The Associates of Four Species of Marine Sponges of Oregon and Washington

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ABSTRACT: Four species of sponge from the coasts of Oregon and Washington were studied and dissected for inhabitants and associates. The four species differed in texture, composition, and habitat, and likewise, the populations of associates of each differed, even when samples of two of these species were found adjacent to one another. Generally, the relationships of the associates to the host sponges were of four sorts: (1) inquilinism or lodging, either accidental or intentional; (2) predation or grazing; (3) competition for space resulting in "co-habitation" of an area (i.e., a plant or animal growing up through a sponge); and (4) mutualism. Fish eggs in the hollow chambers of *Homaxinella* sp. represented fish-in-sponge inquilinism, which is the first such instance reported in the Pacific Ocean and in this sponge. The sponge *Halichondria panicea,* with an intracellular algal symbiont, was found to emit an attractant into the water, which *Archidoris montereyensis* followed, in behavior experiments, in preference to other sponges simultaneously offered. A total of 6,098 organisms, representing 68 species, were found associated with the samples of *Halichondria panicea* with densities of up to 19 organisms per cm^3 of sponge tissue. There were 9,581 plants and animals found with *Microciona prolifera,* and 150 with *Suberites lata.*

Sponges frequently serve as hosts for many plant and animal associates. The relationships of such organisms vary from loose lodging or inquilinism to mutualism, a close type of symbiosis. The first account of sponge symbiosis was that of Radcliffe (1917) in which he reported the goby *Garmannia spongicola* living within unidentified sponges off North Carolina. Other early reports include those of Vosmaer (1911) who found invertebrates in the canals of tropical sponges, and Ridley and Dendy (1887) who found a very abundant oscillatorian alga in *Halichondria panicea.*

Perhaps the most significant reports concerning sponge symbioses were those of Pearse (1935, 1949) who described the inhabitants of various Caribbean sponges, Gudger (1935) who found many fish living in Atlantic sponges, and Forbes (1964, 1966) who described the mutualistic relationship between the sponge *Stellata grubii* and the oyster *Ostrea permollis* from the Gulf of Mexico. Caullery (1952), Dales (1957), Nicol (1964), and Henry (1966) have summarized the symbiotic relationships of marine animals and included in their descriptions many previous reports of sponge symbioses. The following is a description of the associates of four species of sponge, three subtidal and one intertidal in Pacific Northwest marine waters.

Methods and Materials

Because the sponges studied occupied varied habitats, the methods of collection differed. *Microciona prolifera* and *Suberites lata,* which were subtidal, were obtained with SCUBA. They were pulled or scraped off their substrate and immediately placed into zippered plastic bags which were sealed underwater. *Halichondria panicea,* which occurred intertidally upon unprotected rocks, was scraped off the rocks by use of the fingernails and placed into plastic bags. *Homaxinella* sp. was collected from 10 to 15 fathoms with an otter trawl. The collected specimens were subsequently taken to the laboratory

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to recover the associates. The sponges were pulled apart and examined under a binocular microscope (120 ×). The inhabitants found were preserved in AFA for further examination and identification. The results are summarized in Table 1.

OBSERVATIONS AND EXPERIMENTS

Suberites lata

Suberites lata occurred in Hood Canal, Washington, in a distinct zone of its own at a depth of 5–10 meters (MLLW) on nearly vertical rocks that were lightly covered with a fine mud. The water conditions in this narrow inlet were quite stable and calm.

The consistency of the sponge was very tough and impenetrable. It harbored very few organisms. The 15 samples studied had 150 associates, representing 25 species and 6 phyla. The densities of the associates varied from 0.001 to 0.03 (mean 0.1) organisms per cm^3 of sponge (Table 1). The sparsity of inhabitants was most likely due to the toughness of the sponge. The predominant organisms were the small spionid polychaete *Polydora socialis* which was found in every Hood Canal sample, the gammarid *Aoiroides columbiae,* the ectoproct *Crisia* sp., and unidentified, filamentous green algae.

P. socialis was the only organism actually living within the sponge, the remainder were simply attached to the surface. The larger animals, such as the crabs, were usually found hiding among the convolutions and contortions of the sponge.

One clump of *S. lata* was found in an unprotected rocky coast situation at Yaquina Head, Oregon. It harbored only a few more organisms than the Hood Canal samples. The organisms found on the Yaquina Head sample were those of the local community.

