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THE BORING-SPONGE, CLIONA.

BY JOSEPH LEIDY, M. D.

Among the ocean debris of the neighboring Atlantic coast, shells of the oyster, *Ostrea Virginiensis*, and of the clam, *Venus mercenaria*, conspicuous from their being riddled with holes, are frequent. When I first saw such shells I suspected that the numerous perforations were due to an annelid or perhaps a boring mollusk. In 1856, while at Beasley's Point, on Great Egg Harbor, New Jersey, I had the opportunity of observing the shells of both dead and living oysters drilled in the same manner and with the borings occupied by a living, soft, yellow, silicious sponge. A notice of my observations on the sponge, attributed to the genus *Cliona*, with its character, peculiar habit, and incidental importance in the economy of nature, was published the same year in the Proceedings of this Academy, Vol. VIII, p. 162.

Apparently the massive form of the same sponge, was previously described by Desor, under the name of *Spongia sulphurea*, occurring in Vineyard Sound (Proc. Boston Nat. Hist. Soc., 1846, 68).

Later, the sponge of the same locality was noticed by Prof. Verrill as *Cliona sulphurea*, and is described as commencing in the condition of a boring form on dead shells and subsequently growing into masses six or eight inches in diameter (Rep. U. S. Fish Commission, 1873, 421).

In Little Egg Harbor, in the vicinity of Beach Haven, N. J., I have observed the boring-sponge in various stages from the condition in which it occupies the shells of oysters and clams with its sensitive papillæ and oscules protruding from perforations of the surface of the shell, to variously massive forms enclosing at their base the riddled shells from which they sprung. Sometimes I have observed a mass enveloping a pair of open, perforated, shells of an oyster or clam in which the shells were still united at the hinge. Often too, a massive sponge envelops, together with its original cradle, fragments of other shells, pebbles and sand. To the fishermen of Beach Haven, the massive sponge is familiar under the name of Bay-pumpkin; often growing to the size of one's head.

In the oyster beds, the boring-sponge especially invades the upper or more exposed shell, and the living oyster incessantly protects itself by the formation of new shell-layers. The sedentary habit of

the oyster favors the invasion of its boring enemy. The free moving clam, while alive, appears to be exempt from its attack, but the shells of the dead clam are as thoroughly invaded and riddled as those of the oyster. I have occasionally met with an isolated valve of the *Maetra solidissima*, *Pecten irradians*, and the horse-mussel, *Modiola plicatula*, which exhibited the perforations of the boring-sponge, but none containing the living sponge. In one instance I obtained a clam shell having attached to it a shell of *Ilyanassa obsoleta* and tubes of *Serpula*, all together, drilled by the living *Cliona*. On the cultivated oyster beds the massive *Cliona* is less frequent than upon accumulations of dead oyster and clam shells elsewhere, probably from the circumstance that it is more liable to disturbance in its growth in collecting oysters from the beds.

A boring-sponge closely resembling, if it is not identical with ours, and having the same habits, occurs in European seas. It was first definitely noticed by Dr. R. E. Grant, in the Edinburgh New Philosophical Journal, 1826, p. 78, and found on the shells of dead and living oysters (*Ostrea edulis*), in the Frith of Forth, Scotland. The description of the sponge accords with my observations on the boring-sponge as above indicated. From the accidental attachment of some polyps to the sponge, observed by Dr. Grant, supposing the polyps to belong to the sponge, he described it as a zoophyte and named it *Cliona celata*. He also regarded the borings occupied by it as not due to the sponge, but to annelids, though in the concluding part of his account he remarks that it may be questioned whether the shape of the silicious spicules and constant currents of the papillæ do not exert an influence in forming or enlarging the habitation of the zoophyte.

In 1840, Dr. G. D. Nardo, announced the occurrence of the boring-sponge of the oyster in the Adriatic, and gave to it the name of *Vioa* (Un nuovo genere di Spongoli silicei.) Shortly after, Duvernoy noticed the boring-sponge in the *Ostrea hippopus*, at Dieppe, and gave to it the name of *Spongia terebrans* (Comptes rendus, 1841, 683).

