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Three new species of plumatellid bryozoans (Ectoprocta:Phylactolaemata) defined by statoblast nodules

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Abstract. Three new species of plumatellid (Phylactolaemata) bryozoans are distinguished largely by the presence of tiny, rash-like nodules on the floatoblast surface. Nodules are integral parts of the sclerotized floatoblast envelope, and they persist through generations of laboratory rearing. These minute structures are best detected by scanning electron microscopy. In *Plumatella bushnelli*, n. sp., nodules are densely distributed on the floatoblast annulus. Notable in this species are floatoblast dimensions: the dorsal fenestra measures >½ the overall length of 400 μm. The species is known only from single sites in North Carolina and New Zealand. *Plumatella nodulosa,* n. sp., bears nodules over the entire floatoblast surface, not just the annulus; otherwise, the species most resembles the widespread *P. rugosa* (Wood, Wood, Geimer, Massard, 1998). *Plumatella nodulosa* is reported from 5 lentic sites in Illinois, Ohio, and western New York. In *Plumatella similirepens*, n. sp., the floatoblast has a paved annulus with widely scattered nodules; unlike the European species, *P. repens* (L., 1758), the floatoblast suture lacks the row of prominent tubercles on either side. *Plumatella similirepens* is confirmed from 2 sites in Illinois. Contrary to numerous published works, *P. repens* is unknown in North America.

Key words: ectoprocta, bryozoa, phylactolaemata, new species, *Plumatella bushnelli, Plumatella nodulosa, Plumatella similirepens,* taxonomy.

It may be no coincidence that soft-bodied invertebrates are represented by relatively few recognized species. Soft tissues are often difficult to examine and quantify, their features being plastic and inconstant. By contrast, invertebrates with taxonomically useful hard parts total >80% of the known species. Among marine bryozoans, for example, the calcified cheilostomes are represented by nearly 3000 described species, whereas uncalcified ctenostomes have <200 species (Pechenik 1999). Parallel examples can be drawn from cnidarians (true corals with 4000 species, jellyfish with 200), gastropods (shelled species with 38,000 species, unshelled opisthobranchs with 2000), and other groups (Pechenik 1999). Among sponges, many chironomids, and certain molluscs, species identification does not even begin until the soft tissues are removed.

Scanning electron microscopy (SEM) is a standard tool for examining the smallest features when hard anatomical parts are available. SEM is increasingly used for taxonomic work on copepods (Galassi et al. 1999), dinoflagellates (Hernandez-Becerril et al. 2000), gastropods (Absalao and Pimenta 1999), insects (Klein et al. 1998), rotifers (Seegers and Babu 1999), and sponges (Muricy et al. 1998). This list also includes freshwater (phylactolaemate) bryozoans. The presence of statoblast nodules, an important diagnostic feature in the bryozoan species described here, cannot be detected by ordinary light microscopy.

Bryozoans are frequently encountered in freshwater habitats. They grow on submerged rocks, logs, plants, and other firm substrates. These suspension feeders can remove seston from eutrophic lakes at an estimated rate of >30 kg/ha (Kaminski 1991). Freshwater bryozoans also foul irrigation pipelines, wastewater filters, submerged fountain pumps, and similar equipment. Appearing as moss-like growths (Fig. 1A) or gelatinous blobs, each mass is a colony of independent zooids sharing a common coelom (Wood 2001). A whorl of ciliated tentacles extended by each zooid generates a current of water that brings particulate food to the mouth (Fig. 1B). Details of the morphology and ecology of freshwater bryozoans are provided by Pennak (1989) and Wood (2000).

Bryozoan statoblasts represent an important means of asexual reproduction. They are produced by species in the exclusively freshwater Class Phylactolaemata, and consist of yolk and

