地球科学 57 巻，111～127（2003 年）
Earth Science (Chikyu Kagaku) vol. 57, 111-127. 2003

Middle Miocene ostracods from the Omori Formation, Izumo City, Southwest Japan - Its implications for paleoenvironment of the Proto-Japan Sea -*

TANAKA Gengo**

Abstract Ostracods from the Omori Formation in Sugesawa (Izumo City, Shimane Prefecture) comprise 42 species belonging to 26 genera. Five new species, *Cytheropteron shimanense*, *Loxoconcha izumoensis*, *Paradoxostoma yakumotatsunus*, *Schizocythere sakanouei* and *Urocythereis sugesawensis* are described. Two ostracod assemblages (*Ambostracon-Argilloecia-Cytheropteron* assemblage and *Paijenborchella-Palmoconcha-Urocythereis pohangensis* assemblage) are recognized. These assemblages indicate that the uppermost of the Omori Formation was deposited under the environments from cool to warm open sublittoral condition. Principal components analysis of ostracod assemblages from the Omori and Fujina Formations indicates that, in general, the depositional environment becomes deeper and deeper towards the upper horizon.

Key Words : East China Sea, Fujina Formation, Japan Sea, Omori Formation, ostracods, Shimane

Introduction

The Japan Sea is a semienclosed marginal sea located between the Japanese Islands and the Asian continent. It was formed as a result of back-arc spreading prior to early Middle Miocene time. Since then, the Japan Sea has experienced regional tectonics and records global climatic changes. Therefore, the Japan Sea and its adjacent area can be regarded as an ideal experimental field for the study of the geohistorical change of the marginal sea.

Exposures of Miocene marine sediments are sporadically distributed in San'in district and contain mega- and microfossils. Those fossils have great potential for improving our understanding of the paleoenvironmental condition of the Miocene Proto-Japan Sea. Particularly, ostracods are useful in paleoenvironmental studies because many species have geographic and/or bathymetric distributions limited by the living conditions (e.g. bottom water temperature, salinity, sediment and so on). The paleogeographic position of the San'in district, placed near the Tsushima Straits since early Middle Miocene, therefore, also finds importance in the reconstruction of the paleoenvironmental condition of the Proto-Japan Sea. With the exception of the study by Tanaka et al. (2002), Miocene Ostracods are unkonwn from San'in districts.

This work is intended to describe some of the Miocene ostracods and to discuss the paleoenvironmental condition of the southwest part of the Proto-Japan Sea using a quantitative analysis.

Geological Setting of the Omori Formation

The Omori Formation was named by Tomita and Sakai (1937) as a part of the Omori Series. This formation covers over 50 km along the southern part of the Shinji Lowland and is about 750 m in maximum thickness (Fig. 1). The Omori Formation unconformably overlies the Kuri Formation, and is composed of subaerial to shallow-water andesite lava in the lower part and rhyolitic pumice tuff, shallow marine andesitic conglomerate and sandstone in the upper part (Kano et al. 1991, 1994). The Omori Formation is conformably overlain by the Fujina Formation. The two-pyroxene andesite of the

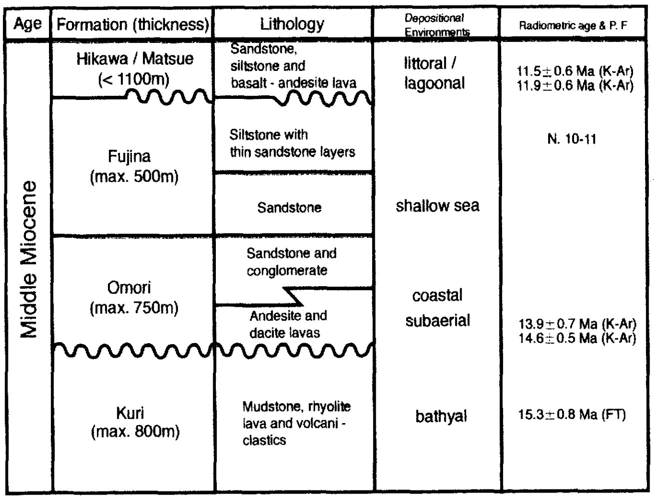

Fig. 1. Summary of the geology of the study area. Stratigraphy and depositional environment compiled after Kano et al. (1991, 1994). Radiometric ages are based on Kano and Yoshida (1984), Kano and Nakano (1985) and Kano et al. (1994). Planktonic foraminifer zone (P. F.) came from Nomura and Maiya (1984).

Received October 7, 2002. Accepted April 11, 2003.
* Partly presented at the 109th Annual Meeting of the Geological Society of Japan (Niigata).
** Institute of Nature and Environmental Technology, Kanazawa University, Ishikawa, 920-1192, Japan.

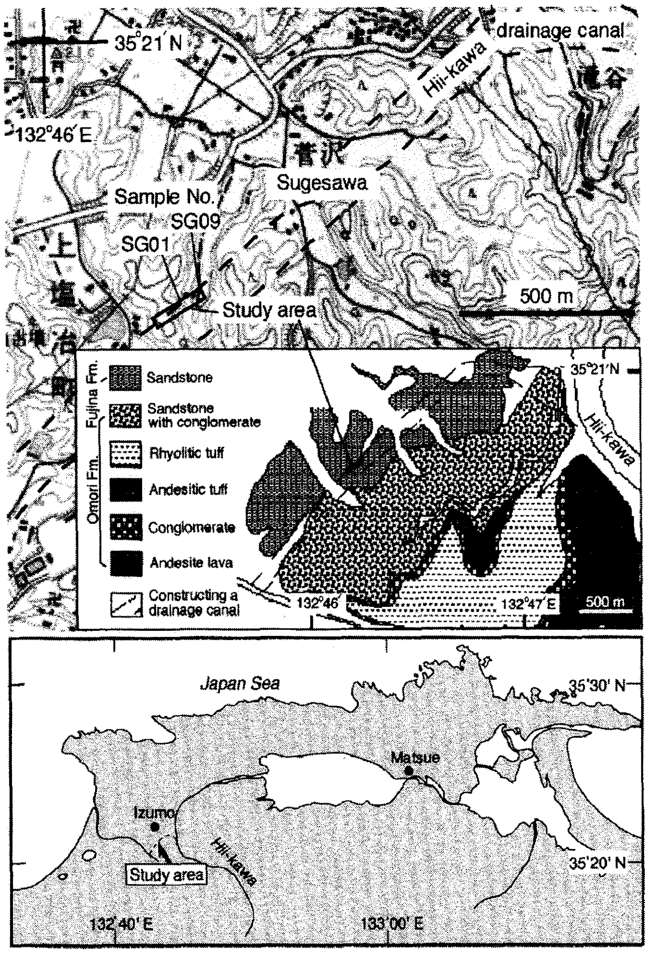

Fig. 2. Geologic sketch map with the study area (after Kano et al. 1991) and topographic map showing locations of sections of the Omori Formation measured along the constructing site of a Hii-kawa drainage canal (broken lines)(a part of topographic map "Izumo-imaichi", 1: 25,000 scale, Geographical Survey Institute of Japan).

Omori Formation was dated at 13.9±0.7 Ma and 14.6±0.5 Ma by the K-Ar method (Kano and Yoshida 1984 ; Kano et al. 1994).

Material and methods

Thirteen microfossil samples were collected from the outcrop at Sugesawa in Izumo City, Shimane Prefecture (Figs. 2 and 3). Six of them came from the tuffaceous bluish gray very fine sandstone and seven samples from the tuffaceous greenish dark gray very fine sandstone (Fig. 3). Between 80 to 1,040 grams of dry sediment were disaggregated by the naphtha method for rock maceration (Maiya and Inoue 1973), washing through a 235 mesh (63 μm) sieve, and drying again. This procedure was repeated until the whole sediment sample was disintegrated. A fraction coarser than 120 mesh (125 μm) sieve was sieved and all the ostracod specimens present were picked. Some of these specimens were examined with a JEOL JSM-5600LV scanning electron microscope (Shizuoka University) operated at 15 kV.

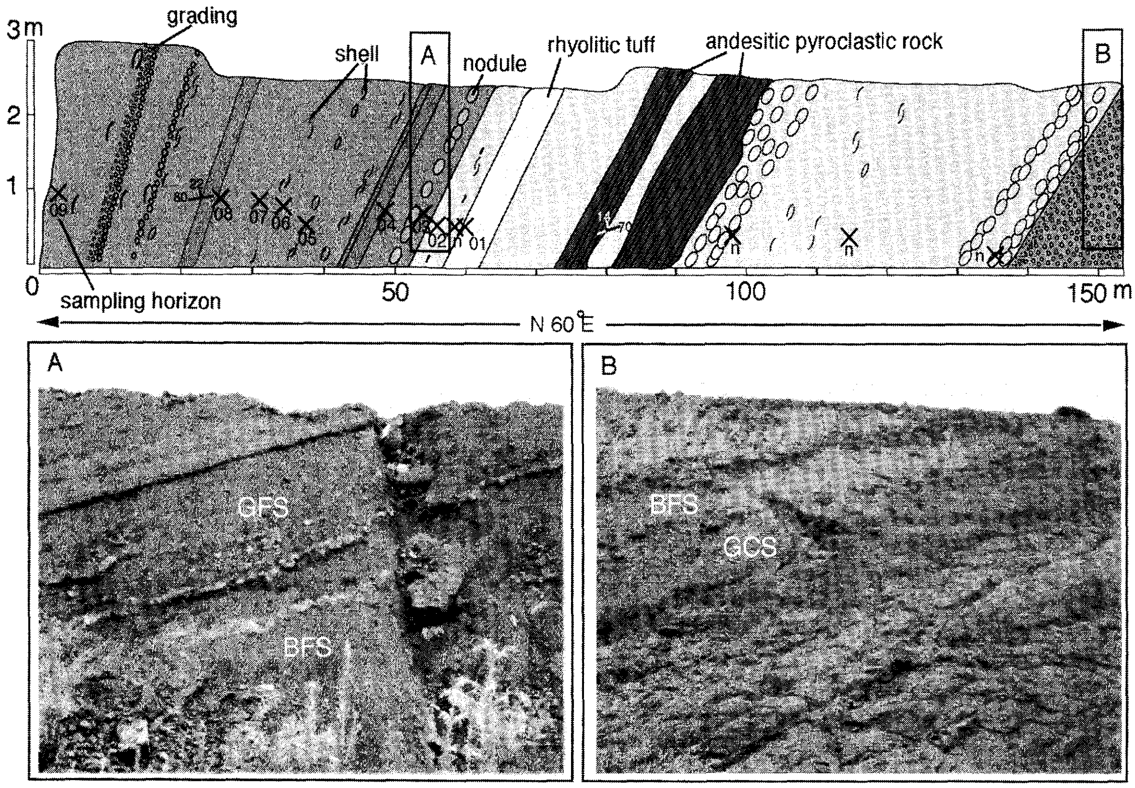

Fig. 3. Schematic sketch of the outcrop of the study area, and photographs which show the lithologic boundary. GFS = tuffaceous greenish dark gray very fine sandstone. BFS = tuffaceous bluish gray very fine sandstone. GCS = greenish gray coarse sandstone with pebble.

