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## Report on RN98 cruise by T/S Nagasaki Maru in the area around the southern Ryukyu Islands

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### Abstract

Investigation of subbottom seismicity, grab sampling of surface sediments, and net sampling of planktonic organisms were carried out in the southern Okinawa Trough and off Miyako Island in November 1998.

Four pop-up type ocean bottom seismographs (OBS) were settled on the seafloor of the southern Okinawa Trough to investigate subbottom seismicity of this area. All OBS's were successfully retrieved after 4 days observation and numerous number of micro-earthquakes were recorded by them.

Surface sediments collected from the island shelf and the adjacent slopes off the west coast of Miyako Island are composed mainly of bioclastic carbonate sand. Foraminifers occur dominantly in some samples and alive benthic organisms such as larger foraminifers, sponges, corals and molluscs were obtained from some samples. Neogene mudstone gravels were taken from the station on the fore-arc slope south of the island.

Ten phyllosoma larvae of Palinurid lobster and Scyllarid lobster are collected by the large larval net (mouth diameter: 2.0 m) from the surface layer north of Iriomote Island. Each phyllosoma larva was kept in the 1 liter bottle, and they were transported to the laboratory to study the larval development.

### Introduction

The educational RN (Ryukyu-Nagasaki) 98 cruise by T/S Nagasaki Maru was undertaken for students of Faculty of Science, University of the Ryukyus, during November 17 to 26, 1998. As a part of this cruise, we carried out some scientific operations using ocean

bottom seismographs and grab and net samplers. The prearranged trawlings were not carried out due to bad weather. In this paper, we present preliminary results of the cruise.

The Okinawa Trough is an active back-arc basin situated in the eastern marginal zone of the Eurasian Continent, where the Philippine Sea Plate subducts under the Eurasian Plate. Sub-bottom seismic activities occur frequently in the southern Okinawa Trough, but their nature has not been well analyzed yet. Ocean bottom seismographs (OBS) are sophisticated instruments for observation of microseismicity under the deep sea floor far from onshore stations, as is the case for the Okinawa Trough. During this cruise, four pop-up type OBS's were deployed around the Yonaguni Graben in the southern Okinawa Trough to investigate the seismicity of this area.

Grab sampling sites were arranged for the investigations of the composition of surface sediments and faunal variations of benthic foraminifers and ostracods in terms of the variety of water depth and coral reef environments. They were preparedly placed at depths between 40 m and 430 m off the west coast of Miyako Island. Miyako Island is situated in the subtropical climate zone where the minimum sea surface temperature is never below 20°C today. There is a wide island shelf (30 x 20km) on the west of the island. The shelf edges are placed at about 100 to 130 m water depth. Maritime Safety Agency (1986) show that the sea floor around Miyako Island varies in surface sediment facies; there are coral reef mainly at the shallow depth of less than 40 m, gravel in the moderately deep area (40-70 m) of the southern part of the island shelf, sandy gravel on the deeper shelf, and medium grained sand in wide areas of the shelf at 50m to 100m depth and of the fore-arc slope.

Phyllosoma larvae of Palinurid and Scyllarid lobster have long planktonic larval life in the ocean. Their larval development and classification have not been known yet, because it is difficult to rear the phyllosoma larvae in the laboratory. Collections of alive phyllosoma larvae near the Kuroshio Current were made during this cruise on purpose to rear these larvae in the laboratory for the classification and the morphological development of the phyllosoma.

The scientific objectives of RN98 cruise are (1) to observe the seismicity in detail at the trough axis of the back-arc basin by using OBS's, (2) to recover surface sediments off Miyako Island for the faunal investigations, and (3) to catch phyllosoma larvae.

### **OBS observation**

Four pop-up type OBS's were deployed around the Yonaguni Graben in the southern Okinawa Trough (Figs. 1, 2; Table 1). The OBS's are Model IV of Kyoto University (Obana et al., 1994). They have 3 component velocity seismometers with 2Hz natural frequency, and digital recording system. Seismic data are recorded continuously, and stored in a magneto-optical disk. The location and periods of observation for all OBS's

