Distribution of Sipuncula in the Coral Reef Community, Carrie Bow Cay, Belize

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ABSTRACT

A survey of sipunculan fauna associated with coral rock and rubble along a transect across the coral reef at Carrie Bow Cay, Belize, revealed eight species, six of which inhabited burrows within rock samples and two of which occurred in crevices and crannies. Comprising 95 percent of the collection, the four most abundant species were, in order of abundance: *Lithacrosiphon alticonus* Ten Broeke; *Aspidosiphon brocki* Augener; *Phascolosoma perlucens* Baird; and *Paraspidosiphon steenstrupi* (Diesing). The greatest concentration of sipunculans, measured as number per square meter of surface area of rock, occurred in reef-crest material. Sipunculans were least abundant in material from the patch-reef zone of the back reef and from the fore-reef slope. The four most abundant species showed a distinct distributional pattern along the transect. Generally, sipunculans from the same reef habitat were densest in fresh, relatively unaltered coral rock having little secondary infill of calcite cement and a rather uniform skeletal framework characteristic of species of *Porites* and *Acropora*. Samples of more highly eroded, commonly well-cemented, and presumably older rocks contained few, if any sipunculans. Aspects of sipunculan distribution suggested for further study include reproductive strategy and variations in substrate characteristics.

Introduction

Marine worms of the phylum Sipuncula are common inhabitants of coral reef communities throughout the world. They occupy a variety of habitats within the community: sand burrowing species occur in sand flats of lagoons and in sediments surrounding the bases of coral growths; other species inhabit crevices in rubble or live within algal mats on surfaces of coral boulders; still others dwell in burrows that they excavate in coral rubble and in coral-rock framework. These rock-boring species, often occurring in great densities, contribute to the erosion of reefs by weakening the supporting structures of the corals and thus increasing their susceptibility to breakage and destruction by physical stresses related to currents and wave action. Numerous papers have referred to the boring activities of sipunculans in coral limestone and to their possible role in reef destruction (Gardiner, 1903; Otter, 1937; Rice, 1969, 1975a, 1976; Rice and Macintyre, 1972).

This study is a preliminary survey of the sipunculan fauna associated with the reef at Carrie Bow Cay, Belize. From the distributions of sipunculans in different zones of this coral reef community and in different types of coral rock, habitat preferences of the rock-boring species are suggested. Reproductive patterns that may have a bearing on distribution are also noted.

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Materials and Methods

Observations and collections were made during three 10-day trips to Carrie Bow Cay in 1972,

