F-5.1.2 Diversity of hermatypic coral communities

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Abstract Twelve representative hermatypic coral communities were investigated by means of a large quadrat method of 50 m x 50 m around Ishigaki Island, southwestern Japan. The coral coverage was 5.1-89.8 %, in which totals ranging from 31 to 132 species were recorded in each community. The species richness increased from the coastal side to the reef margin through the reef flat, was highest at the upper reef slope of approximately 5-15 m, and began to decline below 15 m depth. The coral coverage exhibited the similar trend except for a few sympatrically aggregated communities. The species-area curve was exclusively approximated to logarithmic functions. The number of colonies increased gradually, but suddenly decreased after the summer of 1998 because of the bleaching event. The present results support the non-equilibrium hypothesis because the dominant and fast-growing *Acropora* was suffered the severest damages through bleaching.

Key Words Coral, Coral Reef, Diversity, Community, Bleaching

1. Introduction

Species diversity of hermatypic corals in the coral reef ecosystem has been extraordinarily focused in relation to the conservation of global environment and biological diversity of worldwide marine organisms. Some coral communities consist of a lot of species and others only a few, and therefore the biological diversity should be different each other even within an identical coral reef ecosystem. In this study, we attempted to compare the diversity of hermatypic corals among different kinds of representative communities around the southwestern Japan.

2. Methods

Twelve representative hermatypic coral communities were selected around Urasoko Bay (24° 27' N, 124° 13' E) and the eastern fringing reefs of Ishigaki Island, southwestern Japan (Fig. 1), based on knowledge obtained from the previous survey [1]. The convenient name of communities, location and the depth was as follows.

(1) Faviids community	Inner reef flat (Inside of moat)	1-2 m
(2) *Porites lutea* community	Inner reef flat	1-2 m
(3) *Montipora digitata* community	Inner reef flat	1-2 m

(4) *Heliopora coerulea* community	Outer reef flat (Reef crest)	1-2 m
(5) *Acropora formosa* community	Outer reef flat	1-2 m
(6) *Acropora digitifera* community	Outer reef flat (Reef edge)	1-2 m
(7) *Acropora hyacinthus* community	Upper reef slope (Reef edge)	5-10 m
(8) *Mycedium-Oxypora* community	Middle reef slope	10-20 m
(9) *Acropora subglabra* community	Middle reef slope	10-20 m
(10) *Leptoseris gardineri* community	Lower reef slope (Bottom of bay)	20-25 m
(11) *Galaxea astreata* community	Lower reef slope (Bottom of bay)	20-25 m
(12) Deeper community	Lower reef slope	30-40 m

The field survey was carried out in every summer from 1997 to 1999 by means of a large quadrat method of 50 m x 50 m at the reef flat and 30 m x 30 m at the reef slope. The "individual counting and cover estimate" method [2] was adopted for every subdivided 1 m^2 unit. Percentage of coverage and the number of colonies were recorded for all hermatypic coral species. To compare the species diversity among communities, all species were identified within and around every study sites.

Changes in coral community were monitored at the twenty-one study sites with 1 m^2 permanent quadrat which had been previously established under different environmental conditions of Urasoko Bay.

3. Results

Spatial structure of coral coverage within the large quadrat of 50 m x 50 m or 30 m x 30 m was shown in Fig. 2. The coverage was high at *Acropora digitifera* (89.8 %) and *A. hyacinthus* (73.8 %) communities and low at Faviids (5.1 %) and *Porites lutea* (8.1 %) communities. The distribution pattern within the communities did not exhibited uniform but some different kinds of aggregated patterns.

Totals ranging from 31 to 132 species were recorded in each community. The species richness increased from the coastal side to the reef margin through the reef flat, was highest at the upper reef slope of approximately 5-15 m, and began to decline below 15 m depth (Fig. 3). The coral coverage exhibited the similar trend except for a few sympatrically aggregated communities such as *Galaxea astreata* one (Fig. 4).

