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Sessile Organisms on PVC Panels in the Waters around a Coral Reef of Ishigaki Island, Yaeyama Islands, Japan, Immediately after the Catastrophic Coral Bleaching in 1998

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Abstract Sessile organisms on PVC panels suspended inside and outside coral reef at Ishigaki Island, Yaeyama Islands, Japan, was monitored for 20 days just after the wide-spread incident of coral bleaching in September, 1998. The settlement of a total of 16 species of algae and invertebrates was recorded. Generally, *Enteromorpha* sp. (Chlorophyceae) dominated the panels. The percentage area cover, number of species, biomass and algal growth were significantly greater in waters outside the reef.

Key words: sessile organisms, coral reef, settlement, PVC panels, Ishigaki Island

Introduction

Ecological studies on the sessile organisms in the waters of coral reefs in Japan are rare (see Yamada & Yamazato, 1987; Nishi, 1993), even though sessile organisms in coral reef areas have been studied in the Caribbean and Bermuda Islands (Jackson, 1984; Jackson & Winston 1982; Logan, 1984) and in the Middle East Asia (Benayahu & Loya, 1981). The Ryukyu Islands has a high species diversity and rich growth of corals, and therefore an ideal geographic location to study the community ecology of sessile organisms. Living corals are reported to produce toxins (Jackson & Buss, 1975; Romano, 1990) which prevents other sessile organisms such as algae and invertebrates to settle and grow. Thus, the bare surface of artificial panels can be an alternative settlement substrata for these organisms.

Despite the documentation of the rich and diversified community of sessile organisms around the coral reef areas of Japan (Hoshino, 1987; Yamada & Kubota, 1987; Imajima, 1987; Mawatari, 1987; Nishikawa, 1987; Tsuda, 1991), quantitative information on these organisms is scarce. Generally nutrients in coastal waters are higher inside the reef than outside (Sorokin, 1993), however, the catastrophic coral bleaching that occurred in the summer of 1998 (Fujioka, in press) just prior to this study might have altered the nutrient levels or other factors in the water column. Such changes in the sea water might alter the availability of spores of algae and larvae of invertebrates, which would have altered the establishment of the sessile community in this area during this study. Here, we report some preliminary data on the sessile organisms, including sedentary animals, on polyvinylchloride (PVC) panels suspended inside and outside a coral reef at Ishigaki Island. The potential influence of coral bleaching on the establishment of the communities of sessile organisms is discussed.

Materials and Methods

Four PVC panels ($25 \times 25 \times 0.3$ mm) were suspended for 20 days from 24 September to 13 October, 1998, at two stations in Urasoko Bay, Ishigaki Island (Fig. 1). Station one (St. 1) was located inside the coral reef and Station two (St. 2) was located outside approximate 90 m from

