Preliminary Results from the R.V. Tansei-maru Cruise KT99-14 in the Central and Northeastern Maginal Parts of the Japan Sea : Sediments, Benthic and Planktonic Foraminifers and Ostracodes (Part Ⅰ : Surface Sediments)

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Preliminary Results from the R. V. *Tansei-maru* Cruise KT99-14 in the Central and Northeastern Marginal Parts of the Japan Sea —Sediments, Benthic and Planktonic Foraminifers and Ostracodes— (Part I : Surface Sediments)

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1. INTRODUCTION

Marine geology and micropalaeontology were investigated in the central and northeastern marginal parts of the Japan Sea from the 13th to 21st September 1999, during the R.V. *Tansei-maru* cruise KT99-14 as a part in a series on pursuing time-spatial distribution of depositional facies and spatial distribution of present micro-organisms in the eastern part of the Japan Sea. This cruise report is concerned with onboard observations, and preliminary results from sedimentological and micropalaeontological analyses of surface sediments in the laboratory. Those for cored sediments have been still under the investigation.

Many geological and geophysical studies have been made in the Japan Sea mainly by the Hydrographic Department, M.S.A., Japan (*e.g.* Iwabuchi, 1968), the Geological Survey of Japan (*e.g.* Arita and Okamura, 1989), Ocean Research Institute, the University of Tokyo (*e.g.*, Kobayashi, ed., 1984), the DSDP/ODP (*e.g.* Ingle *et al.*, 1990) and others (*e.g.* Oba *et al.*, 1991 ; Tsukawaki *et al.*, 1993, 1997, 1998, 1999, 2000). Taking these previous studies into account, piston coring and grab surface sampling sites were selected mainly in (1) the Okushiri Basin and the related continental slope and shelf west off Matsumae in the southernmost part of Hokkaido, (2) the lower course of the Toyama Deep Sea Channel and the lower part of the Toyama Deep Sea Fan, (3) the summit and the southeastern slope of the Yamato Bank, central Japan Sea, (4) the upper course of the Toyama Deep Sea Channel, (5) the

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Toyama Trough and related continental slope and shelf northwest off Sado Island, and (6) the Mogami Trough and related continental slope and shelf northwest off Murakami, Niigata Prefecture for the purposes of the following scientific searching; (1) time-spatial distribution of depositional facies in the slope and central parts of the Okushiri Basin, (2) time-spatial distribution of depositional facies in the upper and lower courses of the Toyama Deep Sea Channel and the lower part of the Toyama Deep Sea Fan, (3) spatial distribution of micro-organisms on the continental shelves and slopes off Sado Island and off Murakami, Niigata Prefecture, and (4) palaeoclimatic and palaeoenvironmental changes of the central part of the Japan Sea during the last 20,000 years (Fig. 1). Ten piston cored sediments from 10 sites and 48 grab surface samples were successfully obtained in these areas (Table 1). The site survey was always carried out with a precise depth recorder (PDR) of the R.V. *Tansei-maru* in order to obtain the topographic info mation of the sea floor.

Three plankton net sampling and CTD measurement sites were located in west off the Tsugaru Strait, and the central part of the Japan Sea, and oceanographical study at the Tsugaru Strait was carried out during the cruise by the scientific staff of Hirosaki University, but these results are not included in this report.

2. SEDIMENTS

Sampling methods and sample preparation procedures

An Okean type grab sampler, 1,250 cm^2 in sampling area, were used to obtain bottom surface sediments and benthic organisms. In the laboratory, smear slides were prepared first and examined under a microscope for compositional description of muddy sediments. For sandy sediments, the entire sample was heated over 24 hours at about 50 °C, and its dry weight was measured. Then, it was washed over a screen with opening of 63 μm to remove muddy sediments, and dried and weight again to obtain proportional mud contents. The remained sandy sediments were sieved over screens with openings of 90, 125, 180, 250, 355, 500, 710, 1,000, 1,400, 2,000, 2,800 and 4,000 μm. Then, dry weights of remains on each screen were measured to obtain proportional grain-size distribution for sandy sediments. Further, microscopic observations for each remain were conduced to the textural and compositional description for sandy sediments.

2-1. Okushiri Basin and Related Continental Shelf and Slope

Topography

The Okushiri Basin situating west off the Matsumae Peninsula in southernmost Hokkaido is an obal-shaped trough having a N-S longitudinal axis of about 90 km and a maximum width of about 40 km. The central part of the basin is more than 1,400 m deep and the basin floor is rather flat. The basin is sheltered from the Japan Basin by such topographic highs as the Okushiri Spur and the Matsumae Plateau on the west, and it is separated from the Nishi-Tsugaru Basin by topographic highs such as the Kojima Bank on the south. Several short and narrow submarine canyons are developed in the northern slope of the basin, but less undulated in the western and eastern slopes. The eastern slope of the basin is steep and it is followed by the narrow continental shelf through the shelf edge at water depths around 200 m. Okushiri Island is situated on the northwest of the basin.

Fifteen grab surface sediments from 12 sites from the basin floor through the eastern slope to the shelf and two piston cored sediments from the eastern slope and the central part of the basin were successfully obtained from the area (Fig. 1-1, Table 2).

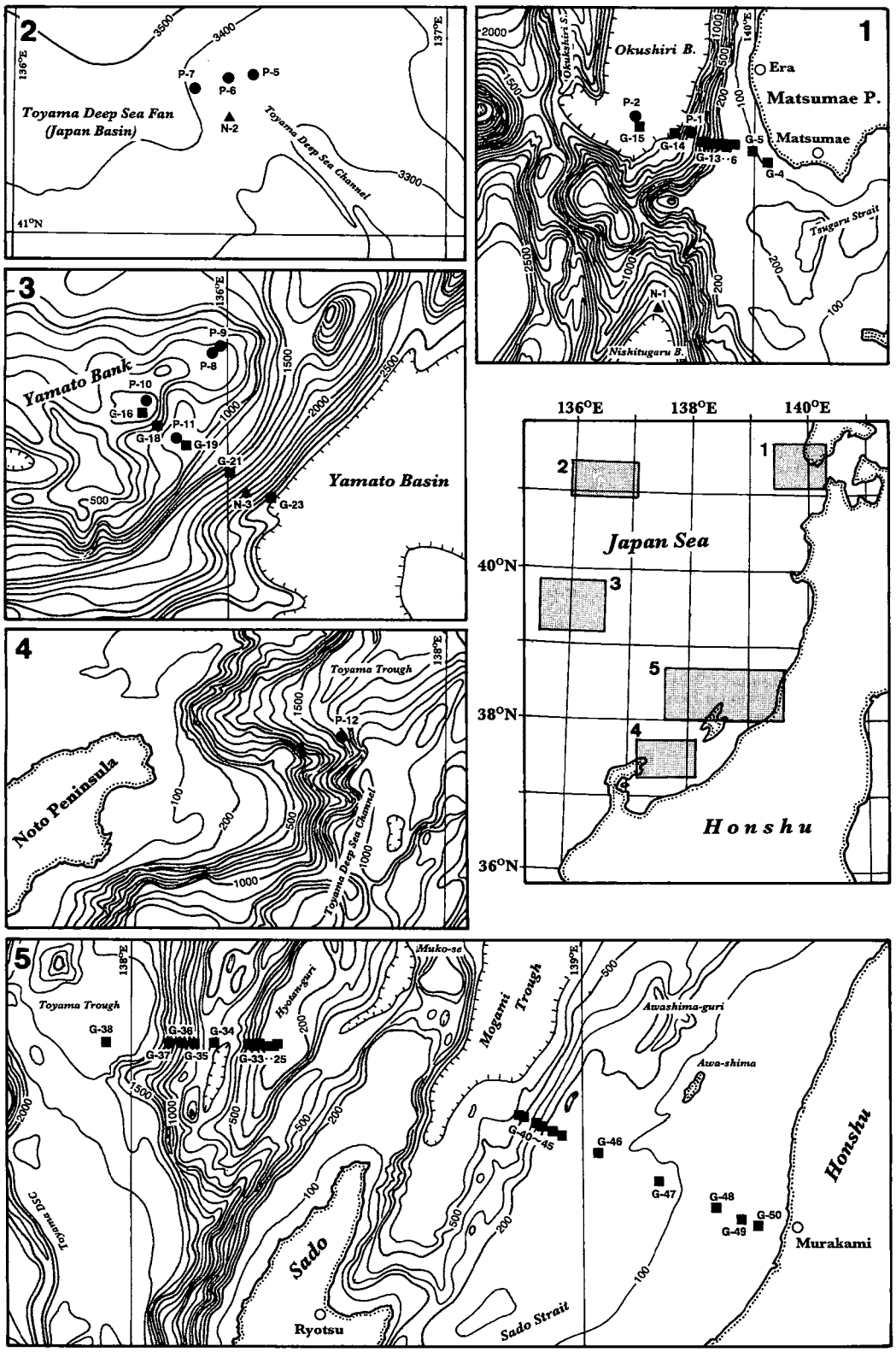

Fig. 1: Submarine topography of the studied area in the central and northeastern marginal parts aof the the Japan Sea, and sampling sites during the R.V. *Tansei-maru* cruise KT99-14 (1: Okushiri Basin and WNW off Matsumae, 2: Toayama Deep Sea Fan, 3: Yamato Bank, 4: Toayama Deep Sea Channel, and 5: Toyama and Mogami Troughs, and NW off Sado Island and WNW off Murakami; based on Hydrographic Department, M.S.A., Japan, 1980a, 1980b).

Table 1 : Log of sampling on the R.V. *Tansei-maru* Cruise KT99-14 in the central and northeastern marginal parts of the Japan Sea.