Microciona prolifera

Microciona prolifera was found attached to subtidal rocks in Willapa Bay, Washington. This sponge was erect, branching, and bushy, sometimes forming a mass of branches 1 foot or more in diameter and 6 or 7 inches high.

M. prolifera provided a place to live for many animals and plants; the population density varied from 0.27 to 3.64 (mean 0.80) organisms per cm^3 of sponge. The organisms most commonly found were the gammarid *Corophium acherusicum,* various caprellids, the polynoid *Harmothoë imbricata,* the sabellid *Sabella media,* and the anemone *Diadumene luciae.* The 15 samples of sponge dissected harbored 9,581 organisms of at least 52 species from 9 phyla. The most common and abundant of this array were the amphipods *Corophium acherusicum* and various caprellids.

The majority of the inhabitants were found attached to the surface of the sponge and relatively few were found within the sponge tissue. Some of the amphipods, sabellids, nereids, and nematodes occurred within the sponge. It was apparently difficult for the associates to penetrate into the tough and fibrous *M. prolifera.*

Due to the branching and bushy morphology of the sponge, mud often collected on it and this mud harbored many of the associates that were found. Therefore, there is a question whether the associates were attracted to the

TABLE 1

AVERAGE THICKNESS, VOLUME, TOTAL ASSOCIATES, AND DENSITY OF POPULATION FOR SAMPLES OF *Suberites lata, Microciona prolifera,* AND *Halichondria panicea*

SPECIES OF SPONGE	NO. OF SAMPLES	AVERAGE THICKNESS (CM)	AVERAGE VOLUME (CM^3)	AVERAGE TOTAL ASSOCIATES	AVERAGE DENSITY
Suberites lata	14	4.5(3–7)	503(195–820)	10(1–59)	0.2(0.001–0.8)
Microciona prolifera	15	5(2–13)	594(24–2,340)	640(21–1,885)	1.2(0.27–3.64)
Halichondria panicea	33	1(0.5–3)	104(20–540)	188(18–670)	1.8(0.126–19.14)

sponge itself or to the mud collected thereupon. The fact that relatively clean samples of the sponge also harbored many associates indicated that there was a definite attraction to it. Other species of sponge occurring near or upon *M. prolifera* were completely devoid of associates, suggesting that the associates preferred *M. prolifera.*

Halichondria panicea

GENERAL OBSERVATIONS: *Halichondria panicea* occurred as an encrusting sheet 1–5 cm thick upon unprotected rocky coast areas in violent surf. It was green in its upper layers and yellow below, the coloration being due to an intracellular single-cell alga.

H. panicea harbored many associates of a great variety. A total of 6,098 organisms of 68 species were found in 32 samples with densities of population of from 0.26 to 19.0 (mean 1.15) organisms per cm^3. The most common associates were amphipods (*Jassa falcata* and caprellids); the barnacles *Balanus glandula* and *B. nubilis;* the isopods *Dynamene sheareri* and *D. dilata;* and the coralline alga *Corallina gracilis.*

The relationships of these associates to the sponges varied considerably. The associates can be grouped in four general headings: (1) those that were caught in the sponge as larvae and subsequently matured; (2) those that were on the sponge accidentally at the time of collection; (3) those that grew simultaneously with the sponge on the same substrate; and (4) those that clung to the sponge because it was abundant and provided purchase.

Such organisms as algae, hydroids, ectoprocts, some crabs, barnacles, mussels, and some molluscs and annelids probably were caught among the sponge spicules as planktonic larvae and, having survived digestion, developed into adults thereupon and therein. Many of the nereids, large crabs, caprellids, gammarids, and fish were found by chance upon the particular sponge collected when they were feeding or using it for temporary shelter. It is most likely that some of the algae (e.g., *Microcladia borealis*) grew simultaneously with the sponge.

Several animals were grazing on the sponge. *Acmaea asmi, Mopalia lignosa, Oedognathus inermis, Pachycheles rudis, Cancer productus,* and, particularly *Archidoris montereyensis* were found to have *H. panicea* spicules in their stomachs.

The only possible examples of truly mutualistic associations were those concerning the intracellular algae of *H. panicea* and the cleaning action of the crustacea associated with *H. panicea,* as well as with *Suberites lata* and *Microciona prolifera.* The algae may have provided needed oxygen or other nutrients to the sponge. The sponge without algae could survive, but it usually appeared as thin, rubbery sheets. The numerous crustacea fed on the material which collected upon the sponge.