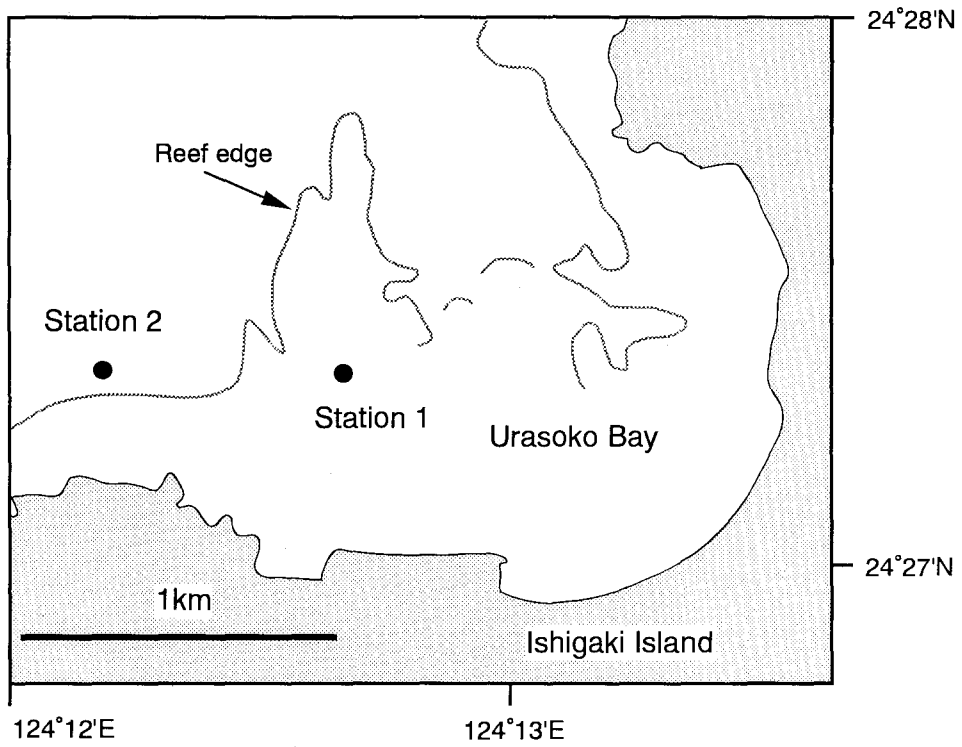

Fig. 1. Map showing the locations of Station 1 and Station 2 in Urasoko Bay, Ishigaki Island.

the reef edge. Panels were suspended at a depth of 1 m from the sea surface using anchored floating buoys. Inside the reef, St. 1 was about 3m deep, protected from waves, and possibly prone to grazing by herbivorous fishes. Outside the reef, St. 2 was about 18 m deep, in the open ocean, and therefore less prone to grazing by herbivorous fishes.

Panels were retrieved and fixed immediately with 3% seawater formalin. In order to avoid an edge effect (Sekar *et al.*, 1998), the area 2.5 cm from the edge was not examined. The sessile communities on the panels were examined and analyzed for species composition, area cover (%), algal filament length (mm) and biomass (dry wt g/m^2). Each panel surface was examined, and the four panels at each station ($n=8$) were pooled because they did not differ in the species composition or area cover.

The area cover of organisms was estimated using the point method (see Nandakumar *et al.*, 1993) and length of the filamentous algae was measured by a vernier calipers. For dry weights, sessile organisms were scraped, dried overnight in an oven at 60°C and weighed. All organisms were identified to the lowest taxonomic level possible.

Results

A total of 16 species of sessile organisms belonging to seven major taxonomic groups settled on the panels during the study period (Table 1). A significantly smaller number of species (6 spp.) settled on panels located inside the coral reef (St. 1) than on panels located outside the reef (14 spp. at St. 2, Mann-Whitney U test, $p < 0.005$). Outside the reef at St. 2, the sessile community included invertebrates such as hydroids, polychaetes,

cirripeds and gastropods, as well as a higher diversity of algal species (9 spp., Table 1). Inside the reef at St. 1, the sessile community comprised 2 species of invertebrates and 4 species of algae (Table 1).

The percentage area cover of sessile organisms was higher on panels suspended outside the reef than inside. The mean bare surface area was 5% outside and 26% inside the reef. Chlorophyceae dominated the panels with very high percentage cover at both stations (Table 2). Outside the reef, Hydrozoa (5%) and Rhodophyceae (3%) were present.

Growth in the filamentous algae was measured by the length of the filaments. Algal growth was significantly higher outside the reef (mean 4.04 mm $\pm$ 0.86 SD) than inside the reef (1.89 mm $\pm$ 0.52 SD, t-test, $p < 0.0001$, $n = 8$ for each station).

The total biomass measured as dry weight was significantly higher outside the reef (9.78g/m^2 $\pm$ 2.13 SD) than inside the reef (6.16g/m^2 $\pm$ 1.78 SD, t-test, $p = 0.0024$, $n = 8$ for each station). The calcareous component of the biomass was negligible because cirripeds and spirorbid polychaetes were rare (Tables 1 & 2).

