** Wicander 1974, p. 30 **emend.** Sarjeant and Stancliffe 1994, p. 52.

Emended diagnosis: (Sarjeant and Stancliffe 1994, p. 52): "Vesicle stellate in outline, formed from five or more processes arising all in the same plane. Spines broad-based and conical, uniform in size or nearly so; distally they are closed, simple and acuminate. The process cavity communicates freely with the centre of the vesicle. Eilyma single-layered or apparently so. Surface of vesicle and spines laevigate to granulate, but without verrucae, striae or secondary spinelets."

Remarks: The limitation of the processes to a single plane and their accuminate extremities distinguish this genus from the *Multiplicisphaeridium* group.

Type species: Palacanthus acutus Wicander 1974, p. 30-31, pl. 6, fig. 4. Late Devonian, Ohio, U.S.A.

Systematic reassignment:

Palacanthus? kahleri (Bachmann and Schmid 1964, p. 59-60, pl. 2, fig. 17; pl. 3, fig. 18; pl. 6, fig. 37) comb. nov. Holotype pl. 2, fig. 17. Silurian, Austria. Originally *Baltisphaeridium kahleri*; subsequently, and transferred provisionally from, *Multiplicisphaeridium*, since the 10-11 processes are arranged in a peripheral zone and are homomorphic. However, the processes are branched and the vesicle is of very large size, casting doubt upon this reassignation. [Note: possibly a muellerisphaerid?].

Genus ***Petaloferidium*** Jacobson 1978, p. 295-296. **emend.**

Petaloferidium Jacobson 1978, p. 295-296; Cramer and Díez 1979, p. 95; Playford and Martin 1984, p. 205; Fensome *et al.* 1990, p. 388

Original diagnosis: (Jacobson 1978, p. 295): "Vesicle single-walled, spherical to subspherical; outline circular to subcircular to subpolygonal; processes conical, hollow; free communication between process and vesicle cavity; process contact with vesicle curved; process tips thickened and rounded or with rounded petaloid lobes arranged palmately."

Emended diagnosis: Vesicle spheroidal to subpolygonal; eilyma single-layered or apparently so. Processes few (ca. 10-20), relatively short and hollow, their cavities communicating directly with the vesicle cavity. Length of processes less than 50% of the vesicle diameter. Distally they are closed and often thickened, of varied form (evexate, capitate, cauliflorate, petaloid, lobulate or secate) but not exhibiting true branching. Processes arise at a sharp angle with the eilyma surface; they may be relatively broad-based, though not modifying the vesicle outline, and taper distally. Eilyma and surfaces of processes laevigate, microgranulate or with other inconspicuous ornamentation, but not striate or areolate and not exhibiting any pattern of indentations.

Remarks: This genus is distinguished by the form and relatively low number of its processes. The mode of excystment has not yet been confirmed; illustrations of the type material suggest it is probably by the opening of a cryptosuture.

The genus *Palaiosphaeridium* Rasul 1977 likewise has few, relatively short processes whose distal extremeties may be acuminate, evexate, flattened or briefly bifurcate. This similarity was noted by Playford and Martin 1984, p. 205, who distinguished the genera on the basis that the processes of *Petalosphaeridium* were "conical-subcylindrical (distally tapering)" whereas those of *Palaiosphaeridium* were "strictly cylindrical". This difference does not seem to us to be substantive. It may well prove, upon restudy, that the genera should be combined, in which case *Palaiosphaeridium* will be the senior synonym.

Type species: Petaloferidium stigii Jacobson 1978a, p. 296-297, pl. 1, figs. 5-6; text-figs. 3a-d. Holotype pl. 1, fig. 5. Late Ordovician (Late Caradocian), Kentucky, U.S.A. [Note: illustrated herein as Text-fig. 3e]

Accepted species:

Petaloferidium ancorum (Wicander and Loeblich Jr. 1977, p. 147, pl. 7, figs. 1-2, 6-7) comb. nov. Holotype pl. 7, figs. 1-2. Late Devonian, Indiana, U.S.A. Originally *Multiplicisphaeridium ancorum*; transferred to *Petaloferidium* since the 12-14 processes are moderate in length and have secate extremities.

Petaloferidium borracherosum (Cramer 1964, p. 289, pl. 1, fig. 11; text-fig. 16, no. 6) comb. nov. Late Silurian (Ludlow), Spain. Originally *Baltisphaeridium borracherosum*; also invalidly placed into *Hystrichosphaeridium* by

Andreeva 1973, p. 192. Subsequently and transferred from *Multiplicisphaeridium*, since the processes are low in number and have petaloid extremities.

Petaloferidium borracherosum forma *borracherosum*. Autonym.

Petaloferidium borracherosum forma *regulare* (Uutela and Tynni 1991, p. 89, pl. 20, fig. 208) comb. nov. Late Ordovician (Middle Ashgill), Estonia. Originally - *Multiplicisphaeridium borracherosum* forma *regulare*.

Petaloferidium comptum Playford and Martin 1984, p. 205-206, figs. 8M-P. Early-Middle Ordovician (Arenig-Llanvirn), Western Australia.

Species formerly placed in *Petaloferidium*:

Petaloferidium florigerum (Vavrdová 1977, p. 116, pl. 4, figs. 1-10) Fensome, Williams, Barss, Freeman and Hill 1990, p. 388. Originally *Evittia*; returned to that genus herein.

Genus ***Piliferosphaera*** Loeblich Jr. 1970, p. 735.

Diagnosis: (Loeblich Jr. 1970, p. 735). "Central body subangular to subspherical, the thin wall ornamented with numerous short spine-like pila (up to 1.3 m in length); major processes numerous, hollow and communicate with the central body, commonly with striations at the proximal end and with small warts along the wall, terminally multifurcate; no pylome observed."

Remarks: This genus differs from *Multiplicisphaeridium* in the ornament of the vesicle wall and the process bases. It is questionable whether so small a difference justifies differention at the generic level; a reduction to subgeneric status might be more appropriate.

Type species: Piliferosphaera setosa Loeblich Jr. 1970, p. 735-736, figs. 31A-C. Middle Silurian, New York, U.S.A.

Systematic reassignments:

Piliferosphaera aculeata (Díez and Cramer 1976, p. 126, pl. 3, figs. 8, 10) comb. nov. Holotype pl. 3, fig. 10. Late Silurian (Ludlow), Spain. Originally *Multiplicisphaeridium aculeatum*; transferred to *Piliferosphaera* since the vesicle is pilate and the process bases are sculptured.

Piliferosphaera almarada (Díez and Cramer 1976, p. 126, 127, pl. 3, figs. 13-14) comb. nov. Holotype pl. 3, fig. 14. Late Silurian (Ludlow), Spain. Originally *Multiplicisphaeridium almaradum*; transferred to *Piliferosphaera* since the vesicle is densely and coarsely granular.

Genus ***Rhaetosphaeridium*** Sarjeant and Vavrdová **n. gen.**

Derivation of name: After the Rhaetian Stage (latest Triassic) and with reference to the generally spherical vesicle.

Diagnosis: Vesicle spherical to ovoidal; eilyma thin composed of a single layer or apparently so. Processes moderately numerous (ca. 20-30), their length between about 10% and 40% of the vesicle diameter. Character of processes highly diverse; their thickness is extremely variable on each single specimen, from very slender to quite massive, their relative length is also variable, and they range in morphology from forms dividing at just above mid-length into 2 major branches of equal or unequal length and thickness, themselves sometimes dividing into branchlets which may undergo a third order of division, to forms where the branching is nearly or exactly distal, again with branches of equal or unequal length and thickness which may likewise subdivide. Some processes may ramify or may divide into a fan of up to 5 branches, themselves capitate, bifid or dividing into branchlets. Alternatively, the processes may be hair-like or acuminate, buccinate, bifid or capitate, the acuminate processes being sometimes so short as to suggest a secondary order of spines. The processes may be wholly or in part solid, but usually have at least a basal cavity, linked directly to the vesicle interior. Eilyma laevigate or with minor ornament, but without granules, verrucae or raised ridges. Process walls may be similar or may be more coarsely microgranulate. Opening of vesicle by polar schism.

Remarks: This new genus differs from *Multiplicisphaeridium* in its much greater diversity of process form and from other spinose genera in having processes of variable length which cannot be separated into two distinct size orders. The form of vesicle opening appears merely a modification of the familiar cryptosuture.

The range of the type and, so far, only species of *Rhaetosphaeridium* is Late Triasssic (Rhaetian) to basal Jurassic (Hettangian: Pre-*planorbis* Beds); thus it occurs at a much later stratigraphical level than any of the other genera examined in this paper, suggesting that it may be quite unrelated in origin. The possibility that this is a dinoflagellate cyst merits full investigation.

Type species: *Rhaetosphaeridium dendroidium* (Morbey 1975, p. 50-51, pl. 16, fig. 21) comb. nov. Late Triassic (Rhaetian), England. Originally *Multiplicisphaeridium dendroidium*. [Note: illustrated herein as Text-fig. 2f]

Genus ***Schizodiacrodium*** Burmann 1968, p. 642.

Diagnosis: (Burmann 1968, p. 642; transl. by Eisenack, Cramer and Díez 1976, p. 709): "Bipolarly constructed vesicles, the polar caps of which are separated by an equatorial zone and which bear bisymmetrically arranged branched processes."

Remarks: The genus *Adorfia* was considered by Cramer and Díez 1979, p. 63 to be a jr. synonym of *Multiplicisphaeridium*. Following our revision of the latter genus, we cannot accept this; however, we consider that the distinctions between *Adorfia* and *Schizodiacrodium* are a mere consequence of preservational chances and regard the former as a taxonomic synonym of the latter. Both species of *Adorfia* are therefore here reallocated to *Schizodiacrodium*.

Type species: Schizodiacrodium ramiferum Burmann 1968, p. 642, pl. 1, figs. 3-4. Holotype pl. 1, fig. 3. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany.

Systematic reassignments:

Schizodiacrodium firmum (Burmann 1970, p. 295, pl. 5, figs. 3-4) comb. nov. Holotype pl. 5, fig. 4. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. Originally *Adorfia firma*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle exhibits a bare central area, possibly striate, and accords in other features with this diacromorph genus. **Herein, Pl. II fig. 11.**

Schizodiacrodium prolongatum (Burmann 1970, p. 295, pl. 5, figs. 1-2, 5) comb. nov. Holotype, pl. 5, fig. 1. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. Originally *Aldorfia prolongata*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle has a rectangular outline and 3 elaborately branching processes appear to be symmetrically distributed about each of the two poles.

Genus ***Stellechinatum*** Turner 1984, p. 137.

