A preliminary report on the Recent ostracodes in sediment samples from the R.V. Tansei-maru Cruise KT01-14 in the southwestern Okhotsk Sea and the northeastern Japan Sea off Hokkaido

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A preliminary report on the Recent ostracodes in sediment samples from the R.V. *Tansei-maru* Cruise KT01-14 in the southwestern Okhotsk Sea and the northeastern Japan Sea off Hokkaido

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1. INTRODUCTION

Changes of geographical distribution in marine organisms during Quaternary climate oscillations provide key insights to the future anthropogenic-induced climatic fluctuations on marine species (e.g., Cronin, 1999). In particular, investigations of the geographical migrations of cryophilic species in response to climate warming have considerable value. The faunas of the northwestern Japan Sea and the southwestern Okhotsk Sea off Hokkaido are particularly suited to this type of study, because these regions are located in the mid latitudes. Quaternary oceanic conditions in these areas would have been susceptible to changes in response to glacio-eustatic sea-level fluctuations linked to climatic oscillations (e.g., Tada, 1994). However, there have been few studies which compared the distributions between ancient and Recent species in and around these areas. Benthic ostracodes (Crustacea) are abundant in both Quaternary and Recent coastal sediments, making them appropriable to such a study (e.g., Ozawa and Kamiya, 2001; Ozawa, 2003a).

Present data on the distribution of Recent ostracodes in the southwestern Okhotsk Sea are fragmentary. These include genera such as *Schizocythere* (Hanai, 1970; Tsukagoshi and Briggs, 1998), *Cythere* (Tsukagoshi, 1988) and *Baffinicythere* (Irizuki, 1996), with some additional information for other species (Ikeya and Cronin, 1993; Itoh, 1996). No detailed ostracode species list is yet reported on this area, nor is there any information as to the mode of occurrence of the abundant species or SEM images of the species.

On the other hand, the species list of the Recent ostracode fauna from both the continental shelf and the upper part of continental slope in the northeastern Japan Sea off Hokkaido have been presented in detail (Itoh, 1996; Ozawa *et al.*, 1999; Tsukawaki *et al.*, 2001). These studies showed the detail distribution of the species. They also showed the relationship between assemblages and the environments provided by the water mass structures. A recent study by Ozawa (2003b) described the distribution of species and assemblages in five areas, extending from the southwestern to northeastern Japan Sea. The study presents the faunal relationship to the properties of the water mass, such as water temperature and salinity. However, few data came from middle and lower slope areas in the northeast. As a consequence, it is still hard to correlate the species distribution of the southwestern with that of northeastern Japan Sea in slope areas.