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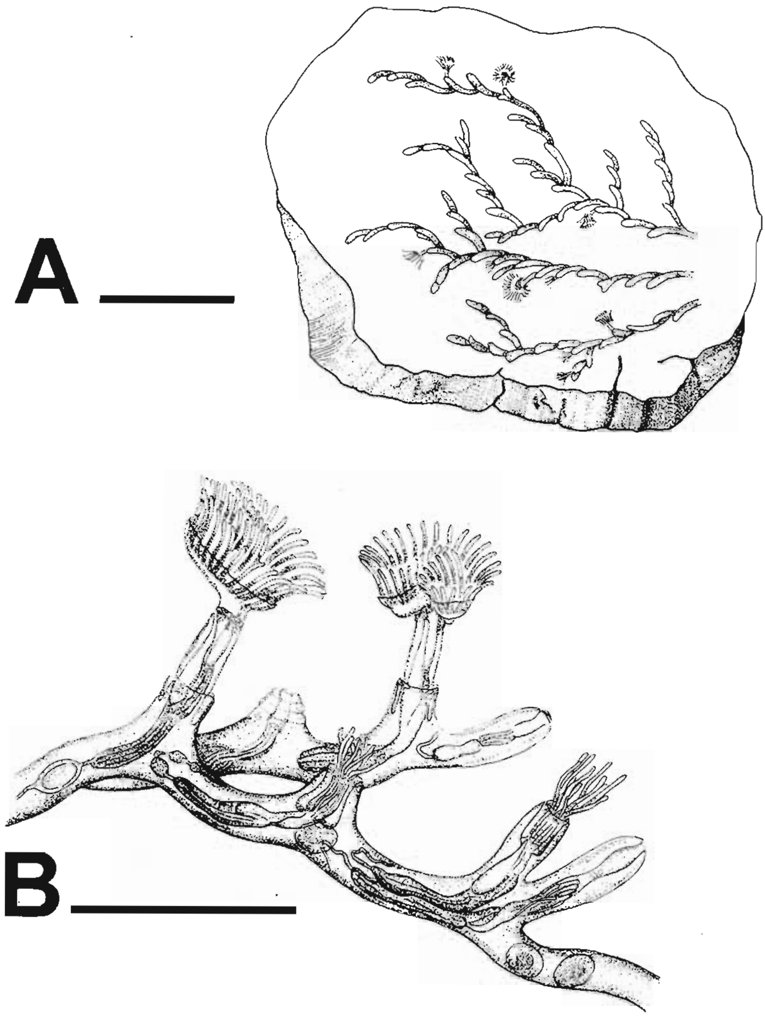

FIG. 1. Colony form in plumatellid bryozoans, based on Allman (1856). A.—Colonies growing on the undersurface of a rock. Scale bar = 10 mm. B.—Portion of a colony, showing lophophores in various stages of extension. Scale bar = 2.5 mm.

germinal tissue enclosed in tiny chitinous envelopes. Those statoblasts known as floatoblasts are usually released as free, buoyant disseminules, effectively dispersing the species to new localities (Fig. 2A, 2B). Sessoblasts, on the other hand, are cemented to the surface on which the colony grows, thus securing a suitable substrate for the next generation (Fig. 2C). Although only floatoblasts are formed by some species, both types of statoblasts are produced in the large genus, *Plumatella*.

Many species of phylactolaemate bryozoans have been distinguished in the past largely by colony form, numbers of tentacles, statoblast dimensions, and details of the flexible outer body wall. These features have been used especially in the taxonomy of *Plumatella* species. However, such characters are subject to environmental influence, as demonstrated by laboratory rearing trials (Toriumi 1971). The surface morphology of statoblasts is more reliable for taxonomic work (Wood and Wood 2000).

The sclerotized parts of a statoblast are split laterally into 2 valves, like the shell of a bivalve mollusc. In sessoblasts the valves are designated as basal and frontal; in floatoblasts they are

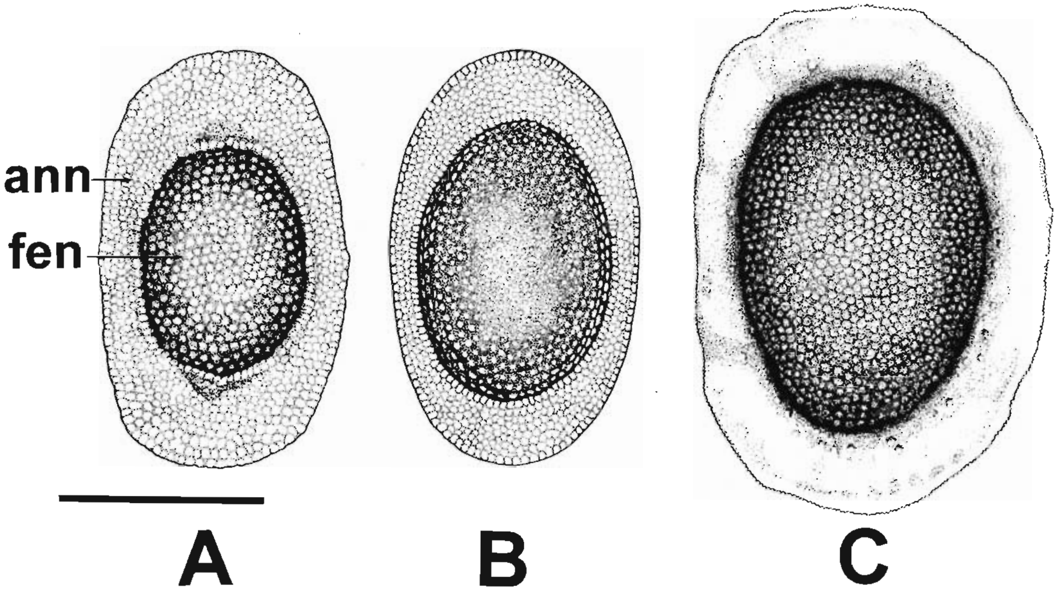

FIG. 2. Statoblasts of *Plumatella bushnelli* n. sp. A.—Dorsal valve of floatoblast showing annulus (ann) and fenestra (fen). B.—Ventral valve of floatoblast. C.—Sessoblast. Scale bar = 200 μm.

