Bryozoans

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Bryozoans

Bryozoans are one of the most abundant kinds of marine animal fossils, and they are also common inhabitants of marine and fresh water today. From 500 million years ago to 230 million years ago and again from 75 million years ago to the present, the calcium carbonate skeletons of bryozoans made up a large part of many lime deposits that accumulated on the sea floors. However, they are sometimes overlooked because they often do not have an obvious, symmetrical shape.

Fossil bryozoans may not have a symmetrical shape because every specimen is a complete or broken piece of a colony made of many tiny units called zooids (Figure 1). There may be hundreds of thousands or even millions of zooids in large colonies.

Each colony started from a small swimming larva that eventually settled and changed into the first zooid of the colony. The first zooid began feeding by using its tentacles to draw in tiny food particles from the nearby water. Extra energy from this food was used to bud first one then more and more zooids, each of which had its own set of tentacles for feeding. As more zooids began to feed, they too helped the colony to grow, both by adding their own extra energy and by forming a base from which more zooids were budded.

Because the colonies consisted of many small zooids, added unit-by-unit, they could grow into many regular or irregular shapes (Figure 2). That is one reason why they are often overlooked by collectors.

Some colonies grew as thin, dividing threads across shell or rock surfaces. Others grew as thin or thick sheets on hard surfaces and, if the shell or rock on which they were growing was overturned by moving water or moving animals, they could keep growing and completely enclose what they started growing on. Still others grew away from the sea floor as brittle bushes made of round or flattened branches. These were sometimes preserved in their entirety if they grew in a very quiet environment, but usually they got broken up into short branch fragments or, if branches were so wide they were more like sheets, into small irregular plates. This tendency to break up into small pieces is another reason that bryozoans are sometimes difficult to recognize.

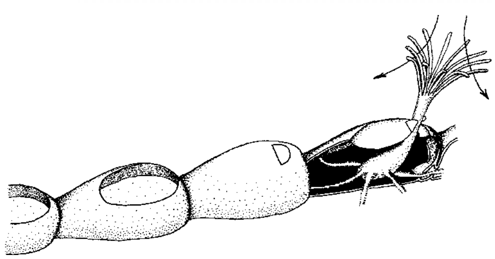

Figure 1. A single chain of bryozoan zooids, enlarged about 10 times. The zooids show features characteristic of the group Cheilostomata. The zooid on the left is dead and has only skeleton remaining, the middle zooid is living but closed, and the living zooid on the right has its feeding structures protruded. The arrows above the feeding zooid indicate the direction of flow of food-bearing water. Based on a drawing in Lidgard and Jackson 1989.

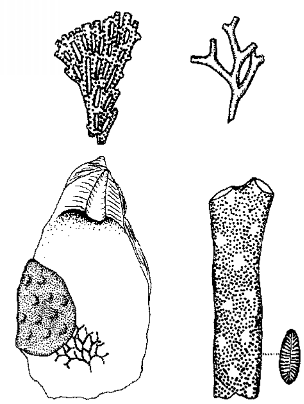

Figure 2. A few of the many shapes that bryozoan colonies can develop. Most of these drawings, plus the one on the front of this brochure, are taken from works by E. O. Ulrich, an important 19th century American specialist on fossil bryozoans. The colonies are drawn approximately life size.

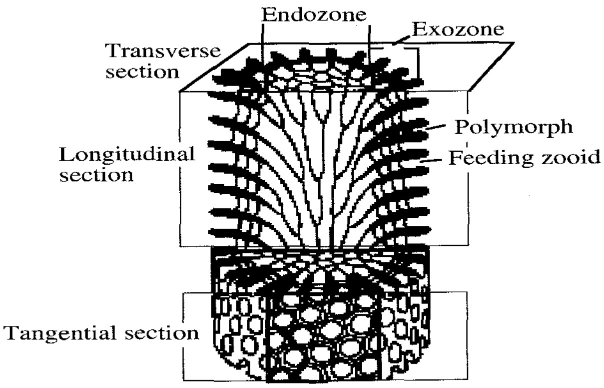

Figure 3. Enlargement of part of a stenolaemate colony that has been cut and polished to show the skeletal remnants of zooids. From Boardman and Cheetham 1987, used with permission of Blackwell Scientific Publishers.

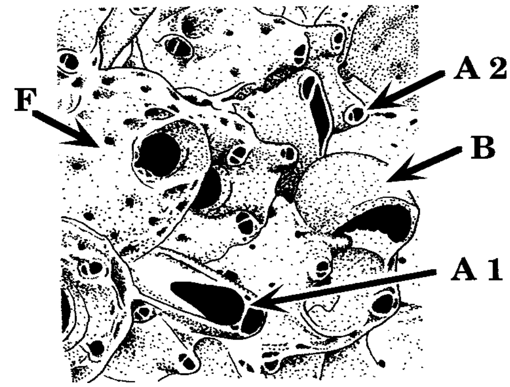

Figure 4. Two kinds of avicularia on a fertile cheilostome colony. A 1, a large avicularium between feeding zooids; A 2, one of many small avicularia on top of feeding zooids; B, brooding chamber of a female zooid; F, a normal feeding zooid. Approximately 15x magnification.

Zooids are usually about 0.5 mm or smaller in surface dimensions, but there are a few species with "giant" zooids over 1 mm in length. A large group of bryozoans (the Stenolaemata) are characterized by elongate, tubular zooids (Figure 3).