Diagnosis: (Turner 1984, p. 137): "Vesicle hollow with polygonal or sub-polygonal outline. Wall thin (< 1 μ), single layered. Eight or more simple, hollow, proximally open, tapering processes having wide bases, curving proximal contacts and acuminate distal terminations. Process stems ornaments with small grana or spines that may become hair like distally. This ornament may extend onto the vesicle surface.

Remarks: The low number of simple, long spines separates this genus from the *Multiplicisphaeridium* group.

Type species: Stellechinatum celestum (Martin 1969, p. 89, pl. 3, fig. 147; pl. 4, fig. 206; pl. 6, fig. 252) Turner 1984, p. 138. Early Silurian (Late Llandovery-Wenlock), Belgium. Originally *Veryhachium*; subsequently *Baltisphaeridium* and *Polygonium*.

Systematic reassignments:

Stellechinatum absonum (Wicander 1974, p. 19, pl. 8, fig. 4) comb. nov. Carboniferous (Early Mississippian; Tournaisian), Ohio, U.S.A. Originally *Diexallophasis absona*; subsequently and transferred from *Multiplicisphaeridium* since the vesicle shape is controlled by the process bases and the seven processes are echinate.

Stellechinatum denticulatissimum (Cramer and Díez 1972b, p. 149, pl. 31, figs. 8-9) comb. nov. Holotype pl. 31, fig. 9. Silurian (Llandovery-Ludlow), Kentucky, U.S.A. Originally *Baltisphaeridium denticulatissimum*; subsequently, and transferred from, *Multiplicisphaeridium*, since the spherical central body and "manately branched" processes are covered with spinelets. [Note: the original authors state that this species has "around 15" processes, but their illustrations indicate a number under 10.]

Stellechinatum spiciferum (Deunff 1955, p. 146, pl. 3, fig. 1; text-fig. 26) comb. nov. Middle Devonian, Canada. Originally *Hystrichosphaeridium spiciferum*; subsequently *Baltisphaeridium*; also invalidly placed into *Evittia* and *Veryhachium*; transferred from *Multiplicisphaeridium*, since the "8 to 15" long processes are ornamented with spinelets and the processes are distally acuminate.

Stellechinatum wenlockium (Dorning 1981, p. 200, pl. 2, fig. 4) comb. nov. Early Silurian (Wenlock), England. Originally *Tylotopalla wenlockia*; transferred to *Stellechinatum* since the processes are long (more than 50% of the vesicle diameter) and ornamented by granules and spinelets.

Genus ***Striatotheca*** Burmann 1970, p. 290 emend. Sarjeant and Stancliffe 1994, p. 46.

Emended diagnosis: (Sarjeant and Stancliffe 1994, p. 46): "Vesicle triangular to quadrangular, with sides convex to concave. The spines arise from the angles and form an integral part of the vesicle, with which they are so completely confluent that no exact base can be defined. Spines arranged in a single plane and of equal or unequal length. Eilyma single-layered or apparently so. Spines hollow, cuneiform to acuminate, distally closed and sometimes with plugged tips, but without branches or other distal expansions. The spine cavity communicates freely with the vesicle interior. Surface of spines and/or vesicle striate to costate, the striations or ribs radiating outward in a fan-like fashion from the spine bases and thereafter assuming an orientation parallel to the vesicle sides, curving if those sides curve. Striations or ribs from adjacent "fans" may fuse or may be separated by a space, into which their ends may alternately extend. One or more secondary, shorter spines may be present on the sides between the major spines and in the same plane. The escape structure, where developed, is an epityche."

Remarks: The low number and arrangement of the spines–and, in particular, the conspicuous ribs or striae–differentiate this genus from the *Multiplicisphaeridium* group.

Type species: Striatotheca principalis Burmann 1970, p. 300, pl. 1, fig. 1. Early -Middle Ordovician (Late Arenig-Early Llanvirn), Germany.

Systematic assignment:

Striatotheca aniae (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 120, pl. 1, fig. 6) comb. nov. Early Silurian (Middle-Late Llandovery), Saharan Algeria. Originally *Baltisphaeridium aniae*; subsequently, and transferred from, *Tylotopalla*, since there are only either 3 or 4 long, unbranched appendages; the vesicle is thick, granular or rugulate; and a pattern of radial striae surround and extend onto the process bases.

Genus ***Timofeevia*** Vanguestaine 1978, p. 272.

Diagnosis: (Vanguestaine 1978, p. 272; new transl.): "Shell hollow, polyhedral, constituted of an arrangement of polygonal facets. According to the number of facets, the outline of the shell is polygonal or rounded. Membrane thin, apparently composed of a single layer. The facets are delimited by thickened sutures, sometimes projecting in the form of membraneous crests. Often, they are curved in towards the interior of the shell. Appendages simple, bifurcate or ramified, hollow or partially hollow and communicating freely with the central cavity of the shell. They are arranged, along the latter or confined to their points of convergence. Membrane smooth, shagreenate, microgranulate or microrugulate. Structure of dehiscence apparently formed by the loss of a variable number of polygonal facets."

Remarks: The faceted vesicle, with facets delimited by thickened sutures or crests, differentiate this genus from the *Multiplicisphaeridium* group.

Type species: Timofeevia lancariae (Cramer and Díez 1972a, p. 42, pl. 1, figs. 1-4, 6, 8; text-fig. 1) Vanguestaine 1978, p. 272. Holotype, pl. 1, fig. 3. Middle Cambrian, Spain.

Systematic reassignment:

Timofeevia albanega (Cramer, Díez, Rodriguez and Fombella 1976, p. 446-447, pl. 1, figs. 4-5, 8-9, 13; text-fig. 2, no. 8) comb. nov. Holotype pl. 1, fig. 4. Late Silurian (Late Ludlow)-Early Devonian (Early Gedinnian), Spain. Originally *Multiplicisphaeridium albanega*; transferred to *Timofeevia* since the thin vesicle is covered by a polygonal meshwork of ridges and the relatively few processes are slender, exhibiting only one order of branching. [Note: The derivation of the trivial name is not explained by Cramer *et al.*, but appears to be a Spanish name treated as a noun in apposition. If this is the case, Fensome *et al.* 1990, p. 339 were incorrect in modifying its ending to '*albanegum*'.]

Genus ***Tylotopalla*** Loeblich Jr. 1970, p. 737-738, **emend.**

Tylotopalla Loeblich Jr. 1970, p. 737-738; Eisenack, Cramer and Díez Rodriguez 1973, p. 1061; Cramer and Díez

1979, p. 109; Dorning 1981, p. 200; Le Hérissé 1989, p. 195; Fensome *et al.* 1990, p. 500.

Original diagnosis: (Loeblich Jr. 1970, p. 737). "An acritarch of small size, with circular to subcircular inflated central body whose interior communicates freely with the numerous short processes; processes terminate in a point or in short bifurcations with a feather or rosette of small spines just below their distal end. Surface variously ornamented, rugulate, scabrate or psilate."

Emended diagnosis: Vesicle typically of small size, generally less than 30 m in diameter. Processes short, their length less than 25% of the vesicle diameter, broad-based and most often tapering, their cavities open to the vesicle interior. Form of processes highly variable, both between species and often on a single individual; they may be acuminate, branched in regular or irregular pattern, or may form a tuft or rosette of small spinelets. Eilyma variously ornamented–coarsely granulate, rugulate, scabrate or verrucate–but not divided into fields by lines or crests and not echinate. This ornament may or may not extend onto the processes. Opening of vesicle by cryptosuture.

Remarks: The diagnosis is emended to place limits upon process length and to emphasize the importance of the vesicle ornamentation. The relations of *Tylotopalla* to the genus *Vandalosphaeridium* Vidal (1981, p. 38) remain to be elucidated; Vidal's genus has short, simple or furcate processes and overlaps both *Micrhystridium* and *Tylotopalla*.

Type species: *Tylotopalla digitifera* Loeblich Jr. 1970, p. 738-739, fig. 33D-E. Middle Silurian, New York, U.S.A. [Note: illustrated **herein as Text-fig. 2e**]

Accepted species:

Tylotopalla actinospinosa (Uutela and Tynni 1991, p. 87-88, pl. 20, fig. 206) comb. nov. Middle Ordovician (Llanvirn), Estonia. Originally *Multiplicisphaeridium actinospinosum*; transferred to *Tylotopalla* since the processes are relatively short and broad-based, with palmate terminations having "about 10 small pinnulae".

Tylotopalla astrifera Kiryanov 1978, p. 86, pl. 13, figs. 5a-b. Holotype pl. 13, figs. 5a-b. Early Silurian (Wenlock), Ukraine.

Tylotopalla brevidigitata (Uutela and Tynni 1991, p. 89, pl. 20, fig. 209) comb. nov. Late Ordovician (Middle Caradoc), Estonia. Originally *Multiplicisphaeridium brevidigitatum*; transferred to *Tylotopalla* since the processes are short, stout and with distal terminations "usually tangentially trifurcated", having "furcations... further bifurcated".

Tylotopalla caelamenicutis Loeblich Jr. 1970, p. 738, figs. 33A-C. Holotype fig. 33C. Middle Silurian, New York, U.S.A.

Tylotopalla cellonensis Priewalder 1987, p. 54, pl. 13, figs. 9-12; text-fig. 25. Holotype pl. 13, fig. 9. Early Silurian (Llandovery-Wenlock), Austria.

Tylotopalla cymoides (Uutela and Tynni 1991, p. 91, pl. 21, fig. 212) comb. nov. Late Ordovician (Middle Caradoc), Estonia. Originally *Multiplicisphaeridium cymoides*; transferred to *Tylotopalla* since the processes are short, and of varied form, sometimes simple, sometimes with bulbous processes that may be bi- or trifurcate and of variable relative length.

Tylotopalla dactilus (Vidal *in* Moczydlowska and Vidal 1988, p. 8, pl. 2, figs. 1-7) comb. nov. Holotype pl. 2, figs. 1-4. Early Cambrian, Sweden. Originally *Multiplicisphaeridium dactilus*; transferred to *Tylotopalla* since the vesicle is small and spherical, while the moderately numerous processes have a length of less than 25% of the vesicle diameter and are hollow and bilobate distally. [Note: When he named this species, Vidal indicated that the derivation of the name was from the Latin '*dactilum*', finger. This spelling was adopted by Fensome *et al.* 1990, p. 343. However, the correct Latin word is '*dactilus*', which must be treated as a noun in apposition, without modification according to gender. This change is made in accordance with Article 73, *I.C.B.N.*]

Tylotopalla furtiva (Playford and Martin 1984, p. 191-192, figs. 4I-M) comb. nov. Holotype fig. 4J. Early-Middle Ordovician (Late Arenig-Llanvirn), Western Australia. Originally *Ammonidium furtivum*; transferred to *Tylotopalla* since the processes are short and broad, showing only one order of abbreviate distal branching.

