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Cambrian Furongian Series acritarchs from the Comley area, Shropshire, England

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ABSTRACT – Acritarch assemblages are reported for the first time from the Cambrian of Comley, Shropshire, England, a historically important area for British Cambrian biostratigraphy. Three assemblages are described from the Furongian Shoot Rough Road Shales. Horizons within the Shoot Rough Road Shales have in the past yielded *Parabolina spinulosa* and *Orusia lenticularis* indicative of the *Parabolina spinulosa* trilobite Zone. Two distinct microfloras are identified, one is characterized by the common occurrence of *Trunculumarium revinium* and diacrodian taxa, the other, by an absence of *T. revinium* and a general paucity of diacrodians but with a significant presence of *Scalenadiacrodium comleyense* gen. et sp. nov. The microfloras are compared with trilobite-controlled Furongian sequences in eastern Newfoundland and the Nuneaton area, England and are found to support the *P. spinulosa* Zone assignment for the Shoot Rough Road Shales. The microfloras are also compared with those from localities lacking direct *P. spinulosa* Zone trilobite control, principally the Ardennes and the East European Platform. Acritarch based recognition of the two trilobite subzones of the *P. spinulosa* Zone remains problematic, but independent subdivision of the zonal interval based on acritarchs is supported. A new acritarch genus *Scalenadiacrodium* gen. nov. and a new species *S. comleyense* sp. nov. are described. *J. Micropalaeontol.* **31**(1): 1–28, February 2012.

KEYWORDS: *acritarchs, Cambrian, Furongian, Comley, P. spinulosa Zone, trilobite*

INTRODUCTION AND GEOLOGICAL BACKGROUND

The Comley area and surrounding districts provide one of a small number of Cambrian outcrops in England, all of limited geographical extent (Fig. 1), but Comley's geological importance is disproportionate to its size. Lapworth (1888) described the first early Cambrian trilobites to be found in Britain from Comley Quarry (Fig. 2) and the condensed carbonate section exposed there is still a major reference for Cambrian biostratigraphy world-wide. With the exception of the quarry section, the solid geology of the area is very poorly exposed and knowledge of the succession is owed mainly to the studies of E. S. Cobbold, undertaken with the aid of numerous excavations, during the early part of the twentieth century. A discontinuous sequence of Terreneuvian to Furongian sedimentary rocks is present.

An account of the Cambrian sequence in the area is provided by Greig *et al*. (1968) and is used as the basis for the geological description given below. A concise description of the Comley Quarry outcrop is given by Rushton (in Rushton *et al*., 1999). The very poorly exposed Furongian Shoot Rough Road Shales are the subject of the present investigation (Fig. 3). The shales were deposited in a relatively shallow-marine environment and represent a transition between the dominantly shallow-marine, more arenaceous, Terreneuvian to Series 3 sediments of the area and the deeper-marine facies of Furongian and Lower Ordovician deposits. Although the true thickness is not determinable, 28.93 m (94'11") of the shales are seen to be resting with non-sequence on the Series 3 Shoot Rough Road Flags in the Geological Survey inclined borehole [National Grid 4889 9645] at Shoot Rough (Greig *et al.*, 1968). The Shoot Rough Road Shales are succeeded by the Tremadocian (Lower Ordovician) Shineton Shales in the Comley area, known from stream sections in woodland north of Shoot Rough, which have yielded a fauna including *Rhabdinopora flabelliformis* (Eichwald, 1840). To the north of the area, at Bentleyford Brook, black Furongian shales (Bentleyford Shales) separate the Shoot Rough Road Shales from the overlying Tremadocian Shineton Shales (Stubblefield, 1930). The apparent absence of these shales in the Comley area is most probably due to faulting, a faulted contact being tentatively suggested to occur between the Shineton Shales and older strata in Cobbold's Excavation 62 in Shoot Rough Wood (Cobbold, 1927).

Recent palaeontological investigations have again focused on the mainly Series 2 carbonate succession exposed at Comley Quarry. Hinz (1987) described the phosphatic microfossils and Siveter *et al*. (2001) report exceptionally well-preserved phosphatocopid crustaceans. The Furongian clastic sequence has been largely neglected since the time of Cobbold's work, although the acritarchs from the Tremadocian Shineton Shales north of the study area have been thoroughly investigated (Downie, 1958; Rasul, 1979). In this contribution we describe acritarch assemblages from three samples of the Shoot Rough Road Shales. Cobbold (1927) recovered the trilobite *Parabolina spinulosa* (Wahlenberg, 1821), diagnostic of the *Parabolina spinulosa* Zone (Furongian Series, Cambrian Stage 9, of recently introduced chronostratigraphical terminology, Cocks *et al*., 2010) from two excavations in the shales and two of the acritarch sample sites were located in the close neighbourhood of these excavations. The presence of *P. spinulosa* in the Shoot Rough Road Shales, as reported in Cobbold (1927), is indicative of the upper *P. spinulosa* Subzone of the *P. spinulosa* Zone (A.W.A. Rushton, pers. comm. 2009). Whilst the subdivision of the zone was introduced by Westergård in 1922, it was formally treated as a subzone by Westergård (1944) after Cobbold's death. The zonal subdivision is summarized by Henningsmoen (1957). C. J. Stubblefield, who identified the trilobite material reported by Cobbold, would have been aware of the description of *Parabolona brevispina* (Westergård, 1922), the index fossil for the lower subzone, and would not have confused the two taxa (Rushton, pers. comm. 2009). Unfortunately the excavations are now completely obscured and their exact location cannot be identified with certainty. The aims of the investigation were to characterize the Comley microfloras and to determine the potential of acritarchs as a tool for biostratigraphy in the Comley area by comparison with assemblages that have an established relationship with trilobite zones in other areas. The assemblages are compared with those from eastern Newfoundland (Martin & Dean, 1981, 1988; Parsons & Anderson, 2000) and with one from the Nuneaton area of the English Midlands (briefly reported by Bridge *et al*., 1998 and unpublished material), these being the only other Avalonian sequences with reliable *P. spinulosa* Zone control together with acritarch data. In addition, comparison is made with similar microfloras elsewhere, notably from the Ardennes and Estonia, where the trilobite evidence is more tenuous or absent.

SAMPLING

Three samples, L1, L2 and L3, were collected from the Furongian Shoot Rough Road Shales of the Comley area and prepared for palynological investigation. The sampling was based primarily on the fieldwork carried out by E. S. Cobbold, published between 1909 and 1933 and summarized with additional borehole information by Greig *et al*. (1968). Cobbold's map (Cobbold, 1927) shows the location of 63 excavations. A previous palynological investigation of the Series 3 and Furongian of the Comley area by one of the authors (Potter, unpublished PhD thesis, University of Sheffield, 1974) was also used in the selection of sample sites. The very limited exposure proved the greatest constraint on site selection. Map references are according to the Ordnance Survey 1: 10,560, 6 inches to the mile, Sheet SO 49 NE. A simplified map showing the sample sites is given in Figure 2. The samples were all collected from small exposures of dark grey shale reported by Cobbold (1921) as *Orusia* Shales Horizon Ca, now and previously (see Cobbold 1921, table 1, 'Shoot-Rough Road Shale') called Shoot Rough Road Shales (Cowie *et al*., 1972). Greig *et al.* (1968) employ the term Grey (*Orusia*) Shales for the same lithological unit. The position of the Shoot Rough Road Shales in relation to the Cambrian stratigraphy of the Comley area is shown in Figure 3.

- L1: SO 49 NE 4857 9671. West bank of Comley Brook, approximately 2 m north of the junction between Comley Brook and a small tributary running west from Shoot Rough. Site L1 is situated at or close to Excavation 60 reported by Cobbold (1927, p. 555). Excavation 60 yielded only a minute *Lingulella*, but the rock exposed was none the less provisionally assigned to the *Orusia* horizon, Ca. Excavation 59, *c*. 27 m to the south in Comley Brook, yielded *Parabolina spinulosa* (Wahlenberg, 1821), *Orusia lenticularis* (Wahlenberg, 1821) and *Acrothele* cf. c*oriacea* Linnarsson, 1876 (Cobbold, 1916, p. 122; 1927, reporting work of C. J. Stubblefield, p. 557).
- L2: SO 49 NE 4871 9653. North bank of a tributary of Comley Brook running WNW from Shoot Rough Farm where it flows just to the south of and parallel to Shoot Rough Road. It is some 30 m downstream from the point where the stream initially converges with the road. Some of Cobbold's excavations just to the north of Shoot Rough Road exposed shales he assigned to the Shoot Rough Road Shales. Excavation No. 21, located some metres north of location L2 in the bank of Shoot Rough Road (now concealed), yielded a small form 'approaching' *Orusia lenticularis*, *Kutorgina* sp. and a small *Acrothele* (Cobbold, 1910, p. 185).

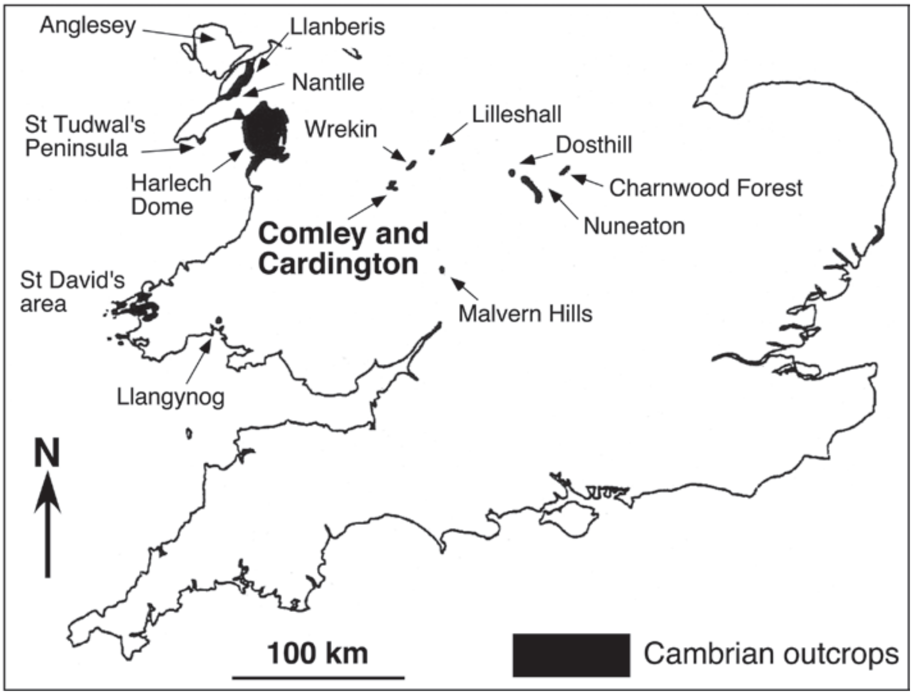


Fig. 1. Distribution of Cambrian outcrops in England and Wales (after Rushton *in* Rushton *et al*., 1999).

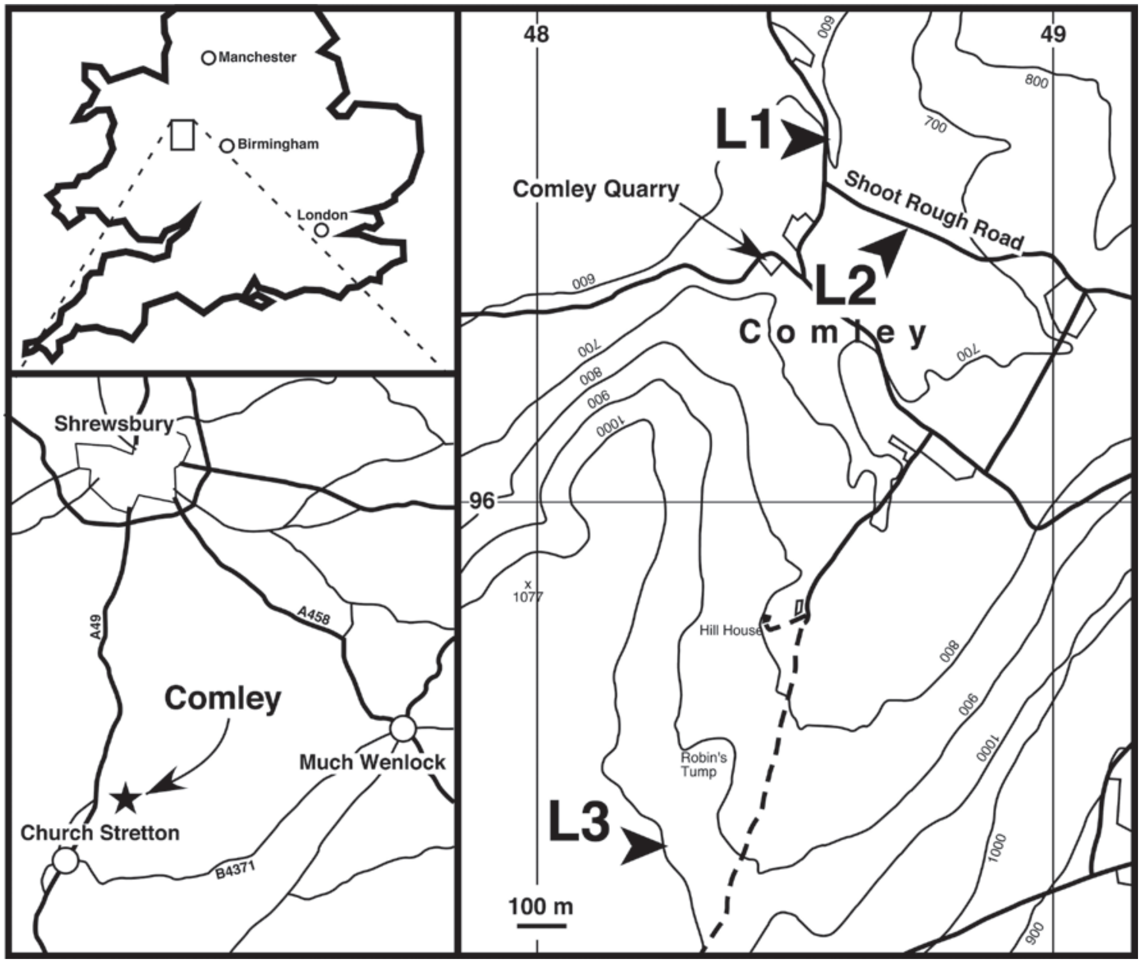
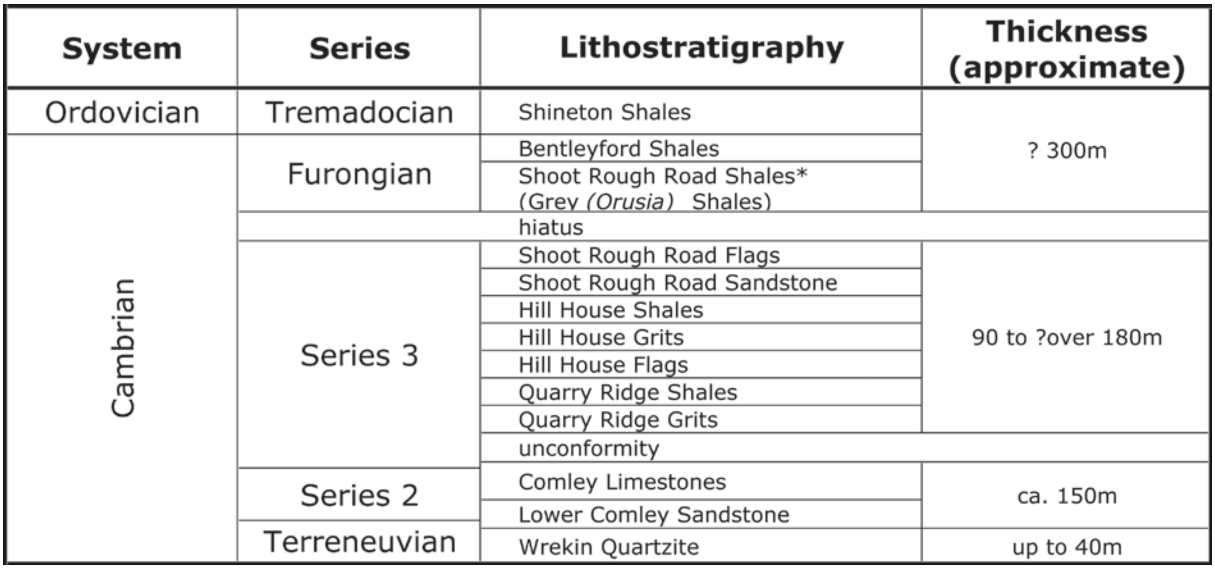


Fig. 2. Map showing sampled localities in the Comley area, Shropshire, UK (after Ordnance Survey map 1: 10,560, 6 inches to the mile, Sheet SO 49 NE).



System	Series	Lithostratigraphy	Thickness (approximate)
Ordovician	Tremadocian	Shineton Shales	? 300m
Cambrian	Furongian	Bentleyford Shales	
		Shoot Rough Road Shales* (Grey *(Orusia)* Shales)	
		hiatus	
	Series 3	Shoot Rough Road Flags	90 to ?over 180m
		Shoot Rough Road Sandstone	
		Hill House Shales	
		Hill House Grits	
		Hill House Flags	
		Quarry Ridge Shales	
		Quarry Ridge Grits	
		unconformity	
	Series 2	Comley Limestones	ca. 150m
		Lower Comley Sandstone	
	Terreneuvian	Wrekin Quartzite	up to 40m

Fig. 3. Stratigraphy of the Cambrian sedimentary succession in the Comley area (after Greig *et al.*, 1968; Cowie *et al.*, 1972; Rushton pers. comm., 2008). Asterisk (*) indicates the provenance of samples L1, L2 and L3 of the present study.

