

## Revision of acritarchs and prasinophyte algae from the lower Silurian of Belgium

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**ABSTRACT** – The type acritarch and prasinophyte algal material of Stockmans & Willière (1963), from the Silurian of the Courtrai region, Belgium, has been re-examined. Revised descriptions for the holotypes of several type species are given, which detail the greater morphological diversity recognized. Four new combinations are proposed (*Buedingiisphaeridium parveroquesi*, *Dictyotidium deflandrei*, *Helosphaeridium echinodermum* and *Multiplicisphaeridium pentagonale*). *Micrhystridium?* *radians* is provisionally retained, although it is probable that this species should be referred to a new, unrecognized genus (it possesses a pylome and spinose, simple and branched processes). The synonymy of *Diexallophasis denticulata* and *Diexallophasis remota* (proposed by Playford, 1977) is rejected, as the latter has broader-based and more robust processes. The generic assignment of *Diexallophasis mucronata* is confirmed. Several of the taxa proposed by Stockmans & Willière have been re-illustrated to show clearly the features of taxonomic importance. These descriptions and illustrations will enable the reliable recognition of these taxa in contiguous sections elsewhere, and will help to form the basis of future population studies. *J. Micropalaeontol.* 21(1): 87–94, May 2002.

### INTRODUCTION

The work of Stockmans & Willière (1963) on the acritarchs of the Courtrai region of Belgium was one of the pioneering studies on Silurian acritarchs. The material they examined was from a borehole, and all of the acritarchs illustrated were from a single level (188.50 m; dated as Tarrannon=upper Llandovery Series). Independent dating by chitinozoans has not been possible as their slides contain only *Lagenochitina* sp. and *Bursachitina conica* (Taugourdeau & De Jekhowsky). They described 38 species of ‘hystrichospheres’ (now assigned to the acritarchs and prasinophyte algae), of which 20 were new. One of their illustrated specimens (*Baltisphaeridium* aff. *polytrichium* Valensi, pl. 3, figs 24–25) was subsequently designated as the holotype of *Filisphaeridium* (now *Comasphaeridium*) *williereae* Lister, 1970. Also, one of their taxa (*Baltisphaeridium denticulatum*) was subsequently designated as the type species of *Diexallophasis* Loeblich, 1970.

A study of Stockmans & Willière’s type material has shown that their original diagnoses and illustrations give little idea of the morphological complexity of many of their species. Therefore a re-description of the holotypes has been undertaken, together with a re-assessment of the original taxonomic assignments (and subsequent revisions) of their species. No emendations to the diagnoses have been proposed, as it is not possible to determine the morphological variability within each species from the type specimen alone. However, the detailed descriptions provided will enable researchers to recognize more accurately these species elsewhere, and they will also provide a basis for future population studies.

Stockmans & Willière’s type material is strongly thermally altered and some specimens are opaque to nearly opaque (e.g. *O.?* *tenuiramusculosum*). However, the preservation is otherwise generally good to excellent. Each slide generally contains only a low number of specimens, and this has negated the possibility of completing more detailed biometric or population variability studies. The mounting media on some of the slides has begun to degrade (air bubbles are forming beneath the coverslips), and all

of the slides are heavily contaminated with elongate mineral laths (also visible on the original plates). It has not been possible to re-examine all of Stockmans & Willière’s holotypes, as several could not be located. The following taxa (all reported to be from their preparation 1179) are, therefore, not discussed here: *Multiplicisphaeridium* (was *Baltisphaeridium*) *fissile* (Stockmans & Willière, 1963) Eisenack *et al.*, 1973; *Unellium* (was *Micrhystridium*) *flandrianum* (Stockmans & Willière, 1963) Sarjeant & Vavrdova, 1997; *Multiplicisphaeridium* (was *Micrhystridium*) *varians* (Stockmans & Willière, 1963) Eisenack *et al.*, 1973; and *Micrhystridium ornatum*.