Station	Locality	Sampling Device*	Date (D/M/Y)	Time Hit	Latitude (N)	Longitude (E)	Water Depth (m)	Recovery (%/cm)	Remaks
N-1	SW off Tsugaru Strait	CTD & Net	15/09/99	19:27	41° 10.1'	139° 47.3'	1,800	-	
G-15	southern part of central Okushiri Basin	Okean L	16/09/99	01:51	41° 29.1'	139° 44.9'	1,426	50 %	*open a lid (no surface)*
G-15'	southern part of central Okushiri Basin	Okean L		02:35	41° 29.3'	139° 44.6'	1,428	80 %	*open a lid slightly*
G-14	lower slope of Okushiri Basin WNW off Matsumae	Okean L		03:56	41° 27.9'	139° 50.6'	1,006	40 %	*open a lid*
G-14'	lower slope of Okushiri Basin WNW off Matsumae	Okean L		04:37	41° 27.8'	139° 50.7'	989	50 %	*open a lid slightly*
G-13	lower slope of Okushiri Basin WNW off Matsumae	Okean L		05:23	41° 27.3'	139° 53.0'	719	100 %	
G-12	middle slope of Okushiri Basin WNW off Matsumae	Okean L		05:56	41° 27.2'	139° 53.4'	500	0 %	*open a lid completely*
G-11	upper slope of Okushiri Basin WNW off Matsumae	Okean L		06:27	41° 27.1'	139° 54.6'	333	60 %	
G-10	upper slope of Okushiri Basin WNW off Matsumae	Okean L		06:48	41° 27.0'	139° 55.3'	242	0 %	
G-9	shelf edge WNW off Matsumae	Okean L		07:04	41° 27.0'	139° 55.5'	199	15 %	
G-8	lower shelf WNW off Matsumae	Okean L		07:19	41° 26.8'	139° 55.6'	172	90 %	
G-7	lower shelf WNW off Matsumae	Okean L		07:33	41° 26.8'	139° 55.7'	151	50 %	
G-6	middle shelf WNW off Matsumae	Okean L		07:50	41° 26.8'	139° 56.7'	128	90 %	
G-5	middle shelf WNW off Matsumae	Okean L		08:23	41° 25.9'	140° 00.0'	110	20 %	
G-4	upper shelf WNW off Matsumae	Okean L		08:45	41° 25.5'	140° 02.2'	76	10 %	
P-1	lower slope of Okushiri Basin WNW off Matsumae	6-m PC		10:26	41° 27.8'	139° 51.7'	953	540 cm	
P-2	southern part of central Okushiri Basin	6-m PC		11:47	41° 29.3'	139° 44.6'	1,428	520 cm	
G-12'	middle slope of Okushiri Basin WNW off Matsumae	Okean L		13:17	41° 27.3'	139° 53.2'	466	70 %	*open a lid slightly*
G-10'	upper slope of Okushiri Basin WNW off Matsumae	Okean L		13:52	41° 27.0'	139° 55.2'	245	50 %	
P-5	main channel of Toyama Deep Sea Channel	6-m PC	17/09/99	08:54	41° 16.3'	136° 33.2'	3,436	340 cm	
P-6	outer lobe of Toyama Deep Sea Fan	6-m PC		10:50	41° 15.9'	136° 29.8'	3,432	390 cm	
P-7	outer lobe of Toyama Deep Sea Fan	6-m PC		13:16	41° 15.3'	136° 25.1'	3,444	530 cm	
N-2	central Japan Sea	CTD & Net		18:00	41° 12.4'	136° 29.8'	3,423	-	
P-8	NE slope of Yamato Bank	6-m PC	18/09/99	08:15	39° 36.2'	135° 58.3'	644	460 cm	
P-9	NE slope of Yamato Bank	6-m PC		09:12	39° 37.2'	135° 58.5'	694	350 cm	
P-10	flat summit of the eastern part of Yamato Bank	6-m PC		11:09	39° 30.9'	135° 48.1'	462	150 cm	
P-11	broad valley in SE slope of Yamato Bank	6-m PC		12:45	39° 26.9'	135° 51.5'	888	540 cm	
G-16	flat summit of the eastern part of Yamato Bank	Okean L		13:57	39° 30.6'	135° 47.6'	504	0 %	
G-16(2)	flat summit of the eastern part of Yamato Bank	Okean L		14:12	39° 30.7'	135° 47.8'	504	0 %	
G-18	SE slope of Yamato Bank	Okean L		14:59	39° 29.1'	135° 50.6'	777	40 %	*open a lid slightly*
G-19	SE slope of Yamato Bank	Okean L		15:51	39° 27.5'	135° 53.6'	1,010	20 %	*open a lid completely*
G-19'	SE slope of Yamato Bank	Okean L		16:30	39° 27.3'	135° 53.7'	1,021	50 %	*open a lid slightly*
G-21	SE slope of Yamato Bank	Okean L		18:24	39° 23.9'	136° 00.1'	1,755	90 %	
G-23	SE slope of Yamato Bank	Okean L		20:08	39° 21.2'	136° 05.8'	2,492	0 %	*no recovery*
N-3	SE off Yamato Bank	CTD & Net		21:04	39° 22.0'	136° 01.9'	2,216	-	
P-12	main channel of Toyama Deep Sea Channel	4-m PC	19/09/99	12:46	37° 31.9'	137° 46.1'	1,660	160 cm	
G-38	basin plain of Toyama Trough NW off Sado Isle	Okean L		18:51	38° 32.2'	137° 55.9'	1,929	90 %	
G-37	base-of-slope of Toyama Trough NW off Sado Isle	Okean L		20:39	38° 32.4'	138° 05.7'	1,456	70 %	*open a lid*
G-36	lower slope of Toyama Trough NW off Sado Isle	Okean L		21:21	38° 32.4'	138° 06.7'	1,233	0 %	*no recovery*
G-36(2)	lower slope of Toyama Trough NW off Sado Isle	Okean L		21:45	38° 32.4'	138° 06.8'	1,227	0 %	
G-35	lower slope of Toyama Trough NW off Sado Isle	Okean L		22:24	38° 32.4'	138° 08.5'	975	90 %	
G-34	upper slope of Toyama Trough NW off Sado Isle	Okean L		22:59	38° 32.4'	138° 10.4'	716	0 %	*no recovery*
G-34(2)	upper slope of Toyama Trough NW off Sado Isle	Okean L		23:16	38° 32.4'	138° 10.5'	708	80 %	
G-33	upper slope of Toyama Trough NW off Sado Isle	Okean L	20/09/99	00:15	38° 32.5'	138° 16.0'	491	90 %	*open a lid slightly*
G-32	upper slope of Toyama Trough NW off Sado Isle	Okean L		00:43	38° 32.6'	138° 16.6'	333	90 %	
G-31	upper slope of Toyama Trough NW off Sado Isle	Okean L		01:05	38° 32.5'	138° 17.0'	245	70 %	
G-30	shelf edge NW off Sado Isle	Okean L		01:25	38° 32.5'	138° 17.4'	184	30 %	
G-30'	shelf edge NW off Sado Isle	Okean L		01:47	38° 32.6'	138° 17.3'	200	30 %	
G-29	lower shelf NW off Sado Isle	Okean L		02:20	38° 32.5'	138° 17.4'	173	10 %	
G-29'	lower shelf NW off Sado Isle	Okean L		02:35	38° 32.5'	138° 17.4'	170	10 %	
G-28	middle shelf NW off Sado Isle	Okean L		03:00	38° 32.5'	138° 17.5'	154	0 %	
G-28'	middle shelf NW off Sado Isle	Okean L		03:10	38° 32.5'	138° 17.5'	150	0 %	*no recovery*
G-27	middle shelf NW off Sado Isle	Okean L		03:33	38° 32.5'	138° 17.8'	127	15 %	
G-26	flat top of Hyotan-guri Bank	Okean L		03:57	38° 32.5'	138° 18.9'	92	0 %	*no recovery*
G-26(2)	flat top of Hyotan-guri Bank	Okean L		04:07	38° 32.5'	138° 18.9'	94	10 %	
G-25	flat top of Hyotan-guri Bank	Okean L		05:05	38° 32.5'	138° 19.0'	96	0 %	*no recovery*
G-50	upper shelf WNW off Murakami	Okean L		11:58	38° 12.6'	139° 23.1'	35	10 %	
G-49	upper shelf WNW off Murakami	Okean L		12:27	38° 13.4'	139° 21.0'	50	40 %	
G-48	middle shelf WNW off Murakami	Okean L		13:02	38° 14.6'	139° 17.2'	75	110 %	
G-47	middle shelf WNW off Murakami	Okean L		13:43	38° 17.2'	139° 10.5'	98	80 %	
G-46	middle shelf WNW off Murakami	Okean L		15:05	38° 20.4'	139° 02.1'	125	40 %	
G-45	lower shelf WNW off Murakami	Okean L		15:53	38° 22.3'	138° 57.2'	148	40 %	*open a lid slightly*
G-44	lower shelf WNW off Murakami	Okean L		16:23	38° 22.9'	138° 55.7'	174	80 %	
G-43	shelf edge WNW off Murakami	Okean L		16:45	38° 23.2'	138° 55.0'	202	110 %	
G-42	upper slope of Mogami Trough WNW off Murakami	Okean L		17:10	38° 23.6'	138° 54.2'	248	100 %	
G-41	upper slope of Mogami Trough WNW off Murakami	Okean L		18:01	38° 24.0'	138° 52.3'	341	0 %	*bounded on the sea-floor ?*
G-41(2)	upper slope of Mogami Trough WNW off Murakami	Okean L		18:20	38° 24.2'	138° 53.0'	341	100 %	
G-40	lower slope of Mogami Trough WNW off Murakami	Okean L		18:52	38° 24.3'	138° 51.8'	555	80 %	

* Okean L: normal type Okean grab sampler
CTD & Net: CTD and plankton net
4-m PC: 4-m-long piston core sampler
6-m PC: 6-m-long piston core sampler with a pilot core sampler

Table 2 : Results of grab surface samplings during the KT99-14 cruise.

Station	Locality	Water Depth (m)	Sediment Thickness (cm)	Mud Content (%)	Sediment Type
G-4	upper shelf WNW off Matsumae	76	5	2%	granule- to cobble-gravelly c.- vc. scoriaceous sand
G-5	middle shelf WNW off Matsumae	110	5	13%	sponge spicules with a small amount of granules and m.- c. scoriaceous sand
G-6	middle shelf WNW off Matsumae	128	20	64%	sponge spicules with a small amount of vf.- f. scoriaceous sand
G-7	lower shelf WNW off Matsumae	151	10	8%	sponge spicules with a small amount of f.- m. scoriaceous sand
G-8	lower shelf WNW off Matsumae	172	20	46%	sponge spicules with a small amount of f.- m. scoriaceous sand
G-9	shelf edge WNW off Matsumae	199	5	3%	granule-gravel and molluscan shell fragment bearing m.- vc. scoriaceous sand
G-10	upper slope of Okushiri Basin	242	0	0%	gravels of volcanic and sedimentary rocks with c.- vc. scoriacesous sand
G-10'	upper slope of Okushiri Basin	245	10	33%	sponge spicules with f.- m. scoriaceous sand and olive grey mud
G-11	upper slope of Okushiri Basin	333	10	17%	m. - c. scoriaceous sand covered by yellowish brown muddy sand
G-12	middle slope of Okushiri Basin	500	0	0%	muddy scoriaceous sand
G-12'	middle slope of Okushiri Basin	466	15	14%	olive grey scoriaceous sand with intercalation of c.- vc. scoriaceous sand
G-13	lower slope of Okushiri Basin	719	20	57%	bluish grey scoriaceous sandy mud covered by olive grey soft mud
G-14	lower slope of Okushiri Basin	1,006	8	65%	olive grey scoriaceous sandy mud
G-14'	lower slope of Okushiri Basin	989	10	79%	olive grey scoriaceous sandy mud
G-15	central Okushiri Basin	1,426	10	67%	olive grey homogeneous mud intercalated with scoriaceous sand layer
G-15'	central Okushiri Basin	1,428	20	61%	olive grey homogeneous mud intercalated with scoriaceous sand layer
G-16	Summit of Yamato Bank	504	0	0%	basaltic pebble-gravels
G-16(2)	Summit of Yamato Bank	504	0	0%	a basaltic cobble-gravel 10 cm in diameter
G-18	upper SE slope of Yamto Bank	777	10	42%	basaltic granule- to pebble-gravel bearing olive grey sandy mud
G-19	upper SE slope of Yamto Bank	1,010	5	96%	bluish grey homogeneous mud covered by reddish brown mud
G-19'	upper SE slope of Yamto Bank	1,021	10	96%	bluish grey homogeneous mud covered by reddish brown mud
G-21	middle SE slope of Yamto Bank	1,755	20	86%	greyish olive compact mud covered by brownish yellow soft mud
G-26(2)	surface of Hyotan-guri Bank	94	5	5%	poorly sorted c.- vc. calcareous sand
G-27	surface of Hyotan-guri Bank	127	7	7%	poorly sorted c.- vc. calcareous sand
G-28	lower shelf of Hyotan-guri Bank	154	0	0%	granule-pebble gravels of sedimentary rocks
G-29	lower shelf of Hyotan-guri Bank	173	3	9%	poorly sorted m.- vc. calcareous sand
G-29'	lower shelf of Hyotan-guri Bank	170	5	12%	granule- to pebble-gravel bearing m.- vc. caclareous sand
G-30	shelf edge NW off Sado Is.	184	5	12%	olive grey muddy m. sand with calcareous fragments
G-30'	shelf edge NW off Sado Is.	200	5	14%	granule- to cobble-gravel bearing m.- c. sand with calcareous fragments
G-31	upper slope of Toyama Trough	245	15	34%	olive grey homogeneous sandy mud
G-32	upper slope of Toyama Trough	333	20	52%	greenish grey homogeneous sandy mud
G-33	upper slope of Toyama Trough	491	20	90%	olive grey compact mud covered by reddish brown soft mud
G-34(2)	upper slope of Toyama Trough	708	20	93%	olive grey compact mud covered by reddish brown soft mud
G-35	lower slope of Toyama Trough	975	20	98%	dark bluish grey compact mud covered by brownish grey soft mud
G-36(2)	lower slope of Toyama Trough	1,227	0	0%	semi-consolidated sedimentary rocks
G-37	base-of-slope of Toyama Trough	1,456	15	99%	bluish grey homogeneous mud covered by reddish brown mud
G-38	basin plain of Toyama Trough	1,929	20	100%	bluish grey homogeneous mud covered by reddish brown soupy mud
G-40	lower slope of Mogami Trough	555	10	98%	olive grey homogeneous mud covered by reddish brown soft mud
G-41(2)	upper slope of Mogami Trough	341	20	96%	bluish grey homogeneous mud covered by reddish brown soft mud
G-42	upper slope of Mogami Trough	248	20	69%	bluish grey muddy vf.- f. sand covered by reddish brown soft muddy sand
G-43	shelf edge WNW off Murakami	202	25	34%	well-sorted bluish grey f. sand covered by reddish brown muddy f. sand
G-44	lower shelf WNW off Murakami	174	20	21%	well-sorted bluish grey f. sand covered by reddish brown f. sand
G-45	lower shelf WNW off Murakami	148	10	18%	well-sorted bluish grey f.-m. sand covered by reddish brown muddy f. sand
G-46	lower shelf WNW off Murakami	125	10	22%	molluscan shell and granule-gravel bearing muddy f.- c. sand
G-47	middle shelf WNW off Murakami	98	20	97%	olive grey bioturbated mud covered by reddish brown soupy mud
G-48	middle shelf WNW off Murakami	75	20	99%	bluish grey homogeneous mud covered by reddish brown mud
G-49	upper shelf WNW off Murakami	50	10	77%	bluish grey muddy sand covered by reddish brown soft muddy sand
G-50	upper shelf WNW off Murakami	35	5	13%	bluish grey f. sand covered by reddish brown soft f. sand

Description of grab surface samples

KT99-14 G-4 : The sample obtained from the upper continental shelf at a water depth of 76 m is composed mainly of granule-to cobble-gravels bearing coarse- to very coarse-grained scoriaceous sand. The mud content is 2 %. The sandy sediments consists mainly of such terrigenous sediments as sedimentary rock fragments, scoria, quartz, hornblendes with a little amount of CPX and feldspars. Biogenic materials such as benthic foraminifers, ostracodes and sponge spicules are rarely recognized.