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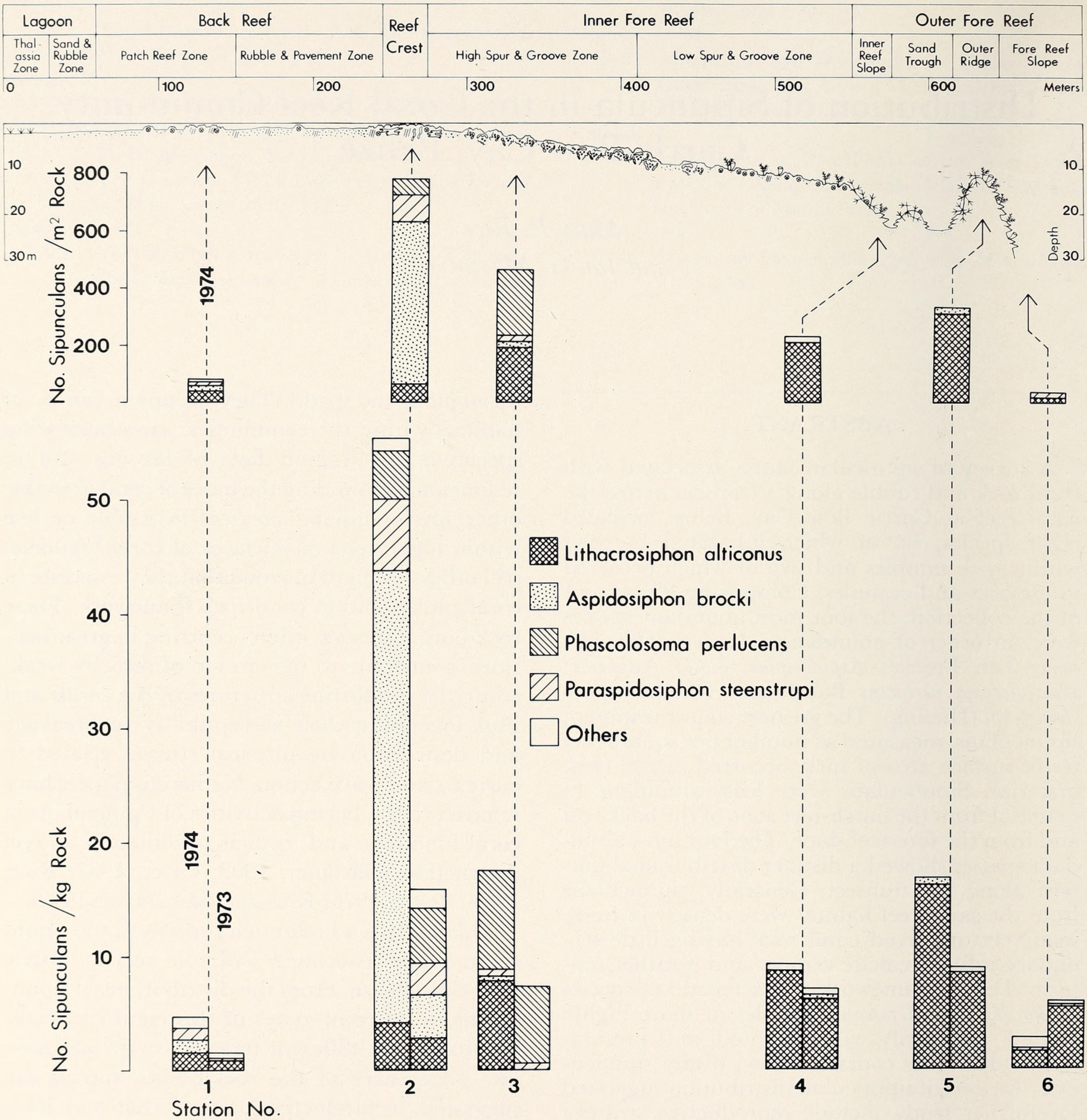

FIGURE 138.—Density of sipunculans in coral rock along the transect of the reef, Carrie Bow Cay, 1973, 1974. Density is expressed as numbers of sipunculans per kilogram of rock (1973, 1974) and as numbers of sipunculans per square meter of rock surface (1974), for each of six stations.

1973, and 1974. Species of sipunculans on the reef were surveyed in 1972, and types of coral rock inhabited as well as numbers of sipunculans per kilogram of rock were determined in 1973. These observations were repeated in 1974 and, in addition, numbers of sipunculans per unit of surface area of rock were determined.

Collecting Sites.—Sipunculans were collected at numerous sites along a transect across different zones of the reef to the north of Carrie Bow Cay (Figure 138). The transect extends from the *Thalassia* beds of the lagoon across the back reef, reef crest, inner fore reef and outer fore reef to a depth of 35 m on the fore-reef slope. This transect, which has been the site of many other studies, is described in detail by Rützler and Macintyre (herein: 9). Density of sipunculan species was examined at six stations ranging in depth from intertidal waters at the reef crest to 35 m on the fore-reef slope (Figure 138).

Collection of Rock.—On average, four rocks were collected at each station but this number varied from two to 10, depending on their availability and size; the greatest number was collected at station 6 on the outer fore-reef slope. These were usually free boulders of coral rock found on the surface of the sediment. Samples of limited size (0.4 to 4.6 kg, averaging 1 to 2 kg) were selected at random at each site.

Description of Rock Samples.—Length, width, thickness, and general shape of each rock were recorded along with associated flora and fauna. Rocks were weighed to the nearest gram, and surface area was calculated by covering the rocks with aluminum foil and converting the weight of the foil to square meters, after the method of Marsh (1970).

Extraction of Sipunculans.—Except for small fragments saved for petrographic analysis, each rock was completely fractured with a rock pick and chisel and all sipunculans were extracted. Species were identified, counted and, in most cases, preserved in 70 percent ethyl alcohol. A few specimens were kept alive for laboratory observations on spawning and developmental patterns.

Identification of Coral Rock.—Component coral species of each rock fragment were identified. Other factors examined included the character and distribution of encrusting biota, the destruction of coral skeleton by bioerosion, and secondary infilling by submarine lithification. The extent of secondary infilling by magnesium calcite cement is said to be directly related to both the length of time and degree of water agitation to which the substrata have been exposed (Macintyre, 1977). Borings of known species were saved for a separate study on boring mechanisms of rock-dwelling sipunculans (Rice, 1976).