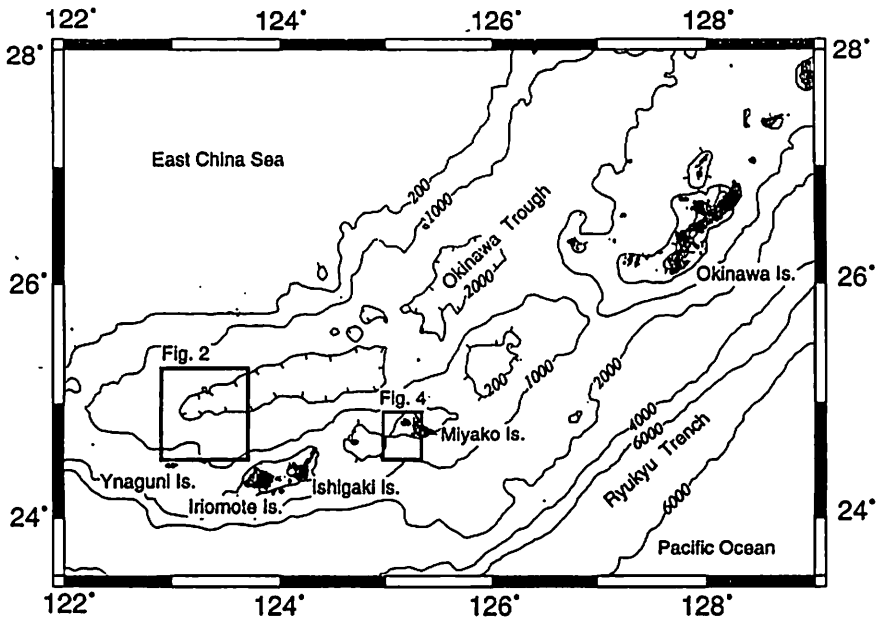


Fig.1. Bathymetric map of the southern Ryukyu Arc. Contours in meters. Details of OBS sites and location of the N1 net sampling site are shown in Fig.2. Details of sites of grab sampling and location of the N2 net sampling site are shown in Fig.4.

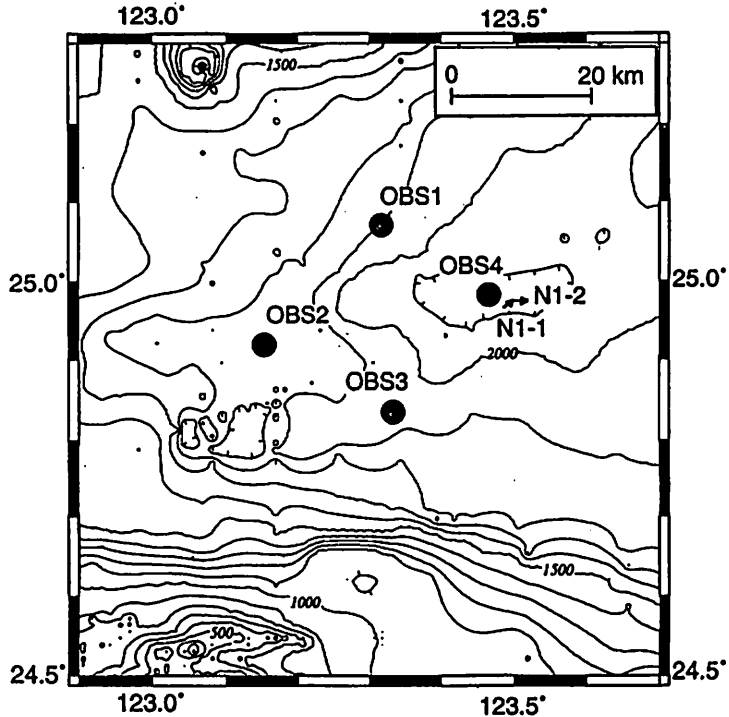


Fig.2. Map denotes the location of OBS's (solid circles with number) and the location of the N1 net sampling (solid square). Bathymetric contours are based on Japan Oceanographic Data Center. Contours in meters.

Table 1. Location of ocean bottom seismographs (OBS).

Station	Latitude (N)	Longitude (E)	Depth (m)	Deployment	Retrieve
OBS-1	25° 04' 23	123° 18' 99	1886	11/19/1998 09:08	11/23/1998 19:08
OBS-2	24° 55' 15	123° 09' 12	1818	11/19/1998 10:16	11/23/1998 16:44
OBS-3	24° 50' 12	123° 20' 03	1861	11/19/1998 11:18	11/23/1998 14:36
OBS-4	24° 58' 93	123° 27' 94	2170	11/19/1998 12:44	11/23/1998 21:16

are listed in Table 1. All OBS's were successfully retrieved after four days observation.