As the skeletal tubes grew longer in many species, a series of partitions was built across each tube in order to seal off its lower parts. Stenolaemates are still alive and are abundant in some places, but they were more conspicuous and numerous during the Paleozoic (500 million to 230 million years ago) and the mid-Mesozoic (175 million to 100 million years ago). The other bryozoans that are common as fossils are the Cheilostomata, which evolved 150 million years ago and became very abundant 100 million years ago. Cheilostome zooids are short and are often shaped like shallow boxes (Figure 1).

Feeding zooids are essential for colonies to grow, and these also fill all the other essential life functions in some species. However, specialist zooids are also present in colonies of many other species. These zooids may specialize in reproduction, defense, structural support, attachment, or other functions. In some cases the specialists can feed, but in other cases they can not so must be nourished by the zooids that do feed. The most interesting specialists are the avicularia, which grow between or on the normal feeding zooids in most species of cheilostomes (Figure 4). Some avicularia apparently help defend the colony against predators or settlement of fouling organisms.

Budding new zooids onto the surface should allow a colony to grow into almost any conceivable shape. But colony shapes have always been limited to a few types, some of which were encrusting, some erect, and some freeliving. This is because each feeding zooid must be at the surface of the colony, and the water that the feeding zooids draw toward the colony must have some way to flow away after the food is captured (Figure 5). Either the colony must be only a few zooids wide so that all the filtered water can flow out from the colony around its margins, or there must be local "collection points" (known as chimneys) regularly scattered across the colony's surface where the filtered water rushes away in a narrow, rapid stream. Another way to eliminate the filtered water is to have all the feeding zooids on one side of narrow, closely spaced branches, but with enough space between branches for the water to be pushed through to the back side of the colony. Some living bryozoans have this kind of feeding current, and it apparently was the way that the Paleozoic fenestrates (Figure 6) handled the water from which they fed.

Collecting Fossil Bryozoans

Bryozoans can be found as fossils in a wide variety of marine rocks. They are so abundant that their piled-up branches make the frame work for some limestones, including the latest Cretaceous and earliest Tertiary chalks in parts of northern Europe and many of the Paleozoic "marbles" used in buildings in North America. They are easiest to find and collect in thinly interbedded clay-rich limestones and marly shales.

Detailed information about zooids is usually necessary to identify bryozoans correctly, so their study requires examination with a microscope. Cheilostomes and some stenolaemate bryozoans can be identified by studying the zooids' surfaces, either with a microscope that uses light

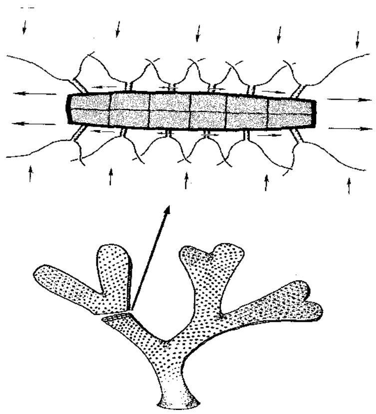

Figure 5. Cut-away view of a colony, showing the feeding zooids. Beating of cilia that line the tentacles drives a food-bearing current that flows down into the bell of tentacles. Food particles are collected at the mouth, and filtered water flows below the tentacles and leaves the colony along the closest edge. Lower drawing is about natural size.

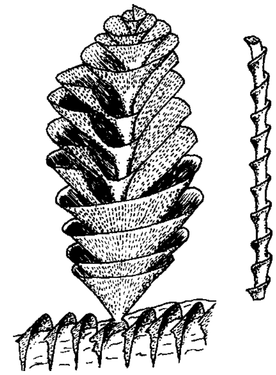

Figure 6. Archimedes is a fenestrate bryozoan that is common in Mississippian age sedimentary rocks in North America. The corkscrew structure shown on the right is the most commonly noticed surviving part. The corkscrew was a central support column for a spiralled lacy sheet, as shown on the left, made of thin branches that were connected by small skeletal bars. Fenestrates are a subgroup of the Stenolaemata that are characterized by thin branches separated by narrow openings. Approximately natural size.

reflected from the surface of the colony or with a scanning electron microscope. Identification of most stenolaemates requires additional information about shape of the skeletal tubes, the microscopic texture of the walls, and any extra structures that were built within the tubes. The best way to get this information is from paper-thin slices called thin sections or plastic peels made from polished and etched surfaces cut through the colony's interior (Figure 3). The thin sections and peels are studied with microscopes in which light passes through the specimen rather than being reflected from the surface.

Suggested Readings

Bassler, R. S. 1953. *Bryozoa. Treatise on invertebrate paleontology*, Part G (edited by R. C. Moore). Geological Society of America and University of Kansas Press. Boulder, CO and Lawrence, KS.

Boardman, R. S. and others. 1983. *Bryozoa. Treatise on invertebrate paleontology. Part G, Volume 1 (revised)* (edited by R. A. Robison). Geological Society of America and University of Kansas Press. Boulder, CO and Lawrence, KS.

Hayward, P.J. and others (editors). 1994. *Biology and palaeobiology of bryozoans*. Olsen & Olsen. Fredensborg, Denmark. (This is the latest of a series of books containing short papers on living and fossil bryozoans, based on research presented at the triennial meetings of the International Bryozoology Association. It can be used to find lists of earlier papers on bryozoans in the scientific literature.)

McKinney, F. K. and Jackson, J. B. C. 1989. *Bryozoan evolution*. University of Chicago Press. Chicago, IL.

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