KT99-14 G-5 and 6 : These samples obtained from the middle continental shelf at water depths of 110 and 128 m are composed of sponge spicules with a small amount of terrigenous and biogenic sandy sediments. The mud contents are 13 and 64 %, respectively. The sandy sediments of former are composed mainly of medium- to very coarse-grained quartz, sedimentary and volcanic rock fragments, CPX, OPX, hornblendes and pumice as terrigenous sediments, and sponge spicules and microscleres, molluscan and echinoide shell fragments, benthic and planktonic foraminifers, ostracodes as biogenic sediments. On the other hand, they of the later consist mainly of very fine-grained sponge microscleres with a small amount of very fine -grained quartz, CPX and pumice as terrigenous sediments, and planktonic and benthic foraminifers and diatoms as biogenic sediments. The muddy sediments

of both are composed chiefly of quartz, clay minerals, coccolith and diatoms.

KT99-14 G-7 and 8: These samples obtained from the lower continental shelf at water depths of 151 and 172 m consist of sponge spicules with a small amount of terrigenous and biogenic sediments. The mud contents are 8 and 46 %, respectively. The sandy sediments of both are composed mainly of sponge microscleres with a small amount of fine- to medium -grained volcanic rock fragments, scoria, quartz, feldspars, hornblendes, CPX and pumice as terrigenous sediments and benthic and planktonic foraminifers and ostracodes as biogenic sediments. The muddy sediments of both are composed chiefly of quartz, clay minerals, coccolith and diatoms.

KT99-14 G-9: This sample obtained from the shelf edge at a water depth of 199 m is composed of molluscan and echinoide shell fragment bearing medium- to very coarse-grained scoriaceous sand. The mud content is very low 3 %. The sandy sediments consist mainly of volcanic rock fragments, hornblendes, CPX, OPX, feldspars with a small amount of quartz as terrigenous sediments. Benthic and planktonic foraminifers, sponge spicules and microscleres, and ostracodes are recognized as biogenic sediments.

KT99-14 G-10, 10' and 11: These samples are obtained from the upper continental slope at water depths of 242, 245 and 333 m, respectively. The mud contents of them are 0, 33 and 17 %. The sample G-10 consists of a few number granule- to pebble-gravels of volcanic and sedimentary rocks with a small amount of coarse-to very coarse-grained scoriaceous sand consisting of quartz, feldspars, rock fragments and hornblendes. Benthic and planktonic foraminifers, sponge spicules and microsclerers are frequently recognized in the sample. However, the sample G-10' obtained almost same locality as the G-10 is composed of sponge spicules with a small amount of fine-to medium grained sand and olive grey mud. The sandy sediments are composed mainly of scoria, feldspars, hornblendes with a small amount of quartz and OPX as terrigenous sediments, and sponge microscleres with a small amount of benthic and planktonic foraminifers, and ostracodes as biogenic sediments. The sample G-11 consists mainly of medium- to very coarse-grained scoriaceous sand covered by 2 cm thick yellowish brown mud. The sandy sediments are composed chiefly of scoria with a certain amount of feldspars, CPX, OPX, hornblendes. Sponge spicules and microscleres are dominant biogenic sediments. Benthic and planktonic foraminifers, diatoms and ostracodes are contained in the sample. The muddy sediments of G-10' and 11 are composed mainly of quartz, clay minerals, coccolith and diatoms.

KT99-14 G-12 and 12': These samples are obtained from the middle continental slope at water depths of 500 and 466 m. A small amount of muddy scoriaceous sand was recovered from the site G-12. In contrast of this, olive grey medium- to coarse-grained scoriaceous sand was obtained from the site G-12'. The mud content of the sample G-12 ' is 14 %. The sandy sediments are composed mainly of medium- to coarse -grained scoria with a certain amount of hornblendes, CPX, OPX, feldspars and quartz as terrigenous sediments, and sponge microscleres and spicules with a small amount of radiolarians and diatoms as biogenic sediments. The muddy sediments consist mainly of quartz, clay minerals and diatom. Coccolith is rarely recognized. About 3 cm thick coarse- to very coarse -grained scoriaceous sand layer is distinguished beneath the sand.

KT99-14 G-13, 14 and 14': These samples obtained from the lower continental slope at water depths of 719, 1,006 and 989 m, respectively are composed of olive or bluish grey scoriaceous sandy muds. The mud contents are rather high 57-79 %. The sandy sediments consist mainly of very fine- to fine-grained scoria, feldspars, hornblendes, CPX, OPX, quartz with a small amount of biotite as terrigenous sediments,

and a great amount of sponge microscleres with a little amount of radiolarians and diatoms as biogenic sediments. Agglutinated foraminifers are occasionally recognized. The muddy sediments consist mainly of quartz, clay minerals and diatom. A 3 cm thick olive grey soft mud is recognized on the surface of the sample G-13.

KT99-14 G-15 and 15' : These samples obtained from the flat basin floor at water depths of 1,426 and 1,428 m are both composed of olive grey homogeneous mud. The mud contents are round 65 %. The sandy sediments consist mainly of medium-to coarse-grained scoria with a small amount of very fine- to fine-grained hornblendes, feldspars, CPX and quartz as terrigenous sediments, and sponge microscleres and spicules with a little amount of radiolarians and diatoms as biogenic sediments.

2-2. A Summit and Southeastern Slope of the East Bank of the Yamato Bank

Topography

The Yamato Bank, having an E-W longitudinal axis of about 230 km and a maximum N-S width of 55 km, is situated in the south of the Yamato Rise. The shallowest part, 236 m deep, is distinguished in the central part of the bank (Iwabuchi, 1968). Several topographic highs with flat summits and depressions are recognized on the bank. The bank is divided roughly into the West, Central and East Banks by the longitudinal lines of 134°40'E and 135°35'E (Iwabuchi, 1968).

Six grab surface samples from four sites are recovered from the summit and the southeastern slope of the East Bank, and two cores (P-8 and 9) from the northeastern gentle slope of the bank, one core (P-10) from a flat summit of the bank, and one core (P-11) from a broad submarine valley in the southeastern slope are obtained.

Description of grab surface samples

KT99-14 G-16 and 16(2) : These samples obtained from a flat summit in the central part of the East Bank at water depths of both 504 m are composed of basaltic pebble- to cobble-gravels. The largest gravel is about 10 cm in diameter. Barnacle remains adhere on the surface of some gravels.

KT99-14 G-18 : The sample obtained from the upper part of the southeastern slope at a water depth of 777 m consist of basaltic granule- to pebble-gravel bearing olive grey sandy mud. The mud content is 42 %. The sandy sediments are composed mainly of very fine- to fine-grained volcanic glass shards with a small amount of basaltic rock fragments as terrigenous sediments, and planktonic and benthic foraminifers, sponge spicules and microscleres, radiolarians and diatoms as biogenic sediments. The muddy sediments are composed chiefly of volcanic glass shards, diatoms and clay minerals. Coccolith is recognized frequently in the muddy sediments.

KT99-14 G-19 and 19' : These samples obtained from the upper part of the southeastern slope at water depths of 1,010 and 1,021 m, respectively, are composed of bluish grey homogeneous muds. The mud contents are both very high 96%. Reddish brown soft mud, about 2 cm thick, covers the underlain bluish grey muds. The sandy sediments consist mainly of very fine- to fine-grained volcanic glass shards, sponge spicules and microscleres, planktonic and benthic foraminifers, radiolarians and diatoms. The muddy sediments are composed chiefly of volcanic glass shards, diatoms and clay minerals. Coccolith is recognized in the muddy sediments.

KT99-14 G-21 : The sample obtained from the middle part of the southeastern slope at a water depth of 1,755 m consists of greyish olive compact mud. The mud content is high 86 %. Reddish brown soft mud, about 2 cm thick, covers the greyish olive muds. The sandy sediments are composed mainly of such biogenic materials as sponge microscleres and spicules, radiolarians and diatoms with very fine

-grained volcanic glass shards. The muddy sediments are composed of volcanic glass shards, diatoms and clay minerals.

2-3. Toyama Trough, Sado Ridge and Related Continental Shelf NW off Sado Island

Topography

The Toyama Trough starting from the inner part of the Toyama Bay extends northward between the Noto Peninsula (Hakusan-se Bank) and the Sado Ridge, then it opens to the Yamato Basin. The N-S longitudinal axis of the basin is about 170 km and the width is 25-40 km (Iwabuchi, 1968). The Toyama Deep Sea Channel flows northwards in the central part of the basin. The eastern slope of the basin is steep and is less undulated on the west of Sado Island, but it in the northern part on the west of the Sado Ridge where the survey line was selected is rather complicated. Some topographic highs such as the Koshiji-sho Bank, small depressions and a flat surface of the sea-floor about 700 m in depth are recognized on the slope. The continental slope in the area can be divided into the upper slope (200-800 m) and the lower slope (800-1700 m) by the flat sea-floor. The Sado Ridge comprises of such island and banks as Sado Island, the Hyotan-guri and Muko-se Banks and so on. The shallowest part of the banks recognized in the south of the Hyotan-guri Bank is less than 85 m (Iwabuchi, 1968).

Fifteen grab surface samples from 13 sites were obtained along a survey line on the west of the Hyotan-guri Bank, and one cored sediments (P-12) was successfully recovered from the central channel of the upper course of the Toyama Deep Sea Channel.

Description of grab surface samples

KT99-14 G-26(2) and 27: These samples obtained from the shallowest part of the Hyotan-guri Bank at water depths of 94 and 127 m are composed of molluscan shells, echinoides and bryozoas bearing poorly sorted coarse- to very coarse-grained calcareous sand. The mud contents are both low less than 7 %. The sandy sediments are composed mainly of such biogenic materials as fragments of molluscan shells and echinoides, planktonic and benthic foraminifers, sponge spicules and microscleres with a small amount of ostracodes and volcanic glass shards. Coccolith is occasionally recognized in the muddy sediments.

KT99-14 G-28: The sample obtained from the top surface of the Hyotan-guri Bank at a water depth of 154 m consists of a number of granule- to pebble-gravels of sedimentary rocks.

KT99-14 G-29, 29', 30 and 30': These samples obtained from the western part of the Hyotan-guri Bank at water depths of 173, 170, 184 and 200 m, respectively, are composed of poorly sorted medium- to very coarse-grained calcareous sand. The samples G-29' and 30' are accompanied by granule- to cobble-gravels of sedimentary rocks. The mud contents of them are round 10 %. The sandy sediments are composed mainly of such biogenic materials as fragments of molluscan shells and echinoides, planktonic and benthic foraminifers, sponge spicules and microscleres with a small amount of ostracodes. Volcanic glass shards are also dominant. The muddy sediments consists chiefly of diatoms, volcanic glass shards and clay minerals. Coccolith is frequently recognized in the muddy sediments.

KT99-14 G-31 and 32: These samples obtained from the upper part of the upper slope at water depths of 245 and 333 m are composed of olive or greenish grey homogeneous sandy mud. The mud contents are 34 and 52 %, respectively. The sandy sediments consist mainly of very fine-to fine-grained volcanic glass shards with a small amount of quartz as terrigenous sediments, and sponge spicules and microscleres, benthic and planktonic foraminifers and diatoms as biogenic sediments. The muddy sediments are composed mainly of diatoms, coccolith, volcanic glass shards and clay minerals.

KT99-14 G-33 and 34(2): These samples obtained from the lower part of the upper slope at water depths of 491 and 708 m consist of reddish brown soft muds. Olive grey compact muds lie the soft muds. The mud contents of the surface soft muds are high more than 90 %. The sandy sediments are composed mainly of such biogenic materials as sponge spicules and microscleres, diatoms, radiolarians. Very fine-grained volcanic glass shards are frequently recognized. The muddy sediments consist mainly of diatoms, volcanic glass shards and clay minerals. Coccolith is commonly distinguished in the muddy sediments.

KT99-14 G-35: The sample obtained from the lower slope at a water depth of 975 m is composed of brownish grey soft mud. Dark bluish grey compact mud lies beneath the soft mud. The mud content of the surface soft mud is 98 %. The sandy sediments are composed mainly of such biogenic materials as sponge spicules and microscleres, diatoms, radiolarians. Very fine-grained volcanic glass shards and quartz are also recognized. The muddy sediments consist mainly of diatoms, volcanic glass shards and clay minerals. Coccolith is rarely distinguished in the muddy sediments.