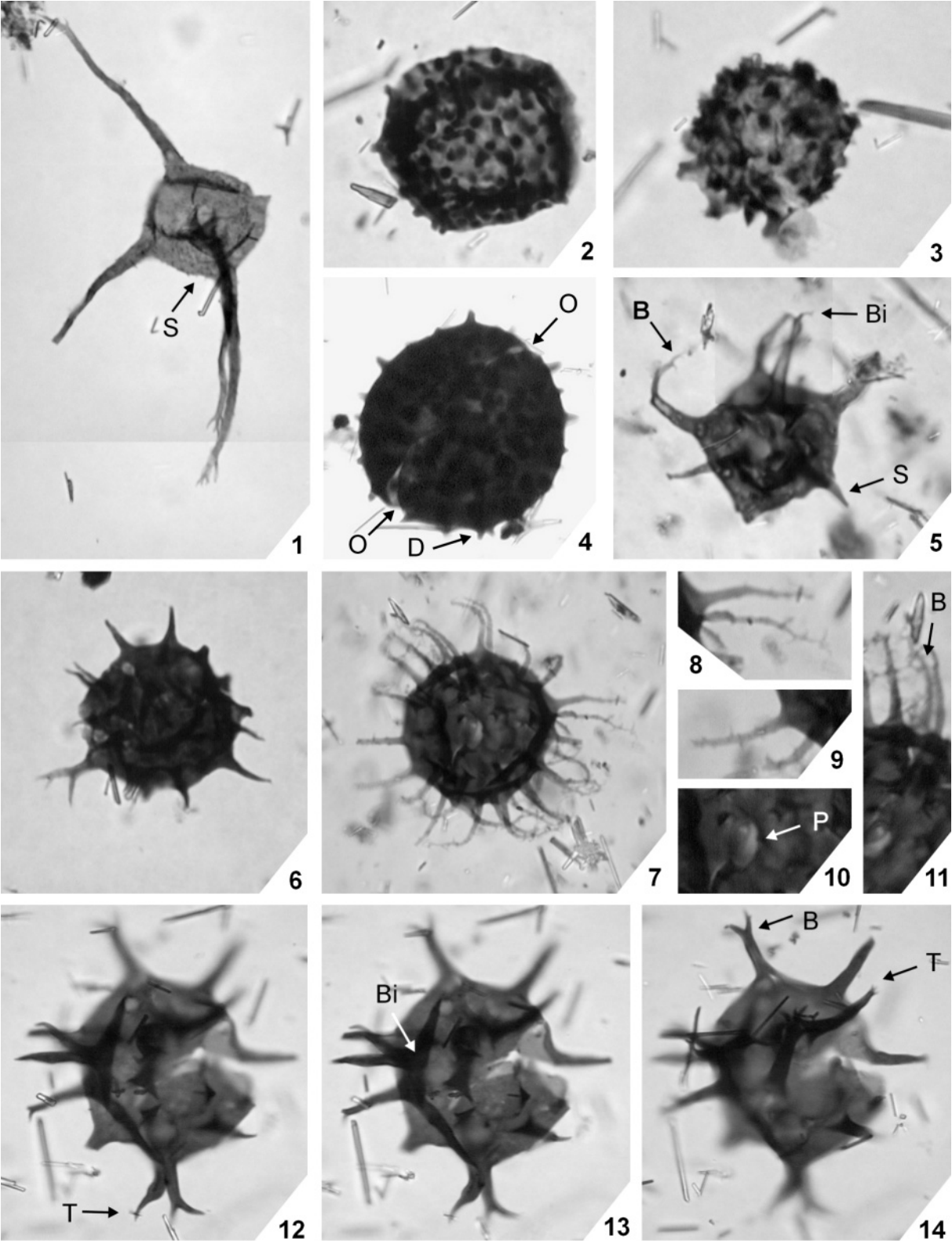
The diagnoses and illustrations of some species in Stockmans & Willière (1963) fully described the morphological features present on the holotypes and these taxa are also not discussed here: *Domasia* (was *Veryhachium*) *delmeri* (Stockmans & Willière, 1963) Umnova, 1975; *Domasia* (was *Veryhachium*) *limaciforme* (Stockmans & Willière, 1963) Cramer, 1970 emend. Hill (1974); *Micrystridium coronatum* and *Leiosphaeridia laevigata*. The description and illustration of *Buedingiisphaeridium parveroquesi* here may be that of the holotype (it has not been possible to confirm this beyond all doubt), but at the least it is topotype material.

The dimensions referred to below are as follows (see also Mullins, 2001, text-fig. 13): V, vesicle diameter; Vl, vesicle length; Vw, vesicle width; Pl, process length; PØb, diameter of the process bases; PØt, diameter of the processes at the site of branching; Pn, number of processes. Specimens illustrated here are deposited in the collection of the Institut Royal des Sciences Naturelles de Belgique, Rue Vautier 29, B-1040 Brussels, Belgium.

### SYSTEMATIC TAXONOMY

*Buedingiisphaeridium parveroquesi* (Stockmans & Willière, 1963)  
comb. nov.  
(Pl. 1, fig. 3)

1963 *Micrhystridium parveroquesi* Stockmans & Willière: 471, pl. 2, fig. 10, text-fig. 33.



**Description.** Vesicle spherical with a slightly roughened surface. The vesicle is covered in projections, which may be entirely solid or have solid tips (Pn, *c.* 50). The projections may be bulbous, taper to a point, or they may be broad, parallel-sided and distally divaginate. No opening of the vesicle was observed.

