DIVING OBSERVATIONS OF THE MARINE BENTHOS AT SYOWA STATION, ANTARCTICA

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Abstract: In January 1981, 15 diving observations were made on the benthos at three locations around Syowa Station (69°00′S, 39°35′E), Antarctica. A total of 87 animal species and 3 algal species were collected. At the Nisi-no-ura Cove location, qualitative and quantitative collections of the sandy bottom samples were made. The biomass was under 500 g/m². The bivalve, *Adamussium colbecki*, was distributed zonally at depth of 3 m. In the highest density zone, the biomass of the shellfish reached about 2 kg/m². The Kita-no-ura Cove location which had a gentle sloping rocky bottom, had a very rich fauna. There was little life in shallow water (5 m) except for small, motile animals. Below 5 m animals were very abundant. Some species composition were changed around 10 m in depth. At the Kita-no-seto Strait location, an area with a steep rocky slope, the landscape was almost the same as that of the former location, but the amount of animals was not so great. In this area many sea urchins, some of which had two species of algae on them, were found. Except for those which were attached to sea urchins, frondose algae were hardly found. An attempt was made to bring several live specimens back to Japan. Although many organisms died on route, some did reach Japan alive.

1. Introduction

It is well known that the biomass of the marine benthos is great along the coasts of Antarctica. The details on biomass and biota of shallow water are, however, not always available due to various reasons. HOSHINO (1976) and HOSHIAI (1978) made trap collections around Syowa Station, and provided some information on the qualitative aspects of the marine benthos. Sessile animals and herbivorous or detritus feeders are especially lacking, because the collections were restricted to motile animals which are mainly attracted by bait. Another way of investigation is necessary to clarify the characteristics of the shallow water benthos around Syowa Station. Recently some diving observations were made in the Antarctic waters (NEUSHUL, 1965; GRUZOV and PUSHKIN, 1970; PROPP, 1970; DAYTON *et al.*, 1970). These studies provided some information about the Antarctic benthos communities. FUKUI (1978) made observations by experimental diving at Langhovde (69°12′S, 39°37′E) near

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Syowa Station, and reported the flora and the fauna. Since that time no other diving experiments have been attempted. This paper is a preliminary report of our diving observations.

2. Method

A total of 15 dives were made between January 15 and 31 of 1981 at three locations around Syowa Station on the East Ongul Island (69°00′S, 39°35′E) (Fig. 1). Dives were made generally through holes dug in the annual sea ice, except at the Nisi-no-ura Cove location. The average duration of the dives was 45 min; the longest dive was 55 min. The deepest dive was 18 m. The water temperature was around 0°C, and the air temperature varied between −1.4 and 4.4°C. The dives were made under relatively good weather conditions. Qualitative and quantitative collections and observations were made on the marine benthos with the aid of underwater cameras and an 8 mm movie camera. Specific equipment and technique of diving were discussed fully by WATANABE *et al.* (1982). All collections, including the quantitative sampling of animals, were made underwater. The specimens are deposited in the National Institute of Polar Research, Tokyo. The main collections are still being processed.

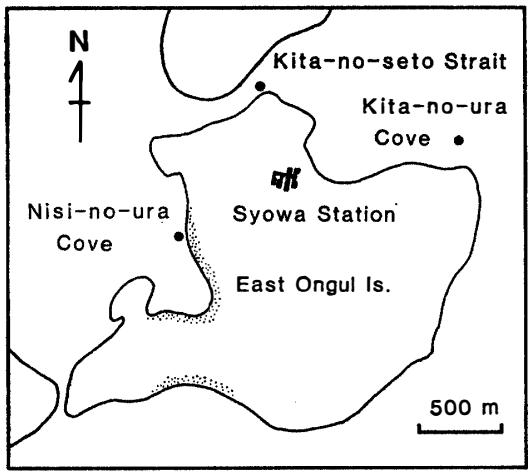

Fig. 1. A map showing three diving locations around Syowa Station (69°00′S, 39°35′E).