KT99-14 G-36(2): Only a little amount of semi-consolidated sedimentary rock fragments were recovered on the edges of the sampler from this site in the lower slope at a water depth of 1,227 m.

KT99-14 G-37 and 38: These samples obtained from the base-of-slope and the basin plain of the Toyama Trough at water depths of 1,456 and 1,929 m, respectively, are composed of reddish brown soft muds. Bluish grey homogeneous muds lie beneath the soft muds. The mud contents of the surface soft muds are both very high more than 99 %. The sandy sediments are composed mainly of such biogenic materials as sponge spicules and microscleres, diatoms, radiolarians. Very fine-grained volcanic glass shards are rarely recognized. The muddy sediments consist mainly of diatoms, volcanic glass shards and clay minerals.

2-4. Mogami Trough and Related Continental Slope and Shelf west off Murakami

Topography

The Mogami Trough is situated between the Sado Ridge and the continental shelf on the west of Northeast Honshu. The trough starting on the northeast of Sado Island extends about 300 km north-northeastwards with an average width of about 60 km, and it opens to the Japan Basin west off the Tsugaru Peninsula. Water depths of the basin-floor in the southern part are shallow 600-800 m, but they increase up to more than 3,000 m in the northernmost (Iwabuchi, 1968). The basin-floor shows complicated topographic features due to existence of some topographic highs such as the Torimi-guri and Awashima-guri Banks and small depressions. The eastern slope of the southernmost part of the trough where the survey line was selected is rather smooth. A broad continental shelf followed by the eastern slope is developed in this area. The shelf edge is recognized at about 170-200 m deep. Eleven grab surface samples from 11 sites were obtained along a survey line west-northwest off Murakami.

Description of grab surface samples

KT99-14 G-50: The sample obtained from the uppermost shelf at a water depth of 35 m is composed of upper reddish brown fine-grained sand, about 2 cm thick, and lower bluish grey fine-grained sand. The mud content of the upper sand is 13 %. The sandy sediments are composed mainly of fine-grained feldspars, quartz, biotite and hornblends. Such biogenic sediments as benthic foraminifers and ostracodes are very rare. The muddy sediments consist mainly of quartz, volcanic glass shards, clay minerals and diatoms.

KT99-14 G-49, 48 and 47: These samples obtained from the upper to middle shelf at water depths of 50,

75 and 98 m, respectively, are composed of reddish brown homogeneous mud or sandy muds. Bluish or olive grey homogeneous/bioturbated muds underlie beneath them. The mud contents of the upper muds or sandy muds are 97, 99 and 77 %, respectively. The sandy sediments consist mainly of very fine-to fine-grained feldspars, quartz, biotite with a small amount of CPX, OPX and volcanic glass shards as terrigenous sediments. Benthic foraminifers, sponge spicules, fragments of echinoides and molluscan shells, and radiolarians are occasionally recognized. The sample G-48 contains a great amount of plant debris. The muddy sediments consist mainly of volcanic glass shards, quartz, clay minerals and diatoms. Coccolith is rarely distinguished in these samples.

KT99-14 G-46 : The sample obtained from the middle shelf at a water depth of 125 m is composed of molluscan shell and granule-gravel bearing fine- to coarse-grained sand. The mud content is comparatively low 22 %. The sandy sediments consist mainly of fragments of such calcareous biogenic materials as molluscan and echinoide shells, feldspars, quartz and sedimentary rock fragments with a small amount of biotite. Such biogenic sediments as benthic foraminifers and ostracodes are rare. The muddy sediments are composed mainly of volcanic glass shards, quartz, diatom and clay minerals. Coccolith is commonly recognized in the muddy sediments.

KT99-14 G-45, 44 and 43 : These samples obtained from the lower shelf to the shelf edge at water depths of 148, 174 and 202 m are composed of reddish brown muddy fine-grained sands, about 3 cm thick, covering bluish grey fine-grained sands. The mud contents of the upper sands are 18-34 %. The sandy sediments consist mainly of very fine- to fine-grained feldspars, quartz, biotite with a small amount of hornblends and volcanic glass shards as terrigenous sediments, and sponge spicules and microscleres as biogenic sediments. Benthic foraminifers, ostracodes and radiolarians are occasionally recognized. The muddy sediments consist mainly of volcanic glass shards, clay minerals and diatoms. Coccolith is frequently recognized in these samples.

KT99-14 G-42 : This sample obtained from the upper slope at a water depth of 248 m is composed of 3 cm thick reddish brown sandy mud. Bluish grey muddy sand is recognized beneath it. The mud content of the upper sandy mud is 69 %. The sandy sediments consist mainly of very fine-grained feldspars, quartz, biotite with a small amount of volcanic glass shards as terrigenous sediments. Sponge spicules and microscleres, and diatoms are commonly recognized, but benthic foraminifers and radiolarians are rare. The muddy sediments consist mainly of volcanic glass shards, quartz, clay minerals and diatoms. Coccolith is distinguished in these samples on rare occasions.

KT99-14 G-41 and 40 : These samples obtained from the lower slope and the basin-floor of the Mogami Trough at water depths of 341 and 555 m, respectively, are composed of 2 cm thick reddish brown soft/soupy muds. Bluish grey homogeneous muds are situated beneath it. The mud content of the upper muds are both high more than 96 %. The sandy sediments consist mainly of very fine-grained feldspars, quartz, biotite with a small amount of volcanic glass shards as terrigenous sediments. Sponge spicules and microscleres, diatoms and radiolarians are commonly recognized. The muddy sediments consist mainly of volcanic glass shards, quartz, clay minerals and diatoms.

3. BIOGENIC MATERIALS

3-1. Benthic Foraminifers

The surface sediment sampling sites of the cruise are grouped into such four areas ; (1) Okushiri Basin and related continental slope and shelf west-northwest off Matsumae, South Hokkaido, (2) Yamato Bank and its northeastern slope, central Japan Sea, (3) Toyama Trough and related continental slope and shelf, northwest off Sado Island, and (4) Mogami

Trough and related continental slope and shelf west-northwest off Murakami, Niigata Prefecture.

Chiji and Konda (1970) studied the benthic foraminifers from 17 samples around Okushiri Island at water depths of 120-2,285 m, and they recognized six assemblages based on their depth-frequency distribution. Uchio (1962) reported the benthic foraminifers in 136 sediment samples from off Niigata to Murakami shallower than 60 m, and discussed the distribution of the benthic foraminifers and influence of the fresh water from the Shinano River on the foraminiferal fauna.

Analytical method

Approximately 10 ml surface wet sediments of grab samples were preliminary examined to clarify the depth distribution of Recent benthic foraminifers. Neutralized formalin in a concentration of approximately 10 % was added to these samples immediately after the sampling. The samples were washed through by water over a screen with an opening of 63μm. To these samples which had been preserved with formalin, an aqueous solution of rose Bengal by dissolving 0.5 g of rose Bengal in 1,000 ml of water was added. After keeping for about 24 hours in the rose Bengal solution, the samples were washed through the same screen mentioned above, and then preserved in hot water for several hours, after which they were washed again and dried. Before extracting the foraminifers, each samples were sieved through a screen with an opening of 125μm, the benthic foraminifers were taken from the coarse fraction. In instance where benthic foraminifers were especially abundant, the samples were split into smaller aliquots, and about 100 specimens were removed.

Results

One hundred and fifty-seven taxa belonging to 91 genera of benthic foraminifers, including named and unnamed species, subspecies and morphotypes were recognized in all examined samples (Tables 3a, 3b and 4).

Off Matsumae (samples G-4~15'): Benthic foraminiferal assemblages are grouped into two types by the depth-frequency distribution. The fauna of the Tsushima Warm Current does not recognized in this area. Zone A (samples G-4, 6, 7, 8, 9, 10, 10', 11 and 12'; shallower than 466 m) is characterized by cold water species of the fauna of the Japan Sea Proper Water. The fauna consists of abundant *Cassidulina yabei* accompanied by *Cibicides lobaturus*, *Angulogerina kokozuraensis* and *Cassidulina japonica*. Zone B (samples 13, 14 and 15; deeper than 719 m) is characterized by such agglutinated foraminifers as *Reophax scorpiurus*, *Trochammina japonica*, *Silicosigmoilina abyssarica*, *Haplophragmoides* sp. A and *Recurvoides contortus*. The frequency of the agglutinated foraminifers occupies more than 98 % in the population. Based on the depth distribution of the calcareous test, it is inferred that the local calcite compensation depth (CCD) is situated at about 600 m deep.

Yamato Bank (samples G-18, 19, 19' and 21; 770-1755m deep): Although the frequency of the calcareous foraminifers occupies more than 48% in all samples, their tests are poorly preserved in the samples G-19, 19' and 21 (deeper than 1,010 m). Benthic foraminiferal assemblages are characterized by the cold water species of the fauna of the Japan Sea Proper Water, such as *Cibicides pseudoungerianus*, *Angulogerina kokozuraensis*, *Cassidulina japonica*, *C. norcrossi*, *Adercotryma glomerata*, *Silicosigmoilina abyssarica*, *Reophax* spp., *Cribrostomoides* spp. and *Alveolophragmium* spp. Based on the preservation of the calcareous tests, the local CCD should be situated at about 900 m in depth.

Off Sado Island (samples G-26(2)~38): Two foraminiferal assemblages were distinguished by the depth-frequency distribution. Zone C (samples G-26 (2), 27, 29, 30', 31 and 32: shallower than 333 m)

Table 3a : List of benthic foraminiferal species from surface sediments of grab samples collected from off Matsumae and the Yamato Bank. Numerals indicate the number of specimens.

Locality	off Matsumae												Yamato Bank			
Sample Number	G-4	G-6	G-7	G-8	G-9	G-10	G-10'	G-11	G-12'	G-13	G-14	G-15'	G-18	G-19	G-19'	G-21
Species / Water Depth(m)	76	110	151	172	199	242	245	333	466	719	1,006	1,428	770	1,010	1,021	1,755
Agglutinated Foraminifera																
Marsipella cylindrica Brady										2	1					
Marsipella spp.										2	3		2		2	
Psammosphaera ? sp.		1					1								4	3
Lagenammina tubulata (Rhmbler)				2												
Lagenammina sp.														1		
Saccammina sp.														1		
Hemisphaerammina sp.										1						
Hyperammina elongata Brady													1			
Hyperammina friabilis Brady													1		2	6
Hyperammina spp.										1						
Ammodiscus gullmarensis Hoeglund										8					7	
Tolypammina ? spp.			2	2		1										
Silicosigmoilina abyssarica Inoue									1	7	13	10		5	10	12
Reophax dentaliniformis Brady										3	3	2		3	10	
Reophax excentricus Cushman		2		1			2			4	3		4			1
Reophax fusiformis (Williamson)										1		2	3			
Reophax guttifer Brady		1														
Reophax pilulifer Brady						1				10		2				1
Reophax scorpiurus Montfort			2	1					3	23	10		7		17	14
Reophax spp.											1	1	4	13		
Cribrostomoides columbiense (Cushman)		2		1						5	3				5	4
Cribrostomoides jeffreysii (Williamson)											6	6				
Cribrostomoides quadratus Uchio		4					1			3	1	9			6	19
Cribrostomoides spp.									3	1						
Haplophragmoides sp. A										15	16		2		3	
Haplophragmoides sp. B		2		1		1	1			2						
Ammoscalaria spp.										1					1	
Adercotryma glomerata (Brady)							1	1	18		7	1	3	1	8	1
Recurvoides contortus Earland	1									11	4	8				
Thalmannammina parkerae (Uchio)										5						
Alveolophragmium crassimargo (Norman)													2	5		
Alveolophragmium scitulum (Brady)										4	4	8			13	1
Morulaeplecta cf. *bulbosa* Hoeglund				1												
Trochammina charlottensis Cushman		7	1				1	1								
Trochammina hadai (Uchio)												3		1	1	3
Trochammina inflata (Montagu)										4	1				5	1
Trochammina japonica Ishiwada									1	19	15	7		5	5	7
Trochammina kellettae Thalmann		1														
Trochammina pacifica Cushman	2									4				1		
Trochammina pygmaea Hoeglund		4					1				1					
Trochammina vesicularis Goes		2					3	1	1	6		1			1	1
Trochammina spp.		1														
Karreriella baccata japonica Asano		1	2		4	3	3	6	5				10	1		
Textularia cf. *neorugosa* Thalmann	1															
Clavulina sp.	1															
Calcareous, Porceraneous Foraminifera																
Spirillina vivipara Ehrenberg		1														
Cyclogyra planorbis (Schultze)		4		4												
Gordiospira sp.								1								
Quinqueloculina contorta d'Orbigny						1										
Quinqueloculina vulgaris d'Orbigny					2		1									
Quinqueloculina spp.		4		1												
Miliolinella circularis (Bornemann)		5	1	6		2				1						
Pateoris spp.		10		5												
Pyrgo murrhyna (Schwager)											1			1	3	3
Pyrgo vespertilio (Schlumberger)						2										
Triloculina trigonula (Lamarck)							1									
Calcareous, Hyaline Foraminifera																
Dentalina ittai Loeblich and Tappan		1														
Lenticulina lucida (Cushman)				1												
Lenticulina sp.													1			
Planularia sp.									1							
Nodosariidae gen. et sp. Indet.													1			
Lagena apiopleura Loeblich and Tappan				2									1			
Lagena elongata (Ehrenberg)																2
Lagena gracillima (Seguenza)													1			
Lagena nebulosa Cushman													1			
Lagena sulcata spicata Cushman and McCulloch		1						1								
Guttulina kishinouyi Cushman and Ozawa								1								
Guttulina yabei Cushman and Ozawa					1											
Guttulina sp.	1															
Oolina hexagona (Williamson)				1												
Oolina melo d'Orbigny				2												
Oolina striatopunctata (Parker and Jones)													1			8
Oolina sp.			1													
Fissurina circulocosta Asano		1							2							
Fissurina echigoensis Asano and Inomata																2
Fissurina lacunata (Burrows and Holland)		1														

Table 3b : continued.

