# SHELL DEFORMITY OF MOLLUSKS ATTRIBUTABLE TO THE HYDROID, *HYDRACTINIA ECHINATA*

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## ABSTRACT

The colonial hydroid, a common epizoon on the external surface of the shell of the sea scallop, *Placopecten magellanicus*, sometimes becomes established on the internal shell surface. This intrusion interferes with the normal activities of the scallop's mantle, often causing shell deformity. The scallop reacts by producing a new shell edge within the existing perimeter of the shell and bypassing the hydroid colony. This relation is amensal—one organism is inhibited, and the other is not affected. No proof was found that the hydroid may ultimately cause the death of the scallop.

These same hydroids, in symbiotic association with pagurid crabs, deform and enlarge the apertures of empty gastropod shells. Enlargement of the "house" is to their mutual advantage.

The availability of surface on which to attach and grow is vital for sessile fouling organisms. The larval forms of these species must eventually settle on firm substrate or perish. The organisms are often able to augment available substrate by settling on the surface of other organisms. The upper valve of the sea scallop, *Placopecten magellanicus* (Gmelin), provides such a surface.

Organisms found on shells of sea scallops are those which are found on any suitable substrate in the vicinity. They are commensals, typical epizoa competing for space. They may be pelagic and settle by chance in a particular area, or benthic and possess mobility during larval and early postlarval stages.

Postlarval commensal species found on the sea scallop include representatives of most marine phyla (Merrill, 1961). Most abundant are the boring sponges, sea anemones, branching and encrusting hydroids and bryozoans, pelecypods, barnacles, tubeworms, and simple and colonial ascidians. Wells and Wells (1964), reporting on a calico scallop, *Aequipecten gibbus* (Linnaeus), community study, made similar observations. They found that of the major taxonomic groups only Asteroidea and Ophinoidea were lacking on calico shells.

Most of these animals have a casual association with the sea scallop. They may gain to some extent in having a shell substrate on which to live and possibly by having particles of food brought to them by water currents produced by the scallop. Although the commensal may cause little inconvenience to the host, the scallop certainly does not appear to benefit from the association. In fact, the association may be detrimental to the scallop if extensive fouling of the shell hinders swimming, or if marine borers excavate excessive quantities of the shell; but usually the association provides neither advantage nor harm to the participants.

An association in which the sea scallop is placed at a distinct disadvantage was observed during routine sea scallop studies. The colonial hydroid, *Hydractinia echinata* (Fleming), which grows frequently on the external shell surface of the sea scallop, was observed occasionally to expand around the shell periphery and invade the internal shell surface. The forward elements of the colony, coming in contact with the mantle of the scallop, caused certain inhibitory reactions by the scallop. This paper describes the association, emphasizing the means by which the scallop reacts to internal



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shell invasion. This type of relation in which one of the associates is inhibited while the other is not affected is best described by the term amensal as defined by Odum (1953).

## BRIEF REVIEW OF THE LIFE HISTORY OF *HYDRACTINIA ECHINATA*

*Hydractinia echinata* is far less exclusive in its choice of habitat than earlier observers indicated. It has been dredged "on every sort of bottom" (Sumner, Osburn, and Cole, 1913), and has been found on a wide variety of substrate (Hargitt, 1908). Bunting (1894) mentioned that the hydroid lives on the sea mussel, *Mytilus edulis* (Linnaeus), and Moore (1937) recorded its occurrence on the shell of another bivalve, *Pectunculus* (=*Glycymeris*), but I have seen no other reports of the association of this hydroid with a specific bivalve.

*Hydractinia echinata* is the well-known hydroid which served formerly as the classic example of symbiosis with the hermit crab, *Pagurus bernhardus* (Linnaeus). Many papers have dwelt on the symbiosis of pagurids and actinians (see Balss, 1924, and Dales, 1957 for a summary of the literature). From experimental studies, however, Schijfsma (1935) concluded that the association of *H. echinata* and *P. bernhardus* could not be defined as true symbiosis—that the hydroid is merely an epizoon.