**Dimensions.** V, 13.2 µm; Pl, 1–1.8 µm; PØb, 0.7–1.5 µm.

**Remarks.** This species, which was retained in *Micrhystridium* by Sarjeant & Stancliffe (1994), is assigned to *Buedingiisphaeridium* as it has heteromorphic processes with a simple, bulbous, or distally divaginate appearance which may be entirely solid or have solid tips. These features conform to the emended diagnosis of *Buedingiisphaeridium* proposed by Sarjeant & Stancliffe (1994). Species of *Micrhystridium* have simple processes which are hollow and open to the vesicle interior.

*Comasphaeridium williereae* (Deflandre & Deflandre-Rigaud, 1965 ex Lister, 1970) Sarjeant & Stancliffe, 1994  
(Pl. 2, fig. 5)

1963 *Baltisphaeridium* aff. *polytrichium* (Valensi); Stockmans & Willière : 460, pl. 3, figs 24, 25, text-fig. 16.

1994 *Comasphaeridium williereae* (Deflandre & Deflandre-Rigaud, 1965 ex Lister, 1970); Sarjeant & Stancliffe : 27.

**Description.** Vesicle spherical, laevigate, thin-walled. The vesicle is covered in numerous (Pn, >100), solid, thin, columnar to slightly tapering processes, with simple, blunt, rounded tips. No opening in the vesicle was observed.

**Dimensions.** V, 25.8 × 24.4 µm; Pl, 4.8–8 µm; PØb, 0.3–1 µm.

**Remarks.** The specimen of *B.* aff. *polytrichium* illustrated by Stockmans & Willière is the holotype of *C. williereae* (as defined by Lister, 1970). The assignment of *williereae* to *Comasphaeridium* was proposed by Sarjeant & Stancliffe (1994, pp. 27, 31, 67–68). An abbreviated synonymy is given above and a more complete history of the taxonomy and junior synonyms of *C. williereae* was given by Mullins (2001, p. 63).

*Dictyotidium deflandrei* (Stockmans & Willière, 1963)  
comb. nov.  
(Pl. 2, fig. 1)

1963 *Leiosphaeridia deflandrei* Stockmans & Willière: 474–475, pl. 1, figs 2, 3.

1987 *Alveosphaera? deflandrei* (Stockmans & Willière, 1963); Priewalder: 23, pl. 1, figs 4, 5.

**Description.** Vesicle spherical, fairly thick-walled (*c.* 1.7 µm), with a distinctive reticulate pattern. The reticulate pattern is produced by ellipsoidal to sub-hexagonal holes in the vesicle wall, or by fields with thin-walled floors. The fracture across the vesicle appears to be an artefact of preservation.

**Dimensions.** V, 30.7 × 31.8 µm; holes, 0.6–1.3 µm.

**Remarks.** The reticulate pattern on the holotype appears to be produced by distinct holes or fields with thin-walled floors. It is probable that the holes (Pl. 2, fig. 1) are a result of preservation (produced by the destruction of the thin wall on the floor of each field) and that they do not represent a primary porous structure. Priewalder's assignment of this taxon to *Alveosphaera?*, a genus characterized by its porous vesicle wall, is therefore rejected and his taxon is assigned to the prasinophyte alga *Dictyotidium*.

*Diexallophasis denticulata* (Stockmans & Willière, 1963)  
Loeblich, 1970  
(Pl. 2, fig. 7)

1963 *Baltisphaeridium denticulata* Stockmans & Willière: 458, pl. 1, fig. 4, text-fig. 13.

1970 *Diexallophasis denticulata* (Stockmans & Willière); Loeblich: 715, figs 8A–E, 9A–C.

