ANATOMY AND PHYSIOLOGY OF THE WINGSHELL ATRINA RIGIDA

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BENJAMIN H. GRAVE

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BY

BENJAMIN H. GRAVE

A Dissertation

SUBMITTED TO THE BOARD OF UNIVERSITY STUDIES OF THE JOHNS HOPKINS UNIVERSITY IN CONFORMITY WITH THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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ANATOMY AND PHYSIOLOGY OF THE WING-SHELL ATRINA RIGIDA.[a]

By BENJAMIN H. GRAVE,
Assistant Professor of Zoology, University of Wyoming.

INTRODUCTORY.

Atrina rigida (Dillwyn) occurs along the eastern coast of America from the northern shore of South America as far north as Cape Hatteras. At Beaufort, N. C., where most of the observations reported in this paper were made, this species is confined to shallow water near low-tide mark, occasionally being exposed during unusually low tides. Another species, *Atrina serrata* (Sowerby), is found in the deeper water of the inlet. The largest specimen found measured 14 by 9 by 3 inches, but the average size is only about 11 by 8 by 2½ inches.

This mollusk is not without an economic interest and value. The black pearls formed in *Atrina* and *Pinna*, and produced in considerable numbers, have been used in the manufacture of brooches and other articles of jewelry, and there is no reason why they should not be used more extensively. They are usually spherical in shape and quite smooth.

The pearls are not found in all specimens, but as many as ten have sometimes been found in a single individual. At a rough estimate I should think pearls would be found in about one-fifth of the individuals. This was about the proportion as regards those examined during the preparation of this paper.

The byssus has been used extensively in the manufacture of various articles, such as shawls, caps, waistcoats, gloves, purses, etc. The following quotation from Simmonds's Commercial Products of the Sea gives in a few words the extent to which the byssus has been used in the past, as well as its present standing as a commercial product:

> The ancients made this [the byssus] an article of commerce, greatly sought after, and the robes formed of it, called "tarentine," were very much in esteem. * * * * *

[a] Dissertation submitted to the Board of University Studies of the Johns Hopkins University in conformity with the requirements for the degree of doctor of philosophy.

I am indebted to Prof. W. K. Brooks for the suggestion that I undertake the study of the anatomy of *Atrina*. My thanks also are due especially to Prof. E. A. Andrews, under whose direction this work has been done and who has offered many helpful suggestions and stimulated my interest in biological study. I am indebted to the Commissioner of Fisheries for the use of a table at the fisheries laboratory at Beaufort, N. C., during the summers of 1908 and 1909; to H. D. Aller, director of the laboratory, for many conveniences while there and for assistance in procuring material; to Prof. G. A. Drew for counsel and suggestions; and to Prof. William H. Dall, of the Smithsonian Institution, for the determination of the species and the free use of his library.

Even in the present day the fiber is utilized, but more for its rarity than anything else. The women comb the *lana* [byssus] with very delicate cards, spin it, and make from it articles which are much esteemed for the suppleness of the fiber and their brilliant burnished gold luster.

A considerable manufactory is established at Palermo; the fabrics made are extremely elegant and vie in appearance with the finest silk. The best products of this material are, however, said to be made in the Orphan Hospital of St. Philomel, at Lucca.

This byssus forms an important article of commerce among the Sicilians, for which purpose considerable numbers of *Pinna* are annually fished up in the Mediterranean from the depth of 20 to 30 feet.

Under normal conditions *Atrina* occupies one position during its entire life—nearly buried in the mud, with its anterior end downward. The enormous byssus extends deep into the mud and attaches to shells and coarse pebbles. Specimens are most easily collected in calm weather at low tide, when they can be seen extending an inch or less above the surface of the mud.

In the following discussion, although the continuity is thereby interrupted, it seems advisable to treat the organs under separate headings, passing briefly over those which have yielded nothing of particular interest. To avoid repetition the anatomy and physiology of the organs will be treated together. The general anatomy is shown in figures 16 and 20.

Since every species is adapted to its peculiar mode of life certain anatomical features are better understood when their function is known. It has therefore been my purpose to study habits and function as well as anatomy.