Schijfsma (1939) described the early stages of growth of colonies of the hydroids, and Fraser (1944) and others have reported in detail the specialization of individuals that make up a colony of *Hydractinia echinata*. This hydroid is polymorphic. Several types of zooids develop, including special generative zooids that produce male and female sporosacs. The ova are fertilized in situ, and after being discharged sink to the bottom where they develop into mobile planulae in 24 to 48 hours. The planulae are never free-swimming; rather they crawl or glide in the manner of turbellarians. The mobile phase lasts at least 24 hours, ending when the planulae fix themselves to a substrate and develop into typical tentacular zooids.

The surface of a sea scallop shell can act as a base for settling planulae. Once attached, the zooids grow from a stoloniferous network of anastomosing tubes to develop into a colony. The coenosarcal expansion is covered with a heavy, chitinous perisarc from which rise the ridged and jagged spines characteristic of the encrusting colony. Nutritive zooids are the most numerous; other types include defensive, sensory, and generative zooids. The mature colony appears as a reddish velvety covering, but feels rough to the touch because of the numerous spines. Batteries of nematocysts in the zooids protect the colony.

## ASSOCIATION OF *HYDRACTINIA ECHINATA* AND *PLACOPECTEN MAGELLANICUS*

The size of a colony of *Hydractinia echinata* on the sea scallop varies with the length of time the colony has been established and with the surface area available. Where there is ample surface for expansion, the zooids in the advancing front of the colony tend to be arranged in concentric rows corresponding to the growth marks on the shell. This arrangement was observed by Frederick M. Bayer (personal communication) of the University of Miami, Fla., to whom material was sent for identification; his finding agrees with remarks by Schijfsma (1939) that the course of stolons is influenced by the surface sculpture of the substrate. The colony, by advancing more rapidly than the scallop grows, may eventually arrive at the periphery of the shell and continue around the shell edge. Long, slender zooids, armed heavily with nematocysts, are especially abundant at the advancing edge. Ultimately, the forward elements of the colony come in contact with the extended mantle of the scallop. The mantle withdraws, presumably because of the nematocysts discharged into it.[1] The mantle retreats steadily as the hydroid colony encroaches inward (fig. 1, a–d). Evidence of this sequence is seen clearly in figure 1, a. To be noted are the numerous relatively

[1] In section, the nematocysts were found to be about 10 microns long and 4 microns wide and the thread was about at the limit of visibility with an ordinary light microscope. Thus a thread in the scallop mantle cannot be distinguished with the histological technique used. The scallop mantle did, however, show evidence of an inflammatory response (personal communication, Clyde Dawe, National Institutes of Health, Bethesda, Md.). This response was indicated by the greatly increased number of cells under the epithelial margin. Dawe considered these to be wandering amoebocytes coming to the site of the insult.

