

## A NEW TYPE OF BRYOZOAN GIZZARD, WITH REMARKS ON THE GENUS *BUSKIA*.

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A certain few of the Ctenostome Bryozoa have long been known to possess a gizzard or grinding organ at the cardiac end of the stomach, though such information may be sought for in vain in nearly all text books dealing with the group.

This structure is best known in the genus *Bowerbankia* Farre, owing to the work of Hincks (1880, text figure on p. xxiii and discussion on pp. xxiv-xxvii), and especially to the excellent histological description by Calvet (1900, p. 227-230, 232-234, Pl. VI, Fig. 13 and Pl. VII, Fig. 4).

Davenport (1891, p. 63) incorrectly homologizes the gizzard with the lower end of the chlostone œsophagus. Calvet (1900, p. 233) is undoubtedly correct in stating that it is the cardiac end of the stomach which is thus modified.

The genera *Amathia* Lamouroux, *Vesicularia* Thompson and *Avenella* Dalyell also possess a gizzard similar to that of *Bowerbankia*. All of these genera belong to the family Vesiculariidae.

In the foregoing genera the gizzard has the appearance of a rounded distension of the cardiac end of the stomach, or, to quote Calvet (p. 228), "la forme d'une sphere tronquee aux deux poles." The epithelial lining of the gizzard consists of enlarged and elongated cells which are easily visible under the ordinary low power of the microscope. The walls of these cells at their inner free ends are heavily chitinized, so that each cell thus presents a separate pointed chitinous tooth for the trituration of the food, (see Fig. 8). The bryozoan gizzard as thus described is unique in its armature.

A strong layer of circular muscles completes the grinding apparatus, which operates by rhythmic contraction and relaxation. Hincks (1880, p. xxvii) states that he has seen the food, after passing through the gizzard, driven back into it by a retrostaltic movement of the stomach and again submitted to its action.

The new type of gizzard to be described has been discovered in another family of the Ctenostomata, the Buskiidæ, of which the genus *Buskia* Alder is the only representative. Alder (1856, p. 156) failed to note the presence of a gizzard in *B. nitens* and Hincks (1880, p. 532) also failed to discover it. Later Hincks (1887, p. 127) described *B. setigera* from the Mergui Archipelago, again failing to note the presence of a gizzard. The small size of the individual in *Buskia* (in *B. armata* the length is .6 mm. and the breadth .2 mm.) and the much smaller size of the gizzard in comparison with that in the Vesiculariidæ, together with the fact that it is divided into lobes, are responsible, no doubt, for this failure to find it.

In 1912 Osburn (p. 256) re-described Verrill's *Vesicularia armata* under the name *Hippuraria armata* (Verrill). In his original description Verrill (Verrill and Smith, 1874, p. 710) had not noticed the gizzard in this species. Osburn figured and described the gizzard for the first time (p. 256, Pl. XXIX, Figs. 84a and 84b). See Figures 1 and 2.

More recently Harmer (1915, pp. 85-89) has restudied the genus *Buskia* and has found a gizzard in *B. nitens* and *B. setigera*. If his figures (Pl. 5, Figs. 10, 15 and 16), which are small and not detailed, are to be relied on, the gizzard in these species is of the same type as in the *armata* of Verrill. Harmer indicates that *armata* belongs to the genus *Buskia* and is closely related to *B. setigera*, a conclusion with which we are quite ready to agree. There is reason for considering it a distinct species, however, for *armata*, as far as observed, does not possess basal spines for the firmer attachment of the zoecium and the zoecial wall is not perfectly transparent as described by Hincks, but is of a yellowish horn color. *Buskia armata* should be kept separate for the present at least, especially since its distribution in the North Atlantic lies to the northward and it tends to disappear toward the tropics.

Osburn's description of the gizzard (1912, p. 256) is as follows: "a small but distinct gizzard, not completely surrounding the gut, but forming several rounded lobes, with pointed teeth projecting into the cavity." The four lobes of the gizzard, with a band of circular muscles, is shown by Osburn in Plate XXIX, Figs. 84a and 84b.

