Pacific Science (1984), vol. 38, no. 1

A Brief Description of a Subtidal Sabellariid (Polychaeta) Reef on the Southern Oregon Coast[1]

MARTIN H. POSEY,[2] A. MARSHALL PREGNALL,[3] AND ROBERT A. GRAHAM[2]

ABSTRACT: The occurrence of a reef patch of tube-building polychaetes (Sabellariidae) is noted from the southern Oregon coast. The vast majority of the individuals in the reef are small *Sabellaria cementarium*. Larger *S. cementarium*, a second species of *Idanthyrsus ornamentatus*, and the ampharetid *Schistocomus hiltoni* are also common, occurring both as solitary individuals and as small monospecific clumps of individuals mixed in with the small *Sabellaria*. The reef extends between 6 m and 10 m below mean sea level (MSL) and is attached to the sandstone bedrock along the subtidal extension of a sea cliff. Measurements of worm abundances and distributions, and observations of larger associated organisms, were performed using SCUBA. Smaller associated fauna were studied from cores taken in the tube matrix. The authors suggest that the structured habitat provided by the worm-tube matrix permits a larger than usual species diversity to occur in the area.

INDIVIDUALS IN THE POLYCHAETE family Sabellariidae typically build tubes of sand grains and may form monospecific clumps or reefs attached to firm substrates. Such reef-building activity has been noted for species of *Sabellaria* in England (Wilson 1971, 1974), Delaware Bay (Wells 1970, Curtis 1978), and along the coast of Florida (Gram 1968, Kirtley and Tanner 1968, Gore, Scotto, and Becker 1978) and is well known from the Pacific Ocean (Hartman 1944). These reefs usually occur in intertidal or near-subtidal areas, for they require a source of sand for their tubes and sufficient wave energy to suspend the sand (Kirtley and Tanner 1968). In Florida, where most of the sediment is calcareous, sabellariid reefs show direct lithification into "beachrock" (Kirtley and Tanner 1968).

In the course of recreational SCUBA diving between Oregon's Sunset Bay and Cape Arago State Park, the authors found a series of polychaete-tube reef patches (Figure 1). Initial collection and identification indicated that the reef was dominated by three tube-building polychaete species: the sabellariids *Sabellaria cementarium* and *Idanthyrsus ornamentatus*, and the ampharetid *Schistocomus hiltoni*. *Sabellaria cementarium* appeared to occur in two distinct size classes. As we had not seen such a community structure anywhere else in the area during the previous few years of diving, we began to inquire among other marine biologists and SCUBA divers familiar with the local fauna; none had encountered these or similar reefs in the area. A more intensive study was then initiated, including field measurements of the worm colony and analysis of reef cores in the laboratory.

MATERIALS AND METHODS

The coastline of Oregon between Gregory Point and Cape Arago (Figure 1) is formed of hard sandstone. The rock strata have been faulted and folded up on end; this folding has created sheer cliffs that are eroded by the heavy winter seas of the northeast Pacific. The sabellariid reef we observed is attached to this

[1] Manuscript accepted 15 September 1983.
[2] Oregon Institute of Marine Biology, Charleston, Oregon 97420.
[3] Present address: University of Chicago, Barnes Laboratory, 5630 S. Ingleside Ave., Chicago, Illinois 60637.