3. Results and Discussions

3.1. Nisi-no-ura Cove location

The Nisi-no-ura Cove location is usually covered with sea ice. During this research, however, there was not much sea ice. It was thus possible to enter the sea from the sandy coast. Eight dives were made and the greatest depth was 18 m. A rope line of 50 m in length ran perpendicular to the coast. The line extended down to approximately 14 m in depth. Quantitative and qualitative collections were made

along the line. At 5 and 10 m in depth, all the animals in a quadrat of 2×2 m were collected. In particular dominant species, sea urchins and bivalves, found within 1 m from the line were collected at several depths. These sampling areas varied between 3 and 10 m^2.

Three layers were distinguished in the sea water. The first layer, from the surface to about 1 m in depth, was characterized by a low salinity of only several ppm. A halocline was found between this layer and the next. The second layer continued to about 10 m in depth and had a high transparency with a visibility of about 10 m. The third layer below this was brown and very turbid. It was assumed that this water contained a high concentration of detrital matter. Light decreased greatly in this layer and visibility was only one meter. This layer continued down past the deepest level at which observations were made.

The bottom was sandy with scattered outcrops of rocks until the water depth reached about 15 m. Past this mark, the substratum changed gradually to unmovable rocks. In this area a total of 26 species of animals were collected (Table 1). A schema of biota is shown in Fig. 2. The shallow region, which is about 1 m

Table 1. Number of species collected in this study (A: Nisi-no-ura Cove location; B: Kita-no-ura Cove location; C: Kita-no-seto Strait location).

	Total	A	B	C
Prorifera	15	2	12	6
Thecata	1	0	1	0
Alcyonacea	3	0	3	2
Gorgonacea	1	0	1	0
Pennatulida	2	0	2	0
Actiniaria	3	2	1	0
Nemertinea	1	1	1	1
Errantia	9	4	4	0
Sedentaria	3	1	2	2
Bivalvia	5	2	4	0
Prosobranchia	3	2	0	2
Nudibranchia	7	1	7	1
Pyconoganida	3	1	3	0
Amphipoda	3	1	2	0
Isopoda	2	0	2	0
Bryozoa	8	1	6	2
Crinoidea	1	0	0	1
Asteroidea	7	3	6	4
Ophiuroidea	3	2	2	0
Echnoidea	1	1	1	1
Holothuroidea	2	0	2	0
Ascidiacea	4	2	4	2
(Total of animals)	(87)	(26)	(66)	(24)
Algae	3	2	0	3

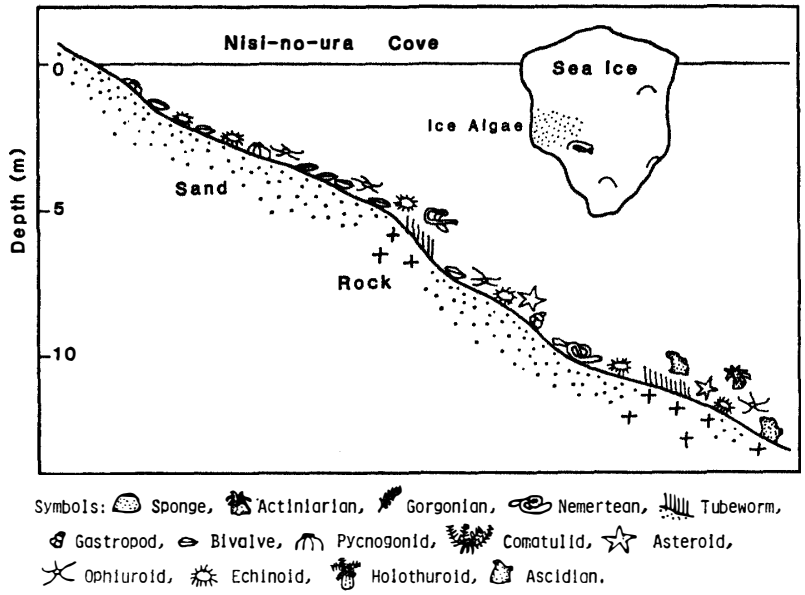

Fig. 2. Schema of the biota of Nisi-no-ura Cove location.