The nature of the gizzard lobes and their mode of formation have been worked out by the junior author. The grinding

structure consists of four mamillate, or low, rounded-conical structures, which are heavily chitinized, provided with pointed chitinous teeth of varying length and thickness and which are continuous with the chitinous cone. The arrangement of these cones, with their bases directed outward, gives a somewhat squared outline to the gizzard in cross-section, as shown in Pl. I, Fig. 3. The rounded surfaces, with the teeth projecting into the lumen of the digestive tract, practically close the cavity when the gizzard muscles are contracted, and the teeth are interdigitated when in this position. In operation in the living specimen, the gizzard lobes are seen to separate for some distance and then to close strongly and sharply together.

While in *Bowerbankia* and related genera each epithelial cell of the gizzard is chitinized on its grinding surface (see Fig. 8), thus making as many teeth as there are cells, in *Buskia* this is not the case. The hollow concavity of the chitinous cone is filled with elongated epithelial cells, those nearest the center being the longest. Together these cells secrete the chitinous lobe as one continuous structure, the teeth also being a part of the mass (Figures 3 to 7).

With its band of muscles, the entire gizzard in *Buskia armata* measures only about .075 mm. in diameter. Each cone measures about .0414 across the base and about .0234 in height. The teeth are quite variable in size but average about .007 mm. in height. Each cone bears about 30 teeth, though often the number is much less than this, and the teeth at the tip of the cone are larger and stronger than those farther down on the side. The layer of chitin is about .002 mm. in thickness, when fully developed, but thins out somewhat toward the base and then suddenly becomes thickened at the margin to form a ring about the base. The teeth are conical and hollow at the base and the chitin forming them is somewhat thicker than that of the cone on which they are borne. These relations are well shown in Figures 3 to 7.

Much variation is shown in both sections and total mounts in the exact form of the chitinous cones, possibly depending somewhat upon the amount of chitinization. Sometimes the lobes are almost hemispherical and seem to lack the rim around the base. As such structures appear thinner and lighter in color, it is probable that they have not reached their full devel-

opment. The teeth also vary much in form, size, number and the angle at which they project.

The difference in the structure of the gizzard affords additional evidence for the separation of the family Buskiidæ from Vesiculariidæ, the other family in which a gizzard is known to occur. That *Buskia* represents a higher specialization in the formation of a grinding organ can scarcely be doubted. There are other evidences of a more highly specialized condition in the greatly elongated and spiral arrangement of the bristles supporting the collar and in the mode of branching, (see Fig. 1). The presence of a lateral membranous area also marks this family off sharply from the Vesiculariidæ.

*Buskia armata* (Verrill) is the only species thus far recorded from the Atlantic coast of North America. Its known distribution is from Massachusetts Bay to Beaufort, North Carolina. On the southern New England coast it grows profusely, spreading over hydroids, algæ, etc. In this region it often rises in free branches more than an inch in height, but toward the limits of its range only the creeping adherent stage is seen.

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## EXPLANATION OF PLATE.

Figures 1 and 2 are from Osburn's Bryozoa of the Woods Hole Region. Figure 8 is modified from Calvet, Bryozoaires Ectoproctes Marins. Other figures by the junior author.

- Fig. 1. An individual of *B. armata* (Verrill), the zooid retracted. The gizzard is shown in partial side view (at G) and the spiral bristles of the collar (at B).
- Fig. 2. Complete intestinal tract, showing the oesophagus (O), gizzard (G), stomach (S) and intestine (I).
- Fig. 3. Diagrammatic cross-section of gizzard showing circular muscles (M), epithelium (E) and chitinous cone (C) with teeth.
- Fig. 4. Diagrammatic side view of a cone showing the arrangement of the teeth and the thickened rim around the base.
- Figs. 5, 6 and 7. Camera lucida drawings of actual cross-sections of different cones. Some of the differences in form may be due to the fact that they are not cut quite in the same direction.
- Fig. 8. Cross-section of the gizzard of *Bowerbankia* for comparison. Note that here each epithelial cell bears its own chitinous tooth. The enlargement is much less in this figure than in the others.