The diversity indexes were the highest at the *Mycedium-Oxypora*, *Acropora formosa* and *A. subglabra* communities of the upper to middle slope (Fig. 5). *Acropora* and *Montipora* formed diverse communities consisting of several allied species of the same genera, while *Galaxea astreata*, *Leptoseris gardineri* and *Heliopora coerulea* formed less diverse communities predominantly consisting of one or a few species only.

The species-area curve was exclusively approximated to logarithmic functions (Fig. 6), in which approximately 10 % species of each community were present in 1 m^2 quadrat.

Relative composition of coral coverage was compared in Fig. 7. The families Faviidae, Poritidae and Acroporidae (mostly *Montipora*) were dominant at the inner reef flat and Acroporidae (mostly *Acropora*) at the outer reef flat, and Pectinidae, Agariciidae and Oculinidae at the reef slope instead of them.

Changes in the number of colonies since 1995 were shown in Fig. 8. They increased gradually, but drastically decreased after the summer of 1998 and all acroporid colonies died at this time.

4. Discussion

Totals of 234 hermatypic coral species belonging to 56 genera and 16 families was recorded from Urasoko Bay [3]. The species diversity was also high even at every communities, one of which 132 species distributed within approximately 1 hectare. The species richness was the highest at the reef edge or upper reef slope, while the species diversity indexes were the highest at the middle reef slope. These results do not agree with those of the previous ones [4] that the diversity becomes higher at the lower than the upper on the reef slope. This might be caused by the thermal stress is not severe in the southwestern Japan because this area is situated near the northern limit of coral reefs, and therefore high species diversity is maintained even at the shallow water.

The bleaching of hermatypic corals that occurred in the summer of 1998 was the most extensive and severest one in recent years [5]. It was evident that coral colonies in the monitoring sites decreased drastically due to the bleaching. Coral reefs are believed to subject to severe disturbance often enough that equilibrium may never attained [1][6]. The present results support their hypothesis because the dominant and fast-growing *Acropora* was suffered the severest damages through bleaching.

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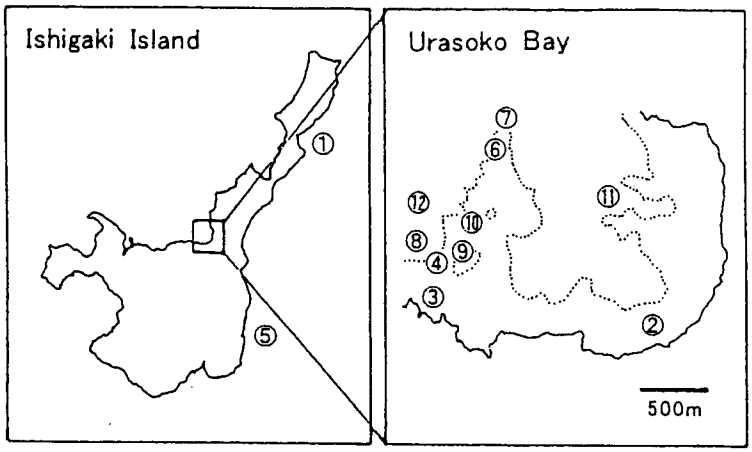


Fig. 1 Location of study sites around Ishigaki Island.

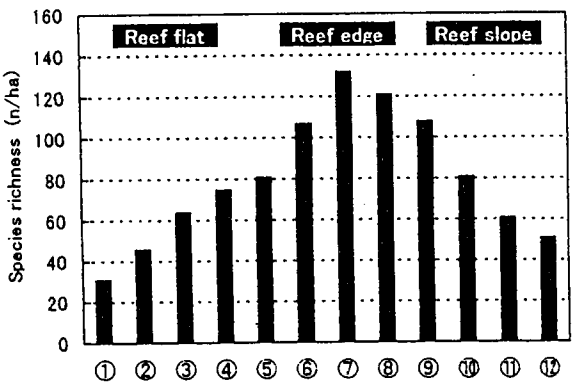


Fig. 3 Number of species of hermatypic corals.