dorsal and ventral. In both cases, each valve has a central *fenestra* surrounded by the peripheral *annulus* (Fig. 2). In sessoblasts, the annulus is a thin flange-like lamella, but in floatoblasts it is composed of large, sclerotized chambers usually containing a gas for buoyancy. In most species the annular surface shows smooth, rounded contours of the close-fitting cells from which it was formed, creating a cobblestone or *paved* appearance (Fig. 5A). Other features of the annulus may include large, rounded prominences called *tubercles* (Fig. 3A), a net-like pattern in relief (*reticulum*) (Fig. 5B), or the presence of tiny, raised bumps called *nodules* (Fig. 5C). These and other topographic features have been used to characterize species (Geimer and Massard 1986, Smith 1992, Wood and Backus 1992, Wood 1996a). Most features are easily seen by light microscopy, especially when they occur on the fenestral re-

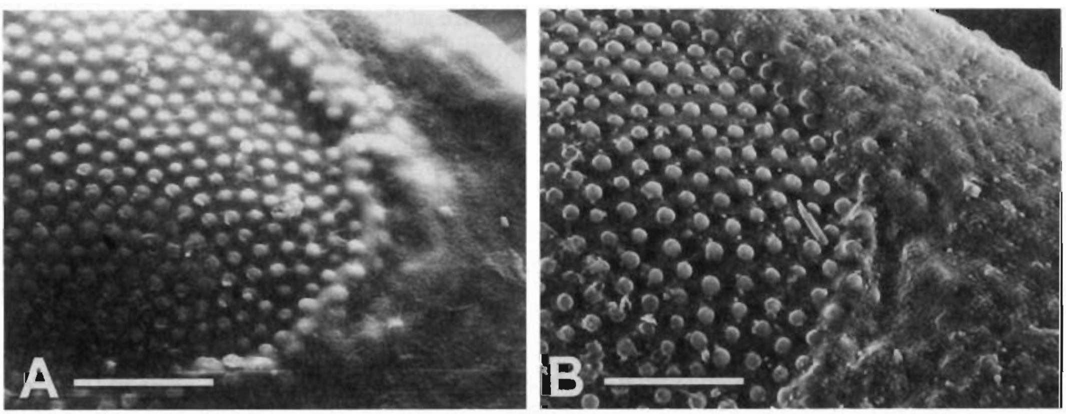

FIG. 3. Scanning electron micrographs of the floatoblast dorsal valve of *Plumatella bushnelli*. A.—Material from North Carolina. B.—Material from New Zealand showing sharply defined fenestra tubercles and uneven annular surface. Scale bars = 50 μm.

gion (Fig. 2A), although the topographic details are far more clearly defined with SEM. Statoblast features on the floatoblast annulus can only be detected with SEM.

Nodules were 1st discussed by Geimer and Massard (1986) as one of the reliable characters distinguishing *Plumatella repens* (L., 1758) from *P. fungosa* (Pallas, 1768). Visible only by SEM, nodules have the collective appearance of a skin rash, each little bump ~0.8 μm in diameter. Nodules are an integral part of the sclerotized statoblast structure; they can withstand exposure to a hot 1 M solution of KOH that would otherwise destroy nonchitinous structures.

The largest genus of phylactolaemate bryozoans is *Plumatella*, currently containing nearly ⅓ of all described species (Wood and Wood 2000). Typical plumatellid colonies have branching tubules, U-shaped lophophores, and at least 2 types of statoblasts (floatoblasts and sessoblasts). At one time, the most common and widely distributed species of *Plumatella* was believed to be *P. repens*, which was reported from every continent except Antarctica (Lacourt 1968, Bushnell 1973). However, the scanning electron micrographs of Geimer and Massard (1986) revealed distinctive surface features of *P. repens* statoblasts, and it became clear that *P. repens* was mainly a European species. In North America, what had previously been reported as *P. repens* is now divided among *P. nitens* Wood, 1996 and *P. rugosa* (Wood, Wood, Geimer and Massard, 1998). In this paper, we describe 3 new *repens*-like species: *P. bushnelli*, *P. nodulosa*, and *P. similirepens*.