Results

Aereal Distribution.—Of the eight species of sipunculans collected from coral rock and rubble at Carrie Bow Cay (Table 22), six species were found in burrows within the rocks and two in crevices or crannies. The four most abundant species, which comprised 95 percent of the specimens collected over the three-year period, were rock-boring species. In order of abundance, they were: *Lithacrosiphon alticonus* Ten Broeke, *Aspidosiphon brocki* Augener, *Phascolosoma perlucens* Baird, and *Paraspidosiphon steenstrupi* (Diesing).

The most common species (47 percent of specimens collected) was *Lithacrosiphon alticonus*, which is also referred to in the literature by its synonym, *L. gurjanovae*. It was found at all depths along the transect, including intertidal sites, but was most common in depths of 3 to 35 m. This small species, which averages about 10 mm in retracted length, possesses an anterior calcareous cone, typical of the genus, that functions to close the opening of the boring when the anterior retractable portion of the body—the introvert—is withdrawn (Figure 139*a*). Endemic to the Caribbean, *L. alticonus* has been reported from beachrock, recent unaltered coral rock, and highly eroded coral rock (Ten Broeke, 1925; Murina, 1967; Rice, 1975a).

Twenty-three percent of the specimens were *Aspidosiphon brocki*, found in small numbers at

TABLE 22.—Sipunculans collected from coral rock at Carrie Bow Cay, 1972, 1973, 1974

Sipunculan species	Number collected (3-year total)	Percent of total sample	Habitats
Aspidosiphon brocki	261	23.0	Borings in recent coral limestone; commonly intertidal to 1 m depth; rubble of *Porites porites*, *P. astreoides*, *Acropora palmata*
Golfingia sp.	6	0.5	Crevices and holes of coral rock; scattered throughout coral reef community
Lithacrosiphon alticonus	531	47.0	Borings in all types of coral rock from fresh, dense coral to extensively bored and eroded limestone; most common in deeper water, 3–35 m
Paraspidosiphon fischeri	9	0.8	Borings in all types of coral rock; most common in rubble of *Porites porites* in shallow water
P. speciosus	8	0.7	Borings usually in eroded coral rock, with secondary infill; most frequent in deeper waters of outer reef slope
P. steenstrupi	107	9.4	Borings in all types of coral rock throughout reef; at all depths, most common at reef crest; *Porites astreoides*, *Acropora palmata*
Phascolosoma perlucens	171	15.1	Borings in recent coral limestone; shallow waters, intertidal to 3 m; abundant in rocks of *Acropora palmata* and *Agaricia sp.*
P. varians	40	3.5	Crevices and holes of coral rock; algal mats covering rocks; most abundant in intertidal and shallow waters

various depths along the transect and in great densities at the reef crest. The smallest species collected, it ranges from 3 to 10 mm in length of the trunk. The thickened anterior and posterior shields of the trunk are characteristic of the genus (Figure 139*b*), although the posterior shield may be weakly developed in specimens that are regenerating after undergoing asexual reproduction. Unlike species that reproduce sexually, *A. brocki* reproduces asexually (Figure 139*c*) by constricting the posterior end to form a juvenile individual; thereafter, the posterior end of the adult regenerates (Rice, 1970). This species was first described from the Philippines and has been reported since from calcareous rock throughout the Caribbean (Murina, 1967; Rice, 1970, 1975a).

Phascolosoma perlucens, which comprised 15 percent of the sipunculans collected, was found only in shallow waters of the reef crest and the high-relief spur and groove zone. Averaging 30 to 40 mm in extended length, this long, slender species has concentrations of conical papillae at the posterior end and at the base of the introvert. The introvert is marked dorsally by bands of reddish-brown pigment (Figure 139*d*). Frequently referred to in the literature by its junior synonym, *Phascolosoma dentigerum*, this circumtropical species has been reported as the most common rock-boring species in the Caribbean (Rice, 1975a).

Paraspidosiphon steenstrupi made up only 9 percent of the collection. Although found in small numbers, it occurred along most of the transect. This species, which has characteristic anterior and posterior shields, averages 20 mm in length when the introvert is retracted (Figure 139*e*). Circumtropical in distribution, it is especially common throughout the Indo-Pacific and is reported from a number of localities in the Caribbean (Shipley, 1903; Fischer, 1922a, 1922b; Ten Broeke, 1925; Murina, 1967; Rice, 1975a).