Table 2. Biomass (wet weight; g/m²) collected at Nisi-no-ura Cove location.

Depth (m)	1.5–3.5	3.5–5.0	5.0	7.0–9.0	10.0	13.0
Sampling area (m²)	10	8	4	8	4	3
Strechinus neumaeri	33	59	78	68	108	176
Adamussium colbecki	13	5	31	9	3	0
Ascidians					273	
Asteroidea					40	
Polychaeta					14	
Total	46	64	109	77	438	176

deep, contained little life except a few sea spiders. From 1 m to about 15 m deep, motile animals such as a species of sea urchin (*Strechinus neumaeri*), bivalve (*Adamussium colbecki*), starfish (*Odontaster validus*) and nemertine (*Lineus corrugatus*), were found. Other starfishes, brittle stars and sea spiders were also found on the sandy bottom. Ascidians and other sessile animals seemed to increase below the depth of 15 m, where more stable substrata were found. The animal life on the sandy bottom seemed to be rather poor. In this location some red algae (*Phyllophora antarctica* and *Phycodrys antarctica*) were collected. These seaweeds were several centimeters in length and attached to sea urchins at about 2–10 m in depth. These algae had no holdfast and seemed to be attached by the tube-feet of the sea urchin.

The biomass at 5 and 10 m in depth was 109 and 438 g/m², respectively (Table 2). The difference between these biomass was almost negligible. In the quadrat at 10 m in depth, there was occasionally a small outcrop of rock with several large sessile ascidians attached to it (total weight: 238 g/m²). The quantity of animal life on the sandy substratum seemed to be very poor.

The biomass of the dominant sea urchin, *Strechinus neumaeri*, varied from 33 to

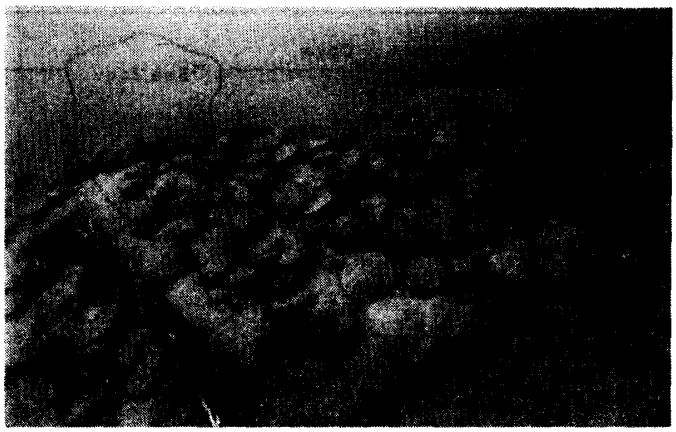

Fig. 3. Underwater photograph showing dense distribution of the bivalve, Adamussium colbecki, near foot ice wall.

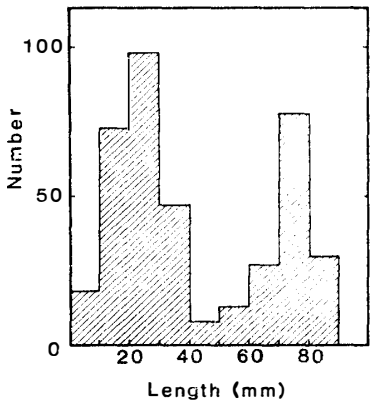

Fig. 4. Shell length distribution of Adamussium colbecki collected at Nisi-no-ura Cove location.