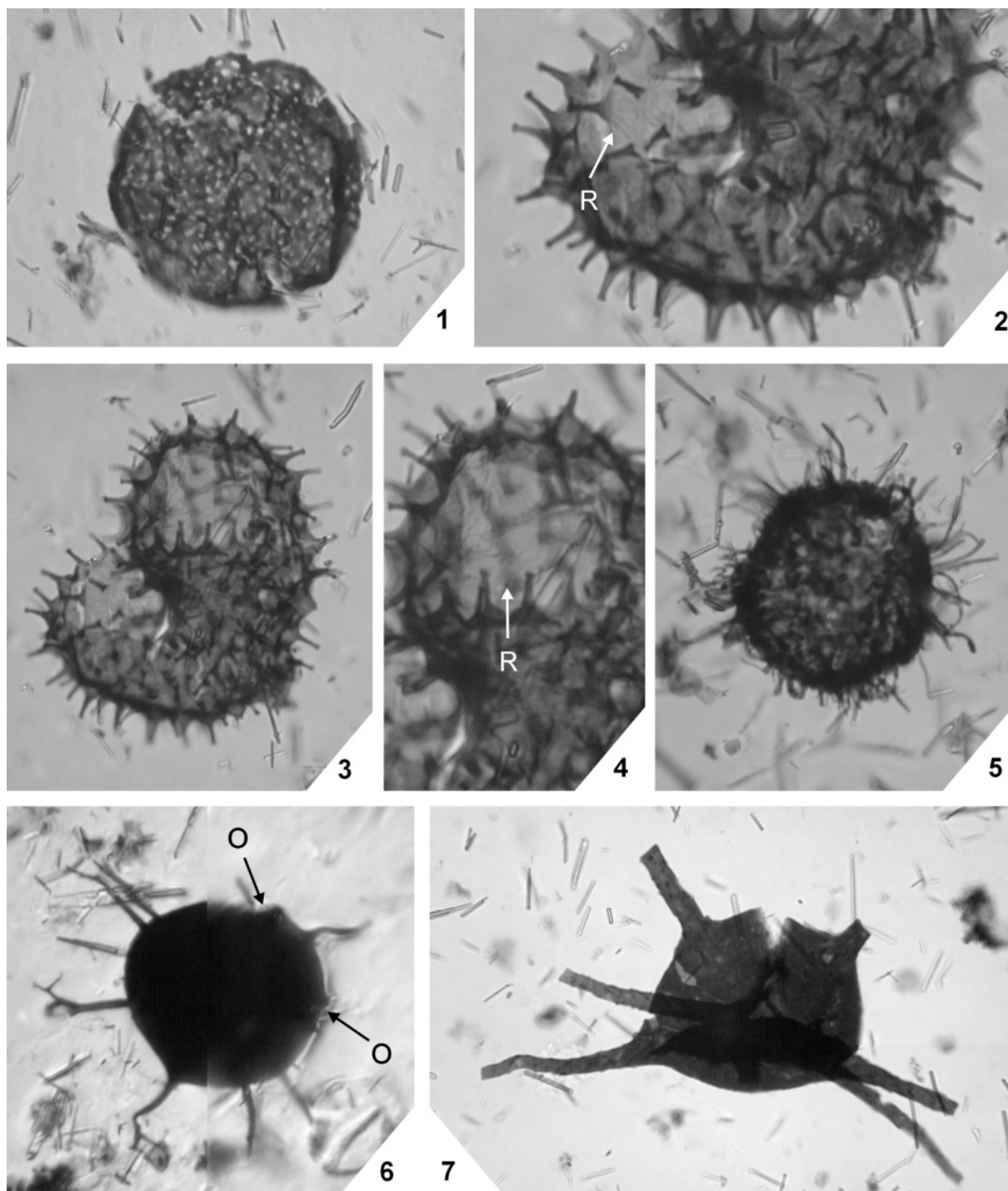
1973 *Multiplicisphaeridium denticulatum* (Stockmans & Willière, 1963); Eisenack *et al.*: 587–591.

**Description.** Vesicle single-walled, broadly ellipsoidal, although it does appear slightly polygonal in aspect. The processes (Pn, 7) are open to the vesicle. The vesicle is faintly ornamented (probably a microfoveolate or micropunctate ornament). The process bases are distinctly striate and these striae radiate out on to the vesicle surface for a short distance (*c.* 4.5 µm). The processes are distinctly echinate along their length (echinae up to 1.1 µm diameter). They are slightly tapering and all of the processes are broken before the distal extremities are reached. There is a lateral split in the vesicle wall which may represent an excystment structure, although the edges are roughened suggesting that it may be an artefact of preservation.

**Dimensions.** V, 35 × 31 µm; Pl, at least 40.9 µm; PØb, 4.5–5.7 µm.

#### Explanation of Plate 1

**Fig. 1.** *Diexallophasis mucronata* (Stockmans & Willière, 1963) Priewalder, 1987, holotype, preparation 1159, composite of three images showing the spinose vesicle ornament (S), × 1250. **Fig. 2.** *Lophosphaeridium parverarum* Stockmans & Willière, 1963, holotype, preparation 1172, × 1500. **Fig. 3.** *Buedingiisphaeridium parveroquesi* (Stockmans & Willière, 1963) comb. nov., possible holotype (see above), preparation 1179, × 2000. **Fig. 4.** *Lophosphaeridium parvum* Stockmans & Willière, 1963, holotype, preparation 1173, the edges of the linear rupture (O) and divaginate process (D) are shown, × 1250. **Fig. 5.** *Multiplicisphaeridium pentagonale* (Stockmans & Willière, 1963) comb. nov., holotype, preparation 1162, composite of three images showing the ramified branched (B), simple (S) and distally bifurcate (Bi) processes, × 1500. **Fig. 6.** *Multiplicisphaeridium cortracumense* (Stockmans & Willière, 1963) Eisenack *et al.*, 1973, holotype, preparation 1166, × 1500. **Figs 7–11.** *Micrhystridium? radians* Stockmans & Willière, 1963, holotype, preparation 1162: **7**, × 1250; **8**, close-up of a process where the spines give it an almost ramified appearance, × 2000; **9**, close-up of a blunt-tipped process with spines along its length, × 2000; **10**, view of the pylome (P), × 2000; **11**, view of the ramified process branching (B), × 2000. **Figs 12–14.** *Multiplicisphaeridium snigirevskaiiae* (Stockmans & Willière, 1963) Fensome *et al.*, 1990, holotype, preparation 1178: **12**, view of the distal trifurcate branching (T), × 1250; **13**, view of the proximally bifurcate process (Bi), × 1250; **14**, view of the ramified process branching (B) and distal, trifurcate branching (T), × 1250.