Tylotopalla guapa (Cramer 1964, p. 294, pl. 1, fig. 12; text-fig. 19, nos. 3, 3a) Eisenack, Cramer and Díez Rodriguez 1973, p. 1069. Early Devonian (Late Siegenian-Early Emsian), Spain. Originally *Baltisphaeridium*; subsequently *Micrhystridium*.

Tylotopalla irregulare (Downie 1982, p. 278, figs. 10q-u) comb. nov. Holotype fig. 10q. Early Cambrian, Alberta, Canada. Originally *Evittia irregulare*; transferred to *Tylotopalla* since the size is small, the eilyma surface heavily ornamented with "prominent acicles and grana" and the processes relatively short and of variable form.

Tylotopalla micropunctata (Uutela and Tynni 1991, p. 93-94, pl. 21, fig. 215) comb. nov. Late Ordovician (Middle-Late Caradoc), Estonia. Originally *Multiplicisphaeridium micropunctatum*; transferred to *Tylotopalla* since the small vesicle is microgranulate and the numerous short processes are distally palmate.

Tylotopalla ornata (Pöthé de Baldis 1971, p. 284, pl. 2, fig. 2) comb. nov. Late Silurian (Ludlow), Argentina. Originally - *Multiplicisphaeridium ornatum*; transferred to *Tylotopalla* since the processes are short, some being furcate at mid-length and some distally, but never showing two orders of branching.

Tylotopalla plicatica Sheshegova 1978, p. 16-17, pl. 1, fig. 4. Late Devonian, Siberia, Russia.

Tylotopalla pyramidalis (Lister 1970, p. 61, pl. 3, figs. 11-14; text-figs. 17h, 20e) Dorning 1981, p. 200. Holotype pl. 3, fig. 12. Late Silurian (Ludlow), England. Originally *Buedingiisphaeridium*.

Tylotopalla robustispinosa (Downie 1959, p. 61, pl. 10, fig. 7) Eisenack, Cramer and Díez Rodriguez, 1973, p. 1071-1072. Early Silurian (Wenlock), England. Originally *Baltisphaeridium*; also placed invalidly into *Evittia*.

Tylotopalla spinosa (Uutela and Tynni 1991, p. 97, pl. 23, fig. 237) comb. nov. Early-Middle Ordovician (Latest Arenig-Early Llanvirn), Estonia. Originally *Multiplicisphaeridium spinosum*; transferred to *Tylotopalla* since the illustration of the holotype shows processes of variable thickness, distally having "whip-like, flagelliform branches, with second-order branches" and "small, whip-like spikes"–thus of very variable form.

Tylotopalla stockmansii (Martin 1966a, p. 363, pl. 1, fig. 17; text-fig. 9) comb. nov. Silurian, Belgium. Originally *Baltisphaeridium stockmansii*; subsequently, and transferred provisionally from, *Multiplicisphaeridium*, since the vesicle is small and the processes very short, rather broad and bearing a "bouquet of small spines", acuminate or irregular in form.

Tylotopalla varipinnosa (Uutela and Tynni 1991, p. 86, pl. 20,

fig. 202) comb. nov. Early-Late Ordovician, Estonia. Originally *Micrhystridium varipinnosum*; subsequently provisionally placed in, and transferred from, *Multiplicisphaeridium*, since the vesicle is small and the processes short, some being simple, some cylindrical and bifurcate, in part exhibiting second order branching.

Species formerly placed in *Tylotopalla:*

Tylotopalla aniae (Jardiné, Combaz, Magloire, Peniguel and Vachey 1974, p. 120, pl. 1, fig. 6) Eisenack, Cramer and Díez 1979, p. 347, 348. Originally *Baltisphaeridium*; transferred to *Striatotheca* herein.

Tylotopalla deerlijkiana (Martin 1973, p. 23, pl. 5, figs. 167, 173; text-fig. 9); Martin 1978, p. 41. Originally *Buedingiisphaeridium*; retained in that genus by Fensome *et al.* 1990, p. 137.

Tylotopalla gordonensis (Cramer 1964, p. 284-285, pl. 1, fig. 9; text-fig. 14, no. 4) Eisenack, Cramer and Díez Rodriguez 1973, p. 1067-1068. Originally *Baltisphaeridium*; subsequently *Micrhystridium*; transferred provisionally to *Villosacapsula* herein.

Tylotopalla maraca Díez and Cramer 1976, p. 130, pl. 1, figs. 3, 9, 14, 18; pl. 2, figs. 10, 12, 14. Transferred to *Dorsennidium* herein.

Tylotopalla reticulata Pöthé de Baldis 1975a, p. 500, 503, pl. 2, figs. 4, 6. Transferred to *Hapsidopalla* by Playford 1977, p. 25.

Tylotopalla tappaniae Kiryanov 1978, p. 87, pl. 13, fig. 7; pl. 14, fig. 1. Transferred to *Diexallophasis* by Wicander 1986, p. 342.

Tylotopalla traumatica (Cramer 1964, p. 286, pl. 1, figs. 3, 5; text-fig. 14, nos. 2-3, 5) Eisenack, Cramer and Díez Rodriguez 1973, p. 1073-1074. Transferred to *Costatilobus* by Playford 1977, p. 15.

Tylotopalla waltonii (Downie 1982, p. 262, figs. 7g-i) comb. nov. Holotype fig. 7g. Early Cambrian, Alberta, Canada. Originally, and transferred from, *Multiplicisphaeridium?*, since the vesicle is small and the spines broad, relatively short and distally acuminate or bifurcate.

Tylotopalla wenlockia Dorning 1981, p. 200, pl. 2, fig. 4. Transferred to *Stellechinatum* herein.

Genus ***Unellium*** Rauscher 1969, p. 35, **emend.**

Unellium Rauscher 1969, p. 35; Cramer and Díez 1977, p. 111; Eisenack, Cramer and Díez 1979b, p. 351; Fensome *et al.* 1990, p. 503; Sarjeant and Stancliffe 1994, p. 46-47.

Original diagnosis: (Rauscher 1969, p. 35): "Shell globular, of small size with smooth surface covered with simple appendages, variable in size and number. The shell extends itself at one or two poles to form one or two simple appendages, longer and in general broader at their bases than the others." [Translation by Eisenack, Cramer and Díez 1979, p. 351].

Emended diagnosis: Vesicle globular to spheroidal, of small size. Eilyma laevigate and bearing a moderate number of simple appendages, typically acuminate or with blunt tips. At one or two poles, appendages of different form are present, longer and, in general, broader proximally than the others. Distally these may be simple or may branch briefly. Opening of the vesicle by cryptosuture.

Remarks: The diagnosis is emended to allow the inclusion of forms whose polar processes are bifurcate or otherwise branched. *Unellium* differs from *Multiplicisphaeridium* in the presence of these distinctive polar processes.

Type species: Unellium piriforme Rauscher 1969, p. 35-36, pl. 1, figs. 1-6. Holotype pl. 1, fig. 1. Middle-Late Devonian, France. [Note: illustrated herein as Text-fig. 2c]

Accepted species:

Unellium duplex (Pykhova 1973, p. 130, fig. 14) Sarjeant and Stancliffe 1994, p. 47. Cambrian, Siberia, Russia.

Unellium elongatum Wicander 1974, p. 35, pl. 18, figs. 10-12. Late Devonian-Carboniferous (Early Mississippian), Ohio, U.S.A.

Unellium lunatum (Stockmans and Willière 1967, p. 236-237, pl. 1, fig. 16; text-fig. 2) Eisenack, Cramer and Díez 1979, p. 357. Early Carboniferous (Mississippian), Belgium. [Note: Sarjeant and Stancliffe 1994, p. 47 were incorrect in believing that they were transferring this species for the first time].

Unellium oscitans Wicander 1974, p. 35, pl. 19, figs. 1-3. Late Devonian, Ohio, U.S.A.

Unellium parvum (Stockmans and Willière 1967, p. 237, pl. 1, fig. 21; text-fig. 3) Sarjeant and Stancliffe 1994, p. 47. Early Carboniferous (Mississippian), Belgium.

Unellium phosphoriense Jacobson, Wardlaw and Saxton 1982, p. 454-457, pl. 1, figs. 17-19. Permian, Utah, U.S.A.

Unellium? polorum (Miller and Eames 1982, p. 239-240, pl. 2, figs. 10-12) Sarjeant and Stancliffe 1994, p. 47. Early Silurian, New York, U.S.A.

Unellium snigirevskaiae (Stockmans and Willière 1963, p. 459-460, pl. 1, fig. 5; text-fig. 15) comb. nov. Silurian, Belgium. Originally *Baltisphaeridium snigirevskaiae*; subsequently, and transferred from, *Multiplicisphaeridium*, since the vesicle is small, the number of spines moderate and two poles are occupied by enlarged, bifurcate processes. [Note: The spelling of the trivial name as '*snigirevskae*' in Fensome *et al.* 1990, p. 355, is an error in citation.]

Unellium unilaterale (Pykhova 1973, p. 130, figs. 11, 15) Sarjeant and Stancliffe 1994, p. 47. Cambrian, Siberia, Russia.

Unellium varians (Stockmans and Willière 1963, p. 465-466, pl. 2, fig. 15; text-figs. 25-26) comb. nov. Early Silurian (Late Llandovery), Belgium. Originally *Micrhystridium varians*; also invalidly placed into *Baltisphaeridium* by Cramer 1970, p. 51. Subsequently, and transferred from, *Multiplicisphaeridium*, since the small vesicle bears processes of two types–a general cover of simple processes plus 1 (or possibly 2) larger axial processes, broad proximally and tapering to an acuminate tip.

Unellium winslowiae Rauscher 1969, p. 36, pl. 1, figs. 7-13. Middle-Late Devonian, France.