Table 1. List of sessile organisms settled on the PVC panels in the two study stations.

No.	Group	Species	St. 1	St. 2
1	Chlorophyceae	*Enteromorpha* sp.	+	+
2		*Chaetomorpha media* (C. Agardh) Kützing	+	+
3		*Caulerpa racemosa* J. Agardh	−	+
4	Rhodophyceae	*Ceramium* sp.	+	+
5		*Polysiphonia* sp.	−	+
6		*Antithamnion* sp.	−	+
7		Rhodophyceae sp.	−	+
8	Phaeophyceae	*Colpomenia sinuosa* (Roth) Derbès et Solier	+	+
9		*Padina* sp.	−	+
10	Hydrozoa	Corynidae sp.	−	+
11		Campanulariidae sp.	−	+
12	Polychaeta	Errantia sp.	−	+
13		Spirorbidae sp.	+	−
14	Cirripedia	*Lepas anatifera* Linnaeus	−	+
15	Gastropoda	*Styliferina goniochira* A. Adams	−	+
16		Gastropoda sp.	+	−

Table 2. Percentage of area cover of sessile organisms on the PVC panels in Station 1 (inside the coral reef) and Station 2 (outside). Data ($n = 8$ for both stations) were pooled.

	Station 1	Station 2
Chlorophyceae	74	86
Rhodophyceae	0	3
Phaeophyceae	0	1
Hydrozoa	0	5
Bare space	26	5

Discussion

The sessile community in reef waters at Ishigaki Island in the subtropics is rich compared to a temperate Japanese coastal area, Amakusa (Nandakumar, 1996). Even though the duration of the study was short, 16 species settled onto the panels. The sessile community comprised mostly of *Enteromorpha* sp. and *Chaetomorpha media* (C. Agardh) Kützing in the Chlorophyceae. In the Rhodophyceae, *Ceramium* sp. dominated the panels at both the stations. Invertebrates, *Lepas anatifera* Linnaeus and hydroids were dominant, but these species were observed only on panels outside the reef. In comparison to temperate Japan at Amakusa (Nandakumar, 1995, 1996), species composition of the sessile community differed to Ishigaki Island, with only one species, *Colpomenia sinuosa* (Roth) Derbès et Solier (Phaeophyceae), common to both locations.

Settlement, growth (filament length) and biomass of the sessile community on the panels suspended at the outer reef (St. 2) were significantly greater than those suspended inside the reef (St. 1). As spatial patterns of sessile communities vary among studies (Sorokin, 1993), it is difficult to generalize whether the pattern observed in this study is common on coral reefs. One of the reasons for the reduced settlement, growth and biomass inside the reef may be due to higher levels of grazing by fishes in this area. The grazing herbivorous fishes are generally absent in the surface water at the outer reef area (Hiatt & Strasburg, 1960), where the panels were suspended. In contrast, inside the reef area, near St. 1, the number of herbivorous grazing fishes (mainly acanthurids) was high and increased substantially after the coral bleaching incident (Shibuno *et al.*, in press). Alternatively, the mass mortality of corals after bleaching might have caused a leakage of nutrients from the dead tissue of corals into the water, which increased the level of nutrients in the water column at both locations. An increased nutrient supply from dead corals might have improved the survival of propagules of sessile organisms in this area during the study period.

In conclusion, this short term study is an example of differences in the sessile community found in waters inside and outside reefs immediately following the mass mortality of the corals after bleaching. Whether the spatial pattern of sessile communities observed in this study is unusual and related to the episode of coral bleaching is an interesting topic for future research.

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References

Benayahu, Y. & Loya, Y. 1981. Competition for space among coral-reef sessile organisms, at Eilata, Red Sea. Bull. mar. Sci., 31: 514–522.