		SG01	SG02	SG03	SG04	SG05	SG06	SG07	SG08	SG09
	Acanthocythereis izumoensis Tanaka, 2002									1
	Acanthocythereis sp. 1						3			
	Acanthocythereis sp. 2			2						
*	*Ambostracon* cf. *ikeyai* Yajima, 1978			9	6	92	68	21	67	25
	Ambtonia shimanensis Tanaka, 2002			1	4	2	5		5	1
	Ambtonia takayasui Tanaka, 2002			1		1				
*	*Argilloecia* cf. *symmetrica* Zhao, 1988			1	3	7	11	1	18	6
	Argilloecia sp. 1						1			1
	Argilloecia sp. 2			1						
	Argilloecia sp. 3						1		1	1
	Argilloecia sp. 4			1			1	2	2	
	Aurila sp.						1	1		1
○	*Cluthia subjaponica* Tanaka, 2002	3		2	3	2	3	1	5	1
	Cytherois aff. *asamushiensis* Ishizaki, 1971								1	
	Cytheropteron shimanense Tanaka sp. nov.				2	7	21	4	20	13
*	*Cytheropteron sawanense* Hanai, 1957b		1	6	3	10	7	3	19	5
*	*Cytheropteron uchioi* Hanai, 1957b			10	8	7	7	1		3
*	*Eucytherura poroleberis* Zhao, 1988							1		
	Falsobuntonia taiwanica Malz, 1982	1								
*/○	*Krithe* cf. *antisawanensis* Ishizaki, 1966	3		8	4	2	3	1	2	
	Laperousecythere ikeyai Tanaka, 2002	2		1						2
*	*Loxoconcha* cf. *taiwanensis* Zhao, 1988							1		
	Loxoconcha izumoensis Tanaka sp. nov.			2			1		3	
	Loxoconchidea sp.	1		2				1		1
*	*Munseyella* cf. *hokkaidoana* (Hanai, 1957a)								3	3
	Munseyella hatatatensis Ishizaki, 1966					1				
○	*Paijenborchella* cf. *tsurugasakensis* Tabuki, 1986	5				1	1		1	1
	Palmenella limicola (Norman, 1865)	1			1					
○	*Palmoconcha irizukii* Tanaka, 2002	4		2	2	2	2	1		
	Paradoxostoma yakumotatsunus Tanaka sp. nov.			2		1	1		1	23
	Paradoxostoma sp.			1				1		
	Phlyctocythere sp. 1					1			1	
	Phlyctocythere sp. 2			1						
	Propontocypris aff. *attenuata* (Brady, 1868)				1					
	Propontocypris aff. *clara* Zhao, 1988			3	3					
	Robertosonites japonicus (Ishizaki, 1966)	1								
	Schizocythere sakanouei Tanaka sp. nov.			10		2	21		18	2
	Sclerochilus sp.			3	1		3		2	1
	Semicytherura aff. *affinis* (Sars, 1925)			1		2	1			7
*	*Semicytherura hanaii* Ishizaki, 1981					1	5		1	1
○	*Urocythereis pohangensis* Huh and Whatley, 1997	4		1						
	Urocythereis sugesawensis Tanaka sp. nov.							5	1	7
	No. of specimens	25	1	71	41	141	167	45	171	106
	No. of species	10	1	23	13	17	21	15	19	21
	Weight of sediments (g)	960	80	880	880	960	1040	800	960	640

Table 1. Ostracod fossils from the Sugesawa area.
Open circle = *Paijenborchella-Palmoconcha-Urocythereis pohangensis* assemblage, asterisk = *Ambostracon-Argilloecia-Cytheropteron* assemblage.

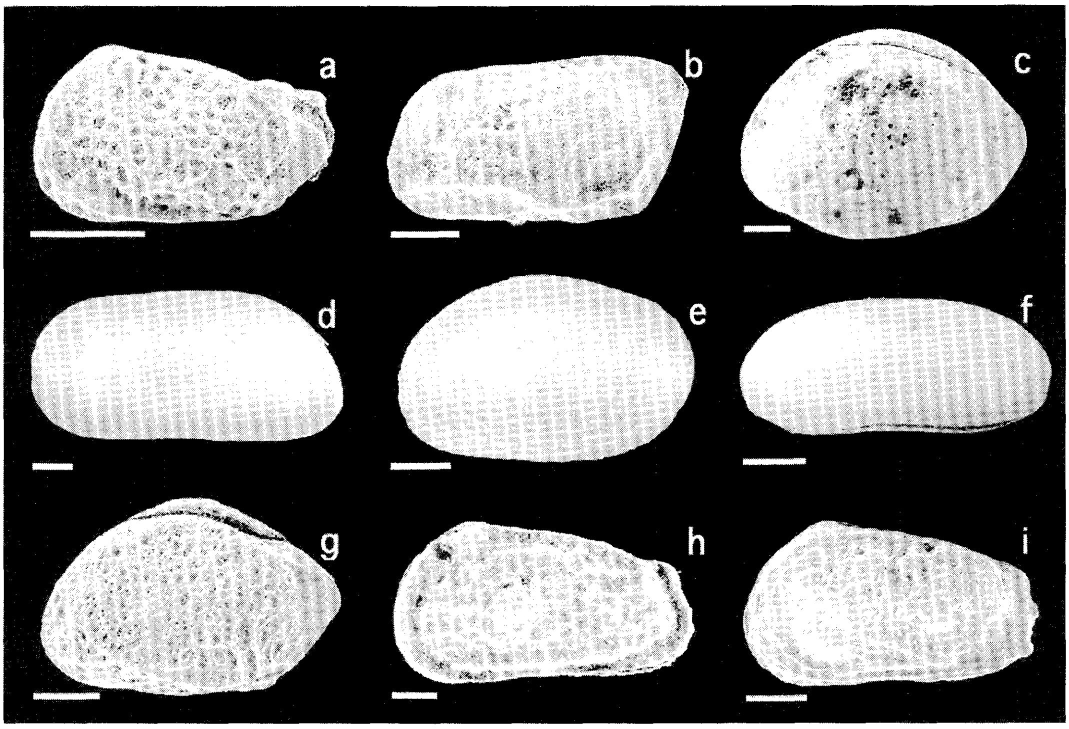

Fig. 4. SEM photographs of the nine species from the Omori Formation. a : *Eucytherura poroleberis* Zhao, 1988; CC male(?), SUM-CO-1351, Sample SG07. b : *Semicytherura hanaii* Ishizaki, 1981; CC male, SUM-CO-1352, Sample SG06. c : *Cytheropteron uchioi* Hanai, 1957b; CC male, SUM-CO-1353, Sample SG05. d : *Krithe* cf. *antisawanensis* Ishizaki, 1966; CC male, SUM-CO-1354, Sample SG04. e : *Loxoconcha* cf. *taiwanensis* Zhao, 1988; CC female, SUM-CO-1355, Sample SG07. f : *Argilloecia* cf. *symmetrica* Zhao, 1988; CC female, SUM-CO-1356, Sample SG08. g : *Cytheropteron sawanense* Hanai, 1957b; CC male, SUM-CO-1357, Sample SG08. h : *Ambostracon* cf. *ikeyai* Yajima, 1978; CC male, SUM-CO-1358, Sample SG08. i : *Munseyella* cf. *hokkaidoana* (Hanai, 1957a); CC female, SUM-CO-1359, Sample SG09. Scale bar is 0.10mm.

Ostracod assemblages

Forty-two ostracod species belonging to 26 genera were discriminated in the nine samples (SG01 - 09)(Fig. 3) from the Omori Formation (Table 1).

Two ostracod assemblages were recognized : *Paijenborchella-Palmoconcha-Urocythereis pohangensis* assemblage and *Ambostracon-Argilloecia-Cytheropteron* assemblage.

The *Paijenborchella-Palmoconcha-Urocythereis pohangensis* assemblage is characterized by following species from two samples (SG01 and 02) of the tuffaceous bluish gray very fine sandstone : *Cluthia subjaponica*, *Krithe* cf. *antisawanensis*, *P.* cf. *tsurugasakensis*, *Palmoconcha irizukii* and *Urocythereis pohangensis*. This assemblage closely resembles that from the uppermost part of the lower member of the Fujina Formation in the Fujina area (Tanaka et al. 2002).

The *Ambostracon-Argilloecia-Cytheropteron* assemblage is characterized by the species which occur in seven samples of the tuffaceous greenish dark gray very fine sandstone. The following extant species and the species which is compared with the living species, are included in this assemblage (Fig. 4) : *Ambostracon* cf. *ikeyai*, *Argilloecia* cf. *symmetrica*, *Cytheropteron sawanense*, *C. uchioi*, *Eucytherura poroleberis*, *Krithe* cf. *antisawanensis*, *Loxoconcha* cf. *taiwanensis*, *Munseyella* cf. *hokkaido* and *Semicytherura hanaii*.

The geographic and stratigraphic distributions of these species are mainly restricted from the South China Sea to off the Japanese Islands since Miocene (Fig. 5). These species are dominant in warm to mild-temperate condition. Some circumpolar and endemic cool-temperate species (*Munseyella hatatatensis*, *Paijenborchella* cf. *tsurugasakensis* and *Palmenella limicola*), however, are also found in this assemblage.

These two ostracod assemblages are compared to the molluscan assemblages that are reported by Sakanoue (2000) in this study area (Table 2).

In the following section, ostracod assemblages reported both from the present study area and the Fujina area (Tanaka et al. 2000, 2002) are analyzed to estimate the paleoenvironmental condition in the Proto-Japan Sea.

Principal components analysis

In order to quantitatively understand paleoenvironments during the deposition of the Omori and Fujina Formations, I carried out a Q-mode principal components analysis for 16 samples, which contained more than 45 individuals, (Fig. 6), of which 6 samples (SG03, 05, 06, 07, 08 and 09) are from

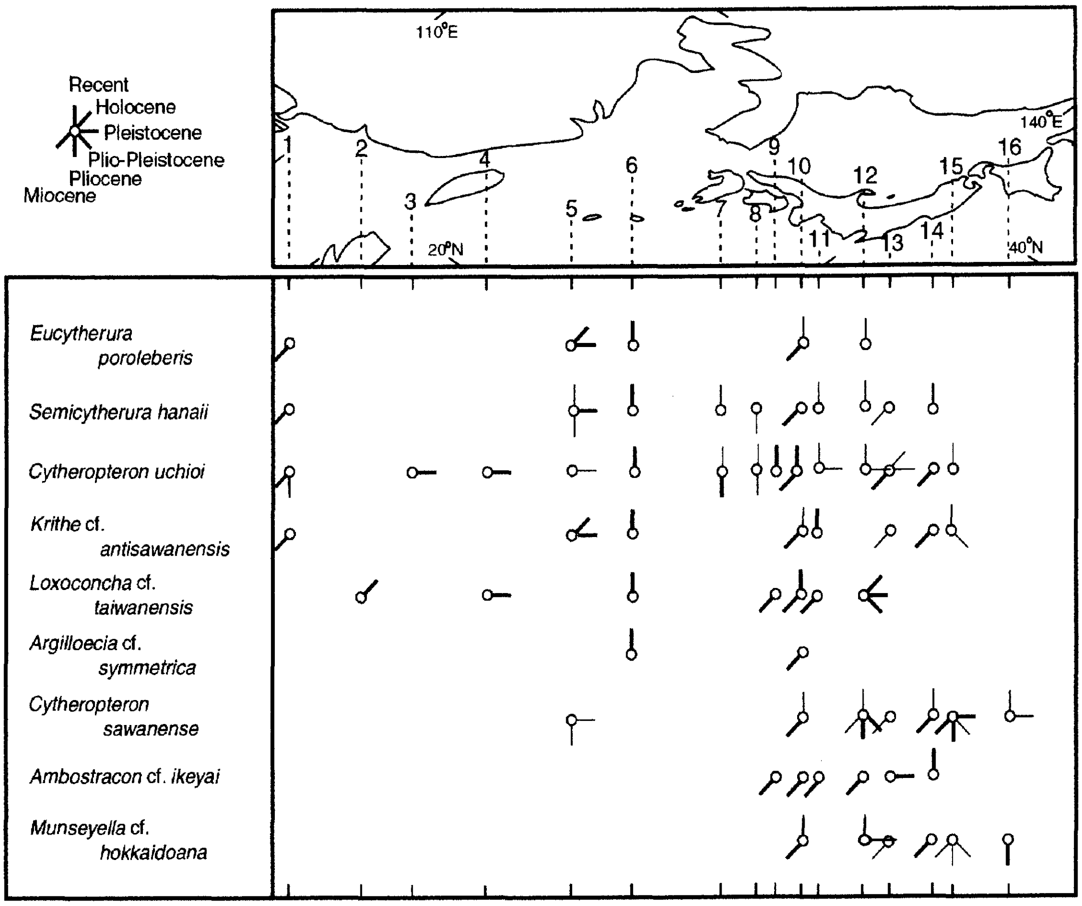

Fig. 5. Geographic and stratigraphic distribution of the "extant" species from the Omori Formation on the basis of previous published data (see Appendix 1). In this study, "extant" species also includes its compare (cf.) species. In the figure, bold bar is occurrence data with photographs of the specimen, fine bar is no photographs data.

Ostracod assemblage	Molluscan assemblage
Ambostracon - Argilloecia - Cytheropteron assemblage	*Pecten - Chlamys* assemblage
Paijenborchella - Palmoconcha- Urocythereis pohangensis assemblage	*Macoma - Cultellus* assemblage

Table 2. Correspondence of ostracod assemblages and molluscan assemblages of Sakanoue (2000).

the Omori Formation (this study) and 10 samples (A1, 11, 14, 15, 16, 17, 18, 19, 20 and B1) are from the Fujina Formation (Tanaka et al. 2002).