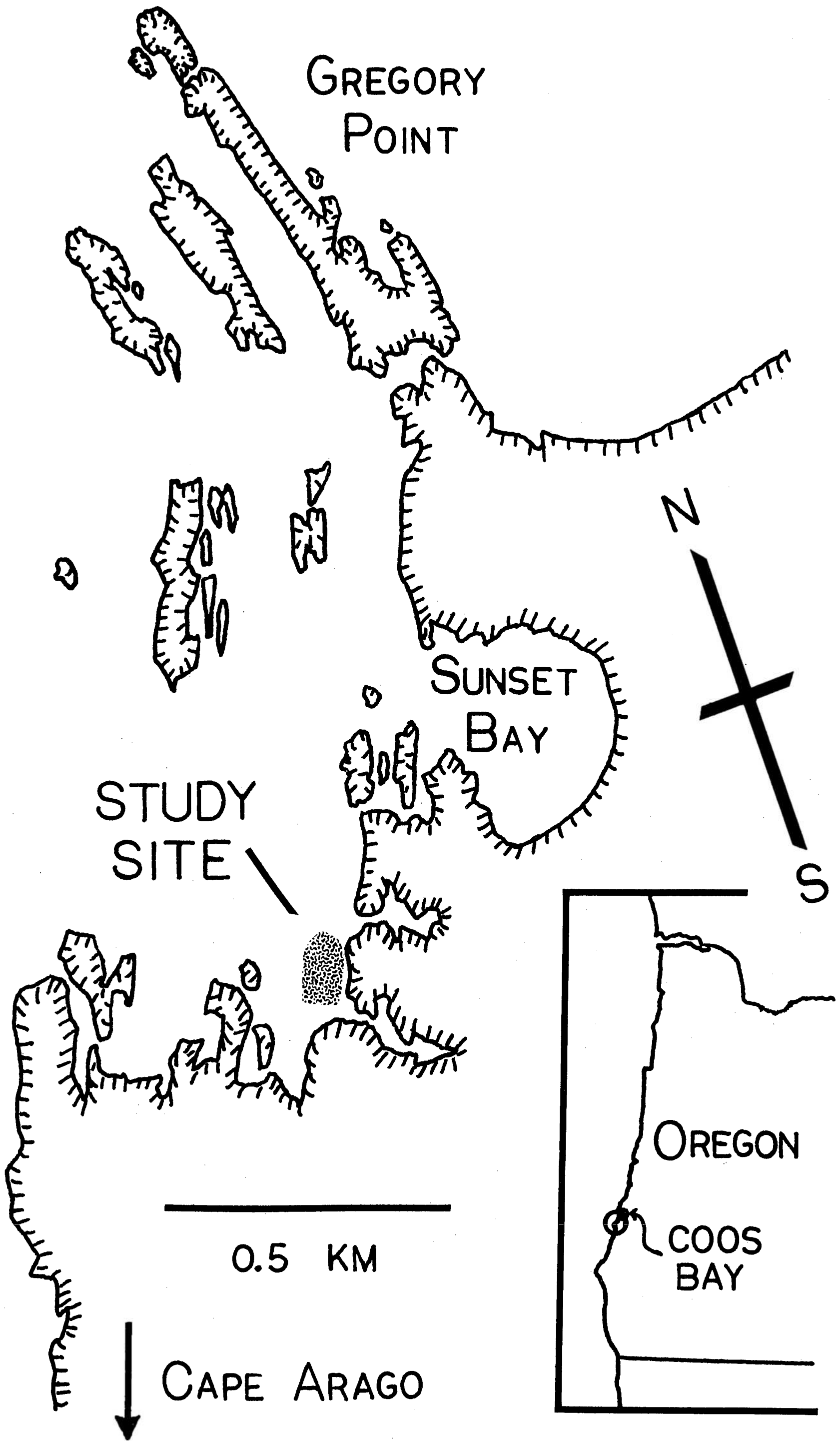

FIGURE 1. Location of the study site on the southern Oregon coast near Coos Bay.