#### Explanation of Plate 2

**Fig. 1.** *Dictyotidium deflandrei* (Stockmans & Willière, 1963) comb. nov., holotype, preparation 1160,  $\times 1250$ . **Figs 2–4.** *Helosphaeidium echinodermum* (Stockmans & Willière, 1963) comb. nov., holotype, preparation 1164: **2**, rugulate ornament (R) radiating out from the process bases,  $\times 2000$ ; **3**, large linear rupture excystment opening,  $\times 1250$ ; **4**, irregular rugulate ornament (R),  $\times 2000$ . **Fig. 5.** *Comasphaeridium williereae* (Deflandre & Deflandre-Rigaud, 1965 ex Lister, 1970) Sarjeant & Stancliffe, 1994, holotype, preparation 1164,  $\times 1250$ . **Fig. 6.** *Oppilatala? tenuiramulosum* (Stockmans & Willière, 1963) Priewalder, 1987, holotype, preparation 1156, composite of two images, edges of the excystment structure are shown (O),  $\times 1250$ . **Fig. 7.** *Diexallophasis denticulata* (Stockmans & Willière, 1963) Loeblich, 1970, holotype, preparation 1160, composite of two images,  $\times 1000$ .

**Remarks.** A detailed description of *D. denticulata* is provided to describe clearly the microfoveolate or micropunctate vesicle ornament. Unfortunately the broken nature of the processes means that the true nature of the branching is not known. *D. denticulata* was considered to be a junior synonym of *Diexallophasis remota* Deunff, 1955 by Playford (1977). This synonymy is rejected here as the processes of *D. remota* are broader-based and much more robust.

*Diexallophasis mucronata* (Stockmans & Willière, 1963)  
Priewalder, 1987  
(Pl. 1, fig. 1)

1963 *Veryhachium mucronatum* Stockmans & Willière: pl. 1, fig. 20; pl. 3, fig. 6; text-figs 10–11.

1970 *Baltisphaeridium mucronatum* (Stockmans & Willière, 1963); Cramer: 142, pl. 13, fig. 43d.

1973 *Multiplicisphaeridium mucronatum* (Stockmans & Willière, 1963); Eisenack *et al.*: 695–697.

1987 *Diexallophasis? mucronata* (Stockmans & Willière, 1963); Priewalder: 32, pl. 5, figs 3, 4.

1994 *Frankea mucronata* (Stockmans & Willière, 1963); Sarjeant & Stancliffe: 42.

1997 *Villosacapsula mucronatum* (Stockmans & Willière, 1963); Sarjeant & Vavrdova: 35.

**Description.** Square vesicle with convex sides and a single wall. The processes (Pn, 5 present + 1 broken off) are open to the vesicle interior. Four processes are situated at each corner of the vesicle, and two processes arise from each side. The processes are long, thin, slender, slightly tapering, with a distinctly spinose form of digitate branching occurring at the very tip. Branching occurs up to the 2nd order. The processes are sparsely ornamented with echinae along their length. The vesicle is densely ornamented with prominent spines or baculae of up to 1 µm in length. No excystment opening is present.

**Dimensions.** V, 14.2 × 16.1 µm; Pl, 27.3–28.4 µm; PØb, 3.4 µm; PØt, 1.1 µm.

**Remarks.** The processes of *D. mucronata* have a distinctly spinose form of digitate branching and the vesicle has a dense, spinose or baculate ornament (Pl. 1, fig. 1). Priewalder (1987) transferred this species to *Diexallophasis?* and the assignment to *Diexallophasis* is confirmed here; the processes and vesicle are ornamented and the branching has the digitate style typical of that genus.

Sarjeant & Stancliffe (1994) assigned *mucronata* to *Frankea*, a genus with a characteristic triangular vesicle. The vesicle of the holotype of *D. mucronata* is, however, square with convex sides (Pl. 1, fig. 1).

Sarjeant & Vavrdova (1997) assigned *mucronata* to *Villosacapsula* as ‘there are only three long processes, branching and without a cover of denticles’. The re-examination of the holotype presented here clearly shows that there are six processes with a sparse covering of echinae along their length and the combination *Villosacapsula mucronata* is therefore rejected.

*Helosphaeridium echinodermum* (Stockmans & Willière, 1963)  
comb. nov.  
(Pl. 2, figs 2–4)

1963 *Baltisphaeridium echinodermum* Stockmans & Willière: 460–462, pl. 2, figs 5, 8; pl. 2, fig. 26; text-fig. 17–20.