Fossil and Recent ostracod assemblages often undergoes selective preservation and transportation by the function of each ostracod valves and their depositional environments (e.g. Irizuki et al. 1999). Those altered assemblages are, therefore, will not show normal distributions. To verify this, I used the principal components analysis based on the propotional similarity index (cos θ) and the covariance matrix, and a VBA program which is modification of Uchida (1996) was used.

Appendix 2 shows that the first four components explain more than 80% of the total variance, and may be sufficient for evaluating the characteristic of ostracod assemblage in each sample horizon.

The first explains 42.75% of total variance. *Acanthocythereis koreana* (score= +90.12), *Palmoconcha irizukii* (score= +71.29), *Paijenborchella* cf. *tsurugasakensis* (score= +67.30), *Kotoracythere tsukagoshii* (score= +44.92) and *Urocythereis pohangensis* (score= +33.59) have high positive scores, and these are characteristic species from the lower member to the lowermost part of the upper member of the Fujina Formation (Tanaka et al. 2002). PC 1 only shows the high positive correlation with the samples from the lower member to the lowermost part of the upper member of the Fujina Formation (A1, 11, 14, 15, 16, 17, 18, 19 and 20). Thus the first component shows characteristic assemblage from the lower member to the lowermost part of the upper member of the Fujina Formation.

The second component explains 30.04% of the total variance. *Ambostracon* cf. *ikeyai* (score= +120.64), *Cytheropteron shimanense* (score= +27.70), *Schizocythere sakanouei* (score= +21.88), *Cytheropteron sawanense* (score= +20.78) and *Argilloecia* cf. *symmetrica* (score= +18.80) have high positive scores. *A. koreana* (score= -7.29), *P.* cf. *tsurugasakensis* (score= -3.85) and *K. tsukagoshii* (score= -3.74) have high negative

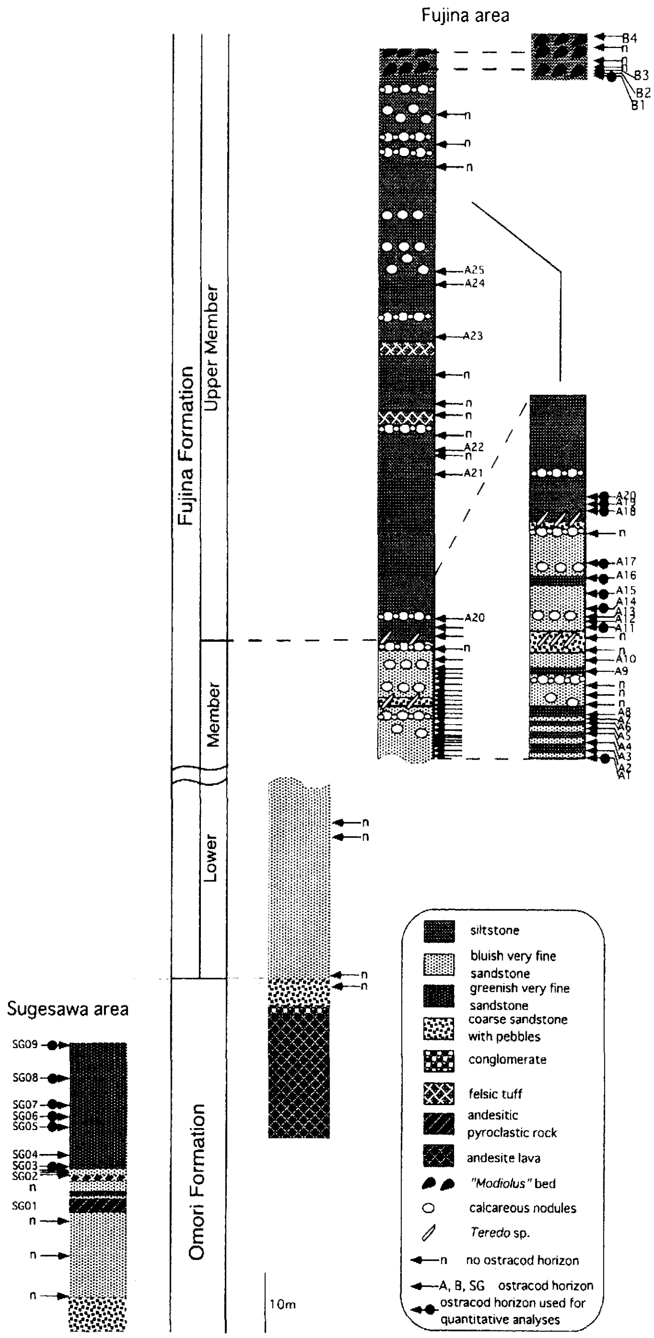

Fig. 6. Columnar sections of the Omori and Fujina Formations. Columnar sections from the Fujina area were quoted from Tanaka et al. (2000, 2002).

scores. Those species having high positive scores characterize the *Ambostracon-Argilloecia-Cytheropteron* assemblage of the Omori Formation (SG03, 05, 06, 07, 08 and 09), and those negative scores characterize the assemblage of the lower member to lowermost part of the upper member of the Fujina Formation (Tanaka et al. 2002). PC 2 only shows the high positive correlation with the samples from the Omori Formation, therefore, this component explains the assemblage from the Omori Formation.

The third component explains 6.92% of the total variance. *Laperousecythere ikeyai* (score= +12.81), *Acanthocythereis izumoensis* (score= +5.53) and *Robertsonites reticuliformus* (score= +2.78) have high positive scores. *L. ikeyai* and *A. izumoensis* are extinct species, and only known from the Omori and Fujina Formations so far. *R. reticuliformus* often occurs with sublittoral species such as *Cythere*, *Cornucoquimba*, *Krithe*, *Loxoconcha*, *Munseyella* and *Schizocythere* during the Middle Miocene (Ishizaki 1966 ; Huh and Paik 1992b). *P.* cf. *tsurugasakensis* (score= -31.79), *P. irizukii* (score= -19.82) and *K. tsukagoshii* (score= -12.49) have high negative scores. *P.* cf. *tsurugasakensis* occurs throughout the horizon of the Fujina Formation, and in the upper member of the formation, occurs with the ostracod assemblage which characterizes upper slope of the Recent Japan Sea such as *A. dunelmensis*, *Robertsonites* and *Cluthia* (Tanaka et al. 2002). *P. irizukii* and *K. tsukagoshii* indicate bay environment (Irizuki and Matsubara 1994).

Thus the third component is interpreted as the depositional environment (positive=sublittoral ; negative=bay or upper slope).

The fourth component explains 5.72% of the total variance. *Robertsonites yatsukanus* (score= +13.08), *Laperousecythere ikeyai* (score= +10.83) and *Acanthocythereis dunelmensis* (score= +9.44) have high positive scores. *R. yatsukanus* and *L. ikeyai* are extinct species. *A. dunelmensis* is, however, extant species, and distributed from middle- to high-latitude regions of the Northern Hemisphere. This species is now distributed on the lower continental shelf to the slope in the Japan Sea region (Ishizaki and Irizuki 1990 ; Ikeya and Suzuki 1992 ; Ozawa and Kamiya 2001). *P. irizukii* (score= -27.23), *P.* cf. *tsurugasakensis* (score= -16.79), *K. tsukagoshii* (score= -8.20) and *A. koreana* (score= -8.10) have negative high scores. Those species having high negative scores are only distributed around the Japanese Islands since Miocene and indicate the cool-temperate and temperate bay environment (Irizuki and Matsubara 1994 ; Tanaka et al. 2002).

Thus the fourth component is interpreted as a function of relative water depth (positive=deep; negative=shallow).

Discussion and conclusion

The ostracods from the Fujina and Omori Formations provide important paleoenvironmental data for the Miocene Proto-Japan Sea. Fig. 7 shows the factor loadings of samples from the Omori and Fujina Formations on the first (PC 1) and second (PC 2) components. All of the samples from the Omori Formation (SG-number) only show the high positive correlation with the PC 2. The second component is characterized by the species which compose the *Ambostracon-Argilloecia-Cytheropteron* assemblage. These species have been distrib-

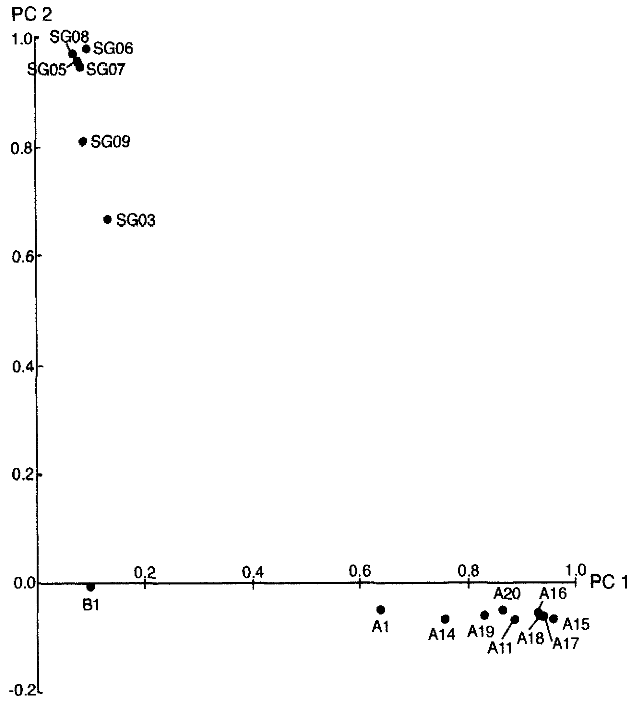

Fig. 7. Plots of samples on first and second factor loadings. Each sample number in figure corresponds as follows : SG-number (= Omori Formation, this study), A-number (= the lower member and lowermost upper member of the Fujina Formation, Tanaka et al. 2002), B-number (= the upper member of the Fujina Formation, Tanaka et al. 2002). Value of each factor loading of sample are listed in Appendix 2.

uted from the South China Sea to Japan since Miocene (Fig. 5). In Miocene, the occurrence of *A. ikeyai* is restricted within Southwest Japan and its adjacent area (Yajima 1988 ; Huh and Paik 1992a, b). *A. symmetrica* is reported from the Recent sediments (70-206 m depth) of the East China Sea (Wang et al. 1988). *C. uchioi* occurs from the Recent sediments between 30 and 986 m depth (Wang et al. 1988 ; Ikeya and Suzuki 1992 ; Zhou 1995 ; Tsukawaki et al. 1998, 1999, 2000). Thus it is thought that the Omori Formation was deposited under the warm open sublittoral environment such as the Recent East China Sea and/or the southwestern part of the Japan Sea.

All the samples from the lower member to the lowermost part of the upper member of the Fujina Formation (A-number) only show positive correlation with the PC 1. The extinct species such as *A. koreana*, *P. irizukii*, *P.* cf. *tsurugasakensis*, *K. tsukagoshii* and *U. pohangensis* have high positive scores. In the Miocene, *A. koreana* and *U. pohangensis* occur from the southwestern part of the Japan Sea side, and *P. irizukii*, *P.* cf. *tsurugasakensis* and *K. tsukagoshii* occur from the Honshu (Tanaka et al. 2002). In the Miocene deposits of Korea, *A. koreana* and *U. pohangensis* occur with the circumpolar species such as *Munseyella hatatatensis* and *Palmenella limicora*, and indicate stable cold shallow sea environment (Huh and Paik 1992b). *P. irizukii* and *K. tsukagoshii* are the temperate species and it is thought that these species adapted to colder environments during the Miocene in the Japan Sea area (Tanaka et al. 2002). *P. irizukii* and *K. tsukagoshii* indicate the stable bay environment (Irizuki and Matsubara 1994). Thus it is thought that the Fujina Formation was deposited under the cool open sublittoral or the cool bay environment during the deposition between the lower member and the lowermost part of the upper member.

Sample B1 from the upper member of the Fujina Formation does not show the correlation with the PC 1 and the PC 2, however, it shows negative and positive correlation with the PC 3 and the PC 4 respectively (Appendix 2). The B 1 sample is dominated by the circumpolar and the cryophilic species such as *A. dunelmensis* and *Acanthocythereis. tsurugasakensis* (Tanaka et al. 2002). This data indicates that the upper member of the Fujina Formation was deposited under the cold upper slope environment.