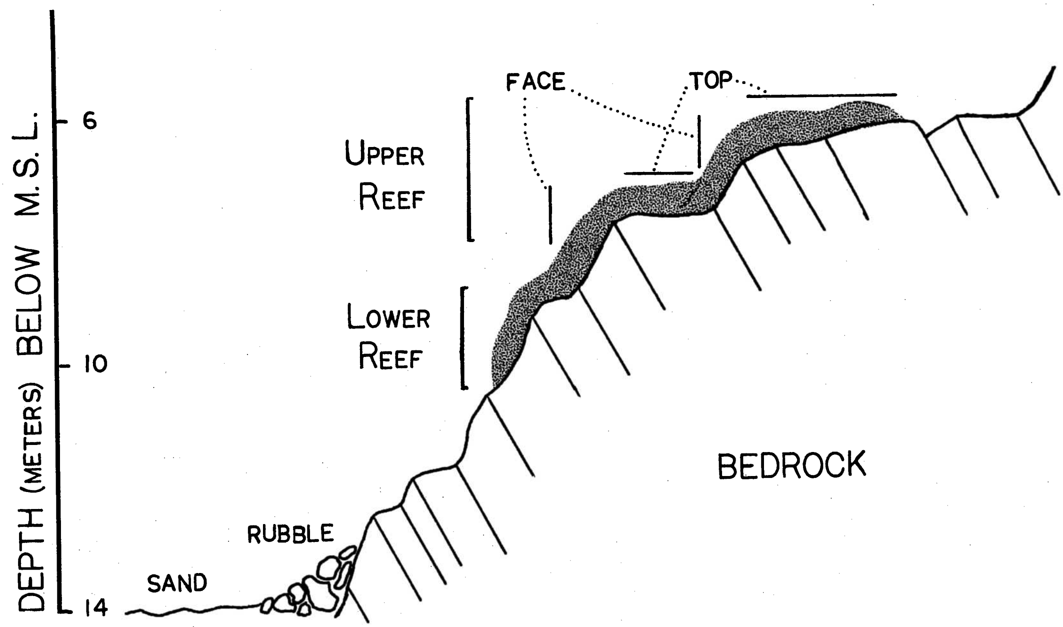

FIGURE 2. General reef cross section: the upper reef has both horizontal surfaces (reef top) and near-vertical surfaces (reef face) and is dominated by *Sabellaria cementarium*, while the lower reef is dominated by *Idanthyrsus ornamentatus*. The stippled area represents the wormtube matrix attached to the tilted sandstone strata.

sandstone bedrock along the subtidal extension of one such cliff. The topography of the study area is similar to that above the ocean surface, with a series of shelves and near-vertical drops which extend to about 14 m below mean sea level (MSL), where a flat sandy bottom meets the rocky rubble (Figure 2). The polychaete reef occurs from 6 m to 10 m below MSL. The particular patch we sampled extends 14.3 m parallel to the cliff face and 6.2 m perpendicular to the face, for a total area of nearly 90 m^2.

Measurements of worm density were taken during a series of dives between July and November 1982. Replicate counts were performed in 15×15 cm quadrats for *Idanthyrsus*, *Schistocomus*, and the larger size class of *Sabellaria*. Because of its abundance and the restricted time available for underwater observations using SCUBA, counts for the smaller *Sabellaria* size class were made in a 7.5×7.5 cm subsection of these quadrats. Abundances of all three species were determined by counting tubes; laboratory and field observations indicated that the large majority of tubes contained living individuals. Counts were made on the horizontal reef top, near-vertical reef face in the upper reef, and in the lower portions of the reef (Figure 2).

The fauna associated with the sabellariid reef was studied by cutting out 7.5×7.5 cm plugs with a diving tool and taking these samples back to the laboratory for further observation. Each plug was fixed in a 5% formaldehyde solution with rose bengal dye and stored in 70% ethanol. The tube matrix was dismantled, and the organisms found between and within the tubes were identified using the description of Hartman (1968, 1969), Scmitt (1921), and Smith and Carlton (1975). While most of the associated fauna could be identified, the method of preservation made the identification of sipunculids and nemerteans difficult.

RESULTS

The reef framework formed by the crowded worm tubes has the appearance of a sandy honeycomb, as described by Kirtley and

TABLE 1

DENSITIES OF REEF-FORMING POLYCHAETES IN NUMBERS OF INDIVIDUALS PER M^2 (± 1 s.d.)

SPECIES	UPPER REEF TOP	UPPER REEF FACE	LOWER REEF
Sabellaria cementarium (small)	16,268.5 ± 9,848.5	9,397.2 ± 4,794.9	0.0 ± 0.0
Sabellaria cementarium (large)	648.3 ± 429.9	456.8 ± 350.3	0.0 ± 0.0
Schistocomus hiltoni	1,466.7 ± 818.1	1,546.7 ± 846.4	266.7 ± 117.6
Idanthyrsus ornamentatus	150.0 ± 190.0	248.9 ± 200.2	1,318.5 ± 647.6

NOTE: For each species the values underlined indicate no significant difference ($p > 0.05$) in densities between areas.

Tanner (1968), Wells (1970), and Wilson (1971, 1974). Worm abundances were highly variable in both the upper and lower reef areas (Table 1). However, there appeared to be differences between the two areas, with *Sabellaria cementarium* dominating the upper reef, and *Idanthyrsus ornamentatus* completely replacing *Sabellaria* in the quadrats we sampled in the lower reef. The upper reef consisted primarily of what we observed in the field as the smaller size class of *Sabellaria* (average length approximately 13 mm; 1.5–2.5 mm outer tube diameter) with larger *S. cementarium* (average length 34 mm; 3.5–4.5 mm outer tube diameter) interspersed among these. Examination of the reef plugs indicated that individuals of a third size class of small *Sabellaria* (3–4 mm in length) were scattered throughout the matrix; however, we were unable to observe these individuals in the field and no density measurements were obtained. There is a significant reduction in the abundance of *S. cementarium* in the 13 mm size class from the reef top to the reef face ($p < 0.05$, $N = 26$), but there is no statistical difference between reef top and reef face for the other three worm groups quantified (Table 1). An April 1983 dive indicated that the reef patches we observed had persisted through the relatively harsh 1982–1983 winter even though there had been large block removal at the lower edge and stunted tube growth at the upper edge during fall 1982.