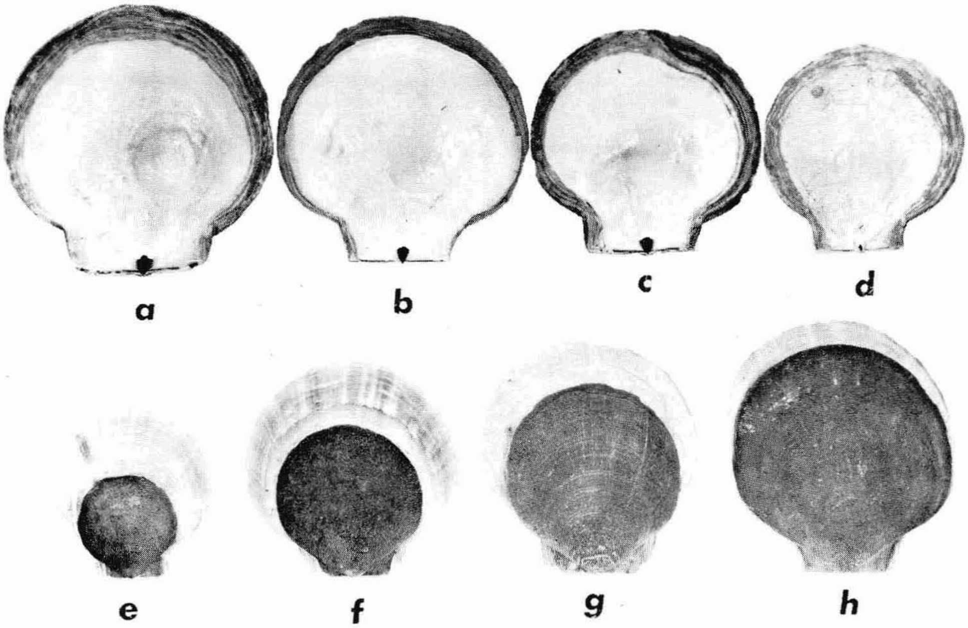


FIGURE 1.—Interior and exterior views of a group of upper (left) valves of *Placopecten magellanicus* showing shell malformation resulting from inner shell invasion by *Hydractinia echinata.* Interior views (a–d) illustrate the persistence of the invading hydroid which causes the scallop to retire further within the shell. External views (e–h) show several scallops that have managed to pass over and grow beyond the hydroids.

thin, slightly irregular, concentric margins secreted by the mantle. Each margin represents successive retreats of the mantle edge.

To resume a normal existence the scallop must successfully overgrow the impinging hydroid colony (fig. 1, e–h). Each time the mantle extends towards the margin it secretes conchiolin, and over this foundation the mantle attempts to produce a new edge of shell over the fringe of the hydroid colony. If it succeeds, shell growth resumes once more. Figure 1b shows an edge of new shell which indicates a successful bridging by the scallop.

A pigment is usually produced in the outer shell layer of the left (upper) valve of the sea scallop. Under some conditions, such as a serious break at the edge of the shell, a scallop secretes new shell material quickly, omitting pigment production until a repair is made and growth becomes normal. The reduction or lack of pigment in scallops as they grow a new lip (fig. 1, e–h) indicates faster rate of shell deposition than usual.

Sometimes a scallop is forced to produce a new edge over the hydroid more than once. Figure 2 shows a scallop that had grown several new shell margins. This is an extreme example but it does illustrate the result of difficulties that sometimes confront scallops. A young scallop increases the periphery of its shell faster than an older one (fig. 1, e) and thus has a better chance to stay ahead of the advancing hydroid.

*Hydractinia echinata* does not always occupy the entire external shell surface; other epizoons compete for this space as well. Most colonial epizoons live to the severe exclusion of others; it is unusual to see one colony overgrowing another. Usually a distinct zone of demarcation is formed. This also occurs when two colonies of *Hydractinia echinata* meet on the same surface (Schijfsma, 1939). I have examined hundreds of colonies of *Hydractinia echinata* but only once did I find another colonial species growing over the hydroid. This was a granular, encrusting type of unidentified bryozoan spread over the older part of a well-established colony of hydroids. Never was a