Dr. George Johnston, in 1842, in his History of British Sponges, p. 125, described the boring-sponge of the oyster, under the name of *Halicondria celata*, from the oyster beds of Inchkeith and from the Frith of Forth. He also referred to the same species a massive variety dredged in Buttribuy Bay.

In 1849, Mr. Albany Hancock, in a paper "On the excavating Power of certain Sponges belonging to the genus *Cliona*," described

the *Cliona celata*, which he observes is the most destructive species to oyster shells, and abounds in the Frith of Forth. His paper is accompanied by a figure of the sponge occupying an oyster shell, and the author remarks that the *Cliona* undoubtedly works out the cavities it inhabits, whether mechanically or otherwise. He attributes the boring power to silicious granules on the surface of the sponge and to its contractility. The silicious granules are figured as hexagonal plates with hexagonal markings. Mr. Hancock also describes boring-sponges found in a number of other molluscous shells, which sponges he referred to several other different species of *Cliona* (Annals and Magazine of Natural History, Vol. VIII, p. 321).

N. Lieberkuhn, in 1859, described the *Cliona celata* as living in oyster shells at Heligoland, and attributed the boring of the shells to the sponge (Archiv für Anatomie, Vol. 26, 515).

Dr. Bowerbank, in his work on the British Spongidæ, II, 1866, 212, referred the *Cliona celata* of Dr. Grant, to another genus, with the name of *Hymeniacidon celata*, to which he also refers the other boring-sponges described by Mr. Hancock. He reports it as occurring in all parts of Great Britain in oyster and other shells, and also in limestone rocks of Tenby. Dr. Bowerbank doubted the boring power of the sponge and regarded it as merely occupying the deserted habitations of living annelids. Rev. A. M. Norman, editor of the fourth volume of the same work, remarks that Dr. Bowerbank persistently refused to entertain any other opinion than that the *Cliona* only occupied previously-formed excavations, and had no power of penetrating shell or stone.

Dr. Johnston is the only European authority who ascribes a massive form of sponge to the same species as the ordinary boring form of oyster shells. Dr. Bowerbank describes and figures a large massive sponge, common on the British coast, under the name of *Raphyrus Griffithsii*, and refers to it the massive variety of *Halichondria celata* of Dr. Johnston, observing that it is not a matter of surprise that it should have been confounded with Dr. Grant's *Cliona celata*, the spicula of the species being so very similar in size and form.

Dr. O. Schmidt describes *Cliona celata*, under the name of *Vioa celata*, occurring on oysters and stones in the Adriatic, and remarks that its spicules are pin-like and of one kind only, (Supplement der Spongien des Adriatischen Meeres, 1864, 40). His distinctive char

acter of *Vioa* is that it is parasitic, and lives in perforations of shells and stones (Die Spongien der Adriatischen Meeres, 1862, p. 40). He also describes what he considers to be a new genus of sponges, *Papillina*, which, except in name, I cannot distinguish from *Cliona*. The species *Papillina suberea* he describes as yellow with numerous warts on the surface and with only pin-like spicules. Bowerbank regards it the same as *Raphyrus Griffithsii*, corresponding with the *Halichondria celata* of Johnston, who described it as a variety of Dr. Grant's *Cliona celata*, and this is admitted by Schmidt (Spongien der Atlantischen Gebietes, 1870, 77). The latter further describes a cushion-like (*polsterförmiger*) *Papillina*, from the coast of Florida, which likewise appears to be a *Cliona*.

As the massive form of *Halichondria celata* of Johnston, synonymous with *Raphyrus Griffithsii* of Bowerbank and *Papillina suberea* of Schmidt, accords in color and structure, and in the form and size of its silicious spicules, with *Cliona celata*, it seems to be related to this, as our massive *Cliona sulphurea* is to the boring form of the oyster and clam. It remains to determine whether our boring-sponge of the oyster is the same species as that of European seas. So far as we may judge from the descriptions of the European sponge in comparison with ours they appear to be identical in color, form, structure and habits. Both also have but one kind and form of silicious spicules. But in these, if the records are correct, we find a very considerable difference in size. Grant, Hancock, Bowerbank, and Lieberkuhn give as the size of the spicules of *Cliona celata*, about $\frac{1}{8}$ th of an inch, while in all our forms of *Cliona*, in the oyster and clam and in the largest massive varieties, the size of the spicules is only about $\frac{1}{16}$ th of an inch. Moreover, if the observation of Mr. Hancock is correct and I have not erred in my own, there is still a more remarkable difference.