Locality	off Matsumae												Yamato Bank			
Sample Number	G-4	G-6	G-7	G-8	G-9	G-10	G-10'	G-11	G-12'	G-13	G-14	G-15'	G-18	G-19	G-19'	G-21
Species / Water Depth(m)	76	110	151	172	199	242	245	333	466	719	1,006	1,428	770	1,010	1,021	1,755
Fissurina lucida (Williamson)									1							
Fissurina marginata (Montagu)									1				1			
Fissurina cf. *quadrata* (Williamson)		1														
Fissurina spp.		1					1						1	2	5	1
Glandulina laevigata (d'Orbigny)															3	5
Bolivina decussata Brady		1													1	
Bolivina pacifica Cushman and MuCulloch														2		
Cassidulina japonica Asano and Nakamura					3	1	6	26	61				28	19	30	
Cassidulina norcrossi Cushman													7	4		28
Cassidulina norvangi Thalmann	5				1				20							
Cassidulina wakasaensis Asano and Nakamura			2		2		7									
Cassidulina yabei Asano and Nakamura		44	83	59	135	80	138	125	33					2	4	4
Cassidulina sp. A					1			3					1	2		
Globocassidulina subglobosa (Brady)						2		6					5		1	
Uvigerina akitaensis Asano									1				1		1	
Angulogerina kokozuraensis Asano		1		5			1	17	61	2			59	13	16	
Fursenkoina sp.		1														
Valvulineria sadonica Asano											1					
Poroeponides cribrorepandus Asano and Uchio					1											
Rosalina vilardeboana d'Orbigny		3														
Rosalina spp.		8	4	4												
Sphaeroidina bulloides d'Orbigny				1												
Heronallenia spp.		1		1												
Hyalinea baltica (Schroeter)				2												
Cibicides lobaturus (Walker and Jacob)		1	9	25	4	4	8	8								
Cibicides pseudoungerianus (Cushman)		20					1		5				27	28	14	
Cibicides sp.		1							1				1		1	
Fontbotia wuellerstorfi (Schwager)				1												
Dyocibicides biserialis Cushman and Valentine						1	1									
Dyocibicides cf. *perforata* Cushman and Valentine					1											
Astrononion hamadaense Asano									2						1	
Gyroidinoides nipponicus (Ishizaki)							1									
Cribroelphidium sp. A					2	2	1	1								
Elphidium crispum (Linnaeus)	1															
Elphidium sp.								1								
calcareous forams gen. et sp. indet.			1	1												
Actually counted number of Benthic Foraminifers	12	139	108	130	157	101	181	199	221	145	94	60	176	110	180	127
Number of Benthic Forams in 10cc of surface sediments	12	2,224	864	4,160	314	101	2,896	3,184	442	290	188	120	2,816	880	720	508
Ratio of Agglutinated Forminifers	42%	20%	6%	7%	3%	6%	8%	5%	15%	98%	98%	100%	22%	34%	56%	58%
Ratio of Calcareous, Porceraneous Foraminifers	0%	17%	1%	12%	1%	5%	1%	1%	0%	1%	1%	0%	0%	1%	2%	2%
Ratio of Calcareous, Hyaline Foraminifers	58%	63%	93%	81%	96%	89%	91%	94%	85%	1%	1%	0%	78%	65%	42%	40%

consists of the cold water species of the fauna of the Japan Sea Proper Water accompanied by the warm water species of the lower half of the Tsushima Warm Current. *Cassidulina yabei, C. japonica, Cibicides lobaturus, C. pseudoungerianus, Uvigerina akitensis, Angulogerina kokozuraensis* and *Bulimina marginata* are dominant in the fauna as the cold water species. Zone D (samples G-33, 34 (2), 35, 37 and 38 ; deeper than 491 m) is characterized by such agglutinated foraminifers as *Reophax* spp., *Silicosigmoilina abyssarica, Trochammina hadai* and *T. japonica.* The frequency of the agglutinated foraminifers occupies more than 71 % in the population. Based on the depth distribution of the calcareous test, it is judged that the local CCD is situated at about 400m.

Off Murakami (samples G-40~50) : The fauna of this area is characterized by the abundant occurrence of the agglutinated foraminifers. Species composition of the fauna is similar to those reported from the lower shelf to continental shelf areas west off Nishi-Tsugaru, Aomori Prefecture (Tsukawaki *et al.* 1998). Two zones and two subzones were distinguished by the depth-frequency distribution. Zone E (samples G-50, 49, 48, 47 and 46 ; shallower than 125 m) is characterized by the fauna of the Tsushima Warm Current, such as *Trochammina pacifica* and *Siphogenerina raphanus*. The fauna of Zone E is grouped into two subzones E-1 and E-2. The subzone E-1 (shallower than 75 m) is the assemblages of *Cribrostomoides columbiense, Nonion japonicum, Ammonica japonica* and *A. ketienziensis angulata* accompanied with the above two species. The subzone E-2 (98-125 m deep) is characterized and distinguished from the subzone E-1 by the abundant occurrence of agglutinated foraminifers, such as *Reophax guttifer, Haplophragmoides bradyi and Eggerella media.* Zone F (samples G-45

~40 ; deeper than 148 m) is characterized by the abundant occurrence of agglutinated foraminifers. The frequency of the agglutinated forms occupies more than 80 % in the population. *Silicosigmoilina abyssarica, Reophax scorpiurus, Adercotryma glomerata, Reculvoides contortus, Alveolophragmium crassimargo, Trochammina hadai* and *T. japonica* are dominant species in the fauna. Based on the depth distribution of the calcareous and agglutinated forms, the local CCD is situated at about 140 m, much shallower than in the adjacent the Japan Sea. The faunal composition and the shallow CCD will be affected by fresh-water and sediment supply from the Shinano River as pointed out by Uchio (1962).

3-2. Ostracodes

Analytical method

Approximately five-millimetres-thick and an area of about 1,250 cm^2 surface wet sediments of grab samples were preliminarily examined to clarify the depth distribution of recent ostracodes. Neutralized formalin in a concentration of approximately 10 % was added to these samples immediately after the sampling, then the samples were washed by water on a screen with an opening of 63μm. After drying, ostracode specimens were picked up from fractions between one millimetre and 250μm to sum up 200 individuals in total from the quantitatively divided samples. Twenty three of 29 grab surface samples yielded less than 100 individuals in total even though all the ostracode specimens were picked up from the fractions.

Results

One hundred and twelve species belonging to 58 genera were identified from 29 grab surface samples (Tables 5a, b, c).

Off Matsumae (samples G-4~14') : Samples from 76 - 333 m in water depths (G-4, 5, 6, 8, 9, 10 and 11) characteristically contain the genera *Neonesidea, Cytheropteron, Phlyctocythere, Xestoleberis, Zabythocypris, Sclerochilus*?, *Sclerochilus* and *Bairdoppilata.* Some specimens were found with appendages considered to be alive. These are generally phytal species with the exception of *Cytheropteron.* This assemblage is different from those of other areas along the Japan Sea coasts. The difference of species composition in this assemblage was thought to be related to unusual type of sediment consisting mainly of masses of fine sponge spicules with a small amount of scoriaceous coarse- to very coarse-grained sands in the area. On the other hand, from 719-989 m in depths (G-13 and 14'), *Argilloecia toyamaensis* and *Krithe sawanensis* dominantly occur with a small amount of *Propontocypris uranippoinica* and *Propontocypris* sp. This species composition and the content of this assemblage is very similar to those reported from the lower shelf to continental slope areas in the cold water region from the southwestern part off Sanin-Mi-shima Island to the northeastern part off Northwestern Hokkaido of the Japan Sea (Ishizaki and Irizuki, 1990 ; Ikeya and Suzuki, 1992 ; Tsukawaki *et al.*, 1993, 1997, 1998, 1999, 2000 ; Ozawa, 1998 ; Ozawa *et al.*, 1999).

Yamato Bank (samples G-18, 19 and 19') : Three samples from 777 - 1,021 m in depths yield only seven individuals of the two species of *Robertsonites hanaii* and *Krithe* sp., These are characteristic species in the lower shelf to continental slope area in the cold water from off Sanin to Tsugaru Peninsula of the Japan Sea (*e.g.* Ozawa, 1998).

Off Sado Island (samples G-26~35) : Two samples from 94-127 m deep (G-26 and 27) in and around the Hyotan-guri Bank contain characteristically *Neonesidea oligodentata, Abrocythereis guangdongensis, Argilloecia lunata, Monoceratina* sp. and *Cytheropteron higashikawai.* These species are members of characteristic species of the lower half of the warm Tsushima Current in Southwest Japan Sea (Ikeya and Suzuki, 1992 ; Tsukawaki *et al.*, 1993, 1997, 1998, 2000). On the other hand, *Falsobuntonia* sp. 2, *Krithe*

Table 4 : List of benthic foraminiferal species from surface sediments of grab samples collected from off Sado Island and Murakami. Numerals indicate the number of specimens.