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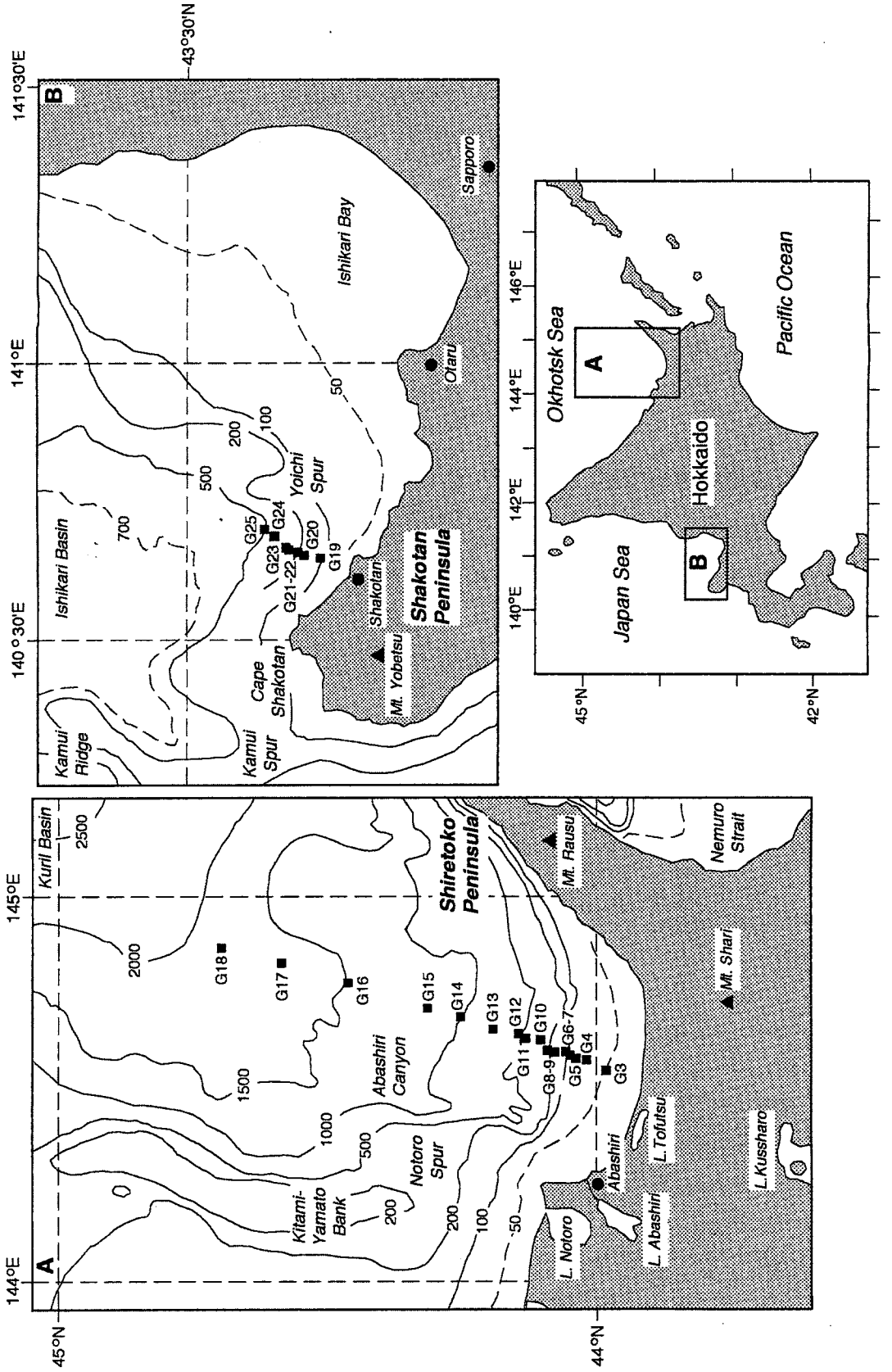

Fig. 1 : Submarine topography of studied areas in southwestern part of Okhotsk Sea off Abashiri, Hokkaido (A), and northeastern part of Japan Sea northeast off Shakotan, Hokkaido (B), based on Hydrographic Department, M. S. A., Japan (1980). Solid square: grab surface sampling site.

Table 1 : List of ostracode species from surface sediments of grab samples in southwestern Okhotsk Sea off Abashiri. Numerals in parentheses indicate number of living specimens.

