

A review of *Plumatella javanica* Kraepelin 1906 (Ectoprocta) with a reassessment of statoblast morphology

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A reexamination of the type collection of *Plumatella javanica* Kraepelin 1906, a freshwater ectoproct in the family Plumatellidae, provided an opportunity to review the morphology of the colony and compare observations of the type with various published accounts of the species. A study of the floatoblast, a resting structure important in freshwater ectoproct systematics, using scanning electron microscopy, has revealed or resolved previously undocumented characters and provides a basis for comparison with other described species of *Plumatella*. It is emphasized that examination of types of other species in the genus be carried out to help clarify the status of various described species, especially those occurring in tropical regions.

KEY WORDS: *Plumatella javanica*, Plumatellidae, Ectoprocta, type, systematics, tropics.

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INTRODUCTION

Bryozoans (phylum Ectoprocta) are among the most common animals that grow on submerged objects in aquatic habitats. The smallest class, Phylactolaemata, occurs exclusively in fresh water, where its species are widespread and often abundant. Nearly half of these approximately 60 described species are classified in the genus *Plumatella* (BUSHNELL 1965, LACOURT 1968). They include all species presumed capable of forming two types of dormant buds (statoblasts): one sessile and the other free floating. The large number of synonyms listed for each *Plumatella* species (see

LACOURT 1968) appears to be due to high morphological variability (see BUSHNELL 1965). Much of the synonymy has also resulted from insufficiently detailed species descriptions. Characteristics of colony growth and form, historically comprising significant portions of descriptions, are often greatly modified by environmental factors. Comparative studies conducted under controlled laboratory conditions, such as those by WOOD (1988) and WOOD & BACKUS (1992), help to separate non-genetic from genetic factors of morphology.

Another means of dealing with the problems of imprecise and inconclusive species descriptions is to reexamine the type specimens of described forms using modern techniques of character assessment. One such tool, the scanning electron microscope, is increasingly used to analyze surface features of statoblasts which distinguish some *Plumatella* species (e.g. MUNDY 1980, GEIMER & MASSARD 1986). A statoblast is essentially germinal tissue enclosed in a sclerotized capsule. The pattern of tubercles, raised reticula, and other features seem to provide reliable taxonomic information.

In this paper we analyze previous descriptions and accounts of *Plumatella javanica* Kraepelin 1906, and we present a scanning electron microscopical study of the free-floating statoblasts, or floatoblasts.

MATERIALS AND METHODS

Plumatella javanica was originally found by Karl Kraepelin in March, 1904, on the underside of *Nymphaea* sp. leaves near Tjitajam, a railroad stop between what are now Jakarta and Bogor, in Indonesia. Unlike the case with most *Plumatella* species, KRAEPELIN (1906) provided good documentation, with a detailed published description and a type specimen. It is the syntype, no. B-98 at the Zoologisches Museum in Hamburg, Germany, that we used in the present study.

Individual floatoblasts were air dried, mounted on Cambridge stubs and sputter coated with gold. Prepared specimens were then examined with a JEOL model JSM-5200 scanning electron microscope (SEM). The type material contained only floatoblasts. Sessoblasts, the second type of statoblast typically formed by *Plumatella* species, were not found in the sample.

RESULTS AND DISCUSSION

KRAEPELIN's (1906) description and line drawing of the syntype specimen of *Plumatella javanica* were generally accurate. In our examination, we found the colony entirely attached to its leaf substrate, with a few long branches spreading widely over the substrate. The ectocyst was nearly transparent and bore a low keel throughout its length. The furrow and zooid emargination were distinctly visible. Zooids were spaced at regular intervals of 2.7 mm, or somewhat closer near the branch tips. The width of the tubular branches was a fairly uniform 1.45 mm. In many places the ectocyst was flattened, as if those portions of the specimen had dried out at one time. Polypides had shrunken to less than half their original size. The entire specimen had nearly 50 elongate floatoblasts, with one or two per zooid.

Analysis of previous descriptions

Since KRAEPELIN's (1906) description of *Plumatella javanica*, the species has been reported from India (ANNANDALE 1910a), Yunnan Province of China (ANNANDALE

1910b), and Congo (WIEBACH 1964). Among the people contributing further information on the species, ANNANDALE (1910a, 1910b), WIEBACH (1967) and LACOURT (1968) had definitely examined syntype specimens. VORSTMAN (1928) had her specimens confirmed by Ernst Marcus in Berlin, who presumably also had access to Kraepelin's original material. TORIUMI (1952) apparently based his discussion solely on KRAEPELIN's 1906 document.