- L3: SO 49 NE 4825 9534. In a clump of trees, approximately 240 m and 190° south of Robin's Tump (a small hillock) on the eastern slopes of Caer Caradoc. It is close to the site of excavation 43 (Cobbold, 1912, p. 115; 1927, p. 556), which exposed shales that Cobbold considered reminiscent of the Shoot Rough Road 'group' north of the Shoot Rough Road and yielded *Orusia lenticularis* and fragments of *Parabolina spinulosa* (according to C. J. Stubblefield, reported by Cobbold, 1927).

Fragments of shale showing the least signs of weathering were selected for preparation and standard palynological preparation procedures were employed. Testing with 10% hydrochloric acid indicated that calcium carbonate was absent and the samples were broken down in 60% hydrofluoric acid, undissolved mineral being removed using sodium polytungstate heavy mineral separation. Oxidation was not required and the residues were sieved to provide slides of the 5–10 μm and the >10 μm fractions. The 5–10 μm fraction is used for concentrating the very small acritarchs that might be present. In addition, a 5 μm and greater fraction was mounted for each sample for establishing the relative abundance of species in a count of more than 300 identifiable specimens. All light photomicrographs were taken using Differential Interference Contrast. Scanning electron microscope (SEM) imaging was undertaken using a Philips XL30 Field Emission Gun SEM at the Natural History Museum, London.

SYSTEMATIC PALYNOLOGY

Previous occurrences are reported in instances where the identification of the taxon could be confirmed using illustrations of the taxon in the relevant publication. When the biozone is confirmed by external macrofossil control, this is indicated. Descriptions and remarks are given where considered relevant. Slides containing the figured specimens are deposited in the micropalaeontological collection of the Palaeontology Department, Natural History Museum, London. All acritarchs can be located within the slides using the England Finder references given for each specimen on the plate captions, e.g. K63/0. Dimensions are given in the convention: lowest (average) highest value.

Species list

The taxa recorded from the Comley samples are listed below.

Actinotodissus achrasii (Martin, 1973) Yin Lei-ming, 1986 (Pl. 1, figs 1, 2)
Cristallinium cambriense (Slavíková, 1968) Vanguestaine, 1978 (Pl. 5, fig. 6; Pl. 7, fig. 11)
Cristallinium randomense Martin *in* Martin & Dean, 1981 (Pl. 5, figs 4, 5; Pl. 7, fig. 12)
Cymatiogalea aff. *aspergillum* Martin *in* Martin & Dean, 1988 (Pl. 4, figs 1–3)
Cymatiogalea virgulta Martin *in* Martin & Dean, 1988 (Pl. 3, figs 4–6; Pl. 7, fig. 6)
Dasydiacrodium obsonum Martin *in* Martin & Dean, 1988 (Pl. 1, figs 3, 4)
Gyalorhethium? sp. 1 (Pl. 3, fig. 9)
Impluviculus sp. 1 (Pl. 2, figs 1–3)
Leiofusa stoumonensis Vanguestaine, 1973 (Pl. 5, fig. 9)
Leiosphaeridia spp. (Pl. 5, fig. 8)
Ninadiacrodium caudatum (Vanguestaine, 1973) Raevskaya & Servais, 2009 (Pl. 5, fig. 7)
Ninadiacrodium aff. *caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009 (Pl. 3, fig. 1)
Ninadiacrodium dumontii (Vanguestaine, 1973) Raevskaya & Servais, 2009 (Pl. 2, fig. 9; Pl. 7, figs 1–3)
Polygonium spp. (Pl. 1, figs 5, 6; Pl. 7, fig. 4)
Scalenadiacrodium comleyense gen. et sp. nov. (Pl. 2, figs 4–8)
Stelliferidium cortinulamorphum Paalits, 1995 (Pl. 4, figs 4–6; Pl. 7, fig. 7)
Stelliferidium cf. *distinctum* (Rasul, 1974) Pittau, 1985 (Pl. 4, figs 7, 8)
Timofeevia aff. *estonica* Volkova, 1990 (Pl. 3, figs 7, 8; Pl. 7, figs 8, 9)
Timofeevia phosphoritica Vanguestaine, 1978 (Pl. 3, figs 2, 3; Pl. 7, fig. 5)
Trunculumarium revinium (Vanguestaine, 1973) Loeblich & Tappan, 1976 (Pl. 4, fig. 9; Pl. 5, figs 1–3; Pl. 7, fig. 10)
Vulcanisphaera africana Deunff, 1961 (Pl. 6, figs 1, 3)
Vulcanisphaera turbata Martin *in* Martin & Dean, 1981 (Pl. 6, figs 2, 4)

INCERTAE SEDIS
Group **Acritarcha** Evitt, 1963

Genus *Actinotodissus* Loeblich & Tappan, 1978

Type species. *Actinotodissus longitaleosus* Loeblich & Tappan, 1978

Remarks. The status of the genus *Actinotodissus* is discussed in relation to the similar genera *Acanthodiacrodium* (Timofeev, 1958) Deflandre & Deflandre-Rigaud, 1962, *Diornatosphaera* Downie, 1958 and *Priscotheca* Deunff, 1961 by Bagnoli *et al.* (1988), Martin *in* Martin & Dean (1988), Parsons & Anderson (2000) and Paalits & Heuse (2000), amongst others. The forms discussed below clearly possess large hollow processes and are here assigned to the genus *Actinotodissus* in accordance with the views of Martin *in* Martin & Dean (1988).

Actinotodissus achrasii (Martin, 1973) Yin Lei-ming, 1986
(Pl. 1, figs 1, 2)

1973 *Acanthodiacrodium achrasi* Martin: 30; pl. V, fig. 11; pl. VI, figs 8, 11, 19; pl. VIII, figs 1, 2, 4.
1986 *Actinotodissus achrasi* (Martin, 1973); Yin Lei-ming, 332; pl. 84, figs 1, 3, 5, 7–11, 13, 15, 16; pl. 92, figs 1, 2, 4, 6; pl. 93, fig. 1, 2, 6, 7; pl. 94, fig. 5; pl. 96, fig. 4; pl. 97, fig. 8; text-fig. 122.

Description. The vesicle outline is elongate polygonal with long, hollow, broad-based, tapering, pointed processes inserted in the polar regions, often with one or two processes located in the otherwise unornamented central region, more or less equidistant from the poles. There are equal numbers of processes in each polar region or with a difference of no more than two. One or more processes on a given individual may be significantly shorter, approximately 1/3 to 2/3 the length of the principal processes. The process cavities are in communication with the vesicle cavity

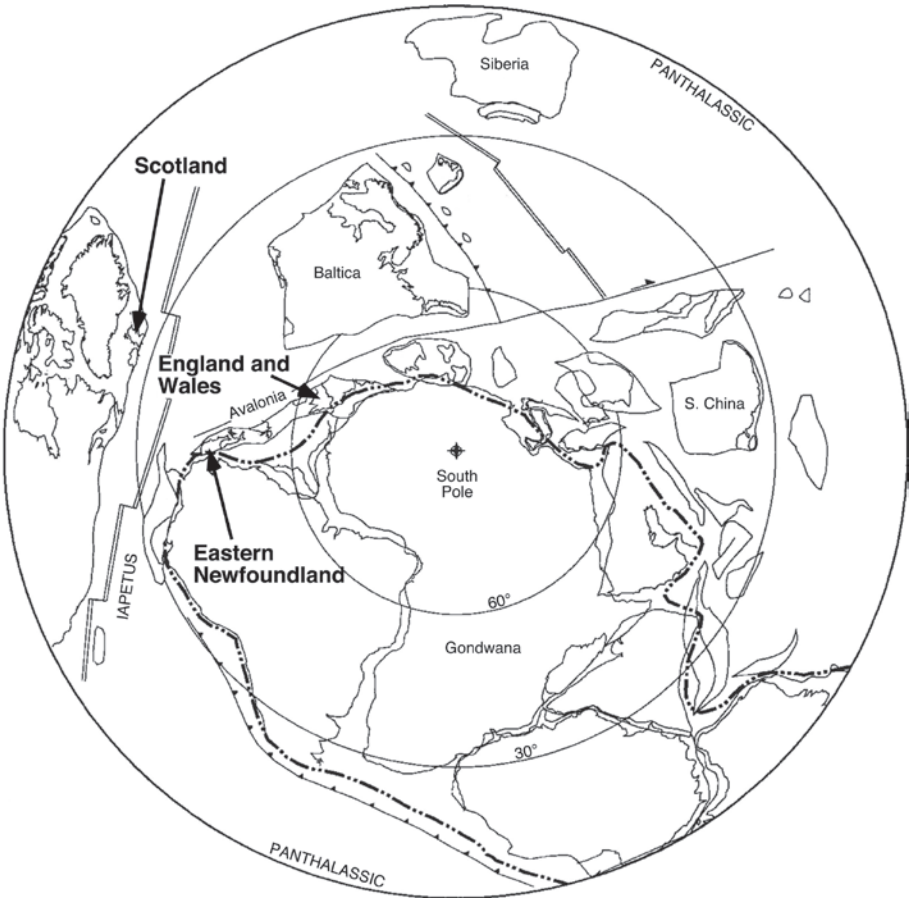


Fig. 4. Palaeogeographical reconstruction of the Furongian showing the relative positions of England and Wales and eastern Newfoundland on the Avalonian continent (after Cocks & Torsvik, 2002).

and the wall of both processes and vesicle is thin. Although the specimens are corroded, a granular, possibly finely echinate sculpture is visible on many specimens, this being most apparent on the processes. A pronounced conical polar protuberance bearing a single process is present in a small number of specimens. Excystment openings were not observed.

Dimensions. 36 specimens. Vesicle length 20 (28.5) 47 µm; vesicle breadth 14 (20.5) 25.5 µm; vesicle breadth: length 57 (74) 100%; maximum process length 13 (20) 37.5 µm; process length: vesicle length 43 (73) 170%; total number of processes 9 (12) 16.

Remarks. The processes of the Comley specimens are considerably longer than those of the Ordovician type material and frequently longer than those of specimens of Cambrian age described by Martin & Dean (1981), Parsons & Anderson (2000) and Moczydłowska & Stockfors (2004). Martin (1973, pl. VIII, fig. 2) illustrates a specimen of *A. achrasii* which appears to display centrally located process insertion and, following Parsons & Anderson (2000), such forms are herein accommodated within the species. The same illustration also displays a conical polar extension and similar forms, although to some extent displaying the features of genus *Tectitheca* Burmann, 1968, are otherwise indistinguishable from *A. achrasii* and are also herein included in the species. Some specimens show disparity of vesicle width of the polar regions with a polygonality approaching that of genus *Polygonium* (Vavrdová, 1966) Moczydłowska & Stockfors, 2004. Forms encountered in the Comley assemblages otherwise resembling *A. achrasii* but lacking a long axis and with more or less evenly distributed processes are referred to the genus *Polygonium*. The species *Actinotodissus achrasii*, *Ninadiacrodium caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009, *Ninadiacrodium* aff. *caudatum*, *Dasydiacrodium obsonum* Martin *in* Martin & Dean, 1988, *Scalenadiacrodium comleyense* gen. et sp. nov., *Ninadiacrodium dumontii* (Vanguestaine, 1973) Raevskaya & Servais, 2009 and *Polygonium* spp. herein may be closely related biological entities with rather arbitrary distinctions subdividing a morphological continuum. Raevskaya & Servais (2009) discuss the continuity of morphological variation between *N. dumontii* and *N. caudatum.*

Previous records. *Actinotodissus achrasii* has been widely reported in Furongian and Lower Ordovician assemblages. The Furongian occurrences are listed here. Furongian, *Parabolina spinulosa* Zone to Lower Tremadocian (verified by macrofossils), eastern Newfoundland, Canada (Martin & Dean, 1981, 1988); Furongian, *Protopeltura praecursor* Zone to Lower Tremadocian (verified by macrofossils), eastern Newfoundland, Canada (Parsons & Anderson, 2000); Furongian, China (Yin Lei-ming,

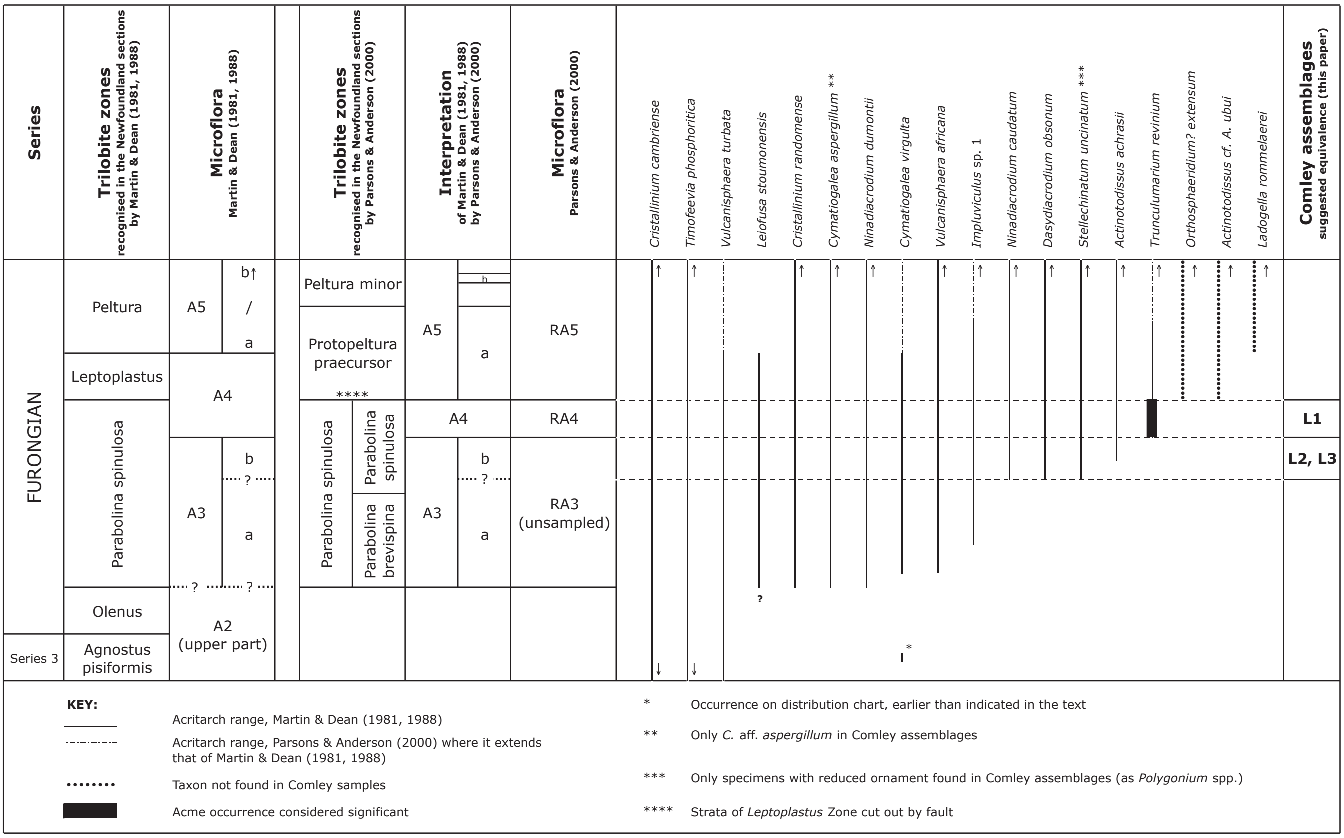


Fig. 5. Ranges of acritarch taxa in eastern Newfoundland given by Martin & Dean (1981, 1988) and Parsons & Anderson (2000). Taxa recorded in Comley assemblages unless otherwise indicated.

1986); Furongian, *Peltura scarabaeoides* Zone (verified by macrofossils), Öland, Sweden (Di Milia *et al*., 1989); Furongian, Algeria (Vecoli, 1996); Furongian to Tremadocian, Arctic Russia (Moczydłowska & Stockfors, 2004); Furongian, northern Spain (Albani *et al*., 2006); Furongian to Tremadocian, Iran (Ghavidel-syooki, 2006; Ghavidel-syooki & Vecoli, 2008).

Genus *Cristallinium* Vanguestaine, 1978

Type species. *Cristallinium cambriense* (Slavíková, 1968) Vanguestaine, 1978

Cristallinium cambriense (Slavíková, 1968) Vanguestaine, 1978
(Pl. 5, fig. 6; Pl. 7, fig. 11)

1968 *Dictyotidium cambriense* Slavíková: 201, pl. II, fig. 1, 3 (nomen nudum).

1972 *Cymatiosphaera ovillensis* Cramer & Diez de Cramer: 44, pl. 2, figs 4, 7, 10.

1978 *Cristallinium cambriense* (Slavíková, 1968); Vanguestaine: 271, pl. II, figs 16, 17; pl. III, figs 16, 26.

1990 *Cristallinium ovillense* (Cramer & Diez de Cramer, 1972); Fensome *et al*.: 161.

Dimensions. 21 specimens. Vesicle size 36 (47) 55.5 μm; field size 14 (20) 24.5 μm; field number about 14–20; ornament height 1 (1.4) 2.5 μm.