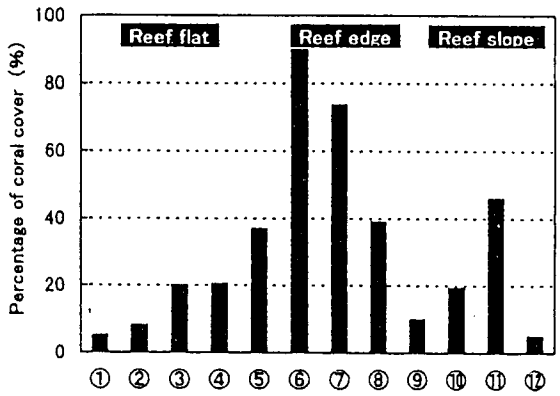
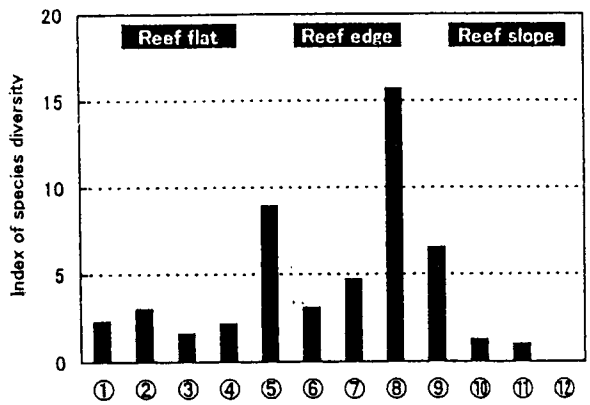


Fig. 4 Coral coverage in the study sites.

Simpson's Index $(1/\lambda = \Sigma (n/N)^2)$



Shannon-Wiener's Index $(H' = -\Sigma n/N * \log_2(n/N))$

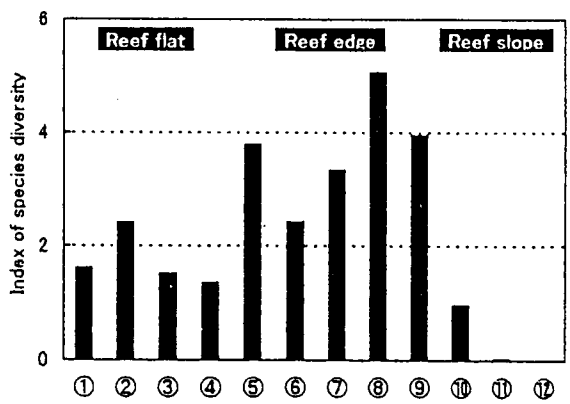
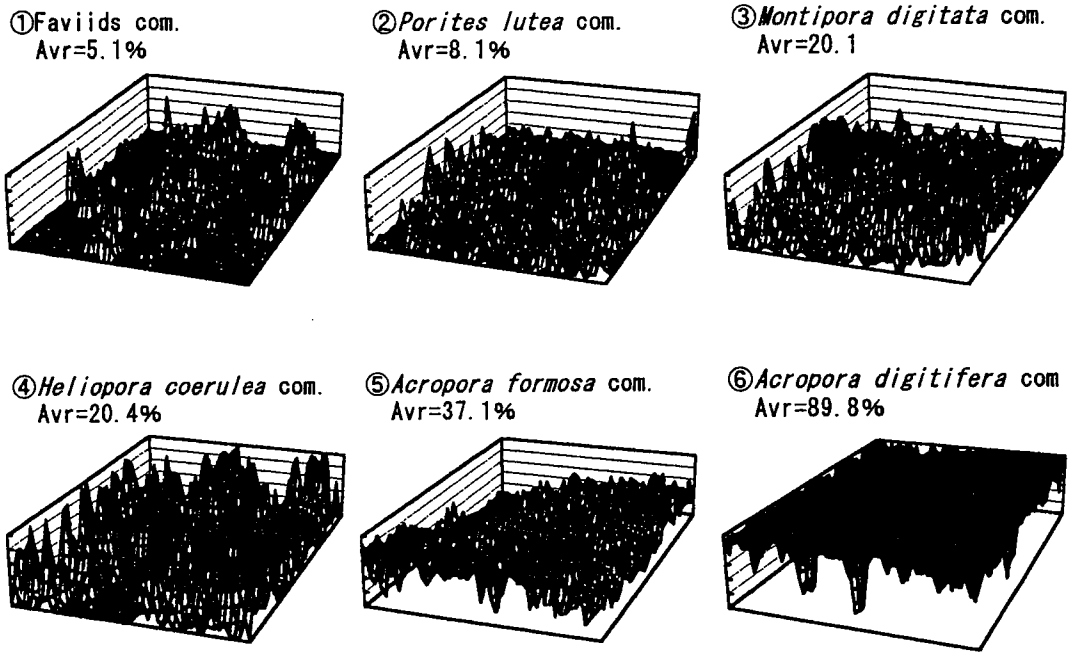