Thus, it is suggested that the bottom water condition of the Omori and the Fujina Formations generally became deeper (colder) and deeper (colder) towards the upper horizons of the Fujina Formation.

Based on the stratigraphic correlation in the San'in district, Takayasu et al. (1992) recognized the Omori Stage (14.5-14Ma) and the Fujina Stage (14-12 Ma). They pointed out that colder molluscan species in these stages increased toward the end of the Fujina Stage. On the basis of foraminiferal oxygen isotopic data, Kim (1999) pointed that the Pohang Basin sequence (Southeast Korea) shows a decrease in isotopic temperatures from 14.5 to 14 Ma. The cooling event of the Proto-Japan Sea in 14.5-14 Ma coincides with global cooling event between 14.5 and 14 Ma manifested by the sharp increase in benthic and planktonic foraminiferal oxygen isotopic values (Miller et al. 1987). Sakanoue (2000) reported the molluscan assemblages such as *Callista-Mercenaria* and *Macoma-Cultellus* assemblages from the Sugesawa area (=this study area). These assemblages indicate the sublittoral environment under the cold water current. The *Macoma-Cultellus* assemblage corresponds to the *Paijenborchella-Palmoconcha-Urocythereis pohangensis* assemblage, and the ostracod assemblage indicates the cool sublittoral environment.

In the same area, however, Sakanoue (2000) reported the *Pecten-Chlamys* assemblage which indicates the warm open sublittoral environment. This assemblage corresponds to the *Ambostracon-Argilloecia-Cytheropteron* assemblage, and the ostracod assemblage also indicates the same paleoenvironmental condition with the molluscan assemblage.

Otofuji et al. (1991) stressed that more than 80% of the clockwise rotation of the Japanese Islands was completed between 16.1 and 14.2 Ma. Nomura (1992) recognized the differential regional uplifting and deepening between the deposition of the Kuri and Omori Formations, and he assumed that these tectonics were correlated with the opening of the Japan Sea. Therefore, during the period of deposition of the Omori Formation, the bottom environment of the Proto-Japan Sea appears to have been controlled by regional tectonics of the Japanese region in combination with global climatic changes. The temporal occurrence of the warm-water ostracods may indicate that the paleo-Tsushima warm-water current flowed in the Proto-Japan Sea during a period of global cooling time. The paleo-Tsushima warm-water current of this period was enough strong to influence the sublittoral benthic ostracods.

After 14 Ma, cold surface waters became dominant in the Japan Sea, but periodic inflows of warm surface waters continued (Tada 1994). The presence of warm-water cephalopod species in several horizons of the Fujina Formation also suggests the influence of a warm-water current (Sakumoto et al. 1996). In this period, the benthic ostracod assemblages are characterized by prominent circumpolar and cryophilic species. The paleo-Tsushima warm-water current of this period was not enough strong to influence the sublittoral and the upper slope benthic ostracods.

Systematic descriptions

All the illustrated specimens are deposited in the collections of the Shizuoka University Museum (SUM-CO-Number). The following abbreviations are used in this paper : CC : complete carapace, RV : right valve, LV : left valve, L : length, H : height, W : width.

Order Podocopida Sars, 1866
Superfamily Cypridoidea Baird, 1845
Family Pontocyprididae G. W. Müller, 1894
Genus ***Argilloecia*** Sars, 1866

Argilloecia cf. ***symmetrica*** Zhao, 1988
Fig. 4f

Argilloecia symmetrica Zhao, 1988, p. 232, 233, pl. 36, figs. 19-21, fig. 5-73.

Remarks : This species was described from the Recent sediments, East China Sea by Zhao (1988). Specimens from the Omori Formation slightly differ from the type specimen, in the shape of posterior area.

Superfamily Cytheroidea Baird, 1850
Cytherideidae Sars, 1925
Subfamily Krithinae Mandelstam, 1958
Genus ***Krithe*** Brady, Crosskey and Robertson, 1874
Krithe cf. ***antisawanensis*** Ishizaki, 1966
Fig. 4d

Krithe antisawanense Ishizaki, 1966[*sic*], p. 137, 138, pl. 18, figs. 17, 24 and 25.

Krithe antisawanensis Ishizaki. Gou et al., 1981, p.155, pl. 78, fig. 16 ; Ruan and Hao, 1988, p. 269, pl. 40, figs. 21-23; Ikeya and Suzuki, 1992, pl. 5, fig. 6 ; Zhou and Ikeya, 1992, p. 1111, 1112, figs. 9-4, 9-5.

Krithe sawanensis Hanai. Gou et al., 1981, p.155, pl. 77, figs. 18-22, pl. 78, fig. 15, pl. 92, fig. 14 ; Gou et al., 1983, p.34, pl. 6, figs. 1-13, text-fig. 8 ; Wang et al., 1988, p. 243, pl. 42, figs., 1, 2.

Remarks : This species was first described from the Miocene Hatatate Formation, Sendai by Ishizaki (1966). Specimens from the Omori Formation slightly differ from the type specimen, in the shape of posteroventral margin.

Family Eucytheridae Puri, 1954
Subfamily Pectocytherinae Hanai, 1957a
Genus ***Munseyella*** van den Bold, 1957
Munseyella cf. ***hokkaidoana*** (Hanai, 1957a)
Fig. 4i

"*Toulminia*" *hokkaidoana* Hanai, 1957a, p. 479, 481, pl. 11, figs. 2a, b, text-figs. 5a, b.

Munseyella hokkaidoana (Hanai). Hanai, 1961, p. 362, Text-fig. 6, figs. 3a, b; Ishizaki, 1966, p. 153, pl. 19, fig. 13; (not) Kamiya et al., 1996, pl. 2, fig. 2; Kamiya et al., 2001, pl. 16, fig. 4.

Remarks : This species was first described from the Upper Pliocene Setana Formation, Hokkaido by Hanai (1957a). Specimens from the Omori Formation slightly differ from the type specimen, in the shape of evenly rounded anterior margin.

Family Cytheridae Baird, 1850
Subfamily Schizocytherinae Mandelstam, 1960
Genus ***Schizocythere*** Triebel, 1950
Schizocythere sakanouei Tanaka sp. nov.
Figs. 8a-h, 9q and 9u

Etymology : In honor of Hajime Sakanoue, who gave me information about type locality of this species.

Types : Holotype, CC male, SUM-CO-1360 (L=0.67mm, H=0.39mm, W=0.34mm). Paratypes, CC female, SUM-CO-1361 (L=0.69mm, H=0.40mm, W=0.35mm) ; LV male, SUM-

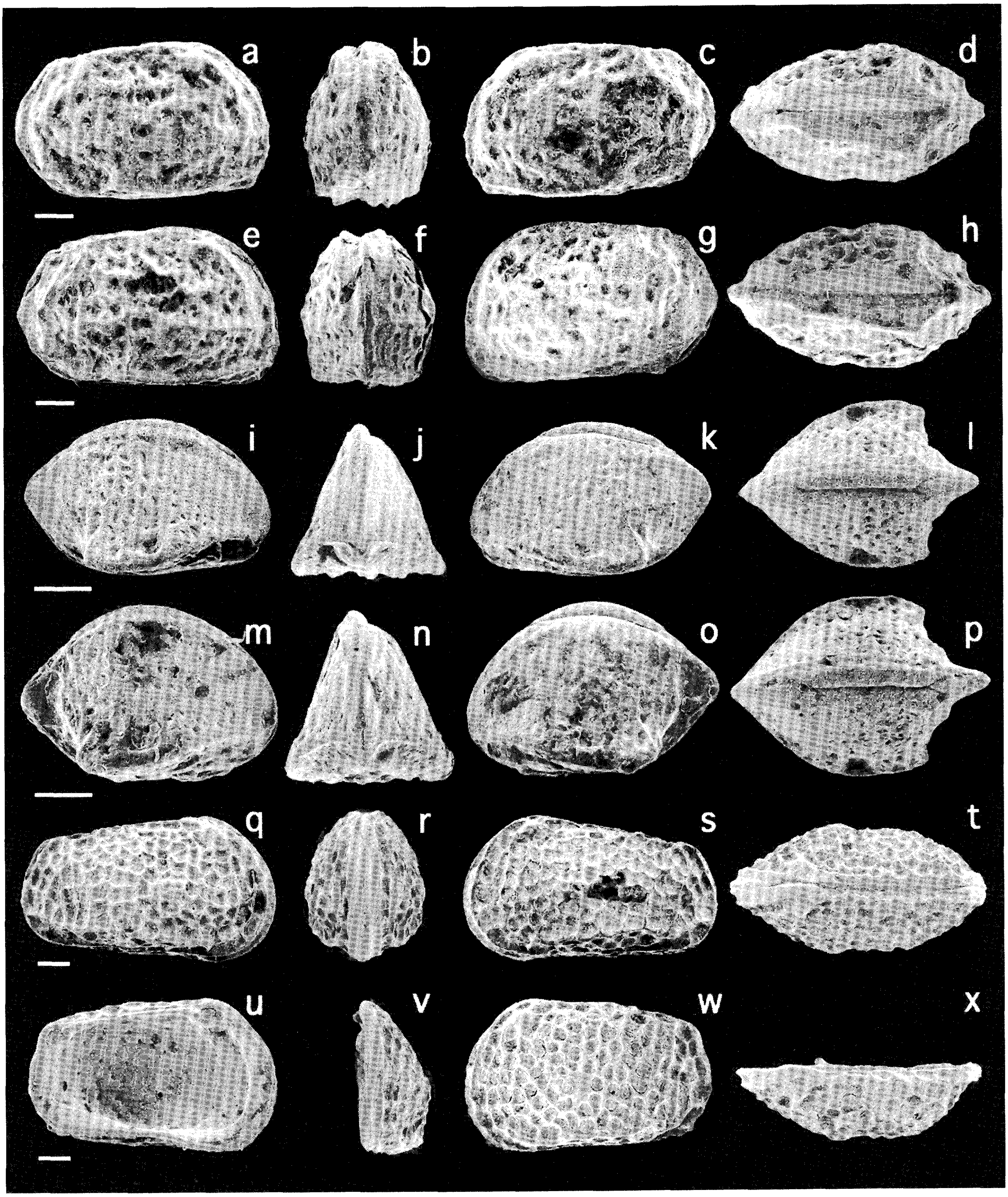

Fig. 8. SEM photographs of new species.
a-h, *Schizocythere sakanouei* Tanaka sp. nov. a-d : holotype, CC male, SUM-CO-1360, Sample SG03. e-h : paratype, CC female, SUM-CO-1361, Sample SG06. i-p, *Cytheropteron shimanense* Tanaka sp. nov. i-l : holotype, CC male, SUM-CO-1362, Sample SG08. m-p : paratype, CC female, SUM-CO-1363, Sample SG06. q-x, *Urocythereis sugesawensis* Tanaka sp. nov. q-t : holotype, CC male, SUM-CO-1364, Sample SG09. u-x : paratype, LV female, SUM-CO-1365, Sample SG09. Scale bar is 0.10mm.