Sample number	G-3	G-4	G-5	G-6	G-7	G-8	G-9	G-10	G-11	G-12	G-13	G-16	G-18
Species name/ Water depth (m)	49	72	99	117	142	174	193	250	423	493	761	1540	1558
Acanthocythereis dunelmensis s.l. (Norman)			1					2					
Acanthocythereis mutsuensis Ishizaki		1											
Acuticythereis? sp.		11	3		6		3						
Argilloecia toyamaensis Ishizaki & Irizuki			2						9 (7)	4 (2)	1 (1)		
Argilloecia sp.							1	1 (1)		1 (1)			
Argilloecia? sp.				1	1			2					
Baffinicythere ishizakii Irizuki		3	4	10		1				1			
Baffinicythere reticulata Irizuki			2	5		1	2						
Baffinicythere robusticostata Irizuki		4	21	15	4	9	2	1					
Bythoceratina sp.			4	1									
Callistocythere reticulata Hanai					1								
Callistocythere undulatifacialis Hanai			1										
Cornucoquimba alata (Tabuki)		1	2	1	4	8	4	1					
Cornucoquimba cf. moniwensis (Ishizaki)				1		2	1						
Cythere golikovi Schornikov		1	2	1		1	1						
Cytherois? sp. 1			1	1		1	1						
Cytheropteron sp. 1		12	15	8	1	1		1	1				
Cytheropteron sp. 2			11	6	4	9 (3)	1						
Cytheropteron sp. 3				5	3	4		2	1				
Cytheropteron sp. 4			6										
Elofsonella cf. concinna (Jones)								5	2				
Eucythere sp. 1				2		12 (2)							
Falsobuntonia sp.										1		1 (1)	
Finmarchinella japonica s.l. (Ishizaki)		1	5	4	2	1	1						
Finmarchinella nealei Okada	1 (1)	2	1	6	3	2							
Hanaiborchella miurensis (Hanai)			1			1							
Hanaiborchella triagularis (Hanai)			1										
Hemicythere orientalis Schornikov						1							
Hemicytherura clathrata (Sars)			7	4									
Howeina camptocytheroidea Hanai		2	6	1		3							
Howeina sp.	4					1	1						
Johnnealella nopporensis Hanai & Ikeya	4	115	16	12	99	68	36 (1)		1				
Kotoracythere sp.		12 (1)	4	1	9	8 (1)			2 (2)	1			
Krithe sp. 1													1
Laperousecythere robusta (Tabuki)		5	26 (3)	20	34	43	22	7	5	4			
Laperousecythere sp. 1			3	2									
Laperousecythere sp. 2					1	1			6 (1)				
Loxoconcha hattorii Ishizaki						1							
Loxoconcha cf. kitanipponica Ishizaki					1				1				
Loxoconcha optima Ishizaki			1										
Loxoconcha ozawai Tabuki		3		3									
Loxoconcha cf. subkotoroforma Ishizaki			4										
Macrocypris sp.								1 (1)					
Munseyella hatatatensis (Ishizaki)		2	10	2 (1)	2	5 (1)	4	3 (3)	2 (2)	1			
Munseyella hokkaidoana (Hanai)			5 (2)	2 (1)	8 (2)	23 (16)	1 (1)	7 (6)					
Munseyella sp. 1						1							
Munseyella sp. 2									4 (4)				
Neonesidea sp.				1									
Normanicythere? sp.									2				
Paijenborchella sp.									2				
Palmenella limicola (Norman)				1	7 (3)	2	3	2	1				
Paradoxostoma sp.							1 (1)	2 (1)					
Pectocythere sp.									1		2		
Pontocythere miurensis (Hanai)			3										
Pontocythere subjaponica (Hanai)		1											
Robertsonites sp.			1										
Schizocythere ikeyai Tsukagoshi & Briggs		4	15	20			1			2			
Schizocythere kishinouyei (Kajiyama)		6	14	9	3		6						
Schizocythere okhotskensis Hanai			9	40	13	13		5	5	1			
Sclerochilus sp.		3	4										
Semicytherura hibema Okubo			1										
Semicytherura miurensis Hanai				1									
Semicytherura sp. 1			3										
Semicytherura sp. 2						1 (1)							
Xestoleberis setouchiensis Okubo			1	5									
Yezocythere hayashii Hanai & Ikeya		6											
Yezocythere? sp.			1			2							
Zabythocypris sp.			3	4	1								
Gen. sp. indet.									1				
Total number	9	195	220	195	207	226	92	42	46	16	3	1	1

During the R.V. *Tansei-maru* Cruise KT01-14 in 2001, grab surface sediment samples were obtained from both shelf and slope areas in the southwestern Okhotsk Sea and the northeastern Japan Sea, off Hokkaido (Tsukawaki *et al.*, 2003; Fig. 1). The purpose of our study in these two areas is to publish a detailed list, accompanied by SEM images, of ostracode faunas. These basic data will help the modeling of future marine ecosystems in mid latitudes.

2. SAMPLING AND ANALYTICAL METHOD

Two marginal areas lying between about 43° and 45°N in the southwestern Okhotsk Sea and the northeastern Japan Sea were investigated (Fig. 1). These two areas are referred to in this study as those off Abashiri and off Shakotan respectively. The samples were obtained from 20 to 23 September 2001, during cruise KT01-14 of the R. V. *Tansei-maru* of the Ocean Research Institute, University of Tokyo (Tsukawaki *et al.*, 2003). A total of 23 surface sediment samples G-3－G-25 were collected along one survey line in each area between the continental shelf and continental slope using an Okean-type grab sampler. Sixteen samples were obtained off Abashiri from depths of approximately 50－1,750 m, and seven samples off Shakotan from depths of 130－530 m (see Tsukawaki *et al.*, 2003 for detailed sample data).

The upper 5 mm of surface sediments, with an area of about 50 x 25 cm^2, were analyzed for the ostracodes. Neutralized 10% formalin was added to all samples immediately after sampling. These were then washed through a 63-μm sieve with water, and oven-dried at 80℃. Up to a total of 200 specimens were then picked from fractions between 0.25 and 1.0 mm from each quantitative split of a sample. Fourteen of the 23 grab surface samples yielded less than 50 individuals in total, even when all ostracode specimens were picked from the fractions.