SHELL.

The shell valves are large in comparison with the size of the body, and they are united to each other along one side by a hinge ligament which extends in a straight line from their anterior to their posterior ends. The hinge ligament is more or less calcified, so that it is not greatly different from the other parts of the shell. The outer surface of each shell is studied with spines, which are distributed in rows radiating from the anterior pointed end as a center to the posterior end. Primary, secondary, and tertiary rows of spines may be distinguished in the shell of a large specimen. The portion of the shell which lies posterior to the adductor [a] consists of a single layer in contrast to the typical lamellibranch shell, which has three layers, easily distinguishable by difference in structure or material. It apparently corresponds to the middle or prismatic layer of the typical lamellibranch shell, being composed of prisms which lie at right angles to the surface. When the surface is examined with a compound microscope it appears honey-combed, while a transverse section, obtained by grinding, looks not unlike a lot of quartz crystals corded like wood. (See fig. 1.) It is possible to dissolve out the lime salts with acid, leaving behind only the organic matrix. This matrix resembles cork in many respects, but when examined histologically it is seen to have the same gross structure as the shell before treatment with acid, except that the chambers formed by the organic matrix are now empty.

[a] I refer here to the posterior adductor muscle, and unless otherwise stated further references to the adductor may be taken to mean the posterior adductor.

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The portion of the shell in the region of, and anterior to, the adductor is composed of two layers, there being a second or nacreous layer of the ordinary type deposited upon the inner surface of the prismatic. This layer is secreted by the general surface of that part of the mantle which lines the shell in these regions. The outer layer frequently wears through, or becomes brittle and broken, on the older portions of the shell, leaving the nacreous layer exposed. A discussion of experiments on the growth and regeneration of the shell will be found at the end of the next section.

MANTLE.

The mantle is a muscular membrane, the folds of which adhere closely to the shell, but are attached to it only at a single point just ventral to the adductor muscle. The muscles which control the ventral and posterior portions of the mantle are attached here and radiate from this point as divisions and subdivisions of a single bundle. Another bundle of muscle fibers is located near the dorsal part of the body. It is not attached to the shell at any point, but is inserted into the mantle itself. This bundle of mantle muscles also divides and subdivides into smaller and smaller bundles and is distributed to a portion of the posterior part of the mantle. (Fig. 16, pl. XLVIII.) It is thus seen that there is no pallial line in the shell for the attachment of the mantle muscles, though that is so common among lamellibranches. Since the muscles are attached so high up, the mantle margin can be withdrawn a considerable distance from the edge of the shell; in fact, it can be withdrawn nearly to the adductor. After being contracted the mantle again expands by creeping outward upon the shell, to which it adheres closely. This result can not be brought about at once. At least half an hour is required for the mantle to again reach the edge of the shell after having been fully contracted. There are no siphons, but the two lobes of the mantle are united posteriorly by an intermantle septum at the place where siphons might be expected to occur. This structure consists of two prominent ridges, one on each mantle lobe, which stretch across posterior to the gills to meet each other in the mid line. Each mantle ridge is continued anteriorly, though reduced in size, and forms the place of attachment for the upper borders of the reflexed lamellæ of the outer gills.

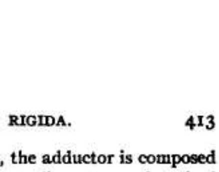

FIG. 1.—The shell. *a*, Surface view; *b*, transverse section showing prismatic structure.

On account of the position assumed by *Atrina*, only the posterior portion of the mantle is exposed to frequent sensory stimulation. Connected with this fact we find that the edge of each mantle lobe has a row of short sensory tentacles, which decrease in size and gradually disappear toward the anterior end. This part of the mantle is thick and muscular, as an adaptation to burrowing. A deep narrow passage or groove, formed by the development of two tall ridges on the inner surface of the mantle, is also correlated with burrowing. (Fig. 16, D, pl. XLVIII.) This groove lies parallel to the edge of the mantle and extends from the region of the foot to the intermantle septum,