Although the observation periods was shortened due to the stormy condition of the sea, numerous number of micro-earthquakes were recorded. Especially, evident swarm activities are observed from 5:50 on December 22. Most of these events have very short S-P time. Example of seismograms are shown in Fig. 3. During this period, seismic observation network on land operated by Japan Meteorological Agency (JMA) could detect only four events in this area. JMA network can detect earthquakes larger than

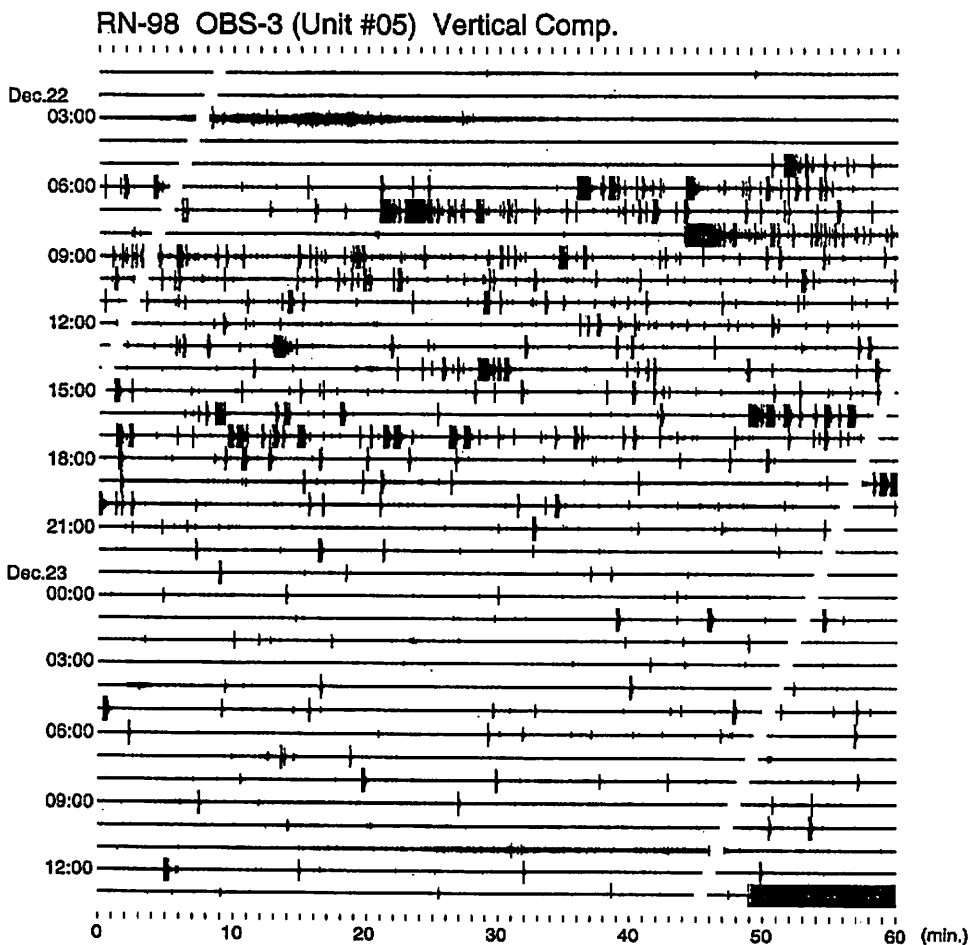


Fig.3. Example of seismograms recorded by OBS. Vertical component of OBS-3 from 15:00 December 22 to 14:00 December 23. Horizontal (time) axis is 1 hour.

Table 2. Results of grab samplings. Sediment temperature is indicated in the right hand column.