After identification of ostracode species, the numbers of individuals were determined by adding together the total of single left and right valves which were more than one half complete, and all whole carapaces. Totals were calculated without regard to sex, instar stage, or the existence of soft parts. All material was deposited in the Department of Geology, National Science Museum, Japan.

3. RESULTS

A total of 75 species belonging to 43 genera were identified from the 20 grab surface samples in the two areas (Tables 1 and 2; Plates 1 and 2).

Table 2 : List of ostracode species from surface sediments of grab samples in northeastern Japan Sea off Shakotan. Numerals in parentheses indicate number of living specimens.

Sample number	G-19	G-20	G-21	G-22	G-23	G-24	G-25
Species name/ Water depth (m)	125	158	182	210	252	388	528
Acanthocythereis dunelmensis s.l. (Norman)			2				
Argilloecia toyamaensis Ishizaki & Irizuki	1	2 (1)	4 (3)		2 (2)	7 (7)	
Cluthia cf. japonica Tabuki		1 (1)					
Cytheridea? sp. 2					1 (1)		
Eucythere sp. 2			2 (2)				
Falsobuntonia sp.	1 (1)	3 (3)	3 (3)	2 (1)	1	6 (6)	14 (12)
Krithe sawanensis s.l. Hanai	8 (2)		2 (1)	5 (3)	6 (5)	29 (28)	3 (2)
Krithe sp. 2							2 (1)
Macrocypris sp.		11 (10)	4 (4)	1 (1)			
Palmenella limicola (Norman)	1 (1)				1 (1)		
Rabilimis septentrionalis (Brady)		1					
Robertsonites hanali Tabuki	18 (4)	1	18 (4)	3 (1)	1 (1)		
Total number	27	19	35	11	12	42	19

Southwestern Okhotsk Sea off Abashiri

Thirteen samples, collected at depths between 49 and 1,558 m (G-3－G-13, G-16 and G-18; Fig. 1A), contained 69 species belonging to 40 genera (Table 1). The twenty most abundant species are shown in Table 3 along with data specifying their individual numbers and their percentage in the total population. Dominant species, defined here as more than 10% in the population, were *Johnnealella nopporensis* and *Laperousecythere robusta*. These two species represented about 40% of all individuals in this area. Nine common species, defined here as 2 to 10% in the total population, were *Schizocythere okhotskensis, Baffinicythere robusticostata, Munseyella hokkaidoana, Schizocythere ikeyai, Cytheropteron* sp. 1, *Schizocythere kishinouyei, Kotoracythere* sp., *Munseyella hatatatensis* and *Cytheropteron* sp. 2. These eleven species accounted for more than 70% of the population.

Table 3 : Most abundant 20 ostracode species, their individual numbers and their percentages against all individuals from southwestern Okhotsk Sea off Abashiri.

	Species names	no.	%
1	*Johnnealella nopporensis*	351	28.0
2	*Laperousecythere robusta*	166	13.2
3	*Schizocythere okhotskensis*	86	6.9
4	*Baffinicythere robusticostata*	56	4.5
5	*Munseyella hokkaidoana*	46	3.7
6	*Schizocythere ikeyai*	42	3.4
7	*Cytheropteron* sp. 1	39	3.1
8	*Schizocythere kishinouyei*	38	3.0
9	*Kotoracythere* sp.	37	3.0
10	*Munseyella hatatatensis*	31	2.5
	Cytheropteron sp. 2	31	2.5
12	*Acuticythereis* ? sp.	23	1.8
13	*Cornucoquimba alata*	21	1.7
14	*Baffinicythere ishizakii*	19	1.5
15	*Argilloecia toyamaensis*	16	1.3
	Palmenella limicola	16	1.3
17	*Finmarchinella nealei*	15	1.2
	Cytheropteron sp. 3	15	1.2
19	*Finmarchinella japonica* s.l.	14	1.1
	Eucythere sp. 1	14	1.1

Table 4 : All 12 ostracode species, their individual numbers and their percentages against all individuals from northeastern Japan Sea off Shakotan.