Methods

I examined specimens from museum collections or shallow-water sites on substrates of dead wood, rocks, or aquatic plants. I also reared all 3 species in the laboratory to confirm the consistency of colony and statoblast morphology, using procedures described by Wood (1996b). I dissected statoblasts from living colonies and preserved them in 70% ethyl alcohol. In preparation for SEM, I cleaned statoblasts by vigorous shaking in a 0.1 M solution of sodium hexametaphosphate (Calgon) and rinsing in deionized water. I then freeze dried the statoblasts, mounted them on aluminum stubs, sputter coated them with gold palladium alloy, and examined them with a Phillips 500 SEM. I took all statoblast measurements from whole statoblasts in water using a compound microscope with an ocular micrometer at 20×. Confidence limits in Table 1 were calculated using GraphPad InStat (version 3.00 for Windows 95, GraphPad Software, San Diego, California).

Plumatella bushnelli, new species
(Fig. 2A, 2B, 2C, 3A, 3B)

Diagnosis

At ~400 μm in length the floatoblast is elongate, roughly similar in size to floatoblasts of *P. reticulata* Wood, 1988 and *P. emarginata* Allman, 1884 (Fig. 2A, 2B) However, the dorsal annulus is much narrower than in those species and the fenestra is correspondingly large. In both *P. reticulata* and *P. emarginata*, the dorsal annular width at the poles is greater than the length of the dorsal fenestra; in *P. bushnelli* this width is <½ the fenestra length. This feature, together with the overall floatoblast size, is sufficient to distinguish *P. bushnelli* from all other known North American bryozoans.

A 2nd notable feature of the floatoblast is the rash of tiny nodules, which covers the entire annular surface. These nodules appear identical to those illustrated for *P. repens* (Geimer and Massard 1986) and *P. orbisperma* (Wood and Wood 2000). However, the floatoblasts of those 2 species are at least 20% smaller and more rounded, and are unlikely to be confused with *P. bushnelli*.

The floatoblast is distinguished by unusually large and uniform tubercles across the entire surface of the dorsal fenestra (Fig. 3A, 3B), becoming less distinct towards the fenestra center. There is no reticulum on the dorsal fenestra, making the tubercles appear relatively well spaced. The same feature was seen in some Costa Rican material (Roush 1998), but it has not been reported elsewhere.

As in many plumatellid species, the sessoblast frontal valve is covered with large tubercles. However, an unusual feature of *P. bushnelli* is the occurrence of individual tubercles on the sessoblast annulus, especially in the proximal region (Fig. 2C). The annulus itself is relatively wide (30 μm) and more widely flared than in many other species. Sessoblast annulus width by itself is not a reliable feature; it is difficult to measure and its orientation is variable.

TABLE 1. General dimensions (μm ± 95% CL) of statoblasts from holotypes of *Plumatella bushnelli*, *P. nodulosa*, and *P. similirepens*. Numbers of measurements are shown in parentheses. Dorsal and ventral data were sometimes taken from the same statoblast.

Measurements	*P. bushnelli*	*P. nodulosa*	*P. similirepens*
Floatoblasts			
Overall length	399 ± 6 (20)	323 ± 2 (155)	339 ± 5 (40)
Overall width	233 ± 4 (20)	240 ± 1 (155)	241 ± 4 (40)
Overall length/width	1.71 ± 0.03	1.34 ± 0.01	1.40 ± 0.02
Dorsal fenestra length	206 ± 4 (19)	174 ± 2 (112)	180 ± 0.02 (19)
Dorsal fenestra width	155 ± 3 (19)	159 ± 2 (1152)	158 ± 2 (19)
Dorsal fenestra length/width	1.33 ± 0.03	1.10 ± 0.01	1.14 ± 0.03
Ventral fenestra length	249 ± 6 (20)	229 ± 3 (135)	221 ± 5 (20)
Ventral fenestra width	171 ± 4 (20)	182 ± 2 (135)	181 ± 4 (20)
Ventral fenestra length/width	1.45 ± 0.03	1.26 ± 0.02	1.22 ± 0.02
Sessoblasts (dimensions without annulus)			
Length	365 ± 5 (18)	331 ± 1 (28)	377 ± 31 (6)
Width	270 ± 2 (18)	234 ± 2 (28)	259 ± 24 (6)
Length/width	1.40 ± 0.02	1.16 ± 0.2	1.47 ± 0.18