All of these papers show general agreement in the interpretation of the species. Authors agree that the colony is entirely recumbent and completely adherent to the substrate, producing linear series of zooids with few branches. The colony may also be compact (WIEBACH 1967: fig. 2, LACOURT 1968) with "antler"-like growth, presumably referring to the formation of a broadly curved branch with several smaller branches arising in one direction (KRAEPELIN 1906, WIEBACH 1967: fig. 3). There is general agreement on the transparent ectocyst and pronounced keel. However, zooid tentacle numbers are reported to be 45 (KRAEPELIN 1906), 20 to 27 (VORSTMAN 1928), and 20 to 45 (LACOURT 1968). We know of no other single bryozoan species in which such variable tentacle numbers have been described.

The floatoblast is oval and elongate, but dimensions are variable, as ANNANDALE (1911) clearly indicated. KRAEPELIN was impressed by the high ratio of length to width, which he gave as 1.88. Using the syntype, WIEBACH (1967) found the ratio to be only 1.68, which is also what we found, and exactly what VORSTMAN (1928) showed in her fig. 1-c. However, VORSTMAN's fig. 4 also illustrates a longer floatoblast, with length/width ratio of about 1.86. LACOURT (1968) specified a length/width ratio of 1.66-1.85, although his plate 15-j showed a floatoblast exactly twice as long as wide. The total floatoblast length measured by the above authors ranges from 0.325 to 0.460 mm.

The coverage of the floatoblast capsule by the annulus is variable, but generally more on one side than the other and the annulus on the least covered side is quite narrow, barely overlapping the capsule margin (WIEBACH 1967: fig. 8, type).

The sessoblast is described as elongate (ANNANDALE 1911) or oblong (WIEBACH 1967: fig. 4). This is unusual among plumatellids, where the sessoblast is normally broadly oval. The sessoblast length is variously reported from 0.325 to 0.480 mm.

TORIUMI (1952) convincingly disputed VORSTMAN's (1928) account of *Plumatella javanica*, claiming that she had a form different from KRAEPELIN's *P. javanica* and that her specimens were of a new species, *P. vorstmani*, described by him. TORIUMI (1952) maintained that true *P. javanica* had 45 tentacles, not 20-27, that the floatoblast was clearly "elongated," not round-oval as depicted by VORSTMAN (1928), and that sessoblast length of *P. javanica* was not so small as the specimens examined by VORSTMAN (1928). Otherwise, by his own admission, the two forms were indistinguishable.

Interpreting previous descriptions of the external surfaces of both the floatoblast and sessoblast of *P. javanica* by previous authors is complicated by both the apparent little regard given this feature and the limitations of available microscopical technology. ANNANDALE (1911) noted that the sessoblast is covered with "rudimentary air-spaces, some of which even contain air". This feature had not been described before or since in this or any other plumatellid. However, LACOURT (1968) described the sessoblast surface as "entirely covered by a reticulation", and further measured the "spaces" within the reticulum to be 0.008 mm. LACOURT extended this description to material from Canada collected by M. Rogick and examined by him. Recent study of

the same material (T.S. WOOD unpublished) suggest that the sessoblasts belong to *Plumatella reticulata* Wood 1988 which has a distinct surface superstructure of prominent reticulated ridges, easily seen with light microscopy. Since LACOURT (1968) apparently believed incorrectly that these specimens were *P. javanica*, he probably lacked a clear concept of the species.

WIEBACH (1967) spoke of an "apparent, regular tuberculation" on both floatoblasts and sessoblasts. However, his figures of statoblasts from both his collections and of the type specimen do not clearly confirm the presence of tubercles. Moreover, WIEBACH (1967) seemed ambivalent or uncertain about certain other morphological features of the floatoblast of *P. javanica*. MARCUS (1984) reiterated WIEBACH's (1967) apprehension over the identity of *P. javanica* and extended it to other tropical plumatellids as well. Consequently, it appears that with the available information some inconsistencies prevail.