	Species names	no.	%
1	*Krithe sawanensis* s.l.	51	30.9
2	*Robertsonites hanaii*	41	24.8
3	*Falsobuntonia* sp.	30	18.2
4	*Argilloecia toyamaensis*	16	9.7
	Macrocypris sp.	16	9.7
6	*Acanthocythereis dunelmensis* s.l.	2	1.2
	Eucythere sp. 2	2	1.2
	Krithe sp. 2	2	1.2
	Palmenella limicola	2	1.2
10	*Cluthia* cf. *japonica*	1	0.6
	Cytherois? sp. 2	1	0.6
	Rabilimis septentrionalis	1	0.6

Northeastern Japan Sea off Shakotan

The seven samples (G-19−G-25; Fig. 1B) obtained from depths of 125−528 m across the lower continental shelf to the middle slope contained 12 species belonging to 11 genera (Table 2). Their individual numbers and the percentages in the total population are given in Table 4. The dominant species were *Krithe sawanensis* s.l., *Robertsonites hanaii*, and *Falsobuntonia* sp. These three species together represented more than 70% of all individuals. Two common species were *Argilloecia toyamaensis* and *Macrocypris* sp. These five species accounted for more than 90% of the population.

4. DISCUSSION

Off Abashiri

The ostracodes off Abashiri are divided into three types depending on the depth range distributions; "shelf species" (50−200 m; 41 spp.), "shelf to slope species" (50−500 m; 21 spp.) and "slope species" (400−1,600 m; 6 spp.). The "shelf species" are e.g. *Schizocythere kishinouyei, Cytheropteron* sp. 2, *Acuticythereis*? sp., *Finmarchinella nealei, Finmarchinella japonica* s.l. and *Eucythere* sp. 1. "Shelf to slope species" are *Johnnealella nopporensis, Laperousecythere robusta, Schizocythere okhotskensis, Baffinicythere robusticostata, Munseyella hokkaidoana* and other 16 species. The slope species are *Falsobuntonia* sp., *Krithe* sp. 1, *Munseyella* sp. 2, *Normanicythere*? sp., *Paijenborchella* sp. and *Pectocythere* sp. Many "shelf species" and "shelf to slope species" commonly occur in the northern Japan Sea (e.g., Itoh, 1996). Most "slope species", such as *Munseyella* sp. 2, *Paijenborchella* sp. and *Pectocythere* sp., have no occurrence records from the Japan Sea. *Falsobuntonia* sp. and *Krithe* sp. 1 may be different from congeneric species which were reported from the Japan Sea. The detailed examination of their carapace morphology and soft part characters are the future subject.

The southwestern Okhotsk Sea represents the distinct seasonal fluctuations of water mass environments. These fluctuations are more complicated than those of northern Japan Sea. At the very surface area, the Soya Warm Current Water appears in summer while seasonal sea-ice develops in winter. Together with these oceanic changes, several different types of water mass appears in each season. The three distributional divisions and the different-common characters of their species compositions are possibly reflected in the distinct seasonal fluctuations through a year, or some environmental factors different

from those in the northern Japan Sea. This examination will be a subject of a future study.

Off Shakotan

The ostracodes in the seven samples collected off Shakotan were mostly species typical of cold Japan Sea Intermediate Water and Japan Sea Proper Water (Ozawa, 2003b), e.g., *Krithe sawanensis, Robertsonites hanaii*, and *Argilloecia toyamaensis*. The species composition of the samples resembled to those reported from the lower continental shelf and slope areas off Sanin-Mishima Island, Oki Islands and Noto Peninsula in the southwestern Japan Sea, off Sado Island and Tsugaru Peninsula in the eastern Japan Sea and off northwestern Hokkaido in the northeastern Japan Sea (Irizuki, 1989; Ishizaki and Irizuki, 1990; Ikeya and Suzuki, 1992; Ikeya and Cronin, 1993; Tsukawaki *et al.*, 1993, 1997, 1998, 1999, 2000, 2001; Itoh, 1996; Kamiya *et al.*, 1997, 2001; Ozawa, 1998, 2003b; Ozawa *et al.*, 1999).