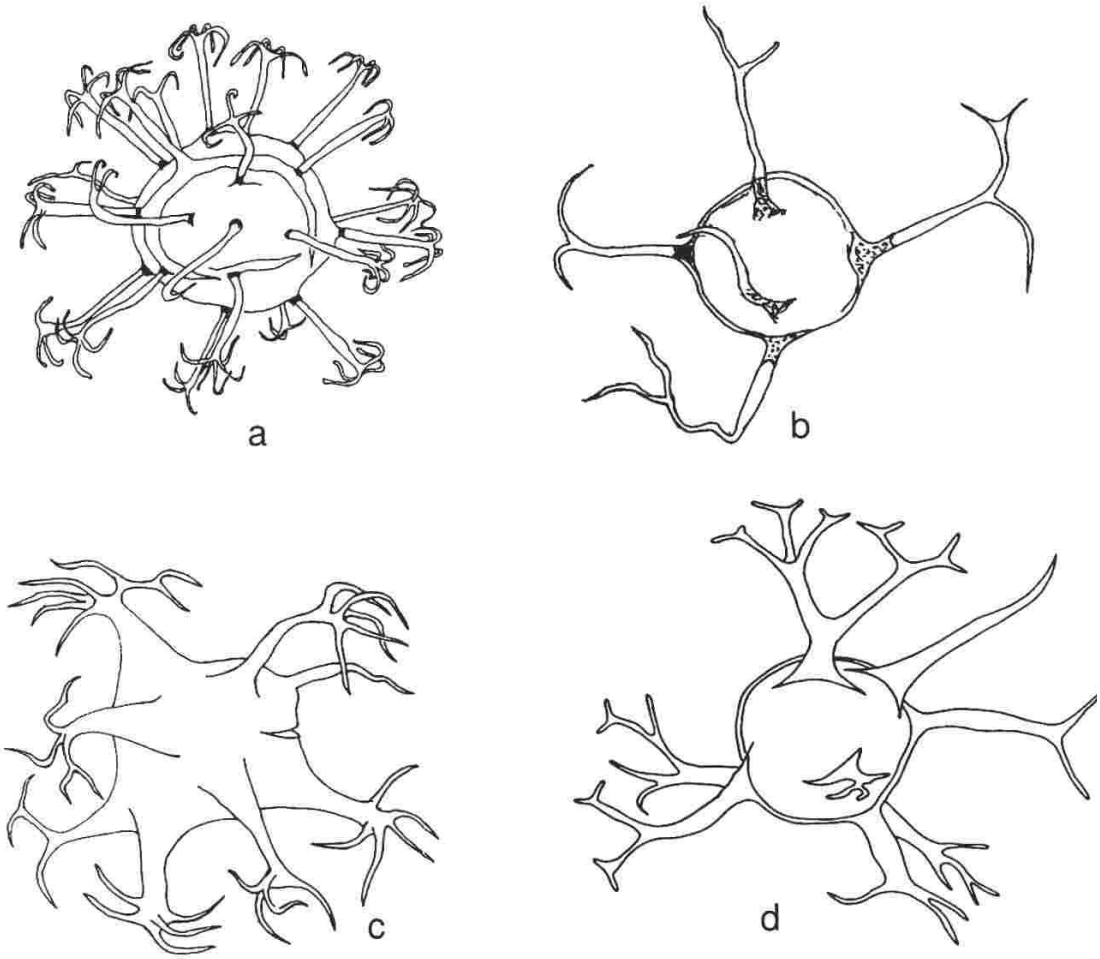
Species formerly placed in *Unellium:*

Unellium ampullium Wicander 1974, p. 34, pl. 18, figs. 7-9. Jr. synonym of *Unellium* (formerly *Micrhystridium*) *piriforme* Rauscher 1969 according to Martin 1981, p. 35.

Unellium cornutum Wicander and Loeblich Jr. 1977, p. 153-154, pl. 8, figs. 5-12. Jr. synonym of *Unellium winslowiae* Rauscher 1969 according to Lu Lichang and Wicander 1988, p. 129.

Genus ***Villosacapsula*** Loeblich Jr. and Tappan 1976, p. 306.

Diagnosis: (Loeblich Jr. and Tappan 1976, p. 306): "Vesicle triangular in outline, with a hollow process at each angle in the plane of the vesicle, rarely with one or more supplementary processes arising from the face of the vesicle, processes



text-figure 4

Genera with processes in low number, open or closed distally. a) *Excultibrachium concinnum* Loeblich Jr. & Tappan: th holotype, aftter Loeblich Jr. & Tappan 1978, pl. 9 fig. 5; b) *Oppilatala vulgaris* (Loeblich & Wicander): the holotyp redrawn aftter Loeblich & Wicander 1976, pl. 6 fig. 13; c) *Vogtlandia multiradialis* Burmann: specimen from the Klaba Formation (Ordovician), Gabriela Mine, Czech Republic; d) *Leptobrachion arbusculiferum* (Downie): the holotype, aft Downie 1963, pl. 91 fig. 5. Sketches not to scale with one another.

communicate freely with the vesicle interior; wall thin, surface of vesicle and commonly that of processes with short scattered microspines, excystment by an epityche."

Remarks: The shape and ornament of the vesicle and the low number of principal processes, differentiate this genus from the members of the *Multiplicisphaeridium* group.

Type species: Villosacapsula setosapellicula (Loeblich Jr. 1970, p. 743, figs. 36a-b, 37a-b) Loeblich Jr. and Tappan 1976, p. 306. Holotype fig. 36a. Late Ordovician, Oklahoma, U.S.A. Originally *Veryhachium*.

Systematic reassignments:

Villosacapsula cazurra (Cramer 1964, p. 315, pl. 13, fig. 1; text-fig. 30, no. 4) comb. nov. Early Devonian (Emsian), Spain. Originally *Veryhachium? cazurrum*, subsequent placed into *Baltisphaeridium* and provisionally into *Multiplicisphaeridium*. Transferred to *Villosacapsula* sin the vesicle surface is echinate and there are only fo branching processes having "roset-like branched stru tures" at their tips.

Villosacapsula? gordonensis (Cramer 1964, p. 284-285, pl. fig. 9; text-fig. 14, no. 4) Eisenack, Cramer and Dí Rodriguez 1973, p. 1067-1068. Early Devonian (Midd Siegenian-Emsian), Spain. Originally *Baltisphaeridiu gordonense*; subsequently placed into *Micrhystridium* a provisionally into *Tylotopalla*. Provisionally transferred *Villosacapsula* since there are only three processes but t wall of the central body, instead of having a cover microspines as is typical for this genus, is rugulate granulate.

Villosacapsula mucronata (Stockmans and Willière 1963, p. 456-457, pl. 1, fig. 20; pl. 3, fig. 6; text-fig. 10-11) comb. nov. Holotype pl. 1, fig. 20. Early Silurian (Late Llandovery), Belgium. Originally *Veryhachium mucronatum*; subsequently placed into *Baltisphaeridium, Multiplicisphaeridium* and provisionally into *Diexallophasis*. Transferred to *Villosacapsula* since there are only three long processes, branching and without a cover of denticles.

Villosacapsula scaber (Díez and Cramer 1976, p. 128, pl. 2, figs. 4-6, 8-9) comb. nov. Holotype pl. 2, fig. 4. Late Silurian (Ludlow), Spain. Originally *Multiplicisphaeridium scaber*; transferred to *Villosacapsula* since the vesicle is granulate and bears only four processes.

Villosacapsula semipunctata (Pöthé de Baldis 1979, p. 165, pl. 1, figs. 12, 15) comb. nov. Holotype pl. 1, fig. 15. Middle Devonian (Givetian), Paraguay. Originally *Multiplicisphaeridium semipuncatum*; transferred to *Villosacapsula* since the processes are few and ornamented at their bases with granules or spinelets.

Genus ***Visbysphaera*** Lister 1970, p. 98, emend. Kiryanov 1978, p. 21.

Emended diagnosis: (Kiryanov 1978, p. 21; Geological Survey of Canada transl.): "Spherical vesicles with distinctly differentiated processes. The surface of the vesicle is smooth or finely sculptured. The processes are formed by the ectoderm and are not differentiated from the latter in the structure and character of the surface. Processes club-shaped, columnar or somewhat widened towards the base (the angular contact between the process and the vesicle is close to a right angle). Besides the club-shaped processes, other processes of different form are slightly widened in their distal part. The processes have a spinocapitate type of structure: the secondary elements of the morphological structures on one and the same vesicle are more or less uniform, made up of granules, spinules or hair-like outgrowths, scattered over the surface of the process and, consequently, not joined together at the base. The spinules or hair-like outgrowths may be simple or form uncomplicated branches. The processes are hollow, the secondary elements of their structure are solid. The cavity of the processes opens out into the vesicle cavity. Pylome round, rarely observed."

Remarks: The shape of the processes and the vesicle ornament, differentiate this genus from *Multiplicisphaeridium*.

Type species: Visbysphaera dilatispinosa (Downie 1963, p. 642, pl. 92, fig. 4) emend. Lister 1970, p. 98-99. Early Silurian (Wenlock), England. Originally *Baltisphaeridium*; subsequently *Visbysphaera* and *Multiplicisphaeridium*. Returned to *Visbysphaera* by Priewalder 1987, p. 60.

Systematic reassignments:

Visbysphaera elias (Cramer, Díez, Rodriguez and Fombella 1976, p. 447, pl. 1, fig. 19; text-fig. 2, no. 1) comb. nov. Late Silurian (Late Ludlow), Spain. Originally *Multiplicisphaeridium elias*; transferred to *Visbysphaera* since the numerous processes are unbranched, closed distally and of spatulate to bud shape. No vesicle opening reported.

Visbysphaera juliae (Cramer 1964, p. 296, pl. 1, fig. 4, text-fig. 19, nos. 5, 20) comb. nov. Holotype pl. 1, fig. 4. Devonian (Middle Siegenian-Emsian), Spain. Originally *Baltisphaeridium juliae*, subsequently *Multiplicisphaeridium*; thereafter returned to *Baltisphaeridium*. Transferred from that genus, since the processes are short and heteromorphic, sometimes with swollen distal extremities and the eilyma thick, probably double.

Visbysphaera? moharra (Cramer, Díez, Rodriguez and Fombella 1976, p. 447, pl. 1, fig. 7; text-fig. 2, nos. 6, 6a) comb. nov. Late Silurian (Late Ludlow) - Early Devonian (Early Gedinnian), Spain. Originally *Multiplicisphaeridium moharra*; provisionally transferred to *Visbysphaera* since the processes are thick, in low number and exhibit an almost arbitrary-seeming branching into irregular spikes. [Note: Fensome *et al.* 1990, p. 350, cited the trivial name as '*moharrum*'. The original authors did not give a derivation of name, but '*moharra*' is a Spanish noun meaning 'head of a spear'. It should thus be treated as a noun in apposition and the ending not modified.]

Visbysphaera perculta Martin 1983, p. 30, pl. 10, figs. 3-4, 20. Holotype pl. 10, fig. 3. Middle Ordovician (Llanvirn-Llandeilo), Quebec, Canada. Originally placed provisionally into *Vogtlandia*. Transferred to *Visbysphaera* since, following revision of that genus, the number of processes and their relation to the vesicle excludes that attribution, whereas the form of the processes accords well with *Visbysphaera*.