Locality	off Sado Island											off Murakami										
Sample Number	G-26(2)	G-27	G-29	G-30'	G-31	G-32	G-33	G-34(2)	G-35	G-37	G-38	G-50	G-49	G-48	G-47	G-46	G-45	G-44	G-43	G-42	G-41(2)	G-40
Species / Water Depth(m)	94	127	173	200	245	333	491	708	975	1,456	1,629	35	50	75	95	125	145	174	202	248	341	555
Agglutinated Foraminifera																						
Marsipella cylindrica Brady							4									2	5	5				
Marsipella spp.													2								1	
Rhabdammina sp.																3						
Psammosphaera ? sp.						4											1					
Astrammina cf. *sphaerica* Heron-Allen and Earland									4											1		
Hyperammina elongata Brady											2						1	2	2			
Hyperammina sp.							1	1			2		1		1	3	3	3	2			4
Ammodiscus gulmarensis Hoeglund						1																
Ammodiscus ? sp.																			1			
Glomospira sp.												1				2			1			
Tolypammina ? sp.																2						
Silicosigmoilina abyssarica Inoue						3	2	8	15	9	13									2		2
Reophax dentaliniformis Brady						11	4	2	3				1	2	2	4		1		8	1	
Reophax excentricus Cushman							3	3										5		2		2
Reophax lusitanicus (Williamson)						4									1		1					3
Reophax guttifer Brady				1												13	1	2				
Reophax pilulifer Brady						1		4	3	10					4	3			1		1	7
Reophax scorpiurus Montfort						5	8									3		37	5	3	2	
Reophax sp.				1	1		12	10	8	4	2	12	4	2	3	8	7	9	13	16	5	
Cribrostomoides columbiense (Cushman)					1			1				2	8	3								
Cribrostomoides jeffreysii (Williamson)											9											
Cribrostomoides quadratus Uchio				3			4			2	1							1	4			
Cribrostomoides triangularis Saidova						1		1													3	2
Cribrostomoides sp.															1							
Haplophragmoides bradyi (Robertson)														2	5	2						
Haplophragmoides sp. A						2													2		2	1
Haplophragmoides sp. B								1	2	1												
Ammoscalaria sp.							1						1			4		1				
Ammolium sp.														3	1							
Adercotryma glomerata (Brady)						4	1	4	7							1			3	8	7	4
Recurvoides contortus Earland							1	1	1	1					3			2	5	3	1	
Thalmannammina parkerae (Uchio)						1	1														5	3
Alveolophragmium crassimargo (Norman)							4		2	4					4					6	8	3
Alveolophragmium scitulum (Brady)						1														2		
Spiroplectammina typica Lacroix																						1
Spirotextularia fistulosa (Brady)	9																					
Spirotextularia sagittula (Defrance)	1	1	1																			
Marulaeplecta bulbosa Hoeglund																						1
Nouria polymorphinoides Heron-Allen and Earland														4	2	1						
Nouria textulariformis Hada														3	3							
Trochammina hadai (Uchio)						1	3	4	1		2									1	2	10
Trochammina inflata (Montagu)								1														
Trochammina japonica Ishiwada						4	5	8	8	1						1		4	3	1	3	20
Trochammina pacifica Cushman	1					1						1	4	3	6	7						
Trochammina pygmaea Hoeglund																1	5	1				1
Trochammina vasicularis Goes	1																					
Trochammina sp.					1						1								1			
Gaudryina yabei Asano	14											1										
Liebusella sokdani (Jones & Parker)															3	5	13	4				
Dorothia scabra (Brady)														5	3	1		1				
Dorothia sp.														3		1						
Eggerella media (Hoeglund)														18	60	5						
Karreriella baccata japonica Asano						1	1															
Textularia agglutinans d'Orbigny		1																				
Textularia earlandi Parker													1	4								
Textularia kerimbaensis (Said)		1																				
Textularia saulcyana d'Orbigny	1																					
Textularia saulcyana d'Orbigny var.	2																					
Agglutinated Foraminifera gen. et sp. indet.									2	3				2		11				1		1
Calcareous, Porcelaneous Foraminifera																						
Planispirillina papillosa (Cushman)	1																					
Siphonaperta sp.	1																					
Quinqueloculina vulgaris d'Orbigny	3																					
Quinqueloculina spp.	2	2							1							3						
Miliolinella circularis (Bornemann)	5	3																				
Pyrgo murrhyna (Schwager)						1																
Pyrgo vespertilio (Schlumberger)	2	1																				
Triloculina rotunda d'Orbigny	5																					
Triloculina trigonula (Lamarck)	1	2																				
Miliolidae gen. et sp. indet.						2						1										
Calcareous, Hyaline Foraminifera																						
Nodosariidae gen. et sp. indet.					1																	
Dentalina sp.						1																
Lenticulina lucida (Cushman)	1	2	3																			
Lenticulina nicobarense (Schwager)	1	1																				
Lenticulina sp.			1	1																		
Planularia tricarinella (Reuss)						1																
Amphicoryna scalaris (Batsch)		1																				
Lagena apiculata Loeblich and Tappan				2																		
Lagena elongata (Ehrenberg)																1						
Lagena nebulosa Cushman																						
Lagena pliocenica Cushman and Gray																1						
Lagena striata (d'Orbigny)					1																	
Lagena sulcata spicata Cushman and McCulloch	1		1	6	1											1						
Lagena sp.	1												2	1								
Guttulina lishenovyi Cushman and Ozawa						1																
Guttulina sadonensis Cushman and Ozawa		2															1					
Guttulina yabei Cushman and Ozawa				2																		
Polymorphinidae gen. et sp. indet				1								1					2					
Fissurina circulocostata Asano			1	1	1	1																
Fissurina echigoensis Asano and Inomata					1																	
Fissurina lacunata (Burrows and Holland)			1																			
Fissurina marginata (Montagu)				1		1										1						
Glandulina sp.														1								
Hoeglundina elegans (d'Orbigny)		7	2																			
Bolivina decussata Brady							1															
Bolivina pacifica Cushman and McCulloch						1																2
Bolivina robusta Brady						1							2	1		2						
Cassidulina carinata Silvestri	15			2																		
Cassidulina japonica Asano and Nakamura				8	1	8	2	1												3		
Cassidulina norcrossi Cushman			1	2	7	2																
Cassidulina norvangi Thalmann		2	4	3																		
Cassidulina yabei Asano and Nakamura		45	63	58	40	11																
Cassidulina sp. A	2	20	12	4	2																	
Cassidulina sp.								1												1		
Cassidulinoides sp.	1																					
Globocassidulina subglobosa (Brady)	10	2	2																			
Siphogenerina raphanus (Parker and Jones)													29	24	1	7	1					
Bulimina marginata d'Orbigny	1	8	8	14	5	12								3		5						
Bulimina sp.				1																		
Globobulimina auriculata (Bailey)					2	1											1			3		
Uvigerina akitaensis Asano			2	1	6	42	9													5	4	
Angulogerina kokouryoensis Asano			3	13	28	26	7														1	1
Cancris auriculus (Fichtel and Moll)														1								
Porosononion orbiroseandus Asano and Uchio	16	1																				
Mississippina concentrica (Parker and Jones)	2																					
Neoconorbina sp.	3		1																			
Sphaeroidina bulloides d'Orbigny				1												1						
Glabratella sp.		2	3																			
Eilohedra nipponica (Kuwano)			1																			
Hyalinea baltica (Schroeter)			3																			
Cibicides lobatulus (Walker and Jacob)	8	38	3	5	3		1										1					
Cibicides pseudoungerianus (Cushman)	11	8	13	10	3	7	2													1		1
Cibicides sp.												2				2						
Fontbotia wuellerstorfi (Schwager)	5	8	6	3																		
Dyocibicides sp.			2																			
Anomalina glabrata Cushman	1	1	1																			
Nonion japonicum Asano													10	3								
Nonionella pulchella Hada														1								
Nonionellina scaphum (Fichtel and Moll)														1								
Astronomon hamadense Asano				1																		
Chilostomella cf. *limriata* Cushman						3																
Pulvina japonica Cushman			1	1												2						
Oridorsalis tener (Brady)																	1					
Heterolepa haidingerii (d'Orbigny)	11	5	2													6						
Gyroidinoides nipponicus (Ishizaki)				1																		
Buccella frigida (Cushman)													3									
Ammonia japonica (Hada)												9	29	2								
Ammonia kotonizaiensis angulata (Kuwano)	2												7	8								
Ammonia tenuiabonsis (Ishizaki)														2		2						
Ammonia sp.															1							
Pseudorotalia gaimardii (d'Orbigny)												4	9									
Elphidium advena Cushman	2	2	1	1		1										3						
Elphidium crispum (Linnaeus)			1	1																		
Elphidium jensoni (Cushman)		1																				
Elphidium subarcticum Cushman			1																			
Elphidium sp.					2							3	4	1								
Operculina sp.																1						
calcareous forams gen. et sp. indet.	1			2	1																	
Actually counted number of Benthic Foraminifera	144	168	144	152	108	168	75	51	53	34	35	36	117	103	104	118	44	78	43	86	44	69
Number of Benthic Forams in 10cc of surface sediments	2,304	21,504	18,432	9,728	6,912	672	150	102	106	68	70	144	234	206	416	238	88	156	86	132	88	138
Ratio of Agglutinated Foraminifera	20%	2%	1%	3%	3%	27%	71%	98%	98%	100%	100%	44%	19%	52%	98%	88%	84%	100%	100%	80%	89%	94%
Ratio of Calcareous, Porcelaneous Foraminifera	14%	5%	0%	0%	0%	2%	0%	0%	2%	0%	0%	3%	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%
Ratio of Calcareous, Hyaline Foraminifera	66%	93%	99%	97%	97%	71%	29%	4%	0%	0%	0%	53%	81%	48%	2%	29%	16%	0%	0%	20%	11%	6%

Table 5a : List of ostracode species from surface sediments of grab samples. Numerals in parentheses indicate the number of living specimens.

Sample number	G-4	G-5	G-6	G-8	G-9	G-10	G-11	G-13	G-14'	G-18	G-19	G-19'	G-26	G-27	G-29'
Species name/ Water depth (m)	76	110	128	172	199	242	333	719	989	777	1010	1021	94	127	170
Abrocythereis guangdongensis Gou													1	6	2
Acanthocythereis dunelmensis s.l. (Norman)															9
Ambtonia obai (Ishizaki)															
Amphileberis nipponica (Yajima)															
Argilloecia lunata Frydl														4	
Argilloecia toyamaensis Ishizaki & Irizuki								6 (6)							
Argilloecia sp. 1			4	2										1	
Argilloecia sp. 2				1										1	1
Aurila cymba (Brady)			1	1											
Aurila kiritsubo Yajima															
Aurila cf. *urancuchiensis* Ishizaki													11	2	3
Baffinicythere ishizakii Irizuki															3
Baffinicythere reticulata Irizuki															
Baffinicythere robsticostata Irizuki		1													
Bairdopplata sp.		9 (1)	4										3	15	4
Bicornucythere bisanensis (Okubo)															
Bythoceratina sp. 1			2	3	1								3	8	
Bythoceratina sp. 2				1											
Callistocythere alata Hanai															
Callistocythere setanensis Hanai															
Callistocythere cf. *setanensis* Hanai															
Callistocythere subjaponica Hanai	1														
Callistocythere tateyamaensis Frydl															
Callistocythere undulatifacialis Hanai															
Celtia japonica Ishizaki															
Cornucoquimba alata Tabuki															1
Cornucoquimba cf. moniwensis (Ishizaki)													9	10	5
Cornucoquimba tosaensis (Ishizaki)														1	
Cythere sp.															2
Cytherois? sp.															
Cytheropteron higashikawai Ishizaki				1										1	2
Cytheropteron miurense Hanai															
Cytheropteron rarum Hanai				2		1									
Cytheropteron sawanense Hanai		3	17	15		5							13	44	45
Cytheropteron uchioi Hanai															
Cytheropteron yajimai Tabuki			1	2											7
Cytheropteron sp. 1			11	31	3	4									
Cytheropteron sp. 2			5	1											3
Cytheropteron sp. 3			5	38	4	8									
Daishakacythere abei (Tabuki)													1	5	
Daishakacythere posterocostata (Tabuki)		1													5
Eucythere sp.						1									
Falsoburtonia sp. 1														1	
Falsoburtonia sp. 2															
Falsoburtonia sp. 3															
Finmarchinella hanaii Okada				2									1	2	3
Finmarchinella japonica s.l. (Ishizaki)						1							1	2	2
Finmarchinella nealei Okada						1								2	8
Finmarchinella uranipponica Ishizaki															
Finmarchinella sp. 1													1	23	16
Finmarchinella sp. 2															8
Finmarchinella sp. 3															1
Finmarchinella? sp. 1															2
Finmarchinella? sp. 2															
Hemicythere emarginata Schornikov		1		1											8
Howeina higashimeyaensis Ishizaki															2
Howeina leptocytheroidea (Hanai)															1
Johnnealella nopporensis Hanai & Ikeya			1												1
Kangarina yamaguchii Tabuki			2											3	
Krithe antisawanensis Ishizaki															2
Krithe sawanensis Hanai								5 (3)	1						
Krithe sp.										2	2				
Krithe? sp.													4		
Laperousecythere robusta (Tabuki)		3				1									
Laperousecythere? sp.						2									
Loxoconcha japonica Ishizaki			1												
Loxoconcha cf. kitanippoinica Ishizaki													1	2	4
Loxoconcha optima Ishizaki															
Loxoconcha subkotoraforma Ishizaki														1	
Loxoconcha cf. tamakazura Yajima															
Loxoconcha tosaensis Ishizaki															
Loxoconcha viva Ishizaki													1		
Mila sp.			2	6											
Munseyella sp.															2
Monoceratina sp.				3									4 (1)		
Monoceratina? sp.				1											
Neonesidea digodentata (Kajiyama)		10	5	25	1	1							56	11	6
Neonesidea sp.		13	34	23	3								49	7	
Nodobythere sp.		1	1	3											
Pacambocythere reticulata (Jian & Wu)															

Table 5b : continued.