Previous records. *C. cambriense* is widely reported from Cambrian, Series 3 to Tremadocian, see Albani *et al.* (1991), Moczydłowska (1998) and Vecoli (1996, reported as *Cristallinium ovillense* (Cramer & Diez de Cramer, 1972) Fensome *et al*., 1990).

Cristallinium randomense Martin *in* Martin & Dean, 1981
(Pl. 5, figs 4, 5; Pl. 7, fig. 12)

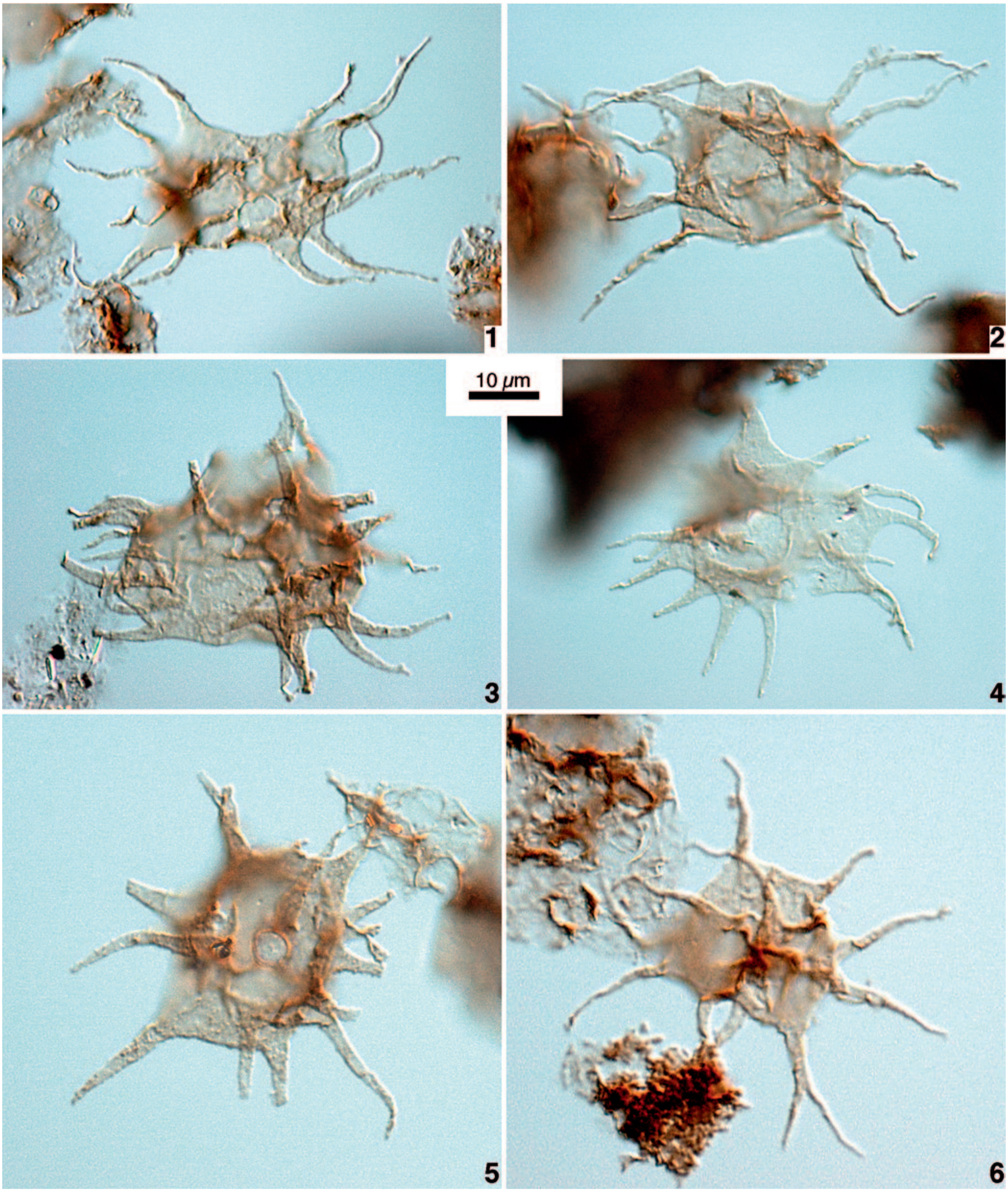
1981 *Cristallinium randomense* Martin *in* Martin & Dean: 18, pl. 3, figs 2, 10, 17, 24, 26 (*non* pl. 3, figs 12, 20; pl. 6, fig. 4, 6).

1988 *Cristallinium randomense* Martin *in* Martin & Dean, 1981 emend.; Martin *in* Martin & Dean: 36, pl. 13, figs 6, 9, 17 (*non* pl. 13, figs 1–5, 7, 8).

Dimensions. 19 specimens. Vesicle size 38.5 (47) 55 μm; process length 4.5 (5.5) 7 μm; process length: vesicle size 9 (12) 16%.

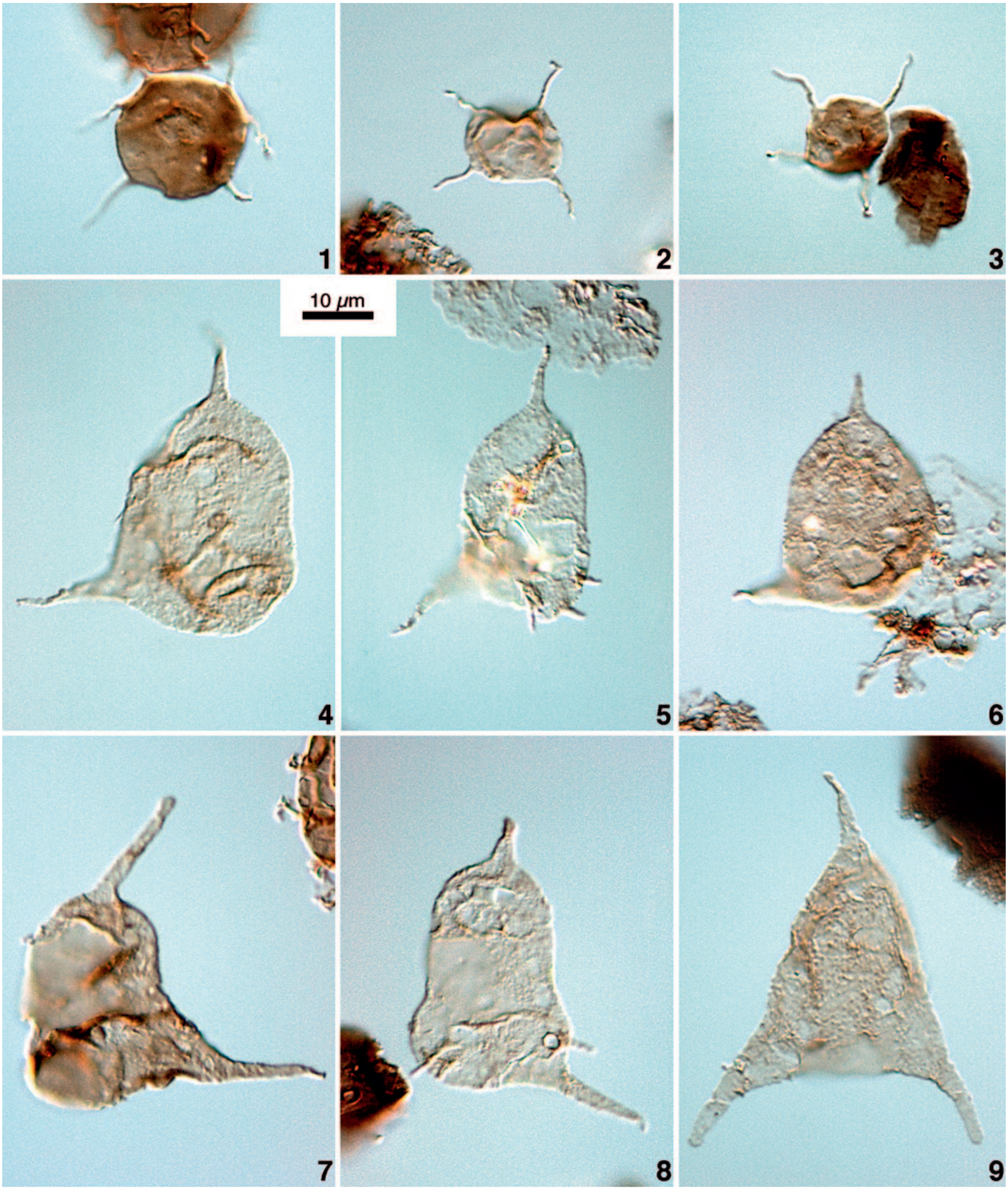
Remarks. The species concept employed here is that provided by Vanguestaine (2002) in his review of the taxon.

Previous records. The stratigraphical range of Furongian given in Vanguestaine & Brück (2008, p. 91) is accepted here. Trilobite-controlled occurrences in eastern Newfoundland (Martin & Dean, 1981, 1988; Parsons & Anderson, 2000), with illustrated specimens critically reviewed in Vanguestaine



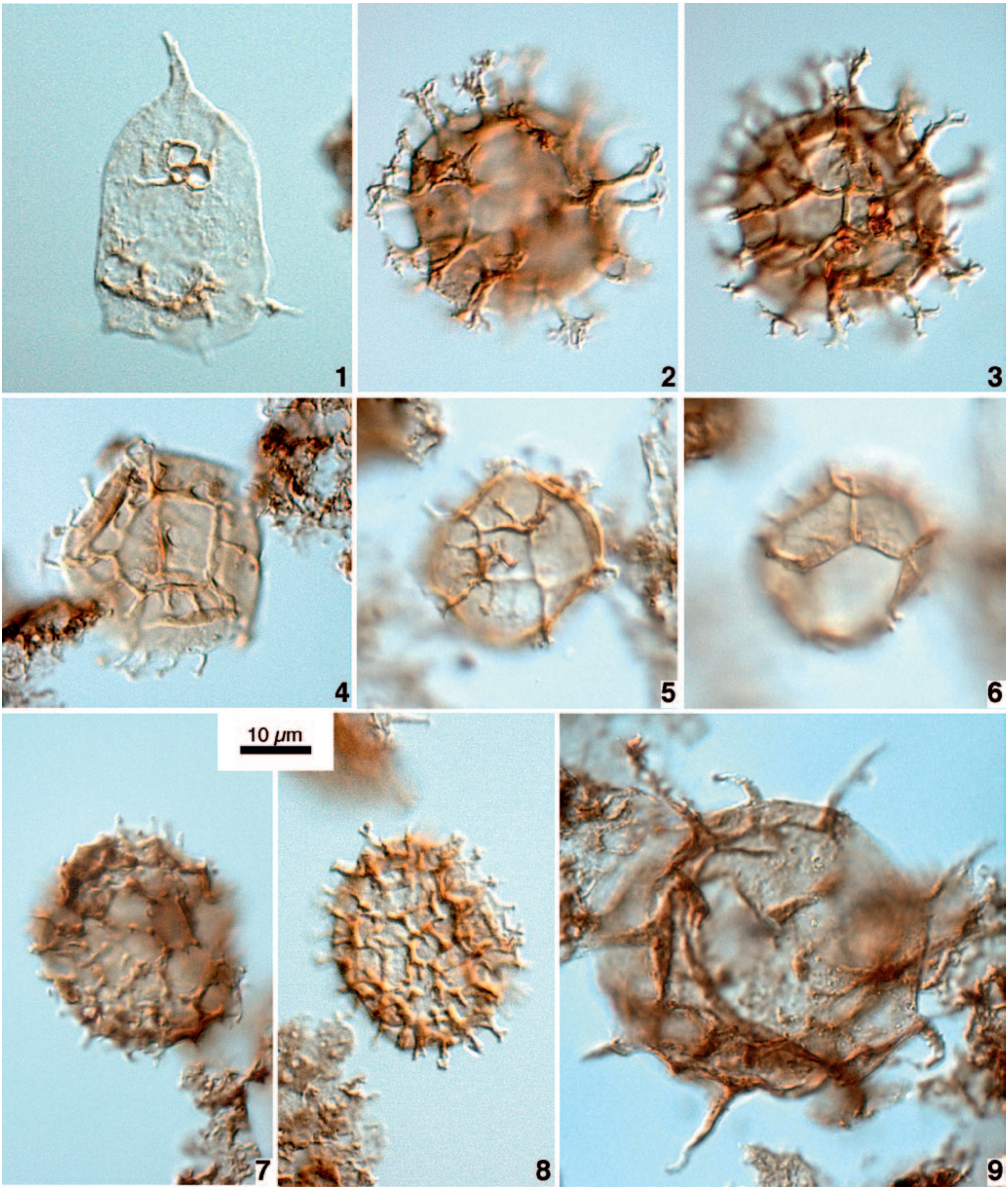
Explanation of Plate 1.

figs 1, 2. *Actinotodissus achrasii* (Martin, 1973) Yin Lei-ming, 1986: **1**, high focus, slide L1a-1 (10 µm), K63/0; **2**, high focus, slide L1a-1 (10 µm), R45/0. **figs 3**, **4**. *Dasydiacrodium obsonum* Martin *in* Martin & Dean, 1988: **3**, high focus, slide L2a-1 (10 µm), M56/0; **4**, high focus, slide L2a-1 (10 µm), F63/0. **figs 5**, **6**. *Polygonium* spp.: **5**, high focus, slide L2a-1 (10 µm), J63/0; **6**, high focus, slide L1a-1 (10 µm), J42/2.



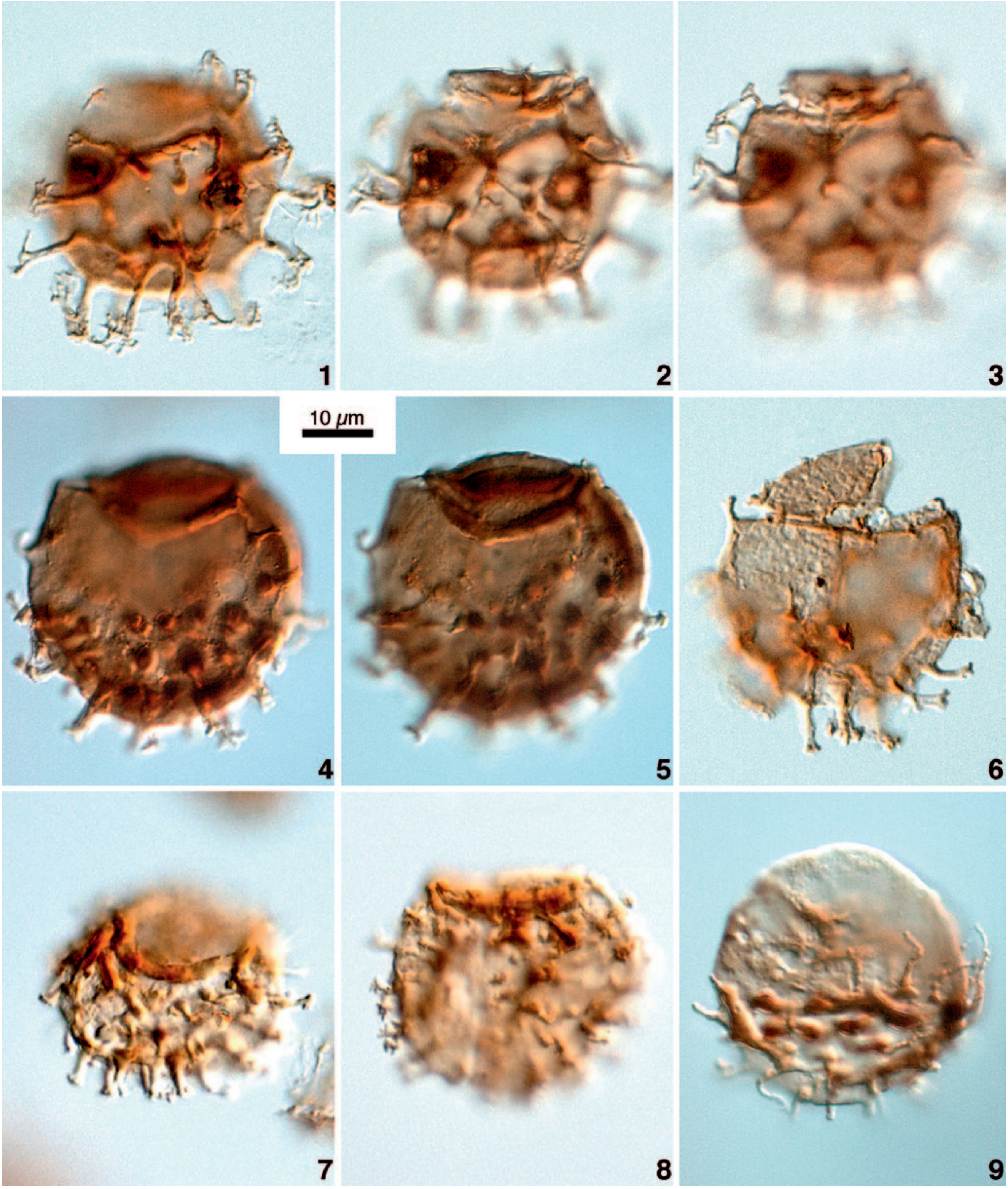
Explanation of Plate 2.

figs 1–3. *Impluviculus* sp. 1: **1**, slide L2a-2 (5 µm), N41/1; **2**, slide L2a-2 (5 µm), N48/3; **3**, slide L2a-2 (5 µm), N48/4. **figs 4–8**. *Scalenadiacrodium comleyense* gen. et sp. nov.: **4**, paratype, slide L3c-1 (10 µm), D51/1; **5**, slide L3c-2 (5 µm), F71/3; **6**, slide L2a-2 (5 µm), F38/0; **7**, slide L2a-1 (10 µm), Q69/0; **8**, holotype, slide L3c-2 (5 µm), R42/0. **fig. 9**. *Ninadiacrodium dumontii* (Vanguestaine, 1973) Raevskaya & Servais, 2009. Slide L2a-1 (10 µm), P46/0.