Site No.	Date (1998)	Time (touch)	Position		Depth (m)	Samples and Remarks	Tem. (°C)
			Latitude (N)	Longitude (E)			
G1	Nov. 24	08:31	24° 49' 04"	125° 04' 05"	328	fine to medium carbonate sand	21
G2	Nov. 24	09:21	24° 45' 58"	125° 01' 73"	259	fine to medium carbonate sand	20
G3	Nov. 24	09:51	24° 43' 59"	125° 04' 03"	114	carbonate sand and gravel, foraminiferal shells, rhodoliths	27
G4	Nov. 24	10:54	24° 38' 11"	125° 00' 01"	177	fine to medium carbonate sand	26
G5	Nov. 24	11:14	24° 38' 17"	125° 01' 32"	211	alive sponge	
G6	Nov. 24	12:18	24° 35' 77"	125° 02' 92"	250	alive sponge, alive gastropods, corals	
G7	Nov. 24	12:53	24° 34' 29"	125° 06' 45"	366	no recovery	
G8	Nov. 24	13:23	24° 37' 72"	125° 07' 74"	80	foraminiferal shells, rhodoliths	26
G9	Nov. 24	13:46	24° 39' 47"	125° 05' 66"	89	medium to coarse carbonate sand, rhodoliths	27
G10	Nov. 24	14:10	24° 41' 11"	125° 07' 26"	44	coral rubble, alive coral	
G11	Nov. 24	14:42	24° 40' 03"	125° 09' 77"	42	coarse carbonate sand, coral rubble	27
G12	Nov. 24	15:13	24° 36' 76"	125° 11' 46"	265	coral rubble (small amount)	
G13	Nov. 24	15:49	24° 37' 21"	125° 13' 41"	400	medium carbonate sand	22
G14	Nov. 24	16:12	24° 39' 44"	125° 14' 58"	131	rhodolith	
G15	Nov. 24	17:05	24° 38' 18"	125° 17' 29"	538	pebbles of bluish grey mudstone	24

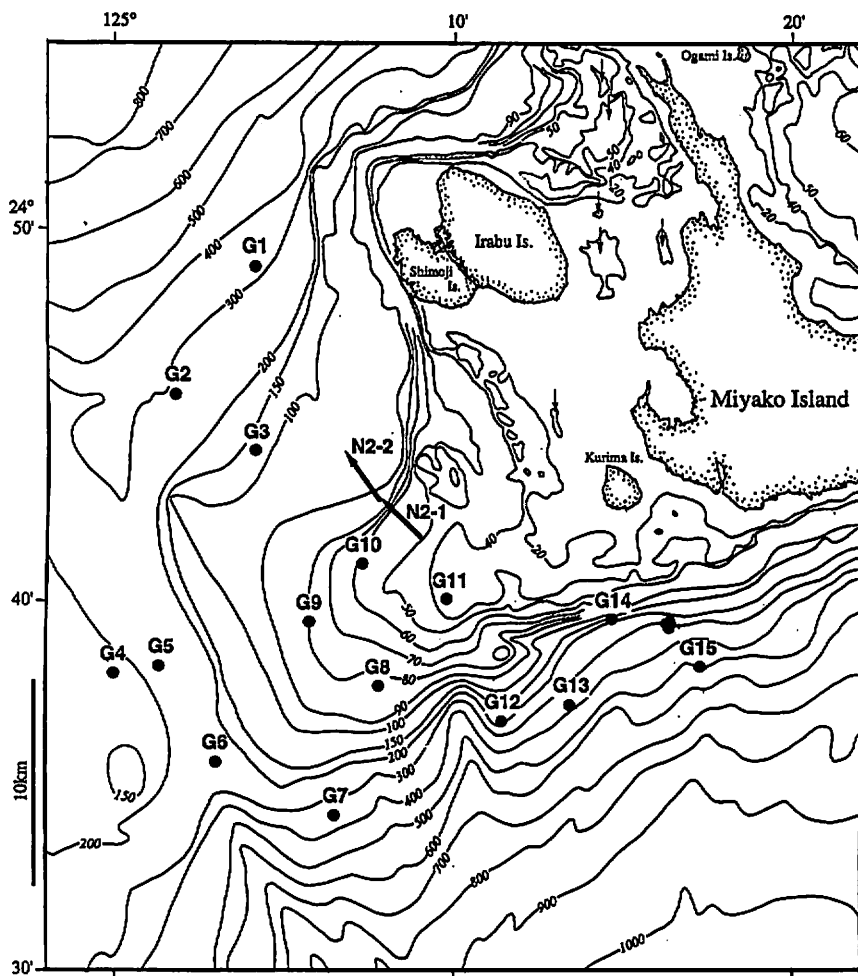


Fig.4. Map showing sites of grab sampling and tracks of the N2 net sampling. Bathymetric contours are redrawn from Maritime Safety Agency (1978). Contours in meters.

