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Plumatella geimermassardi, a newly recognized freshwater bryozoan from Britain, Ireland, and continental Europe (Bryozoa: Phylactolaemata)

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Abstract

Plumatella geimermassardi is a newly recognized species of phylactolaemate bryozoan. Its known range extends from Ireland east through southern Norway and south into Italy. Colonies grow close to the substrate with little free branching; the body wall is mostly transparent and without an obvious raphe. Floatoblasts are broadly oval and relatively small, with distinctively large dorsal fenestra and uniformly narrow ventral annulus. The sessoblast basal valve is low and dish-shaped; the annulus bears tubercles which vary in their prominence. This species brings to 14 the number of phylactolaemate bryozoans known in the region.

Introduction

In the current era of unprecedented species extinctions among freshwater invertebrates (Ehrlich, 1995; Ricciardi & Rassmussen, 1999) the importance of taking inventory has never been greater. Many taxonomists have focused their attention on tropical regions where few previous studies have been done. European and American malacologists, for example, are describing most of their new species from outside their home regions on the apparent assumption that the local species have been largely dealt with (Bouchet, 1997). In this paper we report a longtime resident phylactolaemate species of Britain and Europe, only recently recognized after having escaped detection for over 150 years. This species now boosts the total species number by 7% and signals the possibility of additional freshwater bryozoan species yet to be discovered.

As a whole, the phylactolaemate (freshwater) bryozoans of Britain and Europe seem fairly well known. Since the first species was named by Linné (1758) nearly 50 additional species have been proposed in the region, of which 10 are still considered valid (Geimer & Massard, 1986). During the entire 20th century only one new species was described from Europe (Gruncharova, 1971), and since that time the taxonomic scene has been mostly quiet. Four species known from elsewhere have been added to the European inventory, bringing the species total to 14.

Freshwater bryozoans have recently received renewed attention with the discovery that several species can harbor the myxozoan parasite that goes on to cause proliferative kidney disease in salmonid fish (Anderson et al., 1999; Canning et al., 1999; Longshaw et al., 1999). As a result, the ability to correctly identify freshwater bryozoans at the species level has taken on greater importance. In response to this need, we have reviewed the major phylactolaemate bryozoan collections in Britain, Ireland and Europe, accompanied by intensive field surveys during 2000–2001. Our initial goal was to clarify morphological differences so that species identifications might become easier and more reliable. In the process, we encountered an unexpectedly high level of morphological variability in the known species as well as the presence of one previously undetected species described here. A full account and revised key of freshwater bryozoans

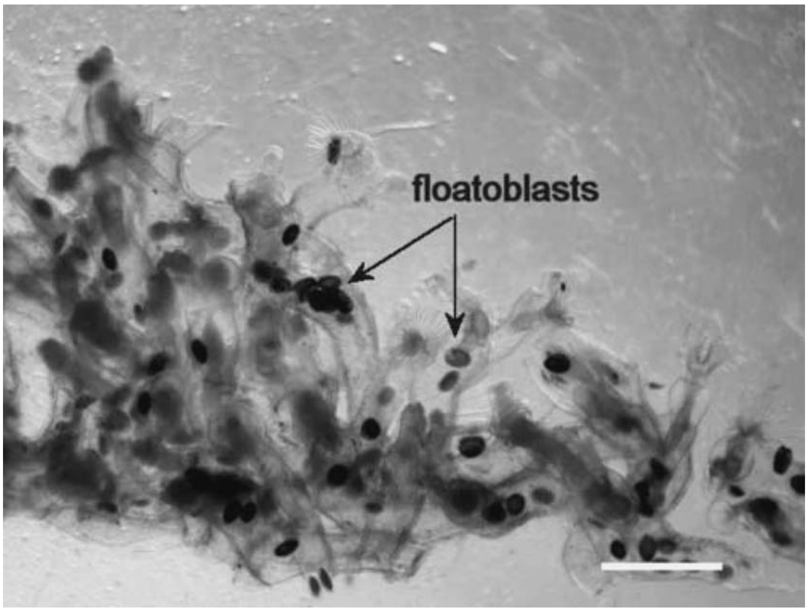

Figure 1. Colony of *Plumatella geimermassardi*, showing transparent body wall and accumulated floatoblasts. Scale bar = 2 mm.