Generally, the samples of *H. panicea* from different areas harbored the same species, and the various members of the community were usually found in the same proportions from sample to sample. However, the exact composition of the sponge communities varied enough among the samples to suggest that a given individual community was related to the fauna of the immediate area.

EXPERIMENTS: Sponges of similar consistency living immediately adjacent to *Halichondria panicea* normally had very few associates of any kind, while the clumps of *H. panicea* were well provided with associates. Also, when the nudibranch *Archidoris montereyensis* was placed into a laboratory tank upon a piece of *Suberites lata* downstream from *H. panicea,* the animal would invariably crawl to the *H. panicea,* indicating a chemotaxis toward the *H. panicea.*

An apparatus similar to that of Davenport (1950) was set up to determine if there was a chemical attraction of *A. monterevensis* to *H. panicea.* The apparatus consisted of a series of waterways which gave the nudibranchs a choice between water passing over *H. panicea* and *Suberites lata.* The majority of the nudibranchs always moved toward the *H. panicea* water outlet: 9 individuals of 15, 10 of 15, 13 of 15 in the three experiments went to the *H. panicea* outlet. None ever moved to the *S. lata* outlet.

Homaxinella sp.

This sponge had much the same shape as *Microciona prolifera,* but it was branched fewer times, and its branches were thicker and hollow. *Homaxinella* sp. occurred at a depth of 20–30 meters off the Oregon coast.

The hollow branches were found to contain clusters of 20–30 fish eggs with living embryos inside. The eggs were probably those of a small blenny or goby that normally deposits its eggs within sponges. All the eggs found died before hatching.

Assuming that these eggs are from a sponge-dwelling fish, this example of fish-sponge inquilinism is the first recorded for *Homaxinella* sp. and for the Pacific Ocean.

DISCUSSION

The four species of sponge studied showed great variation in the community of associates found. These variations were due to the different habitats of the sponges and also to different properties of the sponges that acted as attractants and inhibitors. Other species of sponge adjacent to those studied harbored fewer associates, probably because they lacked factors that attracted the associates, or they possessed something that discouraged them.

In comparing *Halichondria panicea, Microciona prolifera,* and *Suberites lata,* which occurred in progressively deeper waters, the community of associates was progressively more stable, consistent, and predictable and its composition fluctuated less from sample to sample. The intertidal *H. panicea* showed great variation in community density and composition, indicating that these parameters were related to the fauna of the immediate area. When two species of sponge (e.g., *S. lata* and *H. panicea*) occurred next to each other, the tougher, more impenetrable species harbored fewer associates.

The majority of associates did little harm to the host sponge. The numerous crustacea may have benefited the sponges by cleaning them. Such a relationship can be considered mutualistic. The intracellular algae of *H. panicea* were also probably mutualistic with the sponge. The most deleterious associate was *Archidoris montereyensis,* which, along with other predators, fed voraciously on *H. panicea.* Some of the tube worms and amphipods associated with *M. prolifera* caused minor structural damage to the sponge. The sponge-dwelling fish whose eggs were deposited within *Homaxinella* sp. obviously benefited from the water currents and shelter of the sponge, while it did not appear to inhibit the growth or function of the host.

CONCLUSIONS

Four species of sponge from the coasts of Oregon and Washington were studied for associates. A large number and great variety of associates were found. The great numbers of sponge associates suggests that sponges are important to the ecology of the numerous associates. The relationships of these associates fall into four general categories: (1) inquilinism, or lodging, within or upon the sponges; (2) coexistence of two organisms on the same substrate as a result of simultaneous growth; (3) predation or grazing; (4) mutualism.

The 32 samples of *Halichondria panicea* harbored 6,098 organisms, representing 68 species, with a mean density of 1.15 organisms per cm^3 of sponge. The 15 samples of *Microciona prolifera* had 9,581 associates with a mean density of 0.80 organism per cm^3. The 14 samples of *Suberites lata* had 150 associates at a mean density of 0.1 organism per cm^3 of sponge.

Significant differences in composition and density among the sponge communities were attributed to the different habitats of the species studied, and to differences in the exudates and consistencies of the species of sponge. The nudibranch *Archidoris montereyensis,* which frequently occurred on *Halichondria panicea,* exhibited a distinct preference for that species in laboratory experiments.

The tubular sponge *Homaxinella* sp. harbored the eggs of a fish, which was assumed to be an unidentified, sponge-dwelling inquiline.

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