

Fish Fauna under Coral Communities in Kuroshio Waters around Kashiwajima Island in Kochi, Japan

Masaru Kanda*

Non-profit organization:Kuroshio Zikkan Center
(625 Kashiwajima,Otsuki, Hata, Kochi 788-03439)

Abstract

The Kuroshio Zikkan Center is a non-profit organization (NPO) that carries out a variety of activities for promoting the conservation of the marine environment mainly in the sea off Kashiwajima, Ohtsuki, Kochi Prefecture, which is a treasure-house of marine life. Established in 2000, the Center is working as a base for letting people know about the wonders of the sea and for protecting the ecosystem of the area. The Center continues steady and community-oriented activities, which include 1) exhibition of samples of organisms living in the sea around Kashiwajima, 2) recording of marine life by taking underwater photos, 3) environmental education in cooperation with local elementary, junior high and high schools, 4) joint research with universities and other educational institutions and 5) acting as a go-between for fishers and divers and thus helping revitalize fisheries in the area.

Based on the center's activities carried out at a local field in Kuroshio waters, this paper shows present situation of biodiversity focusing on selected fishes under coral communities.

Keywords: coral communities, fish fauna, Kashiwajima Island, Kuroshio Zikkan Center

Introduction

Kashiwajima is a small island located at the south-western tip of Kochi Prefecture, Shikoku, Japan. This island is 3.9 km in circumference and presently has a population of about 500. The waters around the island are a storehouse of various types of marine life because the Kuroshio, a clean and warm current from the south, and the nutritious seawater coming from the Inland Sea through the Bungo Channel come together here. I moved to this island and founded the Kuroshio Zikkan Center in 2000 as a nonprofit organization in cooperation with people on the island, with the aim of conserving the productive marine environment. Considering that the entire island, including its rich natural environment and the lives of the people in Kashiwajima, can be regarded as a living museum, we at the Center are working to create a sustainable Sato Umi (the sea for the area and its inhabitants). Into the term "Sato Umi" we have put our hope for "cultivating, bringing up and protecting both people and the sea, as well as enjoying the great blessings of the ocean." Toward the realization of sustainable Sato Umi, we are promoting three types of activities:

a. Activities for giving people the chance to get in touch with nature

To give people the chance to get in touch with and actually feel nature, we are undertaking studies of the sea around Kashiwajima and holding Sato Umi seminars to report the outcome of our studies to both local people and visitors to Kashiwajima. The Center is also offering programs to help people realize how wonderful the sea around Kashiwajima is; for example, we are giving children, who will lead the next generation, lessons on the ocean environment and the chance to experience and make contact with nature and we are also arranging ecological tours for adults.

b. Activities for helping people make the most of the blessings of nature

It is often said that you cannot survive only with a good natural environment. With this in mind, we are conducting activities to help people utilize the blessings of the environment. These activities include the Sato Umi Fair, a market of local products held in cooperation with the members of the rural development council and organized by local people, and a project to establish propagating and spawning beds for oval squid conducted

*Corresponding author: e-mail kuroshio@divers.ne.jp

together with local fishers, divers and children so as to contribute to the development of productive fishing grounds.

c. Activities for protecting nature and people’s livelihoods

Even if you receive nature’s bounty and have attained economic prosperity by using it, you will be unable to conserve a good environment if you just consume the blessings of the sea. The Center is organizing activities aimed at protecting the environment of the island and the livelihoods of the people on Kashiwajima; we are conducting surveys to observe the subtle changes in the natural environment. We are also working to conserve coral reefs and seaweed beds and have established the Charter For Sato Umi of Kashiwajima as a local ordinance taking account of the need to accept a large number of sightseers who visit the island. Please refer to the previous volume of “Kuroshio Science” 2-1 issued on March 2008, for details.

The following sections will outline the state of the activities for conserving the fish, fauna and coral reefs around Kashiwajima, the life which lends color to Tosa (the old name of Kochi Prefecture), in accordance with the theme, “Biodiversity in Kuroshio Waters,” the spe-

cial focus of this symposium.