Table 1. Critical dimensions of floatoblasts of *Plumatella geimermassardi* from various specimens. Mean measurements are expressed in micrometers with 95% confidence levels. 'Cam' is River Cam at Cambridge, UK; 'Doon' is Loch Doon, Ireland; 'Italy' is Lake Piediluco at Terni, Umbria; 'Norfolk' is Specimen No. 1936.8.6.1 at Natural History Museum (London); 'Norway' is data derived from Massard et al. (2002); 'Tufty' is Tufty's Corner lakes; 'Yeovil' is Sutton-Bingham Reservoir near Yeovil, Devon, U.K. Total dimensions combine all specimen measurements.

	Cam	Doon	Italy	Tufty	Yeovil	Total
Number of measurements	21	23	29	5	26	110
Overall length (L)	339 ± 7	330 ± 5	310 ± 4	304 ± 13	299 ± 4	322 ± 4
Overall width (W)	258 ± 4	252 ± 5	224 ± 3	231 ± 19	235 ± 5	245 ± 3
L/W	1.32	1.31	1.38	1.32	1.27	1.32 ± 0.02
Dorsal fenestra L	200 ± 29	200 ± 3	192 ± 5	190	183 ± 5	197 ± 3
Dorsal fenestra W	163 ± 6	164 ± 2	155 ± 6	160	145 ± 2	159 ± 3
Dorsal fenestra L/W	1.23	1.22	1.25	1.19	1.27	1.24 ± 0.02
Ventral fenestra L	260 ± 12	253 ± 6	255 ± 8	203 ± 32	219 ± 4	247 ± 5
Ventral fenestra W	204 ± 6	202 ± 3	188 ± 3	170 ± 29	174 ± 2	193 ± 3
Ventral fenestra L/W	1.28	1.26	1.36	1.20	1.23	1.27 ± 0.02

from Britain, Ireland, and continental Europe is being published separately (Wood & Okamura, 2004).

Methods

For new collections, most species were taken in the shallow regions of lakes, ponds, rivers, and quarries. Whenever possible, colonies were collected by removing them together with a portion of the substrate to which they were attached. This entailed chipping thin pieces of rock with a cold chisel or using a knife to slice off thin strips of wood along with intact colonies. Material to be preserved was first narcotized with wafers of menthol as described by Wood (2001), then fixed in 70% ethyl alcohol. In many cases, dormant statoblasts were held in vials of water and later refrigerated for several months. These statoblasts then germinated when returned to an optimal growing temperature in the laboratory. Laboratory reared colonies were useful for confirming the stability of morphological features by growing colonies in controlled

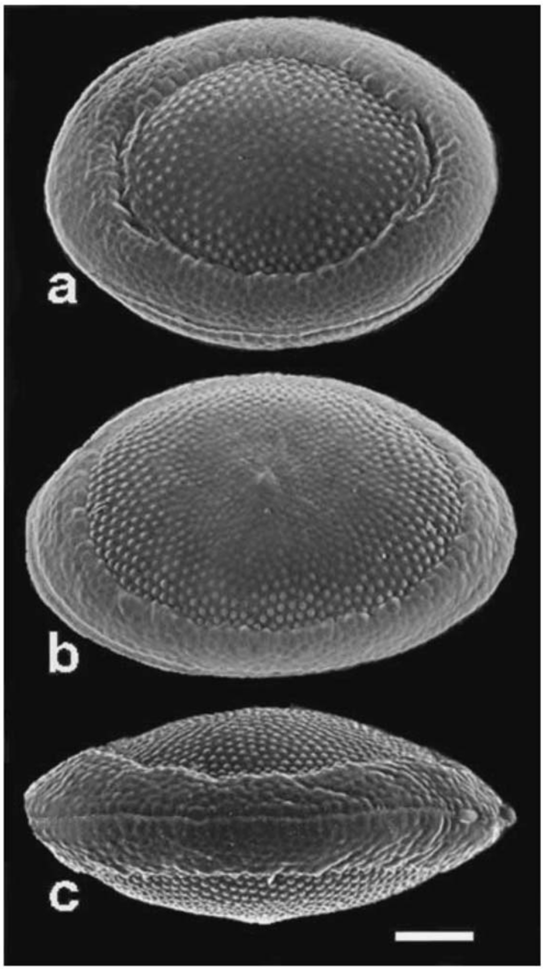

Figure 2. Scanning electron micrographs showing typical floatoblasts of *Plumatella geimermassardi*. (a) Dorsal view; (b) ventral view; (c) lateral view. Scale bar = 50 μm.