In the lower continental shelf to continental slope of the Japan Sea off Mishima, Oki, Noto and Tsugaru, south of the Tsugaru Strait, *Robertsonites hanaii* is more abundant than *Krithe sawanensis* at depths of 150−250 m, but at depths of 350−1,500 m *Krithe sawanensis* dominates over *Robertsonites hanaii* (Ozawa, 2003b). The boundary between the relative abundances of the two species south of the strait lies at a depth of about 300 m. However, off Shakotan, north of the strait, *Robertsonites hanaii* dominates over *Krithe sawanensis* from 125−182 m, but between 210−528 m *Krithe sawanensis* is more abundant than *Robertsonites hanaii*. Here the boundary between the relative abundances is recognized at a depth of around 200 m.
Consequently, the boundary lies at different depths south and north of the strait, with the depth in the south being approximately 100 m deeper than that in the north.

It is possible that the distributional modes of these species in the Japan Sea are determined by changes in water temperature during the year (Ozawa, 2003b), in which case oceanic conditions must differ north and south of the Tsugaru Strait. More details of the correlations between the distributions of these species with respect to the properties of water mass structures will be ascertained in a future study.

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北海道沖オホーツク海南西部および日本海北東部海域に分布する現生介形虫の予察的成果

－淡青丸 KT01-14 次航海で採取された表層堆積物試料について－

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要　旨

2001 年 9 月 17 日～24 日に、オホーツク海南西部網走市沖および日本海北東部積丹半島沖海域での海洋研究船淡青丸の研究航海 KT01-14 において、海底表層堆積物試料 23 点が採取された。これらの試料中の介形虫を検討した結果、以下の予察的成果が得られた。

2 海域の計 20 試料から 43 属 75 種の介形虫が同定された。そのうちオホーツク海域では、水深 49～1558m で得られた 13 試料より 40 属 69 種が見い出され、分布種リストおよび多産種の電子顕微鏡写真が初めて示された。これらは日本海域と共通して分布する種を含む。一方、日本海域では、水深 125～528m で得られた計 7 試料から 11 属 12 種が見い出された。これらは日本海中間水-固有水域に特徴的な種である。