2. Kashiwajima Island

Kashiwajima Island in Otsuki-machi, Hata-gun, Kochi Prefecture, is a small island with an area of 0.57km² situated in Ashizuri-Uwakai National Park. At present, the island is connected with the mainland by two bridges. It is said that the name Kashiwajima (literally the “island of a daimyo oak”) came from the fact that the island has a shape similar to that of the extended leaf of a daimyo oak. Off the island there are many other islands of all sizes, including Okinoshima and Ugurushima, which offer good fishing spots (Fig. 1).

The coastal areas of Kashiwajima are strongly affected by the Kuroshio. They are influenced by the Bungo Channel, too, because the island is located at the entrance to Sukumo Bay. Due to these effects, fish species of the tropics, the subtropics and the temperate zones coexist in the sea around Kashiwajima even though the area is in a temperate zone. A rich variety of fish with as many as 143 families and 884 species has been reported. Investigations are still continuing with about 100 species requiring further study mainly because they have not yet and/or may not yet have been reported in Japan. When

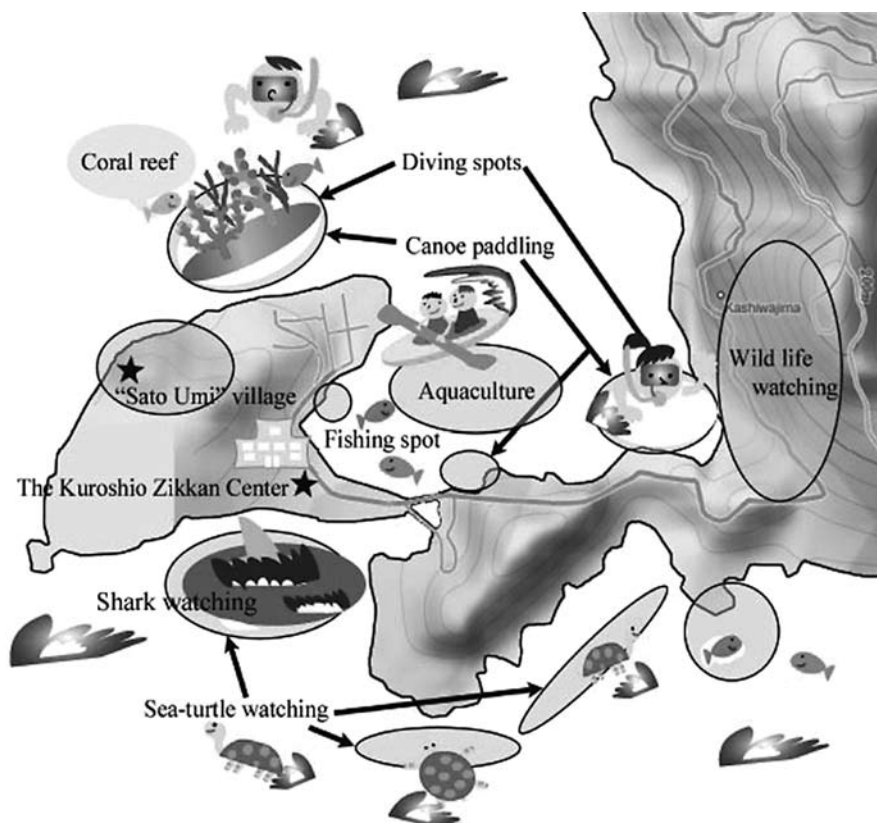


Fig. 1 A chart of Kashiwajima Island showing the whole island as “a museum”

these species are added, nearly 1,000 fish species may be said to live in the waters off Kashiwajima. In the sea around Japan, about 3,800 species of fish have been confirmed, which means that roughly one quarter of all species recorded in Japan have been found in the waters off this small island, the highest figure thus far recorded in Japan. This tells us how rich in fish fauna Kashiwajima's waters are thanks to the island's special location.