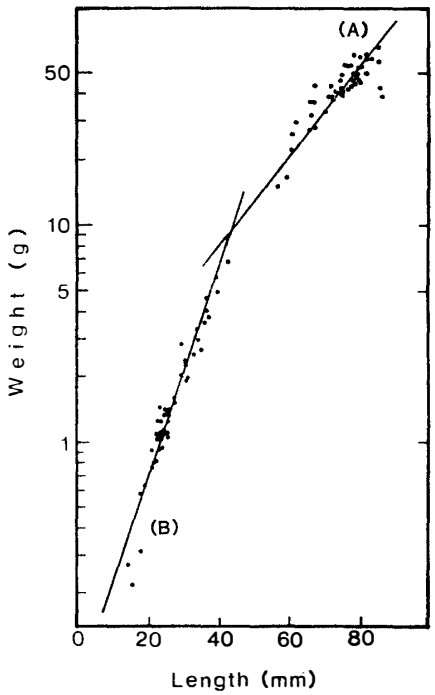

Fig. 5. Relationship between shell length and wet weight of Adamussium colbecki at Nisi-no-ura Cove location
(A): $Y=-1.89+20.6 \ln X$, $r=0.87$, $n=47$.
(B): $Y=23.7+8.80 \ln X$, $r=0.96$ $n=50$.

176 g/m² between 1.5 and 13 m deep. The average was 87 g/m². In terms of test diameter, these sea urchins varied in size from 6 to 64 mm with an average of 40 mm as determined from 96 individuals.

The biomass of the bivalves, *Adamussium colbecki*, varied from 0 to 31 g/m² with an average of 10 g/m² (Table 2). This shellfish seemed to prefer shallow water of about 3–5 m deep. Except for the central portion of the coast, the coastline con-

sisted of perpetual snow and ice. This ice extended down into the water, and formed what is called foot ice. When observed in the water, the foot ice looked like a wall. *Adamussium colbecki* was found distributed zonally in high density near the walls (Fig. 3). The zone of distribution was situated 2 or 3 m away from the wall at a depth of about 3 m, extending past the areas of observation. The habitat of the bivalve was not only sand but also rocks, where most of individuals attached or clung to the surface by the aid of byssus. A quantitative collection was made of this bivalve in particular. In a sampling area of 3 m^2 in this zone, large specimens of the shellfish were collected by hand, while smaller ones were trawled using a hand net of 4 mm mesh. The biomass reached 2144 g/m^2 (wet weight), and the number of shellfish individuals was 112 per m^2. The maximum shell length and weight were 89 mm and 66 g, respectively. More than 90% of the biomass was made up of this shellfish with a shell length of more than 40 mm. The shell length distribution is shown in Fig. 4, which reveals two peaks, 20–30 and 70–80 mm; the mean weight of shellfish in these groups were 2 and 43 g, respectively. It is possible to distinguish two different colored gonads, orange (female) and yellow (male), in the shellfish larger than 40 mm. Some small shellfish attached to large ones using byssus. Other small shellfish were found on the sandy bottom. The length of the attached shellfish was 6 to 28 mm ($\bar{x}=16$ mm), and their host shellfish were 60 to 85 mm ($\bar{x}=75$ mm). It is thought that the age difference between the attached shellfish and the hosts was at least one year. Figure 5 shows the relationship between shell length and wet weight. Two regression lines, (A) and (B), intersect at a point near the shell length of 40 mm. As described above, maturity seemed to occur in shellfish larger than 40 mm. It is therefore assumed that this bivalve changes its growth pattern at about 40 mm in shell length. If the peaks shown in Fig. 4 reflect the age groups, *Adamussium colbecki* must have grown fast within a year. Similar rapid growth was reported of *Patinopecten yessoensis* at an age of 1 to 3 years (YAMAMOTO, 1964). Further investigations of the ecological parameters on the life history of *Adamussium colbecki* will be needed to explain the details.

3.2. Kita-no-ura Cove location

The entire shore at the Kita-no-ura Cove location was covered with thick sea ice and there was a thick layer of snow on the sea ice. About 200 m offshore, a hole (1×2 m) was dug through the one meter thick sea ice. An attempt was made to determine light intensity under the sea ice by using a submarine photometer. Solar radiation was measured at 1000–3000 lux, one third to one tenth of the surface illumination. The water visibility was greatly reduced due to decreased illumination and increased water turbidity. The area of turbidity extended from about 3 to 12 m in depth.

Just 5 m below the hole, lines were extended in four directions. Each line was 10 m long, except for the north line which was 20 m. The north line extended down to a depth of 10 m, the east line about 8 m, and the west and the south lines about 2 m. Qualitative observations and collections were made along these lines. The samples collected are listed in Table 1.