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Plate 1

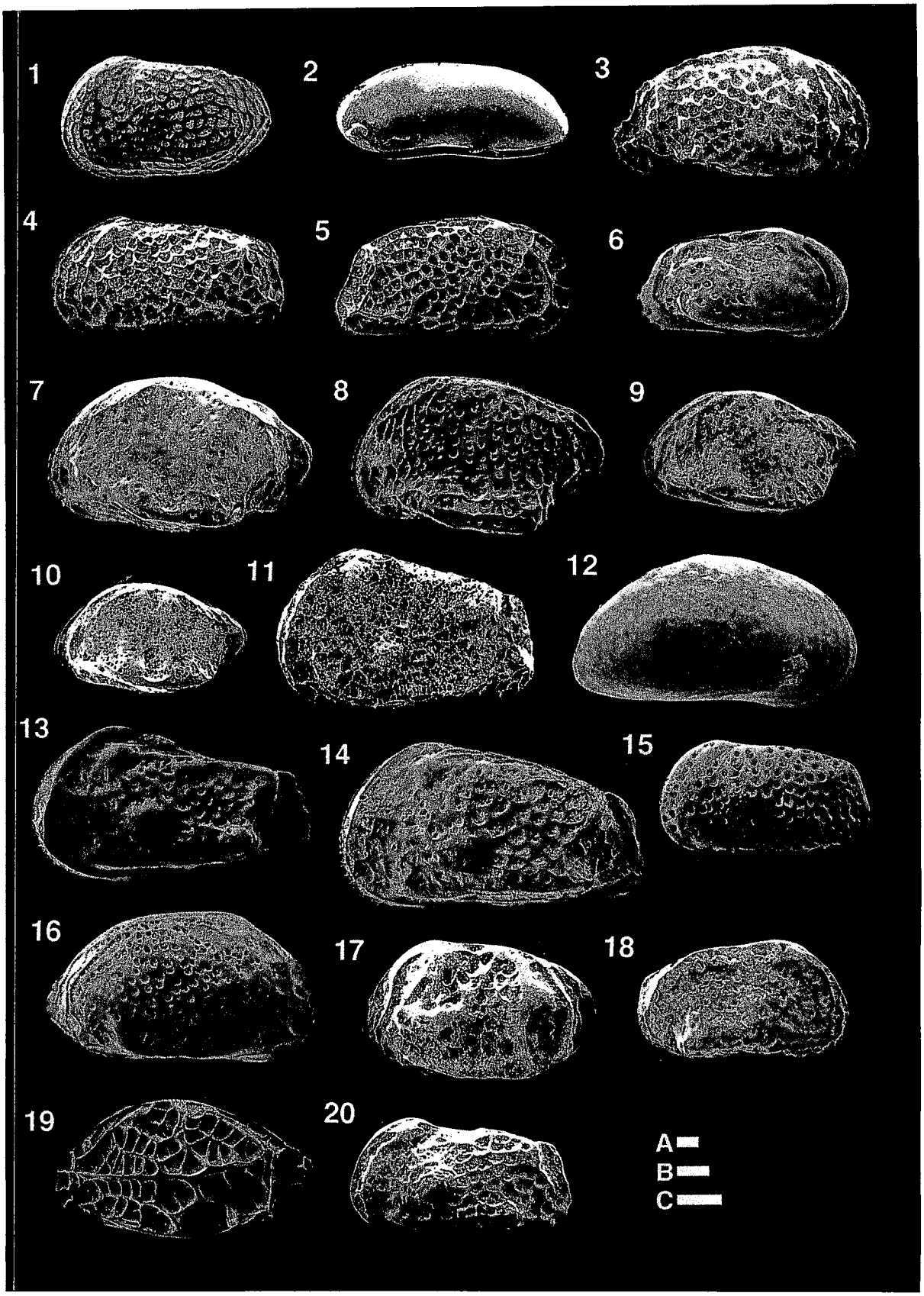

Plate 1 : Ostracodes in samples from KT01-17 cruise. All specimens are from off Abashiri area in the Okhotsk Sea. Scale bars are 0.1 mm: A for 3−6, 15, 20; B for 1, 2, 11, 18; C for 7−10, 12−14, 16, 17, 19.

1. *Acuticythereis* ? sp.: LV, juvenile, sample G4
2. *Argilloecia toyamaensis* Ishizaki & Irizuki: LV, sample G11
3. *Baffinicythere ishizakii* Irizuki: RV, sample G6
4. *Baffinicythere reticulata* Irizuki: LV, sample G5
5. *Baffinicythere robusticostata* Irizuki: RV, sample G5
6. *Cornucoquimba alata* (Tabuki): RV, sample G5
7. *Cytheropteron* sp. 1: LV, sample G6
8. *Cytheropteron* sp. 2: LV, sample G6
9. *Cytheropteron* sp. 3: LV, sample G7
10. *Cytheropteron* sp. 4: LV, juvenile, sample G5
11. *Elofsonella* cf. *concinna* (Jones): LV, sample G10
12. *Eucythere* sp. 1: RV, sample G6
13. *Finmarchinella japonica* s.l. (Ishizaki): LV, sample G5
14. *Finmarchinella nealei* Okada: LV, sample G6
15. *Johnnealella nopporensis* Hanai & Ikeya: LV, sample G4
16. *Howeina camptocytheroidea* Hanai: RV, sample G5
17. *Howeina* sp.: LV, sample G4
18. *Kotoracythere* sp.: RV, sample G4
19. *Hemicytherura clathlata* (Sars): LV, sample G5
20. *Laperousecythere robusta* (Tabuki): LV, sample G5