In the boring-sponge of our oyster and clam I could detect no trace of the silicious, hexagonal granules, which Mr. Hancock regards as the instruments of boring of *Cliona celata*. In the position indicated for these granules, in repeated examinations, I could find nothing but a few scattered irregular particles of quartz sand. The only distinction then, if future observations prove them really to exist, between *Cliona sulphurea* and *Cliona celata*, are the considerably longer, silicious, pin-like spicules of the latter and the presence in the boring form of additional hexagonal, silicious granules; otherwise both would pertain to the single species *Cliona celata*.

A different and pretty form of *Cliona*, and probably an undescribed species, is exemplified by specimens obtained on the coast of Florida by Mr. Joseph Willcox. Though from the same locality, they do not appear to accord with the descriptions of Schmidt of *Papillina cribrosa* and *arenosa* (Spongien des Atlantischen Gebietes, p. 48).

In four specimens, of which one is a twin, making, according to the ordinary view, five individuals, all accord in their upright cylindrical, sausage-like form. In their present state all but one are somewhat dusky-white spotted by brownish rings and smooth as if water-worn. The remaining specimen, shorter and more robust than the others, is dark-brown with a yellow tinge on one side of the base and is covered with warts. It resembles in the same condition the appearance of surface of the massive form of *Cliona sulphurea*, and probably like this, in the fresh state was sulphur-colored.

The specimens range in length from 90 to 175^{mm} and from 35 to 50^{mm} in breadth. The summit is rounded truncate, depressed centrally, and in the unworn or more recent specimen imperforate with a short, stem-like tubercle. The base in the latter specimen is truncate, and looks as if it had been cut away from a fixed attachment. Two of the other specimens are rounded in the same position, broken along a semicircle where they seem to have been attached, and have a depression or cave on one side communicating with a central perforation. A specimen, 130^{mm} long and 35^{mm} broad, cut across the middle, exhibits a central cavity extending the length of the sponge, 16^{mm} wide, and with smooth imperforate sides. The surface of the worn sponges is divided into mostly hexagonal areas 3 or 4^{mm} wide, with a central circular spot and darker border. In the unworn sponge the hexagonal areas are occupied by a central circular papilla variably prominent, level, or slightly depressed. The exterior of the sponge is composed of a more compact, thin lamina or skeleton of silicious spicules with comparatively little of the softer sponge-structure, while the interior greatly thicker portion extending to the inner cavity is composed of a looser texture of the same kind of spicules with a large proportion of the softer structure, pervaded by bands of the more compact substance extending inward from the exterior layer. The silicious spicules of the sponge are of one kind only, pin-like in form, and identical in all other respects, including size, with these of *Cliona sulphurea*.

In the shape of the sponge with its interior chimney-like cavity it resembles the tubular form of individuals of many keratose sponges, and is so unlike the more familiar forms of the living sponge that if not a different species, as a marked variety it might be distinguished as *CLIONA PHALLICA*.

Mr. Willcox, who is now in Florida, writes that the *Cliona phallica* is one of the most common sponges of the coast. He observes that when alive it is of a yellow color, and has an opening at the summit nearly as large as the end of the little finger. It is very sensitive and when disturbed contracts and closes the orifice. The dead specimens never exhibit the latter open. Mr. Willcox says that he observed the sponge at Clear-water Harbor, near Tarpin Springs. At low tide, when covered with only five or six inches of water, this was seen to be in active movement above the sponge indicating a current flowing from the aperture. In wading, when Mr. Willcox approached within four or five feet of the sponges, the currents flowing from them would cease and on touching them they would close the terminal aperture.