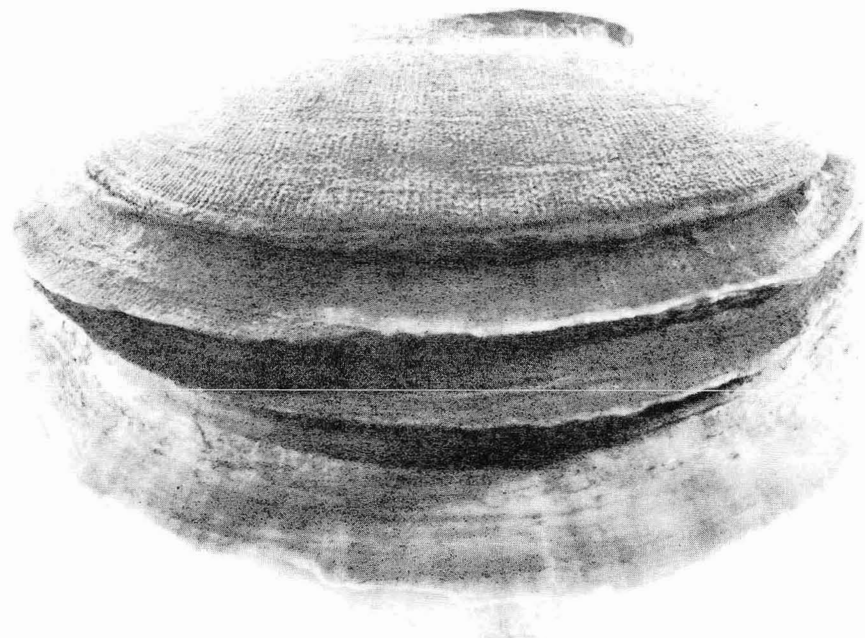

FIGURE 2.—Exterior view of a scallop showing the result when a hydroid colony grows faster than the scallop at successive periods and repeatedly overgrows the shell perimeter.

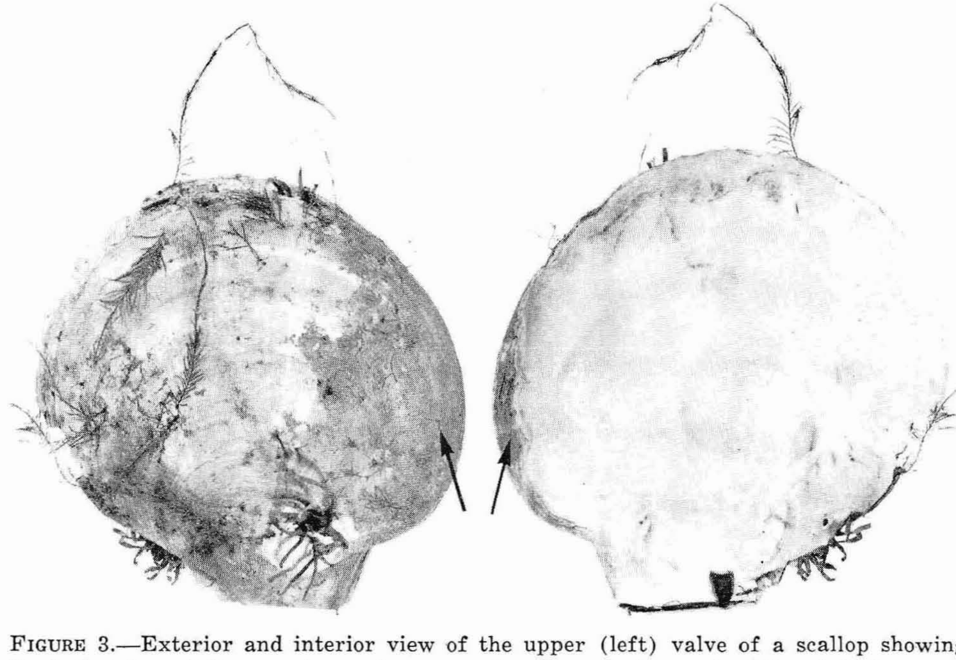

FIGURE 3.—Exterior and interior view of the upper (left) valve of a scallop showing the hydroid partially covering and overgrowing the anterior part of the shell (arrows) causing the scallop to change its shape as it grows in a direction away from the hydroid. (Most fouling organisms were cleaned from the shell before the photo was taken; only chitinous growths remain, including the colonial hydroid, worm tubing, and filamentous hydroids.)

colony of *Hydractinia echinata* seen expanding over another colonial species.

Because of competition with other epizoons, the hydroid often can occupy only a relatively small area of scallop shell surface, hence can inhibit scallop growth over only a relatively small area of the mantle periphery. Limited invasion along the anterior or posterior edge of the shell results frequently in a change in symmetry of the growing scallop; the shell tends to grow more rapidly in a direction away from the disturbed region. Figure 3 shows the interior and exterior view of a scallop shell on which a hydroid that overgrew a short segment of the edge produced a shift in the growth axis. (Note the excavations and deterioration of the shell caused by boring annelids.)