Plate 2

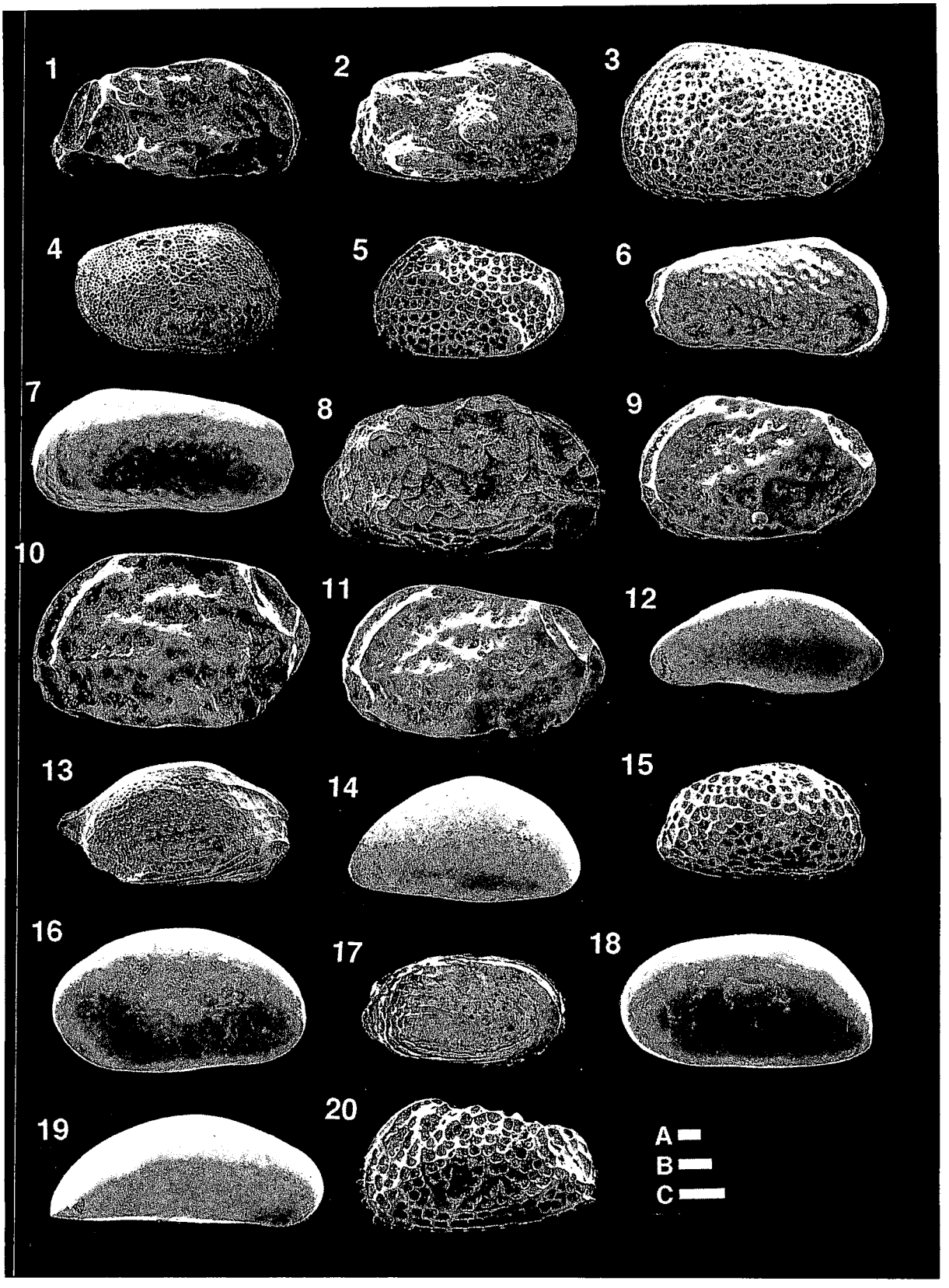

Plate 2 : Ostracodes in sample from KT01-17 cruise. 1−16 are from off Abashiri area in the Okhotsk Sea, and 17−20 are from off Shakotan area in the Japan Sea. Scale bars are 0.1 mm: A for 1, 15, 18−20; B for 2, 9−12, 16, 17; C for 3−8, 13, 14.

1. *Laperousecythere* sp. 1: RV, sample G5
2. *Laperousecythere* sp. 2: RV, juvenile, sample G11
3. *Loxoconcha ozawai* Tabuki: LV, sample G4
4. *Loxoconcha ozawai* Tabuki: RV, juvenile, sample G4
5. *Loxoconcha* cf. *subkotoraforma* Ishizaki: LV, sample G5
6. *Munseyella hatatatensis* Ishizaki: RV, sample G5
7. *Munseyella hokkaidoana* (Hanai): LV, sample G8
8. *Palmenella limicola* (Norman): RV, sample G6
9. *Schizocythere ikeyai* Tsukagoshi & Briggs: LV, sample G5
10. *Schizocythere kishinouyei* (Kajiyama): LV, sample G4
11. *Schizocythere okhotskensis* Hanai: LV, sample G6
12. *Sclerochilus* sp.: LV, sample G5
13. *Semicytherura* sp.: RV, sample G5
14. *Xestoleberis setouchiensis* Okubo: LV, juvenile, sample G6
15. *Yezocythere hayashii* Hanai & Ikeya: RV, sample G4
16. *Zabythocypris* sp.: LV, sample G5
17. *Falsobuntonia* sp.: RV, juvenile, sample G25
18. *Krithe sawanensis* s.l. Hanai: LV, juvenile, sample G24
19. *Macrocypris* sp.: RV, sample G20
20. *Robertsonites hanaii* Tabuki: LV, sample G19