A wide range of stony coral grow considerably widely in colonies on Kashiwajima and in the waters around the island. The scale of the stone coral in this area is comparable to that in other coastal areas of Japan, except for the areas south of the Tokara Islands and the Nansei Shoto (Southwestern Islands), and was one of the largest as of 2000. Thus, Kashiwajima has a very high value as an area for scientific studies, and many researchers have conducted research into the fish of these waters.

Kashiwajima has long been known as a mecca for surf fishing. Recently the beautiful resource-rich sea around the island has been featured in special issues of several magazines; as a result, many divers have begun to visit the island from Kochi and beyond, and Kashiwajima is becoming a center for scuba diving, too. Thus, the number of diving shops has increased on the island, and new diving sites and rare fish have been found, while at the same time devastation of the sea has been increasingly evident at the diving sites.

3. Environment of the Coastal Areas of Kashiwajima

Thanks to the Kuroshio current, the temperature of seawater around Kashiwajima is fairly high throughout the year, ranging from about 16°C to 29°C. Visibility is about 20m on average and reaches as much as 30-40m at peak times. While waves are high on many days in winter because of strong seasonal winds, in most cases summer days do not have many high waves. Tatsugahama, lying on the eastern side of Kashiwajima, is a small cove opening in a northwestern direction; it has a grave beach on the inside, and both of its sides are shore reef areas. The topography of the seabed up to 5-7m from the shore consists of a boulder stone area, and colonies of cactus coral are found here and there in this area. Fine sand areas extend in the center of the cove, which is generally shallow with a maximum depth of 10m or so.

Ushironohama Beach on the coast north of Kashiwajima is small, gently shelving and shallow, and the sea along the beach is shallow in general, having a maximum depth of 5m, with a flat seabed. Culture cages can be found off the beach. The beach extends from the

fishing banks around the red lighthouse to those banks off Kuroiwa. The environment in this area is full of variety, and the coast is formed mainly of boulder stones. Bank-like structures that look like piled up boulder stones are observed in the sea near the red lighthouse at depths of 2-5m. It seems that investigations have been conducted on these structures several times, but it is not clear whether they are natural or artificial. The area at depths of 3m or less is mostly composed of boulder stones, and table-shaped coral reefs and seaweed are also found in this area. In areas with depths of 3-15m, larger boulder stones and shore reefs exist, and the coverage of table-shaped coral reefs is highest; the topography is complex, and tiny sandy places are observed sporadically appearing in patches. The coverage of stony coral was over 90% in areas at depths of about 10m as of 2000. The zones at depths of 15-20m are gently sloping fine sand areas or steep slopes composed of boulder stones, and *Antipathes japonica* and horny coral are observed here and there. Areas at depths of 20m and some zones at depths of 30m or more consist of gradually sloping fine sand.

The area under the floating pier established in front of the office of the fishers' cooperative in the fishing port is a slope at a depth of 4-27m that is formed by piled-up stones. The walls of the floating pier are very colorful because soft coral and colonial cup coral grow densely on them.

4. Fish Fauna in the Sea around Kashiwajima

1) Great variety of coastal ecosystems

At depths of 2m or so around the red lighthouse of Ushironohama Beach, needlefish can be seen swimming in groups at the surface. This fish is piscivorous and has sharp pointed jaws and teeth. It has a habit of rushing towards the lights of underwater lamps, etc. at night; if you carelessly direct a lamp horizontally during night diving, you may be injured by a needlefish rushing toward you. Boulder stones are covered with table-shaped stony coral, where heavenly damselfish and five-banded damselfish can be seen hunting and eating plankton in groups.

Large-scale blackfish and blue humphead parrot fish live in slightly deeper coral reefs at depths of 5-8m. Blue humphead parrot-fish may be found near the algae stuck to the roots of coral on rocks and have teeth similar to the beaks of parrots (these are formed by the fusing of tiny rostral teeth). They shave the algae off along with its matrix when eating algae by striking their bodies against the rock; so if you approach the fish coming within 2m

or so, you will hear the sound caused by the action of the fish. On the patch-like sandy areas formed between boulder stones and coral, lizard fish can be seen hunting for small fish, by burying themselves in the sand.

