

Interrelationships among Seaweed, Fish, Hermatypic Coral and Sea Urchin in the Yokonami Research Site near Kochi City

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Abstract

A new field station named “Yokonami Rinkai Experimental Station” was established in February 2007 at Yokonami Peninsula, central part of Kochi Prefecture. The station is managed by Kochi Prefectural Government, but mainly the researchers of Kochi and Kyoto Universities will utilize for the study of marine biology and the interrelation among forest, river, field and marine environments. The water in front of the station is full of hermatypic corals at the bottom. About 200 species of fishes have been observed and especially chaetodontid fishes are abundant. This site is excellent for the study of marine environmental issues and interrelationships between hermatypic corals and other organisms including reef fishes. The station is also expected as a site for field education for undergraduate and postgraduate students of universities and high-school students.

Introduction

The “Yokonami Rinkai Experimental Station” was established in Uranouchi, Susaki City, Kochi Prefecture, as a new research facility of the Graduate School of Kuroshio Science, Kochi University, on the basis of an agreement among the Field Science Education and Research Center of Kyoto University, Kochi Prefecture and the Ikenoura Fishermen’s Cooperative. The site of this Experimental Station was long used as “Kochi Prefectural Children’s Forest Park” by families and other groups mainly in summer for camping, playing on the beach or other recreational activities. In order to promote investigations and research from a broader viewpoint, the Experimental Station was founded here as a facility for the joint use of Kochi and Kyoto Universities with the approval of the Kochi Prefectural Government.

From an organizational point of view, this Experimental Station belongs to the “Yokonami Rinkai Research and Exchange Center of the Kochi Prefectural Fisheries Experimental Station,” but in terms of actual use, it is called the “Yokonami Rinkai Experimental Station of the Graduate School of Kuroshio Science, Kochi University and the Field Science Education and Research Center, Kyoto University.” “Rinkai” means forest and marine in Japanese. This name selected instead of “Coastal (also *Rinkai* in Japanese) Experimental

Station” suggests that the concepts of environmental sciences, which cover the interrelationships among forests, rivers, rural areas and the sea, lie behind the establishment of the Experimental Station.

1. Characteristics of the coastal area

In front of the Yokonami Rinkai Experimental Station lies a small semicircular bay open to the east (mouth of the bay: about 500m wide). Because the Ikenoura Fishermen’s Cooperative manages the resources of Japanese spiny lobsters and has the fishing rights in the bay, the bay is designated as a no-fishing area. The beach is that of fine sand, and the coastal water becomes deeper quickly. On the bottom, plate-shaped *Acropora* species appear, and these belong to hermatypic coral (a member of Coelenterata having hermatypic skeletons). In the area farther off the shore about 2.5m deep, the coverage of corals is so wide that it covers all parts of the bottom, and nearly 100% coverage like this is observed as far as the area about 5m deep. Coral communities so healthily developed as those seen in this area cannot be found everywhere, and thus the communities in this bay are often called the first-class ones in Japan. According to the preliminary observation by Dr. Hironobu Fukami at the Shirahama Marine Biological Laboratory of Kyoto University, about 50 species of hermatypic coral live in this area. *Acropora* species are the dominant corals,

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and *Acropora hyacinthus*, a temperate species, shows the greatest coverage. Other main *Acropora* species include *A. solitaryensis* and *A. formosa* (Fig.1). *A. formosa* is originally a southern species and is said to have expanded its distribution to northern waters recently. How the interrelationships between this species and temperate species will change in the future will be an interesting subject of study.



Fig. 1 *Acropora formosa*

The characteristics of coral communities in the sea area are not only the very great coverage mentioned above but also the large-scale development of *Pocillopora damicornis* communities not often seen in other areas. Therefore, the competitive relations for spaces between *Pocillopora damicornis* (Fig.2) and *Acropora* species will be one of the subjects of study that could not be taken up in other districts.