Fig. 5 Diversity Index of coral species.

Reef Flat (50m × 50m)



Reef Slope (30m × 30m)

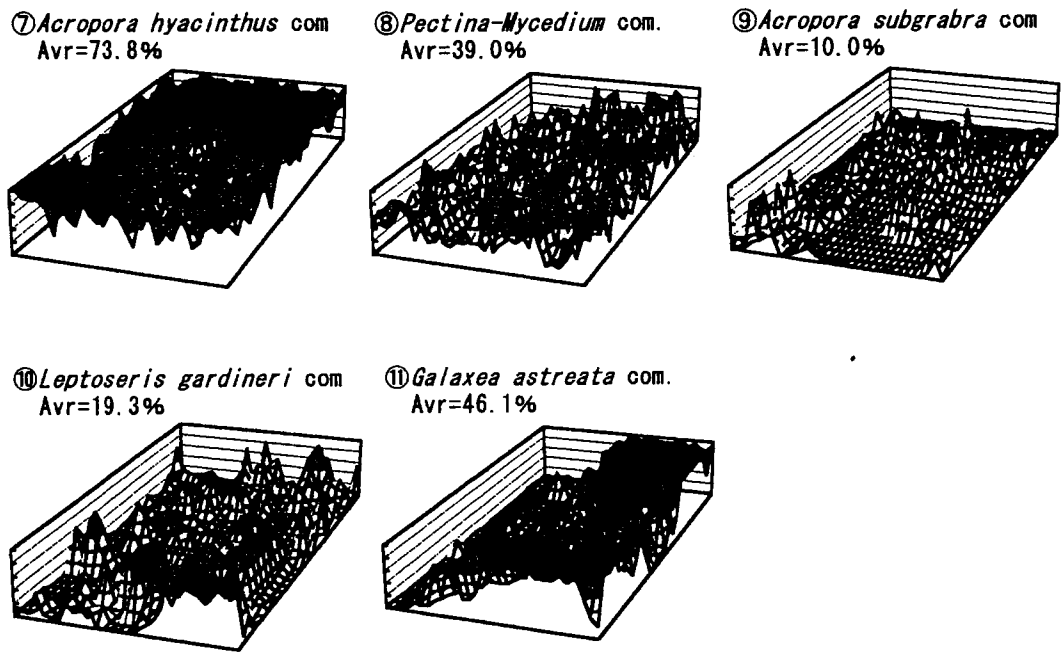


Fig. 2 Spatial structure of coral coverage.