1979 *Gorgonisphaeridium echinodermum* (Stockmans & Willière, 1963); Eisenack *et al.*: 233–224.

1981 *Salopidium? echinodermum* (Stockmans & Willière, 1963); Priewalder: 50–51, pl. 11, figs 9–12.

**Description.** Vesicle originally spherical to ellipsoidal, now almost separated into two equal halves by a large linear excystment opening which encircles the equator of the vesicle. The vesicle has a faint ornament of low rugulae which appear to either radiate out from the bases of the processes, or have an irregular distribution. The processes (Pn, *c.* 150) are hollow, open to the vesicle interior and taper to capitate tips, although some may possibly have small spines arising from their tips.

**Dimensions.** V, 29.5 µm; Pl, 3.5 µm; PØb, 1.1 µm.

**Remarks.** *H. echinodermum* has a spherical to ellipsoidal, single-walled vesicle, numerous hollow processes (which freely communicate with the vesicle) and a large linear rupture type of excystment opening (all diagnostic features of *Helosphaeridium*; see Lister, 1970, p. 76). The processes of *H. echinodermum* appear capitate under transmitted light microscopy; species of *Ammonidium* have processes with a rosette arrangement of branches at the process tip. The holotype of *H. echinodermum* shows similarity to species of *Hapsidopalla* (e.g. *H. jeandeunffii*), but the rugulae are not well developed and they do not join adjacent processes as stipulated in the diagnosis of *Hapsidopalla* (see Playford, 1977, p. 25). The proposed assignment of *echinodermum* to *Salopidium?* and *Gorgonisphaeridium* (see above) are rejected, as species of those genera have entirely simple processes and solid processes respectively. The processes of *H. echinodermum* are capitate, hollow and open to the vesicle interior.

*Lophosphaeridium parverarum* Stockmans & Willière, 1963  
(Pl. 1, fig. 2)

1963 *Lophosphaeridium parverarum* Stockmans & Willière: 473, pl. 3, fig. 21, text-fig. 35.

**Description.** Vesicle ellipsoidal, with a slight polygonal aspect, and thinner-walled than the processes. The vesicle appears laevigate, with the exception of the numerous (Pn, *c.* 115), short processes (height=0.9–1.4 µm). The processes are parallel-sided, taper to rounded tips, or have a warty appearance. The processes are randomly distributed across the vesicle.

**Dimensions.** V, 19.5 × 22.2 µm.

**Remarks.** Whereas Stockmans & Willière (1963; text-fig. 35) showed the processes orientated into distinct rows, the description above highlights the random distribution of the processes.

*Lophosphaeridium parvum* Stockmans & Willière, 1963  
(Pl. 1, fig. 4)

1963 *Lophosphaeridium parvum* Stockmans & Willière: 472–473, pl. 2, fig. 2; pl. 3, fig. 27, text-fig. 34.

**Description.** Vesicle spherical, near opaque, apparently smooth and covered in a random arrangement of processes which taper to simple, rounded tips. A single process appears to be proximally divaginate, although it has the rounded tips characteristic of the other processes. The processes are darker than the vesicle, suggesting that they are solid (although the specimen is too thermally altered to confirm this). The vesicle possesses a large, linear rupture excystment opening which almost divides the vesicle into two equal halves.

**Dimensions.** V,  $26.7 \times 27.3 \mu\text{m}$ ; Pl,  $0.7\text{--}2 \mu\text{m}$ ; PØb,  $1.2\text{--}2.3 \mu\text{m}$ .

**Remarks.** A description of the holotype is given here, as the possible proximal divaginate nature of the processes and large, linear, excystment opening were not reported by Stockmans & Willière (1963, p. 472).

*Micrhystridium?* *radians* Stockmans & Willière, 1963

(Pl. 1, figs 7–11)

1963 *Micrhystridium radians* Stockmans & Willière: 463, pl. 3, fig. 15; pl. 2, fig. 18; text-fig. 21.

1994 *Comasphaeridium radians* (Stockmans & Willière, 1963); Sarjeant & Stancliffe: 22.

**Description.** Vesicle laevigate, spherical overall, with a slight polygonal appearance produced by the straight to slightly concave nature of the vesicle between the processes. The processes are numerous (Pn, c. 49), slightly thinner-walled than the vesicle (which gives them a slightly lighter coloration), although they appear hollow and open to the vesicle interior. The processes are flexuous and taper slightly along their length. Some processes appear blunt-tipped with distinct spines (up to  $1.7 \mu\text{m}$  long) arising from their tips (giving them an almost branched appearance). The tips of others appear to branch in an almost ramified manner. The processes have a covering of elongate spines along their distal length (from about  $\frac{1}{2}\text{--}\frac{1}{3}$  along the length of the process from the base). A small circular pylome ( $2.8 \times 5.1 \mu\text{m}$ ), with a thickened rim, is situated in the centre of the vesicle.