The size and shape of the borings of sipunculans in coral rock reflect the size, shape, and activity of the inhabiting species (Rice, 1969, 1975a). Borings of *Lithacrosiphon alticonus*, a relatively inactive species, are generally straight and cylindrical, and the closed end of the passage is distinctly rounded. The small species, *Aspidosiphon brocki*, has a short, narrow boring, usually straight and always near the surface, extending at any angle from the surface into the rock. The borings of *Phascolosoma perlucens*, a larger, more active species capable of considerable extension and contraction, are long and winding, sometimes extending deep into the interior of the rock. The unpredictable course of these borings makes it difficult to extract specimens without injury. The borings of *Paraspidosiphon steenstrupi* are also long and penetrate far into the rock, but they are usually less sinuous than those of *P. perlucens*.

DISTRIBUTION ALONG THE TRANSECT.—Available surface area of substrate rock is an important limiting factor for sipunculan habitation; among rocks of different thickness, shape, and size, a comparison of densities of the indwelling sipunculan fauna is most meaningful when numbers of sipunculans are related to surface area. In the 1974 data considered below, densities of species at the six transect stations are calculated as numbers per square meter of rock surface (Figure 138).

The greatest concentration of sipunculans was found on the reef crest (station 2). The substratum of this zone, partially exposed at low tide and subject to strong wave action, consists of in-place scattered live coral heads on a coral rock pavement, coral boulders, and coral rubble. The coral rock, predominantly *Porites astreoides* Lamarck and *Acropora palmata*(Lamarck), contains traces of submicrosucrosic magnesium calcite (Macintyre, 1977) and consists of a relatively unaltered aragonite coral skeleton. All four rocks (totaling 4 kg) from this station consisted of dead *Porites astreoides.* Growths of coralline and filamentous