Genus ***Vogtlandia*** Burmann 1970, p. 292, **emend.**

Vogtlandia Burmann 1970, p. 292; Eisenack, Cramer and Díez 1976, p. 841; Cramer and Díez 1977, p. 112; Fensome *et al.* 1990, p. 532.

Original diagnosis: (Burmann 1970, p. 292; new transl.): "Triangular or polyhedral central body with corresponding tri, quadru or multiradial arrangement of the processes. The central body gradually extends into elaborately branched, stout or narrow processes with broadly conical bases. The processes are hollow and communicate freely with the vesicle interior. The ratio between the length of the processes and the dimensions of the central body is variable. Characteristically, the processes are dichotomously branched, forming essentially homomorphic distal clusters. Whereas the first order branches consist of 2-4 pinnae which in turn divide into paired pinnulae of second and third order, the resultant terminations form dense crowns of relatively short branchlets, while the terminal branchlets approximately correspond in size to the first order pinnae."

Emended diagnosis: Vesicle polyhedral, each angle extending into a conical, wide-based process whose position and shape may modify the vesicle outline. Processes essentially homomorphic, showing up to three orders of distal branching to produce dense clusters of spinelets. Processes hollow, their cavity communicating directly with the vesicle interior. Number of processes between 5 and 15. The sides of the vesicle may be concave, flat or convex. Eilyma and processes laevigate or showing minor ornamentation, but not adorned by ridges or a reticulum and lacking granules, verrucae or spinelets. Nature of vesicle opening unknown.

Remarks: The diagnosis is emended to clarify the differences between this genus, *Evittia* and *Lusatia* (see earlier discussion). As a consequence of this limitation, two species are transferred herein to *Lusatia*. The polygonality of the vesicle and the distal character of the processes differentiates this genus from *Multiplicisphaeridium*.

Type species: Vogtlandia ramificata Burmann 1970, p. 292-293, pl. 3, figs. 4-5. Holotype pl. 3, fig. 5. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. [Note: illustrated **herein as Text-fig. 3d]**

Accepted species:

Vogtlandia cervinacornua (Welsch 1986, p. 61-62, pl. 6, figs. 7-10; text-fig. 21) comb. nov. Holotype pl. 6, fig. 8. Early Ordovician (Early Tremadoc), Norway. Originally *Multiplicisphaeridium cervinacornuum*; transferred to *Vogtlandia* since the 9-10 processes are broad-based, their positions modifying the polyhedral shape of the vesicle. **Herein, Pl. IV figs. 3-4.**

Vogtlandia coalita Martin *in* Dean and Martin 1978, p. 9-10, pl. 2, figs. 3, 7. Holotype pl. 2, fig. 3. Early Ordovician (Arenig), Newfoundland, Canada. [Note: The opinion of Martin, expressed as an addendum *in* Dean and Martin 1978, p. 19, that *Vogtlandia coalita* Martin *in* Dean and Martin 1978 is a jr. synonym of *E. flosmaris*, is not accepted since the processes of the former species are much more elaborately branched.]

Vogtlandia flos Martin *in* Dean and Martin 1978, p. 10, pl. 1, figs. 2, 6; pl. 3, figs. 24, 26. Holotype pl. 3, figs. 24, 26. Early Ordovician (Arenig), Newfoundland, Canada.

Vogtlandia multiradialis Burmann 1970, p. 293, pl. 4, fig. 1. Early-Middle Ordovician (Late Arenig-Early Llanvirn), Germany. [Note: The transfer to *Multiplicisphaeridium* by Eisenack, Cramer and Díez 1976 is here rejected, since the vesicle has only around 7 elaborately branched processes, sharply tapering.] **Herein, Pl. II fig. 4; Pl. IV fig. 7 and Text-fig. 4c.**

Vogtlandia opima (Uutela and Tynni 1991, p. 94, pl. 21, fig. 216) comb. nov. Late Ordovician (Early-Middle Caradoc), Estonia. Originally *Multiplicisphaeridium opimum*; transferred to *Vogtlandia* since the vesicle is subpolygonal (not spherical, as stated by the authors) and extends into a low number (not stated, but around 8) of massive, irregularly furcate processes.

Vogtlandia turgida (Uutela and Tynni 1991, p. 98, pl. 23, fig. 240) comb. nov. Middle-Late Ordovician (Early Llandeilo-Late Caradoc), Estonia. Originally *Multiplicisphaeridium turgidum*; transferred to *Vogtlandia* since the vesicle is polygonal and gives rise to a low number (from the illustration, around 7) of broad-based processes, some conical distally, some cylindrical and some bifurcate.

Vogtlandia xiana (Fombella 1977, p. 119, pl. 1, fig. 13; text-fig. 1, no. 10) comb. nov. Early-Middle Cambrian, Spain. Originally *Multiplicisphaeridium xianum*; transferred to *Vogtlandia* since the processes are very broad, their confluence determining the vesicle shape, and show a single order of distal branching.

Voglandia yankauskasii Fensome, Williams, Barss, Freeman and Hill 1990, p. 358, *nom. subst. pro Multiplicisphaeridium dendroideum* (Yankauskas 1976, p. 189, pl. 25, fig. 20) Yankauskas and Kiryanov in Volkova *et al.* 1979, p. 6. Early Cambrian, Lithuania. Originally, and transferred from, *Multiplicispheridium*, in view of the breadth of the process bases and their irregular distal character. [Note: In the original paper, in both text and plate caption, the holotype is wrongly identified as pl. 25, fig. 19].

Species formerly placed in *Vogtlandia:*

Vogtlandia imperfecta Burmann 1970, p. 294, pl. 4, figs. 3-5. Subsequently *Multiplicisphaeridium*; transferred to *Lusatia* herein.

Vogtlandia? perculta Martin 1983, p. 30, pl. 10, figs. 3-4, 20. Transferred to *Visbysphaera* herein.

Vogtlandia tenuata (Burmann 1970, p. 293, pl. 3, fig. 3; pl. 4, fig. 2) Eisenack, Cramer and Díez 1976, p. 485-486. Originally *Vogtlandia*; subsequently *Multiplicisphaeridium*; transferred to *Lusatia* herein.

Genus ***Vulcanisphaera*** Deunff 1961, p. 42, emend. Rasul 1976.

Emended diagnosis: (Rasul 1976, p. 479): "Body spherical to ellipsoidal in outline, sometimes polygonal. Body wall has conical projections (processes) which sometimes are separated into hollow conical primary processes with flat or crater-like top and secondary processes; the latter arise from edge of primary process top like tuft of branches, which vary from two to five in number. These secondary processes may be slender, tapering, or curved, with tips sometimes bifurcated or ramified into numerous filamentous threads. Processes may be solid, erect or curved, short or long, body wall smooth to punctate."

Remarks: The distinctive form of the processes, differentiates this genus from *Multiplicisphaeridium.*

Type species: Vulcanisphaera africana Deunff 1961, p. 42, pl. 2, fig. 1. Early Ordovician (Tremadoc), Algeria.

Systematic reassignments:

Vulcanisphaera ancliforme (Fombella 1978, p. 252, pl. 3, fig. 7) comb. nov. Middle Cambrian, Spain. Originally *Multiplicisphaeridium ancliforme*; transferred to *Vulcanisphaera* since the processes are essentially of conical form, terminating distally in a tuft of filiform spinelets.

Vulcanisphaera elliptica (Cramer and Díez 1977, p. 348, pl. 3, figs. 12-13) comb. nov. Holotype pl. 3, fig. 12. Early Ordovician (Early Arenig), Morocco. Originally *Multiplicisphaeridium ellipticum*; transferred to *Vulcanisphaera* since the processes are short, stout and broad-based, hollow and distally palmate.

Vulcanisphaera? eodigitata (Fombella 1978, p. 253, pl. 1, fig. 4) comb. nov. Early Cambrian-Early Ordovician, Spain. Originally *Multiplicisphaeridium eodigitatum*; provisionally transferred to *Vulcanisphaera* since the processes are low in number and short, distally bifurcate to trifurcate with secondary branches. However, the extremely damaged condition of the holotype precludes confidence in this reassignment.

Vulcanisphaera eopirifera (Fombella 1978, p. 253, pl. 3, fig. 20) comb. nov. Early Cambrian-Early Ordovician, Spain. Originally *Multiplicisphaeridium eopiriferum*; transferred to *Vulcanisphaera* since the vesicle is spheroidal and the processes clavate to baculate, distally bifurcate or trifurcate.

Vulcanisphaera multipugiunculata (Cramer and Díez 1977, p. 348, pl. 3, figs. 14-16, 18) comb. nov. Holotype pl. 3, fig. 15. Early Ordovician (Early Arenig), Morocco. Originally *Multiplicisphaeridium multipugiunculatum;* transferred to *Vulcanisphaera* since the processes of the holotype are short, moderately numerous, sharply tapering and with "six or more palmate pinnae". [Note: In contrast to the holotype, the other two specimens illustrated by Cramer and Díez have more abundant and slender processes; they may well represent a different species and genus.]

Genus ***Wicanderidium*** **n. gen.**

Derivation of name: In tribute to the U.S. specialist in acritarchs, Reed Wicander (Central Michigan University, Mount Pleasant, Michigan), who first jointly described this morphotype.

Diagnosis: Vesicle spheroidal, eilyma single layered or apparently so and of moderate size and thickness. Surface of eilyma ornamented with a rosette-like sculpture. Processes moderately

numerous (ca. 15-45), closed distally and hollow, their interior communicating directly with the vesicle cavity. The processes tips may be acuminate or may show a single order of division into up to 4 short branches, directed almost perpendicularly to the process shafts; however, they are neither linked by trabeculae nor enclosed within an ecteilyma. The process surfaces may be granular but lack conspicuous ornamentation. Opening of vesicle by equatorial schism.

Remarks: This new genus is characterized by the ornament of its vesicle. It resembles *Guttatisphaeridium* in many features, but differs in having a less thick eilyma, in ornamentation of the eilyma and in the absence of secondary filling of the distal portion of the processes. *Ammonidium* lacks ornamentation of the eilyma and *Hapsidopalla* has a reticulate ornament; both genera tend to exhibit more elaborate distal process branching. *Piliferosphaera* differs in exhibiting "short spine-like pila" on the eilyma and "small warts" on the processes, while *Rhacobrachion* Dorning (1981), has a microcostate ornament of both eilyma and processes. *Salopidium* Dorning (1981) has a foveolate eilyma ornament and laevigate processes; the vesicle regularly splits into two halves.