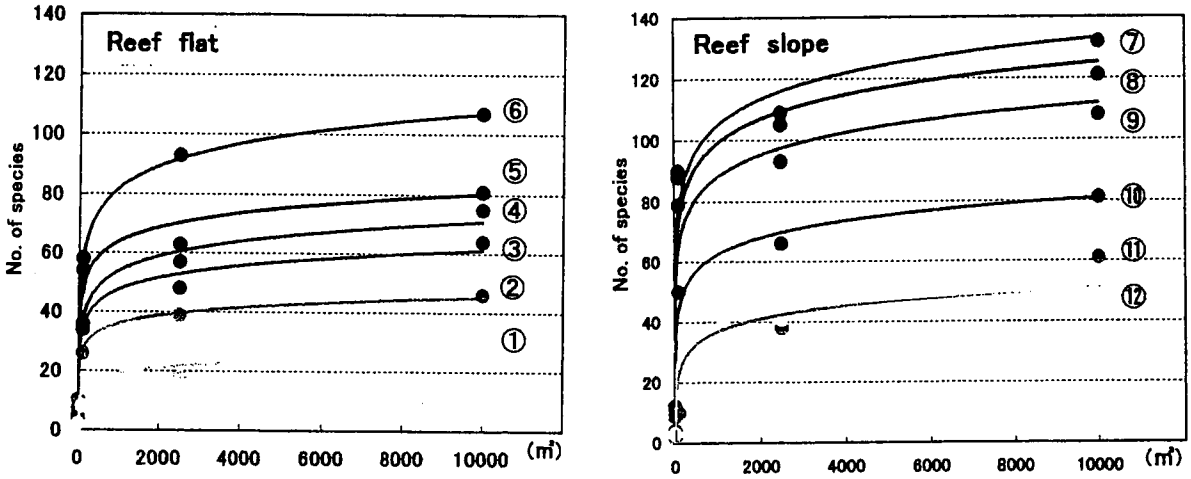


Fig. 6 Species-area curves of hermatypic corals.

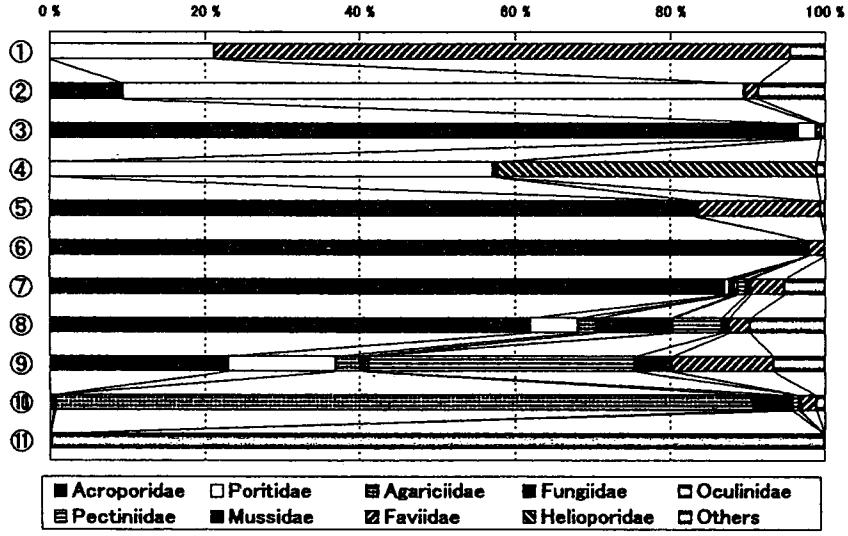


Fig. 7 Relative composition of coral coverage.

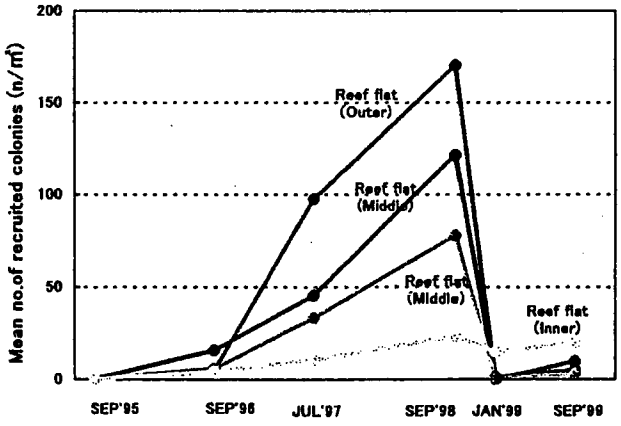


Fig. 8 Changes in the number of coral colonies.