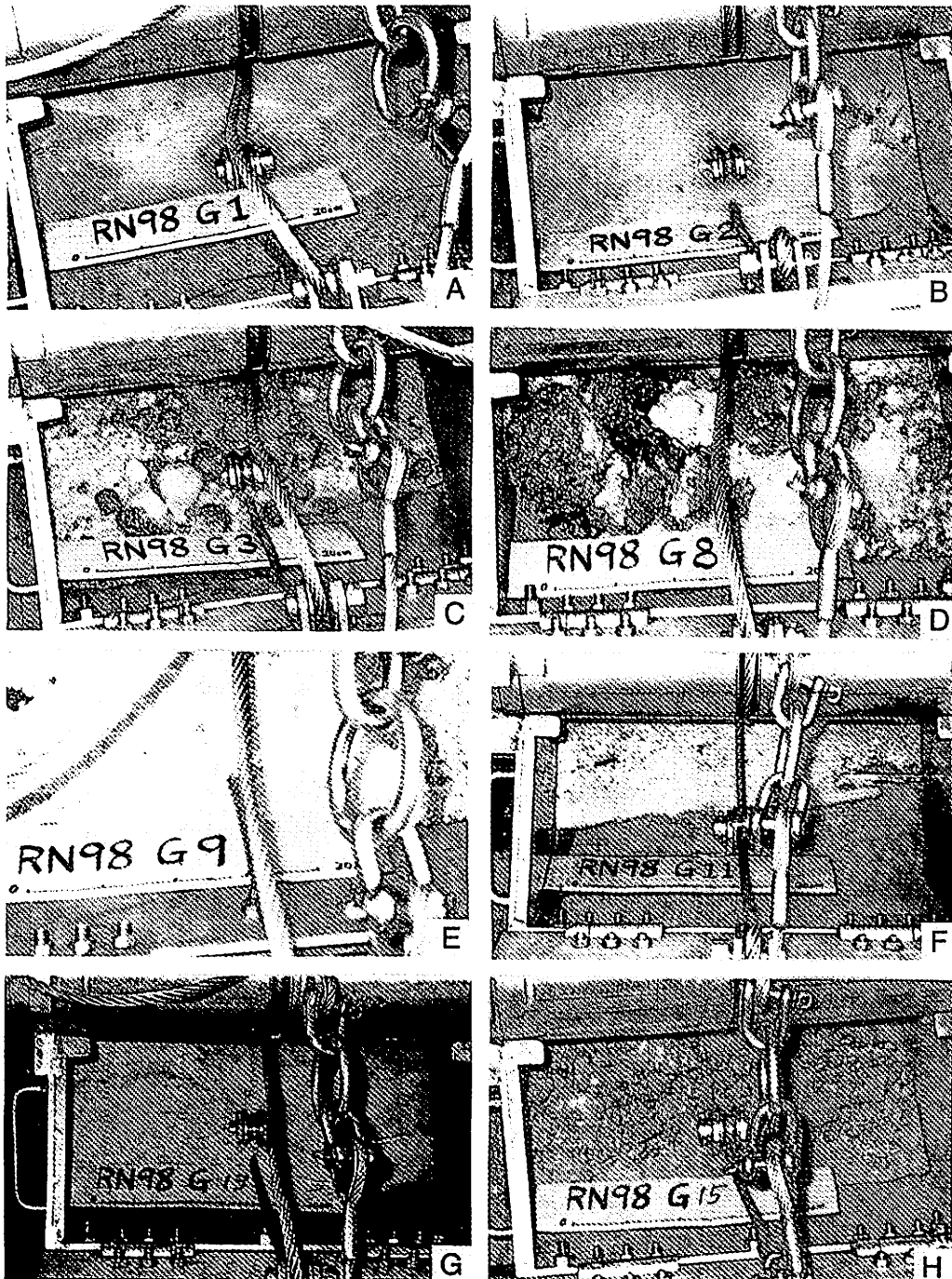


Fig.5. Photographs of surface sediment samples. A, Sample RN98-G1; B, Sample RN98-G2; C, Sample RN98-G3; D, Sample RN98-G8; E, Sample RN98-G9; F, Sample RN98-G11; G, Sample RN98-G13; H, Sample RN98-G15.

M3 in this area. Also, precision of hypocenter determination based on JMA data is not enough. But, OBS can observe many events with smaller magnitude just below this area. In the following studies, precise hypocenter distribution will be determined.

### Sediments

Fifteen grab sites were arranged on and around the island shelf off the west coast of Miyako Island (Figs. 1, 4, Table 2). An Okean type grab sampler was used to obtain sea-bottom surface sediments. Sufficient amount of sediments were recovered from nine sites (RN98-G1, G2, G3, G4, G8, G9, G11, G13, and G15) and only rock fragments or living organisms (sponges, corals, and gastropods) from four sites. Photographs of some of these samples are shown in Fig. 5.