In several instances, expanding colonies of hydroids extended up the plates of barnacles which were also attached to scallop shells. Were they simply seeking additional substrate or did the water currents, created by the feeding barnacles, attract them? Schijfsma (1939) concluded that water currents influence the direction of growth of the colony. Certainly water currents created by a scallop effectively direct growth of a colony toward the shell periphery. Numerous scallops were seen on which the hydroid colony, with equal opportunity to expand in any direction, grew towards the periphery, even obliquely crossing growth lines on the shell in the process.

## EFFECTS OF THE ASSOCIATION

Natural mortality of sea scallops, as determined by the ratio of clapper[2] shells to live shells, was uncommonly high in 1960–62 on parts of the important commercial grounds of Georges Bank, off Cape Cod, Mass. (Merrill and Posgay, 1964). We were naturally concerned with the possibility that the hydroid might be responsible for part of this mortality; therefore, during research cruises to Georges Bank in August and September 1961, frequency estimates of *Placopecten magellanicus* and *Hydractinia echinata* were made at all stations where the two species occurred together. Also samples of quick-frozen material from areas of high natural mortality and from areas of high hydroid occurrence were taken to the laboratory for further analyses.

A summary of the results of the analyses is shown in table 1. Samples 1 and 2 are from areas of high hydroid-scallop frequency as reflected by the numbers of hydroids on live and clapper scallops. Samples 3 and 4 are from areas of high clapper–live shell ratios and show a much lower incidence of hydroids. These data make it obvious that the incidence of hydroids and clappers in the same population of sea scallops is not necessarily correlated.

TABLE 1.—*Incidence of occurrence of* Hydractinia echinata *on live and clapper shells of* Placopecten magellanicus

[Samples taken during M/V Delaware cruises 61–13 and 61–16]

| Date | Sample number | Location | | Number of scallops without hydroids | | Number of scallops with hydroids | |
|---|---|---|---|---|---|---|---|
| | | Latitude W. | Longitude N. | Live | Clapper | Live | Clapper |
| *1961* | | | | *No.* | *No.* | *No.* | *No.* |
| Aug. 15 | 1 | 41°54.0′ | 66°39.8′ | 634 | 4 | 208 | 25 |
| Sept. 24 | 2 | 41°53.0′ | 66°45.9′ | 300 | 0 | 272 | 16 |
| Aug. 18 | 3 | 42°06.1′ | 66°40.1′ | 1,123 | 515 | 2 | 1 |
| Sept. 25 | 4 | 41°47.1′ | 66°22.4′ | 341 | 42 | 30 | 12 |

Still more apparent is the lack of correlation in the distribution of *Hydractinia echinata* and clappers (fig. 4). As indicated by the darkened area on the chart in Figure 4, areas of high clapper concentration (clapper ratios over 10 percent) in 1961 generally rimmed the

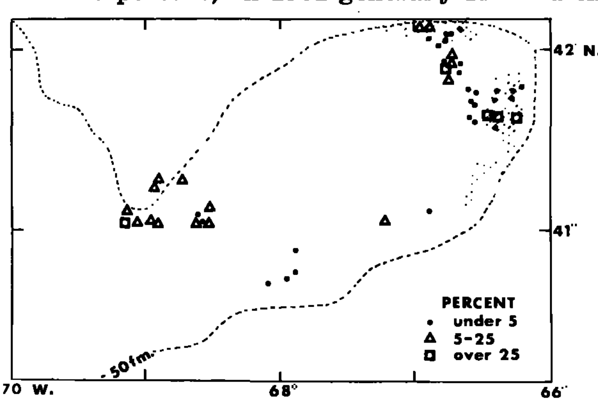


**FIGURE 4.**—Chart of Georges Bank showing the distribution and density of *Hydractinia echinata* on *Placopecten magellanicus* (symbols) at Georges Bank in relation to the area encompassing high natural mortality in the sea scallop in 1961 (darkened area). Percentage of hydroids on sea scallops indicated.