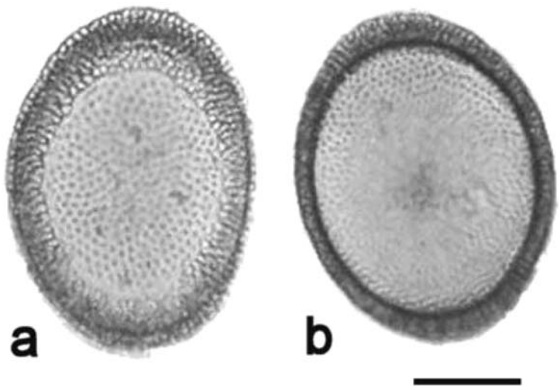

Figure 3. Light microscope photo showing typical floatoblast valves of *Plumatella geimermassardi*, with clear tuberculation on the fenestrae. (a) Dorsal valve; (b) ventral valve. Scale bar = 100 μm.

conditions. We examined statoblast structure by first separating the valves and clearing out organic material in hot KOH solution, as initially described by Wiebach (1975). With light microscopy it was then possible to determine critical dimensions and note sculptured patterns on the central fenestrae. For more detailed work, statoblasts were freeze-dried to minimize distortion, then mounted on aluminum stubs, sputtered with gold palladium alloy, and examined with a Philips 500 scanning electron microscope. Statoblasts dimensions were measured by ocular micrometer on a compound microscope in which each unit represented 10 μm. Statistical treatment of the data was performed with InStat® software (GraphPad Software, Inc.).

Description

Plumatella geimermassardi*, new species*

Description

Colonies are formed as branching tubules of uniform diameter, the branches initially attached fully to the substrate and spreading widely on unrestricted surfaces; zooids becoming crowded on limited substrate with occasional free branching, branches sometimes fusing. The chitinous ectocyst is typically smooth and transparent, sometimes lightly dusted with external particles, nearly colorless and flexible in young colonies but becoming dark and stiff (although still transparent) with age (Fig. 1). The tubule diameter has a range from 250–450 μm; the number of tentacles is around 30–40. Stout internal reinforcing rings (septa) are frequent and conspicuous, formed near diverticulations perpendicular to the axis of the zooid tubule, with a hole in the center that reduces the inner zooecial diameter by as much as 80%. A faint raphe (keel) may occur along the colony tubules, but is usually lacking entirely.

Floatoblasts are relatively small and broad (Figs 2, 3, 6e, dimensions in Table 1). Lateral symmetry is common (Fig. 2c), although in some specimens the ventral valve is more convex than the dorsal. The two valves are similar in frontal view, each with large fenestra and an annulus of nearly uniform width; both fenestrae bear low, weakly defined tubercles that become less distinct towards the center. Polar grooves on the dorsal valve range from deeply indented lines to slight dimples which slightly truncate the dorsal fenestra at each end. The ventral annulus bears a single central prominence. On the ventral valve the fenestra tubercles appear to lean slightly away from the central prominence, becoming larger and more distinct near the periphery. With scanning electron microscopy the individual chambers of the annulus are revealed by the elevation of their rounded walls, giving the lumpy appearance to the annulus surface. In material from Italy these chambers are much less prominent. The suture is a single raised cord.

Sessoblasts are completely covered with well-defined tubercles, which span the frontal valve. The tubercles also continue across both sides of annulus, unless they are expressed as thickened, radiating ridges which can sometimes replace the tubercles completely or partially (Figs 4, 5). The basal valve is low and dish-shaped, flaring outwards to form narrow annulus which lies close to substrate. The cementing material surrounding basal valve is generally more extensive than in other plumatellid species. Dimensions are provided in Table 2.