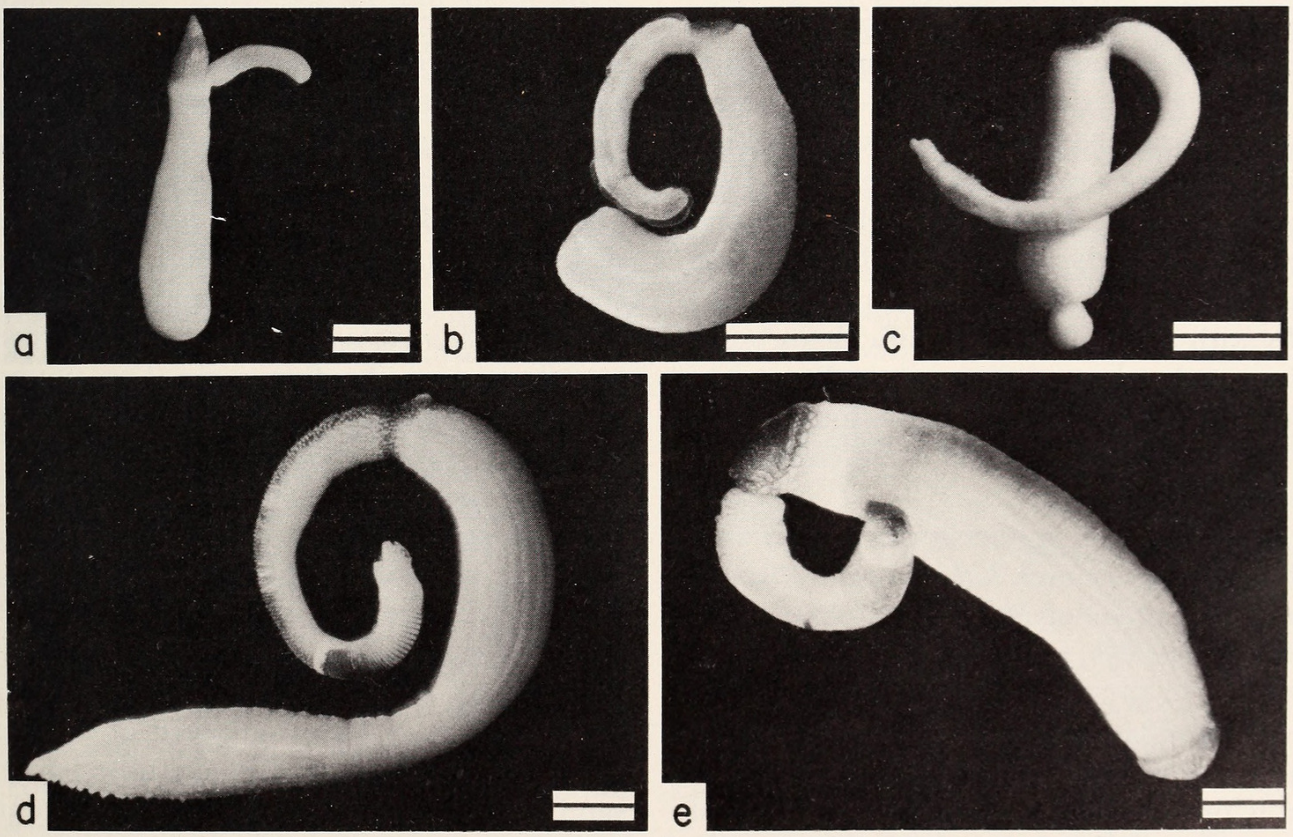

FIGURE 139.—Common sipunculans from Carrie Bow Cay: *a*, *Lithacrosiphon alticonus*; *b*, *c*, *Aspidosiphon brocki* (specimen in *c* undergoing asexual reproduction, division will occur at the point of the constriction, the posterior portion forming a juvenile individual); *d*, *Phascolosoma perlucens*; *e*, *Paraspidosiphon steenstrupi*. (Scale = 2 mm.)

algae, some encrusting sponges and foraminifers (*Homotrema* sp.) were scattered on the rock surfaces. Other than sipunculans, the few living organisms within the rocks consisted of a few polychaetes and boring barnacles (*Lithotrypa* sp.), and some vermetids and boring sponges near the surface.

All four common rock-boring sipunculan species at Carrie Bow Cay occurred at the reef crest; the dominant species, here accounting for 71 percent of the individuals, was *Aspidosiphon brocki*. The order of abundance of the other three species was *Paraspidosiphon steenstrupi*, and equal numbers of *Lithacrosiphon alticonus* and *Phascolosoma perlucens*. Other species associated with the rocks, either in old cavities or in crevices but showing no evidence of forming their own burrows, were *Phascolosoma varians* and an unidentified species of *Golfingia*.

The second largest concentration of sipunculans was found in depths of 2 to 3 m in an area of large coral buttresses seaward of the reef crest (station 3). Known as the high-relief spur and groove zone, it is dominated by a substratum of living corals, coral rubble, and boulders interspersed with sand patches and loose coral that cover a smooth rock pavement. Whereas the reef crest is in part intertidal, the high-relief spur and groove zone is entirely subtidal. Of the four rocks examined (totaling 5.6 kg), one was fresh *Porites astreoides* with no infill. It was difficult to break and contained only one sipunculan. Two rocks were fresh *Acropora palmata* and the fourth fresh *Agaricia* sp. One had a trace of submicrosucrosic magnesium calcite infill.

The most abundant species at this station were *Phascolosoma perlucens* and *Lithacrosiphon alticonus*. Only small numbers of *Phascolosoma varians*, *Paraspidosiphon steenstrupi*, and *Aspidosiphon brocki* were present.

Next in abundance of sipunculans was station 5 on the outer ridge in 15 m of water, where the bottom is primarily living coral with patches of sand and coral rubble. Two rocks totaling more than 5 kg from this area consisted of fresh *Porites astreoides* having little or no infill. One contained numerous *Lithacrosiphon alticonus* and a few *Aspidosiphon brocki*; its upper surface was covered with red boring sponges and encrusting and filamentous algae, whereas the lower surface was almost barren, with a lesser amount of crustose coralline algae and red sponges. This second rock contained only a few polychaetes and one specimen of *L. alticonus*; around its edges were several patches of live coral, also encrusting byrozoans, crustose coralline algae, and a white sponge. Its internal composition was similar to that of the first rock, except that one surface contained more submicrosucrosic magnesium calcite infill.

Next in abundance of sipunculans was station 4 located in 23 m of water at the base of the inner reef slope; here the substratum is mainly sandy sediment with small amounts of scattered rubble and a few heads of live *Montastrea annularis* (Ellis and Solander), dominated by flattened growth forms. Of the three rock samples (6.7 kg) collected, two were *M. annularis* and one *Manicina areolata* (L.). One *Montastrea annularis* rock had considerable crustose coralline algal cover and extensive borings at the surface and contained numerous sipunculans of the genus *Lithacrosiphon*. The other *M. annularis* rock had very little covering growth and was nearly devoid of sipunculans. The third rock had an open porous meandroid skeleton and large masses of boring sponges near the surface. It contained many sipunculans, mainly *Lithacrosiphon*, but they were less concentrated than in the first rock. The sipunculan burrows commonly ran parallel to the dissepiments of the coral skeleton.