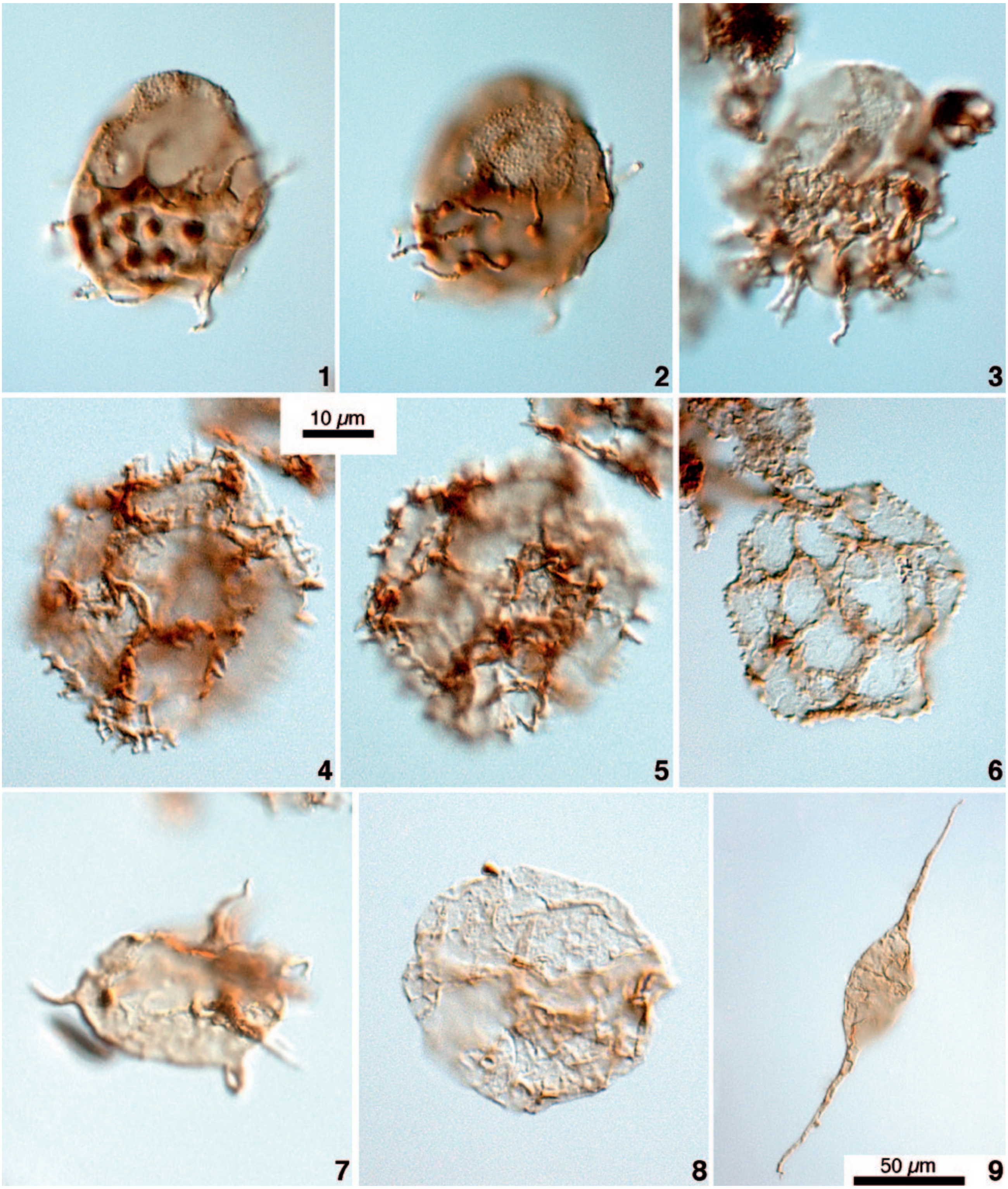
Explanation of Plate 3.

fig. 1. *Ninadiacrodium* aff. *caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009. Slide L3c-3 (5 µm glycerine jelly), Q32/2. **figs 2**, **3**. *Timofeevia phosphoritica* Vanguestaine, 1978: **2**, high focus, **3**, low focus, slide L2a-1 (10 µm), L62/0. **figs 4–6**. *Cymatiogalea virgulta* Martin *in* Martin & Dean, 1988: **4**, high focus, slide L1a-1 (10 µm), J54/4; **5**, high focus, **6**, low focus, slide L1a-5 (10 µm), D62/3. **figs 7**, **8**. *Timofeevia* aff. *estonica* Volkova, 1990: **7**, high focus, slide L1a-1 (10 µm), J37/0; **8**, high focus, slide L2a-1 (10 µm), Q44/0. **fig. 9**. *Gyalorhethium*? sp. 1. Slide L1a-6 (10 µm), J48/3.



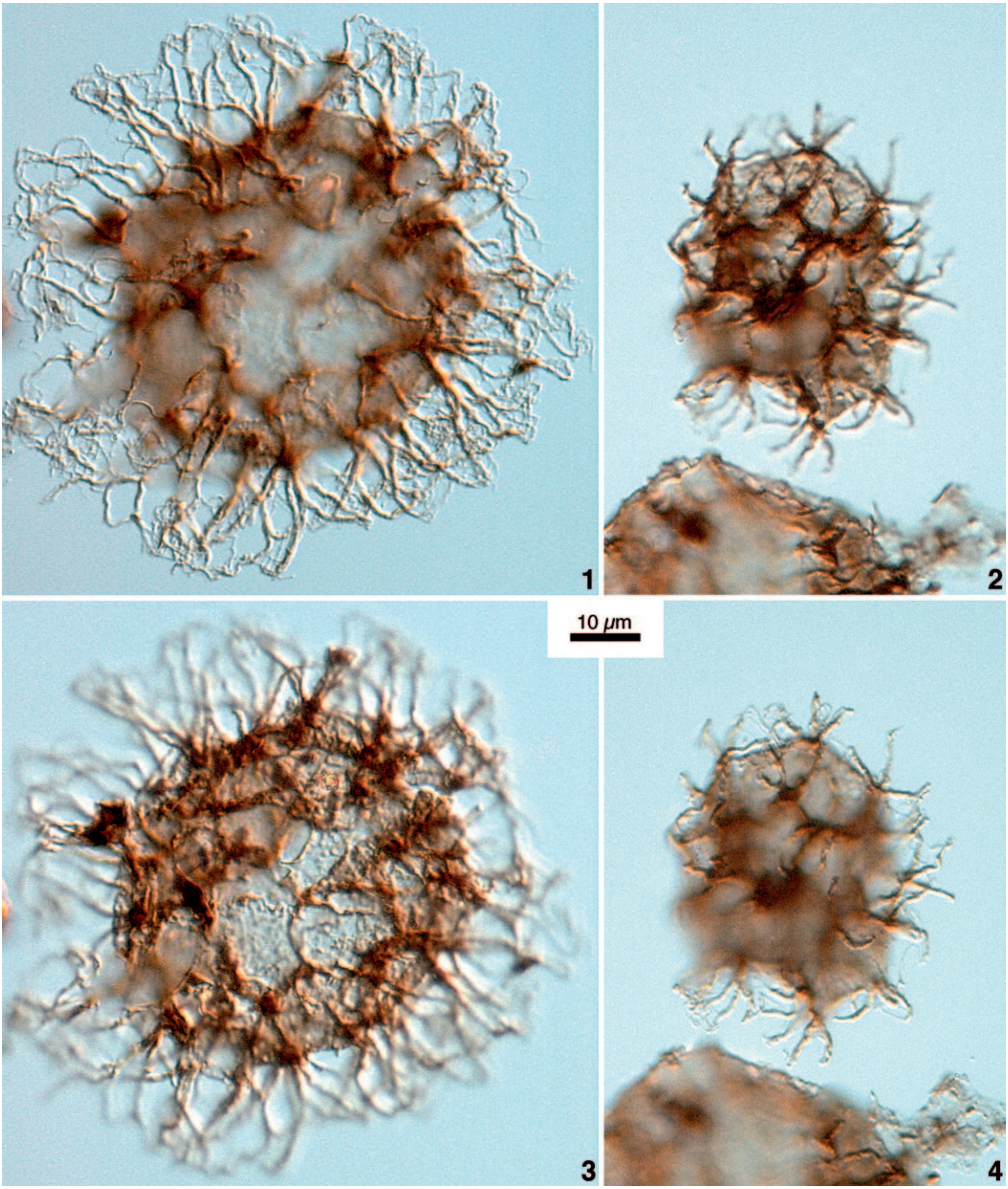
Explanation of Plate 4.

figs 1–3. *Cymatiogalea* aff. *aspergillum* Martin *in* Martin & Dean, 1988: **1**, high focus, **2**, optical section, **3**, low focus, slide L2a-1 (10 μm), P49/4. **figs 4–6**. *Stelliferidium cortinulamorphum* Paalits, 1995: **4**, high focus, **5**, optical section, slide L3c-1 (10 μm), D49/0; **6**, high focus, slide L2a-1 (10 μm), P41/4. **figs 7**, **8**. *Stelliferidium* cf. *distinctum* (Rasul, 1974) Pittau, 1985: **7**, high focus, slide L3c-3 (5 μm glycerine jelly), C60/1; **8**, high focus, slide L2a-5 (10 μm), J 48/0. **fig. 9**. *Trunculumarium revinium* (Vanguestaine, 1973) Loeblich & Tappan, 1976. Slide L1a-4 (10 μm glycerine jelly), D54/1.



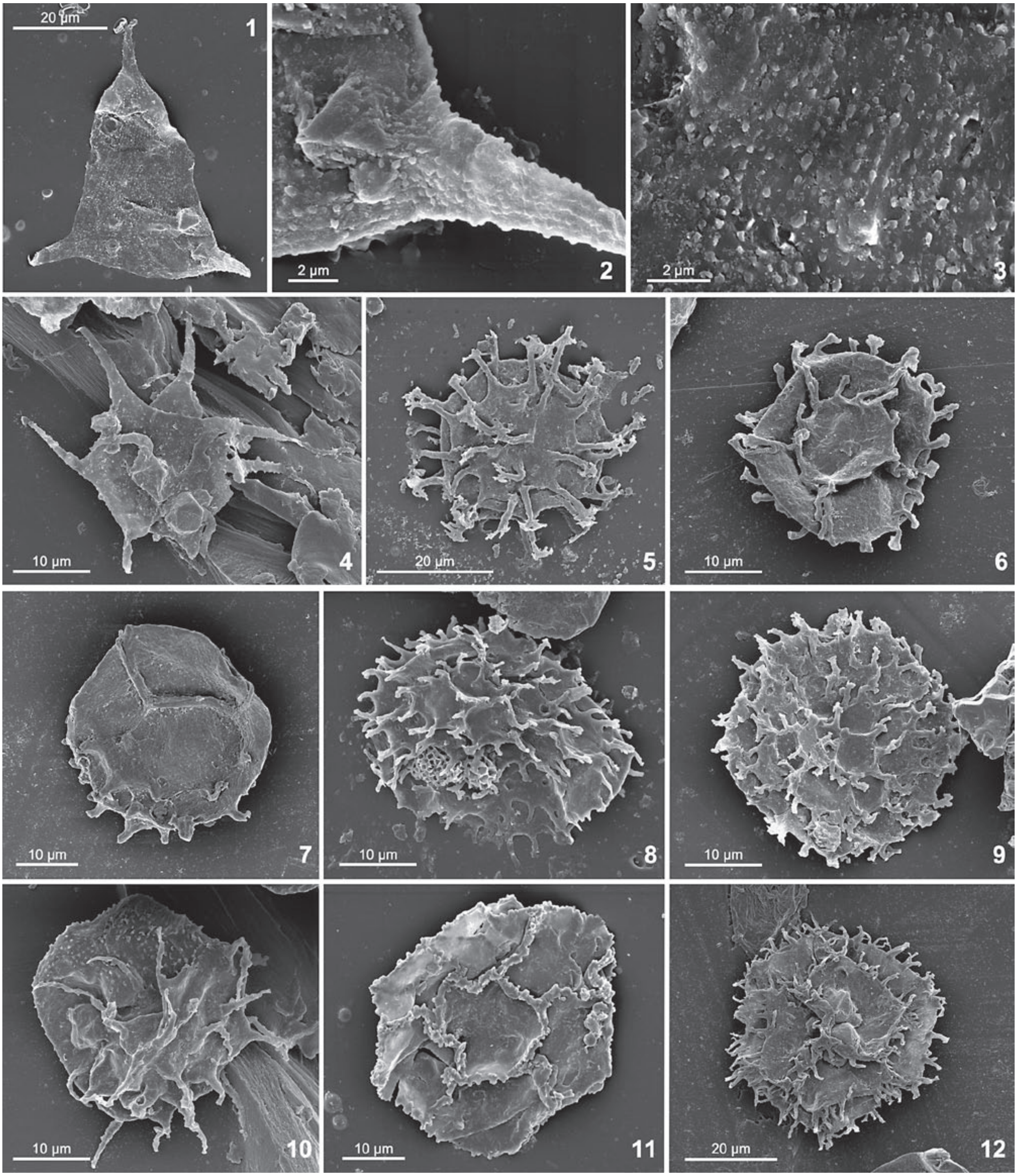
Explanation of Plate 5.

figs 1–3. *Trunculumarium revinium* (Vanguestaine, 1973) Loeblich & Tappan, 1976: **1**, high focus, **2**, low focus, slide L1a-1 (10 μm), H41/0; **3**, high focus, slide L1a-1 (10 μm), P54/1. **figs 4**, **5**. *Cristallinium randomense* Martin *in* Martin & Dean, 1981: **4**, high focus, **5**, optical section, slide L1a-1 (10 μm), C52/1. **fig. 6**. *Cristallinium cambriense* (Slavíková, 1968) Vanguestaine, 1978. High focus, slide L2a-1 (10 μm), K58/3. **fig. 7**. *Ninadiacrodium caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009. Low focus, slide L1a-5 (10 μm), F64/3. **fig. 8**. *Leiosphaeridia* sp. Slide L2a-1 (10 μm), N47/0. **fig. 9**. *Leiofusa stoumonensis* Vanguestaine, 1973. Slide L2a-5 (10 μm), T52/1. Scale bar 10 μm in figs 1–8; 50 μm in fig. 9.



Explanation of Plate 6.

figs 1, 3. *Vulcanisphaera africana* Deunff, 1961: **1**, high focus, **3**, lower focus, slide L2a-1 (10 μm), K63/0. **figs 2**, **4**. *Vulcanisphaera turbata* Martin *in* Martin & Dean, 1981: **2**, high focus, **4**, lower focus, slide L2a-1 (10 μm), O45/3.



Explanation of Plate 7.

figs 1–3. *Ninadiacrodium dumontii* (Vanguestaine, 1973) Raevskaya & Servais, 2009: **2**, **3**, details of **1**; note the arrangement of surface ornament in parallel rows. Specimen from sample L2. **fig. 4**. *Polygonium* sp. Specimen from sample L1. **fig. 5**. *Timofeevia phosphoritica* Vanguestaine, 1978. Specimen from sample L2. **fig. 6**. *Cymatiogalea virgulta* Martin *in* Martin & Dean, 1988. Specimen from sample L3. **fig. 7**. *Stelliferidium cortinulamorphum* Paalits, 1995. Specimen from sample L3. **figs 8**, **9**. *Timofeevia* aff. *estonica* Volkova, 1990: **8**, specimen from sample L2; **9**, specimen from sample L1. **fig. 10**. *Trunculumarium revinium* (Vanguestaine, 1973) Loeblich & Tappan, 1976. Specimen from sample L1. **fig. 11**. *Cristallinium cambriense* (Slavíková, 1968) Vanguestaine, 1978. Specimen from sample L2. **fig. 12**. *Cristallinium randomense* Martin *in* Martin & Dean, 1981. Specimen from sample L3.

(2002), indicate a range of *Parabolina spinulosa* Zone, *P. brevispina* Subzone (*fide* Parsons & Anderson, 2000) to *Peltura* Zones.

Genus *Cymatiogalea* Deunff, 1961 emend. Deunff, Górka & Rauscher, 1974

Type species. *Cymatiogalea margaritata* Deunff, 1961

Cymatiogalea aspergillum Martin *in* Martin & Dean, 1988

1988 *Cymatiogalea aspergillum* Martin *in* Martin & Dean: 37, pl. 14, figs 1–7, 9.

Cymatiogalea aff. *aspergillum* Martin *in* Martin & Dean, 1988
(Pl. 4, figs 1–3)

Description. The vesicle outline is subcircular to subangular in entire specimens. The thin, smooth to weakly shagreenate wall may or may not be subdivided, wholly or partially into polygonal areas by folds. Excysted specimens usually display notching of the apertural margin. The processes appear to arise at the angles of the polygonal fields and their number varies between individuals. The processes display a variable degree of distal branching, usually to the third order and are shorter around and in the neighbourhood of the apertural margin. The margin is without a differentiated collar but is usually folded in entire specimens. The operculum lacks processes and has a subcircular to subpolygonal outline.