Harlequin shrimps live under dead coral. This shrimp is known as furisode-ebi or furisode shrimp in Japan because its chelipeds look like furisode, a long-sleeved kimono for formal occasions. Using its flat and sharp first cheliped, the shrimp eats the innards of starfish.

Around the border between the boulder stone and sandy zones at depths of 15m or so, yellow-dotted butterfly fish can be seen. The adults of this fish are very rare in other districts of Japan but are commonly observed off Kashiwajima. In fine sand areas at depths of 18m or more, *Antipathes japonica* and horny coral are found, while the great seahorse, a type of seahorse species, mimics these fish near the coral roots. The great seahorse is also said to be rare in other parts of Japan, but is often seen in Kashiwajima. The male of this species has a brood pouch which it uses to protect the spawn received from the female. Ghost pipe fish also mimic



Fig. 2 Ghost pipe fish (*Solenostomus paradoxus*)

Antipathes japonica and horny coral (Fig.2). The upper margin of the female's abdominal fin adheres to the body, and the lower margin to the upper margin, thus forming a brood pouch, wherein the female protects its spawn. Behind *Antipathes japonica* hides a shoal of siphon fish. In Japan, this species has been recorded only off Shikoku (off Okinoshima and Kashiwajima), and Kashiwajima is the northern limit of the range of this fish. As other cardinal fish do, the male of this fish conducts mouth breeding. As shown in the picture, the lower jaw of this species is transparent and so the state of spawn in the mouth can be observed from the outside.

From April to July, oval squid come to the root of

Antipathes japonica to spawn. The female lays pea-like egg pouches each containing 5-9 eggs. Every time the female approaches the matrix of *Antipathes japonica* to lay eggs, the male accompanies the female as if to protect it. Orange sea perch live in large groups around the rock and table coral projecting from the seafloor at depths of 5-10m. This species has a nuptial pattern and that females undergo sexual reversal becoming males.

A large number of luna lionfish live in boulder stone zones, coral areas and sandy areas. Spotfin lionfish have a higher position than sea fans and hunt for small fish. Ribbon moray eels, which have bright colors, rare among moray eels, also live in boulder stone zones. This fish is sometimes seen in tropical seas, such as in Okinawa, and several individuals, including black juveniles and adults with light blue with yellow lines, have been confirmed in Kashiwajima's waters too. Kashiwajima is the northernmost place where this fish has been recorded. Purple firefish live at depths of 30 to 40 m. Due to its small population and its beautiful colors, this fish has been a favorite for many divers.

Many banded blue sprats are observed in these waters. I often see this fish gathering in shoals just like clouds in the sea. When you look at a group of banded blue sprat from below while diving, you will see a doughnut-like hole in their formation because they avoid the bubbles you produce while scuba diving. When shoals of banded blue sprat pass above your head while you are diving, you will notice the sea darken a little because sunlight is blocked by the fish. You will also see purplish amberjack, greengarfish and smooth flutemouth, and others hunting for food in groups.

In areas where stones are mixed with sand, scopaenoidae and devil stinger can be seen looking for food by mimicking stones or seaweeds. The species seen relatively frequently seen are humpbacked scorpion fish, monkey fish and false stonefish, as well as goose weedy scorpionfish, a rare species, which can sometimes be observed too. Weedy scorpionfish display remarkable changes in color. There are purple individuals in addition to yellowish green and gray ones and this fish has many protrusions on its body surface and can mimic seaweed. This fish mimics not only the shape of seaweed but also its unique movements. It moves its body from side to side as well as back and forth and behaves just like a drunk. Is the fish imitating the seaweed swinging in the rolling waves? Borokasago or 'boro' scorpion fish, to use its Japanese name, appears to have been named for its skin which falls to pieces ('to pieces' = *boroboro* in Japanese) on its body surface.