Schistocomus hiltoni occurred as single individuals and as small clusters interspersed among the *Sabellaria* and *Idanthyrsus*. However, unlike the two sabellariid species, *Schistocomus* tubes are very flexible and probably make little contribution toward forming the reef framework.

Examination of plugs taken from the reef indicates a very diverse associated fauna (Table 2). The polychaete fauna is particularly important both in terms of total abundance and in number of species, with 12 species being recorded from our samples. Most of the organisms were found in the interstices of the tube matrix, although some of the sipunculids and *Eteone californica* were found within empty *Sabellaria cementarium* tubes. Several of the polychaetes, such as the spionid *Rhynchospio arenicola* and the phyllodocid *Eteone californica*, are more commonly associated with sandy sediments and may be utilizing the sand and detrital material trapped between the sabellariid tubes.

Several larger organisms, not taken in the plugs, are also found on the worm reef and in the immediate area. The more obvious invertebrates in this group include the purple urchin (*Strongylocentrotus purpuratus*), a wide variety of nudibranchs, hermit crabs (*Pagurus* spp.), and the snails *Calliostoma ligatum* and *Searlesia dira*. Sessile organisms found in and around the reef include sabellid, serpulid, and terrebellid polychaetes, encrusting sponges and bryozoans, and solitary and colonial tunicates. In the course of our observations we noted feeding on the extended worm crowns by black rockfish (*Sebastes melanops*), striped surfperch (*Embiotoca lateralis*), and hermit crabs (*Pagurus* spp.).

TABLE 2

FAUNA FOUND IN ASSOCIATION WITH THE *Sabellaria* TUBE MATRIX

TAXON	UPPER REEF TOP	UPPER REEF FACE
Nemertea	2	3
Sipunculida	15	13
Polychaeta		
Halosydna brevisetosa	15	1
Lepidonatus squamatus	3	2
Anaitides medipapillata	1	3
Eteone californica	9	0
Nereis eakini	4	0
Syllus sp.	24	10
Haplosyllus sp.	1	0
Rhynchospio arenicola	0	1
Thelepus crispus	1	0
Pista elongata	0	1
Serpula vermicularis	1	0
Eudistyllia vancouveri	1	0
Amphipods (Gammaridae)	26	10
Decapoda		
Pachycheles rudis	0	4
Loxorhynchus crispatus	0	2
Pugettia gracilis	0	1
Ophiuroidea		
Ophiopholis aculeata var. *kennerlyi*	8	7
Axiognathus squamata	0	1
Bivalvia		
Hinnites gracilis	0	1

NOTE: Counts are from single 7.5 × 7.5 × 15 cm deep plugs cut from the two areas of the reef.

CONCLUSIONS

The requirements of a source of sand and water turbulence for reef-forming sabellariids (Gram 1968, Kirtley and Tanner 1968, Wells 1970) are readily met at this site. There is coarse, well-sorted siliceous sand at the base of the eroding cliff, and the wave surge at depth, which is generated by ocean swells ranging from 1 to 6m reflecting off the cliff face, is nearly always sufficient to keep the finer particles in suspension or moving in the traction load. Indeed, distinct evidence of sand scour at the base of the sea cliff indicates a high energy regime even at 14 m depth.

While the three common tube-building worms found in this reef have been reported from intertidal collections in Sunset Bay just to the north (Figure 1, Hartman and Reish 1950), we have never observed similar reef formations in that area, nor have we received reports of such reefs from our inquiries among local marine biologists and SCUBA divers. However, since sabellariids may have an extended larval period (Wilson 1971), the larval source for this reef need not occur in the immediate vicinity. There is no evidence of lithification at this site, in contrast to the situation found in Florida and Delaware Bay, where both calcareous sediments and warmer waters might contribute to such a process.

The three size classes of *Sabellaria cementarium* found in this study agree closely with the observation of distinct size classes in other sabellariid reefs (Eckelbarger 1976, Wilson 1971). Although size comparisons between species are difficult, the smallest size class found here (3–4 mm in length) would appear to be recently settled individuals (Eckelbarger 1976) and the larger two size classes (13 and 34 mm length) would probably represent two earlier settlements. The pattern of many smaller tubes surrounding a few larger ones, giving a "spongelike" appearance to the reef in places, has also been observed for other sabellariid colonies (Wilson 1971, 1974).