Fig. 2 *Pocillopora damicornis*

We installed a permanent research quadrat 20m x 20m on the bottom at 3.5m deep and prepared the detailed distribution chart of coral, soft coral and other substrata found in the quadrat (Fig.3). Thus it is now possible to observe changes in the development of corals,

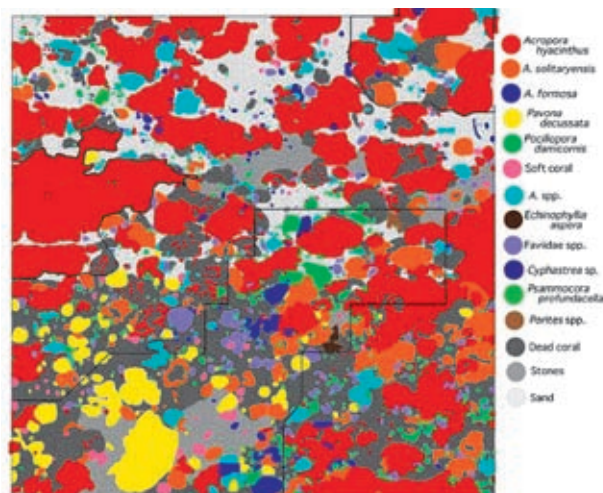


Fig. 3 Bottom chart in 20m x 20m quadrat

2. Fish fauna of coral community

In the area where coral develops, a variety of faunas that use the area as a habitat or a place for getting food can be seen. Especially noteworthy are coral reef fishes; the diving investigations for several months from May 2006 to January 2007 confirmed about 200 species of fish in the area, over 70% of which were coral reef species. The number of the species observed in the area seems to be much fewer as compared with the 608 species (number of the species observed by diving only) in Kashiwajima at the western end of Kochi Prefecture. But it is no low figure relative to about 127 species observed in Iburi, Tosashimizu, for two years, and 120 species in Minamiuwa.

Regarding species diversity, as expected labrid fishes are found most followed by pomacentrid and chaetodontid fishes (20 species). Chaetodontid fishes rank third in terms of the number of species but stand first in the number of individuals (48%) (Fig.4); thus this

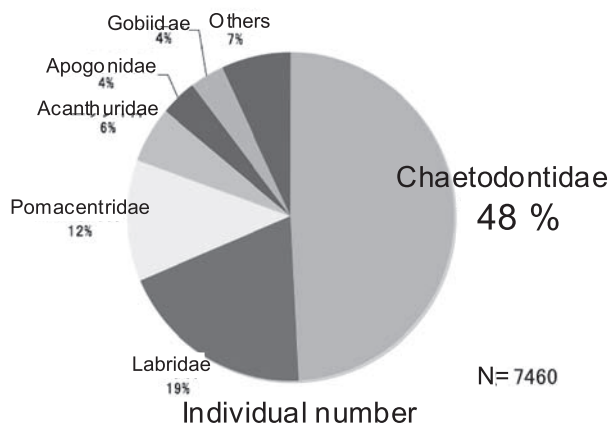


Fig. 4 Rate of fish individual numbers

family characterizes the fish species found at the water in front of the Yokonami Rinkai Experimental Station. If the divers who have dived in various parts of Japan have a chance to dive here, they will see a very large number of chaetodontid juveniles. So many chaetodontid juveniles inhabit the water.

3. Ecology of chaetodontid fishes

Why are such a large number of chaetodontid juveniles observed in this area? Chaetodontid fishes can roughly be classified into the species feeding on the polyps of corals (minute animals like sea anemones living in the numberless small holes on the surface of coral) and omnivorous species. Almost all species observed in this sea are polyp eaters, and *Chaetodon speculum* (Fig.5) and *C. lunulatus* (Fig.6) are found in especially large numbers. Both of these species are typical polyp eaters; it is supposed that these species have been brought to Tosa Bay from southern waters on the Kuroshio Current, and when their body length reaches about 12~17mm, they appear among the branch-shaped *Acropora* species. The spaces between the branches provide the two species with both shelters for avoiding predators and spaces full of polyps on coral, their favorite food. Because food is available in coral colonies, their