Dimensions. 20 specimens. Vesicle size 24 (32) 43.5 μm; process length (antapical) 7 (9.5) 13 μm; process length (antapical): vesicle size 19 (30) 42%; process length (around aperture) 3.5 (4.5) 5.5 μm; process length (around aperture): process length (antapical) 33 (48) 65%; macropyle width (open) 21–41 μm; operculum diameter 14–19 μm.

Remarks. A number of specimens were recorded conforming with the diagnosis of *Cymatiogalea aspergillum* with the exception that the membrane connecting the processes was not seen. Membranous fragments were sometimes noted but it was not clear whether these were the remains of lists connecting the processes or of a sheath that may once have surrounded the acritarch. The processes of the Comley specimens may be restricted to the angles of polygonal fields or with intergonal processes also present, whereas only the latter arrangement is indicated in the diagnosis given by Martin (in Martin & Dean, 1988). In many instances, particularly in cases of poor preservation, it was difficult to distinguish specimens with the operculum in place from specimens of *Timofeevia phosphoritica* Vanguestaine, 1978. The reduced size of processes in the neighbourhood of the presumed excystment site in the Comley specimens (a feature previously noted in *C. aspergillum* by Di Milia *et al*., 1989) could, in suitably preserved specimens, be used to confirm the galeate nature of specimens with the operculum in place. Some of the specimens assigned here to *C.* aff. *aspergillum* lack clearly defined fields but notching of the apertural margin in dehisced specimens confirms the galeate nature of the vesicle. The degree of prominence of field margins may depend to some degree on the extent of compressional folding at field edges. *Cymatiogalea* aff. *aspergillum* differs from *C. geometrica* Di Milia *et al*., 1989 in apparently displaying a less regular arrangement of fields and lacking clearly defined lists between the processes.

Previous records. *C. aspergillum*. Furongian *Parabolina spinulosa* Zone to *Acerocare* Zone (verified by macrofossils) eastern Newfoundland, Canada (Martin & Dean, 1988); Furongian *Protopeltura praecursor* Zone to *Peltura scarabaeoides* Zone (verified by macrofossils) eastern Newfoundland, Canada (Parsons & Anderson, 2000); Furongian *Peltura scarabaeoides* Zone (verified by macrofossils), Öland, Sweden (Di Milia *et al*., 1989); Furongian, Belgium (Ribecai & Vanguestaine, 1993); Furongian, St Tudwal's Peninsula, North Wales (Martin *in* Young *et al*., 1994); Furongian, southern Iran (Ghavidel-syooki & Vecoli, 2008).

Cymatiogalea virgulta Martin *in* Martin & Dean, 1988
(Pl. 3, figs 4–6; Pl. 7, fig. 6)

1988 *Cymatiogalea virgulta* Martin *in* Martin & Dean: 38, pl. 14, figs 10, 13, 14, 17.
1990 *Cymatiogalea* aff. *cristata* (Downie, 1958) Rauscher, 1973; Volkova, pl. IX, fig. 14.

Description. The vesicle has a subcircular to subangular outline. The thin wall has a surface divided into a small number of polygonal areas by low ridges, possibly folds. The processes are simple, rarely branched, of more or less uniform length and have digitate terminations. In a few cases there are membranous lists connecting the processes. The processes occur both at the angles and along the sides of the polygonal fields. Apertures are rarely present and are formed by the loss of a single polygonal area.

Dimensions. 24 specimens. Vesicle size 24 (30.5) 36.5 μm; process length 3 (4.5) 6 μm; process breadth 1 μm; process length: vesicle size 11 (15) 21%; height of process ramification: total process length 26 (32) 44%; field size 13 (16) 18.5 μm; field size: vesicle size 39 (52) 65%.

Remarks. The rarity of delicate translucent membranes connecting processes in the Comley specimens may be a preservational feature. *C. virgulta* is distinguished from *Timofeevia pentagonalis* (Vanguestaine, 1974) Vanguestaine, 1978 by having less complex process terminations and in its possession of a macropyle, although the presence of this latter cannot be anticipated in unopened vesicles in the absence of morphological features which would betray its location. Palacios *et al.* (2009) introduce a new species of a galeate taxon (*Stelliferidium albanii*) which also lacks any trace of opening structures in the encysted phase, distinguishing it from *Timofeevia* species on the presence of radiating striations from the process bases and on process shaft morphology. It is beyond the scope of the present investigation to consider the merits of this approach but, as indicated by Palacios *et al*. (2009), the taxonomy of Furongian specimens of *Timofeevia* should be reviewed. Such a review should include forms such as *C. virgulta* in its remit. Specimens lacking a macropyle and with slightly more complex process terminations appear transitional to *Timofeevia pentagonalis* but are included here in *C. virgulta*. It is distinguished from *Cymatiogalea wironia* Paalits, 1992a by its possession of a greater number of polygonal fields including pentagonal and hexagonal forms. The specimen figured as *Cymatiogalea* aff. *cristata* by Volkova (1990, pl. IX, fig. 14) closely resembles *C. virgulta* in the Comley assemblages.

Previous records. Furongian *Parabolina spinulosa* Zone to *Leptoplastus* Zone (verified by macrofossils), eastern Newfoundland, Canada (Martin & Dean, 1988), range extended to the *Peltura minor* zone by Parsons & Anderson (2000, not illustrated); (*Cymateogalea* aff. *cristata*) Furongian, East European Platform (Volkova 1990); Furongian, Belgium (Ribecai & Vanguestaine, 1993); Furongian, St Tudwal's Peninsula, North Wales (Martin *in* Young *et al.*, 1994); Furongian, Algerian Sahara (Vecoli, 1996); Furongian, Asturias, northern Spain (Albani *et al.*, 2006); Furongian, County Wexford, Ireland (Vanguestaine & Brück, 2008).

Genus *Dasydiacrodium* Timofeev, 1959 ex and emend. Deflandre & Deflandre-Rigaud, 1962 emend. Moczydłowska & Stockfors, 2004

Type species. *Dasydiacrodium eichwaldii* Timofeev, 1959 ex Deflandre & Deflandre-Rigaud, 1962

Dasydiacrodium obsonum Martin *in* Martin & Dean, 1988

(Pl. 1, figs 3, 4)

1988 *Dasydiacrodium obsonum* Martin *in* Martin & Dean: 38, pl. 10, figs 6, 7, 10, 11, 13–15.

Dimensions. 5 specimens. Vesicle length 25.5 (30) 35 µm; vesicle breadth 21 (23.5) 27 µm; process length 10.5 (16.5) 20 µm.

Remarks. *Dasydiacrodium obsonum* displays a morphology transitional between that of *Ninadiacrodium caudatum* and *Actinotodissus achrasii.* It differs from *N. caudatum* by possessing more numerous processes around its apical pole. It can be distinguished from *A. achrasii* by a disparity in the number of processes between poles and the relatively narrower dimension of one (apical) polar region.

Previous records. Furongian, *Parabolina spinulosa* Zone to *Acerocare* Zone (verified by macrofossils), eastern Newfoundland, Canada (Martin & Dean, 1988); Furongian, North Estonia (Paalits, 1992a); Furongian, Belgium and France (Ribecai & Vanguestaine, 1993); Furongian, Northeast China (Martin, 1993); Furongian, Algeria (Vecoli, 1996); Furongian, Arctic Russia (Moczydłowska & Stockfors, 2004); Furongian, northern Spain (Albani *et al.*, 2006); Furongian, Iran (Ghavidel-syooki, 2006; Ghavidel-syooki & Vecoli, 2008).

Genus *Gyalorhethium* Loeblich & Tappan, 1978

Type species. *Gyalorhethium spinuliferum* Loeblich & Tappan, 1978

Gyalorhethium? sp. 1

(Pl. 3, fig. 9)

Description. The vesicle outline is approximately circular, the wall thin with a few broad folds. The processes are simple, hollow and appear to open into the vesicle cavity, tapering gently distally to closed, pointed tips. The processes are widely and evenly spaced, the proximal contacts are angular to slightly curved; the wall is thin. They are of more or less uniform size, one being shorter and thinner. The surface of both vesicle and processes is corroded, but vestiges remain of what was probably an originally granulate or echinate sculpture, slightly more pronounced on the processes.

Dimensions. 3 specimens. Vesicle diameter 48–56 µm; process length 14–21 µm; process breadth (proximal) 1.5–2 µm; process number 17–23 visible at the vesicle periphery.

Remarks. This form matches the diagnostic criteria of the genus *Gyalorhethium* although the state of preservation renders identification of the exact nature of the sculptural elements questionable. It lacks a vesicle outline modified by process insertion typical of the genus *Polygonium* (Vavrdová, 1966) Moczydłowska & Stockfors, 2004. *Gyalorhethium*? sp. 1 resembles a specimen illustrated by Parsons & Anderson (2000, pl. 5, fig. 12) as *Baltisphaeridium crinitum* Martin *in* Dean & Martin, 1978, but has fewer, shorter processes which are open into the vesicle cavity. It also resembles the illustrated specimens of *Goniosphaeridium rasulii* Welsch, 1986 (Welsch, 1986, pl. 5, figs 9, 10), but possesses a positive sculpture. *Gyalorhethium*? sp. 1 closely resembles *Baltisphaeridium verutum* Vecoli, 1996 but has fewer processes and has process cavities apparently in communication with the vesicle cavity. The forms may be conspecific to ?*Goniosphaeridium* sp. illustrated by Paalits (1992a, pl. 6, fig. 2), but more material will be required for a valid comparison.

Genus *Impluviculus* Loeblich & Tappan, 1969 emend. Martin, 1977

Type species. *Impluviculus milonii* (Deunff, 1968) Loeblich & Tappan, 1969

Impluviculus sp. 1

(Pl. 2, figs 1–3)

1988 *Impluviculus* sp. A Martin & Dean: 39, pl. 15, figs 4–6, 10, 11.
2000 *Impluviculus* sp. cf. *I. milonii* (Deunff, 1968) Loeblich & Tappan, 1969; Parsons & Anderson: 51, pl. 8, figs 7, 9, 10.

Description. The vesicle is circular to rounded subangular in outline, is thin-walled and has a smooth to weakly shagreenate surface. Four to seven simple, hollow, tapering processes with a length approximately 40–60% of the vesicle diameter are inserted equatorially and in the same plane. The points of insertion are generally not equidistant. The process tips are slightly rounded, the proximal contacts angular and the process cavities appear to be in communication with that of the vesicle. No well defined excystment openings were observed.

Dimensions. 5 specimens. Vesicle diameter 12–20 µm; process length 8–12 µm.

Remarks. The small number of specimens recorded here could not be assigned with confidence to any formally described species of *Impluviculus*. They closely resemble specimens of *Impluviculus* sp. A illustrated in Martin & Dean (1988) and a specimen of *Impluviculus* cf. *I. milonii* in Parsons & Anderson (2000). There is little to distinguish several species of the genus and the Comley forms resemble *I. multiangularis* (Umnova *in* Umnova & Vanderflit, 1971) Volkova, 1990 but have a less angular outline, *I. villosiusculus* Volkova, 1990 but lack a finely granular surface ornament and *I. cleae* (Martin, 1973) Martin, 1977 but lack a prominent ornamented opening.

Previous records. *Impluviculus* sp. A in Martin & Dean (1988), Furongian, *Parabolina spinulosa* Zone to the *Peltura* Zones (verified by macrofossils), eastern Newfoundland. *Impluviculus* sp. cf. *I. milonii*, Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone to Tremadocian (verified by macrofossils), eastern Newfoundland (Parsons & Anderson, 2000).

Genus *Leiofusa* (Eisenack, 1938) Combaz, Lange & Pansart, 1967

Type species. *Leiofusa fusiformis* (Eisenack, 1934) Eisenack, 1938

Leiofusa stoumonensis Vanguestaine, 1973
(Pl. 5, fig. 9)

1973 *Leiofusa stoumonensis* Vanguestaine: 29; pl. I, figs 7, 11, 12.
1985 *Leiofusa* sp. Albani *et al*.: pl. I, figs 7, 8.

Dimensions. 28 specimens. Vesicle length 36.5 (60.5) 76 µm; vesicle breadth 15 (26.5) 31.5 µm; vesicle breadth: length 34 (45) 54%; process length 33 (58) 77 µm; process length: vesicle length 66 (97) 136%.

Previous records. Furongian, Stavelot, Belgium (Vanguestaine, 1973; Ribecai & Vanguestaine, 1993); Furongian, *Parabolina spinulosa* Zone to *Leptoplastus* Zone (verified by macrofossils), eastern Newfoundland (Martin & Dean, 1981, 1988); Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone (verified by macrofossils) eastern Newfoundland (Parsons & Anderson, 2000); Furongian, central Sardinia (Albani *et al*., 1985; Di Milia, 1991); Furongian, East European Platform (Volkova, 1990; Paalits, 1992a & b); Furongian, St Tudwal's Peninsula, northwestern Wales (Martin *in* Young *et al*., 1994).

Genus *Leiosphaeridia* Eisenack, 1958 emend. Downie & Sarjeant, 1963 emend. Turner, 1984

Type species. *Leiosphaeridia baltica* Eisenack, 1958

Leiosphaeridia spp.
(Pl. 5, fig. 8)

Dimensions. 43 specimens. Vesicle diameter 28 (56.5) 137 µm.

Remarks. Most of the specimens have extremely thin wrinkled walls. No attempt has been made herein to identify individual species of the genus *Leiosphaeridia*.

Genus *Ninadiacrodium* Raevskaya & Servais, 2009

Type species. *Ninadiacrodium dumontii* (Vanguestaine, 1973) Raevskaya & Servais, 2009.

Ninadiacrodium caudatum (Vanguestaine, 1973) Raevskaya & Servais, 2009
(Pl. 5, fig. 7)

1973 *Dasydiacrodium caudatum* Vanguestaine: 30, pl. 1, figs 9, 13.
2009 *Ninadiacrodium caudatum* (Vanguestaine, 1973) emend. nov.; Raevskaya & Servais: 226, pl. 1, figs 1–3; text-fig. 3.

Dimensions. 13 specimens. Vesicle length 23.5 (30) 35 µm; vesicle breadth 18.5 (23) 29 µm; apical process length 7 (11.5) 17.5 µm; antapical process length 10 (13) 18.5 µm; antapical process number 7 (9) 11.

Remarks. *Ninadiacrodium caudatum* is a distinctive and stratigraphically important taxon. To avoid any potential dilution of the specific concept a possibly closely related form encountered in the Comley samples is treated separately below as *N.* aff. *caudatum*.

Previous records. Furongian, Belgium and France (Vanguestaine, 1973; Ribecai & Vanguestaine, 1993); Furongian, *Parabolina spinulosa* Zone to Lower Tremadocian (verified by macrofossils), eastern Newfoundland (Martin & Dean, 1981, 1988); Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone (verified by macrofossils), eastern Newfoundland (Parsons & Anderson, 2000); Furongian, East European Platform (Volkova, 1990); Furongian, North Estonia (Paalits, 1992a); Furongian, southern Tunisia (Vecoli, 1999); Furongian, southwestern Sardinia (Ribecai *et al*., 2005); Furongian, Arctic Russia (Raevskaya & Servais, 2009).

Ninadiacrodium aff. *caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009
(Pl. 3, fig. 1)

Description. The vesicle outline is elongated subtriangular to elliptical with a single process at one (apical) pole of the long axis and four to eight processes of variable length clustered around the antapical pole. The wall of both vesicle and processes is thin and bears a finely granular ornament. The processes are mostly hollow with generally angular proximal contacts and taper distally to pointed tips. The process cavity is in communication with that of the vesicle. Some of the smallest processes may be solid. No excystment openings were observed.

Dimensions. 13 specimens. Vesicle length 28 (34.5) 41 µm; vesicle breadth 21 (25.5) 30.5 µm; apical process length 4.5 (10) 13 µm; antapical process length 3.5 (6) 9.5 µm; antapical process number 4 (6) 8.

Remarks. This form is distinguished from *Ninadiacrodium caudatum* by its more elliptical outline and generally fewer and shorter antapical processes which are often more variable in length. *N.* aff. *caudatum* differs from *Dasydiacrodium setuensis* Paalits, 1992b in possessing shorter, generally more numerous and more variable processes. A small number of specimens were encountered in the Comley assemblages that bear some resemblance to *N.* aff. *caudatum* but are not described here. Some may be compressed and distorted specimens of *Scalenadiacrodium comleyense* whilst others may be extreme variants of the *Ninadiacrodium*/*Scalenadiacrodium* morphologies formally identified.

Ninadiacrodium dumontii (Vanguestaine, 1973) Raevskaya & Servais, 2009

(Pl. 2, fig. 9; Pl. 7, figs 1–3)

1973 *Veryhachium dumontii* Vanguestaine: 28, pl. 1, figs 1, 2, 8.
1992b *Veryhachium incus* Paalits: 47, pl. 2, fig. 6.
2009 *Ninadiacrodium dumontii* (Vanguestaine, 1973) emend. nov.; Raevskaya & Servais: 228, pl. 1, figs 4, 5, 7–12; pl. 2, figs 1–11; text-fig. 3.

Dimensions. 16 specimens. Vesicle length 29 (35.5) 44 µm; vesicle breadth 23.5 (30) 41 µm; apical process length 7 (10.5) 14.5 µm; antapical process length 7 (11.5) 15 µm.