The occurrence of three different species of sandtube-building polychaetes in such a well-mixed state is interesting, for most reports of such reefs usually indicate a monospecific structure. Both *Schistocomus hiltoni* and *Idanthyrsus ornamentatus* occurred as solitary individuals in the upper reef, although *Schistocomus* was also found in small clusters. *Idanthyrsus* replaced *Sabellaria* in the lower reef. It is possible that *Idanthyrsus* is better able to withstand sand scour due to its thicker tube (*Idanthyrsus* tubes were found to have an average thickness of 0.860 ± 0.342 mm while those of *Sabellaria* were 0.465 ± 0.097 mm), but other explanations are possible. There is no distinct break between the *Sabellaria*- and *Idanthyrsus*-dominated regions of the reef.

Several authors have noted a wide variety of organisms associated with sabellariid reefs (Kirtley and Tanner 1968, Wells 1970). Horne

(1982) found a distinct group of ostracods in an English *Sabellaria* reef, and Gore et al. (1978) have described a diverse assemblage of decapods within a sabellariid worm reef in Florida. The sabellariid reef described here was found to have a very diverse polychaete fauna inhabiting the tube framework. Clearly the presence of such a reef increases secondary diversity; with a similar effect on species diversity being demonstrated for other marine communities, such as mussel beds (Suchanek 1978) and benthic infauna (Woodin 1981).

ACKNOWLEDGMENTS

We would like to thank Michael Roberts for assistance in identifying the echinoderms, and Peter Frank and Bayard McConnaughey for their interest and encouragement.

LITERATURE CITED

CURTIS, L. A. 1978. Aspects of the population dynamics of the polychaete *Sabellaria vulgaris* Verrill, in the Delaware Bay. Estuaries 1:73–84.

ECKELBARGER, K. J. 1976. Larval development and population aspects of the reef-building polychaete *Phragmatopoma lapidosa* from the east coast of Florida. Bull. Mar. Sci. 26:117–132.

GORE, R. H., L. E. SCOTTO, and L. J. BECKER. 1978. Community composition, stability, and trophic partitioning in decapod crustaceans inhabiting some subtropical sabellariid worm reefs: Studies on decapod crustacea from the Indian River region of Florida. IV. Bull. Mar. Sci. 28:221–248.

GRAM, R. 1968. A Florida Sabellariidae reef and its effect on sediment distribution. J. Sed. Petr. 38:863–868.

HARTMAN, O. 1944. Polychaetous annelids from California. VI. Paraonidae, Magelonidae, Longosomidae, Ctenodrilidae, and Sabellariidae. Allan Hancock Pac. Exped. 10:311–384.

———. 1968. Atlas of the errantiate polychaetous annelids from California. Allan Hancock Foundation, University of Southern California, Los Angeles.

———. 1969. Atlas of the sedentariate polychaetous annelids from California. Allan Hancock Foundation, University of Southern California, Los Angeles.

HARTMAN, O., and D. J. REISH. 1950. Marine annelids of Oregon. College Press, Corvallis.

HORNE, D. J. 1982. The ostracod fauna of an intertidal *Sabellaria* reef at Blue Anchor, Somerset, England. Est. Coast. Shelf Sci. 15:671–678.

KIRTLEY, D. W., and W. F. TANNER. 1968. Sabellariid worms: Builders of a major reef type. J. Sed. Petr. 38:73–78.

SCMITT, W. L. 1921. The marine decapod crustacea of California. Univ. Calif. Publ. Zool. 23:1–470.

SMITH, R. I., and J. T. CARLTON. 1975. Light's manual: Intertidal invertebrates of the central California coast. 3rd ed. University of California Press, Berkeley.

SUCHANEK, T. H. 1978. The *Mytilus californianus* community: Studies on the composition, structure, organization and dynamics of a mussel bed. Ph.D. Dissertation, University of Washington.

WELLS, H. W. 1970. *Sabellaria* reef masses in Delaware Bay. Chesapeake Sci. 11:258–260.

WILSON, D. P. 1971. *Sabellaria* colonies at Duckpool, North Cornwall, 1961–1970. J. Mar. Biol. Ass. U.K. 51:509–580.

———. 1974. *Sabellaria* colonies at Duckpool, North Cornwall, 1971–1972, with a note for May 1973. J. Mar. Biol. Ass. U.K. 54:393–436.

WOODIN, S. A. 1981. Disturbance and community structure in a shallow water sand flat. Ecology 62:1052–1066.