The substratum was composed of stable rocks and large stones. An outline of

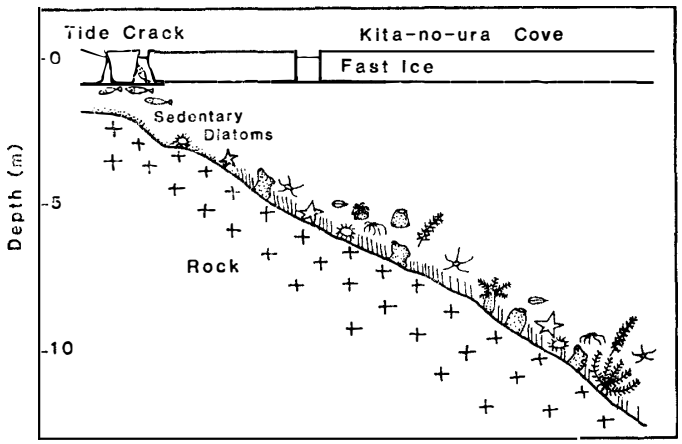

Fig. 6. Schema of the biota of Kita-no-ura Cove location. Symbols: confer Fig. 2.

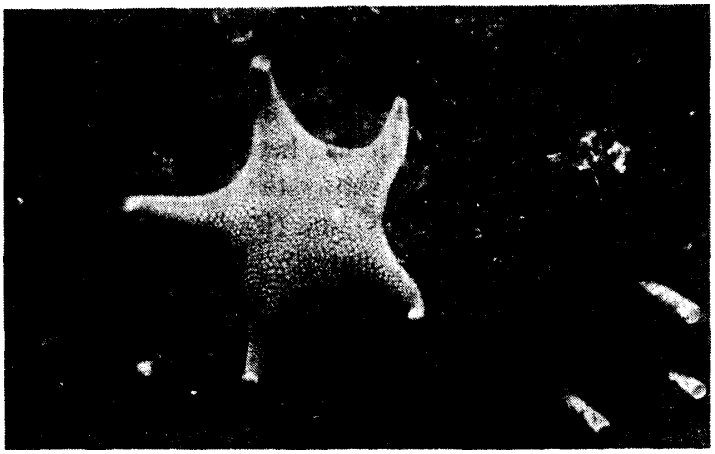

Fig. 7. Benthic fauna of Kita-no-ura Cove location (depth 8 m).

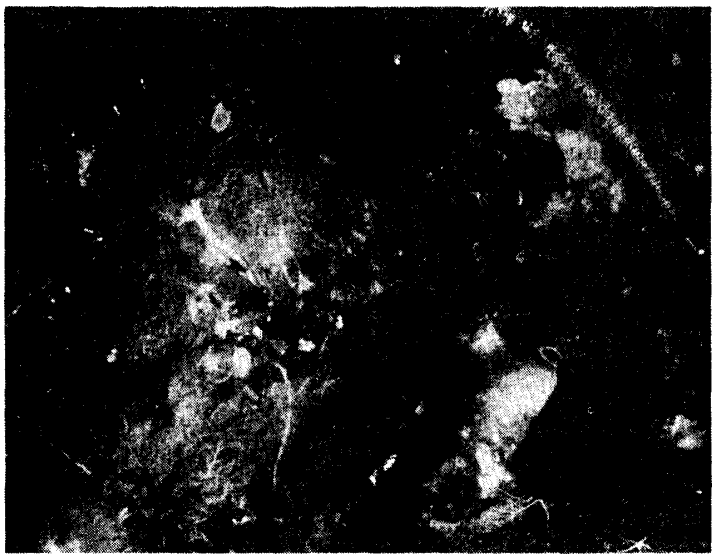

Fig. 8. A variety of benthic fauna of Kita-no-ura Cove location (depth 7 m).