Fujioka, Y. (in press). Mass destruction of the hermatypic corals during bleaching event in Ishigaki Island, southwestern Japan. Galaxea, J. Japanese Coral Reef Soc.

Hiatt, R. W. & Strasburg, D. W. 1960. Ecological relationships of the fish fauna on coral reefs on the Marshall Islands. Ecol. Monog., 30: 65–127.

Hoshino, T. 1987. A preliminary report on demosponges from the coral reef of the Okinawa Islands. Galaxea, 6: 25–29.

Imajima, M. 1987. Serpulidae (Annelida, Polycaeta) collected around Sesoko Island and Bise, Okinawa. Galaxea, 6: 75–82.

Jackson, J. B. C. 1984. Ecology of cryptic coral reef communities. III. Abundance and aggregation of encrusting organisms with particular reference to cheilostome bryozoa. J. Exp. Mar. Biol. Ecol., 75: 37–57.

Jackson, J. B. C. & Buss, L. W. 1975. Allelopathy and spatial competition among coral reef invertebrates. Proc. Nat. Acad. Sci., USA, 72: 5160–5163.

Jackson, J. B. C. & Winston, J. E. 1982. Ecology of cryptic coral reef communities. I. Distribution and abundance of major groups of encrusting organisms. J. Exp. Mar. Biol. Ecol., 57: 135–147.

Logan, A. 1984. Interspecific aggression in hermatipic corals from Bermuda. Coral Reefs 3: 131–138.

Mawatari, S. F. 1987. A preliminary list of cheilostomatous bryozoans from Sesoko, Okinawa. Galaxea, 6: 99–107.

Nandakumar, K. 1995. Competitive interactions among sessile organisms in Tomioka Bay, south Japan: Importance of light conditions on the panel surface. Mar. Biol., 121: 713–719.

Nandakumar, K. 1996. Importance of timing of panel exposure on the competitive outcome and succession of sessile organisms. Mar. Ecol. Prog. Ser., 131: 191–203.

Nandakumar, K., Tanaka, M & Kikuchi, T. 1993. Interspecific competition of fouling organisms in Tomioka Bay, Japan. Mar. Ecol. Prog. Ser., 94: 43–50.

Nishi, E. 1993. Ecological study of a sessile polychaete *Pomatoleios kraussii* (Baird) (Serpulidae, Sedentaria) at Haneji Inlet, Okinawa, with fouling species composition there. The Biological Magazine Okinawa, 31: 29–40 (in Japanese with English abstract).

Nishikawa, T. 1987. A preliminary list of ascidians harboured with copepods in the vicinity of Sesoko Island, Okinawa. Galaxea, 6: 115–117.

Romano, S. L. 1990. Long term effects of interspecific aggression on growth of the reef-building corals *Cyphastrea ocellina* (Dana) and *Pocillopora damicornis* (Linnaeus). J. Exp. Mar. Biol. Ecol., 140: 135–146.

Sekar, R., Nandakumar. K., Venugopalan, V. P., Nair, K. V. K. & Rao, V. N. R. 1998. Spatial variation in the colonization of microalgae on inert panel surfaces. Biofouling, 13: 177–195.

Sorokin, Y. I. 1993. Coral reef ecology. Ecological studies 102, Springer–Verlag, Berlin, Germany. 465pp.

Shibuno, T., Hashimoto, K., Abe. O. & Takada, Y. (in press). Short-term changes in the structure of a fish community following coral bleaching at Ishigaki Island, Japan. Galaxea, J. Japanese Coral Reef Soc.

Tsuda, R. T. 1991. Catalog of the marine benthic algae from the Ryukyu Islands, Japan. Galaxea, 10: 35–64.

Yamada, M. & Kubota, S. 1987. Preliminary report on the marine hydroid fauna in Okinawa Islands. Galaxea, 6: 35–42.

Yamada, M. & Yamazato, K. 1987. Introductory accounts on the cooperative research on the coral reef fauna of Okinawa. Galaxea, 6: 21–24.