The remaining two stations at either end of the transect had the fewest sipunculans. Station 1 in the patch-reef zone of the back reef (depth about 1 m) had substrata of scattered rubble and boulders in a sand matrix between live coral patches (dominantly *Montastrea annularis*). The four rocks from this station were composed of *M. annularis* (total weight, 3.5 kg). Surfaces adjacent to the sand were almost bare, with scattered foraminifers (*Homotrema* sp.) and some crustose coralline algae. On the upper surfaces, crustose coralline algae and red and brown filamentous algae were common. The degree of infiltration and erosion and the amount of freshly preserved coral skeleton varied from a highly eroded skeleton with extensive sediment-rich submicrosucrosic magnesium calcite to an almost freshly preserved skeleton. The highest density of sipunculans was found in the rock having the most intact skeleton and the least calcite infill. Species of sipunculans at station 1 were *Lithacrosiphon alticonus*, *Aspidosiphon brocki*, *Paraspidosiphon steenstrupi*, and *Phascolosoma varians*.

Station 6 was located on the fore-reef slope in depths of 25 to 35 m. The substratum exposed between the rich cover of octocorals and dominantly platy coral colonies was in-place coral framework with a thin cover of *Halimeda*-rich sand and scattered rubble. The coral rock from this zone was highly eroded and infiltrated with sponge growth. The 10 rocks collected (total weight, 14 kg) were covered with numerous sponges, some compound tunicates, tunicates, coralline algae, "leafy" brown and green algae, bryozoans, and small serpulid worm tubes. These rocks were lying on, or were partially embedded in the sediment. Three were so extensively bored, infilled, and lithified with dense microcrystalline and porous submicrosucrosic magnesium calcite that the coral skeleton could not be recognized. Five corals were identified in the other seven rocks: *Porites astreoides*, *Meandrina* sp. *Stephanocoenia* sp., *Agaricia* sp., and *Siderastrea siderea* (Ellis and Solander). Two rocks were fresh coral with their skeletal structure intact and with little secondary infill. The others were water worn and extensively bored and they contained some submarine lithification. Boring sponges had infiltrated the rocks. Empty borings and other large holes within the rocks were filled with sand and mud and patches of submicrosucrosic magnesium calcite. Few sipunculans were found in any of these rocks, the most occurring in a sample of fresh *Porites astreoides* that contained five *Lithacrosiphon alticonus* and one *Paraspidosiphon steenstrupi*. *Paraspidosiphon speciosus* was found only in highly eroded samples. A few polychaetes, alphaeid shrimp, and an echiuran occurred within the sand-filled holes in the rock.

When density of sipunculans was measured as number per kilogram of rock, the distribution of species and relative densities were almost the same as when measured as number per square meter of surface area. Data from 1973 and 1974 are compared in Figure 138.

DISTRIBUTION IN DIFFERING ROCK TYPES.—Of the nine types of coral rock in the 1974 collections, *Porites*, *Agaricia*, and *Acropora* specimens contained the greatest density (Table 23) and diversity of sipunculans. These rocks were not distributed equally along the transect; only *Porites astreoides* and *Agaricia* sp. were collected at more than one station. *Porites* rock, the most common, was found at four stations: reef crest, high-relief spur and groove, outer ridge, and fore-reef slope. *Porites* rock at the reef crest contained, in order of abundance, *Aspidosiphon brocki*, *Paraspidosiphon steenstrupi*, and equal numbers of *Lithacrosiphon alticonus* and *Phascolosoma perlucens*. The sipunculan fauna in *Porites* rocks from other stations consisted almost entirely of *Lithacrosiphon alticonus* (Figure 140). All *Porites* samples were recent, unaltered coral rock having little secondary calcite infill. The density of sipunculans varied considerably, even among rocks of the same composition at the same locality (Figure 140).