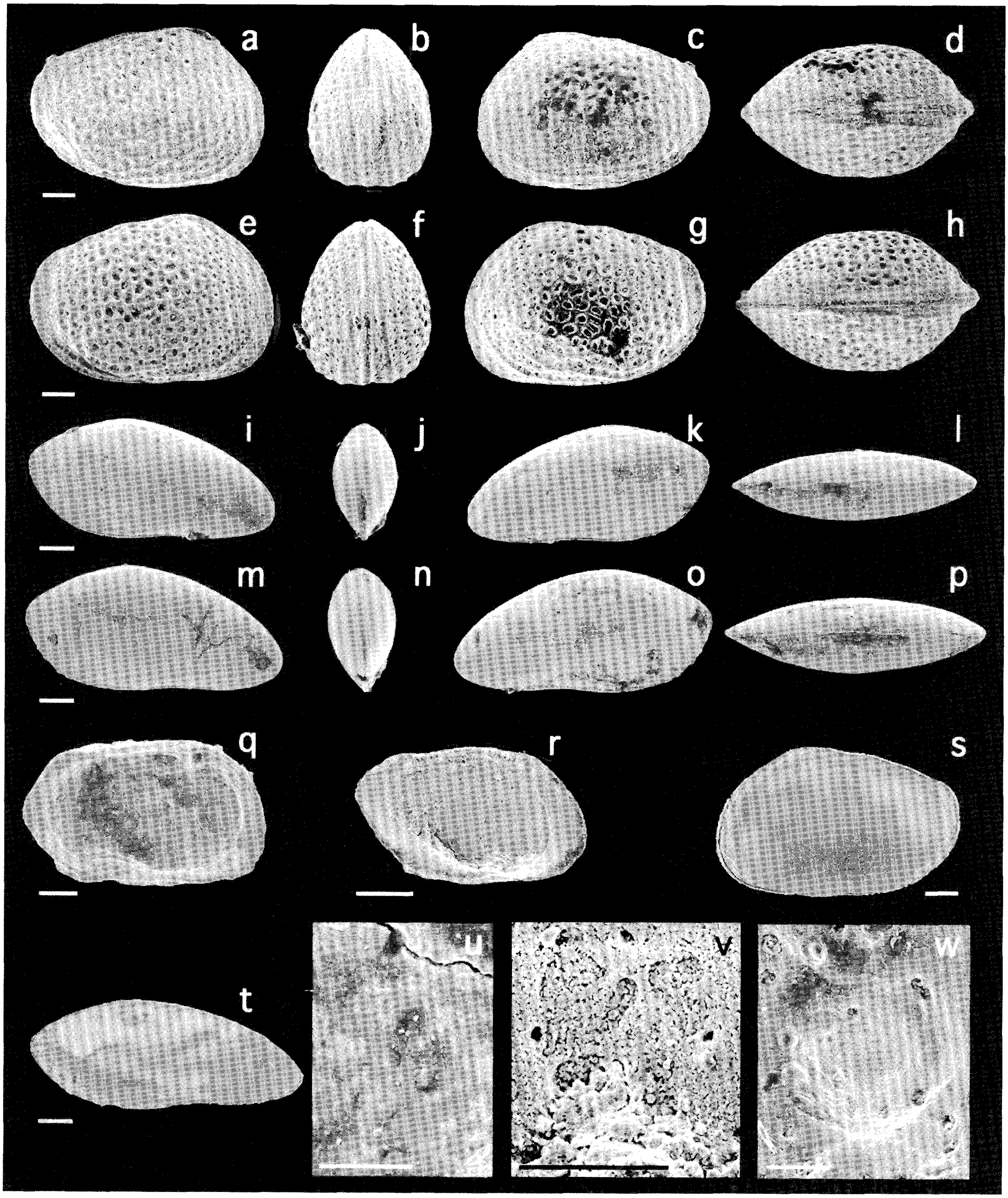

Fig. 9. SEM (a-r and u-w) and transmitted optical (s and t) photographs of new species.
a-h and s, *Loxoconcha izumoensis* Tanaka sp. nov. a-d : holotype, CC male, SUM-CO-1366, Sample SG06. e-h : paratype, CC female, SUM-CO-1367, Sample SG08. s : paratype, CC female in the left lateral view, SUM-CO-1368, Sample SG08. i-p and t, *Paradoxostoma yakumotatsunus* Tanaka sp. nov. i-l : holotype, CC small form (male?), SUM-CO-1369, Sample SG09. m-p : paratype, CC large form (female?), SUM-CO-1370, Sample SG09. t : paratype, CC small form (male?) in the right lateral view, SUM-CO-1371, Sample SG09. q and u, *Schizocythere sakanouei* Tanaka sp. nov., paratype, LV male , SUM-CO-1372, Sample SG09. r and v, *Cytheropteron shimanense* Tanaka sp. nov., paratype, LV male, SUM-CO-1373, Sample SG08. w, *Urocythereis sugesawensis* Tanaka sp. nov., paratype, adductor muscle scars of LV female, SUM-CO-1374, Sample SG09. Scale bar is 0.05mm for a-h, u and w ; 0.10mm for i-t, 0.03mm for v.

CO-1372 (L=0.66mm, H=0.37mm).

Type locality : Uppermost part of the Omori Formation, Sample SG03 (35°20.58'N, 132°46.25'E).

Diagnosis : Valve subquadrate in lateral view. dorsal and ventral margin straight. A strong carinal ridge, bifurcating in mid-ventral area and running into posteromedian area. Four adductor scars (the upper three are elliptical, the lowermost one is semicircular).

Description : Valve subquadrate in lateral view. Anterior margin evenly rounded with infracurvature; dorsal margin straight; posterior margin triangular, slightly concave in upper half and slightly convex in lower half; ventral margin straight. Sexual dimorphism prominent; in lateral view, male forms more elongate; in dorsal view, female forms have more inflated carapace in the anteroventral and posteroventral areas. Eye spot large and protruding. A weak carinal ridge occurs at the anterodorsal part of eye spot, runs nearly parallel to anterior margin, and ends at anteromedian area. A strong short carinal ridge, arising from anteromedian area, runs to the posteromedian area. A strong carinal ridge starting at the anteroventral area, bifurcating in mid-ventral area and running into posteromedian area. Surface ornamented by irregular reticulations between carinal ridges. In dorsal view, carapace subhexagonal ; lateral outline sinuate, widest in the posteromedian area. In anterior view, carapace subhexagonal, broadest at point near mid-height. Marginal zone relatively broad anteriorly and posteriorly. Selvage well developed. Hinge schizodont : In LV, anterior element has an auxiliary tooth in a large elongate socket ; anteromedian element is a tooth, posteromedian element is a crenulate bar; posterior element is an elongate socket. One elongate elliptical frontal scar. A row of four adductor scars are nearly vertical in a gentle curve, convex side to the posterior (the upper three are elliptical, the lowermost one is semicircular). One elongate elliptical mandibular scar. Frontal and mandibular scars are very difficult to see. Prominent fulcral point.

Remarks: This species differs from *S. okhotskensis* Hanai, 1970 reported from the Recent sediment of Okhotsk Sea, in its outline and more irregular ornamentation. The present species is distinguished from *S. hatatatensis* Ishizaki, 1966 from the Miocene Hatatate Formation, the north Japan, in its straight ventral margin and lack of posteroventral spine. *S. sakanouei* sp. nov. also differs from *S. kishinouyei* (Kajiyama, 1913), in its elongate lateral outline, the outline of the anterior margin and weak anterodorsal carinal ridge.

Family Cytheruridae G. W. Müller, 1894
Subfamily Cytherurinae G. W. Müller, 1894

Genus ***Eucytherura*** G. W. Müller, 1894
Eucytherura poroleberis Zhao, 1988
Fig. 4a

Eucytherura poroleberis Zhao, 1988, p. 261, pl. 50, figs. 15-18 ; Ruan and Hao, 1988, p. 290, pl. 49, figs. 13, 14.

Eucytherura neoalae Ishizaki. Gou et al., 1981, p. 160, pl. 79, figs. 14-16.

Eucytherura sp. Ishizaki, 1981, p. 50, 51, pl. 10, figs. 10, 11a, b, pl. 11, figs. 1, 2, 5, pl. 14, figs. 9, 10, pl. 15, fig. 7; Ikeya and Suzuki, 1992, p. 114.

Genus ***Semicytherura*** Wagner, 1957
Semicytherura hanaii Ishizaki, 1981
Fig. 4b

Semicytherura hanaii Ishizaki, 1981, p. 55,56, pl. 11, figs. 11, 12, pl. 12, figs. 1-4, pl. 13, figs. 8, 9, pl. 14, fig. 3; Wang and Zhao, 1985, pl. 8, fig. 11; Ruan and Hao, 1988, p. 302, pl. 53, figs,1-3; Wang et al., 1988, p. 262, pl. 51, figs. 1, 2.

Kangarina nanhaiensis Gou, 1981, p. 160, pl. 79, figs. 12, 13.

Subfamily Cytheropterinae Hanai, 1957b
Genus ***Cytheropteron*** Sars, 1866

Cytheropteron shimanense Tanaka sp. nov.
Figs. 8i-p, 9r and 9v

Etymology : The prefecture name, Shimane, of the type locality.

Types : Holotype, CC male, SUM-CO-1362 (L=0.42mm, H=0.24mm, W=0.27mm). Paratypes, CC female, SUM-CO-1363 (L=0.44mm, H=0.28mm, W=0.29mm) ; LV male, SUM-CO-1373 (L=0.39mm, H=0.22mm).

Type locality : Uppermost part of the Omori Formation, Sample SG08 (35°20.60'N, 132°46.28'E).

Diagnosis : Valve subrhomboidal in lateral view. Surface ornamented by scattered fossae; a broad, rounded carinal ridge occurs at the anteroventral margin, runs along the edge of ala.

Description : Valve subrhomboidal in lateral view. Anterior margin evenly rounded with infracurvature; dorsal margin arched; posterior margin angular, making nearly a right angle with dorsal margin; ventral margin nearly straight. Sexual dimorphism prominent; in lateral view, male forms more elongate; in dorsal view, female forms have more inflated carapace in the anteroventral area. Eye spot not observed. Surface ornamented by scattered fossae. A broad, rounded carinal ridge occurs at the anteroventral margin, runs along the edge of ala. In dorsal view, carapace is an arrowhead-shaped. In anterior view, carapace subtriangular, broadest at the carinal ridge. Marginal zone broad anteriorly and posteriorly. Selvage well developed. Hinge antimerodont: In LV, anterior element has three sockets; median element consists of about 20 teeth; posterior element has some sockets. One V-shaped frontal scar. A row of four adductor scars in a vertical row (the uppermost one is semicircular, the middle two are elliptical. The lowermost one not observed). Mandibular scar not observed. Fulcral point not observed.

Remarks : This species differs from *C. sawanense* Hanai, 1957b reported from the Upper Pliocene Sawane Formation, Sado Island, in its elongate outline and not bifurcated murus. The present species is distinguished from *C. postornatum* Zhao, 1988 from the Recent sediments of East China Sea, in its murus occurs at the anteroventral margin and outline of posterior margin.

Family Hemicytheridae Puri, 1953
Subfamily Hemicytherinae Puri, 1953
Genus ***Ambostracon*** Hazel, 1962
Ambostracon cf. ***ikeyai*** Yajima, 1978
Fig. 4h

Ambostracon ikeyai Yajima, 1978, p. 394,395, pl. 49, figs. 5a-c, pl. 50, figs. 1, 2, text-fig. 7, figs. 2a, b ; Yajima, 1988, pl. 1, fig. 4, pl. 2, fig. 13 ; Ikeya and Itoh, 1991, p. 108, fig. 10A ; Huh and Paik, 1992a, pl. 2, fig. 1 ; Huh and Paik, 1992b, pl. 2, fig. 1; Yajima, 1992, p. 263, pl. 32, fig. 11.

Remarks : This species was first described from the Upper Pleistocene Narita Formation, Central Japan by Yajima (1978). Specimens from the Omori Formation slightly differ from the type specimen, in the shape of evenly rounded anterior margin.

Subfamily Urocythereidinae Hartmann and Puri, 1974
Genus ***Urocythereis*** Ruggieri, 1950
Urocythereis sugesawensis Tanaka sp. nov.
Figs. 8q-x and 9w

Etymology : For the type locality.

Types : Holotype, CC male, SUM-CO-1364 (L=0.79mm, H=0.42mm, W=0.38mm). Paratypes, LV female, SUM-CO-1365 (L=0.77mm, H=0.45mm); LV female, SUM-CO-1374 (L=0.78mm, H=0.45mm).

Type locality : Uppermost part of the Omori Formation, Sample SG09 (35°20.61'N, 132°46.30'E).

Diagnosis : Valve subquadrate in lateral view. Surface ornamented by polygonal reticulations; two posterior ridges run obliquely toward at posteroventral area. Two circular frontal scars.

Description : Valve subquadrate in lateral view. Anterior margin evenly rounded; dorsal margin straight, sloping gently toward posterior; posterior margin evenly rounded; ventral margin nearly straight. Large sexual dimorphism; in lateral view, male forms more elongate; in dorsal view, female forms have inflated carapace in the posteroventral area. Eye spot large and flat. Surface ornamented by polygonal reticulations. Two posterior ridges run obliquely toward at posteroventral area. In dorsal view, lateral outline nearly straight; anterior end more pointed than posterior. In anterior view, carapace subovate, broadest at point near mid-height. Marginal zone relatively broad. Selvage well developed. Hinge holamphidont : in LV, anterior element has a large ovate socket; anteromedian element is a smooth tooth, posteromedian element is a bar; posterior element is an elongate socket. Two circular frontal scars. Four circular/elliptical adductor scars; the middle two are subdivided. One elliptical mandibular scar. Prominent fulcral point. Ocular sinus conspicuous.