Sample number	G-4	G-5	G-6	G-8	G-9	G-10	G-11	G-13	G-14'	G-18	G-19	G-19'	G-26	G-27	G-29'
Species name/ Water depth (m)	76	110	128	172	199	242	333	719	989	777	1010	1021	94	127	170
Paijenborchella locosa Kingma															
Palmenella limicola (Norman)															
Paracytheridea dialata Gou & Huang				1											
Paradoxostoma spp.		1	2	5	2 (1)								5 (1)	7	
Parakrithella pseudadonta (Hanai)															
Phlyctocythere sp.			22 (1)	13 (1)									1	2	
Pistocythereis bradyformis (Ishizaki)															
Pontocythere subjaponica (Hanai)															
Propontocypris uranippolnica Ishizaki & Irizuki								1 (1)							
Propontocypris sp. 1													3		
Propontocypris sp. 2								1 (1)							
Pseudocythere sp.													1		
Robertsonites hanaii Tabuki										1	1	1			
Robertsonites reticuliforma Tabuki															
Robertsonites sp.															
Robustaurila ishizakii (Okubo)														1	
Schizocythere kishinouyei (Kajiyama)														1	7
Schizocythere okhotskensis Hanai						1									
Sclerochilus spp.	2 (1)		9										7	3	
Sclerochilus? spp.		1	10	4	2	2	2								
Semicytherura miurensis (Hanai)			1												3
Semicytherura sp. 1															2
Semicytherura sp. 2															1
Spinileberis rhomboidaris Chen															
Trachyleberis niitsumai (Ishizaki)															
Trachyleberis scabrocuneata (Brady)															
Trachyleberis sp.															
Xestoleberis hanaii Ishizaki			1										1		
Xestoleberis setouchiensis Okubo	6	1 (1)	17	10		4								1	2
Xestoleberis sp.															2
Xiphichilus sp.															
Zabythocypris sp.			16	17 (1)	1		1								
Total number	9	45	174	212	17	32	3	13	1	3	3	1	177	166	175

Sample number	G-30'	G-31	G-32	G-33	G-34'	G-35	G-41	G-42	G-43	G-44	G-46	G-48	G-49	G-50
Species name/ Water depth (m)	200	245	333	491	708	975	341	248	202	174	125	75	50	35
Abrocythereis guangdongensis Gou	2													
Acanthocythereis dunelmensis s.l. (Norman)	1													
Ambtonia obai (Ishizaki)													15	
Amphileberis nipponica (Yajima)												3		
Argilloecia lunata Frydl														
Argilloecia toyamaensis Ishizaki & Irizuki			4 (4)	2 (1)	1 (1)	1	4 (3)		2 (2)					
Argilloecia sp. 1									1 (1)					
Argilloecia sp. 2														
Aurila cymba (Brady)														
Aurila kiritsubo Yajima														24 (5)
Aurila cf. *urancuchiensis* Ishizaki	1													
Baffinicythere ishizakii Irizuki														
Baffinicythere reticulata Irizuki	1													
Baffinicythere robsticostata Irizuki														
Bairdoppilata sp.														
Bicornucythere bisanensis (Okubo)													2	
Bythoceratina sp. 1														
Bythoceratina sp. 2														
Callistocythere alata Hanai													6	3
Callistocythere setanensis Hanai	1													
Callistocythere cf. *setanensis* Hanai	1													
Callistocythere subjaponica Hanai														
Callistocythere tateyamaensis Frydl														1
Callistocythere undulatifacialis Hanai													50	
Celtia japonica Ishizaki													1	1
Cornucoquimba alata Tabuki														
Cornucoquimba cf. moniwensis (Ishizaki)														
Cornucoquimba tosaensis (Ishizaki)														
Cythere sp.														
Cytherois? sp.														1
Cytheropteron higashikawai Ishizaki	1												4	
Cytheropteron miurense Hanai													2	
Cytheropteron rarum Hanai	1													
Cytheropteron sawanense Hanai	5	1												
Cytheropteron uchiol Hanai	1													
Cytheropteron yajimai Tabuki														
Cytheropteron sp. 1														
Cytheropteron sp. 2														
Cytheropteron sp. 3	1													
Daishakacythere abei (Tabuki)	2													
Daishakacythere posterocostata (Tabuki)														
Eucythere sp.														
Falsoburntonia sp. 1														
Falsoburntonia sp. 2			28 (21)	5 (5)	10 (8)		6 (1)	5 (4)						
Falsoburntonia sp. 3				1 (1)										

Table 5c : continued.

Sample number	G-30'	G-31	G-32	G-33	G-34'	G-35	G-41	G-42	G-43	G-44	G-46	G-48	G-49	G-50
Species name/ Water depth (m)	200	245	333	491	708	975	341	248	202	174	125	75	50	35
Finmarchinella hanaii Okada	2													
Finmarchinella japonica s.l. (Ishizaki)	1													
Finmarchinella nealei Okada	1													
Finmarchinella uranipponica Ishizaki														8
Finmarchinella sp. 1			1											
Finmarchinella sp. 2														
Finmarchinella sp. 3														
Finmarchinella? sp. 1	1													
Finmarchinella? sp. 2													1 (1)	
Hemicythere emarginata Schornikov	3													
Howeina higashimeyaensis Ishizaki														
Howeina leptocytheroidea (Hanai)														
Johnnealella nopporensis Hanai & Ikeya	1													
Kangarina yamaguchii Tabuki		1												
Krithe antisawanensis Ishizaki										2 (2)	2 (1)			
Krithe sawanensis Hanai		5 (3)	2 (1)	3 (1)	9 (7)		1		1 (1)					
Krithe sp.					1 (1)	1		2 (2)	5 (2)					
Krithe? sp.														
Laperousecythere robusta (Tabuki)														
Laperousecythere? sp.														
Loxoconcha japonica Ishizaki														
Loxoconcha cf. kitanippoinica Ishizaki	1													
Loxoconcha optima Ishizaki														4
Loxoconcha subkotoraforma Ishizaki														
Loxoconcha cf. tamakazura Yajima													2 (1)	
Loxoconcha tosaensis Ishizaki														2
Loxoconcha viva Ishizaki													17	
Mila sp.														
Munseyella sp.		1												
Monoceratina sp.														
Monoceratina? sp.														
Neonesidea oligodentata (Kajiyama)		1												
Neonesidea sp.	4													
Nodobythere sp.														
Pacambocythere reticulata (Jian & Wu)											1 (1)			
Paijenborchella locosa Kingma												1		
Palmenella limicola (Norman)	1													
Paracytheridea dialata Gou & Huang														
Paradoxostoma spp.														
Parakrithella pseudadonta (Hanai)													3	21
Phlyctocythere sp.		1 (1)												
Pistocythereis bradyformis (Ishizaki)														1
Pontocythere subjaponica (Hanai)														8
Propontocypris uranippoinica Ishizaki & Irizuki														
Propontocypris sp. 1														
Propontocypris sp. 2		4 (3)							2 (1)					
Pseudocythere sp.														
Robertsonites hanaii Tabuki			8					1						
Robertsonites reticuliforma Tabuki	1													
Robertsonites sp.			1											
Robustaurila ishizakii (Okubo)														2
Schizocythere kishinouyei (Kajiyama)	3													
Schizocythere okhotskensis Hanai														
Sclerochilus spp.														
Sclerochilus? spp.			1											
Semicytherura miurensis (Hanai)														
Semicytherura sp. 1														
Semicytherura sp. 2		1												
Spinileberis rhomboidaris Chen														1
Trachyleberis niitsumai (Ishizaki)														3
Trachyleberis scabrocuneata (Brady)														1
Trachyleberis sp.														3
Xestoleberis hanaii Ishizaki														
Xestoleberis setouchiensis Okubo														
Xestoleberis sp.														
Xiphichilus sp.										1				
Zabythocypris sp.														
Total number	37	15	45	11	21	2	11	8	11	3	3	4	103	84

sawanensis, Argilloecia toyamaensis, Acanthocythereis dunelmensis, Krithe sp., *Robertsonites hanaii, Propontocypris* sp., *Palmenella limicola* and *Robertsonites reticuliforma* are characteristically found in the samples from 170-975 m in depths (G-29', 30', 31, 32, 33, 34' and 35). This assemblage is very similar to those recognized from the lower shelf to continental slope areas in the cold water from off Sanin to Hokkaido in the Japan Sea (*e.g.* Ozawa, 1998).

From four samples from 94 - 200 m deep (G-26, 27, 29' and 30'), many disarticulated valves were found with very bad-preservation state of *Baffinicythere* spp., *Cornucoquimba alata, Cytheropteron sawanense, Daishakacythere* spp., *Finmarchinella nealei, Hemicyth-*

ere emarginata, Howeina spp. and *Johnnealella nopporensis*. Most of them are the members of cryophilic species called the Omma-Manganji ostracode fauna (Cronin and Ikeya, 1987) dominantly occurred from the Plio-Pleistocene strata along the Japan Sea coast (*e.g.* the Omma Formation; Ozawa,1996). In the present Japan Sea, the Omma-Manganji species inhabit only the coasts around Hokkaido at cold- and relatively lower saline-water mass conditions (Ozawa, 1998; Ozawa *et al.*, 1999). Sediments of these four samples are coarse- to very coarse-grained sand with a certain amount of gravels and calcareous shell fragments. Therefore, there is a high possibility that those ostracode specimens with bad-preservation state are derived from the Pleistocene Sawane Formation in Sado Island which yields many Omma-Manganji ostracode fossils or some correlative strata distributed probably in the Hyotan-guri Bank as already mentioned by Tsukawaki *et al.* (1993). The similar fossil occurrences of the Omma-Manganji ostracodes from the present surface sediments have been reported around the Sanin-Mi-shima Island and off Noto Peninsula area (Tsukawaki *et al.*, 1997, 2000; Ozawa, 2000).

Off Murakami (samples G-41~50): *Callistocythere undulatifacialis, Aurila kiritsubo, Parakrithella pseudadonta, Loxoconcha viva, Ambtonia obai, Callistocythere alata, Finmarchinella uranipponica* and *Pontocythere subjaponica* are dominant from the samples of 35-75 m deep (G-48, 49 and 50), along with *Trachyleberis* spp., *Loxoconcha optima, Amphileberis nipponica* and *Loxoconcha* cf. *tamakazura*. These are characteristic species in the upper half of the warm Tsushima Current in the southwestern to eastern part of the Japan Sea (Tsukawaki *et al.*, 1997, 1998, 1999, 2000; Ozawa, 1998). From the samples of 125 and 174 m deep (G-44 and 46), few ostracodes were recognized, and only six individuals were counted. The similar occurrences were reported from the area off Tsugaru Peninsula of the depth interval 86-137 m (Tsukawaki *et al.*, 1999). On the other hand, between 202-341 m in depths (G-41, 42 and 43), *Falsobuntonia* sp. 2, *Krithe* sp., *Argilloecia toyamaensis, Krithe sawanensis, Propontocypris* sp. and *Robertsonites hanaii* are found. This assemblage is similar to those recognized from the lower shelf to continental slope areas in the cold water from off Sanin to Hokkaido along the Japan Sea (*e.g.* Ozawa, 1998).

3-3. Planktonic Foraminifers

Analytical method

Approximately 20 ml of the surface wet sediments of 33 grab samples were preliminarily examined to clarify spatial distribution of planktonic foraminifers in the studied areas. Buffered formalin and Rose Bengal solution were then added to these samples after the samplings. Each sample was washed by water over a screen with an opening of 63 μm. The remaining particles were dried and weighed. In instance where planktonic foraminifers were relatively abundant, the samples were split into smaller aliquots to obtain more than 100 specimens. Each sample was then sieved again through a screen with an opening of 125 μm, all planktonic foraminifers were picked up from the coarser fractions of the aliquots.

Results

Seven species belonging to four genera of planktonic foraminifers were recognized in 14 examined samples (Table 6).

Off Matsumae (samples G-10', 11 and 12'): Planktonic foraminiferal assemblage in these samples is characterized by the dominance of *Neogloboquadrina incompta* and *Neogloboquadrina pachyderma* associated with *Globigerina bulloides*.

Yamato Bank (samples G-18, 19 and 19'): Planktonic foraminiferal assemblage in these three samples is characterized by the dominance of *N. pachyderma* associated with *N. incompta* and *G. bulloides*. Some of the specimens found in fragile state in these

Table 6 : List of planktonic foraminiferal species from surface sediments of grab samples. Numerals indicate the number off specimens.

Sample Number	G-10'	G-11	G-12'	G-18	G-19	G-19'	G-44	G-43	G-27	G-29'	G-30'	G-31	G-32	G-37
Species Name / Water Depth (m)	245	333	466	777	1,010	1,021	174	202	127	170	200	245	333	1,456
Globigerina bulloides d'ORBIGNY	13	21	10	17	11	13		2	1	5	5	15	7	4
Globigerina quinqueloba NATLAND	2		1				11	17	17	23	28	25	22	
Globigerinita uvula (EHRENBERG)							1			1				
Globigerinoides ruber (d'ORBIGNY)	1						3	7	1	2	2			
Globigerinoides tenellus PARKER							3	4		3	1		1	1
Neogloboquadrina incompta (CIFELLI)	159	63	66	19	15	27	124	140	123	124	62	131	71	273
Neogloboquadrina pachyderma (EHRENBERG)	18	27	71	125	132	124	1	0	7	5	9	19	14	34
Total Planktonic Foraminifers	193	111	148	161	158	164	143	170	149	163	107	190	115	312
Division	1/64	1/32	1/8	1/256	1/64	1/64	3/4	7/16	1/1024	1/2048	1/2048	1/256	1/32	1/1

samples indicate the signs of dissolution.

Off Sado Island (samples G-27, 29', 30', 31, 32 and 37) : Planktonic foraminiferal assemblage in these samples is characterized by the dominance of *N. incompta* associated with *Globigerina quinquelob*. *N. pachyderma* and *G. bulloides* are commonly found. *Globigerinoides ruber* and *Globigerinoides tenellus* are rarely recognized. Poorly preserved specimens are frequently observed in these samples. Some of the specimens found only irregular portions in the sample G-37 indicate the signs of dissolution.