Grab samples RN98-G1 and RN98-G2 were recovered from the slope outside the northern shelf edge off Shimoji Island. Sample RN98-G1 is composed of fine grained carbonate sand with abundant foraminifers, rare ostracods, and rare small molluscan and pteropod shells. Sample RN98-G2 is composed of fine to medium grained carbonate sand, which contains abundant foraminifers, rare ostracods, and rare small molluscan shells.

Sample RN98-G3 obtained from the northern shelf edge comprises fine to coarse grained carbonate sand, containing abundant foraminifers and rare ostracods. Rhodoliths are common in the sample.

The stations RN98-G4, RN98-G5, RN98-G6, and RN98-G7 were placed outside the southwestern shelf edges. Sample RN98-G4 consists of fine to coarse calcareous sand with abundant foraminifera, rare ostracods, and common pteropods. Sample RN98-G5 is only a piece of alive sponge (2 cm). Sample RN98-G6 consists all of a piece of sponge (10 cm in length), two alive gastropods and a coral fragment. No material was recovered from the RN98-G7 site.

Samples RN98-G8, RN98-G9, RN98-G10, and RN98-G11 were obtained from the southern part of the shelf. Sample RN98-G8 is composed of biogenic calcareous tests and rhodoliths (<20cm in diameter). The calcareous tests are dominated by dead larger foraminifers and the rhodoliths are attached by many alive larger foraminifers. Sample RN98-G9 consists of foraminifer-rich coarse grained sand and rhodoliths with very rare ostracods. Sample RN98-G10 is composed of coral rubble (< 5 cm in length) and a piece of alive coral (20 cm in length). Sample RN98-G11 consists of well sorted coarse grained carbonate sand dominated by foraminiferal tests.

Samples RN98-G12, RN98-G13, and RN98-G15 were recovered from the fore-arc slope south of Kurima Island. Station RN98-G14 was placed on the shelf edge on the south of the shelf. Sample RN98-G12 is composed of a small amount of coral rubble. Sample RN98-G13 consists of medium grained carbonate sand. The sands include abundant foraminiferal tests, rare pteropod and rare small molluscan shells. Sample RN98-G14 is



a rhodolith (9 cm in diameter). Sample RN98-G15 consists of foraminifer-rich muddy sand and pebbles of semi-consolidated bluish gray mudstone. The sand contains rare ostracods, small molluscs, and pteropods too. The semi-consolidated mudstone resembles to the mudstone of the upper Neogene Shimajiri Group that outcrops on Miyako and Okinawa Islands.

Table 3. Locations of plankton net sampling. Sea surface temperature is indicated in the right hand column.

Site No.	Date (1998)	Time (set & up)	Position		Depth of towing	Surface temp.
			Latitude (N)	Longitude (E)		
N1 1st try	Nov. 23	21:41	24° 58' 1	123° 29' 2	0 m & 40-0 m	26.9°C
		22:04	24° 58' 6	123° 30' 0		
N1 2nd try	Nov. 23	22:09	24° 58' 5	123° 30' 2	0 m & 40-0 m	26.9°C
		22:29	24° 58' 5	123° 31' 1		
N2 1st try	Nov. 24	18:00	24° 41' 8	125° 09' 0	40-0 m	26.9°C
		18:27	24° 42' 8	125° 07' 8		
N2 2nd try	Nov. 24	18:30	24° 42' 7	125° 07' 7	40-0 m	26.9°C
		18:57	24° 44' 1	125° 06' 7		

### Larval net sampling

Planktonic organisms were collected by horizontal surface hauls of a small size larval net (mouth diameter: 1.0 m, mesh size of the net-end: 2.0 mm), and were collected by a large size larval net (mouth diameter: 2.0 m, mesh size of the net-end: 310  $\mu$ m) in towing obliquely from 40 m to 0 m depth.

Two horizontal hauls by the small larval net were operated at the site N1 north of Iriomote Island at night (Figs. 1, 2; Table 3).

Two oblique hauls towed by the large larval net were operated at the site N1 and the site N2 near Miyako Island after sunset (Figs. 1, 2, 4; Table 3).

The towing speed of the larval net is about 2.5 knots for 15 minutes.

A total of ten phyllosoma larvae were collected by the large larval net of the site N1's first try. These ten phyllosoma larvae were classified into nine specimens of *Scyllarus* sp. (Family Scyllaridae) and a single specimen of *Parribacus* sp. (Family Palinuridae). The nine specimens of *Scyllarus* sp. were identified with the late larval stage and the single specimen of *Parribacus* sp. was the middle larval stage, when they were captured.

No phyllosoma larvae were taken from the site N2.

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