Type species: Wicanderidium invenustum (Wicander and Wood 1981, p. 44-45, pl. 11, figs. 4-6; pl. 12, fig. 1) comb. nov. Holotype pl. 11, fig. 4. Middle Devonian (Givetian), Ohio, U.S.A. Originally *Hapsidopalla invenusta*. [Note: illustrated herein as Text-fig. 2g]

Accepted species:

Wicanderidium chelum (Wicander and Wood 1981, p. 43, pl. 10, fig. 8; pl. 11, figs. 1-2) comb. nov. Holotype pl. 10, fig. 8. Middle Devonian (Givetian), Ohio, U.S.A. Originally *Hapsidopalla chela* transferred to *Wicanderidium* since its morphology is close to that of the type species, but differs in that the processes are not simple, but show a single order of distal division, into up to four branches.

3. Stratigraphical conclusions

The taxonomic revisions herein proposed involve the reconsideration, not only of the 241 species placed hitherto in *Multiplicisphaeridium*, but also the entire contents of 11 other genera whose diagnoses are proposed or revised herein. The result, we believe, is to give a greater degree of stratigraphical coherence to these genera. The ranges of species presented in Tables I-III, refer only to those quoted in the original descriptions of the species; later attributions to those species are necessarily subjective judgments and, though we would concur with many of these, all must be considered questionable.

The distributions, as presented in the tables, show a considerable degree of stratigraphical coherence. The range of *Multiplicisphaeridium* itself is now from Early Ordovician (Arenig) to Early Carboniferous (Tournaisian). The two most similar genera, *Ammonidium* and *Martinsphaeridium*, have comparable ranges–respectively, from Middle Ordovician (Llanvirn) to Early Carboniferous (Tournaisian) and from Early Ordovician (Arenig) to latest Devonian (Famennian). These three genera may well form a natural grouping.

Of the other genera for which revised diagnoses are proposed, *Tylotopalla* and *Unellium* exhibit the longest ranges and also the simplest morphology. *Tylotopalla* ranges from Early Cambrian to latest Devonian (Famennian) and *Unellium* from Early Cambrian to Early Permian.

The remaining emended genera each have shorter ranges. *Vogtlandia* ranges from Early Cambrian to Middle Ordovician (Llanvirn). *Petaloferidium* ranges from Early Ordovician (Arenig) to Late Devonian (Famennian)–but it should be noted that only one post-Silurian species, *P. ancorum*, has been reported. *Evittia* ranges from Early Ordovician (Arenig) to Middle Devonian (Givetian), with one questionable Late Devonian record. *Lusatia* has a reliable range from Early Ordovician (Arenig) to Early Silurian (Llandovery), with a questionable earlier (Tremadocian) record. *Diexallophasis* ranges from Early Silurian (Llandovery) to Early Carboniferous (Tournaisian). *Wicanderidium* and *Rhaetosphaeridium* have closely circumscribed ranges, respectively from the Middle Devonian (Givetian) and the Late Triassic (Rhaetian); it is likely that the latter genus may prove to be a dinoflagellate cyst.

The stratigraphical positions of species transferred to unemended genera are presented in Table 3. In the discussion that follows, comparison is made with the known ranges of those genera, as recorded in Fensome *et al.* (1990) and Sarjeant & Stancliffe (1994). Four of the genera–*Buedingiisphaeridium*, *Comasphaeridium*, *Dorsennidium* and *Gorgonisphaeridium*–have simple morphologies and a long stratigraphic range, which these generic transfers do not modify. The ranges of five other genera are extended, but remain coherent. *Acriora* is now known from Late Silurian to Late Devonian; *Actipilion* from Late Ordovician to earliest Devonian; *Barathrisphaeridium* now ranges from Early to Late Devonian; and the ranges of *Dateriocradus* and of *Frankea* are extended into the Devonian.

Only two reattributions produce apparent anomalies. The placement of the species *albanega* into *Timofeevia* extends the range of that genus surprisingly, from earliest Ordovician to earliest Devonian and may require rescrutiny. The allocation of the species *kahleri* to *Palacanthus* is, in any case, merely provisional and its eventual placement into a separate genus is likely.

The reattributions to eleven other genera (*Estiastra*, *Hapsidopalla*, *Hoegklintia*, *Oppilatala*, *Piliferosphaera*, *Schizodiachrodium*, *Stellechinatum*, *Striatotheca*, *Villosacapsula*, *Visbysphaera* and *Vulcanisphaera*) do not affect their known ranges.

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Index of species names

In the list that follows, no attempt is made to differentiate between the changing suffixes of trivial names; the suffix earliest cited in the text is utilized. In the few cases where exactly the same trivial name has been applied to morphotypes now placed into different genera, the citation below will refer to both morphotypes since they cannot readily be distinguished in a list such as this.