Remarks. Questions concerning the generic assignment of this species are reviewed by Servais *et al.* (2007) who concluded that the species should be regarded as a diacrodian acritarch. Raevskaya & Servais (2009) duly proposed the new genus *Ninadiacrodium* and recombined, with emendation, the species *V. dumontii* Vanguestaine, 1973 as type species. Raevskaya & Servais (2009) regard *Veryhachium incus* Paalits, 1992b as a junior synonym of *N. dumontii*, an opinion accepted herein.

Previous records. Furongian, Belgium and France (Vanguestaine, 1973; Ribecai & Vanguestaine, 1993); Furongian, *Parabolina spinulosa* Zone to *Acerocare* Zone, possibly Tremadocian (verified by macrofossils) eastern Newfoundland (Martin & Dean 1981, 1988); Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone to *Acerocare* Zone (verified by macrofossils), eastern Newfoundland (Parsons & Anderson, 2000); Furongian, East European Platform (Volkova, 1990; Paalits, 1992b); Furongian, North and northwestern Estonia (Paalits, 1992a; Mens *et al*., 1997); Tremadocian (considered reworked), central Sardinia (Di Milia & Tongiorgi, 1993); Furongian, Algerian Sahara (Vecoli, 1996); Furongian, Arctic Russia (Raevskaya & Golubkova, 2006; Raevskaya & Servais, 2009); Furongian, northern Spain (Albani *et al*., 2006); Furongian, southern Iran (Ghavidel-syooki & Vecoli, 2008).

Genus *Polygonium* (Vavrdová, 1966) Moczydłowska & Stockfors, 2004

Type species. *Polygonium gracile* Vavrdová, 1966 emend. Jacobson & Achab, 1985.

Polygonium spp.

(Pl. 1, figs 5, 6; Pl. 7, fig. 4)

Description. The vesicle outline is polygonal being strongly modified by the broad-based processes. The thin wall of both vesicle and processes bears a granulate sculpture variably expressed. The processes are simple, hollow and open into the vesicle cavity, tapering distally to closed pointed tips. No regular openings were observed.

Dimensions. 11 specimens. Vesicle size 22 (26.5) 33 µm; process length 10.5 (17) 24.5 µm; process breadth 1.5–3.5 µm; process length: vesicle size 37 (65) 100%; process number 10 (12) 16.

Remarks. Specimens assigned to *Polygonium* spp. lack the prominent echinate ornament of *Stellechinatum uncinatum* (Downie, 1958) Molyneux, 1987. Specimens included here in *Polygonium* spp. range from those with a subquadrangular outline but with processes seemingly randomly disposed over the vesicle surface, to those with an essentially subcircular outline strongly modified by the processes. It is possible that some specimens of *Actinotodissus achrasii* and *D. obsonum* in polar compression might resemble *Polygonium* spp. Specimens figured as *Stellechinatum* or *Polygonium* sp. and *Polygonium* sp. in Parsons & Anderson (2000, pl. 3, figs 5, 6) appear to closely resemble the Comley specimens. Similarly, a specimen figured as *Stellichinatum uncinatum* (Downie, 1958) Martin *in* Martin & Dean (1988, pl. 17, figs 14, 15) has a subdued ornament and may resemble the Comley forms.

Genus *Scalenadiacrodium* gen. nov.

Type species. *Scalenadiacrodium comleyense* sp. nov.

Derivation of name. Latin, *scalenus* = unequal, reflecting the variation in length of the processes on the antapical polar area of this diacromorph genus.

Diagnosis. The vesicle outline is elongate-triangular (isosceloid) with rounded apices. The wall of both vesicle and processes is single-layered, shagreenate or with a finely granular ornament. The process distribution is ‘heteropolar’. The antapical pole bears a single, simple, hollow process tapering to a closed, pointed tip. The process cavity freely communicates with the vesicle cavity. A morphologically similar process, of approximately equal or longer length, is located at one of the apices of the antapical pole, arising at an angle to the polar axis. There may be no additional processes or one or a small number of ‘secondary’ processes, often concentrated in the neighbourhood of the antapical polar angle not bearing the ‘primary’ process, and often not in the same plane as the two primary processes. The ‘secondary’ processes are considerably smaller than the ‘primary’ processes, have a similar morphology to the ‘primaries’ but may be solid. No excystment opening has been observed.

Comparison. *Scalenadiacrodium* gen. nov. is distinguished from *Ninadiacrodium* Raevskaya & Servais, 2009 by possessing only two as opposed to three or more ‘primary’ processes, the third angle of the elongate triangular vesicle is either without processes or with one or a small number of ‘secondary’ processes of considerably smaller size. In most other respects *Scalenadiacrodium* resembles *Ninadiacrodium* with which it may have a close phylogenetic relationship. *Sylvanidium* Loeblich, 1970 resembles *Scalenadiacrodium* but has a generally ‘bean-shaped’ vesicle, ‘secondary’ processes arising uniformly at right angles to the two ‘primaries’ and a smooth wall (Loeblich, 1970, p. 736).

Scalenadiacrodium is distinguished from *Leiofusa* (Eisenack, 1938) Combaz, Lange & Pansart, 1967 by its elongate triangular outline and from *Veryhachium* (Deunff, 1954) Turner, 1984 by its possession of only two 'primary' processes.

Remarks. The systematic position of *Ninadiacrodium* is discussed in detail by Raevskaya & Servais (2009) and their arguments generally apply to *Scalenadiacrodium*. The possession of two rather than three 'primary' processes is here considered sufficient for the generic separation, reflecting some morphographical similarities with leiofusid acritarchs. Emending *Ninadiacrodium* to encompass the elongate triangular forms with two 'primary' processes would represent a major dilution of the original concept.

Scalenadiacrodium comleyense sp. nov.

(Pl. 2, figs 4–8)

?1988 *Dasydiacrodium caudatum* Vanguestaine, 1973; Martin & Dean: pl. 16, figs 5, 8.
1988 *Veryhachium dumontii* Vanguestaine, 1973; Martin & Dean: pl. 16, figs 3, 13, 14 (*non* pl. 16, figs 2, 7, 10–12, 15–18).
1995 ?*Leiofusa* sp. Paalits: 89; pl. II, figs 4, 6.

Derivation of name. After the type area, the Comley area, Shropshire, England.

Diagnosis. The compressed vesicle has a rounded, elongate-triangular outline. The wall of the vesicle and processes is thin, single-layered, with a shagreenate to granulate surface. In some instances there is a suggestion of alignment of the granular ornament parallel to the polar axis of the vesicle. Two primary processes of equal or unequal length are always present, one, generally shorter, located at the apex of the vesicle, the other at one of the antapical angles. The primary processes are hollow, have subangular proximal contacts, are open into the vesicle cavity and taper to closed, pointed tips. The antapical process is not aligned with the apical process, but at an angle to and away from the vesicle long axis. One to four secondary processes, considerably smaller than the primary processes, may or may not be present and, whilst generally clustered in the neighbourhood of the third antapical angle of the vesicle, they are often not in the same plane as the primary processes. No definitive excystment openings have been observed.

Holotype. Slide L3c-2 (5 μm), England Finder (EF) reference: K34/3 (Pl. 2, fig. 8).

Paratype. Slide L3c-1 (10 μm), EF ref.: Y25/1 (Pl. 2, fig. 4).

Locality and horizon. Shoot Rough Road Shales, Locality L3, SO 49 NE 4825 9534, Comley, Shropshire, UK.

Dimensions. 28 specimens. Vesicle length 28 (38.5) 47 μm; vesicle breadth 21 (27.5) 37.5 μm; 'primary' process length (near broader, antapical, pole of vesicle) 7 (14.5) 23.5 μm; 'primary' process length (narrower, apical, pole of vesicle) 6 (12) 17.5 μm; 'secondary' process length (longest of any secondaries present) 2.5 (4) 7 μm.

Stratigraphic range. Furongian Series, most probably *Parabolina spinulosa* trilobite Zone.

Comparison. *Scalenadiacrodium comleyense* is distinguished from *Ninadiacrodium dumontii* (Vanguestaine, 1973) Raevskaya & Servais, 2009 by its possession of two rather than three primary processes. *S. comleyense* resembles *Ninadiacrodium caudatum* (Vanguestaine, 1973) Raevskaya & Servais, 2009 but has a different arrangement of antapical processes which are of non-uniform size. Species attributed to the genus *Nellia* Golub & Volkova in Volkova & Golub, 1985 have a more symmetrical subtriangular outline and recurved processes (Volkova & Golub, 1985). *S. comleyense* is distinguished from *Sylvanidium paucibrachium* Loeblich, 1970 by its considerably smaller size, thin wall, surface sculpture and less fusiform vesicle outline, and from *Sylvanidium*? *hawbanense* Miller & Al-Ruwaili, 2007 by the less uniform size and distribution of its processes (Miller & Al-Ruwaili, 2007). *S. comleyense* closely resembles several of the specimens figured as *Veryhachium dumontii* Vanguestaine, 1973 by Martin (*in* Martin & Dean, 1988). Specimens of *S. comleyense* which lack secondary processes and with a poorly expressed subtriangular outline resemble *Leiofusa* cf. *L. gravida* Pittau, 1985 of Martin *in* Young *et al*. (1994) and *Leiofusa somniculata* Pittau, 1985 (Pittau, 1985, pp. 190–192). However, all specimens attributable to *S. comleyense* have an asymmetrical vesicle outline tending towards subtriangularity, processes in an angular relationship and frequently more than two processes.

Remarks. This species was informally described by one of the authors in his unpublished PhD thesis (Potter, University of Sheffield, 1974) under the name *Leiofusa scalenabullata*, although the possible presence of secondary processes was not included. It was subsequently compared with ?*Leiofusa* sp. in the Furongian Ulgase Formation of Estonia by Paalits (1995). He also reports that a similar species was found by M. G. Parsons in sequences assigned to the lower and middle parts of the *spinulosa* Zone in Newfoundland (Paalits, 1995, p. 89). Care must be exercised in distinguishing *S. comleyense* from damaged specimens of *N. dumontii* from which the second 'primary' antapical process has been lost.

Previous records. *Veryhachium dumontii* Vanguestaine, 1973 in Martin & Dean, 1988, pl. 16, figs 3, 13, 14, Furongian, *Parabolina spinulosa* Zone (verified by macrofossils), eastern Newfoundland, Canada (Martin & Dean, 1988); ?*Leiofusa* sp. in Paalits, 1995, p. 89; pl. II, figs 4, 6, Furongian, North Estonia (Paalits, 1995).

Genus *Stelliferidium* Deunff *et al.*, 1974

Type species. *Stelliferidium striatulum* (Vavrdová, 1966) Deunff *et al.*, 1974

Stelliferidium cortinulamorphum Paalits, 1995

(Pl. 4, figs 4–6; Pl. 7, fig. 7)

1990 *Stelliferidium* aff. *S. cortinulum* (Deunff, 1961) emend. Deunff *et al.*, 1974; Volkova: 82, pl. II, figs 16, 17, 19.

?1991 *Stelliferidium* sp. cf. *S. cortinulum* (Deunff, 1961) Deunff *et al.*, 1974; Di Milia: pl. 2, fig. 12.
1992b *Stelliferidium* sp. Paalits: pl. 1, fig. 7.
1995 *Stelliferidium cortinulamorphum* Paalits: 93, pl. III, figs 2, 3, 5.

Description. The vesicle outline is circular in polar view, with a flattened apical area in lateral view in specimens with the operculum detached. The vesicle wall is about 1 μm thick with a shagreenate surface and there is a suggestion in some specimens of faint striae radiating from the process bases. The processes, numbering about 25 to 30, have brief conical bases, more or less cylindrical shafts with short, very briefly bifurcate or trifurcate terminations, the pinnae having rounded tips. The processes are apparently solid or thick-walled with a narrow cavity apparently not in communication with the vesicle cavity and are mostly concentrated on the antapical hemisphere where they appear to be distributed without regular arrangement. Membranous fragments are sometimes attached to the processes, being the remnants of lists or possibly an enclosing sheath. A few short processes are usually present on the apical hemisphere, in several rows perpendicular to the aperture margin, reflecting a tabulation. Processes or corroded vestiges thereof may occur around the aperture and the apertural margin of open specimens may be notched, further suggesting tabulation. A low collarette with a subpolygonal outline may be present, most marked in specimens with the operculum in place.

Dimensions. 19 specimens. Vesicle diameter (equatorial) 29 (34) 39 μm; process length (antapical) 8 (9) 10.5 μm; process breadth 1.5–2 μm; process length: vesicle diameter 23 (27) 31%; length of process terminal structure: total process length 17 (22) 31%; diameter of operculum 18 (21) 25 μm.

Remarks. The specimens encountered in the Comley assemblages match the original diagnosis with the exceptions that the processes are longer (average length 9 μm as opposed to 6.5 μm), the opercular diameter is less variable and the vesicle surface is shagreenate rather than rugulate. This last difference may be at least in part due to conditions of preservation. In some specimens, the presence of processes on the apical hemisphere could not be firmly established. Such specimens are included here in *S. cortinulamorphum* on the basis that this is probably a result of poor preservation. Paalits (1995) pointed out that *S. cortinulamorphum* displays features of both the genera *Cymatiogalea* (Deunff, 1961) Deunff *et al.*, 1974 and *Stelliferidium*, suggesting that it may be an intermediate form. Servais & Eiserhardt (1995) and Stricanne & Servais (2002) discuss the complex, unstable taxonomy of the galeate acritarchs. This instability may have resulted in a confused taxonomy and it is possible that specimens in the Furongian assigned to such taxa as *Cymatiogalea bellicosa* Deunff, 1961, *Cymatiogalea cylindrata* Rasul, 1974 and *Stelliferidium cortinulum* (Deunff, 1961) Deunff *et al.*, 1974 may be conspecific with *Stelliferidium cortinulamorphum*.

Previous records. Furongian, Pskov Region, Russia (Paalits, 1992b); Furongian, North Estonia (Paalits, 1995); *S.* aff. *cortinulum*, Furongian to Tremadocian, East European Platform (Volkova, 1990).

Stelliferidium distinctum (Rasul, 1974) Pittau, 1985

1974 *Priscogalea distincta* Rasul: 50; pl. 4, fig. 1; pl. 7, fig. 3.
1985 *Stelliferidium distinctum* (Rasul, 1974); Pittau: 194 (*non* pl. 8, fig. 7).

Stelliferidium cf. *distinctum* (Rasul, 1974) Pittau, 1985
(Pl. 4, figs 7, 8)

?2000 *Stelliferidium* sp. B Parsons & Anderson: 67, pl. 12, figs 10–12.

Description. The vesicle outline is circular in polar view, with a flattened apical area in lateral view when the operculum is missing. The wall varies in thickness between specimens and has a smooth to shagreenate surface. The processes are well separated, of more or less uniform size and are evenly distributed on the vesicle surface including the apertural margin but excluding the operculum. A low collar surrounding the macropyle is visible in some specimens. Opercula, when observed in place, have a diameter of about 14 μm to 19 μm. In one case an operculum was observed fallen inside a vesicle, having a more or less circular outline and a diameter of 21 μm. It is probable that the rim of the operculum is folded together with the apertural margin of the vesicle, resulting in a prominent collar and in an apparently reduced opercular diameter. The processes, in the order of 40 to 60, have conical bases with cylindrical to slightly tapering shafts, are mainly simple or with a single brief bifurcation or trifurcation and have terminations being divided into a number of brief, rounded pinnae. The processes appear generally solid but may, in some cases, be thick-walled with a narrow cavity. In the latter case it is not clear whether the process and vesicle cavities are in communication. In some cases, variably developed striae radiate from the bases of the processes; their absence in others may be due to poor preservation.

Dimensions. 19 specimens. Vesicle size (equatorial) 29 (34.5) 42 μm; process length 3.5 (4.5) 6.5 μm; process breadth 0.5 (1) 1.5 μm; process separation 2.5 (3) 4.5 μm; process length: vesicle size (equatorial) 10 (13) 18%; wall thickness 0.5 (1) 2.5 μm.

Remarks. The specimens were insufficiently well preserved for precise determination but closely resemble *Stelliferidium distinctum*. The process style matches that shown by Rasul (1974, pl. 7, fig. 3) but may be less complex than that described by Rasul and illustrated on the holotype. The processes may, in some cases, possess a narrow cavity, a feature not mentioned by Rasul. *Stelliferidium* sp. B in Parsons & Anderson (2000) closely resembles the Comley form, the clearly hollow nature of the processes and presence of a fragmentary list on some specimens of *Stelliferidium* sp. B may merely be a symptom of superior preservation. The Comley specimens also resemble *Priscogalea chevronensis* Vanguestaine, 1974 but may have more numerous processes with less complex process terminations, and a vesicle wall which is shagreenate rather than possessing an ornament of granules. They also resemble *Stelliferidium simplex* (Deunff, 1961) Deunff *et al.*, 1974 but may possess thicker-walled processes with more complex process terminations. The Comley specimens differ from *Stelliferidium pingiculum* Martin *in* Martin & Dean, 1988 in lacking striate, spinose processes and from *Stelliferidium* sp. A of Parsons & Anderson (2000) in possessing considerably fewer processes.

Previous records. *Stelliferidium distinctum*, Tremadocian, Shropshire, England (Rasul, 1974).

Genus *Timofeevia* Vanguestaine, 1978

Type species. *Timofeevia lancarae* (Cramer & Diez de Cramer, 1972) Vanguestaine, 1978

Timofeevia estonica Volkova, 1990

1990 *Timofeevia estonica* Volkova: 84, pl. IX, figs 4, 5.