the biota of the Kita-no-ura Cove location is shown in Fig. 6. Shallow areas of 3 to 4 m in depth contained little life other than mats consisting of diatoms and motile animals such as starfish and sea slugs. The lack of sessile animals in this zone was assumed to be due to scouring by sea ice. Below 5 m, rich and abundant animal life was found, most of which were sessile ascidians and sponges. Many tubeworms (*Serpura narconebsis*), gorgonians, holothurians and several species of starfish were also found in abundance. Photographic aspects of the biota are shown in Figs. 7 and 8. The sea urchins collected in this water were smaller than those in the Nisi-no-ura Cove location. The maximum and average diameters of samples collected were 34 mm and 16 mm, respectively. In addition, *Adamussium colbecki* larger than 40 mm in shell length were not found. Investigations were made at depths of 2 to 12 m. Some species composition showed gradual changes with increasing depth. Tubeworms were commonly found at depths of 5 to 12 m, especially abundant between 6 and 8 m. On the other hand, comatulids and gorgonians were seen abundantly below 10 m. Although no qualitative collections were made, the biomass seemed to be larger than that of the Nisi-no-ura Cove location. In this region no algae were observed.

3.3. Kita-no-seto Strait location

One dive was made down to a depth of 15 m. The sea ice was about 30 cm thick and relatively transparent. A hole was made with ease near the shore. The water was slightly turbid until 8 m in depth. A current was not observed there, although it could have been expected owing to the existence of a channel. From a point just below the hole (about 2 m) there were steep rock formations down to about 12 m, and from there a sandy bottom sloped gently into deeper water. The underwater landscape down to 12 m was similar to that of the Kita-no-ura Cove location. The

Fig. 9. Underwater photograph of benthic fauna of Kita-no-seto Strait location (depth 10 m).

Fig. 10. Large sponge, 27 kg and 65 cm in height, collected at Nisi-no-ura Cove location.

number of species was, however, smaller than that of the latter (Table 1). On rocks in particular, sea urchins were seen abundantly. Sessile animals were also found (Fig. 9). A sponge 65 cm in height and 27 kg in wet weight (Fig. 10) was collected. Only sea urchins and snails (*Neubuccinum eatoni*) were scattered on the sandy bottom. There, large numbers of nemertine, *Lineus corrugatus*, were collected by traps, but these were not seen so much in the water.

Two red algae, *Phycodrys antarctica* and *Phyllophora antarctica*, were reported previously around Syowa Station (OHNO, 1976). They were found abundantly also in this location, attached to sea urchins as in the Nisi-no-ura Cove location. Few were found attached directly to surface or other stable substrata. Sea urchins with algal growth were relatively small in size with diameters around 20–30 mm and a maximum size of 37 mm. On the Langhovde coast, FUKUI (1968) observed that brown and red algae grew at depths of 2 to 4 m and sea urchins were covered densely with some of the brown algae. Most of the seaweeds which were collected at Syowa Station were found attached to sea urchins collected in traps. During this survey two red frondose algae were observed only on sea urchins. There have been some questions on the distribution of these algae and the life span for the reproduction. Both two red algae collected had no reproductive organs. A coralline algal species of Melobesioideae was found on the sandy bottom 15 m in depth. This alga encrusted one side of several pebbles. Such crustose coralline algae were not found on the other rock surfaces which had been closely inspected. This is the first report of Melobesioideae from Syowa Station.

Some live specimens collected until January 31 were carried to the icebreaker FUJI. They were kept in a refrigerator, in which the temperature was maintained at around 0°C, and put into 3 *l* flexigrass bottles. Each culture bottle contained one or two individuals with about 1 *l* of sea water. The water was changed at intervals of about three days. After the two month voyage back to Tokyo, the sea urchins, sea spiders and starfish were still alive. Fishes and bivalves were all dead.

Later they were transported to a room, which was maintained at a constant temperature of 0°C, in the National Institute of Polar Research. They were fed with shucked shellfish, fish meal and pellets. However, they did not eat these foods. It is suggested that these animals were able to tolerate long term starvation for at least several months. A few algae obtained at Kita-no-seto Strait were also brought back to Japan. They were kept in almost the same conditions as the above-mentioned animals, but under fluorecent lamps. No special measures were taken to enrich the culture media. The ease of transporting animals and plants suggests the feasibility of doing studies on the physiological aspects of Antarctic benthic species even in Japan.

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