**Dimensions.** V,  $20.4 \mu\text{m}$ ; Pl,  $13.6\text{--}17.6 \mu\text{m}$ ; PØb,  $2.3 \mu\text{m}$ ; PØt, up to  $1 \mu\text{m}$  wide (often much thinner).

**Remarks.** The assignment of *radians* to *Comasphaeridium*, proposed by Sarjeant & Stancliffe (1994), is rejected as species of *Comasphaeridium* have thin, simple, solid, hair-like processes (see Staplin *et al.*, 1965; Sarjeant & Stancliffe, 1994). The spinose and occasionally branched nature of the processes, and presence of a circular pylome, were not discussed in the original diagnosis of Stockmans & Willière (1963, p. 463). Their diagnosis stated only that the processes were simple. This species is provisionally retained in *Micrhystridium*, although it excysts via a pylome and therefore most probably represents an undescribed genus. However, as only a single specimen has been observed no new generic assignment can be proposed.

Some species of *Micrhystridium* possess a similar spinose process ornament to *M.?* *radians* (e.g. *M. intonsurans*), but the diagnosis of *Micrhystridium* stipulates that excystment occurs via a rupture, epityche or cryptosuture, not a pylome (see

Sarjeant & Stancliffe, 1994, p. 12). Species of *Uncinisphaera* Wicander, 1974 are similar (they also have echinate processes), but excyst via a rupture. Species of *Peteinosphaeridium* Staplin *et al.*, 1965 and *Polyancistrodorus* Loeblich & Tappan, 1969 differ in possessing processes with longitudinal membranes along their length. The processes of *Rhopaliophora* Tappan & Loeblich, 1971 are distinctly short and stout.

*Multiplicisphaeridium cortracumense* (Stockmans & Willière,

1963) Eisenack *et al.*, 1973

(Pl. 1, fig. 6)

1963 *Micrhystridium cortracumense* Stockmans & Willière: 468–469, pl. 1, fig. 11; pl. 3, fig. 13?; text-fig. 29.

1973 *Multiplicisphaeridium cortracumense* (Stockmans & Willière, 1963); Eisenack *et al.*: 579.

1997 *Micrhystridium cortracumense* Stockmans & Willière, 1963; Sarjeant & Vavrdova: 28.

**Description.** Vesicle spherical, dark, apparently laevigate. The processes (Pn, 27) are mostly simple, although a single process branches in a ramified manner to the 2nd order. The tip of this process is noticeably lighter (thinner-walled) than the rest of the process or the vesicle. The processes are broad-based, laevigate, apparently open to the vesicle interior and taper distinctly. No opening was observed.

**Dimensions.** V,  $16.1 \times 16.5 \mu\text{m}$ ; Pl,  $3.1\text{--}5.7 \mu\text{m}$ ; PØb,  $1.1\text{--}1.7 \mu\text{m}$ ; PØt,  $1.1 \mu\text{m}$ .

**Remarks.** This species was retained in *Micrhystridium* by Sarjeant & Vavrdova (1997) on the basis that the majority of the processes are simple. However, the single process that does branch is ramified to the 2nd order (Pl. 1, fig. 6). This is a characteristic feature of species of *Multiplicisphaeridium*, and acritarchs with multifurcate tips were excluded from *Micrhystridium* by Sarjeant & Stancliffe (1994, p. 12).

*Multiplicisphaeridium pentagonale* (Stockmans & Willière,

1963) comb. nov.

(Pl. 1, fig. 5)

1963 *Micrhystridium pentagonale* Stockmans & Willière: 470–471, pl. 3, fig. 18, text-fig. 32.

1994 *Micrhystridium?* *pentagonale* (Stockmans & Willière, 1963); Sarjeant & Stancliffe: 18.

**Description.** Vesicle pentagonal, laevigate. The processes (Pn, 7 + 2 broken off) are laevigate, open to the vesicle interior, straight or slightly flexuous, and taper distinctly from broad bases to either simple or branched tips (branching 1st order, possibly up to the 2nd order). No excystment opening was observed.

**Dimensions.** V,  $15.1 \times 15.9 \mu\text{m}$ ; Pl,  $9.8\text{--}12.2 \mu\text{m}$ ; PØb,  $2.3 \mu\text{m}$ .

**Remarks.** Sarjeant & Stancliffe (1994) noted the damage on the holotype of *M. pentagonale* and questionably retained it within *Micrhystridium*. The assignment of *pentagonale* to *Multiplicisphaeridium* is proposed as the holotype has processes which have ramified branching and distal bifurcations.

*Multiplicisphaeridium snigirevskaiiae* (Stockmans & Willièrè, 1963) Fensome *et al.*, 1990  
(Pl. 1, figs 12–14)

1963 *Baltisphaeridium snigirevskaiiae* Stockmans & Willièrè: 459–460, pl. 1, fig. 5, text-fig. 15.