Remarks : This species differs from *U. pohangensis* Huh and Whatley, 1997 reported from the Miocene Yeonil Group, Korea, in its evenly rounded posterior margin. The present species is distinguished from *U. gorokuensis* Ishizaki, 1966 from the Pliocene Tatsunokuchi Formation, the north Japan, in its two posterior ridges run obliquely toward at posteroventral area and evenly rounded posterior margin.

Family Loxoconchidae Sars, 1926
Genus ***Loxoconcha*** Sars, 1866
Loxoconcha izumoensis Tanaka sp. nov.
Figs. 9a-h and 9s

Etymology : Izumo is the ancient provincial name of the type locality.

Types : Holotype, CC male, SUM-CO-1366 (L=0.36mm, H=0.24mm, W=0.19mm). Paratypes, CC female, SUM-CO-1367 (L=0.38mm, H=0.24mm, W=0.20mm); CC female, SUM-CO-1368 (L=0.37mm, H=0.25mm, W=0.20mm).

Type locality : Uppermost part of the Omori Formation, Sample SG06 (35°20.60'N, 132°46.27'E).

Diagnosis : Valve rhomboidal. Dorsal margin straight, sloping toward posterior. Surface ornamented by punctations and rounded fossae. Two concentric muri occur in the anteroventral area, convex posteroventrally in the posteroventral area, ends at mid-posterior area. In dorsal view, widest in the posteromedian area.

Description : Valve rhomboidal in lateral view. Anterior margin evenly rounded; dorsal margin straight, sloping toward posterior; posterior margin truncated obliquely in upper half and lower half making blunt angle slightly above mid-height; ventral margin nearly straight to slightly convex. Sexual dimorphism weak. Eye spot small and flat. Surface ornamented by punctations in the anterior and posterior areas, rounded fossae in the median area. Two concentric muri occur in the anteroventral area, convex posteroventrally in the postero-ventral area, ends at mid-posterior area. In dorsal view, carapace ovate, widest in the posteromedian area. In anterior view, carapace subovate, broadest a little below mid-height. Marginal zone relatively broad.

Remarks : This species differs from *Loxoconcha subkotoraforma* Ishizaki, 1966 from the Miocene Hatatate Formation, the north Japan, in its outline of anterior margin and punctations in the anterior and posterior areas.

Family Paradoxostomatidae Brady and Norman, 1889
Subfamily Paradoxomatinae Brady and Norman, 1889
Genus ***Paradoxostoma*** Fischer, 1855
Paradoxostoma yakumotatsunus Tanaka sp. nov.
Figs. 9i-p and 9t

Etymology : "Yakumo-tatsu", a poetic epithet modifies Izumo in a traditional Japanese poetry.

Types : Holotype, CC small form (male?), SUM-CO-1369 (L=0.76mm, H=0.34mm, W=0.20mm). Paratypes, CC large form (female?), SUM-CO-1370 (L=0.79mm, H=0.36mm, W=0.22mm); CC small form (male?), SUM-CO-1371 (L=0.76mm, H=0.34mm, W=0.21mm).

Type locality : Uppermost part of the Omori Formation, Sample SG09 (35°20.61'N, 132°46.30'E).

Diagnosis : Valve elongate subrhomboidal in lateral view. Anterior margin narrowly rounded extremities. In dorsal view, carapace elongate subovate, anterior end more pointed than posterior. Marginal zone broad.

Description : Valve elongate subrhomboidal in lateral view. Anterior margin narrowly rounded extremities; dorsal margin abruptly arched behind the mid-length; posterior margin truncated dorsally and evenly arched ventrally; ventral margin concave. Sexual dimorphism weak; in lateral view, small forms smaller; in anterior view, large forms are more inflated. Eye spot not observed. In dorsal view, carapace elongate subovate, anterior end more pointed than posterior. In anterior view, carapace subovate, pointed in ventral. Marginal zone broad.

Remarks : This species differs from *P. tabulata* Guan, 1978 reported from the Pliocene boring core samples from Leizhou Peninsula and Hainan Island, South China, in its posteroventral outline. The present species is distinguished from *P. sohni* Okubo, 1980 from the Recent samples, the Inland Sea, Japan, in its more protrude anterior.

Acknowledgements

The author expresses sincere thanks to K. M. Satish (Shizuoka University) for reading manuscript. I thank Hajime Sakanoue (Matsue City) for his generous help in collecting the samples and his information about the study area. I thank T. Irizuki and an anonymous reviewer of *Earth Science (Chikyu Kagaku)* made helpful comments for improvement of this paper. This study has been partly subsidized by the Grant-in-Aids for JSPS Research Fellow (No. 08594 in 2003).

References

Baird W (1845) Arrangement of the British Entomostraca, with a list of species, particularly noticing those which have as yet been discovered within the bounds of the Club. Berwickshire Naturalists Club (History) Proceedings : 145-148.

Baird W (1850) The natural history of the British Entomostraca. Ray Society, London, 364p.

Brady GS, Crosskey HW and Robertson D (1874) A Monograph of the Post-Tertiary Entomostraca of Scottland (including species from England and Ireland). Palaeontographical Society, vol. 24, no.1874 : 1-232.

Brady GS and Norman AM (1889) A Monograph of marine and freshwater Ostracoda of the North Atlantic and of Northwestern Europe. Section 1, Podocopa. Scientific Transactions of the Royal Dublin Society, Ser 2, vol. 4, no. 2 : 63-270.

Cao MZ (1998) Ostracods from the Quaternary Kengkou Formation, Liyu-men, Hong Kong. In Li ZM, Chen JH and He GX eds, Fossils and Geology of Hong Kong : 171-183, Science Press, Beijing, China.*

Cheong HK, Lee EH, Paik KH and Chang SK (1986) Recent ostracodes from the southwestern slope of the Ulleung Basin, East Sea, Korea. Jour Paleont Soc Korea, vol. 2, no. 1 : 38-53.

Fischer S (1855) Beitrage zur Kenntnis der Ostracoden. Abhandlungen der Physikalischen Classe der Koeniglich-Bayerischen Akademie der Wissenschaften, 7 : 635-665.[4)]

Gou YX, Chen TC, Guan SZ, Jiang YW, Liu ZY, Lai XH, Wu QJ and Chen CY (1981) 2 Ostracoda. In Hou YT ed, Tertiary palaeontology of north continental shelf of South China Sea : 138-187, Guangdong Science and Technology Press, Guangzhou, China.*

Hanai T (1957a) Studies on the Ostracoda from Japan, II. Subfamily Pectocytherinae, new subfamily. Jour Fac sci, Univ of Tokyo, Sec 2, vol. 10, pt. 3 : 469-482.

Hanai T (1957b) Studies on the Ostracoda from Japan, III. Subfamilies Cytherurinae G. W. Muller (emend. G. O. Sars 1925) and Cytheropterinae n. subfam. Jour Fac Sci, Univ of Tokyo, Sec II, vol. 11, pt. 1 : 11-36.

Hanai T (1961) Studies on the Ostracoda from Japan : Hingement. Jour Fac Sci, Univ of Tokyo, Sec 2, vol. 13, pt. 2 : 345-377.

Hanai T and Yamaguchi T (1987) Plio-Pleistocene Ostracod Fauna of Shimokita, Aomori Prefecture (Preliminary Report). Mem Nat Sci Mus, no. 20 : 45-51.[6)]

Hartmann G and Puri HS (1974) Summary of neontological and palaeontological classification of Ostracoda. Mitteilung aus dem hamburgischen zoologischen Museum und Institut, no. 70 : 7-73.

Hayashi K (1988) Pliocene-Pleistocene Palaeoenvironment and

Fossil ostracod fauna from Southwestern Hokkaido, Japan. In Hanai T, Ikeya N and Ishizaki K eds, Evolutionary Biology of Ostracoda, its Fundamentals and Applications : 557-568, Kodansha, Tokyo.

Hazel JE (1962) Two new hemicytherid ostracods from the lower Pleistocene of California. Jour Paleont, vol. 36, no. 4 : 822-826.

Hu CH (1978) Studies on Ostracodes from the Toukoshan Formation (Pleistocene), Miaoli District, Taiwan. Petroleum Geology of Taiwan, no. 15 : 127-166.

Hu CH (1983) Ostracoda from the Maanshan Mudstone, Hengchun Peninsula, Southern Taiwan. Petroleum Geology of Taiwan, no. 19 : 149-178.

Hu CH (1986) The Ostracodes from the Tungshiao Formation (Pleistocene), west coast of Miaoli district, Taiwan. Quarterly Journal of the Taiwan Museum, vol. 39, no. 1 : 99-174.

Huh M and Paik KH (1992a) Miocene Ostracoda from the Seojeongri Area, Pohang Basin, Korea. Jour Geol Soc Korea, vol. 28, no. 3 : 273-283.

Huh M and Paik KH (1992b) Miocene Ostracoda from the Pohang Basin, Korea. Paleont Soc Korea, Spec Publ, no. 1 : 101-119.

Huh M and Whatley R (1997) New species of Miocene cytheracean Ostracoda from the Pohang Basin, SE Korea. Jour Micropalaeont, vol.16, pt. 1 : 31-40.

Ikeya N and Itoh H (1991) Recent Ostracoda from the Sendai Bay region, Pacific coast of northeastern Japan. Rep Fac Sci Shizuoka Univ, 25 : 93-145.

Ikeya N and Suzuki C (1992) Distributional patterns of modern ostracodes off Shimane Peninsula, southwestern Japan Sea. Rep Fac Sci Shizuoka Univ, 26 : 91-137.

Irizuki T (1989a) Recent ostracode assemblages from Toyama Bay and off Noto Peninsula. In Arita M and Okamura Y eds, The study about submarine geology of the continental shelf around Southwest Japan, Report from the Geol Surv Japan : 137-144.[6]

Irizuki T (1989b) Fossil ostracode assemblages from the Pliocene Sasaoka Formation, Akita City, Japan-with reference to sedimentological aspects-. Trans and Proc Palaeont Soc Japan, New Ser, no. 156 : 296-318.

Irizuki T (1994) Late Miocene ostracods from the Fujikotogawa Formation, northern Japan-with reference to cold water species involved with trans-Arctic interchange. Jour Micropalaeont, vol. 13, part 1 : 3-15.

Irizuki T (1996) Lithology and Ostracoda from the Pliocene Tentokuji Formation along the southern marginal area of Mt. Taiheizan, Akita Prefecture, Northeast Japan. Bull Aichi Univ of Educ (Natural Science), 45 : 23-32.

Irizuki T, Fujiwara O and Fuse K (1999) Taphonomy of fossil ostracode assemblages in Holocene deposits on the Miura Peninsula, central Japan. Memoir Geol Soc Japan, no. 54 : 99-116.[7]

Irizuki T, Ishizaki K, Takahashi M and Usami M (1998) Ostracode faunal changes after the mid-Neogene climatic optimum elucidated in the Middle Miocene Kobana Formation, central Japan. Paleont Research, vol. 2, no. 1 : 30-46.

Irizuki T and Matsubara T (1994) Vertical changes of depositional environments in the Lower to Middle Miocene Kadonosawa Formation based on analyses of fossil ostracode faunas. Jour Geol Soc Japan, 100 : 136-149.[7]

Irizuki T and Matsubara T (1995) Early Middle Miocene ostracodes from the Suenomatsuyama Formation, Ninohe City, Northeast Japan and their paleoenvironmental significance. Trans and Proc Palaeont Soc Japan, New Ser, no. 177 : 65-78.

Ishizaki K (1966) Miocene and Pliocene Ostracodes from the Sendai Area, Japan. Sci Rep Tohoku Univ, Second Ser (Geology), vol. 37, no. 2 : 131-163.

Ishizaki K (1981) Ostracoda from the East China Sea. Sci Rep Tohoku Univ, Second Ser (Geology), vol. 51, nos. 1/2 : 131-163.

Ishizaki K (1983) Ostracoda from the Pliocene Ananai Formation, Shikoku, Japan -description-. Trans and Proc Palaeont Soc Japan, New Ser, no. 131 : 135-158.

Ishizaki K, Fujiwara O and Irizuki T (1996) Ostracod faunas from the Upper Miocene Tsunaki Formation near the southern border of Sendai City, Northeast Japan. Proc of the Second European Ostracodologists Meeting : 113-120.

Ishizaki K and Irizuki T (1990) Distribution of bathyal ostracodes in sediments of Toyama Bay, central Japan. Courier Forshungsinstitut Senckenberg, no. 123 : 53-67.