Restudy of the floatoblast and conclusions

The floatoblasts of the type specimen, when viewed with SEM, reveal a unique ornamentation. The fenestrae of both surfaces of the capsule (Fig. 1A-C) show a dense pattern of rounded tubercles, or mammillations, extending to the inner annulus margin, although nearest the margin they become less defined. The mammillations are uniform in size, averaging about 4 μm in diameter, and leaving no open space between

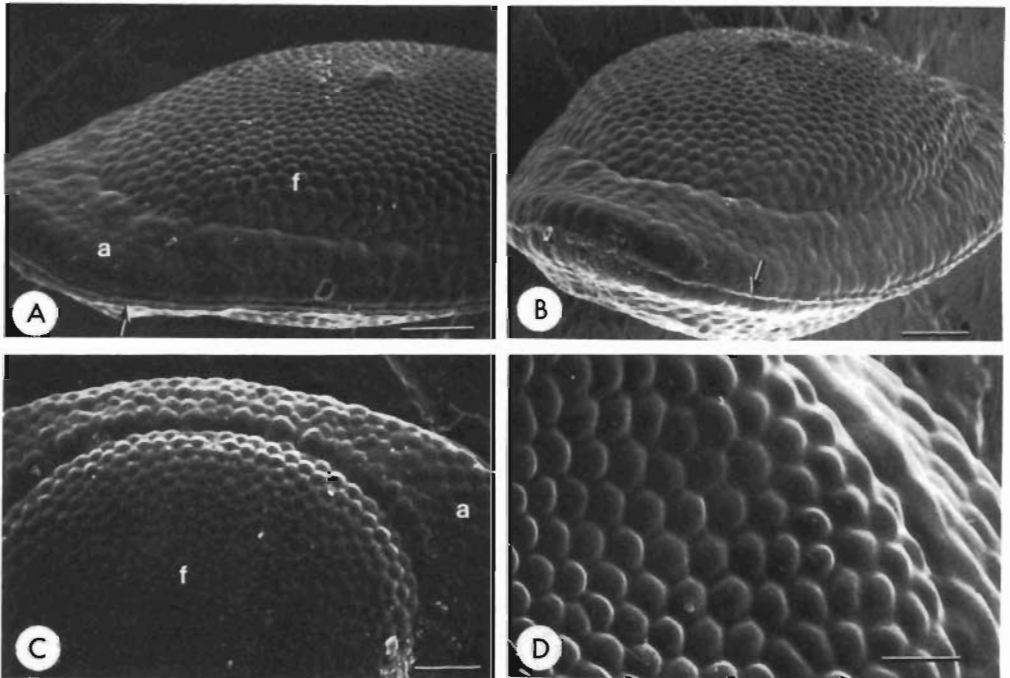


Fig. 1. — Surface morphology of floatoblasts of the type of *Plumatella javanica*. Arrows in (A) and (B) indicate suture, *a* = annulus, *f* = fenestrum. Scale bars in (A-C) are 50 μm , in (D) 10 μm .

them. Upon closer examination (Fig. 1C), the borders of the mammillations do not form an unbroken circle but are hexagonal and minutely pitted, the pitting most evident at the angles of the hexagon. The annulus surface is less sculptured (Fig. 1A-D), the mammillations are present but much less pronounced. Unlike other plumatellid species, there is no indication of a raised reticulation anywhere on the capsule surface. No raised reticulation appears on the annulus either. A single protuberance occurs at the center of the dorsal fenestra, similar to the structure on sessoblasts of *Plumatella casmiana* Oka 1907, or on certain floatoblasts of *Hyalinella punctata* (Hancock 1850). The suture (Fig. 1A-B, arrow) is consistent with certain other species of *Plumatella* and shows a raised thickened bead without special modification.

Such dense surface tuberculation has so far not been described in any other plumatellid species. Superficially it resembles the condition of *Hyalinella punctata* floatoblasts, but there the tuberculation is much less dense. The morphology of the floatoblast (specifically the capsule fenestra and annulus) as determined by SEM study, demonstrates features which clearly distinguish *P. javanica* from other well known species from tropical and temperate regions [*Plumatella repens* (Linn. 1758), *P. casmiana*] for which similar methods of study have been applied. It is certainly different from populations of an as yet undetermined West Indian and Central American species (SMITH 1993). Unfortunately, the absence of sessoblasts in the type material of *P. javanica* prevents additional comparison.

The question remains as to whether other poorly known but somewhat similar tropical species are distinct from one another in terms of statoblast morphology as well as other morphological and non-morphological characteristics. Clarification is especially needed to distinguish *Plumatella philippinensis* Kraeplin 1887, *Plumatella agilis* (Marcus 1942), and *Plumatella longigemmis* (Annandale 1915), which have equatorial and overlapping distributions. The reality of declining biodiversity in many tropical regions undergoing rapid economic development necessitates renewed taxonomic efforts in order to better understand the systematic relationships of these animals and to optimize conservation efforts.

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