Type material
No. 2003.10.1.1. Natural History Museum (London), collected at Tufty's Corner, one of the lakes originating as gravel pits in Dinton Pastures Country Park, southeast Reading, Berkshire, UK, August 14, 2000 by Timothy S. Wood and Vivian Rimmer; whole colony on wood in alcohol.

Etmology
The specific epithet honors Gaby Geimer-Massard and her husband Jos A. Massard, two contemporary investigators in Luxembourg whose numerous published works have contributed significantly to the understanding of freshwater bryozoans in Europe.

Dimensions
Critical statoblast measurements from the holotype and other specimens are given in Tables 1 and 2.

Distribution
Plumatella geimermassardi is known so far from Ireland, England, Belgium, southern Norway, northern Germany and Italy. Based on these points, the species is presumed to occur throughout much of Europe, although the eastern limit of its range is yet to be determined.

Specimens
The species has been identified from material examined from the following locations: Belgium – La Voer, Institute Royal des Sciences Naturelles No. 9541.8; England – Tufty's Corner at Reading (Berkshire), Swansholme Lakes (Lincolnshire), River Cam at Cambridge (Cambridgeshire), Sutton-Bingham Reservoir at Yeovil (Devon), the largest of several lakes at Christ's Hospital, Horsham (West Sussex); 'Norfolk' Natural History Museum, London (NHM) #1936.8.6.1; 'Aquarium' at Christ's Hospital (West Sussex) NHM #1971.2.16.2; 'River Yare, Norfolk'. NHM #1929.2.28.2; Ireland – Lough Doon (County Clare), Lough Derg (County Tipperary), 'A pond' near Belfast, NHM #1847.9.24.199 (Johnston Collection). Germany – 'Bille, Hamburg' US National Museum #5161; Italy – Lake Piediluco at Terni (Umbria), Lake Alserio at Como (Lombardia), Lanca del Chiappo, oxbow of the river Po at Pavia (Lombardia). In addition, the species appears in scanning electron micrographs of sessoblasts from sites in southern Norway (Massard et al., 2002).

Discussion

Plumatella geimermassardi is not a recent arrival to the region. It is represented by what may be the oldest phylactolaemate specimen in existence, a small colony with many floatoblasts in the Johnston Collection of the Natural History Museum (London). The specimen is labeled, '*Plumatella repens*, adherent to a decaying submerged leaf of *Plantago major* in pond at Lismoyae, near Belfast', collected September 12, 1845. Other specimens at London and in museums elsewhere have been variously labeled as '*Plumatella repens*', '*Plumatella fungosa*', or '*Plumatella coralloides*'. Such misidentifications are not surprising, since plumatellid bryozoans can be difficult to distinguish, and the most conspicuous morphological features are somewhat variable. The Belgian specimen had been identified and published by Lacourt (1968) as '*Fredericella australiensis*' in what can only have been an unfortunate error.

The small, broad floatoblasts with relatively narrow annulus offer an easy identifying feature in this species (Fig. 6e). With an average length of around 320 μm they are among the smallest floatoblasts among all European plumatellids. Although small floatoblasts of *Plumatella repens* also fall within the dimensional range, those can be distinguished by a much wider annulus. In *P. geimermassardi* the chitinous valves are often unusually thin and fragile. Unlike floatoblasts of other species, the dorsal valve often curls at the edges when it is separated from the ventral

Table 2. Critical dimensions of sessoblasts of *Plumatella geimermassardi* from various specimens. Annulus dimensions are approximate due to variation around individual specimens. Mean measurements are expressed in micrometers with 95% confidence levels. Abbreviations are the same as those in Table 1. Total dimensions combine all specimen measurements.

	Cam	Doon	Italy	Norway	Tufty	Yeovil	Total
Number of measurements	0	15	6	12	10	8	39
Overall length (L)	–	368 ± 4	365 ± 4	488	412 ± 6	436 ± 4	322 ± 4
Overall width (W)	–	280 ± 3	236 ± 3	365	260 ± 4	314 ± 3	245 ± 3
L/W	–	1.31	1.58	1.34	1.54	1.39	1.38 ± 0.02
Annulus width	–	32	38	31	45	41	37

Figure 4. Scanning electron micrograph showing typical sessoblast of *Plumatella geimermassardi*. Scale bar = 100 μm.