Off Murakami (samples G-44 and 43) : Planktonic foraminiferal tests are especially well preserved in these two samples. The assemblage is characterized by the dominance of *N. incompta* associated with *G. quinqueloba*. *G. ruber* and *G. tenellus* are rarely recognized.

4. CONCLUDING REMARKS

The preliminary results from marine sedimentological and micropalaeontological investigations on the R.V. Tansei-maru KT99-14 cruise in the central and eastern marginal parts of the Japan Sea are summarized as follows :

1. Surface sediments of the Okushiri Basin, and related continental slope and shelf west-northwest off Matsumae, South Hokkaido are composed generally of gravelly coarse-grained sand in the upper shelf, masses of sponge spicules in the middle to lower shelf, gravelly coarse-grained scoriaceous sand in the upper slope, medium-grained scoriaceous sand in the middle slope, scoriaceous sandy mud in the lower slope and homogeneous sandy mud in the basin-floor.
2. Surface sediments of the East Bank of the Yamato Bank and the southwestern slope of the bank consist mainly of basaltic gravels on the summit of the bank, basaltic gravel bearing sandy mud in the upper slope and bluish grey homogeneous muds in the middle slope.
3. Surface sediments of the northern part of the Toyama Trough, and related continental slope and shelf west off the Hyotan-guri Bank, northwest off Sado Island are composed generally of poorly sorted calcareous sand on the top of the bank, gravel and calcareous fragment bearing medium- to coarse-grained sand in the lower shelf and shelf edge area, reddish brown homogeneous sandy muds or homogeneous muds in the upper slope, and reddish brown homogeneous muds in the lower slope and basin-floor. A semi-consolidated stratum should be exposed in part in the lower slope.
4. Surface sediments of the southernmost part of the Mogami Trough, and related continental slope and shelf west-northwest of Murakami, Northeast Honshu, are composed generally of reddish brown fine-grained sand in the uppermost shelf, reddish brown sandy muds or muds in the upper to middle shelf, molluscan shell and granule bearing reddish brown muddy sands or fine-grained sands in the lower shelf and shelf edge areas, reddish brown homogene-

ous muds or sandy muds in the lower slope to basin -floor. Land plant debris is a marked biogenic sediments in the middle shelf area.

5. One hundred and fifty-seven taxa belonging to 91 genera of benthic foraminifers were recognized in 38 samples. Based on the depth-frequency distribution, the benthic foraminiferal assemblages are grouped into zones in each area as follows; (1) off Matsumae, Zone A (shallower than 446 m) and Zone B (deeper than 719 m); (2) around the Yamato Bank, one zone (777-1755 m); (3) off Sado Island, Zone C (shallower than 333 m) and Zone D (deeper than 491 m); (4) off Murakami, Zone E (shallower than 125 m) and Zone F (deeper than 481 m). Zone E is subdivided into two subzones by the species composition.
6. One hundred and twelve species belonging to 58 genera of ostracodes were identified from 29 surface sediments obtained in the central and northeastern marginal parts of the Japan Sea. Assemblages recognized in each area are followings; 1) off Matsumae, two assemblages (76-333 m and 719 -989 m), 2) Yamato Bank, one assemblage (777 - 1021 m), 3) northwest off Sado Island, two assemblages (94-127 m and 170-975 m), 4) off Murakami, two assemblages (35-75 m and 202-341 m). These divisions are attributed to the difference of water depth and water mass structure.
7. Seven species belonging to four genera of planktonic foraminifers were identified from 14 surface samples.

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日本海中央部ならびに北東縁部における淡青丸 KT 99-14 次航海の予察的成果
—堆積物，底生有孔虫・浮遊性有孔虫，介形虫—
（第Ⅰ部：表層堆積物）

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要　旨

1999 年 9 月 13 日～21 日，日本海中央部ならびに北東縁部での海洋研究船淡青丸の研究航海 KT 99-14 おいて，奥尻海盆および松前町沖陸棚～斜面，富山深海長谷および同深海扇状地外縁部，大和堆の東堆頂部および南東斜面，富山舟状海盆および佐渡北東沖陸棚～斜面，そして最上舟状海盆および村上市沖陸棚～斜面より柱状試料 10 点ならびに表層試料 48 点が得られた。これらの試料の中で表層堆積物試料を堆積学的ならびに微古生物学的に検討した結果，以下の予察的成果が得られた。

1．北海道南部松前町沖の陸棚から大陸斜面をへて奥尻海盆にかけての表層堆積物は，陸棚上部では含礫粗粒砂，同中～下部ではわずかに砂質堆積物をともなう海綿骨針塊，斜面上部では含礫粗粒スコリア砂，同中部では中粒スコリア砂，同下部～海盆底ではスコリア砂質泥からそれぞれ構成される。

2．大和堆東堆頂部から南東斜面中部にかけての表層堆積物は，頂部では玄武岩岩片，斜面上部では玄武岩岩片をともなう砂質泥，そして同中部では均質な青灰色泥からそれぞれ構成される。

3．佐渡島北東方，佐渡堆の瓢箪堆から大陸斜面をへて富山舟状海盆にかけての表層堆積物は，堆頂部では石灰質粗粒砂，陸棚下部～陸棚外縁では含礫含貝殻中～粗粒砂，斜面上部では赤褐色砂質泥あるいは泥，そして斜面下部ならびに海盆底では赤褐色泥からそれぞれ構成される。

4．新潟県村上市沖の陸棚から大陸斜面をへて最上舟状海盆にかけての表層堆積物は，陸棚最上部では赤褐色細粒砂，陸棚上～中部では赤褐色砂質泥～泥，陸棚下部～陸棚外縁では礫や貝殻片をともなう赤褐色細粒砂～泥質砂，斜面下部～海盆底では均質な赤褐色泥～砂質泥からそれぞれ構成される。なお，陸棚中部の表層堆積物は陸上植物遺骸に特徴的に富む。

5．表層堆積物 38 試料より産出した 91 属 157 種の底生有孔虫は，その深度分布にもとづいて，海域ごとに以下のような複数の群集に区分される；(1)松前沖：446 m 以浅群集，719 m 以深群集；(2)大和堆周辺：1 群集（777-1755 m）；(3)佐渡島沖：333 m 以浅群集，491 m 以深群集；4)村上沖：125 m 以深群集，481 以深群集．また村上沖の 125

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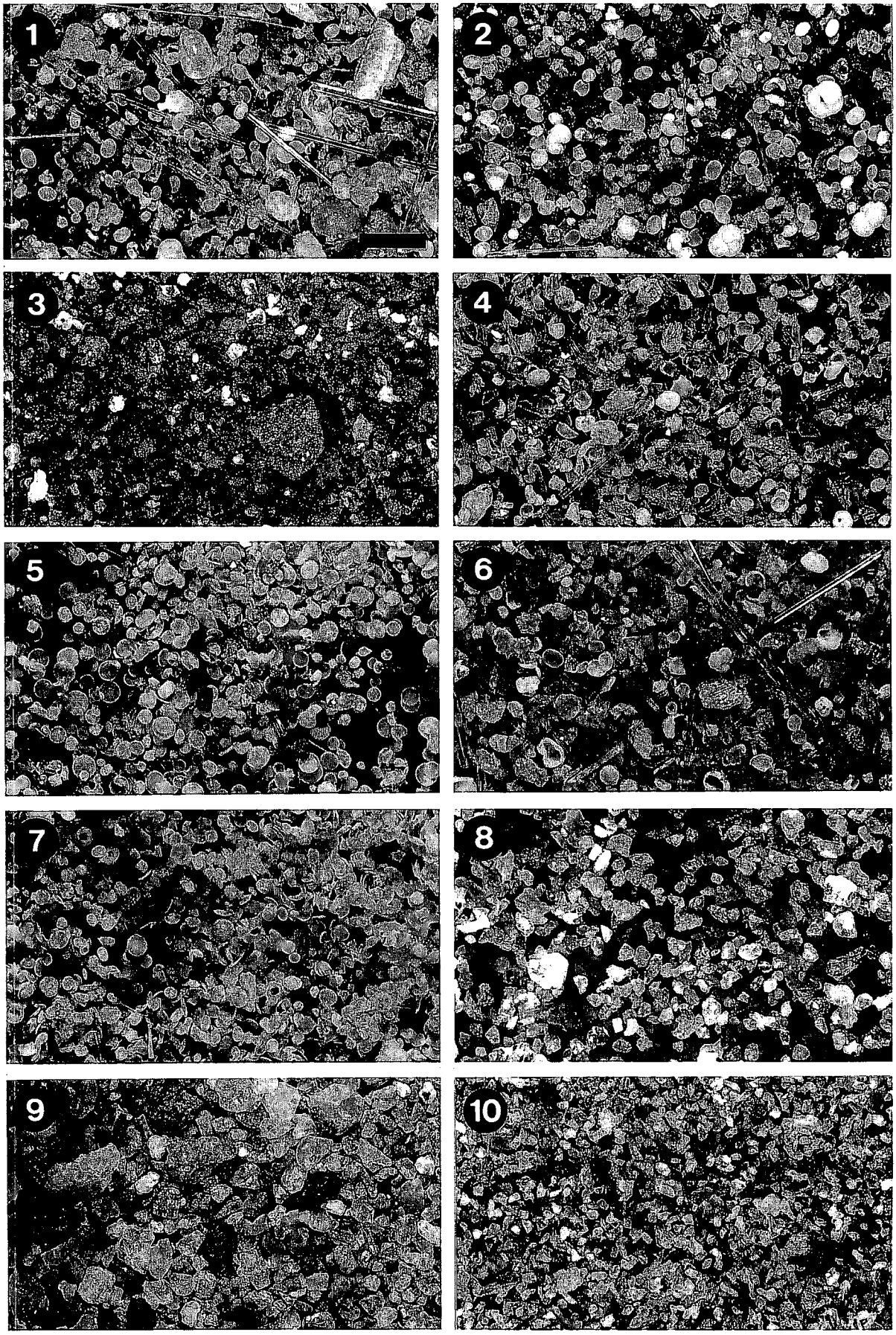
m 以浅群集は，構成種の特徴からさらに二つの群集に区分される．

6．表層試料より 58 属 112 種の介形虫が同定され，これらは深度分布ならびに水塊構造によって地域ごとに以下のような複数の群集に区分される；1) 松前沖：2 群集 (76-333 m、719-989 m)；2) 大和堆周辺：1 群集 (777-1021 m)；3) 佐渡島沖：2 群集 (94-127 m、170-975 m)；4) 村上沖：2 群集 (35-75 m、202-341 m)。また佐渡島沖の試料 G-26、27、29'、30' (94-200 m) より、更新統からの再堆積と考えられる大桑-万願寺型介形虫が産出する。

7．表層資料より 4 属 7 種の浮遊性有孔虫が同定され，これらは(1)松前沖，(2)大和堆，(3)佐渡沖，および(4)村上沖のそれぞれの海域を特徴づける群集に区分される。

Plate 1



Explanation of Plate 1

Mircoscopic photographs of sandy sediments. Scale bar, 0.5 mm long, is indicated in fig. 1 (lower, left).

fig. 1: Sponge spicules and microscleres with a small amount of biogenic calcareous materials in the sample G-5 from the middle shelf off Matsumae (110 m deep).

fig. 2: Sponge microscleres and scoria grains with a small amount of biogenic calcareous materials in the sample G-10' from the upper slope of the Okushiri Basin (245 m deep).

fig. 3: Scoria grains with a small amount of quartz, feldspars and heavy minerals in the sample G-15' from the central Okushiri Basin (1,428 m deep)

fig. 4: Volcanic glass shards, planktonic foraminiferal tests and sponge spicules in the sample G-18 from the southeastern slope of the Yamato Bank (777 m deep).

fig. 5: Diatoms and volcanic glass shards with a small amount of sponge spicules in the sample G-21 from the southeastern slope of the Yamato Bank (1,755 m deep).

fig. 6: Sponge microscleres and spicules, foraminiferal tests and terrigenous sediments in the sample G-30' from the upper shelf west of the Hyotan-guri Bank (200 m deep).

fig. 7: Diatoms, sponge microscleres and volcanic glass shards in the sample G-38 from the basin-floor of the Toyama Trough (1,929 m deep)

fig. 8: Fine-grained quartz, biotites and feldspars in the sample G-44 from the lower shelf off Murakami (174 m deep).

fig. 9: Coarse-grained quartz, feldspars and sedimentary rock fragments in the sample G-46 from the middle-lower shelf off Murakami (125 m deep).

fig. 10: Very fine-grained quartz, feldspars and biotites with a certain amount of land-plant debris in the sample G-48 from the upper shelf off Murakami (75 m deep).