Timofeevia aff. *estonica* Volkova, 1990

(Pl. 3, figs 7, 8; Pl. 7, figs 8, 9)

Description. The vesicle outline is circular to subcircular, its surface divided by low ridges into numerous polygonal fields, about 40–60, or possibly more. The ridges probably comprise folds of the vesicle wall along lines of weakness. The folds, and the polygonal fields they help define, are not always uniformly expressed and may in some specimens be absent. The vesicle wall is thin and has a smooth to shagreenate surface. Processes are located at the angles of the polygonal fields and occasionally intergonal processes may be present. The processes are short with angular proximal contacts and taper slightly to blunt or briefly furcate tips. Whether the processes are solid or hollow is unclear. A large opening may be present resulting from the loss of several polygonal plates.

Dimensions. 20 specimens. Vesicle diameter 25.5 (31) 37.5 μm; polygonal field size 4.5 (6) 7.5 μm; process length 2.5 (3) 3.5 μm; process length: vesicle diameter 7 (10) 13%.

Remarks. *Timofeevia* aff. *estonica* differs from *T. estonica* Volkova, 1990 in lacking the consistent presence of intergonal processes and in possessing less complex process terminations. The latter feature may, to some extent, be a preservational artefact. *Timofeevia* aff. *estonica* has shorter processes with less complex distal terminations than those of *Timofeevia manata* Albani *et al.*, 1991.

Previous records. *Timofeevia estonica*, Furongian, Estonia (Volkova, 1990); Furongian, North Estonia (Paalits, 1992a); Furongian, Belgium and France (Ribecai & Vanguestaine, 1993); Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone (verified by macrofossils), eastern Newfoundland (Parsons & Anderson, 2000).

Timofeevia phosphoritica Vanguestaine, 1978

(Pl. 3, figs 2, 3; Pl. 7, fig. 5)

1959 *Archaeohystrichosphaeridium ianischewskyi* Timofeev: 33, pl. 3, fig. 2 (nomen nudum).
1959 *Archaeohystrichosphaeridium minor* Timofeev: 33, pl. 3, fig. 3 (nomen nudum).
1976 *Cymatiogalea ianischewski* (Timofeev, 1959); Vavrdová: 60.
1976 *Cymatiogalea minor* (Timofeev, 1959); Vavrdová: 60.
1978 *Timofeevia phosphoritica* Vanguestaine: 272, pl. III, figs 1-8, 10-12; text-fig. 11.

Dimensions. 19 specimens. Vesicle diameter 27 (32.5) 37 μm; process length 7 (9) 13 μm; process length: vesicle diameter 19 (28) 37%; field size 7 (10) 13 μm; field size: vesicle diameter 22 (30) 36%; process ramification length: total process length 33 (40) 53%.

Remarks. The specimens encountered here conform to the diagnosis except that the processes are generally longer. The process terminations are less complex than those of *Timofeevia lancarae* (Cramer & Diez de Cramer, 1972) Vanguestaine, 1978 and the overall process length shorter but the distinction between end-members of the two species appears arbitrary.

Previous records. *T. phosphoritica* is widely reported in assemblages of Cambrian Series 3 to Tremadocian age, see Vecoli (1996), who also notes that the Tremadocian records have been interpreted as reworked.

Genus *Trunculumarium* Loeblich & Tappan, 1976

Type species. *Trunculumarium revinium* (Vanguestaine, 1973) Loeblich & Tappan, 1976

Trunculumarium revinium (Vanguestaine, 1973) Loeblich & Tappan, 1976

(Pl. 4, fig. 9; Pl. 5, figs 1–3; Pl. 7, fig. 10)

1973 *Ooidium revinium* Vanguestaine: 30, pl. 1, figs 3, 4, 5, 6, 10, 14.
1976 *Trunculumarium revinium* (Vanguestaine, 1973); Loeblich & Tappan: 305.

Dimensions. 33 specimens. Vesicle length 27 (36) 44.5 μm; vesicle breadth 22 (28.5) 36.5 μm; vesicle breadth: length 70 (79) 89%; process length 7 (11.5) 16.5 μm; process length: vesicle length 22 (32) 44%.

Remarks. *T. revinium* has a distinctive morphology and occurs in quantity over a limited stratigraphical range.

Previous records. Furongian, Belgium and France (Vanguestaine, 1973, 1974; Ribecai & Vanguestaine, 1993); Furongian, *Parabolina spinulosa* Zone (base and acme) to *Peltura* Zones (verified by macrofossils), eastern Newfoundland (Martin & Dean, 1981, 1988); Furongian, *Parabolina spinulosa* Zone, *P. spinulosa* Subzone (base and acme) to *Acerocare* Zone (verified by macrofossils) eastern Newfoundland (Parsons & Anderson, 2000); Furongian, north Norway (Welsch, 1986); Furongian, East European Platform (Volkova, 1990); Furongian, North Estonia (Paalits, 1992a); Furongian, Poland (Szczepanik, 2001); Furongian, southern Iran (Ghavidel-syooki & Vecoli, 2008).

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

Type species. *Vulcanisphaera africana* Deunff, 1961.

Vulcanisphaera africana Deunff, 1961

(Pl. 6, figs 1, 3)

1958 *Hystrichosphaeridium* Downie: 340, pl. 16, fig. 10.
1961 *Vulcanisphaera africana* Deunff: 42, pl. 2, fig. 1, 2.
1976 *Vulcanisphaera cirrita* Rasul: 480, pl. 1, fig. 3; text-figs 1, 2.

Dimensions. 12 specimens. Vesicle diameter 43.5 (51) 62 µm; process length 15 (20.5) 24.5 µm; process length: vesicle diameter 28 (40) 54%.

Remarks. Three species of the genus *Vulcanisphaera* appear to differ mainly in quantitative rather than qualitative terms. *V. africana* differs from *V. cirrita* Rasul, 1976 only by possessing generally shorter processes with possibly less extensive distal ramifications, and from *V. turbata* Martin *in* Martin & Dean, 1981 in having usually longer processes, lacking a prominently granular vesicle wall and possibly possessing more complex process distal terminations. Both *V. africana* and *V. turbata* display a vesicle wall divided into polygonal fields (Martin *in* Martin & Dean, 1988, p. 43) and it is probable that weakly expressed polygonal fields are present in *V. cirrita*. The granular ornament may not be a consistently expressed feature of *V. turbata* and transitional forms between *V. turbata* and *V. africana* are recorded (Martin & Dean, 1988). The specimens recorded here as *V. africana* match the diagnosis of both *V. africana* and *V. cirrita*. They mainly bear the complex filamentous process terminations of the latter, and display a vesicle wall divided into polygonal fields, a feature most clearly observed in fragmented examples. Martin (*in* Martin & Dean, 1981) and Vecoli (1996) regard *V. cirrita* as a junior synonym of *V. africana*. The distinction between *V. africana* and *V. turbata* is maintained here partly on utilitarian grounds. The forms with relatively short processes and often with a granular vesicle surface ornament make their first appearance earlier in the Cambrian than *V. africana* (Martin & Dean, 1981). Most of the relatively subtle distinctions between *V. turbata* and *V. africana* summarized by Martin (*in* Martin & Dean, 1988, p. 43) cannot be recognized in the Comley material due to condition of preservation. Specimens of *Vulcanisphaera* with a granulate wall sculpture and those with relatively short processes are here assigned to *V. turbata*.

Previous records. *V. africana* is widely distributed in the Furongian and Tremadocian, references to Cambrian records are listed here. Furongian, *Parabolina spinulosa* Zone to Tremadocian (verified by macrofossils), eastern Newfoundland, Canada (Martin & Dean, 1981, 1988); Furongian, *Protopeltura praecursor* Zone to Tremadocian (verified by macrofossils), eastern Newfoundland, Canada (Parsons & Anderson, 2000); Furongian to Tremadocian, north Norway (Welsch, 1986); Furongian, *Peltura scarabaeoides* Zone (verified by macrofossils), Sweden (Di Milia *et al.*, 1989; Tongiorgi & Ribecai, 1990); Furongian, Belgium and northern France (Ribecai & Vanguestaine, 1993); Furongian to Tremadocian, Algerian Sahara (Vecoli, 1996); Furongian, Poland (Szczepanik, 1997; Żylińska *et al*. 2006); Furongian to Tremadocian, northwest Argentina (Rubenstein *et al*., 2003; Aráoz & Vergel, 2006); Furongian, southwestern Sardinia (Ribecai *et al*., 2005); Furongian–Tremadocian, southern Iran (Ghavidel-syooki & Vecoli, 2008).

Vulcanisphaera turbata Martin *in* Martin & Dean, 1981
(Pl. 6, figs 2, 4)

1981 *Vulcanisphaera turbata* Martin *in* Martin & Dean: 23, pl. 1, figs 2–4; text-fig. 6.
1990 *Raphesphaera turbata* (Martin, 1981); Volkova: 80, pl. VI, figs 1–4, 6-8.

Dimensions. 7 specimens. Vesicle diameter 40 (48) 54 µm; process length 11.5 (15.5) 21 µm; process length: vesicle diameter 26 (32) 40%.

Remarks. For remarks, see under *V. africana*, above.

Previous records. ?Series 3 to Furongian, ?*Lejopyge laevigata* Zone to *Leptoplastus* Zone (verified by macrofossils), eastern Newfoundland (Martin & Dean, 1981, 1988), range extended to the *Peltura minor* Zone by Parsons & Anderson (2000, not illustrated); Furongian, Sardinia (Albani *et al.*, 1985; Di Milia, 1991); Series 3 to Furongian, north Norway (Welsch, 1986); ?Series 3/Furongian, USA (Wood & Stephenson, 1989); *Raphesphaera turbata,* Series 3 to Tremadocian, East European Platform (Volkova, 1990); Furongian, Libya and southern Tunisia (Albani *et al*., 1991; Tawadros *et al*., 2001); Furongian, western Russia (Paalits, 1992b); Furongian, North Estonia (Paalits, 1992a); Series 3 to Furongian, Belgium and France (Ribecai & Vanguestaine, 1993); Series 3 to Furongian, northwestern Wales (Martin *in* Young *et al*., 1994); Furongian, northern Spain (Albani *et al*., 2006); Furongian, probably *Olenus*/*Homagnostus obesus* Zone, *Olenus scanicus* Subzone/*Parabolina spinulosa* Zone, *P. brevispina* Subzone (in association with macrofossils), Poland (Żylińska *et al*., 2006); Guzhangian to Furongian, Iran (Ghavidel-syooki, 2006; Ghavidel-syooki & Vecoli, 2008); ?Series 3/Furongian, southeastern Ireland (Vanguestaine & Brück, 2008).

COMLEY ACRITARCH ASSEMBLAGES

The Comley assemblages are numerically rich and taxonomically diverse. The species composition and approximate relative proportion of each taxon are given in Table 1. The samples yielded generally well-preserved assemblages. Sample L1 is particularly rich in amorphous organic matter.

Cymatiogalea virgulta, *Timofeevia phosphoritica* and *Timofeevia* aff. *estonica* are numerically important taxa in all three assemblages. *Actinotodissus achrasii* and *Trunculumarium revinium* are also numerically important in L1, *Cristallinium cambriense* in L2 and L3, and *Stelliferidium cortinulamorphum* in L1 and L3. Sample L1 yielded the most taxonomically diverse assemblage, distinguished from the others importantly by the presence of *T. revinium*. The L3 assemblage, in addition to the absence of *T. revinium*, lacks *A. achrasii* and *Impluviculus* sp. 1 found in the other assemblages. The stratigraphically important taxa *Cristallinium randomense*, *Ninadiacrodium caudatum* (questionable in L2), *Leiofusa stoumonensis* and *Ninadiacrodium dumontii* are present in all three assemblages. *Scalenadiacrodium comleyense* is a significant component of the L2 and L3 assemblages. *Leiofusa stoumonensis*, *Ninadiacrodium dumontii* and *Vulcanisphaera africana* are numerically more important components of the L2 assemblage, whilst *Stelliferidium cortinulamorphum* has its greatest numerical expression in assemblage L3.

COMPARISON WITH OTHER AREAS

The Comley area assemblages are compared here with those of known age elsewhere, as well as those less well age-controlled, but that can be related to published acritarch zonations. Eastern Newfoundland provides the most intensively studied and comprehensively trilobite dated area for correlation (Martin & Dean,

	Acritarch species counts			Relative abundance (%)		
	L3	L2	L1	L3	L2	L1
Cristallinium cambriense	22	55	P	3.7	11.6	P
Cristallinium randomense	3	2	P	0.5	0.4	P
Cymatiogalea aff. *aspergillum*	6	1	2	1.0	0.2	0.6
Cymatiogalea virgulta	292	170	165	48.7	35.7	48.0
Dasydiacrodium obsonum	1	P	1	0.2	P	0.3
Leiofusa stoumonensis	2	22	8	0.3	4.6	2.3
Leiosphaeridia spp.	6	26	6	1.0	5.5	1.7
Ninadiacrodium caudatum	P	P?	P	P	P?	P
Ninadiacrodium aff. *caudatum*	1	P	1	0.2	P	0.3
Ninadiacrodium dumontii	P	18	P	P	3.8	P
Polygonium spp.	P	1	1	P	0.2	0.3
Scalenadiacrodium comleyense	7	4	P?	1.2	0.8	P?
Stelliferidium cf. *distinctum*	P	P	P	P	P	P
Stelliferidium cortinulamorphum	35	5	19	5.8	1.1	5.5
Timofeevia aff. *estonica*	84	52	24	14.0	10.9	7.0
Timofeevia phosphoritica	129	100	51	21.5	21.0	14.8
Vulcanisphaera africana	6	14	6	1.0	2.9	1.7
Vulcanisphaera turbata	6	5	P	1.0	1.1	P
Actinotodissus achrasii		P?	25		P?	7.3
Impluviculus sp. 1		1	P		0.2	P
Gyalorhethium? sp. 1			1			0.3
Trunculumarium revinium			34			9.9
Total	600	476	344			

Table 1. Acritarch occurrence and relative abundances in the three assemblages from the Comley area.
p, present out of count; ?, questionable identification

1981, 1988; Parsons & Anderson, 2000). Trilobite-controlled dating of acritarch assemblages is also available from the Nuneaton area of England (Potter reported in Bridge *et al*., 1998, and unpublished data). Both these areas share with Comley a palaeogeographical location on the Avalonian microcontinent on the northern fringes of Gondwana (Fig. 4). Similar but less well age-controlled assemblages are reported from the Ardennes area (mainly Belgium) and the East European Platform (primarily Estonia).

The Comley assemblages are closely comparable to those reported by Martin (*in* Martin & Dean, 1981, 1988) from the Manuels River and Random Island areas of eastern Newfoundland. Although Parsons & Anderson (2000) examined only one additional sample from the interval comparable with Comley, new trilobite data are reported and some of Martin & Dean's (1981, 1988) samples are repositioned in relation to the trilobite stratigraphy. They also provide a thorough critique of Martin & Dean's (1981, 1988) acritarch zonation and provide a zonation of their own. The implications for the age control of the Comley assemblages of the differing interpretations of the trilobite control in eastern Newfoundland suggested by Martin & Dean and by Parsons & Anderson are considered here. The relationship of the two microfloral schemes to the trilobite zones, including Parsons & Anderson's interpretation of the Martin & Dean scheme, is shown in Figure 5.

Assemblage L1 is directly comparable to microflora RA4 of Parsons & Anderson (2000) and the lower part of microflora A4 of Martin *in* Martin & Dean (1988), principally defined by the presence in quantity of *Trunculumarium revinium*. In addition to common *T. revinium*, the presence of *Actinotodissus achrasii* (present in A4 assemblages), *Ninadiacrodium caudatum*, *Leiofusa stoumonensis* and *Ninadiacrodium dumontii*, in particular, further support an RA4 equivalence. Whilst these taxa are not restricted to the RA4 assemblage, their presence in the absence of *Actinotodissus* cf. *A. ubui* (Martin, 1969) Martin *in* Martin & Dean, 1988, *Orthosphaeridium*? *extensum* Parsons & Anderson, 2000 and *Ladogella rommelaerei* (Martin *in* Martin & Dean, 1981) Di Milia *et al*., 1989, first appearing in the succeeding RA5 microflora, strongly supports an RA4 assignment. Parsons & Anderson (2000) equate the RA4 microflora with part of the A4 microflora of Martin & Dean (1981, 1988), but exclude three of the assemblages (those without *T. revinium* in quantity), reassigning them to their younger RA5 unit.

Assemblages L2 and L3 comprise, amongst other taxa, *Cristallinium randomense*, *Ninadiacrodium dumontii*, and a form similar to *Cymatiogalea aspergillum* which, by their first appearance, define the base of Martin & Dean's (1981, 1988) A3 microflora. *Vulcanisphaera africana* and *Impluviculus* sp. A (*Impluviculus* sp. 1 of the Comley assemblages) also make their first appearances in the A3 microflora. *Cymatiogalea virgutta*, abundant in the Comley assemblages, is present. The additional presence, although very infrequent, in the L2 and L3 assemblages of *N. caudatum* (questionable in L2) and *D. obsonum* further restricts correlation to a microflora no older than A3b of Martin & Dean (1988), which has a base defined by the first appearance of such diacrodian taxa. The presence of *Ninadiacrodium* aff. *caudatum* and *Scalenadiacrodium comleyense* sp. nov., both diacrodian taxa, and *Polygonium* spp., some of which appear to fall within the variability of *Stellechinatum uncinatum* (Downie, 1958) Molyneux, 1987 as reported from eastern Newfoundland and with a base in A3b, further supports an A3b (or younger) assignment.