Fig. 5 *Chaetodon speculum*

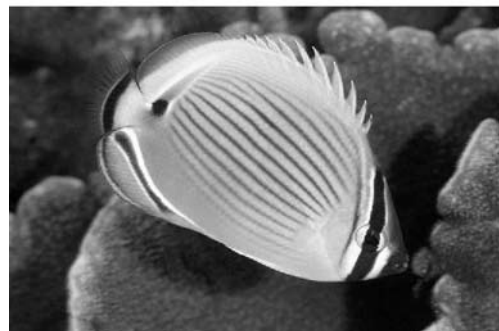
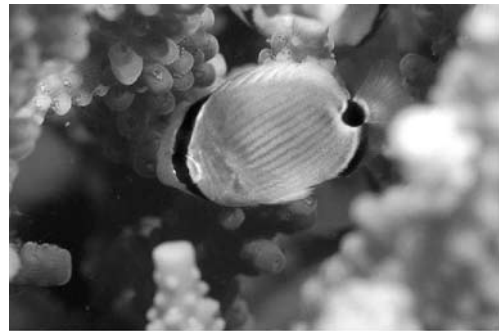


Fig. 6 *C.lunulatus*

habitat, small-sized juveniles never leave these communities. It is considered that many chaetodontid juveniles live in this area because healthy *Acropora* species, which give them both habitats and food, develop well here.

While it is supposed that these chaetodontid juveniles have been carried to this water by the Kuroshio Current as noted above, what is the situation of their reproduction (propagation) here? In ecology, the phenomenon where the larvae, etc. of an animal are carried by a wind or an ocean current to the environment where they cannot complete their life history is called invalid dispersion or abortive migration. In this sense, the chaetodontid juveniles about 20mm that come into the water in front of the Rinkai Experimental Station as late as January are considered to be typical cases of invalid dispersion. These juveniles die because unable to endure the low temperatures in late February. But in Shizuoka Prefecture where the lowest water temperature in winter is 13°C, the temperature of water reaches 16°C or more in winter near the outlet of warm wastewater from a power plant; thus *C. lunula*, *C. lineolatus* and other Chaetodontidae can winter and be observed in this area throughout the year. The water temperature at the research site in Yokonami (water depth: 3.5m) was 17.5°C on February 18, 2007 and did not go under 16°C. Therefore, it is supposed that the chaetodontid juveniles, which arrive at this water even in January, can survive here in a warm winter.

4. Algae communities

When we stand on the beach in front of the Station a little apart from the sea and look at the whole bay, we see, at the right (southern side) of the bay, a reef area sticking out to the east. The sight causes us to suppose that this reef area has much to do with the growth of such large-scale coral communities in the water. This is because we can consider that the reef area blocks large waves and prevents the direct impact of waves from reaching the area of coral communities. In addition to the coral communities, the development of small communities of *Sargassum fulvellum* are seen in the sea about 1m deep at the rocks on the right near the beach. On the left (northern) side of the bay are large rocks, too, where fairly large communities of *S. fulvellum* have developed and where Mr. Seiya Taino, a researcher at the Kochi Prefectural Fisheries Experimental Station, is studying the mechanism of the growth and decline of seaweed beds. As stated, the water before the Station has diverse environments and offers the site for a variety of research work, including not only the ecological study of coral itself and coral reef fishes but also the study of crown-of-thorns (it has been confirmed that several crown-of-thorns live here) and gastropods belonging to the genus *Drupella* that forage coral polyps and that of the mechanism of the development and degeneration of seaweed beds. In addition, researchers can conduct their

studies here without any intervention by anglers, sea bathers and other people. This water can be regarded as an “experimental water” for marine research equivalent to “experimental forest” for forestry research.

Considering the situation of their development, it seems that coral colonies in Yokonami have not been subjected to any fatal blow by crown-of-thorns for about 30 years. According to a newspaper report, there were large-scale outbreaks of crown-of-thorns in the sea around the Ashizuri Peninsula near Yokonami, but why was the Yokonami area not affected by the outbreaks? This will be one of the subjects of our future study.

Conclusion

The Experimental Station is the facility for joint use by Kochi and Kyoto Universities. As expected from its nickname “Kyoto Exploration University,” Kyoto University is characterized by activities at its field science section. The Graduate School of Kuroshio Science of Kochi University also has an important policy, “laying emphasis on the field.” Thus it is hoped that the two universities will carry out research projects in cooperation with each other here. The Experimental Station aims at building up the unique and original new fields that will herald the “age of small and few” to come and will produce brilliant and splendid ideas.