[2] The ligament (resilium) holds together the upper and lower valves of a scallop for a period of time after the scallop dies. In this state the shell is referred to as a "clapper."

perimeter from the northern to the lower eastern part of Georges Bank, mostly in depths of 40 to 50 fathoms (73 to 92 m.). Hydroids on scallops in this area, however, were distributed in a more or less straight line from the northern to the eastern part. Furthermore, a high incidence of scallop-hydroid association was found in the western part of Georges Bank where natural mortality was relatively low (fig. 4).

In summary, it can be stated that *Hydractinia echinata* inhibits the sea scallop, but no proof has been found that the hydroid causes the death of scallops.

## ASSOCIATION OF *HYDRACTINIA ECHINATA* AND OTHER MOLLUSKS

One colony of hydroids was found partially covering the shell of a 10-mm. pelecypod, *Anomia aculeata* Gmelin, that was attached to the shell of the sea scallop. Careful dissection of the perisarc in this area revealed the shell remains of two other *A. aculeata*, both less than 2 mm. in diameter, completely covered by the colony. *Anomia* attaches to a surface by a partly calcified byssal plug that passes through the bottom shell valve. After the animal dies and the soft parts decompose, the valves soon separate and wash away. As the two valves of both animals were still intact, it appears that the young *Anomia* may have been completely enveloped and smothered by the invader. This circumstantial evidence suggests that mortality of a pelecypod can be attributed to *Hydractinia echinata.*

Gastropod shells also may be occupied by *Hydractinia echinata.* Dead shells of *Nassarius trivittatus* (Say), *Lunatia heros* (Say), *Buccinum undatum* Linnaeus, *Acirsa costulata* (Mighels and Adams), *Colus pygmaea* (Gould), and *Epitonium greenlandicus* (Perry) dredged from the Northern Edge of Georges Bank were covered with *Hydractinia echinata.* The shell apertures were badly deformed, greatly enlarged, and globose. A survey of a large assortment of *Nassarius trivittatus* in the mollusk collection of the Museum of Comparative Zoology at Harvard University revealed several other specimens almost identical to the disfigured ones described above. Apparently this phenomenon is not particularly unusual in nature. Until recently I believed that these deformities of gastropod shell apertures were due to adverse relation between gastropods and hydroids (Merrill, 1964). Further field observations and literature research show, however, that I was wrong. The hydroid grows out on the mouth of the shell only after the snail is dead and only when a pagurid crab inhabits the shell. The deformed and enlarged portion of the shell is made of two layers, the lower by glands of the pagurid, the upper by the hydroid (Aurivillius, 1891). This, then, is a symbiotic association. Enlarging the domain is advantageous to both animals.

One other interesting observation was made regarding the association of *Nassarius trivittatus* and *Hydractinia echinata.* In one dredge haul during R/V *DELAWARE* Cruise 62–7 (station 27, south of Nantucket (lat. 41°11′ N.; long. 70°16′ W.) on June 16, 1962, in 15 fathoms (27 m.)) many live specimens of *Buccinum undatum* were taken. Most of the specimens had colonies of *Hydractinia echinata.* On top of some of the colonies, *N. trivittatus* had deposited masses of egg cases. Evidently the organs necessary for locomotion and egg laying in gastropods are not as sensitive as the mantle in pelecypods to the defensive elements of the hydroid.

## CONCLUSIONS AND SUMMARY

*Hydractinia echinata* frequently lives as an epizoon on the shell of the sea scallop, *Placopecten magellanicus.* It often expands over and around the margin of the shell and interferes with the normal mantle activity of the host. This interference in turn affects normal metabolism and can cause shell malformation. Mortality possibly attributable to this hydroid was noted in a pelecypod, *Anomia aculeata,* as was deformity of many gastropod shells. Thus, *Hydractinia echinata,* which normally uses a shell only as a substrate, is capable of becoming a harmful epizoon.

Geographic distribution of scallops in areas of known high natural mortality and areas of high hydroid occurrence were analyzed to determine the possibility that the hydroid is an epizootic agent. A lack of correlation indicated that the hydroid was not the cause of the heavy natural mortality of scallops.

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