Description

Colonies tubular, divided among many uniformly short branches; entirely recumbent when not crowded; zooids with only faint frontal crease (keel) throughout their length; colony wall mostly transparent and colorless, sometimes lightly encrusted but always sufficiently clear to reveal statoblasts inside. Internal septa frequent, dark, thin, perpendicular to axis of colony branch. Floatoblasts elongate (see Table 1 for dimensions), their sides straight to gently curved (Fig. 2A, 2B); dorsal valve less convex than ventral valve, sometimes flaring slightly at margin. Tubercles on floatoblast dorsal fenestra sharply defined, well-spaced, uniform in size, mounting annulus beyond outer fenestral margin and blending into annulus itself (Fig. 3A, 3B); ventral fenestral tubercles similar to dorsal but less elevated, becoming markedly smaller towards fenestra center. Floatoblast annulus lumpy, uneven; cell margins poorly defined; polar grooves mostly small, straight or C-shaped depressions; entire annular surface covered by minute nodules arranged densely and uniformly, sometimes scattered on dorsal fenestra among large tubercles. Sessoblast frontal valve with clearly defined, irregularly shaped tubercles, each well separated from the next, tubercles blending into wide, peripheral annulus; basal valve similarly tuberculated along its outer surface (Fig. 2C).

Material examined

Holotype. **USA, North Carolina:** Carteret Co., Shackleford Bank, Mullet Pond, 5 km SSE of Beaufort, 34°41′N, 75°38′W, 7.v.1998, T. S. Wood, US National Museum (USNM) No. 21602. *Paratype.* **NEW ZEALAND, Manawatu–Wanganui region,** Mangaone River 6 km S of Kaitawa, 40°30′S, 175°55′E, 28.i.1995, T. S. Wood & L. J. Wood, author's private collection. Both specimens whole colonies in alcohol.

Remarks

The population in New Zealand was sampled only once from a single site on the North Island (Wood et al. 1998). By contrast, I have frequently visited and sampled the North Carolina population over the past 25 y. At both sites the water is clear and brownish with a pH near 7. Both sites are frequented by animals that wade, drink, and defecate there (sheep in New Zealand, wild horses in North Carolina). In both cases the habitats are atypical for the region. I have neither recovered any additional specimens in surveys of nearby sites, nor have I encountered any more material during recent searches of major freshwater bryozoa collections in North America, Europe, India, and Australia. This finding is not surprising because few of the world's freshwater sites have been surveyed for bryozoans. Clearly, the main source areas for