TABLE I: *Multiplicisphaeridium* – range of accepted species

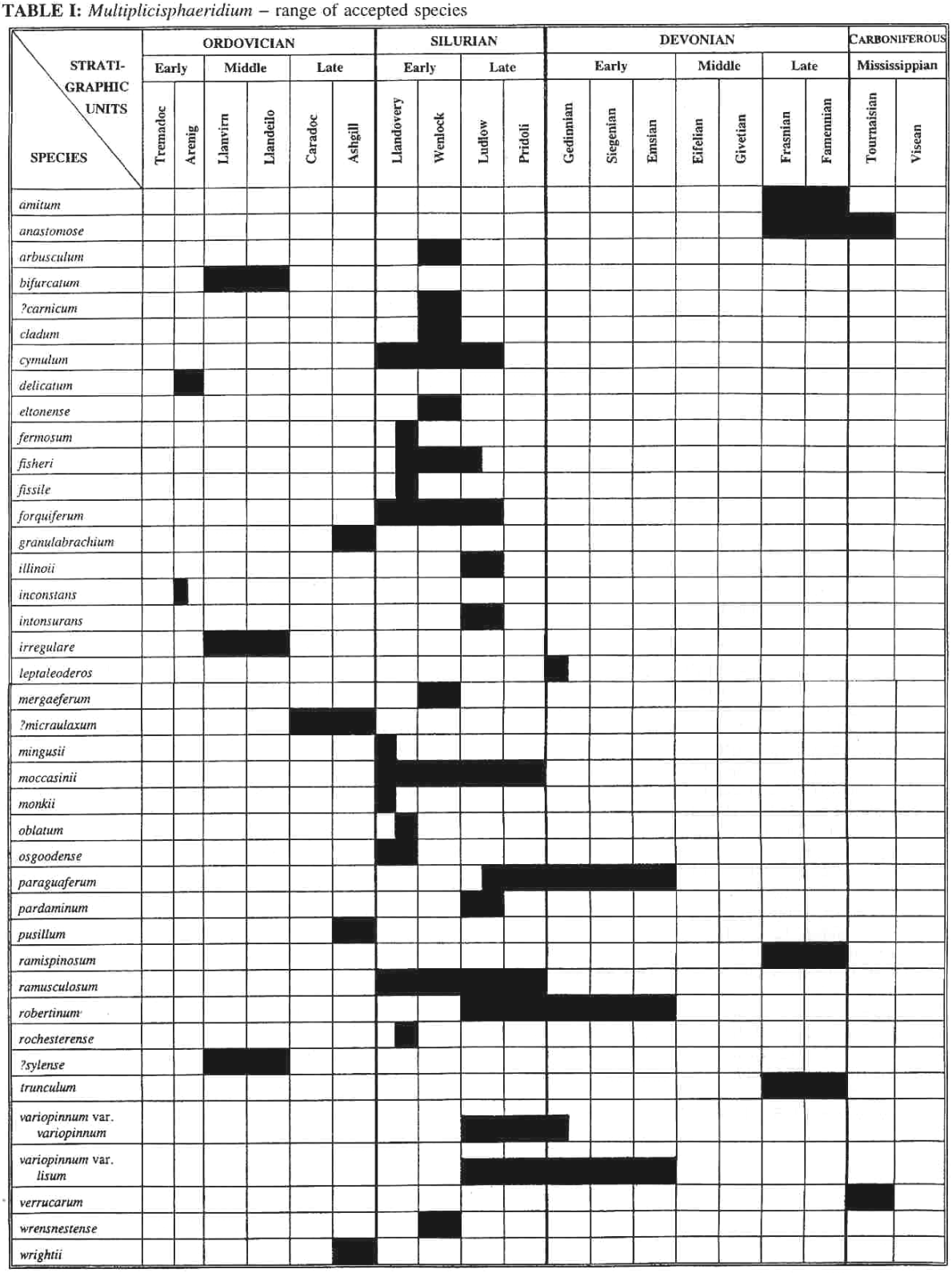


TABLE IIA: New and emended genera – range of accepted species

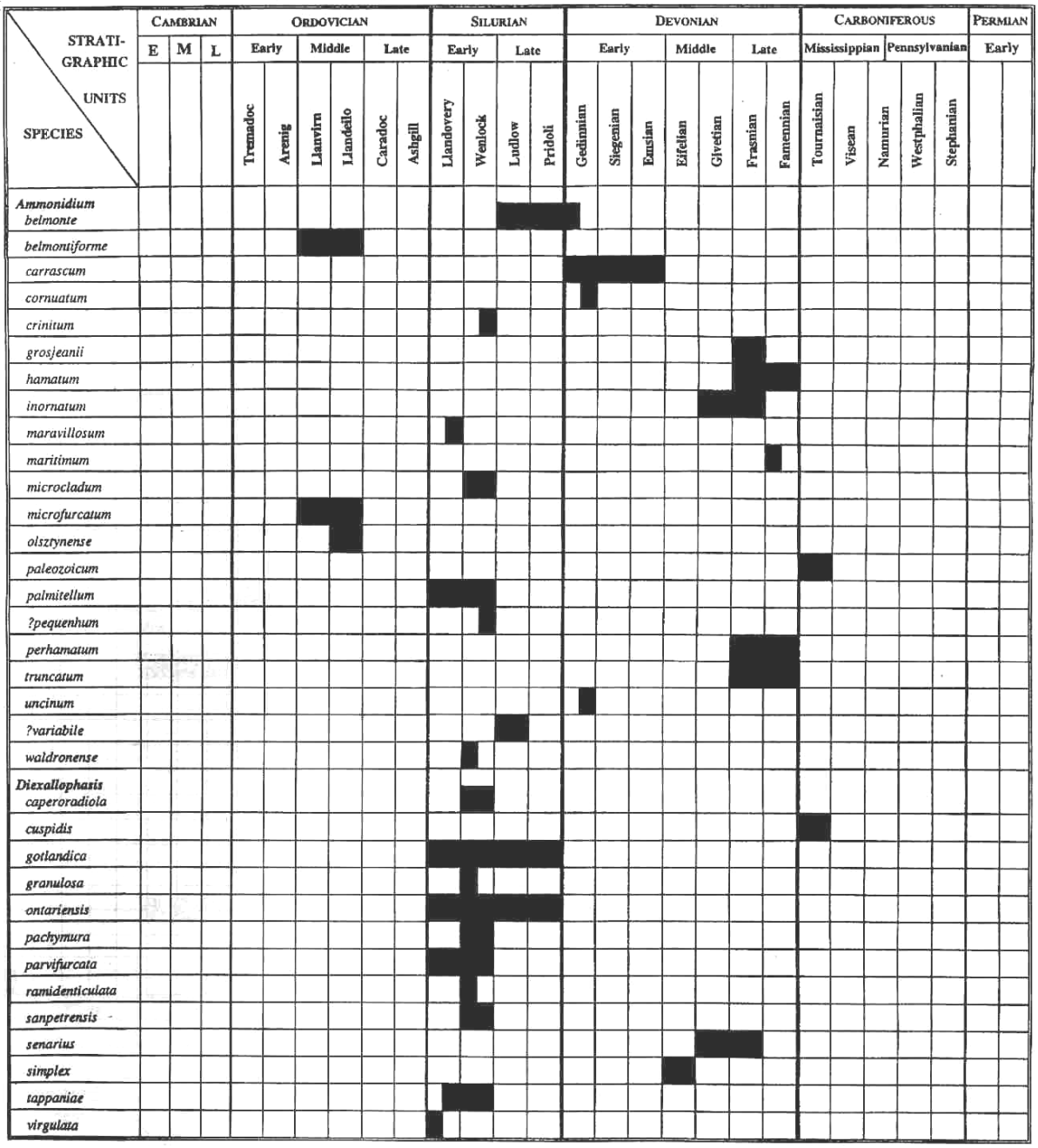


TABLE IIB: New and emended genera – range of accepted species

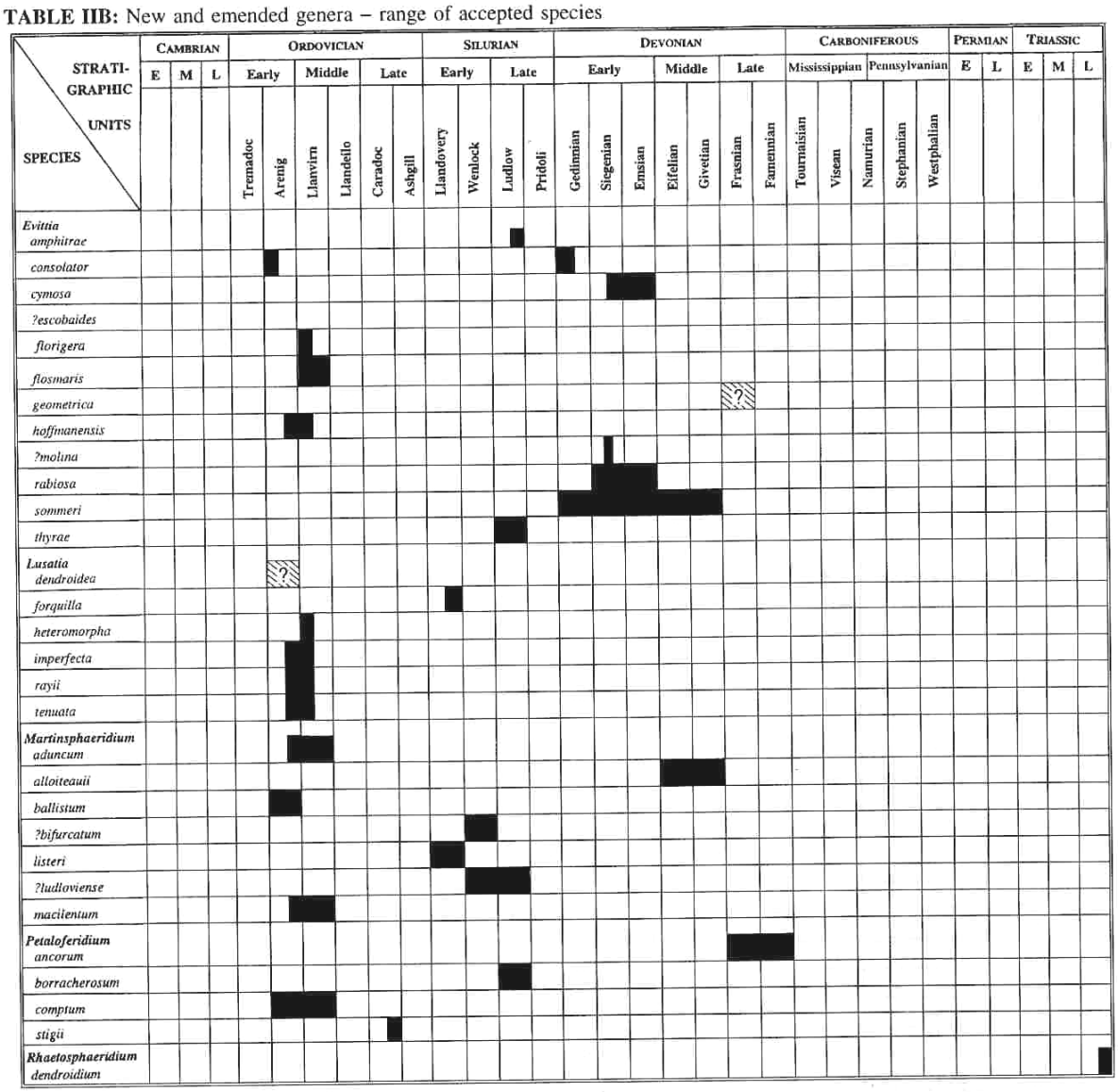


TABLE IIC: New and emended genera – range of accepted species