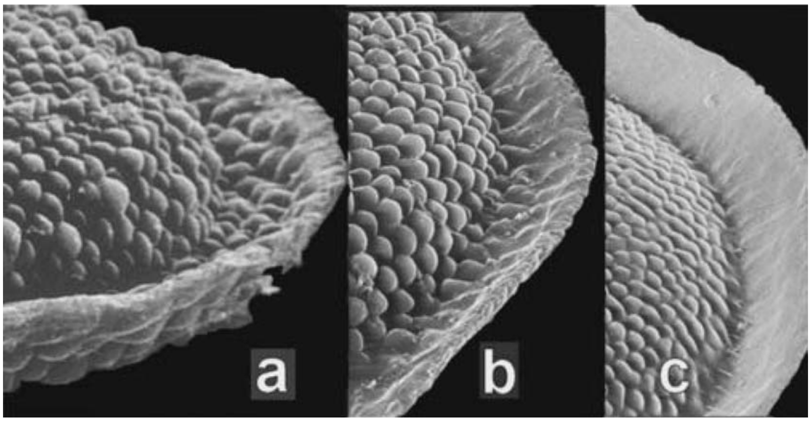

Figure 5. Scanning electron micrographs showing variation in the sessoblast annulus. (a) Laboratory cultured sessoblast from Tufty's Corner lakes, UK; (b) from Loch Doon, Ireland; (c) from Italy.

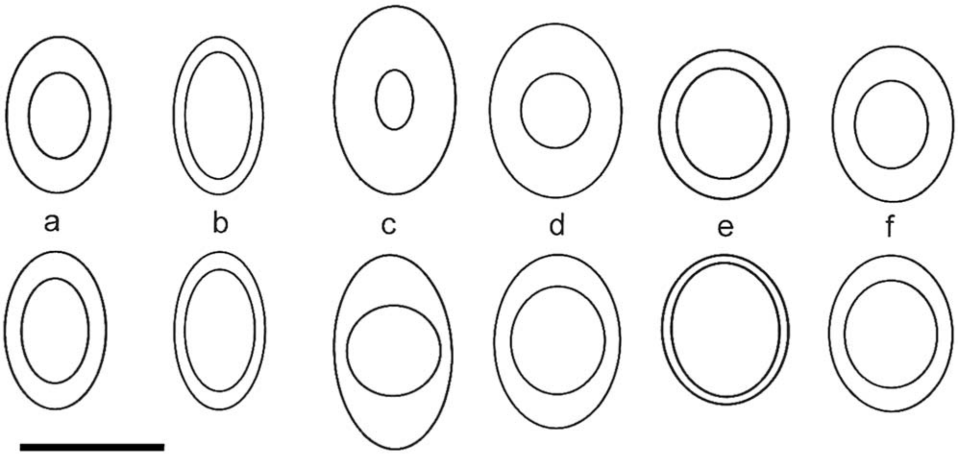

Figure 6. Comparative outlines of common plumatellid floatoblasts showing dorsal valves in the upper row and ventral valves in the lower row. Although overall dimensions are accurate, the curves are slightly stylized in these computer generated images. (a) *Plumatella casmiana* capsuled floatoblasts; (b) *P. casmiana* leptoblast; (c) *P. emarginata*; (d) *P. fungosa*; (e) *P. geimermassardi*; (f) *P. repens*. Scale bar = 300 μm.

valve by brief exposure to a hot potassium hydroxide solution. This coupled with a tenacious, slippery, gelatinous envelope makes the floatoblast difficult to manipulate and study in detail. The relatively large area of dorsal and ventral fenestrae are matched only by those of *P. nitens* or *Stephanella hina* on other continents (Wood, 1996; Toriumi 1955a). However, each of these other species also has its own distinctive features.