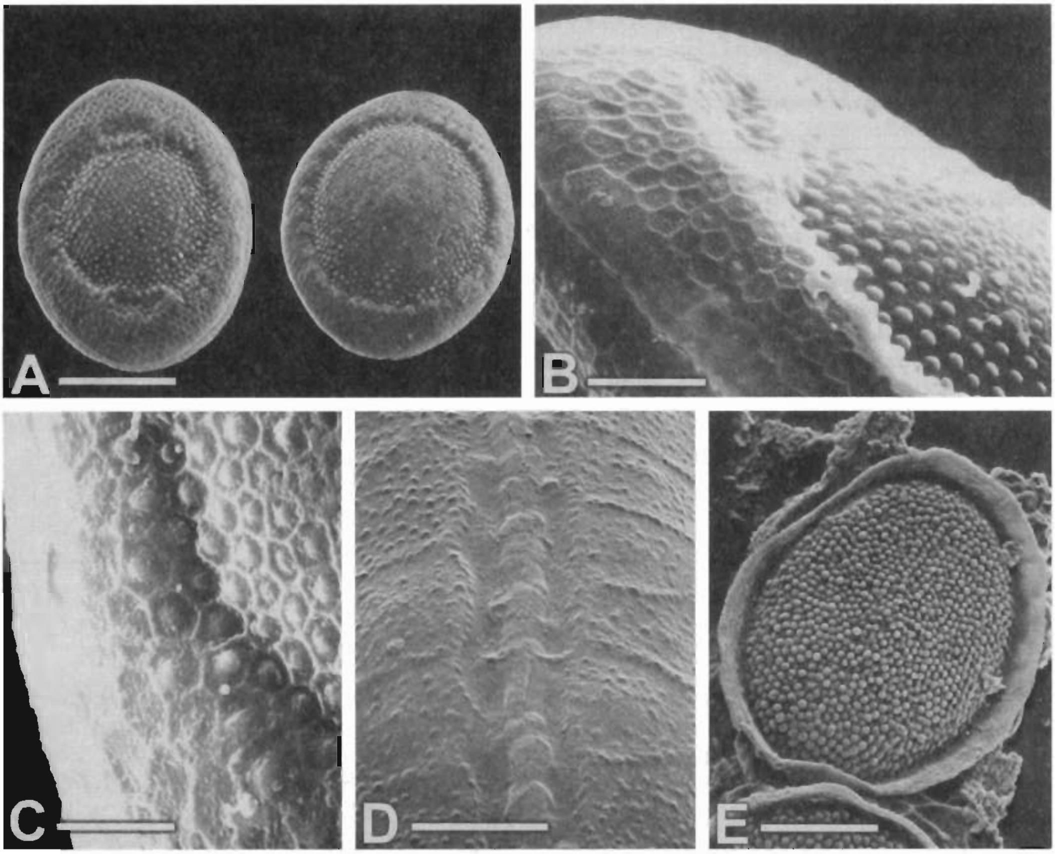

FIG. 4. Statoblasts of *Plumatella nodulosa*. A.—Dorsal (left) and ventral sides of floatoblasts, from holotype. Scale bar = 150 μm. B.—Lateral view of floatoblasts showing nodules on annulus and fenestra, from holotype. Scale bar = 50 μm. C.—Floatoblast dorsal surface showing pronounced reticular ridges. Specimen from USNM 476 Rogick Collection. Scale bar = 35 μm. D.—Floatoblast suture, from holotype. Scale bar = 15 μm. E.—Sessoblasts, from holotype. Scale bar = 150 μm.

dispersal of *P. bushnelli* have not yet been located. If the distribution is truly as spotty as it seems, it may be the result of narrow habitat preferences, or it could be poor dispersal of local populations. The colonies grew only poorly in the laboratory, presumably because I did not provide the optimal environmental conditions.

Colonies reared from holotype statoblasts retained all features of naturally occurring material, including statoblast shape, dimensions, nodules, and other surface ultrastructure. Laboratory colonies tended to be somewhat less compact than the holotype, but they remained entirely adherent to the glass substrate.

Etymology

The specific epithet honors Dr John Bushnell of the University of Colorado at Boulder, whose study of Michigan bryozoans in the 1960s set a high standard for surveys to follow.

Plumatella nodulosa, new species
(Fig. 4A, 4B, 4C, 4D)

Diagnosis

The floatoblast is unique because of the presence of tiny nodules over the entire surface of both valves (Fig. 4A). By contrast, nodules in *P. repens, P. orbisperma, P. bushnelli,* and *P. similirepens* are associated almost exclusively with the annulus. In *P. nodulosa* the nodules on both the fenestra and annulus may combine with a raised-surface reticulum to cover the ridges of the reticulated lines as well as the spaces in between (Fig. 4C).

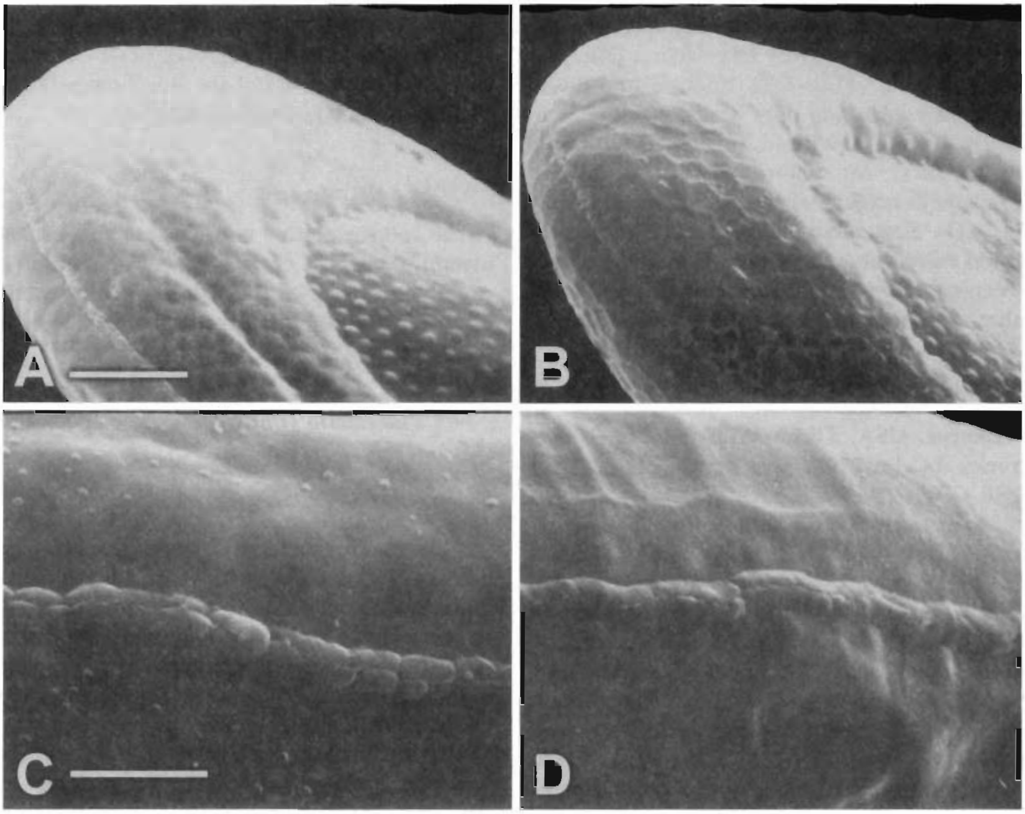

FIG. 5. Comparison of *Plumatella similirepens* and *P. rugosa* floatoblasts. A.—Dorsolateral view of *P. similirepens* floatoblast showing nodules on paved annulus. Scale bar = 50 μm. B.—Dorsolateral view of *P. rugosa* floatoblast showing convex annular cells and no nodules. Same scale. C.—Suture of *P. similirepens* floatoblast. Scale bar = 15 μm. D.—Suture of *P. rugosa* floatoblast. Same scale.