OBSERVATIONS ON REPRODUCTIVE ACTIVITY.—After removal from coral rock, specimens of *Phascolosoma perlucens*, *Phascolosoma varians*, *Paraspidosiphon steenstrupi*, and *Lithacrosiphon alticonus* were

TABLE 23.—Density of sipunculans in different types of coral rocks

Coral species	Rocks		Sipunculans	
	Number	Weight (kg)	Total number	Number/ kg rock
Acropora palmata	4	10.78	75	6.96
Agaricia sp.	2	3.34	27	8.08
Manicina sp.	–	–	–	–
Meandrina sp.	–	–	–	–
Montastrea annularis	7	8.09	50	6.18
Porites astreoides	6	11.10	72	6.49
Porites sp.	4	5.37	22	4.10
Siderastrea siderea	7	10.84	61	5.63
Stephanocoenia sp.	–	–	–	–

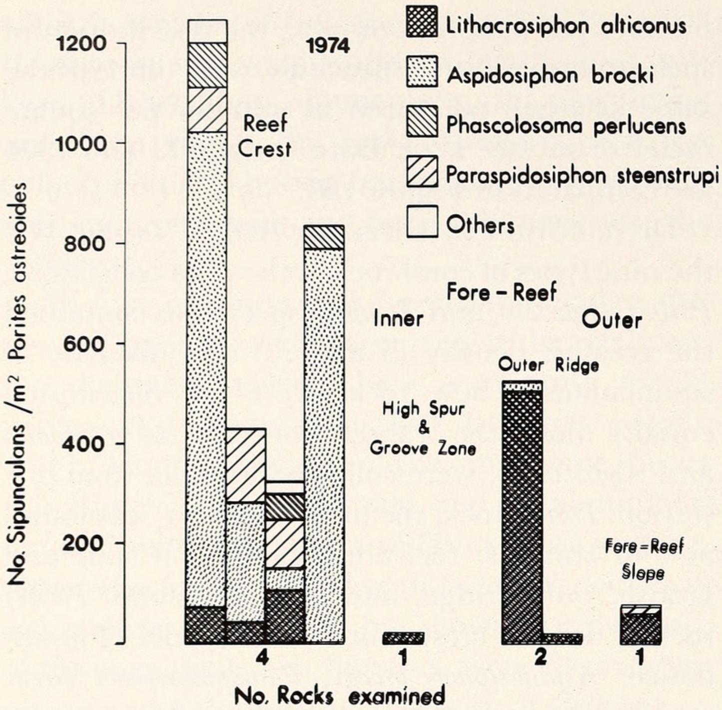

FIGURE 140.—Density of sipunculans along the transect in *Porites astreoides* rock, Carrie Bow Cay, 1974.

kept alive in the laboratory for one to two months for observations on spawning. The first two species were observed to spawn in April and *Paraspidosiphon steenstrupi* in June. *Lithacrosiphon alticonus* did not spawn even though oocytes in the body cavity were visible through the body wall of many specimens. A planktotrophic larval stage occurs in the development of *Phascolosoma perlucens* and *P. varians.* Although development of *Paraspidosiphon steenstrupi* has not been observed, the small size of the egg and the relatively sparse yolk indicate that development of this species is also planktotrophic.

Specimens of *Aspidosiphon brocki*, known to reproduce asexually by constricting the posterior end to form a new individual (Rice, 1970), were examined for evidence of reproductive activity. Nineteen percent of the April 1974 collections had posterior constrictions. An additional eight percent had juveniles in their burrows.

Discussion and Conclusions

The rock-boring sipunculans at Carrie Bow Cay showed specific distribution within the reef community, the greatest diversity occurring at the reef crest where six species (of which four were common rock borers) were found. The four rock borers, found together only in the reef crest and high-relief spur and groove zones, each had distinctive distribution on the transect. *Lithacrosiphon alticonus* was found all along the transect in both deep and shallow waters but it was most abundant from the high-relief spur and groove zone to the outer ridge. *Aspidosiphon brocki* was dominant at the reef crest but occurred only sporadically and in small numbers in other areas. *Paraspidosiphon steenstrupi* was most abundant at the reef crest but occurred in small numbers along most of the transect. *Phascolosoma perlucens* was limited to the reef crest and to the shallow waters of the fore-reef zone. In being related to reef zonation, the overall distribution of these four sipunculan species must also be related directly or indirectly to physical parameters that control this zonation, the most important of which are water agitation and light intensity, both depth-dependent factors.