A second useful identifying feature in this species is the reduction or absence of a lateral basal wall in the sessoblast. The resulting squat profile of the sessoblast is easily seen with low magnification and is unusual among plumatellids. Only *Internectella bulgarica* has a similar sessoblast profile, but that species also has a twisted floatoblast symmetry (Gruncharova, 1971) and a root-like relief pattern on the frontal sessoblast valve (Wiebach, 1975). In *P. geimermassardi* the tuberculation of the sessoblast annulus also is unusual, and although similar tubercles sometimes also occur in *Plumatella fungosa* (Massard & Geimer, 1990) they are seldom as easily visible with ordinary light microscopy.

We recognize that at least some of the material reported from Norway as *Plumatella casmiana* is probably *P. geimermassardi*. This determination is based entirely on the sessoblast morphology as illustrated by Massard et al. (2002) in their Figs 7 and 8. Geimer & Massard (1986) clearly show by scanning electron micrographs that the sessoblast of *P. casmiana* has a narrow annulus and only faint frontal tubercles (see their Plate 8, Figs 1, 2). These features are fully consistent with *P. casmiana* taken from North America, Britain, France, Korea, Thailand, India and Ethiopia (Wood, unpublished). They are quite unlike *P. geimermassardi* as described above and illustrated in Figure 4.

Under scanning electron microscopy the floatoblast of *P. geimermassardi* bears a strong resemblance to that of *Hyalinella minuta* Toriumi, 1941 (see, for example, Specimen No. 214, Zoologisches Museum, Hamburg). There is the same weak tuberculation and a similarity in the annular surface. Floatoblast dimensions for *H. minuta*, as reported by Toriumi (1955b), are slightly less than those in *P. geimermassardi*, but both fall within the same statistical range. On the other hand, there are significant differences: Toriumi's (1955b) detailed taxonomic study of *P. minuta* concludes that this species produces no sessoblasts, and that septa are 'not observable in any part of the colony'. Toriumi further states that the ectocyst of *H. minuta* is 'swollen and soft, ... not chitinized ....' which is clearly unlike the sclerotized ectocyst of *P. geimermassardi*.

All colonies we examined during our field survey were packed with floatoblasts. A series of three zooids may enclose up to 20 of the dormant structures. This suggests that floatoblasts may not be released from the living colony, as they are in many other plumatellids.

Taken together, the features described above are sufficiently distinctive for us to be satisfied with the validity of *Plumatella geimermassardi* as a new species. However, the considerable variation in morphological features had us initially considering the possibility of three distinct species. For example, the Swansholme Lakes colonies differ from the others by their very dark and stout ectocyst; here the floatoblasts are well sclerotized and the slippery enveloping film has been replaced by a tough outer membrane. Colonies from Italy exhibit branches growing free from the substrate, with considerable fusion among adjacent zooids. Norwegian zooids reported as *P. casmiana* exhibit a distinct raphe (Massard et al., 2002), and if some of these are actually *P. geimermassardi* the raphe would be departure from a normally smooth zooid surface. The degree of incrustation also is variable: zooids walls are normally transparent, but may occasionally be clouded with encrusting particles. Floatoblasts from different geographic regions show variability in their overall dimensions (Table 1), lateral symmetry, and the distinctness of surface tubercles. Sessoblasts are somewhat more reliable, but the distinctive annular tubercles of the holotype are replaced by radiating ridges in one Irish specimen, and are almost completely absent in Italian material (Fig. 5).

The species has so far been encountered only in still waters of lakes and ponds. Material taken from the Cam River (Cambridgeshire, England) was scraped from the wooden hulls of punts in an area with no discernible current. Other bryozoans occurring at the same sites as *P. geimermassardi* include *Cristatella mucedo*, *Fredericella sultana, Plumatella fruticosa*, and the ctenostome *Paludicella articulata*.

Plumatella geimermassardi appears to be uncommon throughout its known range. In England and Ireland we encountered it at only six of more than 80 sites surveyed during 2000 and 2001. Only a few specimens were found at the Natural History Museum (London) and one at the Institute Royal des Sciences Naturelles. It is possible that specimens were overlooked at museums in Leiden, Berlin, and Hamburg, since the species was recognized only after those collections had been examined.

Acknowledgements

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