Ishizaki K and Matoba Y (1985) Excursion 6: Akita (Early Pleistocene cold shallow water Ostracoda). Guidebook of excursions for the 9th International Symposium on Ostracoda : 1-12, Shizuoka University Press, Shizuoka.

Kajiyama E (1913) The Ostracoda of Misaki (3). Zoological Magazine of Tokyo (Dobutsugaku-zassi), vol. 25, no. 291 : 1-16.[6]

Kamiya T and Nakagawa T (1993) Ostracode fossil assemblages in the Holocene Shell bed found in Takahama-Cho, Fukui Prefecture, central Japan. Bull Fukui Municipal Museum of Natural History, no. 1 : 115-133.[6]

Kamiya T, Ozawa H and Kitamura A (1996) Paleo-water mass structure during the deposition of middle part of the Omma Formation based on the change of ostracode assemblage. Hokuriku Geology Institute Report, no. 5 : 145-165.

Kamiya T, Ozawa H and Obata M (2001) Quaternary and Recent marine Ostracoda in Hokuriku district, the Japan Sea coast. In Organizing Committee of ISO 2001, 14th International Symposium on Ostracoda Guidebook (Field Excursion D) : 73-106. Shizuoka University Press.

Kano K and Nakano S (1985) Stratigraphic correlation of the Neogene in the San-in district, Southwest Japan, in the light of radiometric dating. Bull Geol Surv Japan, 36 : 427-438.[7]

Kano K, Takeuchi K and Matsuura H (1991) Geology of the Imaichi District. Quadrangle Series Scale 1:50,000, Okayama (12), no. 16. Geol Surv Japan, Tsukuba, 79p.[7]

Kano K, Yamauchi S, Takayasu K, Matsuura H and Bunno M (1994) Geology of the Matsue District. Quadrangle Series Scale 1:50,000, Okayama (12), no. 17, Geol Surv Japan, Tsukuba, 126 p.[7]

Kano K and Yoshida F (1984) Radiometric ages of the Neogene in centeral eastern Shimane prefecture, Japan, and their implications in stratigraphic correlation. Bull Geol Surv Japan, 35 : 159-170.[7]

Kim JM (1999) Early Neogene biochemostratigraphy of Pohang Basin: a paleoceanographic response to the early opening of the Sea of Japan (East Sea). Marine Micropaleontology, 36 : 269-290.

Maiya S and Inoue Y (1973) On the effective treatment of rocks for microfossil analysis. Fossils, nos. 25/26 : 87-96.[7]

Mandelstam NI (1958) In : Bubikyan SA., Ostracods of the Paleogene deposits of the Erivian Basin. Izvestiya Akademii Nauk Armyanskoy SSSR, (seriya Geologicheskii I Geograficheskii Nauk), vol. 11, no. 3 : 3-16.[10]

Mandelstam MJ (1960) Ostracoda. In Tschernysheva EN ed, Basic Paleontology, Arthropoda Volume : 264-421, State Scientific Technological Publishing House, Moskow.[10]

Miller KG, Fairbanks RG and Mountain GS (1987) Tertiary oxygen isotope synthesis, sea level history, and continental margin erosion. Paleoceanography, vol. 2, no. 1: 1-19.

Müller GW (1894) Die Ostracoden des Golfes von Neapel und der angrenzenden Meeresabschnitte. Fauna Flora des Golfes von Neapel. Monographie 21 : 1-404.[4)]

Nohara T (1981) Ostracodes of Pleistocene Naha Limestone, Okinawa-jima. Bull College of Educ, Univ of the Ryukyus, no. 25, part 2 : 35-47.

Nohara T (1987) Cenozoic Ostracodes of Okinawa-jima. Bull College of Educ, Univ of Ryukyus, no. 30, part 2 : 1-105.

Nohara T and Miyagi (1984) Notes on Nakoshi Sand of Northern Okinawa-jima. Bull College of Educ, Univ of the Ryukyus, no. 27, part 2 : 149-165.[7)]

Nohara T and Tabuki R (1985) Excursion 6: Okinawa Island (Plio-Pleistocene tropical and subtropical Ostracoda, and Ostracoda of Recent coral reef). Guidebook of excursions for the 9 th International Symposium on Ostracoda : 1-15, Shizuoka Univ Press, Shizuoka.

Nomura R (1992) Miocene benthic foraminifera from the Bihoku Group: The geologic age of the Foram. Sharp Line in Southwest Honshu and the relation to the opening of the Sea of Japan. Jour Geol Soc Japan, 98 : 587-610.

Nomura R and Maiya S (1984) Geologic age of the Fujina Formation, Shimane Prefecture, based on planktonic foraminifera. Memoirs of Natural and Cultural Researches of the San-in Region, Shimane Univ, no. 24 : 1-9.[6)]

Otofuji Y, Itaya T and Matsuda T (1991) Rapid rotation of South west Japan: Paleomagnetism and K-Ar ages of Miocene volcanic rocks of Southwest Japan. Geophys Jour International, 105 : 397-405.

Otofuji Y and Matsuda T (1984) Timing of rotational motion of Southwest Japan inferred from paleomagnetism. Earth and Planet Sci Lett, 70 : 373-382.

Ozawa H (1996) Ostracode fossils from the Late Pliocene to Early Pleistocene Omma Formation in Hokuriku district, central Japan. Sci Rep Kanazawa Univ, vol. 40, nos. 1/2 : 9-37.

Ozawa H, Ikehara K and Katayama H (1999) Recent ostracode assemblages from the northeastern Japan Sea and off northwestern Hokkaido. In Ikehara K and Okamura Y eds, The synthetic study about the environmental change in the area of sea around western Hokkaido, and the study about the evaluation method of the active fault in its area, Report from the Geol Surv Japan : 103-117. [6)]

Ozawa H and Kamiya T (2001) Palaeoceanographic records related to glacio-eustatic fluctuations in the Pleistocene Japan Sea coast based on ostracods from the Omma Formation. Palaeogeography, Palaeoclimatology, Palaeoecology, 170 : 27-48.

Ozawa H, Kamiya T and Tsukagoshi A (1995) Ostracode evidence for the paleoceanographic change of the Middle Pleistocene Jizodo and Yabu Formations in the Boso Peninsula, central Japan. Sci Rep Kanazawa Univ, vol. 40, no. 1 : 9-37.

Puri HS (1953) The ostracod genus Hemicythere and its allies. Washington Academy of Sciencecs Journal, vol. 43, no. 6 : 169-179.

Puri HS (1954) Contribution to the study of the Miocene of the Florida Panhandle. Pt. 3, Ostracoda. The Florida Geol Surv, Geol Bull, no. 36 : 215-345.

Ruan P and Hao Y (1988) 2. Ostracoda. In Research Party of Marine Geology, Ministry of Geology and Mineral Resources, Chinese University of Geosciences eds, Quarternary Microbiotas in the Okinawa Trough and their Geological Significance : 227-395, Geological Publishing House, Beijing, China.**

Ruggieri G (1950) Gli Ostracodi delle sabbie grigie quaternarie (Milaziano) di Imola. Parte 1. Giornale di Geologia, Annali del Museo Geologico di Bologna, Serie 2, vol. 21 : 1-58.*

Sakanoue H (2000) Miocene molluscan fossils from the Omori Formation, Sugesawa, Izumo City, Southwest Japan. Sci Rep Toyohashi Museum of Natural History, no. 10 : 13-21.[7)]

Sakumoto T, Seto K and Takayasu K (1996) Fossil cephalopods from the Middle Miocene Fujina Formation of southwest Japan and its paleoenvironmental significance. Earth Science (Chikyu Kagaku), 50 : 408-413.[7)]

Sars GO (1866) Oversigt af Norges marine Ostracoder: Forhandlinger I. Videnskabs-Selskabet Christiania, 8 : 1-130. [9)]

Sars GO (1925) An account of the Crustacea of Norway. Volume 9 – Ostracoda. Parts 11 and 12 Cytheridae (continued) : 177-208, Bergen Museum, Bergen.

Sars GO (1926) An Account of the Crustacea of Norway. Volume 9 – Ostracoda. Parts 13 and 14 Cytheridae (continued) : 209-240, Bergen Museum, Bergen.

Tabuki R (1986) Plio-Pleistocene Ostracoda from the Tsugaru Basin, North Honshu, Japan. Bull College of Educ, Univ of the Ryukyus, no. 29 : 27-160.

Tada R (1994) Paleoceanographic evolution of the Japan Sea. Palaeogeography, Palaeoclimatology, Palaeoecology, 108 : 487-508.

Takayasu K, Yamasaki H, Ueda T, Akagi S, Matsumoto T, Nomura R, Okada S, Sawada Y, Yamauchi S and Yoshitani A (1992) Miocene stratigraphy and paleogeography of San'in district, Southwest Japan. Memor Geol Soc Japan, no. 37 : 97-116.[7)]

Tanaka G, Seto K, Mukuda T and Nakano Y (2002) Middle Miocene ostracods from the Fujina Formation, Shimane Prefecture, Southwest Japan and their paleoenvironmental significance. Paleontological Research, vol. 6, no. 1 : 1-22.

Tanaka G, Seto K, Mukuda T, Nakano Y, Kitakaze K and Kosaka T (2000) Middle Miocene ostracods from the Fujina Formation. Abstracts with Programs, the 2000 Ann Meeting of the Geol Soc Japan : 29.[6)]

Tomita T and Sakai E (1937) Cenozoic geology of the Huzina-Kimati district, Izumo province, Japan: A contribution to the Igneous geology of the East–Asiantic province of Cenozoic Alkaline rocks. The Journal of the Shanghai Science Institute, Section 2, Geology, Palaeontology, Minelalogy and Petrology, 2 : 147-204.

Triebel E (1950) Homomorphe Ostracoden-Gattungen. Senckenbergiana Lethaea, vol. 31, nos. 5/6 : 313-330. [4)]

Tsukawaki S, Kamiya T, Ozawa H and Kato M (1998) Preliminary Results on the Sediment Samplings during the R. V. Tansei-maru Cruise KT96-17 Leg 2 in the Southwestern Part of the Japan Sea-Sediments, Benthic Foraminifers, and Ostracodes-. Bull Japan Sea Research Institute, no. 29 : 67-89.

Tsukawaki S, Ozawa H, Domitsu H, Kamiya T, Kato M and Oda M (2000) Preliminary Results from the R. V. Tansei-maru Cruise KT98-17 in the Southwestern Marginal Part of the Japan Sea-Sediments, Benthic and Pranktonic Foraminifers, and Ostracodes-. Bull Japan Sea Research Institute, no. 31 : 89-119.

Tsukawaki S, Ozawa H, Domitsu H, Tanaka Y, Kamiya T, Kato M and Oda M (1999) Preliminary Results from the R. V. Tansei-maru Cruise KT97-15 in the Eastern Marginal Part of the Japan Sea off Tsugaru Peninsula, Northeast Japan -Sediments, Benthic and Pranktonic Foraminifers, and Ostracodes-. Bull Japan Sea Research Institute, no. 30 : 99-140.

Uchida O (1996) The multivariate analysis by EXCEL. Tokyo Tosho, Tokyo, Japan, 206p.6)

Wagner CW (1957) Sur les Ostracodes du Quaternarie recent des Pays-Bas et leur utilisation dans l'etude geologique des depots Holocenes. Mouton & Co., Netherlands, 259p.***

Wang PX, Zhang JJ, Zhao QH, Min QB, Bian YH, Zheng LF, Cheng XR and Chen RH (1988) Foraminifera and Ostracoda in bottom sediments of the East China Sea. Ocean Press, Beijing, China, 438p.**

Wang PX and Zhao Q (1985) Ostracod distribution in bottom sediments of the East China Sea. In Wang PX et al. eds, Marine Micropaleontology of China : 70-92, China Ocean Press, Beijing, China.

Yajima M (1978) Quaternary Ostracoda from Kisarazu near Tokyo. Trans and Proc Palaeont Soc Japan, New Ser, no. 112 : 65-78.

Yajima M (1987) Pleistocene Ostracoda from the Atsumi Peninsula, Central Japan. Trans and Proc Palaeont Soc Japan, New Ser, no. 146 : 49-76.

Yajima M (1988) Preliminary Notes on the Japanese Miocene Ostracoda. In Hanai T, Ikeya N and Ishizaki K eds, Evolutionary Biology of Ostracoda-its Fundamentals and Applications : 1073-1085. Kodansha, Tokyo.