The succeeding A4 microflora is distinguished from A3b almost entirely on the presence of *Trunculumarium revinium*. However, most taxa present in the A3b microflora range through A4 into A5 so that there are few criteria for distinguishing an A3b from a (lower part) A5 microflora. The Comley assemblages L2 and L3 are from isolated exposures in a structurally complex setting and their stratigraphical relationship to the A4 equivalent (L1) is not known. Furthermore, the nature of the microflora immediately succeeding that of A4 in eastern Newfoundland is unknown. Both Martin & Dean (1981) and Parsons & Anderson (2000) recognized a fault separating the shales assignable to the *Parabolina spinulosa* Zone from younger strata. The microflora (lower part A4 with common *Trunculumarium revinium*) below the fault occurs together with *Parabolina spinulosa* (Martin & Dean, 1981), the index fossil for the upper subzone of the *P. spinulosa* Zone. The Parsons & Anderson (2000) interpretation requires the faulting out of the *Leptoplastus* Zone, resulting in the succeeding *Protopeltura praecursor* Zone directly overlying the *P. spinulosa* Zone. If a sequence assignable to the *Leptoplastus* trilobite Zone succeeds the *P. spinulosa* Zone, as suggested by Martin & Dean (1981, 1988), the faulting may have only minor consequence and the nature of an immediately post-*P. spinulosa* Zone microflora can be characterized to a limited extent. The first appearance of *Actinotodissus* cf. *A. ubui* in the *Leptoplastus* Zone would assist in distinguishing the *P. spinulosa* Zone from younger assemblages and support an A3b assignment for the L1 and L2 acritarch microflora. *Leiofusa stoumonensis*, common in the L2 and present in the L3 microflora, is only present (rare) in one *Leptoplastus* Zone assemblage (Martin & Dean, 1988) and was not recorded in the post-RA4 samples analysed by Parsons & Anderson (2000). The two RA5 index taxa *Orthosphaeridium? extensum* and *Ladogella rommelaerei* are absent from the Comley assemblages. *Timofeevia estonica* Volkova, 1990 does not range above RA4, according to Parsons & Anderson (2000), thus the presence of (common) *Timofeevia* aff. *estonica* in L2 and L3 may also point towards an A3b rather than an RA5 assignment. The absence of *T. revinium* from L2 and L3 may be of little significance because, although missing from A3b assemblages, it is only extremely rare in those of RA5. Some discrepancies are noted. *Cymatiogalea virgulta* is abundant in the L2 and L3 assemblages but in eastern Newfoundland it is not present in quantity prior to the *Leptoplastus* Zone (Martin & Dean 1988) or *Peltura minor* Zone (Parsons & Anderson 2000). *Timofeevia phosphoritica*, abundant in all three Comley assemblages, is relatively rare in the A3, A4 and RA4 microfloras of eastern Newfoundland.

Martin & Dean (1988) assigned microflora A3b and the upper part of A3a to the *Parabolina spinulosa* Zone. A microfloral assemblage (GSC 87793) referred to ?A4 in Martin & Dean (1981), apparently reassigned to A3b in Martin & Dean (1988, figure 9; p. 33) was found in association with *P. spinulosa*, indicative of the upper subzone of the *P. spinulosa* Zone. The remaining A3b and the upper part A3a assemblages were assigned to the *P. spinulosa* Zone on the basis of their association with *Orusia lenticularis* (Wahlenberg, 1821), a brachiopod generally considered a reliable indicator for the trilobite zone (see Martin & Dean, 1988, p. 14). Martin & Dean found no evidence for the lower *Parabolina brevispina* Subzone. Parsons & Anderson (2000) reported the presence of *P. brevispina*, indicative of the *P. brevispina* Subzone, and assigned A3a to the subzone with a possible extension into the *P. spinulosa* Subzone. They assigned A3b in its entirety to the *P. spinulosa* Subzone but with uncertainty concerning the position of the microflora's base (Parsons & Anderson 2000, text-fig. 2). Unfortunately, the trilobite evidence of Parsons & Anderson (2000) is not supported by illustrations.

Considering this evidence, the Comley microfloras L2 and L3 can be referred to the A3b microfloral subdivision of Martin & Dean (1988), equivalent to the lower part of the *P. spinulosa* Subzone of the *P. spinulosa* Zone. The L1 microflora can be referred to the lower part of the A4 subdivision of Martin & Dean (1988) and RA4 subdivision of Parsons & Anderson (2000). The lower part of A4 is equivalent to the upper part of the *P. spinulosa* Subzone. The upper boundary of the lithological unit assigned to the lower part A4 (and RA4) microfloral subdivisions is faulted with section missing; therefore, it is theoretically possible that the microflora could extend into the *Leptoplastus* Zone in Martin & Dean's interpretation or to the *Protopeltura praecursor* Zone in Parsons & Anderson's interpretation. There are no reliable macrofaunally controlled microfloras described from the *Leptoplastus* Zone elsewhere for comparison. Parsons & Anderson (2000) maintained that attribution of an impoverished microfloral assemblage from Norway to the *Leptoplastus* Zone (Welsch, 1986) is insufficiently supported by macrofaunal evidence.

One of the authors (Potter, unpublished data) has studied an acritarch assemblage from the British Geological Survey borehole Merevale No. 1 from an interval dated on trilobite evidence as belonging to the *P. brevispina* Subzone of the *Parabolina spinulosa* Zone (see Taylor & Rushton, 1972 for full details of the trilobite zonal assignment). The results from the sample at 350'2" in the Monks Park Shale Formation, briefly mentioned by Bridge *et al.* (1998), are outlined here. The assemblage includes, amongst other taxa, *Trunculumarium revinium* (in quantity), *Actinotodissus* sp., *Cristallinium cambriense*, *Cymatiogalea* sp., *Ninadiacrodium caudatum*, *Impluviculus* sp. 1, *Leiofusa stoumonensis*, *Ninadiacrodium dumontii* and *Timofeevia* aff. *estonica*. This assemblage, though poorly preserved, closely resembles the L1 assemblage from Comley and the RA4 (Parsons & Anderson, 2000) and lower part A4 (Martin & Dean, 1988) microfloras from eastern Newfoundland. The Merevale No. 1 acritarch assemblage is derived from a horizon near the top of an interval assigned by Taylor & Rushton (1972) to the *P. brevispina* Subzone and indicates that the lower boundary of an RA4 microflora can occur within the *P. brevispina* trilobite Subzone in England, earlier than is apparently the case in eastern Newfoundland.

Published descriptions of acritarch assemblages from successions with reliable macrofaunal control to indicate a *Parabolina spinulosa* Zone are not currently available from other localities. However, the distinctive nature of the Comley assemblages permits comparison with others, principally from Belgium, and the East European Platform of western Russia and the Baltic states.

The Cambrian palynostratigraphy of Belgium has been extensively reported and a zonation developed by Vanguestaine (1974, 1978, 1986) Ribecai & Vanguestaine (1993) and Ribbert *et al.*, (2001). The assemblage of Zone 5 from the Revin Group (Rn2b) of the Stavelot Massif (Vanguestaine, 1973, 1974; Ribecai & Vanguestaine, 1993) closely resembles the L1 assemblage from

Comley. The presence of *T. revinium* without species of the genus *Ladogella* and the presence of *N. caudatum* and *N. dumontii* support the comparison. The preceding Zone 4 (Vanguestaine, 1974, subdivided into 4a and 4b in Vanguestaine, 1978) encompasses assemblages that pre-date the first appearances of *N. caudatum* and *N. dumontii* and cannot be compared with the L2 and L3 assemblages of Comley. However, Ribbert *et al*. (2001) mention a third subdivision, '4c' of Zone 4, the microflora of which (from the Stavelot-Venn Anticline) shows some similarities with assemblages L2 and L3, containing *N. dumontii* and *Leiofusa stoumonensis* in the absence of *T. revinium*. However, the presence of *Ninadiacrodium caudatum* and *Dasydiacrodium obsonum* in the Comley samples suggests a slightly younger age for L2 and L3. The three Comley assemblages would be encompassed by the *Trunculumarium revinium–Veryhachium dumontii* Superzone V of the international zonation of Vanguestaine & Van Looy (1983), a scheme which combined the Belgian zones with others available at that time.

Similar assemblages to those at Comley have been reported from the East European Platform area, mainly from Estonia, Ukraine and western Russia. Expanding upon the data in Volkova (1990), Volkova & Kir'yanov (1995) summarize a regional scheme for the East European Platform. Comley assemblages L2 and L3 can be compared with the upper subdivision (VK2b) of the 'Vorchin regional horizon' VK2 (Volkova, 1990). The base coincides with the first appearances of the taxa *Leiofusa stoumonensis*, *Ninadiacrodium dumontii* and *Timofeevia estonica*, with the species *Ninadiacrodium caudatum* and *Stellechinatum uncinatum* (Downie, 1958) Molyneux, 1987 appearing within the zone and defining the base of the upper VK2b subdivision (Volkova & Kir'yanov, 1995). Whilst *S. uncinatum* does not occur in the Comley assemblages (some specimens of *Polygonium* spp. with pronounced sculpture begin to resemble this form), an assemblage above base *N. caudatum* and below base *T. revinium* would satisfactorily describe L2 and L3 which, therefore, can be compared with VK2b assemblages.

Two assemblages described by Paalits (1992b, 1995) from western Russia and North Estonia resemble L2 and L3 of Comley. An assemblage from the Panikovitshi core of the Petseri Formation in the Pskov Region of Russia (Paalits, 1992b), whilst not containing *N. caudatum* or *D. obsonum*, does include a probable dasydiacrodian ?*Dasydiacrodium setuensis* Paalits, 1992b, *L. stoumonensis* and *Veryhachium incus* Paalits, 1992b, a junior synonym of *N. dumontii*. Paalits (1992b) argues that this assemblage may pre-date the inception of the genus *Impluviculus* (Loeblich & Tappan, 1969) Martin, 1977, a taxon present in the L2 assemblage of Comley. The assemblage may be of similar age to or slightly older than assemblages L2 and L3. The second assemblage including *Cristallinium randomense*, *Stelliferidium cortinulamorphum*, *Ninadiacrodium dumontii* and *Leiofusa stoumonensis*, reported as assemblage A1 from the upper part of the Ülgase Formation of the Tõnismägi outcrop, North Estonia (Paalits, 1995), also lacks *N. caudatum* and *D. obsonum*. However, the assemblage includes ?*Leiofusa* sp., which Paalits (1995) compares with '*Leiofusa scalenabullata* Potter, 1974' (*nomen nudum*, herein published as *Scalenadiacrodium comleyense* gen. et sp. nov.) and which is characteristic of L2 and L3. Paalits (1995) notes, as a personal communication from Parsons, the occurrence of a similar species in Newfoundland from the 'lower and middle parts of the *Parabolina spinulosa* Zone'. In overall characteristics, the A1 assemblage resembles L2 and L3 from Comley although there is a greater variety of the galeate taxa (*Cymatiogalea* and *Stelliferidium*).

Volkova (1990) presented an assemblage from the North Estonian Mardu-9 borehole (137.4–146 m), including *N. caudatum*, *N. dumontii*, *L. stoumonensis* and common *T. revinium*, which she assigned to Zone VK3. The topmost sample includes *Lusatia dendroidea* Burmann, 1970, a form typical of younger Cambrian assemblages. The L1 assemblage corresponds well with the underlying microflora (138.4–146 m) and could thus be considered equivalent to the lower part of Zone VK3 in the Mardu-9 sequence. Parsons & Anderson (2000, p. 10) also note the anomalous occurrence of *L. dendroidea* and suggest that, as the preceding samples are from the Tsitre Formation and are separated by a considerable stratigraphical break from the overlying Mardu Member (sample with *L. dendroidea*), the latter sample should be reassigned to the younger VK5 assemblage of Volkova (1990). Parsons & Anderson (2000) explain the anomalous occurrence of common *T. revinium* together with *L. dendroidea* as a result of reworking. Parsons & Anderson (2000) also invoke reworking to explain the presence of typical VK3 taxa, including *Leiofusa stoumonensis* and *Ninadiacrodium caudatum*, in the succeeding VK4A subdivision of the Volkova (1990) zonation for the East European Platform. An assemblage described by Paalits (1992a) from the Tsitre Formation of borehole core M-72 (112.8–119.6 m), North Estonia, is very closely comparable to Comley assemblage L1. The same core interval is adopted as stratotype for the 'Tsitre regional horizon' by Volkova & Kir'yanov (1995) and assigned to their VK3 acritarch complex. As in the Comley L1 assemblage, *Trunculumarium revinium*, *Timofeevia estonica* (comparable with *T.* aff. *estonica* of Comley) and a form *Cymatiogalea* aff. *virgulta*, illustrated but not described, possibly similar to *C. virgulta*, are common and *D. obsonum*, *L. stoumonensis*, *N. caudatum* and *N. dumontii* present. Volkova & Kir'yanov (1995) state that deposits yielding a VK3 assemblage transgressively overlie those yielding a VK2 assemblage in North Estonia. This would support the assignment of a younger age to the L1 assemblage (similar to VK3) than to the L2 and L3 assemblages (similar to VK2b).

Ghavidel-syooki & Vecoli (2008) report acritarch assemblages including *Trunculumarium revinium* from the High Zagros Mountains of southern Iran. The majority of the species comprising acritarch assemblage zone IVa are encountered in the Comley L1 assemblage but the additional presence of abundant *Lusatia dendroidea* Burmann, 1970, emend. Albani *et al*., 2007, would indicate a slightly younger age for the assemblage. Assuming that the presence of *L. dendroidea* is not the result of palaeogeographical or palaeoenvironmental influences on an assemblage age-equivalent to the RA4 microflora (Parsons & Anderson, 2000) of eastern Newfoundland, the Iranian assemblage may represent an unsampled or missing interval in the eastern Newfoundland succession preceding the first occurrence of *Orthosphaeridium*? *extensum* and *Ladogella rommelaerei* in both areas.

The microflora of the Maentwrog and Ffestiniog Flags Formation of the St Tudwal's Peninsula and St Tudwal's Island East in North Wales is described by Martin *in* Young *et al*. (1994) and reviewed by Martin *in* Young *et al*. (2002). The Maentwrog Formation is tentatively assigned, on trilobite evidence, to the *Olenus* Zone. The microfloras, which include *C. aspergillum*, *C. virgulta*, *L. stoumonensis*, *T. phosphoritica* and *V. turbata*, are compared with the upper part of the microfloras A2 and A3a of eastern Newfoundland (*Olenus* trilobite Zone/lower part of *Parabolina spinulosa* Zone). Diacrodian taxa are absent, although *N. dumontii* is present elsewhere in the North Wales Ffestiniog Flags Formation. For this reason, the assemblage is here considered to pre-date those of the Comley area.

Although the assemblages are not necessarily closely comparable, some distinctive taxa in the Comley assemblages are reported from North Africa (Vecoli, 1996, 1999), northern Norway (Welsch, 1986), Poland (Szczepanik, 2001; Żylińska *et al.*, 2006), Ireland (Vanguestaine & Brück, 2008) and Arctic Russia (Raevskaya & Golubkova, 2006).

CONCLUSIONS

The Furongian Shoot Rough Road Shales of the Comley area yield numerically abundant, taxonomically diverse and generally well-preserved assemblages of acritarchs. The macrofossil zone assignment of the Shales to the Furongian *Parabolina spinulosa* trilobite Zone by Cobbold (summary in Cobbold, 1927) can now be further restricted to the *Parabolina spinulosa* Subzone.

Two distinct microfloras are comparable with *Parabolina spinulosa* Zone assemblages from Newfoundland and Nuneaton, England. The Comley L2 and L3 assemblages resemble the Newfoundland Microflora 3b of Martin & Dean (1988) assigned to the *Parabolina spinulosa* Subzone (lower part). In the absence of any published definitive *Leptoplastus* Zone microfloras for comparison with the Comley L2 and L3 assemblages, a *Leptoplastus* Zone age for L2 and/or L3 cannot be entirely ruled out. The L1 assemblage resembles Microflora A4 (lower part) of Martin & Dean (1988) and Microflora RA4 of Parsons & Anderson (2000), assigned to the upper part of the *Parabolina spinulosa* Subzone. The L1 assemblage also resembles a microflora from the *Parabolina brevispina* Subzone of the *Parabolina spinulosa* Zone recovered from BGS borehole Merevale No. 1, Nuneaton, but differs from the assemblage that characterizes the Subzone in Newfoundland. The resolution of this discrepancy must await the acquisition of additional data to determine whether palaeoenvironmental, palaeogeographical or sampling constraints are responsible.

Similar assemblages have also been reported primarily from the Ardennes and the East European Platform. Assemblage L1 is similar to that of Zone 5 of Ribecai & Vanguestaine (1993) from the Stavelot Massif, Ardennes, Belgium. The L2 and L3 microflora corresponds with the acritarch complex VK2b of Volkova & Kir'yanov (1995) and the L1 assemblage is comparable with the lower part of acritarch complex and VK3 of Volkova (1990) from the East European Platform.

Acritarchs are shown to have considerable biostratigraphical potential for high-resolution biostratigraphy in the classic Comley area and should be used in any further investigation of the area as new exposures are identified. This contribution extends our knowledge of the microfloral characterization of the *Parabolina spinulosa* trilobite Zone.

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