The presence of so many nodules on the fenestral region of a floatoblast is unusual. Fenestral nodules sometimes occur in other species (e.g., laboratory reared *P. bushnelli*), but never in such abundance, and never organized in a reticulated pattern in the absence of raised lines (e.g., Fig. 3A).

There is little to distinguish this species from *P. rugosa.* Both species have the same sparsely branching, repent, mostly recumbent colony form, and in both species the colony wall is lightly encrusted, bearing a distinct keel. Floatoblast shapes and dimensions also are similar, also resembling the floatoblasts of *P. fungosa* and *P. repens.* Nor does the tuberculated sessoblast offer any features to distinguish the species from many other plumatellids. However, the floatoblast nodules on the dorsal fenestra and the combination of nodules and reticulation define *P. nodulosa.*

Description

Colony tubular with narrow, sinuous branches, entirely recumbent, zooids straight and erect, often standing perpendicular in unbroken linear series of up to 8 zooids on unrestricting substrate. Walls of crowded zooids in contact but never fused; colony wall lightly encrusted even in young branches, keel distinct though not prominent, occasional internal septa present. Floatoblasts broadly oval (Fig. 4A) with slight lateral asymmetry; dorsal fenestra nearly round, polar grooves small, slightly depressed; fenestral tubercles large, prominent at periphery, blending into annulus, becoming smaller and more numerous toward center of fenestra, especially on ventral valve. Each fenestral tubercle occupying center of polygonal space formed by raised lines of reticular pattern, the lines themselves formed by linear series of nodules (Fig.

4B); stout reticular walls occasionally present, with thickenings at every intersection (Fig. 4C); general pattern of tubercles, nodules, and raised reticulum continuing onto annulus with tubercles considerably reduced; floatoblast suture an uneven cord set within distinct peripheral groove with occasional rib-like lateral processes (Fig. 4D). Sessoblasts heavily tuberculated on frontal valve, tubercle height increasing towards center, tubercles absent from annulus and basal valve, annulus faintly reticulated (Fig. 4E).

Material examined

Holotype. **USA, Ohio:** Williams Co., Beaver Creek, 14 km NW of Bryan, 41°32.47′N, 84°30.42′W, 12.vi.1974, T. S. Wood, USNM No. 21603. *Paratypes*. **Ohio:** Ottawa Co., Lake Erie at East Harbor, 8.viii.1932, M. D. Rogick, USNM No. 369 Rogick Collection; Montgomery Co., woodland pond 1.3 km S of Huber Heights, 39°48.75′N, 84°07.95′W, 7.vi.2000, T. S. Wood; **Illinois:** Will Co., Lockport Prairie Pond, 19.viii.1990, T. G. Marsh & T. S. Wood, Illinois Natural History Survey collection. **New York:** (probably Tompkins Co.), Cayuga Lake, vii.1943, labeled "Stanley Newcomer of Cornell U.", USNM 476 Rogick Collection. All specimens whole colonies in alcohol.

Remarks

Unlike the Ohio specimens, material from Cayuga Lake has a more sparse distribution of nodules on the fenestra, although all the other features are similar. Minor local variation is not uncommon among bryozoan statoblasts. The species diagnosis rests on the presence of both nodules and interstitial tubercles over the entire floatoblast surface regardless of the relative prominence of these features.

Floatoblasts of *P. nodulosa* bear strong resemblance to both *P. rugosa* (with annulus reticulation) and *P. orbisperma* (with nodules). *Plumatella rugosa* is extremely common throughout eastern North America and beyond; cellular elements of the floatoblast annulus are individually concave, producing the effect of raised reticulated lines at their edges, much like those of *P. nodulosa* (Fig. 5B, 5D). *Plumatella orbisperma* is rare and restricted to the Great Lakes region; the best specimen known to exist (USNM No. 5618) has a smooth floatoblast annulus except for a heavy rash of nodules (Wood and Wood 2000). Laboratory reared colonies of *P. nodulosa* derived from Ohio Greene County material are morphologically indistinguishable from the holotype.

Etymology

The specific epithet is from the Latin, *nodulus*, meaning knobby or knotty. *Nodule* is the accepted term for the tiny, rash-like protuberances that occur so abundantly on the floatoblast of this species.