Yajima M (1992) Early Miocene Ostracoda from Mizunami, Central Japan. Bull Mizunami Fossil Museum, no. 19 : 247-267.

Yamaguchi T and Hayashi H (2001) Late Miocene ostracodes from the Kubota Formation, Higashi-Tanagura Group, Northeast Japan, and their implications for bottom environments. Paleontological Research, vol. 5, no. 4 : 241-257.

Yamane K (1998) Recent ostracode assemblages from Hiuchi-nada Bay, Seto Inland Sea of Japan. Bull Ehime Prefectural Science Museum, no. 3 : 19-59. 7)

Zhou B (1995) Recent ostracode fauna in the Pacific off Southwest Japan. Memoir Fac Sci, Kyoto Univ, vol. 57, no. 2 : 21-98.

Zhou B and Ikeya N (1992) Three species of *Krithe* (Crustacea: Ostracoda) from Suruga Bay, central Japan. Trans and Proc Palaeont Soc Japan, New Ser, no. 166 : 1097-1115.

* : in Chinese
** : in Chinese with English abstract
*** : in French
4) : in German
5) : in Italian
6) : in Japanese
7) : in Japanese with English abstract
8) : in Korean with English abstract
9) : in Norwegian
10) : in Russian

田中源吾．2003．西南日本，出雲市，大森層からの中部中新統介形虫群―古日本海の古環境についての示唆―．地球科学，57，111-127.

TANAKA Gengo, 2003. Middle Miocene ostracods from the Omori Formation, Izumo City, Southwest Japan -Its implications for paleoenvironment of the Proto-Japan Sea-. Earth Science (Chikyu Kagaku), 57, 111-127.

要　旨

島根県，出雲市菅沢の大森層より26属42種の介形虫化石を抽出し，2つの介形虫群（*Ambostracon-Argilloecia-Cytheropteron* 群集および *Paijenborchella-Palmoconcha-Urocythereis pohangensis* 群集）を認めた．これらの群集は冷温～温暖な公海の下浅海環境を示唆する．大森層および布志名層からの介形虫化石群の主成分分析は，その堆積環境が上部層準に向かってしだいに深くなっていったことを示唆する．5 新種（*Cytheropteron shimanense*, *Loxoconcha izumoensis*, *Paradoxostoma yakumotatsunus*, *Schizocythere sakanouei* および *Urocythereis sugesawensis*）を記載した．

district	location	age	formation name	literature
1	Hainan Island	l. M-P	(boreholes)	Gou et al., 1981
2	South China Sea	H	(cores)	Cao, 1998
3	Southern Taiwan	P-Q	Maanshan Mudstone	Hu, 1983
4	Northern Taiwan	Q	Toukoshan Fm.	Hu, 1978
"	"	"	Tungshiao Fm.	Hu, 1986
5	Ryukyu islands	P	Shinzato Fm.	Nohara and Tabuki, 1985
"	"	"	Somachi Fm.	Nohara, 1987
"	"	Q	Naha Fm.	Nohara, 1981
"	"	"	Chinen Fm.	Nohara, 1987
"	"	"	Nakoshi Sand	Nohara and Miyagi, 1984
"	Okinawa Trough	l.Q-H	(cores)	Ruan and Hao, 1988
"	Ryukyu islands	R	-	Zhou, 1995
6	East China Sea	"	-	Ishizaki, 1981; Wang and Zhao, 1985; Wang et al., 1988
7	Miyazaki	P	Heki Fm.	Hanai, 1957b
"	Hyuga-nada	R	-	Zhou, 1995
8	Shikoku	P	Ananai Fm.	Ishizaki, 1983
"	Hiuchi-nada	R	-	Yamane, 1998
9	Korean Peninsula	m.M	Yeonil Gr.	Huh and Paik, 1992a, b
"	Ulleung Basin	R	-	Cheong et al., 1986
10	Bihoku district	m.M	Yoshino Fm.	Yajima, 1988
"	Izumo district	"	Omori Fm.	this study
"	off Hagi	R	-	Tsukawaki et al., 2000
"	off Shimane	"	-	Ikeya and Suzuki, 1992
"	off Oki islands	"	-	Tsukawaki et al., 1998
11	Mizunami	m.M	Shukunohora Sandstone	Yajima, 1988
"	Atsumi peninsula	Q	Atsumi Gr.	Yajima, 1987
"	Kumano-nada	R	-	Zhou, 1995
"	off Suruga Bay	"	-	Zhou and Ikeya, 1992
12	Hokuriku district	m.M	Togi Mud Fm.	Yajima, 1988
"	Sado Island	l.P	Sawane Fm.	Hanai, 1957b
"	Hokuriku district	P-Q	Omma Fm.	Ozawa, 1996
"	"	l.Q	Hiradoko Fm.	Kamiya et al., 2001
"	"	H	Takahama Shell Bed	Kamiya and Nakagawa, 1993
"	off Toyama	R	-	Irizuki, 1989a
"	off Sado Island	"	-	Tsukawaki et al., 1999
13	Kanto district	m.M	Kobana Fm.	Irizuki et al., 1998
"	"	m-l.Q	Jizodo, Kamiizumi, Narita, Semata and Yabu Fm.	Yajima, 1978; Ozawa et al., 1995
14	Tohoku district (P)	m.M	Kadonosawa Fm.	Irizuki and Matsubara, 1994
"	"	"	Suenomatsuyama Fm.	Irizuki and Matsubara, 1995
"	"	M	Hatatate Fm.and Moniwa Mb.	Ishizaki, 1966
"	"	l.M	Kubota Fm.	Yamaguchi and Hayashi, 2001
"	"	"	Tsunaki Fm.	Ishizaki et al., 1996
"	Otsuchi Bay	R	-	Zhou, 1995
"	Sendai Bay	"	-	Ikeya and Itoh, 1991
15	Tohoku district (J)	m.M	Kamikoani Fm.	Yajima, 1988
"	"	l.M	Fujikotogawa Fm.	Irizuki, 1994
"	"	P	Sasaoka Fm.	Irizuki, 1989b
"	"	"	Tentokuji Fm.	Irizuki, 1996
"	"	"	Wakimoto Fm.	Ishizaki and Matoba, 1985
"	"	P-Q	Daishaka Fm.	Tabuki, 1986
"	"	"	Hamada Fm.	Hanai and Yamaguchi, 1987
"	off Tsugaru	R	-	Tsukawaki et al., 1999
16	Hokkaido	l.P	Setana Fm.	Hanai, 1957a
"	"	P-Q	Setana Fm.	Hayashi, 1988
"	off West Hokkaido	R	-	Ozawa et al., 1999

Appendix 1. The supplementary data about Fig. 4.
Each district number (1-16) corresponds to those in Fig. 5.
(P) = Pacific side ; (J) = Japan Sea side ; l = Late ; m = Middle ; M = Miocene ; P = Pliocene ; Q = Pleistocene ; H = Holocene ; R = Recent ; Gr = Group ; Fm = Formation ; Mb = Member.

	PC 1	PC 2	PC 3	PC 4
Eigenvalue	6.84	4.81	1.11	0.92
Percentage	42.75	30.04	6.92	5.72
Cumulative Percentage	42.75	72.79	79.71	85.43

Factor loadings	PC 1	PC 2	PC 3	PC 4
SG03	0.13	0.66	0.02	-0.02
SG05	0.08	0.95	-0.01	0.00
SG06	0.09	0.97	-0.01	-0.01
SG07	0.08	0.95	-0.01	-0.01
SG08	0.08	0.97	0.00	0.00
SG09	0.08	0.81	0.03	0.05
A1	0.64	-0.05	-0.29	-0.07
A11	0.89	-0.07	0.21	0.20
A14	0.76	-0.07	0.46	0.35
A15	0.96	-0.07	0.11	0.05
A16	0.93	-0.06	-0.09	-0.17
A17	0.94	-0.06	-0.21	-0.19
A18	0.93	-0.06	-0.21	-0.18
A19	0.84	-0.06	0.35	0.27
A20	0.87	-0.05	-0.22	-0.30
B1	0.10	-0.01	-0.70	0.70

Principal Components	PC 1	PC 2	PC 3	PC 4
Acanthocythereis dunelmensis (Norman, 1865)	0.51	-0.04	-8.62	9.44
Acanthocythereis Tanaka, 2002	1.36	-0.12	0.81	0.85
Acanthocythereis izumoensis Tanaka, 2002	11.22	-0.58	5.53	3.81
Acanthocythereis koreana Huh and Whatley, 1997	90.12	-7.29	-1.88	-8.10
Acanthocythereis sp. 1	0.10	1.33	-0.02	-0.03
Acanthocythereis sp.1 Tanaka et al., 2002	1.34	-0.10	-0.02	-0.19
Acanthocythereis sp.2 Tanaka et al., 2002	1.33	-0.09	-0.84	-1.23
Acanthocythereis tsurugasakensis Tabuki, 1986	0.31	-0.02	-5.31	5.81
Ambostracon cf. *ikeyai* Yajima, 1978	8.94	120.64	-0.61	0.28
Ambtonia shimanensis Tanaka, 2002	8.82	5.34	-1.17	-2.66
Ambtonia takayasui Tanaka, 2002	2.04	0.57	1.73	1.53
Argilloecia cf. *symmetrica* Zhao, 1988	1.37	18.80	0.00	0.21
Argilloecia sp. 3	0.09	1.25	0.02	0.04
Argilloecia sp. 4	0.21	2.49	-0.01	-0.04
Aurila sp.	0.10	1.24	0.01	0.03
Cluthia sp.	0.12	-0.01	-1.99	2.18
Cluthia subjaponica Tanaka, 2002	2.21	5.67	-0.62	-0.66
Cluthia tamayuensis Tanaka, 2002	4.65	-0.36	-1.63	-1.81
Cytheropteron sawanense Hanai, 1957b	1.63	20.78	0.05	0.08
Cytheropteron shimanense Tanaka sp. nov.	2.03	27.70	0.07	0.47
Cytheropteron sp.	4.13	-0.34	-0.17	2.08
Cytheropteron uchioi Hanai, 1957b	1.06	10.70	0.12	-0.14
Falsobuntonia taiwanica Malz, 1982	1.38	-0.10	-0.83	-0.99
Kotoracythere tsukagoshii Tanaka, 2002	44.92	-3.74	-12.49	-8.20
Krithe cf. *antisawanensis* Ishizaki, 1966	2.45	5.79	-0.21	-0.62
Laperousecythere ikeyai Tanaka, 2002	25.56	-1.14	12.81	10.83
Loxoconcha izumoensis Tanaka sp. nov.	0.22	2.37	0.02	-0.04
Loxoconchidea sp. Tanaka et al., 2002	1.40	-0.11	0.00	0.06
Loxoconchidea sp.	0.16	1.40	0.05	0.00
Munseyella cf. *hokkaidoana* (Hanai, 1957a)	0.18	2.43	0.08	0.16
Paijenborchella cf. *tsurugasakensis* Tabuki, 1986	67.30	-3.85	-31.79	-16.79
Palmenella limicola (Norman, 1865)	4.02	-0.34	0.75	0.59
Palmoconcha irizukii Tanaka, 2002	71.29	-2.64	-19.82	-27.23
Paradoxostoma yakumotatsunus Tanaka sp. nov.	0.91	10.42	0.63	1.06
Propontocypris aff. *clara* Zhao, 1988	0.15	0.91	0.05	-0.06
Robertosonites japonicus (Ishizaki, 1966)	4.47	-0.39	-0.87	0.44
Robertsonites reticuliformus (Ishizaki, 1966)	12.12	-1.00	2.78	1.53
Robertsonites yatsukanus Tanaka, 2002	0.70	-0.05	-11.94	13.08
Schizocythere sakanouei Tanaka sp. nov.	1.84	21.88	0.00	-0.23
Sclerochilus sp.	0.34	3.49	0.05	-0.03
Semicytherura aff. *affinis* (Sars, 1925)	0.36	4.20	0.18	0.30
Semicytherura hanaii Ishizaki, 1981	0.62	3.43	-0.23	-0.19
Urocythereis pohangensis Huh and Whatley, 1997	33.59	-2.57	-0.94	1.78
Urocythereis sugesawensis Tanaka sp. nov.	0.41	5.18	0.15	0.30

Appendix 2. Results of the Q-mode principal components analysis.