The substratum most densely inhabited by sipunculans was generally fresh coral rock with almost uniform skeletal framework, as is characteristic of *Porites* and *Acropora* species, and with relatively little secondary calcite cement infill. The more highly eroded, water-worn, older rocks on the transect generally contained few, if any, sipunculans. Internally, such rocks showed considerable infilling of calcite cement and were heavily infiltrated by boring sponges. The presence of numerous tunnels and cavities suggested previous habitation by boring organisms such as sipunculans. The absence of extant sipunculans might be explained by natural death of specimens that had formed the borings, by natural succession of boring organisms, or by death due to a catastrophic event (for example, rocks having been buried in sediment). The lack of new boring by sipunculans might be due to unavailability of sufficient solid substratum in rocks that are heavily bored and infiltrated with sponges.

Typically, the rocks containing sipunculans were covered by sponges and algal growths (filamentous, leafy and crustose coralline). Encrusting organisms such as bryozoans and the foraminiferan *Homotrema* sp. occurred most commonly but not exclusively on the underside of the rock samples. Sponges, along with a host of other invertebrates such as crabs, stomatopods, alpheid shrimp, isopods, barnacles, certain polychaetes, and bivalves, were found within the rocks—either in interstices and cavities or in burrows that they had formed in the rocks. Organisms in burrows included the boring sponges, polychaetes of the families Spionidae, Sabellidae, and Serpulidae as well as certain boring bivalves (*Lithophaga* sp. and *Gastrochaena* sp.) and boring barnacles (*Lithotrya* sp.). Sipunculans were rarely found in rocks with barren surfaces and were not observed in live portions of coral colonies. Sipunculan borings open most commonly on the upper surfaces and sides of rocks, but also on the lower surface lying on the sand. Boring sipunculans are known to feed on the surfaces of rocks they inhabit, ingesting bits of debris and sand entrapped in the surface cover and possibly pieces of algae (Rice, 1969, 1975a); thus the epibiota are probably important to the survival of the animals within the rock, although details of this association remain to be investigated.

The present study points out pertinent factors for future evaluation of the relative influence of various physical and biotic factors on distribution of rock-dwelling sipunculans in the coral community. The greater density of animals in recent unaltered coral rock from Carrie Bow Cay than in highly eroded rock indicates the probable importance of internal structure of the rock to infiltration by boring sipunculans. On the other hand, the observation that different species may inhabit the same type of coral rock in different areas of the reef community suggests that physical factors associated with locality—such as agitation and depth of water—may be even more significant than coral skeleton in determining specific distribution. These data, however, must be considered preliminary because the same rock types could not be collected in each reef locality. Moreover, the variation in density of sipunculans in similar rocks from the same locality indicates the complexity of the problem and the necessity for more rigidly controlled quantitative procedures. Further studies should compare the relative significance to rock-boring sipunculans of the type of coral skeleton and degree of secondary infilling. Tests of habitat preference could be made by transplanting rocks of known composition to different parts of the reef community and by examining these rocks over a period of years.

Many other questions concerning colonization of coral rock by boring sipunculans remain to be explored. Factors affecting larval settlement are unknown, yet they undoubtedly play an important role in determining distribution of those species having planktotrophic larvae, such as *Phascolosoma perlucens* (Rice, 1975b). Distribution of species lacking planktotrophic larvae would be regulated by different factors. For example, an explanation for the localized concentrations of *Aspidosiphon brocki* might be found in the pattern of asexual reproduction of this species. Young, crawling juveniles, unable to traverse great distances, probably would colonize either the same rock as the parent or other rocks in the vicinity.

Recent studies on infaunal communities of coral rock have suggested that surface area, porosity of rock, percentage of live coral and epibiota may influence infaunal distribution and colonization (Hutchings, 1978). Therefore, reliable quantitative data and improved methods of approach are obviously necessary. Brock and Brock (1977) proposed the use of acid dissolution of rock for quantitative removal of specimens previously preserved in formalin. Hutchings (1977) measured exposed surface area of substrata by coating surfaces with Playtex rubber which, after drying, can be peeled off, traced and measured with a polar planimeter. Various other techniques for measurements and sampling have been listed in a recent review of research methods for studies of coral reef cryptofauna (Hutchings, 1978). To date, most research efforts on specific groups of rock-dwelling fauna in coral reefs have focussed on polychaetes, although sipunculans have been recognized as a significant component of the coral-rock infauna (Kohn and Lloyd, 1973; Peyrot-Clausade, 1974; Hutchings, 1974, 1977). It is hoped that future studies will apply the more refined current techniques to the rock-boring sipunculans and thus may provide a better understanding of their distribution in the reef community and of their significance to the total reef ecosystem.

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