Plumatella similirepens, new species
(Fig. 5A, 5C)

Diagnosis

Three features of the floatoblast distinguish this species from the European *P. repens*. The annulus is distinctly paved, not smooth (Fig. 5A); the annulus nodules are only sparsely distributed (Fig. 5C); and the suture lacks 2 crooked rows of large, tooth-like tubercles (e.g., fig. 11 of Wood et al. 1998). Only the latter feature is visible by ordinary light microscopy. By contrast, *P. rugosa*, within whose range *P. similirepens* occurs, has floatoblasts with concave annular cells and no nodules at all (Fig. 5B, 5D).

Description

Colony diffuse, spreading; long branches adhering entirely to substrate; body wall thin, transparent, colorless, with longitudinal striations but lacking keel. Internal septa absent. Floatoblasts laterally symmetrical, annular cells paved, sparsely dotted with minute nodules (Fig. 5A, 5C); suture marked by double, lumpy cord with no nearby tubercles (Fig. 5C); dorsal and ventral fenestra with raised reticulum and interstitial tubercles, the tubercles especially prominent at outer margins, these features less pronounced on ventral valve; polar grooves small, shallow. Sessoblasts strongly tuberculated on frontal valve; annulus well developed, lightly reticulated.

Material examined

Holotype. **USA, Illinois:** McHenry Co., Spring Grove Fish Pond, 0.5 km SW of Spring Grove, 88°14.42′W, 45°26.43′N, 28.vi.1990, T. S. Wood &

T. G. Marsh, Illinois Natural History Survey collection. *Paratype.* **Illinois:** Williamson Co., Little Grassy Creek at Fish Hatchery, 11.5 km SE of Carbondale, 28.ix.1990, T. S. Wood. All specimens whole colonies in alcohol.

Remarks

This North American species most closely resembles the European *P. repens. Plumatella similirepens* differs from the European species in morphological details of the floatoblast, as noted. I originally considered the differences part of the expected variation among such geographically disparate populations, but the discovery of *P. repens* in New Zealand (Wood et al. 1998), virtually identical to European material, suggests a strong morphological stability in this species. I interpret this finding as strengthening the species status of *P. similirepens.*

I encountered *P. similirepens* during a bryozoan survey of Illinois with nearly 300 collecting sites. These included 5 fish hatcheries, of which two, 570 km apart, are the only places where *P. similirepens* was found. I conclude either that the fish hatcheries offer conditions particularly suitable for this species, or else that the bryozoans were introduced to the sites along with received shipments of fish. The transport of viable statoblasts by fish is possible, having already been demonstrated in salamanders, frogs, turtles, and ducks (Brown 1933). The species has apparently neither spread from the 2 known sites, nor have additional sites been located.

Etymology

The specific epithet refers to the similarity of features shared with *P. repens,* which has been previously reported from North America (Rogick 1935, Bushnell 1965, Wood 1989), but never verified from statoblast ultrastructure.

Discussion

There are now 5 known bryozoan species with floatoblast nodules, including the 3 described here. *Plumatella repens* is so far the most common, with numerous records in Europe (Geimer and Massard 1986), the United Kingdom (Mundy 1980), and New Zealand (Wood et al. 1998). All other nodule-bearing species are known only from widely scattered and isolated sites. *Plumatella orbisperma,* for example, is documented only from a few ponds in Michigan (Bushnell 1965, Kellicott 1882) and Georgian Bay, Ontario (Ricciardi and Wood 1992).

The oddly sparse and wide distribution of nodular species complicates any simple scheme for natural grouping based on nodules alone. Conceivably, statoblast nodules could have evolved independently more than once. Although they arise presumably as subcellular elements of the floatoblast, their ontogeny and function are unknown.

When the tiny statoblast nodules were 1st highlighted by Geimer and Massard (1986), I wondered whether they might be ecophenotypic features, possibly imposed by bacterial contamination. However, laboratory rearing of the 3 species described here alongside other plumatellid species demonstrated the genotypic nature of floatoblast nodules. Second and 3rd generation floatoblasts of laboratory reared *P. bushnelli* and *P. nodulosa* retained their densely distributed nodules; those of *P. similirepens* invariably carried the same widely scattered nodules as the parental stock. By contrast, floatoblasts of *P. rugosa* and *P. reticulata* reared under the same conditions never developed nodules. Floatoblast nodules have been consistently either present or absent in every species I have studied.

Eight new bryozoan species have been described from North American fresh waters in the past dozen years, yielding a total of 22. Many of the new species are reported only from scattered sites or within a narrow geographic range, apparently being less vagile than their better- known relatives. Much of North America is still unexplored for bryozoans, including vast regions west of Ontario and the Mississippi River, so the likelihood of encountering additional new species remains high.

Acknowledgements

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