1970 *Multiplicisphaeridium snigirevskaiiae* (Stockmans & Willièrè, 1963); Lister: 84 (invalid combination, Lister did not clearly use the name *M. snigirevskaiiae*).

1990 *Multiplicisphaeridium snigirevskae* (Stockmans & Willièrè, 1963); Fensome *et al.*: 355.

1997 *Unellium snigirevskaiiae* (Stockmans & Willièrè, 1963); Sarjeant & Vavrdova: 33.

**Description.** Vesicle polygonal (hexagonal), single-walled, laevigate. The processes (Pn, 14) are laevigate, open to the vesicle interior, simple or branched. The nature of the branching is variable. Some processes have a trifurcate arrangement of short spines at their very tip. One process bifurcates proximal to the vesicle surface. Processes may also be bifurcate or trifurcate in the last third of their length or at the very tip, and occasionally another subdivision is possible. The vesicle possess a linear rupture, although this is probably an artefact of preservation.

**Dimensions.** V,  $22 \times 24.2 \mu\text{m}$ ; Pl, 6.8–9.4  $\mu\text{m}$ ; PØb, 2.2–2.5  $\mu\text{m}$ ; PØt, 0.6–2.5  $\mu\text{m}$ .

**Remarks.** A description of this species is given here to highlight the heteromorphic nature of the process branching. The processes may be ramified, distally trifurcate, or may even bifurcate proximal to the vesicle. Text-figure 15 of Stockmans & Willièrè (1963) does not accurately reflect the distribution and nature of the processes on the holotype and it should not be relied upon.

The assignment of this species to *Unellium* by Sarjeant & Vavrdova (1997) was based on the small size of the vesicle, the moderate number of processes and the distribution of the processes; Sarjeant & Vavrdova considered the two poles of the vesicle to be occupied by enlarged, bifurcate processes. However, the processes on the holotype of *M. snigirevskaiiae* are randomly distributed and the majority have distal trifurcate branches, with one being proximally bifurcate and one distally bifurcate (Pl. 1, figs 12–14). The assignment of *snigirevskaiiae* to *Unellium* is therefore rejected.

*Oppilatala? tenuiramusculosa* (Stockmans & Willièrè, 1963)  
Priewalder, 1987  
(Pl. 2, fig. 6)

1963 *Baltisphaeridium tenuiramusculosum* Stockmans & Willièrè: 457–458, pl. 3, fig. 9, text-fig. 12.

1965 *Micrhystridium tenuiramusculosum* (Stockmans & Willièrè, 1963); Deflandre & Deflandre-Rigaud: fiche 2491.

1973 *Multiplicisphaeridium tenuiramusculosa* (Stockmans & Willièrè, 1963); Eisenack *et al.*: 807.

1981 *Oppilatala? tenuiramusculosa* (Stockmans & Willièrè, 1963); Priewalder: 49–50, pl. 11, figs 1–4.

**Description.** Vesicle opaque, spherical, apparently laevigate. Thin, columnar to slightly tapering processes arise perpendicularly from a sharp contact with the vesicle. The processes are branched in a ramified manner (1st, 2nd or possibly even up to

the 3rd order). The processes are laevigate. The edges of what may be an excystment opening can be seen (Pl. 2, fig. 6). It is not possible to determine the exact nature of the opening.

**Dimensions.** V,  $22.7 \times 24.4 \mu\text{m}$ ; Pl, 8–11.9  $\mu\text{m}$ ; PØb, 1.3  $\mu\text{m}$ ; PØt, 0.6–1.3  $\mu\text{m}$ .

**Remarks.** The holotype shows a possible excystment opening on the sides of the specimen (Pl. 2, fig. 6), and it appears to possess a plate-centred process and is suggestive of the operculate type of opening typical of *Cymbosphaeridium*. However, the vesicle is too opaque to confirm the nature of the opening with any certainty, and no further specimens of this taxon have been observed. This species is, therefore, retained in *Oppilatala?*, although the specimen is too opaque to confirm the presence of proximally plugged processes that are a characteristic feature of *Oppilatala*. However, the specimen does have processes which branch in a ramified manner (a feature common in *Oppilatala*), and it lacks the typical cauliflorate process branching of *Cymbosphaeridium*. The holotype is situated near an area affected by air bubbles forming beneath the cover-slip. However, these air bubbles do not extend as far as the specimen and the possible excystment opening is therefore not an optical illusion created by their presence.

## CONCLUSION

The detailed descriptions of Stockmans & Willièrè's holotypes provided will form the basis for future population studies and will enable the species to be recognized in contiguous sections elsewhere. This will help to highlight any potential biostratigraphical importance. Further work is required to ascertain the true generic affinity of *Micrhystridium? radians*.

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