In sandy areas, gobies, such as yellownose shrimp

goby, filament finned prawn mosaic-fin shrimp goby and white-rayed shrimp goby are observed. All of these live symbiotically with snapping shrimp. Of these gobbies species, *Stonogobiops pentafasciata* has been recorded as a new species in Kashiwajima's waters. These symbiotic gobies are very popular with divers.

2) Rare species

Some rare species have already been mentioned above. Two rare species that have been reported on in the Kochi Shimbun, a local newspaper, are described below (Fig. 3 & 4):

(1) Pygmy sea horse (*Hippocampus coronatus*)



Fig. 3 Pygmy seahorse

This is the general term *Hippocampus coronatus* and has no Japanese name because this species has not been formally reported in Japan. Pygmy sea horses are the smallest types of sea horse and have a tiny body length of about 1-1.5cm. In Kashiwajima's waters, three individual sea horses live by winding themselves round sea fans, a kind of coral that exists at depths of about 25m. Because it is a rare species and has a lovely form, the pygmy sea horse is very popular with divers. Since the fish was discovered in 2000, tens of thousands of divers have visited Kashiwajima, making it a prized species indeed. This fish is an expert in mimicry; its body color is the same shade of red as that of the sea fan, while the wart-like protrusion on its body have a shape just like that of the polyps of sea fans closing their tentacles. Because it is difficult for red rays to reach the sea bottom at these depths, pygmy sea horses look bluish or light violet, making them harder to find. Moreover, this organism hardly moves; so you may well know that three of them live around the sea fan but you will have difficulty detecting them. If you stay too long at depths of 25m, you will face a high risk of suffering from

decompression sickness (commonly known as "diver's disease"); thus you have to find the organism as soon as possible to observe it. Pygmy sea horses are highly sought by divers but very troublesome to diving guides.

(2) Sea slug (*Thecacera pacifica*)



Fig. 4 Sea slug

This is a type of sea slug which became very popular among Japanese divers, who gave it the nickname "Pikachu (one of the pocket monsters)," because of its unique shape and color. It helped create a new type of diving: sea slug watching. Its two black protrusions are antennae and the black hair-like parts at the center of its body are the gills, beneath which lies the anus. Sea slugs are monoecious; in other words, there is no distinction between males and females. They copulate by sticking the parts known as common genital orifices together. This can often be seen in early spring.

5. Reef Check

Reef check is an activity strongly connected with the international coral reef conservation program which started in 1997. As a regular monitoring technique, it has been carried out in over 80 countries and regions in the world. Reef check may be thought of as the health examination of the sea. In Kashiwajima, the Otsuki Branch of the Sukumo Bay Divers' Council and the Kuroshio Zikkan Center have conducted reef checks each year since 2001 in cooperation with volunteer diving groups. Reef checks include investigations for studying the state of the sea bed, of fishes and invertebrates (e.g., sea urchin, sea cucumber, spiny lobster, triton) and of the disease and destruction of coral (Fig. 5).

While annual reef checks are not high-profile tasks, they have provided us with lots of information and data as they have been continued for many years. For example, investigations of the condition of the sea

bottom show that the ratio of living coral gradually fell to 61.9% at depths of 3m and 53.1% at depths of 10m in 2003. This is a result of the great propagation of coral-eating snails, which consumed coral rapidly. The percentage dropped sharply in 2004 and 2005 because large-scale typhoons struck Kashiwajima for two consecutive years breaking the coral around the island into pieces. By 2005, Kashiwajima, which had once been considered a paradise of coral reefs, lost almost all of its living coral (3.13% at a depth of 3m and 1.25% at 10m). This led to the disappearance of the fish and many other organisms dependent on coral. Fortunately, recent reef checks in 2006 and 2007 have shown that coral is increasing

slowly. This is because coral has been restored on the rocks where old coral was destroyed by the typhoons.