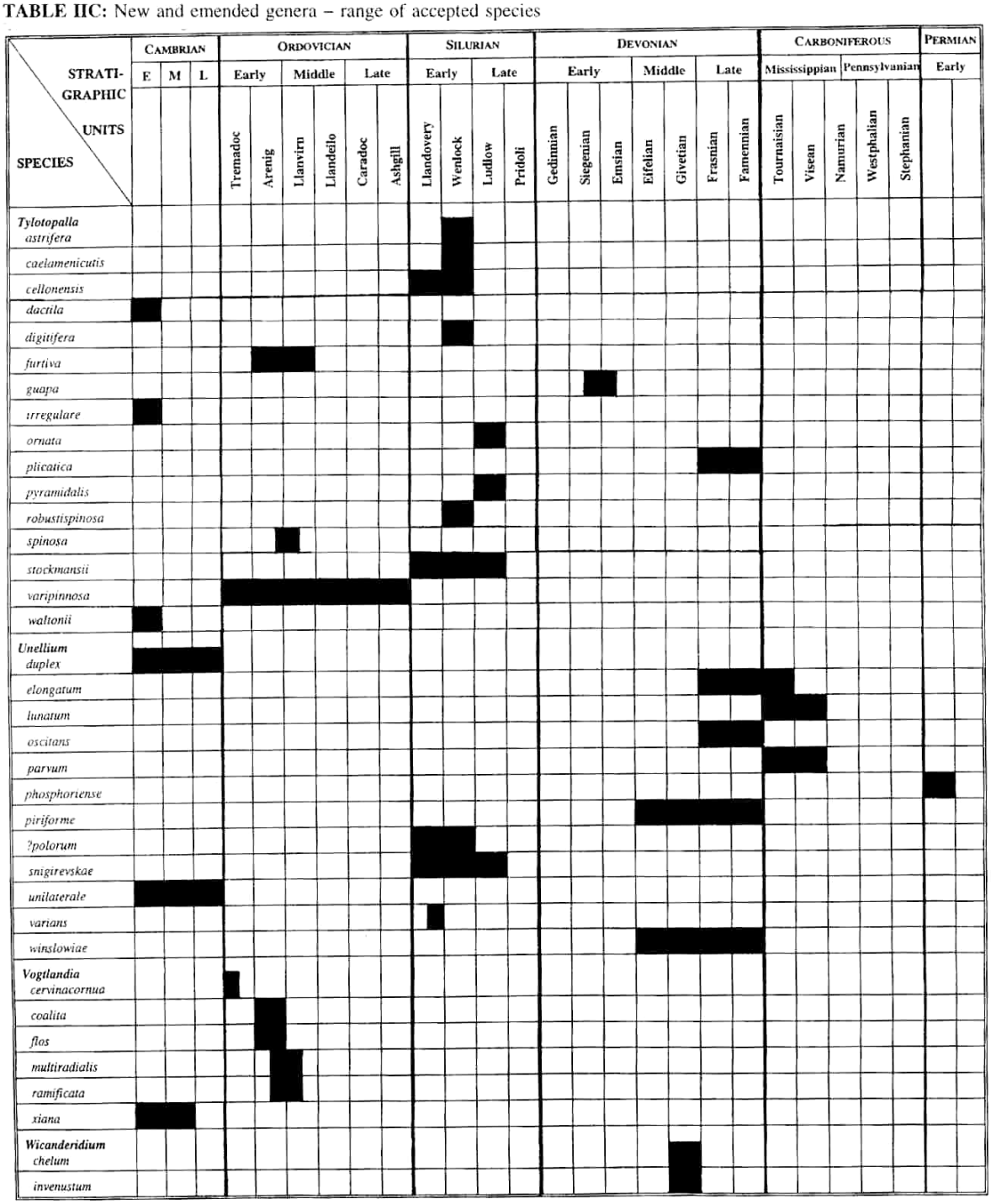


TABLE IIIA: Species referred to – unemended genera

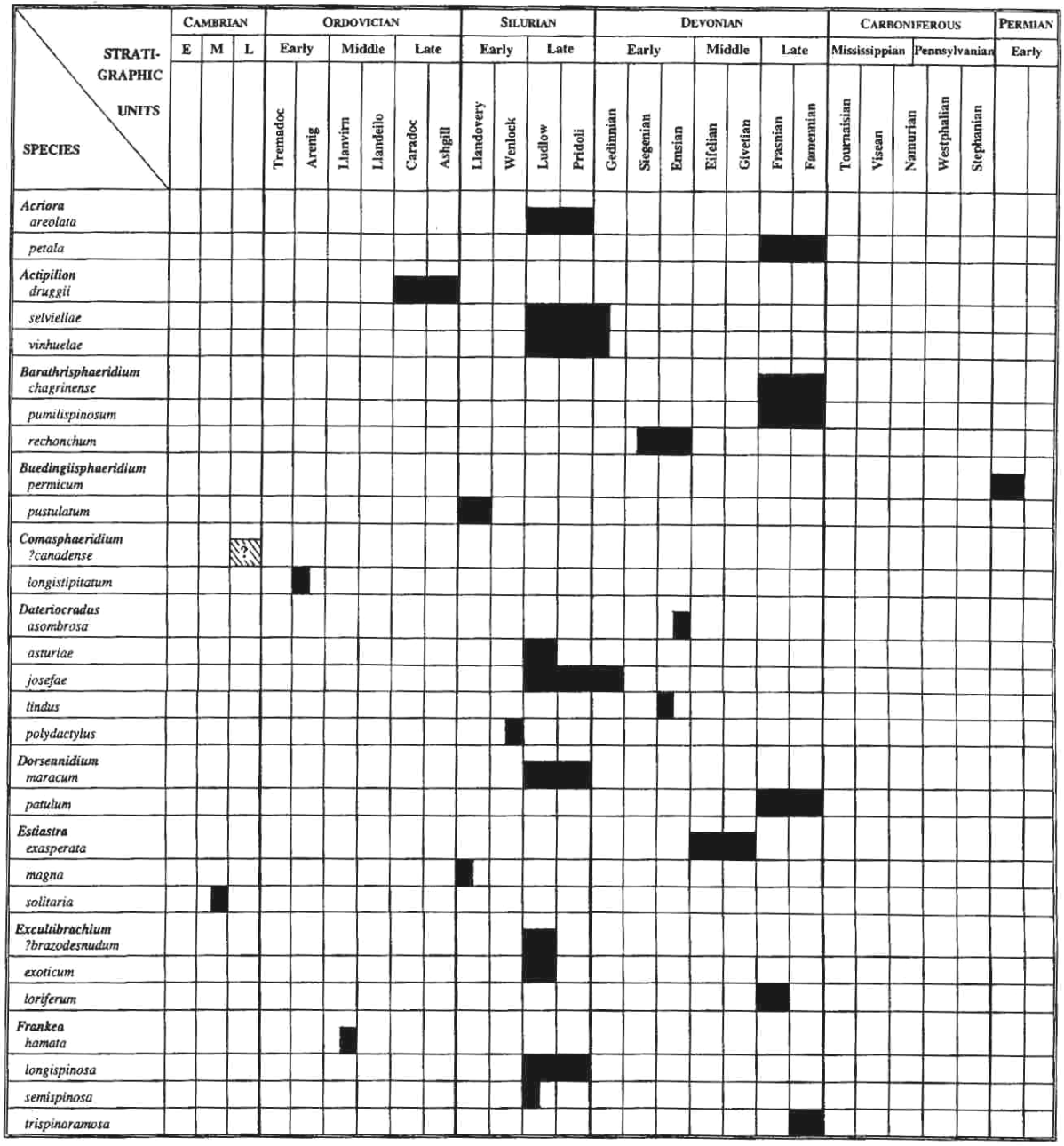


TABLE IIIB: Species referred to – unemended genera

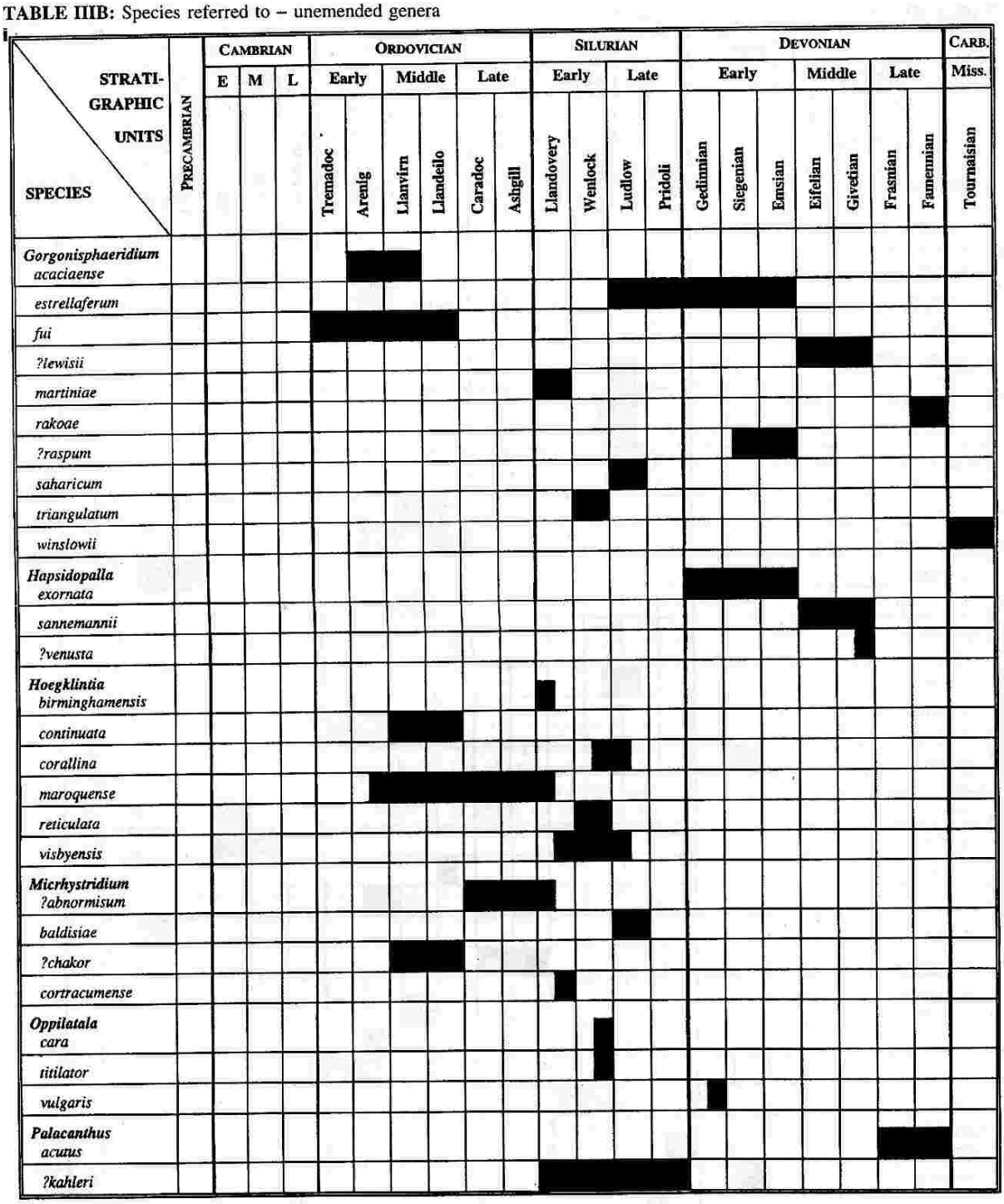
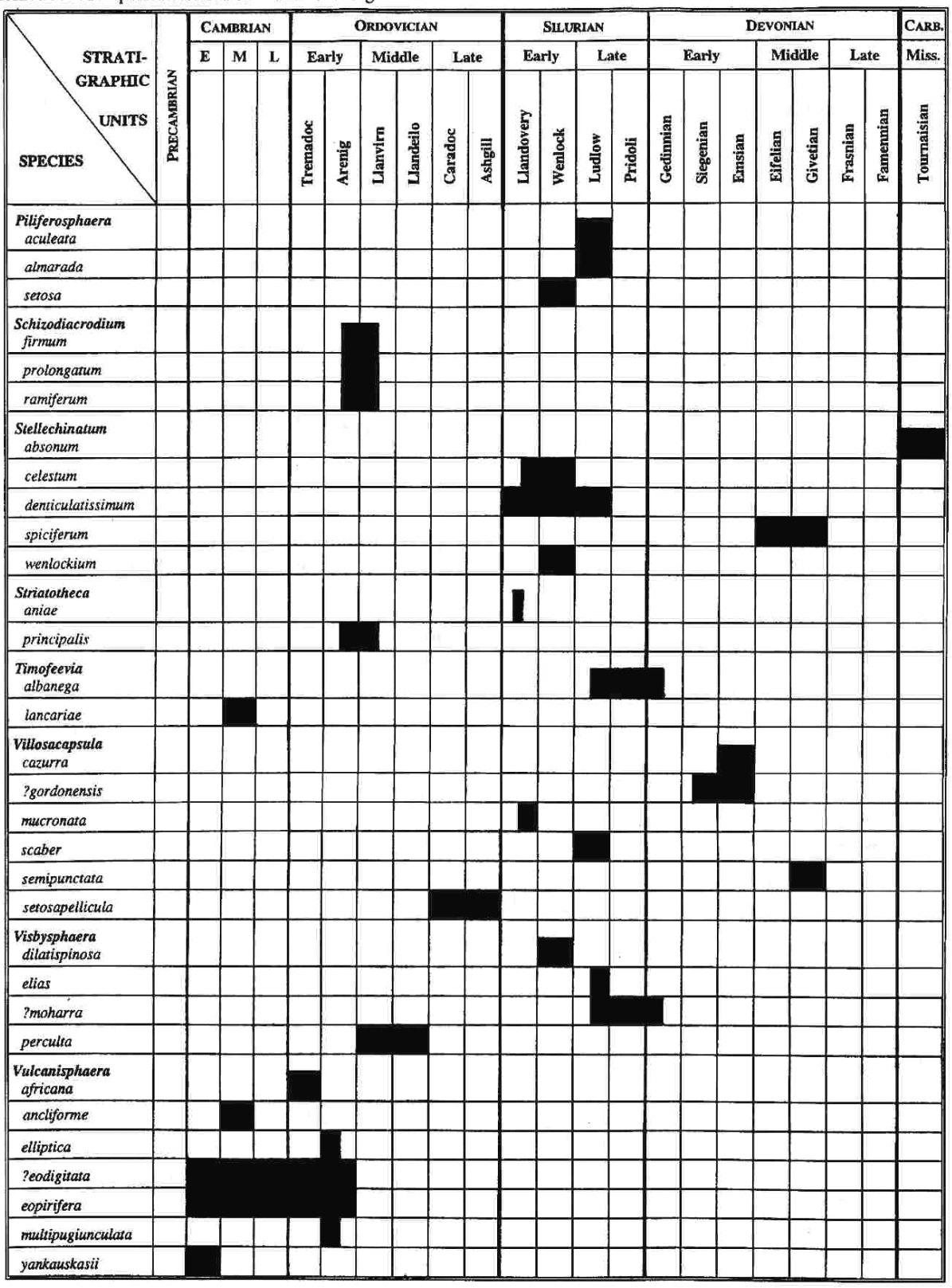


TABLE IIIC: Species referred to – unemended genera



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