This means that the sea off Kashiwajima has not been so contaminated as to be unsuitable for the growth of coral. This is evident from the fact that young coral has been growing quickly and that the ratio of live coral reached 27.5% at 3m and 31.3% at 10m according to a survey in May 2008. These results suggest how important it is to constantly monitor changes not only in marine life but also in living creatures in mountains, rural areas and rivers. The Ministry of the Environment is promoting nature revitalization projects in all parts of the country, and Kochi Prefecture is carrying out a program to revive the sea for coral in the Tatsukushi area. Which age of nature should we restore, then? To answer this question, we must have data for the nature we should restore. Data that can show changes scientifically over time as a result of our reef checks will enable us to work on the restoration of nature.

Conclusion

As described above, the waters of Kashiwajima where the Kuroshio joins the seawater coming from the Bungo Channel is the treasure house of marine life. In an effort to sustainably utilize this environment and hand it over intact to the next generation, activities for conserving and protecting the natural environment of the entire prefecture are increasing in Kochi, where this environment is regarded as a living field museum. There are also moves under way to develop learning facilities in the prefecture where people can actually experience the sea, mountains, rivers, *satoyama* (neighboring hills) and other forms of nature as a network, and plans are being implemented to enhance the ability of people in the prefecture to learn about environmental problems through the interchange and sharing of information among nature guides. To utilize and conserve the wonderful nature that remains in the prefecture, there is a need for close cooperation among the prefectural government, the people in the prefecture and academe. I believe that the activities of the Kuroshio Zikkan Center, a museum of natural history of the sea, in the Kashiwajima area will provide a model for this cooperation. I pray that our activities will spread to the countries sharing the Kuroshio with us and that understanding of and interest in biodiversity in the Kuroshio waters will increase even further.

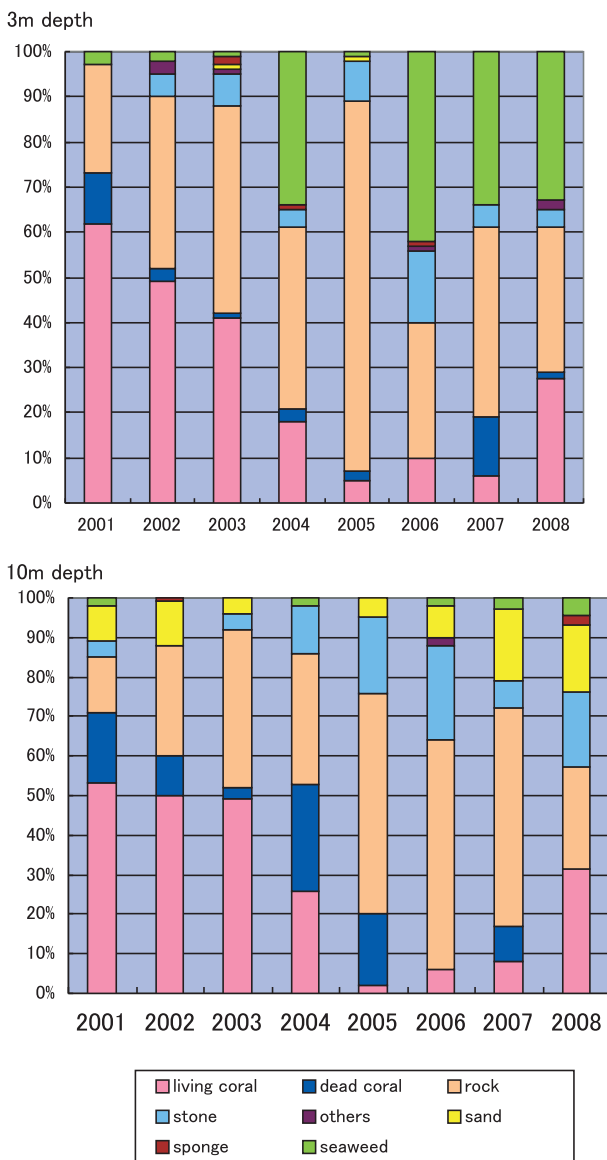


Fig. 5 Results of annual coral reef check based on sea depth on Kashiwajima Island in Otsuki, Kochi Prefecture, 2001-2008